CCIR ACADEMY

THE CAMBRIDGE FUTURE SCHOLAR

2025 SPRING RESEARCH PROGRAMME

SCIENCE OLYMPIAD
Since 1984 · 40 YEARS
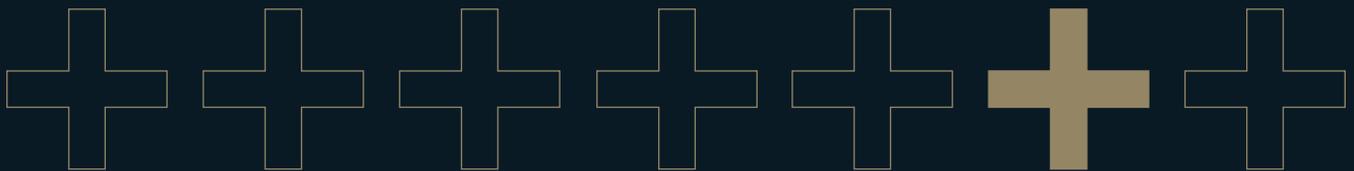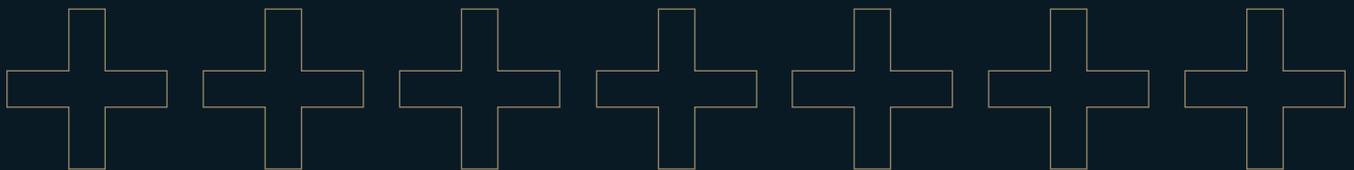
Science Olympiad's
Preferred Student Research
Partner

ADVICE TO CCIR STUDENTS

Dr David Baltimore
President Emeritus, Caltech
Nobel Prize in Medicine '75

Caltech

"I have met many scientists who had a chance to do research before they went to college, and they all point to that as an experience that was seminal in their lives."

–Speaking at CCIR Student Research Symposium 2024

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THE CCIR DIFFERENCE

CCIR is a **research organisation** registered at Cambridge, whose overarching mission is to benefit the public by increasing the accessibility of knowledge.

As an organisation founded by **two Cambridge professors and a group of Oxbridge alumni**, our staff boost strong academic backgrounds and have unique access to the faculty networks at top universities in the US and UK, which allow us to provide the best educational experiences possible for admitted students.

WORLD-CLASS PROFESSORS

We only partner with current teaching faculty members at the University of Cambridge, University of Oxford, and nine top US universities: Harvard, MIT, Yale, Brown, Columbia, UC Berkeley, UPenn, Princeton, and Stanford.

PUBLISHING SUPPORT

Publishing requires know-how. Our expert team will not only help you transition from high school to academic writing, we will also actively assist you in getting your work published at undergraduate or industry level journals and conferences.

CCIR THINK TANK

At CCIR Think Tank, we operate a range of free programmes and regular podcast series on the latest developments in various fields. This grows our faculty network and helps us cultivate a serious academic presence at top universities.

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PROFESSOR-ADMISSION SYSTEM

Instead of admission officers admitting and assigning students, the professors will personally review, sometimes interview, and finally admit each student into their own cohorts. Although this results in cohorts with five students or less, this ensures that our professors are fully invested in each admitted student.

RIGOROUS STANDARDS

Because our faculty members are all leaders in their field, we are committed to maintaining the highest standards in our admissions. This means we are able to pair leading academics with the brightest young minds of today.

LASTING RELATIONSHIPS

Many of our past students at different CCIR programmes have been maintaining close friendships with their peers and mentors even after their programmes ended. Many mentors provide invaluable guideline on their future.

THE CCIR DIFFERENCE

NATURE JOURNAL HIGHLIGHTS CCIR ACADEMY

On the March 2024 issue of *Nature Nanotechnology*, the neuroscience-focused research journal of Nature, published an article by Rachel Lou, a CCIR alumna from Carey Baptist Grammar School in Melbourne, Australia, recounting her experience conducting research with CCIR. Her article is accompanied by a reflection from her professor mentor at CCIR, Professor Landry of UC Berkeley.

At CCIR Academy, Rachel conducted a research project titled "*RNA-based Therapeutics: A Future in Cancer Immunotherapy*," where she examined the latest developments in RNA-based technologies used for COVID-19 vaccines and their vast potential for future cancer treatments. Her paper was later accepted and published in the *Research & Reviews: Medical and Clinical Oncology* journal.

The feature published by *Nature*, one of the most prestigious and influential academic journals, speaks volumes about the quality and rigor of CCIR Academy's programmes. Read below an excerpt from Rachel's *Nature* article:

I searched for research programmes that would allow me to extend myself and dive into this field. I found the Cambridge Centre for International Research (CCIR). CCIR is a research organization that provide rigorous online research programmes for talented students around the world working with leading researchers and professors from top US and UK universities to each produce an independent research paper that showcases academic passion and commitment.

After a rigorous application process, I conducted an online interview with an academic coordinator and the recordings were sent to prospective mentors. I was accepted by Professor Landry, an Associate Professor at the University of California, Berkley. Professor Landry was everything I hoped for in a mentor: kind and encouraging, introducing and guiding me along the path of her specialty....

...I am incredibly grateful for the opportunity and knowledge I have gained from CCIR and Professor Landry. I am fortunate to have met a mentor who cultivated my curiosity and love for science, guiding my inspiration towards a path in research. I hope other researchers will be inspired to get involved in mentoring and guiding future scientists, helping them to make their own mark in the world of scientific research.

nature

The potential for academics to inspire the next generation

Rachel Lou

Programmes to inspire the next generation of researchers can have a huge impact, as Rachel Lou explains in the recounting of her own experience.

As a young girl I was inspired by the novel *Sadako and the Thousand Paper Cranes* where a young Japanese girl diagnosed with leu-

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Professor Markita del Carpio Landry's reflections on her experiences mentoring as part of the CCIR programme

"I became a mentor with the Cambridge Centre for International Research based on my own experiences, interacting with teachers and scientists who became mentors, which greatly influenced my decision to pursue science as a career. I've found it tremendously gratifying to rework my course and publication materials for the CCIR programme, as this is highly relevant to science communication. Mentoring exceptional and bright high school students like Rachel can easily be the highlight of my week. I always value the fresh perspective that students like Rachel bring." Professor Markita del Carpio Landry, University of California, Berkeley

CCIR STUDENT RESEARCH SYMPOSIUM

WITH NOBEL LAUREATES AT THE UNIVERSITY OF CAMBRIDGE

Every year, a select number of CCIR's students have the opportunity to present their research findings on the campus of Cambridge, to showcase their work and their achievements (in-person or virtual; at no additional cost to the invited presenters).

For the 2024 Symposium, 10 Nobel laureates have attended and interacted with CCIR student presenters over two days.

The annual CCIR Symposium is open to apply for all current and past CCIR students, regardless of the status of their research. Participants must submit a 200 to 400 word fully polished abstract. A most recent draft of the paper is also encouraged, but not required for the submission.

The 2025 CCIR Student Research Symposium will return again in July 2025 with Nobel laureate Dr Thomas Cech attending in person.

Dr David Baltimore
President Emeritus, Caltech
Dr William Daniel Phillips
Distinguished Professor, University of Maryland
Dr Thomas Cech
Distinguished Professor, University of Colorado
Sir Richard Roberts
Chief Scientific Officer, New England Biolabs
Dr Aaron Ciechanover
Distinguished Research Professor, Israel Institute of Technology
Dr Robert Lefkowitz
The Chancellor's Distinguished Professor of Medicine, Duke University
Dr Joachim Frank
Professor, Columbia University
Dr Barry C. Barish
Professor of Physics, Emeritus, Caltech
Dr Harvey J. Alter
Fmr. Chief of the Infectious Disease Section, National Institutes of Health
Dr Ardem Patapoutian
Professor, Scripps Research

CCIR LAB AT MIT

CONDUCTING IN-PERSON RESEARCH ON MIT CAMPUS

Starting in Spring 2025, current and future CCIR student researchers from both the Future Scholar Programme and the 1-on-1 Research Mentorship Programme will be able to conduct their own research and experiments, taking advantage of the lab's state-of-the-art facilities on the campus of MIT.

The lab access comes at **no additional fees** for CCIR student researchers as part of the programmes. Depending on the research, certain additional material costs incurred may need to be covered by the CCIR student researchers.
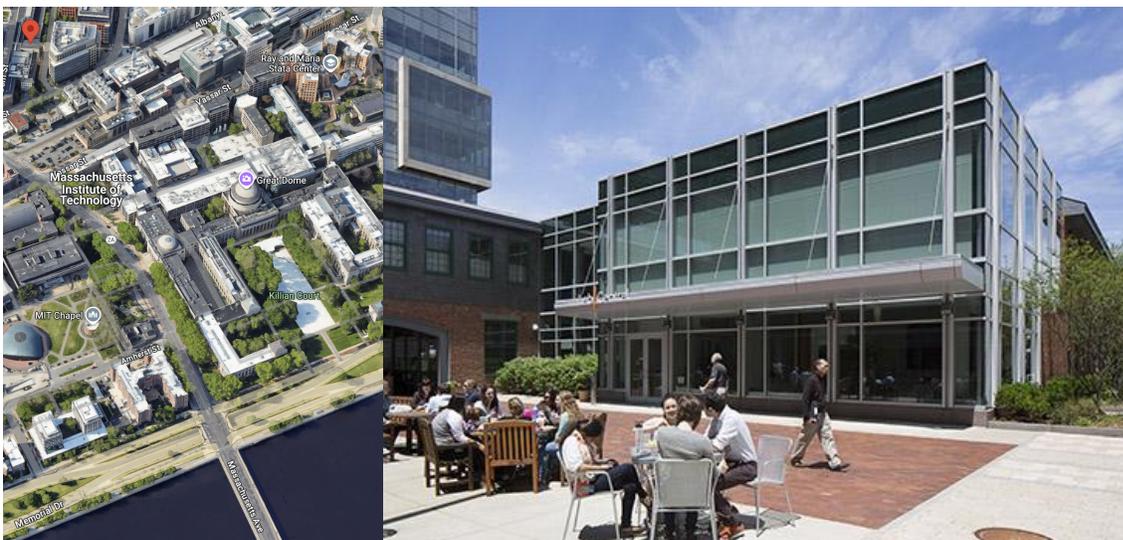
OPEN TO ALL CCIR STUDENTS, FROM STEM TO HUMANITIES

Students interested in exploring STEM concepts without the need for a lab environment are encouraged to select from a list of pre-approved experiments in the lab. These experiments provide an opportunity to delve deeper into STEM subjects and maybe spark new research passions.

EXPERT GUIDANCE

Students are welcomed to work on pre-approved projects, but if they wish to pursue their own projects, the academic team will collaborate with them to obtain approval from the Boston regulatory authorities and procure the necessary materials. CCIR's PhD level lab managers will also be on site to supervise each student researcher's project.

After enrollment, CCIR student researchers can reserve the CCIR Lab at MIT by submitting the Lab Access and Experiment Approval Form.

OUR EXCEPTIONAL ALUMNI

The rise of test-optional admissions has meant a fundamental shift in the US and global university admissions alike. Successful alumni of CCIR have found ways to effectively set themselves apart from other applicants academically.

PUBLICATIONS AT JOURNALS AND CONFERENCES

Doing and publishing research—even just at the undergraduate level—has become an emerging trend in undergraduate admissions.

Our majority high school level student body has obtained incredible success at publishing at many prestigious undergraduate, graduate, and even professional conferences and journals.

US UNIVERSITY ADMISSION RESULTS

Spring 2020 - Fall 2023 CCIR Alumni (US-bound)

With a large percentage intended to apply for top universities in the US, CCIR alumni in the past years, packed with rigouous research experience and academic passion, enjoyed stellar admission results in the ever-changing admissions race.

30.8%
of US-bound CCIR Alumni currently in
Ivy Leagues/Stanford/MIT

75%
of US-applying CCIR Alumni currently in
Top 30 US Universities

92.4%
of US-applying CCIR Alumni currently in
Top 50 US Universities

GLOBAL UNIVERSITY ADMISSION RESULTS

Spring 2020 - Spring 2023 CCIR Alumni (all)

When looking at the global alumni body, including alumni currently in the UK, CCIR alumni achieved equally amazing results applying to top universities around the world.

60.3%
of All CCIR Alumni currently in
Global Top 50 Universities

30.7%
of UK-bound Alumni currently in
Cambridge/Oxford

80%
of UK-bound Alumni currently in
Russell Group Universities

*US university ranking are based on **2023 US News National Universities Ranking** and **2023 US News Global University Rankings**. The sample covered CCIR Alumni attended Spring 2020 until Spring 2023 cohorts. US admission statistics covered students with college destinations in the US only. Data gathered from students' self-reporting or any publicly available admission results.

CHOOSING YOUR CCIR PROGRAMME

		Cambridge Future Scholar	1-on-1 Research Mentorship
Programme Overview		Choose from over 80 research courses mirroring freshmen-level courses from top universities in small 2 to 5 students group.	One student, One mentor, One project. Each mentorship is tailored to the specific needs and interests of each individual student.
Professor Mentors		Current faculty members at Ivy League, Oxbridge, and other top-tier universities with vast research and teaching experience.	
Teaching Assistants		PhD candidates that are closer to students' age to provide support	N/A
Admissions	**Application Form**	**Required** • Personal and academic information • Transcript/report card for the most recent academic year • Personal Statement (no more than 500 words) ***Optional*** Standardised testing reports | CV/Resume | Writing Sample | Other supplementary materials	
	Academic Interview	Successful applicants will be invited to a 20 to 30 minutes interview with the a CCIR Academic Advisor (a PHD candidate in the same field) as part of the application for the research course's professors' final review.	
	Professor Introductory Meeting	N/A* *Professor will review applications and interview recordings.	The students and their mentors will get to know each other and finalise the direction of the student's research project. The professor will make the final admission decision after the meeting.
Students admitted through the Professor-Admission System: Each professor will receive all application materials and interview recordings of shortlisted students, before making final admission decisions.			
Programme	**Structure**	2 to 5 students (Oxbridge style small group mentorship)	One professor and one student throughout.
	Professor Sessions	**13 one-hour weekly sessions.** *Week 1 to 7: Foundation* *Week 8 to 13: Research*	**14 one-hour sessions** (flexible scheduling and meeting frequency) *Professor develops a custom curriculum for the student.*
	TA Sessions	**13 one-hour weekly sessions.**	N/A
	Office Hours	Additional weekly one-on-one office hours (30 minutes) with professor/TA upon availability	
	Academic Support	• Unlimited Academics Team support to assist research, writing, journal publication, and journal submission guidance (by the mentor and Journal Publishing Team) • Writing Centre and Ethics Review Committee • Literature Request portal with access of journals, papers, and e-books for free • Assigned Academic Coordinator to support each student • Access to all session recordings permanently	
After the Programme	**Outcome**	• 4,000 to 10,000 word independent research paper • An option to request a Letter of Recommendation written and signed by the mentor • CCIR Certificate • An Academic Evaluation Report written and signed by the mentor	
	After Programme Support	• Letter of Recommendation delivery to universities' Admission Offices via the mentor's university email • Invitation to join CCIR's global alumni network • Continous access to Literature Request portal and academic journal submission guidance (with the mentor and Journal Publishing Team) until successful paper publication	

PROGRAMME OVERVIEW

ADVICE TO CCIR STUDENTS

Dr Harvey J. Alter

Fmr. Chief of the Infectious
Disease Section, NIH (USA)

Nobel Prize in Medicine 20'

**NIH** National Institutes
of Health

"You need to find a mentor, someone who
is interested in fostering your career.
Make them proud of you. Work hard, and
hopefully publish something."

*–Speaking at CCIR Student
Research Symposium 2024*

*"This course was absolutely wonderful and I am so glad that I was able to
take it. I enjoyed all of the classes as well as the research I got to do, and
I think that it was brilliantly taught and facilitated. I learned a great
deal and would highly recommend this course."*

--- Audrey (Emerald Hills, USA)
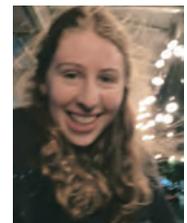
OVERVIEW

+ 13 weeks, 2 interaction hours per week (not including office hours)
+ Foster lasting relationship with leading world-class academics
+ Academic journal publication guidance
+ Experience a first year course at top universities
+ Develop a unique research project
+ Intimate class size (Faculty ratio of 1:2)

The Cambridge Future Scholar programme is a **highly-selective online research programme** designed and taught by top university faculty for gifted high school students around the world. In this programme, students will be able to explore and deepen their academic interests in one of the many exciting courses we offer (see Course Catalogue).

+ As with all CCIR programmes, we partner exclusively with **current teaching faculty members** at top US/UK/EU universities including University of Cambridge, University of Oxford, Harvard, MIT, Columbia, Princeton, UPenn, Brown, UC Berkeley, Yale, Stanford, and more.

+ Our faculty design their courses to suit the needs and interests of **advanced high school students**, providing lectures and supervision, and teaching them the skills and knowledge that are required for doing high-level independent research.

+ Each Future Scholar course mirrors **one semester's worth of material** at the top univesity each professor is from, based on the undergraduate syllabus, with a strong emphasis on students delivering an outstanding **research paper** under the supervision of world-class faculty.

The result is a truly enriching and engaging research-oriented academic experience.

LEARNING OUTCOMES

During the course, the mentors will take the students along in a deep dive of the topic they are focused on. Through this time, students are expected to actively engage, discuss, conduct research, so that they may ultimately produce a research paper.

Ultimately, the student's learning experience will culminate in a **research project**.

In most cases, the research project will take the format of a **4,000 to 10,000 word** research paper intended either for **publication in academic journals**, or for submission in non-academic publications and competitions. For students interested in publication and submission, our Academic Team and mentors will together be able to provide the expertise needed to guide them through the process.

As noted, however, the format of the final project is itself customizable. In the past, we have had students who, instead of writing a research paper, produced creative final research projects, such as art portfolios, creative writing pieces, and films.

By the end of our programme, our students will have:

+ **AN INDEPENDENT RESEARCH PROJECT**, supervised by a current teaching faculty at Oxbridge and nine top universities in the US.

+ **A LETTER OF RECOMMENDATION** penned by world-class faculty at your request.

+ **A SEMESTER'S WORTH OF RESEARCH SUPERVISION** and lecturing from world-class faculty members.

+ **JOURNAL PUBLICATION GUIDANCE** when opting to submit your final paper to publication journals, with support from your mentor and Academic Team.

+ **A SIGNED EVALUATION REPORT** from your mentor, issued by the programme.

COURSE STRUCTURE

+ 13 Weeks Course Length
+ 2 to 5 Students in each class
+ 1:2 Average faculty* to student ratio
  *Mentor and teaching assistant

+ 4 Hours Weekly hours students expected to invest in the course (including attending classes, office hours, researching, and writing)

Each of our 13-week courses is divided into Lecture Weeks and Research Weeks:

LECTURE WEEKS (1-7)

+ Taught by Mentors, the weekly lectures are based on first-year level syllabus at the top university each professor is from.

+ Together with the Mentor and TA, students cover the course material intensively, so as to lay the groundwork for their own research into the subject.

• **One hour lecture** each week by Mentor

• **One hour TA session** each week with Teaching Assistant

• **30-minute Office Hour** per request

RESEARCH WEEKS (8-13)

+ Here the focus is for students to become familiar with research methodology and gain hands-on research experience.

+ By attending supervisions and writing sessions, students will construct, edit, and perfect their research paper to the most rigorous academic standard.

• **One hour lecture** each week by Mentor

• **One hour TA session** each week with Teaching Assistant

• **30-minute Office Hour** per request

For summer round, enrolled students can vote for a compressed 10-week schedule with the same contacting hours.

COURSE MODULES

Each course includes five modules that help students build up background knowledge and research skills:

LECTURES

Taught by world-class current teaching faculty members who have taught the same or similar university courses, our lectures allow students to experience a real and undiscounted top university education.

TEACHING ASSISTANT SESSIONS

Led by our TAs, who are PhD candidates of the same field at top universities, the weekly writing sessions help students frame their arguments, polish their language, as well as analyze the structure of their papers and recieve constructive critique.

SUPERVISIONS

Praised as "Cambridge's greatest strength," the five-century old supervision system will engage students to intensively discuss, explore, and reflect their ideas with their lecturer in a close and intellectual setting.

1-ON-1 OFFICE HOURS

The one-on-one approach allows students to develop personal relationships with their mentors and guarantees that each student can receive the attention needed to develop a deep grasp of the material.

RESEARCH AND METHODOLOGY SESSION

During this session, student will study different aspects of academic research that can apply to their research papers. Topics may cover how to structure a paper, literature review, citation styles, data analysis, etc.
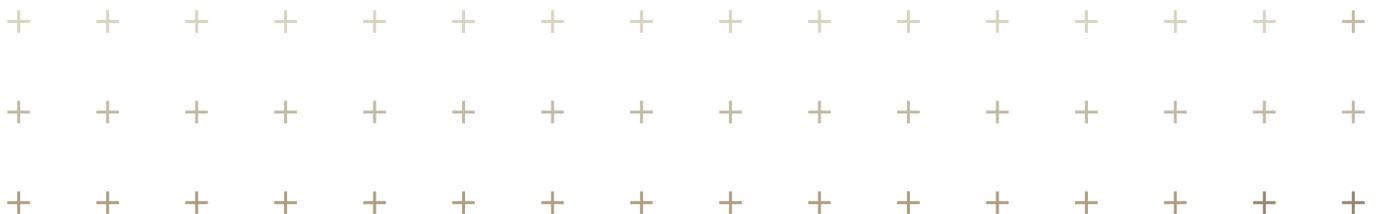
RESEARCH COURSE CATALOGUE

ADVICE TO CCIR STUDENTS

Dr Aaron Ciechanover

Distinguished Research Professor,
Israel Institute of Technology
Nobel Prize in Chemistry '04

Technion
Israel Institute of Technology

"We are not in a school. We are in a university. We are in research. In research, you are discovering. We are not transmitting already knew knowledge."

–Speaking at CCIR Student Research Symposium 2024
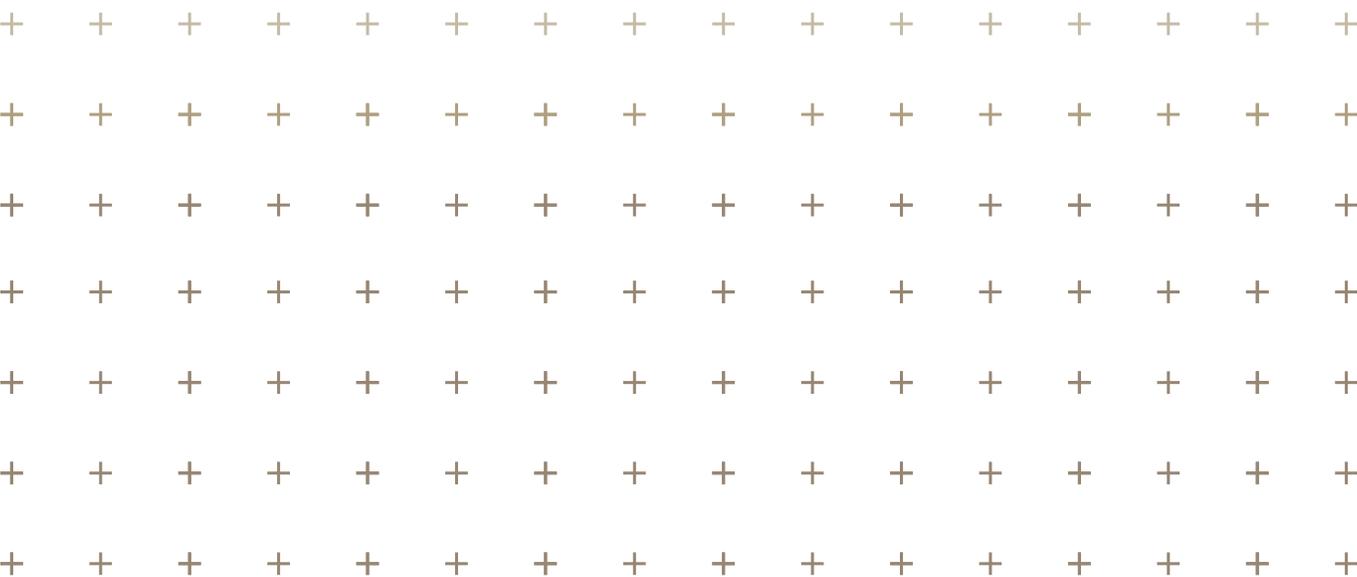
Biology, Bioinformatics, Genetics, Medicine, Biomedical and Life Sciences

Developmental Biology: Gene Editing, Stem Cells, Model Organisms, and Epigenetics

Dr Hakan Coskun
Harvard (Harvard Medical School), Department of Cardiology

In this research course, we will talk about the principles of developmental biology and stem cell biology, study organ development (such as the heart), and discuss genome engineering using the CRISPR-Cas9 (a novel genetic modification tool). The objective of the research course is to encourage students to think creatively about how a cell develops an organism, how we can study them experimentally, how we can edit genes, and how we can use animal models to analyse in vivo data.

Advanced Cell and Developmental Biology

Dr Mamiko Yajima
Brown, BioMed MCB Department

In this research course, each student is tasked to read, digest, and present assigned peer-reviewed research articles in the field of Cell and Developmental Biology, which is the science that investigates how interacting processes generate an organism's heterogeneous shapes, size, and structural features that arise on the trajectory throughout a life cycle. Topics of interest include asymmetric cell division, cell signalling and metabolism, cellular specification and differentiation, mRNA translation, embryonic development, germ cell and stem cell development, and cancer regulation.

Regenerative Neurobiology and Gene Therapy

Dr Bart Nieuwenhuis
Cambridge, Cambridge Institute for Medical Research

Injury to the brain and spinal cord has devastating consequences as adult neurons in the central nervous system do not repair their nerve fibres. This research course covers the cellular and molecular biology of the nervous system and has a particular focus on the regrowth of nerve fibres after an acute injury – a process called axon regeneration. The independent research project will enable students to gain hands-on experience in the analysis of real experimental data from fluorescence microscopy of neurons and the presentation of scientific results.

Molecular Building Plans for the Cell: How to Build Cellular Structures using Biochemical Approaches

Dr Jodi Kraus
Princeton, Department of Molecular Biology

In this course, students will receive a comprehensive introduction to the fascinating world of protein biochemistry. We will span several decades of technological advancements including the polymerase chain reaction (PCR), recombinant protein expression technologies, CRISPR/Cas9 gene editing, and advances in optical microscopy approaches. We will combine fundamental concepts in molecular biology and biochemistry with the seminal literature in the field that has led to major scientific breakthroughs and altered the way textbooks are written. Students will explore protein-based machines through independent research projects using basic molecular biology and biochemical techniques (if available) and/or computational AI-based tools.

Computational Genetics: Data Science, Biology, and Medicine

Dr Struan Murray
Oxford, Department of Biochemistry

In this research course, we will explore genetics utilising computational and data scientific techniques. By analysing the vast quantities of data using these cutting-edge techniques, students will learn how to observe and analyze molecular events across the genomes of biological systems.
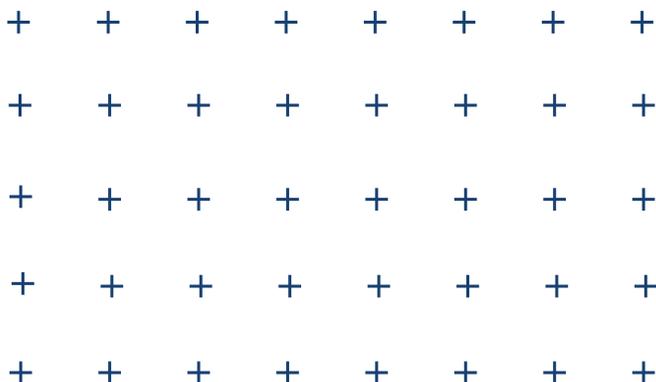
Computational Genetics and Drug Discovery: Combatting Infectious Diseases

Dr Ashraf Zarkan
Cambridge, Department of Genetics

In this research course, students will learn about the role of genetics in understanding and combatting infectious diseases, while developing skills relevant in modern computational analyses, known as bioinformatics, which will open the door for understanding infection mechanisms at the gene and protein levels.

Molecular Epidemiology: Emergence, Evolution and Spread of Pathogens

Dr Marta Matuszewska
Cambridge, Department of Medicine

Pandemics are a major threat to public health and can have severe consequences for global economies, making it important to study the factors that drive their emergence and spread. This research course will delve into the fascinating and complex world of infectious diseases from a genetic perspective. It will focus on the use of whole-genome genetic data to better understand the molecular mechanisms underlying the spread and evolution of pathogens that cause infectious diseases.

Cancer Bioinformatics: Mining the 'Big Data'

Dr Begüm Akman-Tuncer
Cambridge, Department of Pharmacology

In this course, we will learn the basic principles of cancer biology and how to use different bioinformatics tools to analyse health data. We will discuss the hallmarks of cancer to better understand how we can interpret the results we can discover from the data-mining exercises. We will explore large-scale biological data using different bioinformatics tools and platforms. These findings will allow students to uncover genes that can have a potential role as biomarkers or that have therapeutic applications.

Precision Medicine and Bioinformatics: Genomics-based Personalized Treatment

Dr Begüm Akman-Tuncer
Cambridge, Department of Pharmacology

In this course, we will learn the basic principles of genomics and molecular profiling approaches used to analyse an individual's genetic information. We will also engage in hands-on research by utilising bioinformatics tools to identify biomarkers—specific indicators associated with particular diseases or treatment responses. As precision medicine involves integrating data from various omics sources, such as genomics, transcriptomics, proteomics, and metabolomics, we will use bioinformatics tools to explore and integrate multi-dimensional data, offering a more comprehensive view of biological processes. The potential role of artificial intelligence, machine learning and other innovative approaches in shaping the future of precision medicine will also be discussed.

Frontiers in Cancer Research: Exploring Metabolomics Applications

Dr Naama Kanarek
Harvard (Harvard Medical School), Kanarek Lab, Department of Pathology

In this research course, students will embark on a research journey into the dynamic realm of cancer research, with a particular focus on metabolomics application. As the landscape of cancer investigation continues to evolve, yielding an abundance of new insights, the course offers an exploration of cutting-edge knowledge in cancer research. By conducting their independent research project, students will gain an understanding of the interplay between metabolism and cancer, along with the skills to contribute to the forefront of cancer research.

Emerging Topics in Engineering Biotechnology:
From CRISPR to Cloning

Dr Markita P. Landry
UC Berkeley, Landry Lab, Department of Chemical and Biomolecular Engineering

This research course will cover emerging topics in applied biotechnology – from CRISPR to cloning. We will learn the fundamental principles of DNA, RNA, and protein biochemistry and think about how analogous techniques to study and analyse these systems have emerged. Next, we will discuss the development of CRISPR-based genome editing applications. The scope of the research course will allow students to probe the cutting-edge interface of biology with engineering.

Decoding Life: DNA Sequencing and Cancer Diagnostics

Dr Maria Neofytou
Cambridge, Cancer Research UK Cambridge Institute

This research course aims to explain how genetic variations in our genome affect our phenotype and how genetic variations lead to single gene and complex diseases such as cancer. Most importantly we will explore modern cancer diagnostics and novel methods for early cancer detection and how clinicians nowadays use patients' DNA to target and treat cancer – offering a new approach to personalised treatment.

Molecular Biology and Drug Discovery

Dr Cigdem Sahin
Harvard, Joslin Diabetes Center

Throughout the research course, students will explore cutting-edge strategies and technologies used in drug discovery with a focus on metabolism-targeting therapeutics. The rapidly advancing field of drug development offers various approaches, including novel drug design, high-throughput screening methods, and precision medicine techniques. By exposing students to these state-of-the-art methodologies, the course aims to equip them with the knowledge and skills necessary to engage in contemporary research efforts and contribute to the development of next-generation drugs aimed at combating metabolic diseases.

Exploring Life Through Modern Imaging Techniques

Dr Adeeba Fathima Valiya Thodiyil
Cambridge, Biomineral Research Lab

Biological imaging methods serve as indispensable tools for illuminating the dynamics of biological systems, offering insights into their inner workings at the cellular and molecular levels. This research course acts as a gateway into the realm of bio-image processing techniques, empowering students with the necessary knowledge and skills to dissect, analyse, and interpret biological images with precision and efficacy. The aim of the course is to cultivate both a theoretical and practical understanding of image processing methods meticulously tailored to meet the unique challenges posed by biological data.

Regenerative Medicine: Stem Cells, Biomaterials, Tissue Engineering

Dr Birol Ay
Harvard / Massachusetts General Hospital

Regenerative medicine, using biologically compatible materials (biomaterials) and stem cells, aims to restore the functions of damaged organs or tissues. We will examine the basics of stem cell biology, explore different types of biomaterials, discuss current tissue engineering strategies and commercially available tissue engineering products. Ultimately, students will each conduct a research project in which students can develop their own hypothetical tissue engineering strategies to restore a type of tissue of their own choosing.
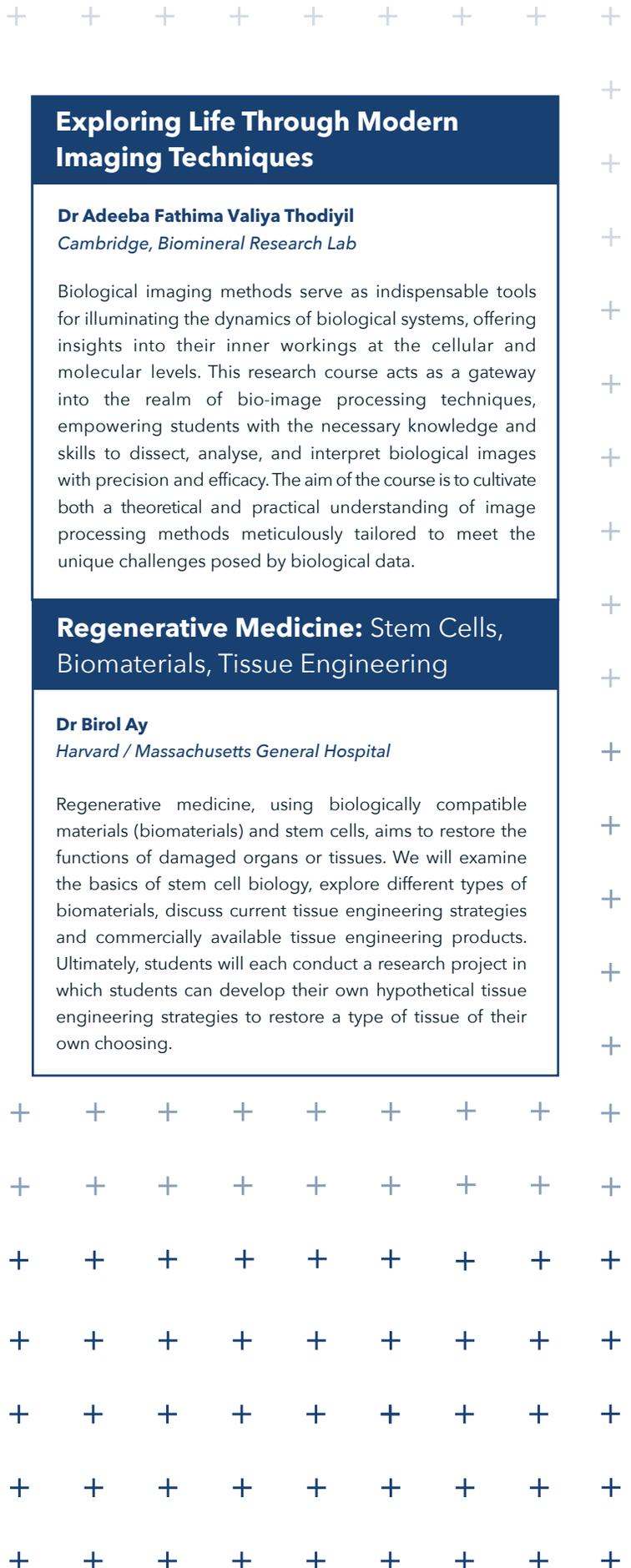
The Future of Medicine:
Combating Antimicrobial Resistance Through Bacterial Genomics

Dr Ibrahim Xiaoliang Ba
Cambridge, Department of Veterinary Medicine

This course offers an introduction to bacterial genomics within the context of the pressing global concern–antimicrobial resistance (AMR). Students delve into resistance genes, horizontal gene transfer, and cutting-edge DNA sequencing techniques, gaining practical skills in bioinformatics for AMR surveillance. The course goes beyond theoretical understanding, exploring strategies to combat AMR, including responsible antibiotic use, alternative therapies, and global initiatives. Emphasis is placed on hands-on exercises, discussions, and collaborative projects that empower students to analyse real-world genomic data and propose solutions to address AMR challenges.

Analytical Chemistry and Cutting-Edge Biotechnologies:
From CRISPR to Biomarker Detection

Dr Dongxia Wang
Princeton, Molecular Biology Department

Analytical chemistry plays a crucial role in modern science, particularly in areas such as disease biomarker detection, biosensor development, and gene-editing technologies. In this research course, students will explore the fundamental concepts of disease biomarkers and their applications in disease diagnosis, delving into how chemical analysis techniques achieve high sensitivity and specificity in detection. The research course also focuses on the principles and design of biosensors, including the integration of nanomaterials and chemical modification techniques to enhance sensing performance.

Neuroscience, Cognitive Science , and Psychology

Neuroscience: From Understanding the Neuron to Treating Brain Disorders

Dr Alejandro Carnicer-Lombarte
Cambridge, Department of Engineering

Our brain controls how we perceive our surroundings and how we interact with them, how we feel, and who we are. In this research course, we will explore how the brain and nervous system function with a particular attention to its core building block – the neuron. We will also explore how technology can be utilised to better understand and treat the brain.

Neuroscience and Neurotechnology:
Understanding and Enhancing the Human Mind

Dr Amparo Güemes
Cambridge/Johns Hopkins, Bioelectronics Laboratory

Neuroscience and Neurotechnology are crucial research area that provide us with a better understanding of the intricacies of the human brain. This knowledge serves as the foundation for developing treatments for brain disorders, ultimately improving the quality of life for countless individuals. The objective of this research course is to invite the students to study neuroscience and neuroanatomy, and to understand the state-of-the-art technology being used to interface with the nervous system.

The Neuropsychology of Emotions: From Psychology, Psychiatry, and Psychopharmacology

Dr Anne Kever

University of Toronto, Keenan Research Centre for Biomedical Sciences / St Michael's Hospital

This research course offers an engaging introduction to psychology's fundamental concepts and principles. Students will be provided with an overview of the scientific study of human behaviour and thought by exploring topics such as perception, attention, memory, motivation, and decision-making. Particular focus is placed on the emotions. We will discuss the evolutionary origins of distinct emotions, as well as the impact of emotions on our cognitive processes and social relationships. Students will also be trained to discuss and present on research data and clinical experiences to enhance their understanding.

Cognitive Psychology: The Building Blocks of Human Intelligence

Dr Jelena Sučević

Oxford, Department of Experimental Psychology

This research course will examine the building blocks of human intelligence through the lenses of cognitive psychology. We will explore the fundamental cognitive processes such as attention, memory, and learning. We will then examine how these core abilities give rise to more complex processes such as decision making, problem solving and abstract thinking, and ultimately to what we consider intelligent behaviour. The overall aim of the course is to provide students with a thorough understanding of the key topics in cognitive psychology, to provide a space to integrate theoretical and experimental knowledge, and equip students with a thorough understanding of the tools and approaches used to study cognition.

Advanced Neuroscience: Physiology of the Blood-Brain Barrier

Dr Deniz Altunsu Kurt

Harvard (Harvard Medical School) / Beth Israel Deaconess Medical Center, Boston

The blood-brain barrier is a major field in neuroscience, because it protects the brain from harmful substances in the blood while allowing essential nutrients to pass through. In this research course, we will grasp the essential concepts in cellular and molecular medicine, neuroscience, and genetics, specifically focusing on the blood-brain barrier (BBB) and its critical role in brain function.

Introduction to Stem Cell Biology and Regenerative Medicine

Dr Deniz Altunsu Kurt

Harvard (Harvard Medical School) / Beth Israel Deaconess Medical Center, Boston

This research course offers a comprehensive introduction to the foundational principles of stem cell biology and the emerging and transformative field of regenerative medicine. It is designed for students seeking to understand the dynamic role of stem cells in both biological research and clinical applications. This foundation will equip students with the knowledge needed to pursue further studies or a career in stem cell science and regenerative medicine, fostering their contribution to one of the most promising and rapidly evolving areas of modern biology.

Brain, Psychology, and Optometry: How We Perceive the World Through Visual Perception

Dr Mengxin Wang

Oxford, Department of Experimental Psychology

Our visual sense is one of the most important means of gathering information about the surrounding physical world. In this research course, we will examine the core topics in visual perception, which form a major part in experimental psychology, cognitive science, and optometry. Students will obtain a foundational understanding of the principles, theories, and processes involved in visual perception, spanning from the basic functions of the eye to the complexities of visual cognition.

Understanding and Preventing Dementia: Alzheimer's, Parkinson's, and More

Dr Anna Jane Dreyer

Cambridge, Department of Clinical Neurosciences

Many of us will be personally affected by dementia by either getting dementia ourselves or caring for someone with dementia. The research course will introduce students to dementia and dementia research. We will cover different types of dementias, including Alzheimer's, Vascular dementia, frontotemporal dementia, Parkinson's, and HIV-associated brain injury, and more. Through them we will gain an understanding of how brain diseases influence cognition, emotion, and behaviour. We will also study dementia prevention, in which we will look at evidences of how our own lifestyle choice could affect getting dementia.

The Neuroscience of Decision Making: Linking Brain and Behavior

Dr Alireza Soltani
Dartmouth, Computational and Cognitive Neuroscience Lab, Department of Psychological and Brain Sciences

In this research course, we will examine decision making from both behavioural and neurobiological points of view. Specifically, we will learn about different methods used in psychology and neuroscience to study decision making at various levels, from mental and cognitive processes to underpinning neural activity and mechanisms. Ultimately, this research course will alter students' perspectives on decision-making by imparting knowledge of brain function.

Neuroeconomics: Multidisciplinary Science of Decision Making

Dr Alireza Soltani
Dartmouth, Computational and Cognitive Neuroscience Lab, Department of Psychological and Brain Sciences

Neuroeconomics is a new emerging field in which a combination of methods from neuroscience, psychology, and economics is used to better understand how we make decisions. Neuroeconomics uses various cutting edge techniques to study how the brain integrates information from various sources. In this research course, we learn about economic and psychological theories that are used to investigate and understand choice behaviour, as well as mental and neural processes that underlie decision-making.

Cognitive Neuroscience of Learning and Decision-Making: A Computational Approach

Dr Ali Mahmoodi
Oxford, Department of Experimental Psychology

This research course delves into the fascinating realm of how the human brain supports learning and decision-making processes, drawing insights from computational neuroscience. Throughout the course, we will explore fundamental concepts such as reinforcement learning and Bayesian decision theory, unravelling the intricate mechanisms that underlie our cognitive abilities. By synthesising insights from neuroscience, psychology, and computer science, students will develop a holistic understanding of human learning and decision-making processes. In summary, this course offers a multidisciplinary perspective that will deepen students' understanding of the complex interplay between the brain, behaviour, and computational principles.

The Behavioural Neuroscience of Emotion and Motivation

Dr David Belin
Cambridge, Department of Psychology

Motivation and emotion are critical functions of the brain, allowing individuals to enhance their likelihood of survival and passing on their genes. In this research course, we will aim to provide a foundation of research, theory and practical skills acting as a primer for the student interested in the psychological and neural basis of emotion, motivated behaviours and the mechanisms of abnormal emotion and motivation.

Disorders of the Central Nervous System: Pharmacology and Drug Treatment for Strokes, Anxiety, and Epilepsy

Dr David Belin
Cambridge, Department of Psychology

In this research course, we will explore foundational research, theory and practical skills related to molecular and systems pharmacology of central nervous system disorders. The course will provide the students with a solid background in cellular and molecular neuroscience, neuro-pharmacology and behavioural neuroscience that will then be used to discuss the neuropsychopharmacology of neuropsychiatric disorders. The aim of this research course is to provide an understanding of the chemical pathology of the major central nervous system diseases/disorders, and how these conditions are treated with drugs.

Parkinson's Disease (PD): From Pathogenesis to Intervention

Dr Ulf Dettmer
Harvard (Harvard Medical School), Dettmer Lab, Department of Neurology

In this research course, students will deepen their under-standing of brain anatomy, brain biology and the degenera-tion that occurs in Parkinson's disease and causes the hallmarks of PD. Potential intervention strategies will be evaluated. The importance of biomarkers for diagnosis and drug development will be discussed, and potential biomarker strategies will be highlighted. The goal is to outline novel strategies towards (early) diagnosis and treatment of PD, and this may include the combination of different approaches.

Robotics, Engineering, Biotechnology

Spacecraft Engineering

Dr Hannah Rana
Harvard, Center for Astrophysics / NASA Jet Propulsion Laboratory (JPL)

In this research course, students will generate a scientific exploration case, develop the mission concept, as well as design and investigate custom subsystems of a spacecraft, such as structures, thermal, power, attitude and orbit and propulsion. Students will study celestial mechanics/astrodynamics in order to determine the most suitable orbits in space and how this affects key engineering considerations. This course is well suited to students with an interest across space research, astronomy, aerospace engineering, and mechanical engineering.

Sustainable Aerospace Engineering, Aerodynamics, and Thermofluids

Dr Nafiz Chowdhury
Oxford, Department of Engineering Science
This research course provides a comprehensive exploration of the essential engineering principles of thermofluids, aerodynamics, and experimental design, equipping students with the theoretical knowledge and practical skills needed to address challenges in aerospace, energy, and sustainable technologies. Students will be prepared to apply these skills to innovate and create solutions for achieving sustainability and net-zero objectives in the industries of aerospace, sustainable energy, industrial systems, and beyond.

DNA Nanotechnology: Design and Function of Smart Nano-Constructs

Dr Rafael Carrascosa Marzo
UCL

DNA molecules have particular chemical and physical properties that can be applied to solve tasks that go beyond the scope of their function in nature. In this research course, we will explore first DNA's functional characteristics and how can they be used to produce complex architectures at the nanoscale that can then perform customised tasks for a wide range of applications – from biomedicine to the manufacturing industry, including data storage and complex chemical production.

Bio-Inspired Robotics: Machine Learning, Design, and Control

Dr Thomas George Thuruthel
UCL, Department of Computer Science

Biorobotics is a cutting-edge interdisciplinary science at the intersection of biology, biomedical engineering, computer science and robotics. It studies ways to improve the intelligence, locomotion, and other performances of robotic systems inspired by nature. In this research course, students will be introduced to novel bio-inspired ideas that have revolutionised modern day robotics, particularly in the field of soft-robotics. The course delves into the principles and methods behind the design of physically compliant robots. Students will learn the programming language MATLAB and develop their independent research projects on bio-inspired robotics.

Robotics Using Machine Learning and AI

Dr Arsen Abdulali
Cambridge, Bio-Inspired Robotics Lab

This research course introduces students to the intersection of robotics and artificial intelligence, with a focus on the machine learning techniques that power advancements in modern robotics. Covering a broad spectrum of intelligence levels, the research course begins with foundational concepts, such as understanding touch and interaction with the physical environment, and progresses to advanced methodologies, including reinforcement learning, learning from human demonstrations, and multi-agent collaboration.

Soft Robotics: Biomimetic Engineering

Dr Ryman Hashem
Oxford, Department of Engineering Science

Soft robotics is a rising branch of robotics that aims to develop delicate, flexible and safe robotic devices which interact with humans using soft actuators that mimic biological behaviour, which state of the art rigid robots cannot accomplish otherwise. In practice, they can perform tasks that would be impossible or dangerous for humans to do. This research course will introduce students to this nascent branch of robotics and have a deeper insight into soft robots' concept, development, and control. With this, the students will develop a full awareness of the topics, which will allow them to work on their independent research projects.

Frontiers in Biomedical Engineering:
Microfluidics and Robotic Chemistry

Dr Stelios Chatzimichail
Oxford, Department of Physics, University of Oxford

This is an interdisciplinary research course at the interface of microengineering, analytical chemistry, and robotics, designed to explore the innovative applications of miniaturized analytical systems and automated chemical processes. Students will learn cutting-edge techniques in microfluidics and robotics and apply them to real-world problems in analytical chemistry and biomedical engineering.

Hands-on Engineering with Microprocessors For Mechanical Systems

Dr George Anwar
UC Berkeley, College of Engineering

This research course provides preparation for the conceptual design and prototyping of mechanical systems that use microprocessors to control machine activities, acquire and analyse data, and interact with operators. Participants will perform laboratory exercises that lead through studies of different levels of software. Software coverage includes C and Matlab. Participants will have the opportunity to work with an Infineon PSOC6 microcontroller.

Fundamentals of Mechanics and Mechanical Engineering:
Statics and Dynamics

Dr Elsiddig Elmukashfi
Oxford, Department of Engineering

In this research course, we will explore the fundamental principles of mechanics in this comprehensive course that covers the essential and advanced concepts of statics and dynamics. Throughout the research course, hands-on exercises, problem-solving sessions, and interactive simulations will allow students to apply theoretical concepts to practical situations. By the end of this course, students will possess a solid understanding of basic mechanics, enabling them to analyse static equilibrium, assess structural members, and predict the behaviour of particles and rigid bodies in dynamic situations.

Synthetic Biology: Design And Engineering of Live Synthetic Machines

Dr Hafez El Sayyed
Oxford, Department of Physics

In this research course, we will explore the fundamental principles of mechanics in this comprehensive course that covers the essential and advanced concepts of statics and dynamics. We then delve in genetic design and molecular biology techniques required in synthetic biology. Finally, we will look at examples of synthetic biology frameworks such as projects in the IGEM competition that pushed the boundaries in various fields of science. We can assemble so many machines from our DNA Lego bits with the right knowledge.

Nanomaterials: Applications In Industry, Sustainability, and Healthcare

Dr Marco Alban Paccha
Cambridge, Department of Medicine / Department of Engineering

Nanotechnology is a multidisciplinary field that draws from physics, chemistry, biology, and engineering. It is a rapidly evolving field that offers novel solutions for many industrial challenges. In this research course, students will learn about various aspects of nanotechnology and nanomaterials, and how they are applied to create devices such as solar cells, superconductors, and medical sensors.

Sensors in Wearable Technology:
From Data Science to Machine Learning

Dr Marco Alban Paccha
Cambridge, Department of Medicine / Department of Engineering

This research course covers the entire process of sensor data science: data collection, pre-processing, feature extraction, and machine learning modelling. Mobile and wearable sensors will be mainly used, and the types of sensor data covered include motion (e.g. vibration/acceleration, GPS), physiological signals (e.g. heart rate, skin temperature), and interaction data (e.g. app usage). Students will learn the basic digital signal processing and feature extraction techniques. Basic machine learning techniques will be reviewed, and students will master these techniques with a final mini-project to solve real-world sensor data science problems.

Mathematics, Logic, Algorithms

Advanced Research in Mathematics:
Differential Geometry of Curves and Surfaces

Dr Tsz Kiu Aaron Chow
MIT, Department of Mathematics

Geometry, the study of shapes, is a fundamental aspect of both mathematics and our understanding of the world around us. In this advanced research course, we will embark on an exploration of the beautiful and intricate structures that define our universe. By the end of the course, students will have developed a strong foundation in modern differential geometry and be guided to write a paper proving a geometric theorem on their own, providing them with a taste of conducting research in pure mathematics.

Topics in Algebraic Number Theory:
Quadratic Residue and Quadratic Reciprocity

Dr Jianqi Liu
UPenn, Department of Mathematics

The quadratic reciprocity law, conjectured by Euler and elegantly proved by Gauss, is one of the most profound theorems in mathematics. Its significance extends beyond its initial discovery, laying the groundwork for modern algebraic number theory and inspiring countless general-izations. This research course is designed to introduce students to the foundational concepts of number theory through the lens of quadratic residues and reciprocity. The research-oriented approach aims to equip students with the analytical skills needed to explore open problems in mathematics.

Mathematics and Philosophy:
An Interdisciplinary Approach

Dr Owen Griffiths
Cambridge, Faculty of Philosophy

This research course will delve into the intricate relationship between mathematics and philosophy. Students will explore topics such as mathematical logic, set theory, and computability theory. The aim of this course is to inspire students to engage in independent research projects focusing on fundamental questions in mathematics, logic, and philosophy. Through this exploration, students will gain a fresh perspective on mathematics and its connection to broader philosophical inquiries.

The Mathematics of Computer Science

Dr Daniel Raggi
Cambridge, Department of Computer Science and Technology

This research course is designed for students with a keen interest in computer science, mathematics, or related disciplines who want to develop a strong mathematical foundation. Mathematics lies at the core of computer science and programming, providing the tools to understand and analyze the algorithms and structures that underpin modern computation. Through this research course, students will explore essential mathematical concepts such as discrete mathematics, set theory, logic, probability, and algebra, all of which are crucial for understanding the theoretical and practical aspects of computer science.

Mathematical Logic:
Foundations of Computation

Dr Daniel Raggi
Cambridge, Department of Computer Science and Technology

For millennia, humanity has pondered the nature of reasoning and whether it can be governed by clear rules. The quest for these "simple enough" rules, rooted in basic principles yet powerful enough to encompass various processes, spurred the development of mathematical logic and theoretical models of computation. This research course explores this historical journey, from Euclid's axioms to the works of Frege, Peano, Russell, Gödel, and Turing, delving into formal systems, Gödel's incompleteness theorems, and computational models like recursive functions and Turing machines. Bridging theory and practice, students explore automated reasoning and interactive theorem proving, gaining insight into the potential and limitations of formal systems, thus equipping them with tools for their development and application.

Applied Mathematics for Machine Learning

Dr Kutsev Bengisu Ozyoruk
National Institutes of Health (NIH), National Cancer Institute

Machine learning has emerged as a powerful tool across various industries, revolutionising how we approach complex problems. At its core, machine learning relies heavily on mathematical principles and techniques to make sense of data and make informed decisions. In this research course, students will be introduced to many concepts in advanced mathematics, from linear algebra, to derivatives, gradients, optimisation theory and information theory. By the end of the research course, students will gain a solid understanding of the mathematical principles that drive machine learning algorithms, equipping them with the knowledge and skills needed to tackle complex problems in the field.

Machine Learning, AI, Natural Language Processing, and Computer Vision

Machine Learning for Engineering Design

Dr Hannah Rana
Harvard, Center for Astrophysics / NASA Jet Propulsion Laboratory (JPL)

In this research course, we will cover the fundamentals of machine learning as well as study how to develop code that can be applied to engineering system design. This research course will allow students to hone their coding skills, predominantly using Python, in order to perform linear regressions, data analytics, Bayesian optimizations, and multi-parameter analyses for engineering design cases. Having the ability to program and code in Python is an increasingly vital skill for all engineers. This course will be of interest to students interested in bioengineering, mechanical engineering, aerospace engineering, with a specific focus on using machine learning and computer vision tools.

Cutting Edge Deep Learning (DL), Natural Language Processing (NLP), and Large Language Models (LLMs)

Dr Mohammad Taher Pilehvar
Cambridge, Language Technology Lab

In this research course, we will explore key concepts in Deep Learning and Natural Language Processing. Hands-on components will let the students build and train deep learning models, fine-tune advanced language models like GPTs. This research course offers a transformative experience, gearing the students up for future academic and professional pursuits in AI.
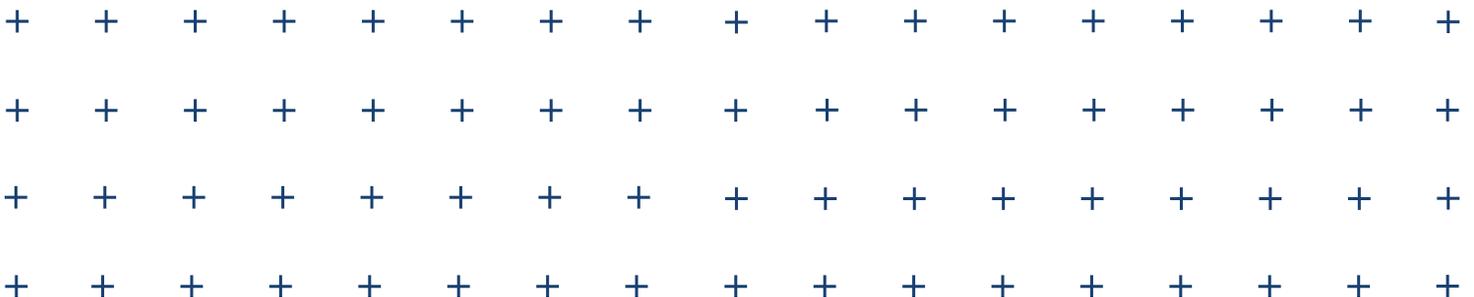
Machine Learning in Computer Vision: Image Analysis and Segmentation

Dr Robail Yasrab
Oxford, Department of Biomedical Engineering

The focus of this research course is learning end-to-end models for these tasks, particularly image classification and segmentation, using machine learning architectures. During this course, students will gain a detailed understanding of cutting-edge research in the fields of artificial intelligence, computer vision, and artificial neural networks. Additionally, the final assignment will allow them to apply their hands-on knowledge to real-world vision problems.

Deep Learning for Computer Vision and Image Analysis

Dr Pramit Saha
Oxford, Department of Engineering Science

This research course provides a comprehensive introduction to deep learning techniques tailored for computer vision and medical image analysis. Through a combination of theoretical discussions and hands-on projects, students will explore techniques for image classification, segmentation, object detection, and anomaly detection. By the end, students will have able to design, train, and evaluate state-of-the-art models for a variety of computer vision tasks.

Latest Trends in AI: Foundation Models and Multimodal LLMs

Dr Pramit Saha
Oxford, Department of Engineering Science

This research course delves into the cutting-edge advancements in artificial intelligence, with a particular focus on the latest trends, i.e, foundation models and multimodal large language models (LLMs), such as GPT, BERT, and DALL-E. The research course examines the architectures and training paradigms underpinning these models, including self-supervised learning, attention mechanisms, and scaling laws.

ChatGPT and Natural Language Processing: Crafting the Future with AI Linguists

Dr Robail Yasrab
Cambridge, School of Clinical Medicine

This research course introduces students to large-scale language models like GPT, exploring how machines comprehend and generate human-like text. It blends theory with practical exercises in natural language processing, aiming to demystify AI and inspire further study and careers in technology. Beginning with intensive introductions to machine learning and neural networks, the course progresses to independent research projects supervised by faculty. Students delve into advanced NLP techniques and are prompted to consider the ethical implications and boundaries of AI.

Building Better AI: Investigating Errors in Large Language Models (LLMs) such as ChatGPT

Dr Chiraag Lala
Imperial College London, Department of Computing

This research course delves into the realm of Natural Language Processing (NLP) and Large Language Models (LLMs), such as ChatGPT, which have revolutionised various domains but are prone to errors with significant implications. It aims to equip students with NLP tools to analyse, understand, and mitigate LLM errors. Beginning with NLP basics, the course explores LLM principles, architecture, and training methods, fostering hands-on experience with state-of-the-art tools for error analysis. Students engage in ethical discussions on AI deployment and decision-making, emphasising accountability and fairness. Through independent research projects, students investigate LLM errors, developing critical thinking and problem-solving skills essential for responsible AI development.

Data Science and Machine Learning in Smart Spaces: Computer Vision and the Internet of Things

Dr Faisal Nawab
University of California, School of Information

The proliferation of smart spaces, ranging from intelligent homes and offices to advanced urban environments, has resulted in an explosion of video data generated by connected devices such as surveillance cameras, drones, and IoT-enabled sensors. Harnessing this data effectively requires a unique intersection of expertise in data science, distributed systems, and video analytics. This course aims to equip students with the knowledge and skills to design, implement, and optimize systems for processing and analyzing video data in smart spaces.

Data Science with Hands-on Projects: ML Algorithms, Statistical Methods, and LLMs

Dr Faisal Nawab
University of California, School of Information

This research course offers an in-depth exploration of data science, blending foundational principles with hands-on applications to equip students with the skills needed for real-world challenges. We will also delve into large language models (LLMs), such as GPT, and their transformative role in modern data science. Through practical projects, students will have a comprehensive understanding of the data science pipeline, from data preparation to advanced machine learning and AI integration.

Real-world Applications of AI and ML: From Stock Market Prediction to Vaccine Development

Dr Perman Jorayev
Cambridge, Centre for Advanced Research and Education

Artificial Intelligence and Machine Learning are transforming industries and driving innovation across diverse fields, from healthcare to finance to environmental sustainability. This research course explores real-world applications of AI and ML, showcasing how these tools are used to address critical challenges, including vaccine development in the case of Moderna, text mining for stock market prediction, to computer vision for autonomous robots, and many more.

The Data Science of Social Networks: Modelling, Visualizing, and Analyzing the Social World

Dr Benjamin Rosche
Princeton, Office of Population Research

Ever wonder how connections between people, ideas, and things shape everything, from friendships to global events? This research course dives into the fascinating world of social networks, where we'll uncover the hidden patterns that influence our lives—like who's really the most popular in your class, how rumors spread like wildfire, and why certain influencers go viral overnight. You'll learn how to use social network analysis to visualize, understand, and harness the power of networks and relationships.

Data Science: From Correlation to Causation

Dr Dejan Kovac
Harvard, Center for International Development

As the field of data science continues to grow at an unprecedented pace, its applications are transforming industries, influencing policy decisions, and shaping the way organizations operate. This research course is designed to provide students with a foundational understanding of data science and its applications. By the end of the research course, students will have gained the skills and confidence to independently perform data analysis, distinguish between correlation and causation, and critically assess the validity of data-driven conclusions.

Environmental Data Science: Examining Climate Change and Environmental Risk Using Machine Learning

Dr Robert Edwin Rouse
Cambridge, Department of Applied Mathematics & Theoretical Physics

Climate change is among the most significant existential threats facing humanity, driving increased frequency and intensity of environmental hazards, ecosystem degradation, and widespread societal challenges.This research course aims to equip participants with the knowledge and skills to analyze climate change and environmental risks using machine learning, bridging scientific understanding and data-driven solutions.Students will have the opportunity to engage with algorithms and datasets, applying theoretical knowledge to pressing climate and environmental issues.

Understanding Social Network:
From Data Science to Cybercrime on Social Media

Dr Hridoy Sankar Dutta
Cambridge, Department of Computer Science and Technology

This research course is an in-depth exploration of the realm of social networks, arguably the most important platform for collaboration and communication among the global population. We will explore the widespread adoption of social media platforms such as Facebook, Twitter, Instagram etc., which enable users to share diverse content like opinions, experiences, perspectives, and various media formats. Additionally, students will be taught cutting-edge methodologies for analysing and visualising data pertaining to social network structures and dynamics.

Artificial Intelligence in Healthcare:
Biomedical Sensors, Signal Processing and Machine Learning

Dr Shadi Ghiasi
Oxford, Department of Engineering Science

In this research course, students will gain an understanding of how AI-based technologies are revolutionising healthcare. Students will be introduced to biomedical sensors and wearable systems and gain knowledge on the underlying physiological phenomena. They will also learn to programme in Python/MATLAB and implement their own AI pipeline on healthcare data, from scratch.

Drug Discovery, Chemical Development & Machine Learning

Dr Connor Taylor
Cambridge, Innovation Centre for Digital Molecular Technologies

In this multidisciplinary research course, students will explore the rise of machine learning (or artificial intelligence) with specific reference to drug discovery and chemical development, as well as emerging techniques for effective chemical/pharmaceutical synthesis. Combining topics from chemistry, biology, chemical engineering, and computer science, the research course equips students with the interdisciplinary knowledge needed to tackle cutting-edge problems in these fields.

Artificial Intelligence Applications in Medical Imaging Analysis

Dr Kutsev Bengisu Ozyoruk
National Institutes of Health (NIH), National Cancer Institute

This research course explores how Artificial Intelligence (AI) is reshaping medical imaging, from improving diagnostic accuracy to enhancing patient outcomes. Students gain theoretical knowledge and practical experience in applying AI to various medical imaging modalities, learning about machine learning and deep learning techniques. Specific AI applications like computer-aided diagnosis systems and image reconstruction are examined, highlighting their potential to streamline healthcare workflows and benefit patients. Through independent research projects, students gain a deeper understanding of AI's transformative impact on medical imaging and healthcare delivery.

VR, Mixed Reality, and the Metaverse

Dr Arsen Abdulali
Cambridge, Department of Engineering

Virtual Reality (VR) and Mixed Reality (MR) hold immense potential and represent the future of technology. They find applications in training simulations, gaming, healthcare therapies, architectural visualisation, manufacturing, and design. In this research course, students will be introduced to these cutting-edge technologies and learn how to unlock their potential through their research projects. During the research project, students will have the opportunity to choose from a variety of related topics, ranging from VR simulations to the development of tactile interfaces and psychophysical studies.

Artificial Intelligence and Machine Learning for Robotics

Dr Nived Chebrolu
Oxford, Oxford Robotics Institute

This research course offers students a comprehensive understanding of Artificial Intelligence (AI) and Machine Learning (ML) in the context of robotics. It delves into advanced concepts and cutting-edge applications, catering to those interested in the intersection of AI and robotics. Students gain a strong foundation in AI/ML before exploring the intricacies of robotics, including its challenges and transformative potential across industries. Equipped with this knowledge, they are prepared to pursue careers in robotics, automation engineering, or AI research, ready to contribute meaningfully to this dynamic field.

AI and Machine Learning: Tools for Addressing Social Problems

Dr Danny Ebanks
Harvard, The Institute for Quantitative Social Science (IQSS)

This research course equips students with advanced statistical, machine learning, and AI methods to address complex social science issues such as political polarisation, gerrymandering, and criminal justice. It aims to demystify these methods and provide practical guidance on their evaluation and application. Through hands-on experience with real-world datasets, students learn to use tools like GitHub and cloud computing for analysis. The course covers a range of methods including Ordinary Least Squares, Bayesian statistics, Large Language Models, and survey methods, preparing students to communicate results effectively to policymakers and the public.

Quantum Physics, Quantum Chemistry, and Astrophysics

Quantum Computation: Algorithms, Information, and Cryptography

Dr Sergii Strelchuk
Cambridge, Department of Applied Mathematics and Theoretical Physics

This research course will provide an introduction to quantum processes. We will begin by expounding the principles of quantum mechanics in our setting (and Dirac notation) and then immediately make connections to information (quantum states viewed as information carriers, quantum teleportation) and computation (notion of qubits and quantum gates). At the same time, we will discuss quantum cryptography (quantum key distribution), and quantum computing, culminating in an exposition of principal quantum algorithms, such as the Deutsch-Jozsa algorithm. While no previous knowledge of quantum physics is required for this course, a relatively strong background in mathematics or physics would be beneficial.

Quantum Chemistry in Light Matter Interactions

Dr Tian Zhao
Princeton, Department of Chemistry

This research course focuses on classic light-matter interactions, delving into the realm of physical chemistry, with a special emphasis on photoluminescence. Throughout the course, students will grasp the fundamental principles of light-matter interactions, including basic quantum mechanics to extend their understanding from classical to quantum physics. Through hands-on experimentation, they will cultivate a deeper understanding of the dynamic processes that govern the interplay of light and matter.

Quantum Physics: Information, Foundations And Gravity

Dr Damián Pitalúa-García
Cambridge, Centre for Quantum Information and Foundations

Quantum physics is confirmed with overwhelming experimental evidence at the microscopic scales (e.g., at the atomic scale), producing many technological applications. This research course will address the foundational issues of quantum physics as it relates to quantum measurement and general relativity. Students with a relatively strong background in mathematics or physics would excel in this research course.

Data-Driven Astronomy: Machine Learning and Statistics for Modern Astronomy

Dr Daniel Muthukrishna
MIT, Kavli Institute for Astrophysics and Space Research

Astronomy is entering an unprecedented era of big data, as new facilities are observing more phenomena than humans can possibly visually examine. Dealing with millions of astronomical objects and producing terabytes of data every day requires machine learning and statistical methods to classify, model, and characterise the data influx. In this research course, we will learn cutting-edge machine-learning methods and apply them to real astronomical datasets to discover, model, and further our understanding of the universe.

Astrophysics of Black Holes, White Dwarves, and Neutron Stars

Dr Alexander Mushtukov
Oxford, Department of Physics

White dwarfs, neutron stars and black holes are compact objects forming at the final stages of the evolution of massive stars. In this research course, we will learn the nature of compact objects and see their place in the history of the universe. During the research course, we will touch on many topics from high energy astrophysics and talk about the recent progress in the detection of gravitational waves. Finally, we will discuss open issues standing in front of the scientific community and try to figure out how further steps in the investigation of black holes, neutron stars, and white dwarfs will help in probes of fundamental physics under extreme conditions.

Physics and the Evolution of Isolated and Binary Stars

Dr Alexander Mushtukov
Oxford, Department of Physics

This research course deals with the structure and evolution of isolated stars and starts in binary systems.Through a blend of theoretical concepts, observational data, and computational models, student will gain an understanding of the physical phenomena governing stars' evolution. Throughout the research course, students will engage in hands-on activities, computer simulations, and observational projects to reinforce theoretical concepts and gain practical skills in data analysis.

Unveiling The Secrets of Dark Matter With Machine Learning

Dr Tariq Yasin
Oxford, Beecroft Institute for Particle Astrophysics and Cosmology

Our standard model of cosmology posits that around 85% of the matter in the universe is "dark matter": an elusive, invisible, hypothetical substance that interacts noticeably with ordinary matter only through gravity. A key challenge in astrophysics is mapping out dark matter using subtle observations that give us clues to its gravitational influence, such as the arrangement of billions of galaxies photographed by telescopes and the bending of light by dark matter's gravity. We will gain hands-on experience with advanced statistical techniques and machine learning methods, utilizing the same tools used by leading academic researchers in the field that allows us to unravel its secrets.

The Astrophysics of High Density Objects: Plasma Physics, General Relativity, and Quantum Electrodynamics

Dr Bart Ripperda
University of Toronto, Canadian Institute for Theoretical Astrophysics

The last decade saw remarkable discoveries related to black holes, including gravitational waves from merging neutron stars and plasma flows near black holes. However, the plasma dynamics that produce these emission signatures are still poorly understood. In this research course, we will study the required theories (plasma physics, general relativity, quantum electrodynamics) necessary to understand how black holes and neutron stars shine and how we can use their observed emission to understand the nature of strong gravity.
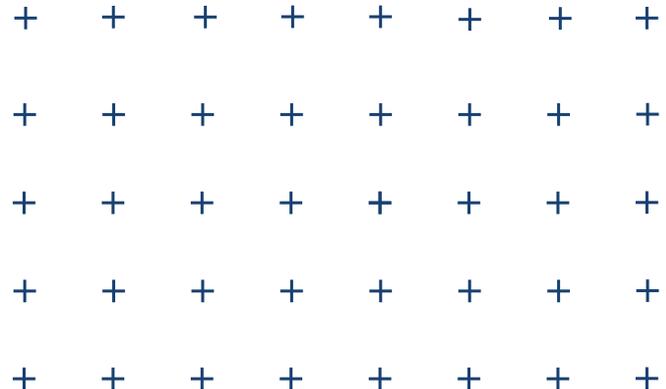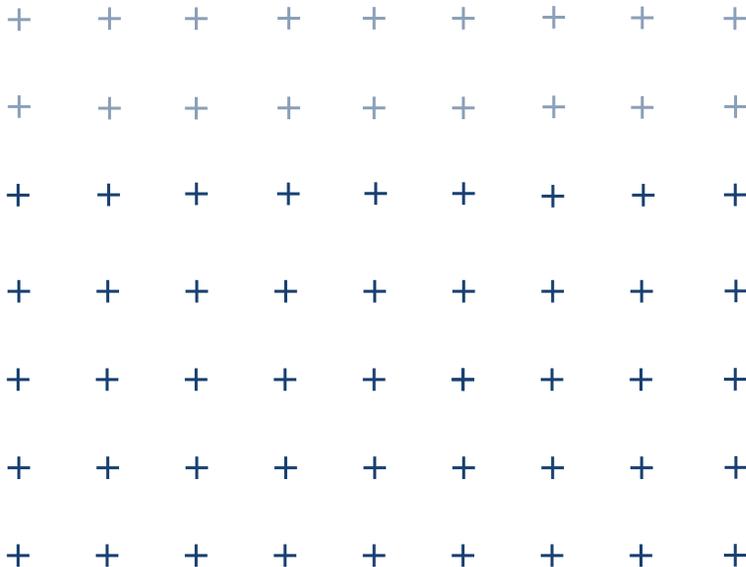
Economics, Public Health, Game Theory, Decision Making

Computational Economics and Social Science: Networks and Modeling of the Real World

Dr Daniele Cassese
Cambridge, Faculty of Economics

Networks are all around us. From the architecture of financial systems, trade between companies and across countries, to the complex transportation system linking cities. This research course will explore how the events within the network interact and influence one another, and how can we represent, describe, or predict the events. We will emphasise a computational approach to social and economic network applications. Students will learn how to use Python to set and simulate network models; they will become familiar with the most recent research and techniques in network science and will develop excellent research skills.

Behavioural and Experimental Economics

Dr Noah Bacine
Oxford, Center for Experimental Social Sciences

Combining insights from economics, psychology and philosophy, this research course teaches students how experiments have advanced economic theory to better reflect the world we live in. Departing from standard theory which assumes humans are coldly rational and always make decisions that offer the greatest personal benefit, students will learn how experiments have shown us that behaviour consistently differs in predictable ways. As students develop their understanding of the common biases we all exhibit, they will be encouraged to apply the lessons they've learned to their own experiences.

International Political Economy: How Do International Economic Activities Shape Politics

Dr Zarlasht Razeq
Princeton, Niehaus Center for Globalization and Governance

This research course delves into the dynamic field of International Political Economy (IPE), exploring the complex ways in which international economic activities shape political relationships among states. It provides students with analytical frameworks needed to explore how trade, finance, and global production networks intersect with political power and decision-making.

How Much Does Mental Health Cost? The Economics of Addiction and Substance Use

Dr Corneliu Bolbocean
Oxford, Department of Primary Care Sciences

This research-intensive course serves as an exploration into the relationship between economics, mental health, addiction and substance use. We will discuss addiction and substance use through an economic lens, and students will be introduced to cutting-edge theories and models. Students will develop their research skills within health economics, particularly focusing on economic evaluations. With a spotlight on methodologies employed to assess the cost-effectiveness of healthcare interventions, students will engage in rigorous examination and measurement of health outcomes and cost valuation. They will also learn how to apply economic evaluations alongside clinical trials and employ decision-modelling techniques crucial for comprehensive research projects in mental health economics.

Healthcare Crisis in Marginalised Populations: Equity, Power, and Intersectionality

Dr John Salerno
Columbia, Columbia Population Research Center

Certain groups of individuals, including LGBTQ+, Hispanic/Latinx, Black/African American, Native Hawaiian/ Pacific Islander, Native American/American Indian, are at greater risk of experiencing significant health challenges due to systemic inequities. This research course introduces students to Intersectionality and Population Health, two vital frameworks that help us examine and address these challenges. Each student will identify an intersectionality vulnerable population to study, design a research project, and propose a social justice intervention to address health inequities affecting that population. This action-oriented approach will equip students with both analytical and advocacy skills, bridging academic learning with meaningful community impact.

Economics of Inequality and Sustainability

Dr Ceyhun Elgin
Columbia, Department of Economics

To improve our understanding of the economic impact of the pandemic, this research course will introduce students to surveys of several contemporary policy issues in economic literature. Notably, we will discuss current economic and financial matters arising through and after the COVID-19 pandemic.

The Economics and Sociology of Inequality

Dr Annalena Oppel
LSE, International Inequalities Institute

What is inequality, and how is it best measured and tracked over time? How do people experience inequality? Inequality is an important and complex issue that manifests in people's lives, national politics, public policies, and economic systems. Its scientific study draws on multiple disciplines, including economics, sociology, and development studies. This research course will examine key perspectives on inequality, sociology, and development studies.

The Economics of Human Capital: Migration, Labour, and Policy

Dr Gokhan M Aykac
Harvard University, The Center for Labor and a Just Economy (CLJE)

This research course delves into the multidisciplinary study of skilled immigration, combining economics, policy analysis, and case studies.This research course offers a comprehensive exploration of skilled immigration economics, bridging the gap between research and policy. By completion, participants will be equipped with a solid foundation in the field, enabling them to critically analyse and actively contribute to ongoing discussions regarding skilled immigration and its economic impact.

Quantitative Research Design in International Relations

Dr Changwook Ju
Stanford, Center for International Security and Cooperation

Designed for students aiming to enhance their analytical skills, the research course covers the fundamentals of statistical computing, data visualization, and causal inference, focusing on practical applications to pressing questions in global politics. Students will learn to navigate complex datasets, assess causal relationships, and interpret statistical results in the context of international security, global governance, and political economy.

Game Theory and Decision Making: Unleashing Strategy in Complex Environments

Dr Carles Mañó-Cabello
KU Leuven (US News World Top 50), Department of Economics

This research course explores Game Theory, an interdisciplinary field that delves into strategic decision-making across different domains. Game Theory uncovers hidden strategies and dynamics behind decision-making in diverse situations, influencing individuals, organisations, nations, and animals. By the end of the course, interactive discussions, case studies, and real-world examples will have enriched the students' understanding of game theory concepts, fostering a solid foundation in strategic thinking across diverse contexts.

Environmental Economics: Finding the Balance Among Climate Change, Sustainability, and Economic Growth

Dr Carles Mañó-Cabello
KU Leuven (US News World Top 50), Department of Economics

This research course offers an immersive exploration into how economic decisions shape the trajectory of our planet's future. Students will delve into a rich array of topics, including the management of non-renewable resources such as oil and gas, the harnessing of renewable resources like solar and wind energy, and the critical analysis of cost-benefit implications associated with green policies and sustainable development initiatives.

Sociology, Gender and Race, Linguistics, and Globalisation

Race, Racism, and Society: A Global Perspective

Dr Dana Brablec
Cambridge, Department of Sociology

Issues relating to 'race' and ethnicity, whether #blacklivesmatter or COVID-19, today lie at the forefront of public debate. In this course, students will critically analyze the concepts and processes of 'race' and ethnicity, understand as social constructions, looking at the UK, the US, and beyond.

International Development: Challenges for Policy-makers, Corporations, and NGOs

Dr Dana Brablec
Cambridge, Department of Sociology

This research course aims to cultivate critical thinking and provide a comprehensive understanding of contemporary global development issues. Topics we will discuss include, Millennium and Sustainable Development Goals, development traps, pandemic and post-pandemic challenges, urbanisation and gentrification, development theory, international and regional co‑operation for development, bottom-up perspective, decolonial studies, development and intersectionality, and corruption, among others.

Political Psychology in Comparative Politics

Dr Xiaoxiao Shen
Yale, Department of Political Science

Political psychology seminars often focus on American political behavior, while comparative politics rarely address psychological perspectives directly. This research seminar bridges that gap by exploring how psychological factors intersect with comparative political systems, shaping attitudes and behaviors across diverse contexts. The research course examines how political beliefs are formed, revised, and expressed through action, emphasizing the influence of personality traits, cognitive processes, and identity—both individual and collective—on political engagement.

Intersectionality, Identity, and Equality: The Body and Social Identities

Dr Hande Güzel
Cambridge, Department of Sociology

Bodies are central to the human experience. We move, function in society, and make sense of our existence and relatedness through our bodies. However, within our societies, not all bodies are treated equally. Based on social rules and norms, some bodies are deemed deviant, incomplete, marginalised, or less than, compared to others. This research course invites students to critically explore the relationship between intersectionality and the body. Through engaging with thought-provoking literature, this course will open up discussions about how bodies are disciplined, moulded, surveyed, and the hierarchies formed around bodies.

Health, Gender, and Power: Inequalities, Intersections, Conflicts

Dr Hande Güzel
Cambridge, Department of Sociology

Spanning across both physical and mental health and borrowing primarily from sociology of health and illness and gender, students taking this research course will develop a critical understanding of the main themes and debates in these fields. By the end of the research course, students will have completed a research paper, which will cut across several themes in health and gender according to their personal research interests.

Law, Justice, and Violence

Dr Caitlyn McGeer
Oxford, Centre for Socio-Legal Studies / University of Toronto, Department of Sociology

This research course delves into violence, exploring its meaning, origins, and manifestations. It examines debates on defining and documenting violence, focusing on distinguishing interpersonal from state-sanctioned violence. The course analyses societal, cultural, and individual factors influencing violent behaviour, including legal frameworks and power dynamics. It scrutinises colonial legacies' impact on violence and how racial and gender dynamics intersect with it. Overall, the course aims to provide a comprehensive understanding of violence as a complex social phenomenon shaped by historical influences, power dynamics, and cultural contexts.

Applied Linguistics and Big Data

Dr Victoria Fendel
Oxford, Faculty of Classics

Why are languages so different – and thus so hard to learn? We will explore the social relevance of language and the results of language contact. Students will conduct independent research by constructing linguistic data, analysing big data and performing context-oriented keyword analysis. Students will investigate how language develops, interacts, and how to what extent we can manipulate our patterns of language usage for specific purposes.

