



CCIR ACADEMY

THE CAMBRIDGE FUTURE SCHOLAR

2024 SUMMER RESEARCH PROGRAMME

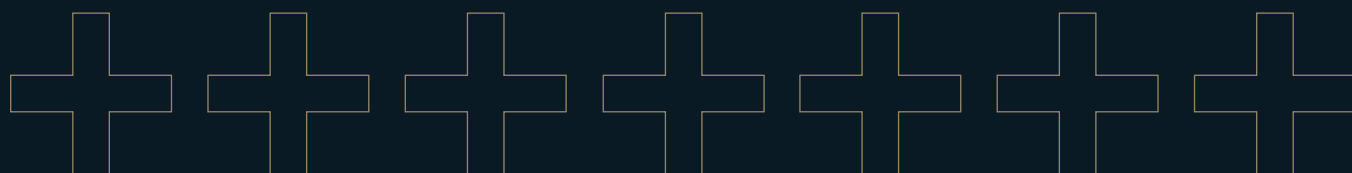
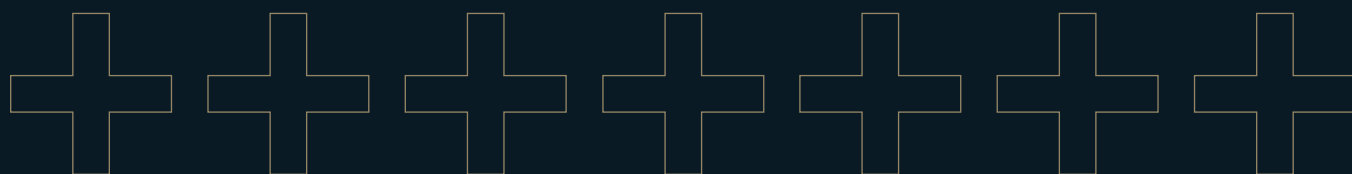


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THE CCIR DIFFERENCE

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 a group of **Oxbridge alumni**, our staff boast 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.

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.

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.

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.

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.

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 guidance 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-

paper crane cancer. My grandfather had cancer. I was trying to do something to help him. My grandfather's story spurred me on.

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

THE CCIR DIFFERENCE

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).

We are beyond excited to announce that 10 Nobel laureates have confirmed to attend and speak at CCIR's Student Research Symposium, with live sessions with participated student presenters.

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



The 2024 symposium is open to apply for all current and past CCIR students, who enrolled before June 15th, 2024, 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 CCIR Student Research Symposium presenters and their companies are also invited to the Reception hosted at the hall of King's College, on the evening of 30th July, 2024. The Reception is a traditional Oxbridge style high table dinner, with both Nobel laureates and select CCIR professor mentors expected to sit at the high table.

For the invited student presenters, there is no cost for presenting at the Symposium and attending the Reception. The Symposium does not accept papers from the public, but they are welcomed to attend as observers or watch the livestream. The evening Reception is a closed door event.

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.

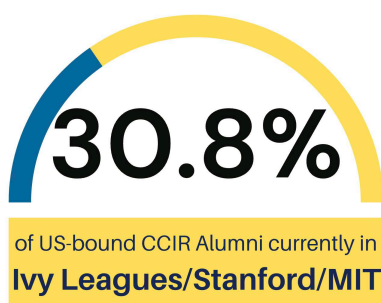
Our majority high school level student body has obtained incredible success at publishing at many prestigious undergraduate, graduate, and even professional conferences and journals.



US UNIVERSITY ADMISSION RESULTS

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

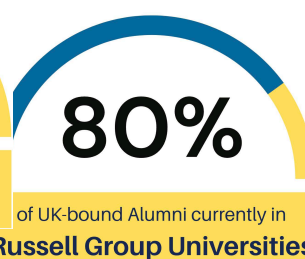
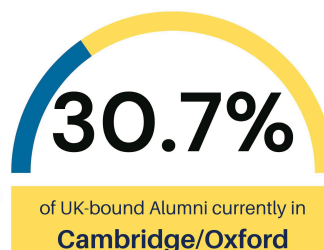
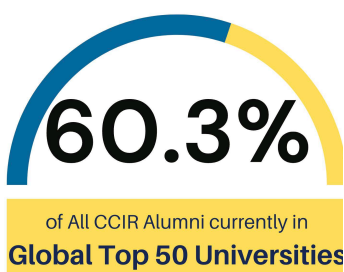
With a large percentage intended to apply for top universities in the US, CCIR alumni in the past years, packed with rigorous research experience and academic passion, enjoyed stellar admission results in the ever-changing admissions race.



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.



*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.

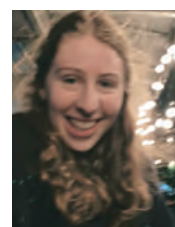
CHOOSING YOUR CCIR PROGRAMME

		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 <ul style="list-style-type: none"> 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. <i>Week 1 to 7: Foundation</i> <i>Week 8 to 13: Research</i>	14 one-hour sessions (flexible scheduling and meeting frequency) <i>Professor develops a custom curriculum for the student.</i>
	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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Letter of Recommendation delivery to universities' Admission Offices via the mentor's university email Invitation to join CCIR's global alumni network Continuous access to Literature Request portal and academic journal submission guidance (with the mentor and Journal Publishing Team) until successful paper publication 	

PROGRAMME OVERVIEW

"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 university 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 receive 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

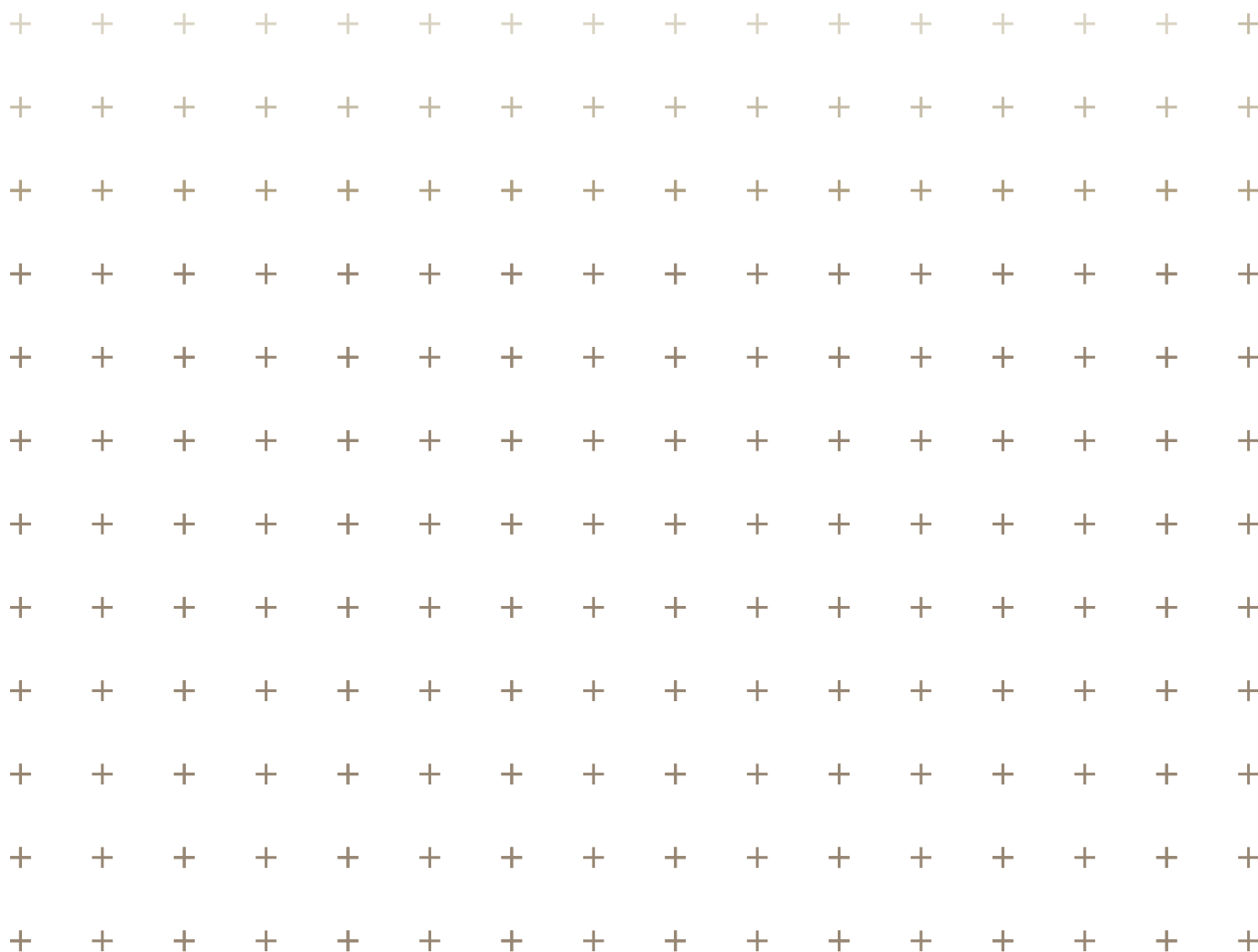
The one-on-one approach allows students to develop personal relationships with their mentors and guarantees that each student can receive the attention needed to develop a deep grasp of the material.

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



STEM (1 of 14)

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.

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.

STEM (2 of 14)

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.

The New Wave of Cancer Research: The Principles and Practice of Cancer Metabolism

Dr Boryana Petrova
Harvard, Department of Pathology

In this research course, students will be introduced to the forefront of cancer research through the lens of cancer metabolism. They will gain knowledge in cutting-edge areas and study the principles and practices of cancer metabolism from the perspective of metabolomics. The approach will be multifaceted. Students will have the opportunity to delve deep into the current developments of cancer research, as well as using different research tools to gain hands-on experiences. Students are expected to conduct their independent research.

Harnessing LC-MS: The Principles and Practice of Cancer Metabolism

Dr Boryana Petrova
Harvard, Department of Pathology

LC-MS (Liquid Chromatography-Mass Spectrometry) is a technique that separates chemicals before identifying and quantifying them with unparalleled precision. This research course aims to help students understand and unlock the potential of LC-MS and metabolomics and to equip them with the knowledge to contribute to the next wave of discoveries in biological and medical sciences. Students will delve into essential components of the technology, including principles in sample preparation and chromatography, the fundamentals of mass spectrometry, and the art of data analysis and visualisation.

STEM (3 of 14)

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.

Computational Genetics and Epidemiology

Dr Marta Matuszewska

Cambridge, Department of Medicine

Pandemics are a major threat to public health and can have severe consequences for global economies. One of the key drivers of pandemics is the ability of pathogens to switch hosts and establish themselves in new species. 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.

Practical Computing in Medical Science

Dr Marta Matuszewska

Cambridge, Department of Medicine

This research course is interdisciplinary in nature. It helps students to build the bridge and develop their research project between computing and medical science and biology. Students would see how computational methods bring new insights to many questions in life science and promise new solutions. At the conclusion of this research course, students will be equipped with the skills and confidence to effectively utilise computational techniques for tackling biological and medical challenges and applying them to real-world applications. It will help them to think about the questions from a computational perspective. They will establish a crucial connection in their understanding between traditional biological methods and the growing significance of computing in contemporary biological studies, setting them up for their future exploration in medical science, biology, or life science in general.

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.

Machine Learning in Drug Discovery and Chemical Development

Dr Connor Taylor

Cambridge / Astex Pharmaceuticals

In this research course, students will explore the rise of machine learning and artificial intelligence with specific reference to drug discovery and chemical development, as well as emerging techniques for effective chemical /pharmaceutical synthesis. Furthermore, they will examine state-of-the-art drug discovery techniques and machine learning approaches. This multidisciplinary research course features topics from chemistry, biology, chemical engineering, and computer science.

STEM (4 of 14)

Decoding Life with Biological Imaging: From Microscopy to Machine Learning

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.

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. 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.

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.

STEM (5 of 14)

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

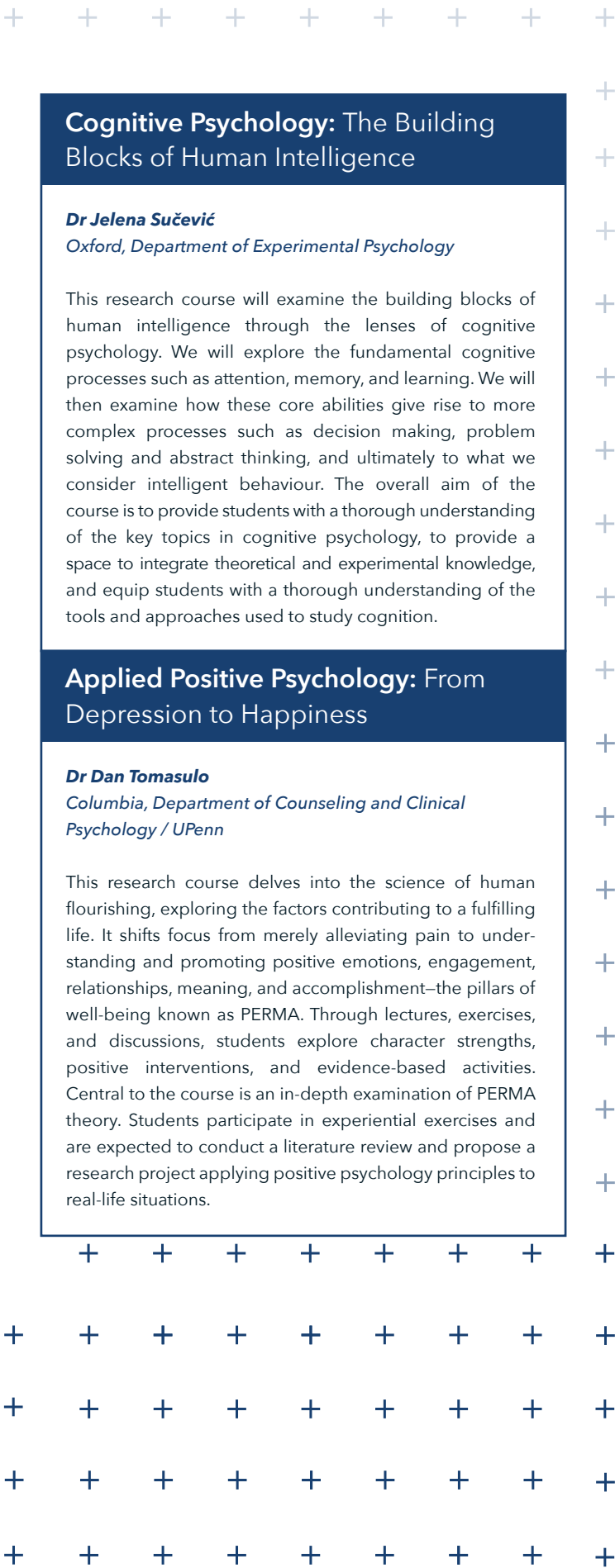
Dr Jelena Sučević
Oxford, Department of Experimental Psychology

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.

Applied Positive Psychology: From Depression to Happiness

Dr Dan Tomasulo
Columbia, Department of Counseling and Clinical Psychology / UPenn

This research course delves into the science of human flourishing, exploring the factors contributing to a fulfilling life. It shifts focus from merely alleviating pain to understanding and promoting positive emotions, engagement, relationships, meaning, and accomplishment—the pillars of well-being known as PERMA. Through lectures, exercises, and discussions, students explore character strengths, positive interventions, and evidence-based activities. Central to the course is an in-depth examination of PERMA theory. Students participate in experiential exercises and are expected to conduct a literature review and propose a research project applying positive psychology principles to real-life situations.



STEM (6 of 14)

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.

STEM (7 of 14)

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.

Robotics, Engineering, Biotechnology

DNA Nanotechnology: Design and Function of Smart Nano-Constructs

Dr Rafael Carrascosa Marzo

Oxford, Department of Physics / University College London

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.

Soft Robotics: Biomimetic Engineering

Dr Ryman Hashem

UCL, Department of Medical Physics and Biomedical Engineering

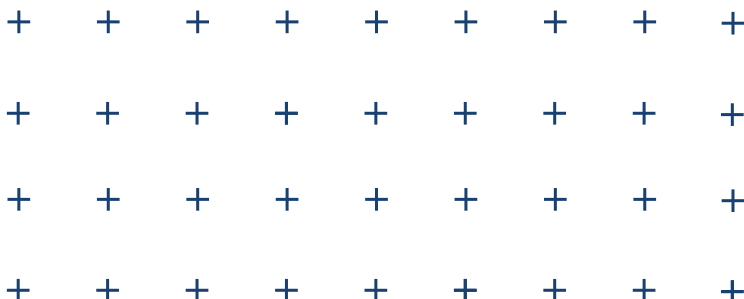
Soft robotics is a rising branch of robotics that aims to develop delicate, flexible and safe robotic devices which interact with humans using soft actuators that mimic biological behaviour, which state of the art rigid robots cannot accomplish otherwise. In practice, they can perform tasks that would 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.

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.



STEM (8 of 14)

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

In this research course, you 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. Students 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.

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

The Applications of Mathematical Optimisation: Mixed-Integer Linear Programming

Dr Benoît Legat
UCLouvain, Department of Mathematical Engineering

Nowadays, crucial modern infrastructures are operated by optimising the decisions using what is called mixed integer linear programming (MILP). This includes smart electrical grids, planning of deliveries for online shopping, scheduling at hospitals, or the design of transportation networks. In this research course, students will learn the mathematical foundation of MILP as well as its numerical aspects with practical applications. They will conduct research projects on MILP and learn how to solve complicated real-world problems by leveraging their knowledge in MILP.

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STEM (10 of 14)

Machine Learning and Natural Language Processing

Dr Weiwei Sun

Cambridge, Department of Computer Science and Technology

Natural language processing (NLP) is a field of artificial intelligence that has seen significant development in recent years with current applications include virtual assistants, language translation tools, and sentiment analysis for social media. In this research course, students will learn about the fundamental techniques for processing language for several subtasks, such as morphological processing, parsing, word sense disambiguation, etc. They will also have the opportunity to explore the various applications of these techniques in real-world scenarios.

Frontiers of Machine Learning: Solving Real World Problems

Dr Weiwei Sun

Cambridge, Department of Computer Science and Technology

Machine learning provides computers with the ability to learn without explicit programming and is fundamental to today's Artificial Intelligence landscape. This research course aims to equip students with the technical skills and knowledge required to implement and apply machine learning techniques to real-world problems. During the first few weeks, students will delve into the foundational concepts of machine learning and how it could be applied in different real-world applications. The topics such as linear algebra, naive Bayes, and neural networks will also be covered. The learning environment will be intensive, with hands-on assignments designed to sharpen students' programming skills and cultivate an intuitive understanding of machine learning principles.

Natural Language Processing: Artificial Intelligence, Machine Learning, and Semantics

Dr Mohammad Taher Pilehvar

Cambridge, Language Technology Lab

Natural Language Processing (NLP) is one of the major areas of AI that provides computers with the aptitude to understand and use our natural language. In this research course, we will learn the fundamentals of NLP and students will be able to design cutting-edge NLP models that can encode the meanings of words involving the programming language Python.

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.

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

Dr Robail Yasrab

Oxford, Department of Biomedical Engineering

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.

STEM (11 of 14)⁺

Research in ML/AI: At the Intersection of Natural Language Processing and Computer Vision

Dr Josiah Wang

Imperial College London, Department of Computing

This research course provides an introduction to Machine Learning, aiming to demystify its concepts and practical applications. Students will gain intuition and skills in applying Machine Learning to real-world tasks, particularly focusing on text and image-related problems. Through hands-on projects, they'll learn problem identification, dataset selection, data preprocessing, model selection, evaluation, and improvement techniques. By the course's end, students will be equipped to navigate the field of Machine Learning confidently, with practical research experience and the ability to critically assess advancements in the field.

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.

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.

Explainable Machine Learning: Understanding How AI Think

Dr Francesco Leofante

Imperial College London, Department of Computing

This research course delves into Explainable Artificial Intelligence (XAI) in response to the growing importance of understanding AI decision-making processes and mitigating biases. It aims to provide methods and tools for interpreting black-box AI models, fostering comprehension and trust in their outputs. Topics include feature attribution explanations, counterfactual explanations, and evaluation metrics, with applications spanning engineering, finance, and healthcare. Ultimately, the aim of the couriers is to have students develop a deep understanding of XAI fundamentals and its implications across various domains.

Quantum Physics,
Quantum Chemistry,
and Astrophysics

Quantum Computation and Information: Algorithms, Information, and Cryptography

Dr Sergii Strelchuk

Cambridge, Department of Applied Mathematics and Theoretical Physics

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.

The Quantum Mechanics and Physical Chemistry of Photoluminescence

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

Diving Inside Black Holes: Relativity, Gravitational Waves, and Black Hole Imaging

Dr Daniel Mayerson

KU Leuven (US News World Top 50), Institute of Theoretical Physics (ITF)

In this research course, students will explore the exciting world of relativity (both special and general). They will build up a new and deep conceptual understanding of relativistic physics and gravity using thought experiments, and learn the powerful mathematics that allow us to quantify this new understanding of the universe. They will then learn, apply, and even expand on current analytical and numerical techniques used for simulating, analysing, and predicting gravitational waves and black hole imaging.

Astrophysics of Black Holes, White Dwarves, and Neutron Stars

Dr Alexander Mushtukov

Oxford, Department of Physics

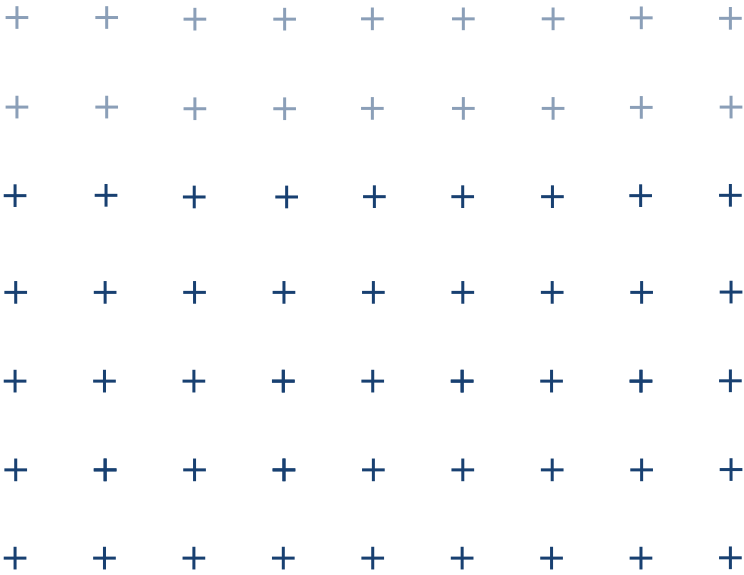
White dwarfs, neutron stars and black holes are compact objects forming at the final stages of the evolution of massive stars. In this research course, we will learn the nature of compact objects and see their place in the history of the universe. During the research course, we will touch on many topics 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

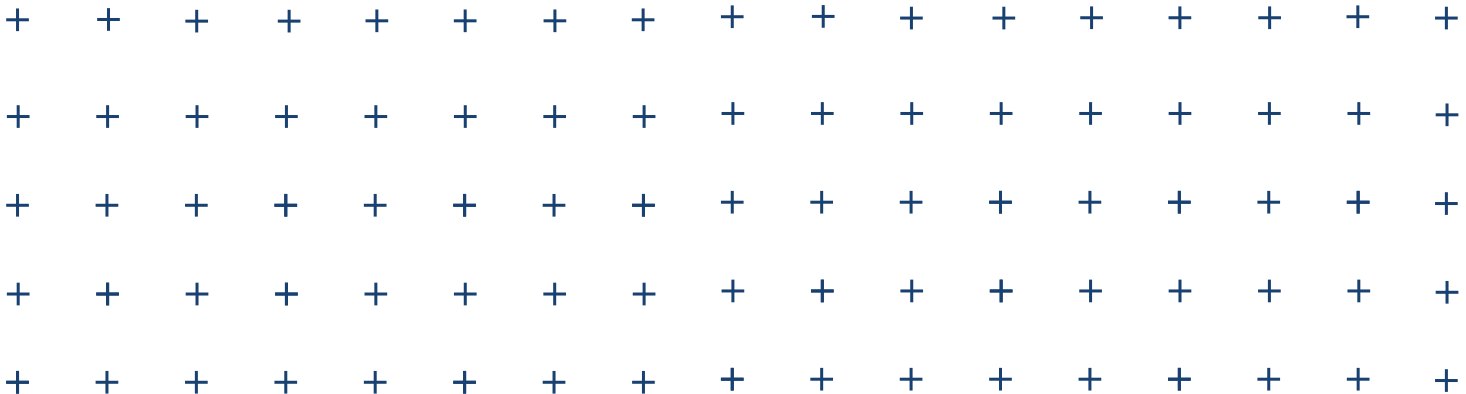
Oxford, Department of Physics

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.



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SOCIAL SCIENCE (1 of 5)

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.

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.

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 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.

SOCIAL SCIENCE (2 of 5)

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The Economics of Poverty and Inequality: Understanding, Examining, and Eradicating

Dr Gokhan M Aykac

Harvard University, The Center for Labor and a Just Economy (CLJE)

This research course delves into the multifaceted issue of poverty, examining its scope, causes, and strategies for mitigation. Beginning with a historical overview of poverty-related thought, students explore methodologies for quantifying poverty, including poverty lines and measures like basic needs approaches. The course explores the relationship between economic growth and poverty reduction, analysing theories and real-world case studies. Policy interventions are scrutinised, with discussions on urban versus rural development, healthcare, education, and aid effectiveness. Through independent research projects, students learn research methodology and gain insights into effective poverty reduction strategies, preparing them to contribute to the discourse on economic policy and poverty alleviation.

Toward A Blue Economy: Sustainable Development and the Ocean

Dr Caroline Karp

Brown, Watson Institute for International and Public Affairs / Center for Environmental Studies

Oceans define our borders, but also enable the global exchange of goods, services and ideas. In fact, the World Economic Forum estimates that the ocean will be the eighth largest economy in the world based on direct economic activity and the resources and services it provides to us on an annual basis. The goal of this research course is to understand how human activities in the world's oceans are governed currently, and to explore international, regional and state efforts to develop a more equitable and sustainable Blue 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.

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SOCIAL SCIENCE (3 of 5)

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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.

Social Anthropology: Religion, Family, Economy, and State

Dr Angel Naydenov

Cambridge, Mongolia and Inner Asia Studies Unit (MIASU)

In this research course, students will explore the dynamic nature of human societies and cultures. Through seven core themes, including power dynamics, kinship patterns, economic life, rituals, social movements, and cultural perceptions of time and space, students will gain insight into anthropological perspectives. Ethnographic case studies from diverse global contexts enrich the understanding of these themes. Additionally, students have the opportunity to read and review ethnographies and conduct their own independent ethnographic projects, fostering a deeper understanding of anthropological methods and theories.

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.

Identity in the Digital Age:

Stereotypes, Race, Gender, and Labels on Social Media

Dr Dilshad Dayani

Columbia University, The Morton Deutsch International Center for Cooperation and Conflict Resolution (MD-ICCRC) Center / United Nations / New York Times

In this research course, students explore the impact of social media on human behaviour and identity formation, examining its connections to education, communication, and group dynamics. They investigate global ideas, biases, and conflicts perpetuated by digital platforms, particularly focusing on issues of discrimination and racism. Through discussions on technology and cultural networks, students analyse how social media shapes individual and community identities, considering factors like race, gender, and socio-economic class. Through independent research projects, students gain deeper insights into the complexities of social media's influence on society, empowering them to become catalysts for change in reshaping the digital landscape.