The Social, The Political, and The Environmental Dimensions in Architecture and Urbanism

Dr José Aragüez
Columbia, Department of Architecture

This research course explores the intersection of architecture with social, political, and environmental concerns, prompting critical inquiry into the discipline's role in addressing contemporary challenges. Students examine debates and arguments surrounding architecture's engagement with societal issues and its environmental impact. Through case studies spanning recent decades, topics such as aesthetics, sustainability, spatial organisation, and cultural contexts are explored. Emphasis is placed on developing a nuanced understanding of architecture's role in addressing pressing issues while maintaining fidelity to its unique principles. The course fosters critical thinking and encourages students to navigate the complexities of architectural discourse within broader societal contexts.

Architectural Thinking:
Concepts, Innovations, and Theories

Dr José Aragüez
Columbia, Department of Architecture

This research course will examine the core topics in architectural thinking by introducing students to critical arguments and debates in the discipline's contemporary discourse. Covering approximately the last 30 years, we will look at architectural projects, buildings, material configurations, construction systems, and organisational models along with a series of theoretical and historical frameworks relevant to them. Topics include representation, programme, spatial organisation, context, whole, element, content, referent, the digital, aesthetics, phenomenology, evolving notions of sustainability, and developing cultures of reuse and renovation.

Marketing Management and Brand Strategy in a Digital Age

Dr Tom Hafen
Columbia, School of Business / Geico, Head of Marketing

In today's ultra-competitive business world, effective Marketing Management and Brand Strategy are key components for any business to achieve success. However, these are not easy tasks, especially given that modern-day consumers are constantly overwhelmed with information. This research course introduces the principles of brand management and advertising as practised by industry leaders today. This research course is relevant for students interested in driving consumer demand regardless of career path.

Startup Financing and Investment

Dr Keivan Aghasi
Cambridge, Judge Business School

Why do some start-ups receive a valuation of several billion dollars, while others cannot even raise the amount to get by and survive? Why do only a handful of start-ups go public? The research course will focus on entrepreneurial finance, i.e. venture capital investment. This research course exposes students to the core theories, concepts, and tools used to screen high-potential start-ups and maximize the return on investment. Students will learn key theoretical concepts, tools, and approaches to entrepreneurial finance and their application in valuation and investment in new businesses.

Entrepreneurship in the AI Era

Dr Keivan Aghasi
Cambridge, Judge Business School

This research course delves into the dynamic landscape of entrepreneurship in the age of AI and complementary digital technologies. It will explore the fundamental principles of entrepreneurship, including identifying opportunities, developing innovative business models, and securing funding. Students will explore the eminent challenges and opportunities presented by the rapid advancement of generative AI and digital technologies. By the end of the course, students will gain practical experience and develop the academic skills necessary to conduct rigorous academic research at the intersection of entrepreneurship and disruptive digital technologies.

Modelling Stock Price: Stock Market Dynamics and Risk Management

Dr Abdullah Yalaman
Australian National University, Centre for Applied Macroeconomic Analysis (CAMA)

What drives stock prices? This research course covers the basics of stock market dynamics. Students will grasp fundamental concepts in finance and economics, and specifically, learn to forecast economic and financial data using statistics and economic models. Real-world case studies, simulations, and practical exercises will be integrated to provide hands-on experience in applying modelling techniques and investment strategies to actual financial data. By the end of this research course, students will be equipped to make informed investment decisions and manage financial risk adeptly in today's dynamic financial markets.

Financial Markets and Trading: Practical Strategies in the World of Finance

Dr Kevin Schneider
University of Cambridge, Cambridge Judge Business School

Investments, securities, markets, bonds, trading…This is a dynamic and engaging research course designed to explore the fascinating world of finance. It will provide students with a solid foundation in financial markets, trading, and the principles that drive stock prices, making it perfect for those interested in pursuing careers in business, economics, or investing, simply wanting to understand how financial markets operate.

Breaking the Glass Ceiling: Understanding Gender Inequality in the Workplace

Dr Aparna Venkatesan
LSE, Department of Management

In this research course, students learn to question and apply sociological or psychological theories to understand inequalities in organisations. The course particularly helps students to understand why women don't progress at the same pace as men at work. The course specifically looks at gender and stereotypes attached to the gender within a society and how this transpires to the workplaces. It also extends to other identities that might equally explain the reasons for inequalities within workplaces. By studying this course and working on their independent research projects, students will develop hands-on research skills and also understand the interdisciplinary process of applying theories from different fields in solving complex problems.

Organisational Behaviour and Business Psychology: How to Bring Your Startup From Garage to NASDAQ

Dr Aparna Venkatesan
LSE, Department of Management

This research course focuses on organisational behaviour, aiming to understand how individuals' actions impact organisational success. Through case studies and discussions, students explore the dynamics that shape behaviour within startups, social enterprises, and other organisations. The course delves into psychological and sociological perspectives, examining how cultural factors influence decision-making and behaviour, particularly in global contexts. Students conduct independent research projects to gain insights into real-world scenarios and develop a comprehensive understanding of organisational dynamics and effectiveness.

From Lab to Market: How Science, Technology, Finance, and Economics Shape the Future

Dr Perman Jorayev
Cambridge, Centre for Advanced Research and Education

The first ever AI conference was held in 1956. Why did it take half a century for technologies to become ubiquitous in our lives? This research course is designed for aspiring entrepreneurs, innovators, and investors that are fascinated by the interaction of multiple areas, like science, technology, finance, and economics. From the basics of finance and startup economics to assessing technological feasibility and market fit, this research course provides an comprehensive introduction to the entrepreneurial and venture capital world.
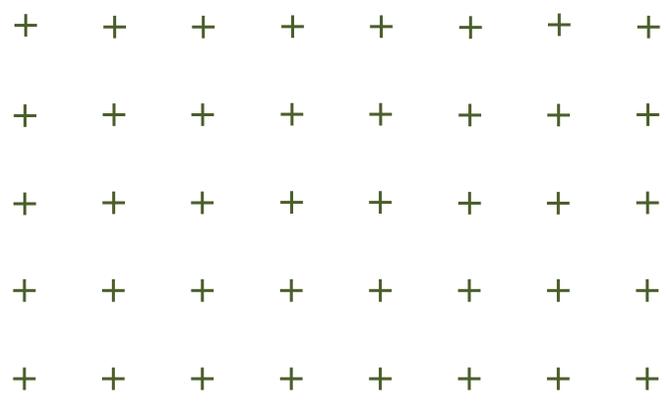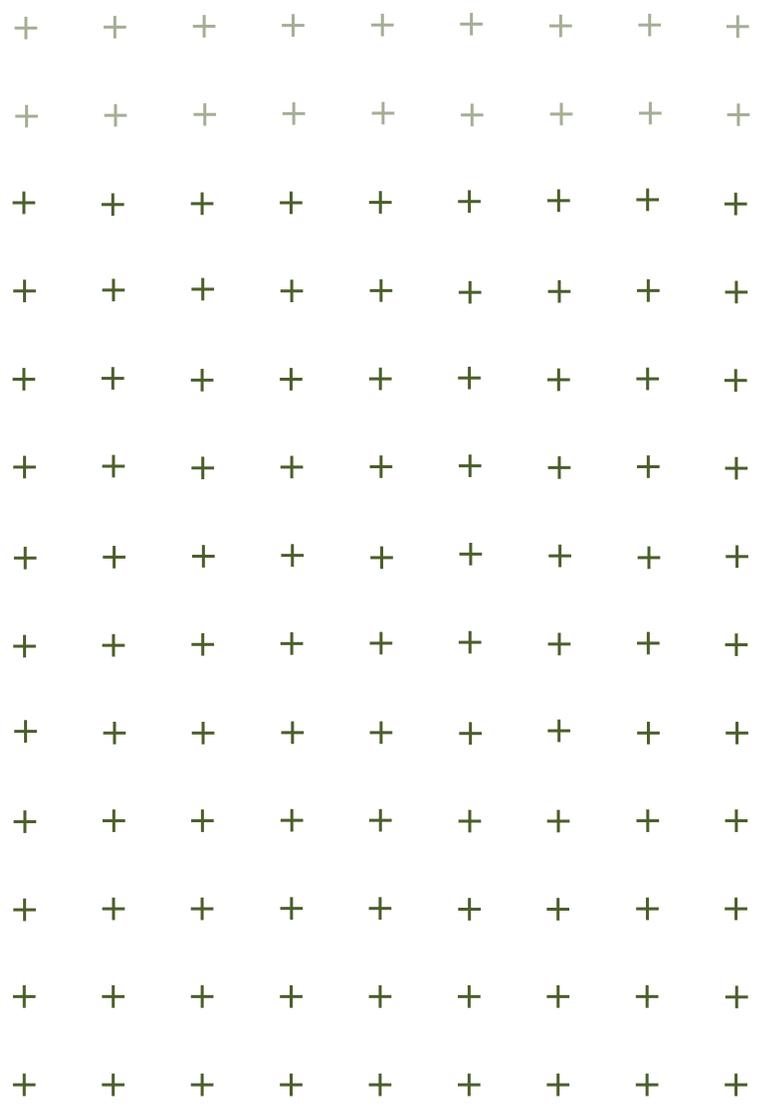
Politics, Philosophy, Law, and International Relations

The Geopolitics of the New World Order: Russia, China, and the USA

Dr Harald Wydra
Cambridge, Department of Politics and International Studies

The key question of this research course is: 'How to maintain stability and order in a world that seems to be changing at an ever increasing pace?' Students will be introduced to the fundamentals of Europe post-World War II order, the foundations of post-1991 US hegemony, the rise and growing integration of China in the global economy, aspects of revisionism by Russia, and the geostrategic challenges of growing multipolarity.

The Anatomy of War: Motivations, Strategies, and Consequences

Dr Harald Wydra
Cambridge, Department of Politics and International Studies

Students will be introduced into key texts on the causes of war, including material from psychology, evolutionary biology, archaeology, history, social anthropology, and international relations. The course will furthermore draw on a selected range of cases from mythology, history, and current instances of warfare in order to illustrate some of the most cogent hypotheses. It will also explore the purpose and rationality of warfare, be it for territorial expansion, economic gain, for religious faith, or for collective identity. Last not least, the course aims to assess possibilities of preventing, containing, or regulating war as a system of organised violence by means of legal and ethical norms as well as strategies of conflict-resolution.

The Decline of Democracy and The Rise of Authoritarianism

Dr Othon Anastasakis
Oxford, European Studies Centre

Is democracy under siege? This research course focuses on understanding the challenges facing democracy today, including the rise of autocratic regimes and the erosion of democratic norms. Students explore the factors contributing to democratic decline through scholarly literature, case studies, and empirical data analysis. They engage in original research projects using diverse methodologies to investigate the root causes and consequences of democratic erosion. By cultivating analytical skills and interdisciplinary dialogue, students aim to contribute to the study of democratic governance and political theory. The course culminates in research papers offering insights and recommendations for safeguarding democratic principles in the global landscape.

Environmental Sociology: Money, Power, and Nature

Dr Jason Sexton
UCLA, Department of Sociology

Students will be able to analyse the world in ways that transcend binaries between nature (natural sciences) and society (social sciences), particularly in relation to real-world issues like climate, environmental sustainability, transitions, health inequality, and environmental justice. Engaged students will obtain a nuanced and diverse set of analytical tools to assist in understanding how "the environment" and environmental matters cannot be understood outside of and apart from the social world, and how the social world is deeply intertwined and embedded within "the environment."

Rhetoric and Politics: From Ancient Greece to Today

Dr Victoria Fendel
Oxford, Faculty of Classics

Making one's voice heard in public was a sought-after skill for those at the heart of the Athenian democracy, the Roman republic and later the Roman empire. The skilful use of language was a critical tool and a powerful weapon. We will focus from the orators of the Athenian democracy to the politicians of the Roman republic. Students will develop an independent research project on political rhetoric, ancient history or relevant areas in the context of its time and discourse.

The Individual and the State: Law, Economics, and Political Philosophy

Dr Karl T Muth
University of Chicago, Booth School of Business

There is a significant contemporary debate on how the state should interact with the individual, especially in the context of respecting the individual's concepts of norms, privacy, and history. Students will conduct their independent research project throughout the research course, which will enable them to explore and delve into the central questions surrounding law, economics, and political philosophy.

Civil Disobedience, Resistance, and Revolution: The Politics and Philosophy of (Non-)Violence

Dr Eraldo Souza dos Santos
Cornell University, Department of Government

Over the last half-century, civil disobedience has become a key political concept around the world. But what does "civil disobedience" mean? Is it compatible with the rule of law and democratic life? Does it represent a danger to state authority? This research course examines the politics and philosophy of civil disobedience through a global historical lens. We will trace the evolution of the concept–from the phrase's origins in American abolitionist circles in the mid-nineteenth century, to its circulation in the British Empire, and its eventual appropriation by activists, lawyers, and philosophers from the 1960s onwards.

The Self in Philosophy, Psychology, and Neuroscience

Dr Esther Rosario
Dartmouth, Department of Philosophy

This research course delves into the concept of personal identity and self-transformation, exploring questions about what defines an individual's identity. Topics include whether the self is constituted by narratives, if it persists over time, and the role of embodied cognition. Students also examine how social factors such as culture, religion, and identification with social groups influence personal identity. Ethical considerations regarding self-transformation, including changes in values and authenticity, are also explored. The course draws from philosophy, psychology, biology, and social sciences to address these complex issues.

Refounding Modernity: The Political Philosophy of J.J. Rousseau and Immanuel Kant

Dr Nicholas Anderson
Harvard, Department of Philosophy

This research course will examine Kant's philosophy primarily in light of Rousseau's diagnosis of the ills of modern society and commercial liberalism. We begin by examining Rousseau's major political writings–First Discourse, Second Discourse, and The Social Contract. We will then turn to some of Kant's major political and moral writings, including selections from the Critique of Pure Reason, Groundwork for the Metaphysics of Morals, Conjectural Beginnings of Human History, and Toward Perpetual Peace. Through examining the dialogue between Kant and Rousseau, we will gain insight into questions concerning the character of history, the grounding of human freedom, morality, epistemology, and the source of legitimate political authority.

The Global History of Colonialism, 1800-Present

Dr Chandra Mallampalli
Harvard, Lakshmi Mittal and Family South Asia Institute

Was colonialism good for the world, or did it make life worse for people who lived under it? This is a live debate among people who are still trying to come to terms with their colonial pasts. This research course probes such questions by examining the British Empire during the 19th and 20th centuries, its means of expansion, economic incentives, and its racial assumptions. The course explores special topics relating to the imperial legacy. These include trade in cotton, opium and tea; colonial wars fought in Afghanistan and China, and anti-colonial movements, such as the one led by Gandhi, in the twentieth century. We also discuss violence, the drawing of borders, emigration, and refugees. The case studies of Israel-Palestine and India-Pakistan will factor prominently.

Gender and Human Rights

Dr Hannah Elsisi Ashmawi
Cambridge/Brandeis/NYU, Center for Middle East Studies

Through integrating diverse bodies of scholarship–including gender theory, decolonial and postcolonial studies, queer theory, and human rights frameworks from legal and policy perspectives–the course provides an interdisciplinary approach to the study of human rights deeply rooted in questions of gender. Students will engage with seminal works by scholars such as CLR James, Sylvia Wynter, Gayatri Spivak, Michel Rolph Trouillot, Ratna Kapur, Hannah Arendt, Audra Simpson, Walter Mignolo, Giorgio Agamben, Judith Butler, Lila Abu-Lughod, and Wendy Brown, among others. Alongside these theoretical perspectives, students will analyze the evolution and application of international legal frameworks aimed at securing the rights of women and other marginalized groups.

History of Capitalism

Dr Hannah Elsisi Ashmawi
Cambridge/Brandeis/NYU, Center for Middle East Studies

Since the global financial crisis of 2008, understanding the history of capitalism has become more crucial than ever, sparking a surge of interest and discourse. In this research course, we delve into the complexities of capitalism beyond face-value narratives. We will develop a comprehensive and critical understanding of capitalism, including its historical evolution and transformation, and its profound and far-reaching impact on our society and the world. Students will understand the importance of a global perspective in comprehending capitalism's development and impact across various regions and cultures.

The Politics and History of Prisons: Reform, Abolition, and Carceral Justice

Dr Hannah Elsisi Ashmawi
Cambridge/Brandeis/NYU, Center for Middle East Studies

Does anyone deserve to be unfree? What does captivity tell us about freedom? This research course tracks the history of captivity, prison, and incarceration. We examine laws and literatures of captivity in ancient Rome and the mediaeval Islamic world through to humanitarian debates around slavery and modern prisons and the political economy of successive wars on Crime, Poverty, Drugs, and Terror in the Americas. Our protagonists range from anti-colonial nationalists in Kenya and Chinese indentured labourers, to prisoners of the Russo-Ottoman wars and convict labourers in Australia.

Literature, Arts, Music, and Media

Racial Justice and the Politics of Literature

Dr Joaquin Terrones
MIT, Department of Literature

This research course will explore key topics and texts in Black, Latinx, and Indigenous literature. Students will learn how to read closely different literary forms as well as how to perform the kind of interdisciplinary research that analysing texts from a racial justice lens requires. Some of the authors we will read include James Baldwin, Ta-Nehisi Coates, Audre Lorde, Gloria Anzaldua, Valeria Luiselli, and Tommy Orange. In addition to analysing literary works, students will also explore key concepts from Black, Latinx, and Indigenous studies such as double-consciousness, the borderland, decoloniality, Afrofuturism, and critical fabulation.

Approaches to Contemporary Chinese Art: From Chairman Mao to NFTs

Dr Ellen Larson
U Chicago, Department of History

The aim of this course is to introduce a history of contemporary art from China since the 1970s. The course begins with a brief overview of modern art activities in China during the early 20th century along with art production under Mao. The course will then focus on contemporary avant-garde movements during the 1970s and 1980s, the response to urbanisation in art at the onset of the new millennium, the influence of globalisation since 2000, and a new generation of young artists from China as well as Chinese diasporic artists working transnationally.

Art and Colonialism in Mediterranean History

Dr Danai Thomaidis
Princeton, Seeger Center for Hellenic Studies

This research course explores the dynamic relationship between art and colonialism in the Mediterranean, from antiquity to the modern day. It offers a comprehensive examination of how diverse colonial powers have influenced and shaped the rich tapestry of cultural production within the region. Employing a multidisciplinary approach, the course blends art history, cultural studies, and historical analysis to unravel the nuanced complexities of artistic expression within the intricate web of colonisation.

DR HAKAN COSKUN

CURRENT POSITIONS

Research Fellow in Pediatrics, Department of Cardiology, Harvard Medical School / Boston Children's Hospital

Member, American Heart Association

PREVIOUS APPOINTMENT

Postdoctoral Research Fellow, Department of Developmental Neuroscience, Instituto de Neurociencias (Spanish National Research Council)

A peadiatric cardiologist working on stem cell research and investigating the genetic mechanism of heart diseases.

As a cardiologist, Dr Coskun's research focuses on heart development and disease. He is interested in examining cardiac progenitor cells heterogeneity in a single-cell level resolution during early heart development by using zebrafish as an animal model. Dr Coskun is developing congenital heart disease models and investigating the molecular and genetic mechanisms of heart diseases. Previously, his publications have appeared in prestigious peer-reviewed journals, including *Placenta, Stem Cells Translational Medicine*, and *Nature*.

As a mentor, Dr. Coskun has taught a wide range of subjects, including the principles of developmental biology and stem cell biology, genome engineering using the CRISPR-Cas9 system, and animal model organisms.

DR HAKAN COSKUN, HARVARD UNIVERSITY

DEVELOPMENTAL BIOLOGY:

GENE EDITING, STEM CELLS, MODEL ORGANISMS, AND EPIGENETICS

Suitable for students interested in:

BIOLOGY
Biochemistry | Developmental Biology | Stem Cells

MEDICINE
Cardiology | Drug Discovery | Genome Engineering

"Omnis cellula e cellula," said Rudolph Virchow who was one of the 19th century's foremost leaders in medicine and pathology. It means that each cell derives from a pre-existing cell by division. Each of us starts life by the joining of one cell from our father and one cell from our mother. Likewise, our father and mother began their lives from the union of a single cell from each of their parents. Then we should ask ourselves: "How does a functioning organism arise out of a bunch of cells? If all these cells have the same genetic information, where is the programme that controls this?" These are still fundamental questions that remain unanswered.

In this research course, we will talk about the principles of developmental biology and stem cell biology. Then, we will continue with organ development such as the heart. We use different tools to do functional experiments in biology. Thus, we will talk about genome engineering using the CRISPR-Cas9 which is a novel genetic modification tool. The 2020 Nobel Prize in Chemistry was awarded to Prof Emmanuelle Charpentier and Prof Jennifer Doudna, for their discovery of the CRISPR/Cas9 genetic scissors that have revolutionised genome editing.

We will also have the opportunity to talk about model organisms such as flyes, zebrafish, chicken embryos and mice, and advantages of organoids technology.

Furthermore, we will discuss featured research articles which are published in high impact journals in developmental biology, stem cells and genetic fields. The objective of the research course is to encourage students to think creatively about how a cell develops an organism, how we can study them experimentally, how we can edit genes, and how we can use animal models to analyse in vivo data. By working on individual research projects, students will develop a good understanding of developmental biology from various perspectives.
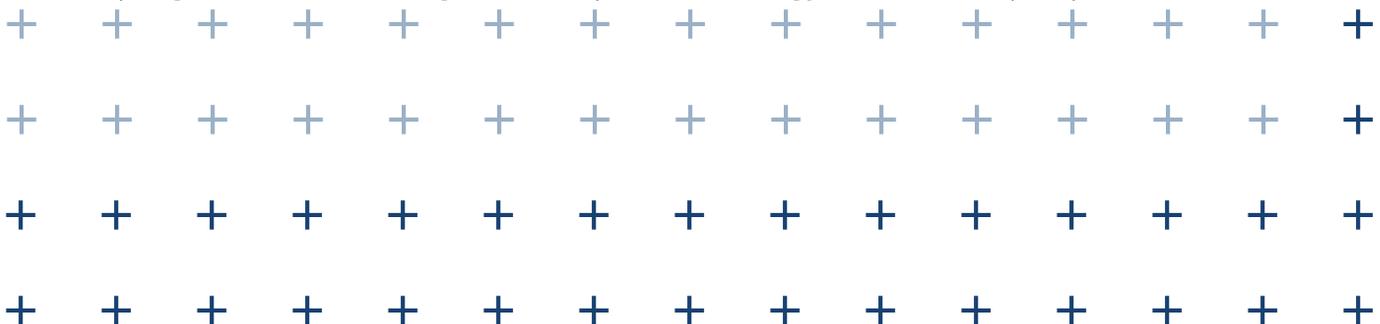
BROWN UNIVERSITY

DR MAMIKO YAJIMA

CURRENT POSITIONS

Assistant Professor (Research), BioMed MCB Department, Brown University

Principal Investigator, Yajima Lab, Brown University

PREVIOUS APPOINTMENT

Investigator, BioMed MCB Department, Brown University

A developmental biologist trying to the fundamental biological question of cells and studying the connections between embryonic plasticity, epigenetics, and oncology.

As a researcher, Dr Yajima focuses on developmental biology, specifically the mechanisms of developmental plasticity that are essential for any living organism to successfully survive, develop, and/or regenerate in various environments. She leads the Yajima Lab, with the goal of answering the fundamental biological question of "what makes each cell type unique and different from another" using advanced microscopy, proteomics, metabolomics, and systems-level approaches. Dr Yajima's research has been published in leading scientific journals, such as *Nature Communications, Current Topics in Developmental Biology, Proceedings of the National Academy of Sciences of the United States of America, Developmental Dynamics*, etc. In addition, several of her papers have been chosen as the cover image for various journals, including *Cancer Science, Developmental Biology, Molecular Reproduction and Development*, and others.

Since 2008, Dr Yajima has served as a reviewer for numerous research journals, including *Stem Cell Reports, Molecules, Gene, Developmental Dynamics, Experimental Cell Research,* etc.

As a mentor, Dr Yajima leads graduates and undergraduates at her lab at Brown. In 2021, she was recognized for her outstanding teaching and research skills, receiving both the Undergraduate Teaching and Research Award and Faculty Research Award at Brown.
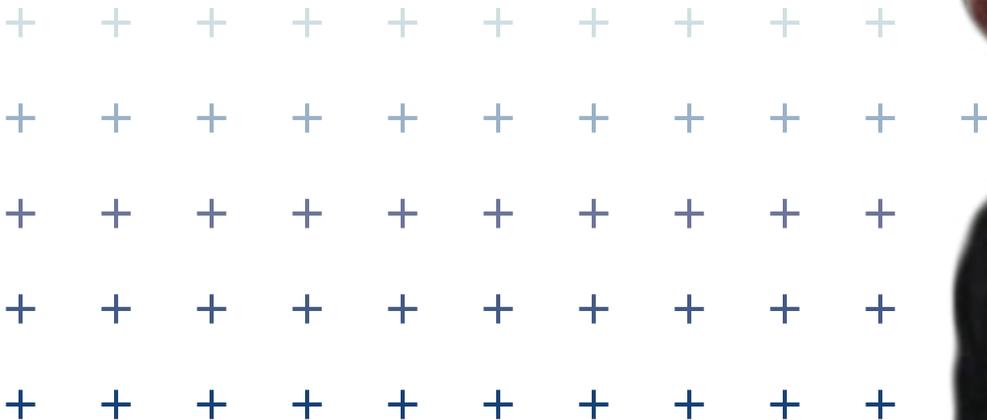
DR MAMIKO YAJIMA, BROWN UNIVERSITY

ADVANCED CELL AND DEVELOPMENTAL BIOLOGY

Suitable for students interested in:

BIOLOGY

Cell Biology | Developmental Biology | Genetics

MEDICINE

Stem Cells | Cancer Research | Drug Discovery

In this research course, each student is tasked to read, digest, and present assigned peer-reviewed research articles in the field of cell and developmental biology—to investigate how a variety of interacting processes generate an organism's heterogeneous shapes, size, and structural features that arise on the trajectory from embryo to adult or, more generally throughout a life cycle. It represents an exemplary area of contemporary experimental biology that focuses on phenomena that have puzzled natural philosophers and scientists for more than two millennia.

Students will be asked to dive into the background, methods, and technologies and be able to critically assess the scientific data. The mentor will present example articles for the first 1–2 classes to cover the foundations of a scientific presentation and each student will take turns presenting articles after this preparation period. Each presenter of the week is expected to present literature in a scientifically professional manner, which is followed by scientific questions and discussion with peers and an instructor. The presenter may be asked further to look up the details for the questions that were not answered during the presentation in the following weeks.

This research course is discussion-based rather than lecture-based to improve one's critical reading and scientific presentation skills in science. Topics of interest include asymmetric cell division, cell signalling and metabolism, cellular specification and differentiation, mRNA translation, embryonic development, germ cell and stem cell development, and cancer regulation.

Students may also propose literature of their own interest starting from the 2nd round of presentation cycles. Furthermore, students are encouraged to reflect on broader societal implications of the research, such as how each study contributes to advancing the field and technologies, and impacts human life and the world. Creative and independent thinking with self-learning motivation is critical in this class.
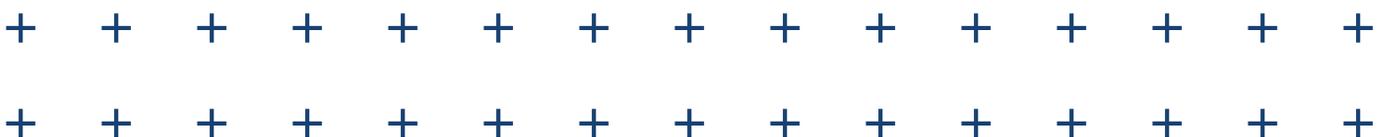
DR BART NIEUWENHUIS

CURRENT POSITION

Research Associate, Cambridge Institute for Medical Research, University of Cambridge

PREVIOUS APPOINTMENT

Research Associate, Department of Clinical Neurosciences, University of Cambridge

A neuroscientist who studies gene therapy, nerve repair, and regeneration.

As a neuroscientest, Dr Bart Nieuwenhuis' interest lies in neuronal regeneration and plasticity. His research contributes to the field of gene therapy, which is a promising tool for the promotion of axon regeneration, and restorative neuroscience. His research contributes to the field of gene therapy, which is a promising tool for the promotion of axon regeneration, and restorative neuroscience. In addition to that, he is also interested in laser axotomy and axon transport. His research has been funded by Spinal Research, a leading charity in the United Kingdom (UK) that funds medical research around the world in order to develop effective treatments for paralysis caused by a spinal cord injury. His studies have been published in many prestigious journals, including *Gene Therapy, EMBO Molecular Medicine, International Journal of Molecular Sciences, Biological Reviews,* and he has presented his research a number of times, including at the 19th Spinal Research Network Meeting, the British Society for Gene and Cell Therapy, and the Society for Neuroscience.

As a mentor, Dr Nieuwenhuis is keen to help students develop a good understanding of regenerative neurobiology and to share his passion for the subject and his research.

REGENERATIVE NEUROBIOLOGY AND GENE THERAPY

Suitable for students interested in:

MEDICINE

Spinal cord injury | Regenerative Medicine | Gene therapy

NEUROSCIENCE

Axonal Regeneration | Axonal Transport | Molecular and Cellular Biology

BIOINFORMATICS

Experimental data | Data Analysis

Injury to the brain and spinal cord has devastating consequences as adult neurons in the central nervous system do not repair their nerve fibres. There are 130,000 new cases of spinal cord injury per year worldwide, and this injury can have a severe impact on patients as it can cause paralysis.

This research course covers the cellular and molecular biology of the nervous system and has a particular focus on the regrowth of nerve fibres after an acute injury – a process called axon regeneration. For instance, how axon regeneration is affected by the site of the injury and the changes that happen within neurons due to ageing will be explored. Gene therapy, which is a promising approach to promoting repair in neurons, and common laboratory techniques used in neurobiology, such as DNA manipulation, cell culture, and microscopy, will also be discussed.

The independent research project will enable students to gain hands-on experience in the analysis of real experimental data from fluorescence microscopy of neurons and the presentation of scientific results. Furthermore, students will learn how to read and understand primary research articles. Key scientific papers in regenerative neurobiology will be discussed in order to attain in-depth insights into this topic.

By the end of this research course, students will have a good understanding of the nervous system, both when healthy and after traumatic injury, and will have a good grasp of how the nervous system is studied at a cellular and molecular level. They will also have an improved understanding of research articles and be knowledgeable about experimental microscopy analysis.

DR JODI KRAUS

CURRENT POSITIONS

Presidential Postdoctoral Research Fellow, Department of Molecular Biology, Princeton University

Helen Hay Whitney Research Fellow, Helen Hay Whitney Foundation

PREVIOUS APPOINTMENTS

National Science Foundation Graduate Research Fellow, National Science Foundation

Instructor, Summer Undergraduate Research Program, Department of Molecular Biology, Princeton University

As a researcher, Dr Kraus explores the intersections of chemistry and molecular biology. She has left her mark through a wide range of groundbreaking results that delve into topics ranging from protein structure dynamics to advanced spectroscopy techniques. Her work in the field of microtubule nucleation pathways, as showcased in her latest paper "Microtubule Nucleation for Spindle Assembly," reflects her dedication to pushing the boundaries of knowledge in molecular biology. Dr Kraus has, in this process, garnered an impressive array of fellowships including the Presidential Postdoctoral Research Fellowship and the Helen Hay Whitney Foundation Research Fellowship.

Beyond scholarly work, Dr Kraus is also an avid advocate for community engagement and leadership in her capacity as Vice President of the Hunger and Homelessness Prevention Coalition at Drexel University and her contributions as Secretary and Fundraising Chair for the Women in Chemistry at Princeton.

Dr. Kraus has presented her research at prestigious conference venues, including the *Frontiers in the Chemistry-Biology Interface Virtual Symposium*, *the 63rd Annual Meeting of the Biophysical Society*, and the *59th Experimental Nuclear Magnetic Resonance Conference*. Her contributions extend to peer-reviewed publications featured in prominent journals, such as the *Journal of Biological Chemistry, Nature Communications, ChemPhysChem, Journal of Physical Chemistry B*, and the *Journal of Biomolecular NMR*.

As a mentor, Dr Kraus's passion for teaching is evident through her involvement in various educational initiatives. In her teaching at Princeton University, she aims to cultivate dynamic learning environments. She has also served as an instructor for the Summer Undergraduate Research Program and the Junior Molecular Biology Tutorials, where she creates tailored learning experiences that bridge the gap between theoretical knowledge and practical application.
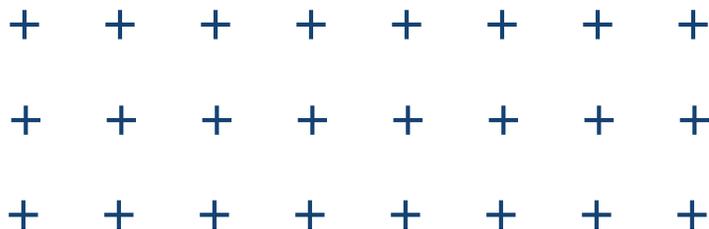
DR JODI KRAUS, PRINCETON UNIVERSITY

MOLECULAR BUILDING PLANS FOR THE CELL:

HOW TO BUILD CELLULAR STRUCTURES USING BIOCHEMICAL APPROACHES

Suitable for students interested in:

BIOLOGY

Biochemistry | Cell Biology | Structural Biology

MEDICINE

Nanotechnology | Drug Discovery | Biotechnology

In this course, students will receive a comprehensive introduction to the fascinating world of protein biochemistry. The first section of the course will introduce the basics of protein function and the different levels of protein structure. We will then discuss types of protein-based machinery within the cell that allows cells to complete very specific functions that are critical for viability and survival. Examples of protein-based machinery include the mitotic spindle, which segregates chromosomes during cell division and ATPases, which convert chemical energy from ATP into mechanical work.

The second section of the course will be focused on introducing molecular biology tools and experimental techniques to identify and study new proteins, using both in-vivo (live cell) and in-vitro approaches via purified systems. We will span several decades of technological advancements including the polymerase chain reaction (PCR), recombinant protein expression technologies, CRISPR/Cas9 gene editing, and advances in optical microscopy approaches. We will combine fundamental concepts in molecular biology and biochemistry with the seminal literature in the field that has led to major scientific breakthroughs and altered the way textbooks are written. Students will explore protein-based machines through independent research projects using basic molecular biology and biochemical techniques (if available) and/or computational AI-based tools.

UNIVERSITY OF OXFORD
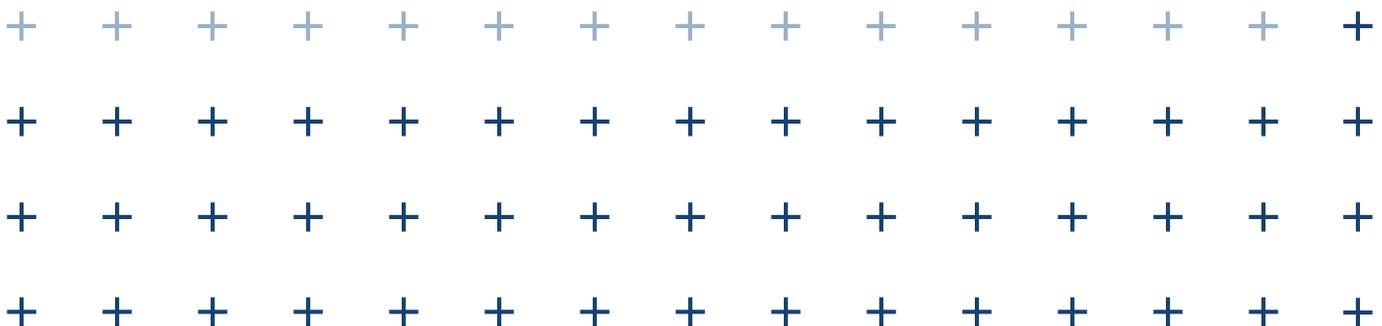
DR STRUAN MURRAY

CURRENT POSITIONS

Lecturer in Biochemistry, Corpus Christi College, University of Oxford

Research Associate, Department of Biochemistry, University of Oxford

Grant Recipient, Leverhulme Research Project

PREVIOUS APPOINTMENT

Tutor in Biochemistry, St John's College, University of Oxford

A biologist utilising advanced computational techniques to investigate genetics and address fundamental questions related to gene regulation.

As a researcher, Dr Murray is focused on studying chromatin, gene regulation, and bio-informatics in order to improve our understanding of how cells work and how diseases develop. This knowledge can be used to develop new therapies and treatments that can help to improve the lives of people affected by these conditions.

His research involves both experimental and computational methods. Currently, Dr Murray is exploring the mechanisms of gene regulation through the use of computational techniques. Particularly, he studies how non-coding RNAs regulate and how genes are transcribed, bringing about fundamental changes in gene behaviour. Previously, his research has been published in *Molecular Systems Biology, BioArchitecture, Nucleic Acids Research,* and many other leading journals.

As a mentor, Dr Murray is responsible for teaching Molecular and Cellular Biology to students at the University of Oxford. He works with 1st-3rd year biochemists, helping them to gain a deeper understanding of the fundamental concepts and techniques used in this field. In addition, he also teaches 1st-year medical students, providing them with a strong foundation in the biological principles that are essential for their future careers.

DR STRUAN MURRAY, UNIVERSITY OF OXFORD
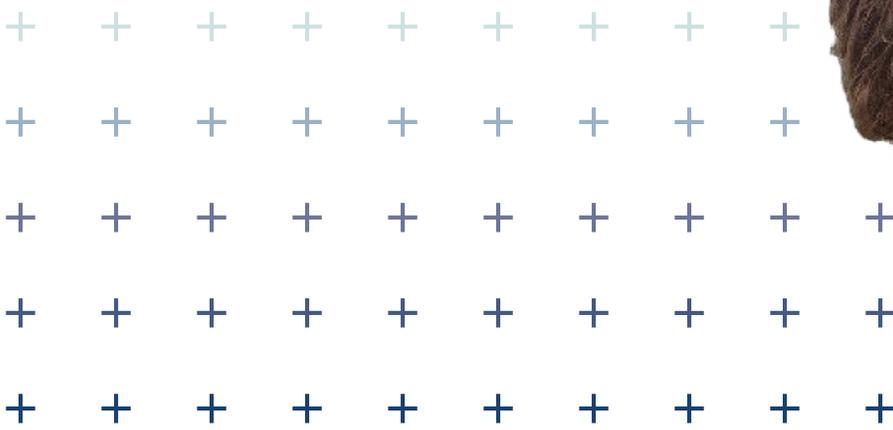
COMPUTATIONAL GENETICS:

DATA SCIENCE, BIOLOGY, AND MEDICINE

Suitable for students interested in:

COMPUTER SCIENCE
Data Science | Data Analysis | Modelling

MEDICINE
Clinical Data | Cancer Research

BIOLOGY AND BIOINFORMATICS
Statistics | Biological Data | Cellular Biology | Genes and Genomes

Genetics sits at the centre of cellular biology and governs the behaviour of all life on Earth. In recent years, the use of computational methods has become increasingly essential for the analysis and understanding of genetic data. By utilising technological approaches, researchers are able to gain a deeper insight into the genetic basis of various biological processes and phenomena.

In this research course, students will explore genetics by delving into the biology of genes and genomes, with a particular emphasis on how computational approaches can be used to further our understanding of both.

Students will learn how modern, cutting-edge experimental techniques are able to observe molecular events across the genome of an organism, producing vast quantities of data that can then be analysed computationally. Throughout the course, students will be introduced to the programming language MATLAB, and will be given the opportunity to use MATLAB to analyse real data of this kind. By working on individual research projects, students will learn how using computational approaches to study clinical data can further our understanding of diseases such as cancer.

The objective of the research course is to encourage students to think creatively about how genes and genomes work, how we can study them experimentally, and how we can use computational approaches to analyse experimental data. By the end of the course, students will have a good idea of the basics of MATLAB, and how it can be used to analyse genome-wide datasets.

UNIVERSITY OF CAMBRIDGE
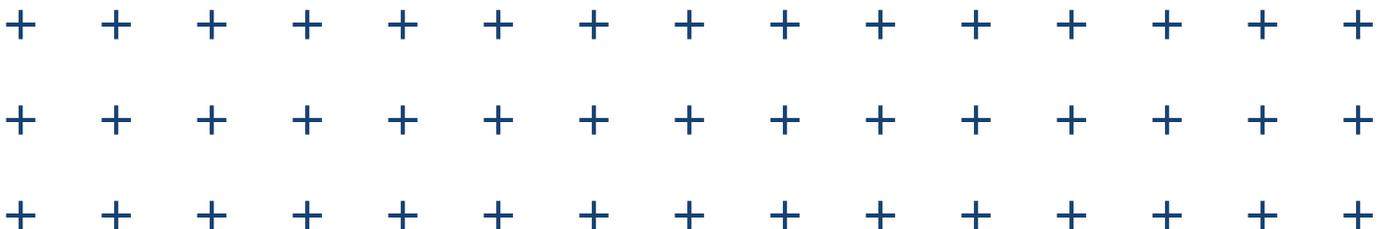
DR ASHRAF ZARKAN

CURRENT POSITIONS

Research Fellow, Department of Genetics, University of Cambridge

Entrepreneurial Lead, Biofilms ICURe Sprint

A scientist endeavouring to tackle antibiotic resistance, which is viewed by many researchers as the potential next pandemic and a significant threat to global health.

As a researcher, Dr Zarkan is a geneticist and microbiologist with a pharmaceutical background, holding a PhD in Biochemistry from the University of Cambridge. By employing computational and experimental approaches, he studies antibiotic resistance and the mechanism of indole signalling in bacteria, using E. coli as a model organism. He is also passionate about tackling the increasingly pressing problem of antibiotic resistance. Previously, he has published on top peer-reviewed journals, including *Scientific Reports (published by Nature) and Trends in Microbiology*. His research has been supported by Cambridge Trust & Said Foundation, Leverhulme Trust, and Innovate UK, SBRI: Antimicrobial Resistance (AMR) in Humans.

Additionally, he currently serves as the Entrepreneurial Lead at the Biofilms ICURe Sprint, a joint initiative by Innovate UK and the National Biofilms Innovation Centre (NBIC). In this role, he is working on developing a novel therapy for infections and conducting research to explore and validate the clinical need and market potential for this research.

As a mentor, Dr Zarkan has a wealth of teaching experience as a mentor at Cambridge University, where he supervises both undergraduate and PhD students.

DR ASHRAF ZARKAN, UNIVERSITY OF CAMBRIDGE

COMPUTATIONAL GENETICS AND DRUG DISCOVERY:

COMBATTING INFECTIOUS DISEASES

Suitable for students interested in:

MEDICINE
Clinical Research | Drug Discovery | Antibiotic Resistance

BIOLOGY
Bioinformatics | Genetics | Microbiology

COMPUTER SCIENCE
Computational Biology | Data Science

The human body is a complex ecosystem containing many beneficial microorganisms. However, some microorganisms, known as pathogens, can cause contagious infections. A recent example is the spread of the Coronavirus which led to the COVID-19 pandemic. There are four major groups of pathogenic microorganisms including bacteria, viruses, fungi, and parasites.

In this research course, we will explore prevention and treatment strategies against infectious diseases, with a particular emphasis on vaccination. We will also delve into the rise of antimicrobial resistance (AMR), which occurs when pathogens develop the ability to defeat the medicines designed to kill them.

We will learn about the role of genetics in understanding and combating infectious diseases and how modern computational analysis known as bioinformatics enhances our understanding of infection mechanisms at the gene and protein levels.

Students will be introduced to the use of bioinformatics and will be given the opportunity to access bioinformatics tools to probe DNA and learn more about protein function. The learning process will start from the basics of representing proteins and DNA in simplified sequences of letters. We will then move into searching databases to understand more about the functions of genes and proteins, which can further our understanding of infection mechanisms.

The objective of the research course is to encourage students to think creatively about how infectious diseases occur and spread, how we can prevent and treat them, and how we can use bioinformatics to explore genetics and understand pathogenic properties. By the end of the research course, students will have a good idea of the foundation of bioinformatics, and particularly how it can be used to analyse genomic bacterial datasets.

DR MARTA MATUSZEWSKA

CURRENT POSITION

Research Associate, Department of Medicine, University of Cambridge

PREVIOUS APPOINTMENT

Research Associate, Department of Veterinary Medicine, University of Cambridge

An evolutionary microbiologist using computational methods to explore bacterial adaptation and behaviour.

As a researcher, Dr Matuszewska is trained in evolutionary microbiology and has a particular research interest in bacterial host adaptation, as well as the genomic and ecological contexts of host switching. Her research involves both laboratory and computational analysis, and sample collection from wild and domestic animals. Currently, she uses comparative genomic analyses to investigate host range and host switching dynamics in the important and often highly antibiotic-resistant pathogen *Staphylococcus aureus*.

Dr Matuszewska's research works have been published in a number of prestigious peer-reviewed scientific journals, including M*icrobiology Spectrum, Antimicrobial Agents and Chemotherapy, Journal of Antimicrobial Chemotherapy, Trends in Microbiology,* and *PLOS Genetics*, to name a few. From 2016 to 2018, she was invited as a guest speaker at several prestigious conferences including the *Microbiology Society Annual Conference, the 19th Annual Conference in Proteomics and Genomics, and Understanding and Predicting Microbial Evolutionary Dynamics*.

As a mentor, Dr Matuszewska serves as a research projects supervisor at the University of Cambridge. Meanwhile, she actively volunteers and collaborates with organisations such as the Cambridge Science Festival, Nature Portfolio, and CRUK Science Day to promote accessibility to science among the general public and young scientists.

DR MARTA MATUSZEWSKA, UNIVERSITY OF CAMBRIDGE
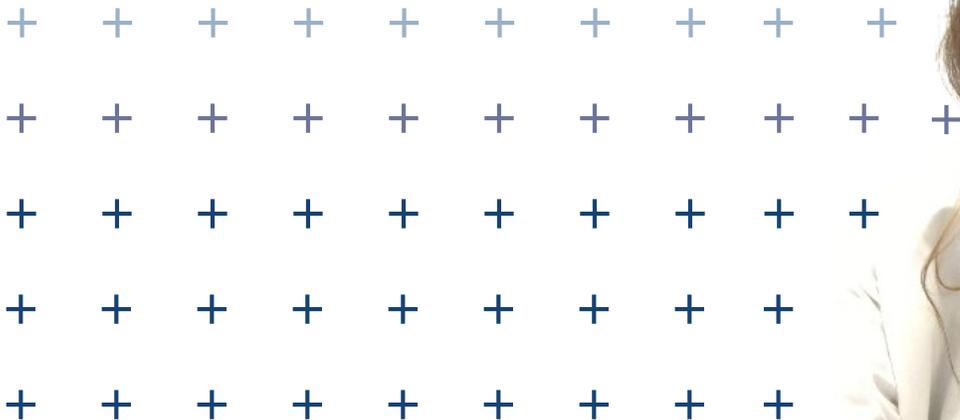
MOLECULAR EPIDEMIOLOGY:

EMERGENCE, EVOLUTION AND SPREAD OF PATHOGENS

Suitable for students interested in:

BIOLOGY

Molecular Epidemiology | Infectious Diseases | Pathogen-Host Ranges

GENETICS

Evolutionary Theory | Genetic Mutations | Computational Genetics

Pandemics are a major threat to public health and can have severe consequences for global economies, making it important to study the factors that drive their emergence and spread. One of the key drivers of pandemics is the ability of pathogens to switch hosts and establish themselves in new species. We will explore the factors that contribute to host switching and adaptation, including changes in host specialisation, transmission, and genetic mutations.

This research course will delve into the fascinating and complex world of infectious diseases from a genetic perspective. We will focus on the use of whole-genome genetic data to better understand the molecular mechanisms underlying the spread and evolution of pathogens that cause infectious diseases.

We will examine several examples of host switching and adaptation in infectious diseases, including the emergence of viruses like HIV-1 and SARS-CoV-2, and bacteria like Methicillin-resistant Staphylococcus aureus (MRSA). We will also explore how antimicrobial resistance can arise in bacteria and pose a significant threat to public health and food security.

Students will have the opportunity to conduct their own independent research projects, which will enable them to apply the concepts and techniques learned throughout the course to real-world scenarios. By doing so, students will gain a comprehensive understanding of the emergence, evolution, and spread of pathogens.
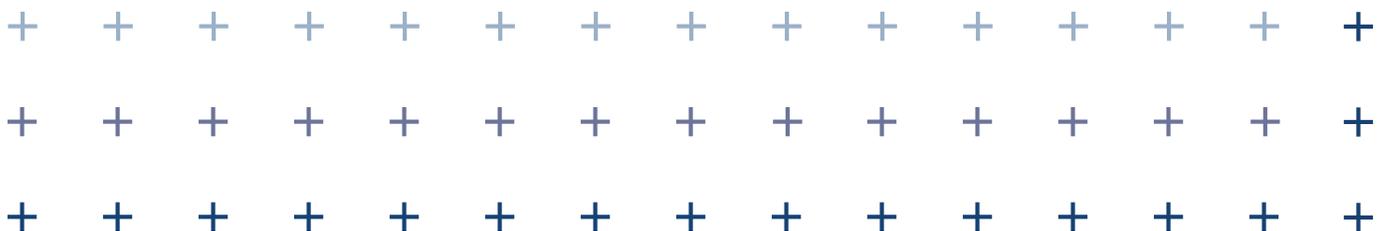
UNIVERSITY OF CAMBRIDGE
DR BEGÜM AKMAN-TUNCER

CURRENT POSITIONS

Research Associate, Cancer Research UK Cambridge Institute, University of Cambridge

Research Associate, Department of Pharmacology, University of Cambridge

A cancer researcher who focuses on ubiquitin signalling and how it controls the cell cycle and cell proliferation.

As a researcher, Dr Akman's work investigates fundamental issues in cancer research and the development of cancer therapies. She is interested in understanding the complexity of the human proteome by studying non-coding RNAs and their involvement in post-transcriptional gene regulation. Her current research mostly focuses on targeted protein degraders (TPDs) where she uses biochemical and bioinformatics tools to unravel novel therapeutic targets and target them using TPDs. For this, she works with human mammalian cell cultures and uses techniques such as flow cytometry, mass spectrometry and single-cell imaging using fluorescent microscopy. She combines wet-lab practices with data mining to uncover novel TPD targets and subsequently test them.

Her research has been published in high-impact journals such as *Nucleic Acids Research, Mammalian Genome, Human Molecular Genetics, and Journal of Cell Science.* She is a recipient of the prestigious CoCirculation2 fellowship.

As a mentor, Dr Akman has been involved in training and mentoring several MPhil and PhD students in the lab during her postdoctoral research work. In addition to her research, She is also passionate about communicating her research findings to the public by being involved in public-outreach events, having organised the Cambridge Science Festival where they used hands-on activities to explain to the public how to use fluorescent proteins in cell-biology research.

DR BEGÜM AKMAN-TUNCER, UNIVERSITY OF CAMBRIDGE
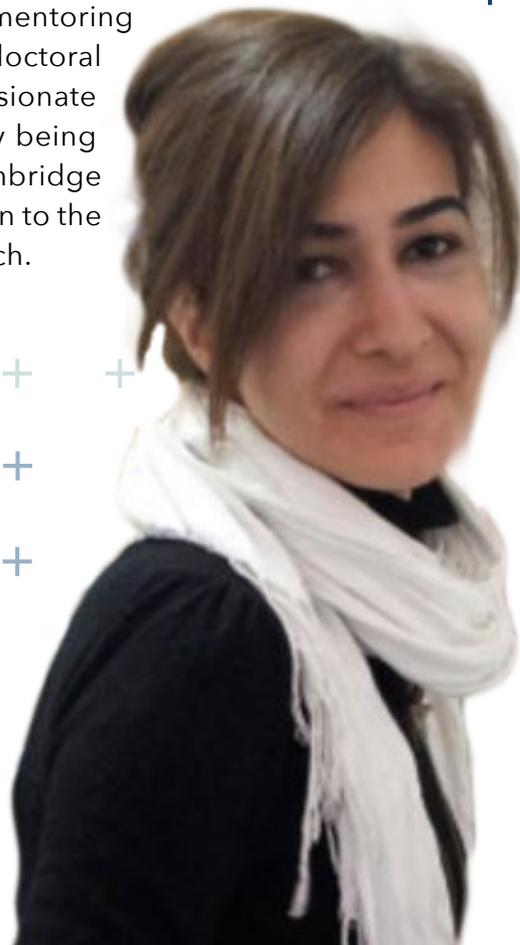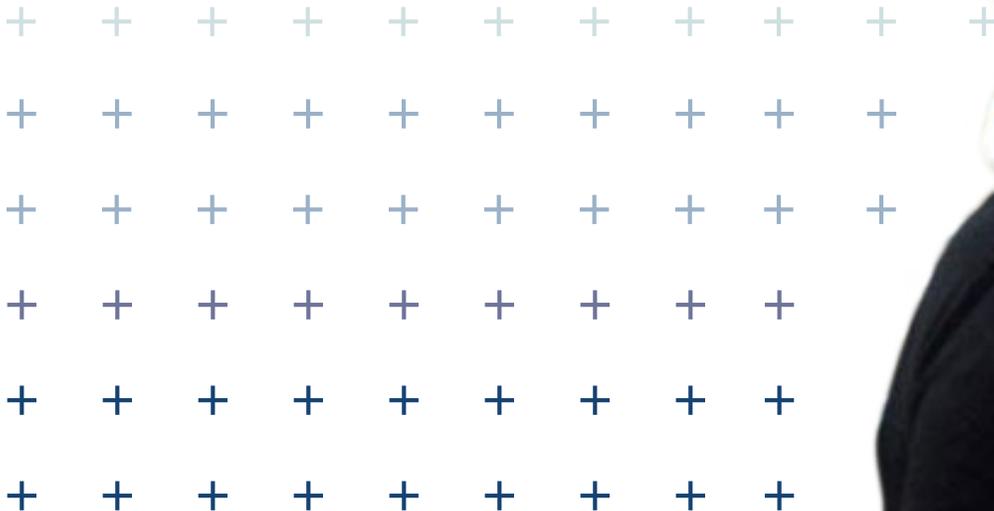
CANCER BIOINFORMATICS:

MINING THE "BIG DATA"

Suitable for students interested in:

BIOLOGY
Genetics | Genomics | Bioinformatics

MEDICINE
Oncology | Computational Medicine

COMPUTER SCIENCE
Data Science | Machine Learning

Cancer is a leading cause of death worldwide, accounting for nearly 10 million deaths each year and representing one of the biggest biomedical-research challenges of our time. Understanding the molecular basis and cell biology of cancer is crucial to find new tools for early diagnosis and novel therapeutics. In the past two decades, with advances in high-throughput technologies (such as Next-Generation Sequencing [NGS] and gene microarray), genomic, transcriptomic and epigenomic data of cancer patients have become available via public databases, such as Gene Expression Omnibus (GEO) and The Cancer Genome Atlas (TCGA). For example, TCGA is a cancer-genomics program that includes over 20,000 molecularly characterised primary cancer spanning 33 cancer types. These datasets provide opportunities to explore important cancer-related molecules, diagnostic and prognostic biomarkers, and therapeutic targets.

In this research course, we will learn the basic principles of cancer biology and how to use different bioinformatics tools to analyse health data. The biological basis for the occurrence and appearance of tumour cells will be explained. We will discuss the hallmarks of cancer to better understand how to interpret the results that we discover from data-mining exercises. The biochemical pathways involved in cancer formation, including oncogenes and tumour-suppressor genes, will be discussed. To be able to comprehend why some genes are more important in the context of cancer, we will have a closer look at the gene structures and how to analyse genes using in-silico tools.

Lastly, we will explore large-scale biological data using different bioinformatics tools and platforms. These practices are useful to understand functions of discovered genes and relevant biochemical pathways. Eventually, these findings will allow students to uncover genes that may have a potential role as biomarkers or have therapeutic applications.
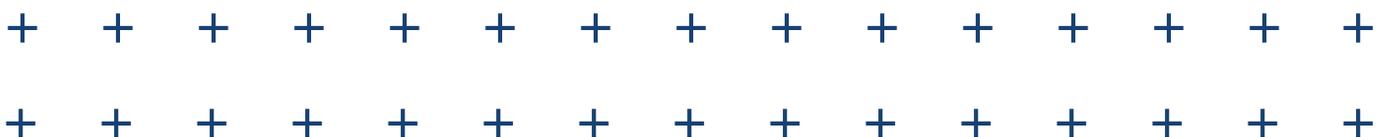
DR BEGÜM AKMAN-TUNCER, UNIVERSITY OF CAMBRIDGE

PRECISION MEDICINE AND BIOINFORMATICS:

GENOMICS-BASED PERSONALIZED TREATMENT

Suitable for students interested in:

BIOLOGY
Genetics | Genomics | Bioimarkers

MEDICINE
Personalised Treatment | Precision Medicine

Precision medicine, also known as personalized medicine, is a transformative approach to medical treatment and healthcare. By considering individual differences in patients' genes, environments, and lifestyles, precision medicine aims to tailor interventions for improved outcomes. Central to this revolution is bioinformatics, which provides the computational tools necessary to interpret vast biological datasets generated in this era of genomics and personalized care.

This research course delves into the dynamic intersection of genomics, gene-editing technologies, data science, and personalized healthcare, offering students a comprehensive understanding of how cutting-edge innovations are revolutionizing the diagnosis, treatment, and prevention of human diseases. Through the use of bioinformatics tools, students will learn to analyze large-scale biological datasets to extract meaningful insights. Topics will include the groundbreaking potential of gene-editing technologies such as CRISPR-Cas9, the role of gene therapy in addressing genetic disorders, and the transformative impact of artificial intelligence and machine learning in healthcare.

Students will explore key concepts in genomics and molecular profiling, gaining a thorough understanding of how CRISPR enables precise genome editing with far-reaching implications for treating genetic disorders. They will also investigate the role of gene therapy, which modifies or delivers genes to correct underlying genetic defects. Practical sessions will focus on identifying disease biomarkers and integrating multi-omics data—such as genomics, transcriptomics, proteomics, and metabolomics—to provide a holistic view of biological systems.

As part of the research course, students will engage in independent research projects that apply bioinformatics analyses and gene-editing techniques. These hands-on projects will allow students to generate novel data, contribute to scientific knowledge, and prepare their findings for potential publication.

By the end of this research course, participants will have gained both foundational and practical expertise in precision medicine, mastering the use of bioinformatics tools, CRISPR-based gene-editing technologies, and gene therapy approaches. Equipped with these skills, students will be ready to contribute to the advancement of personalized healthcare and the future of medicine.

HARVARD MEDICAL SCHOOL

DR NAAMA KANAREK

CURRENT POSITIONS

Assistant Professor, Department of Pathology, Harvard Medical School /

Boston Children's Hospital

Principal Investigator, Kanarek Lab

PREVIOUS APPOINTMENTS

Cancer Researcher, Columbia University Medical Center

Postdoctoral Researcher, MIT Whitehead's Institute

An oncologist exploring metabolic systems at the whole-organism level to push the boundaries of cancer research.

As a researcher, Dr Kanarek and her team use genetic perturbations, biochemical assays, molecular biology and metabolite profiling for a comprehensive study of folate homeostasis at the cellular level and the whole-organism level. Her Lab (The Kanarek Lab) investigates folate utilisation by various cell types and tissues and explores the cancer-specific survival mechanisms of folate-deprived cells in culture and in vivo. Dr Kanarek is the recipient of many awards and honours, including the Margaret and Herman Sokol Postdoctoral Award (2018) and the Leukaemia and Lymphoma Society New Idea Award (2017).

As a practising physician working mainly with paediatric cancer patients, Dr Kanarek developed great care for these patients and a deep understanding of their needs. She established No Empty Bedsides (www.noemptybedsides.com), a charitable organisation that helps find solutions for parents who, for personal or financial reasons, have difficulty remaining in hospital while their children undergo medical treatment.
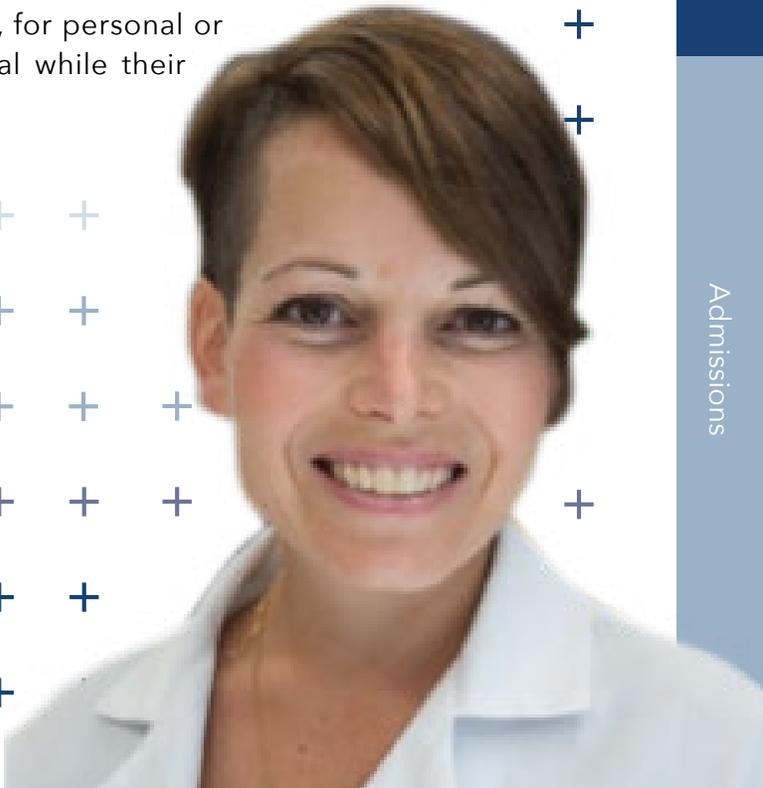
DR NAAMA KANAREK, HARVARD MEDICAL SCHOOL

FRONTIERS IN CANCER RESEARCH:

EXPLORING METABOLOMICS APPLICATIONS

Suitable for students interested in:

MEDICINE

Cancer Research | Metabolomics | Clinical Research

BIOLOGY

Cellular Biology | Systems Biology | Molecular Biology

In this research course, students will embark on a research journey into the dynamic realm of cancer research, with a particular focus on metabolomics application. As the landscape of cancer investigation continues to evolve, yielding an abundance of new insights, the course offers an exploration of cutting-edge knowledge in cancer research.

At the beginning of the research course, students will be introduced to metabolomics application in cancer research. Metabolism is the front line of all cellular functions. Metabolites are the little workers that actually do what needs to be done in a cell. When a cell grows, nutrients feed that growth, and when a signalling event happens, metabolites provide the materials (such as phosphates) and the energy to enable functioning. When cell fate decisions are made, metabolite sensing is often a critical part of that decision-making process. Therefore, it is not surprising that cancer cells reprogram metabolism to feed their own needs, and metabolic rewiring drives tumour initiation, progression, and metastasis. In some cases, specific mutations in metabolic genes are sufficient to cause cancer, emphasising the critical role played by metabolic rewiring in tumour transformation.

Under such context, students will explore cancer metabolism and discuss how unique metabolic traits are, or can be, targeted to treat cancer. The cancer metabolism field incorporates research on metabolic adaptations of cancer cells, unique and targetable metabolic needs of cancer cells, and the cancer microenvironment from the nutritional perspective. A relatively new and exciting frontier is the competition between cancer and immune cells over limiting nutrients in the tumour microenvironment. Recent technological advancements allow more and more cancer researchers to incorporate metabolite profiling of cancer cells and tumours in their research. The technological advancement facilitates exciting research and novel findings that make the cancer metabolism field a lively front in cancer therapy development.

By conducting their independent research project, students will gain a solid understanding of the intricate interplay between metabolism and cancer, along with the skills necessary to contribute to the forefront of cancer research development in their future academic career.
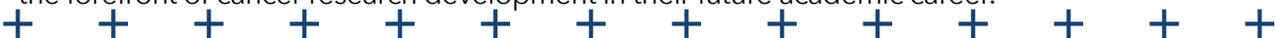
DR MARKITA P. LANDRY

CURRENT POSITIONS

Assistant Professor of Chemical and Biomolecular Engineering, University of California, Berkeley

Principal Investigator, Landry Lab, University of California, Berkeley

Faculty Scientist, Lawrence Berkeley National Laboratory

Assistant Professor, Hellen Wills Neuroscience Institute

Investigator, Chan-Zuckerberg Biohub

Investigator, Innovative Genomics Institute

Scientific Advisory Board Member, Terramera, Inc. / Chi Botanic, Inc.

A chemical and biomolecular engineer leveraging the cutting edge tools of genetic biotechnology and nanoscience to develop medical and agricultural innovations.

As a researcher, Dr Landry's research centres on the development of synthetic nanoparticle-polymer conjugates for imaging neuromodulation in the brain, and for the delivery of genetic materials into plants for agricultural biotechnology applications. She leads the Landry Lab, which focuses on the highly tunable chemical and physical properties of nanomaterials for the creation of bio-mimetic structures, molecular imaging, and plant genome editing.

Through her pioneering work, she has received numerous accolades. She is a recipient of early career awards from the Brain and Behavior Research Foundation, the Burroughs Wellcome Fund, The Parkinson's Disease Foundation, the DARPA Young Investigator program, the Beckman Young Investigator program, the Howard Hughes Medical Institute. She is also a Sloan Research Fellow, an FFAR New Innovator, and is a Chan-Zuckerberg Biohub Investigator. Her works have been published in *Nature Nanotechnology, Nature materials, Nature communications, Trends in Biotechnology,* etc. Her research papers have received over 5,000 citations from other researchers.

As a mentor, Dr Markita has led courses in neuroscience, chemical engineering, and nanoscience at UC Berkeley, MIT, and UIUC. Currently, she supervises a number of students and researchers at the undergraduate and graduate students at her lab.
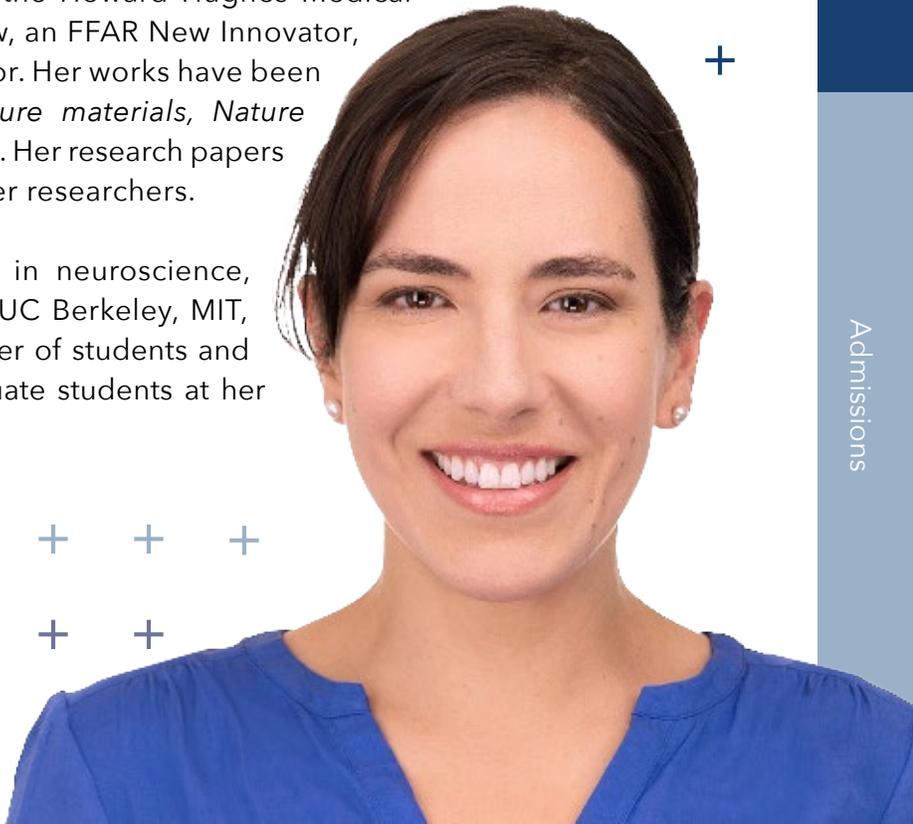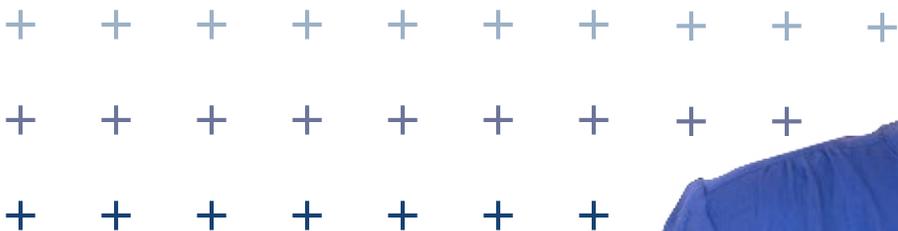
DR MARKITA P. LANDRY, UNIVERSITY OF CALIFORNIA

EMERGING TOPICS IN ENGINEERING BIOTECHNOLOGY:

FROM CRISPR TO CLONING

Suitable for students interested in:

BIOMEDICAL ENGINEERING

DNA Biotechnology | Cloning | Protein Biotechnology

BIOLOGY

Biochemistry | Genetics | Applied Biology

This research course will cover emerging topics in applied biotechnology – from CRISPR to cloning. In the first part of the course, we will learn the fundamental principles of DNA, RNA, and protein biochemistry and think about how analogous techniques to study and analyse these systems have emerged. Such topics include recombinant protein generation and purification, cell culture, cloning, protein folding, and time and length scales in molecular biology, as well as emerging topics in nanomaterials in biology, and the relevance of using synthetic nano-tools to probe, study, and engineer biology at a molecular level. Topics here may include bio-toxicity, nanotechnology in agriculture, nanotechnology in gene delivery, and biomolecular sensors.

We will discuss the central dogma of biology and provide a crash course on techniques in DNA, RNA, and protein biotechnology. Next, we will discuss the development of CRISPR-based genome editing applications in healthcare and agriculture, mRNA-based covid vaccines, and techniques for biological imaging.

The scope of the research course will allow students to probe the cutting-edge interface of biology with engineering. Students are expected to become familiar with the terminologies and mechanisms presented in class and in the reading assignments. The course will include the basics of experimental design in biotechnology and an introduction to university-level research and research integrity ethics. The course will conclude with an interactive research experience in which students will contribute to ongoing active research projects in biotechnology and will familiarise students with emerging techniques of relevance to both industry and academic biotechnology.
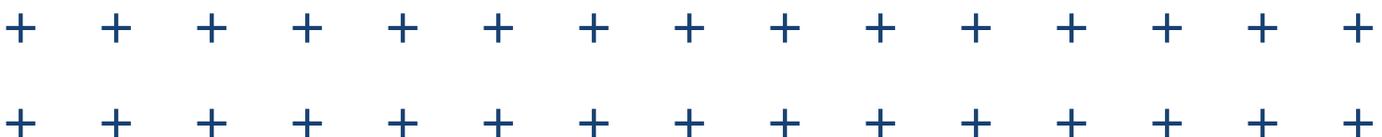
DR MARIA NEOFYTOU

CURRENT POSITION

Postdoctoral Research Associate, Cancer Research UK Cambridge Institute, University of Cambridge

PREVIOUS APPOINTMENTS

Postdoctoral Research Fellow, MRC Weatherall Institute of Molecular Medicine, University of Oxford
Postdoctoral Research Fellow, Laboratory of Cytogenetics & Genome Research, KU-Leuven

A scientist dedicated to developing more humane and personalised early detection cancer diagnostics for women.

As a researcher, Dr Neofytou has a strong background in cancer research and molecular diagnostics. She is currently based at the Cancer Research Cambridge Institute of the University of Cambridge, where she focuses on the early molecular diagnosis of cancer using circulating nucleic acids in plasma and urine. One of her primary areas of work involves analysing next-generation sequencing data from circulating tumour DNA to detect cancer at earlier stages.

Prior to her current position, she worked as a Postdoctoral Researcher at the University of Oxford and KU Leuven in Belgium where she investigated non-invasive prenatal testing (NIPT) and liquid biopsy fields. Dr Neofytou also has expertise in analysing cell-free DNA (cfDNA) for detecting and quantifying low abundance mutations in non-invasive genetic testing. She worked on detecting somatic copy number aberrations by shallow whole-genome sequencing in a large cohort of asymptomatic population, which could have implications in early cancer detection.

Dr Neofytou has authored a chapter in the book *Noninvasive Prenatal Testing (NIPT): Applied Genomics in Prenatal Screening and Diagnosis* published by Academic Press. Her works were also published in a wide range of peer-reviewed scientific journals including *Annals of Oncology, PLoS One*, and *Genetics in Medicine*.

As a mentor, she has supervised MSc and PhD students in their dissertations as well as undergraduate students in their research projects at Oxford and Cambridge.

DR MARIA NEOFYTOU, UNIVERSITY OF CAMBRIDGE
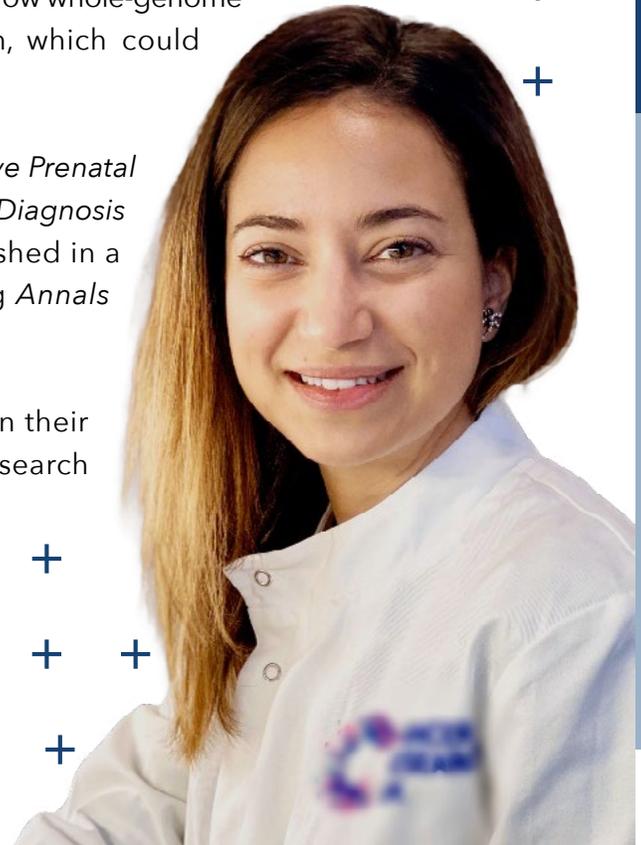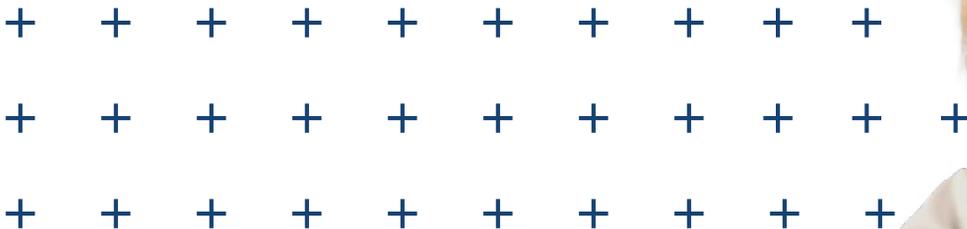
DECODING LIFE:

DNA SEQUENCING AND CANCER DIAGNOSTICS

Suitable for students interested in:

MOLECULAR MEDICINE

Bioinformatics | Molecular diagnostics | Pharmacogenomics

BIOTECHNOLOGY

DNA Sequencing | Cancer Genetics | Therapeutics

One of the greatest scientific achievements in history is the decoding of the whole human genome back in 2003. This was only possible with advancements in DNA sequencing methods, where scientists were able to determine the exact order of the bases in DNA – the As, Cs, Gs and Ts that make up a fragment of DNA. In the following years, the next generation sequencing, NGS, which is a massively parallel sequencing technology, offered ultra-high throughput and speed in reading multiple genomes at the same time. NGS has revolutionised the biological sciences, as now we have the power to read every single base pair of the genome and identify errors in the DNA even before babies are born, just by examining the mother's blood.

This research course aims to explain how genetic variations in our genome affect our phenotype and how genetic variations lead to single gene and complex diseases such as cancer. We will focus on cancer genetics and discuss the role of genetic mutations in initiating and promoting this uncontrolled growth. Most importantly we will explore modern cancer diagnostics and novel methods for early cancer detection and how clinicians use patients' DNA to target and treat cancer – offering a new approach to personalised treatment. Personalised medicine, also called precision medicine, has helped clinicians to offer better and improved treatment to patients that increases survival and prolonged life.

HARVARD UNIVERSITY
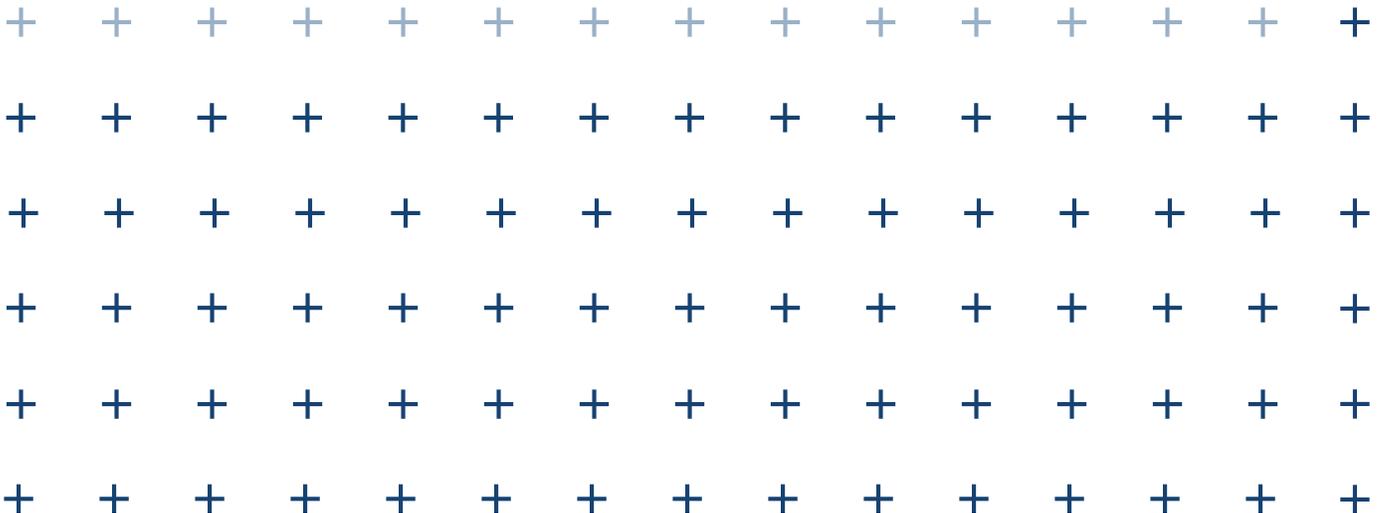
DR CIGDEM SAHIN

CURRENT POSITION

Postdoctoral Research Fellow, Joslin Diabetes Center, Harvard Medical School, Harvard
University

**A highly experienced researcher interested in the field of drug discovery for the treatment
of metabolic diseases.**

As a researcher, Dr Sahin is a member of the Tseng Lab at Harvard's renowned Joslin
Diabetes Center, a leading global clinic, and research and educational hub dedicated to
diabetes. Her area of expertise lies in pharmaceutical sciences, where she explores innovative
approaches to treating metabolic diseases. Notably, she has conducted significant research
on potential therapeutic applications of novel PPAR (Peroxisome proliferator-activated receptor)
agonists, a class of molecules with promising implications for managing metabolic disorders.

In pursuit of groundbreaking discoveries, Dr Sahin has engaged in collaborative efforts
with scientists from laboratories situated in Israel, Canada, and Brazil. Together, they have
worked to uncover novel therapeutics that could revolutionise the treatment landscape
for metabolic diseases, providing hope for millions worldwide.

The impact of Dr Sahin's research is widely recognized, and she has had the privilege of
presenting her findings at prestigious conferences like the AAPS PharmSci 360, a platform
where leading minds converge to discuss the latest advancements in pharmaceutical
sciences. Additionally, her work has been acknowledged and disseminated
through notable scientific journals, including the *European Journal of
Pharmaceutical Sciences, the Journal of Medicinal Chemistry*, and
Science Signaling, among others.