The Power of Protest: How Social Movements Lead to Social Change

Dr Sarah Hummel

Harvard, Department of Government

In this research course, students explore the power of protests as catalysts for societal change, drawing from academic research across social sciences. The course introduces core frameworks in the study of collective action and protest, analysing successful protest characteristics and the contexts conducive to achieving goals. Topics include motivations for protest participation and the impact of social media on mobilisation. Emphasising real-world experiences, students examine diverse protest movements, such as the Civil Rights Movement and the Arab Spring, through activist memoirs, interviews, and videos. Students have freedom to select protests for research projects, integrating theoretical concepts with case studies throughout the course.

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SOCIAL SCIENCE (4 of 5)

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 course will examine the core topics in architecture by introducing students to critical arguments and debates in the discipline's contemporary discourse. 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. 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, and the unexpected synergies and tensions that will open up stimulating research territories in design culture.

BUSINESS (1 of 2)

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.

The Psychology of Business Leadership

Dr Bethania Antunes

LSE, Department of Management

This research course aims to balance theory and practical application by focusing on issues that will help students understand how to influence the attitudes, behaviour, and success of people in contemporary organisations (including leaders themselves). Topics covered in this course include the individual in the organisation, motivation, the multicultural workplace, decision-making, and effective leadership. The ability to understand, motivate, and lead people is key to becoming an effective manager in any industry or sector.

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.

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BUSINESS (2 of 2)

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.

The Psychology of Negotiations: Conflict And Communication in Business World

Dr Dilshad Dayani
Columbia University, The Morton Deutsch International Center for Cooperation and Conflict Resolution (MD-ICCRR) Center / United Nations / New York Times

This research course explores conflict resolution frameworks and strategies in personal and business contexts, emphasising intercultural negotiation skills. Students learn about conflict dynamics and strategic communication techniques to de-escalate tensions and promote constructive dialogue. Real-world examples are used to analyse conflict situations, power dynamics, culture, diversity, and emotional regulation. Through theoretical frameworks and practical applications, students develop research projects that apply these concepts. By honing intercultural communication skills and mastering conflict resolution, students emerge as adept negotiators capable of bridging cultural divides and driving success in today's interconnected business landscape.



HUMANITIES (1 of 4)

Philosophy, Politics, 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.



HUMANITIES (2 of 4)

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.

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.

Gender, Sexuality, and Politics in the Middle East

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

What is Gender? What is Sexuality? What do they have to do with biological sex or sex-acts? This research course examines different gender and sexual identities in the Middle East, and the social, political and cultural contingencies that gave rise to them. Throughout the course, each student will conduct a self-directed research project and gain a deeper understanding of the issues related to gender, sexuality, and politics in the Middle East.

Feminisms in East Asia, 1900-Present

Dr Alice Baldock
Oxford, Nissan Institute of Japanese Studies

This research course will allow students to investigate different feminisms that have been employed by feminists across East Asia in the 20th Century and up until the present day. The course will broadly focus on constructions of femininity, masculinity, non-binary, and other identities in Japan, Korea, and China. AdditionallyHowever, it will allow students flexibility to explore other areas in the region and take a transnational approach to historical work. We will also look at how these identities and the disparities between them contributed to the emergence of many transformed into many different feminist movements across and between places in this region. These feminisms will include formal protest movements, literary movements, grassroots organisations, and more subtle cultural critiques of gender normativity.

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.

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HUMANITIES (3 of 4)

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

Dr Hannah Elsis 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.

Music and Wellness: Cultural Identity
and Health In Global Perspectives

Dr Hermann Hudde
UCLA, Herb Alpert School of Music

Since ancient times in humankind history, sound, music and health have been intertwined. People around the world have realised and experienced the health-enhancing effects of sound and music. Traditional music therapy uses music to support healing and improve well-being, addressing various physical, emotional, and cognitive needs. Therapists employ music elements to aid in communication, reduce stress, and enhance overall quality of life, often in healthcare or therapeutic settings. This course studies how different cultures use sound and music in healing rituals around the world.

Around the World in 80 Tunes:
A Global Look at Popular Music

Dr Hermann Hudde
UCLA, Herb Alpert School of Music

This interdisciplinary research course delves into the profound influence of popular music on identities throughout history, examining diverse musical traditions from Africa, Europe, Asia, America, and Oceania. Through hands-on activities and participatory exercises, students explore the social, cultural, and historical contexts of popular music, transcending genre and geography. Through readings, discussions, and research projects, students develop critical thinking skills and deepen their understanding of how popular music influences society and identity. All students, regardless of music experience, are welcome to participate in this inclusive exploration of global popular music.

Approaches to Contemporary
Chinese Art

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.



HUMANITIES (4 of 4)

Art and Colonialism in Mediterranean History

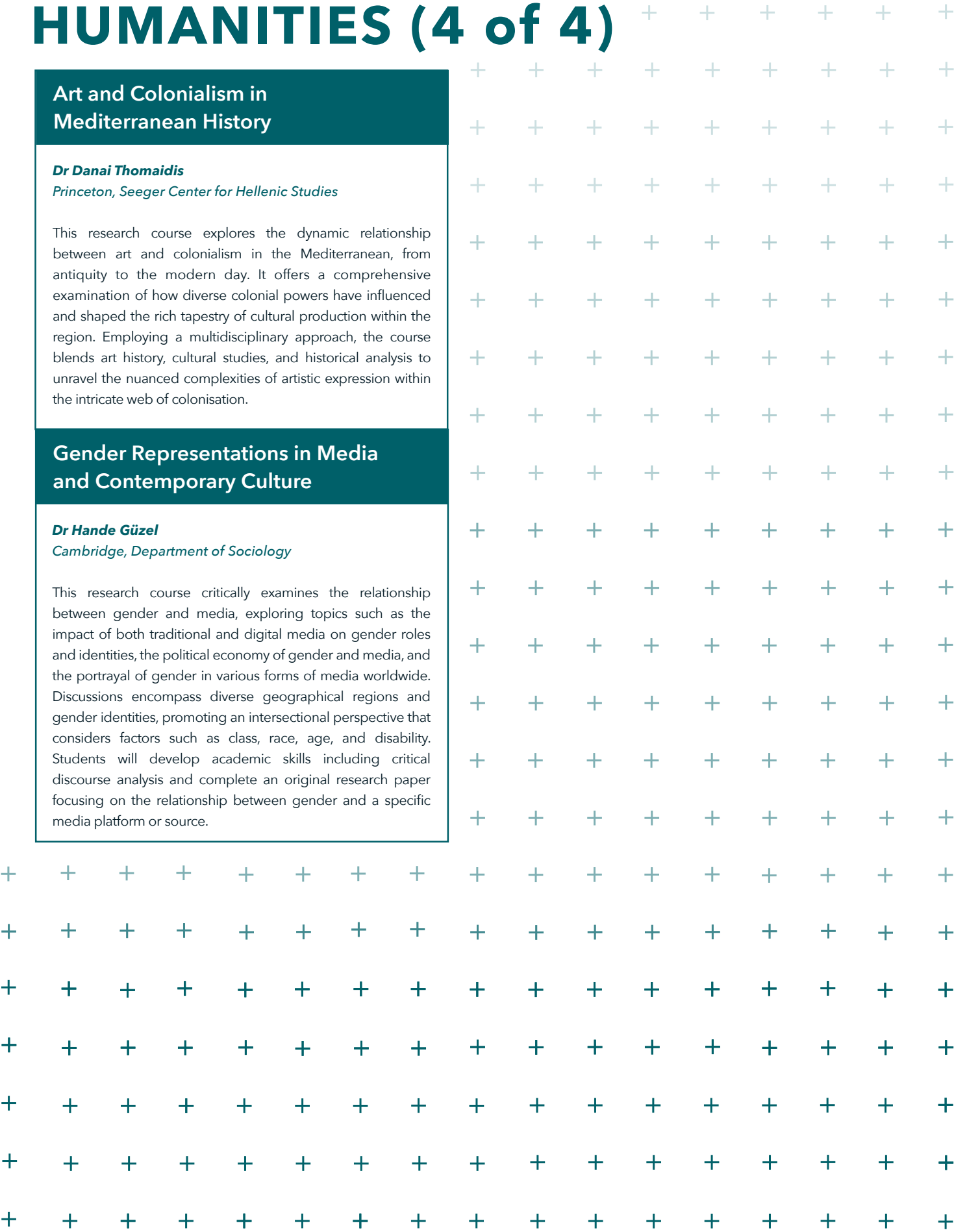
Dr Danai Thomaidis
Princeton, Seeger Center for Hellenic Studies

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.

Gender Representations in Media and Contemporary Culture

Dr Hande Güzel
Cambridge, Department of Sociology

This research course critically examines the relationship between gender and media, exploring topics such as the impact of both traditional and digital media on gender roles and identities, the political economy of gender and media, and the portrayal of gender in various forms of media worldwide. Discussions encompass diverse geographical regions and gender identities, promoting an intersectional perspective that considers factors such as class, race, age, and disability. Students will develop academic skills including critical discourse analysis and complete an original research paper focusing on the relationship between gender and a specific media platform or source.



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.



DEVELOPMENTAL BIOLOGY:

GENE EDITING, STEM CELLS, MODEL ORGANISMS, AND EPIGENETICS

Suitable for students interested in:

BIOLOGY

Biochemistry | Developmental Biology | Stem Cells

MEDICINE

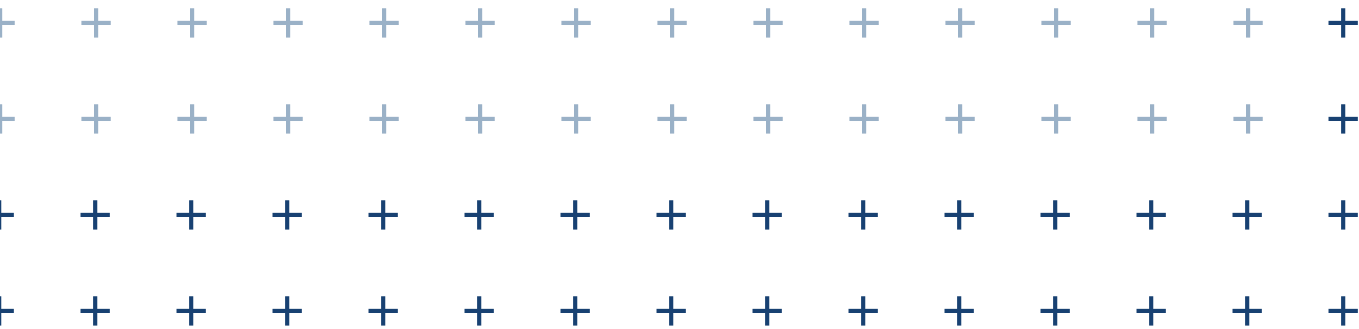
Cardiology | Drug Discovery | Genome Engineering

“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 flies, 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.



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.



ADVANCED CELL AND DEVELOPMENTAL BIOLOGY

Suitable for students interested in:

BIOLOGY

Cell Biology | Developmental Biology | Genetics

MEDICINE

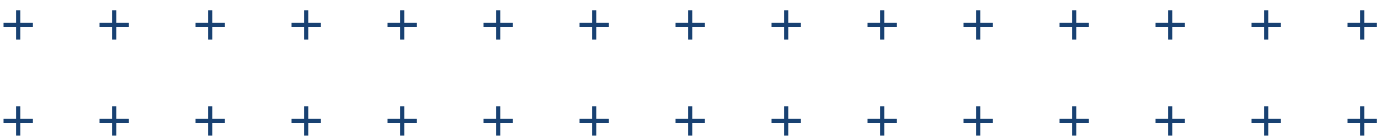
Stem Cells | Cancer Research | Drug Discovery

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.



PRINCETON UNIVERSITY

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

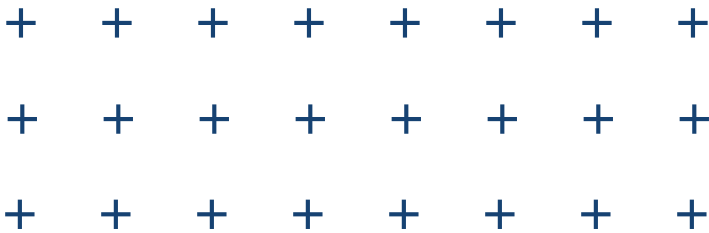
Instructor, Summer Undergraduate Research Program, Department of Molecular Biology, Princeton University

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

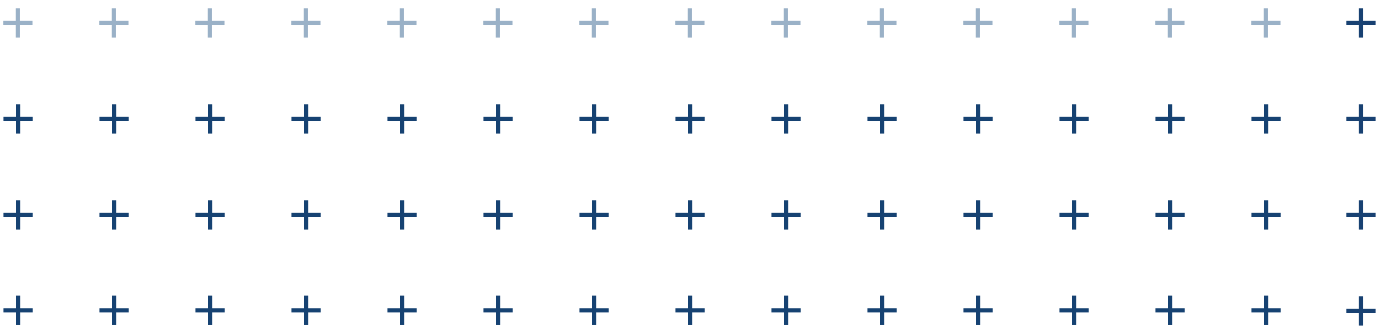
Biochemistry | Cell Biology | Structural Biology

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.



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.



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

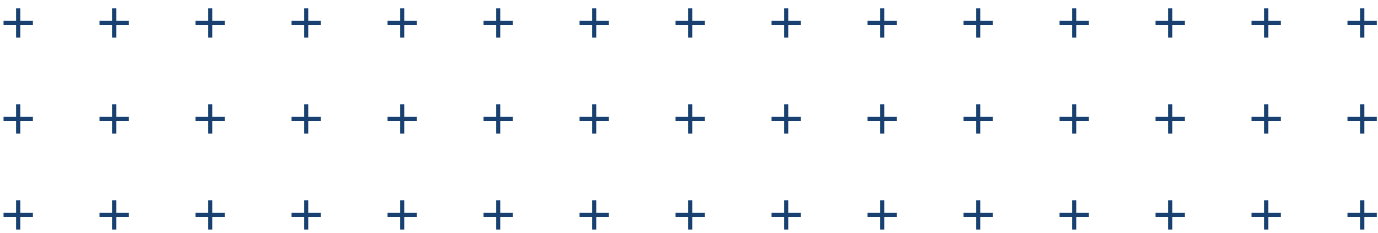
Statistics | Biological Data | Cellular Biology | Genes and Genomes

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.



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.



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 BEGÜM AKMAN-TUNCER

CURRENT POSITIONS

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

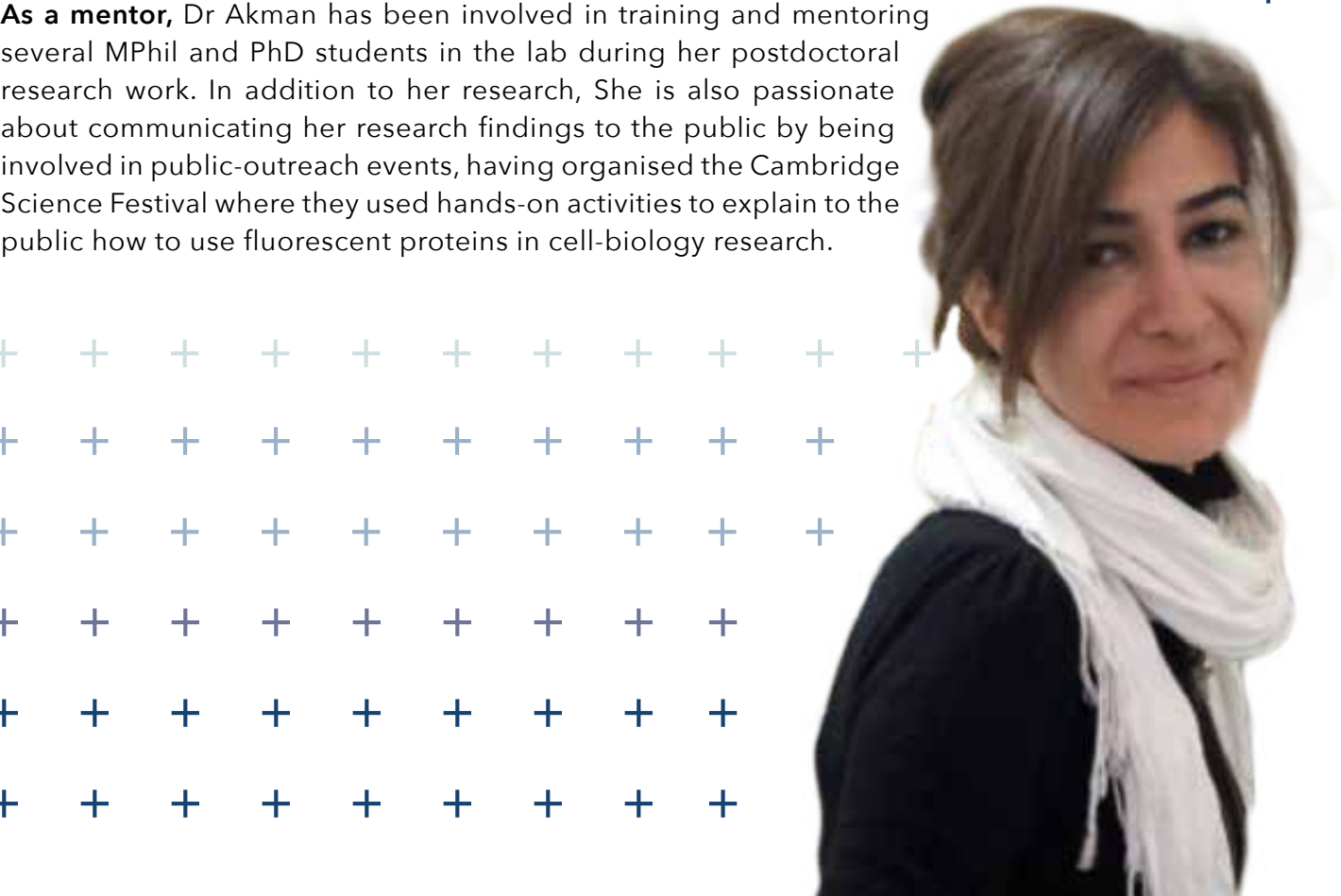
Research Associate, Department of Pharmacology, University of Cambridge

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.



CANCER BIOINFORMATICS:

MINING THE “BIG DATA”

Suitable for students interested in:

BIOLOGY

Genetics | Genomics | Bioinformatics

MEDICINE

Oncology | Computational Medicine

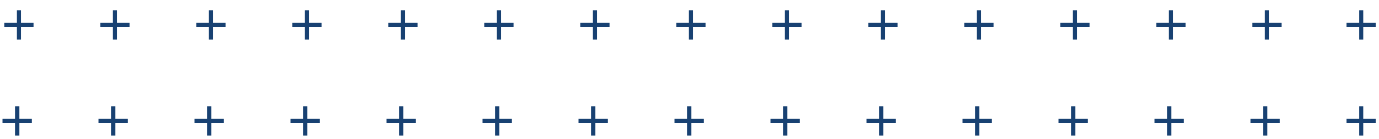
COMPUTER SCIENCE

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.



PRECISION MEDICINE AND BIOINFORMATICS:

GENOMICS-BASED PERSONALIZED TREATMENT

Suitable for students interested in:

BIOLOGY

Genetics | Genomics | Bioimarkers

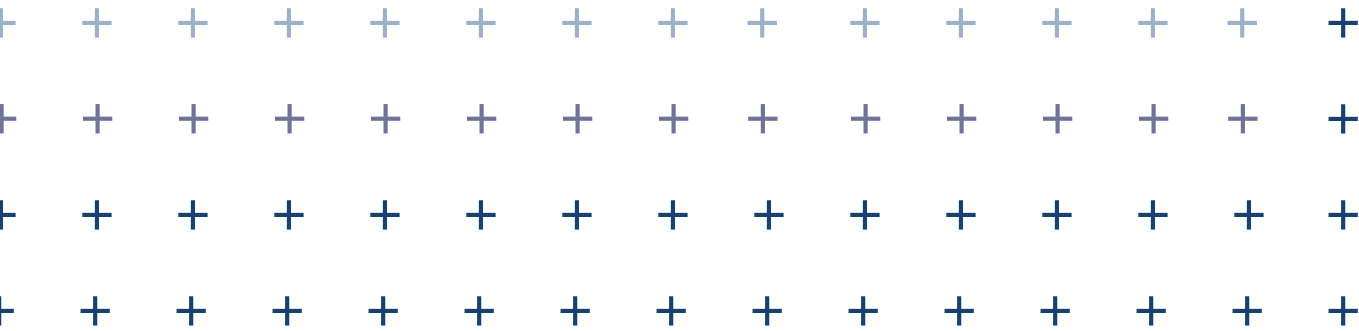
MEDICINE

Personalised Treatment | Precision Medicine

Precision medicine, also known as personalised medicine, is an innovative approach to medical treatment that integrates individual differences in patients’ genes, environments, and lifestyles. Bioinformatics plays a critical role in precision medicine by providing the tools and methodologies needed to analyse, interpret, and make sense of the vast amounts of biological data generated in the era of genomics and personalised medicine.

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.

Students will delve into the intersection of genomics, data science, and personalised healthcare to gain a deep understanding of how precision medicine is revolutionising research, diagnosis, and treatment of human diseases. Throughout the research, by using bioinformatics tools and techniques, we will learn to interpret and extract meaningful insights from large-scale datasets. The potential role of artificial intelligence, machine learning and other innovative approaches in shaping the future of precision medicine will also be discussed. Students will have the opportunity to conduct their own independent research projects and generate their own data in preparation for publication.



DR NAAMA KANAREK

CURRENT POSITIONS

Assistant Professor, Department of Pathology, Harvard Medical School / Boston Children’s Hospital

Principal Investigator, Kanarek Lab

PREVIOUS APPOINTMENTS

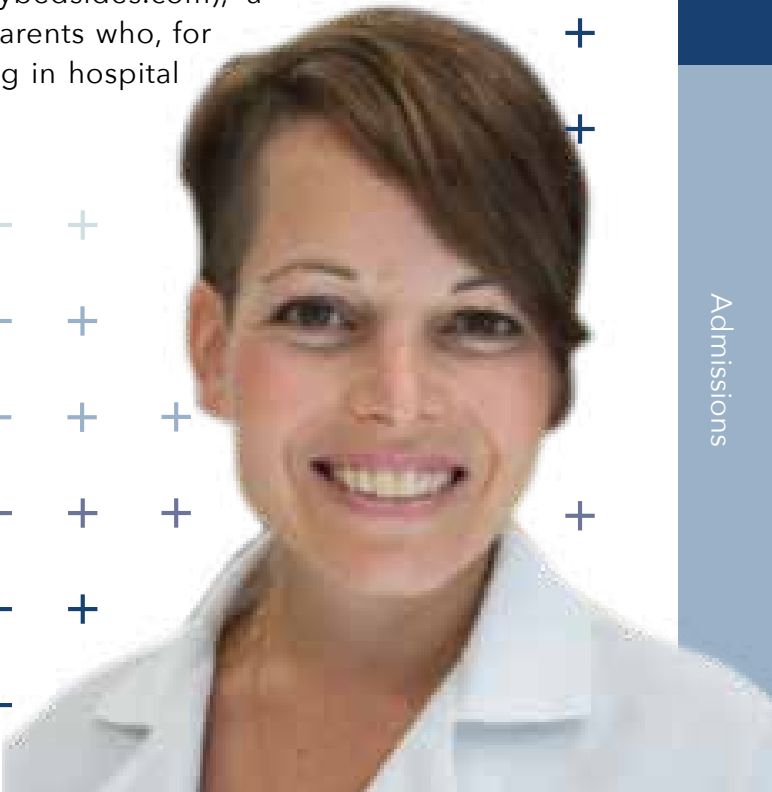
Cancer Researcher, Columbia University Medical Center

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.



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 BORYANA PETROVA

CURRENT POSITIONS

Instructor, Department of Pathology, Harvard Medical School / Boston Children’s Hospital, Harvard University +

Staff Scientist, Kanarek Lab, Harvard Medical School / Boston Children’s Hospital +

Lecturer, Northeastern University +

PREVIOUS APPOINTMENT

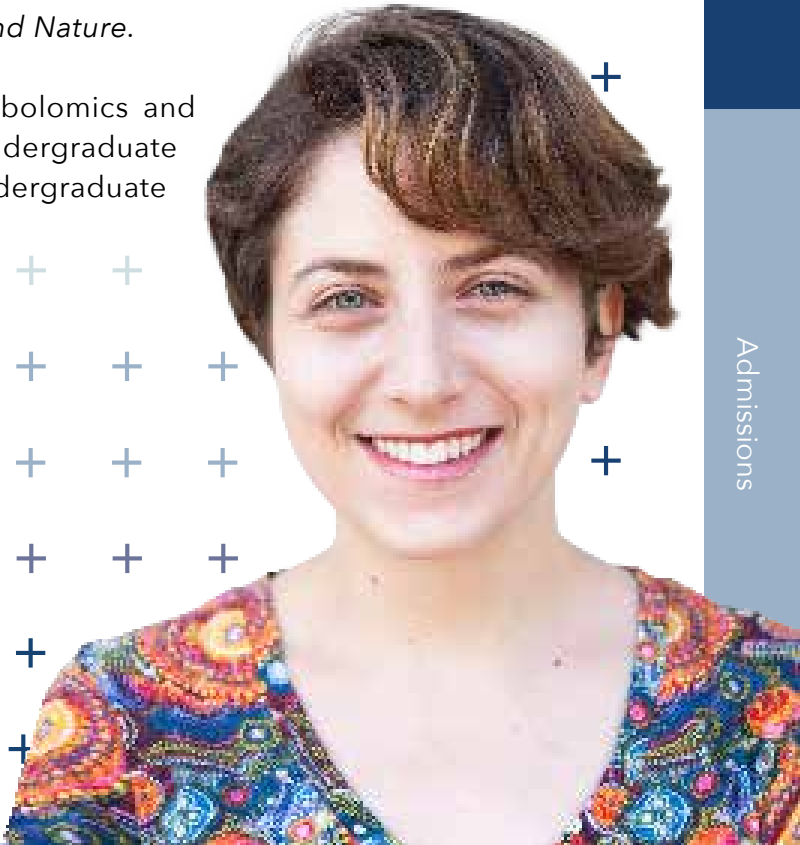
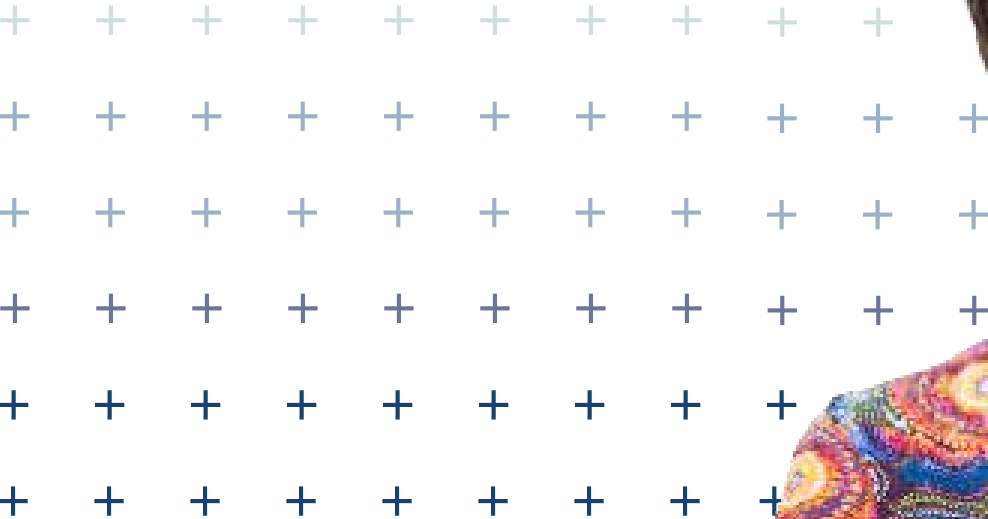
Postdoctoral Researcher, Whitehead Institute for Biomedical Research, MIT +

A scientist committed to understanding cellular health and metabolism-related disorders for potential therapeutic approaches. +

As a researcher, Dr Petrova has a strong background in cell and molecular biology, LC-MS, metabolomics, genetics, imaging, and working with diverse model organisms. During her stay at the Whitehead Institute, she developed a particular interest in mass spectrometry, metabolomics, and metabolism. This passion has led to current research projects on metabolomics, specifically on folate homeostasis and metabolism at the Kanarek Lab. For her outstanding contributions to the field, Dr Petrova was given the Harvey Lodish Service Award by the Whitehead Institute at MIT. +

Her works have been presented at prestigious research conferences in Japan, Europe, and the US. Moreover, she has published articles in peer-reviewed scientific journals such as *Nature Communications*, *Science*, and *Nature*. +

As a mentor, Dr Petrova teaches courses on Metabolomics and Biotechnology at Harvard at both graduate and undergraduate levels. She is also supervising PhD, MSc, and undergraduate students in their dissertations and research projects. +



THE NEW WAVE OF CANCER RESEARCH:

THE PRINCIPLES AND PRACTICE OF CANCER METABOLISM

Suitable for students interested in:

MEDICINE

Cancer Research | Metabolomics | Clinical Research

BIOINFORMATICS

Data Collection | Data Analysis | Data Visualisation

In the past decade, within the realm of cancer research, the field of cancer metabolism has experienced a resurgence, surpassing more traditional approaches such as genetics and offering successful clinical solutions. It has contributed to major advancements in our understanding of this complex disease and to improvements in diagnosis and treatment of tumours.

In this research course, students will be introduced to the forefront of cancer research through the lens of cancer metabolism. They will gain knowledge in cutting-edge areas and study the principles and practices of cancer metabolism from the perspective of metabolomics.

The approach will be multifaceted. Students will have the opportunity to delve deep into the current developments of cancer research, as well as using different research tools to gain hands-on experiences. Students are expected to conduct their independent research.

In the first half of the course, students will become familiar with fundamental topics in cancer metabolism. A discussion-based approach and reviewing current literature will instruct students on the essential cancer metabolism toolkit, method advancements, and limitations. In the second part of the research course, students will learn about a major tool in the cancer metabolism field - metabolomics by liquid chromatograph mass spectrometry (LC-MS). Students will learn LC-MS basics, including how to properly prepare and collect samples for research or medical applications, how data is acquired, analysed, and visualised, and finally, tools and ideas on how to interpret and present metabolomics data to peers.



HARNESSING LC-MS:

UNDERSTANDING THE EMERGING TECHNOLOGY THAT ARE RESHAPING MEDICAL PRACTICE

Suitable for students interested in:

BIOTECHNOLOGY

Drug Discovery | Bioinformatics | Data Analysis and Visualisation

MEDICAL SCIENCES

Clinical Practice | Biochemistry | Genetics | Molecular Biology

In recent years, the burgeoning field of metabolomics has propelled forward our understanding of biological systems, and its utility extends well beyond the confines of any single discipline. Central to this discipline is LC-MS (Liquid Chromatography-Mass Spectrometry), a powerful analytical technique that separates chemicals before identifying and quantifying them with unparalleled precision. This cutting-edge research course is an invitation to immerse in the transformative power of metabolomics and LC-MS, technologies that are reshaping scientific inquiry and clinical practice alike.

This research course aims to help students understand and unlock the potential of LC-MS and metabolomics and to equip them with the knowledge to contribute to the next wave of discoveries in biological and medical sciences.

Students will delve into essential components of the technology, including principles in sample preparation and chromatography, the fundamentals of mass spectrometry, and the art of data analysis and visualisation. Interactive discussions and hands-on examples will illustrate how these elements coalesce to create a powerful analytical approach.

The research course will illuminate how LC-MS can unravel the complexities of biological samples, capturing the minute but critical changes that underlie health and disease. Through case studies and current literature, we will examine how these techniques are being applied in novel ways, such as single-cell metabolomics, to anticipate the future trajectory of the field.

Emphasising accessibility, the research course is crafted for the inquisitive mind—with no prerequisite knowledge beyond a general curiosity about emerging technologies. We will embark on a journey through the versatile applications of LC-MS and metabolomics, exploring their role in both clinical and fundamental biology contexts.

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

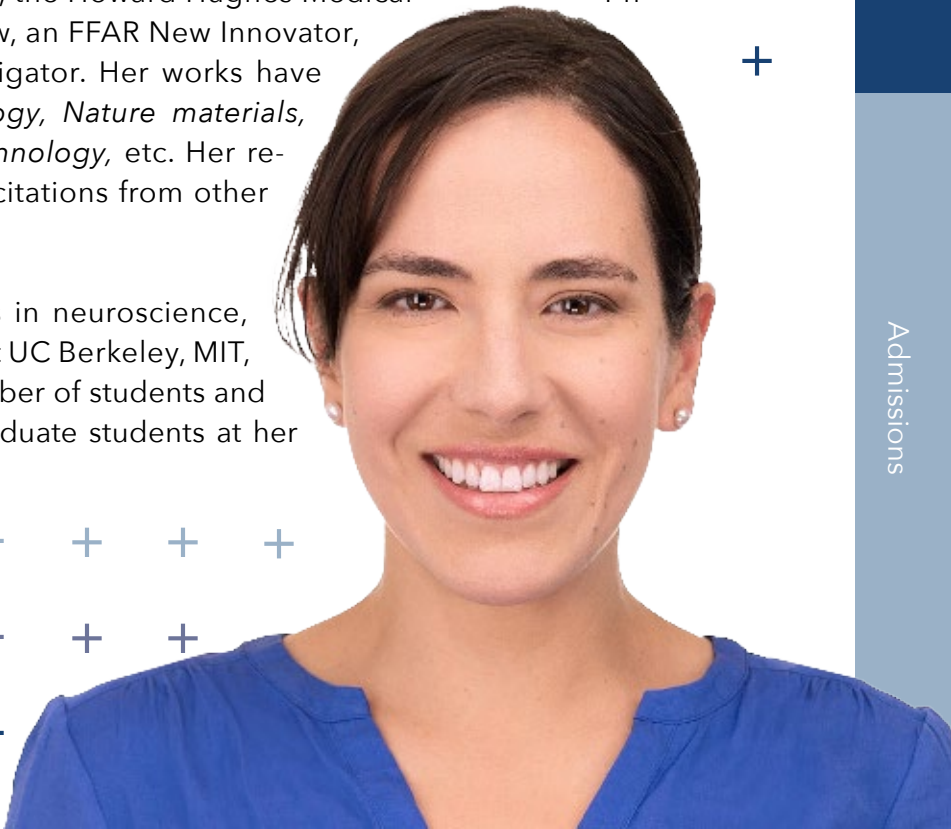
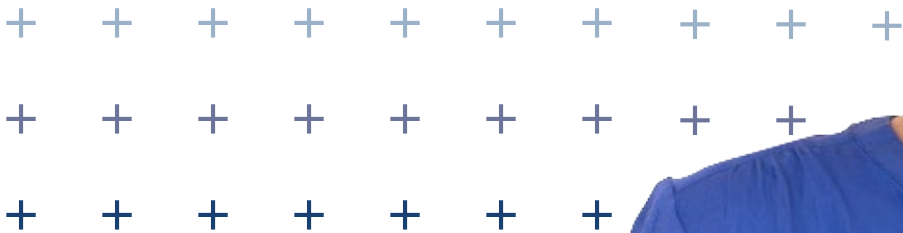
Scientific Advisory Board Member, Terramera, Inc. / Chi Botanic, Inc.

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.



EMERGING TOPICS IN ENGINEERING BIOTECHNOLOGY:

FROM CRISPR TO CLONING

Suitable for students interested in:

BIOMEDICAL ENGINEERING

DNA Biotechnology | Cloning | Protein Biotechnology

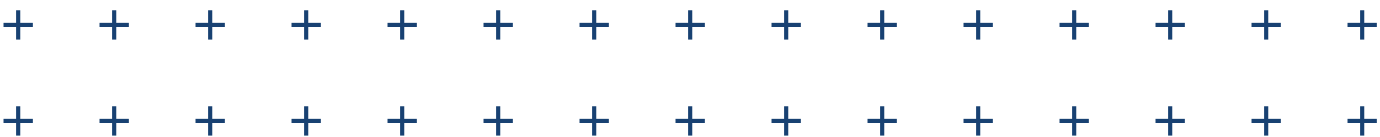
BIOLOGY

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

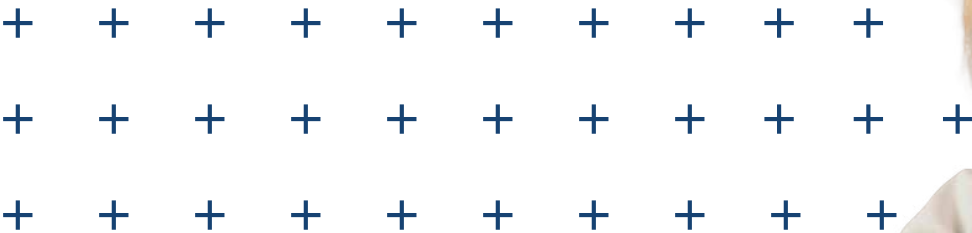
A scientist dedicated to developing more humane and personalised early detection cancer diagnostics for women.

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.



DECODING LIFE:

DNA SEQUENCING AND CANCER DIAGNOSTICS

Suitable for students interested in:

MOLECULAR MEDICINE

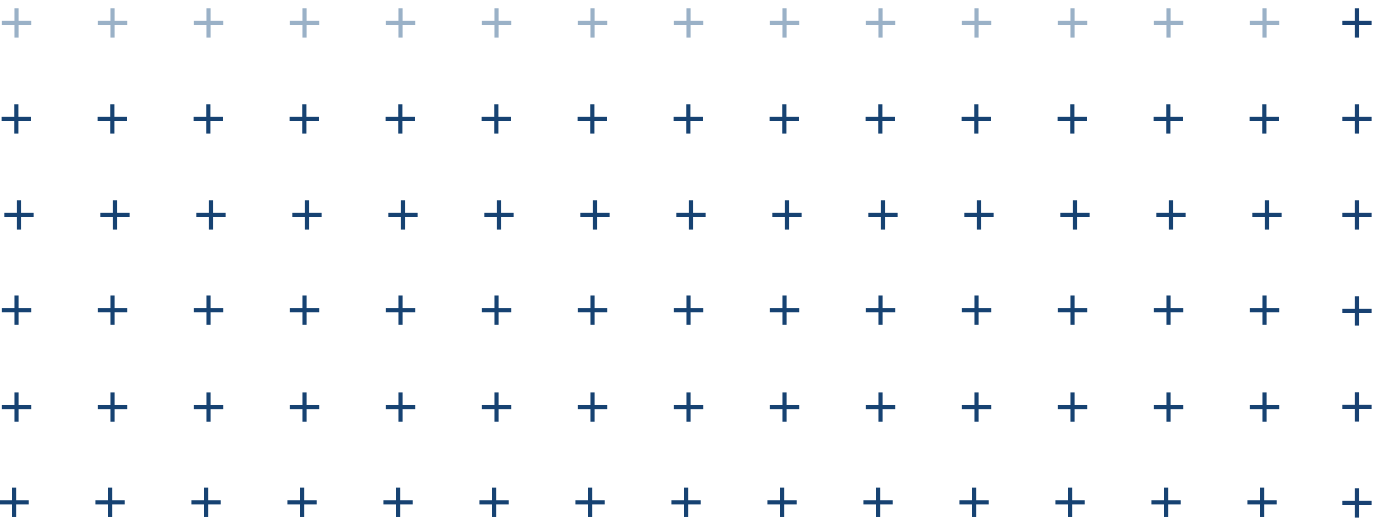
Bioinformatics | Molecular diagnostics | Pharmacogenomics

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.



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 *Microbiology 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.



COMPUTATIONAL GENETICS AND EPIDEMIOLOGY

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 for 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.

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PRACTICAL COMPUTING IN MEDICAL SCIENCE AND BIOLOGY

Suitable for students interested in:

MEDICAL SCIENCE

Biomedical Engineering | Clinical Research and Trials | Biotechnology

BIOINFORMATICS

Genome Analysis | Statistical Analysis | Biological Datasets

COMPUTER SCIENCE

Programming | Data Science | Modelling

Nowadays, research in medical science and biology heavily relies on computational tools, whether it is for diagnosis, drug discovery, or biotechnology areas.

This research course is interdisciplinary in nature. It helps students to build the bridge and develop their research project between computing and medical science and biology. Students would see how computational methods bring new insights to many questions in life science and promise new solutions.

Throughout this course and by conducting their research project, students will gain hands-on experience and practical applications of computing, especially in the field of biology and genetics.

Students will be introduced to fundamental programming concepts, data analysis techniques, and the use of relevant software tools. The course will cover the topics such as data manipulation, statistical analysis, and visualisation, genomic analysis, equipping students with the abilities to extract valuable insights from vast biological datasets. Additionally, students will be introduced to commonly used programming languages in biological research, equipping them with the tools to efficiently automate tasks.

At the conclusion of this research course, students will be equipped with the skills and confidence to effectively utilise computational techniques for tackling biological and medical challenges and applying them to real-world applications. It will help them to think about the questions from a computational perspective. They will establish a crucial connection in their understanding between traditional biological methods and the growing significance of computing in contemporary biological studies, setting them up for their future exploration in medical science, biology, or life science in general.

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 university-level courses in pharmaceutical sciences, clinical laboratory medicine, metabolic biochemistry, and immunology. She has also mentored researchers at the undergraduate and graduate level.



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.



DR CONNOR TAYLOR

CURRENT POSITIONS

Sustaining Innovation Research Associate, University of Cambridge & Astex Pharmaceuticals

Member, The Royal Society of Chemistry

Founder, Compunetics

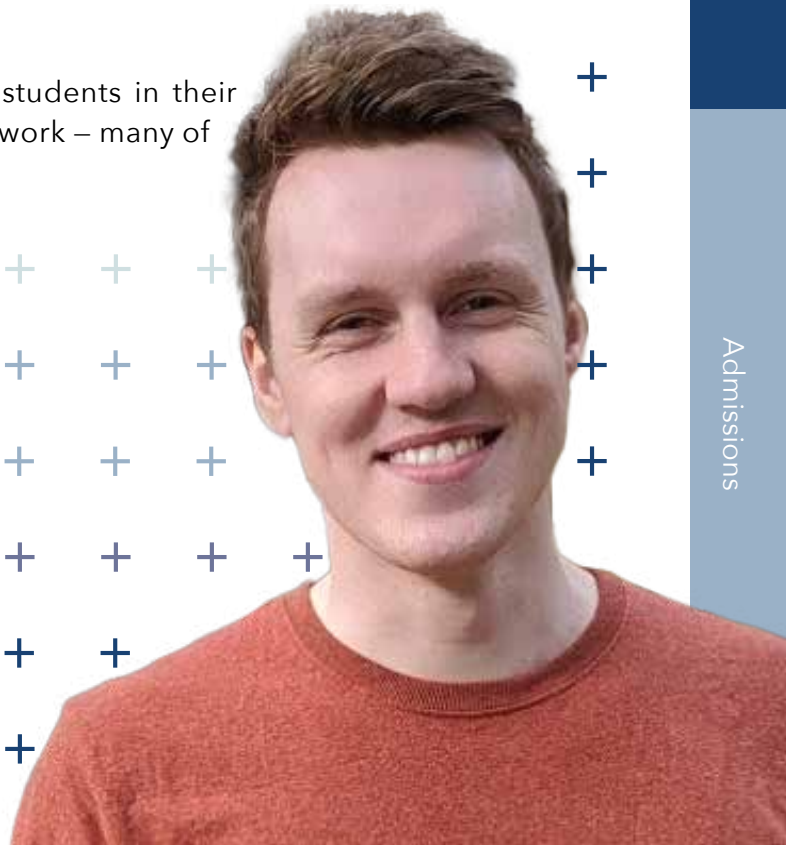
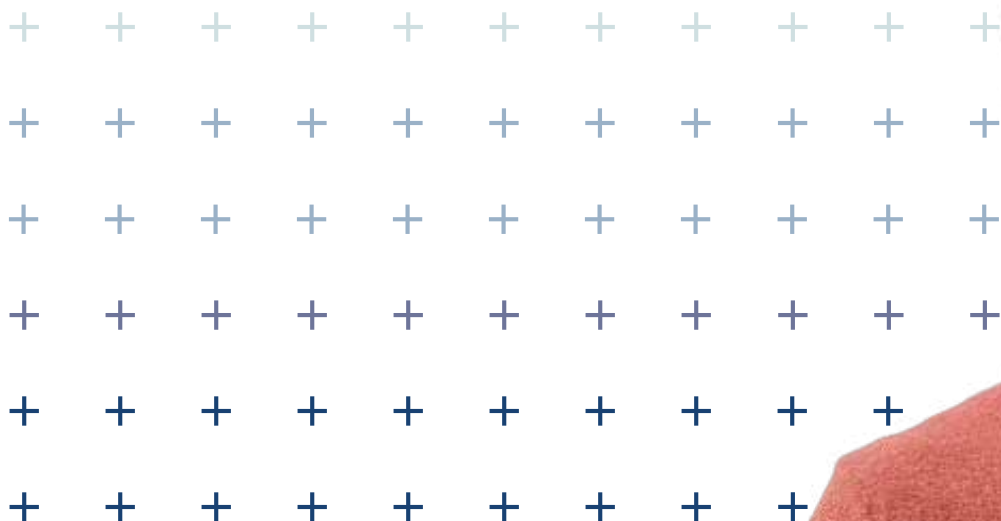
A chemical engineer working on bioactive drug discoveries with real-world impact.

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

MACHINE LEARNING IN DRUG DISCOVERY AND CHEMICAL DEVELOPMENT

Suitable for students interested in:

CHEMISTRY & BIOLOGY

Chemical Engineering | Chemical Development | Bioactive Drug Discovery |
Flow Chemistry

COMPUTER SCIENCE

Machine Learning | Technology | Automated Synthesis

PUBLIC HEALTH & MEDICINE

COVID-19 | Pharmaceutical Synthesis

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 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. This is a multi-disciplinary course that will teach students how to utilise several key topics to tackle modern problems.

This research course will examine state-of-the-art drug discovery techniques, including fragment-based drug discovery, high-throughput screening, and machine learning approaches. Machine learning will also be broadly covered, including how to fit neural networks to large datasets and optimise parameters using introductory programming. Modern chemical synthesis techniques will also be explored, including flow chemistry, automated synthesis, high-throughput experimentation and their place in the modern laboratory.

This research course features topics from chemistry, biology, chemical engineering and computer science, which will be hugely beneficial for student understanding in these areas. This will result in a broad and strengthened understanding of multidisciplinary techniques and the fundamentals of these core research areas, as this research course will cover cutting-edge techniques that are currently being actively utilised in academic research.



DR ADEEBA FATHIMA VALIYA THODIYIL

CURRENT POSITION

Postdoctoral Researcher, Biomineral Research Lab, University of Cambridge

PREVIOUS APPOINTMENT

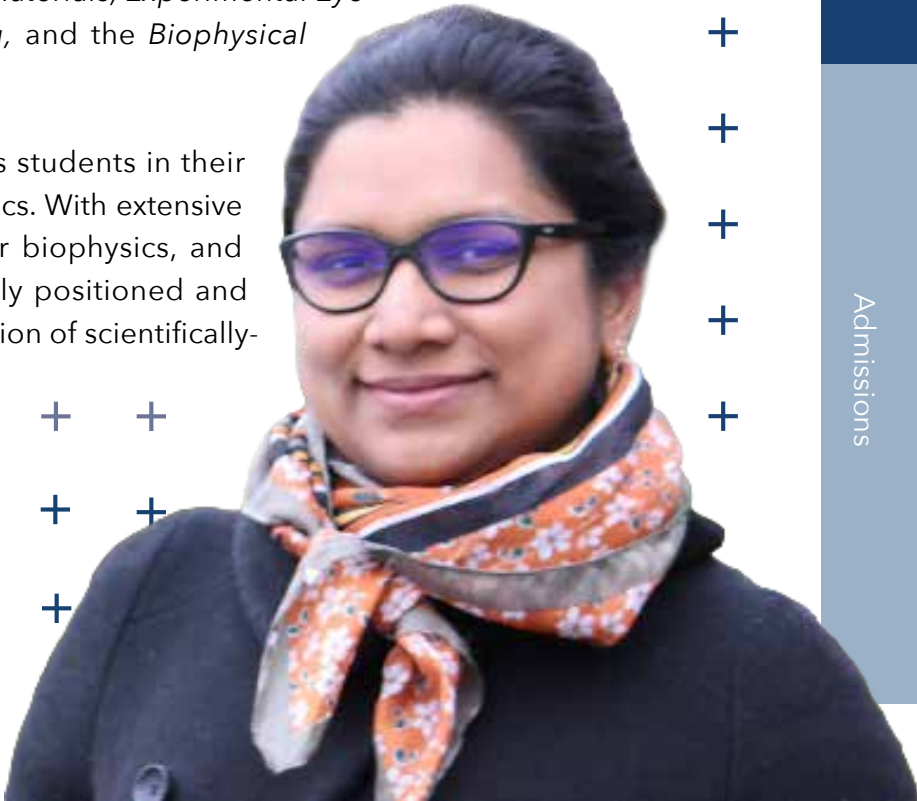
Postdoctoral Research Associate, Trinity Hall, University of Cambridge

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.



DECODING LIFE WITH BIOLOGICAL IMAGING:

FROM MICROSCOPY TO MACHINE LEARNING

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.



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.



REGENERATIVE MEDICINE:

STEM CELLS, BIOMATERIALS, TISSUE ENGINEERING

Suitable for students interested in:

BIOLOGY

Stem Cells | Regenerative Biology

MEDICINE

Regenerative Medicine

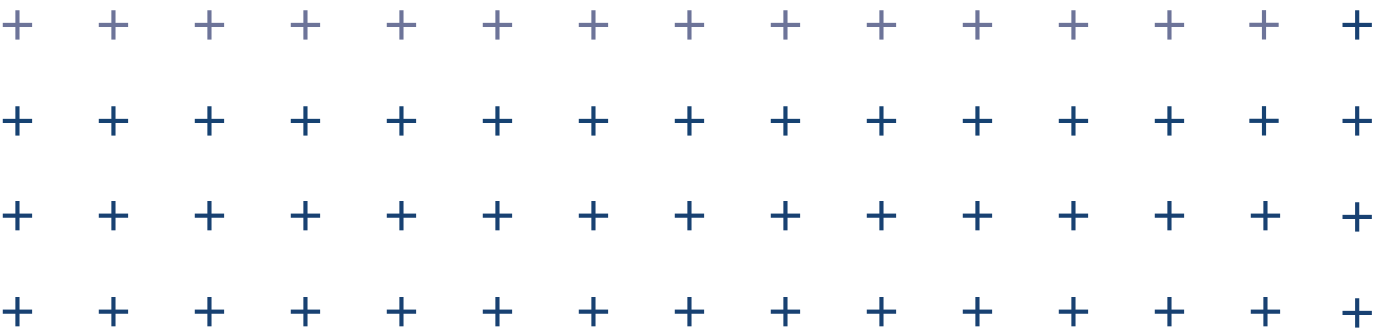
BIOMEDICAL ENGINEERING

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 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 researcher, As a neuroscientist, Dr 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 aging 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 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.

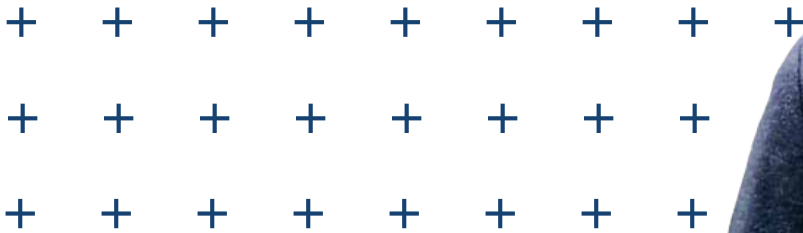
As a researcher, Dr Ba specialises in multiple fields, including genomics, molecular biology, epidemiology, and bioinformatics. His primary focus is on understanding and combating antimicrobial resistance mechanisms in Staphylococcus aureus and other clinically significant bacterial pathogens.

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 anti-biotic-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.



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.

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DR ALEJANDRO CARNICER-LOMBARTE

CURRENT POSITIONS

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

PREVIOUS APPOINTMENT

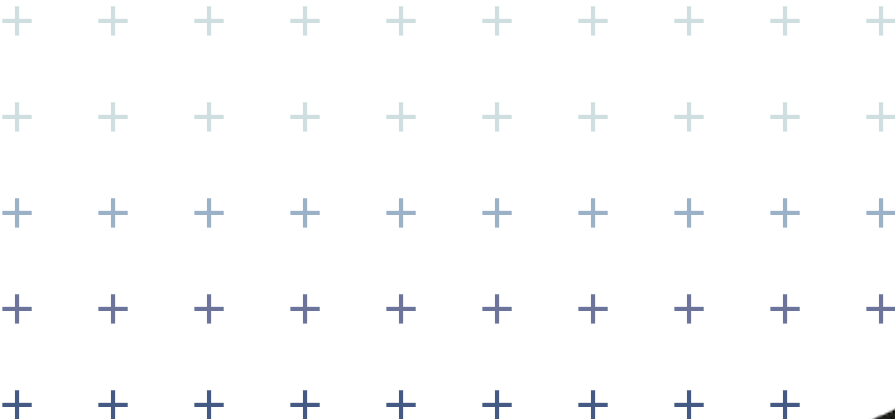
Research Associate, Department of Engineering, University of Cambridge

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.



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.