As a mentor, Dr Sahin has extensive experience in teaching uni-
versity-level courses in pharmaceutical sciences, clinical laboratory
medicine, metabolic biochemistry, and immunology. She has also
mentored researchers at the undergraduate and graduate level.
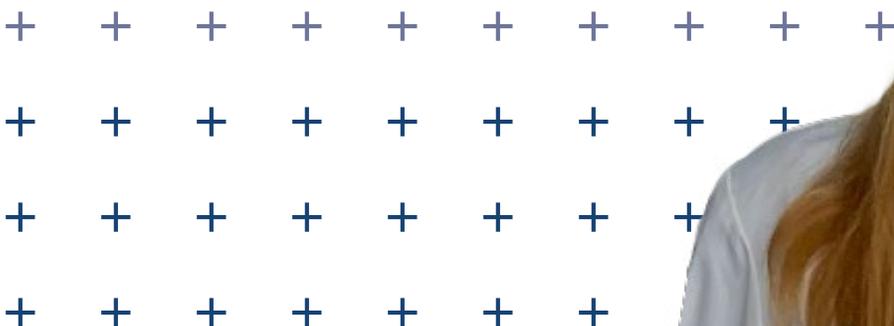
DR CIGDEM SAHIN, HARVARD UNIVERSITY

MOLECULAR BIOLOGY AND DRUG DISCOVERY

Suitable for students interested in:

MOLECULAR BIOLOGY

Cellular Metabolism | Dysregulation and Disease | Molecular Mechanisms

DRUG DISCOVERY

Metabolic Diseases | Process of Drug Discovery | Strategies and Technologies

This research course is designed to provide students with a deep understanding of cellular metabolism and drug discovery. Cellular metabolism refers to the complex network of chemical reactions within cells that regulates energy production, nutrient utilisation, and other vital cellular processes. It is a fundamental aspect of biology, influencing various physiological functions and contributing to the overall health of an organism.

One key focus of the course is to elucidate the critical molecular mechanisms that govern cellular metabolism and how they can be dysregulated in disease conditions. Dysregulation of cellular metabolism has been implicated in several metabolic diseases, including diabetes and obesity. By comprehending these underlying pathophysiological changes, students can gain insights into the development and progression of these diseases, laying the groundwork for potential therapeutic interventions.

Moreover, the research course emphasises the significance of metabolism as a promising target for drug development. By understanding the intricate relationships between metabolic pathways and disease states, students can identify potential points of intervention for drug targets. Developing drugs that modulate cellular metabolism opens up new avenues for treating various metabolic disorders effectively.

Throughout the research course, students will explore cutting-edge strategies and technologies used in drug discovery with a focus on metabolism-targeting therapeutics. The rapidly advancing field of drug development offers various approaches, including novel drug design, high-throughput screening methods, and precision medicine techniques. By exposing students to these state-of-the-art methodologies, the course aims to equip them with the knowledge and skills necessary to engage in contemporary research efforts and contribute to the development of next-generation drugs aimed at combating metabolic diseases.

UNIVERSITY OF CAMBRIDGE

DR ADEEBA FATHIMA VALIYA THODIYIL

CURRENT POSITION

Postdoctoral Researcher, Biomineral Research Lab, University of Cambridge

PREVIOUS APPOINTMENT

Postdoctoral Research Associate, Trinity Hall, University of Cambridge

An expert in microscopy, quantitative imaging, and image processing in cell biology, molecular biophysics, and mathematical biology.

As a researcher, Dr Thodiyil's work focuses on quantitative imaging, molecular biophysics, and mathematical biology. She has experience in single-molecule super-resolution microscopy such as PALM/STORM, electron microscopy (TEM, SEM), correlative super-resolution and electron microscopy (sCLEM), 3D confocal imaging, single-cell time-lapse imaging, and TIRF/HILO microscopy. She has also conducted computational analysis of diatom valve morphology, employing custom microscopy image processing techniques to quantify the impact of CRISPR-Cas protein knockouts in Thalassiosira pseudonana (Tp) biosilica. Dr Thodiyil has received multiple recognitions for her work in quantitative imaging and image processing, including commendation from the Royal College of Pathologists, as well as awards from the German Biophysical Society and the Joint German and French Biophysical society meeting.

Dr Thodiyil's research has been published and presented in various high-impact scientific journals and conferences, such as *Discover Materials, Experimental Eye Research, Optics and Lasers in Engineering,* and the *Biophysical Society Conference.*

As a mentor, Dr Thodiyil supervised Masters students in their theses and research projects in Nanobiophysics. With extensive expertise in quantitative imaging, molecular biophysics, and mathematical biology, Dr Thodiyil is uniquely positioned and intensely passionate to uplift the next generation of scientifically-minded students.

DR ADEEBA FATHIMA VALIYA THODIYIL, UNIVERSITY OF CAMBRIDGE
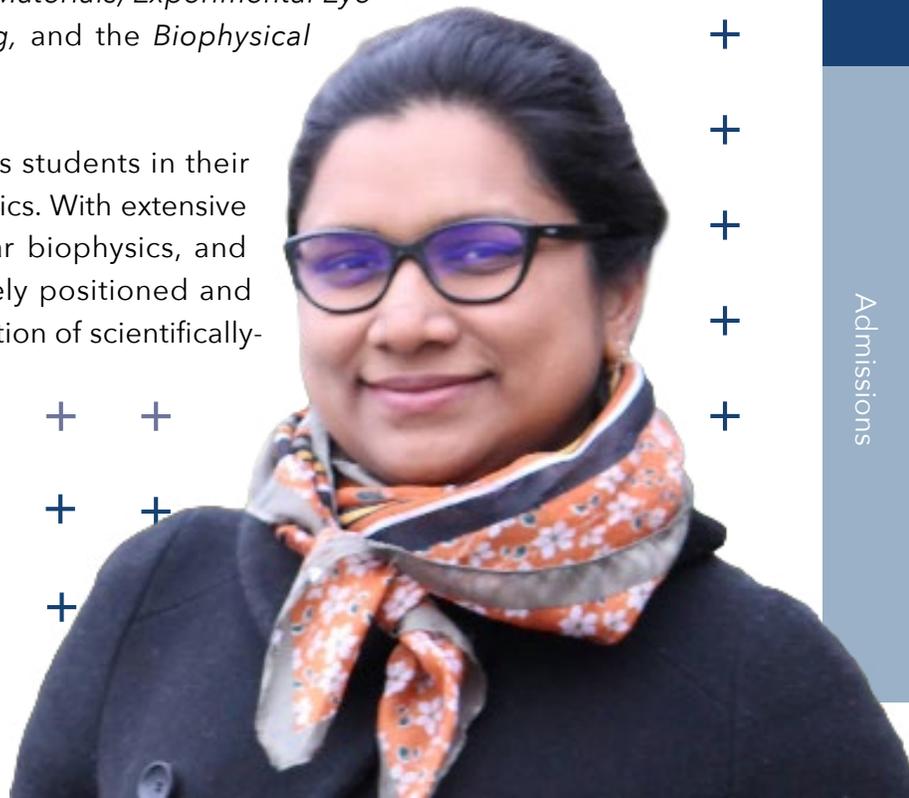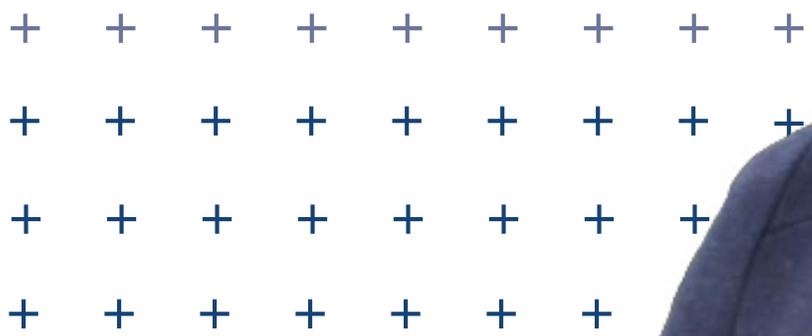
EXPLORING LIFE THROUGH MODERN IMAGING TECHNIQUES

Suitable for students interested in:

BIOTECHNOLOGY
Bioinformatics | Image Analysis | Medical Biotechnology

COMPUTER SCIENCE & DATA SCIENCE
Machine Learning | Algorithms | Data Extraction | Mathematical Biology

Biological imaging methods serve as indispensable tools for illuminating the intricate dynamics of biological systems, offering unparalleled insights into their inner workings at the cellular and molecular levels.

This research course acts as a gateway into the realm of bio-image processing techniques, empowering students with the necessary knowledge and skills to dissect, analyse, and interpret biological images with precision and efficacy. Through a meticulously crafted blend of theoretical insights and hands-on practical sessions, you will cultivate a solid understanding of image processing methods meticulously tailored to meet the unique challenges posed by biological data.

Within the research course curriculum, students will immerse themselves in the exploration of microscopy data, leveraging it to glean meaningful information and embark on the quantitative analysis of biological images. This multifaceted journey encompasses tasks ranging from the nuanced art of noise reduction and image enhancement to the intricate processes of segmentation and feature extraction.

Furthermore, the course will venture into the frontier of technological innovation, exploring cutting-edge tools and algorithms, including the transformative applications of machine learning. By fostering an interdisciplinary approach that seamlessly integrates insights from both biology and technology, students will emerge equipped with the interdisciplinary acumen necessary to unravel complex biological phenomena and confront the challenges of modern scientific inquiry with confidence and competence.

HARVARD UNIVERSITY
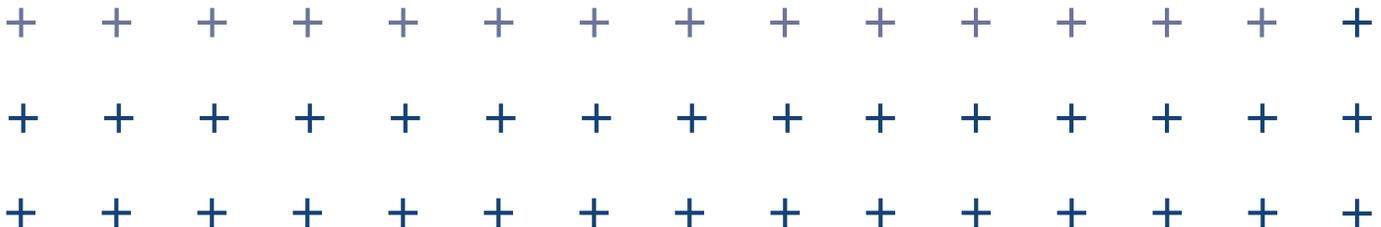
DR BIROL AY

CURRENT POSITIONS

Research Fellow, Endocrine Unit, Massachusetts General Hospital, Harvard University

Member, The American Society for Bone and Mineral Research

A biologist utilising regenerative medicine and biomedical engineering to produce functional tissue-like constructs to restore damaged tissues or organs.

As a researcher, Dr Ay has received funding for his projects from scientific organisations such as the Scientific and Technological Research Council of Turkey, Zimmer Biomet Dental, Florida, USA, Canadian Light Source, Canada with the latest being from the National Institutes of Health (NIH), USA. For his current research project, Dr Ay is focusing on the mechanism of skeletal FGF23 hormone production in Bone by G proteins, which is essential for easing the effects of kidney disease on bone health. He also held several significant research leadership positions, including being the co-chair of the Judge Recruitment Committee at the Annual Research Conference of the Institute of Biomaterials and Biomedical Engineering (iARC 2019), University of Toronto, Canada. Last October 2022, he was invited to talk at the Center for Skeletal Research (CSR) Bone Research Workshop at Harvard University and Massachusetts General Hospital.

As a mentor, Dr Ay has supervised and mentored PhD and undergraduate students in their research. His students have received the Director's Summer Research Opportunity Scholarship and have been invited to present at the University of Toronto. He also mentored bioengineering and biomedical engineering students from Mehmetbey University and the University of Toronto.

DR BIROL AY, HARVARD UNIVERSITY

REGENERATIVE MEDICINE:

STEM CELLS, BIOMATERIALS, TISSUE ENGINEERING

Suitable for students interested in:

BIOLOGY
Stem Cells | Regenerative Biology

MEDICINE
Regenerative Medicine

BIOMEDICAL ENGINEERING
Biomaterials | Tissue Engineering

Regenerative medicine aims to restore the functions of damaged organs or tissues. For this purpose, a combination of biologically compatible materials (biomaterials) and stem cells, which can differentiate into different cell types, are used. In this intersection, tissue engineering develops engineering strategies to produce functional tissue-like constructs to restore damaged tissues or organs. Artificial skin and cartilage are examples of engineered tissues currently used in clinical applications.

In this research course, we will examine the basics of stem cell biology and learn what is considered a biomaterial and the types of biomaterials. Finally, students will complete their research course by discussing current tissue engineering strategies and commercially available tissue engineering products.

At the end of the research course, students will conduct a research project in which they develop their own hypothetical tissue engineering strategies to restore a type of tissue of their own choosing. The learning outcome of this course is to understand the concept of regenerative medicine and improve participants' knowledge beyond basic biology. This research course will be particularly interesting for participants who plan to have a career in medicine, bioengineering, and biomedical engineering.
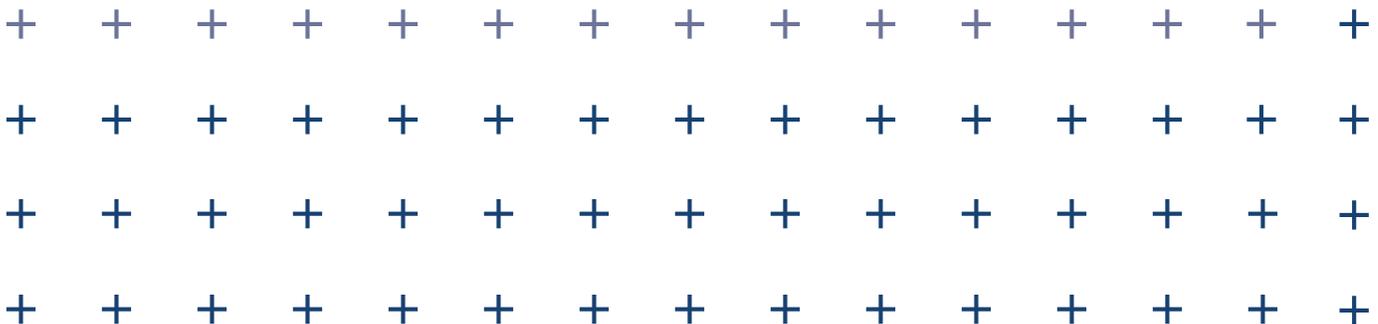
DR IBRAHIM XIAOLIANG BA

CURRENT POSITION

Research Associate, Department of Veterinary Medicine, University of Cambridge

A biologist focusing on antimicrobial resistance mechanisms in Staphylococcus aureus and other clinically important bacterial pathogens.

As a researcher, Dr Ba specialises in multiple fields, including genomics, molecular biology, epidemiology, and bioinformatics. His primary focus is on understanding and combating antimicrobial resistance mechanisms in Staphylococcus aureus and other clinically significant bacterial pathogens.

One of Dr Ba's current projects involves investigating the transmission dynamics of multi-drug-resistant pathogens in Chinese hospitals, supported by the MRC-China. This research aims to shed light on the spread and evolution of drug-resistant bacteria, informing strategies to control their dissemination.

In the past, Dr Ba conducted research on livestock-associated methicillin-resistant Staphylococcus aureus (LA-MRSA) in both China and the UK. This work is crucial in understanding how antibiotic-resistant bacteria move between animals and humans, potentially affecting public health. Furthermore, he has explored innovative treatment options for MRSA infections, addressing the pressing need for novel therapies against these resilient bacterial strains.

Dr Ba has received numerous research grants, including Cambridge's Research Incubator Fund, which supports cutting-edge projects with high potential impact. His contributions to the field of antimicrobial resistance have been widely recognized; he has published in reputable scientific journals such as *Microbiology Spectrum, the Journal of Medical Microbiology, and Nature*. Moreover, his expertise has been sought after globally, as evidenced by his invitations to present his research at prestigious international conferences held in Denmark, the UK, and the US.

As a mentor, Dr Ba shares his expert knowledge with undergraduate and graduate students through teaching as well as through invited public talks in universities.

DR IBRAHIM XIAOLIANG BA, UNIVERSITY OF CAMBRIDGE
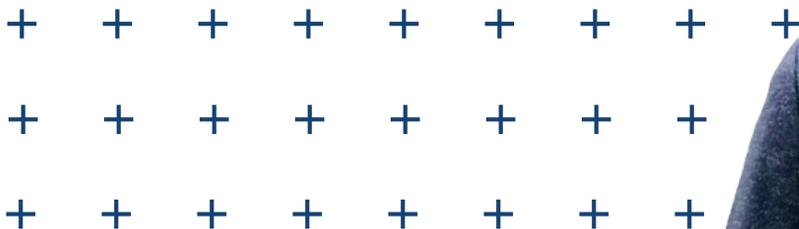
THE FUTURE OF MEDICINE:

COMBATING ANTIMICROBIAL RESISTANCE THROUGH BACTERIAL GENOMICS

Suitable for students interested in:

BIOMEDICAL SCIENCES
Resistance Genes | Gene Transfer | DNA Sequencing

PUBLIC HEALTH
Treatment Options | Antibiotic Use | Global Initiatives

This course offers an introduction to bacterial genomics within the context of the pressing global concern—antimicrobial resistance (AMR). The curriculum integrates foundational genomics concepts with an in-depth examination of mechanisms underlying bacterial AMR.

Students delve into resistance genes, horizontal gene transfer, and cutting-edge DNA sequencing techniques, gaining practical skills in bioinformatics for AMR surveillance. The course goes beyond theoretical understanding, exploring strategies to combat AMR, including responsible antibiotic use, alternative therapies, and global initiatives.

Emphasis is placed on hands-on exercises, discussions, and collaborative projects that empower students to analyse real-world genomic data and propose solutions to address AMR challenges. The final sessions focus on emerging technologies, career opportunities, and student project presentations, ensuring a holistic understanding of the field's future directions.

By combining theoretical knowledge with practical application, this course equips students with a robust foundation to contribute meaningfully to the ongoing fight against antimicrobial resistance, making it an ideal preparation for those pursuing careers in biomedical sciences, public health, or related disciplines in college.
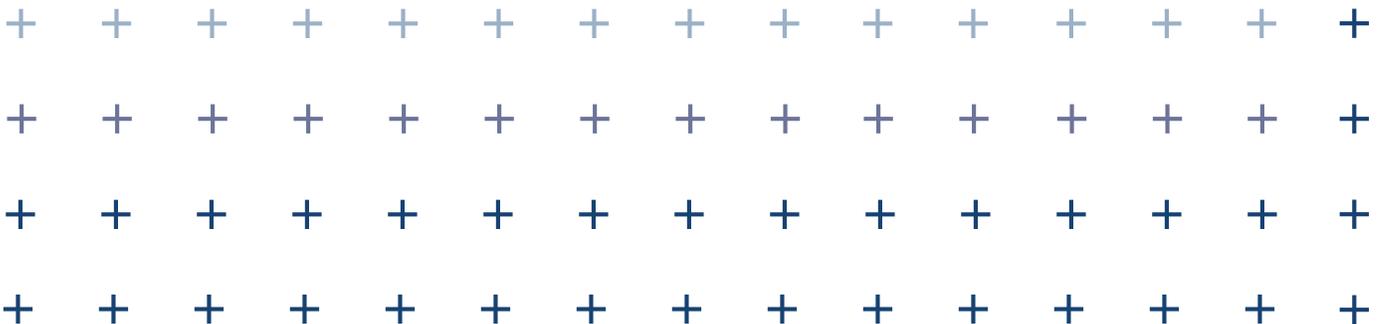
DR DONGXIA WANG

CURRENT POSITION

Postdoctoral Fellow, Myhrvold Lab, Molecular Biology Department, Princeton University

A molecular biologist specializing in CRISPR/Cas technologies and innovative biosensing techniques to explore virus-host interactions and cellular mechanics.

As a researcher, Dr Wang's current work focuses on applying CRISPR/Cas13 imaging systems to investigate virus-host interactions, particularly mechanisms of viral replication and assembly in living cells. She has developed innovative multicolor imaging techniques to label genomic fragments, providing groundbreaking insights into the assembly and packaging processes of the influenza A virus.

Dr Wang's previous research include designing functional DNA nanostructures for biosensing and bioimaging, such as CRISPR/Cas12 sensors for live-cell biomarker detection and rapid point-of-care diagnostic devices. Her innovations extend to DNA-based smart devices, including paper-based sensors and microneedles, which integrate laboratory advancements with clinical applications, enhancing diagnostic accessibility and precision.

Additionally, Dr Wang has utilized Metal-Induced Energy Transfer (MIET) microscopy and DNA tension probes to explore cellular mechanics, cell membrane dynamics, and biophysical processes with sub-nanometer precision. Her expertise spans nucleic acids, biosensing, nanotechnology, and cell surface engineering, reflecting a multidisciplinary approach to solving complex biological challenges.

Her discoveries have been published in leading journals such as *ACS Nano, Analytical Chemistry,* and *Chemical Science*, showcasing her impact to molecular biology and bioengineering.

As a mentor, Dr Wang fosters a collaborative learning environment by providing expert guidance on molecular biology, bioimaging, and nanotechnology research, while also encouraging students to develop their research skills and approach complex challenges with innovative, interdisciplinary solutions.
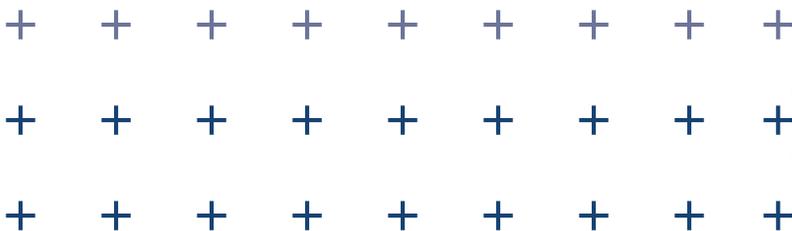
DR DONGXIA WANG, PRINCETON UNIVERSITY

ANALYTICAL CHEMISTRY AND CUTTING-EDGE BIOTECHNOLOGIES:

FROM CRISPR TO BIOMARKER DETECTION

Suitable for students interested in:

ANALYTICAL CHEMISTRY

Biomarkers | Biosensors | Nanomaterials

MOLECULAR BIOLOGY

Gene-Editing Technologies | CRISPR/Cas | Medicine

This research course is specifically designed for high school students aspiring to pursue scientific research and aims to build a robust foundation for undergraduate studies in biochemistry and medicine. Analytical chemistry plays a crucial role in modern science, particularly in areas such as disease biomarker detection, biosensor development, and gene-editing technologies. Gaining foundational knowledge in these areas not only enhances students' understanding but also opens numerous opportunities for future academic and professional endeavors.

In this research course, students will explore the fundamental concepts of disease biomarkers and their applications in disease diagnosis, delving into how chemical analysis techniques achieve high sensitivity and specificity in detection. The research course also focuses on the principles and design of biosensors, including the integration of nanomaterials and chemical modification techniques to enhance sensing performance. Additionally, students will be introduced to the basic mechanisms of the CRISPR/Cas system, uncovering its groundbreaking applications in bio-detection and the transformative potential it holds for modern science.

Through a combination of theoretical lectures, case studies, and group discussions,students will engage with the material in dynamic and meaningful ways. They will have the opportunity to design simulated research projects, cultivating critical scientific thinking and problem-solving skills. This research course offers a unique opportunity for students to showcase their research abilities, providing them with a competitive edge in their future undergraduate applications.

Whether driven by a passion for scientific discovery or a desire to lay the groundwork for careers in medicine, life sciences, or chemistry, this research course offers a comprehensive introduction to the exciting world of modern science and innovation.

DR ALEJANDRO CARNICER-LOMBARTE

CURRENT POSITIONS

Researcher, Cambridge Neuroscience, University of Cambridge

Wellcome Trust ISSF Fellow, Department of Engineering, University of Cambridge

PREVIOUS APPOINTMENT

Research Associate, Department of Engineering, University of Cambridge

A neuroscientist developing novel brain-computer interface systems to restore function following injury to the nervous system.

As a researcher, Dr Carnicer-Lombarte is bridging the fields of neuroscience and engineering. He holds a Wellcome Trust ISSF Fellowship, a prestigious position only awarded to outstanding scientists who can translate research into improved therapies, disease management, healthcare and preventive strategies at the population level.

He aims to develop novel brain-computer interface systems to restore function following injury to the nervous system. Brain-computer interfaces is an exciting research area that aims to acquire brain signals, and analyse and translate them into commands that are relayed to output devices designed to carry out desired actions. In his previous research, he developed a low-stiffness bio-medical nerve implant, funded by the MRC/Sackler Foundation scholarship. He was involved in designing, manufacturing and assessing the biocompatibility in culture of high-density implantable electrode arrays designed to interface with and stimulate the nervous system. His papers have been published in Nature Communications, Progress in Neurobiology, Journal of Hepatology and several other publications.

As a mentor, Dr Carnicer-Lombarte is passionate about his subjects and has taught and supervised a wide range of topics at Cambridge.

DR ALEJANDRO CARNICER-LOMBARTE, UNIVERSITY OF CAMBRIDGE
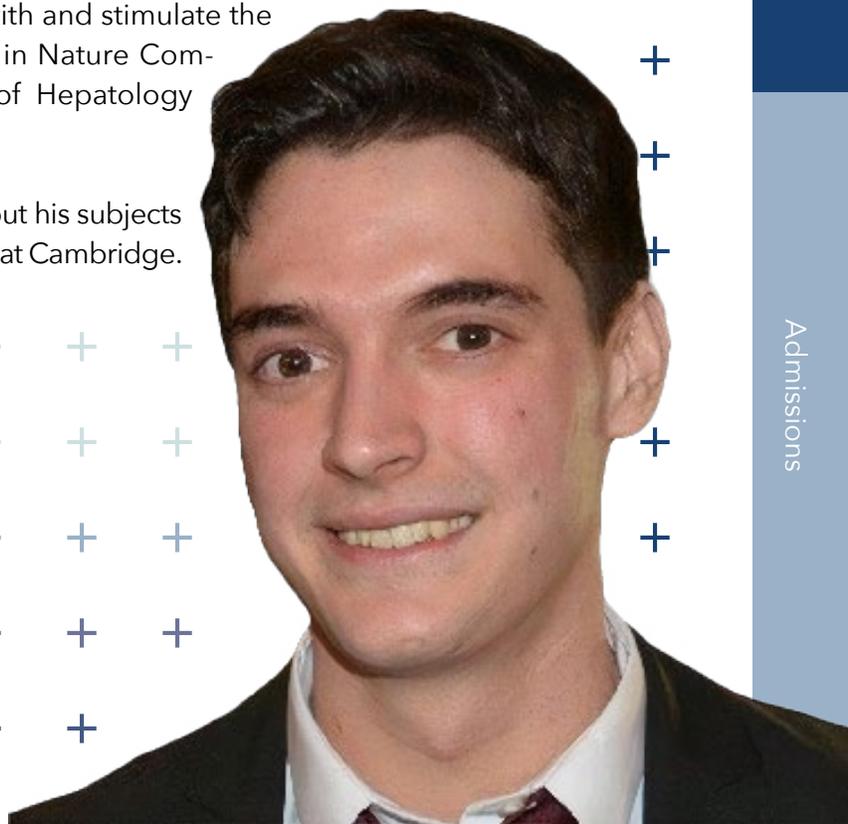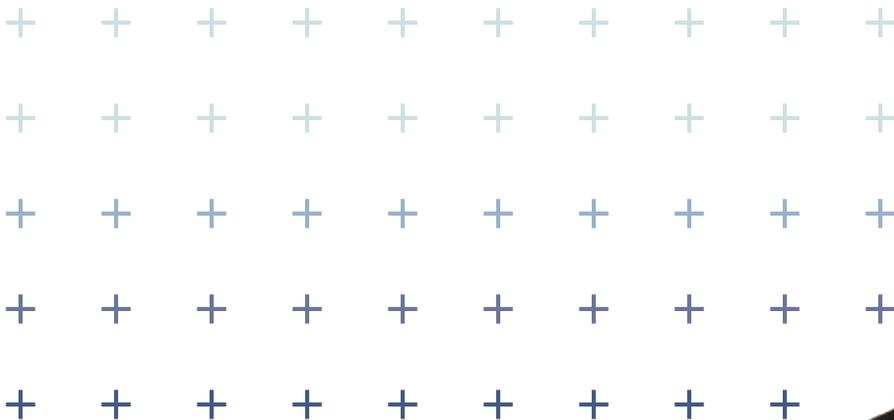
NEUROSCIENCE:

FROM UNDERSTANDING THE NEURON TO TREATING BRAIN DISORDERS

Suitable for students interested in:

NEUROSCIENCE

Neurophysiology | Brain Functions | Brain Activity | Brain Injury

ENGINEERING

Mind-Machine Interface | Bioelectronics | Brain Signal

COMPUTER SCIENCE

Machine Learning

We are our brains. This incredibly complex organ controls how we perceive our surroundings and how we interact with them, how we feel, and who we are. Despite its incredible complexity, brains are made comparatively simpler units – neurons – which communicate with each other in the form of electrical signals. Understanding how neurons work and how they are connected with each other can help us understand what happens when things go wrong – how neural disorders manifest.

I**n this research course we will explore how the brain and nervous system function.** We will pay particular attention to its core building block – the neuron – how it generates electrical signals and how these signals combine to give rise to more complex processes. We will then move on to study how brain disorders and similar conditions arise due to issues in these complex circuits. Finally, we will explore how technology can be utilised to better understand and treat the brain. We will study brain-computer interfaces, an exciting new class of systems that can read information from the brain and modify its activity to both better understand it and to treat disorders.

Students will have the opportunity to analyse real datasets recorded from brain-computer interfaces making use of MATLAB. This will allow them to experience first-hand the language of the nervous system and become familiar with the way brain-computer interfaces make sense of this language, while also developing coding skills.

The aim of this course is to give students an overview of how the nervous system functions, how new technologies in the form of brain-computer interfaces can be used to enhance understanding, and how these interfaces can be used to treat brain disorders. By working on independent research projects, students will also become familiar with MATLAB, and in particular how it can be used to drive these systems.

DR AMPARO GÜEMES

CURRENT POSITIONS

1851 Postdoctoral Research Fellow, Bioelectronics Laboratory, Engineering, University of Cambridge

Project leader in COVID Control, Johns Hopkins University

PREVIOUS APPOINTMENT

Researcher, Imperial College London, ProtonDx

An electrical biomedical engineer utilising mathematical modelling in order to develop novel bioelectronic medical technology.

As a researcher, Dr Güemes' background spans the fields of electronic engineering, biomedical engineering, neurotechnology, and mathematical modelling. She distinguishes herself in the field of diabetes treatments based on neuromodulation. The interdisciplinary nature of her work includes signal processing, modelling, bioelectronics and electrophysiology to develop advanced algorithms and neurotechnology to be integrated into a closed-loop platform aiming to improve metabolic control.

Dr Güemes is author of more than 10 publications and presentations, in highly recognised journals and international conferences, such as the *Journal of Bioelectronic Medicine* and the *IEEE Journal of Biomedical and Health Informatics*. She has won multiple awards from leading institutions including Imperial College and John Hopkins University, such as the Ash Prize for the best academic performance and the Stella Bagrit Centenary Memorial Prize in Imperial College London, the Johns Hopkins Discovery Award in 2019. She has also been recipient of the Rafael del Pino Fellowship , and was recently awarded the prestigious 1851 Research Fellowship by the Royal Commission for the Exhibition of 1851 to continue her research as a researcher at the University of Cambridge.

As a mentor, Dr Güemes has not only mentored PhD students at Cambridge on projects in biomedical and electrical engineering, but she also has extensive experience working with undergraduate students through her participation in undergraduate teaching at Imperial College London.
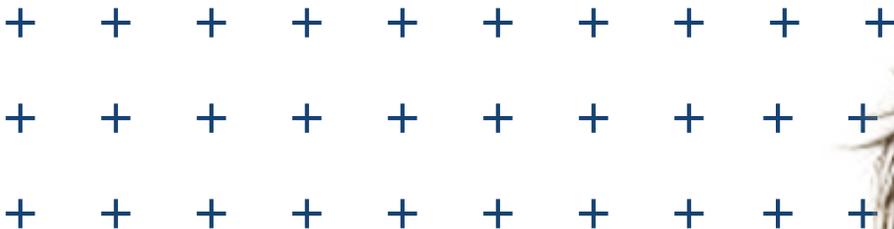
DR AMPARO GÜEMES, UNIVERSITY OF CAMBRIDGE

NEUROSCIENCE AND NEUROTECHNOLOGY:

UNDERSTANDING AND ENHANCING THE HUMAN MIND

Suitable for students interested in:

NEUROSCIENCE
Neuroanatomy | Physiology | Pathology

NEUROTECHNOLOGY
Brain-computer Interfaces | Neural Engineering | Computational Modelling

Neuroscience and neurotechnology are crucial research areas that provide us with a better understanding of the intricacies of the human brain. This knowledge serves as the foundation for developing treatments for brain disorders, ultimately improving the quality of life for countless individuals.

The objective of this research course is to invite students to study neuroscience and neuroanatomy, and to understand the state-of-the-art technology being used to interface with the nervous system. In particular, we will learn the physiological basis of electrical and chemical signalling in the nervous system, including the brain and the sensory systems (visual, auditory, olfactory and taste, and hearing), and understand how electronic systems can be used to artificially substitute them when damaged (e.g. recovery of hearing in deaf people).

We will explore the different types of recording and current day stimulating neural interface technologies, with a special focus on prostheses and multisensory interfaces. The neurophysiological principles and computational modelling of neurons, current flow through tissue, and the tissue-electrode interface will also be covered to understand how electrical signals and information are transmitted between the devices and neurons. Practical and ethical considerations for translating these neural interface technologies into humans will be briefly presented.

A final independent research project will allow the students to become familiar with the breadth and variety of research in neurotechnology, and develop presentation, writing and critical analysis skills. Students will develop cutting-edge research capabilities under close supervision, from writing comprehensive literature reviews to working with real neurological data. By the end of this research course, students will develop a high-level understanding of the nervous system güend human senses, and will become familiarised with the requirements and challenges that arise from working with neural signals and electronic systems.

DR ANNE KEVER

CURRENT POSITION

Research Scientist, Keenan Research Centre for Biomedical Sciences, University of Toronto
Research Scientist, St Michael's Hospital, Toronto, Canada

A researcher utilising neuropsychology to develop a deeper understanding of common psychological disorders.

As a researcher, Dr Kever has received grants from American Committee for Treatment and Research in Multiple Sclerosis (ACTRIMS) and has been invited as a speaker in several conferences, including The European/American Committee for Treatment and Research in Multiple Sclerosis (ECTRIMS/ACTRIMS) and the Neuroimmunology Divisional Seminar.

Among her notable works is her research project entitled, "When the Body Matches the Picture: The Influence of Physiological Arousal on the Subjective Familiarity of Novel Stimuli," which has been published in the *American Psychological Association's Journal of Experimental Psychology: Human Perception and Performance*. Other key research projects, such as "*Social Support is Linked to Mental Health, Quality of Life, and Motor Function in Multiple Sclerosis*," have been published by the Springer's Journal of Neurology.

As a mentor, Dr Kever has worked with a number of undergraduate and graduate students on psychology, cognitive science, and neuroscience projects at Columbia University.

THE NEUROPSYCHOLOGY OF EMOTIONS:

PSYCHOLOGY, PSYCHIATRY, AND PSYCHOPHARMACOLOGY

Suitable for students interested in:

PSYCHOLOGY
Emotions | Decision-Making | Perception

NEUROSCIENCE
Complex Brain Disorders | Neurochemistry

PSYCHOPHARMACOLOGY
Psychiatric Disorders | Drug Treatments | Drug Discovery

This research course offers an engaging introduction to psychology's fundamental concepts and principles. Students will be provided with an overview of the scientific study of human behaviour and thought by exploring topics such as perception, attention, memory, motivation, and decision-making. Particular focus is placed on the fascinating world of emotions. We will discuss the evolutionary origins of distinct emotions, as well as the impact of emotions on our cognitive processes and social relationships.

Students will discuss and present on research data and clinical experiences to enhance their understanding. Through these discussions, students will be introduced to common psychiatric disorders, their diagnoses, and treatments. Students can learn about what schizophrenia is, and how to diagnose it. They will also learn and study what the difference between depression and bipolar disorder is, and how antidepressants work. Additional conditions include, but are not limited to, generalised anxiety disorder, post-traumatic stress disorder, major depression disorder, psychotic disorders, and anorexia nervosa.

UNIVERSITY OF OXFORD

DR JELENA SUČEVIĆ

CURRENT POSITION

Postdoctoral Research Scientist, Department of Experimental Psychology, University of Oxford

PREVIOUS APPOINTMENTS

Career Development Fellow and Lecturer, St Hugh's College, University of Oxford
Junior Dean, St Hugh's College, University of Oxford
Research Assistant, Language & Brain Lab, University of Oxford

An experimental neuroscientist committed to unravelling the complexities of cognition and intelligence, bridging the realms of neuroscience and artificial intelligence.

As a researcher, Dr Sučević delves into the intersection of Cognitive Development, Neural Network Modelling, and cognitively inspired AI. Central to her work is deciphering how essential cognitive faculties like attention, memory, and language shape the learning process, paving the way for intelligence to emerge. She investigates the phenomenon of learning to learn, probing the depths of how the developing brain navigates complex cognitive tasks, utilising biologically inspired neural networks.

Further, Dr Sučević's interests extend to leveraging insights from early learning principles to innovate machine learning algorithms, especially in areas like multimodal and weakly supervised learning. She studies the interplay between language development, attention, episodic memory systems, and sleep, employing a blend of experimental methodologies and computational modelling techniques. Beyond her primary pursuits, Dr Sučević's research includes bilingualism and the nuances of languages featuring pitch accents.

Dr Sučević currently serves as a scientific consultant for Oxford University Press and Oxford's Said Business School. Moreover, her research has been showcased in prestigious peer-reviewed scientific journals and conference proceedings, including publications such as the *Journal of Experimental Child Psychology, Developmental Psychology,* and the *Proceedings of the 37th Annual Meeting of the Cognitive Science Society.*

As a mentor, Dr Sučević teaches a course in Cognitive Psychology and has held tutorials in Developmental Science, and Language and Cognition at Oxford University. She is also supervising students from the undergraduate to postgraduate levels in the research projects.

DR JELENA SUČEVIĆ, UNIVERSITY OF OXFORD

COGNITIVE PSYCHOLOGY

THE BUILDING BLOCKS OF HUMAN INTELLIGENCE

Suitable for students interested in:

COGNITIVE SCIENCE
Brain Imaging | Attention, Memory, and Learning | Neuroinformatics | Brain Injury

PSYCHOLOGY
Cognitive Psychology | Experimental Psychology

What makes humans smart? What is human intelligence and how can we better understand it? Can intelligence be improved, and if so, how?

This research course will examine the building blocks of human intelligence through the lenses of cognitive psychology. We will explore the fundamental cognitive processes such as attention, memory, and learning. We will then examine how these core abilities give rise to more complex processes such as decision making, problem solving and abstract thinking, and ultimately to what we consider intelligent behaviour.

Each of the core topics will be explored on multiple levels to gain an understanding of how it is reflected in the behaviour and in the brain. We will discuss key theories, as well as the most influential empirical discoveries. Moreover, to better understand how cognition works, we will approach the topics from different angles. For instance, we will learn how attention develops over the life span, how brain injuries might affect attention and consider attention in neurodiverse populations.

Throughout the research course, the students will learn about a range of different methodologies used studying cognitive processes. Our aim is to see how each technique can contribute to our understanding of cognition, but also their potential and limitations, and how they can help us reveal the relationship between the mind, the brain and behaviour.

We will explore how cognitive processes are reflected in behaviour and how techniques that measure behaviour can reveal mechanisms of cognitive functioning. In addition, we will learn about how techniques that use eye-tracking and brain imaging methods provide a deeper look into cognitive functioning.

The overall aim of the course is to provide students with a thorough understanding of the key topics in cognitive psychology, integrate theoretical and experimental knowledge, and equip students with knowledge of tools and approaches used to study cognition. Furthermore, the course inspires students to actively explore how knowledge in cognitive sciences can be implemented in practice and put to good use.

DR DENIZ ALTUNSU KURT

CURRENT POSITION

Postdoctoral Research Fellow, Harvard Medical School / Beth Israel Deaconess Medical Center

PREVIOUS APPOINTMENT

Postdoctoral Research Fellow, Research Centre for Translational Medicine, Koç University

An expert in neuroscience and neuropsychology with a passion to mentor the next generation of medical innovators.

As a researcher, Dr Kurt investigates Blood-Brain Barrier (BBB) disruption in Early Course Psychosis using patient-derived Induced Pluripotent Stem Cells (iPSC) at Harvard Medical School. Her innovative approach involves creating patient-specific iPSC models to unravel the complex mechanisms behind BBB dysfunction, aiming to uncover potential therapeutic targets for early intervention in psychotic disorders. This cutting-edge research is poised to significantly advance our understanding of the pathophysiology of psychosis and pave the way for novel treatments.

Her academic interests lie at the intersection of Cellular and Molecular Medicine, Neuroscience, and Genetics and Bioinformatics. This interdisciplinary approach enables her to tackle complex biological questions from multiple angles, integrating advanced techniques in molecular biology, genetics, and bioinformatics to drive forward the field of neuropsychiatric research.

Dr. Kurt's extensive research has been published in peer-reviewed scientific journals, including *Molecular Diagnosis & Therapy, Brain Research, and Acta Physiologica*. Additionally, she has authored several book chapters discussing DNA sequencing techniques in brain tumors and the re-epithelialization process, further showcasing her expertise in applying cutting-edge molecular techniques to clinical challenges.

As a mentor, Dr. Kurt is dedicated to imparting her expertise to promising students eager to make a meaningful impact in the medical field. Dr Kurt's mentorship philosophy emphasizes critical thinking, scientific rigor, and the importance of interdisciplinary collaboration.
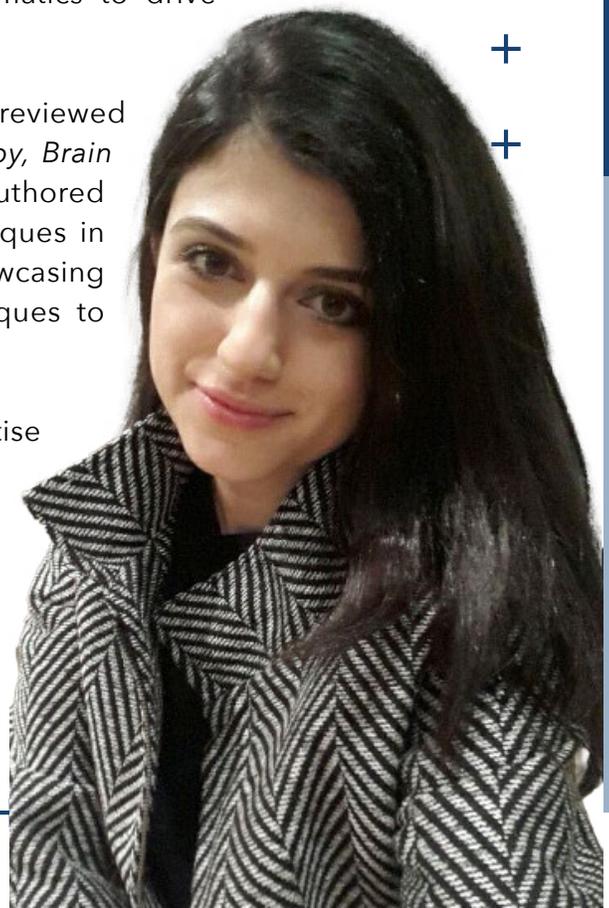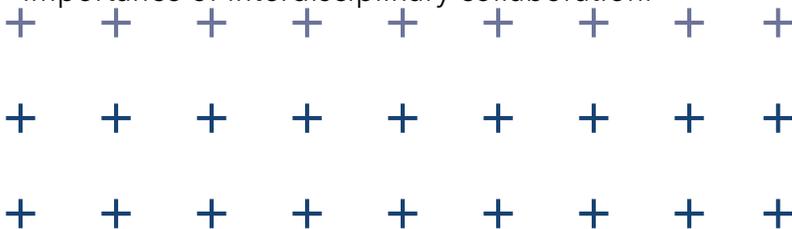
ADVANCED NEUROSCIENCE:

PHYSIOLOGY OF THE BLOOD-BRAIN BARRIER

Suitable for students interested in:

NEUROSCIENCE

Neuropathology | Brain Health | Neurodegenerative Diseases

MEDICINE

Neurobiology | Neurology

In this research course in the Physiology of the Blood-Brain Barrier, **we will grasp the essential concepts in cellular and molecular medicine, neuroscience, and genetics,** specifically focusing on the blood-brain barrier (BBB) and its critical role in brain function.

Starting with an overview of the BBB as a highly selective semi-permeable membrane, students will delve into its structure and function, learning how it regulates the movement of molecules and ions between the blood and the brain. Key topics include the physiological and biochemical processes that control the influx and efflux of biological substances at the BBB, and how its impairment can lead to neurological disorders.

Advanced topics cover the impact of various factors on BBB integrity, such as inflammation, infection, and disease, with a particular focus on recent research findings and cutting-edge techniques used to study how disruptions in the BBB can affect brain homeostasis and contribute to conditions like Alzheimer's disease, multiple sclerosis, and stroke.

Through a combination of lectures, laboratory exercises, and case studies, students will gain practical experience in techniques used to investigate BBB physiology. This includes the use of advanced imaging methods, molecular biology tools, and patient-derived induced pluripotent stem cells (iPSCs) to model BBB disruptions.

By the end of the course, students will have gained a strong understanding of the fundamental concepts in BBB physiology. More specifically, they will have developed a solid foundation in investigating the molecular and cellular mechanisms that underlie BBB function and its role in maintaining brain health.
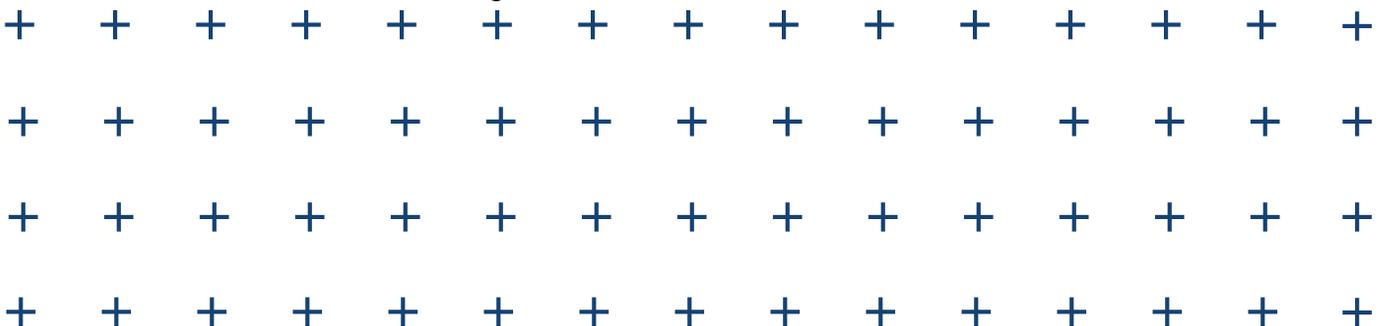
DR DENIZ ALTUNSU KURT, HARVARD UNIVERSITY

INTRODUCTION TO STEM CELL BIOLOGY AND REGENERATIVE MEDICINE

Suitable for students interested in:

STEM CELL BIOLOGY

Tissue Engineering | Cell Culture Techniques | Genetic Modification

REGENERATIVE MEDICINE

Therapeutics | Tissue Repair | Diseases

MEDICAL ETHICS

Ethical Issues | Regulatory Landscape | Future Challenges

This research course is a comprehensive introduction to the foundational principles of stem cell biology and the emerging field of regenerative medicine. It is designed to understand the dynamic role of stem cells in biological research and clinical applications. Basic Stem Cell Biology explores stem cells' unique properties, including self-renewal and differentiation potential. You will learn about different types of stem cells, such as embryonic, adult, and induced pluripotent stem cells (iPSCs), and how stem cells contribute to organismal development and tissue homeostasis. Also, we will investigate how stem cells are utilized in novel treatments aimed at repairing or replacing damaged tissues and organs. This includes discussing therapies for conditions such as neurodegenerative diseases, heart failure, and diabetes by gaining insights into the methodologies used in stem cell research, including cell culture techniques, genetic modification, and tissue engineering. This course will delve into the ethical issues and regulatory landscape influencing stem cell research and its translational to clinical applications by reviewing recent advancements in stem cell research and exploring future directions and challenges in the field.

By the end of the course, the students will have a solid understanding of how stem cell's function, their potential for regenerative therapies, and the ongoing scientific and ethical discussions surrounding their use. This course will equip students with the knowledge needed to pursue further studies or a career in stem cell science and regenerative medicine.
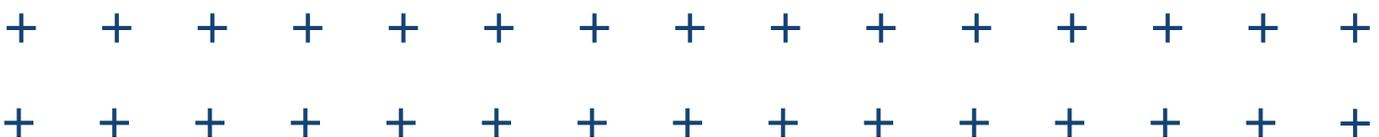
DR MENGXIN WANG

CURRENT POSITION

Research Associate, Department of Experimental Psychology, Oxford University

PREVIOUS APPOINTMENTS

Postdoctoral Research Associate, The Adaptive Brain Lab, University of Cambridge

Associate Researcher, Visual Neuroscience Group, University of Nottingham

An experimental psychologist exploring the relationship between fine-scale eye movements and performance in a variety of visual tasks, to help with theoretical and computational modelling.

As a researcher, Dr Wang's research encompasses spatial vision, early visual processing, visual plasticity, and both normal and abnormal binocular vision, with a focus on exploring the significance of fixational eye movements in optimising information sampling for visual perception. Utilising psychophysical methods and advanced technologies like adaptive optics scanning laser ophthalmoscope (AO-SLO), she investigates the intricate relationship between fine-scale eye movements and performance across diverse visual tasks, contributing to theoretical and computational modelling efforts. Her prior investigations include exploring inter-ocular suppression and sensory eye dominance in human vision, as well as studying neural mechanisms underlying visual perceptual learning using ultra-high field fMRI techniques. Dr Wang's works have been published in peer-reviewed scientific journals including *Vision Research, Journal of Vision,* and *Perception.*

As a mentor, Dr Wang has taught psychology to undergraduates at both the University of Oxford and the University of Cambridge. She has also taught computational tools and techniques to graduate students at the University of Oxford.
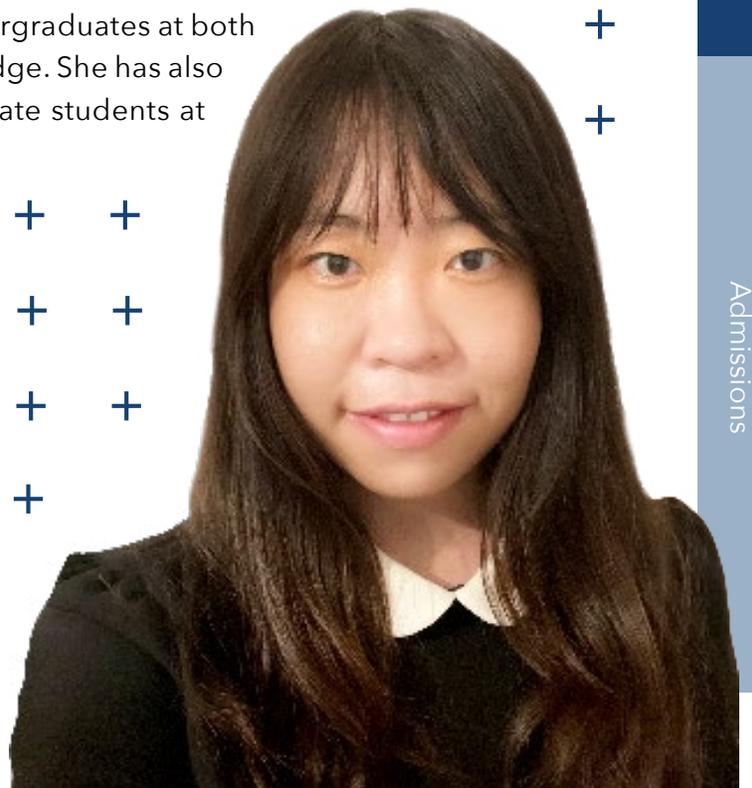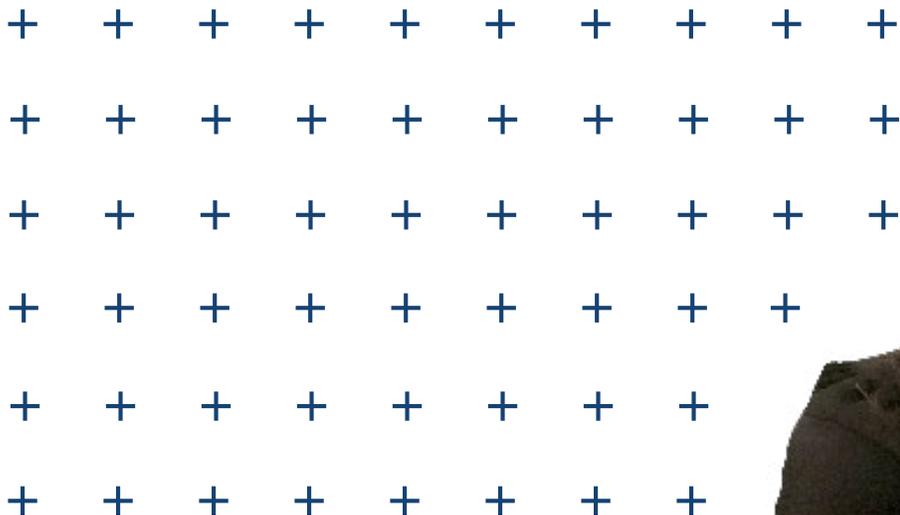
DR MENGXIN WANG, UNIVERSITY OF OXFORD

BRAIN, PSYCHOLOGY, AND OPTOMETRY:

HOW WE PERCEIVE THE WORLD THROUGH VISUAL PERCEPTION

Suitable for students interested in:

COGNITIVE SCIENCE

Neuroscience | Physiology of the Mind | Cognitive Development

PSYCHOLOGY

Neuropsychology | Experimental Psychology | Cognitive Psychology

VISUAL PERCEPTION

Sensory Input | Optometry | Perception Models | Anatomy of the Eye

Our visual sense is one of the most important means of gathering information about the surrounding physical world. The brain receives light inputs, processes them in certain ways, and ultimately turns these signals into meaningful interpretations which are important for guiding our behaviour. In this research course, we will provide an overview of a range of well-established visual phenomena that we experience and discuss possible mechanisms that might underlie them. We will attempt to answer some fundamental questions such as: What is the physiological basis of visual perception? Why do we see colours? How do we identify the shape of an object? Why do we perceive things in three dimensions? How do we perceive the motion of objects?

This research course will examine the core topics in visual perception, which form a major part in experimental psychology, cognitive science, and optometry. Students will obtain a foundational understanding of the principles, theories, and processes involved in visual perception, spanning from the basic functions of the eye to the complexities of visual cognition.

Topics covered include the anatomy and physiology of the visual system, including the structure and function of the eye and the neural pathways involved in visual processing. Students will also examine the fundamental principles of visual sensation, including the perception of light, colour, depth, motion, and form.

UNIVERSITY OF CAMBRIDGE
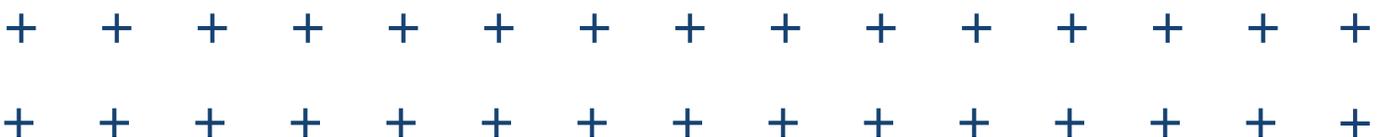
DR ANNA JANE DREYER

CURRENT POSITION

Postdoctoral Research Associate, Cambridge Centre for Frontotemporal Dementia and the Cambridge Centre for Parkinson-Plus, Department of Clinical Neurosciences, University of Cambridge

PREVIOUS APPOINTMENT

Research Officer, HIV Mental Health Research Unit, Department of Psychiatry and Mental Health, University of Cape Town

A neuropsychologist committed to advancing knowledge in the field and advocating for a more equitable healthcare landscape.

As a researcher, Dr Dreyer specialises in neuropsychology and delves into dementia, cognitive displacement, and psychoanalytic neurorehabilitation. Her research zeroes in on the intersection of dementia and HIV-associated cognitive impairment. She is driven by a keen interest in unravelling the impact of social determinants on cognitive decline and dementia, while also striving to develop fair and precise methods for assessing cognitive impairment within diverse and socioeconomically disadvantaged populations.

Her investigations into cognitive impairment among individuals living with HIV are multi-faceted, encompassing measurement, diagnosis, contributing factors, and their correlation with treatment adherence. Beyond HIV, she extends her expertise to various projects examining mental health, cognitive function, and outcomes in conditions like tuberculosis, meningitis, and dementia.

A staunch advocate for health equity, her work is dedicated to understanding the modifiable risk factors for dementia, particularly those intertwined with socioeconomic disparities. Currently, she delves into the repercussions of deprivation on dementia syndromes associated with frontotemporal lobar degeneration and Parkinson's disease.

Her impactful findings are published in the pages of high-impact peer-reviewed scientific journals such as Frontiers in Psychology, Applied Neuropsychology, and the Journal of NeuroVirology, among others.

As a mentor, Dr Dreyer has taught a course in HIV Neuropsychology and tutored students in Clinical Neuropsychology and quantitative methods.
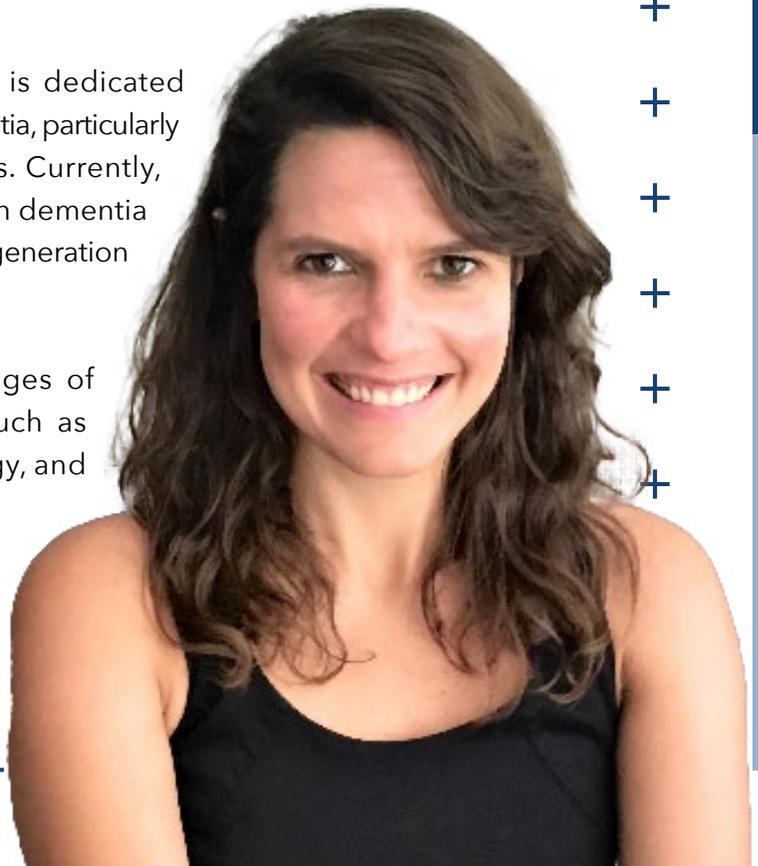
DR ANNA JANE DREYER, UNIVERSITY OF CAMBRIDGE

UNDERSTANDING AND PREVENTING DEMENTIA:

ALZHEIMER'S, PARKINSON'S, AND MORE

Suitable for students interested in:

NEUROSCIENCE

Dementia | Cognitive Neuroscience | Neurodegenerative Disease Pathology

PSYCHOLOGY

Cognitive psychology | Neuropsychology

MEDICAL SCIENCE

Public Health | Biomedical Engineering | Drug Development

Given the projected trends in population ageing and population growth, the number of people with dementia is expected to triple by 2050. Many of us will be personally affected by dementia by either getting dementia ourselves or caring for someone with dementia.

This first half of the research course will provide students with an introduction to dementia and dementia research. This will include a broad overview of brain structure and function, neuropsychology, the various cognitive domains (such as executive functioning, memory, attention), and the different types of brain scans (such as MRI, PET, EEG).

Students will study different types of dementias, covering Alzheimer's disease, Vascular dementia, frontotemporal dementia, Lewy Body dementia, Parkinson's disease, and HIV-associated brain injury. For each type, students will learn about the underlying pathology, brain areas affected and clinical symptoms. They will gain an understanding of how the brain diseases influence cognition, emotion, and behaviour.

The course will also cover dementia prevention. Strong evidence has emerged that 40% of cases of dementia are linked to modifiable factors we can influence ourselves, such as environmental and lifestyle factors. We will look closely at each of these modifiable risk factors for dementia.

In the second half of the course, students will undertake an independent research project focusing on a dementia-related topic of their choosing. Students will be encouraged to approach these topics from a broader perspective, fostering a deeper understanding of dementia and its implications.

DARTMOUTH COLLEGE

DR ALIREZA SOLTANI

CURRENT POSITIONS

Associate Professor / Director of Graduate Studies, Department of Psychological and Brain Sciences, Dartmouth College

Principal Investigator, Computational & Cognitive Neuroscience Lab, Dartmouth College

PREVIOUS APPOINTMENTS

HHMI Research Associate, Stanford University

Postdoctoral Scholar, California Institute of Technology

Postdoctoral Associate, School of Medicine, Yale University

Postdoctoral Associate, Baylor College of Medicine

A neuroscientist exploring the psychophysical bases of decision-making utilising computational methods.

As a researcher, Dr Soltani is interested in exploring adaptive decision-making and learning using computational modelling. Specifically, he is interested in exploring neural mechanisms, adaptive processes and how computations required for flexibility in behaviour are performed by neuronal elements in the brain. He uses detailed computational modelling at different levels (synaptic, cellular, and network), as well as psychophysics and behavioural studies in humans, to look for feasible mechanisms that account for both behavioural and neural data. The ultimate goal of his research is to bridge the gap between cognitive and neuronal processes, and further explain behavioural laws in terms of biophysical parameters and constraints. He is the founder and principal investigator of the Computational and Cognitive Neuroscience lab in Dartmouth College which is supported and heavily funded by National Institutes of Health's (NIH) National Institute on Drug Abuse (NIDA) and the National Science Foundation (NSF). Through his lab, Dr Soltani and his team of neuroscientists created computational models to capture adaptive learning and decision-making across multiple scales and developed computational methods for estimating timescales of neural dynamics and quantifying consistency in learning and choice behaviour. Moreover, Dr Soltani has received the National Science Foundation CAREER award in recognition of his significant contributions to the field of neuroscience. Additionally, he was awarded the McLane Family Fellowship from Dartmouth College.

He has an extensive publication record in prestigious scientific journals, including *Neuropsychopharmacology, Cognitive, Affective, and Behavioral Neuroscience, Current Opinion in Behavioral Sciences*, and the *Journal of Cognitive Neuroscience*, among others. He was also a contributor in a book entitled *Neural Circuit Mechanisms of Value-Based Decision-Making and Reinforcement Learning published by Elsevier*.

As a mentor, Dr Soltani leads courses on neuroscience and computational models of cognition at the graduate level, as well as neuroeconomics and decision-making. Furthermore, he has mentored and supervised students from the undergraduate, graduate, and Ph.D. levels in their thesis.
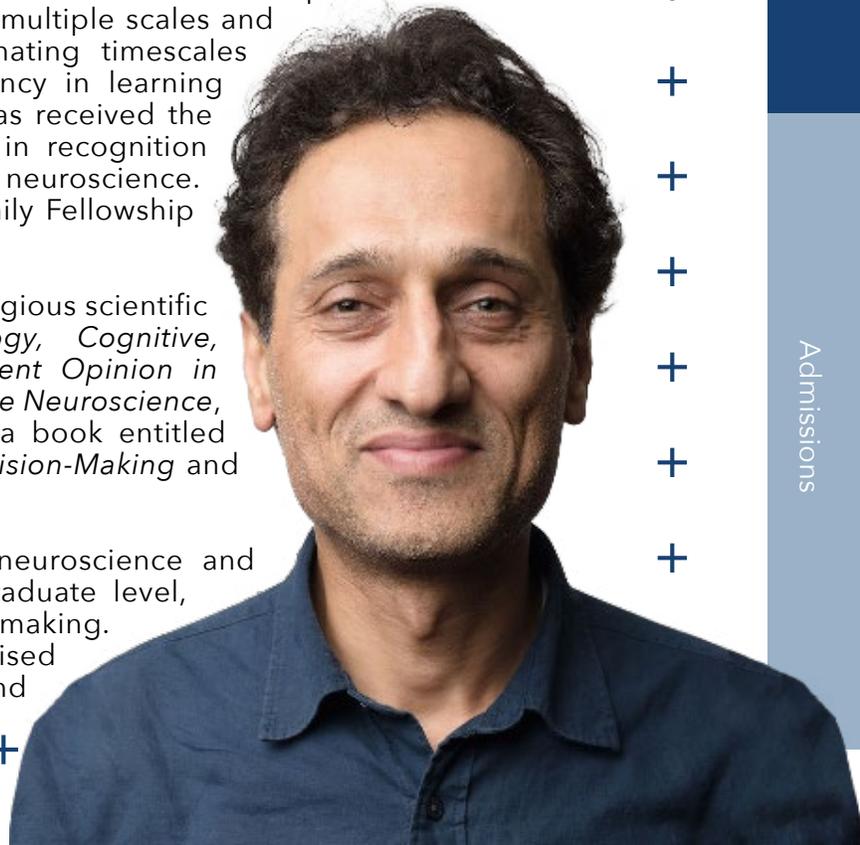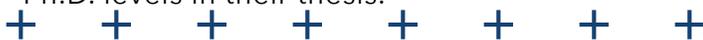
DR ALIREZA SOLTANI, DARTMOUTH COLLEGE

THE NEUROSCIENCE OF DECISION MAKING:

LINKING BRAIN AND BEHAVIOR

Suitable for students interested in:

NEUROSCIENCE

Decision-Making | Cognitive Neuroscience | Psychology

DECISION THEORY

Game Theory | Prospect Theory | Behavioural Economics

In our daily lives we are faced with many decisions: what to eat for lunch, whether to spend the next hour on Instagram or on homework, or what courses to take next semester. Some of those decisions require gradual deliberation while others can be made quickly. Nevertheless, to make any decision we rely on external information and what outcomes we expect from those decisions. Decisions are easy to make if information is complete and the outcomes are certain. But how does the brain combine different sources of partial information to make decisions in the face of uncertain outcomes?

In this research course, we will examine decision making from both behavioural and neurobiological points of view. Specifically, we will learn about different methods used in psychology and neuroscience (e.g., operant conditioning, reinforcement learning, game theory, prospect theory, electrophysiology, neuroimaging, etc.) to study decision making at various levels, from mental and cognitive processes to underpinning neural activity and mechanisms.

By undertaking independent research projects, students will gain insight into various aspects of decision-making and their association with neural processes in the brain. They will also become familiar with the different techniques and instruments employed in the study of decision-making. Upon completion of the research course, students will be able to apply their newfound knowledge to their everyday lives, becoming more mindful of how different environmental factors influence their decision-making. Ultimately, this research course will alter students' perspectives on decision-making by imparting knowledge of brain function.

DR ALIREZA SOLTANI, DARTMOUTH COLLEGE

NEUROECONOMICS:

MULTIDISCIPLINARY SCIENCE OF DECISION MAKING

Suitable for students interested in:

NEUROSCIENCE
Decision-making | Psychology | Cognitive Neuroscience

ECONOMICS
Behavioural Economics | Marketing

Neuroeconomics is a new emerging field in which a combination of methods from neuroscience, psychology, and economics is used to better understand how we make decisions. Neuroeconomics uses various techniques, including neuroimaging (e.g. fMRI, EEG), behavioural experiments and computational modelling to study how the brain integrates information from various sources (e.g.past experience, social norms and expected outcomes) to make economic decisions. The insights from neuroeconomics can have important implications for understanding human behaviour and for developing more effective policies and interventions in areas such as finance, marketing and public health.

In this research course, we learn about economic and psychological theories that are used to investigate and understand choice behaviour, as well as mental and neural processes that underlie decision-making. Importantly, we examine how recent neurobiological discoveries are used to refine decision theories and models developed in psychology and economics. Students not only learn about the field of neuroeconomics but also develop the ability to apply their knowledge to influence decision-making and inform society about the implications of neuroeconomic findings.

Moreover, students will be encouraged to develop a research paper on neuroeconomics and its implications for society and policy making. We will cover various topics in neuroeconomics and introduce students to the diverse methods employed in this field. By the end of the research course, students will have honed their critical thinking skills regarding decision-making phenomena and gain insight into the implications of these phenomena for society.

UNIVERSITY OF OXFORD
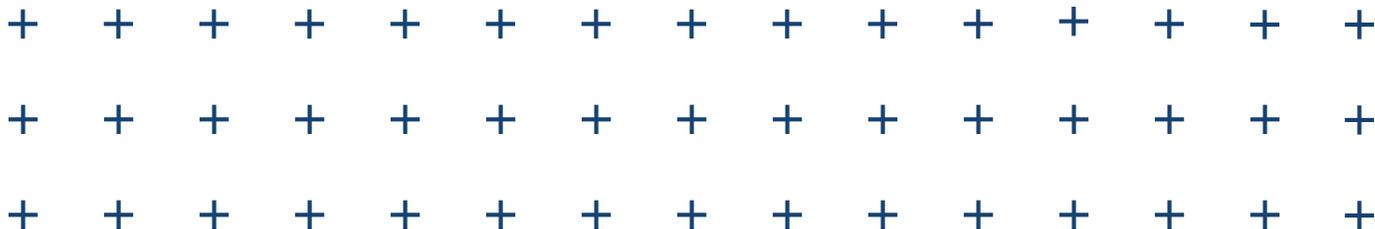
DR ALI MAHMOODI

CURRENT POSITION

Postdoctoral Researcher, Department of Experimental Psychology, University of Oxford

A neuroscientist studying the neural basis of social behaviours and decision-making.

As a researcher, Dr Mahmoodi specialises in social neuroscience and decision-making. He tries to understand the reasons behind the brain's specific responses in social situations. His prior work includes exploring human social decision-making through psychophysics and computational modelling. He has delved into the neural underpinnings of changes in opinion and conformity within social contexts. His research is trying to understand the reasons behind the brain's specific responses in social situations. His research findings have been published in many prestigious journals, including Neuron, PLoS biology, and Proceedings of the National Academy of Sciences. Moreover, he has been invited to present his work at notable institutions, including the Max Planck Institute for Biological Cybernetics, the Interacting Minds Centre in Denmark, and the Institute for Systems Neuroscience at the University of Hamburg.

As a mentor, he has taught a behavioural neuroscience course and supervised PhD students at the University of Oxford.

DR ALI MAHMOODI, UNIVERSITY OF OXFORD

COGNITIVE NEUROSCIENCE OF LEARNING AND DECISION-MAKING:

A COMPUTATIONAL APPROACH

Suitable for students interested in:

COGNITIVE SCIENCE

Computational Cognitive Modeling | Cognitive Neuroscience | Neuroinformatics

PSYCHOLOGY

Social Psychology | Experimental Psychology | Decision-making

COMPUTER SCIENCE

Reinforcement Learning | Algorithms | Bayesian Inference

This research course delves into the fascinating realm of how the human brain supports learning and decision-making processes, drawing insights from computational neuroscience. Throughout the course, we will explore fundamental concepts such as reinforcement learning and Bayesian decision theory, unravelling the intricate mechanisms that underlie our cognitive abilities.

Starting with an exploration of the neural substrates of learning and decision-making, we will dissect the brain's architecture and its role in shaping our behaviour. Through a combination of theoretical discussions and hands-on activities, students will gain a comprehensive understanding of the neural circuits involved in learning, reward processing, risk assessment, and adaptive behaviour. We will then examine computational models of learning, shedding light on how the brain optimises choices in uncertain environments. From reinforcement learning algorithms to Bayesian decision frameworks, students will learn how these models implement sophisticated behaviour in the brain, gaining deep insights into the computational principles governing human cognition.

Furthermore, the course will explore the large-scale applications of these theoretical frameworks, ranging from behavioural economics to our complicated social behaviour. By synthesising insights from neuroscience, psychology, and computer science, students will develop a holistic understanding of human learning and decision-making processes.

In summary, this course offers a multidisciplinary perspective that will deepen students' understanding of the complex interplay between the brain, behaviour, and computational principles.

DR DAVID BELIN

CURRENT POSITIONS

Professor of Behavioural Neuroscience, Department of Psychology, University of Cambridge

Adjunct Professor, Icahn School of Medicine at Mount Sinai

Member, Federation of European Neuroscience Societies, the British Neuroscience Association, the Society for Neuroscience, and the European Behavioural Neuroscience Society

PREVIOUS APPOINTMENTS

Director of the INSERM Team Psychobiology of Compulsive Disorders, University of Cambridge

Visiting Scientist, Intramural Research Programme, National Institute for Drug Abuse, Baltimore, USA

A behavioural neuroscientist researching the neural bases of addiction, obsession, and compulsion.

As a researcher, Dr David Belin is interested in the neural, cellular and molecular substrates of inter-individual vulnerability to develop impulsive/compulsive disorders such as drug addiction, obsessive/compulsive disorder, Tourette's Syndrome, pathological gambling or dopamine dysregulation syndrome in Parkinson Disease. His research group's working hypothesis is that impulses, originating from the amygdalo-insular networks, can drive the behaviour through explicit knowledge involving prefrontal and orbitofrontal loops or implicit mechanisms that instead depend upon the functional relationships of these structures with several domains of the striatum.

Dr Belin has made significant contributions to the fields of neuroscience and psychology. His papers have been published in numerous top neuroscience and psychology journals, including *Psychopharmacology, Neuropsychopharmacology, The European Journal of Neuroscience, Current opinion in Behavioural Sciences, Biological Psychiatry, Molecular Psychiatry, and Genes, Brain and Behavior*. Since 2009, Dr Belin has constantly obtained funding in different countries, either as principal investigator or co principal investigator, for an overall amount of more than 5.5 million GBP.

As a mentor, he has mentored graduate and undergraduate students at the University of Cambridge on a wide variety of topics in psychology and neuroscience. He has taught courses on subjects including learning and memory, prediction error, pharmacology, and other topics in neuroscience.

DR DAVID BELIN,UNIVERSITY OF CAMBRIDGE

THE BEHAVIOURAL NEUROSCIENCE OF EMOTION AND MOTIVATION

Suitable for students interested in:

NEUROSCIENCE
Emotion | Motivation | Neurochemistry

PSYCHOLOGY
Addiction | Compulsion Emotion | Motivation

In this research course, we will aim to provide a foundation of research, theory and practical skills acting as a primer for the student interested in the psychological and neural basis of emotion, motivated behaviours and the mechanisms of abnormal emotion and motivation.

The study of motivation and emotion has not always been straightforward, but work in the field of behavioural neuroscience has shown that both processes depend upon a distributed network involving areas such as the brainstem, the hypothalamus and the limbic forebrain. The main objectives of this research course are thus to acquaint students with the psychological as well as the physiological approaches to the field of brain mechanisms of motivation. By taking a critical approach to examine the experimental evidence, students may gain a richer understanding of controlling mechanisms for motivation at both the psychological and neural levels.

By the end of the research course, each student will understand motivation from a distributed neural systems perspective and the role of dopamine. They will be familiar with the notion of reward, reinforcement and punishment, including the psychological and neural basis of pavlovian conditioning, instrumental learning and their interaction, interoception and its role in emotion regulation/coping, impulse control and the psychological and neural basis of impulsive/compulsive disorders such as Obsessive-Compulsive Disorder.

Through working on their independent research projects, students will develop a good understanding of the theories of drug addiction and an ability constructively to critique ideas and scientific papers. Students will become acquainted with contemporary brain investigation and intervention techniques, as well as learn about experimental and statistical design.
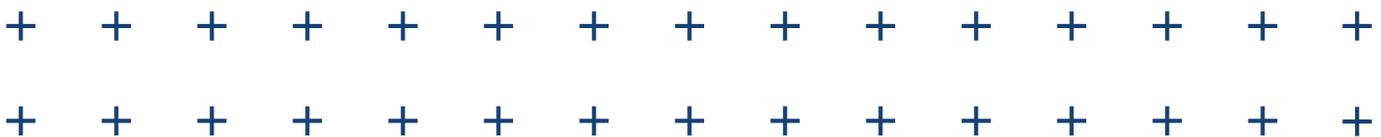
DR DAVID BELIN, UNIVERSITY OF CAMBRIDGE

DISORDERS OF THE CENTRAL NERVOUS SYSTEM:

PHARMACOLOGY AND DRUG TREATMENT FOR STROKES, ANXIETY, AND EPILEPSY

Suitable for students interested in:

NEUROSCIENCE

Cellular and Molecular Neuroscience | Neuropharmacology | Behavioural Neuroscience

PSYCHOPHARMACOLOGY

Mental Disorders | Medications | Neuropsychology

Psychopharmacology is the study of the use of medications in treating mental disorders. The complexity of this field requires continuous study in order to keep current with new advances. Psychopharmacologists need to understand all the clinically relevant principles of pharmacokinetics (what the body does to medication) and pharmacodynamics (what the medications do to the body). This includes an understanding of protein binding (how available the medication is to the body), half-life (how long the medication stays in the body), polymorphic genes (genes which vary widely from person to person), and drug-to-drug interactions (how medications affect one another).

In this research course, we will explore foundational research, theory and practical skills related to molecular and systems pharmacology of central nervous system disorders. The course will provide the students with a solid background in cellular and molecular neuroscience, neuropharmacology and behavioural neuroscience that will then be used to discuss the neuropsychopharmacology of neuropsychiatric disorders. **The aim of this research course is to provide an understanding of the chemical pathology of the major central nervous system diseases/disorders, and how these conditions are treated with drugs.**

Upon completing independent research papers, students will develop a good understanding of the major neurotransmitter systems in the CNS (e.g. glutamate, GABA, dopamine, 5-HT and noradrenaline), as well as roles of specific neurotransmitters in conditions such as particularly stroke, anxiety, epilepsy, depression, addiction, Parkinson's Disease and schizophrenia. Students will learn about pharmacological theories and become familiar with potential new drugs for the treatment of less well-understood disorders (e.g. cerebral ischemia (stroke) and addiction).

HARVARD UNIVERSITY

DR ULF DETTMER

CURRENT POSITIONS

Associate Professor of Neurology, Harvard Medical School

Principal Investigator, Dettmer Lab, Harvard University

Associate Scientist, Brigham and Women's Hospital

PREVIOUS APPOINTMENT

Research Fellow, Department of Neurology, Harvard University

A neuroscientist developing innovative approaches and exploring new strategies to treating Parkinson's disease and dementia.

As a researcher, Dr Ulf Dettmer is currently an Associate Professor at Harvard Medical School, where he explores new strategies for the treatment of Parkinson's disease and related disorders. There, he leads the Dettmer Lab, where they explore new strategies for the treatment of Parkinson's disease (PD) and related synucleinopathies such as dementia with Lewy bodies (DLB). These diseases are characterised by the aggregation of the protein α-synuclein (αS), an abundant nerve cell component in the brain. With no disease-modifying drugs available, there is a great need for robust models that recapitulate how early changes in the normal maintenance of α-synuclein can lead to these aggregates.

Combining cell biology, biochemistry, microscopy, imaging and screening approaches, his lab probes the biology of alpha-synuclein: defining its normal and abnormal states, developing screens for its toxic, aggregated structure, and using the restoration of its normal structure as a readout for drug discovery. His research has been published in highly prestigious journals including Nature Communications, Journal of Biological Chemistry, Molecular Cell, Proceedings of the National Academy of Sciences, Neuron, and Current Opinion in Neurobiology.