In 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

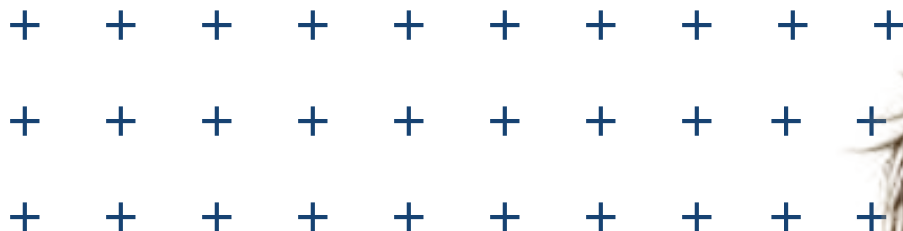
Researcher, Imperial College London, ProtonDx

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 and 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 POSITIONS

Research Scientist, Keenan Research Centre for Biomedical Sciences, University of Toronto +

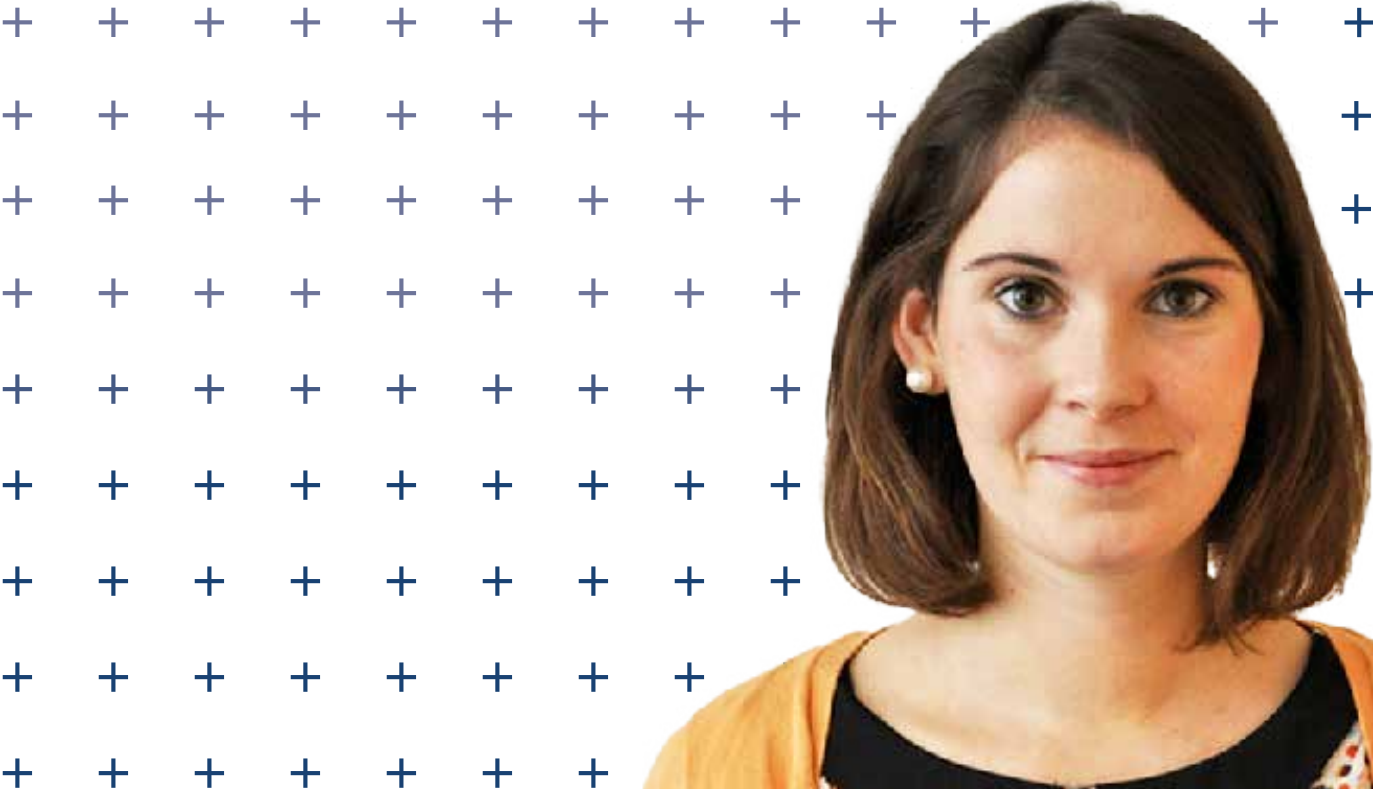
Research Scientist, St Michael’s Hospital, Toronto, Canada +

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 both University of Toronto and before then, 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.

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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.



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.



DR DAN TOMASULO

CURRENT POSITIONS

Academic Director & Core Faculty, Spirituality Mind Body Institute, Columbia University
Adjunct Assistant Professor of Psychology and Education, Department of Counseling and Clinical Psychology, Columbia University
Assistant Instructor, University of Pennsylvania

A renowned psychologist and expert in intellectual and developmental disabilities widely recognized for his work in promoting mental health and well-being through innovative interventions and compassionate therapy approaches.

As a psychologist, Dr Tomasulo’s clinical specialisation in psychodrama and sociometry is coupled with his academic expertise in intellectual disabilities. He pioneered Interactive Behavioral Therapy (IBT) and Positive-Interactive Behavioral Therapy (P-IBT), revolutionising group psychotherapy for individuals with intellectual disabilities. His unwavering commitment to Positive Psychology reflects his belief in harnessing strengths to cultivate meaningful and fulfilling lives, embodying a transformative approach to mental well-being. Notably, Dr Tomasulo recently received the 2024 Gardner Award from the National Center for START Services which recognizes Dr Tomasulo’s exceptional contributions to improving the lives of individuals with intellectual and developmental disabilities (IDD) and their families.

His long list of publications include book chapters and articles in high-impact scientific journals such as Character Strengths and Abilities Within Disabilities: Advances in Science and Practice, Positive Psychological Intervention Design and Protocols for Multi-Cultural Contexts, and the Handbook of Positive Psychology in Intellectual and Developmental Disabilities by Springer.

As a mentor, Dr Tomasulo was given the 2021 Teaching award by Columbia University as recognition for his exceptional commitment in cultivating a dynamic and supportive educational environment, where students are empowered to explore, learn, and grow.



APPLIED POSITIVE PSYCHOLOGY:

FROM DEPRESSION TO HAPPINESS

Suitable for students interested in:

PSYCHOLOGY

Evidence-based Psychotherapy Interventions | Counselling Psychology | Mental Health

COGNITIVE SCIENCE

Neuroscience | Physiology of the Mind | Cognitive Development

Aristotle called it eudaimonia, Navaho philosophy called it Hozho, and modern-day researchers call it human flourishing. Judging whether life is worth living amounts to answering the fundamental question of philosophy. Toward this end, the science of psychology had previously focused on understanding the mechanics of negative feelings and alleviating pain. However, not being depressed isn't the same as being happy, and it is only recently that scientists have turned their attention to what contributes to a good life. Zest, passion, grit, flow, engagement, positivity resonance, vagal tone, oxytocin, brain coupling, mirror neurons, love, achievement, and relationships are emerging topics in positive psychology. No longer the province of poets, playwrights, and philosophers, scientists are proposing the good life may have a blueprint.

In this research course, we will focus on character strengths and virtues, using positive interventions, examining evidence-based intentional activities, and considering how these findings inform our relationships, psychotherapy, spirituality, business practices and the humanities. Central to this exploration is a deep understanding and discussion of new theories of well-being. Most prominent among these theories is the one put forth by Dr. Martin Seligman, commonly known as PERMA.

PERMA stands for positive emotions, engagement, positive relationships, meaning, and accomplishment. These are the five pillars of well-being and form a psychological construct for understanding the elements behind happiness and thriving. We will study each of these in depth.

The research course utilises a combination of lectures, experiential and meditative exercises, videos, demonstrations, and discussions. Students are expected to participate in the positive interventions suggested and offered in class. As the nature of the course is geared toward applying positive psychology principles, students will be expected to do a literature review of a current topic in positive psychology and a research project outlining how to use positive psychology principles in a real-life situation. Students will not be expected to carry out this application; instead, they will need to make a convincing argument for why and how it should be used and what makes it likely to succeed.

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.



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.



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.



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.



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

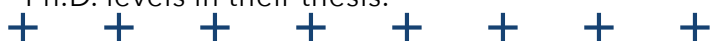
Postdoctoral Associate, Baylor College of Medicine

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.



THE NEUROSCIENCE OF DECISION MAKING:

LINKING BRAIN AND BEHAVIOR

Suitable for students interested in:

NEUROSCIENCE

Decision-Making | Cognitive Neuroscience | Psychology

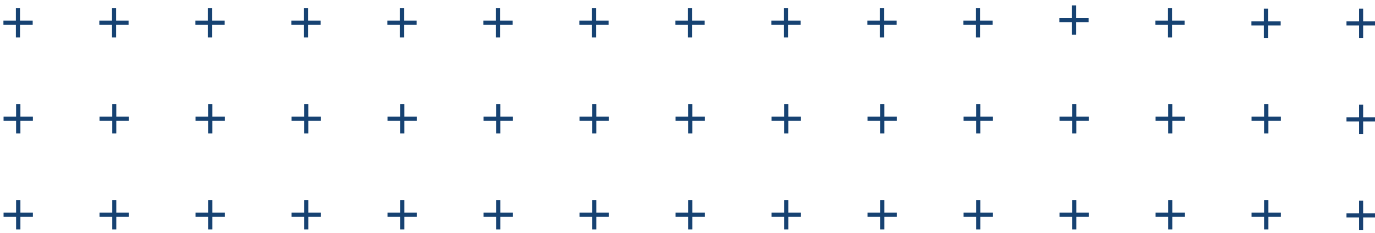
DECISION THEORY

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.



NEUROECONOMICS:

MULTIDISCIPLINARY SCIENCE OF DECISION MAKING

Suitable for students interested in:

NEUROSCIENCE

Decision-making | Psychology | Cognitive Neuroscience

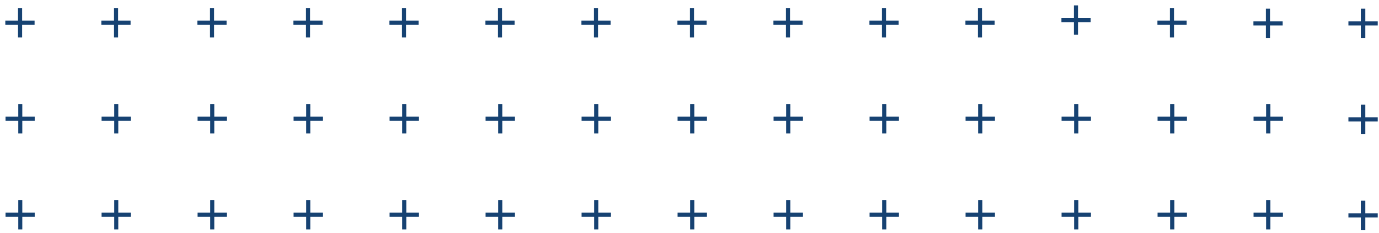
ECONOMICS

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.



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.



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.



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.



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).

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DR RAFAEL CARRASCOSA MARZO

CURRENT POSITIONS

Researcher, Department of Physics, University of Oxford

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.

As a mentor, Dr Marzo has supervised undergraduate and graduate students at the University of Oxford.



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

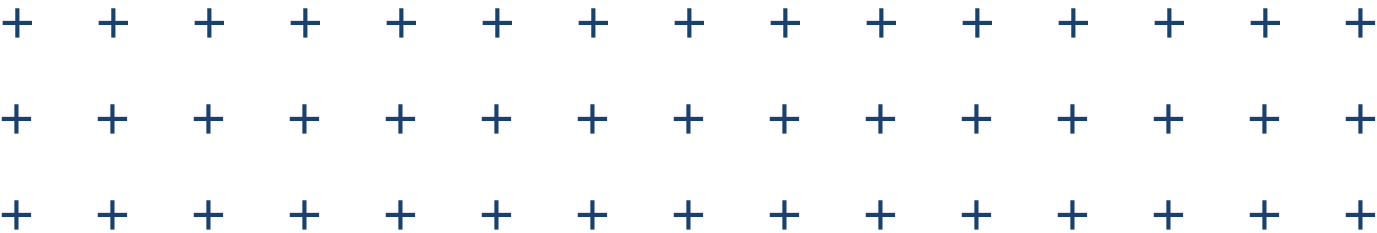
BIOLOGY

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

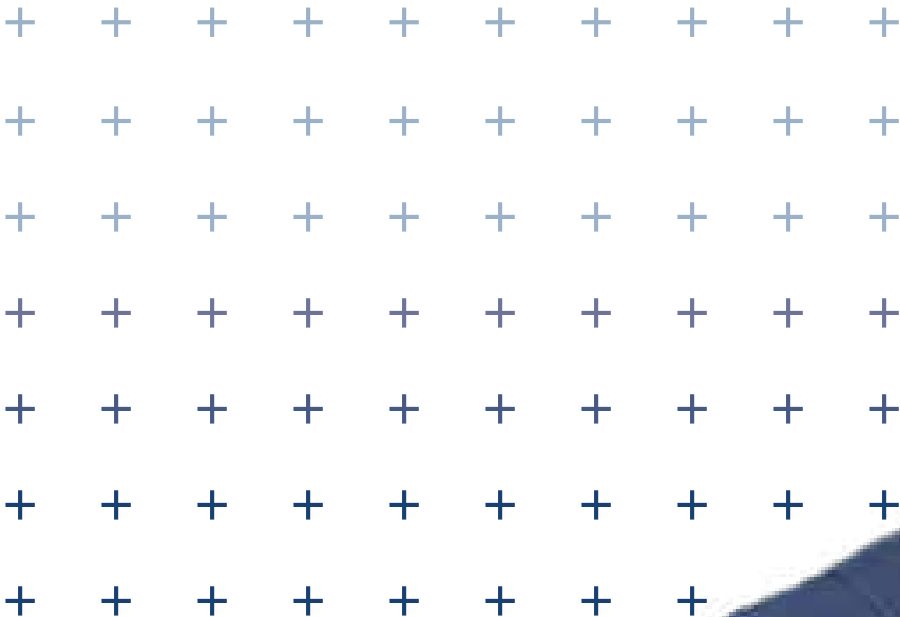
PREVIOUS APPOINTMENT

Research Associate, Department of Engineering, University of Cambridge

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 autonomously 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.



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

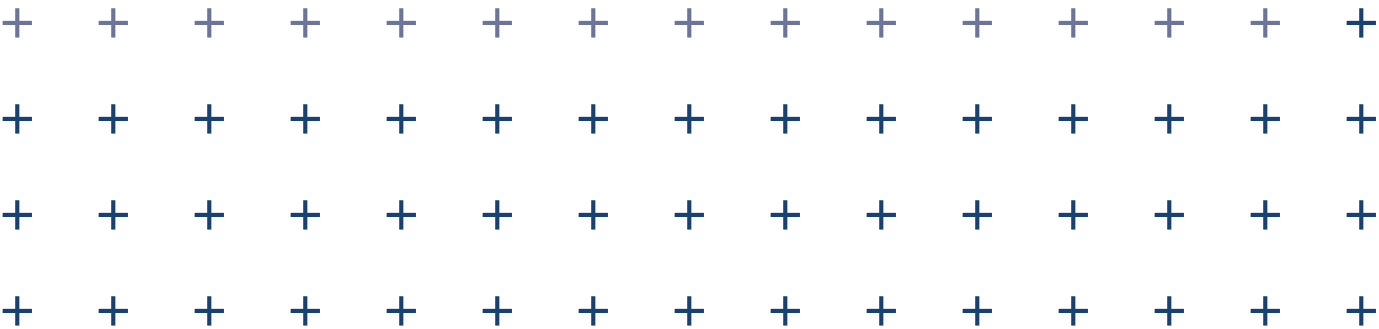
Bio-inspired Robotics | Control Theory | Self-Healing Soft Robots

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?



DR RYMAN HASHEM

CURRENT POSITION

Senior Research Fellow in Medical Robotics, Department of Medical Physics and Biomedical Engineering, University College London

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.



SOFT ROBOTICS:

BIOMIMETIC ENGINEERING

Suitable for students interested in:

ENGINEERING

Robotics | Soft Robotics | Biomedical Engineering

COMPUTER SCIENCE

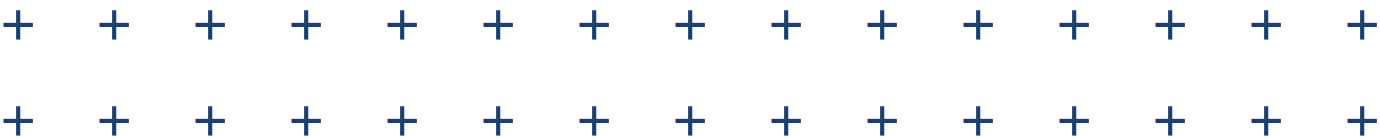
Modelling | 3D Modelling | Machine Learning

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.



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.



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

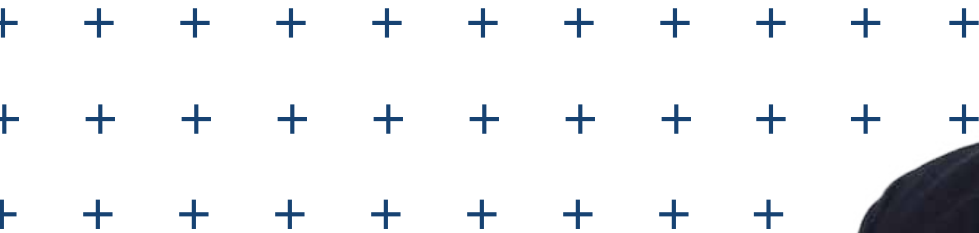
Mechanical Engineer, The Sudanese Petroleum Company

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.



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.



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

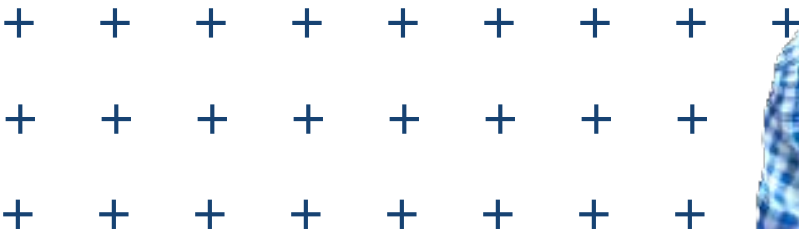
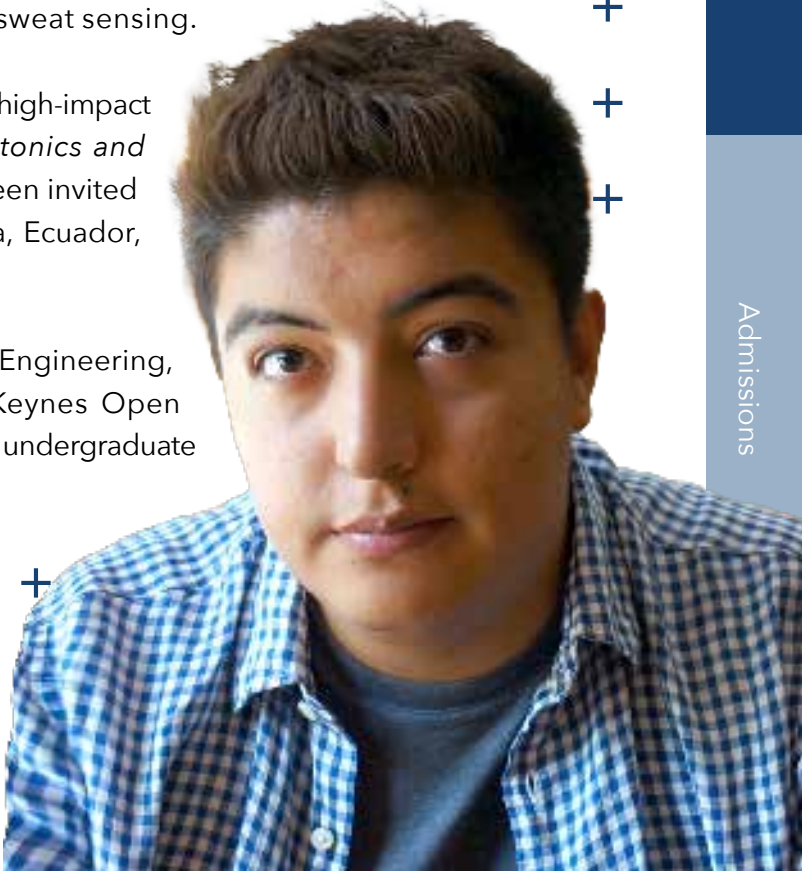
A scientist developing cutting-edge technology such as wearable electronics, sensing, optical imaging, and AI tools in the biomedical sectors.

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.



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.



SENSORS IN WEARABLE TECHNOLOGY:

FROM DATA SCIENCE TO MACHINE LEARNING

Suitable for students interested in:

BIOTECHNOLOGY

Sensor Data Science | 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 research 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. 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.



DR BENOÎT LEGAT

CURRENT POSITION

Professor, Department of Mathematical Engineering (INMA), Institute of Information and Communication Technologies, Electronics and Applied Mathematics, UCLouvain

PREVIOUS APPOINTMENTS

Postdoctoral Fellow, Laboratory for Information and Decision Systems, Massachusetts Institute of Technology

Reviewer, Institute of Electrical and Electronics Engineers (IEEE), Society for Industrial and Applied Mathematics (SIAM), and International Federation of Automatic Control (IFAC)

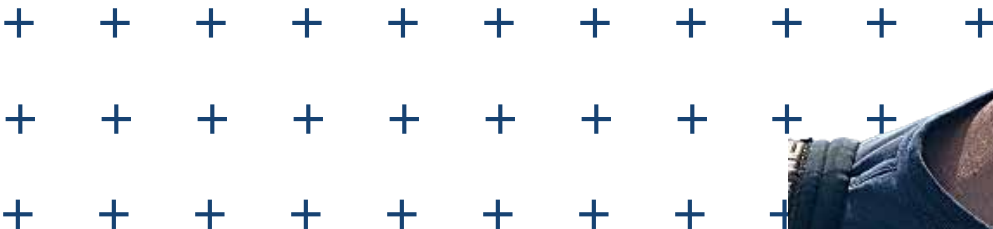
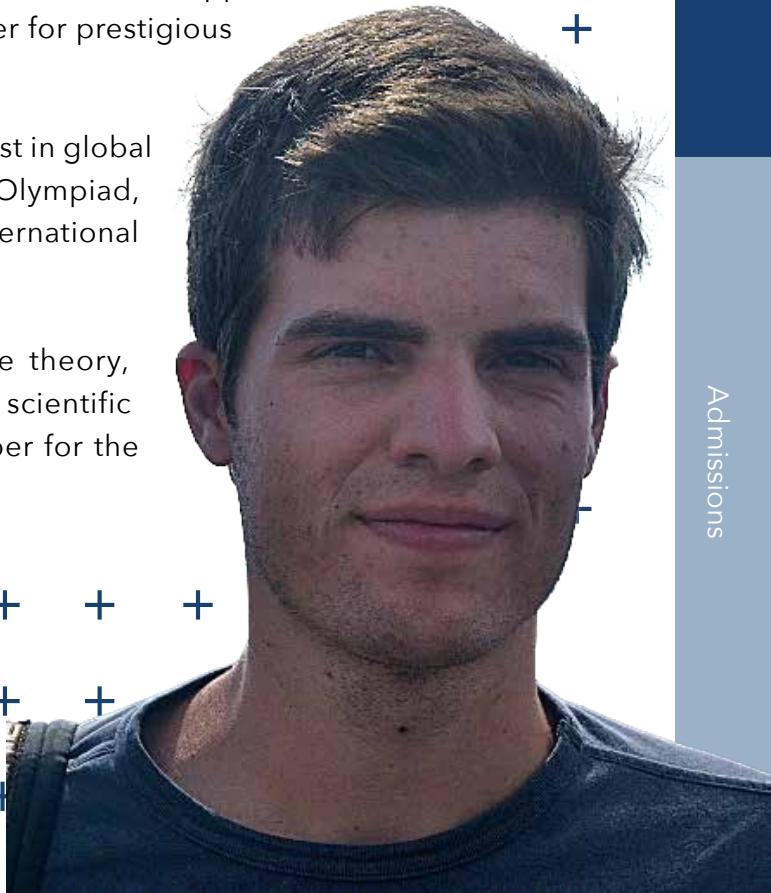
Jury Member, Benelux Mathematical Olympiad (Belgium Society of Mathematics Professors)

A mathematician and computer scientist pushing the boundaries of programming at both the theoretical and applied fronts.

As a researcher, Dr Legat examines issues related to mathematical optimization, invariant set computation, and optimal control. His current research focuses on set programming—the computation of sets satisfying given properties and maximising criteria, such as volume. He is interested in computing infeasibility certificates for set programs, applying set programming to the stability analysis and control synthesis of hybrid systems, and the approximation of the entropic cone. Due to his expertise in the field of theoretical and applied mathematics, he is frequently invited as a guest speaker for prestigious institutes.

Before his academic career, he was a decorated medalist in global competitions, such as the International Mathematical Olympiad, International Collegiate Programming Contest, and International Olympiad in Informatics.

As a mentor, Dr Legat has taught courses on game theory, modelling and analysis of dynamical systems, and scientific computing. Previously, he also served as a jury member for the Benelux Mathematical Olympiad.



THE APPLICATIONS OF MATHEMATICAL OPTIMISATION:

MIXED-INTEGER LINEAR PROGRAMMING

Suitable for students interested in:

COMPUTER SCIENCE

Machine Learning | Scientific Computing | Optimisation

MATHEMATICS

Applied Mathematics | Modelling | Pure Mathematics

Nowadays, crucial modern infrastructures are operated by optimising the decisions using what is called mixed integer linear programming (MILP). This includes smart electrical grids, planning of deliveries for online shopping, scheduling at hospitals, or the design of transportation networks.

In this research course, students will learn the mathematical foundation of MILP as well as its numerical aspects with practical applications. They will conduct research projects on MILP and learn how to solve complicated real-world problems by leveraging their knowledge in MILP.

The course will start with an introduction to linear programming. We will first cover how to model a problem as a linear program and its numerous applications. We will then review the different algorithms that can be used to solve it and the size of programs that can be handled by a computer. We will learn how to write programs in Julia (a high-level, high-performance, dynamic programming language for technical computing) and then solve concrete problems by modelling them as linear programs using JuMP. In addition, we will cover data manipulation, visualisation and analysis in order to integrate real data into the model to obtain interpretable results.

The course will then focus on integer variables in the modelling, expanding the topic into mixed-integer linear programs (MILPs). We will show how to formulate problems ranging from vehicle routing to machine learning as MILPs. Mixed-integer linear programs can be solved using a branch and bound algorithm that we will detail in the course. The same problem can be formulated as different MILPs. However, while some formulations can be solved in a few seconds, some may take hours! We highlight the key aspects that are important for a formulation to be solved efficiently.

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.



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.

DR DANIEL RAGGI

CURRENT POSITION

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

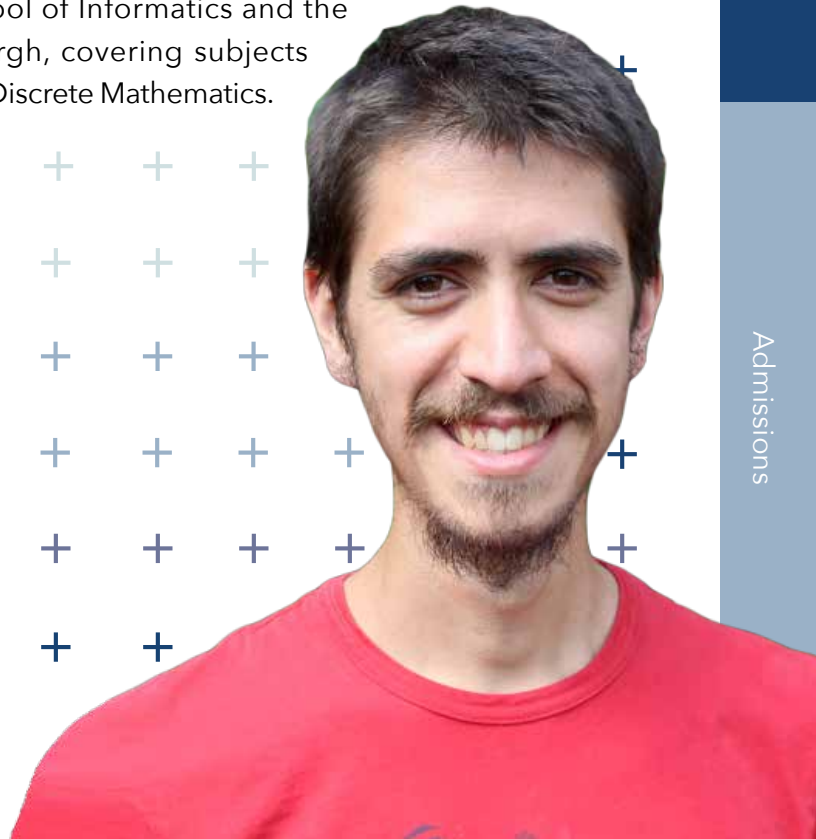
PREVIOUS APPOINTMENT

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

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.



DR CHENYI FEI

CURRENT POSITION

Postdoctoral Associate, Department of Mathematics, Massachusetts Institute of Technology (MIT)

PREVIOUS APPOINTMENT

Postdoctoral Associate, Lewis-Sigler Institute, Princeton University

A biophysician passionate about unravelling the complexities of biology and medicine using mathematical modelling.

As a researcher, Dr Fei’s academic pursuits lie at the intersection of theoretical Biophysics and Mathematical Modeling, where he channels his passion for employing mathematical and computational methodologies to tackle intricate challenges within biology and medicine. Presently, his endeavours involve harnessing data-driven inference tools to deepen comprehension of complex biological systems and phenomena. His prior research was dedicated to investigating the collective development of bacterial communities through modelling techniques.

Dr Fei’s works were published in high-impact scientific journals such as *Nature Communications*, *PLOS Genetics*, and *Nature Plants*. Further, he serves as a journal referee for *Nature Communications*, *PLOS Computational Biology*, *Microbiology Research*, among several others.

As a mentor, Dr Fei teaches a course on Differential Equations at MIT. He also previously taught in Princeton’s Integrated Science Curriculum. Dr Fei is excited to bring his expertise to a new generation of scholars and guide students to launch their own academic careers.



MATHEMATICAL AND COMPUTATIONAL METHODS IN QUANTITATIVE BIOLOGY

Suitable for students interested in:

COMPUTATIONAL BIOLOGY

Quantitative Biology | Programming | Bioinformatics

MATHEMATICS

Applied Mathematics | Differential Equations | Statistical Inference

This research course is centred on the exploration of quantitative biology, an interdisciplinary field that integrates mathematical and computational methodologies to investigate the complexities of living systems. Throughout the program, students are immersed in a comprehensive study aimed at equipping them with the necessary tools and techniques to engage in rigorous research at the intersection of mathematics and biology.

Quantitative biology relies on mathematical modelling and computational analysis to scrutinise biological phenomena with precision and depth. Students delve into a diverse range of mathematical concepts, including but not limited to differential equations and statistical inference. These foundational principles serve as the cornerstone of quantitative approaches in biology, providing students with a robust theoretical framework to formulate hypotheses, design experiments, and interpret results within a quantitative context.

An integral aspect of this course is the integration of computational methods into the research process. Given the exponential growth in biological data, computational techniques play a vital role in analysing complex datasets and extracting meaningful insights. Through hands-on experience with programming languages such as MATLAB or Python, students learn to implement computational algorithms and statistical techniques to address pressing questions in biology. This practical exposure enables students to simulate dynamic biological systems, analyse genomic data, and conduct cutting-edge research with computational proficiency.

This course emphasises a research-oriented approach, encouraging students to explore open-ended questions and pursue independent inquiry. By engaging in research projects and case studies, students may apply quantitative methods to real-world biological problems, refining their critical thinking skills and scientific acumen in the process. Whether investigating cellular signalling pathways or unravelling ecological systems' complexities, students gain firsthand experience in the iterative process of scientific inquiry, from hypothesis generation to experimental validation.



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

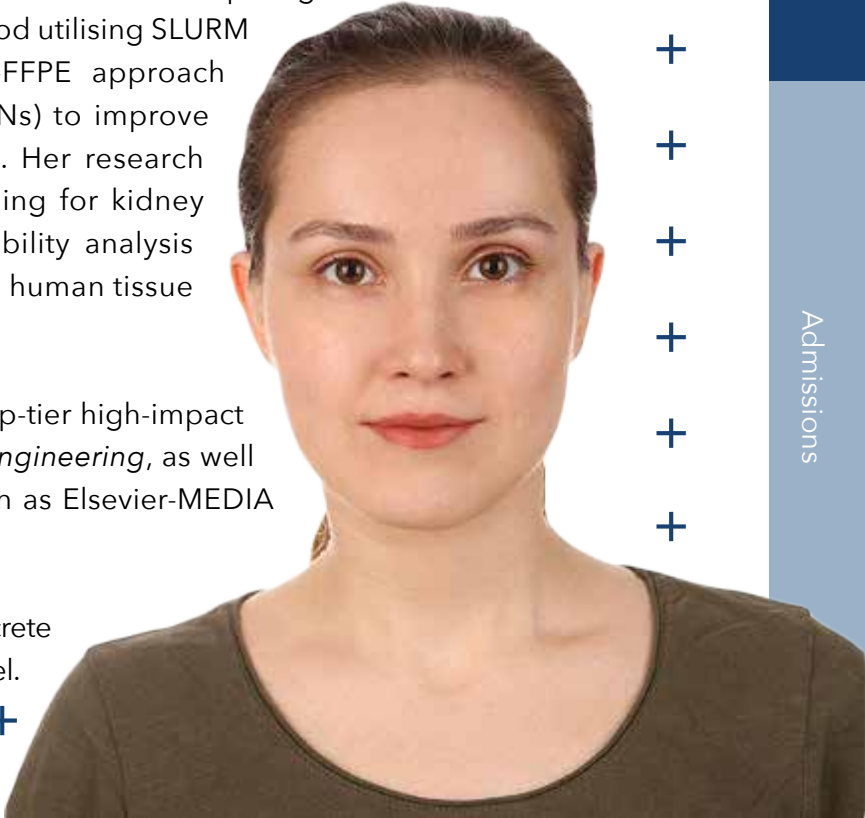
A visionary scientist committed to revolutionising healthcare through the power of Artificial Intelligence.

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.



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.

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

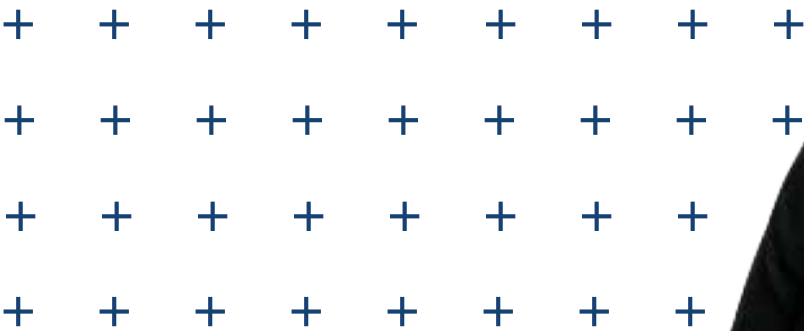
An aerospace engineer, astrophysicist and medical engineer with a commitment to mentoring young minds.

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 Healthcare 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.



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 WEIWEI SUN

CURRENT POSITION

Senior Lecturer, Department of Computer Science and Technology, University of Cambridge

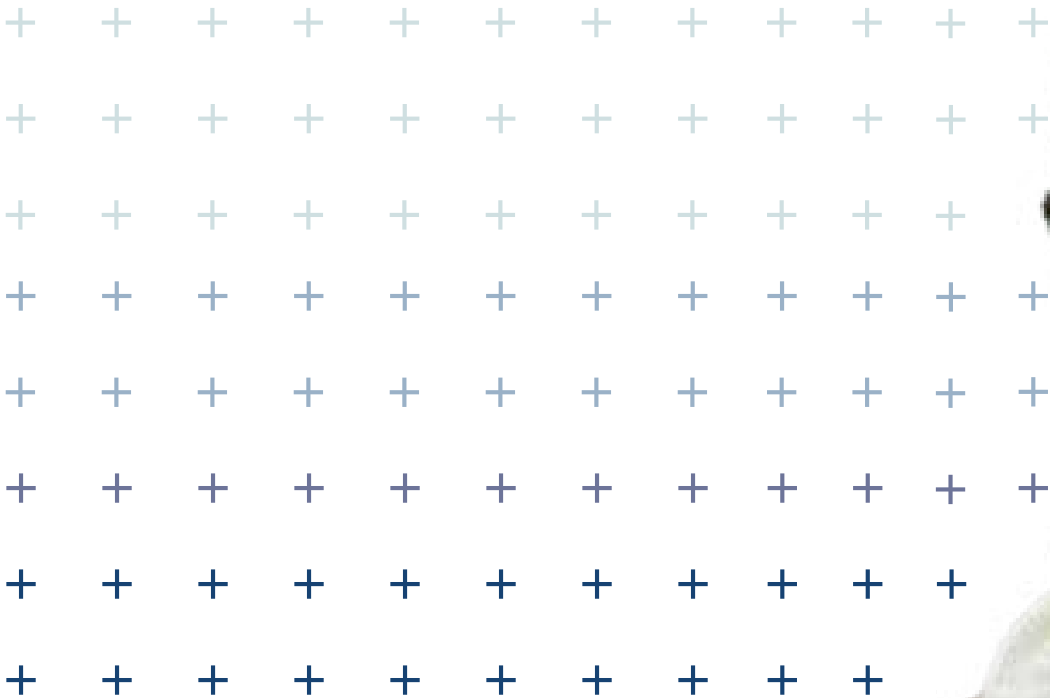
PREVIOUS APPOINTMENT

Associate Professor, Wangxuan Institute of Computer Technology, Peking University

As a researcher, Dr Sun is interested in the fields of natural language processing and computational linguistics. Her research concentrates on applying graphs to encode syntactic and semantic analyses and exploiting graph-centric formalisms and algorithms to formulate linguistic theories explicitly.

With a background in both linguistics and computer science, she believes that the scientific and engineering goals of computational linguistics share a common ground – modelling the complexity of natural languages in sophisticated linguistic representations precisely. She studies mathematical models for linguistic analysis, which allows precise formalisms and sound algorithms to manipulate graphs in a principled way. Her papers have been published in many prestigious journals and conferences, including Computational Linguistics and Transactions of the Association for Computational Linguistics.

As a mentor, Dr Sun provided guidance and supervision to graduate students in her lab while also teaching a course on computational semantics and natural language processing at the University of Cambridge.



MACHINE LEARNING AND NATURAL LANGUAGE PROCESSING

Suitable for students interested in:

COMPUTER SCIENCE

Machine Learning | Deep Learning | NLP

MATHEMATICS

Applied Mathematics | Modelling | Statistics

LINGUISTICS

Semantics | Computational Linguistics | Linguistic Theory

Natural language processing (NLP) is a field of artificial intelligence that focuses on enabling computers to understand, interpret, and generate human language. It has seen significant development in recent years, with advancements in machine learning and data processing capabilities allowing for more advanced language processing tasks. Some examples of current NLP applications include virtual assistants, language translation tools, and sentiment analysis for social media. There is also ongoing research in areas such as automated summarization and dialog systems.

In this research course, students will gain a solid understanding of NLP through developing their own research projects. They will learn about the fundamental techniques for processing language for several subtasks, such as morphological processing, parsing, word sense disambiguation, etc. On this basis, students will learn about how these techniques draw on and relate to other areas of computer science, in particular machine learning. They will also have the opportunity to explore the various applications of these techniques in real-world scenarios.

Throughout this research course, students will be encouraged to gain hands-on experiences in programming and in research. They will learn the scientific principles of designing and running an NLP experiment. By the end, students will gain an appreciation for the complexity of the scientific study of language and the diverse approaches and interdisciplinary knowledge that are required to make progress in this field.



FRONTIERS OF MACHINE LEARNING:

SOLVING REAL WORLD PROBLEMS

Suitable for students interested in:

COMPUTER SCIENCE

Machine Learning | AI | Data Science

MATHEMATICS

Applied Mathematics | Modelling | Statistics

Machine learning provides computers with the ability to learn without explicit programming and is fundamental to today's Artificial Intelligence landscape. Nowadays, whether it's understanding complex social problems, driving technological innovation, or devising business solutions, machine learning enables us to address a myriad of questions and challenges.

This research course aims to equip students with the technical skills and knowledge required to implement and apply machine learning techniques to real-world problems. During the first few weeks, students will delve into the foundational concepts of machine learning and how it could be applied in different real-world applications. The topics such as linear algebra, naive Bayes, and neural networks will also be covered. The learning environment will be intensive, with hands-on assignments designed to sharpen students' programming skills and cultivate an intuitive understanding of machine learning principles.

Throughout the duration of the course, students will engage in independent research projects, allowing them to apply their newfound knowledge in practical settings. By the culmination of the research course, students are expected to demonstrate proficiency in implementing three representative supervised machine learning algorithms and adeptly applying these algorithms to real-world datasets. This hands-on experience will solidify their understanding and prepare them for tackling complex challenges in the field of machine learning.



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



NATURAL LANGUAGE PROCESSING:

ARTIFICIAL INTELLIGENCE, MACHINE LEARNING, AND SEMANTICS

Suitable for students interested in:

COMPUTER SCIENCE

Machine Learning | Deep Learning | NLP

MATHEMATICS

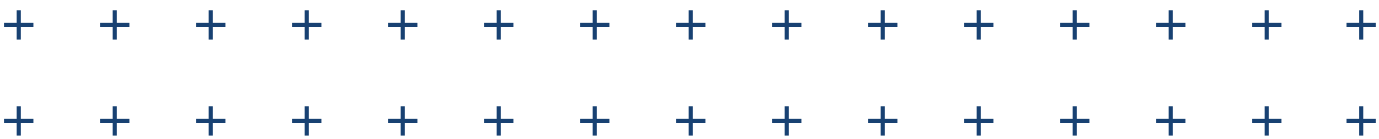
Applied Mathematics | Modelling | Statistics

Artificial Intelligence (AI) is rapidly transforming our world by enabling a wide range of technologies that can change the way we live. Natural Language Processing (NLP) is one of the major areas of AI that provides computers with the aptitude to understand and use our natural language. Many of the tools and services we use in our day-to-day lives exist thanks to the advancements in NLP (e.g. smart assistants such as Apple’s Siri or Amazon’s Alexa, grammar checkers, email filtering or targeted advertisements). NLP also allows machines to benefit from their massive processing capabilities to read and understand large amounts of text (e.g. thousands of tweets on a specific topic) and provide a summary or highlight key trends, which would have otherwise been impossible for humans to carry out manually.

In this research course, we will learn the fundamentals of NLP and see how recent techniques can help computers understand the meanings of words. We will also learn how a computer can be trained on a downstream NLP task, such as detecting the emotions behind sentences (the so-called sentiment analysis) or classifying sentences based on their content.

Students will be working on an NLP project that involves Python programming and requires familiarity with using external libraries such as NLTK, Word2ve, and Keras. Students will develop their research project and gain first-hand experience in the growing world of AI, machine learning, and deep learning.

By the end of this research course, students will be able to design cutting-edge NLP models that can encode the meanings of words in a computer-interpretable form and accurately classify sentences based on their sentiment. Students will have hands-on experience with the application of deep learning and neural networks in a real-world-problem setting and will have come to understand the process of injecting human intelligence into machines.



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.



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.



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.



DR CHIRAAG LALA

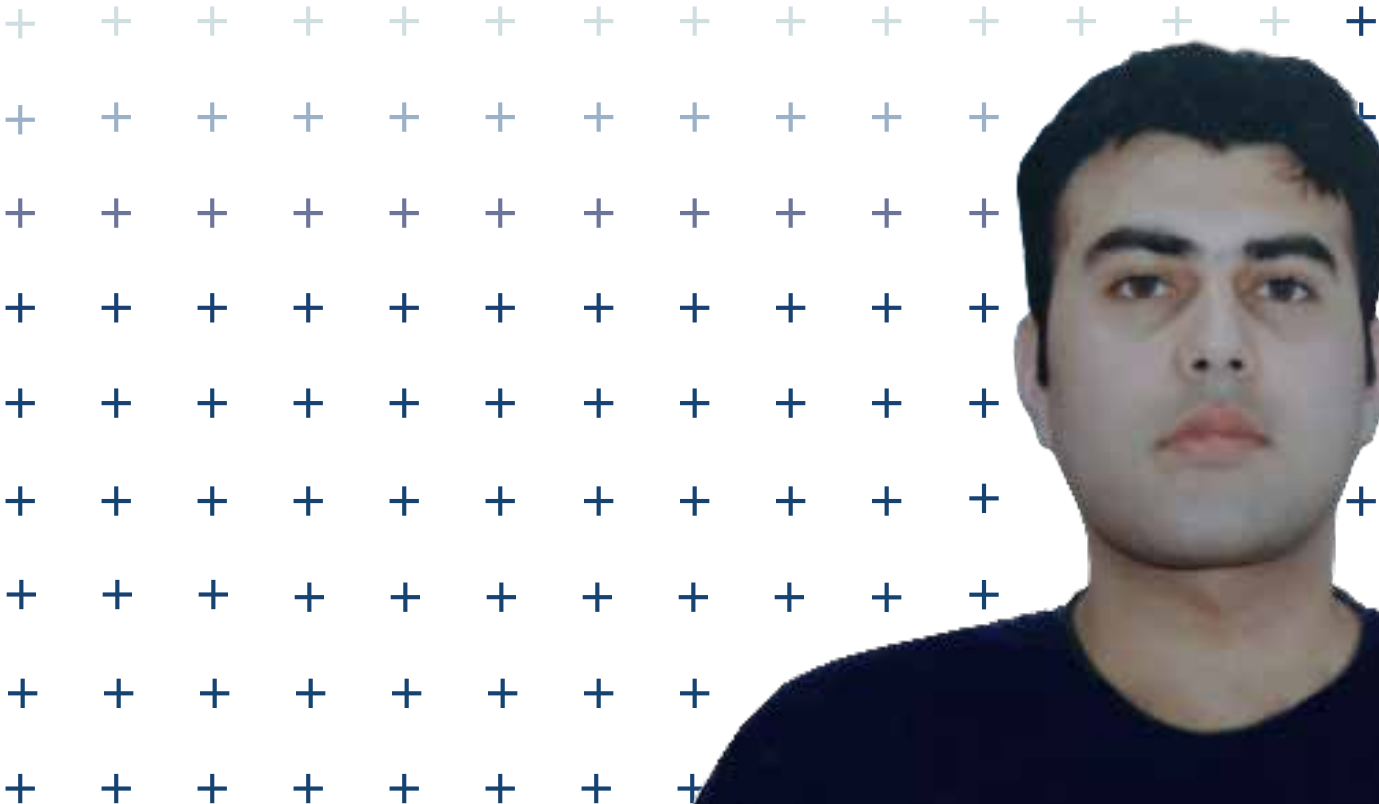
CURRENT POSITION

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.



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 biased 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.

DR JOSIAH WANG

CURRENT POSITIONS

Senior Teaching Fellow, Department of Computing, Imperial College London
Director of Master Degree in Computing, Department of Computing, Imperial College London

PREVIOUS APPOINTMENTS

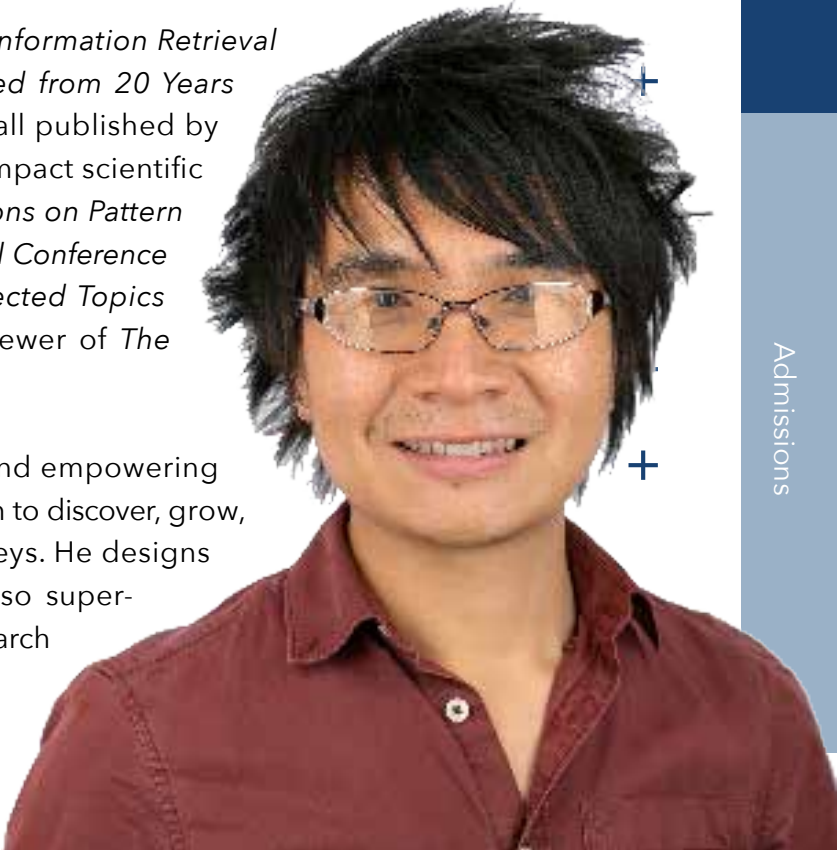
Research Fellow, Department of Computing, Imperial College London
Research Associate, Department of Computer Science, University of Sheffield

A pioneering researcher in Artificial Intelligence, specialising in multimodal systems at the intersection of Computer Vision and Natural Language Processing, with a vision to advance autonomous knowledge acquisition and application across disciplines.

As a researcher, Dr Wang explores the realm of multimodality within Artificial Intelligence, particularly at the juncture of Computer Vision and Natural Language Processing. More specifically, he endeavours to fuse visual and linguistic data to address challenges in text and image comprehension. Beyond this, his curiosity extends to investigating how various modalities intersect, shaping human perception and language acquisition, while drawing inspiration from cognitive sciences like neuroscience, psychology, and philosophy to enhance multimodal systems. With a steadfast vision, Dr Wang aims to pioneer AI systems capable of autonomously acquiring broad knowledge from diverse data streams and leveraging this knowledge for specialised tasks with minimal supervision, envisioning their applications across disciplines such as linguistics, gaming, music, and art.

Dr Wang has contributed three book chapters in *Information Retrieval Evaluation in a Changing World - Lessons Learned from 20 Years of CLEF* and *Lecture Notes in Computer Science*, all published by Springer. He has also published his work in high-impact scientific journals and conferences including *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *IEEE International Conference on Computer Vision*, and the *IEEE Journal of Selected Topics in Signal Processing*. Further, he serves as a reviewer of *The Computer Vision Journal*.

As a mentor, Dr Wang is dedicated to nurturing and empowering his students to unlock their full potential, guiding them to discover, grow, and flourish in their personal and academic journeys. He designs undergraduate and postgraduate modules, and also supervises undergraduate and PhD students for their research projects.



RESEARCH IN ML/AI:

AT THE INTERSECTION OF NATURAL LANGUAGE PROCESSING AND COMPUTER VISION

Suitable for students interested in:

COMPUTER SCIENCE

Machine Learning | Artificial Intelligence

MACHINE LEARNING

Text and Image Analysis | Computer Vision | Natural Language Processing

Machine Learning. You may have been bombarded with this phrase especially in recent years with the boom of Deep Learning and more recently Large Language Models. But what is Machine Learning really? Is it really as magical as the media makes it out to be? Are Machine Learning and Artificial Intelligence the same thing? And how can Machine Learning be useful in your life?

This research course will introduce you to the world of Machine Learning by giving you a good intuition on fundamental concepts and skills in the field. And rather than taking an abstract approach, you will apply Machine Learning specifically to concrete tasks and problems related to text and pictures, for example classifying documents or detecting objects in pictures. Beyond learning about the fundamentals, you will also dive into the essential, practical skills that a machine learning researcher or specialist need to complete a machine learning project: how to identify and think about a problem and task, how to identify suitable datasets, how to transform your data into a representation suitable for your Machine Learning model and algorithm, how to select your model and algorithm, and how to evaluate, analyse and improve your models and algorithm.

You will have the opportunity to work on a Machine Learning project of your choice to solve a problem or task that involves text or pictures (or both!) You will also gain experiences and insights on how to write a good Machine Learning research paper that you will be proud to present at Machine Learning, Computer Vision, and Natural Language Processing conferences.

By the end of the research course, you will be able to cut through the Machine Learning hype, gain some practical experience in conducting and writing up Machine Learning research, and be equipped to delve deeper into the state of the art in Machine Learning on your own in the future.

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)

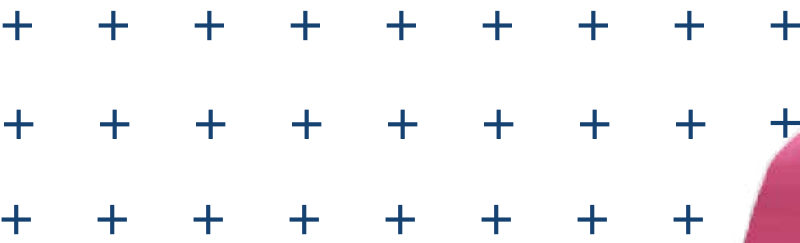
A cybersecurity and social network specialist engaged in detecting online collusion and fake engagements.

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.



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

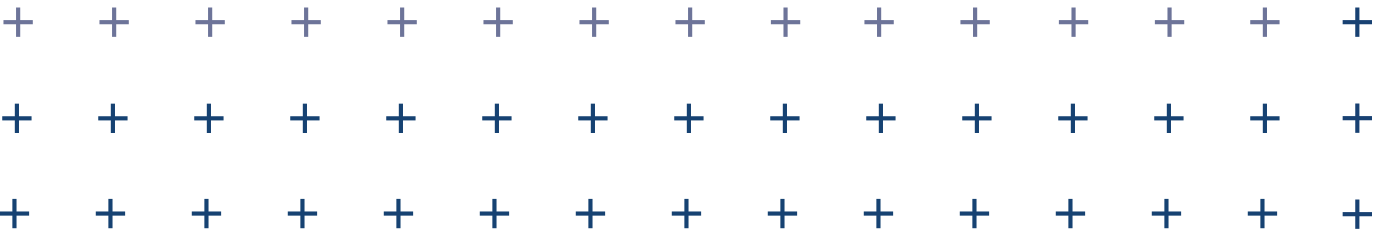
CYBERCRIME & SECURITY

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

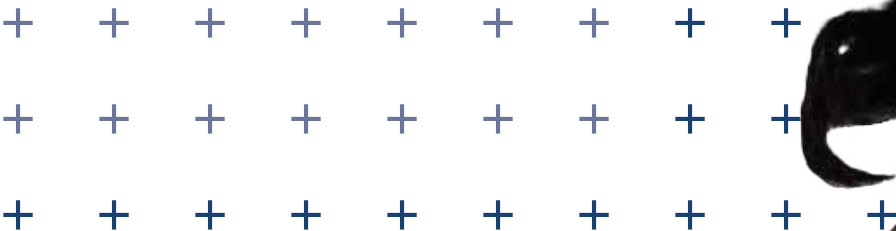
A computer scientist pushing the boundaries of Machine Learning (ML) and Artificial Intelligence (AI) to enhance healthcare technologies.

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.



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

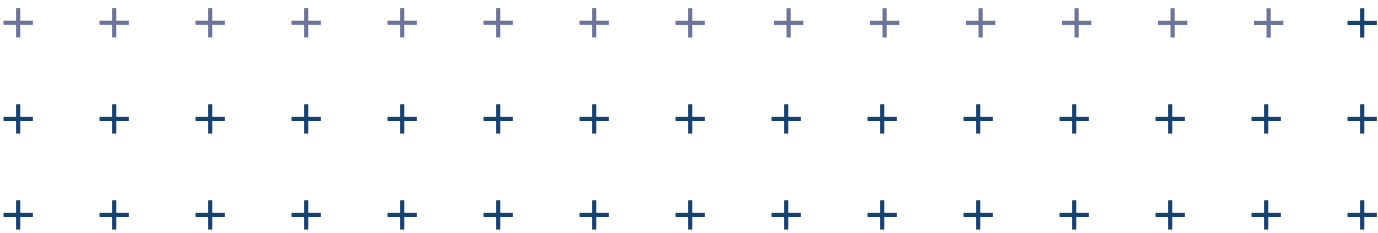
MEDICINE

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.