As a mentor, Dr Dettmer has led undergraduate and graduate students in his capacity as his lab's leader at Harvard. He also sat on the grant review committees of the Parkinson's Foundation, Agence National de Recherche (France), and the US Department of Defense. Since 2018, he has also been a member of Harvard's admission committee, in which he conducts admission interviews of the neuroscience program at Harvard.
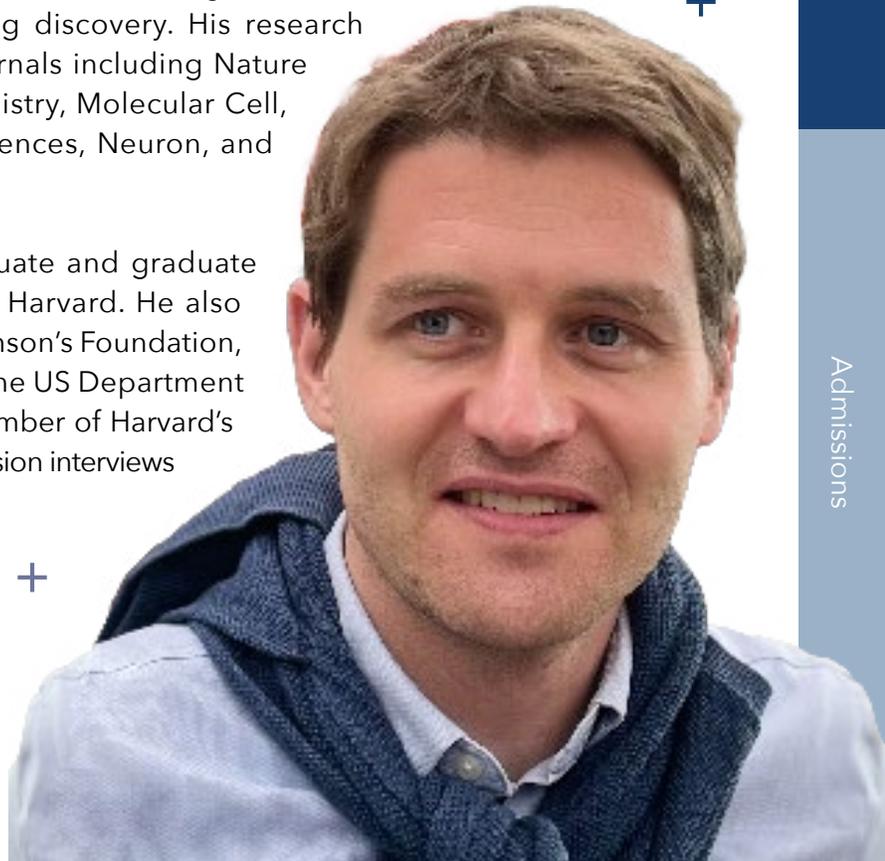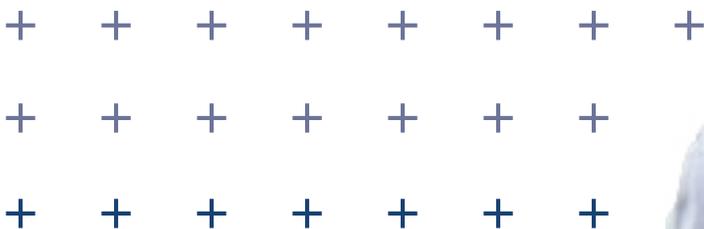
DR ULF DETTMER, HARVARD UNIVERSITY

PARKINSON'S DISEASE:

FROM PATHOGENESIS TO INTERVENTION

Suitable for students interested in:

NEUROSCIENCE
Neuropathology | Parkinson's Disease | Neurodegenerative Diseases

BIOLOGY
Neurobiology | Neurology

MEDICINE
Neurotherapeutics | Drug Development

The English physician-scientist James Parkinson described the 'Shaking Palsy' in 1817. More than 200 years later, we understand the underlying biology of Parkinson's Disease (PD) to some extent. We now know that a protein called α-synuclein aggregates in patients' brains. We also discovered genetic and environmental risk factors and learned that we can treat patients symptomatically.

But why has it so far been impossible to develop a therapy that truly stops or even reverses the pathology? What cellular pathways should we target with small-molecule strategies? Are lipid pathways worth investigating? Beyond small molecules, what approaches might be promising? Antibody therapies? Gene editing? Tissue replacement? And why has it likewise been impossible to find suitable biomarkers to diagnose and study the progression of PD? What could turn out to be a viable biomarker for PD? Lastly, what makes PD unique among neurodegenerative diseases, and what does it have in common with Alzheimer's, frontotemporal dementia and other brain diseases? This research course will explore many such questions. We will introduce students to the original research on the discovery of α-synuclein as the key protein in PD pathogenesis and attempts that have been made towards harnessing this insight into therapeutics.

Through this research course, students will conduct their independent research projects and deepen their understanding of brain anatomy, brain biology and the degeneration that occurs in PD and causes the hallmarks of PD: Lewy-body formation, neuronal loss in specific brain areas and motor phenotypes. Potential intervention strategies will be evaluated. The importance of biomarkers for diagnosis and drug development will be discussed, and potential biomarker strategies will be highlighted. Later in the course, students will work with Dr Dettmer towards defining therapeutic strategies, conducting literature reviews and thinking creatively. The goal is to outline novel strategies towards (early) diagnosis and treatment of PD, and this may include the combination of different approaches.

DR HANNAH RANA

CURRENT POSITIONS

Research Scientist, Centre for Astrophysics, Harvard-Smithsonian Center for Astrophysics
Postdoctoral Research Fellow, Ophthalmology AI Lab, Harvard University
Science Fellow, Schepens Eye Research Institute, Massachusetts Eye and Ear, Harvard Medical School
**Science Fellow,** Department of Neurosurgery, Massachusetts General Hospital, Harvard Medical School

An aerospace engineer, astrophysicist and medical engineer with a commitment to mentoring young minds.

As a researcher, Dr Rana's areas of expertise span aerospace engineering and astrophysics, underpinned by a decade of invaluable experience in the space industry. Her industry experience has encompassed renowned organisations, including NASA, the European Space Agency, CERN, Oxford University and the California Institute of Technology (Caltech) to name a few.

Dr Rana's impactful contributions extend to various space missions, with noteworthy involvement in projects like the Russian-European lunar lander mission Luna-27, the Mars Sample Return mission, and the Earth observation mission Sentinel-3, among a multitude of others. Furthermore, her role as an applied physicist at CERN was pivotal in the development of superconducting radiofrequency accelerating cavities for the Large Hadron Collider.

Dr Rana's excellence in the field of medical engineering was further acknowledged when she was featured on the 2022 Forbes '30 Under 30' Europe list in the Science and Health-care category. Her significant research has been published in high-impact, peer-reviewed scientific journals. Additionally, she authored a book titled "Mathematical Methods for Cryocoolers," published by the Institute of Physics.

As a mentor, Dr Rana has taught undergraduate and postgraduate-level courses at Oxford University, Harvard University, and Caltech.

DR HANNAH RANA, HARVARD UNIVERSITY

SPACECRAFT ENGINEERING

Suitable for students interested in:

ENGINEERING
Mechanical Engineering | Aerospace Engineering

ASTRONOMY
Space Research | Mission Development

MATHEMATICS
Applied Mathematics

In this research course, we will cover all the key phases and elements to developing a spacecraft mission from the concept phase to the engineering phases up until launch. Developing a spacecraft mission encompasses several pivotal phases. It begins with the conceptual stage, focusing on defining objectives, conducting feasibility studies, and outlining initial designs. Following this, the pre-development phase involves meticulous planning, including instrument selection, spacecraft specifications, and overall mission architecture. Engineers then delve into detailed designs and prototypes, rigorously testing subsystems during the design and engineering phase. Assembly, integration, and testing follow, ensuring the spacecraft's functionality and endurance for space. Subsequently, the launch phase involves transportation to the launch site, integration with the launch vehicle, and preparation for liftoff. Once in space, the operations phase begins, where continuous monitoring, data collection, and scientific analysis drive the mission's success. Throughout this journey, collaboration, adherence to safety protocols, and adaptability to unforeseen challenges remain crucial elements in every stage of spacecraft mission development.

Students will generate a scientific exploration case, develop the mission concept, as well as design and investigate custom subsystems of a spacecraft, such as structures, thermal, power, attitude and orbit and propulsion. We will also study celestial mechanics/ astrodynamics in order to determine the most suitable orbits in space and how this affects key engineering considerations. Finally, research investigations will be assigned to each student on the course to help further our understanding of a novel concept in each one of these engineering research fields. This course is well suited to students with an interest across space research, astronomy, aerospace engineering, and mechanical engineering.

Students should expect a lively, interactive research course where their ideas and responses drive much of the class discussion. Ultimately, students will learn to exercise critical thinking skills and conduct their own academic investigations via the research project.

DR NAFIZ CHOWDHURY

CURRENT POSITIONS

Lecturer in Engineering Science, Lincoln College, University of Oxford

Senior Research Fellow, Osney Thermofluids Institute, Department of Engineering Science, University of Oxford

An aerospace engineer advancing gas turbine innovation through cutting-edge cooling technologies, advanced manufacturing, and industry-leading research.

As a researcher, Dr Chowdhury's research lies at the core and forms the foundation of aerospace engineering. At Oxford, he oversees the Engine Component Aerothermal Test (ECAT) Facility at the Thermofluids Institute. This advanced facility supports high-technology-readiness-level research, enabling new technology demonstrations and engine component validations. Dr Chowdhury's research also focuses on gas turbine aerodynamics and heat transfer, with a particular interest in developing and testing innovative cooling technologies for turbine components.

Dr Chowdhury also explores the use of Direct Metal Laser Sintering (DMLS) for manufacturing engine-scale parts, including film cooling holes and internal cooling structures. His expertise in advanced measurement techniques—such as Infrared Thermography, Pressure Sensitive Paint (PSP), Temperature Sensitive Paint (TSP), and Liquid Crystals—allows for precise analysis and optimization of component performance.

Since 2010, Dr Chowdhury has collaborated with leading industrial partners, including Honeywell Aerospace, Rolls-Royce Holdings, Solar Turbines, Siemens Energy, the U.S. Department of Energy, and Samsung Techwin, bridging academic research with practical industry applications.

As a mentor, Dr Chowdhury serves as a College Lecturer in engineering science at the University of Oxford, and actively contributes to the field as a reviewer for leading journals and conferences. His guidance helps aspiring engineers refine their skills and contribute to the advancement of aerospace technologies.
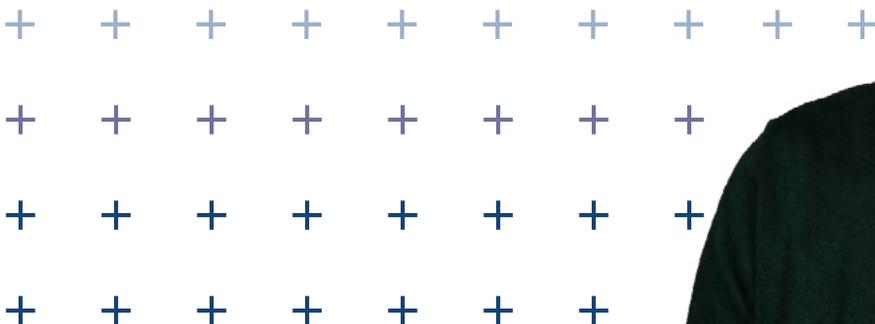
DR NAFIZ CHOWDHURY, UNIVERSITY OF OXFORD

SUSTAINABLE AEROSPACE ENGINEERING, AERODYNAMICS, AND THERMOFLUIDS

Suitable for students interested in:

AEROSPACE ENGINEERING

Aerospace Technologies | Innovation | Sustainability

AERODYNAMICS

Heat Transfer | Jet Engine Cooling | Advanced Propulsion Systems

FLUID MECHANICS

Thermofluids | Sustainable Energy Solutions | Industrial Systems

This research course provides a comprehensive exploration of the essential engineering principles of thermofluids, aerodynamics, and experimental design, equipping students with the theoretical knowledge and practical skills needed to address challenges in aerospace, energy, and sustainable technologies. With a focus on real-world applications, students will delve into core topics such as heat transfer, fluid mechanics, and aerodynamic theory, examining how these principles contribute to the development of advanced propulsion systems and jet engine cooling technologies aimed at achieving net-zero emissions.

In addition to theoretical learning, this course emphasizes hands-on experimentation, teaching students how to design, execute, and analyze engineering experiments effectively. Students will gain practical experience in selecting and calibrating sensors, collecting and processing data, and analyzing results with a strong emphasis on managing and minimizing measurement errors. This crucial skillset is essential for ensuring the accuracy, reliability, and validity of experimental outcomes in engineering practice.

A unique feature of this research course is its integration of sustainability considerations into the study of aerospace engineering. Through case studies and practical projects, students will explore how innovations in thermofluids and aerodynamics can contribute to the reduction of greenhouse gas emissions and the advancement of sustainable energy solutions.

By the end of this research course, students will have a deeper understanding of how thermofluids, aerodynamics, and experimental design intersect to address critical challenges in modern engineering, and they will be prepared to apply these skills to innovate and create solutions for achieving sustainability and net-zero objectives in the industries of aeropsace, sustainable energy, industrial systems, and beyond.

UNIVERSITY COLLEGE OF LONDON

DR RAFAEL CARRASCOSA MARZO

CURRENT POSITION

Science for Policy Officer (SAPEA), Cardiff University

A nanobiotechnologist, drawing on physics, biology, and engineering to develop cutting edge technology at the nanoscale.

As a researcher, Dr Marzo is a nanobiotechnologist working in the cutting-edge field of DNA robotics. He has broad knowledge in the fields of molecular biology and genetics with an emphasis on its medical applications, particularly in the realm of nanomedicine. His research is focused on the novel technique of DNA Origami and its possibilities. His work consists of designing and constructing complex architectures at the nanoscale using DNA strands as the building blocks. These structures can have tailored, dynamic capabilities, which can be actuated with different types of inputs, making them devices of interest in a wide variety of fields. His research has been published in *ACS Nano, Small,* and *Science Robotics*.

In addition, Dr Marzo's interests also lay in the interphase between science and the greater public, science policy and science communication. He serves as a Science for Policy Officer at Cardiff University, being involved in SAPEA projects within the Science Advice Mechanism (SAM) for the EU commission.

DR RAFAEL CARRASCOSA MARZO, UNIVERSITY COLLEGE OF LONDON

DNA NANOTECHNOLOGY:

DESIGN AND FUNCTION OF SMART NANO-CONSTRUCTS

Suitable for students interested in:

PHYSICS

Biophysics | Medical Physics | The Applications of Physics

BIOMEDICAL ENGINEERING

Robotics | Nanotechnology

BIOLOGY

Biochemistry | Biophysics | Genetics | Neuroscience

DNA was one of the first biomolecules to gain function in the development of life; it is not by chance that it takes part in one of the most important roles in the perpetuation of life, the storage and expression of information that makes living beings what they are. Given these key functions, DNA molecules have particular chemical and physical properties that can be applied to solve tasks that go beyond the scope of their function in nature.

In this research course, we will first explore DNA's functional characteristics and how they can be used to produce complex architectures at the nanoscale that can then perform customised tasks for a wide range of applications – from biomedicine to the manufacturing industry, including data storage and complex chemical production.

The field is still in its infancy, but many different structures have been developed, using DNA exclusively or in concomitance with other biomolecules/chemical elements of interesting functionalities. The type and application of the DNA nanostructures can vary greatly, so an overview of the different subfields within DNA nanotechnology will also be presented. Once the basics of the field and the material have been explained, the students will be introduced to the tools that researchers at the cutting edge of this field use daily to design and test (in silico) these fascinating constructs. Through conducting their independent research projects, students will be able to apply the concepts shown in the theoretical section. At the end of the course, the students will be familiar with and will have the specific tools for working in a relevant field at the frontier of multidisciplinary research that will play a key role in the development of new technologies in the bio and technological fields worldwide.
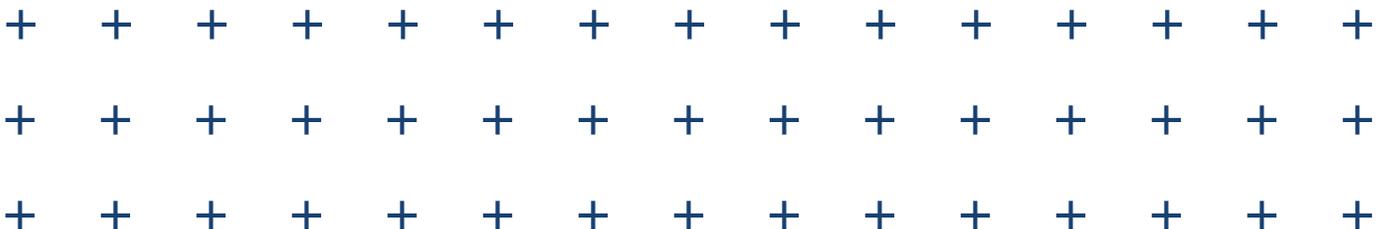
DR THOMAS GEORGE THURUTHEL

CURRENT POSITION

Lecturer in Robotics and AI, Department of Computer Science, University College London.

A roboticist fusing machine learning, mechanical engineering, and biology to push the boundaries of robotics.

As a researcher, Dr Thuruthel is involved in the most cutting-edge areas of robotics through designing, modelling, and controlling soft-bodied systems, dexterous manipulation, and applications of AI in robotic systems. With expertise in the field of robotics, machine learning and material science, he is currently working on designing robots that can autono-mously develop their tactile perception system and use it for identifying the self from the environment. He is also working on self-healing soft robots, development of soft sensing technologies and 3D printing of advanced functional materials.

As a well-established researcher, he has already had 30 major publications. His works appear in top peer-reviewed journals including *Science Robotics, Soft Robotics, IEEE Transactions on Robotics*, etc. He has edited Machine Learning Techniques for Soft Robots, Frontiers in Robotics and AI and has reviewed Soft Robotics Journal, Robotics and Automation Letters, Transactions on Neural Networks and Learning Systems, Transactions on Systems, Man and Cybernetics: Systems, Advanced Robotics, Robotics and Computer-Integrated Manufacturing, among others.

As a mentor, Dr Thuruthel has taught at both the undergraduate and graduate levels at Cambridge. He has supervised Ph.D. and Master students for their research and theses.
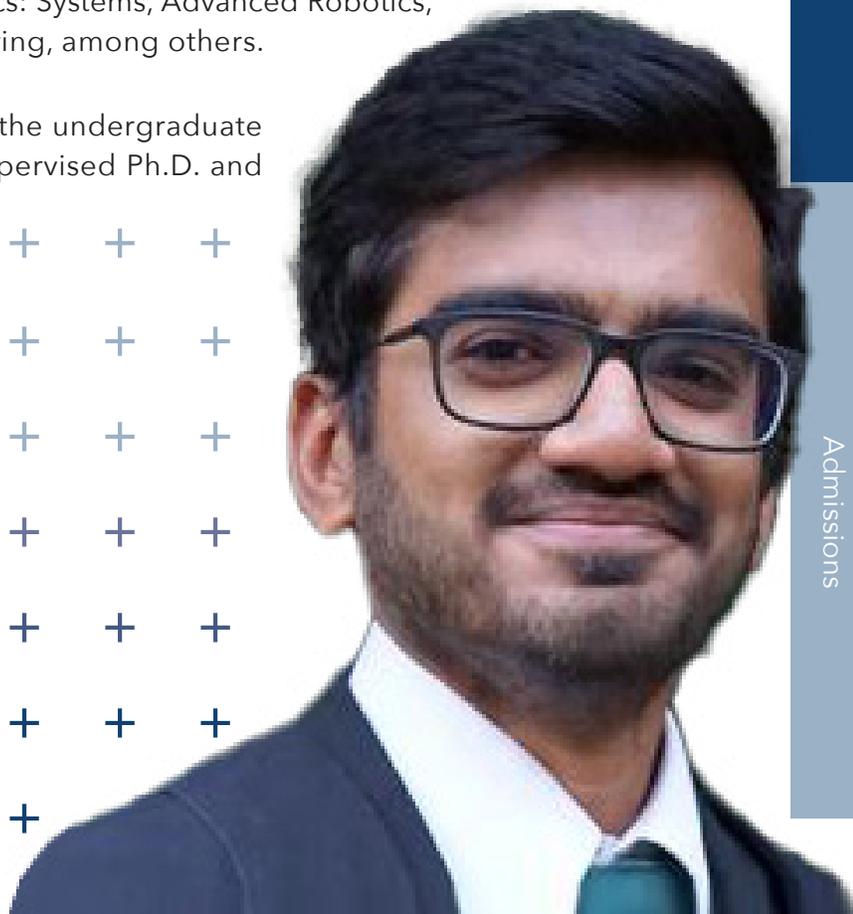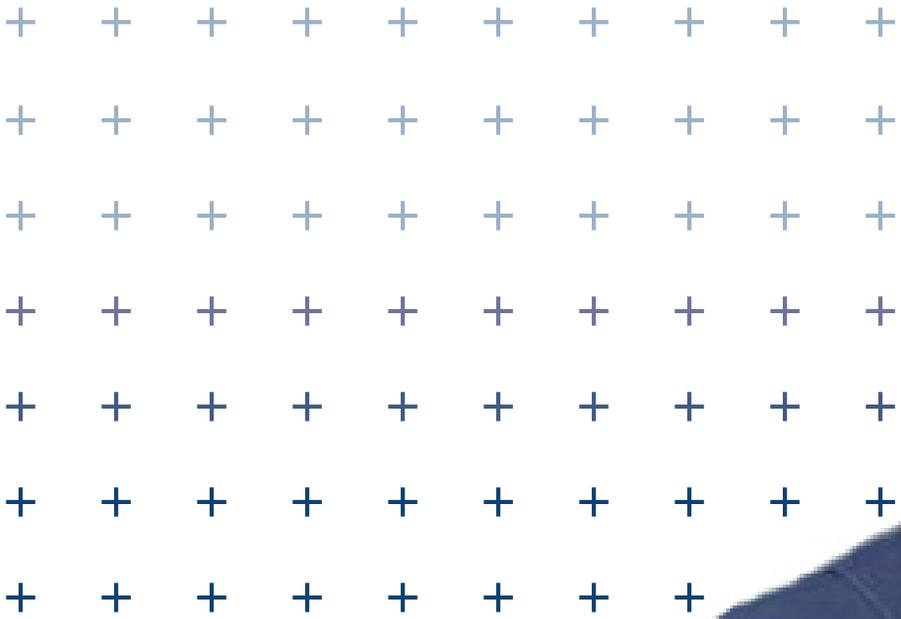
DR THOMAS GEORGE THURUTHEL, UNIVERSITY COLLEGE LONDON
BIO-INSPIRED ROBOTICS:

MACHINE LEARNING, DESIGN, AND CONTROL

Suitable for students interested in:

ENGINEERING
Mechanical Engineering | Electrical Engineering | Industrial Design

COMPUTER SCIENCE
Machine Learning | MATLAB | Modeling and Simulation

ROBOTICS
Bio-inspired Robotics | Control Theory | Self-Healing Soft Robots

Biorobotics is a cutting-edge interdisciplinary science at the intersection of biology, bio-medical engineering, computer science and robotics. It studies ways to improve the intelligence, locomotion, and other performances of robotic systems inspired by nature.

In this course, students will be introduced to novel bio-inspired ideas that have revolutionised modern day robotics, particularly in the field of soft-robotics. The course delves into the principles and methods behind the design of physically compliant robots. Students will learn about the dynamics and control of traditional robots as well. Comparisons between different designs will help students to better understand the challenges and opportunities in the field of robotics.

Students will learn the programming language MATLAB and develop their independent research projects on bio-inspired robotics. The learning outcome results in a strengthened understanding of the interrelated concepts of control, optimisation, and reinforcement learning.

This course will help students to develop their knowledge in biology and will cultivate their programming skills and ability to apply them to robotics research. Ultimately, these developments will lead students to think about bio-inspired robotics creatively: how, and to what extent, can we use nature as a model for designing and improving robotic designs? How can bio-robotics solve real-world problems?

UNIVERSITY OF CAMBRIDGE

DR ARSEN ABDULALI

CURRENT POSITION

Marie Sklodowska-Curie Future Roads Fellow, Bio-Inspired Robotics Lab, Cambridge University

PREVIOUS APPOINTMENTS

Research Associate, Bio-Inspired Robotics Lab, Cambridge University
Postdoctoral Researcher, Mathematical Biology Lab, Kyung Hee University

A robotics researcher specializing in haptic interaction modeling and human-robot collaboration.

As a researcher, Dr Abdulali's research focuses on advancing haptic interaction modeling within the metaverse, where the realms of the physical and virtual seamlessly intertwine. A central objective of his work is to facilitate haptic engagement with simulated environments, allowing individuals to experience tactile sensations such as the deformation of soft objects, the dynamics of liquids within containers, or the textures of surfaces they interact with, all within a virtual context. This innovation extends its utility across a spectrum of educational applications, including medical training, construction site simulations, and the operation of industrial machinery and vehicles.

Beyond haptic modeling, Dr Abdulali's research interest extends to the realm of human-robot collaboration. In this domain, he explores scenarios where humans control one or multiple remote robots through implicit communication, while the robotic manipulation at the remote location occurs in a semi-automated fashion. Currently, Dr Abdulali is pioneering a novel approach to human-robot social cooperation, where the human operator orchestrates the robot's actions from a remote location. This collaborative interaction involves the robot executing manipulation routines with objects and navigating the roadside environment in a semi-automated capacity. The proposed human-in-loop design has the potential to relocate roadside workers to remote offices, mitigating the health and safety risks associated with their roles.

Dr Abdulali has showcased his research findings at various IEEE and Springer conferences, contributing significantly to the field of haptic interaction modeling and human-robot collaboration. Notably, a research paper he co-authored titled "Mastication-Enhanced Taste-Based Classification of Multi-Ingredient Dishes for Robotic Cooking" received the Outstanding Article Award by *Frontiers in Robotics and AI* journal.

As a mentor, Dr Abdulali provides invaluable guidance, leveraging his expertise to nurture and inspire his mentees, fostering a dynamic learning environment that extends across diverse applications.

DR ARSEN ABDULALI, UNIVERSITY OF CAMBRIDGE

ROBOTICS USING MACHINE LEARNING AND AI

Suitable for students interested in:

ROBOTICS
Simulations | Human-Robot Interactions | Learning

ARTIFICIAL INTELLIGENCE
Reinforcement & Demonstrations | Machine Learning | Embodied AI

This research course introduces students to the intersection of robotics and artificial intelligence, with a focus on the machine learning techniques that power advancements in modern robotics. Covering a broad spectrum of intelligence levels, the research course begins with foundational concepts, such as understanding touch and interaction with the physical environment, and progresses to advanced methodologies, including reinforcement learning, learning from human demonstrations, and multi-agent collaboration.

Students will explore the principles of physical and embodied intelligence, which emphasize how robots interact with and learn from their environments. The research course also delves into the emerging field of Embodied AI, where sensory data, motor control, and machine learning converge to enable robots to develop adaptive and intuitive responses in complex environments.

A key component of this research course is its hands-on approach. Students will engage in a range of activities, from theoretical discussions to practical implementations, to gain a deep understanding of robotic learning and AI techniques. Topics include robotic learning in simulations, modeling interactions with humans, human-robot collaboration, and multi-robot systems.

In the second half of the research course, students will apply their learning by undertaking independent research projects. These projects provide the opportunity to delve into specific interests within robotics, whether it's training robots to learn from simulations, designing algorithms for human-robot interaction, or developing collaborative systems for multi-agent robotics. Students will learn to identify challenges, design experiments, and interpret results, ultimately contributing novel insights to the field.

By the end of the research course, students will have acquired a solid foundation in machine learning applications in robotics, gained hands-on experience with cutting-edge research tools, and developed the skills needed to advance in robotics, AI, and related fields.
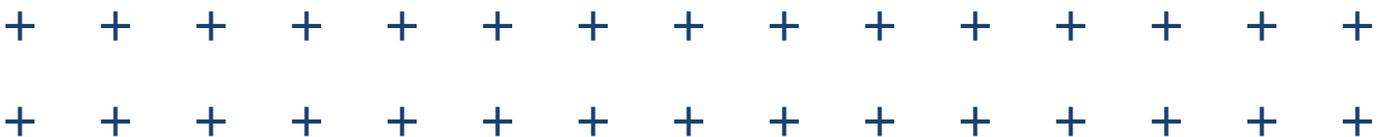
DR RYMAN HASHEM

CURRENT POSITION

Senior Research Fellow in Biomedical Engineering, Department of Engineering Science, University of Oxford

PREVIOUS APPOINTMENTS

Research Associate, Bio-Inspired Robotics Laboratory, Department of Engineering, University of Cambridge

Researcher, Biopsy Automation, National Health System, United Kingdom

A scientist focused on designing novel concepts for bio-mimicking human muscular systems in soft mechatronic systems.

As a researcher, Dr Hashem has focused his work in hybrid and soft robotics development (concept, design, fabrication, modelling, and control) of several actuators. He specialises in designing novel concepts for bio-mimicking human muscular systems in soft actuators and sensors through the development of mechatronic systems. Currently, he is also collaborating with NHS to automate the biopsy process at the pathology department, with the goal to solve the slide production backlogs, permitting rapid development, and help mitigate the significant shortage of pathologists, both in the UK and internationally. He has a prolific publication record, having published in numerous high-impact engineering journals including: *Transactions on Mechatronics, Frontiers in Robotics and AI, and Soft Robotics.*

As a mentor, Dr Hashem has mentored both undergraduate and graduate students at the University of Cambridge and the University of Auckland, helping them develop academic and industry experience through the design, development, and construction of robot prototypes.

DR RYMAN HASHEM, UNIVERSITY OF OXFORD
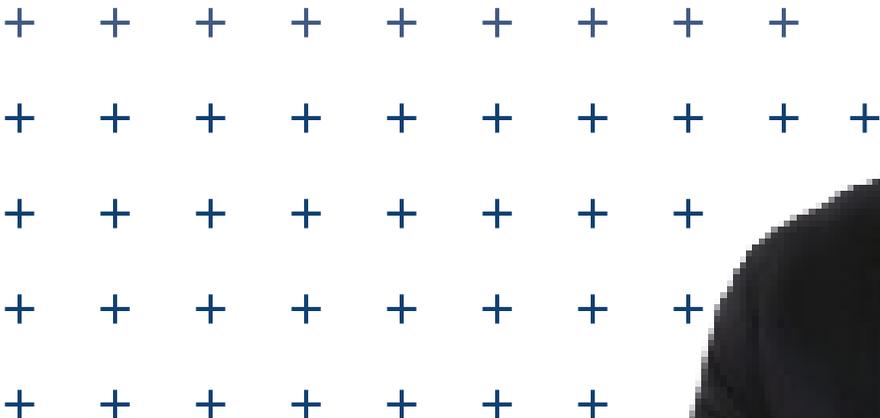
SOFT ROBOTICS:

BIOMIMETIC ENGINEERING

Suitable for students interested in:

ENGINEERING
Robotics | Soft Robotics | Biomedical Engineering

COMPUTER SCIENCE
Modelling | 3D Modelling | Machine Learning

Soft robotics is a rising branch of robotics that interests many researchers from different disciplines such as biology, medicine, and robotics. Soft robots accomplish a delicate, flexible and safe interaction with humans using soft actuators that mimic biological behaviour, which state of the art rigid robots cannot accomplish otherwise. In practice, they can perform tasks that would be impossible or dangerous for humans to do.

This research course will introduce students to this nascent branch of robotics and have a deeper insight into soft robots' concept, development, and control. With this, the students will develop a full awareness of the topics, which will allow them to work on their independent research projects. We will explore how to design and simulate soft actuators with available software such as MATLAB and open-source CAD systems. We will investigate the different methods of building soft actuators and their advantages and disadvantages. The concept and design of soft robots are the initial steps to understand what we need the robot for and why "softness" is required. After establishing the concept, a 3D model of a simple soft robot can be established. With the 3D model, we can investigate the model in a simulator to validate the performances or build the robot by printing the 3D model. The design depends entirely on the type of soft actuators, which we will explore in this research course.This research course aims to motivate students to practise critical thinking skills while honing their understanding of soft robotics. Students will interactively engage with the process of learning to build a soft robot from scratch and understanding the specifications required to build a soft robot for a given application. outcomes of this course also include using MATLAB and CAD software to develop and test builds. We will also explore simple control methods for soft robotics. Through conducting research projects, students will have a broad understanding of soft robotics and its practical applications.

UNIVERSITY OF OXFORD

DR STELIOS CHATZIMICHAIL

CURRENT POSITION

Research Associate, Department of Physics, University of Oxford

PREVIOUS APPOINTMENT

Research Associate, Imperial College London

A scientist revolutionising rapid bacterial detection and antimicrobial resistance testing through advanced microfluidic and lab-on-a-chip technologies.

As a researcher, Dr Chatzimichail is actively engaged in the Antimicrobial Resistance Testing initiative, with a keen focus on advancing lab-on-a-chip technologies for swift bacteria detection in liquid biopsies. Previously, he has developed microfluidic platforms that facilitated the high-throughput proteomic analyses of circulating tumour cells from high haematocrit blood samples.

Antimicrobial resistance testing is at the forefront of medical innovation, aiming to provide rapid and accurate diagnostic tools to combat the rising threat of drug-resistant infections. By integrating microfluidics with advanced detection methods, Dr Chatzimichail seeks to revolutionize how bacterial infections are identified and treated, significantly reducing the time to diagnosis and enabling timely medical interventions. His previous research in microfluidic platforms has been instrumental in enhancing our understanding of circulating tumour cells, offering new avenues for cancer diagnostics and personalized medicine.

His ongoing work centres on crafting microanalytical platforms and employing molecular barcoding methods to expedite the identification of bacteria within patient samples, while also facilitating the assessment of their susceptibility to antimicrobial agents. Previously, he dedicated his efforts to pioneering tools for investigating circulating tumour cells at a single-cell resolution. His findings were published in high-impact peer-reviewed scientific journals including *Communications Chemistry, Scientific Reports,* and *ACS Synthetic Biology.*

As a mentor, Dr Chatzimichail supervises PhD and Master's students in their dissertation work at Oxford, providing expert guidance and support. He also serves as an undergraduate lab demonstrator, delivering specialised instruction and assistance in physical chemistry experiments.

DR STELIOS CHATZIMICHAIL, UNIVERSITY OF OXFORD

FRONTIERS IN BIOMEDICAL ENGINEERING:

MICROFLUIDICS AND ROBOTIC CHEMISTRY

Suitable for students interested in:

PHYSICS AND CHEMISTRY
Microfluidics | Fluid Mechanics | Fluid Dynamics | Analytical Chemistry

BIOMEDICAL ENGINEERING
Biotechnology | Robotics | Nanotechnology

This is an interdisciplinary research course at the interface of microengineering, analytical chemistry, and robotics, designed to explore the innovative applications of miniaturized analytical systems and automated chemical processes. This research course introduces students to the fundamental principles of microfluidics, emphasizing the advantages of operating in low-Reynolds number regimes, which enable precise control of fluid behavior at the microscale.

In this research course, students will learn cutting-edge techniques in microfluidics and robotics and apply them to real-world problems in analytical chemistry and biomedical engineering. The course will introduce students to the design and fabrication of microfluidic devices, the principles of fluid dynamics at the microscale, and the integration of robotic systems for automated analysis and experimentation. They will learn about the various applications of microfluidic technology, such as in point-of-care diagnostics, environmental monitoring, and high-throughput screening.

The first half of the research course will help students develop a strong foundation in the principles of microfluidics and robotics. The second half will focus on hands-on projects, where students will design and implement their own microfluidic systems and integrate them with robotic automation. Students will gain practical experience in using software tools for design and simulation, as well as in programming robotic systems for precise control and operation.

Throughout the course, students will engage in real-world case studies, simulations, and laboratory exercises to reinforce their learning and develop practical skills. By the end of the course, students will have a comprehensive understanding of how microfluidics and robotics can be combined to create innovative solutions for complex analytical challenges. This knowledge will empower them to contribute to advancements in fields such as biomedical engineering, environmental science, and chemical analysis.
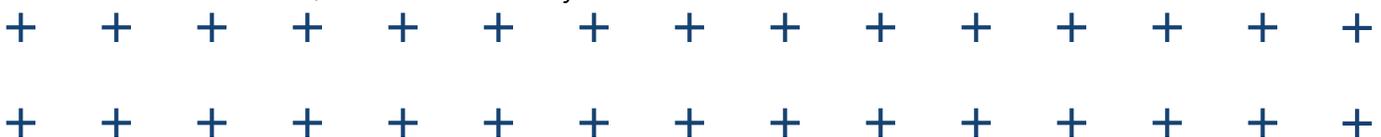
DR GEORGE ANWAR

CURRENT POSITIONS

Lecturer, UC Berkeley

Co-founder / President, Integrated Motions, Inc.

A researcher specialising in robotics and applying his expertise to consult for leading organisations including IBM, Ford, Applied Materials, and NASA.

As a researcher, Dr Anwar is passionate about robotics and control systems. His main research focus is on the development of embedded systems by utilising multitasking and real-time programming methods. He is also interested in model predictive control, distributed and robust constrained control, automotive control systems and energy efficient building control systems. He has had a number of publications in the field of robotic controls.

In addition to research, Dr Anwar also has extensive industry experience; he co-founded an engineering consulting firm in the area of controls and instrumentation. His consulting has been in the field of automation, testing and measurements, manufacturing and medical devices. Prominent clients of his firm include IBM, Ford, Applied Materials and NASA. Furthermore, Dr Anwar holds two patents: one in the field of microfluidics and another in the field of building automation.

As a mentor, Dr Anwar has been teaching mechanical engineering in the area of controls and embedded-system design for over 17 years. Courses include Electronics for IOT and Design with Microprocessors. His courses are typically both theoretical and hands-on. All his courses involve design and the development of prototypes.

Dr Anwar George has supervised and coached many students through various robotic competitions, such as First Lego League and First Robotics. He is the faculty advisor to the CalSol solar-car team as well as the Pioneer in Engineering team at UC Berkeley. His students have built projects such as wall-climbing robots, a functioning replica of the Star Wars BB8 robot, as well as a robot that broke the world record in solving the Rubik's cube 14 years ago. Dr Anwar is also an advisor to a number of projects at UC Berkeley, including NASA RC Rover, High-Mileage Vehicle, Hyperloop and more.
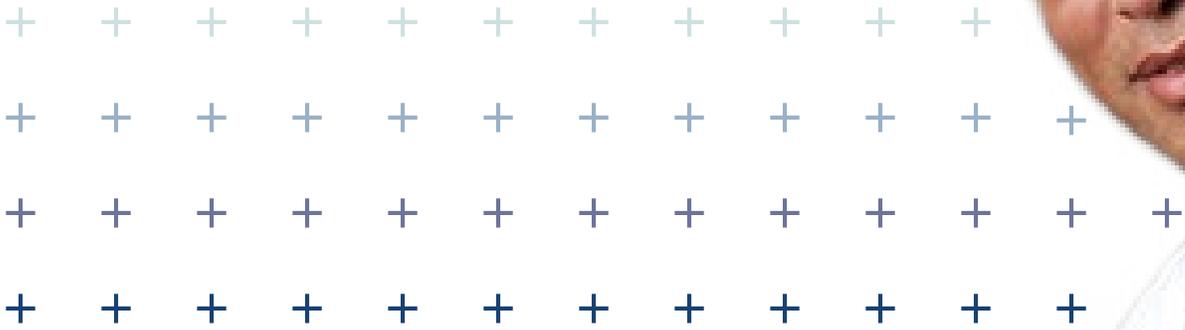
DR GEORGE ANWAR, UNIVERSITY OF CALIFORNIA

HANDS-ON ENGINEERING WITH MICROPROCESSORS FOR MECHANICAL SYSTEMS

Suitable for students interested in:

ENGINEERING
Mechanical Engineering | Computational Engineering

COMPUTER SCIENCE
Data Analysis | Hardware Design | MATLAB

Microprocessors have revolutionised the field of mechanical engineering by providing greater control, accuracy, and the ability to perform complex tasks and make real-time decisions in mechanical systems. This technology is essential for modern manufacturing and the development of advanced mechanical systems.

In this research course, students will delve into the use of microprocessors in the design and control of mechanical systems, gaining hands-on experience and improving their programming skills. This research course provides preparation for the conceptual design and prototyping of mechanical systems that use microprocessors to control machine activities, acquire and analyse data, and interact with operators. The architecture of microprocessors is related to problems in mechanical systems, including electromechanical components, thermal components and a variety of instruments. The research course is project-based wherein students are expected to perform laboratory exercises that use different levels of software, which includes C and MATLAB. Participants will have the opportunity to work with an Infineon PSOC6 microcontroller.

Throughout the research course, students will gain a comprehensive understanding of the foundations of design and mechanical systems, including microprocessor architecture and an introduction to feedback control using PID. They will have the opportunity to work with MATLAB and real-time operating systems, as well as learn programming methodology. Additionally, they will learn about sensors, electromechanical actuators, and their uses within the context of a mechanical system.

While working on their independent research projects, students will gain a strong understanding of the scientific research process and develop the skills necessary to tackle hands-on projects. Under the mentor's guidance, they will learn how to estimate the resources required to solve arising issues and how to generate feasible solutions. Additionally, students will learn how to develop and document a design, identify critical safety issues, simulate a prototype solution, and test and evaluate the final product.
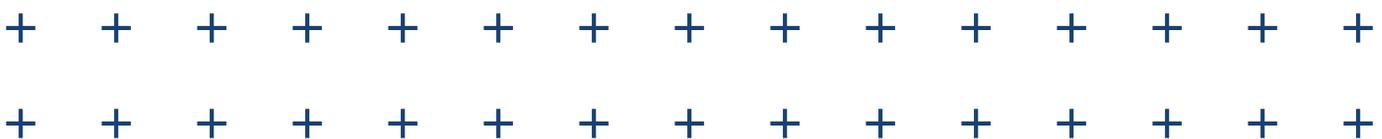
DR ELSIDDIG ELMUKASHFI

CURRENT POSITIONS

Senior Research Fellow in Solid Mechanics and Material Engineering, Department of Engineering, University of Oxford

Lecturer in Engineering Science, St Anne's College, University of Oxford

PREVIOUS APPOINTMENT

Mechanical Engineer, The Sudanese Petroleum Company

As a researcher, Dr Elmukashfi's expertise lies in material mechanics, particularly fracture and damage mechanics, evident from his prolific publications in highly reputed journals and conferences. His comprehensive knowledge extends to nonlinear solid mechanics, experiment design, and computational mechanics, making him a formidable force in the field. As a Lecturer at St Anne's College, University of Oxford, Dr Elmukashfi continues to share his wealth of knowledge and experience with aspiring engineers at both master and bachelor levels.

Some of his notable publications include "A modelling framework for coupled hydrogen diffusion and mechanical behaviour of engineering components" in *Computational Mechanics,* "A theoretical and computational framework for the creep crack growth" in the *International Journal of Fracture*, and "Numerical analysis of dynamic crack propagation in biaxially strained rubber sheets" and "Numerical analysis of dynamic crack propagation in rubber" in *Engineering Fracture Mechanics and the International Journal of Fracture*, respectively.

Outside the realm of academia, Dr Elmukashfi previously served as a Mechanical Engineer at the Department of Engineering and Projects for the Sudanese Petroleum Company (SudaPet) in Khartoum, Sudan, gaining valuable industry experience prior to embarking on his successful academic career.

As a mentor, Dr Elmukashfi has worked with students at both master and bachelor levels.

DR ELSIDDIG ELMUKASHFI, UNIVERSITY OF OXFORD
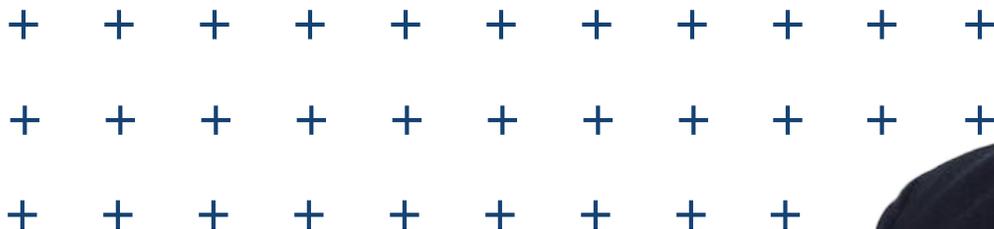
FUNDAMENTALS OF MECHANICS AND MECHANICAL ENGINEERING:

STATICS AND DYNAMICS

Suitable for students interested in:

ENGINEERING
Mechanical Engineering | Material Science

PHYSICS
Mechanics | Statics | Dynamics

In this research course, we will explore the fundamental principles of mechanics in this comprehensive course that covers the essential and advanced concepts of statics and dynamics. Through a balanced blend of theoretical insights and practical applications, students will develop a strong foundation in analysing equilibrium, structural members, and the motion of particles and rigid bodies.

The research course begins with an in-depth study of statics, focusing on the equilibrium of objects under various forces and moments. Students will learn to calculate and analyse forces, moments, and couples acting on stationary structures. The course then delves into "Structural Members." An integral part of statics, this module delves into the analysis of different structural members. Students will gain insight into the behaviour of beams, columns, and cables under different loading conditions. They will learn to determine internal forces, stresses, and deflections, enabling them to make informed decisions in structural design and analysis. Transitioning finally into dynamics, the course delves into the motion of particles and rigid bodies. Students will study the fundamental principles of kinematics and kinetics, covering concepts such as displacement, velocity, acceleration, and Newton's laws of motion. The course also includes topics like work-energy principle, impulse-momentum theorem, and rotational motion. Practical applications, including projectile motion and collisions, will provide students with insights into real-world scenarios where dynamic principles come into play.

Throughout the research course, hands-on exercises, problem-solving sessions, and interactive simulations will allow students to apply theoretical concepts to practical situations. By the end of this course, students will possess a solid understanding of basic mechanics, enabling them to analyse static equilibrium, assess structural members, and predict the behaviour of particles and rigid bodies in dynamic situations. This knowledge forms a crucial foundation for further studies in engineering, physics, and related fields.

Prerequisites: Basic understanding of algebra, trigonometry, and physics concepts.

DR HAFEZ EL SAYYED

CURRENT POSITION

**Senior Postdoctoral Research Fellow,** Department of Physics, University of Oxford

PREVIOUS APPOINTMENT

Postdoctoral Research Fellow, Department of Physics, University of Oxford

As a researcher, Dr. El Sayyed has made significant contributions to the field of RNA polymerase redistribution and the functional allocation of universal transcription factors. Throughout his career, Dr. El Sayyed has held various academic and research positions that have allowed him to develop a diverse skill set. In 2012, he served as a researcher at ISSB, Evry University Paris, France, gaining valuable experience in the scientific research process. Subsequently, he joined the Oxford University in 2017 as a Postdoctoral Research Fellow in the Department of Physics, where he has been actively involved in ground-breaking projects.

Dr. El Sayyed's contributions to the scientific community extend beyond the lab, with numerous publications in prestigious journals. Notably, his work on RNA polymerase redistribution and universal transcription factor NusG has been published in high-impact journals like *Nucleic Acids Research* and the *SSRN Electronic Journal.* His research findings have provided valuable insights into fundamental biological processes and have garnered significant recognition in the academic world.

As a mentor, Dr El Sayyed has been tutor and demonstrator in the Department of Biochemistry at Oxford University since 2018. Moreover, he has taken up the role of a Lecturer for the MSc Nanotech for Medicine and Healthcare program in the Department of Engineering Science at Oxford University since 2022, where he shares his knowledge and expertise with aspiring undergraduate and graduate students.

DR HAFEZ EL SAYYED, UNIVERSITY OF OXFORD
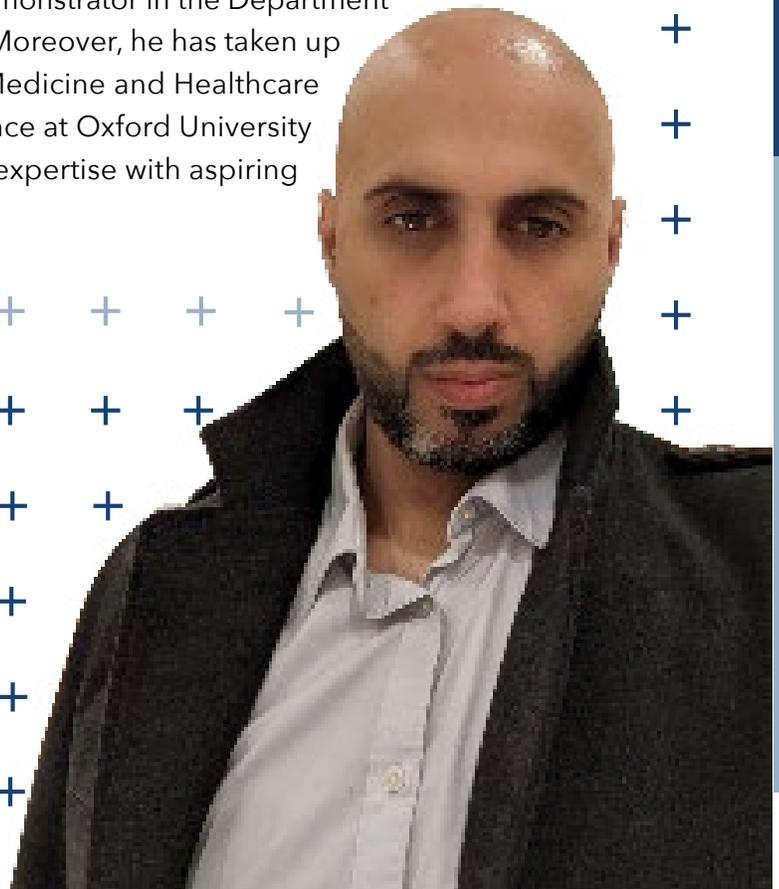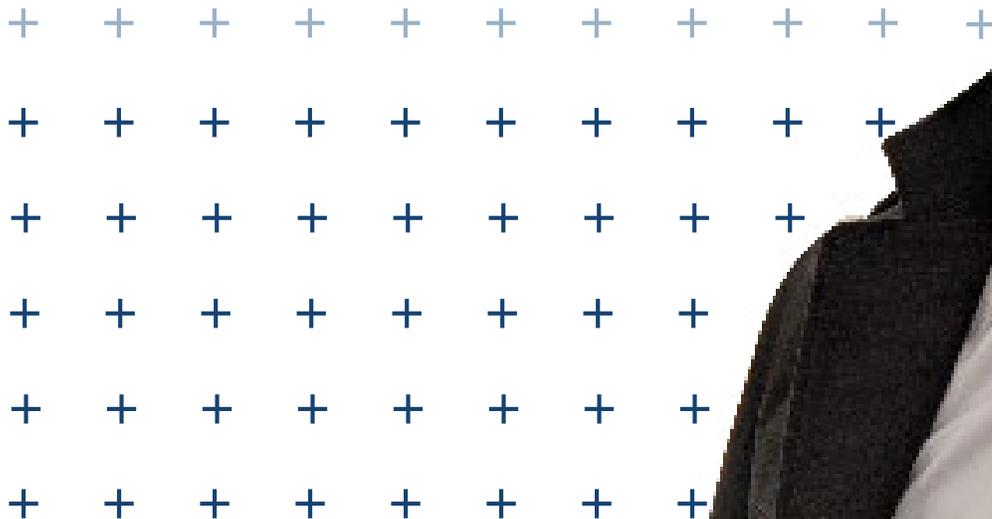
SYNTHETIC BIOLOGY:

DESIGN AND ENGINEERING OF LIVE SYNTHETIC MACHINES

Suitable for students interested in:

BIOLOGY
Biochemistry | Synthetic Biology | Genetics

MEDICINE
Nanotechnology | Drug Discovery | Genetic Engineering

DNA evolved as the bearer of genetic information expressed as instructions called genes. Genes serve to preserve and propagate the genetic identity of organisms. Decades of biochemical research, and the advent of sequencing techniques have elevated our understanding of gene regulation across fields such as genetic diseases, pathogenesis, and biotechnology techniques optimization to name a few. Knowledge is power; as understanding computer codes allows us to program and hack computers to perform novel or altered operations, synthetic biology allows us to hack live cell gene expression giving rise to novel genetic functions through the knowledge of the genetic code.

In this research course we will explore the basics of synthetic biology starting with bio-bricks and requirements to make functional genetic constructs. We then delve in genetic design and molecular biology techniques required in synthetic biology. Finally, we will look at examples of synthetic biology frameworks such as projects in the IGEM competition that pushed the boundaries in various fields of science. We can assemble so many machines from our DNA Lego bits with the right knowledge.

Once the students get a good grasp of the principles of synthetic biology, we will then encourage students to design and conceive a synthetic biology project from conception to completion in silico. The students will be inducted in the ways of IGEM team members. The students are given the freedom to challenge themselves and perhaps come up with an actual viable idea that can be perhaps tested in collaboration with established synthetic biology labs.

At the end of the course students will be fully equipped with the necessary tools and know-how to undertake any molecular biology project in the lab. The material covered would be useful in any field of applied biological research.
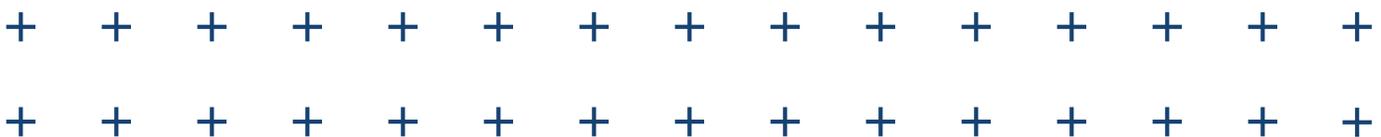
DR MARCO ALBAN PACCHA

CURRENT POSITIONS

Postdoctoral Research Associate, Department of Medicine & Department of Engineering, University of Cambridge

Postdoctoral By-Fellow, Churchill College, University of Cambridge

**Associate Lecturer,** The Open University, Milton Keynes

A scientist developing cutting-edge technology such as wearable electronics, sensing, optical imaging, and AI tools in the biomedical sectors.

As a researcher, Dr Paccha's primary area of interest lies in developing cutting-edge technologies in wearable electronics, sensing, optical imaging, and AI applications within the healthcare and biomedical sectors.

Previously, he worked on thin dry electrodes and wearable electronics for cardiovascular sensing. Currently, he is actively involved in the ADVANTAGE research consortium, which is part of the UK Advanced Pain Discovery Platform. In this role, he collaborates with the Bioelectronics Group at the Department of Engineering and the Pain Group at the Department of Medicine of the University of Cambridge. Dr Paccha develops wearable sensor solutions and implements machine learning algorithms to detect, classify, and predict pain episodes in humans. Specifically, he works on the application of wearable electronics and mobile apps to understand visceral pain and the development of an organic electro-chemical transistor-based platform for multi-analyte sweat sensing.

Dr Paccha's work has been published in a wide range of high-impact peer-reviewed scientific journals including *ACS Photonics and Flexible and Printed Electronics*. Furthermore, he has been invited as a speaker at several talks and consortiums in Korea, Ecuador, and the UK.

As a mentor, Dr Paccha teaches courses on Nanoscale Engineering, and Computing and intelligent systems at Milton Keynes Open University and has developed laboratory experiments for undergraduate students.
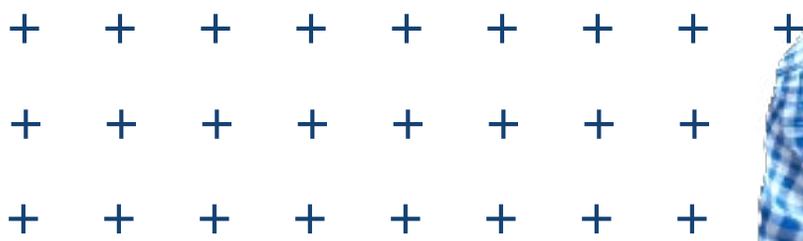
DR MARCO ALBAN PACCHA, UNIVERSITY OF CAMBRIDGE

NANOMATERIALS:

APPLICATIONS IN INDUSTRY, SUSTAINABILITY, AND HEALTHCARE

Suitable for students interested in:

BIOTECHNOLOGY
Nanotechnology | Micro & Nano-Structured Devices | Biomedicine

ENGINEERING AND MATERIAL SCIENCE
Surface & Films | Superhydrophobicity | Energy Storage

Nanotechnology is a multidisciplinary field that draws from physics, chemistry, biology, and engineering. It is a rapidly evolving field that offers novel solutions for many industrial challenges. **In this research course, students will learn about various aspects of nanotechnology and nanomaterials, and how they are applied to create devices such as solar cells, superconductors, and medical sensors.**

The first part of the research course will cover surfaces and films, and how they can be used to give materials special properties such as superhydrophobicity – a remarkable water-repelling effect inspired by nature. Students will learn about micro and nanostructured devices, how they are made and how they work; examples of these devices include pressure sensors and gyroscopes. Students will also be introduced to nanoparticles, their synthesis, their characterisation, and the unique properties they have due to their size. The second part of the course will focus on semiconductor solar cells and light–matter interaction, both at large and small scales. Students will learn how nanostructures can be used to manipulate light. They will also study devices for energy storage and generation: batteries, supercapacitors, and fuel cells. They will see how nanoparticles, with their high surface-to-volume ratio, are used to enhance the storage performance of devices. The last part of the course will explore nanotechnology and its applications to health and provide students with the skills they need to further their knowledge in this field.

In this research course, students will choose a topic of interest from the latest research developments in the nanotechnology field. They will learn how to critically evaluate and interpret the most relevant and cutting-edge literature, as well as how to communicate and pitch their ideas effectively through a research/commercial project proposal.
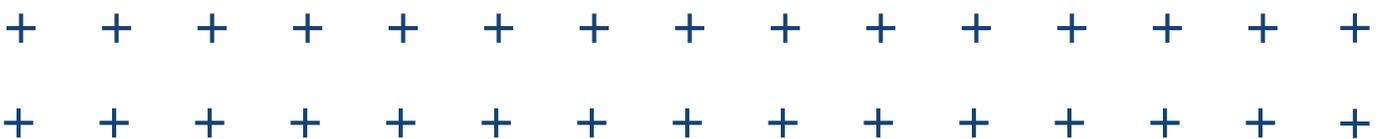
DR MARCO ALBAN PACCHA, UNIVERSITY OF CAMBRIDGE

SENSORS IN WEARABLE TECHNOLOGY:

FROM DATA SCIENCE TO MACHINE LEARNING

Suitable for students interested in:

BIOTECHNOLOGY

Sensor Data Science | Basic Machine Learning | Physiological signalling

COMPUTER SCIENCE

Data Science | Machine Learning and AI

This research course centres around devices that convert physical phenomena into electrical signals that can be processed by computers. Sensors are embedded in everyday objects, such as smartphones, wearables, vehicles, machines, and more, to enable data collection and communication. Applying data science to sensors can help us understand the patterns, trends, and anomalies in the sensor data, and provide solutions for various challenges and opportunities in the real world. The goal of this course is to learn the basics of how to use sensor data for designing intelligent mobile and IoT services.

The research course covers the entire process of sensor data science: data collection, pre-processing, feature extraction, and machine learning modelling. Mobile and wearable sensors will be mainly used, and the types of sensor data covered include motion (e.g. vibration/acceleration, GPS), physiological signals (e.g. heart rate, skin temperature), and interaction data (e.g. app usage). Students will learn the basic digital signal processing and feature extraction techniques. Basic machine learning techniques (e.g. clustering, supervised learning, time-series learning, and deep learning) will be reviewed, and students will master these techniques with a final mini-project to solve real-world sensor data science problems.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
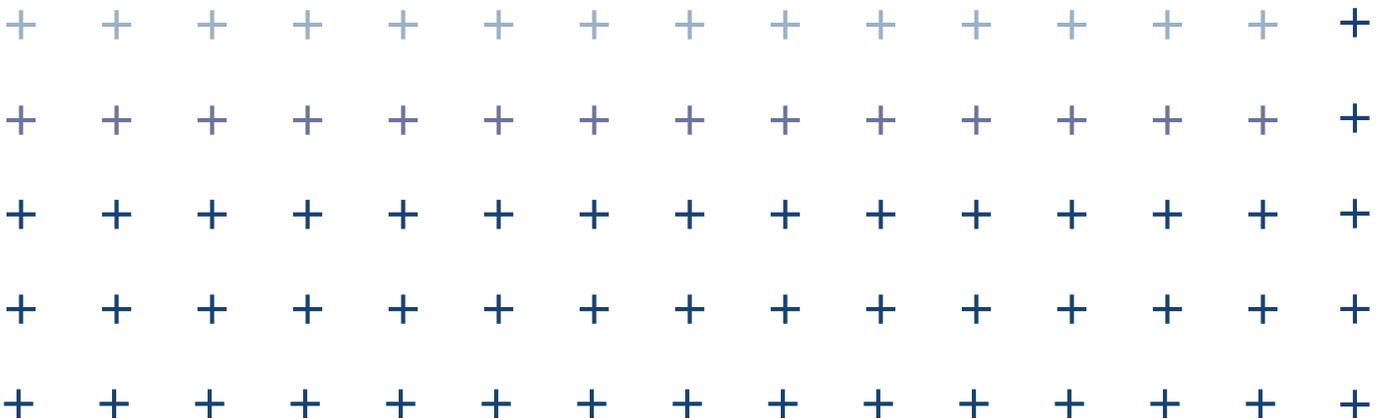
DR TSZ KIU AARON CHOW

CURRENT POSITION

Instructor and Postdoctoral Fellow, Department of Mathematics, Massachusetts Institute of Technology

A mathematician whose innovative research on Ricci flow and geometric analysis is advancing our understanding of higher-dimensional manifolds and their implications.

As a researcher, Dr Chow specialises in geometric analysis, with a particular emphasis on Ricci flow and its profound implications. His research addresses critical challenges in the field, focusing on how Ricci flow can advance our understanding of higher-dimensional manifolds.

At MIT, Dr Chow is currently leading two innovative research projects. The first project investigates the existence of Ricci flow solutions on complete manifolds in higher dimensions, relying solely on a pinching condition applied to the initial metric. This pioneering work aims to extend Hamilton's pinching conjecture, which is established for three dimensions, to more complex settings, potentially transforming our understanding of geometric flows in higher dimensions.

The second project seeks to refine radius estimates in higher-dimensional contexts. This problem builds on the foundational work of Schoen and Yau from 1983, which addressed similar issues in three dimensions. The results from this project have the potential to impact significant areas such as black hole formation, offering new insights into the nature of these cosmic phenomena.

Dr Chow's research spans Differential Geometry, Geometric Analysis, and Partial Differential Equations. His contributions to the field have been widely recognized and published in esteemed journals, including the *Journal of Geometric Analysis, Mathematical Research Letters*, and *International Mathematics Research Notices*. His work continues to advance the boundaries of geometric analysis and enrich our understanding of complex mathematical structures.

As a mentor, Dr Chow is dedicated to mentor the next generation of mathematicians. At MIT, he has experience teaching multiple courses in the areas of advanced calculus, linear algebra, partial differential equations, and more.

DR TSZ KIU AARON CHOW, MASSACHUSETTS INSTITUTE OF TECHNOLOGY
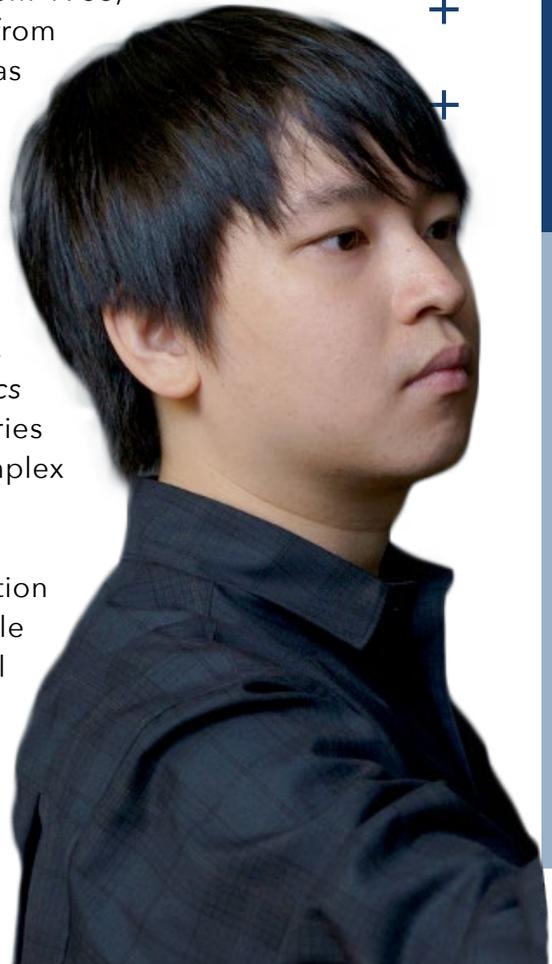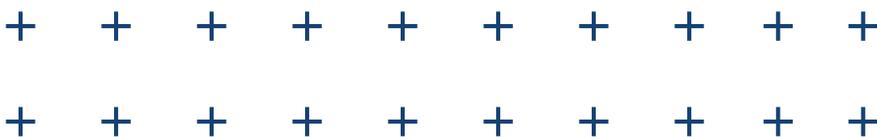
ADVANCED RESEARCH IN MATHEMATICS:

DIFFERENTIAL GEOMETRY OF CURVES AND SURFACES

Suitable for students interested in:

DIFFERENTIAL GEOMETRY

Gaussian Curvature | Gauss-Bonnet Theorem | Real World Applications

MATHEMATICS FOUNDATIONS

Multivariable Calculus | Linear Algebra

Geometry, the study of shapes, is a fundamental aspect of both mathematics and our understanding of the world around us. In this advanced research course on Differential Geometry of Curves and Surfaces, we will embark on an exploration of the beautiful and intricate structures that define our universe.

Differential geometry, a field that extends shapes beyond lines and planes using the tools of calculus and linear algebra, is essential in many scientific and engineering disciplines. Outside of pure mathematics, differential geometry is the cornerstone of Albert Einstein's theory of General Relativity, where it is used to describe the curvature of spacetime. It also plays a crucial role in computer graphics, enabling the creation of realistic animations and models, and is influential in fields such as robotics, physics, and even medical imaging.

This research course is designed to provide a thorough introduction to the differential geometry of curves and surfaces. Students will begin with essential knowledge in multivariable calculus and linear algebra, laying the necessary groundwork for more advanced topics. Moving forward, they will delve into foundational concepts in differential geometry, starting with the properties of curves, including the tangent vector, normal vector, curvature, torsion, and the Frenet-Serret frame. The course will then expand to the study of surfaces, covering key concepts such as regular surfaces, tangent planes, the first and second fundamental forms, Gaussian curvature, and geodesics. Essential geometric theorems, such as Gauss's Theorema Egregium and the Gauss-Bonnet theorem, will also be explored, highlighting the profound connections between geometry and topology. Finally, students will be guided to write a short paper proving a geometric theorem on their own, providing them with a taste of conducting research in pure mathematics.

The course is structured to challenge and inspire students, encouraging them to think deeply and creatively about the shapes and structures that make up our world. By the end of the course, students will have developed a strong foundation in modern differential geometry.

UNIVERSITY OF PENNSYLVANIA

DR JIANQI LIU

CURRENT POSITION

Instructor and Postdoctoral Researcher, Department of Mathematics, University of Pennsylvania

A mathematician specializing in vertex operator algebras and two-dimensional conformal field theory, with a focus on their algebraic and geometric aspects.

As a researcher, Dr Liu specializes in vertex operator algebras (VOAs) and two-dimensional conformal field theory (CFT), focusing primarily on their algebraic aspects. His previous research illuminates the structural and theoretical underpinnings of VOAs, exploring topics such as fusion rules, Zhu's algebra, Borel-type subalgebras, the classical Yang-Baxter equation, and Rota-Baxter operators. These explorations enhance the understanding of algebraic frameworks foundational to CFT. At the University of Pennsylvania, Dr Liu extends his expertise to the geometric aspects of VOAs and their interdisciplinary applications, particularly their deep connections to physics. His work integrates advanced mathematical constructs with physical theories, contributing to the broader understanding of two-dimensional conformal systems.

Dr Liu has shared his research at various notable institutions and conferences, such as the BUGCAT conference at Binghamton University (2024), seminars at Illinois State University and the University of Pennsylvania, and the National Lie Theory Conference in China. His active engagement with the mathematical community also extends to serving as a reviewer for prestigious scientific journals, including the *Journal of Pure and Applied Algebra, Advances in Mathematics, Communications in Mathematical Physics,* and *Communications in Contemporary Mathematics.*

As a mentor, Dr Liu is an experienced educator, having taught algebra and calculus courses at the University of Pennsylvania and UC Santa Cruz. He is committed to fostering mathematical curiosity and rigor in his students, ensuring a blend of foundational understanding and research-driven learning in the field of mathematics.

DR JIANQI LIU, UNIVERSITY OF PENNSYLVANIA

TOPICS IN ALGEBRAIC NUMBER THEORY:

QUADRATIC RESIDUE AND QUADRATIC RECIPROCITY

Suitable for students interested in:

PURE MATHEMATICS
Algebraic Number Theory | Theorems | Tools

APPLIED MATHEMATICS
Quadratic Congruence | Problem Solving | Research Applications

The quadratic reciprocity law, conjectured by Euler and elegantly proved by Gauss, is one of the most profound theorems in mathematics. Its significance extends beyond its initial discovery, laying the groundwork for modern algebraic number theory and inspiring countless generalizations. **This research course is designed to introduce students to the foundational concepts of number theory through the lens of quadratic residues and reciprocity.**

The research course begins by equipping students with essential tools in number theory, including the congruence symbol, congruence equations, and the Legendre symbol, which provides a compact way to express and compute quadratic residues. These concepts build towards a rigorous exploration of the quadratic reciprocity law, where students will delve into its statement, proof, and implications. The research course also emphasizes practical applications, teaching students to use this theorem to solve quadratic congruence problems.

As the research course progresses, students will explore historical and modern perspectives on the theorem, analyzing its role in advancing algebraic number theory. Through guided discussions and problem-solving sessions, students will examine the theorem's broader implications, uncovering potential research directions and applications in areas such as cryptography, coding theory, and computational mathematics.

By the end of the research course, students will not only have a deep understanding of the quadratic reciprocity law but also be prepared to engage with advanced topics in number theory. This research-oriented approach aims to inspire curiosity and equip students with the analytical skills needed to explore open problems in mathematics.
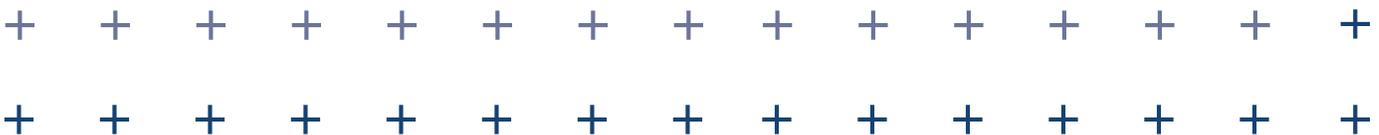
DR OWEN GRIFFITHS

CURRENT POSITIONS

Lecturer, Faculty of Philosophy, Cambridge

By-Fellow, Churchill College, Cambridge

Director of Studies, Churchill College, Cambridge

PREVIOUS APPOINTMENTS

Lecturer & Fellow in Logic, LSE

Stipendiary Lecturer, Wadham College, Oxford

A philosopher investigating issues at the heart of logic, set theory and the foundations of mathematics.

As a highly accomplished researcher and logician, Dr Griffiths held several positions at Oxford and LSE before coming back as a lecturer at Cambridge. His research examines philosophical issues at the heart of logic: Under what circumstances is an argument valid? Is there one correct system of logic, or are there many? What are the uses of non-classical systems of logic? Dr Griffiths' research has been published in many prestigious journals, including *Notre Dame Journal of Formal Logic, Analysis, Thoughts, and The Review of Symbolic Logic*, among many others. Notably, his recent monograph entitled, "One True Logic," which he co-authored with Professor Alex Paseau at the University of Oxford, was published by *Oxford University Press* in 2022. He was invited as a guest speaker at several academic conferences, which include the *Popper Seminar by the London School of Economics (LSE), Logic Workshop and Philosophy of Mathematics Seminar both by Oxford University, Serious Metaphysics Group by the University of Cambridge*, and others.

As a mentor, Dr Griffiths wrote a textbook on sets, relations, and probability for Cambridge undergraduate students. He has supervised undergraduate and graduate students, and taught courses in mathematical logic, set theory and further logic, philosophical logic, and metaphysics.

DR OWEN GRIFFITHS, UNIVERSITY OF CAMBRIDGE

MATHEMATICS AND PHILOSOPHY:

AN INTERDISCIPLINARY APPROACH

Suitable for students interested in:

PHILOSOPHY

Propositional Logic | First-Order and Higher-Order Logic | Proof | Soundness and Completeness

LOGIC

Philosophy of Mathematics | Philosophical Logic | Metaphysics

MATHEMATICS AND COMPUTER SCIENCE

Naive Set Theory | Iterative Set Theory | Infinity | Axiom of Choice | Computability Theory | History of Mathematics

Mathematical logic plays a fundamental role in computer science and philosophy. It appears in most programming languages, and it is often used and seen in machine learning and data science. For philosophers and mathematicians, mathematical logic is a powerful tool for investigating and answering many fundamental questions.

In this research course, students will be introduced to first-order logic. After that, the course will move onto set theory, a branch of mathematical logic, which is common in computer sciences, especially in database and computability theory. Students will learn how set theory promised to provide the way out when the foundational crisis of mathematics occurred in the early 20th century. And finally, students will learn about the applications of mathematical logic in different areas, the concept of completeness and soundness, and Gödel's incompleteness theorems.

This research course aims to encourage students to think about and develop their independent research project on the fundamental questions in mathematics, logic, and philosophy, and how they can use logic to solve real-world problems in other relevant research areas. By the end of this course, students will have a good understanding of mathematical logic, which will help them in their future studies of mathematics, computer science and philosophy.

UNIVERSITY OF CAMBRIDGE
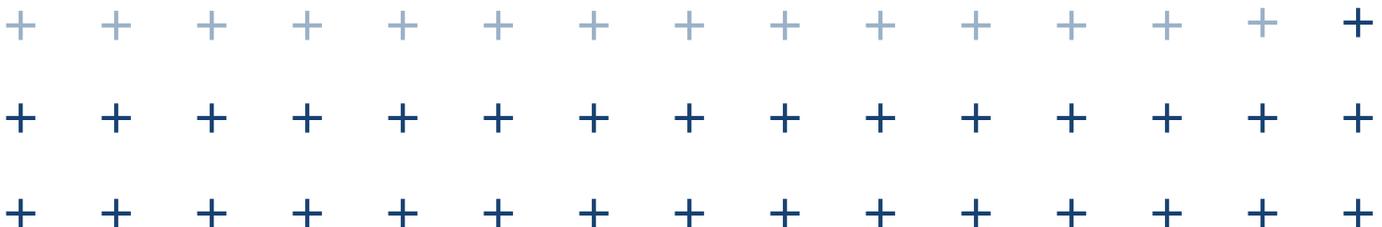
DR DANIEL RAGGI

CURRENT POSITION

Research Associate, Department of Computer Science and Technology, University of Cambridge

PREVIOUS APPOINTMENT

Research Associate, School of Informatics, University of Edinburgh

A rigorous artificial intelligence researcher with expertise in Mathematical Logic and Computer Science.

As a researcher, Dr Raggi brings a fervent expertise in mathematics, mathematical logic, computer science, and artificial intelligence to his research endeavours, fueling a passion for exploring the intricate intersections and potentials within these disciplines. He has extensive experience in interdisciplinary research on the nexus of logic, formal methods, AI, and cognitive science, specifically automated reasoning with a focus on human-like computing and creative reasoning. He is currently working on automating representation choice for AI tools. His works have been featured in the conference proceedings of IEEE 32nd International Conference on Tools with Artificial Intelligence (ICTAI), the 2020 IEEE Symposium on Visual Languages and Human-Centric Computing, and the 2023 International Conference on Intelligent Computer Mathematics, among others.

As a mentor, Dr Raggi teaches Logic and Proof at the Computer Laboratory, University of Cambridge, where he set exams in 2023 and served as a supervisor in 2018. Moreover, he contributed to teaching and tutorials at the School of Informatics and the School of Mathematics at the University of Edinburgh, covering subjects such as Logic and Reasoning, AI, Problem Solving, and Discrete Mathematics.

DR DANIEL RAGGI, UNIVERSITY OF CAMBRIDGE

THE MATHEMATICS OF COMPUTER SCIENCE

Suitable for students interested in:

PURE MATHEMATICS
Logic | Algebra | Set Theory

APPLIED MATHEMATICS
Discrete Math | Probability | Structures

COMPUTER SCIENCE
Foundations | Algorithms | Programming

This research course is designed for students with a keen interest in computer science, mathematics, or related disciplines who want to develop a strong mathematical foundation. Mathematics lies at the core of computer science and programming, providing the tools to understand and analyze the algorithms and structures that underpin modern computation. Through this research course, students will explore essential mathematical concepts such as discrete mathematics, set theory, logic, probability, and algebra, all of which are crucial for understanding the theoretical and practical aspects of computer science.

The research course is structured to provide a balance between theoretical understanding and practical application. Students will delve into discrete mathematics topics like combinatorics, graph theory, and Boolean algebra, which are essential for algorithm design and data structures. Set theory and logic will be explored to help students develop precise reasoning skills for programming and system design. Probability and algebra will provide a foundation for topics like machine learning, cryptography, and network analysis.

While the breadth of topics makes this research course intensive, the teaching approach emphasizes hands-on problem-solving and real-world applications. Students will work on solving challenging mathematical problems that build critical thinking and analytical skills, which are invaluable in any career path.

Throughout the research course, students will also engage in their independent research project, exploring a specific mathematical topic or its application in computer science. These projects will encourage creativity, deepen understanding, and provide experience in conducting academic research.

By the end of this research course, students will have a comprehensive understanding of the mathematical structures and concepts they are likely to encounter in their future studies or careers. More importantly, they will have honed problem-solving skills that extend far beyond mathematics, preparing them for success in a variety of fields.

DR DANIEL RAGGI, UNIVERSITY OF CAMBRIDGE

MATHEMATICAL LOGIC:

FOUNDATIONS OF COMPUTATION

Suitable for students interested in:

MATHEMATICS
Pure Mathematics | Logics | Incompleteness Theorems

COMPUTER SCIENCE
Automated Reasoning | Interactive Theorem Proving | Symbolic Manipulation

For thousands of years we have been trying to figure out what it means to reason, and whether there is a method to it: can truth be found through the application of unambiguous rules or instructions? Arithmetic calculation has long been known to be executable by mindlessly following instructions, even before the existence of modern computers. Without computers, we needed intelligent beings even to apply rules mindlessly! But surely, if a set of rules were simple enough, we would not need an intelligent being to apply them. Thus, for a long time we were searching for such "simple enough" rules, grounded in basic physical principles, yet sufficient to capture all sorts of processes: from adding two numbers to determining the truth of statements. This search led, simultaneously, to mathematical logic and theoretical models of computation.

The research course traces the historical evolution that drove the formalisation of mathematical reasoning, from with Euclid's axiomatic method the works of figures like Frege, Peano, Russell, Gödel and Turing. Students will get an introduction to formal systems, logical foundations, and the limitations revealed by Gödel's incompleteness theorems. A major emphasis will be placed on formalising the notion of computation itself: how might a system of basic rules look like, to capture anything from simple calculation to reasoning? The students will explore this through the study of mathematical models of computation like recursive functions, Turing machines, and the lambda calculus. This allows examination of fundamental questions in computability theory surrounding decidability and the intrinsic limitations on what can be computed by formal systems.

Moving from theory to practice, the research course covers automated reasoning and interactive theorem proving. Students will learn some of the techniques used for automating logical inference, and get hands-on experience with interactive theorem provers, witnessing how mathematical truths can be derived through systematic symbolic manipulation.

By the end, students will have a broad understanding of logic and computability, with a deep grasp on the limitations and potential of formal systems. They will be equipped with conceptual and practical tools for the development and use of formal systems.

NATIONAL INSTITUTES OF HEALTH (NIH)

DR KUTSEV BENGISU OZYORUK

CURRENT POSITION

Postdoctoral Research Fellow, Artificial Intelligence Resource, Molecular Imaging Branch, National Cancer Institute at National Institutes of Health

PREVIOUS APPOINTMENTS

Postdoctoral Research Fellow, AI for Pathology Image Analysis Lab, Department of Pathology, Brigham & Women's Hospital, Harvard Medical School
**Research Scientist,** Afiniti

A visionary scientist committed to revolutionising healthcare through the power of Artificial Intelligence.

As a researcher, Dr Ozyoruk's current research centres in advancing computer vision and deep learning algorithms for clinical applications in radiology and computational pathology. At the National Center Institute, she is developing a generative AI model aimed at transforming MR images to address the diagnostic challenges posed by inadequate ADC maps. Additionally, Dr. Ozyoruk is working on an image retrieval algorithm to create a decision support tool tailored for detecting rare lesions in prostate cancer.

During her research appointment at Harvard Medical School, Dr Ozyoruk focused on enhancing surgical procedures by integrating the EndoSfM Learner algorithm with the NVIDIA Clara Holoscan Tool for real-time depth estimation in laparoscopic surgery. Additionally, she created self-supervised DINO models, enabling the creation of lightweight versions of large deep learning models suitable for mobile devices without requiring labelled data. Dr Ozyoruk also contributed to the field of high-performance computing by developing a Neural Architecture Search method utilising SLURM schedulers. Furthermore, she devised an AI-FFPE approach based on generative adversarial networks (GANs) to improve diagnostic accuracy in lung and brain cancers. Her research extended to virtual immunohistochemical staining for kidney rejection probability estimation and interpretability analysis of UNet Semantic Segmentation performance in human tissue imaging through class activation mapping.

Dr Ozyoruk's research has appeared in several top-tier high-impact scientific journals, including *Nature Biomedical Engineering*, as well as prestigious medical imaging conferences such as Elsevier-MEDIA and IEEE-TMI.

As a mentor, Dr Ozyoruk has taught courses in Discrete Mathematics and Linear Algebra at the university level.

DR KUTSEV BENGISU OZYORUK, NATIONAL INSTITUTES OF HEALTH (NIH)

APPLIED MATHEMATICS FOR MACHINE LEARNING

Suitable for students interested in:

APPLIED MATHEMATICS
Probability & Statistics | Linear Algebra | Calculus

MACHINE LEARNING
Mathematical Principles | Algorithms | Optimisation & Information Theories

Machine learning has emerged as a powerful tool across various industries, revolutionising how we approach complex problems. At its core, machine learning relies heavily on mathematical principles and techniques to make sense of data and make informed decisions.

This course aims to explore the fundamental aspects of applied mathematics that underpin machine learning algorithms. It helps the students to develop a deeper, more intuitive understanding of machine learning.

Students will be introduced to many concepts in advanced mathematics. The course will start with linear algebra, and students will learn its importance in representing and manipulating data in machine learning models.Topics such as vectors, matrices, and eigenvalues will be covered, with a focus on their applications in dimensionality reduction and feature extraction.

In addition, the concepts like derivatives and gradients will be discussed in the context of cost functions and gradient descent. Students will explore advanced topics such as optimisation theory and information theory, elucidating their applications in model selection, regularisation, and ensemble learning. Real-world examples and case studies will be used throughout the lecture to demonstrate how these mathematical concepts are applied in practice.

By the end of the research course, students will gain a solid understanding of the mathematical principles that drive machine learning algorithms, equipping them with the knowledge and skills needed to tackle complex problems in the field. Whether the student is a novice or an experienced practitioner in machine learning, this course offers valuable insights into the mathematical foundations of machine learning, paving the way for innovative applications and advancements in the field.

HARVARD UNIVERSITY

DR HANNAH RANA

CURRENT POSITIONS

Research Scientist, Centre for Astrophysics, Harvard-Smithsonian Center for Astrophysics
Postdoctoral Research Fellow, Ophthalmology AI Lab, Harvard University
Science Fellow, Schepens Eye Research Institute, Massachusetts Eye and Ear, Harvard Medical School
Science Fellow, Department of Neurosurgery, Massachusetts General Hospital, Harvard Medical School

An aerospace engineer, astrophysicist and medical engineer with a commitment to mentoring young minds.

As a researcher, Dr Rana's areas of expertise span aerospace engineering and astrophysics, underpinned by a decade of invaluable experience in the space industry. Her industry experience has encompassed renowned organisations, including NASA, the European Space Agency, CERN, Oxford University and the California Institute of Technology (Caltech) to name a few.

Dr Rana's impactful contributions extend to various space missions, with noteworthy involvement in projects like the Russian-European lunar lander mission Luna-27, the Mars Sample Return mission, and the Earth observation mission Sentinel-3, among a multitude of others. Furthermore, her role as an applied physicist at CERN was pivotal in the development of superconducting radiofrequency accelerating cavities for the Large Hadron Collider.

Dr Rana's excellence in the field of medical engineering was further acknowledged when she was featured on the 2022 Forbes '30 Under 30' Europe list in the Science and Health-care category. Her significant research has been published in high-impact, peer-reviewed scientific journals. Additionally, she authored a book titled "Mathematical Methods for Cryocoolers," published by the Institute of Physics.

As a mentor, Dr Rana has taught undergraduate and postgraduate-level courses at Oxford University, Harvard University, and Caltech.

DR HANNAH RANA, HARVARD UNIVERSITY

MACHINE LEARNING FOR ENGINEERING DESIGN

Suitable for students interested in:

ENGINEERING

Computational Engineering | Mechanical Engineering | Aerospace Engineering

COMPUTER SCIENCE

Machine Learning | Data Science | Computer Vision

MATHEMATICS

Mathematical Optimization | Applied Mathematics

Machine Learning has become pivotal in engineering design, revolutionising processes by swiftly analysing vast datasets and identifying optimal solutions efficiently. Its knack for deciphering complex problems, automating design iterations, and predicting system behaviour enhances risk assessment and accelerates the design cycle. Machine learning's adaptability and continuous learning further ensure designs evolve and improve based on real-world feedback, empowering engineers to innovate with unprecedented efficiency.

In this research course, we will cover the fundamentals of machine learning as well as study how to develop code that can be applied to engineering system design. **This research course will allow students to hone their coding skills, predominantly using Python, in order to perform linear regressions, data analytics, Bayesian optimizations, and multi-parameter analyses for engineering design cases.** Real-life cutting-edge research cases will be assigned to students based on their interests, ranging from bioengineering devices such as artificial retinas, to computer vision for deep learning, to engineering hardware design, so they acquire an opportunity to immediately apply their recently gained skill set and produce research to a high level.

Having the ability to program and code in Python is an increasingly vital skill for all engineers. This course will be of interest to students interested in bioengineering, mechanical engineering, aerospace engineering, with a specific focus on using machine learning and computer vision tools.

Students should expect a lively, interactive research course where their ideas and responses drive much of the class discussion. They are also expected to work on their own independent research project. Students will learn to exercise critical thinking skills and conduct their own academic investigations via the research project.

UNIVERSITY OF CAMBRIDGE

DR MOHAMMAD TAHER PILEHVAR

CURRENT POSITIONS

Lecturer, Language Technology Lab, University of Cambridge

Assistant Professor, Tehran Institute for Advanced Studies

PREVIOUS APPOINTMENT

Research Associate, Language Technology Lab, University of Cambridge

A leading computer scientist in Natural Language Processing, Machine Learning, and Artificial Intelligence.

As a computer scientist, Dr Pilehvar has worked on Natural Language Processing (NLP), Machine Learning, and AI. He especially focuses on statistical machine translation, semantic representation, semantic similarity, ontology construction and enrichment, and word sense disambiguation. Previously, his research was funded by the European Research Council. He has an outstanding publishing record, with works in many top conferences and journals, including *ACL, International Conference on Computational Linguistics, Computational Linguistics and Intelligent Text Processing*.

As a mentor, Dr Pilehvar co-authored an NLP textbook called Embeddings in Natural Language Processing: Theory and Advances in Vector Representations of Meaning. He has taught NLP and deep learning at undergraduate and graduate levels and advised PhD students at the University of Cambridge.

DR MOHAMMAD TAHER PILEHVAR, UNIVERSITY OF CAMBRIDGE

CUTTING EDGE DEEP LEARNING (DL), NATURAL LANGUAGE PROCESSING (NLP), AND LARGE LANGUAGE MODELS (LLMS)

Suitable for students interested in:

COMPUTER SCIENCE
Machine Learning | Deep Learning | NLP

MATHEMATICS
Applied Mathematics | Modelling | Statistics

This research course introduces students to the most exciting techniques in computer science, demonstrating how these cutting-edge methods can be applied to solve complex problems. By exploring deep learning, natural language processing, and large language models, students will gain hands-on experience and insights into their practical applications and transformative potential.

At the beginning, students will explore key concepts in deep learning and natural language processing, helping them build a solid foundation in the field. They will learn about representation learning, word embeddings (e.g., word2vec), neural networks, and the revolutionary Transformer model.

Besides the conceptual aspects, students are encouraged to take on multiple hands-on research projects to gain experience in building and training deep learning models, fine-tuning advanced language models like BERT and GPT, and applying prompting strategies. They can choose from diverse research topics to explore their interests and contribute original ideas.

By the end of this course, students will have a good understanding of machine learning and AI, as well as how to implement and innovate with these powerful techniques and tools in computer science. It will be a transformative and challenging experience, preparing students for future academic and professional pursuits in AI.

DR ROBAIL YASRAB

CURRENT POSITION

Senior Research Associate, Medical Research Council (MRC) Biostatistics Unit (BSU), School of Clinical Medicine, University of Cambridge

PREVIOUS APPOINTMENTS

Senior Research Fellow, Biomedical Imaging Group, Oxford Institute of Biomedical Engineering, University of Oxford, United Kingdom

Research Fellow, Computer Vision Lab, School of Computer Science, University of Nottingham

A computer vision scientist utilising machine learning and artificial intelligence to enhance biomedical image analysis.

As a researcher, Dr Yasrab's background spans the fields of computer vision, biomedical engineering, and environmental science. His research recently focuses on biomedical image analysis, computer vision, and computational (machine-learning based) analysis of images. His research work aims to develop and deploy image-based phenotyping computer vision techniques and tools needed to recover quantitative data from a wide range of images of plants, in hopes of contributing to UK food security research and helping to innovative the technological capabilities needed to drive world-leading basic discovery research in the plant, crop and agricultural sciences. Dr Yasrab's works have been published in a wide range of high-impact AI and ML journals including *Journal of Imaging, Applied Sciences, Journal of Computer Science and Technology, Ultrasound in Obstetrics and Gynecology.*

As a mentor, Dr Yasarb has mentored undergraduates and graduate students at the University of Oxford on a variety of machine learning, AI, and computer vision projects in biomedical imaging, environmental science, image analysis, deep learning, and others.

DR ROBAIL YASRAB, UNIVERSITY OF CAMBRIDGE

MACHINE LEARNING IN COMPUTER VISION:

IMAGE ANALYSIS AND SEGMENTATION

Suitable for students interested in:

COMPUTER SCIENCE
Machine Learning | AI | Computer Vision | Deep Learning

ENGINEERING
Biomedical Engineering | Computer Engineering | Mechanical Engineering

Machine learning is a subfield of computer science that evolved from the study of pattern recognition and computational learning theory in artificial intelligence. Machine learning explores the construction and study of algorithms that can learn from and make predictions on data such as audio, text, videos, and images. A wide range of applications of machine learning have become ubiquitous in our society, including search, image understanding, apps, mapping, medicine, drones, and self-driving cars. Many of these applications involve visual recognition tasks such as image classification, localization, and detection. In recent years, neural network (aka 'deep learning') approaches have greatly improved the performance of these state-of-the-art visual recognition systems.

The focus of this research course is learning end-to-end models for these tasks, particularly image classification and segmentation, using machine learning architectures. **During this course, students will gain a detailed understanding of cutting-edge research in the fields of artificial intelligence, computer vision, and artificial neural networks.** Additionally, the final assignment will allow them to apply their hands-on knowledge to real-world vision problems. By participating in a variety of hands-on assignments and tasks, students will gain a comprehensive understanding of how machine learning tasks are set up as well as practical knowledge for their future engineering careers.

UNIVERSITY OF OXFORD

DR PRAMIT SAHA

CURRENT POSITION

Postdoctoral Researcher, Department of Engineering Science, University of Oxford

A scientist merging advanced machine learning with biomedical imaging to drive innovation in healthcare and assistive technologies.

As a researcher, Dr Saha specializes in Federated Learning, Semi-supervised Learning, and Multimodal Learning for applications in Computer Vision and Medical Image Analysis. His current research tackles challenges in federated learning, such as class imbalance and non-IID data distribution, enabling multi-institutional collaborations while preserving patient data privacy.

Previously, Dr Saha explored alternative communication pathways for individuals with speaking disabilities. Employing deep learning techniques, he advanced artificial voice synthesis by mapping thoughts or gestures to the acoustic space. His work also addressed information-theoretic aspects of speech-related motor control, investigating how categorical speech perception could simplify hand-to-speech tasks. Additionally, he contributed to gesture-based speech interfaces and EEG-based imagined speech recognition systems.

Dr Saha has contributed a chapter to the book *Computational Biomechanics for Medicine*, published by Springer International Publishing. Further, Dr Saha's findings have been featured in esteemed conferences, including AAAI, MICCAI, and ICASSP. He has served as a reviewer for leading journals such as IEEE Access, Neural Computing & Applications, and Elsevier's Knowledge-Based Systems, alongside conferences like IEEE ISBI, MICCAI, and IEEE TENCON.

Dr Saha's work exemplifies innovative intersections between artificial intelligence, biomedical imaging, and assistive technologies, reflecting his commitment to impactful research and advancing global healthcare solutions.

As a mentor, Dr. Saha combines technical rigor with an emphasis on ethical and impactful research, encouraging his students to approach real-world challenges with creativity, confidence, and a innovation -driven mindset.
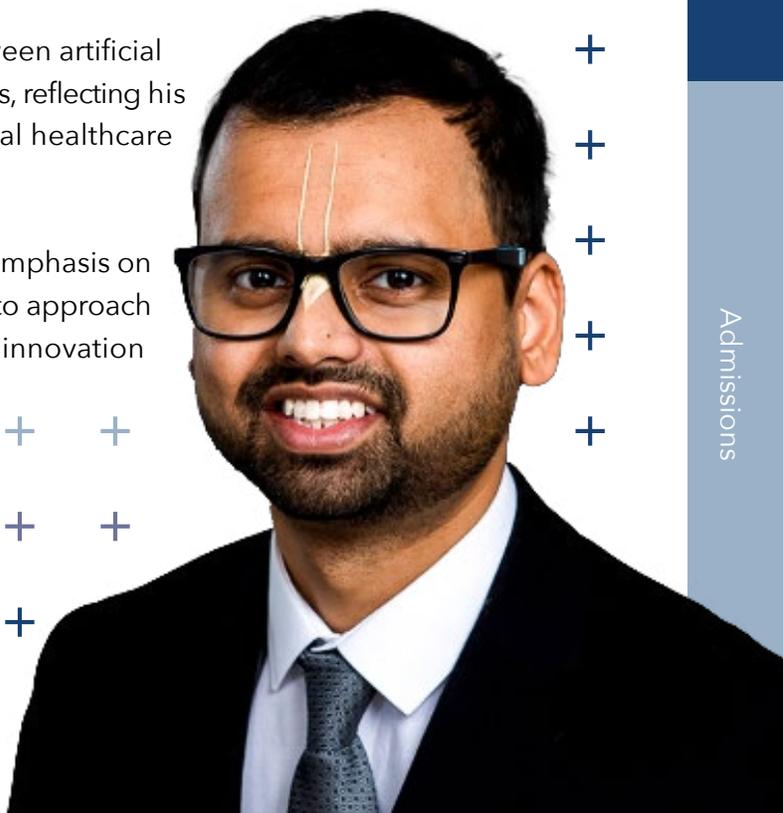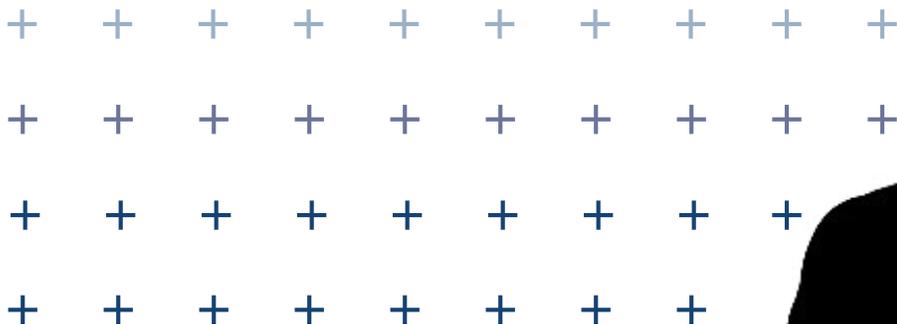
DR PRAMIT SAHA, UNIVERSITY OF OXFORD

DEEP LEARNING FOR COMPUTER VISION AND IMAGE ANALYSIS

Suitable for students interested in:

MACHINE LEARNING
Architectures | Neural Networks | Computer Vision

AI IN HEALTHCARE
Medical Image Analysis | Ethical AI | Health Informatics

This research course provides a comprehensive introduction to deep learning techniques tailored for computer vision and medical image analysis. Participants will gain a strong foundation in core concepts such as convolutional neural networks (CNNs), transfer learning, and advanced architectures like UNet, ResNet, and Transformers, with a focus on their applications in real-world tasks. The research course also emphasizes the unique challenges of medical imaging, including data preprocessing, annotation scarcity, and the integration of domain knowledge into deep learning pipelines.

Through a combination of theoretical discussions and hands-on projects, students will explore techniques for image classification, segmentation, object detection, and anomaly detection, with applications in natural images and videos, X-rays, CT scans, MRIs, etc. Topics such as explainable AI (XAI), model robustness, and fairness are introduced to highlight the ethical considerations in deploying AI systems in critical domains like healthcare. Additionally, the research course delves into recent innovations, including self-supervised learning, federated learning for privacy preservation, and multi-modal learning that combines imaging and textual data.

Participants will work on medical datasets, leveraging popular deep learning frameworks such as PyTorch or TensorFlow. By the end of the research course, students will have developed the expertise to design, train, and evaluate state-of-the-art models for a variety of computer vision and medical imaging tasks, equipping them with the skills needed for academic research or industry roles in AI-driven healthcare.

DR PRAMIT SAHA, UNIVERSITY OF OXFORD
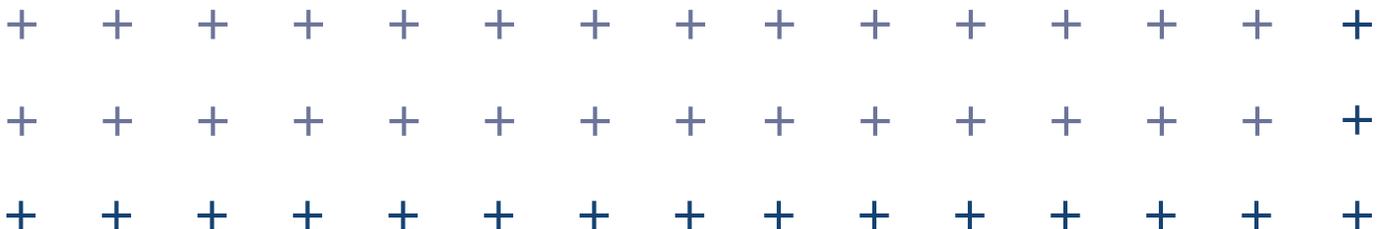
LATEST TRENDS IN AI:

FOUNDATION MODELS AND MULTIMODAL LLMS

Suitable for students interested in:

ARTIFICIAL INTELLIGENCE
Deep Learning | Foundation Models | Ethics

LARGE LANGUAGE MODELS
Generative AI | Tools | Computer Vision

This research course delves into the cutting-edge advancements in artificial intelligence, with a particular focus on the latest trends, i.e, foundation models and multimodal large language models (LLMs). Participants will explore the transformative impact of foundation models, such as GPT, BERT, and DALL-E, which have redefined AI capabilities by pretraining on massive datasets and enabling fine-tuning for a wide range of tasks.

The research course examines the architectures and training paradigms underpinning these models, including self-supervised learning, attention mechanisms, and scaling laws. Special emphasis is placed on multimodal LLMs, such as CLIP, Flamingo, and GPT-4V, which seamlessly integrate text, images, audio, and other modalities. Students will learn how these models excel in tasks requiring cross-modal understanding, such as visual question answering, image captioning, and medical report generation. We will also explore parameter-efficient fine-tuning of large language models and vision-language models in resource-constrained settings.

Ethical considerations, such as bias, fairness, and the environmental impact of training large models, are also discussed. The research course includes practical components where students will fine-tune and deploy foundation models on domain-specific applications as well as investigate the hallucinating tendencies of LLMs, leveraging tools like Hugging Face Transformers. By the end, participants will understand the state-of-the-art in AI, its limitations, and its potential, preparing them for research or industry roles in the evolving AI landscape.

UNIVERSITY OF CAMBRIDGE
DR ROBAIL YASRAB

CURRENT POSITION

Senior Research Associate, Medical Research Council (MRC) Biostatistics Unit (BSU), School of Clinical Medicine, University of Cambridge

PREVIOUS APPOINTMENTS

Senior Research Fellow, Biomedical Imaging Group, Oxford Institute of Biomedical Engineering, University of Oxford, United Kingdom

Research Fellow, Computer Vision Lab, School of Computer Science, University of Nottingham

A computer vision scientist utilising machine learning and artificial intelligence to enhance biomedical image analysis.

As a researcher, Dr Yasrab's background spans the fields of computer vision, biomedical engineering, and environmental science. His research recently focuses on biomedical image analysis, computer vision, and computational (machine-learning based) analysis of images. His research work aims to develop and deploy image-based phenotyping computer vision techniques and tools needed to recover quantitative data from a wide range of images of plants, in hopes of contributing to UK food security research and helping to innovative the technological capabilities needed to drive world-leading basic discovery research in the plant, crop and agricultural sciences. Dr Yasrab's works have been published in a wide range of high-impact AI and ML journals including *Journal of Imaging, Applied Sciences, Journal of Computer Science and Technology, Ultrasound in Obstetrics and Gynecology.*

As a mentor, Dr Yasarb has mentored undergraduates and graduate students at the University of Oxford on a variety of machine learning, AI, and computer vision projects in biomedical imaging, environmental science, image analysis, deep learning, and others.

DR ROBAIL YASRAB, UNIVERSITY OF CAMBRIDGE

CHATGPT AND NATURAL LANGUAGE PROCESSING:

CRAFTING THE FUTURE WITH AI LINGUISTS

Suitable for students interested in:

COMPUTER SCIENCE
Machine Learning | AI | Natural Language Processing

LINGUISTICS
Computational Linguistics | Large Language Models

MATHEMATICS
Applied mathematics | Statistics and Probability

This research course introduces students to the fascinating world of large-scale language models, focusing on how machines understand, interpret, and generate human-like text. Through a blend of theoretical concepts and practical exercises, students will explore the basics of natural language processing, the architecture of models like GPT (Generative Pre-trained Transformer), and their applications in various fields. The course aims to demystify artificial intelligence, foster a deeper understanding of the technology behind AI-driven text generation, and inspire students to explore further studies and careers in technology and AI.

At the start of the research course, students will receive an intensive introduction to machine learning, AI and language models, neural networks, statistical language models, transformer models, and other concepts. Strong emphasis is placed on hands-on programming assignments. Students will gain a solid foundation in natural language processing that would be crucial for their research project.

During the latter portion of the course, focus shifts to independent research projects. Students are expected, under the supervision of faculty members, to conduct and build their research projects, as well as writing up the research paper. Through the research journey, students will encounter and learn about advanced NLP Techniques and Models. Additionally, students are encouraged to contemplate and discuss the ethics, bias, and fairness in AI, as well as boundaries of the field.

IMPERIAL COLLEGE LONDON

DR CHIRAAG LALA

CURRENT POSITION

Teaching Fellow, Faculty of Engineering, Imperial College London

An expert in Mathematics for Artificial Intelligence, Machine Learning, Computing, and Natural Language Processing.

As a researcher, Dr Lala's areas of expertise are in Mathematics for Artificial Intelligence, Machine Learning, Computing and Natural Language Processing; each of these areas are then applied across fields of Medicine, Art, AI, and Forensics. He previously developed a novel semi-supervised learning methodology involving regular expressions to account for lack of human labelled gold-standard training dataset at Google. He also did a study on Multimodal Word Sense Translation and other topics in Natural Language Processing which were published in peer-reviewed scientific journals and conferences such as the *IEEE Journal of Selected Topics in Signal Processing and the American Academy of Neurology*.

As a mentor, Dr Lala is a Teaching Fellow at Imperial College London where he is the lecturer of the Probability and Statistics module and a tutor of various other Mathematics, Machine Learning and Natural Language Processing modules taught in the Department of Computing. Dr Lala is passionate about guiding students to better understand the real-world applications of machine learning and artificial intelligence.
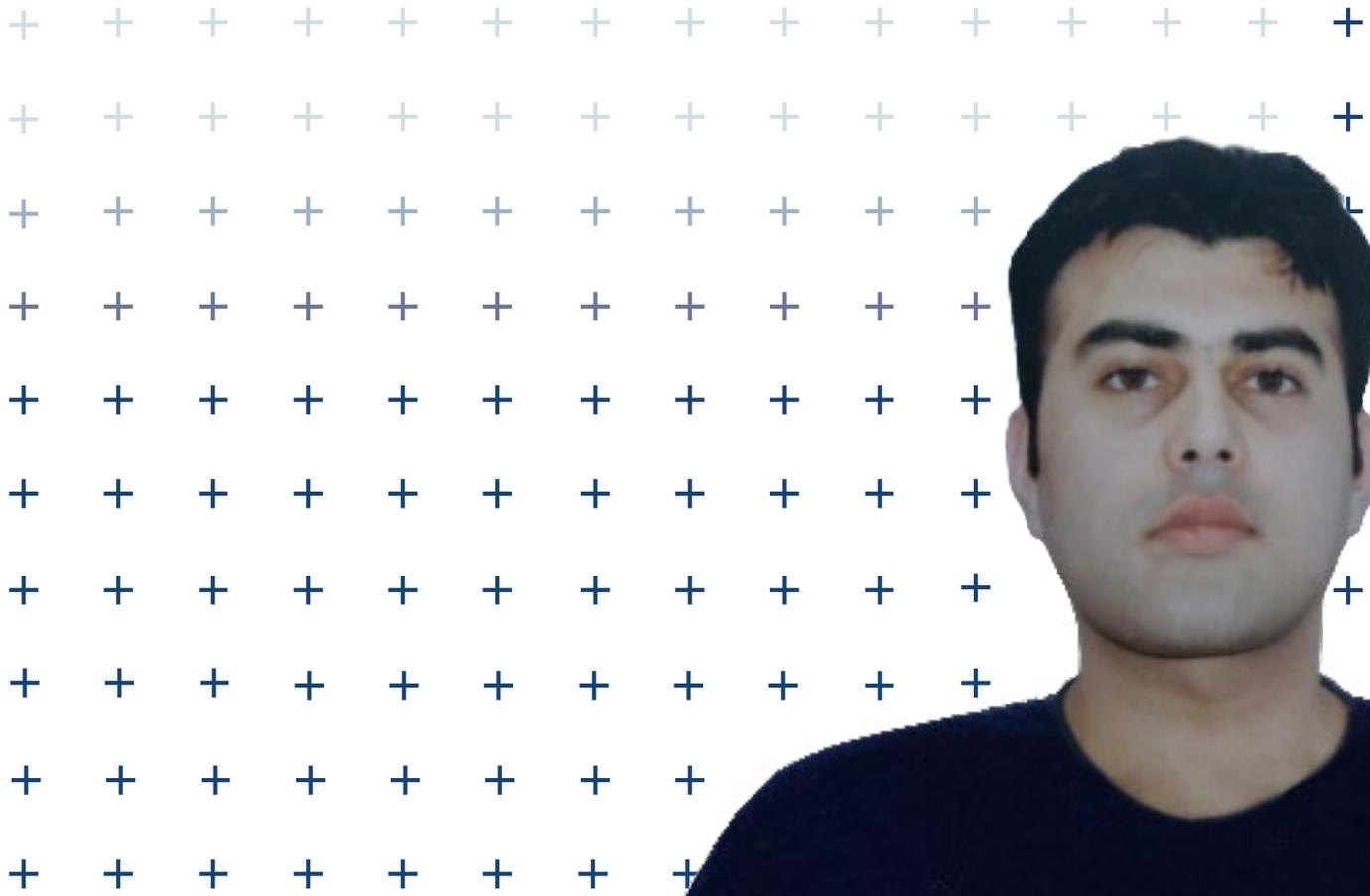
DR CHIRAAG LALA, IMPERIAL COLLEGE LONDON

BUILDING BETTER AI:

INVESTIGATING ERRORS IN LARGE LANGUAGE MODELS (LLMS) SUCH AS CHATGPT

Suitable for students interested in:

COMPUTER SCIENCE

Machine Learning | Artificial Intelligence

NATURAL LANGUAGE PROCESSING (NLP)

Large Language Models | Computational Linguistics

RESPONSIBLE AI

Algorithmic Fairness | Transparency | Privacy

In the rapidly evolving landscape of Artificial Intelligence (AI) and Natural Language Processing (NLP), the advent of Large Language Models (LLMs), which power applications like ChatGPT, has revolutionised various domains, from content generation to decision-making systems. However, alongside their remarkable capabilities, LLMs are not immune to errors, which can have profound implications in critical applications. **This research course aims to equip students with the tools and knowledge of NLP necessary to analyse, understand, and mitigate errors in LLMs.**

This research course will begin with the basics of NLP and then explore the fundamental principles underlying LLMs, elucidating their architecture, training methodologies, and inference mechanisms. Through a hands-on approach, students will gain practical experience utilising state-of-the-art NLP tools and libraries for model evaluation and error analysis. By examining real-world case studies and scenarios, students will develop a critical eye for identifying and categorising different errors, ranging from syntactic inconsistencies to biassed predictions.

Furthermore, the research course will explore the ethical and societal implications of LLM errors, emphasising the importance of responsible AI deployment and decision-making. Students will engage in discussions surrounding algorithmic fairness, transparency, and accountability, fostering a comprehensive understanding of the broader implications of AI technologies in contemporary society.

To facilitate experiential learning, students will undertake independent research projects where they can apply their acquired skills to investigate specific instances of LLM errors. Students will conduct empirical analyses, propose hypotheses, and draw actionable insights to address identified issues effectively.

Through this research course, students will develop proficiency in AI and NLP methodologies and cultivate critical thinking, problem-solving, and ethical reasoning skills essential for navigating the complex landscape of modern AI technologies. By fostering a culture of inquiry and accountability, this research course aims to empower the next generation of researchers and innovators to harness AI's potential responsibly, ensuring its beneficial impact on society while mitigating the risks associated with erroneous behaviour in LLMs.

UNIVERSITY OF CALIFORNIA
DR FAISAL NAWAB

CURRENT POSITION

Assistant Professor, Donald Bren School of Information, University of California Irvine (UCI)

PREVIOUS APPOINTMENTS

Assistant Professor of Computer Science and Engineering, University of California Santa Cruz
Research Associate, Hewlett-Packard Labs

A computer scientist driving innovation in edge-cloud systems, blockchain, and machine learning.

As a researcher, Dr Nawab's research is dedicated to advancing data management and distributed systems. As the Principal Investigator of the EdgeLab at UCI,his research focuses on Edge-Cloud Data Management (ECDM) systems to support next-generation Internet of Things (IoT) and edge computing applications. He is also interested in Machine Learning and Blockchain; his research explores how to build protocols to manage the unpredictable/sporadic availability and distrust of edge nodes with decentralization and blockchain technologies.

Dr Nawab co-owns a patent on Consensus in Data Management, with applications ranging from distributed commit protocols to foundational blockchain systems. His research is widely recognized and has been published in leading conferences, including the ACM International Conference on Management of Data (SIGMOD), the IEEE International Conference on Data Engineering (ICDE), and the IEEE International Conference on Blockchain and Cryptocurrency.

As a mentor, Dr Nawab teaches courses across a broad spectrum of computer science, including Transaction Processing and Distributed Data Management, Blockchain Systems, Machine Learning. He actively mentors both PhD and MS students, guiding them through their thesis research.
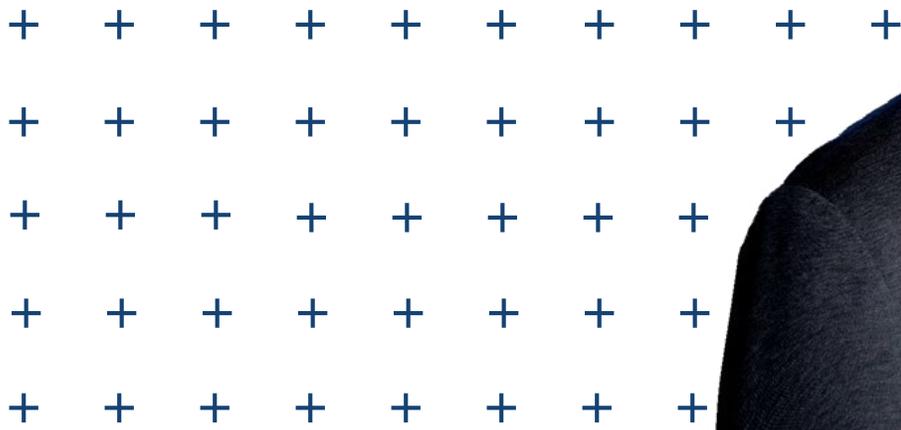
DR FAISAL NAWAB, UNIVERSITY OF CALIFORNIA

DATA SCIENCE AND MACHINE LEARNING IN SMART SPACES:

COMPUTER VISION AND THE INTERNET OF THINGS

Suitable for students interested in:

COMPUTER SCIENCE
Data Science | Edge Computing | Cloud Integration

ARTIFICIAL INTELLIGENCE
Machine Learning | Computer Vision | Predictive Analytics

INTERNET OF THINGS
Architectures | Smart Spaces | Sensors

The proliferation of smart spaces, ranging from intelligent homes and offices to advanced urban environments, has resulted in an explosion of video data generated by connected devices such as surveillance cameras, drones, and IoT-enabled sensors. Harnessing this data effectively requires a unique intersection of expertise in data science, distributed systems, and video analytics. **This course aims to equip students with the knowledge and skills to design, implement, and optimize systems for processing and analyzing video data in smart spaces.**

The research course begins by introducing the fundamentals of video data analytics, including techniques for object detection, activity recognition, and spatial-temporal analysis. Students will learn the foundational principles of computer vision and data science as applied to real-world scenarios, with a focus on practical applications such as traffic monitoring, energy-efficient building management, and enhanced security protocols. Building on this foundation, the research course delves into distributed systems and data management strategies necessary for handling the massive scale and real-time nature of video data. Topics include edge computing, cloud integration, and the role of distributed databases in managing high-throughput video streams. Students will gain hands-on experience with technologies like Apache Kafka, TensorFlow, and OpenCV to process and analyze video data efficiently.

An essential component of the research course is the exploration of IoT architectures and their integration with video analytics pipelines. Students will examine case studies of smart cities and spaces where IoT-enabled video data has been successfully utilized for predictive analytics and decision-making. The research course will also address the challenges of scalability, latency, and privacy, ensuring that students understand the ethical and technical considerations in building video analytics systems. Through a combination of lectures, hands-on projects, and research-oriented discussions, participants will develop the ability to architect and deploy robust video data analytics solutions tailored to the unique needs of smart spaces. By the end of the research course, students will be proficient in designing systems that extract actionable insights from video data while leveraging distributed computing and IoT technologies for maximum efficiency and scalability.

DR FAISAL NAWAB, UNIVERSITY OF CALIFORNIA

DATA SCIENCE WITH HANDS-ON PROJECTS:

ML ALGORITHMS, STATISTICAL METHODS, AND LLMS

Suitable for students interested in:

DATA SCIENCE
Data Management | Visualization | Practical Applications

MACHINE LEARNING
Algorithms | Statistical Methods | Large Language Models (LLMs)

This research course offers an in-depth exploration of data science, blending foundational principles with hands-on applications to equip students with the skills needed for real-world challenges.

Students will explore data management techniques, data wrangling, data visualization, and master the methods and best practices for designing efficient data workflows. Building on this foundation, the research course will then cover essential machine learning algorithms and statistical methods to be utilized in the data science pipeline, empowering students with the knowledge and tools to analyze complex data and extract meaningful insights.

The research course also delves into large language models (LLMs), such as GPT, and their transformative role in modern data science. Students will explore the capabilities of LLMs and learn how to integrate to enhance data science projects for tasks like text processing, natural language understanding, and predictive modeling.

Through practical projects, students will be able to apply the concepts learned in the research course and gain valuable experience in implementing real-world data science solutions. By the end of the research course, students will have a comprehensive understanding of the data science pipeline, from data preparation to advanced machine learning and AI integration, preparing them to tackle challenges that can be addressed with data science across diverse industries with confidence.

UNIVERSITY OF CAMBRIDGE

DR PERMAN JORAYEV

CURRENT POSITION

Research and Start-up Advisor, University of Cambridge

A multidisciplinary expert who bridges advanced science and business strategy.

As a researcher, Dr Jorayev bridges the gap between research and industry while leading and advising on research direction. His expertise spans AI/ML, chemistry, biology, and materials science, with a strong focus on drug discovery and pharmaceutical innovation. In addition to his work in these fields, Dr. Jorayev has contributed to cutting-edge research in quantum computing and advancements in cell and gene therapy, demonstrating a commitment to interdisciplinary approaches that drive innovation.

Beyond academia, Dr. Jorayev has extensive experience in venture capital, currently serving as a Senior Investment Associate at Verve Ventures. He specializes in target and market analysis, competitive landscape evaluations, and the development of business models and go-to-market strategies. His deep understanding of financials, including investment and unit economics, equips him to assess business plans and identify high-potential investment opportunities. Dr. Jorayev also provides guidance on mergers and acquisitions, effectively bridging the gap between scientific advancements and business growth strategies. His ability to translate complex scientific discoveries into viable business solutions underscores his unique expertise and impact on both fields.

As a mentor, Dr Jorayev supports students by offering guidance in scientific research, innovation, and entrepreneurial thinking. He provides insights into emerging market and technological trends, empowering students to explore the intersections of science, technology, and business. By fostering a comprehensive interdisciplinary learning environment, Dr Jorayev prepares mentees to tackle complex challenges and make meaningful contributions to both research and industry.

DR PERMAN JOYAYEV, UNIVERSITY OF CAMBRIDGE
REAL-WORLD APPLICATIONS OF AI AND ML:
FROM STOCK MARKET PREDICTION TO VACCINE DEVELOPMENT

Suitable for students interested in:

ARTIFICIAL INTELLIGENCE
Data Science | Programming | Optimized ML Models

PRACTICAL APPLICATIONS OF AI
Medicine | Environmental Science | Business and Finance

Artificial Intelligence (AI) and Machine Learning (ML) are transforming industries and driving innovation across diverse fields, from healthcare to finance to environmental sustainability. This research course explores real-world applications of AI and ML, showcasing how these tools are used to address critical challenges such as:

- Vaccine development in the case of Moderna
- Disease prediction based on patient data
- Novel materials discovery such as optimum solar panel or battery material composition and manufacturing
- Porous materials for CO_2 capture, water purification, and precious and rare earth metals recovery
- Novel enzymes to degrade plastic
- Pesticide detection/absorption in the environment
- Image (e.g. CT scans, MRI) analysis for various disease diagnostics
- Crop health assessment via drone imaging to assess irrigation and fertilisation requirements
- Text mining for stock market prediction (sentimental analysis)
- Computer vision for autonomous robots to do dangerous jobs

and the list goes on.

The first seven lectures provide foundational training in data science, covering key supervised and unsupervised ML algorithms implemented in Python, enabling students to develop practical skills in data manipulation, model building, and analysis. Students will work on hands-on projects such as customer segmentation for a telecom, patient disease prediction, personalized drug recommendation for patients, and synthesis of new materials.

In the following six group supervisions, students will be able to implement the ML algorithms they have learned on novel datasets and unique problems of their choice. Guided by collaborative feedback, they will optimize their models, analyze results, and craft a polished project. Each student will leave the course with a written report or presentation showcasing a novel dataset, an optimised ML model on the selected problem, and the results of ML predictions, demonstrating their mastery of AI/ML applications. This project can serve as a valuable asset to launch future endeavors, equipping students with in-demand skills that they can apply to pressing real-world problems.

PRINCETON UNIVERSITY

DR BENJAMIN ROSCHE

CURRENT POSITION
Postdoctoral Research Associate, Office of Population Research, Princeton University

PREVIOUS APPOINTMENT
Data Scientist, Organization for Economic Cooperation and Development (OECD)

A computational sociologist leveraging advanced quantitative methods to uncover the social dynamics driving inequality and stratification.

As a researcher, Dr Rosche specializes in social inequality, social networks, and family demography. He combines innovative quantitative and computational methods to explore how individual interactions within social and environmental contexts shape broader patterns of stratification. His research emphasizes the interplay of friendship, family, political, and climate dynamics in influencing life chances and societal inequality.

With expertise in causal inference, relational dynamics, multilevel analysis, and modeling group heterogeneity, Dr Rosche's work has been featured in journals such as the *Annual Review of Sociology* and *Survey Research Methods*. His contributions include studies on network segregation, adolescent friendship dynamics, and the socioeconomic impacts of climate change and migration.

He is the Principal Investigator of a National Science Foundation-funded project amount to USD 250,000 in grants examining the links between friendship networks and socioeconomic outcomes. Dr Rosche's work has earned him multiple accolades, including best paper awards from the American Sociological Association and Cornell University.

Currently, Dr Rosche collaborates on diverse projects with leading scholars across disciplines, investigating topics like the long-term impacts of network segregation and the role of elite networks in impeding progressive tax reforms. His research bridges sociology, economics, and computational science, offering transformative insights into the dynamics of inequality in modern society.

As a mentor, Dr Rosche is dedicated to fostering student growth and interdisciplinary collaboration. He has mentored students across sociology, economics, and network science. As a former lab manager for the Social Dynamics Lab, he assisted students with diverse research projects, and his teaching experience spans sociology, statistics, and inequality courses at Cornell University, Utrecht University, and Mannheim University.
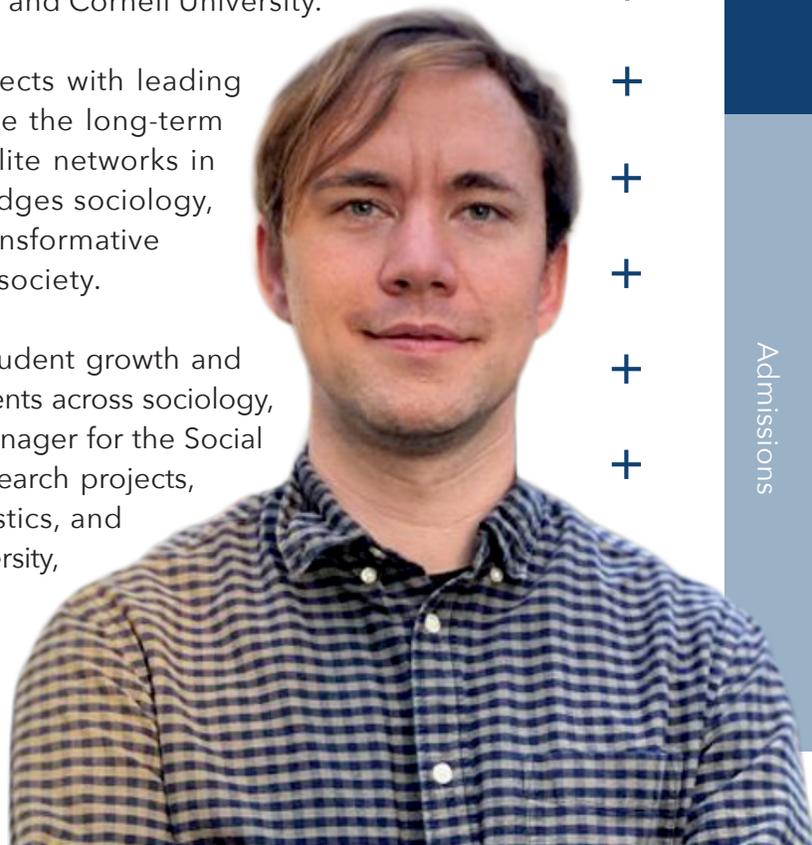
DR BENJAMIN ROSCHE, PRINCETON UNIVERSITY

THE DATA SCIENCE OF SOCIAL NETWORKS:

MODELLING, VISUALIZING, AND ANALYZING THE SOCIAL WORLD

Suitable for students interested in:

SOCIOLOGY
Group Dynamics | Social Media | Real-World Data

SOCIAL NETWORK ANALYSIS
Visualization & Modelling | Data Science | Programming

Ever wonder how connections between people, ideas, and things shape everything, from friendships to global events? **This research course dives into the fascinating world of social networks, where we'll uncover the hidden patterns that influence our lives**—like who's really the most popular in your class, how rumors spread like wildfire, and why certain influencers go viral overnight.

You'll learn how to use social network analysis to visualize, understand, and harness the power of networks and relationships. We'll tackle exciting topics like what makes someone "popular", the secrets behind social media algorithms, and how networks shape decisions in society.

Through hands-on activities with beginner-friendly tools like R, engaging examples, and relatable projects, you'll gain the skills to visualize connections, identify key influencers, track the flow of ideas, and even map out networks from your own life.

This research course takes a "learning by doing" approach. It begins with foundational lectures introducing key concepts in social network analysis, ensuring you understand the basics. As the course progresses, the focus shifts to interactive lab sessions, where you'll gain hands-on experience working with real-world data. Topics covered include an introduction to R programming, network visualization techniques, and network modeling methods, equipping you with practical skills to explore and analyze networks.

For the final project, you'll have the opportunity to choose your own dataset from a selection of provided options and develop research questions that spark your curiosity. Lab sessions and homework are carefully designed to guide you in working with your chosen dataset, allowing you to apply course concepts to your specific questions as you complete the exercises. These activities naturally build toward a polished final report, enabling you to experience the full data science process—from research question to final report.

No prior experience is required—just curiosity and a willingness to dive into the exciting world of social networks. By the end of the course, you'll think like a network scientist, equipped to analyze group dynamics and see your world in a whole new way!

DR DEJAN KOVAC

CURRENT POSITION
Postdoctoral Research Fellow, Center for International Development, Harvard University

PREVIOUS APPOINTMENTS
Postdoctoral Research Associate, Halle Institute for Economic Research (IWH), Germany
Researcher, Empirical Studies of Conflict Section, Princeton University
Lead Project Researcher, The World Bank Group
Postdoctoral Research Associate, Princeton School of Public and International Affairs and Economics Department, Princeton University

As a researcher, Dr Kovac specializes in studying the detrimental effects of wars and conflicts on child development, human capital accumulation, health, and societal norms. His interdisciplinary work bridges International Political Economy, Behavioral Economics, and Education Economics. Dr Kovac's research provides vital insights into migration processes and human capital development, with a particular focus on Croatia and the broader Central and Eastern European (CEE) region.

Collaborating with Croatian governmental agencies, including the Ministry of Science and Education and the Ministry of Veterans, Dr Kovac has tackled critical policy issues. His projects explore the effects of school starting-age policies, the impact of paternal mortality on education, peer influences on college choices, and the efficiency of centralized college admissions systems.

At Harvard, Dr Kovac's research explores how education policies influence migration and how peer effects shape outcomes for migrants post-relocation. His consultancy work with the World Bank on forced displacement of refugees in Croatia and Bosnia further under-scores his commitment to tackling global humanitarian challenges.

In addition to academic pursuits, Dr Kovac is committed to advancing trans-parency and civic engagement through an NGO initiative aimed at improving access to information and strengthening democratic governance in the CEE region. His research has been featured in esteemed journals like the Journal of *Comparative Economics, Defence and Peace Economics*, and the *Quarterly Journal of Economics.*

As a mentor, Dr Kovac has taught a range of subjects such as Macroeconomics, Public Finance, and Econometrics. He has also led workshops on economic modeling and research methods, helping students build practical skills for academic and professional success. Known for his clear and supportive teaching style, Dr Kovac encourages critical thinking and intellectual growth, empowering his students to excel in their academic and professional pursuits.

DR DEJAN KOVAC, HARVARD UNIVERSITY

DATA SCIENCE:

FROM CORRELATION TO CAUSATION

Suitable for students interested in:

DATA SCIENCE
Analysis | Visualization | Methods & Tools

COMPUTATIONAL SOCIAL SCIENCE
Social Systems | Network Analysis | Algorithms

As the field of data science continues to grow at an unprecedented pace, its applications are transforming industries, influencing policy decisions, and shaping the way organizations operate. By 2030, it is estimated that over 11.5 million data science roles will be in demand globally. **This research course is designed to provide students with a foundational understanding of data science and its applications, equipping them with essential skills to navigate an increasingly data-driven world.**

The research course begins by introducing the structure and types of data commonly encountered across various industries. Students will explore foundational techniques for analyzing, interpreting, and visualizing data using accessible software tools, with no prior experience required. The curriculum emphasizes the distinction between correlation analysis and causal inference—a critical skill for making sound, evidence-based decisions. Students will learn how to identify meaningful relationships in data and apply methods to uncover the underlying causes behind observed patterns.

Through hands-on exercises and practical assignments, students will work with real-world datasets, gradually developing their proficiency in data analytics tools such as Excel, R, or Python. Weekly or bi-weekly assignments will be tailored to individual research topics, enabling students to immediately apply what they learn to areas of personal or academic interest.

By the end of the research course, students will have gained the skills and confidence to independently perform basic data analysis, distinguish between correlation and causation, and critically assess the validity of data-driven conclusions. This research course is ideal for high school students curious about data science, aspiring researchers, or anyone looking to build a strong foundation in this dynamic field.
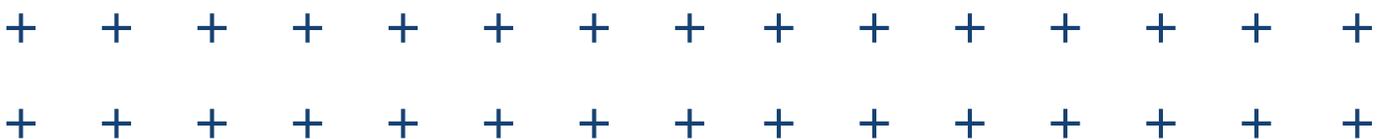
DR ROBERT EDWIN ROUSE

CURRENT POSITION

Early Career Advanced Fellow, Department of Applied Mathematics & Theoretical Physics, University of Cambridge

A climate scientist who uses machine learning and predictive modeling in reshaping disaster preparedness and driving sustainable decarbonization strategies.

As a researcher, Dr Rouse is an expert in statistical and machine learning methodologies applied to real-world challenges, with a focus on sustainability and environmental issues. His current research centers on developing predictive models to assess the impact of severe meteorological events—such as floods, storms, and heatwaves—aimed at improving disaster preparedness, mitigating risks, and informing policy decisions to strengthen resilience against climate change. Additionally, Dr Rouse leads AI optimization initiatives to enhance built environment systems, with a particular focus on decarbonization strategies for commercial and industrial infrastructures.

A multi-disciplinary scholar, Dr Rouse's expertise spans applied mathematics, engineering, design, and the traditional arts, with research interests in complex natural and human systems. He is dedicated to public engagement, transitioning his research into impactful ventures. As Founder and Chief Scientific Officer of Viriturr Ltd., he developed innovative machine learning methods for decarbonizing existing buildings, incorporating data collection, climate modeling, and optimization strategies.

Dr Rouse has contributed to projects funded by UKRI, Schmidt Sciences, and AI@Cam. His work has been featured in journals like *Environmental Data Science* and *Climate Informatics*. He also serves as a technology consultant for companies such as the NHS and BAE Systems.

As a mentor, Dr Rouse has supervised undergraduate and postgraduate students at the University of Cambridge. He is committed to fostering a deep understanding of complex topics, encouraging critical thinking, and providing practical guidance in research. In addition to his academic mentorship, Dr Rouse is actively involved in educational outreach, lecturing in schools and inspiring the next generation of researchers, innovators, and climate leaders.
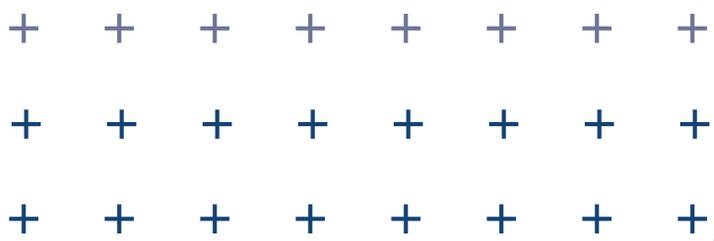
DR ROBERT EDWIN ROUSE, UNIVERSITY OF CAMBRIDGE

ENVIRONMENTAL DATA SCIENCE:

EXAMINING CLIMATE CHANGE AND ENVIRONMENTAL RISK USING MACHINE LEARNING

Suitable for students interested in:

ENVIRONMENTAL SCIENCE

Ecosystem Vulnerability | Risks & Hazards | Technologies & Policies

CLIMATE CHANGE

Projections | General Circulation Models (GCM) | Socioeconomic Drivers

DATA SCIENCE

Machine Learning | Probability Theory | Maths

Anthropogenic climate change is among the most significant existential threats facing humanity, driving increased frequency and intensity of environmental hazards, ecosystem degradation, and widespread societal challenges. While emerging technologies hold promise in addressing these issues, critical questions remain about their efficacy and whether societal transformation can occur rapidly enough to avert the most severe risks. At the same time, the vast amounts of climate and environmental data being collected present an unprecedented opportunity for machine learning and data-driven frameworks to enhance understanding, guide interventions, and predict future impacts. **The research course aims to equip participants with the knowledge and skills to analyze climate change and environmental risks using machine learning, bridging scientific understanding and data-driven solutions.**

This research course will be divided into four key sections. First, we will explore the underlying physics behind climate change, including how General Circulation Models are used to project future scenarios, the concept of climate tipping points, ecosystem vulnerability, and the political and socioeconomic drivers of anthropogenic climate change. Second, we will examine environmental hazards, such as hurricanes or cyclones, flooding, and heatwaves, and how their risk profile is changing and the implications for ecosystems and human communities. Third, we will focus on what technologies and policies can help to reverse or mitigate the effects of climate change, including an exploration of their technological and economical viability and any unintended consequences from these interventions. Finally, we will cover the fundamentals of machine learning, including essential concepts in linear algebra, calculus, and probability and examine how machine learning is applied to climate and environmental challenges, with practical applications to real-world problems.

The research course combines seminar-style discussions with hands-on tutorials, featuring applied examples of machine learning research in environmental data science. Participants will have the opportunity to engage with algorithms and datasets, applying theoretical knowledge to pressing climate and environmental issues.

UNIVERSITY OF CAMBRIDGE

DR HRIDOY SANKAR DUTTA

CURRENT POSITIONS

Research Associate, Cambridge Cybercrime Centre, Department of Computer Science and Technology, University of Cambridge
Co-Founder, Assam AI Initiative

PREVIOUS APPOINTMENTS

Research Assistant, Cambridge Cybercrime Centre, Department of Computer Science and Technology, University of Cambridge
**Assistant Project Engineer,** Indian Institute of Technology, Guwahati (IITG)

A cybersecurity and social network specialist engaged in detecting online collusion and fake engagements.

As a researcher, Dr Dutta's areas of expertise are in data-driven cybersecurity, social network analysis, and web mining. He previously worked on natural language processing and machine learning. Notably, He co-owns a patent for an end-to-end system and method of operation for offline localised crisis mapping.

Dr Dutta has made significant contributions to his fields, including groundbreaking studies on black-market-driven collusion in online media. His research has identified core collusive users within the YouTube black-market and pioneered techniques for detecting fake retweeters on Twitter, among other accomplishments.

His findings have been published in high-impact scientific journals such as *ACM/ICS Transactions on Data Science, Elsevier Journal of Network and Computer Applications,* and *IEEE Transactions on Information Forensics and Security.* Furthermore, Dr. Dutta actively contributes to the academic community as a reviewer for prestigious scientific journals and conferences, including the *ACM International Conference on Web Search and Data Mining (WSDM 2024), Nature Scientific Reports*, and the *Springer Machine Learning Journal.*

As a mentor, Dr Dutta taught courses on Security, and Machine Learning and Real-World Data at the University of Cambridge. He has also supervised undergraduate students in their theses.

DR HRIDOY SANKAR DUTTA, UNIVERSITY OF CAMBRIDGE
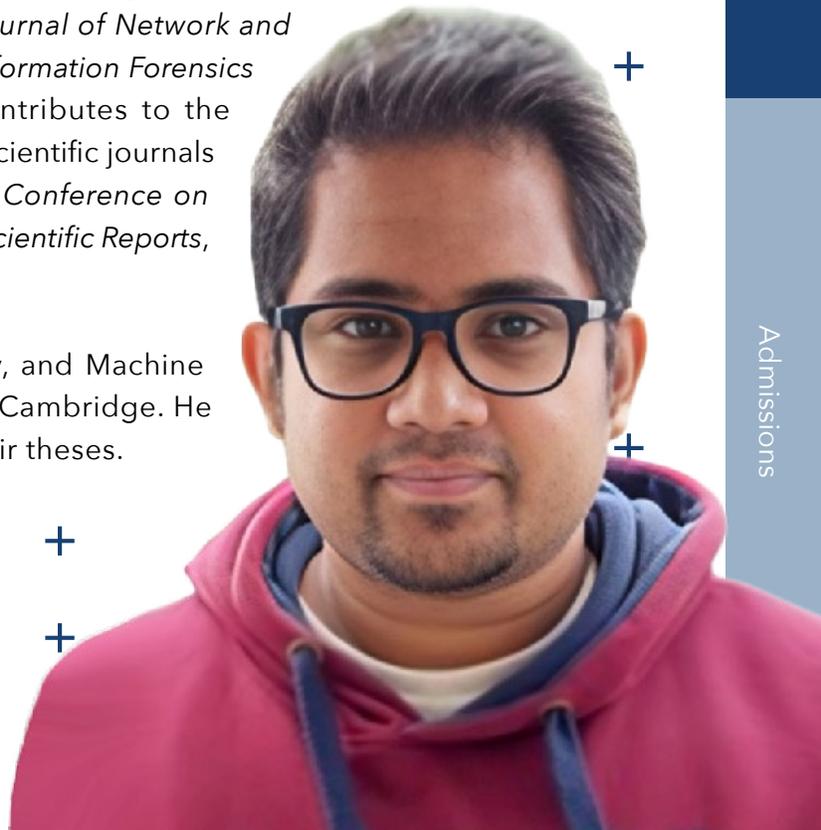
UNDERSTANDING SOCIAL NETWORK:

FROM DATA SCIENCE TO CYBERCRIME ON SOCIAL MEDIA

Suitable for students interested in:

SOCIAL NETWORK ANALYSIS
Social Media | Network Dynamics | Network Visualization

CYBERCRIME & SECURITY
Online Black Markets | Social Media Fraud | Cybersecurity Practices

This research course is an in-depth exploration of the realm of social networks, arguably the most important platform for collaboration and communication among the global population. We will explore the widespread adoption of social media platforms such as Facebook, Twitter, Instagram etc., which enable users to share diverse content like opinions, experiences, perspectives, and various media formats. The students will gain an understanding of the underlying principles and concepts that form the basis of social network analysis. They will learn about the key components involved in designing research studies in social networks.

The research course will cover various techniques for gathering data from different social networks for interesting research problems. Additionally, students will be taught advanced methodologies for analysing and visualising data pertaining to social network structures and dynamics. The research course will equip students with the ability to identify influential or prominent individuals within social networks. They will learn methods for how information propagates and diffuses across the connections in a network structure. We will also dive deep into various security and cybercrime research problems in social networks.

The students will gain practical experience applying the analytical and modelling techniques to tackle actual, real-world problems and scenarios in the research area of social networks.

DR SHADI GHIASI

CURRENT POSITIONS

Lead AI Specialist, Baker Hughes

Researcher, University of Oxford

PREVIOUS APPOINTMENTS

Visiting Research Fellow, University of Oxford

Marie Skłodowska-Curie Research Fellow, University of Pisa

A computer scientist pushing the boundaries of Machine Learning (ML) and Artificial Intelligence (AI) to enhance healthcare technologies.

As a researcher, Dr Ghiasi focuses on the applications of AI and ML in healthcare technologies. Currently, she is developing healthcare technologies for low and middle- income countries, and working on a project that draws on deep learning to develop novel clinical applications at the Computational Health Informatics lab (CHI lab). Her research is generously funded by the Wellcome Trust.

Previously, she studied the development of signal-processing methodologies for quantifying physiological sensor data and the adaptation of machine-learning algorithms to assess mental health disorders. She developed signal-processing methods for analysing time-series data. She also developed machine-learning and deep-learning models for recognition models in digital healthcare for small and large datasets and explainable AI methodologies for healthcare data. At Oxford, she worked on the interpretability of data-driven models by incorporating psycho-physiological knowledge into Gaussian- process models and developed sleep arousal-detection algorithms through deep learning algorithms.

Dr Ghiasi's work has been published in a wide range of high impact journals in computer science, biomedical engineering and medicine, including *Scientific Reports, Physiological Measurements, Computing in Cardiology and Journal of Affective Disorders.*

As a mentor, Dr Ghiasi has lectured and supervised undergraduate and graduate students across multiple disciplines, including applied mathematics, biomedical engineering, computer science and mechanical engineering.

DR SHADI GHIASI, UNIVERSITY OF OXFORD

ARTIFICIAL INTELLIGENCE IN HEALTHCARE:

BIOMEDICAL SENSORS, SIGNAL PROCESSING AND MACHINE LEARNING

Suitable for students interested in:

COMPUTER SCIENCE

Machine Learning | AI | Computer Vision | Data Science

MEDICINE

Signal Processing | Healthcare Data | Mental Health | Biomedical Engineering

Recent scientific advances in AI and the significant growth of the use of medical sensors have ushered in an exciting new phase in digital solutions in healthcare. Particularly, with the recent pandemic, we have seen the global importance of digitisation in healthcare and remote patient monitoring.

In this research course, students will gain an understanding of how AI-based technologies are revolutionising healthcare. Students will establish a core knowledge on machine-learning and signal-processing methods and will see how these methods are applied to healthcare systems. Students will be introduced to biomedical sensors and wearable systems and gain knowledge on the underlying physiological phenomena. They will learn to programme in Python/MATLAB and implement their own AI pipeline on healthcare data, from scratch.

At the end of the research course, students will be able to have an exciting hands-on experience in using their creativity and applying their own AI model on real-world patient data. They will utilise the interdisciplinary knowledge they gained during the course to solve a high-impact real-world problem in healthcare. At the end of the journey, students will have developed theoretical and practical knowledge of AI models in healthcare, knowledge of biomedical sensors and methods to analyse them. They will also have acquired MATLAB/Python-programming skills within a hands-on project on healthcare data. The whole journey will spark in students a creative mindset to solve real-world healthcare problems with AI.

UNIVERSITY OF CAMBRIDGE
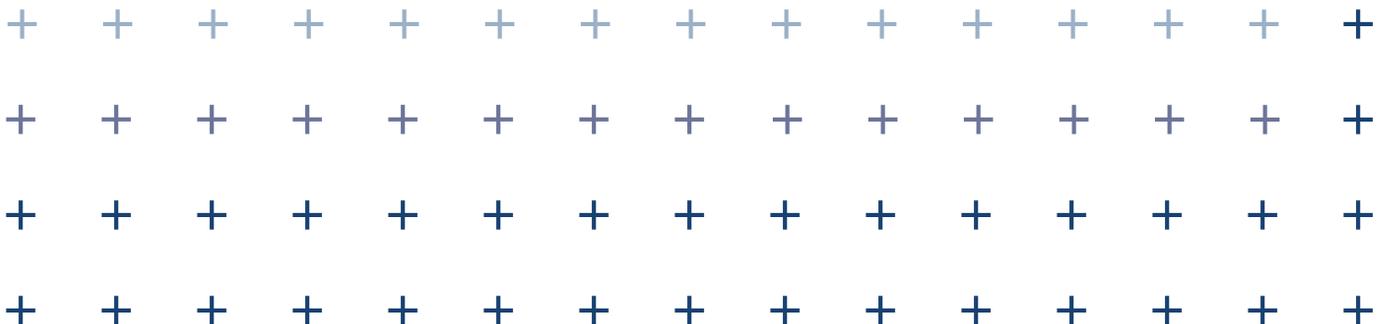
DR CONNOR TAYLOR

CURRENT POSITIONS

Researcher and Honorary Associate, Innovation Centre for Digital Molecular Technologies, University of Cambridge

Assistant Professor of Chemical Engineering, Faculty of Engineering, University of Nottingham

Research Fellow, Royal Academy of Engineering

Founder, Compunetics

A chemical engineer working on bioactive drug discoveries with real-world impact.

As a researcher, Dr Taylor is a chemist with novel ideas and clear academic aspirations for the future. In partnership with the University of Leeds and AstraZeneca, he has founded and developed *"Compunetics"*, a kinetic modelling and optimisation tool that performs data fitting and experimental simulations. This tool, currently, has been downloaded by over 150 academic institutions worldwide.

Dr Taylor has led several research collaborations with both internal and external academic partners and the industrial sector. Notably, one of his research projects received £1.2M in funding from EPSRC. These collaborations include the Universities of Leeds, Cambridge, Newcastle, York, Bath,and Glasgow.

He is active in the international scene as well, having worked in Aachen, Singapore, and Shenzhen. Furthermore, his industry experiences include AstraZeneca, DeepMatter, CatSci, Shionogi, Vapourtec, and FarmaTrust. Dr Taylor's research papers have been published in various prestigious publications such as *The Chemical Engineering Journal* and *Journal of Flow Chemistry.*

As a mentor, Dr Taylor supervised PhD and Master students in their projects, both in research direction and experimental work – many of whom subsequently won prizes for their theses.

DR CONNOR TAYLOR, UNIVERSITY OF CAMBRIDGE

DRUG DISCOVERY, CHEMICAL DEVELOPMENT & MACHINE LEARNING

Suitable for students interested in:

DRUG DISCOVERY

Biotechnology | Pharmacology | Drug Chemistry

CHEMISTRY

Flow Chemistry | Reaction Analysis | Synthesis

MACHINE LEARNING

Neural Networks | Optimization | Techniques and Tools

Machine learning is continuing to yield profound societal benefits, with notable examples including early detection of cancer from CT imaging and protein structure determination, to other areas such as chess computers and weather forecasting. **In this multidisciplinary research course, students will explore the rise of machine learning (or artificial intelligence) with specific reference to drug discovery and chemical development, as well as emerging techniques for effective chemical/pharmaceutical synthesis.** Combining topics from chemistry, biology, chemical engineering, and computer science, the research course equips students with the interdisciplinary knowledge needed to tackle cutting-edge problems in these fields.

Through a blend of lectures and hands-on workshops, students will gain both theoretical and practical expertise in applying machine learning to drug discovery. Topics include state-of-the-art techniques such as fragment-based drug discovery, high-throughput screening, and machine learning approaches for data analysis and parameter optimization using introductory programming. Additionally, students will explore modern chemical synthesis methods, including flow chemistry, automated synthesis, and high-throughput experimentation, and understand their pivotal roles in the modern laboratory.

The latter half of the research course focuses on research workshops designed to refine students' skills in research techniques, academic paper critiques, and scientific writing. These workshops will prepare students to craft high-quality academic papers, contributing to innovative research in drug discovery and chemical sciences.

By bridging multiple disciplines, this research course provides students with the tools to address real-world challenges at the intersection of machine learning and chemical science. Students will leave with a broad understanding of modern techniques and the ability to conduct impactful, interdisciplinary research, as well as the expansive opportunities in this field.

NATIONAL INSTITUTES OF HEALTH (NIH)

DR KUTSEV BENGISU OZYORUK

CURRENT POSITION

Postdoctoral Research Fellow, Artificial Intelligence Resource, Molecular Imaging Branch, National Cancer Institute at National Institutes of Health

PREVIOUS APPOINTMENTS

Postdoctoral Research Fellow, AI for Pathology Image Analysis Lab, Department of Pathology, Brigham & Women's Hospital, Harvard Medical School
**Research Scientist,** Afiniti

A visionary scientist committed to revolutionising healthcare through the power of Artificial Intelligence.

As a researcher, Dr Ozyoruk's current research centres in advancing computer vision and deep learning algorithms for clinical applications in radiology and computational pathology. At the National Center Institute, she is developing a generative AI model aimed at transforming MR images to address the diagnostic challenges posed by inadequate ADC maps. Additionally, Dr. Ozyoruk is working on an image retrieval algorithm to create a decision support tool tailored for detecting rare lesions in prostate cancer.

During her research appointment at Harvard Medical School, Dr Ozyoruk focused on enhancing surgical procedures by integrating the EndoSfM Learner algorithm with the NVIDIA Clara Holoscan Tool for real-time depth estimation in laparoscopic surgery. Additionally, she created self-supervised DINO models, enabling the creation of lightweight versions of large deep learning models suitable for mobile devices without requiring labelled data. Dr Ozyoruk also contributed to the field of high-performance computing by developing a Neural Architecture Search method utilising SLURM schedulers. Furthermore, she devised an AI-FFPE approach based on generative adversarial networks (GANs) to improve diagnostic accuracy in lung and brain cancers. Her research extended to virtual immunohistochemical staining for kidney rejection probability estimation and interpretability analysis of UNet Semantic Segmentation performance in human tissue imaging through class activation mapping.

Dr Ozyoruk's research has appeared in several top-tier high-impact scientific journals, including *Nature Biomedical Engineering*, as well as prestigious medical imaging conferences such as Elsevier-MEDIA and IEEE-TMI.

As a mentor, Dr Ozyoruk has taught courses in Discrete Mathematics and Linear Algebra at the university level.

DR KUTSEV BENGISU OZYORUK, NATIONAL INSTITUTES OF HEALTH (NIH)

ARTIFICIAL INTELLIGENCE APPLICATIONS IN MEDICAL IMAGING ANALYSIS

Suitable for students interested in:

ARTIFICIAL INTELLIGENCE

Machine Learning | Deep Learning | Image Analysis

MEDICAL IMAGING

Computer-Aided Diagnosis (CAD) | Algorithms | Computer Vision

Artificial intelligence (AI) has emerged as a transformative technology in the field of medical imaging, offering new approaches to image analysis that can enhance diagnostic accuracy, improve patient outcomes, and streamline healthcare workflows. This research course explores the various applications of AI in medical imaging analysis, highlighting its potential to revolutionise the practice of radiology and other imaging-based specialties.

This research course aims to help students to gain knowledge and hands-on experience between Artificial Intelligence applications and medical science. They would learn how these knowledge could potentially revolutionise medical practice and bring great benefits to patients. The course begins by discussing the basics of medical imaging modalities, including computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound, emphasising the importance of accurate and timely image interpretation for clinical decision-making.

Students will be introduced to the concept of AI and its subsets, such as machine learning and deep learning, explaining how these technologies can be applied to medical imaging analysis. Topics include image classification, segmentation, and detection, as well as the use of AI for image enhancement and artefact reduction.

Students will explore specific AI applications in medical imaging, such as computer-aided diagnosis (CAD) systems, which can assist radiologists in detecting and diagnosing abnormalities in medical images. Other applications include image reconstruction, where AI algorithms can improve image quality from low-dose scans, and image registration, which enables the fusion of multiple imaging modalities for more comprehensive analysis.

This research course offers valuable insights into the rapidly evolving field of AI in medical imaging. By conducting their independent research projects, students will get a comprehensive overview of the application of AI in medical imaging analysis. They will see its potential to transform healthcare delivery and improve patient outcomes.

UNIVERSITY OF CAMBRIDGE
DR ARSEN ABDULALI

CURRENT POSITION
Marie Sklodowska-Curie Future Roads Fellow, Bio-Inspired Robotics Lab, Cambridge University

PREVIOUS APPOINTMENTS
Research Associate, Bio-Inspired Robotics Lab, Cambridge University
Postdoctoral Researcher, Mathematical Biology Lab, Kyung Hee University

A robotics researcher specializing in haptic interaction modeling and human-robot collaboration.

As a researcher, Dr Abdulali's research focuses on advancing haptic interaction modeling within the metaverse, where the realms of the physical and virtual seamlessly intertwine. A central objective of his work is to facilitate haptic engagement with simulated environments, allowing individuals to experience tactile sensations such as the deformation of soft objects, the dynamics of liquids within containers, or the textures of surfaces they interact with, all within a virtual context. This innovation extends its utility across a spectrum of educational applications, including medical training, construction site simulations, and the operation of industrial machinery and vehicles.

Beyond haptic modeling, Dr Abdulali's research interest extends to the realm of human-robot collaboration. In this domain, he explores scenarios where humans control one or multiple remote robots through implicit communication, while the robotic manipulation at the remote location occurs in a semi-automated fashion. Currently, Dr Abdulali is pioneering a novel approach to human-robot social cooperation, where the human operator orchestrates the robot's actions from a remote location. This collaborative interaction involves the robot executing manipulation routines with objects and navigating the roadside environment in a semi-automated capacity. The proposed human-in-loop design has the potential to relocate roadside workers to remote offices, mitigating the health and safety risks associated with their roles.

Dr Abdulali has showcased his research findings at various IEEE and Springer conferences, contributing significantly to the field of haptic interaction modeling and human-robot collaboration. Notably, a research paper he co-authored titled "Mastication-Enhanced Taste-Based Classification of Multi-Ingredient Dishes for Robotic Cooking" received the Outstanding Article Award by *Frontiers in Robotics and AI* journal.

As a mentor, Dr Abdulali provides invaluable guidance, leveraging his expertise to nurture and inspire his mentees, fostering a dynamic learning environment that extends across diverse applications.

DR ARSEN ABDULALI, UNIVERSITY OF CAMBRIDGE

VR, MIXED REALITY, AND THE METAVERSE

Suitable for students interested in:

COMPUTER SCIENCE
Human-Computer Interaction | Virtual Reality | Mixed Reality | Simulation

ENGINEERING
Robotics | Electrical Engineering | Mechanical Engineering

PSYCHOPHYSICAL STUDIES
Perception | Visualisation | Ergonomics

When the Apple Vision Pro is released, it surprises users with its groundbreaking features. One of the most impressive aspects is that when users put on the headset, they can seamlessly merge virtual elements with the physical world, intertwining computer-generated information with their real surroundings. This very feature is often referred to as Mixed Reality (MR). MR enables users to interact with both real-world objects and virtual elements concurrently, fostering a blended experience that combines the best of virtual and physical realms.

These technologies hold vast potential across numerous fields. Virtual Reality (VR) finds applications in training simulations, gaming, healthcare therapies, architectural visualisation, and remote collaboration. Mixed Reality (MR) augments real-world experiences in fields like education, manufacturing, remote assistance, and design, offering a blend of virtual and physical elements.

In this research course, we will cover the fundamental principles of interactive virtual and mixed realities, with a focus on both computer graphics rendering and haptics, which refers to tactile feedback in VR and MR. Graphics rendering and haptics are crucial as they enable users to feel and interact with virtual environments, enhancing immersion and realism. This will also allow us to delve into key aspects of human perception in the context of realism and immersiveness.

Students will conduct their independent research project, encouraged to delve into a diverse array of topics including VR simulations, the advancement of tactile interfaces, and psychophysical studies. By the conclusion of the research course, students will not only attain a comprehensive understanding of these cutting-edge technologies but also acquire invaluable hands-on experiences, preparing them to apply their knowledge effectively in real-world scenarios.
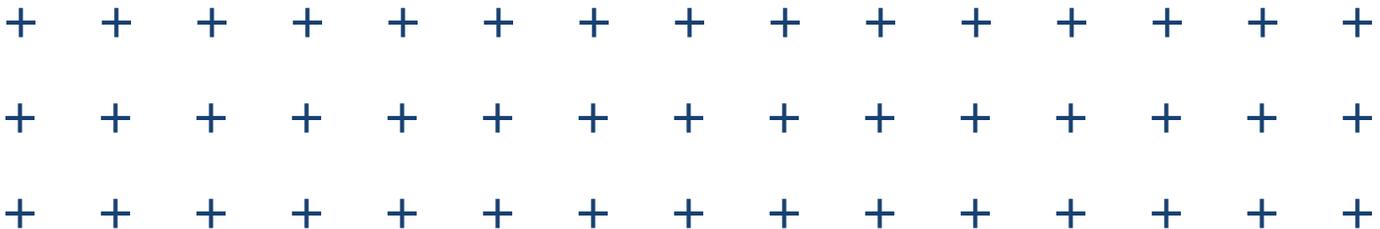
DR NIVED CHEBROLU

CURRENT POSITION

Postdoctoral Researcher, Dynamic Robot Systems Group, Oxford Robotics Institute, University of Oxford

PREVIOUS APPOINTMENT

Research Assistant, Photogrammetry and Robotics Lab, University of Bonn

A robotics specialist dedicated to creating meaningful societal change through his expertise.

As a researcher, Dr Chebrolu he works on navigation and mapping for field robots at Oxford's Dynamic Robot Systems Group. His research centres on advancing registration techniques for SLAM systems, integrating vision and LiDAR data collected over extended periods.

Prior to this, he designed localization and mapping methodologies tailored for robotic applications in agricultural environments. Notably, he received the *IEEE Robotics & Automation Magazine* Best Paper Award in 2021 for his paper titled Building an *Aerial-Ground Robotics System for Precision Farming: An Adaptable Solution.* He also was recently given the Departmental Award for Excellence by the Department of Engineering Science at the University of Oxford.

Dr Chebrolu's research has been published in high-impact, peer-reviewed scientific journals including the *IEEE Robotics and Automation Letters, PLOS ONE,* and *Robotics and Automation Systems.*

As a mentor, Dr Chebrolu is dedicated to education, delivering Master degree courses in Mobile Sensing and Robotics, as well as Techniques for Autonomous Vehicles at Oxford. He also supervises both Master and Undergraduate students in their theses and research projects. Prolific in his own publication history, Dr Chebrolu feels passionate to share his expertise with the next generation of scholars.

DR NIVED CHEBROLU, UNIVERSITY OF OXFORD

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR ROBOTICS

Suitable for students interested in:

ROBOTICS
Computational Robotics | Robot vision

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING
Computer Vision | Data Science | Neural Networks

This research course is designed to provide students with a comprehensive overview of Artificial Intelligence (AI) and Machine Learning (ML), reflecting the cutting-edge advancements in these fields as it relates to robotics. Tailored for students interested in the intersection of AI and robotics, this research course promises a journey into cutting-edge advancements and innovative applications within this dynamic field.

From its inception, the course is designed to provide students with an understanding of both AI/ML and robotics, delving deep into the intricate mechanisms and sophisticated algorithms that drive this rapidly evolving domain. With a robust foundation laid in AI and ML fundamentals, students will seamlessly transition to exploring the unique challenges and opportunities presented by robotics.

Throughout the duration of the research programme, students will engage in an intensive exploration of robotics, dissecting its multifaceted facets and uncovering its myriad applications across diverse industries. From autonomous navigation systems to human-robot interaction, students will gain invaluable insights into the transformative potential of robotics in revolutionising modern society. Whether aspiring roboticists, automation engineers, or AI researchers, students will be well-equipped to navigate the complex landscape of robotics with confidence and competence, poised to make meaningful contributions to this transformative field.
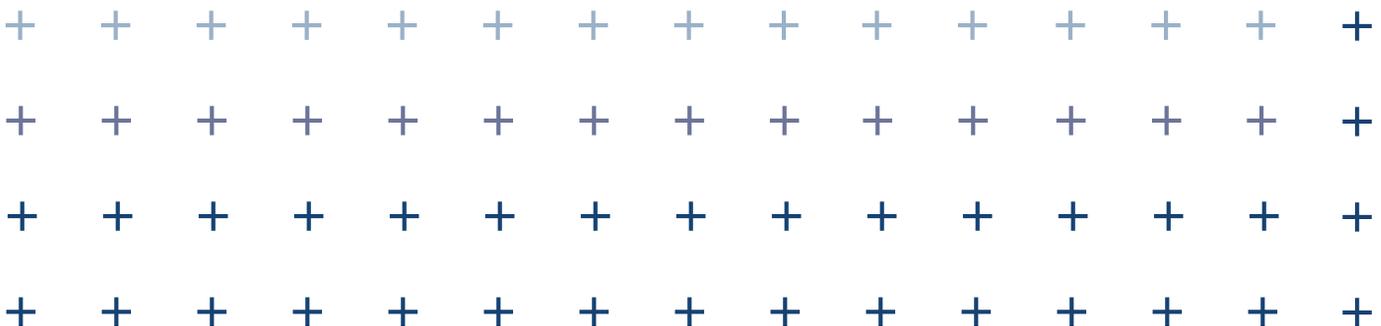
DR DANNY EBANKS

CURRENT POSITION

Postdoctoral Research Fellow, The Institute for Quantitative Social Science (IQSS), Harvard University

A computational social scientist dedicated to utilising statistics, machine learning, and natural language processing to deconstruct US politics.

As a researcher, Dr Ebanks specialises in using latent variable models, Bayesian statistics, and natural language processing in his research on Political Methodology, American Politics, elections, and Congress. At IQSS, he dedicates himself to developing and implementing cutting-edge statistical methods, harnessing the power of machine learning and AI to innovate and enhance our understanding of the complex dynamics within our political landscape. Dr Ebanks has recently investigated the influence of abortion rights in the 2024 US elections which was published in PLOS ONE. Dr Ebanks previously conducted research on political parties and representation in the US Congress, congressional elections, public trust in scientists, the interplay between fossil fuel companies and climate-focused IGOs/NGOs, and collective action movements such as MeToo. Additionally, he has contributed to the development of tensor-based methods for latent variable models, and explored their applications in studying US legislatures at both the federal and state levels. Before his appointment at Harvard, Dr Ebank earned his PhD at Caltech in Quantitative Social Sciences.

As a mentor, Dr Ebanks was also presented with the Divisional Award for Excellence in Teaching by the Reserve Bank Operations and Payments Systems at the Federal Reserve. With in-depth experience across academic and professional spheres, Dr Ebanks is passionate about inspiring the next generation of scholars.

DR DANNY EBANKS, HARVARD UNIVERSITY
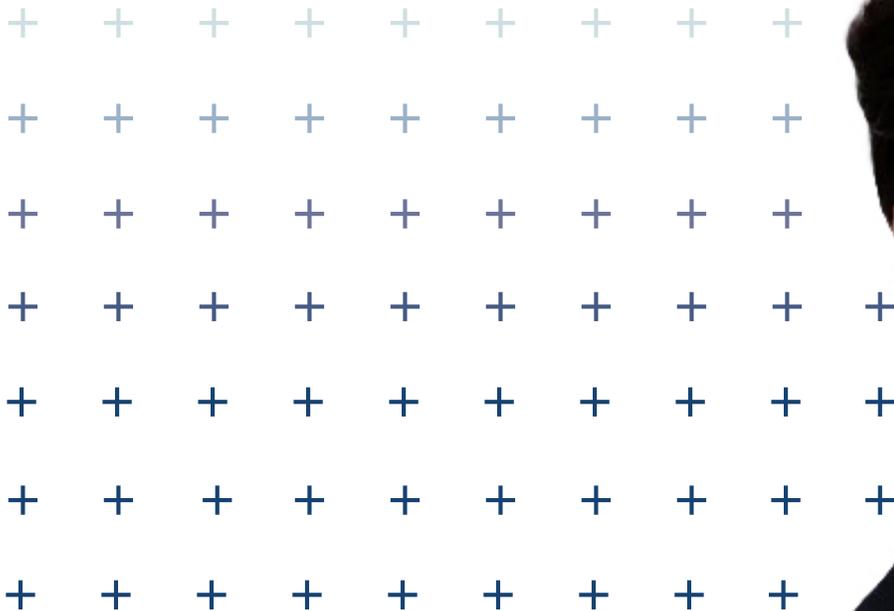
AI AND MACHINE LEARNING:

TOOLS FOR ADDRESSING SOCIAL PROBLEMS

Suitable for students interested in:

SOCIAL SCIENCE
Social Media | Public Interest | Forecasting Models

COMPUTER SCIENCE
Machine Learning | Big Data | Artificial Intelligence

POLITICAL SCIENCE
Partisan Bias | Legislative Agenda Setting | Election Analysis

In a world of big data and ever-increasing computational power, researchers now have feasible access to cutting-edge statistical, machine learning, and AI methods to analyse pressing social science problems ranging across political polarisation, Gerrymandering, criminal justice, and democratic outcomes.