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.



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.

DR ARSEN ABDULALI

CURRENT POSITIONS

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.



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 seam-lessly 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 ele-ments 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 visualisa-tion, 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.

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| Programme Overview | |
| Course Catalogue | |
| Admissions | |

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.



ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR ROBOTICS

Suitable for students interested in:

ROBOTICS

Computational Robotics | Robot vision

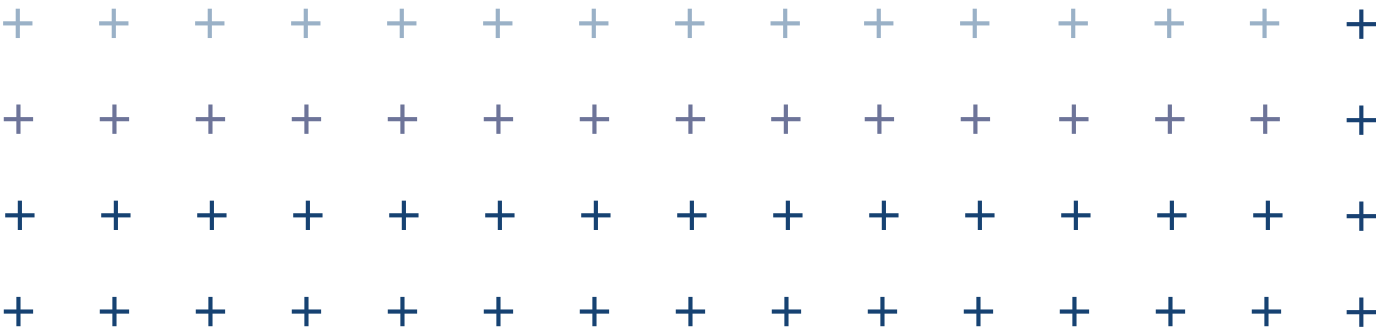
ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

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

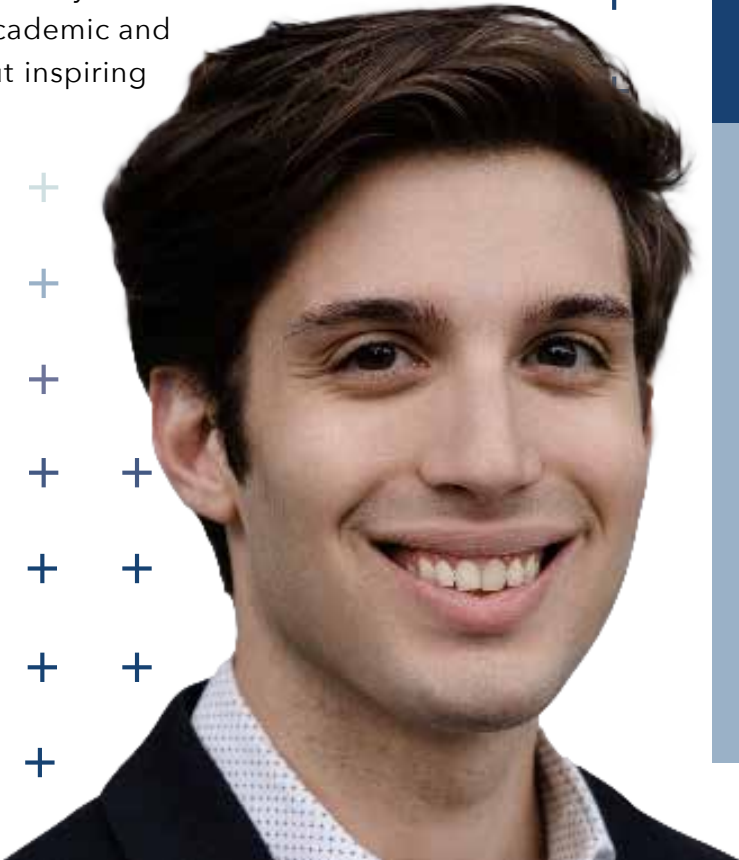
CURRENT POSITION

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 Ebanks 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.



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.

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DR FRANCESCO LEOFANTE

CURRENT POSITIONS

Research Fellow, Centre for Explainable AI, Department of Computing, Imperial College London

PREVIOUS APPOINTMENTS

Research Associate, Verification of Autonomous Systems Group, Department of Computing, Imperial College London

AI Consultant, Imperial Consultants (ICON) Ltd.

An expert in artificial intelligence whose research largely focuses on safe & explainable AI, with special emphasis on contrastive explanations and their robustness.

As a researcher, Dr Leofante focuses on the advancement of safe and explainable AI, with a particular emphasis on the development and robustness of contrastive explanations. The area of Explainable Artificial Intelligence (XAI) is concerned with providing methods and tools to improve the interpretability of learned models, such as Deep Neural Networks (DNNs). A widely recognised factor contributing to this end is the availability of contrastive explanations, arguments supporting or contrasting the decisions taken by a DNN. While several approaches exist to generate such explanations, they are often lacking robustness, i.e., they may produce completely different explanations for similar events. Such is the motivation for Dr Leofante's work. Additionally, he previously designed OMTPlan, a tool for Optimal Planning Modulo Theories. Further, he worked on improving the reliability of myocontrol using formal verification. Dr Leofante's works have been published in the *Journal on Satisfiability*, *Boolean Modeling and Computation*, *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, and *Information Systems Frontiers* as well as in conference proceedings of the AAAI Conference on Artificial Intelligence, The 15th Asian Conference on Machine Learning, and the 24th European Conference on Artificial Intelligence, among others.

As a mentor, Dr Leofante taught PhD courses in AI Planning, and MSc courses in Ethics, Fairness and Explanation in AI, and Planning as Satisfiability. He has also taught courses in Design and Analysis of Algorithms and Modeling and Verification of Cyber-Physical Systems. Further, Dr Leofante co-supervised a number of PhD, MSc and BSc students covering topics including Explainable AI, Safe Machine Learning, and AI Planning. For his dedication to teaching, he received the PFDC Supporting Research Staff and Students Award from Imperial College London in 2023.



EXPLAINABLE MACHINE LEARNING:

UNDERSTANDING HOW AI THINK

Suitable for students interested in:

COMPUTER SCIENCE

Artificial Intelligence | Machine Learning Black-box AI | Algorithmic Recourse | XAI Applications

PUBLIC POLICY

Tech policy | AI and Society

We have entered an era of rapid Artificial Intelligence development. **It has become more important than ever to have a full understanding of the AI decision-making processes and not to trust the AI output blindly.** AI bias, based on race, gender, age and more, has been a common risk in training AI models.

Machine learning models are long thought of as black boxes that are impossible for humans to interpret. The area of Explainable Artificial Intelligence (XAI) is concerned with providing methods and tools to improve the interpretability of such black-box AI models, with the aim of allowing humans to comprehend and trust the results and output created by machine learning algorithms, deep learning and neural networks.

A widely recognised factor contributing to this end is the availability of explanations, arguments supporting or contrasting the decisions of an AI model. Explanations allow us to understand why a given AI has reached a decision, but can also be used to understand whether those decisions are justified and ethical.

The research course spans over 13 sessions, aiming to familiarise students with fundamental concepts in XAI, cultivate a strong foundation for future studies, enhance their ability to read and analyse scientific texts, and facilitate clear communication of ideas. Topics covered encompass Introduction to XAI, Feature attribution explanations (including LIME and SHAP), Counterfactual explanations and recourse, Evaluation metrics, Deep dive into robustness issues, Applications of XAI, and concluding with student presentations, providing a comprehensive understanding of Explainable AI and its applications across various domains such as engineering, finance, and healthcare.

The research course includes assignments comprising student presentations and active participation in tutorial discussions. Students are expected to conduct their own research projects and to develop a deep understanding of machine learning.

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.

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THE QUANTUM MECHANICS AND PHYSICAL CHEMISTRY OF PHOTOLUMINESCENCE:

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.

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.



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.

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.



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

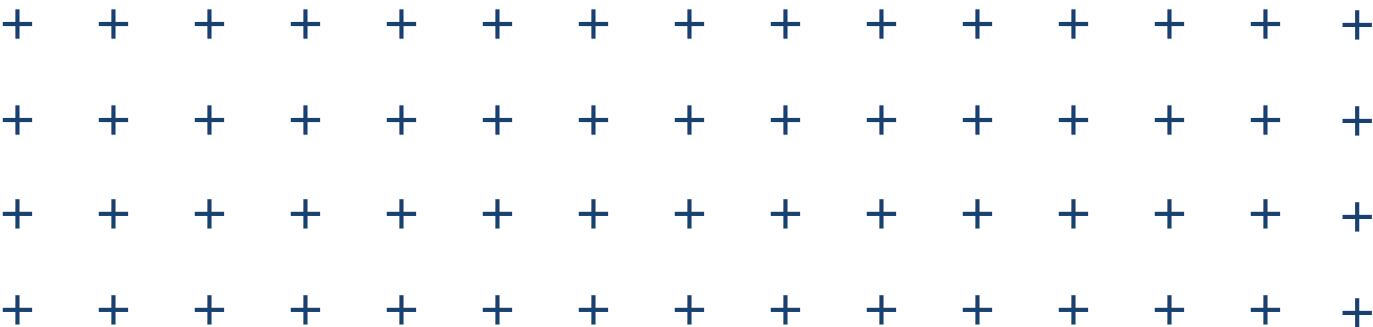
COMPUTER SCIENCE

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.



KU LEUVEN (US NEWS WORLD TOP 50)

DR DANIEL MAYERSON

CURRENT POSITION

Senior Postdoctoral Research Fellow, Institute of Theoretical Physics (ITF), Department of Physics, KU Leuven, Belgium

PREVIOUS APPOINTMENTS

Postdoctoral Research Fellow, Institut de Physique Théorique, CEA Saclay, France

Postdoctoral Research Fellow, Department of Physics, University of Michigan

A theoretical physicist exploring the potential of string theory to explain and understand black holes and the cosmos.

As a researcher, Dr Mayerson's areas of expertise include using string theory to understand black holes and Dr Mayerson's area of expertise includes using string theory to understand black holes and their interiors. In recent years, he has focused on bringing string theory closer to the experimental world. He combines theoretical insights from string theory, computational (astro)physics, and observational data to pioneer new methods of potentially observing string theory effects in black hole physics in gravitational wave signals and black hole imaging.

Dr. Mayerson's works have been published in several high-impact scientific journals, such as *Physical Review Letters*, *Journal of High Energy Physics*, *Living Reviews in Relativity*, and others. He is a member of the Laser Interferometer Space Antenna (LISA) Consortium and the Einstein Telescope (ET) Collaboration, two of the foremost scientific communities developing new technologies for future gravitational wave detectors. He has received four years of continuous research grants from Tier-1 Supercomputing to support his complex computations on potential string theory observational data. He has also been an invited speaker at numerous conferences and workshops worldwide on both theoretical string theory and observational physics topics, and has given numerous invited seminars of his work at top institutions including Princeton, MIT, Perimeter, and the University of Cambridge.

As a mentor, Dr. Mayerson enjoys sharing his enthusiasm for physics with inquisitive students. He has been teaching Relativity for over a decade, including a summer course on special and general relativity for high school students at the University of Michigan. His lecture notes on relativity have been published as the book *"Relativity: A Journey through Warped Space and Time"* by Springer Nature. He supervises many BSc and MSc students in their dissertations and has received a Teaching Award for his dedication to teaching.



DR DANIEL MAYERSON, KU LEUVEN (US NEWS WORLD TOP 50)

DIVING INSIDE BLACK HOLES:

RELATIVITY, GRAVITATIONAL WAVES, AND BLACK HOLE IMAGING

Suitable for students interested in:

THEORETICAL PHYSICS

Relativity | String Theory | Black Holes | Gravity

MATHEMATICS

Mathematical Physics | Applied Mathematics

Einstein forever altered our understanding of the nature of space and time with his theories of relativity. These theories tell us that the speed of light is a universal constant, declare that the fabric of space and time is warped by matter, and demand that matter moves through spacetime by following its curvature. Introduced 100 years ago, these concepts clash mightily with our everyday physical intuition, but are nevertheless cornerstones of modern-day physics.

Although predicted over a century ago by Einstein, gravitational waves were directly observed for the first time only a handful of years ago. Since then, gravitational wave observations have started to reveal the properties of black holes in ways that optical experiments could never do. Additionally, only a few years ago the Event Horizon Telescope managed to closely image the near-horizon region of black holes, which are illuminated by light emission from the violent plasma surrounding them.

Finally, more than a century after Einstein first formulated his theory, these exciting new observations give us a new window into the physics of strong gravity and may even offer a glimpse of what lies beyond general relativity.

In this research course, students will explore the exciting world of relativity (both special and general). They will build up a new and deep conceptual understanding of relativistic physics and gravity using thought experiments, and learn the powerful mathematics that allow us to quantify this new understanding of the universe. They will then learn, apply, and even expand on current analytical and numerical techniques used for simulating, analysing, and predicting gravitational waves and black hole imaging.

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 is related to accretion processes onto compact objects (mostly neutron stars, but also black holes and white dwarfs), radiation hydrodynamics, radiative transfer theory, QED under conditions of extremely strong fields, plasma and computational astrophysics. Particularly, he focuses on the regimes of extreme accretion onto strongly magnetised neutron stars and leads the theoretical group on accretion onto magnetised neutron stars at NASA's space mission IXPE (the Imaging X-ray Polarimetry Explorer). He has made important contributions to his field and has published 43 papers in top journals with a total of 1,170 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, Saint Petersburg State University, and the University of Amsterdam.



ASTROPHYSICS OF BLACK HOLES, WHITE DWARVES, AND NEUTRON STARS

Suitable for students interested in:

PHYSICS

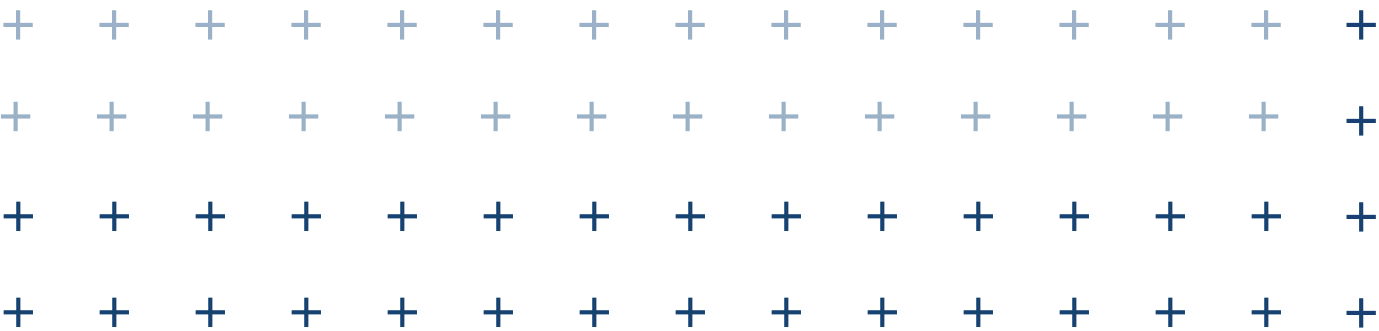
Cosmology | Astrophysics | High Energy Physics

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.



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 are the objects that gave the science of astronomy its name. Stars contain most of the luminous mass of galaxies, are the most important suppliers of electromagnetic energy to the universe, and their evolution has largely determined the chemical composition of the modern universe.

This research course centres around the structure and evolution of isolated stars and stars in binary systems. We will learn about the nature of diverse stars and their developmental progression. We will approach the study of stars from a physics perspective, focusing on elements of classical mechanics, aspects of thermodynamics and electromagnetism, nuclear physics and the basic elements of special and general relativity. We will discuss in detail how stars form, live and die, giving birth to compact objects: white dwarfs, neutron stars and black holes. We will see how the process of star life shapes the chemical composition of the world we live in. We will learn about specific phenomena related to binary stars’ evolution, including mass transfer and ejection, common envelopes, nova stars and supernova explosions, x-ray binaries and gravitational wave sources.

Through a blend of theoretical concepts, observational data, and computational models, students 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. Moreover, discussions on recent breakthroughs and ongoing research in the field will keep students informed of latest developments in stellar astrophysics. They will be equipped with the necessary knowledge and skills to conduct their own independent research projects.

By the end of this research course, students will have acquired a profound knowledge of stellar evolution, binary interactions, and the role of stars in shaping the universe’s chemical composition.



DR ALEXANDER PHILIPPOV

CURRENT POSITION

Assistant Professor, Department of Physics, University of Maryland

PREVIOUS APPOINTMENTS

Associate Research Scientist, Flatiron Institute, Center for Computational Astrophysics

Visiting Research Scholar, Astrophysics Department, Princeton University

NASA Einstein and TAC Postdoctoral Fellow, UC Berkeley

An accomplished theoretical astrophysicist intrigued by the enigmatic realms of neutron stars and black holes.

As a researcher, Dr Philippov specialises in the study of neutron stars, black holes, accretion disks surrounding neutron stars and white dwarfs, as well as the progenitors and emission mechanisms of Fast Radio Bursts (FRBs). Leading the Extreme Astrophysical Plasmas group at the University of Maryland, Dr Philippov and his team develop models to elucidate coherent radio emission stemming from phenomena such as pair production lightning and relativistic magnetic reconnection within the magnetospheres of neutron stars, with applications in understanding rotation-powered pulsars and the enigmatic FRBs. Further, they delve into the mechanisms underlying electromagnetic flares within the accretion flows around supermassive black holes, as well as within the magnetospheres of merging neutron stars and magnetars. They also explore the interplay of kinetic plasma effects in shaping the dynamics and observable characteristics of accreting plasmas surrounding black holes, both in the M87 galaxy and our own Milky Way. Lastly, they investigate the processes of electron and proton acceleration within radiative plasma turbulence occurring within the magnetised coronae of black holes.

Dr Philippov's tenure at the Center for Computational Astrophysics, Flatiron Institute, involved groundbreaking research into how relativistic magnetospheres of compact objects generate non-thermal electromagnetic radiation, alongside efforts to construct quantitative models of boundary layers within accretion disks encircling neutron stars and white dwarfs.

Dr Philippov's research has been published in prestigious scientific journals including the *Monthly Notices of the Royal Astronomical Society*, *The Astrophysical Journal Letters*, and *Physical Review Letters*, among others. These influential publications have garnered a total of 2,946 citations, highlighting the significant impact of Dr Philippov's contributions to the field.

As a mentor, Dr Philippov teaches courses in Plasma Physics, Mathematical Methods for Physicists, Numerical Methods in Plasma Physics and Applications in Astrophysics, Relativistic Plasma Astrophysics, and Introduction to Plasma Physics. He is also mentoring PhD, graduate, and undergraduate students in their dissertations and projects.



COMPUTATIONAL ASTROPHYSICS:

SIMULATING AND VISUALISING NEUTRON STAR MAGNETIC FIELD PARTICLES

Suitable for students interested in:

ASTROPHYSICS

Neutron Stars | Black Holes | Magnetic Fields

COMPUTER SCIENCE

Data Analysis | Computational Physics

Our universe is filled with remarkable objects, and astrophysical compact objects -- neutron stars (NSs) and black holes (BHs) -- are perhaps the most powerful and exotic among them. NSs and BHs with masses ~ 10 times the solar mass are produced in the collapse of stars. Most galaxies contain a supermassive BH at their centres - these range in mass from a million to a billion solar masses. BHs and NSs are unique cosmic laboratories, exhibiting extremes of many physical parameters and a rich interplay of various branches of physics, from general relativity and quantum electrodynamics to plasma and nuclear physics. BHs exhibit an event horizon and result in a singularity of the spacetime, making them unique probes of gravity. NSs possess the highest matter densities (several times that of atomic nuclei) and the strongest magnetic fields, up $\sim 10^{15}$ times the Earth's magnetic field and comparable or exceeding the field strengths at which quantum effects become extreme.

Observationally, BHs and NSs are awe-inspiring sources of electromagnetic radiation covering 18 orders of magnitude in photon energy, from radio waves to highest energy gamma-rays, and of high-energy neutrinos and gravitational waves. The last decade saw remarkable observational discoveries uncovering the nature of neutron stars and black holes. Among these are Fast Radio Bursts, cosmologically distant millisecond flashes of extremely intense radio waves, images of matter in the vicinity of the event horizon of supermassive black holes, and bursts of gamma rays reaching Earth from the merger of two neutron stars. Theoretically, it is important and challenging to understand how charged particles (electrons, positrons, and protons) get accelerated to produce the observed radiation. It is breathtaking to be working on these problems in the current age!

In this research course, students are expected to conduct their independent research projects that utilises computer programmes and visualisations showing the motion of charged particles in magnetic fields of neutron stars. They will study the properties of neutron stars and black holes. They will examine the key physics principles that are essential for understanding light observed from distant sources such as basic electrodynamics, the motion of charged particles in electromagnetic fields, and mechanisms behind the production of energetic photons.

DR GONZALO ALONSO ÁLVAREZ

CURRENT POSITION

Postdoctoral Researcher, Department of Physics, University of Toronto

PREVIOUS APPOINTMENTS

McGill Trotter Chair Astrophysics Postdoctoral Fellow, McGill Space Institute, McGill University, Canada

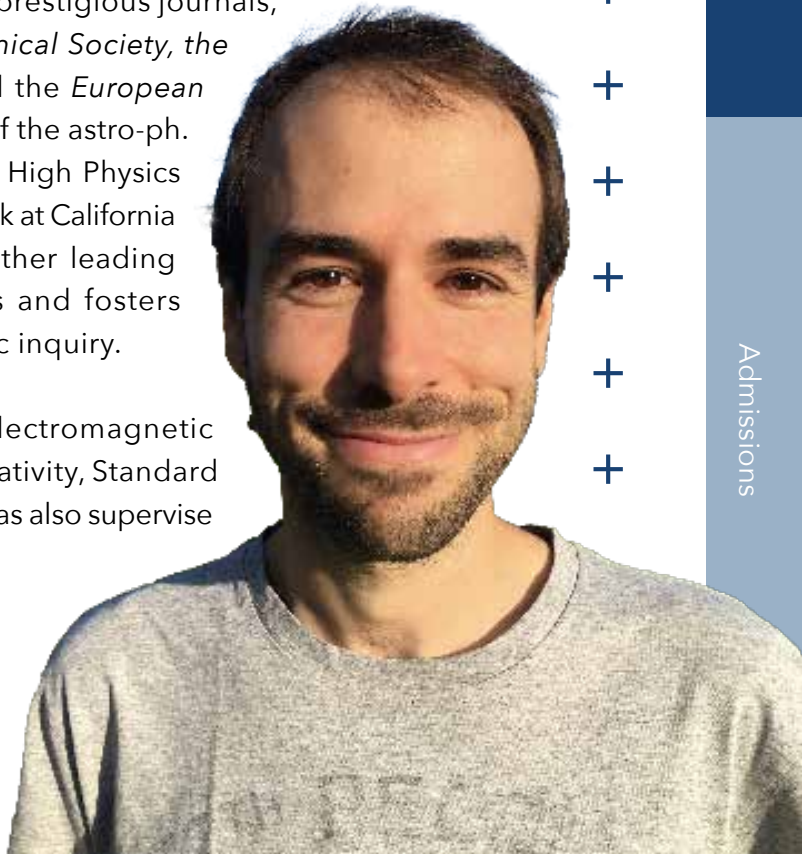
Postdoctoral Researcher, Institut für Theoretische Physik, Heidelberg University, Germany

An astrophysicist interested in exploring dark matter and its implications for particle physics and cosmology.

As a researcher, Dr Álvarez’s research interests focuses on dark matter, exploring its nature and potential links to unresolved quandaries in particle physics and cosmology via theoretical frameworks empirical observations and experiments. Working alongside fellow scientists, his research delves into Nonabelian kinetic mixing within a confining phase, providing insights into composite dark photons. Additionally, he explores the flavour of QCD axion dark matter and scrutinises the distortion of neutrino oscillations caused by dark photon dark matter, among numerous other investigations. His findings were published in high-impact peer-reviewed scientific journals such as the *Journal of High Energy Physics*, *Physical Review D*, and *Physics Letters B*, among others.

Beyond research, Dr Álvarez serves as a reviewer for prestigious journals, including the *Monthly Notices of the Royal Astronomical Society*, the *Journal of High Energy Physics*, *SciPost Physics*, and the *European Physical Journal C*. Further, he serves as a moderator of the astro-ph.CO category on arXiv.org and as an organiser of the High Physics Seminar at the University of Toronto. He is invited to speak at California Institute of Technology, Columbia University, and other leading research universities, where he shares his insights and fosters collaborative discussions at the forefront of scientific inquiry.

As a mentor, Dr Álvarez has taught courses in Electromagnetic Theory, Relativistic Quantum Mechanics, General Relativity, Standard Model of Particle Physics, and Statistical Mechanics. He has also supervise graduate students for their research projects.



DARK MATTER AND OTHER MYSTERIES OF OUR UNIVERSE

Suitable for students interested in:

COSMOLOGY

Gravitational Waves | Dark Matter | Cosmic Microwave Background

PHYSICS

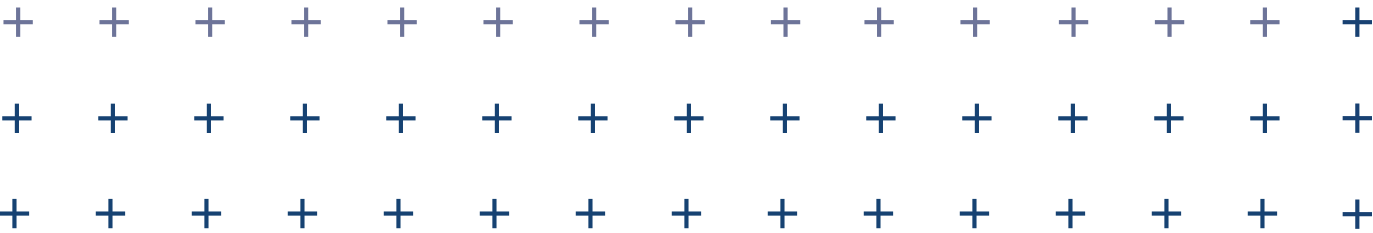
High-Energy Physics | General Relativity | Quantum Mechanics

Cosmology is the study of the origin and evolution of our universe, from the hot Big Bang to the formation of the complex structures that we see around us today. Though cosmology has become a precision science over the last few decades in many aspects, a number of observed phenomena remain unexplained.

In this research course, students will explore the most outstanding open problems in our understanding of the history and fate of our universe, including the reason behind its homogeneity and isotropy at large scales and the presence of structure at small ones, the source of its present-day accelerated expansion, and the origin of the matter-antimatter asymmetry. The focus will be on the nature of dark matter, the substance that makes up 80 percent of the gravitating matter in galactic systems and whose fundamental nature is the target of active experimental and theoretical research.

The basic tools of theoretical cosmology are general relativity and quantum mechanics. Students will learn how microphysical processes like particle scattering rates are crucial in balancing the different contents of our universe, which in turn dictate the rate at which spacetime expands. They will also be introduced to the different types of observations, from the Cosmic Microwave Background to the large-scale structure and gravitational waves, that give us clues to what the early stages of our Universe may have looked like.

The research course will follow an active-learning approach, so students will engage in hands-on research activities, including analytical calculations, numerical simulations, and observational projects to reinforce the theoretical concepts learned and put them into practice.