In this research course, we aim to demystify these new methods and give practical guidance on how to evaluate the effectiveness of these tools. **Students will gain hands-on experience with how these advanced quantitative methods guide political scientists, economists, and public policy researchers in problem-solving.** We will also show how to communicate results from these methods to a wider public, including policymakers and those in the legal profession.

Students will learn how to manage a code-base in GitHub, work locally and in the cloud to apply the latest AI methods to real-world datasets of their choice. Students will gain insights into how methodological researchers invent statistical and machine learning tools to address issues surrounding but not limited to election forecasting models, natural language processing of social media, partisan bias in the news media, legislative agenda setting, and scientific information networks that serve the public. Methods covered in this research course include Ordinary Least Squares, Logit Regression, Bayesian Statistical methods, Large Language Models, Latent Dirichlet Allocation, and survey methods/polling. This course targets students with advanced levels of academic preparation.

DR SERGII STRELCHUK

CURRENT POSITIONS

Royal Society University Research Fellow, Department of Applied Mathematics and Theoretical Physics, University of Cambridge
Director of Studies and Governing Body Fellow, Sidney Sussex College, University of Cambridge
Co-founder and Organiser, Cambridge-Warwick Quantum Computing Colloquium

PREVIOUS APPOINTMENTS

Leverhulme Early Career Fellow, Department of Applied Mathematics and Theoretical Physics, University of Cambridge
John and Delia Agar Junior Research Fellow, Sidney Sussex College, University of Cambridge

A highly accomplished research scientist specialising in the fields of quantum computing and quantum information.

As a researcher, Dr Strelchuk is a co-leader of the Cambridge-Southampton Algorithms for Quantum Field Theory project, which aims to apply recent advances in general-purpose quantum algorithms to problems in quantum chromodynamics (QCD) and advance classical simulation methods of lattice QCD. Furthermore, he is currently working on a research project on quantum verification which is funded and supported by the EPSRC Robust and Reliable Quantum Computing Grant. He is also one of the founders and organisers of the Cambridge-Warwick Quantum Computing Colloquium, a platform for internationally distinguished researchers in the field of theoretical quantum computing. Moreover, he previously served as an external advisor at the Hitachi Cambridge Laboratory advisory committee.

In addition to his academic pursuits, Dr Strelchuk has been involved in various public engagement activities. He was a guest speaker at a public quantum evening event in Dublin, Ireland, and co-led the "Cambridge Mathematics - Unveiling Mysteries of the Quantum World," a virtual alumni event that explored new developments at the intersection of applied mathematics and quantum physics. Further, he was one of the organisers of the Cambridge Philosophical Society's meeting on quantum technologies and a panel speaker of the PISA Strategic Visioning Panel at the Royal Society of Chemistry.

Throughout his career, Dr Strelchuk has co-authored and published numerous papers and preprints on the topics of quantum computing and quantum information in prestigious technology journals and well-known science blogs.

As a mentor, He is passionate about sharing his knowledge and expertise with others. He has supervised several PhD students and undergraduate mathematics courses, and has also taught Masters level Quantum Information Theory and Quantum Computation at the University of Cambridge. He also has served as an essay supervisor in quantum computation and quantum complexity theory.

QUANTUM COMPUTATION:

ALGORITHMS, INFORMATION, AND CRYPTOGRAPHY

Suitable for students interested in:

COMPUTER SCIENCE & MATHEMATICS
Algorithms | Artificial intelligence | Machine Learning

QUANTUM COMPUTATION
Qubits | Quantum Gates | Quantum Cryptography

QUANTUM INFORMATION
Quantum Mechanics | Quantum States | Quantum Algorithms

Quantum processes can provide extraordinary benefits for communication and security, offering striking novel features beyond the possibilities of classical computation. These include remarkable new kinds of algorithms (so-called quantum algorithms) providing an exponentially faster method for some computational tasks, new modes of communication such as quantum teleportation, and the possibility of unconditionally secure communication in quantum cryptography. Most of these exciting developments have occurred in just the past few decades and they underpin transformative applications for quantum technologies that are currently being developed.

This research course will provide an introduction to these topics. We will begin by expounding the principles of quantum mechanics in our setting (and Dirac notation) and then immediately make connections to information (quantum states viewed as information carriers, quantum teleportation) and computation (notion of qubits and quantum gates). At the same time, we will discuss quantum cryptography (quantum key distribution), and quantum computing, culminating in an exposition of principal quantum algorithms, such as the Deutsch-Jozsa algorithm.

To cultivate a robust understanding of quantum computing and its various applications, students are expected to undertake a research project as part of the course requirements. This independent research project provides students with an opportunity to delve deeper into a specific area of quantum computing that aligns with their interests and expertise. While no previous knowledge of quantum physics is required for this course, a relatively strong background in mathematics or physics would be beneficial.
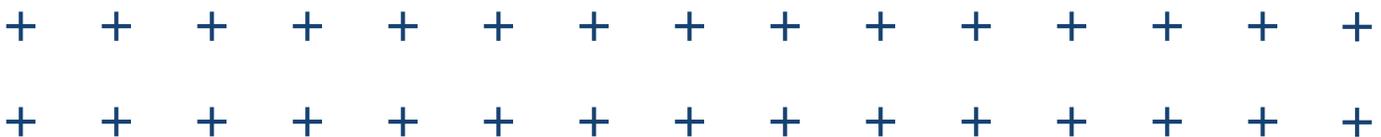
DR TIAN ZHAO

CURRENT POSITION

Postdoctoral Research Associate, The Haw Yang Lab, Department of Chemistry, Princeton University

PREVIOUS APPOINTMENTS

Research Assistant, Department of Chemistry, Pennsylvania State University
Research Assistant, Chemistry Institute of the Chinese Academy of Sciences
Research Assistant, AVIC Beijing Aeronautical Manufacturing Technology Research Institute

A highly-experienced researcher working at the crossroads of physical and applied chemistry.

As a researcher, Dr Zhao's primary focus is on developing a groundbreaking 3D multi-resolution system aimed at unravelling the physical and chemical behaviours of single units within complex systems. This cutting-edge technology will enable a deeper understanding of the intricate interactions and dynamics at the microscopic level, providing valuable insights into the fundamental principles governing complex systems. With his research, Dr Zhao aims to push the boundaries of current research, enabling scientists to study individual units within complex systems with unprecedented precision. This innovative approach has the potential to revolutionise various fields, including materials science, biology, and nanotechnology, by shedding light on previously hidden phenomena and driving advancements in the development of new materials and technologies.

His expertise is in physical and applied chemistry and has published extensively on this topic in high-impact scientific journals including *Nano Letters, Scientific Reports,* and the *Journal of Chemical Physics.* His most recent works delve into Quantum Dots, 3D Microscopy, and 3D single-particle tracking. Dr Zhao has also been invited to present his research at prestigious conferences such as the *Biophysical Society Annual Meeting, American Physics Society Meeting, and the American Chemistry Society Meeting.* Furthermore, Dr He currently holds two patents for "Graphene Hybrids for Biological and Chemical Sensing" and "Method to Electrodeposit Iridium in Water Solution."

As a mentor, Dr Zhao has supervised undergraduate and graduate students in their research projects.

DR TIAN ZHAO, PRINCETON UNIVERSITY

QUANTUM CHEMISTRY IN LIGHT MATTER INTERACTIONS

**Suitable for students interested in:**

CHEMISTRY
Light-Matter Interaction | Photoluminescence | Dynamical Chemistry

PHYSICS
Quantum Physics | Classical Physics

Light, beyond being essential to our daily lives, serves as a remarkable tool enabling exploration into the realms of science. Its wave-particle duality allows us to detect and study sub-microsecond processes, leading to groundbreaking discoveries of intriguing phenomena. This course delves into classic light-matter interactions from the aspects of physical chemistry, such as photoluminescence, wherein exciting target materials, like fluorescence proteins, unveils their optical properties, such as spectral and temporal information. These light-sensitive proteins can act as probes to detect local environment variations using their unique spectroscopic and microscopic information, presenting invaluable applications within cellular studies and beyond.

This research course focuses on classic light-matter interactions, delving into the realm of physical chemistry, with a special emphasis on photoluminescence. **Throughout the course, students will grasp the fundamental principles of light-matter interactions, including basic quantum mechanics to extend their understanding from classical to quantum physics.** To deepen students' comprehension and appreciation of light-matter interactions, students will have the opportunity to engage in numerical simulations, exploring and simulating representative scenarios that mirror real-world interactions. Through hands-on experimentation, they will cultivate a deeper understanding of the dynamic processes that govern the interplay of light and matter. Finally, the course concludes with the introduction of optical microscopy, providing a practical application that integrates the knowledge acquired throughout the journey. This application allows students to witness the magic of using light as a powerful tool in scientific investigation, inspiring curiosity-driven pursuit of knowledge.

UNIVERSITY OF CAMBRIDGE
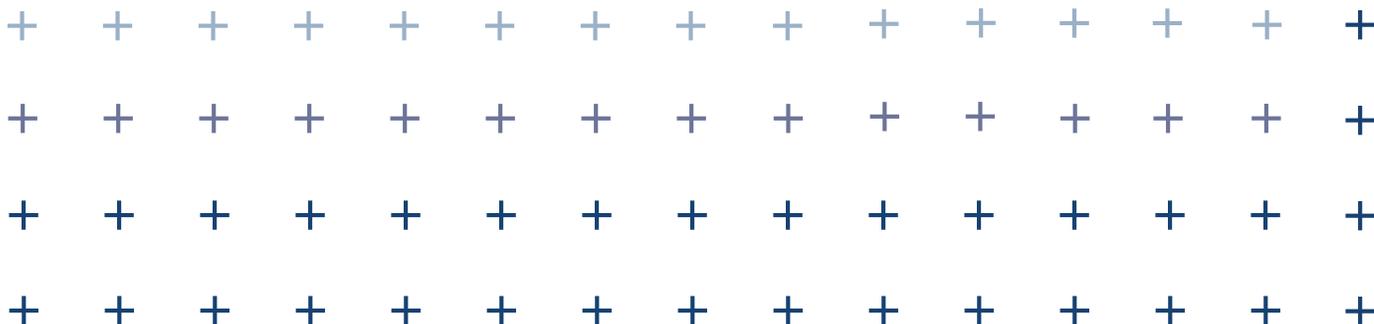
DR DAMIÁN PITALÚA-GARCÍA

CURRENT POSITION

Research Associate, Centre for Quantum Information and Foundations, Department of Applied Mathematics and Theoretical Physics, University of Cambridge

PREVIOUS APPOINTMENTS

Postdoctoral Researcher, Institut de Recherche en Informatique Fondamentale, Université Paris Diderot

Postdoctoral Researcher, Laboratoire d'Information Quantique, Université libre de Bruxelles

A rising-star scientist specialising in the field of quantum physics, quantum information and quantum computing.

As a researcher, Dr Pitalúa-García is interested in quantum information, quantum cryptography, quantum foundations and relationships between spacetime and quantum theory. As a member of the University of Cambridge's Centre for Quantum Information and Foundations, he collaborates with other quantum scientists in developing quantum communications and quantum cryptography technologies. He holds a US patent for the method and system for spacetime-constrained oblivious transfer, and is recently pending for an additional two US and UK patents. Moreover, his current research with the University of Cambridge is being generously funded by the UK Quantum Communications Hub.

Dr Pitalúa-García's research is widely published and presented in leading scientific journals and conferences. Due to his extensive experience in his fields of expertise, he is often invited as a guest speaker in international workshops and seminars, the most recent being the Single Photon Workshop in South Korea, the Next Generation Quantum Protocols Workshop, and QCRYPT 2022 held in Taiwan. Moreover, he was a peer-reviewer for *Physical Review Letters, Science Advances, the International Journal for Quantum Information*, scientific projects for the Mexican National Council for Science and Technology (CONACYT), *Quantum and Revista Mexicana de Física, Quantum Information Processing 2019, Nature Communications,* and *Quantum Information and Computation.*

As a mentor, Dr Pitalúa-García supervises masters and PhD students in their research on quantum cryptography, quantum information, quantum foundations, and gravity.

DR DAMIÁN PITALÚA-GARCÍA, UNIVERSITY OF CAMBRIDGE

QUANTUM PHYSICS:

INFORMATION, FOUNDATIONS AND GRAVITY

Suitable for students interested in:

PHYSICS

Quantum Evolution | Quantum State | Massive Systems

QUANTUM COMPUTING

Quantum Cryptography | Quantum Technologies | Quantum Internet

Quantum physics is confirmed with overwhelming experimental evidence at the microscopic scales (e.g. at the atomic scale), producing many technological applications. However, there remains unanswered questions for future discovery.

There are two known types of quantum evolution: the deterministic unitary evolution (e.g. the Schrödinger equation), and the probabilistic collapse of the quantum state upon a quantum measurement. It is unknown when during a quantum measurement the unitary evolution stops, and the collapse takes place: if quantum theory (QT) is universal, then a quantum measurement device should also be described by QT and should therefore be subject to unitary evolution itself. This is the quantum measurement problem. Some proposed solutions are that the quantum state never collapses, as in the many-worlds QT; or that the laws of QT must be changed, as in collapse models.

Einstein's theory of general relativity (GR), which describes gravity and spacetime, has been confirmed with overwhelming experimental evidence at the macroscopic scales (e.g. at Earth scales and beyond). However, it is in strict conflict with quantum physics. This is because GR assumes that massive systems have well defined locations; while, according to QT, the locations of massive systems can be in undefined locations, as described by quantum superpositions. Thus, to deal with the quantum superpositions of massive systems, GR must be modified. Due to lack of experimental evidence at the interface of GR and QT, very little is known about how to do this. In particular, it is unknown whether a fundamental theory of gravity has any quantum features. Recently, experiments have been proposed to test whether gravity has quantum features, which are believed to be implementable in the near future.

This research course will address the foundational issues of quantum physics as it relates to quantum measurement and general relativity. Its objective is to stimulate students' interest in this field of study. By conducting a research project or writing a review paper on quantum physics, students are expected to gain a solid understanding of the subject matter and current debates in the research fields. While no previous knowledge of quantum physics or general relativity is required for this course, a relatively strong background in mathematics or physics is beneficial.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DR DANIEL MUTHUKRISHNA

CURRENT POSITION

Postdoctoral Researcher, Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology

An astrophysicist using deep learning and Bayesian modelling to develop data-driven astrophysics.

As a researcher, Dr Muthukrishna is a computational astrophysicist applying deep learning and statistical methods to model and better understand astrophysical time-series data. His experience as an expert developer led him to develop a real-time anomaly detection framework for identifying unusual and interesting astronomical time-series data using Bayesian models and temporal convolutional neural networks. He also developed a real-time photometric identification algorithm for classifying astronomical time-series in large-scale telescope surveys using recurrent neural networks. Dr Muthukrishna has also published a novel spectroscopic classification tool for supernovae using CNNs.

He was invited to be a speaker in various conferences such as *Korea Astronomy and Space Science Institute (Cosmology Seminar Series, ESO Garching* in Germany (SciOps 2022: Artificial Intelligence for Science in Astronomy), *Dark Energy Science Collaboration* (Machine Learning Topical Team), *Telstra Telecommunications Company* (AI ML forum), among others. He has received numerous awards for his research projects, the latest being the Paul Murdin Prize for Best Published Journal Paper given by the University of Cambridge in 2021.

As a mentor, he has supervised undergraduate and PhD students during his time as a course organiser and lecturer in the University of Cambridge, where he taught big-data analysis, Markov Chain Monte Carlo sampling, and machine learning.

DR DANIEL MUTHUKRISHNA, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DATA-DRIVEN ASTRONOMY:

MACHINE LEARNING AND STATISTICS FOR MODERN ASTRONOMY

Suitable for students interested in:

ASTROPHYSICS
Cosmology | Astronomy | Astronomical Object Detection

MATHEMATICS
Statistics | Applied Mathematics

COMPUTER SCIENCE
Data Analysis | Computational Modelling

Astronomy is entering an unprecedented era of big data, as new facilities are observing more phenomena than humans can possibly visually examine. Modern telescopes are recording millions of astronomical objects and producing terabytes of data every night. Dealing with this deluge of data requires machine learning and statistical methods to classify, model, and characterise the data influx.

In this research course, students will learn cutting-edge machine-learning methods and apply them to real datasets of supernovae, exoplanets, and other astronomical transient objects. The course will introduce students to exoplanet detection methods, transients, variable stars, and the basics of supernovae and their importance for cosmology. They will learn about these astronomical objects and how machine learning and statistics can be used for discovery, modelling, and furthering our understanding of the universe.

The first half of the research course will help students develop knowledge of astronomy and of machine learning principles. The second half will develop their skills in Python programming and help them apply machine learning and statistics to astrophysics datasets. Students will gain a new appreciation for how machine learning and statistics can be applied to answering some of the most fundamental questions about our universe.
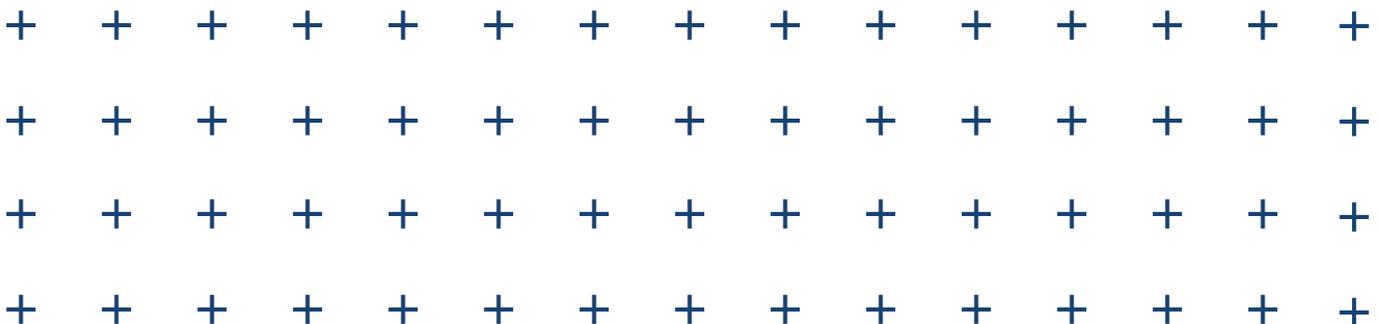
DR ALEXANDER MUSHTUKOV

CURRENT POSITIONS

Stephen Hawking Fellow, Department of Physics, University of Oxford

NWO Veni Fellow, Leiden Observatory

PREVIOUS APPOINTMENT

Researcher, University of Amsterdam

An astrophysicist exploring high density objects such as black holes, neutro stars, and supernovas.

As a researcher, Dr Alexander Mushtukov is a Stephen Hawking fellow at the University of Oxford, working on high energy astrophysics. His research focuses on accretion processes onto compact objects, predominantly neutron stars, but also includes black holes and white dwarfs. He specializes in radiation hydrodynamics, radiative transfer theory, Quantum Electrodynamics (QED) under extreme field conditions, plasma physics, and computational astrophysics. Currently, his focus is on the study of extreme accretion onto strongly magnetized neutron stars, and he is part of the leading theoretical group contributing to research on accretion onto magnetized neutron stars for the NASA space mission IXPE (the Imaging X-ray Polarimetry Explorer). He has made important contributions to his field and has published more than 65 papers in top journals with a total of 2130 citations.

As a mentor, Dr Mushtukov has taught courses and mentored graduates and undergraduates on subjects ranging from relativistic astrophysics, computational astrophysics, to time series analysis in astrophysics at the University of Oxford, Leiden University, Saint Petersburg State University, the University of Amsterdam and the University
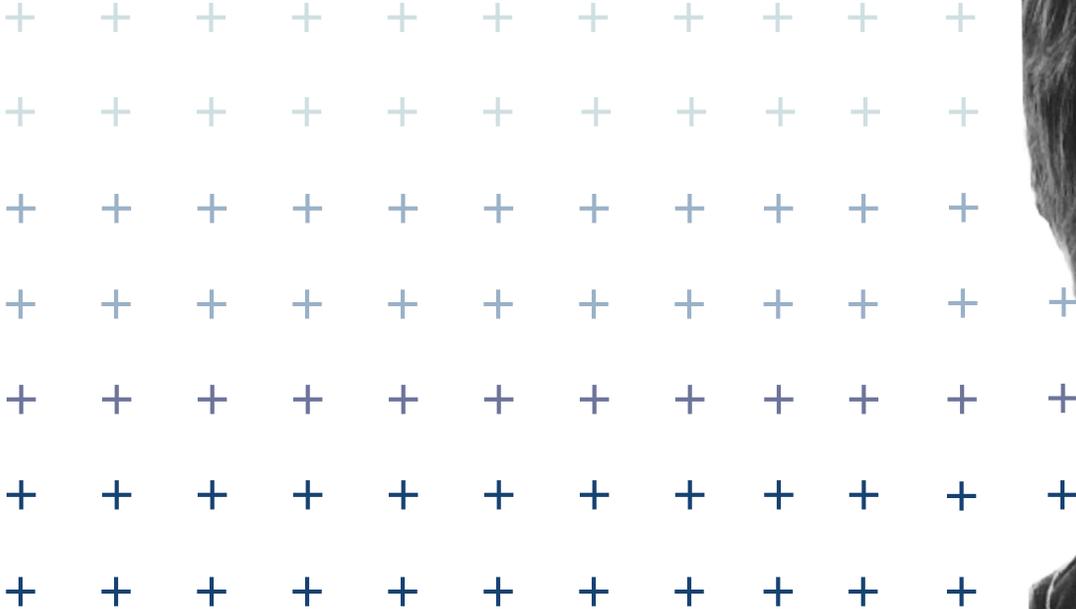
DR ALEXANDER MUSHTUKOV, UNIVERSITY OF OXFORD

ASTROPHYSICS OF BLACK HOLES, WHITE DWARF, AND NEUTRON STARS

Suitable for students interested in:

PHYSICS
Cosmology | Astrophysics | High Energy Physics

MATHEMATICS
Applied Mathematics | Pure Mathematics

White dwarfs, neutron stars and black holes are compact objects forming at the final stages of the evolution of massive stars. The basic features of compact objects are strongly affected by the fundamentals of general relativity and quantum physics. These objects contain the strongest gravitational, electric and magnetic fields in the universe. They are places of extreme density and temperature, which by no means can be achieved in terrestrial labs. As such, they serve as unique laboratories to study fundamental physics under extreme conditions. Although the physics of white dwarfs are well understood up to date, there remain many unanswered questions in the physics and astrophysics of neutron stars and black holes.

In this research course, we will learn the nature of compact objects and better understand their place in the history of the universe. We will start with aspects of fundamental physics in the base phenomenon of compact objects. Next, we will discuss theoretical models and examine recent observational results. We will investigate what happens to isolated compact objects and how they behave in binary systems. We will discuss recent progress in the detection of gravitational waves. Finally, we will examine current issues in the scientific community and brainstorm further steps in the investigation of black holes, neutron stars, and white dwarfs to better understand fundamental physics.

DR ALEXANDER MUSHTUKOV, UNIVERSITY OF OXFORD

PHYSICS AND THE EVOLUTION OF ISOLATED AND BINARY STARS

Suitable for students interested in:

PHYSICS

Cosmology | Thermodynamics | High Energy Physics | Classical Mechanics | Nuclear Physics

MATHEMATICS

Applied Mathematics | Pure Mathematics | Data Analysis

Stars, the luminous objects that inspired the name of astronomy, are fundamental to our understanding of the universe. They constitute the majority of a galaxy's luminous mass, drive the production of electromagnetic energy, and play a key role in determining the chemical composition of the modern cosmos. This course explores the structure and evolution of stars, both as isolated objects and in binary systems. Students will examine the diversity of stellar life cycles and uncover how factors like mass, composition, and environment shape a star's journey. To fully understand stars, we will draw upon essential principles of physics, including classical and quantum mechanics, thermodynamics, electromagnetism, nuclear physics, and elements of relativity.

The course delves into stellar formation, life, and death, culminating in the creation of compact objects such as white dwarfs, neutron stars, and black holes. We will also explore unique processes in binary star evolution, including mass transfer, common envelopes where giant, star-like structures host both a stellar core and a black hole, nova phenomena driven by nuclear explosions in stellar atmospheres, supernova explosions involving white dwarfs, and the formation of X-ray binaries and gravitational wave sources.

While the focus of the course is theoretical, students will learn through engaging discussions, problem-solving exercises, and interactive activities. Recent breakthroughs and cutting-edge research in stellar astrophysics will also be highlighted, ensuring students remain connected to the latest developments in the field.

By the end of the course, students will have gained a profound understanding of the principles governing stellar evolution and the impact of stars on the universe's chemical makeup. Participants will be well-prepared to embark on further study or independent research in astrophysics.

UNIVERSITY OF OXFORD

DR TARIQ YASIN

CURRENT POSITION

Postdoctoral Researcher, Beecroft Institute for Particle Astrophysics and Cosmology,

University of Oxford

An astrophysicist whose cutting-edge research in galaxy dynamics and dark matter, combined with his expertise in Bayesian statistics and machine learning, is transforming our understanding of the universe.

As a researcher, Dr Yasin specialises in the field of galaxy dynamics and phenomenology, with a focus on understanding dark matter, the empirical and statistical constraints on the galaxy-halo connection, weak lensing, and cosmological simulations. His work is distinguished by the application of Bayesian statistics and machine learning techniques, which he uses to tackle complex problems in astrophysics and enhance our knowledge of the universe.

In addition to his research, Dr Yasin contributes to the academic community as a journal referee for the *Monthly Notices of the Royal Astronomical Society*, where he plays a key role in evaluating and ensuring the quality of significant astronomical research. His expertise and innovative approaches have earned him the opportunity to present his findings at a number of prestigious institutions, including Yale, the Flatiron Institute, Carnegie Mellon, and Columbia University, among others.

Through his rigorous research and active engagement in the scientific community, Dr Yasin continues to push the boundaries of our understanding of galaxy dynamics and related phenomena, making significant contributions to both theoretical and empirical astrophysics.

As a mentor, Dr Yasin supervises PhD and MSc students at Oxford, providing them with guidance and support throughout their dissertation research. His expertise in galaxy dynamics and phenomenology enriches the academic experience, fostering a rigorous and stimulating environment for his students

DR TARIQ YASIN, UNIVERSITY OF OXFORD

UNVEILING THE SECRETS OF DARK MATTER WITH MACHINE LEARNING

Suitable for students interested in:

ASTROPHYSICS
Galaxy Dynamics | Gravity | Modelling

COSMOLOGY
Multivariable Calculus | Linear Algebra

MACHINE LEARNING
Deep Learning | Precision Mapping

In this course, students will learn how to use machine learning techniques to uncover one of the most profound mysteries of our universe: the nature of **dark matter**—the invisible substance that constitutes approximately 85% of all matter in existence. Despite its elusive nature, dark matter leaves its fingerprints across the cosmos through its gravitational influence, bending light from distant galaxies and shaping the motion of stars and gas. Using state-of-the-art **machine learning** techniques, this research course focuses on building detailed maps of dark matter and thereby refining our understanding of the cosmos.

Discover the Frontiers of Cosmology

The course begins with the **Standard Model of Cosmology**, a framework grounded in Einstein's relativity theory and influenced by quantum mechanics and the Big Bang theory. Students will explore the interplay of dark matter and dark energy in shaping the universe whilst exploring the unresolved tensions and mysteries that drive modern cosmological research. This foundation sets the stage for key questions: What is dark matter and how can we uncover its properties?

Model Galaxies and Simulate the Universe

Students will then investigate **galaxy dynamics**, using the motion of stars and gas—some orbiting at hundreds of kilometers per second—to model the invisible dark matter halos around galaxies. Through hands-on programming, students will solve the equations governing these motions and run simulations, exploring how dark matter shapes the universe.

Master Bayesian Inference and Statistics

In the next phase, students will embrace the power of **Bayesian inference**, a statistical approach that underpins the analysis of modern astrophysical data. Using this method, they'll extract precise constraints on dark matter distributions from observational data. Students will also test competing theories, such as exotic particle models or alternative gravity frameworks, applying rigorous statistical techniques to evaluate their viability.

Harness Machine Learning Techniques for Dark Matter Research

Finally we will explore how machine learning is transforming astrophysics. Students will learn to apply sophisticated machine learning architectures such as neural networks to map the complex relationships between luminous matter and dark matter. By training algorithms to detect hidden patterns in galaxy data, students will construct precision maps of dark matter distributions and extend what telescopes like the **James Webb Space Telescope** can reveal. Students will gain hands-on experience with the most advanced tools in artificial intelligence, providing new ways to explore the cosmos.

Prepare for Future Opportunities

By the end of this course, students will not only have a deep understanding of the mysteries of dark matter but also have practical experience with **machine learning** and **data science** techniques. This fusion of cosmological knowledge and computational expertise opens pathways to academic research and careers in fields such as artificial intelligence, astrophysics, mathematics, and more.

UNIVERSITY OF TORONTO

DR BART RIPPERDA

CURRENT POSITION

Assistant Professor, Canadian Institute for Theoretical Astrophysics, University of Toronto

PREVIOUS APPOINTMENTS

Postdoctoral Fellow, Department of Astrophysical Sciences, Princeton University

Postdoctoral Fellow, Center for Computational Astrophysics, Flatiron Institute

A leading theoretical astrophysicist advancing research in black hole and neutron stars.

As a researcher, Dr Ripperda is interested in theoretical and computational astrophysics and fundamental plasma physics with applications in black holes and neutron stars. He is a developer of both the general relativistic magnetohydrodynamics code BHAC (Black Hole Accretion Code) and its Newtonian basis MPI-AMRVAC. Previously, he received the 2020 Breakthrough Prize in Fundamental Physics, the 2020 Einstein Medal, and a research award from the 2020 European Physical Society Plasma Physics Division in recognition of his outstanding research achievements. He was invited to talk at various prestigious conferences at the MPA seminar, Max Planck Institute for Astrophysics, NASA Hubble Fellowship Program Fellows Symposium, the 48th EPS Plasma Physics conference, etc. His research papers have been published in *PRL, Astrophysical Journal Letters, Journal of Plasma Physics*, and many more.

As a mentor, Dr Ripperda brings extensive research experience and a collaborative approach to guiding students in exploring complex astrophysical phenomena.
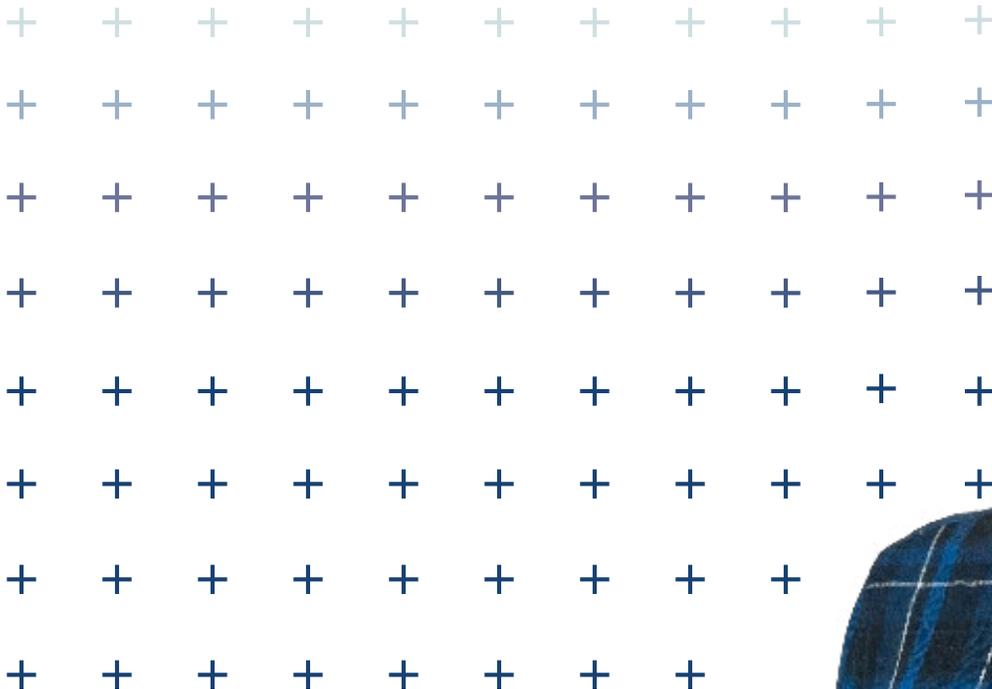
THE ASTROPHYSICS OF HIGH DENSITY OBJECTS:

PLASMA PHYSICS, GENERAL RELATIVITY, AND QUANTUM ELECTRODYNAMICS

Suitable for students interested in:

PHYSICS

Quantum Physics | Astrophysics | High Energy Physics

MATHEMATICS

Applied Mathematics | Pure Mathematics

The last decade saw remarkable discoveries related to black holes: Event horizon-scale observations of plasma flows near black holes like in our own galaxy (Sgr A*) and in M87 by the GRAVITY and the Event Horizon Telescope missions, and electromagnetic counterparts to gravitational waves from merging neutron stars and black holes.

The plasma dynamics that produce these emission signatures are still poorly understood. The mean free path to collisions for electrons is typically larger than the system size, rendering the plasma collisionless such that its description requires a fully kinetic many-body treatment.

Furthermore, the energetic plasma engages strongly with radiation fields; the quantum electrodynamic interaction of photons with each other and with strong magnetic fields may lead to the creation of electron-positron pairs. Finally, because of strong gravity, general relativity is a necessary part of the equation, altogether creating a multidimensional, nonlinear, many-body problem.

In this research course, we will study the required theory (plasma physics, general relativity, quantum electrodynamics) necessary to understand how black holes and neutron stars shine and how we can use their observed emission to understand the nature of strong gravity.
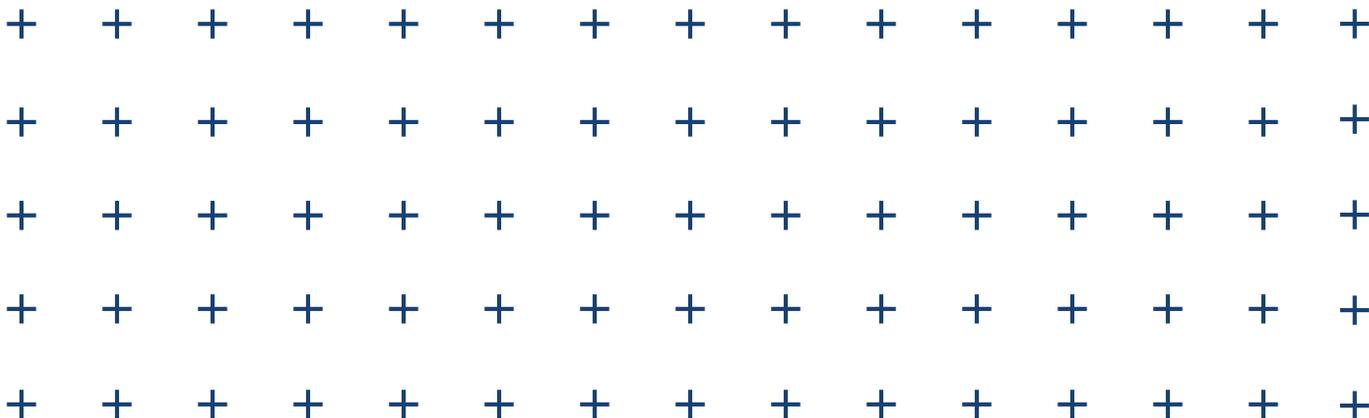
DR DANIELE CASSESE

CURRENT POSITIONS

Lecturer (Economics), Emmanuel College, University of Cambridge

Mead Research Fellow (Economics), Emmanuel College, University of Cambridge

Director of Studies in Economics, Emmanuel College, University of Cambridge

An economist and mathematician specialising in game theory, mathematical modelling and dynamic processes on networks.

As a researcher, Dr Cassese focuses on the study of complexity and networks. He is particularly interested in understanding how connectivity influences dynamic processes such as trade, epidemic spreading, and natural selection. He uses topological data analysis to further explore these topics.

Dr Cassese is currently working on models of dynamics on higher-order structures, which are networks where interactions are not just between a couple of agents, but also groups of several dimensions. Moreover, he is exploring inequality from a network perspective, both in terms of mathematical models and data analysis using persistent homology. He has published and presented his works at *The Rimini Centre for Economic Analysis, Applied Network Science, European Journal of Physics, 7th Spain–Italy–Netherlands Meeting on Game Theory,* among others.

As a mentor, he has supervised and guided undergraduate students at the University of Cambridge.

DR DANIELE CASSESE, UNIVERSITY OF CAMBRIDGE

COMPUTATIONAL ECONOMICS AND SOCIAL SCIENCE:

NETWORKS AND MODELING OF THE REAL WORLD

Suitable for students interested in:

ECONOMICS
Behavioral Economics | Finance | Trading

SOCIAL SCIENCE
Social Simulation | Cultural Evolution | Social Phenomena

COMPUTER SCIENCE
Data Analysis | Modelling | Game Theory | Network Dynamics

The real world is complex and often chaotic. If we imagine the architecture of financial systems or the trade between firms and across countries as a network, then within this network, we will find that there are often thousands of decisions, some of which will have far-reaching consequences to the real world. The questions we should ask are – how do all the events within the network interact and influence one another, and how can we represent, describe, or predict the events?

This research programme will introduce the concepts of the science of networks, focusing particularly on the effects of dynamics on networks, such as how information (or value, cultural trait, or an economic decision) diffuses across a network and how the network structure affects this diffusion. The course will emphasise a computational approach to social and economic network applications. Students will learn how to use Python to set and simulate network models; they will become familiar with the most recent research and techniques in network science and will develop excellent research skills.

The aim of the course is to show that networks are all around us. Students will learn how to think structurally in terms of network about different social phenomena and to realise how networks make a fundamental difference to our understanding of complexity. At the end of the course, students will have the ability to develop their own network models and analyse them computationally.
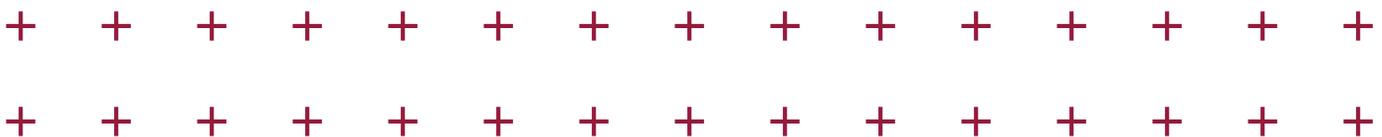
DR NOAH BACINE

CURRENT POSITION

Lab Director, Center for Experimental Social Sciences, Nuffield College, University of Oxford

PREVIOUS APPOINTMENT

Postdoctoral Research Officer, Center for Experimental Social Sciences, Nuffield College, University of Oxford

An economist exploring the complexities of human decision-making in the market.

As a researcher, Dr Bacine's research expertise is in the fields of public, experimental, and behavioural economics. He investigates the role of identity in shaping economic behaviours and outcomes across different social groups as well as understanding the complexities of human decision-making. His work at CESS allowed him to delve into various facets of identity, trust, and social norms to unravel in-group bias and its implications on economic disparities. Furthermore, Dr Bacine has collaborated with esteemed researchers on groundbreaking papers like "Trust and Betrayal: An Investigation into the Influence of Identity'' and "Disrupting Gender Norms with Incentives." His work has been presented at research conferences worldwide, including the *Economic Science Association World Meetings* and the *IAST-OXPO Conference*. He is currently working on three academic papers discussing oppression, punishment, and the political economy of inequality and crime.

As a mentor, Dr Bacine has been an Instructor for courses on Experimental Economics and Principles of Microeconomics. In recognition of his excellence in teaching, He has received the Murray and Celeste Fasken Distinguished Graduate Student Teaching Award and the Award for Excellence in Teaching from Texas A&M University.

DR NOAH BACINE, UNIVERSITY OF OXFORD

BEHAVIOURAL AND EXPERIMENTAL ECONOMICS:

Suitable for students interested in:

ECONOMICS
Consumer Behaviour | Decision-Making | Game Theory

PSYCHOLOGY
Rationality | Social Psychology

This research course explores the core concepts of behavioural economics, which assist economists in understanding seemingly irrational behaviour. Why do people purchase gym memberships if they never go to the gym? Why don't people save enough for retirement? Why do they make different meal decisions when dessert is placed at the beginning versus the end of a buffet? Why do some give to charity while others are willing to spend money to make others worse off?

In this research course, students will learn how economic experiments are used to study decision making and to measure individual preferences. We will begin our journey by discussing the various ways economists use data to model and understand the world around us. Standard approaches using observational data will be contrasted with the world of experiments to highlight the benefits of using a variety of different approaches to studying the world around us.

Combining insights from economics, psychology and philosophy, this research course teaches students how experiments have advanced economic theory to better reflect the world we live in. Departing from standard theory which assumes humans are coldly rational and always make decisions that offer the greatest personal benefit, students will learn how experiments have shown us that behaviour consistently differs in predictable ways.

Students will learn how insights generated by experimental and behavioural economics have led to both great benefit and harm. Examples of ways in which governments, charities, and NGOs have helped people make better decisions for themselves and those around them will be contrasted with unfortunate examples in which some have used the same insights to take advantage of people for personal gain. As students develop their understanding of the common biases we all exhibit, they will be encouraged to apply the lessons they've learned to their own experiences. At the end of course, students will be asked to write a research paper which proposes an experiment which answers a behavioural economics research question of interest to them.
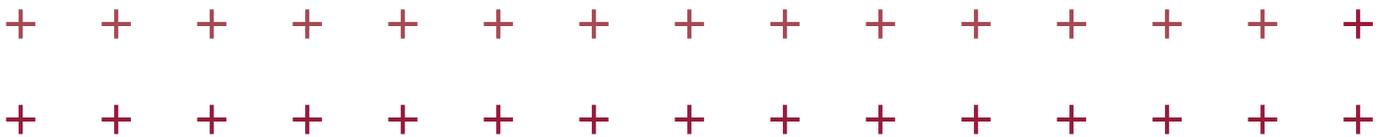
DR ZARLASHT RAZEQ

CURRENT POSITION

Postdoctoral Research Fellow, Center for International Security and Cooperation, Stanford University

PREVIOUS APPOINTMENTS

Research Fellow, Warwick Business School, University of Warwick

Research Consultant, Division on Investment and Enterprise (DIAE), United Nations Conference on Trade and Development (UNCTAD)

A scholar in international political economy, specializing in global value chains, trade, foreign direct investment, and their intersection with climate change.

As a researcher, Dr Razeq's expertise is in the international political economy (IPE) of trade and global value chains (GVCs), with a particular focus on firms and development. Her research integrates the study of trade institutions and policy with the dynamics of global production and supply chains. She has examined the impact of trade agreements on countries' and firms' integration into GVCs and is currently expanding on her dissertation work, exploring topics like multinational corporations' (MNCs) supply chain networks, foreign direct investment (FDI), and the relationship between FDI and climate change. Dr Razeq's research also investigates the role of international trade institutions in strengthening supply chain resilience.

In 2022, Dr Razeq received the UNCTAD & the Academy of International Business Award for Best Research on Investment and Development. She has published extensively in leading journals, including Transnational Corporations and the Canadian Journal of Political Science, and authored a book with New York Palgrave and Macmillan titled UNDP's Engagement with the Private Sector. Her work continues to push the boundaries of understanding in the IPE of trade, GVCs, and FDI, addressing crucial global challenges like climate change and the resilience of global supply chains.

As a mentor, Dr Razeq has taught courses on Quantitative Methods for Development and International Politics of Economic Relations, and has contributed to courses on international business and economic relations. Known for her engaging teaching style, Dr Razeq encourages students to think critically and apply their learning to real-world challenges.
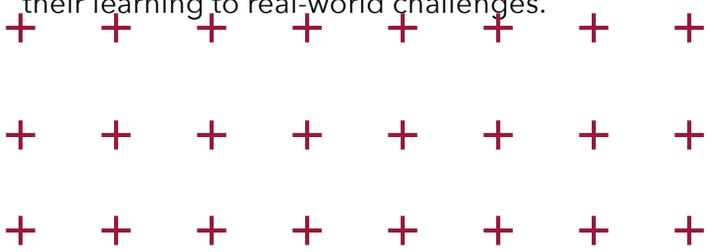
INTERNATIONAL POLITICAL ECONOMY RELATIONS

HOW DO INTERNATIONAL ECONOMIC ACTIVITIES SHAPE POLITICS?

Suitable for students interested in:

INTERNATIONAL POLITICAL ECONOMY
International Relations | Global Institutions | History | Contemporary Issues

TRADE AND FINANCE
Trade Theory and Policy | Investments | Firms and Supply Chains

This research course delves into the dynamic field of International Political Economy (IPE), exploring the complex ways in which international economic activities shape political relationships among states. It provides students with analytical frameworks needed to explore how trade, finance, and global production networks intersect with political power and decision-making. Through a combination of readings, lectures, discussions, and assignments, students will gain a deeper understanding of core IPE concepts, including international trade and finance, investments, firms, supply chains, and the role of global institutions.

The research course examines both historical and contemporary events in international trade and finance, focusing on how these developments have shaped economic and political landscapes. Students will analyze key issues such as the evolution of trade theory, policy shifts, and the impact of globalization on economic development.

Additionally, the course addresses contemporary challenges, including trade wars, the rise of regional economic blocs, and the role of multilateral organizations in fostering international cooperation and prosperity.

Special emphasis is placed on the relationship between trade and economic development, enabling students to critically assess how economic policies influence global inequality and political stability. By the end of the course, students will be prepared to independently research and write an in-depth research paper on a significant IPE topic, with guidance from the professor.
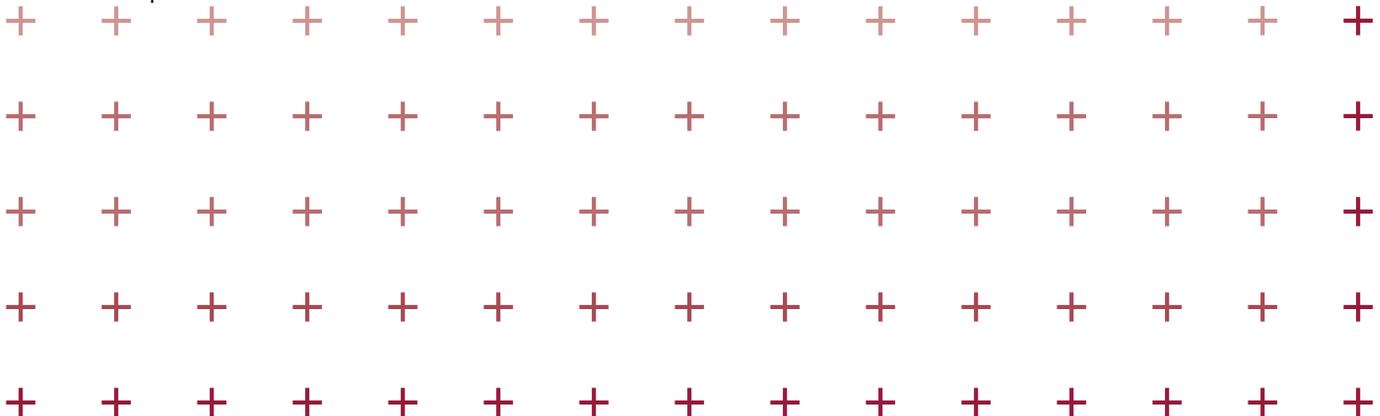
UNIVERSITY OF OXFORD
DR CORNELIU BOLBOCEAN

CURRENT POSITIONS

Senior Researcher in Health Economics, Nuffield Department of Primary Care Sciences, University of Oxford

Faculty Associate, Canadian Centre for Health Economics

PREVIOUS POSITIONS

Research Fellow, The Centre of Addiction and Mental Health

Lead Health Economist, EPGEN Study, British Columbia Children's Hospital

Visiting Scientist, Centre for Applied Neurogenetics, University of British Columbia

Clinical Assistant Professor of Economics, Baylor University

National Consultant, World Bank / UNICEF

Research Assistant, British Columbia Cancer Research Centre

An applied economist committed to improving public health outcomes through rigorous research and evidence-based interventions.

As a researcher, Dr Bolbocean has a strong research background in public policy interventions and their impact on early life health outcomes. Throughout his career, he managed a wide range of applied economics and health economic studies, including policy evaluation, applied health economic evaluations, preference elicitation studies, and analyses of cross-sectional, trial, and cohort data using econometric techniques. Due to his expertise in the field of health economics, he is a recipient of numerous research grants, the most recent being a study investigating the economic costs of misscarriage funded by the National Institute for Health and Care Research (NIHR) School for Primary Care Research. Additionally, he recently led a study the impact of the COVID-19 pandemic on health-related quality of life in children with Autism Spectrum Disorders and Intellectual Disability funded by the Phelan-McDermid Syndrome Foundation, RettSyndrome.org, SYNGAP1 Foundation and SynGAP Research Fund.

Dr Bolbocean's work has been widely recognized and published in leading health economics and health services journals, which includes the *International Journal of Health Economics and Management, PharmacoEconomics, Autism Research, and the Journal of Autism and Developmental Disorders*, to name a few. He also authored a chapter on health economics in the book "Adult Lumbar Scoliosis: A Clinical Guide to Diagnosis and Management" published by Springer. Moreover, his research has been presented in numerous prestigious conferences, such as the 100th Health Economists Study Group, the 15th World Congress of the International Health Economics Association, and the International Health Economics Association Congress.

As a mentor, He supervises PhD students at Oxford interested in methodological issues related to health economics research, outcome research, policy evaluation, applied econometrics and machine learning. He is also passionate about public policy and health education for the broader public.

DR CORNELIU BOLBOCEAN, UNIVERSITY OF OXFORD

HOW MUCH DOES MENTAL HEALTH COST? THE ECONOMICS OF ADDICTION AND SUBSTANCE USE

Suitable for students interested in:

ECONOMICS

Health Economics | Public Economics | Experimental Economics

HEALTHCARE

Cost-effectiveness of Healthcare Interventions | Health Informatics

PSYCHOLOGY

Addiction | Substance Use | Mental Health

This research-intensive course serves as an exploration into the relationship between economics, mental health, addiction and substance use, culminating in comprehensive research projects. The course commences by discussing the core issues in mental health, addiction and substance use with a focus on marijuana and opioids.

In this research course, students delve into defining mental health economics, dissecting core issues, and examining the nuanced features of mental health service delivery. We will discuss addiction and substance use through an economic lens, and students will be introduced to cutting-edge theories and models. Emphasis is placed on Becker's theory of rational addiction while critically analysing and extending addiction models. From scrutinising substances like smoking, recreational marijuana, to opioids, students navigate concepts of dynamic selection and multidimensionality to comprehend the multifaceted nature of addictive behaviours and their economic implications.

Students will develop their research skills within health economics, particularly focusing on economic evaluations. With a spotlight on methodologies employed to assess the cost-effectiveness of healthcare interventions, students will engage in rigorous examination and measurement of health outcomes and cost valuation. They will also learn how to apply economic evaluations alongside clinical trials and employ decision-modelling techniques crucial for comprehensive research projects in mental health economics.

A significant component in our course will be the independent research project. Students will be tasked with conceptualising, executing, and presenting an original research project that applies economic theories and models to real-world health issues, such as mental health, addiction, or substance use. Students will be expected to get familiar with data analysis, utilising statistical software and methodologies relevant to health economics. The course will help students to engage with health economists, policy advisors, decision makers as advisors, or research collaborators.

COLUMBIA UNIVERSITY

DR JOHN SALERNO

CURRENT POSITIONS

Postdoctoral Research Scientist, School of Social Work, Columbia University

Research Fellow, Columbia Population Research Center, Columbia University

Adjunct Lecturer, College of Social Work, Columbia University

Adjunct Lecturer, College of Global Public Health, New York University

A scholar with a focus on social work who champions health equity and social justice by addressing systemic barriers impacting marginalized communities.

As a researcher, Dr Salerno focuses on addressing mental health inequities within marginalized Latinx youth communities, including undocumented immigrants, Northern Triangle immigrants, and LGBTQ+ individuals. Through critically oriented and community-engaged research, Dr Salerno counters structural inequities such as racism, xenophobia, heterosexism, and cisgenderism that influence mental health in these groups. Grounded in Intersectionality, Life-Course, and Minority Stress theories, his research has garnered significant recognition and support, including a $120,000 grant from the National Institute of Mental Health. This funding supports his exploration of psychosocial risk and protective factors for mental health among Latinx immigrant adolescents from the Northern Triangle. Recently, he was awarded a seed grant from the Columbia Population Research Center to study the lived experiences of Latinx LGBTQ+ immigrant youth.

Beyond his research, Dr Salerno is a dedicated leader and advocate. He founded the LGBTQ+ Students and Allies in Public Health organization and co-established the University of Maryland's Prevention Research Center Anti-Racism Committee. His advocacy extends to the University Senate Equity, Diversity, and Inclusion Committee. Dr. Salerno's work reflects his unwavering dedication to amplifying the voices and needs of disadvantaged populations, earning him numerous accolades, including the 2024 National Award of Excellence in Research by a New Investigator from the National Hispanic Science Network.

As a mentor, Dr Salerno has guided undergraduate and graduate students at Columbia University and the University of Maryland in research projects addressing social justice and health equity. Many of his mentees have presented their work at conferences and published in esteemed academic journals, further advancing the mission of equity and inclusion in public health.
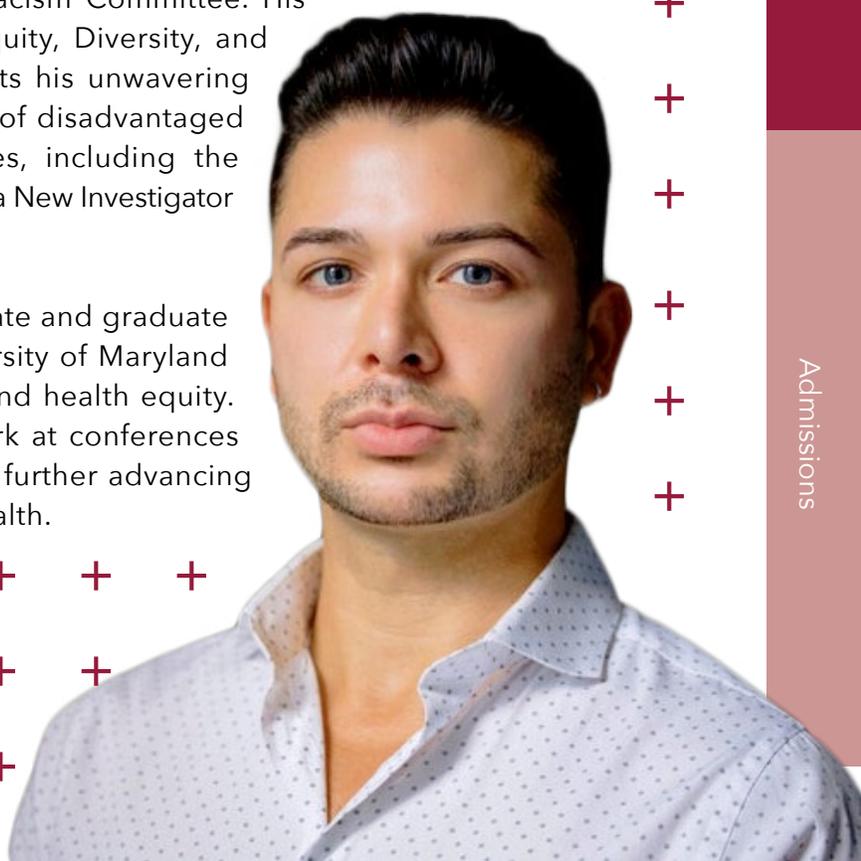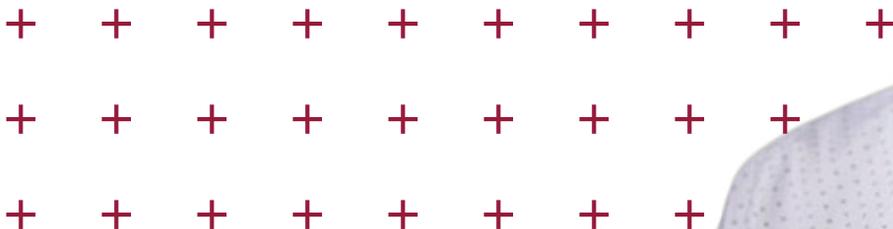
DR JOHN SALERNO, COLUMBIA UNIVERSITY

HEALTHCARE CRISIS IN MARGINALISED POPULATIONS:

EQUITY, POWER, AND INTERSECTIONALITY

Suitable for students interested in:

POPULATION STUDIES

Marginalized Communities | Vulnerable Population | Socioeconomics | Intersectionality

SOCIOLOGY OF HEALTH

Systemic Inequities | Public Health | Health Equity | Social Justice

Certain groups of individuals, including LGBTQ+, Hispanic/Latinx, Black/African American, Native Hawaiian/Pacific Islander, Native American/American Indian, individuals with disabilities, and socioeconomically disadvantaged communities, are at greater risk of experiencing significant health challenges due to systemic inequities. Identified as health disparity populations, these groups face unique challenges rooted in overlapping forms of discrimination and oppression. Addressing these disparities requires a nuanced understanding of how different social factors—such as race, ethnicity, gender identity, sexual orientation, socioeconomic status, and disability—intersect to create complex systems of inequality.

This research course introduces students to Intersectionality and Population Health, two vital frameworks that help us examine and address these challenges. Intersectionality investigates how overlapping identities influence an individual's experiences, while Population Health emphasizes improving health outcomes for entire communities. Students will explore how these frameworks can be applied to promote health equity and counter systemic oppression.

Throughout the research course, students will learn about the foundations of the Intersectionality theoretical framework and its relevance in public health. They will investigate real-world examples that demonstrate how holding multiple marginalized identities can lead to compounded health disparities. Alongside this conceptual grounding, students will also gain hands-on experience with the scientific research process, including conducting literature reviews, crafting research questions, collecting and analyzing data, interpreting results, and disseminating findings. In addition to research, students will engage in practical applications of their learning. Each student will identify an intersectionality vulnerable population to study, design a small-scale research project, and propose a social justice intervention to address health inequities affecting that population. This action-oriented approach will equip students with both analytical and advocacy skills, bridging academic learning with meaningful community impact.

Ideal for students interested in public health, research, social justice, and health equity, this research course empowers students to contribute to the elimination of health disparities. By the end of the research course, students will possess the tools, knowledge, and confidence to drive change and promote health equity within marginalized communities.

COLUMBIA UNIVERSITY

DR CEYHUN ELGIN

CURRENT POSITIONS

Director of Master's Program, Department of Economics, Columbia University

Lecturer in Discipline, Department of Economics, Columbia University

Professor of Economics, Bogazici University

PREVIOUS APPOINTMENTS

Economics Advisor, International Monetary Fund

Economics Advisor, World Bank

An economist utilising applied macroeconomic theory to understand economic growth and political economics in the informal sector.

As a researcher, Dr Elgin is interested in applied macroeconomics, economic growth, and political economics with a particular emphasis on the economics of the informal sector. This academic focus also translates into policy expertise. He was a policy advisor at UNESCO, the IMF, and the World Bank. He has made many contributions to his field. His papers have been published in a wide range of high-impact journals, including *The European Journal on Criminal Policy and Research, Sustainable Development, The Eastern Economic Journal, The Developing Economies, the Bulletin of Economic Research, Macroeconomic Dynamics, and the Journal of Banking and Finance.*

As a mentor, Dr Ceyhun Elgin has supervised undergraduates and graduate students on a variety of projects on topics including international macroeconomics, developmental economics, and labour economics. At Columbia, he taught courses on public economics for undergraduates and International economics for graduate level students.
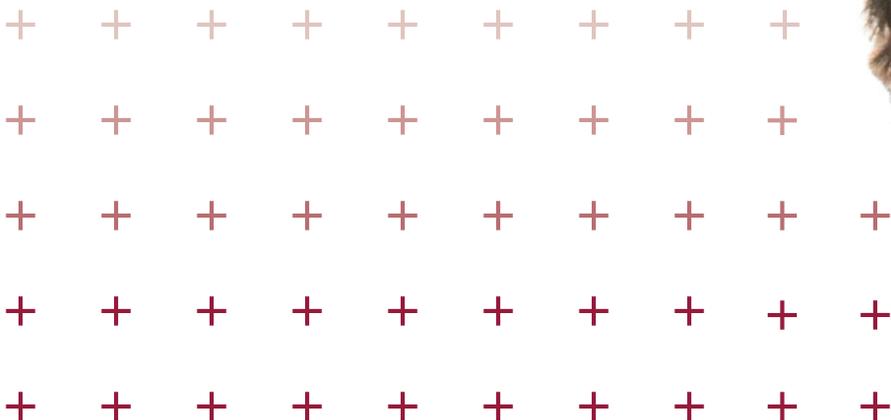
DR CEYHUN ELGIN, COLUMBIA UNIVERSITY

ECONOMICS OF INEQUALITY AND SUSTAINABILITY

Suitable for students interested in:

ENVIRONMENTAL SCIENCES
Environmental Health | Sustainable Practices

ECONOMICS
Income Disparities | Labour Market Competition | Poverty Rates

The economics of inequality and sustainability examines the relationship between income disparities, environmental health, and social stability. It delves into the distribution of income and wealth among individuals, alongside the impact of economic activities on the environment and social cohesion. This field explores policy interventions to address disparities while promoting sustainable practices, considering long-term consequences and potential trade-offs between equity and environmental goals. Its aim is to create more balanced, inclusive, and environmentally responsible societies.

This research course covers both theories (Why is there inequality? How can inequality persist in a competitive labour market? What are the implications of sustainability on economic theory?) and empirical work (What explains long-run trends in poverty rates and income/ wealth inequality dynamics? Can we measure sustainability?). The goal of this course, however, is not to resolve these issues but to demonstrate their complexity. It is the hope that students will leave this course feeling that they know less about sustainability and inequality than they thought they did when they began the course.

In many ways the goal of this course is to help students to think like an economist, but the readings and discussion will not be limited to economics. Above all, this course will help them to develop as rigorous thinkers and precise presenters of their ideas.

By the end of the course, students will be stronger critical thinkers and will be much more adept at assessing the meaning and limits of arguments related to poverty, inequality, and sustainability.
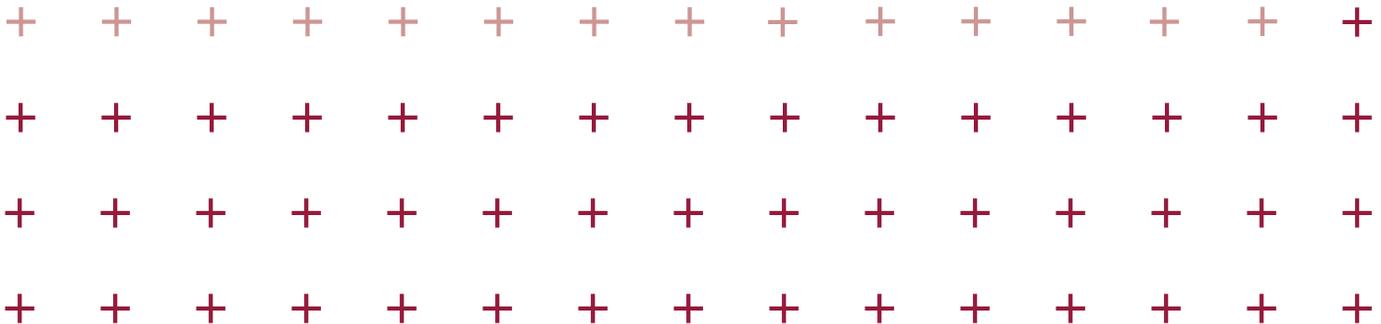
DR ANNALENA OPPEL

CURRENT POSITION

Research Fellow, International Inequalities Institute, London School of Economics

PREVIOUS APPOINTMENTS

Research Associate, World Income Inequality Database, United Nations World Institute for Development Economics Research

Project Lead, Government Revenue Database, United Nations World Institute for Development Economics Research

Visiting Research Fellow, Institute for Quantitative Social Sciences, Harvard University

A scholar in development studies specializing in economic inequality, social protection, and decolonialism.

As a researcher, Dr Oppel focuses on economic inequality, the politics of social protection, and taxation, with particular emphasis on the Global South. Her work explores how inequality perceptions, political preferences, and economic uncertainty shape people's views on redistribution and social policies. She is especially interested in the justifications of inequality and how social protection systems operate within developing countries. Currently, Dr Oppel is investigating the dynamics of success and failure perceptions in South Africa, examining their influence on redistributive preferences.

Her research has been widely recognized and published in top journals such as *The European Journal of Development Research*, *World Development*, and *Social Identities*. Additionally, Dr Oppel has contributed chapters to influential books, including *Cushioning against Crises: The Role of Tax-Benefit Systems in the Developing World*, published by Oxford University Press. Her work is informed by a decolonial perspective, aiming to rethink development research and practice in innovative and transformative ways. Through her research, Dr Oppel is advancing our understanding of inequality, social policies, and economic systems in the Global South, making a significant impact on both academic discourse and policy discussions.

As a mentor, Dr Oppel encourages critical thinking and exploration of complex social issues, especially in the context of economic inequality and social protection. She guides students in conducting research that incorporates diverse perspectives and prioritizes practical applications in the field of development, empowering them to address real-world challenges effectively.
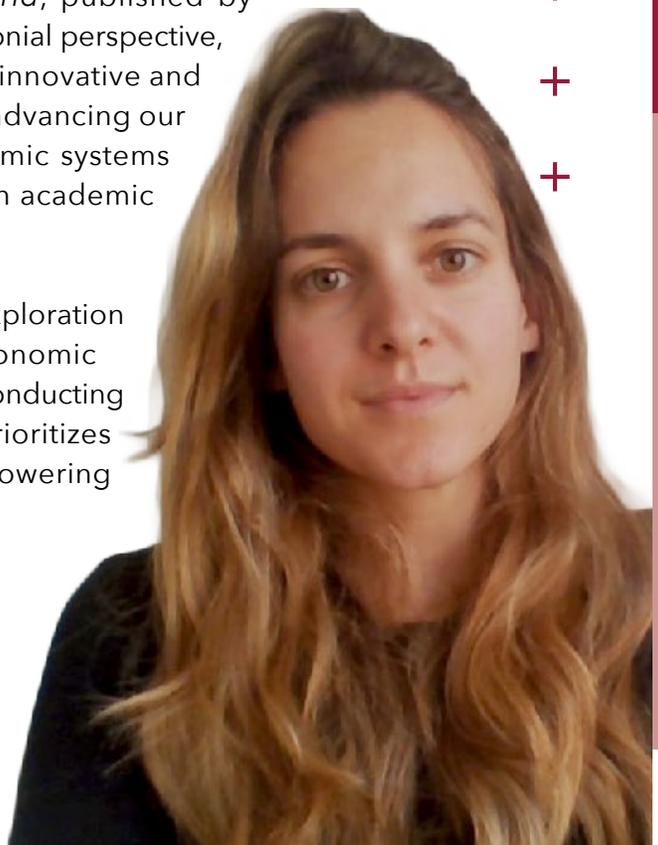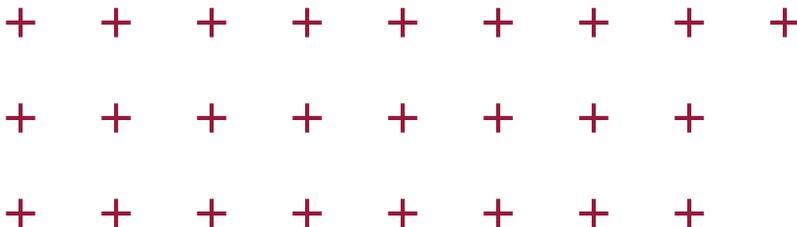
DR ANNALENA OPPEL, LONDON SCHOOL OF ECONOMICS

THE ECONOMICS AND SOCIOLOGY OF INEQUALITY

Suitable for students interested in:

ECONOMICS
Inequality | Systems | Public Policies

SOCIOLOGY
Societal Structures | Power and Privilege | Social Relationships

DEVELOPMENT STUDIES
Sustainable Development Goals | Public Discourses | Development Paradigms

Inequality is an important and complex issue that manifests in people's lives, national politics, public policies, and economic systems. Its scientific study draws on multiple disciplines, including economics, sociology, and development studies. Often, these disciplines are combined into interdisciplinary perspectives to create more comprehensive answers to fundamental questions such as: What is inequality, and how is it best measured and tracked over time? How do people experience inequality? How does it shape their social relationships with others? How does it influence political preferences and funding decisions for addressing inequality? Who is in charge, who is represented, and who decides on behalf of whom?

This research course will examine key perspectives on inequality, sociology, and development studies. We begin by exploring how we encounter inequality in our daily lives, from access to education and healthcare to disparities in income and opportunity. We then move on to understand how inequality is measured and tracked in economics, focusing on simple ways to comprehend prominent measures used in political and public discourses. We also review how inequality is featured in major development paradigms, such as the Sustainable Development Goals and the Paris Agreement. Finally, we incorporate sociological perspectives to examine how inequality shapes social structures and relationships in society.

By the end of the research course, students will have gained a more holistic understanding of what is predominantly understood as inequality today, how it is discussed in public and political discourses, how it guides research questions and methodologies, and how it shapes global agendas, such as the Sustainable Development Goals. Students will also engage with critical debates on inequality, exploring its intersections with power, privilege, and access to resources. These discussions will help cultivate their analytical skills and foster a nuanced appreciation of inequality as a complex, pervasive issue, preparing them to contribute thoughtfully to ongoing conversations and initiatives addressing this critical global challenge.

HARVARD UNIVERSITY

DR GOKHAN M AYKAC

CURRENT POSITIONS

Senior Research Associate, The Center for Labor and a Just Economy (CLJE), Harvard University

Associate Professor, Department of Economics, Ankara Hacı Bayram Veli (AHBV) University

Board member, Migration Studies Research and Application Center, AHBV University

Co-founder, Employment Research Association, AHBV University

PREVIOUS APPOINTMENTS

Postdoctoral Research Fellow, Labor and Worklife Program, Harvard University

Research Assistant, Department of Economics, AHBV University

Lecturer, Department of Social Sciences, Turkish Naval Academy

A prolific author and educator in economics, specialising in labour economics, migration, the economics of science, and financial markets.

As a researcher, Dr Aykaç's areas of expertise are in labour economics, the economics of migration, the economics of science, poverty, and financial markets and he has published extensively on these topics. At Harvard, Dr Aykaç is currently working on the economics of scientific workforce migration. He has previously worked on EU Erasmus projects on solving unregistered employment in the agricultural sector and a digital portal for parents, teachers, and students.

He has authored and published two books on Turkey's labour markets and the scientific brain drain, and he has contributed book chapters on economics. Furthermore, He has been invited to present his research at seminars and conferences in Europe, China, and the US..

As a mentor, Dr Aykaç teaches labour economics, migration economics, mathematical economics, and financial markets at both under-graduate and graduate levels.
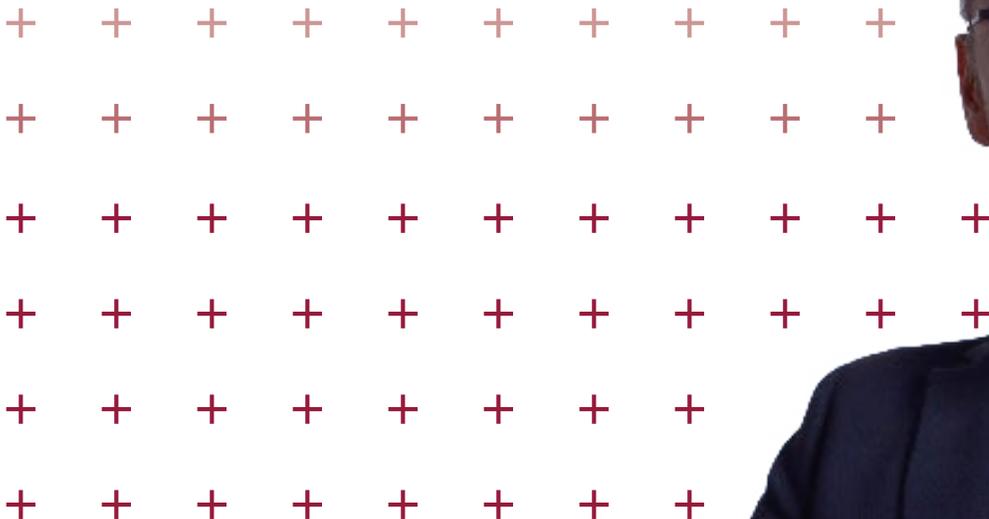
DR GOKHAN M AYKAC,HARVARD UNIVERSITY

THE ECONOMICS OF HUMAN CAPITAL:

MIGRATION, LABOUR, AND POLICY

Suitable for students interested in:

LABOR & IMMIGRATION ECONOMICS

Macroeconomics | Skilled Immigration | Labour Market | Brain Drain

POLITICAL SCIENCE

International Relations | Political Economics

This research course delves into the multidisciplinary study of skilled immigration, combining economics, policy analysis, and case studies. Through a blend of theoretical analysis, empirical evidence, and practical exercises, participants will be equipped with the knowledge and tools necessary to engage in research and policy discussions surrounding skilled immigration.

The research course commences by introducing various research strategies employed in studying immigration economics and labour economics. Key topics, such as labour market impacts, wage differentials, and human capital mobility, are explored, laying the groundwork for designing and implementing robust research methodologies to address critical questions in the field. The course also delves into specific research examples related to skilled immigration from developing countries to developed nations, including the phenomena of reverse brain drain and brain circulation. Through these case studies, participants will gain a deeper understanding of the complex interactions between source and destination countries, encompassing economic, social, and cultural implications.

Equally crucial is the guidance provided on getting ready to write high-quality research papers in immigration economics and labour economics. Students will learn some best practices in research design and result interpretation, with a strong emphasis on effectively communicating their future findings and contributing to the scholarly discourse on skilled immigration.

In summary, this research course offers a comprehensive exploration of skilled immigration economics, bridging the gap between research and policy. By course completion, participants will be equipped with a solid foundation in the field, enabling them to critically analyse and actively contribute to ongoing discussions regarding skilled immigration and its economic impact.

STANFORD UNIVERSITY
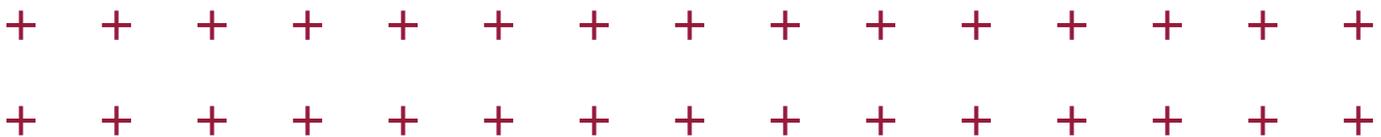
DR CHANGWOOK JU

CURRENT POSITIONS

Postdoctoral Scholar, Center for International Security and Cooperation, Stanford University

Hans J. Morgenthau Fellow, Notre Dame International Security Center, University of Notre Dame

An expert in international security specializing in military dynamics, civil-military relations, East Asian security, and the political implications of conflict and violence.

As a researcher, Dr Ju focuses on East Asian security, political violence, and conflict-related sexual violence, with a particular emphasis on China and global politics. His work also explores military recruitment, battlefield effectiveness, civil-military relations, democracy and war, and public nuclear attitudes. Dr Ju's research has been published in leading journals such as the *American Journal of Political Science, Foreign Policy Analysis, International Studies Quarterly,* and *International Studies Review*. His policy analysis and commentary have appeared in respected outlets, including *Chicago Policy Review, The Diplomat,* and *Foreign Policy*.

Dr Ju's research and training have been supported by prestigious institutions including the American Political Science Association, the National Science Foundation, and the Carnegie Corporation of New York. He has also received support from the Whitney and Betty Mac-Millan Center at Yale University, the Women Faculty Forum at Yale, the Arnold A Saltzman Institute of War and Peace Studies at Columbia University, and the Institute for Humane Studies at George Mason University. His work significantly advances our understanding of the intersections between military dynamics, global security, and political violence, influencing both scholarly and policy-oriented discussions in these critical areas.

As a mentor, Dr Ju encourages critical thinking and helps students develop their research skills in international relations and security studies. He fosters a collaborative learning environment, offering constructive feedback and encouraging open dialogue to help students excel in their academic and professional pursuits.
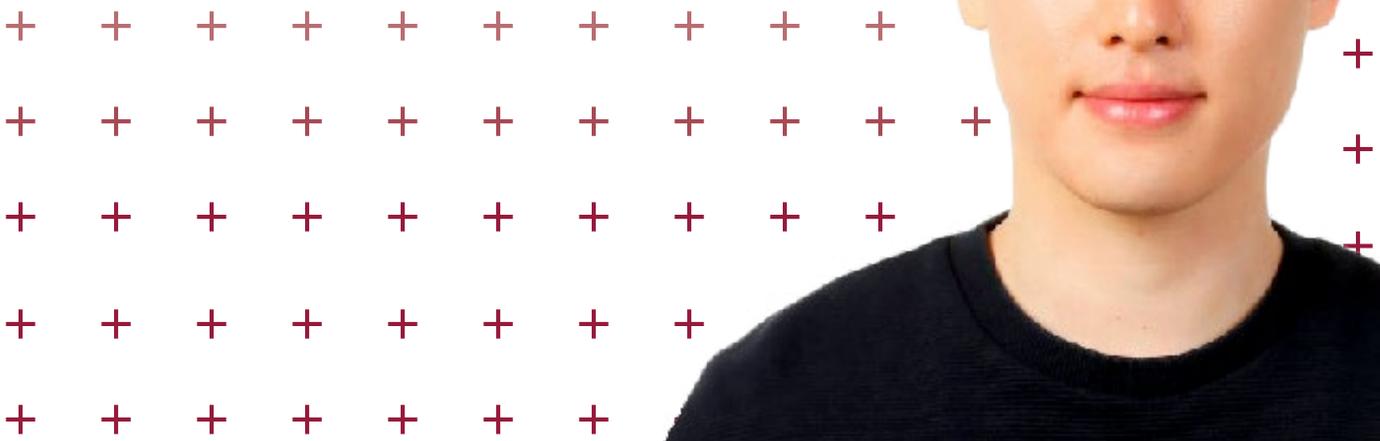
DR CHANGWOOK JU, STANFORD UNIVERSITY

QUANTITATIVE RESEARCH DESIGN IN INTERNATIONAL RELATIONS

Suitable for students interested in:

QUANTITATIVE SOCIAL SCIENCE
Data Visualization | Statistics | Causal Inference

INTERNATIONAL RELATIONS
Security | Regional Studies | Politics | Political Economy

This research course offers a unique opportunity for students to bridge theoretical knowledge with practical skills in the field of International Relations, provides comprehensive training in quantitative research methodologies tailored to the study of international relations.

Designed for students aiming to enhance their analytical skills, the research course covers the fundamentals of statistical computing, data visualization, and causal inference, focusing on practical applications to pressing questions in global politics. Students will learn to navigate complex datasets, assess causal relationships, and interpret statistical results in the context of international security, global governance, and political economy. The curriculum establishes foundational principles and best practices in research design, hypothesis testing, and the development of analytical frameworks, utilizing free, open-source statistical software, enabling students to build technical proficiency with tools widely employed in both academic and policy research. Students will develop their own applied projects by identifying a substantive issue in International Relations, design and execute a quantitative study using real-world datasets, and produce empirically robust analyses and professional-grade visualizations.

By the end of the research course, students will be equipped with the tools and knowledge to conduct methodologically rigorous research and contribute effectively to academic and policy-focused discourse within the field of International Relations. They will then apply the methodologies learned to develop a project or research aligned with their specific interests and passions within the field of international relations.
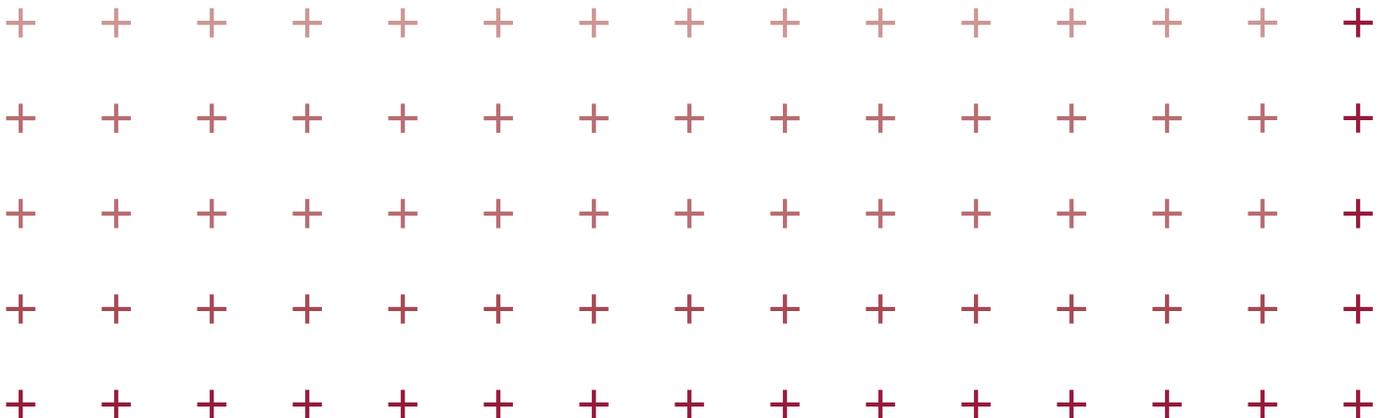
DR CARLES MAÑÓ-CABELLO

CURRENT POSITION

Postdoctoral Researcher, Department of Economics, KU Leuven, Belgium

A rising researcher in the field of game theory and its applications to environmental studies.