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

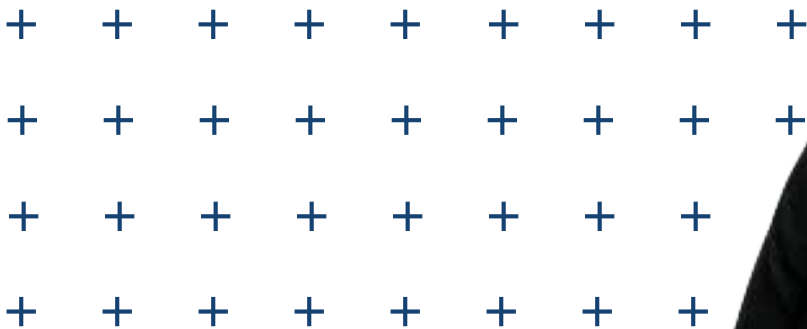
An aerospace engineer, astrophysicist and medical engineer with a commitment to mentoring young minds.

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 Healthcare 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

EXPERIMENTAL BLACK HOLE PHYSICS:

SPACE INSTRUMENTS FOR DETECTING BLACK HOLES

Suitable for students interested in:

ENGINEERING

Space Detectors | Cryogenic Instruments | Engineering

ASTROPHYSICS

Black Holes | Gravity | Radio Astronomy

MATHEMATICS

Mathematical Physics | Applied Mathematics

Black holes are regions in space where gravity is so intense that nothing, not even light, can escape their pull. They form when massive stars collapse under their own gravity. Observing black holes has been challenging because they don't emit light themselves, making them invisible to traditional telescopes. Instead, scientists rely on indirect methods like detecting their effects on nearby stars or observing the radiation emitted by matter falling into them to infer their presence and properties.

In this research course, we will cover astronomical instrumentation considerations and design required to conduct experimental study and detection of black holes, including M87* and Sgr A*, from space using very long baseline interferometry (VLBI), with a particular focus on the development of cryogenic instruments required to image black holes. Cryogenic instruments, in particular, are vital for imaging black holes as they operate at ultra-low temperatures, minimising interference and enhancing the precision needed to capture faint electromagnetic emissions. Their sensitivity and reduced noise allow for clearer detection and analysis of the subtle signals emitted by matter close to black holes, aiding in the imaging process. Accordingly, we will consider the parameters of interest of black holes, the elements necessary for detection, and the requirements for a cryogenic-detector radio astronomy subsystem to successfully resolve and gather vital data on black holes from space.

This research course will admit students interested in both astronomy and engineering, as we will cover key concepts that are transferable across these fields, within the context of space research. Students should expect a lively, interactive research course where their ideas and responses drive much of the class discussion, and they are also expected to work on their own independent research project.

SPACECRAFT ENGINEERING

Suitable for students interested in:

ENGINEERING

Mechanical Engineering | Aerospace Engineering

ASTROPHYSICS

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 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.



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

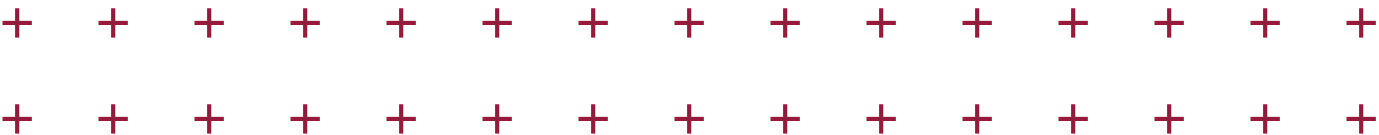
COMPUTER SCIENCE

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.



BEHAVIOURAL AND EXPERIMENTAL ECONOMICS:

Suitable for students interested in:

ECONOMICS

Consumer Behaviour | Decision-Making | Game Theory

PSYCHOLOGY

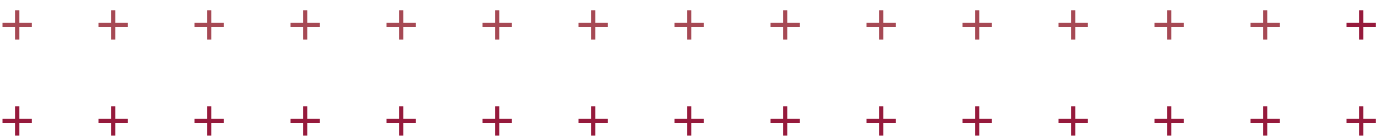
Rationality | Social Psychology

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 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 miscarriage 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.



HOW MUCH DOES MENTAL HEALTH COST?

THE ECONOMICS OF ADDICTION AND SUBSTANCE USE

Suitable for students interested in:

PSYCHOLOGY

Addiction | Substance Use | Mental Health

HEALTH ECONOMICS

Becker’s Theory of Rational Addiction | Economic Evaluation | Cost-effectiveness of Healthcare Interventions

This research-intensive course serves as an exploration into the relationship between economics, mental health, addiction and substance use, culminating in comprehensive research projects. Divided into three foundational modules, the coursework commences by discussing the core issues in mental health, addiction and substance use with a focus on marijuana and opioids. In this module, students delve into defining mental health economics, dissecting core issues, and examining the nuanced features of mental health service delivery. Transitioning into the realm of addiction and substance use through an economic lens, the course introduces 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. The final module revolves around honing 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 engage in rigorous examination and measurement of health outcomes and cost valuation. This section emphasises applying economic evaluations alongside clinical trials and employing decision-modelling techniques crucial for comprehensive research projects in mental health economics.

A significant component in our course will be the empirical 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. This project will involve data analysis, utilising statistical software and methodologies relevant to health economics. Exceptional projects may be selected for presentation at relevant conferences. Successfully completing this course will help students to engage with health economists, policy advisors, decision makers as advisors, or research collaborators.

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.



ECONOMICS OF INEQUALITY AND SUSTAINABILITY

Suitable for students interested in:

ENVIRONMENTAL SCIENCES

Environmental Health | Sustainable Practices

ECONOMICS

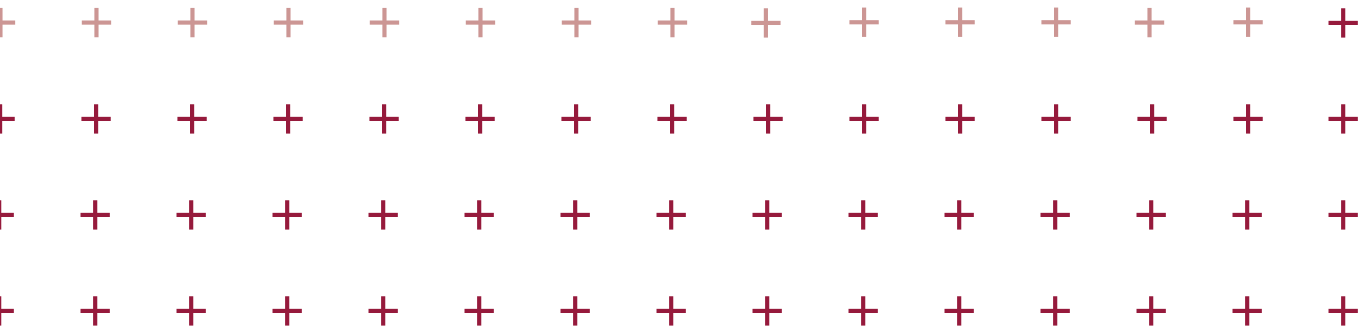
Income Disparities | Labour Market Competition | Poverty Rates

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 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 undergraduate and graduate levels.

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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.



DR GOKHAN M AYKAC, HARVARD UNIVERSITY

THE ECONOMICS OF POVERTY AND INEQUALITY:

UNDERSTANDING, EXAMINING, AND ERADICATING

Suitable for students interested in:

ECONOMICS

International Economics | Public Economics | Development Economics

SOCIAL SCIENCE

Public Policy | Inequality | Social Justice

Poverty and inequality reduction present significant challenges in our world. However, addressing questions related to poverty is far more intricate than commonly perceived. It necessitates a deep understanding of historical and social contexts, along with the utilisation of sophisticated economic tools to measure and comprehend this complex issue.

This research course will delve into the complex and pervasive issue of poverty, examining its scope, underlying causes, and the variety of strategies formulated to mitigate and potentially eradicate it. Throughout the course, we begin by quantifying poverty, understanding its prevalence, and dissecting the reasons behind its existence. The introduction part of our exploration includes a very brief journey through the evolution of poverty-related thought post-1950, offering students a historical context and the development of new perspectives in understanding and addressing poverty.

A central focus of the course lies in unpacking the methodologies and measures used to assess poverty, including the establishment of poverty lines and debates surrounding their validity. Through discussions on basic needs approaches, revealed preference tests, and relative poverty lines, students will develop a nuanced understanding of poverty measurement challenges and solutions. Exploring the relationship between economic growth and poverty reduction, students will delve into theories of economic growth, distributional change, and the concept of pro-poor growth. Real-world case studies will illuminate the complexities of growth's impact on poverty and inequality, offering valuable insights into effective strategies for poverty alleviation.

Policy interventions form a critical component of the course, with students evaluating the effectiveness of various approaches such as urban versus rural development priorities, health-care policies, education initiatives, and targeted interventions like conditional cash transfers. Through rigorous analysis and discussion, students will assess the role of development aid and the potential of policy interventions to address systemic inequalities.

With an emphasis on independent research projects, students will learn exemplary research methodology practices and hone their skills in interpreting results. By the research course's conclusion, students will not only possess a solid understanding of the economic dimensions of poverty but also a nuanced perspective on the policies and practices essential for effective poverty reduction. Armed with theoretical knowledge and practical insights, students will be prepared to contribute meaningfully to the ongoing discourse on poverty alleviation and economic policy.

DR CAROLINE KARP

CURRENT POSITIONS

Senior Lecturer Emerita in Environmental Studies and International and Public Affairs,

Watson Institute for International and Public Affairs, Brown University

Acting Director, Center for Environmental Studies, Brown University

Member, Energy and Environment Committee of the RI Bar Association

Member, RI Environmental Business Council

PREVIOUS APPOINTMENTS

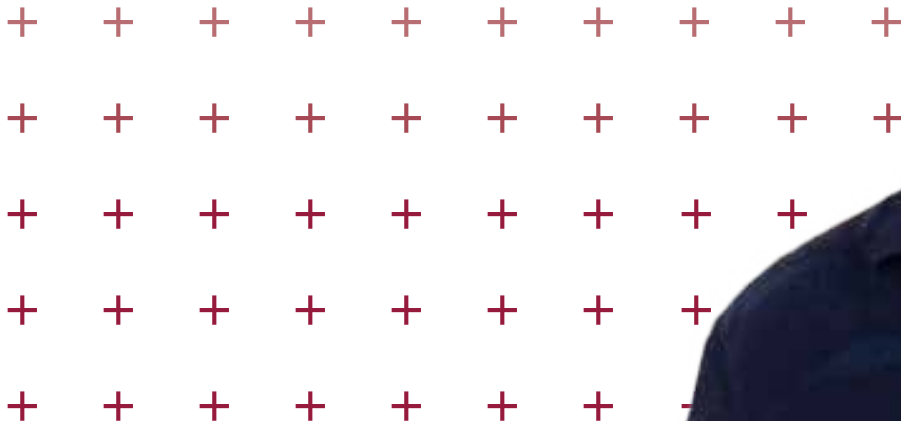
Senior Lecturer, Environmental Studies, Brown University

Attorney, Rhode Island Department of Environmental Management

A researcher committed to driving policy change and addressing environmental issues.

As a researcher, Dr Karp is a researcher who is deeply interested in domestic and international environmental law and policy. She has focused her long-term research on understanding and addressing the impacts of various entities on water use, water quality and marine resources. Previously, she has been a guest speaker at various conferences, including the *Great Journeys Program at Brown University*, the *Reframing the Arctic Workshop* and the *Diplomacy on the Rocks Conference*. In addition, Dr Karp is committed to driving policy change and tackling real-world problems. Currently, she is working on two projects: a legal analysis of state and local authority to regulate land use in high hazard flood areas, and the development of a crowd-sourced app to monitor jellyfish as an indicator of ecological change.

As a mentor, she has supervised undergraduate and graduate students at Brown University, while teaching courses in environmental law, and international environmental policy.



TOWARD A BLUE ECONOMY:

SUSTAINABLE DEVELOPMENT AND THE OCEAN

Suitable for students interested in:

ENVIRONMENTAL SCIENCES

Sustainable Development | Ocean Systems | Resource Allocation

ECONOMICS

Equitable Economy | International Trade

POLITICAL SCIENCE

Policy Brief | International Cooperation | Laws of Natural Resource Protection

Oceans define our borders, but also enable the global exchange of goods, services and ideas. In fact, the World Economic Forum estimates that the ocean will be the eighth largest economy in the world based on direct economic activity and the resources and services it provides to us on an annual basis. However, our dependence on the oceans for seafood, waste assimilation, energy production, transportation and climate regulation comes at a cost. Almost 90 percent of the wild capture marine fisheries are fully exploited, and 35 percent are overfished or depleted. Additionally, it is estimated that plastic in the oceans will outweigh all fish by 2050. **The goal of this research course is to understand how human activities in the world’s oceans are governed currently, and to explore international, regional and state efforts to develop a more equitable and sustainable Blue Economy.**

We will start by looking at the United Nations Convention on the Law of the Sea (UNCLOS) to understand how access to and use of coastal waters, fisheries, the seabed and the open ocean are governed. We will also explore how UNCLOS and other international agreements assign responsibility for environmental protection, fishing, shipping, and deep sea mining. By the end of the course, students will better understand why Russia seized Crimea, as well as the simmering international conflicts in the South China Sea and the Arctic. Students will also understand how the international community addresses marine conservation; resource extraction in the Area Beyond National Jurisdiction (ABNJ); and the impact of shipping and cruise ships on the environment. Finally, we will consider why the United States is not a party to UNCLOS and discuss what this means for the United States and the rule of law for the world ocean.

Each student will write a final paper in the form of a policy brief. Potential topics include efforts to regulate commercial uses of the ABNJ; the effect of international law on the evolution of ship design; enforcement of fisheries laws in protected marine areas; and how UNCLOS might affect the future of small island states threatened by climate change.

DR CARLES MAÑÓ-CABELLO

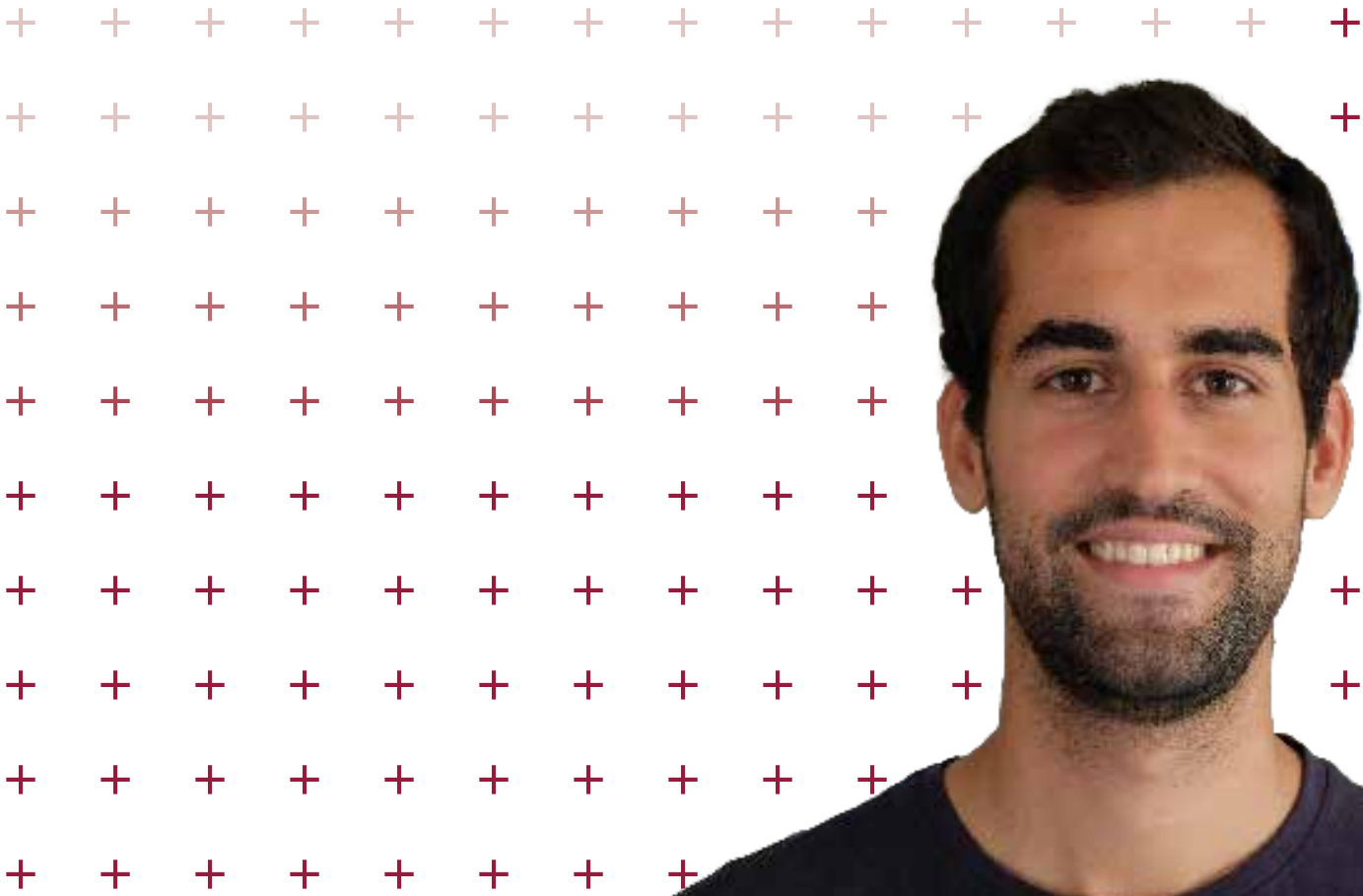
CURRENT POSITION

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.



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

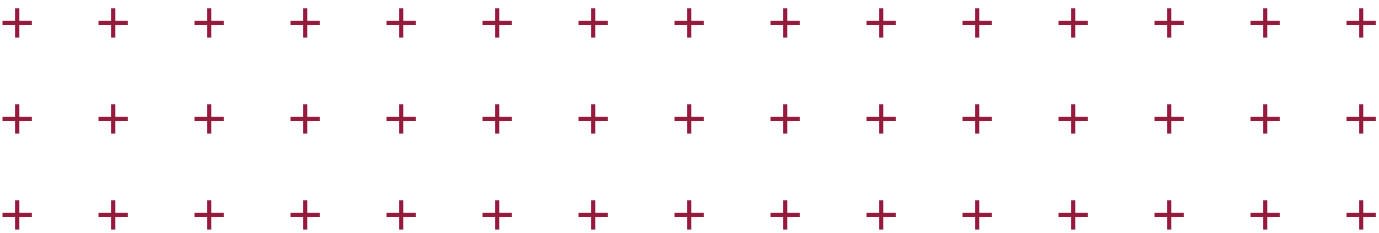
PSYCHOLOGY

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.



ENVIRONMENTAL 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!

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DR STEPHEN CHAUDOIN

CURRENT POSITION

Assistant Professor, Department of Government, Harvard University

PREVIOUS POSITIONS

Assistant Professor, University of Illinois at Urbana-Champaign

Assistant Professor, University of Pittsburgh

A political scientist analysing international organisations and international political economy.

As a researcher, Dr Chaudoin is interested in international institutions, international political economy, and formal and quantitative methods. His research contributes to questions of how international institutions affect member state behaviour. His theoretical research on how preferences, political strength, and strategic behaviour of domestic actors facilitate and constrain domestic enforcement mechanisms is empirically tested in scenarios ranging from international trade and the World Trade Organization (WTO), to war crimes and the International Criminal Court (ICC), as well as environmental contexts. He has received multiple research grants from prestigious institutions, such as the Weatherhead Center for International Affairs and Linowes Fellowship for the Cline Center for Democracy at the University of Illinois. From 2019-2021, he was a member of the editorial board of the *Journal of Politics*.

Dr Chaudoin's research has been extensively published in peer-reviewed academic journals, including the *British Journal of Political Science*, the *Review of International Economy*, the *Journal of Conflict Resolution*, and the *Review of International Organizations*, among others. One of his papers, titled "Public Reactions to International Legal Institutions: The ICC in a Developing Democracy," published in the *Journal of Politics*, received the best paper award in the international collaboration section from the American Political Science Association (APSA)

As a mentor, Dr Chaudoin teaches both undergraduate and graduate level courses in International Relations, International Organizations, International Political Economy, Human Rights, and Formal Modelling at Harvard University. He also supervises theses and dissertations at both the undergraduate and graduate levels.



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THE CAUSES OF WAR:

GAME THEORY AND THE INTERNATIONAL ORDER

Suitable for students interested in:

INTERNATIONAL RELATIONS

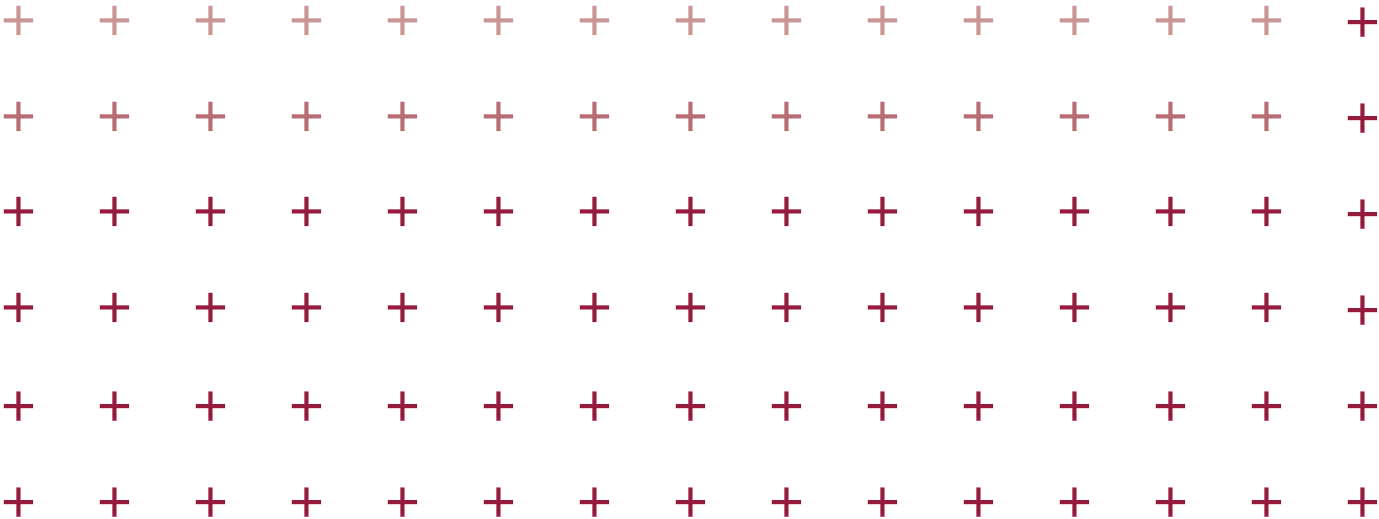
International Institutions | War and Conflict | Conflict Management

POLITICAL SCIENCE

US Domestic Politics | Elections | Theory-Building

History textbooks and, unfortunately, current events are filled with examples of countries that resort to warfare to resolve conflicts over territory, natural resources, or ideological disagreements. Yet, many potential sources of tension do not erupt in violent conflict. What explains why some situations escalate to warfare while others do not? **We approach the question of war and conflict from a political science perspective using game theoretic models of countries that bargain, and potentially fight, with one another.** Instead of asking “why do countries fight,” we ask “why do they fail to reach more peaceful agreements?” Failure to reach an agreement short of fighting is all the more puzzling given the tremendous costs, in lives and beyond, of interstate war. We will use a model of bargaining to explain how states choose war for a variety of reasons. We will further look at how domestic politics, elections, and political institutions affect the decision to go to war.

Students of this research course will learn the basics of theory-building in political science and gain an introduction to game theory as we build our models of war. We will also focus on how to design empirical social scientific studies to answer questions about the causes and consequences of war. Students are encouraged to conduct independent research projects, working with larger datasets describing the onset and intensity of international conflicts. Throughout, we will apply our arguments to modern day and historical events.



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.



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

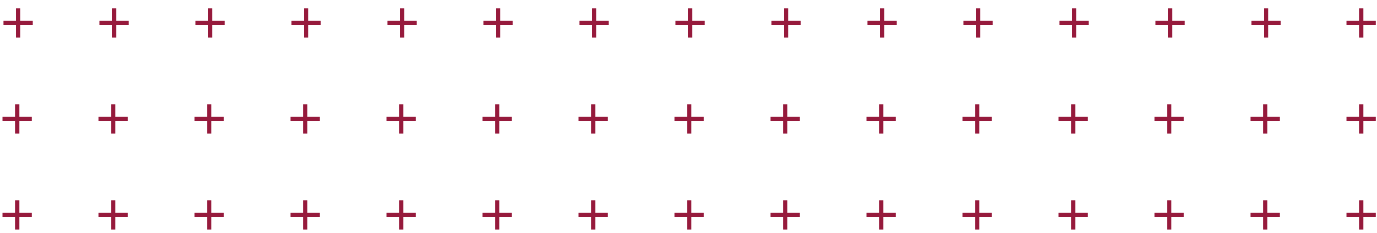
Is there scientific evidence to support the existence of human ‘races’? If not, why does ‘race’ remain such a powerful determinant of individual and collective identities today? And what does this mean for the practices of racism?

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.



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

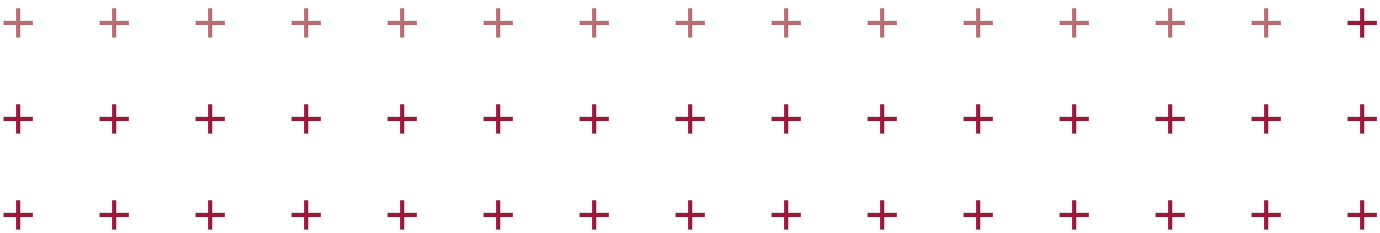
POLICY STUDIES

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.



DR HANDE GÜZEL

CURRENT POSITIONS

Research 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

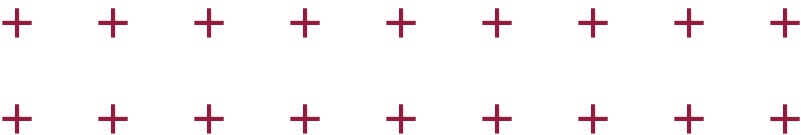
Teaching Associate, Department of Sociology, University of Cambridge

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.



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.

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DR EMMANOUIL PRATSINAKIS

CURRENT POSITIONS

Research Affiliate, Centre on Migration, Policy and Society (COMPAS), University of Oxford
Assistant Professor in Social Geography, Department of Geography, Harokopio University, Athens

PREVIOUS APPOINTMENTS

SEESOX/Onassis Research Fellow / Departmental Lecturer in Migration, School of Anthropology and Museum Ethnography, University of Oxford
SEESOX/Onassis Research Fellow, Department of Politics and International Relations, University of Oxford
Research Consultant, St Antony's College, University of Oxford

A highly accomplished social scientist investigating the vicissitudes of migration and diasporas.