As a researcher, Dr Cabello's primary focus is on dynamic games, investigating topics on theoretical derivations, discounting, natural resource management, pollution control, emissions, and climate change. He uses dynamic programming techniques and optimal control theory to delve into decision-making processes while considering multiple interacting agents. Lately, he has ventured into the fascinating domain of Mean Field Games (MFG) and its applications in macroeconomics, particularly exploring its relevance to real-world issues such as inequality. Additionally, he has worked in the realm of International Trade models involving natural resources. He has presented works at research conferences on game theory in Spain and Russia and is currently a journal referee for *Resource and Energy Economics.*

As a mentor, Dr Cabello has taught college-level mathematics courses and has tutored PhD students in Advanced Game Theory, Econometrics, Dynamic Optimization, and Econometrics.
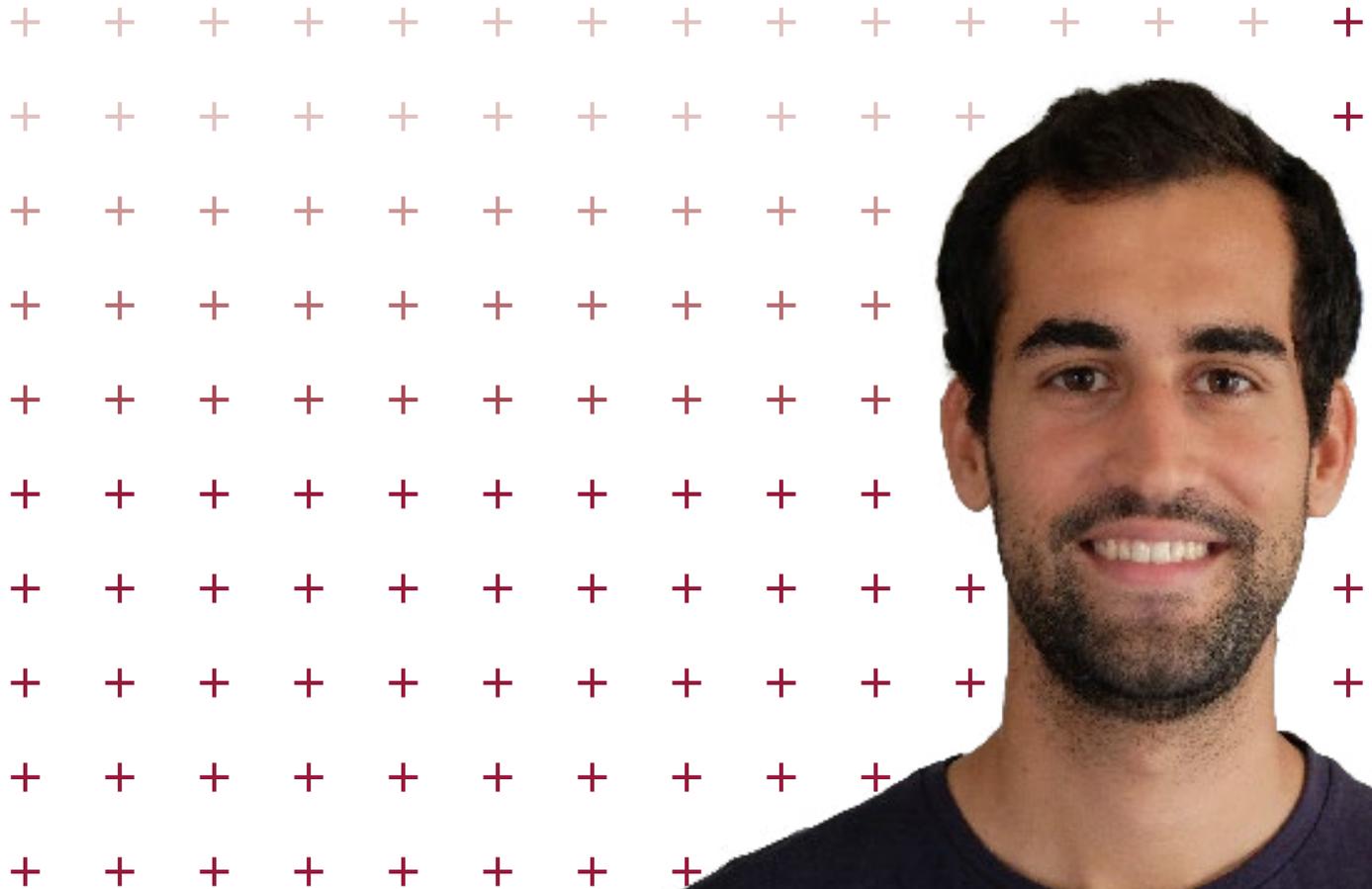
DR CARLES MAÑÓ-CABELLO, KU LEUVEN (US WORLD TOP 50)

GAME THEORY AND DECISION MAKING:

UNLEASHING STRATEGY IN COMPLEX ENVIRONMENTS

Suitable for students interested in:

ECONOMICS
Static Games | Mixed Strategies

APPLIED MATHEMATICS
Nash Equilibrium | Probability Theory | Logic

PSYCHOLOGY
Behavioural economics | Rationality

This research course explores game theory, an interdisciplinary field that delves into strategic decision-making across different domains. Students from various disciplines are welcome to understand the power of game theory in unravelling strategic interdependence. Game theory uncovers hidden strategies and dynamics behind decision-making in diverse situations, influencing individuals, organisations, nations, and animals. By studying game theory, students gain insights into incentives, conflicts, and cooperation that shape social, economic, political, and biological landscapes.

The research course begins with an introduction to game theory, covering applications, fundamental concepts, players/agents, strategies, payoffs, and Nash equilibrium—a stable solution for strategic interactions. Students will explore static games, understanding extensive form representation, dominant and dominated strategies, and Nash equilibrium in pure strategies. Next, students will delve into dynamic games, focusing on normal form representation, backward induction, and subgame perfection, illuminating sequential decision-making impacts. Mixed strategies introduces the concept of probability distributions, applicable to game theory, and uncovers mixed strategy Nash equilibrium's implications.

By the end of the course, interactive discussions, case studies, and real-world examples will have enriched the students' understanding of game theory concepts, fostering a solid foundation in strategic thinking across diverse contexts.
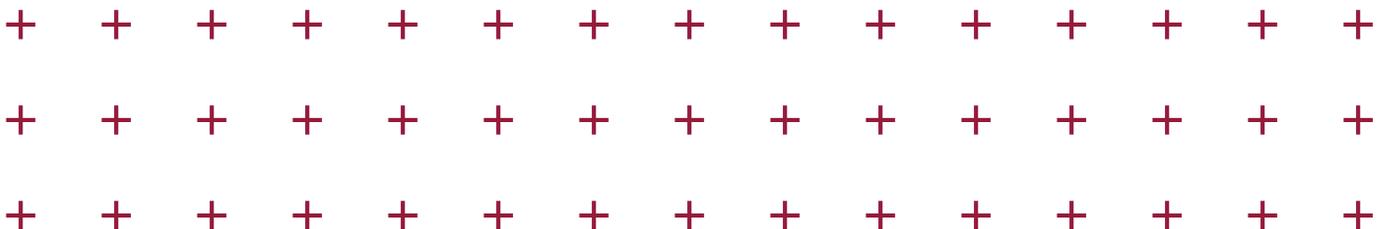
DR CARLES MAÑÓ-CABELLO, KU LEUVEN (US WORLD TOP 50)

ENVIRONENTAL ECONOMICS:

FINDING THE BALANCE AMONG CLIMATE CHANGE, SUSTAINABILITY, AND ECONOMIC GROWTH

Suitable for students interested in:

ENVIRONMENTAL STUDIES
Sustainability | Renewable Energy | Non-renewable Energy

ECONOMICS
Macroeconomics | International Cooperation

POLITICAL SCIENCE
Green Policies | Sustainable Development

Embark on a captivating research journey into the realm of environmental economics, where the intricate dance between economic activities and ecological ramifications unfolds. **This research course offers an immersive exploration into how economic decisions shape the trajectory of our planet's future.**

Students will delve into a rich array of topics, including the management of non-renewable resources such as oil and gas, the harnessing of renewable resources like solar and wind energy, and the critical analysis of cost-benefit implications associated with green policies and sustainable development initiatives.

A focal point of the course lies in the examination of climate change economics, where students will dissect strategies for fostering international cooperation and consensus. Through engaging case studies and interactive discussions, students will unravel the complexities inherent in addressing environmental challenges and crafting viable solutions.

This course is for students passionate about understanding and influencing the economic drivers behind a sustainable future. As climate change has become one of the most urgent issues facing humanity and impacting the global economy, students are welcome to apply to this research course and craft solutions for a better planet!
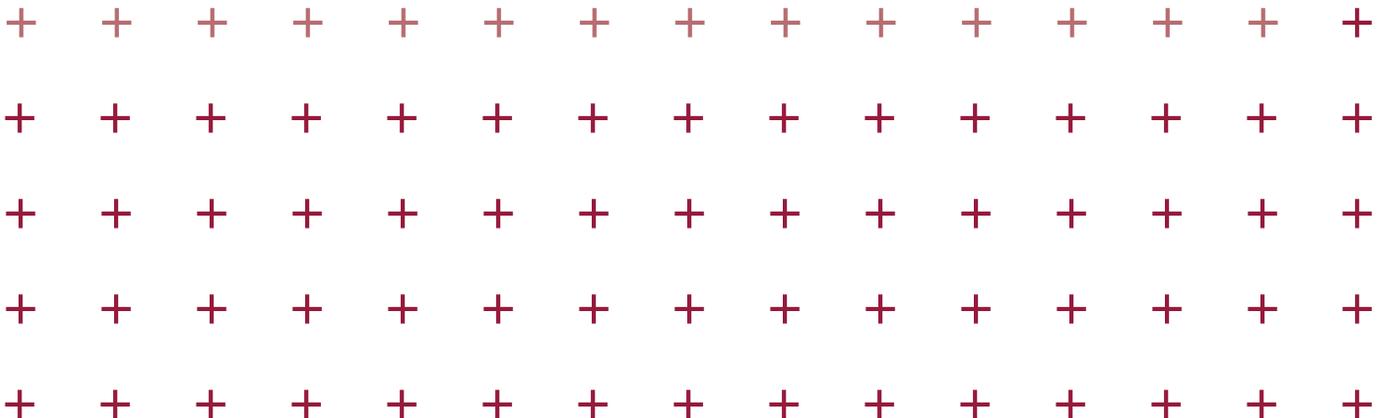
DR DANA BRABLEC

CURRENT POSITIONS

Lecture, Department of Politics and International Studies, University of Cambridge

Research Affiliate, Department of Sociology, University of Cambridge

Teaching Associate, Centre of Latin American Studies, University of Cambridge

Assistant Professor in Race, Decoloniality and Intersectionality, CEDLA, University of Amsterdam

PREVIOUS APPOINTMENT

Visiting Scholar, Institute of Latin American Studies, Columbia University

A sociologist studying urban indigeneity, ethnicity, race, migration, mobility, inequality and Latin America.

As a political scientist and sociologist, Dr Brablec is particularly interested in community-based organisations, ethnicity and race, migration, mobility and inequality. Her research focuses on civic stratification and border (un)making practices of civil society and police organisations concerning migrants and Roma in different European countries. She has worked on a research project funded by the Economic and Social Research Council (ESRC) concerning border security and migration.

Dr Brablec has an outstanding publishing record. Her works appear in several prestigious journals, including *Bulletin of Latin American Research, Journal of Ethnic and Migration Studies, Native American and Indigenous Studies Journal*, among others. She is a contributor to several books and media. Due to her expertise in political economy, Dr Brablec was interviewed by BBC World Service Radio as a subject matter expert on the recent political events in Chile.

As a mentor, Dr Brablec has extensive teaching experience. She has taught a wide range of courses for undergraduate and graduate students at the University of Cambridge and University College London.

DR DANA BRABLEC, UNIVERSITY OF CAMBRIDGE
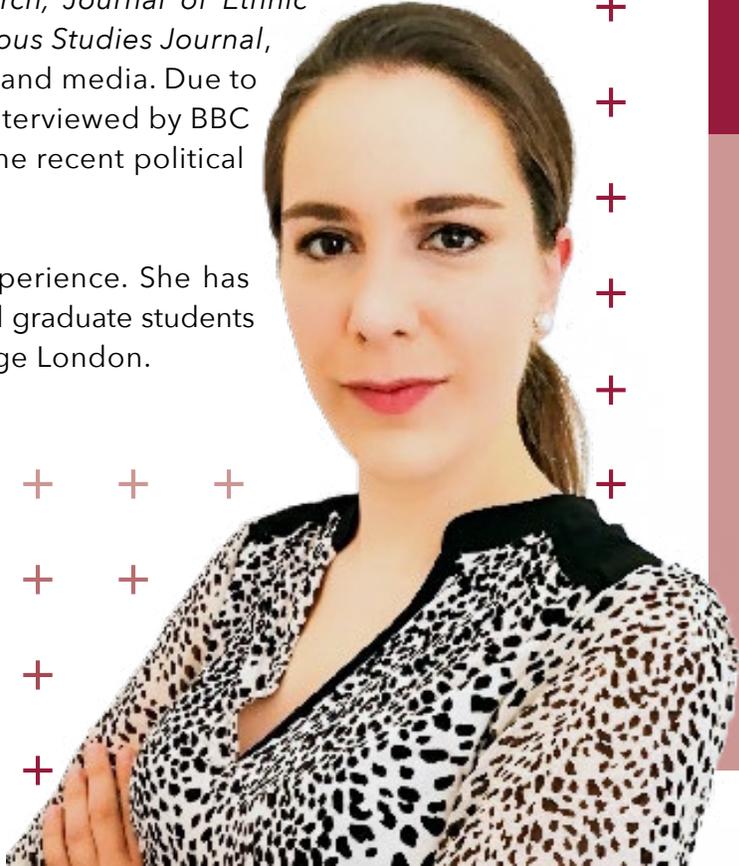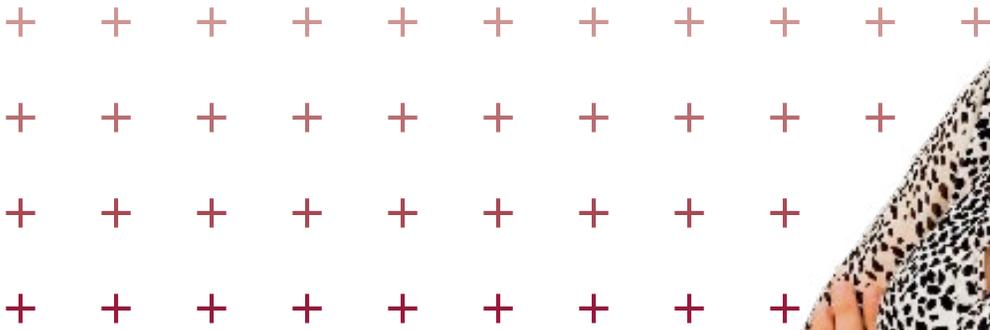
RACE, RACISM, AND SOCIETY:

A GLOBAL PERSPECTIVE

Suitable for students interested in:

RACE AND ETHNICITY
Social Inequality | Environmental Justice | The Concept of Race

GLOBAL SOCIOLOGY
Environmental Justice | Immigration Reform | Border Policies

### SOCIAL INJUSTICES

Healthcare | Refugees | Discrimination

Is there scientific evidence to support the existence of human 'races'? If not, why does 'race' remain such a powerful determinant of individual and collective identities today? And what does this mean for the practices of racism?

Issues relating to 'race' and ethnicity, whether #blacklivesmatter or COVID-19, are at the forefront of public debate. This course will provide critical analysis of the concepts and processes of 'race' and ethnicity, understood as social constructions, looking at the UK, the US and beyond.

The idea of 'race' has been used to define and separate us for centuries, leading to a series of very real economic, political, and social inequalities around the world.

In this research course, we will approach the understanding of 'race' and ethnicity by assessing the social implications of racism and the persistence of racial and racist ideas. We will explore the relationships between 'race' and ethnicity with wider global social problems around issues, such as migration, environmental destruction, intersectional inequalities, health, and anti-racist practices.

The objective of the research course is to understand and examine major concepts and debates concerned with 'race' and ethnicity, to compare implications of 'race' and ethnicity in different contemporary social settings, and to creatively think about ways to counteract social injustices around the world. At the end of the course, students will have finished an independent research project, examining and thinking about the issues related to race and racism in a broad social and global context.

DR DANA BRABLEC, UNIVERSITY OF CAMBRIDGE

INTERNATIONAL DEVELOPMENT:

CHALLENGES FOR POLICY-MAKERS, CORPORATIONS, AND NGOS

Suitable for students interested in:

ECONOMICS
Human Capital and Natural Resources | Technological Change

SOCIOLOGY
Human Development

POLICY STUDIES
Income Inequality | Environmental Sustainability

This research course aims to cultivate critical thinking skills and provide a comprehensive understanding of contemporary global development issues. By exploring the practical application of academic knowledge to address real-world problems, the course will analyse the key debates shaping development models in the Global North and Global South, along with the challenges faced by countries worldwide.

We will examine various perspectives on development at local, national, regional, and global levels, including both traditional and decolonial approaches. Moreover, the course will delve into the involvement of non-academic sectors, such as policy-makers, corporations, NGOs, and other societal actors, in these ongoing debates. By considering the perspectives of different stakeholders, we aim to foster a holistic understanding of the complexities and potential solutions in the realm of global development.

In no particular order, the topics we will discuss include, Millennium and Sustainable Development Goals, development traps, pandemic and post-pandemic challenges, urbanisation and gentrification, development theory, international and regional co-operation for development, bottom-up perspective, decolonising development studies, development and intersectionality, and corruption, among others. At the end of the course, students will have finished an independent research project, examining and thinking about the issues related to development in a broad social and global context.
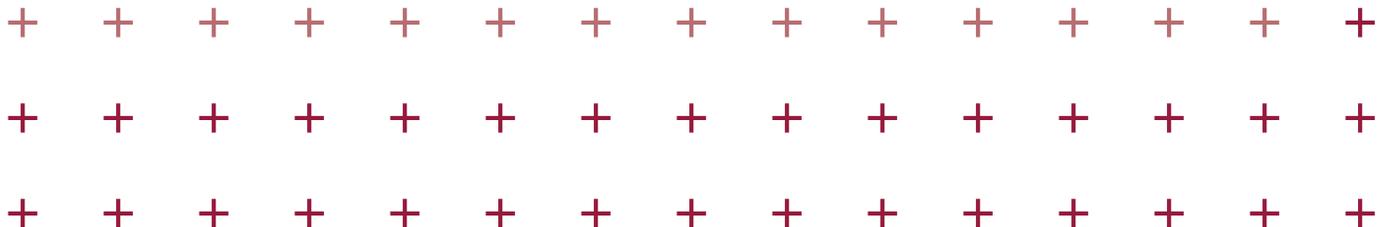
YALE UNIVERSITY

DR XIAOXIAO SHEN

CURRENT POSITIONS

Postdoctoral Associate, Council on East Asian Studies, Whitney and Betty MacMillan Center, Princeton University

Lecturer, Department of Political Science, Princeton University

A scholar in political science specializing in political psychology, authoritarian politics, and quantitative methods to understand political behavior in authoritarian contexts.

As a researcher, Dr Shen's expertise is in comparative political behavior, political psychology, and authoritarian politics, with a strong emphasis on understanding citizens' political attitudes and behavior in authoritarian regimes. Her research combines quantitative methods with psychological insights to explore political behavior, shedding light on how individuals in such regimes navigate their political environments. Dr Shen's work has been published in prestigious journals, including the *British Journal of Political Science, Governance*, and *World Development,* with forthcoming publications in the *Journal of Experimental Political Science* and *Political Science Research and Methods.*

Beyond her academic contributions, Dr Shen has contributed to the field of social science research through innovation, developing tools like ReChat, a patented software designed to support complex research workflows.

Her interdisciplinary approach bridges political science and psychology, offering valuable perspectives on authoritarianism and its effects on political behavior. Through her work, Dr Shen continues to shape the field, contributing both theoretical advancements and practical tools for researchers in political science.

As a mentor, Dr Shen guides students in developing a deep understanding of political behavior and psychology. She emphasizes quantitative methods and fosters an analytical approach to exploring authoritarian politics. Her teaching style at Yale, where she teaches political psychology in comparative politics, encourages critical thinking and hands-on learning. She also brings her expertise from Princeton, where she previously taught microeconomics, Chinese politics, and quantitative social science, equipping students with a versatile skill set to address complex questions in political science.

DR XIAOXIAO SHEN, YALE UNIVERSITY

POLITICAL PSYCHOLOGY IN COMPARATIVE POLITICS

Suitable for students interested in:

POLITICAL PSYCHOLOGY
Political Behavior | Elections | Individual and Collective Identity

COMPARATIVE POLITICS
Institutions | Political Systems | Sociocultural Environment

Political psychology seminars often focus on American political behavior, while comparative politics rarely address psychological perspectives directly. This research seminar bridges that gap by exploring how psychological factors intersect with comparative political systems, shaping attitudes and behaviors across diverse contexts. **The research course examines how political beliefs are formed, revised, and expressed through action, emphasizing the influence of personality traits, cognitive processes, and identity–both individual and collective–on political engagement.**

The research course takes a comparative approach to understanding political psychology, analyzing how varying institutional frameworks, cultural norms, and societal structures shape political attitudes and actions. Topics include why individuals engage in politics, how political insiders and the general public differ (or converge) in their behavior, and the relevance of distinguishing between these groups. We will also examine whether universal political behaviors and attitudes exist and how they can be identified and studied.

Students will critically engage with theories and empirical research, applying psychological frameworks to understand political behavior in a global context. The research course will explore phenomena such as political participation, polarization, belief systems, and collective action, investigating how they are influenced by factors like authoritarianism, democratization, and cultural diversity.

By the end of the research course, students will gain a nuanced understanding of the interplay between psychology and politics across different institutional and cultural environments. Students will develop analytical tools to assess political behavior, preparing them for advanced research or practical applications in areas like policy analysis, governance, or international relations.

UNIVERSITY OF CAMBRIDGE

DR HANDE GÜZEL

CURRENT POSITIONS
RResearch Affiliate and Consultant, Department of Sociology, University of Cambridge
Undergraduate Supervisor, Department of Sociology, University of Cambridge
Tutor, Oxford Prospects and Global Development Institute, Regent's Park College, University of Oxford
Mercator-IPC Fellow, The Istanbul Policy Center-Sabancı University-Stiftung Mercator Initiative

PREVIOUS APPOINTMENT
Teaching Associate, Department of Sociology, University of Cambridge

A sociological researcher exploring gender, migration, and health complexities.

As a researcher, Dr Güzel delves into the complexities of gender, migration, and health from a sociological lens. She has previously investigated the experiences of women in Turkey who seek to recreate their technical virginity using the feminist interpretation of Deleuzian concepts. Dr Güzel has also conducted qualitative research on the discourses and rituals in the Turkish physical education system. She is currently working on a research project on skilled migration, particularly immigrant doctors living in Turkey as well as the migration of Turkish doctors to Germany. She is a recipient of a number of research grants, including funding for her project titled "Migration and Medicine: Bridging the Gap between Patients and Migrant Doctors" from the British Institute at Ankara. At Cambridge, Dr Güzel is involved in an active initiative advocating for the end of racism in the campus. Further, she is a co-founder of the CRASSH (Centre for Research in the Arts, Social Sciences and Humanities) Health, Medicine and Agency Research Network, and founder of the Social Studies of Health and Illness Research Group at the Department of Sociology.

Dr Güzel's works have been extensively published in peer-reviewed academic journals including the *Journal of Sociological Research, the Journal of Middle East Women's Studies*, and the *Scottish Journal of Performance*. She also has presented her research at prestigious conferences such as the *British Sociological Association Medical Sociology Annual Conference, the International Union of Anthropological and Ethnological Sciences Commission on the Middle East,* and the *European Society for Health and Medical Sociology Biennial Conference.*

As a mentor, Dr Güzel has taught a wide range of courses at Cambridge. She has taught courses on Gender Studies, Race, Racism and Ethnicity, Global Social Problems, Social Theory, Sociology, Social and Ethical Context of Health and Illness, and Statistics. She also teaches Modern Social Theory and Social Policy to undergraduate students at Oxford.
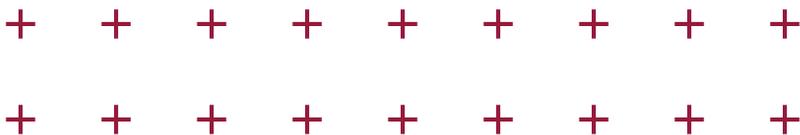
DR HANDE GÜZEL, UNIVERSITY OF CAMBRIDGE

INTERSECTIONALITY, IDENTITY, AND EQUALITY:

THE BODY AND SOCIAL IDENTITIES

Suitable for students interested in:

SOCIOLOGY
Social Identities | Social Norms | Marginalisation

POLITICAL THEORY
Social Justice | Power | Identity Politics

GENDER STUDIES
Feminist Theory | Embodiment | Body Modification

Bodies are central to the human experience. We move, function in society, and make sense of our existence and relatedness through our bodies. However, within our societies, not all bodies are treated equally. Based on social rules and norms, some bodies are deemed deviant, incomplete, marginalised, or less than, compared to others. These rules and norms are often organised around social identity categories such as gender, 'race', religion, disability/able-bodiedness, and age. As a result of the categorisation of bodies based on social norms, bodies become unfinished (Shilling 1993), leading to an increased pressure for body modification practices, and the incessant need to work on their bodies to conform to societal ideals

This research course invites students to critically explore the relationship between intersectionality and the body. Through engaging with thought-provoking literature, this course will open up discussions about how bodies are disciplined, moulded, surveyed, and the hierarchies formed around bodies. Students will also learn to examine the lived, subjective experiences of the body through a more critical and intersectional lens.

The outcome of the research course is an original research paper that focuses on the relationship between body and intersectionality, shaped according to their personal research interests. Throughout the course the students will develop essential academic skills including critical discourse analysis that they can apply to wider social problems in various disciplines.

The aim is for students to develop a comprehensive understanding of how intersectionality shapes our experiences of embodiment. This knowledge will empower students to critically address social justice issues and contribute meaningfully to discussions about identity and equality.
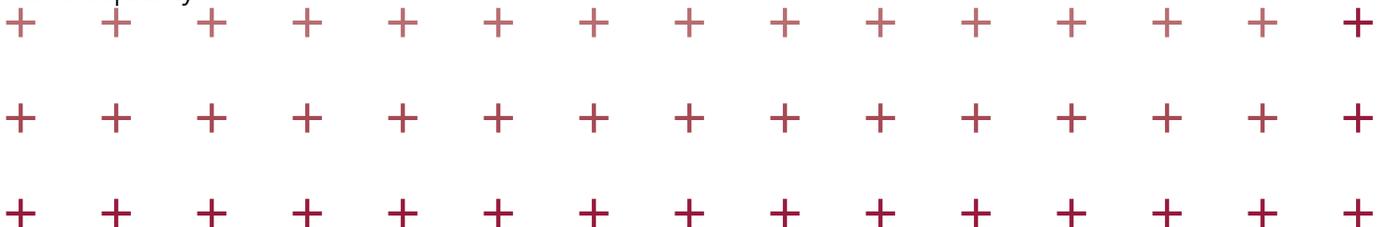
DR HANDE GÜZEL, UNIVERSITY OF CAMBRIDGE

HEALTH, GENDER, AND POWER:

INEQUALITIES, INTERSECTIONS, CONFLICTS

Suitable for students interested in:

SOCIOLOGY
Inequality | Concepts of Health | Gender

GENDER STUDIES
Gender-based oppression | Intersectionality

PUBLIC HEALTH
Gender | Race | Health Equity | Mental Health

This research course focuses on the intricate relationship between health and gender. **Spanning across both physical and mental health and borrowing primarily from sociology of health and illness and gender, students will develop a critical understanding of the main themes and debates in these fields.** Gender inequalities in health, the gendered experience of pain, health, and illness, care responsibilities, cosmetic surgery, medicalisation of women's different phases of life (such as childbirth and menopause), and reproduction will be among the themes that will be explored.

While taking gender into its centre, this research course also underlines the necessity to take an intersectional approach to health and illness, and hence addresses 'race', age, disability, and class, among others. An intersectional approach will allow the students to recognise the diverse experiences of health and gender inequalities historically and contemporarily. Furthermore, we will explore not only women's experiences of health and illness, but also men's and non-binary individuals', which are often overlooked.

At the end of the research course, students will have completed a research paper based on an independent research project, which will cut across several themes in health and gender according to their personal research interests. Students will also be introduced to first-hand accounts of health and illness that they can use both for their research and to get a better understanding of the topics explored in the course.

UNIVERSITY OF OXFORD / UNIVERSITY OF TORONTO
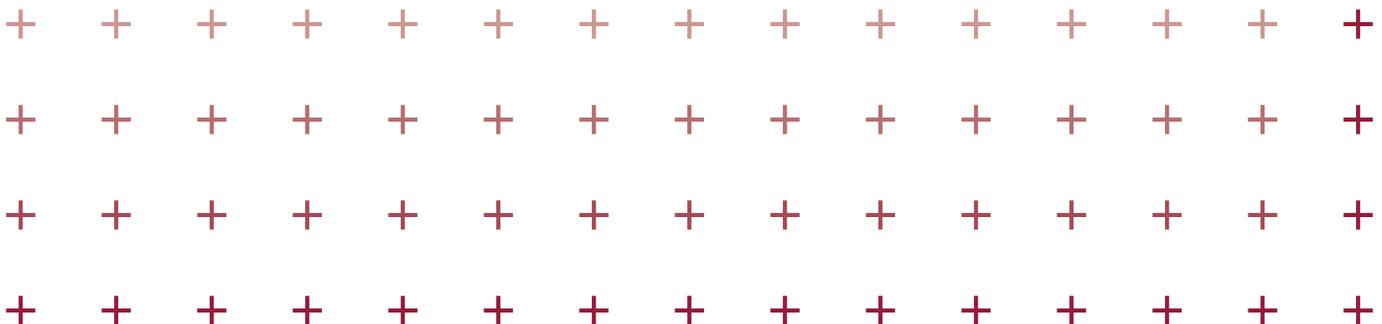
DR CAITLYN MCGEER

CURRENT POSITIONS

**Postdoctoral Researcher,** Centre for Socio-Legal Studies, University of Oxford

Lecturer, Department of Sociology / Centre for Criminology & Sociolegal Studies, University of Toronto

A socio-legal scholar investigating artificial intelligence and social media in conflict settings.

As a researcher, Dr McGeer is a postdoctoral researcher working on the ERC-funded ConflictNet project within the Programme in Comparative Media Law and Policy at the Centre for Socio-Legal Studies. She focuses on the use of artificial intelligence and social media in conflict settings in Africa. Dr McGeer specialises in anticipatory action for conflict prevention and hate speech and disinformation in conflicts. Her research interests consist of gender and technology, human rights, and security. Dr McGeer holds a DPhil in Criminology from the University of Oxford, where she worked in Nigeria and the UK to assess how law enforcement agencies operationalize the United Nations protocols on trafficking in persons and the smuggling of migrants.

Beyond academia, Dr McGeer's professional background centres on capacity building that is premised on securing welfare and rights protections. She is a strategic development and impact assessment specialist. She has worked extensively on both local, national, and transnational-level projects, including ones in the UK, Canada, Guatemala, Ghana, and Ecuador. She has held senior management and front-line roles for various non-governmental, governmental, and United Nations entities

As a mentor, Dr McGeer currently lectures at the University of Toronto on topics related to criminology and sociology and has previously lectured at the University of Oxford on qualitative and quantitative methods.

**DR CAITLYN MCGEER, UNIVERSITY OF OXFORD /
UNIVERISTY OF TORONTO**

LAW, JUSTICE, AND VIOLENCE

Suitable for students interested in:

LAW
Justice System | Social Justice | Criminal Law

POLITICAL SCIENCE
Comparative Politics | Theories of Power | Political Theory | Democracy

SOCIOLOGY
Power structures | Violence | Oppression

This research course delves into the study of violence, aiming to understand its underlying meaning, purposes, and origins. The course content primarily revolves around exploring the various debates surrounding the definition and documentation of violence, with a particular emphasis on differentiating between illegitimate, interpersonal violence and violence that is sanctioned or initiated by the state.

One key area of investigation will be to examine the cultural, social, and individual factors that contribute to interpersonal violence. This entails analysing how societal norms, individual beliefs, and cultural contexts can influence the occurrence and patterns of violent behaviour between individuals. Additionally, the course will explore the concept of violence within the legal framework. Students will investigate instances where the law itself can perpetrate violence, either directly or indirectly, and examine how such violence may be justified or even denied within legal and institutional settings.

A critical aspect of the course is to address criminological inquiries into how power structures and systems of control can shape the occurrence and perception of violence. This includes exploring the historical legacies of colonialism and how they continue to impact violence dynamics across different regions and periods. Furthermore, the course will explore how racial and gender dynamics intersect with violence. It will investigate how societal norms and power imbalances based on race and gender can influence the perpetration and response to violent acts.

As a whole, this research course aims to provide a comprehensive understanding of violence as a multifaceted social phenomenon, taking into account the complexities of power dynamics, historical influences, and cultural contexts that shape the perception and interpretation of violence across different geographical locations and historical timeframes.

DR VICTORIA FENDEL

CURRENT POSITIONS

Leverhulme Early Career Research Fellow, Lady Margaret Hall, University of Oxford

Faculty Member, Faculty of Classics, University of Oxford

A researcher from an interdisciplinary background exploring the development and the patterns of usage of languages from the ancient world to today.

As a researcher, Dr Fendel comes from an interdisciplinary background. She is not only familiar with ancient languages but also has extensive experience in big data and linguistics. She was trained as a classicist (DPhil in Classical Languages and Literature from Oxford) and a linguist (MPhil in Theoretical and Applied Linguistics from Cambridge). Her main research interests concern the development and patterns of usage and the function of languages. In her research, she is interested in language contact, especially between Greek and Egyptian (Coptic), syntax, especially the interface between syntax and semantics and the application of general linguistic concepts to corpus languages. She has published in *Grapholinguistics, Varieties of Post-classical and Byzantine Greek, the Journal of Graeco-Roman Studies, etc.*

As a mentor, Dr Fendel has taught at the University of Oxford and the University of Cambridge. She has lectured on and supervised a wide range of topics including classical and comparative philology and linguistics, classical Greek and Latin languages, biblical Hebrew, and others.

DR VICTORIA FENDEL, UNIVERSITY OF OXFORD

APPLIED LINGUISTICS AND BIG DATA

Suitable for students interested in:

LINGUISTICS
Morphology | Lexicology | Syntax | Semantics

COMPUTER SCIENCE
Computational Linguistics | Data Analysis | Linguistic Data

### SOCIOLINGUISTICS
Language Change | Pragmatics | Language Ideology

Have you ever wondered why 'we are going home' but 'we went to Europe'? Or why do we 'take a step' rather than 'make a step'? Why are we swallowing half the syllables in 'parliament' and why do we spell 'doughnut' with a lot more letters than probably necessary? And why are languages so different – and thus so hard to learn? Questions like the above sit at the heart of modern linguistics.

Linguistics is a vast field including areas, such as the diachronic development of languages, the social relevance of patterns of language usage, the cognitive processing of language and the generation of new linguistic forms when languages come in contact. Our focus will lie on the social relevance of language and the results of language contact.

This research course enables students to develop an independent research project and explore complex linguistic issues by building and constructing linguistic data. Students will learn how to analyse big data and perform context-oriented keyword analysis.

Students will also learn about the analysis of lexical clusters, focusing on meaning-related aspects and the concordancing of items, making it possible to gain an insight into the morphosyntax. Students will be introduced to data analysis tools, especially Voyant and Sketengin.

By conducting independent research projects, students will gain a deep understanding of how language evolves and how to analyse language through various quantitative and qualitative methods. This process will allow them to develop critical thinking skills and approach language with a more analytical mindset.
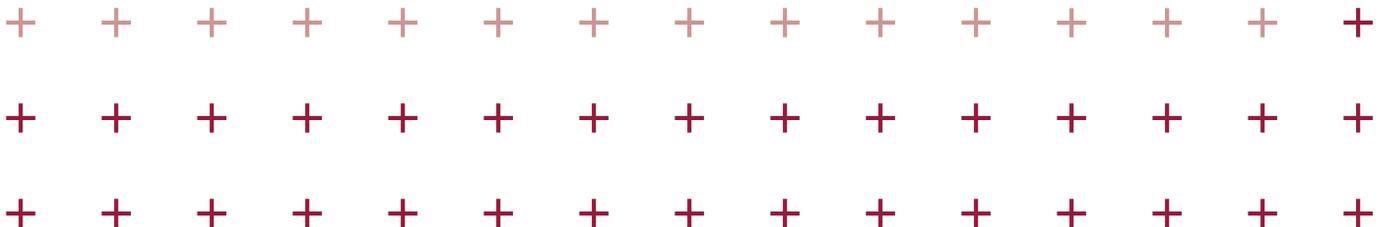
COLUMBIA UNIVERSITY
DR JOSÉ ARAGÜEZ

CURRENT POSITIONS

Founding Principal, Atelier Aragüez

Adjunct Assistant Professor, Department of Architecture, Columbia University

A practising architect and researcher exploring the history and theory of architecture.

As a researcher and architect, Dr Aragüez led a project titled The Building, which is now widely regarded in international circles as one of the most significant contributions to the architectural discourse in the 2010s. The project was launched via two symposia in 2014 – held at the Architectural Association and at Columbia GSAPP, it continued through a theory seminar at Cornell University in Fall 2015, and it was published as a book by Lars Müller in November 2016. An estimate of over 400 people directly participated in or helped with the project, which overall generated an unprecedented total of 23 events – conferences, lectures, and panel discussions – across Europe and the US. A vast majority of the essential figures in the discursive scene worldwide contributed to The Building. His writings have appeared in e-flux, LOBBY, Flat Out, European Architecture History Network Proceedings, Pidgin, and The Routledge Companion to Criticality in Art, Architecture and Design (Routledge, 2018). His latest piece, titled 'Spatial Infrastructure', is forthcoming in Log.

As a mentor, Dr Aragüez has lectured extensively across Europe and North America – including most of the top schools – in addition to the Middle East and Japan. Besides Columbia, he has taught at Cornell, Princeton, Rice University in Paris, and the University of Granada and has worked for Antonio J. Torrecillas (Spain), MVRDV (Rotterdam), and Idom/ACXT (London).
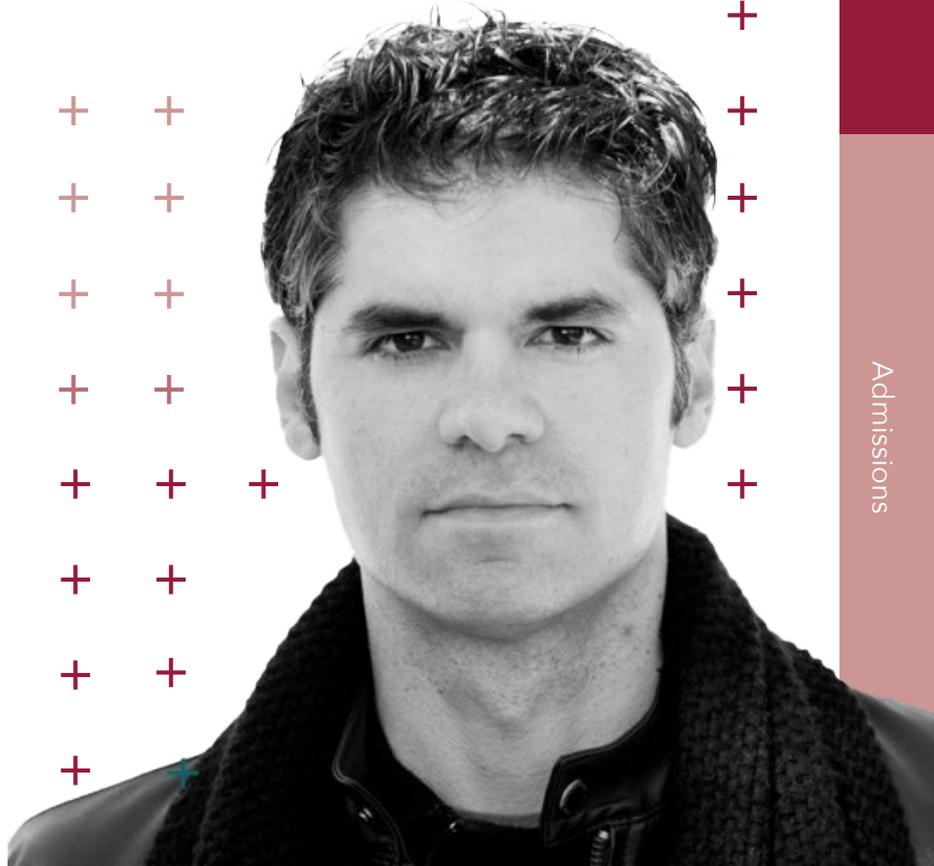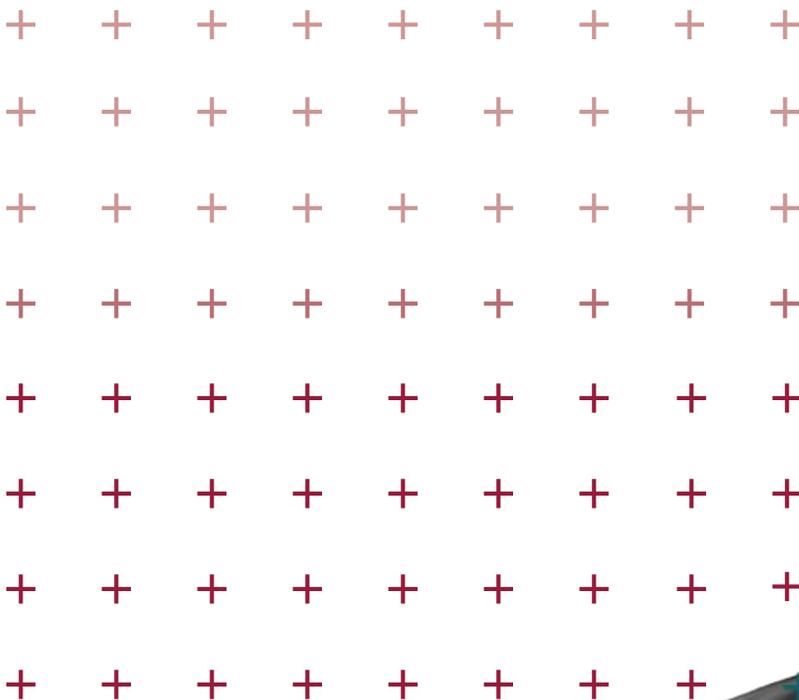
DR JOSÉ ARAGÜEZ, COLUMBIA UNIVERSITY

THE SOCIAL, THE POLITICAL, AND THE ENVIRONMENTAL DIMENSIONS IN ARCHITECTURE AND URBANISM

Suitable for students interested in:

SOCIAL SCIENCE

Environment Issues | Political Science | Societal Change

ARCHITECTURE

Design | Architecture History | Aesthetics

Perhaps more than ever, architecture is being called upon today to reimagine the tools and modes of thinking specific to the discipline in light of the pressing social, political, and environmental occurrences of the present moment. How does architecture engage with the social and political domains? Is architecture "political" and/or "social" by definition? How does the artistic aspect of architecture play into the kinds of political, social, and environmental concerns being raised today? How can I go about designing an environmentally-conscious building without compromising on architectural qualities? Moreover, how can a newly required environmental consciousness be mobilised so as to channel novel possibilities for invention in architectural thinking?

This research course will examine some of the core topics in architectural thinking pertaining to the social, the political, and the environmental by introducing students to critical arguments and debates in the discipline's contemporary discourse. Covering the last few decades, we will look at a number of buildings and urban projects along with a series of theoretical and historical frameworks relevant to them. Topics will include aesthetics, evolving notions of sustainability, representation, programme, spatial organisation, context, phenomenology, the subject, private vs. public, and developing cultures of reuse and renovation.

Through detailed analyses of a series of case studies, students will gain a solid understanding of some of the most fundamental themes in contemporary architecture involving social, political and environmental issues. The course will thus fuel their capacity to think critically about the field today. Emphasis will be placed on the importance of concepts in architecture as well as on remaining firmly rooted in the specificities of architectural thinking when venturing into domains of knowledge and practise external or peripheral to architecture. The serendipitous encounters between the diverse case studies will unveil unexpected synergies and tensions that will open up stimulating research territories in design culture.

DR JOSÉ ARAGÜEZ, COLUMBIA UNIVERSITY

ARCHITECTURAL THINKING:

CONCEPTS, INNOVATIONS, AND THEORIES

Suitable for students interested in:

ARCHITECTURE
Theory | History | Practice

SOCIOLOGY AND ANTHROPOLOGY
Design | Architecture History | Aesthetics

PHILOSOPHY
Aesthetics | Phenomenology

Architecture is everywhere around us. And yet, it remains one of the creative disciplines the most difficult to judge. What is architecture, first of all? What makes a work of architecture good? What makes a work of architecture interesting? Are good and interesting the same thing? How does the artistic aspect enter into architectural design, exactly? Are art and science opposed in architectural thinking? How can I go about designing a building that contributes something new to the history of architecture? How is that prospect exciting? Seeking answers to those and other important questions, **this research course will examine the core topics in architectural thinking by introducing students to critical arguments and debates in the discipline's contemporary discourse.**

Covering approximately the last 30 years, we will look at architectural projects, buildings, material configurations, construction systems, and organisational models along with a series of theoretical and historical frameworks relevant to them. Topics include representation, programme, spatial organisation, context, whole, element, content, referent, the digital, aesthetics, phenomenology, evolving notions of sustainability, and developing cultures of reuse and renovation. Through detailed analyses of some of the creatively richest projects of the last three decades, students will gain a solid understanding of the most fundamental themes in contemporary architecture. The research course will thus fuel their capacity to think critically about the field today. Emphasis will be placed on the importance of concepts in architecture relative to their role in other disciplines, such as philosophy and the visual arts, while the serendipitous encounters between the diverse case studies will unveil unexpected synergies and tensions that will open up stimulating research territories in design culture.

COLUMBIA UNIVERSITY
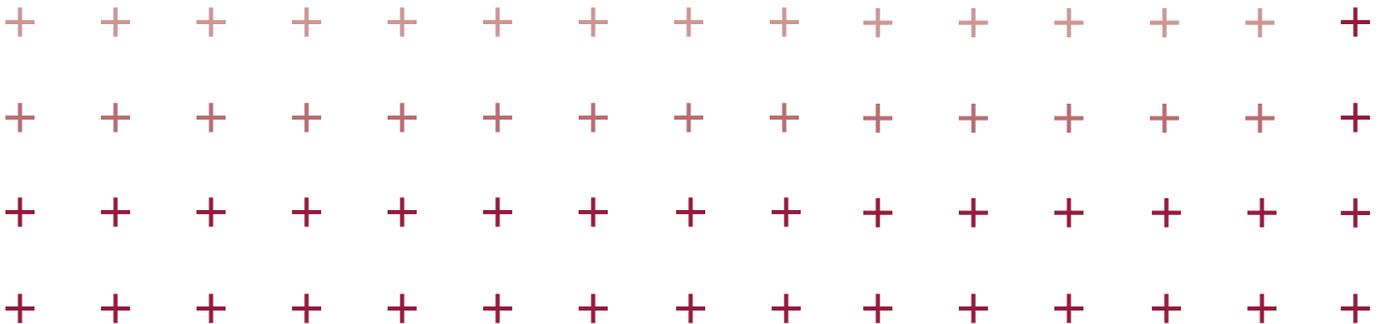
DR TOM HAFEN

CURRENT POSITIONS

Head of Marketing, Geico
Adjunct Professor of Marketing, School of Business, Columbia University
Lecturer, School of Professional Studies, Columbia University
Lecturer, School of Management, Yale University
Adjunct Professor, Booth School of Business, University of Chicago

PREVIOUS APPPOINTMENTS

Senior Vice President of Consumer Marketing, Goldman Sachs Consumer Bank
Head of Marketing, Nestlé Waters Growth Brands
Marketing Group Leader, Gerber Infant Nutrition, Nestlé
Senior Category Manager, Microsoft
Global Brand Manager, Procter & Gamble

A seasoned marketing professional and educator with over 15 years of experience across a variety of industries.

As a researcher, Dr Hafen has published with leading academic journals his work on business and marketing topics such as digital marketing, social media, and U.S. business history. Notably, he has a wealth of industry experience with well-known multinational companies which helped him establish his network within the corporate community. In these positions, Dr Hafen managed portfolios of products and brands, oversaw marketing communications, media planning, innovation, and retail strategy, and has been responsible for profit and loss management. Furthermore, he helped multinational corporations exceed growth and profit targets, and delivered above-average sales and volume targets.

During his tenure at Goldman Sachs, Dr Hafen was responsible for leading consumer communications, public relations, customer acquisition, media planning, innovation, and product strategy in the bank's digital division. He and his team of 20 employees launched Goldman Sachs' first influencer program, resulting in a 50% increase in acquisition efficiencies and Goldman Sachs' entrance into new social media platforms such as TikTok.

Dr Hafen also held various roles at Nestle S.A., where he oversaw consumer communications, media planning, innovation, retail strategy, and P&L management on the company's brand portfolio. He launched Nestle Splash, which was ranked #4 in IRI's Top 10 Innovations out of 23k new products in food and beverage. At Microsoft, he led the marketing strategy for U.S. Surface Tablets and Windows Phones and drove a 50% increase in unit sales, 33% increase in share, and 20% increase in brand consideration and purchase intent for Microsoft Devices.

As a mentor, Dr Hafen teaches courses on Marketing Strategy and Advanced Marketing Strategy courses in Yale and Columbia University. His courses are highly rated by students and have been recognized as the top-rated class at the Columbia Business School.

DR TOM HAFEN, COLUMBIA UNIVERSITY

MARKETING MANAGEMENT AND BRAND STRATEGY IN A DIGITAL AGE

Suitable for students interested in:

BUSINESS MANAGEMENT
Consumer Patterns | Market Analysis | Strategy

MARKETING
Advertising | Brand Management | Digital Marketing

In today's ultra-competitive business world, effective Marketing Management and Brand Strategy are key components for any business to achieve success. However, these are not easy tasks, especially given that modern-day consumers are constantly overwhelmed with information. Furthermore, with the emergence of new channels and tools for marketing, it has become increasingly challenging to navigate the marketing landscape effectively.

This research course introduces the principles of brand management and advertising as practised by industry leaders today. Although the implementation of marketing programs has undergone a massive transformation from conventional to digital media, the underlying principles of consumer driven marketing remain essentially the same; we will discuss how great marketing, including digital programming, is driven by a sound understanding of consumer segmentation, brand positioning, distinct product benefits, and relevant in-market executions.

Upon completion of this research course, students should understand essential marketing concepts and use them to develop marketing strategies. A marketing strategy is a long-term plan that outlines how a company or organisation intends to build, develop, and manage its brand to achieve its business goals. It is a comprehensive approach to branding that encompasses all aspects of how a company presents itself to the world, including its visual identity, messaging, and customer experience. In this research course, students will develop this understanding through core readings, basic frameworks, and case studies involving firms such as Nike, Microsoft, Louis Vuitton, Coca-Cola, Dove, Porsche, Nestle, and Sephora.

This research course is relevant for students interested in driving consumer demand regardless of career path. Students will be encouraged to conduct their own research projects through the course to gain a deeper understanding of marketing management and brand strategy. There are no prerequisites to taking this research course.
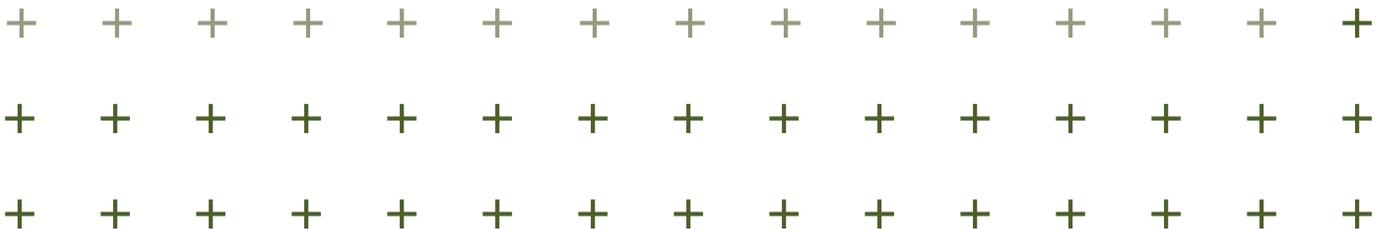
DR KEIVAN AGHASI

CURRENT POSITIONS

Honorary Associate at the Cambridge Judge Business School, University of Cambridge

Assistant Professor (Lecturer) in Entrepreneurship at the Management School, University of Sheffield

Dr. Keivan Aghasi is a Lecturer in Entrepreneurship at the University of Sheffield. Prior to his current appointment, he was a Research Associate at the Entrepreneurship Centre, University of Cambridge Judge Business School where he currently holds an honorary Associate position. His research areas revolve around unravelling and alleviating the challenges of growth and transformation of start-ups into viable businesses. In particular, he is investigating the impact of structured support programmes (e.g. accelerators and incubators) and scalable (regional) interventions in the start-up ecosystem to bolster entrepreneurship. He has participated and been consulted in several European Commission and nationally funded projects in the UK and Italy related to understanding the challenges of resource acquisition for start-ups and growth for SMEs as the driver of innovation in various sectors, including high-tech, knowledge-intensive, and cultural creative industries.

As a mentor, Dr Aghasi has taught MBA and Executive MBA courses at the University of Sheffield and the University of Cambridge. He also mentors graduate and PhD students studying entrepreneurship and entrepreneurial finance.

DR KEIVAN AGHASI, UNIVERSITY OF CAMBRIDGE

STARTUP FINANCING AND INVESTMENT

Suitable for students interested in:

ENTREPRENEURSHIP
Startups | Disruptive Technology | Venture Capital

INVESTMENT AND FINANCE
Valuation and Investment | Business Model Analysis

FINANCIAL MANAGEMENT
Fundraising | Wealth Management | Merger & Acquisation

Why do few start-ups receive a valuation of over $1 Billion, while many more cannot even raise the amount to get by and survive? Why do we have only a handful of start-ups to go public? Which start-ups to invest in in an overcrowded entrepreneurial ecosystem? These are very important questions for any active investor or venture capital firm to think about.

The research course will focus on entrepreneurial finance (i.e. venture capital investment). It first will cover fundamentals in the valuation of start-ups, modes of investment, and fundraising processes. The students will learn where to look in entrepreneurs' pitch decks, how to assess business plans, and how to ask the right questions to prompt evaluation regarding the viability of entrepreneurial ideas belonging to various fields, from deep tech (e.g. AI, machine learning, and fintech) to creative tech (e.g. games and virtual reality). Students then will gain expertise in designing the optimal portfolio for more efficient returns on investment and protecting the investment. These skills and expertise will develop business acumen and investor mentality to spot a unicorn start-up. By the end of the course, students will conduct a research project related to these areas; this will help students develop a deeper understanding of finance and investment.

This research course exposes students to the core theories, concepts, and tools used to screen high-potential start-ups and maximise the return on investment. Students will learn key theoretical concepts, tools, and approaches to entrepreneurial finance and their application in valuation and investment in new businesses. They will understand the essential topics in business model analysis, intellectual property screening, route to financing, and corporate governance.
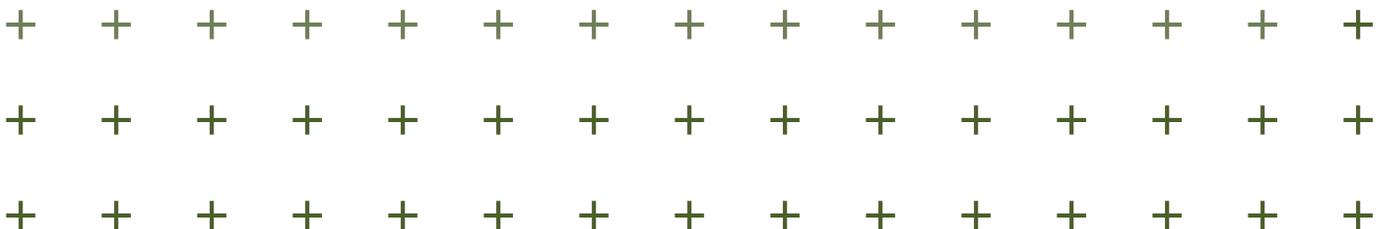
DR KEIVAN AGHASI, UNIVERSITY OF CAMBRIDGE

ENTREPRENEURSHIP IN THE AI ERA

Suitable for students interested in:

ENTREPRENEURSHIP
Innovation | Venture Capital | Investments

BUSINESS TECHNOLOGY
Artificial Intelligence | Data Analytics | Digital Disruption

In today's fast-paced digital landscape, entrepreneurship is being transformed by the rapid advancement of artificial intelligence and other disruptive technologies. **This research course offers students an in-depth exploration of the opportunities and challenges in launching and scaling ventures in the AI era.** The curriculum emphasizes foundational principles of entrepreneurship, such as opportunity identification, innovative business model development, and effective strategies for securing funding. These essentials are paired with a keen focus on the unique dynamics introduced by generative AI and emerging digital technologies.

The research course begins by examining the profound impact of digital disruption on traditional industries and the rise of new markets shaped by technology. Students will learn to leverage AI and machine learning to drive innovation, streamline processes, and enhance decision-making. Key topics include data-driven entrepreneurship, where participants will explore how to use data analytics to uncover insights, optimize operations, and identify untapped opportunities. The research course also covers practical approaches to navigating the complex funding ecosystem, including venture capital, angel investing, and crowd-funding, as well as strategies for scaling businesses and achieving sustainable growth.

Leadership and team-building are integral components of the research course, equipping students with the skills to inspire and manage teams in a rapidly evolving digital environment. Students will explore how to cultivate adaptive, innovative organizational cultures capable of responding to technological and market shifts.

Through engaging lectures, TA-led sessions, and a comprehensive research project, participants will develop both practical and academic expertise at the intersection of entrepreneurship and disruptive technologies. The research course culminates in a final project that synthesizes their learning and applies it to real-world business challenges.

By the end of the research course, students will be well-prepared to navigate the complexities of entrepreneurship in the AI era, equipped with the knowledge and skills needed to turn innovative ideas into successful ventures.
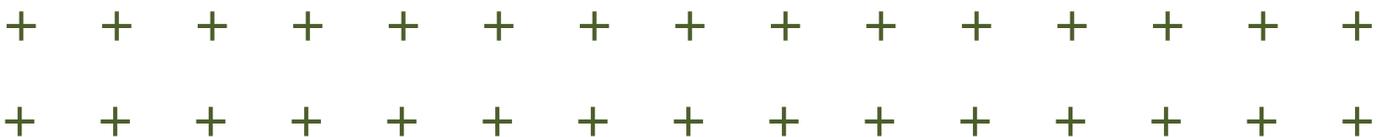
DR ABDULLAH YALAMAN

CURRENT POSITIONS
Associate Researcher, Centre for Applied Macroeconomic Analysis (CAMA), Australian National University
Professor of Finance, Eskisehir Osmangazi University

PREVIOUS APPPOINTMENT
Visiting Professor, University of Cambridge

A leading researcher in finance, with over 20 years of experience, noted for his work on financial market behaviour, high-frequency data analysis, and advanced modelling, particularly in the context of volatility spillover and the global impacts of COVID-19.

As a researcher, Dr Yalaman specialises in High-Frequency Data Analysis and Financial Econometrics, with a focus on volatility spillover and risk management. His research interests encompass Finance, Fintech, Financial Market Microstructure, Financial Crises, Macro-Finance, Behavioral Finance, Sustainability, Data Science, and Big Data. He is particularly intrigued by the global economic and financial impacts of COVID-19, alongside advanced studies in high-frequency data analysis and international economics.

Dr. Yalaman's work delves into the nuances of financial market behavior, exploring how information flows through markets at high speeds and the implications for trading strategies and risk assessment. His expertise in financial econometrics allows him to develop sophisticated models that capture the complexities of market dynamics and predict potential volatility and spillover effects. In addition to his focus on traditional finance topics, Dr. Yalaman is passionate about the intersection of finance and technology, particularly how innovations in Fintech and Big Data can transform financial markets and enhance sustainability practices. His research on the macroeconomic implications of financial crises provides critical insights into the resilience of financial systems and the efficacy of policy interventions in times of economic distress.

With 20 years of experience in finance, Dr. Yalaman has authored numerous articles in leading peer-reviewed journals including the *Cambridge Journal of Regions, Economy and Society, The Journal of International Development,* and *Economics Letters.* His insights on global COVID-19 stimulus packages have also garnered attention from major media outlets such as BBC, TIME, Forbes, and the Washington Post.

As a mentor, Dr Yalaman teaches a diverse array of courses, including Business Finance, Financial Management, and Investment for MSc students, Advanced Econometrics, Financial Modeling, International Economics, as well as Applied Econometrics at Columbia University, among others.

DR ABDULLAH YALAMAN, AUSTRALIA NATIONAL UNIVERSITY

MODELLING STOCK PRICE:

STOCK MARKET DYNAMICS AND RISK MANAGEMENT

Suitable for students interested in:

BUSINESS
Risk Management | Investment Strategies

FINANCE
Stock Market Dynamics | Modelling | Volatility

ECONOMICS
Models | Statistical Analysis | Forecasting

This research course covers the basics of stock market dynamics and risk management. Students will grasp fundamental concepts in finance and economics, and specifically, learn to forecast economic and financial data using statistics and economic models.

Starting with essential finance and economic principles, you'll then delve into risk management in stock trading and investments. Students will explore theories like modern portfolio theory to understand the relationship between risk and return, along with asset pricing principles, market efficiency, and factors affecting stock prices.

Advanced topics include modelling stock market volatility and predicting stock market movements, especially during financial crises, while also examining the interconnectedness among stock markets.

Furthermore, students will gain practical experience through case studies and exercises using statistical software and programming languages commonly used in finance and economics. These exercises will test for the significance of links among stock markets and how these connections change during financial crises.

Throughout the course, real-world case studies, simulations, and practical exercises will be integrated to provide hands-on experience in applying modelling techniques and risk management strategies to actual financial data.

By the end of the course, participants will have gained a strong understanding of basic finance and economics concepts. More specifically, they will have developed a solid foundation in modelling stock price dynamics and implementing effective risk management strategies. This knowledge will empower them to make informed investment decisions and manage financial risk adeptly in today's dynamic markets.

UNIVERSITY OF CAMBRIDGE

DR KEVIN SCHNEIDER

CURRENT POSITION

Research Associate in Theoretical Finance, Cambridge Judge Business School, University of Cambridge

A scholar who integrates real options theory into corporate finance, revealing how managerial flexibility under uncertainty shapes optimal corporate strategies and influences stock returns.

As a researcher, Dr Schneider investigates the impact of real options on corporate policies and expected stock returns, focusing on how the flexibility and choices available to firm managers under uncertainty shape these outcomes. By examining optimal exercise strategies of real options, he uncovers value-maximising corporate policies, while analysing the value and riskiness of these options to gauge firms' expected stock returns and cost of capital. His research bridges corporate finance and asset pricing, with a specialisation in theoretical finance, particularly Investment-Based Asset Pricing and Real Options and Firm Dynamics.

Dr. Schneider's work delves into the strategic decision-making processes within firms, highlighting how managerial flexibility in investment and operational choices under uncertainty can significantly influence a firm's financial performance and market valuation. He employs advanced mathematical and econometric models to dissect the intricate relationships between corporate policies and market outcomes. Additionally, his research provides critical insights into the dynamic interplay between firm behavior and broader economic factors, offering a comprehensive understanding of how firms can navigate and thrive in volatile markets.

Dr Schneider has presented his work at numerous prestigious conferences, including the 2024 SFS Cavalcade North America, the 2024 European Finance Association (EFA) conference, and the 2024 CMU-Pitt-PSU Finance Conference.

As a mentor, Dr Schneider has taught courses in Introduction to Derivatives, Financial Derivatives, Derivatives Securities at the University of Cambridge. His other teaching experience also includes the Kellogg School of Management of Northwestern University, University of Michigan Ross School of Business, NYU Shanghai, and Ecole Normale Supérieure (Paris).

DR KEVIN SCHNEIDER, UNIVERSITY OF CAMBRIDGE

FINANCIAL MARKETS AND TRADING:

PRACTICAL STRATEGIES IN THE WORLD OF FINANCE

Suitable for students interested in:

FINANCE
Institutions | Instruments | Trading

INVESTMENT
Strategies | Behavioural Finance | Capitalization

ECONOMICS
Cryptocurrency | Indicators | Currencies

Financial Markets and Trading is a dynamic and engaging research course designed to explore the fascinating world of finance. This course will provide students with a solid foundation in financial markets, trading, and the principles that drive stock prices, making it perfect for those interested in pursuing careers in business, economics, or investing. The course includes both fundamental and technical analysis, teaching students how to evaluate financial statements and read market charts. A highlight is the hands-on stock market simulation, where students can apply their knowledge in a risk-free environment.

Throughout this research course, students will gain a comprehensive understanding of financial markets and the role of various financial institutions. Students will learn about different financial instruments, such as stocks, bonds, mutual funds, and derivatives, and how these are traded in the market. We'll also discuss asset classes such as currencies, commodities, and cryptocurrencies.

Students will also develop practical skills in trading and investment strategies, including both fundamental and technical analysis. Fundamental analysis will teach you how to evaluate financial statements, earnings reports, and economic indicators, while technical analysis will help you read charts and use indicators to predict market movements. We will explore the factors that influence stock prices, from economic conditions and company performance to market sentiment and behavioural finance.

This interactive course combines lectures, discussions, and practical activities, using real-world examples and current events to bring concepts to life. It's perfect for students with an interest in finance, business, or economics, whether students aim for a career in the financial sector or simply want to understand how financial markets operate.

LONDON SCHOOL OF ECONOMICS
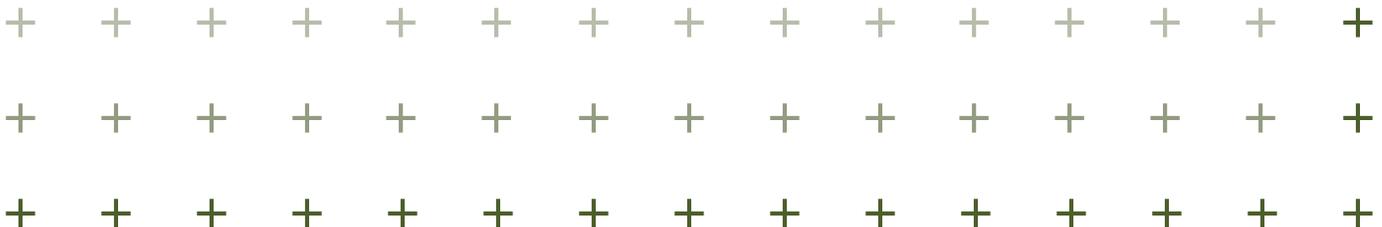
DR APARNA VENKATESAN

CURRENT POSITIONS

Fellow, Department of Management, London School of Economics

Associate Teaching Fellow, Higher Education Academy, UK

PREVIOUS APPPOINTMENTS

Senior Teaching Fellow, Department of Business and Management, University of Manchester

External Management Consultant, HME Derby

A research scientist specialising in the fields of organisational behaviour and human resource management, advocating for gender equality in the workplace.

As a researcher, Dr Venkatesan is interested in exploring and identifying the sources of intersecting inequalities in the formal labour market, with particular interest in South Asia. She employs intersectionality-informed multilevel models while simultaneously analysing labour market policies or conditions that impact gender inequality. Her previous research discusses the interests of UNDP's Millenium Development Goal 3 for India in promoting gender equality in the formal employment sector.

She is presently a member of several prestigious academic organisations, such as the British Academy of Management (BAM), British Sociological Association (BSA), and the European Group of Organisational Studies, to name a few. Furthermore, Dr Venkatesan is a recipient of many awards and research grants, the most recent being the Global Development Institute Seed Grant from the University of Manchester

Her work has been published in a number of established journals, including Human Relations, Human Resource Management Journal, and Gender Work and Organisation Journal. She has also presented her research and was invited as guest speaker in various conferences and universities, such as the International Labour Organization (ILO) Conference, University of Brighton Business School, and Women in Engineering Conference at the University of Aberdeen. Currently, Dr Venkatesan serves as a peer reviewer for the *International Journal of Human Resource Management, Gender, Work and Organization, Equality, Diversity and Inclusion: An International Journal*, and *Contemporary South Asia*.

As a mentor, she teaches courses on management, organisational behaviour and theory, strategy and business analytics, and gender studies to both graduate and undergraduate students of the London School of Economics.

DR APARNA VENKATESAN, LONDON SCHOOL OF ECONOMICS

BREAKING THE GLASS CEILING:

UNDERSTANDING GENDER INEQUALITY IN THE WORKPLACE

Suitable for students interested in:

SOCIAL SCIENCE
Economics | Gender Studies | Inequality

SOCIAL JUSTICE
Economic Justice | Intersectionality

In 2023, Harvard economist Claudia Goldin was awarded the Nobel Prize in economics for her work examining the gender pay gap. Despite the ongoing conversations about gender inequality, the persistent reality is that the gender pay gap has yet to disappear.

In this research course, we will delve deeper into the complex issues surrounding gender inequality, particularly within organisations. We will ask and examine these difficult yet important questions: Why do women not progress at the same pace as men in the workplace? How do gender and stereotypes attached to gender within a society transpire to and shape the workplace? How do unconscious biases contribute to workplace inequality?

The course will approach these questions from various perspectives, examining real-world scenarios through multiple theoretical frameworks in behavioural science, psychology, and sociological theory. Students will be encouraged to explore the questions through structural, cultural, and individual factors.

During the course, students will be expected to work on their independent research projects. They will gain an understanding of the interdisciplinary process involved in applying theories from various fields to analyse complex problems related to gender inequality. Moreover, they will be encouraged to contemplate and explore strategies for addressing these issues and making a real-world impact.

DR APARNA VENKATESAN, LONDON SCHOOL OF ECONOMICS

ORGANISATIONAL BEHAVIOUR AND BUSINESS PSYCHOLOGY:

HOW TO BRING YOUR STARTUP FROM GARAGE TO NASDAQ

Suitable for students interested in:

BUSINESS
Startups | Venture Capital | Startup Funding

INVESTMENT MANAGEMENT
Impact Investing | ESG Investing

ORGANISATIONAL BEHAVIOUR
Decision-Making | Interactions and Influences

How can one build a successful startup akin to Google and Facebook? Or achieve something as extraordinary as what OpenAI and Apple have accomplished, where their projects fundamentally alter how we live? The key aspect of this endeavour is the involvement of "people." It's not just the effort of a visionary founder but rather a collaborative effort of people from diverse backgrounds and cultures within the organisation.

As the number of people grows, challenges within the organisation would inevitably arise. Some may not be as effective and may slow progress, while others may seize opportunities to propel the startup/organisation to the next level. Organisational behaviour, at this moment, would be an important tool to tackle the challenge.

In this research course, students will delve into the realm of organisational behaviour, gaining insights into why individuals behave as they do within various organisational contexts. Whether in startups, social enterprises, non-profits, or other settings, students will explore how each individual's behaviour influences the organisation as a whole. Through case studies, discussions, and practical applications, students will uncover the intricate dynamics that shape organisational behaviour and its impact on organisational success.

Furthermore, students will be encouraged to analyse organisational behaviour through both psychological and social perspectives. The research course will guide students to understand how sociology and psychology shape individuals' behaviour within organisational settings. They will explore how cultural factors influence individuals' thoughts, decision-making processes, and behaviour, especially in cross-cultural contexts within global organisations. By examining these dimensions, students will develop a comprehensive understanding of how various factors intersect to shape organisational dynamics and effectiveness. Students are expected to conduct independent research projects throughout the course and actively engage in discussions while considering various real-world scenarios.

UNIVERSITY OF CAMBRIDGE

DR PERMAN JORAYEV

CURRENT POSITION

Research and Start-up Advisor, University of Cambridge

A multidisciplinary expert who bridges advanced science and business strategy.

As a researcher, Dr Jorayev bridges the gap between research and industry while leading and advising on research direction. His expertise spans AI/ML, chemistry, biology, and materials science, with a strong focus on drug discovery and pharmaceutical innovation. In addition to his work in these fields, Dr. Jorayev has contributed to cutting-edge research in quantum computing and advancements in cell and gene therapy, demonstrating a commitment to interdisciplinary approaches that drive innovation.

Beyond academia, Dr. Jorayev has extensive experience in venture capital, currently serving as a Senior Investment Associate at Verve Ventures. He specializes in target and market analysis, competitive landscape evaluations, and the development of business models and go-to-market strategies. His deep understanding of financials, including investment and unit economics, equips him to assess business plans and identify high-potential investment opportunities. Dr. Jorayev also provides guidance on mergers and acquisitions, effectively bridging the gap between scientific advancements and business growth strategies. His ability to translate complex scientific discoveries into viable business solutions underscores his unique expertise and impact on both fields.

As a mentor, Dr Jorayev supports students by offering guidance in scientific research, innovation, and entrepreneurial thinking. He provides insights into emerging market and technological trends, empowering students to explore the intersections of science, technology, and business. By fostering a comprehensive inter-disciplinary learning environment, Dr Jorayev prepares mentees to tackle complex challenges and make meaningful contributions to both research and industry.

DR PERMAN JOYAYEV, UNIVERSITY OF CAMBRIDGE

FROM LAB TO MARKET:

HOW SCIENCE, TECHNOLOGY, FINANCE, AND ECONOMICS SHAPE THE FUTURE

Suitable for students interested in:

ENTREPRENEURSHIP AND VENTURE CAPITAL
Startup Economics | Capital Investments | Market

TECHNOLOGICAL INNOVATION
Tech Companies | Early Stage Tech | Tech Sub Sectors

The first ever AI conference was held in 1956. From the discovery in 1883, the first ever commercial solar panel was made by Bell Laboratories in 1954. Why did it take half a century for these technologies to become ubiquitous in our lives?

This research course is designed for aspiring entrepreneurs, innovators, and investors that are fascinated by the interaction of multiple areas, like science, technology, finance, and economics. From the basics of finance and startup economics to assessing technological feasibility and market fit, this research course provides an comprehensive introduction to the entrepreneurial and venture capital world. By blending theory with practice, the research course combines real-world case studies with interactive workshops, inspiring students to think critically about the future of innovation.

We begin with the studying of how some of the world's greatest companies–Illumina (genome sequencing), Tesla, and Google–were built. In the first weeks, students will explore the building blocks of technological innovation, including the capital investments required to build a company, market size estimation, go-to-market strategies, pricing models, and financial planning. This curriculum aims to show the progression from the inception of an idea within a laboratory, basement, or garage to its subsequent introduction into the marketplace, followed by the expansion and scaling of businesses. Whether you are interested in the role of an entrepreneur or an investor, this research course will serve as a solid foundation for analyzing ideas and early-stage technologies.

In the second half of the research course, students will apply these learnings and principles to technologies and markets of their choice, such as batteries, quantum computing, cell and gene therapy, AI, or large language models (LLMs), etc. They will conduct deep dives into specific subsectors, creating market maps and stress-testing their ideas with the team in collaborative supervisions. By the end of the course, students will produce a polished project, while gaining practical skills to evaluate and champion innovation.

UNIVERSITY OF CAMBRIDGE
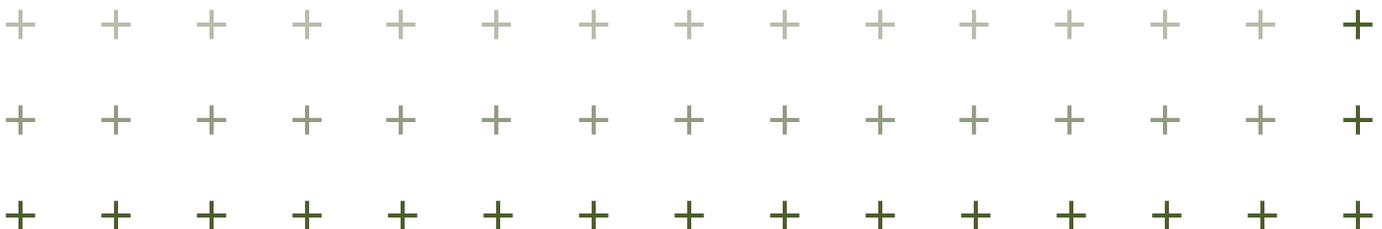
DR HARALD WYDRA

CURRENT POSITIONS

Professor of Politics, Cambridge

Official Fellow of St Catharine's College, Cambridge

Affiliated Lecturer, Department of Politics and International Studies, Cambridge

College Lecturer, Corpus Christi College, Cambridge

Founding Editor of International Political Anthropology

PREVIOUS APPOINTMENTS

Visiting Professor, Luiss Guido Carli University, Rome

Visiting Professor, University of Wrocław

Visiting Professor, University of Paris Ouest Nanterre La Défense

Visiting Fellow, Australian National University, Canberra

Assistant Professor of Political Science, University of Regensburg

A political scientist working on the politics of memory with a regional focus on Eastern Europe.

As a researcher, Professor Harald Wydra's work in political science and history reflects his own autobiography. Born in Poland and raised in Germany, his research in the past two decades has focused on Eastern European and Russian politics, notably the transformation processes from communism to democracy. He has also published widely on the politics of memory and political anthropology. He is the author and editor of six books, amongst which *Communism and the Emergence of Democracy* (Cambridge University Press, 2007), *Democracy and Myth in Russia and Eastern Europe* (Routledge, 2007), *Politics and the Sacred* (Cambridge University Press, 2015), and the *Handbook of Political Anthropology* (Edward Elgar, 2018).

As a mentor, Professor Wydra teaches courses on European and post-Soviet politics at Cambridge, and has supervised under-graduates, as well as PhD students in politics and history, on a wide range of issues including the politics of memory and political anthropology.
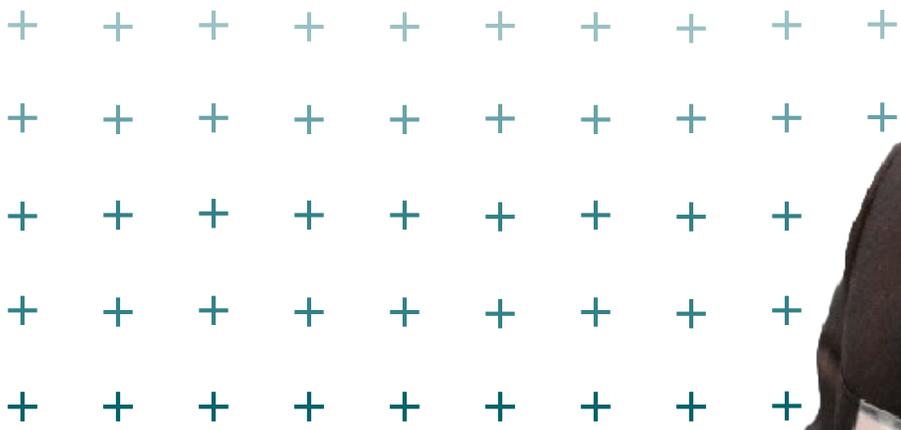
DR HARALD WYDRA, UNIVERSITY OF CAMBRIDGE

THE GEOPOLITICS OF THE NEW WORLD ORDER:

RUSSIA, CHINA, AND THE USA

Suitable for students interested in:

POLITICAL SCIENCE

Great Power Hegemony | International Security | Peace and Conflict Resolution

HISTORY

Cold War in Europe | East Asia | Post-Soviet Space

INTERNATIONAL RELATIONS

Post-World War II Orders | The Architecture of the Liberal International Order | The End of the American Age | Russian Revisionism | The Rise of China | The New Wars of the 21st Century

The key question of this research course is: 'How to maintain stability and order in a world that seems to be changing at an ever increasing pace?' Following the collapse of the Soviet Union, the end of the Cold War promised the dawn of a New World Order. The apogee of the American Age was founded on presumably universal values, a globalised economy, and the provision of public goods. Yet, evidence of the last thirty years or so suggests that such a unilateral order could barely conceal the imperial overstretch of liberalism and US hegemony. Revisionist powers such as Russia or newly rising economic powers such as China have challenged the liberal consensus. Challenges by international terrorism, failed attempts at regime change, rising tensions at peripheral regions, and the return of hot wars are indicators for the end of unilateralism and a growing confusion about the contours of a new world order. This course aims to gauge such contours by applying a historically rich and culturally sensitive approach to international relations. It will draw on theories, historical configurations, ideological traditions, and civilizational patterns that have shaped longer-standing patterns of power, influence, and ambition.

Students will be introduced to the fundamentals of Europe post-World War II order, the foundations of post-1991 US hegemony, the rise and growing integration of China in the global economy, aspects of revisionism by Russia, and the geostrategic challenges of growing multipolarity.

The research course will give particular attention to domestic ideological traditions, types of regimes, and strategic ambitions of individual nations. It will introduce into the main patterns of the American age, Russian revisionism, and China's rise as an economic giant as well as a political heavyweight. Moreover, it will introduce students into the main theories by which we can assess the contours of a future world order, including the geopolitics of spaces and territory, new forms of warfare, including hybrid war, frozen conflicts, and the challenges of digital warfare.

DR HARALD WYDRA, UNIVERSITY OF CAMBRIDGE

THE ANATOMY OF WAR:

EXPLORING MOTIVATIONS, STRATEGIES, AND CONSEQUENCES

Suitable for students interested in:

HISTORY
War-Making |State-Building | Types of War

INTERNATIONAL RELATIONS
Anarchy and War | Rules of Warfare | International Law

PSYCHOLOGY
Theories of Aggression | Violence and its Containment | Theories of Parochial Altruism

EVOLUTIONARY AND SOCIAL ANTHROPOLOGY
Roots of Human Violence | Natural Selection and Struggle for Survival

This course explores the question: 'Why do people lead war?' The aim is not to provide a definite answer but to open different perspectives beyond the narrow lens of contemporary international politics. Warfare is arguably the most destructive and long-standing form of organised violence. With the decline of the classical forms of inter-state wars, new types of warfare have made the phenomenon more difficult to discern. Today, we see instances of hybrid war, civil wars, the war on terror, or climate wars. For all its destructiveness, wars can also be productive as they may lead to economic and political stability. Many even consider them to be the potential source of a moral good and a legitimate order around which a political community can be built. What are the key motivations, strategies, and goals of engaging in organised violence? Are wars driven by the struggle for survival, natural aggression, or the imperative of reproduction? Are they consequences of great ambition, evil intentions, or revenge? Can we approach such a multi-faceted phenomenon by a systematic pursuit of hypotheses at all?

Students will be introduced into key texts on the causes of war, including material from psychology, evolutionary biology, archaeology, history, social anthropology, and international relations. The course will furthermore draw on a selected range of cases from mythology, history, and current instances of warfare in order to illustrate some of the most cogent hypotheses. It will also explore the purpose and rationality of warfare, be it for territorial expansion, economic gain, for religious faith, or for collective identity. Last not least, the course aims to assess possibilities of preventing, containing, or regulating war as a system of organised violence by means of legal and ethical norms as well as strategies of conflict-resolution.

UNIVERSITY OF OXFORD

DR OTHON ANASTASAKIS

CURRENT POSITIONS

Director, European Studies Centre, Oxford University
Director of South East European Studies, Oxford University
Senior Research Fellow, St Antony's College, Oxford University
Associate, Department of Politics and International Relations and the Faculty of History, Oxford University
Senior Research Fellow, Oxford School of Global and Area Studies (OSGA), Oxford University
Visiting Professor, Prague School of Economics
Region Head in Europe, Oxford Analytica

PREVIOUS APPOINTMENTS

Researcher, London School of Economics
Expert & Advisor on European Union Matters, Greek Ministry of Foreign Affairs
Director of the European Studies Centre, St Antony's College, Oxford University

A researcher exploring the impact of diaspora communities on political economies and sociocultural aspects in Europe.

As a researcher, Dr Anastasakis is the Principal Investigator of two research projects at Oxford: the Greek Diaspora Project at SEESOX and the OX/BER funded Migration Diplomacy and Turkey-EU Relations. Both projects seek to understand how diaspora affects the political economy and sociocultural aspects of both home and host countries. Dr Anastasakis has a wide range of research interests spanning various areas of politics and geopolitics, with a particular focus on the Balkan region and Southern and South Eastern Europe.

Dr Anastasakis has published ten books discussing extensively on these topics, the most recent is "Diaspora engagement in times of severe economic crisis; Greece and beyond" published by Palgrave Macmillan. Furthermore, He has contributed a number of book chapters as well as journal articles published in *Caucasus International, South East European and Black Sea Studies,* and *Perceptions Journal of International Affairs*, among others.

As a mentor, Dr Anastasakis teaches courses on "South East European Politics and European Integration," "EU Politics," and "Global Geopolitics" at the University of Oxford.
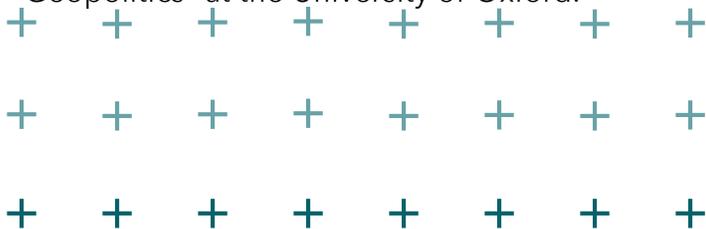
DR OTHON ANASTASAKIS, UNIVERSITY OF OXFORD

THE DECLINE OF DEMOCRACY AND THE RISE OF AUTHORITARIANISM

Suitable for students interested in:

POLITICAL SCIENCE

Democracies | Regime Challenges | Ideological Polarisation

In most parts of the world, democracy is under attack by autocrats, authoritarian leaders and groups that reject pluralism and freedom of expression.

According to many non-governmental organisations which measure democratic politics, the world, at present, has more dictatorships than liberal democracies, with almost 70% of the world population living under autocratic regimes. In these regimes, one sees a low quality of electoral politics, problems with the rule of law, control of civil society, lack of media independence and investigative journalism, weakness of the liberal institutions to control the power of politicians and increasing references to nationalistic politics.

Some of these trends are also happening in the democratic West, in some states in Europe and the United States, where protectionism, identity politics and ideological polarisation are espoused openly by far right parties and populist leaders.

Why is democracy under threat? How is this happening? What is its impact on the citizens and, especially, the younger generations? Our research course will attempt to answer these questions by looking at the conditions which lead to the rise of undemocratic politics and what should be done in order to avoid the democratic decline.

In this research course, students will engage in rigorous exploration of the multifaceted challenges facing democracy today. Through in-depth analysis of scholarly literature, case studies, and empirical data, students will develop a comprehensive understanding of the factors contributing to the erosion of democratic norms and institutions worldwide. They will have the opportunity to conduct original research projects, employing diverse methodologies such as qualitative analysis, comparative politics, and statistical modelling to investigate the root causes and consequences of democratic decline.

Through critical inquiry and interdisciplinary dialogue, students will cultivate the analytical skills and methodological toolkit necessary to contribute meaningfully to the study of democratic governance and political theory. By the end of the course, students will produce research papers that offer insights into the dynamics of democratic erosion and propose actionable recommendations for safeguarding democratic principles in an increasingly challenging global landscape.

UCLA

DR JASON SEXTON

CURRENT POSITIONS

Lecturer, Department of Sociology, UCLA
Visiting Research Scholar, California Center for Sustainable Communities, UCLA

PREVIOUS APPOINTMENTS

Associate Dean of Academic Programs, UCLA
Visiting Fellow, UC Berkeley Center for the Study of Religion
President, American Academy of Religion-Western Region
Editor, Boom California

A social theorist who uses an interdisciplinary approach to study group behaviour, law and ethics, religion/theology and norms.

As a researcher, Dr Sexton studies internal structural commitments of communities and their members and how these relate to assumed cultural and theological norms that show up in social and ethical action. His research focuses closely on California and its culture, the prison and its governance structures, contemporary religion/theology, and on convergent points where these subjects intersect.

His scholarly contributions were published in high-impact academic journals such as *Political Theology* (Taylor & Francis), *International Journal of Public Theology* (Brill), and Theology (Sage), to name a few. Additionally, he has authored a book titled *The Trinitarian Theology of Stanley J. Grenz*, published by Bloomsbury, and has contributed chapters to theology books released by Routledge and HarperCollins, among others. Beyond academia, Dr Sexton also engages in popular writing which has appeared in the *LA Times, SF Chronicle,* and *Los Angeles Review of Books*, etc.

As a mentor, Dr Sexton has taught a wide range of courses in the Sociology department. He uses an interdisciplinary approach in teaching to raise the level of inquiry and focus on big questions. Through readings, writing, lectures, and Socratic conversations, he challenges students to develop their own conclusions, helping them assemble intellectual and practical tools to cultivate their minds and hearts in order to most meaningfully see the world from their unique perspectives.
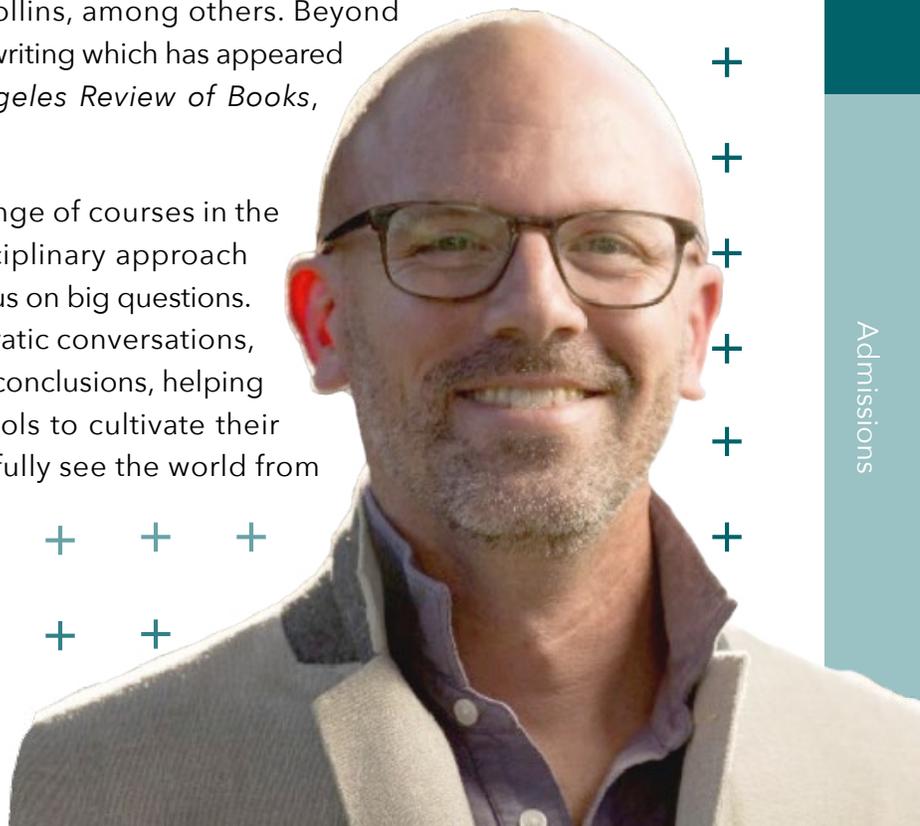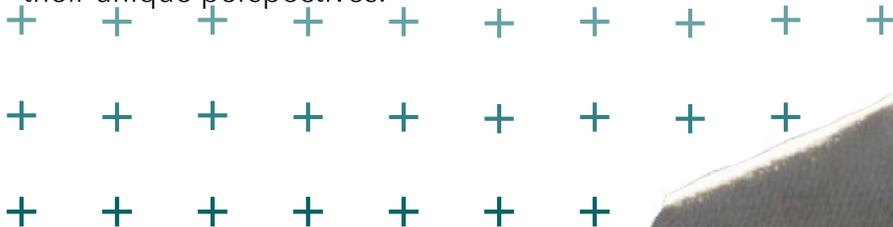
DR JASON SEXTON, UCLA

ENVIRONMENTAL SOCIOLOGY:

MONEY, POWER, AND THE NATURE

Suitable for students interested in:

SOCIOLOGY

Intersectionality | Power Dynamics | Resource Allocation

ENVIRONMENTAL STUDIES

Sustainability | Justice | Health Inequality

POLITICAL SCIENCE

Political Contention | Mobilisation | Policy Reform

This course will provide an interdisciplinary overview of the relationship between society and the environment, along with the opportunity to explore a particular regional institution or socio-political entity and its relationship to the environment, society, and larger questions of relevance. We will discover how the environment, environmental challenges and nature are all inherently social. Additionally, we will explore ways that things we normally think of as social–like politics and the economy–are shaped by nature and the environment, including how one may even begin to understand what is "natural." Engaged students will obtain a nuanced and diverse set of analytical tools to assist in understanding how "the environment" and environmental matters cannot be understood outside of and apart from the social world, and how the social world is deeply intertwined and embedded within "the environment."

Students will be able to analyse the world in ways that transcend binaries between nature (natural sciences) and society (social sciences), particularly in relation to real-world issues like climate, environmental sustainability, transitions, health inequality, and environmental justice. They will engage with cutting-edge research on the links between economic growth and environmental harm; investigate the relationship between social inequality and toxic exposure; interrogate cultural understandings of the environment and approaches to place; and critically analyse how culture and politics shape the solutions people develop to address pressing environmental issues.

Through independent research projects, students will learn how to explore interdisciplinary and social-scientific methodological possibilities. Research methods include quantitative modelling, case-based ethnographies, comparative-historical methods, and foundational disciplinary insights such as social construction, the constraining and structuring effects of culture and social institutions, and the dynamics of political contention, mobilisation, and policy change.

DR VICTORIA FENDEL

CURRENT POSITIONS

Leverhulme Early Career Research Fellow, Lady Margaret Hall, University of Oxford

Faculty Member, Faculty of Classics, University of Oxford

A researcher from an interdisciplinary background exploring the development and the patterns of usage of languages from the ancient world to today.

As a researcher, Dr Fendel comes from an interdisciplinary background. She is not only familiar with ancient languages but also has extensive experience in big data and linguistics. She was trained as a classicist (DPhil in Classical Languages and Literature from Oxford) and a linguist (MPhil in Theoretical and Applied Linguistics from Cambridge). Her main research interests concern the development and patterns of usage and the function of languages. In her research, she is interested in language contact, especially between Greek and Egyptian (Coptic), syntax, especially the interface between syntax and semantics and the application of general linguistic concepts to corpus languages. She has published in *Grapholinguistics, Varieties of Post-classical and Byzantine Greek, the Journal of Graeco-Roman Studies, etc.*

As a mentor, Dr Fendel has taught at the University of Oxford and the University of Cambridge. She has lectured on and supervised a wide range of topics including classical and comparative philology and linguistics, classical Greek and Latin languages, biblical Hebrew, and others.

DR VICTORIA FENDEL, UNIVERSITY OF OXFORD

RHETORIC AND POLITICS:

FROM ANCIENT GREECE TO TODAY

Suitable for students interested in:

CLASSICS
Ancient History | Ancient Greece and Rome

POLITICS
Political Theory | Democracy | History

RHETORIC
Linguistics | Graeco-Roman Literature

Making one's voice heard in public was a sought-after skill for those at the heart of the Athenian democracy, the Roman republic and later the Roman empire. The skilful use of language was a critical tool and a powerful weapon.

This research course provides (i) a detailed discussion of five giants of Graeco-Roman literature, the poets laureates or Nobel prize winners of the time, (ii) a deep understanding of how historical texts and events relate to the modern world, and (iii) a journey through space and time, from the margins of the Graeco-Roman world to its very centres and from the fifth century BC to the modern-day.

We will focus on the orators of the Athenian democracy, the politicians of the Roman republic and the poets of the Roman empire. Each of the three topics explores a political system and literary masterpieces written by ancient masters (our protagonists) as well as explores theories and methods that are relevant to fully comprehend and discover the topic. We will explore the theme of each topic in three ways, from a historical point of view (our political systems), from a linguistic point of view (our methods) and an analytic point of view (our theory). Thus, we are going to embed literary masterpieces in their wider historical context, see through their linguistic ingenuity and relate them to the here-and-now.

Students will develop independent research projects on political rhetoric, ancient history or relevant areas. They will learn about how to discuss the relevance of a literary masterpiece in the context of its time and discourse. In addition, students will gain transferable skills in the areas of critical thinking and analysis, and linguistic awareness and skill.
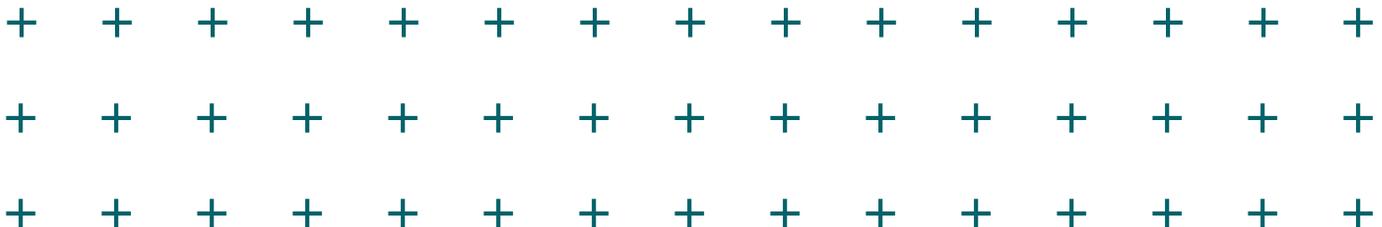
DR KARL T MUTH

CURRENT POSITIONS

Adjunct Assistant Professor, Booth School of Business, University of Chicago
Admissions Committee Member, MBA Program, Booth School of Business, University of Chicago
Adjunct Professor of Law, Pritzker School of Law, Northwestern University
Board of Directors, Founder, CEO, Haystack
Advisor, Maiden Labs Global
Advisor, Central Bank Digital Currency Lab, MIT

PREVIOUS APPPOINTMENTS

Lecturer in Economics, Law, Organisational Behaviour, Public Policy, and Statistics, Northwestern University
Board of Regents, Loyola University
Advisory Council, Rustandy Center, University of Chicago
Senior Mentor, Microsoft Ventures
CEO, FRST
CFO and Director, CHG

 A legal scholar and economist exploring the philosophical, legal, and economic foundations of business and financial management.

As a researcher, Dr Muth focuses on the effects of regulation on investors and markets. His writings have been cited in over a dozen recent Security and Exchange Commission (SEC) rulemaking documents. He is deeply interested in technology and has maintained his technical skills, inventing multiple innovations in large-scale multimedia library search, ranking, and content recommendation tasks. He taught the first Ethereum contract seminar ever taught at Northwestern's law school and has spoken on technical blockchain topics to audiences at various prestigious institutions.

Dr Muth is a highly accomplished professional with a wealth of experience in regulated industries. He has designed complex restructuring transactions and rebrokered assets worth billions of dollars from a failed NASDAQ-listed bank under FDIC supervision. Further, he designed the demutualization of a Fortune 250 insurance firm, resulting in a significant increase in profits. Dr Muth's expertise in financial regulations has earned him recognition from prominent figures such as the Secretary of the SEC. Dr Muth has been cited as well in SEC final rules and rulemaking documents. Moreover, he served as an expert witness in a securities fraud matter covered by The New York Times and The Wall Street Journal.

His works have been widely published in leading journals, such as the *Harvard Black Letter*, the *Harvard Kennedy School Africa Political Journal,* and *Rutgers Race and Law Review,* to name a few. He also has authored book chapters in the *Oxford Handbook: Global Policy and Transnational Administration* published by the Oxford University Press, *Controversies in Globalization* published by CQ Press, as well as *Emergence, Convergence and the Future of Aid and Charity & Philanthropy for Dummies* both published by John Wiley & Sons. Moreover, due to his expertise in the field of business and financial management, Dr Muth has presented his work and been invited as guest speaker in a long list of symposiums, conference, and media interviews, including the American Economic Association 2022 Annual Conference, ASPA Annual Conference, The Chicago Sun-Times, The Chicago Tribune, and TEDx, among others.

As a mentor, Dr Muth has also made significant contributions to education in addition to his impressive professional accomplishments. He has taught across five disciplines at Northwestern, developed and taught a popular innovation management curriculum, and currently teaches at the University of Chicago's Booth School of Business. He is an incumbent member of the admissions committee of the University of Chicago's MBA program for over a decade and created an endowed scholarship to make entrepreneurial paths more accessible to MBA graduates.

DR KARL T MUTH, UNIVERSITY OF CHICAGO

THE INDIVIDUAL AND THE STATE:

LAW, ECONOMICS, AND POLITICAL PHILOSOPHY

Suitable for students interested in:

PHILOSOPHY

Political Philosophy | Philosophy of Law | Philosophy of Economics

ECONOMICS

Libertarianism | Cryptocurrency | Regulation

LAW

Technological Law | Criminal Law

There is significant contemporary debate on how the state should interact with the individual, especially in the context of respecting the individual's concepts of norms, privacy, and history. The reading list in this research course is diverse and very demanding, including weekly analysis of writings from leading legal scholars, U.S. Supreme Court Justices, philosophy-of-law and law-and-economics scholars, and interdisciplinary thinkers on the topic of individualism. The individual's interaction with the state is conceptualised as a mixture of accords, bargains, and truces.

Students of this research course will traverse between, and combine, frameworks and hypotheticals that are not normally considered together, such as whether it is a zoological fact or a legal fiction that a dog's olfactory abilities are sui generis or whether Kylloian concepts of privacy are really a safeguard against future tech surveillance or are merely a small and temporary fig leaf. Macrosocietal questions of how and when truly individual action is possible are raised, including self-sovereignty concepts common to rural empowerment movements, freed people movements, cryptocurrency discussions, and libertarian subcultures.

Instruction focuses on postwar Occidental concepts of interaction between the state and the individual, with an emphasis on the evolution of new bargains in American legal philosophy and with a special interest in American criminal procedure. This research course begins with Griswoldian and Mirandesque ideas and wraps up with the implications of new technologies and on the individual's place in society, including discussion of the instructor's newest research on Timmsen and other cutting-edge appellate cases. The seminar discussion will be led as a series of debates, requiring careful reading of the texts. Students will conduct their independent research project throughout the research course, which will enable them to explore and delve into the central questions surrounding law, economics, and political philosophy.

CORNELL UNIVERSITY
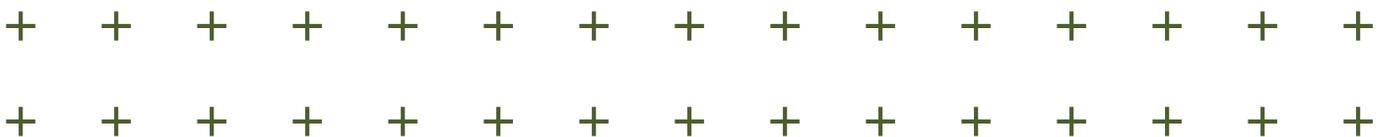
DR ERALDO SOUZA DOS SANTOS

CURRENT POSITIONS

Klarman Fellow, Department of Government, Cornell University
Assistant Professor of Criminology, Law, and Society, University of California Irvine (incoming)

An intellectual historian who examines the evolution and contestation of political concepts, uncovering their enduring impact on modern discourse and practice.

As a researcher, Dr dos Santos explores the history of ideas, the invention of political traditions, and the politics of translation. His work examines how political concepts shape discourse and practice, and how political actors contest their meanings. His first book project traces the global history of civil disobedience, shedding light on contemporary anti-protest rhetoric. Dr dos Santos also investigates forced labor and the legacies of slavery in twentieth- and twenty-first-century Brazil, with creative writing pieces stemming from this work nominated for the Pushcart Prize 2025.

His scholarly articles are forthcoming in the *Annual Review of Law and Ethics* and The *Tocqueville Review*, while his review essays have appeared in *American Ethnologist* and *GLQ: A Journal of Lesbian and Gay Studies.* Dr dos Santos' public scholarship has been featured in *Al Jazeera, The Washington Post, Folha de S. Paulo*, and *Jacobin Brasil*, among others. His research and writing bridge historical analysis, political critique, and creative expression, offering new insights into the politics of memory and identity.

As a mentor, Dr dos Santos encourages critical thinking and intellectual growth. He helps students develop their research skills and engage with complex political and historical ideas, fostering a collaborative and reflective approach to learning.
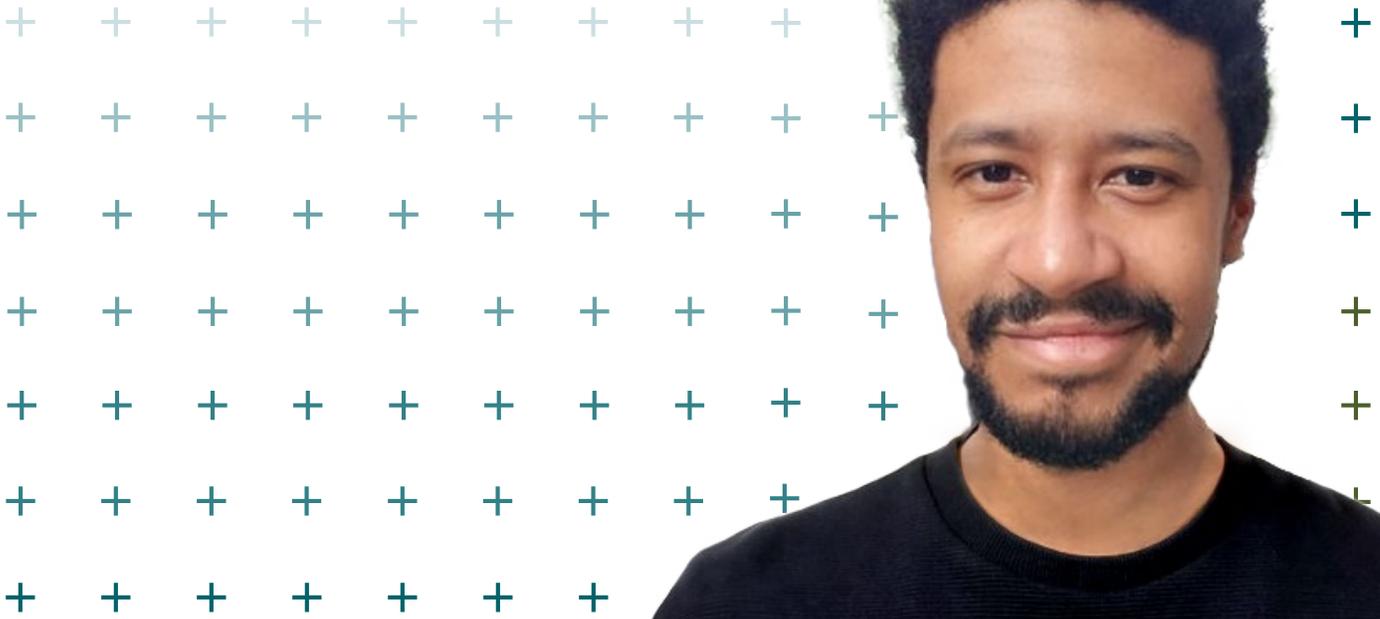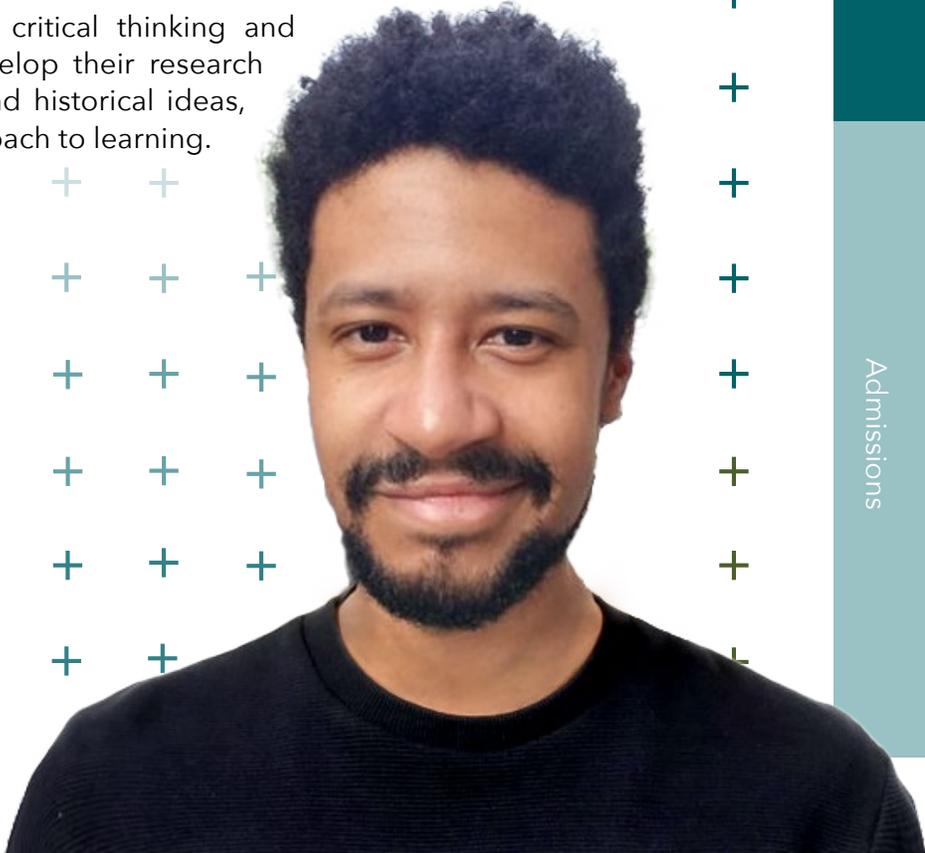
DR ERALDO SOUZA DOS SANTOS, CORNELL UNIVERSITY

CIVIL DISOBEDIENCE, RESISTANCE, AND REVOLUTION:

THE POLITICS AND PHILOSOPHY OF (NON-)VIOLENCE

Suitable for students interested in:

POLITICAL SCIENCE
Political Theory | Political Philosophy | Democracy

RADICALISM
Social Movements | Civil Disobedience | Rule of Law

Over the last half-century, civil disobedience has become a key political concept around the world. The meaning of the phrase, however, has been contested on more than one occasion—from discussions on the radicalism of Occupy Wall Street, Black Lives Matter, and Extinction Rebellion to controversy over the legitimacy of Edward Snowden's whistleblowing and recent debates about the appropriation of the concept by anti-abortion movements. But what does "civil disobedience" mean? Is it compatible with the rule of law and democratic life? Does it represent a danger to state authority? What are the differences between civil disobedience and crime, resistance, and revolution? Can civil disobedience be a right and a duty?

This research course examines the politics and philosophy of civil disobedience through a global historical lens. Drawing on both published materials and archival sources from Africa, Asia, Europe, and the Americas, we will trace the evolution of the concept—from the phrase's origins in American abolitionist circles in the mid-nineteenth century, to its circulation in the British Empire, and its eventual appropriation by activists, lawyers, and philosophers from the 1960s onwards. We will read and discuss the works of political thinkers like Plato, Thomas Hobbes, Henry David Thoreau, Mohandas Gandhi, Martin Luther King, Jr., John Rawls, and Hannah Arendt. In analyzing a variety of historical sources, we will engage with both contemporary and traditional methodological questions in the fields of intellectual history and the history of political thought, political theory, and social movement studies. Throughout this research course, we will also discuss how to produce academic writing in these fields by exploring genres such as articles, historiographical essays, book reviews, and op-eds. By the end of this research course, students will be equipped with the tools to apply historical and theoretical insights to today's most pressing political and ethical debates.

DR ESTHER ROSARIO

CURRENT POSITION

Lecturer, Department of Philosophy, Dartmouth College

A multifaceted researcher, specialising in the philosophy of sex and gender, the philosophy of science, and metaphysics, with a keen interest in race, love, and empirical philosophies of the mind.

As a researcher, Dr Rosario's expertise spans across several areas including the philosophy of sex and gender, the philosophy of science, and metaphysics. Additionally, she is also interested in philosophy of race, the philosophy of love, and empirical philosophy of mind. Dr Rosario's ongoing research is centred on the metaphysical aspects of sex and the practice of conceptual engineering. Dr Rosario has contributed a chapter in the forthcoming book titled *Routledge Handbook of Essence in Philosophy*. Further, Dr Rosario has presented her research in various prestigious conferences including the American Philosophical Association meeting, Canadian Society for the History and Philosophy of Science meeting, and the Western Canadian Philosophical Association meeting.

As a mentor, Dr Rosario is an award-winning lecturer who takes great pleasure in working with students as they harness philosophical tools to engage complex issues with creative and critical thought. Dr Rosario encourages the students to apply the concepts and theories they study to the problems of political and ordinary life. In doing so, students develop public philosophy projects, creative or curatorial projects, and sharpen their critical thinking and communication skills through philosophical writing and oral exams. Additionally, Dr Rosario supervises graduate and undergraduate research in philosophy and feminist theory.
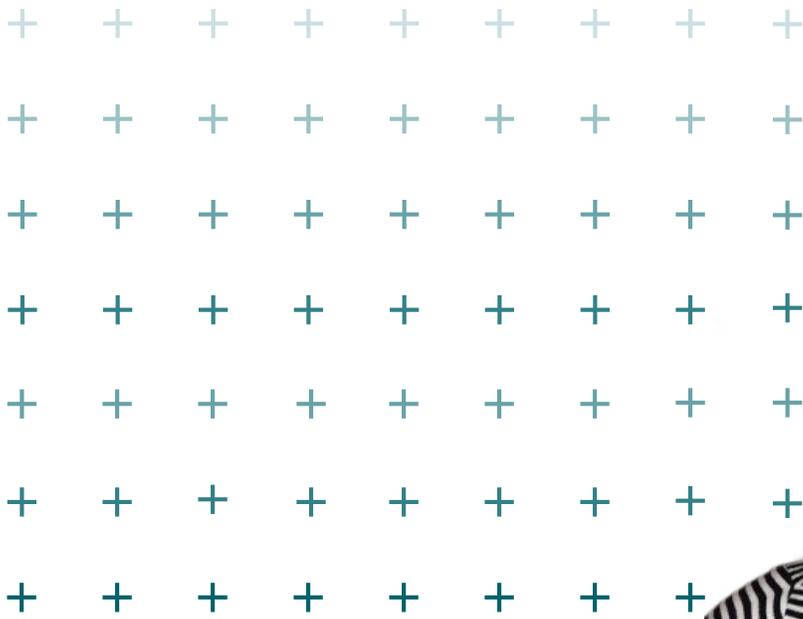
DR ESTHER ROSARIO, DARTMOUTH COLLEGE

THE SELF IN PHILOSOPHY, PSYCHOLOGY, AND NEUROSCIENCE

Suitable for students interested in:

PSYCHOLOGY

Cognitive Psychology | Social Psychology | Behavioural Psychology

PHILOSOPHY

Philosophy of Mind | Philosophy of Science | Mind-Body Connection

SOCIAL SCIENCE

Value Theory | Social Implications | Gender Studies

What makes you who you are? If you decided to become a vampire would you still be you? If so, what about you would continue to exist? Your memories? Your newly transformed body? Or would you acquire a new self? Would you (still) be a person? Are you the same person you were five years ago? What about two days ago? Are you just a collection of experiences and emotions?

In this research course, we'll consider what it means to have a self, a personal identity, and to undergo self-transformation. In particular, we'll address whether selves are constituted by narratives, if they persist over time, or if we acquire many selves in a lifetime. We shall also consider whether embodied cognition constitutes the self, if the self is extended, and whether cosmetic changes can lead to self-transformation. In addition to these issues, we'll explore contemporary texts in philosophy, psychology, and the biological sciences on applied matters related to the self, which include what happens to the self when we sleep, when we overwork, and when our gut microbiome changes.

We'll also engage with social issues related to the self such as culture and religion and identification with a social group like gender, race, sexual orientation, and disability, and whether we express agency when we can choose how we wish to be perceived by others. In addition to these social issues, we'll consider whether there are ethical limits to how (much) we can transform ourselves, change our values, and whether or how persons can be authentic.

DR NICHOLAS ANDERSON

CURRENT POSITION

Postdoctoral Fellow, Program on Constitutional Government, Harvard University

PREVIOUS APPOINTMENT

Research Fellow & Lecturer, Department of Politics, Princeton University

A scholar in political philosophy specializing in the German political thought.

As a researcher, Dr Anderson specializes in political philosophy, with a particular focus on the history of German political thought. His research spans constitutional government, U.S. politics, ethics, and Kantian philosophy. Currently, he is completing a book on the role of hope in Kant's political philosophy, which is under review at Northwestern University Press.

Dr Anderson has published articles in prominent journals such as The Review of Politics, The Plí Journal of Philosophy, and Ethics in Progress. His work explores diverse topics, including the ethical implications of life in the thought of Hegel and Jonas, and the political and metaphysical dimensions of Kant's work. He also co-authored a chapter in the book Science Fiction & Political Philosophy, exploring philosophical themes through speculative fiction.

Dr Anderson has delivered invited talks at prestigious institutions such as the University of Texas at Austin and Princeton University. His conference presentations have addressed topics such as Kant's political theory and the intersection of republicanism and despotism at prominent events, including the American Philosophical Association, the American Political Science Association, the Midwestern Political Science Association, and the Association for Political Theory.

As a mentor, Dr Anderson has extensive teaching experience, having taught both undergraduate and graduate students at Tuft University, the University of Texas at Austin, and Princeton University covering topics like Western Political Thought, Constitutional Principles, and The Art of Statesmanship. Known for his engaging and thought-provoking approach, Dr. Anderson encourages critical thinking and meaningful discussion, equipping students to grapple with complex philosophical ideas. Beyond the classroom, he provides mentorship to graduate-level students, fostering their academic and professional growth.

DR NICHOLAS ANDERSON, HARVARD UNIVERSITY

REFOUNDING MODERNITY:

THE POLITICAL PHILOSOPHY OF J.J. ROUSSEAU AND IMMANUEL KANT

Suitable for students interested in:

POLITICAL PHILOSOPHY
Social Contract | Liberalism | History

PHILOSOPHY OF MODERNITY
Enlightenment Politics | Commercial Liberalism | Modern Reason

It is said that the citizens of Königsberg could set their clocks to the daily walk of the philosopher Immanuel Kant. He is reported to have missed just two walks in his long life. The first was due to the arrival of his copy of Rousseau's *Emile*, which so thoroughly enraptured Kant that he read it in a single afternoon. The second came in 1789, while Kant was waiting for the arrival of news of the developing French Revolution. These anecdotes provide unusual insight into the concerns at the heart of Kant's philosophy: his admiration for modernity's potential and his response to Rousseau's critique of its moral and existential costs.

Troubled by Rousseau's devastating critique of modern civilization while admiring its practical orientation, Kant attempts to give a defense of modern culture and enlightenment politics while setting its commitments to the pursuit of scientific knowledge and human freedom on firmer foundations. Kant, in other words, sought to refound modernity by responding to Rousseau's charge that scientific progress not only undermines morality but robs human life of meaning. **This research course will examine Kant's philosophy primarily in light of Rousseau's diagnosis of the ills of modern society and commercial liberalism.** We begin by examining Rousseau's major political writings—*First Discourse, Second Discourse, and The Social Contract*. We will then turn to some of Kant's major political and moral writings, including selections from the *Critique of Pure Reason, Groundwork for the Metaphysics of Morals, Conjectural Beginnings of Human History*, and *Toward Perpetual Peace*. Through examining the dialogue between Kant and Rousseau, we will gain insight into questions concerning the character of history, the grounding of human freedom, morality, epistemology, and the source of legitimate political authority. Above all, this research course will shed light on the contemporary "crisis of liberalism" and the loss of faith in the prospect that reason can guide political life. Can Kant's response to Rousseau's challenge be recovered to reverse the decline of Western liberalism or did Rousseau see deeper and farther into the nature of modern reason and its project to reshape the world?

HARVARD UNIVERSITY

DR CHANDRA MALLAMPALLI

CURRENT POSITIONS

Research Associate, Lakshmi Mittal and Family South Asia Institute, Harvard University
Fletcher Jones Foundation Chair and Professor of History, Westmont College

A historian investigating the complex relationships between religion, law, and society in South Asia and beyond.

As a researcher, Professor Mallampalli's areas of expertise include modern South Asia, British Empire, world history, and global Christianity. He has published four books and numerous articles that explore the complex relationship between religion, law, and society in colonial South India.

One of his notable publications is "*South Asia's Christians: Between Hindu and Muslim*" to be released by *Oxford University Press* this year. This book examines how the lives of Christians in the Indian subcontinent have been shaped by their interactions with Hindus and Muslims throughout centuries. Another significant work is "*A Muslim Conspiracy in British India? Politics and Paranoia in the Early 19th Century Deccan,*" published by *Cambridge University Press* in 2017. In this book, Professor Mallampalli delves into the political climate and conspiracy theories prevalent in the Deccan region of British India during the 19th century. "*Race, Religion and Law in Colonial India: Trials of an Interracial Family*" is another noteworthy publication by Professor Mallampalli, published in 2011 by *Cambridge University Press.* This book explores the trials faced by an interracial family in colonial India, shedding light on the intersection of race, religion, and law during that era. Lastly, "*Christians and Public Life in Colonial South India: Contending with Marginality*" was published by *Routledge* in 2004. This book examines the experiences of Christians in colonial South India and their struggles with marginalisation in public life.

Professor Mallampalli's next project, titled "*Religion, Law, and Cosmopolitanism,*" aims to explore how religious discourses and laws either foster global citizenship, promote complex solidarities and collaboration with religious others, or contribute to cultural and ideological closure or radicalization. This project takes a comparative approach, examining case studies from South Asia, Europe, and North America.

As a mentor, Professor Mallampalli has extensive teaching experience as a tenured professor. He has led courses on World History, Modern South Asia, British Empire, and comparative Asian history at Westmont College.
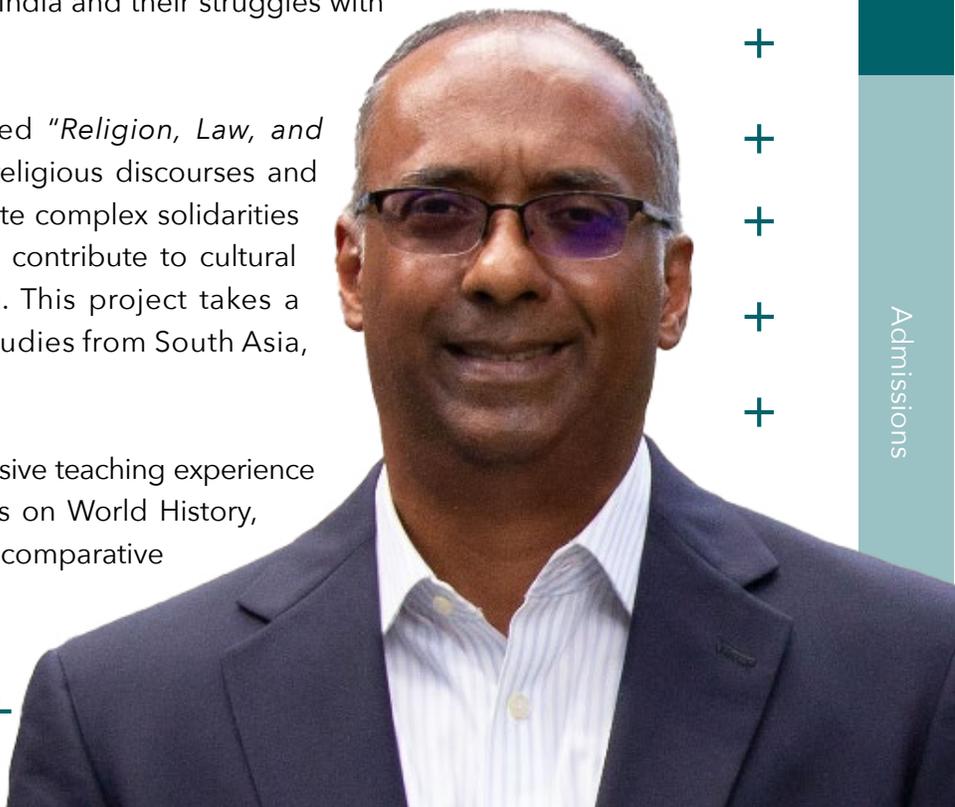
THE GLOBAL HISTORY OF COLONIALISM, 1800-PRESENT

Suitable for students interested in:

HISTORY AND POLITICS
European Imperialism | Ideology | Religion

COLONIAL STUDIES
Repression | Decolonization | Postcolonialism

Was colonialism good for the world, or did it make life worse for people who lived under it? This is a live debate among people who are still trying to come to terms with their colonial pasts. In Oxford and South Africa, the "Rhodes Must Fall" movement opposes monuments and romantic portrayals of Cecil Rhodes, the British miner and prime minister who oversaw the brutal treatment of black South Africans. Citizens of Kenya have sued the British government for reparations for what they suffered in detention camps after the Mau Mau rebellion of the 1950's. And the Indian writer and statesman, Shashi Tharoor, has passionately argued that the British owe India reparations for their history of violence, and for turning a hugely prosperous civilization into a poor one. On the other side of the debate, however, are historians such as Niall Ferguson or Nigel Biggar, who believe in the importance of Western power and contend that it delivered human rights, democracy, and the rule of law worldwide. Is one side right and the other wrong, or are there elements of truth and distortion on both sides?

This research course probes such questions by examining the British Empire during the 19th and 20th centuries, its means of expansion, economic incentives, and its racial assumptions. The course explores special topics relating to the imperial legacy. These include trade in cotton, opium and tea; colonial wars fought in Afghanistan and China, and anti-colonial movements, such as the one led by Gandhi, in the twentieth century. We also discuss violence, the drawing of borders, emigration, and refugees. The case studies of Israel-Palestine and India-Pakistan will factor prominently. Films or documentaries from each of the world areas will serve as catalysts for discussion and opportunities for informed reflection. The central task of each student is to produce a paper based on primary texts that explore some aspect of British imperialism of interest, and its lasting legacy.

DR HANNAH ELSISI ASHMAWI

CURRENT POSITIONS
Junior Research Fellow, Pembroke College, University of Cambridge
Junior Research Fellow, Crown Center for Middle East Studies, Brandeis University
Visiting Assistant Professor of Gender, Governance, and Society, New York University Abu Dhabi

PREVIOUS APPOINTMENTS
Lecturer, King's College London
**T.E. Lawrence Prize Scholar,** Merton College, University of Oxford

A historian, scholar, and educator specialising in the modern political and cultural history of the Middle East.

As a researcher, Dr Ashmawi examines the history of political imprisonment, repression, and torture in Modern Egypt, tracing the ways in which authoritarian regimes have sought to control dissent and maintain power through the use of violence and coercion. Her work is highly regarded in the field and has earned her numerous awards and honours, including the Malcolm H. Kerr Dissertation Award from the Middle East Studies Association and the Leigh Douglas Memorial Award from the British Society for Middle East Studies.

Dr Ashmawi's forthcoming books, *Lovers in the Citadel: Prisons and Other Architectures of Subjection in Egypt and Behind the Sun: Prison Writing in an Egyptian Century* promise to be important contributions to the field of Middle Eastern studies, shedding new light on the history of political repression and resistance in Egypt.

In addition, Dr Ashmawi is deeply committed to promoting academic and political freedoms in the Middle East and has worked extensively with human rights organisations, grassroots groups, and media forums on issues related to revolutionary mobilisation and repression. She has also been a vocal advocate for the rights of scholars and intellectuals in the region, speaking out against government censorship and repression of academic freedom.

As a mentor, Dr Ashmawi has taught courses on modern Middle Eastern history at King's College London, where she served as a lecturer before joining Cambridge. Her dedication to teaching and mentoring students is widely recognized, and she has been praised for her ability to engage students in complex and challenging topics.
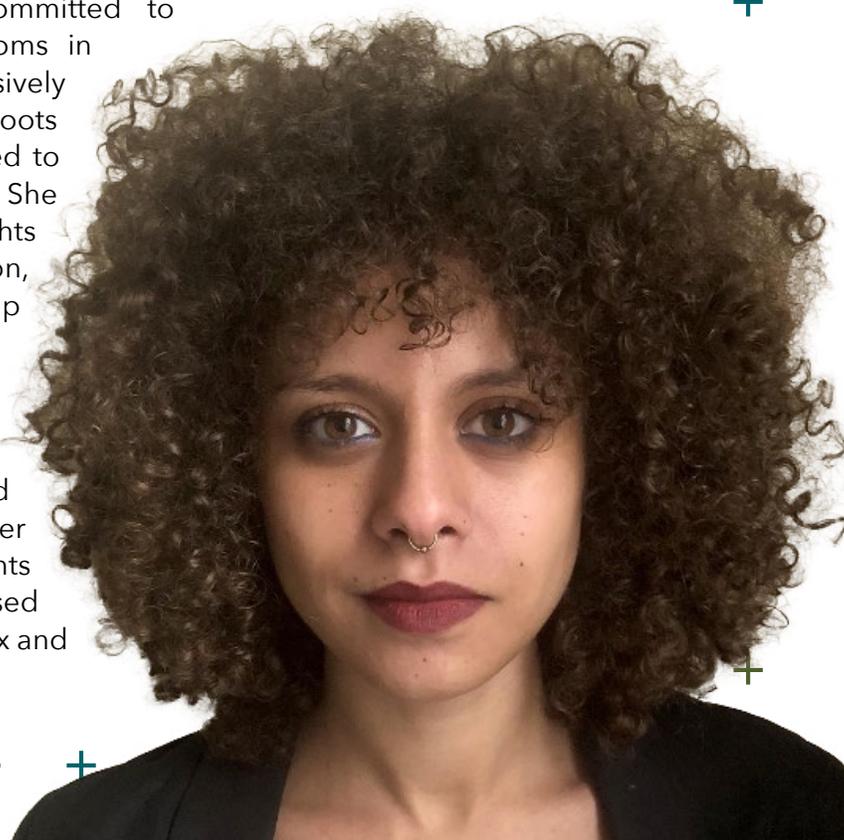
DR HANNAH ELSISI ASHMAWI, UNIVERSITY OF CAMBRIDGE

GENDER AND HUMAN RIGHTS

Suitable for students interested in:

GENDER STUDIES
Feminism | Queer Theory | Sexual Rights

SOCIOLOGY
Postcolonial Studies | Human Rights | Neoliberalism

What is Gender? What are the rights accorded to that classification? How does their intersection shape our world history, policy and political economy?

T**his research course offers students a transnational and intersectional gender perspective on contemporary theories and practices of gender, rights, and humanitarianism.** Through integrating diverse bodies of scholarship—including gender theory, decolonial and postcolonial studies, queer theory, and human rights frameworks from legal and policy perspectives—the course provides an interdisciplinary approach to the study of human rights deeply rooted in questions of gender. Students will engage with seminal works by scholars such as CLR James, Sylvia Wynter, Gayatri Spivak, Michel Rolph Trouillot, Ratna Kapur, Hannah Arendt, Audra Simpson, Walter Mignolo, Giorgio Agamben, Judith Butler, Lila Abu-Lughod, and Wendy Brown, among others. Alongside these theoretical perspectives, students will analyze the evolution and application of international legal frameworks aimed at securing the rights of women and other marginalized groups.

The research course will examine how systemic power structures and cultural norms shape the recognition and enforcement of rights for marginalized genders and sexualities, emphasizing the intersections of gender, race, class, and nationality in influencing lived experiences and global struggles for justice. Special attention will be given to the contested notions of "humanity," "civilization," and "indigeneity," as well as the tensions between citizenship rights and human rights, and the transformative impact of the former on the latter.

Through critical engagement with human rights theories, and decolonial and anti-colonial perspectives, this research course encourages students to question dominant narratives and explore alternative frameworks for understanding and advocating for justice. By the end of the research course, students will have developed the analytical tools and interdisciplinary knowledge necessary to contribute meaningfully and critically to debates on gender and human rights.
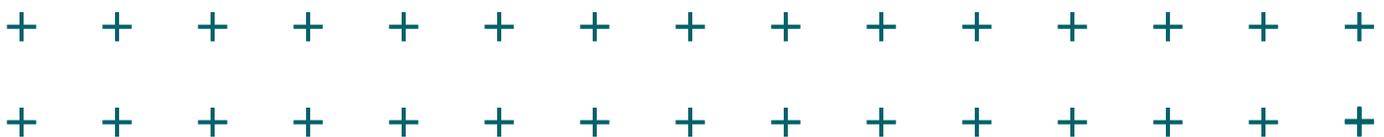
DR HANNAH ELSISI ASHMAWI, UNIVERSITY OF CAMBRIDGE

HISTORY OF CAPITALISM

Suitable for students interested in:

POLITICAL ECONOMY
Capitalism | Economics Development | Financial Crises

INTERNATIONAL RELATIONS
Colonialism & Imperialism | Geopolitics | Global Financial Systems

SOCIOLOGY
Race | Migration | Gender

What is capitalism? How has it changed over time? And why do we need a global perspective to fully understand its development and impact? How are structures of race, gender, culture, the arts and technology imbricated in capitalist social property relations?

Since the global financial crisis of 2008, understanding the history of capitalism has become more crucial than ever, sparking a surge of interest and discourse. Some narratives highlight capitalism's flaws, with a focus on environmental destruction and waste production, overpowered corporations, exploitation of workers, or outrageous inequality. Others are more positive, telling a story about unparalleled prosperity, longer life expectancies, integration of markets, connectivity among peoples, and poverty alleviation.

In this research course, we delve into the complexities of capitalism beyond face-value narratives.. By adopting a global lens, we investigate a myriad of explanations and impacts of capitalism on local, national, regional and global levels. We also examine a range of key themes deeply connected to the evolution of capitalism, including labour relations, migration, commodities, consumption, finance, war, imperialism, development, energy, and the environment.

Sessions will be organised into four main topics on capitalism, each accompanied by a set of thought-provoking readings, that are designed to help students reflect the insights gained from these interconnected topics in their research project.

By the end of this course, students will develop a comprehensive and critical understanding of capitalism, including its historical evolution and transformation, and its profound and far-reaching impact on our society and the world. Students will understand the importance of a global perspective in comprehending capitalism's development and impact across various regions and cultures. Additionally, students will critically evaluate different narratives about capitalism, assessing both its shortcomings, such as waste, environmental destruction, and inequality, and its achievements, such as prosperity, market integration, and poverty alleviation. By appreciating the complexity of capitalism, students will investigate its multifaceted nature and its effects on local, national, regional, and global scales. The knowledge from this course will empower students to contribute thoughtfully and critically to discussions about the opportunities and challenges of our economic future in our capitalist world.

DR HANNAH ELSISI ASHMAWI, UNIVERSITY OF CAMBRIDGE

THE POLITICS AND HISTORY OF PRISONS:

REFORM, ABOLITION, AND CARCERAL JUSTICE

Suitable for students interested in:

POLITICS
Political Economy | Carceral Justice | Political Theory

HISTORY
History of law | History of the State | History of Criminal Justice

Does anyone deserve to be unfree? What does captivity tell us about freedom? Does incarceration evidence a move away from cruel punishment in modern times? Is confinement always about punishment? Is punishment a universal component of justice?

This research course tracks the history of captivity, prison, and incarceration. We examine laws and literatures of captivity in ancient Rome and the mediaeval Islamic world through to humanitarian debates around slavery and modern prisons and the political economy of successive wars on Crime, Poverty, Drugs, and Terror in the Americas. Our protagonists range from anti-colonial nationalists in Kenya and Chinese indentured labourers, to prisoners of the Russo-Ottoman wars and convict labourers in Australia.

Through the writings of captives, lawmakers, architects, and activists, we explore the personal and political consequences of incarceration in sites such as prisons, ships, penal colonies, POW camps, asylums and detention centres. We interrogate how class, gender and race co-determine who ends up in these sites, and how different carceral regimes shaped local environments and global relations of power, production, trade, mobility and culture.

This research course will be driven by lectures and discussions. In these sessions we shall address the themes outlined below. Students' engagements with the texts will be reinforced outside of the classroom through engaging the near-weekly primary sources, films, songs and poetry provided as well as through a student-led presentation and discussion each week. Students will be assessed through a mixture of participation, presentations, source reflections, fieldnotes, draft and final papers as well as a significant self-directed research project: conducting or transcribing an oral history interview and writing up a reflexive analysis of both its form and content.
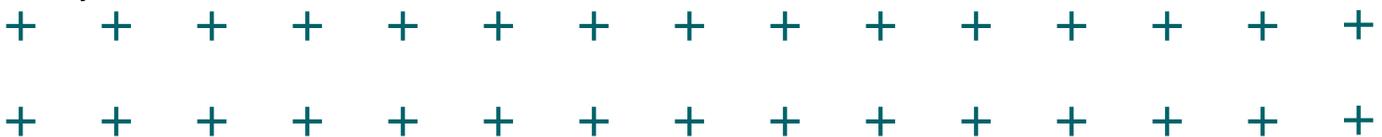
DR JOAQUIN TERRONES

CURRENT POSITION

Lecturer in Literature and Women's & Gender Studies, Department of Literature, MIT

PREVIOUS APPOINTMENT

Lecturer, Department of Literature, Harvard University

As a researcher, Dr Joaquín Terrones focuses on contemporary literature and film in the Americas. He is interested in race, gender and sexuality in the Americas, hemispheric studies, science fiction and comic books, and realism and violence in contemporary Brazilian cinema. His current book project, which concerns the representation of disease in literature and visual culture during the last two decades of the twentieth century, is under contract with Wayne State University Press. As an expert critic, Dr Terrones has been a guest speaker, panellist, and organiser in numerous conferences, including the *Society for Cinema and Media Studies* conference in Toronto, the *Society for the Study of Multi-Ethnic Literature, the Modern Language Association, and the Bilingual Aesthetics Conference.*

He has actively participated in various social discussions and events. He was an invited speaker at World AIDS Day Vigil (Harvard), Multicultural Conference (MIT), Shades of PRIDE: Coming Out in Communities of Color (MIT), and amongst others.

As a mentor, Dr Terrones has taught a variety of courses, including Literature and Social Conflict, Global Literature, European and Latin American Fiction, and HIV/AIDS in American Culture. Moreover, he has mentored student projects in creative writing, literary criticism, cultural theory, and film criticism. He has been recognized for his dedication to teaching with several awards, including the James A. and Ruth Levitan Teaching Award, the J-WEL Grant in Higher Education Innovation, and the d'Arbeloff Fund for Excellence in Education, all from MIT.
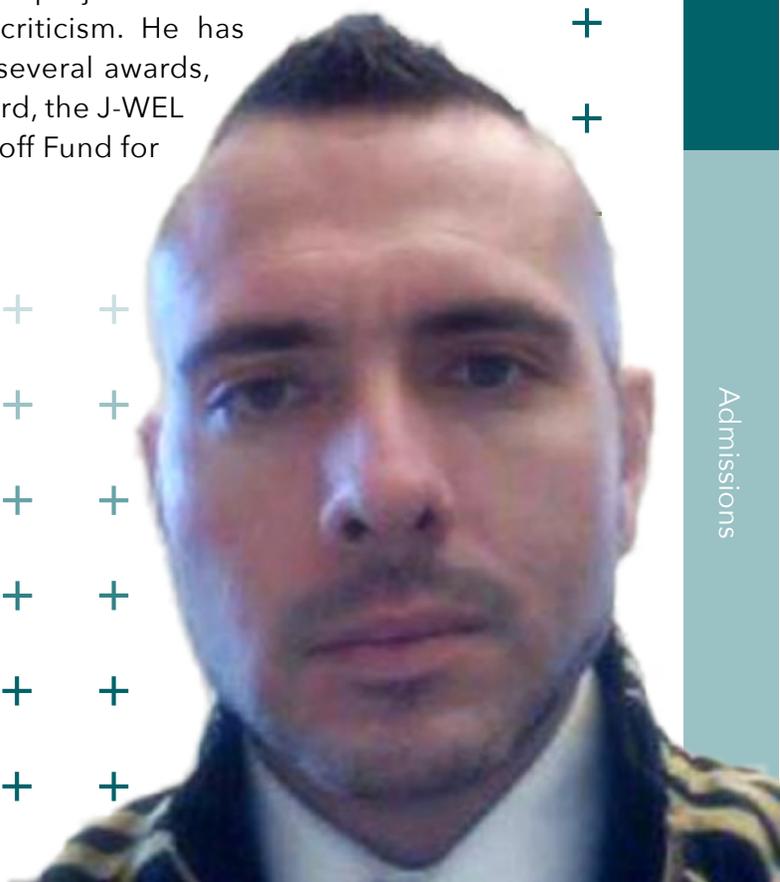
DR JOAQIN TERRONES, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

RACIAL JUSTICE AND THE POLITICS OF LITERATURE

Suitable for students interested in:

LITERATURE

North American Literature | Latin American Literature | Film

SOCIOLOGY

Race | Gender | Indigenous Culture

POLITICAL THEORY

Social Justice | Aesthetics | Critical Theory

What role do writers play in social movements? How does literature today respond to systemic racism and rampant xenophobia, travel bans and deportation sweeps, police brutality and mass incarceration? Can a poem, a novel, or an essay make a difference?

This research course will tackle these questions by pairing contemporary literature with works by earlier writers who used literature to speak out, fight back, and bear witness. Students will see how writers play a crucial role in social movements as they use their platform to bring attention to and shed light on important issues. Through their writing, they can inspire change, raise awareness, and advocate for marginalised groups.

By conducting the research project, students will delve into the rich and diverse world of Black, Latinx, and Indigenous literature. They will examine a range of texts and topics, and gain a deeper understanding of how to critically analyse literature from a racial justice perspective. Through close reading and interdisciplinary research, students will explore the unique forms and themes of these literary works and gain a deeper appreciation for the cultural, social, and political contexts in which they were created.

Students will be exploring the work of a range of authors including James Baldwin, Ta-Nehisi Coates, Audre Lorde, Gloria Anzaldua, Valeria Luiselli, and Tommy Orange. Alongside analysing their literary works, we will also delve into the concepts of double-consciousness, the borderland, decoloniality, Afrofuturism, and critical fabulation, which are central to Black, Latinx, and indigenous studies. By analysing primary texts and engaging with secondary literature, students will be able to develop their research projects, and gain a deeper understanding of the relationship between literature and social change.

UNIVERSITY OF CHICAGO

DR ELLEN LARSON

CURRENT POSITION

Postdoctoral Instructor of Art History, Center for the Art of East Asia, Department of History, University of Chicago

PREVIOUS APPOINTMENTS

Instructor, Department of History of Art and Architecture, University of Pittsburgh
International Project Consultant, Cao Fei Studio, Beijing, China
Assistant Curator, University Art Gallery, Pittsburgh, Pennsylvania
Programming Director, Si Shang Art Museum, Beijing, China

A scholar of contemporary Chinese art with a passion for exploring the intersections of technology and culture using an interdisciplinary approach.

As a researcher, Dr Larson explores the intricate depiction of temporalities in moving image art, primarily originating from Mainland China. Her primary objective is to unravel how contemporary artists capture facets of accelerated time within a cultural landscape where physical spaces and social bonds are rapidly diminishing. This decline is attributed to significant investments in robotics, AI technologies, online communication platforms, and virtual monetary exchange applications. Dr Larson's research is fueled by a diverse array of academic influences, encompassing urban studies, Asian futurisms, memory studies and cyberfeminism studies. Employing a methodological approach that integrates curation and design as essential forms of applied practice, she illuminates the intersection of art and its cultural context.

In her prior research endeavours, Dr Larson focused on contemporary Chinese video art, specifically delving into emerging video and new media art since the turn of the new millennium. Her scholarly pursuits have received support from prestigious institutions, including the American Council of Learned Societies, the Henry Luce Foundation, and the Dunhuang Foundation. Further, Dr Larson's works have been published in peer-reviewed scholarly journals including the *Journal of Contemporary Chinese Art, Hemisphere: Visual Cultures of the Americas,* and *The Dispatch (Carnegie International)*, among others.

As a mentor, Dr Larson teaches courses in Contemporary Asian Art at the University of Chicago and has previously held courses on Asian Art, Global Art, Contemporary Art in Practice, and Introduction to Aesthetics at the University of Pittsburgh and New York Institute of Technology in Beijing.

DR ELLEN LARSON, UNIVERSITY OF CHICAGO

APPROACHES TO CONTEMPORARY CHINESE ART

FROM CHAIRMAN MAO TO NFTS

Suitable for students interested in:

ART HISTORY

Modern and Contemporary Art | Asian Art | Theory and Methodology in Art History

SOCIAL SCIENCE

Political Science | Sociology | Anthropology

CHINESE STUDIES

Chinese History | Chinese Diaspora Studies | Chinese Society and Anthropology

In the late 20th century, China underwent significant societal and political changes. These transformations are vividly reflected in contemporary Chinese arts, enabling Chinese artists to bring forth unique perspectives in the global art landscape. T**he aim of this research course is to introduce students to a history of contemporary art from China since the 1970s. By delving into contemporary Chinese art, we gain a fresh perspective on Chinese society, offering insights into its complexities and dynamics.**

At the beginning of the research course, we will delve into a brief overview of modern art activities in China during the early 20th century, along with art production under Mao. Students will see the intersection of artistic expression and state ideology during this pivotal period in Chinese history. Then, we will move on to contemporary avant-garde movements during the 1970s and 1980s, the response to urbanisation in art at the onset of the new millennium, the influence of globalisation since 2000, and a new generation of young artists from China as well as Chinese diasporic artists working transnationally.

Through this research course and by conducting their independent research project, students would be encouraged to pay critical attention to how artists respond to the obsolescence of physical environments and interactions due to major investments in robotics, AI technologies, online communication platforms, and virtual monetary exchange applications. Additionally, students will also be encouraged to engage in current debates related to contemporary arts, and to share their ideas during discussions with faculty members and their peers.

By the end of this course, students will gain a solid understanding of contemporary Chinese art. In turn, through the lens of contemporary Chinese art, they will understand the history and societal changes of China from a new perspective.

DR DANAI THOMAIDIS

CURRENT POSITION

Postdoctoral Fellow, Seeger Center for Hellenic Studies, Princeton University

PREVIOUS APPOINTMENT

Postdoctoral Fellow, Stavros Niarchos Foundation Centre for Hellenic Studies, Simon Fraser University

A passionate art historian exploring the intricate interplay between art and religion.

As a researcher, Dr Thomaidis is an expert in Byzantine Art History specialising in the Western reception of Byzantine art. Her research centres on the production and presentation of icons in Venice and the Venetian Stato da Mar, with a focus on how the interplay between the domestic and public spheres shapes religious identities. Additional areas of interest include cross-cultural interactions in the Mediterranean, Marian cult, Venetian colonialism in the Levant and its impact on artistic production, sacred landscapes, the modern reception of Byzantium, art production in Venetian-ruled Crete, Byzantine religious feasts and processions, and the cultural characteristics of Byzantine artefacts. Previously, she conducted a study on the introduction, cult, and exhibition of Byzantine icons in the churches, streets, and homes of Venice, as well as in the Venetian-ruled colonies of the Mediterranean.

Dr Thomaidis has received support for her research from the Leventis Foundation and the Swiss State Secretariat for Training, Research, and Innovation (SEFRI). Her works have been published in top peer-review academic journals, and presented at international conferences across Europe and North America. Her forthcoming book, *The Life of Icons in Venice*, explores the production, introduction, cult, and display of icons in Venice, both within domestic and public urban spaces, and provides a historical account of icon perception in Venice and the Venetian Levant.

As a mentor, Dr Thomaidis has taught courses on Art History, Art and Architecture of the Eastern Empire, History of Venice, and Early Christian Art students at Princeton University, Rutgers University, Simon Fraser University, and Ca' Foscari University in Italy.

DR DANAI THOMAIDIS, PRINCETON UNIVERSITY

ART AND COLONIALISM IN MEDITERRANEAN HISTORY

Suitable for students interested in:

ART HISTORY
Artistic Production | Cultural Studies | Historical Analysis

HISTORY
Colonisation | Imperial Dominance

This research course explores the dynamic relationship between art and colonialism in the Mediterranean, from antiquity to the modern day. It offers a comprehensive examination of how diverse colonial powers have influenced and shaped the rich tapestry of cultural production within the region. Employing a multidisciplinary approach, the course blends art history, cultural studies, and historical analysis to unravel the nuanced complexities of artistic expression within the intricate web of colonisation.

By adopting a cross-cultural and diachronic perspective, students will delve into the same phenomenon across different cultures and time periods. This approach facilitates a deeper understanding of the ever-evolving relationship between art and colonialism in the Mediterranean. The course's case studies are diverse and rich, exploring the visual consequences of imperial dominance in ancient Greece and Rome, the hybridity evident in late antiquity, the unique artistic synthesis resulting from the coexistence of Arab and Norman cultures in Sicily, the impact of Venetian and Spanish rule, and modern French and British colonialism.

Through engaging with diverse case studies and critical readings, students will develop a nuanced understanding of the intricate relationship between cultural production and colonialism. This fosters critical thinking and encourages cross-disciplinary analysis, equipping students with a broader perspective on the complexities inherent in the subject matter. Ultimately, this course serves as a captivating journey through time, unravelling the layers of influence, resistance, and adaptation that have defined the artistic landscape of the Mediterranean under the ever-shifting dynamics of colonialism.
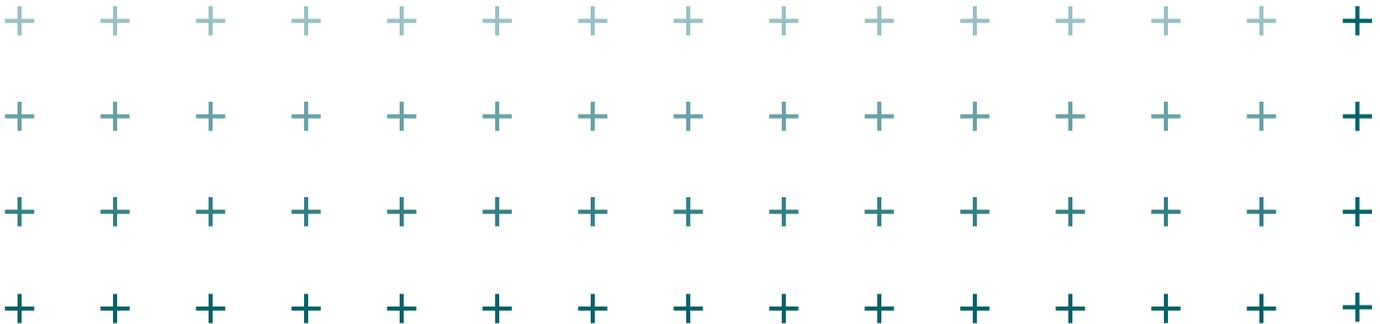
ADMISSIONS

EARLY ADMISSION DEADLINE : 1 March 2025
REGULAR ADMISSION DEADLINE: 15 March 2025
PROGRAMME START DATE: March/April 2025 (Rolling)

Because of the limited group size and professor's availability, some research courses may close admission early before the Regular Admission deadline and start early.

*All CCIR programme schedules are flexible with holiday breaks and will taking into account the group's admitted student's availability.

"My mentor always challenge me and inspire me to think deeper into the topics. The most important thing I learned from this course is how I can always challenge my thinking and think of different arguments. My mentor also spent a lot of time on my literature review, outline, and my eventually my paper. For that I really, really want to thank my mentor."

--- Simon (Oakville, Canada)
University of Pennsylvania 24'

ADMISSION PROCESS

SPRING 2025 EARLY AND REGULAR ADMISSIONS POOL

1   SUBMIT APPLICATION MATERIALS ON THE CCIR ADMISSIONS PORTAL

To start the admissions process, prospective applicants are expected to submit the application form and supplementary documents on the CCIR Admissions Portal:

+ Basic information*
+ Cumulative GPA* (attaching transcript/report card for the past academic year)
+ Standardized test score (attaching official score report)
+ A 500-word personal statement*
+ Honours and awards
+ Writing Sample

Required

2   INTERVIEW (ONE TO TWO WEEKS AFTER SUBMISSION)

Shortlisted applicants will be invited to an interview with the a CCIR Academic Advisor (a PHD candidate in the same field) as part of the application for the research course's professors' final review.

The 15 to 30 minutes interview is designed to assess the applicants' interest in the subject, relevant experience, and the ability to engage in discussion and thinking critically. Applicants can also get some understanding of how the discussions and supervision would be like.

Please head to **CCIR Admissions Portal** for:

+ Register for an applicant account
+ Download Application and Interview Guidelines
+ Application Submission

PRE-APPLICATION PROCESS

FOR SUMMER 2025 PRE-APPLICATION POOL

1 APPLICATION FORM

Submit the Application Form and relevant attachments at CCIR Application Portal. Applications are evaluated by the Academics Team on a rolling basis. A complete Application Form should provide the following information:

- Basic Information*
- Cumulative GPA* (attaching transcript/report card for the past academic year)
- Standardized test score (attaching official score report)
- A personal statement (500 words or less)*
- Honours and awards
- University offers received

*Required

2 INTERVIEW
TWO TO THREE WEEKS AFTER SUBMISSION

Shortlisted applicants will be invited to an interview with a CCIR Academic Advisor, who is usually a PhD candidate of the same field. The 15 to 30 minutes interview is designed to assess the applicants' interest in the subject, relevant experience, and the ability to engage in discussion and thinking critically. Applicants can also get some understanding of how the discussions and supervision would be like.

The interview recording will be passed on to the professor for final professor review.

PRE-APPLICATION PROCESS

FOR SUMMER 2025 PRE-APPLICATION POOL

3

CONDITIONAL OFFER & DEPOSIT
THREE WEEKS AFTER THE INTERVIEW

Successful applicants who pass the interview round will then receive conditional offers, which grant their admission to the programme, pending the specific research course.

To confirm the offer and secure their seats, conditional offer holders will complete a 500 GBP / 600 USD refundable deposit.

4

PRIORITY RESESARCH COURSE SELECTION
APRIL 2025

Upon the official opening of the next round of admission and the release of the prospectus, pre-application students will be invited to select the research courses before other applicants.

5

FINAL PROFESSOR REVIEW & OFFICIAL OFFER
APRIL 2025

After research course selection is made, Conditional Offer holders will receive a final admissions evaluation from the professors teaching their selected courses. Successful students will then be extended an Official Offer to one of the research courses that they selected.

The rest of the tuition is expected to be paid in full within ten business days.

ADMITTED STUDENT PROFILE

Through our strong partnerships with top high schools and college counselors around the world, our programmes are able to admit students with extremely strong academic backgrounds.

AVERAGE GPA (4.0 SCALE)

3.90

AVERAGE SAT SCORE

1500

EXTRACURRICULAR EXCELLENCE

Our admitted students have:

+ Received IMO Medals

+ Interned at top corporations and institutions, such as J.P. Morgan and Mayo Clinic

+ Studied at prestigious Ivy League summer schools or programmes

+ Participated in NASA's CubeSat Launch Initiative

+ Achieved Top 10 national rankings in sports

+ Founded their own businesses and NGOs

SELECT UNIVERSITY OFFERS OF OUR ALUMNI

|		
Harvard University	University of California Berkeley	University of Cambridge
MIT	Columbia University	Cornell University
Duke University	Georgetown University	University of Hong Kong
London School of Economics	New York University Abu Dhabi	University of Pennsylvania
Pomona College	Stanford University	Yale University

FUTURE SCHOLAR ACCEPTANCE
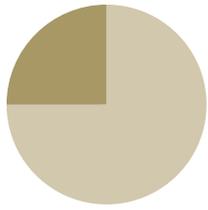
Percentage of Total Applicants
Received an Invite to Interview
~25%

Percentage of Total Applicants
Received an Offer
~19.5%
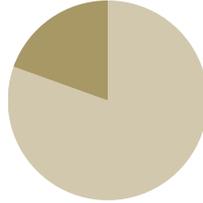
APPLICATIONS RECEIVED
(% increase compared to
the previous round)

+~120%

+~900%

SUMMER 21'
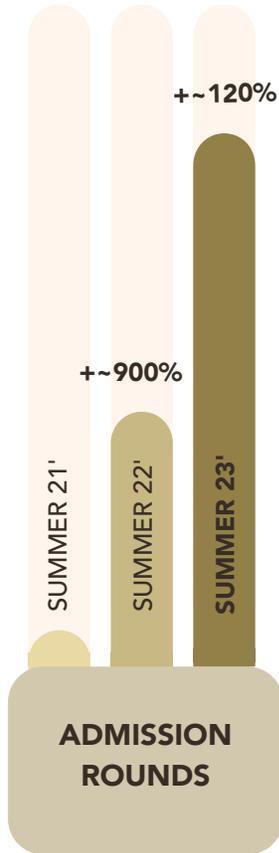
SUMMER 22'

SUMMER 23'

1-ON-1 MENTORSHIP ACCEPTANCE
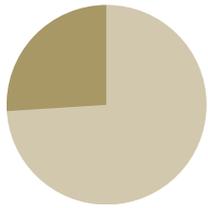
Percentage of Total Applicants
Received an Invite to Interview
~26%

Percentage of Total Applicants
Received an Official Offer
~17.5%

**ADMISSION
ROUNDS**
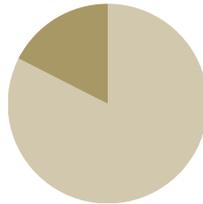
GLOBAL STUDENT COMMUNITY FROM OVER 40 COUNTRIES
(*SPRING 20'
TO SUMMER 23'*)

China (inc. Hong Kong)
2.6%

Other
11.1%

Japan, S. Korea, Singapore,
Malaysia, Indonesia,
Australia, New Zealand
7.8%

India
9.8%

United States
55.6%

European
Union
13.1%
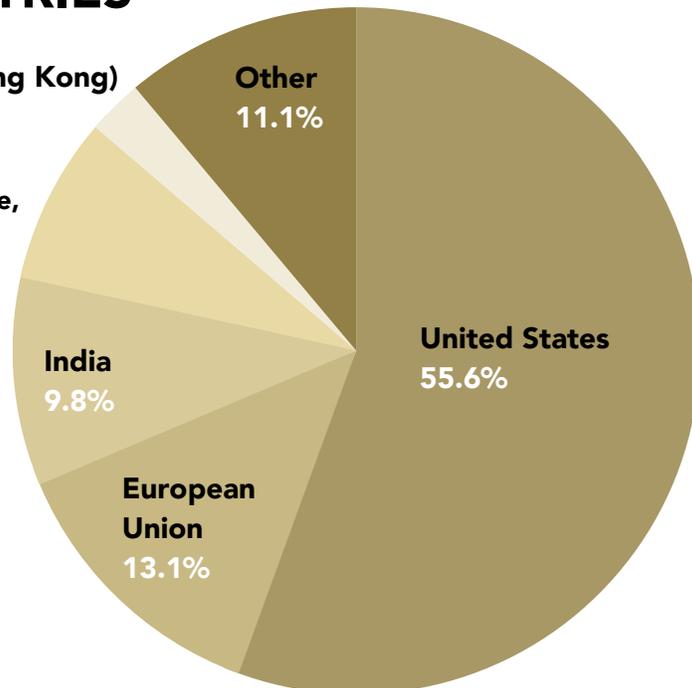
TUITION STRUCTURE

Cambridge Future Scholar Programme	
Full Tuition (Spring 2025*)	**3,300 GBP (3,900 USD)**

*Effective the upcoming Summer 2025 round, a new tuition rate will be applied, reflecting an increase to better support our faculty and administrative work.

INSTALLMENT OPTION
Installment plans of 6-month (0% interest) and 36-month (with interest) are available to apply through our banking partner Climb Loan upon an applicant's successful admission. The borrower must be a U.S. citizen or permanent resident to qualify.

THE TUITION INCLUDES:

RESEARCH MENTORSHIP

+ Weekly hour-long session with the Mentor for 13-weeks

+ Weekly hour-long session with Teaching Assistant for 13-weeks

+ Additional weekly one-on-one office hours (30 minutes), if requested

+ Literature Request portal with access of journals, papers, and e-books for free

+ Free access to CCIR Lab at MIT to conduct in-person research

+ Academic journal submission guidance (by the mentor and Journal Publishing Team)

ACADEMIC SUPPORT

+ Oxbridge and Ivy League level Writing Centre and Ethics Review Committee

+ Access to all session recordings permanently

+ Assigned Academic Coordinator to support each student

AFTER THE PROGRAMME

+ An option to request a Letter of Recommendation written and signed by the mentor

+ An Academic Evaluation Report written and signed by the mentor

+ Paper and reference delivery to universities' Admission Offices via the mentor's university email
  or CCIR's official email

+ Continous access to Literature Request portal and academic journal submission guidance (with the
  mentor and Journal Publishing Team) until successful paper publication

SCHOLARSHIPS & FINANCIAL AID

Each applicant is **automatically considered for one of the three CCIR Merit Scholarships** (ranging from £100 to £300) based on funding availability, application materials, and interview assessment. Should the student being awarded a CCIR Merit Scholarship, it will reflect on the student's offer letter.

Between 2020 to 2024, about 45% of admitted students received some level of the merit scholarship.

At CCIR, we are trying to make research opportunities accessible to as many students as possible. In doing so, our first consideration is to award scholarships at different level to as many students as possible. Only after we are confident a good portion of our admitted students will receive a Merit Scholarship, we will proceed with using the remaining of our scholarship pool to provide **Need-aware Financial Aid** to select students facing economic hardship.

CCIR Academy's Financial Aid pool is limited and highly competitive. Students who request less Financial Aid will be prioritized, so more students could benefit from the rest of the funding.

Please submit your financial aid request (with supplements) on the CCIR Admissions Portal with your application. Failure to do so would result in your financial aid request being declined.

START YOUR APPLICATION

**REGISTER AN ACCOUNT ON
THE CCIR ADMISSIONS PORTAL.**

QUESTIONS & INFORMATION

FOR MORE INFORMATION on CCIR Academy programmes:

Visit **CCIR Academy website.**

TO REVIEW FREQUENTLY ASKED QUESTIONS

Visit **CCIR Academy FAQs.**

IF YOU HAVE ANY QUESTIONS and want to reach out to our team members

Contact admissions@cambridge-research.org

TO REGISTER FOR UPCOMING INFORMATION SESSIONS

Sign up here.