As a researcher, Dr Pratsinakis' research interests encompass various aspects related to migration, nationalism, immigrant-native relations, and access to social resources. He has conducted research and published articles on topics such as ethnic boundaries, categorization, everyday nationhood, migration decision-making, brain drain, intra-EU mobility in the post-2008 period, immigrants' responses to stigmatisation, immigrants' access to housing, and more. One of his recent research projects examines the experiences and negotiations of ideologies of national belonging in everyday life between two categories of residents in a neighbourhood in Thessaloniki, Greece. The study involves Greeks born and raised in the country and those of Greek descent who immigrated from countries formerly belonging to the Soviet Union and lack any roots within the borders of the Greek state. Another one of his projects is an ethnography that explores the experiences, fears, and hopes of people, both immigrants and natives, living in a deprived area of central Athens. This research aims to understand the actual experiences of everyday coexistence in the area and how they relate to the politicised master narratives about immigrant-native relations represented in the media. Dr Pratsinakis was also involved in the GEITONIES project, which focused on the development of relationships between immigrants and natives at the neighbourhood level in several European cities. The project included a survey conducted in 18 neighbourhoods in 6 European cities, examining factors influencing the development of immigrants' intimate interethnic relations. His research projects have been generously funded by the Oxford-Berlin Seed Funding, the IMES (Institute of Migration and Ethnic Studies) Seed Grant, and the National Bank of Greece Research Grant, among others.

Dr Pratsinakis has contributed chapters in nine books discussing extensively on diasporas and migration. Moreover, his works have been widely published in peer-reviewed academic journals including the Journal of Ethnic and Migration Studies, International Migration, and Nations and Nationalism.

As a mentor, He teaches courses on Social Geography and Migration Studies at both postgraduate and undergraduate levels. He also supervises PhD and Masters students in their dissertations.



NATIONALISM AND COSMOPOLITANISM IN A CHANGING WORLD

Suitable for students interested in:

SOCIAL ANTHROPOLOGY

Diaspora | Transnationalism | Globalisation

POLITICAL ECONOMICS

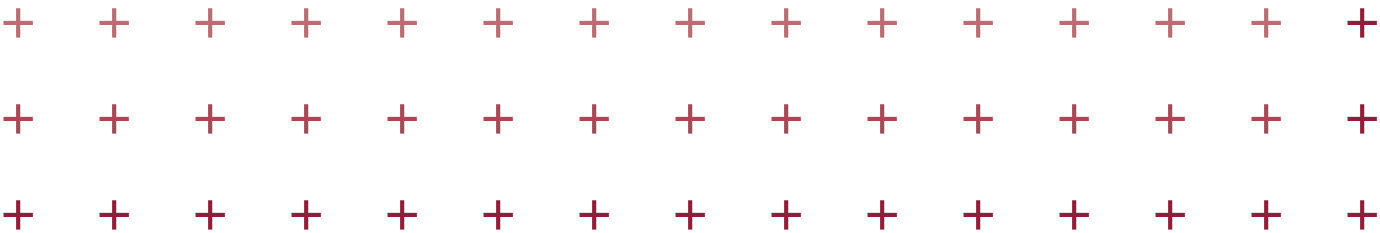
Conflict | Pluralism | Migration

This research course offers a comprehensive exploration of contemporary migration, drawing insights from various disciplinary perspectives. It aims to provide students with a broad theoretical understanding of human mobility, encompassing its impacts, causes, and historical, economic, and political contexts. Rather than viewing migration solely as a “problem to be solved,” the course emphasises that it is an integral part of social change, uneven development, and globalisation.

By delving into case studies from around the world, with a primary focus on Europe, the course examines key topics such as the determinants of migration, migrant rights, integration, diaspora, and transnationalism. The course explores migration as a complex phenomenon that arises from a combination of economic, social, and political factors. It provides students with an in-depth understanding of the motivations behind human mobility, which can include seeking better economic opportunities, fleeing conflicts or persecution, or reuniting with family members. Moreover, the course challenges students to view migration not as a singular issue but as an intrinsic part of broader social changes.

Throughout the course, students will examine the complexities of migration governance, considering how states regulate and manage migration flows. The course also explores the topic of migrant integration, delving into the challenges and opportunities faced by migrants as they settle into new societies and cultures.

Overall, this research course equips students with critical thinking skills to assess and engage with public debates and policies surrounding migration. By combining theory, case studies, and interdisciplinary perspectives, students gain a holistic understanding of the multifaceted nature of contemporary migration and its significance in shaping societies and the world at large.



DR CAITLYN MCGEER

CURRENT POSITIONS

Postdoctoral Researcher, Centre for Socio-Legal Studies, University of Oxford

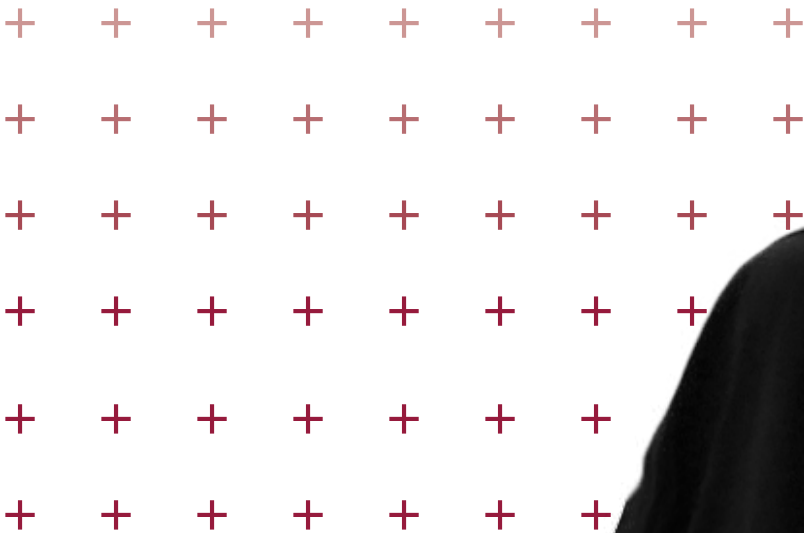
Lecturer, Department of Sociology / Centre for Criminology & Sociolegal Studies, University of Toronto

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.



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

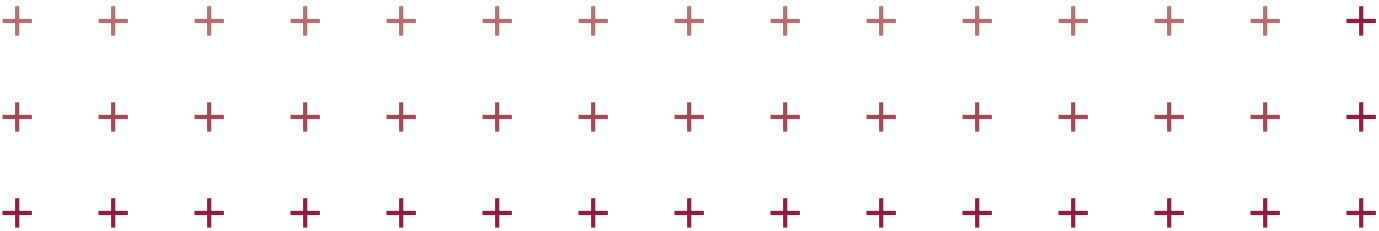
Power structures | Violence | Oppression

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 ANGEL NAYDENOV

CURRENT POSITIONS

Affiliate Scholar, Mongolia and Inner Asia Studies Unit (MIASU), University of Cambridge

PREVIOUS APPOINTMENTS

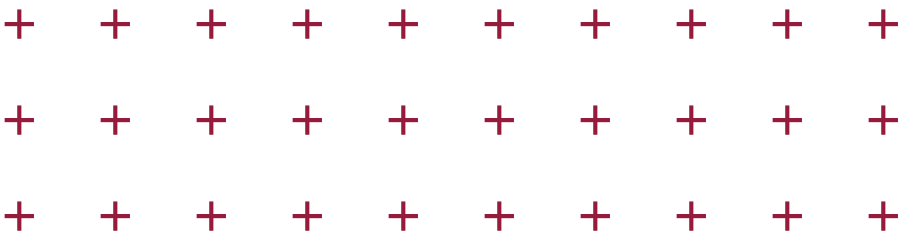
- Undergraduate Supervisor, Department of Social Anthropology, University of Cambridge
- Project Coordinator and Tutor, Global Talents Online Program, Confucius Institute for Business, London School of Economics
- Research Assistant, University of Cambridge

A social anthropologist specialising in the social construction of time with a focus on China.

As a researcher, Dr Naydenov conducted immersive ethnographic fieldwork in Leshan Prefecture, Sichuan Province, China, where he explored the entanglement of temporality and selfhood from the perspective of value pursuits in which selves seek realisation and recognition. His research focuses on basic rhythmic structures of recognition such as synchrony, dissonance, and continuity that symbolically extend the self in relation to others. He previously conducted research in the Bulgarian countryside resulting in a paper discussing the Kurban Sacrificial Feast using the perspective of the Balkan Mountain River Valley inhabitants. Furthermore, he received numerous scholarships and grants for his invaluable contribution to the field of anthropology, which include the Cambridge Department of Social Anthropology Henry Ling Roth Scholarship, the Cambridge University Mongolia and Inner Asia Studies Unit Fund, and the Sichuan University New Sinology Joint-Research Fellowship, to name a few.

Dr Naydenov is currently preparing to publish the first ethnographic monograph on Chinese temporality in the English language, as well as articles with the Journal of the Royal Anthropological Institute and HAU: Journal of Ethnographic Theory based on his doctoral research in Sichuan.

As a mentor, Dr Naydenov taught a diverse range of students on courses in social anthropology. He worked as a course supervisor at the Cambridge Department of Social Anthropology and as a tutor for the Global Talents Online Program at the Confucius Institute for Business (LSE).



SOCIAL ANTHROPOLOGY:

RELIGION, FAMILY, ECONOMY, AND STATE

Suitable for students interested in:

ANTHROPOLOGY

Social Analysis | Meaning-making | Morality | Kinship | Power Dynamics

CROSS-CULTURAL STUDIES

Asia | Africa | Latin America | Europe | Oceania

Often described as ‘philosophy with people in it’, anthropology questions basic presumptions about what it means to be human by drawing insight from the full range of socio-cultural possibilities. **In this lecture course, students will learn how anthropologists approach, analyse, and theorise about the social world**; how taken-for-granted categories like religion, family, economy, and state are infinitely dynamic, and how everyday matters such as food, play, work, and exchange may be bound up with religious and other symbolic meanings. Students will learn what it means to think like an anthropologist through a close examination of seven core themes:

- 1) Power, Authority, and Patterns of Social Organisation
- 2) Patterns of Kinship: Descent, Alliance, Relatedness, and New Reproductive Technologies
- 3) The Moral Foundations of Economic Life I: Gift, Commodity, Accumulation, and Excess
- 4) The Moral Foundations of Economic Life II: Value and Desire
- 5) Ritual and Sincerity: The Symbolic Foundations of Human Existence
- 6) Movements of Radical Change: Millenarian Cults and Revolutions
- 7) The Cultural Mastery of Time and Space

Ethnographic case studies will be drawn from a variety of contexts including Asia, Africa, Latin America, Europe, and Oceania. In addition to the lectures, students will have the chance to read and review a full-length ethnography from a list of choices and present it in class, as well as conduct their own independent ethnographic project.

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DR VICTORIA FENDEL

CURRENT POSITIONS

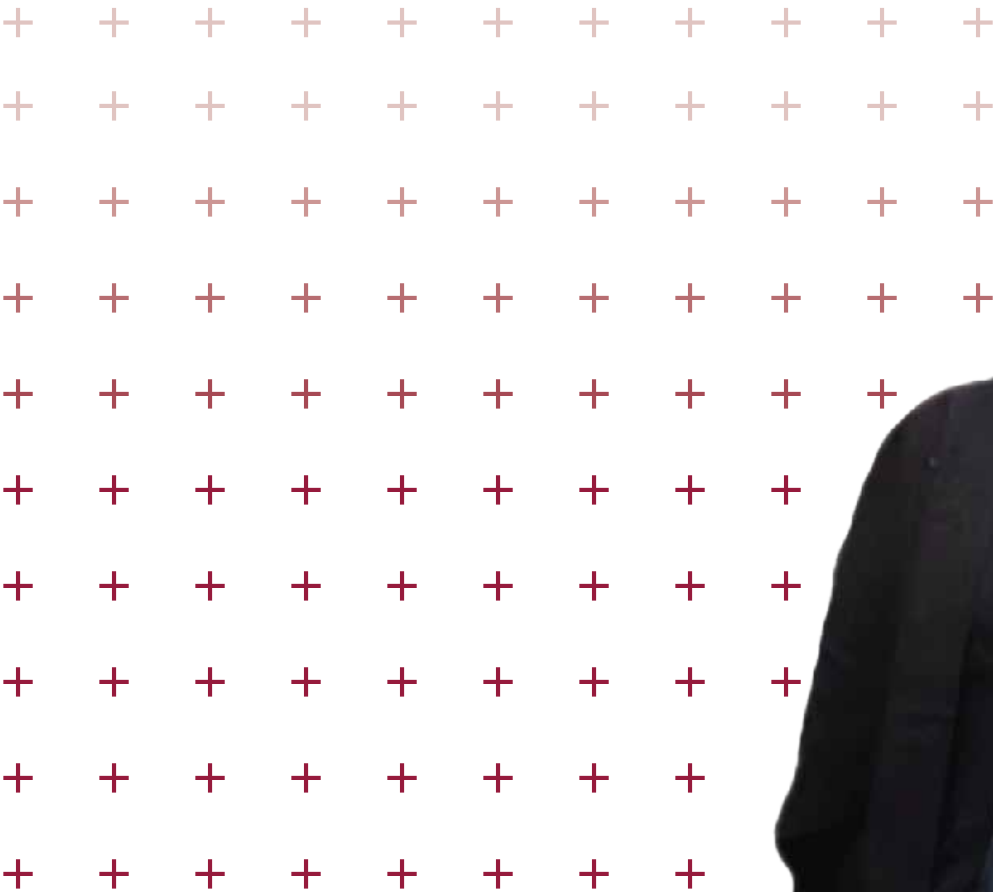
Leverhulme Early Career Research Fellow, Lady Margaret Hall, University of Oxford

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.



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

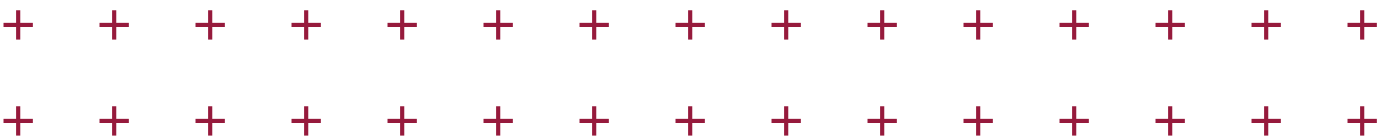
Have you ever wondered why ‘we are going home’ but ‘we went to Europe’? Or why do we ‘take a step’ rather than ‘make a step’? Why are we swallowing half the syllables in ‘parliament’ and why do we spell ‘doughnut’ with a lot more letters than probably necessary? And why are languages so different – and 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.



DR DILSHAD DAYANI

CURRENT POSITIONS

Associate Professor, *The Morton Deutsch International Center for Cooperation and Conflict Resolution (MD-ICCCR) Center, Teachers College, Columbia University*

Consultant, *United Nations*

Lead Faculty, Consultant, & Journalist, *New York Times*

PREVIOUS APPOINTMENTS

Program Developer/Trainer, *International Business Leadership Exchange Program, US Department of State*

Adjunct Summer Faculty Professor, *Georgetown University*

Diversity and Communication Consultant, *IBM*

Vice President of Diversity and Leadership Program, *National Women's Diversity Council*

A dynamic and influential academic, impactful media figure, and staunch advocate for social justice and gender equity.

As an advocate-academic, Dr Dayani is a multifaceted leader whose impact spans across academia, media, diplomacy, and social advocacy. With a rich background as an award-winning journalist, author, and social impact strategist, she embodies a commitment to empower individuals and communities worldwide.

Drawing from three decades of civic leadership experience, Dr Dayani has curated training programmes for conflict-prone regions, particularly in South Asia. Notably, her programme on Conflict Resolution and Faith-Based Interventions has fostered peaceful transformation through strategic dialogue. She has also dedicated tremendous efforts to promoting gender equity, notably through her founding roles in organisations like the World Women Global Council and Lead 2 Empower platforms.

In addition to her academic and advocacy roles, Dr Dayani has made significant contributions to media, having produced and hosted over 400 award-winning talk shows aimed at empowering immigrant families. Through her work, she has bridged cultural gaps, advocated against domestic violence, and promoted cross-cultural understanding.

Dr Dayani has been recognised nationally for her contributions, including receiving the "Obama's Immigrant Journey Award" for professional excellence. She has also founded the Lead 2 Empower institute, dedicated to leadership training and economic empowerment.

As an active member of various advisory boards and a consultant for UN projects, Dr Dayani continues to mentor and advocate for global causes.

As a mentor, Dr Dayani's commitment to education is reflected in her instructed courses on Immigration in NYC, Diverse Voices, and Inside The UN Journalism at the New York Times. At Columbia, she teaches courses in Social-Organisational Psychology.



IDENTITY IN THE DIGITAL AGE:

STEREOTYPES, RACE, GENDER, AND LABELS ON SOCIAL MEDIA

Suitable for students interested in:

SOCIAL SCIENCE

Political Science | Sociology | Ethics of Technology

PSYCHOLOGY

Identity | Cultural Psychology

How are human behaviour and identity formation impacted by social media? In this research course, we will explore the intricate connections between social media, education, communication, group behaviour, and their profound impact on society. Students will explore global ideas, biases, stereotypes, and conflicts propagated by digital platforms, shedding light on the pervasive issues of discrimination and racism in today’s interconnected world.

We will explore how technologies and cultural networks influence our sense of self and community as we empower individual voices to effect change. Looking through the lens of social media and apps, students will explore how their own identity is shaped and changed by their digital activities. **We will delve into Identity “markers” such as race/ethnicity, gender, and socio-economic class for deeper discussion around our evolving self, divided between with and without online presentation.**

We will discuss essential components of technology, race, and our identity in the backdrop of culture-sharing influential research and the power of storytelling from prominent authors. What is the role of social media in helping/hindering an international, comparative, and interdisciplinary agenda forward? How can we promote Global Perspectives in cultivating diversity as our strength? What filter tools can we employ to redefine research and unbiased theories?

Throughout this research course and by conducting independent research projects, students will not just be equipped with a deeper understanding of the matter, but empowered with a newfound understanding of the complexities surrounding education, social media, and societal influence. Armed with critical insights and analytical tools, students are poised to become catalysts for change and pioneers in reshaping the digital landscape.



DR SARAH HUMMEL

CURRENT POSITION

Visiting Assistant Professor, Department of Government, Harvard University

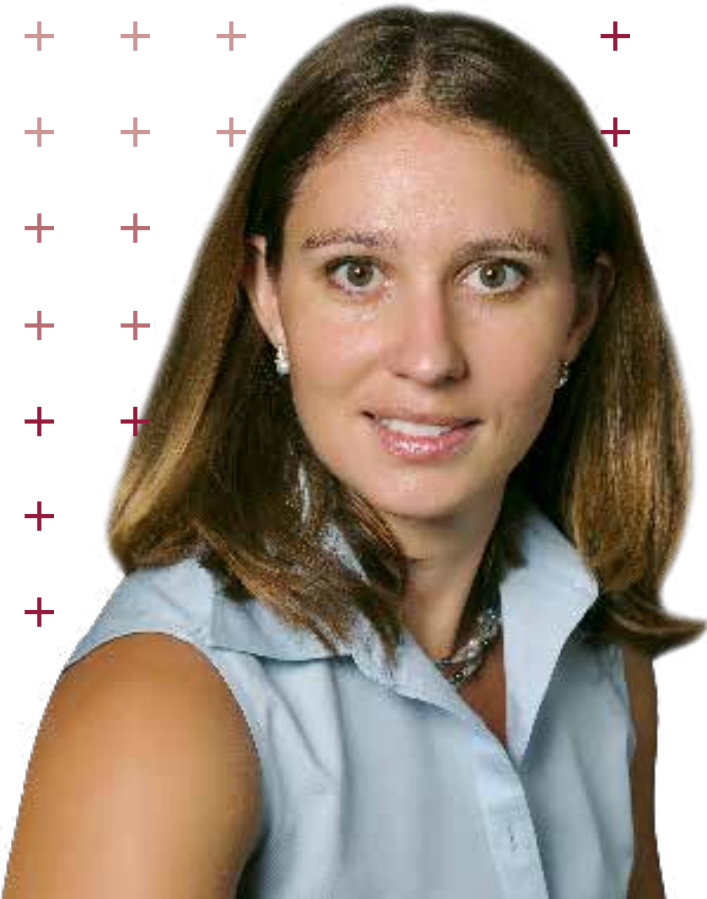
PREVIOUS APPOINTMENT

Assistant Professor, Department of Political Science, University of Illinois Urbana-Champaign

A political scientist specialising the intricate dynamics within authoritarian regimes.

As a researcher, Dr Hummel focuses on the nuanced dynamics within authoritarian regimes, particularly delving into their internal and external politics, with a specialised regional emphasis on post-Soviet Central Asia, where she explores themes such as international resource management and political protest. She is also especially interested in international resource management, and political protest. One of her papers, titled "Leader Age, Death, and Political Liberalisation in Dictatorships," is forthcoming in the Journal of Politics. It explores how expectations regarding the likelihood of a dictator's death influence the strategic calculations of both regime insiders and potential challengers. Her other research works have been published or presented in various prestigious journals and conferences, including Comparative Politics and International Studies Quarterly.

As a mentor, Dr Hummel teaches Strategic Models of Politics, and The Success and Failure of Protest Movements at Harvard. She also supervises PhD dissertations and Masters theses. Notably, Dr Hummel is the recipient of the Clarence Berdahl Award for Excellence in Undergraduate Teaching.



THE POWER OF PROTEST:

HOW SOCIAL MOVEMENTS LEAD TO SOCIAL CHANGE

Suitable for students interested in:

POLITICAL SCIENCE

International Relations | Political Economy | Comparative Politics | Political Theory

HISTORY

Political History | Economic History | Diplomatic History

ACTIVISM

Protest Movements | Civil Rights | Social Change

Protests are powerful forces for change. Whether they are single, explosive events or part of a sustained social movement, they have the potential to upend existing power structures and fundamentally alter the societies in which they occur. **When and why do protests have this world-changing power? We will engage with academic research across the social sciences to uncover answers to this vital question.**

This research course begins by introducing students to core frameworks in the study of collective action and protest. We will discuss the characteristics of successful protests, identify the contexts in which protests are most likely to achieve their goals, and grapple with the question of why individuals join protests, despite the high personal costs they often face for doing so. The course will then turn to topics of particular relevance in the contemporary world, including the role of social media in mobilisation and the connection between online and offline protest.

Throughout, the course emphasises the real-world experiences of activists and the societies they seek to change. We will draw lessons from diverse examples of protest movements, ranging from the Civil Rights Movement to Black Lives Matter, and from the Coloured Revolutions of Eastern Europe to the Arab Spring. We will read from activist memoirs, listen to interviews, and watch videos of protests to bridge the gap between academic research and the lived experiences of those who protest. Students will also be encouraged to draw on their own experiences and observations.

In line with the course’s broadly comparative approach to the study of protest, students will have a great deal of freedom to select which protest(s) they wish to study for their research project. As the course progresses, we will increasingly use these protests to illustrate theoretical concepts and as a jumping-off point for discussion.



COLUMBIA UNIVERSITY

DR JOSÉ ARAGÜEZ

CURRENT POSITION

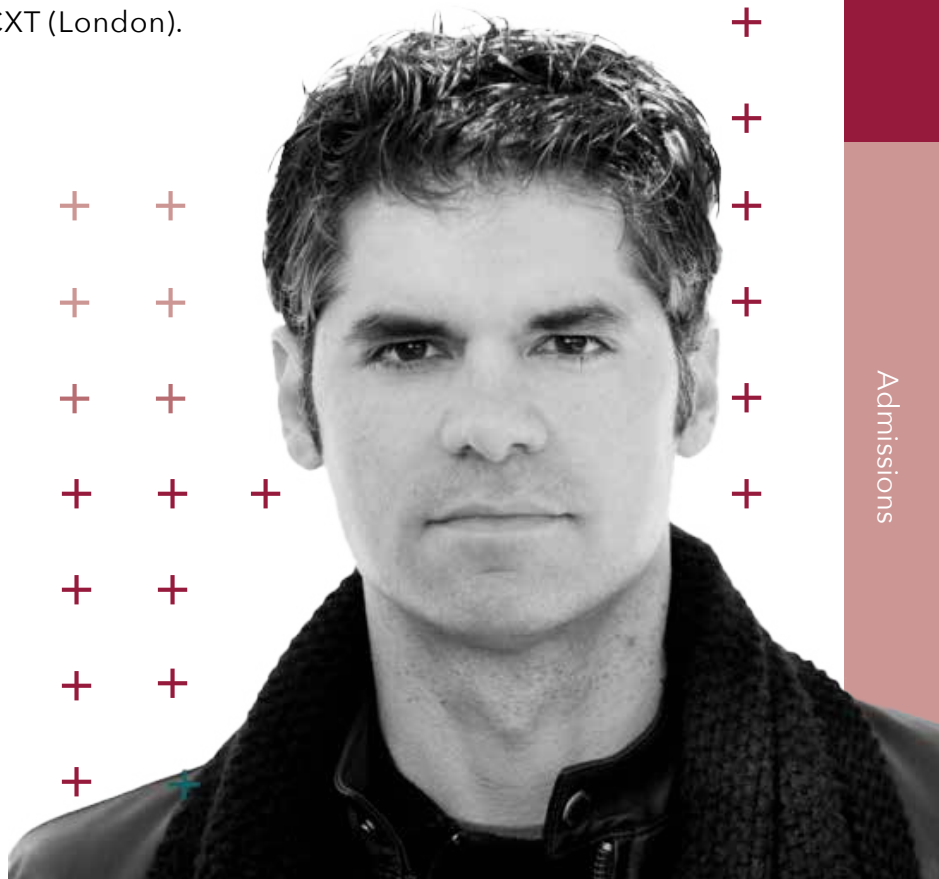
Founding Principal, Atelier Aragüez

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.



ARCHITECTURAL THINKING:

CONCEPTS, INNOVATIONS, AND THEORIES

Suitable for students interested in:

ARCHITECTURE

Theory | History | Practice

SOCIOLOGY AND ANTHROPOLOGY

Space and Place | Materiality

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.



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 APPOINTMENTS

- 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.



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 & Acquisition

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.

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DR BETHANIA ANTUNES

CURRENT POSITION

Associate Professorial Lecturer in Management, London School of Economics

PREVIOUS APPOINTMENTS

- Assistant Professor of Human Resource Management, Surrey Business School, University of Surrey
- Program Director, MA International HRM, Business School, University of Greenwich
- Assistant Professor of Reward Management, Business School, University of Greenwich

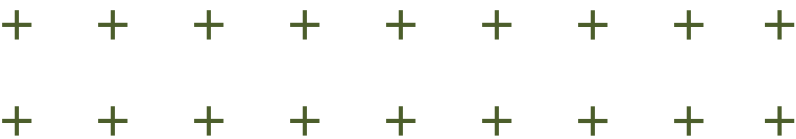
A researcher in the field of business and management advocating for equality and diversity in the workplace.

As a researcher, Dr Antunes is particularly interested in research at the intersection of work and volunteering, and how corporate volunteering programs can create mutually beneficial opportunities for both for-profit and nonprofit organisations while ensuring a positive impact on their target communities. Her commitment to advocate for social impact and workplace equity inspires her research on sustainable human resources practices. Her research projects are currently supported by various organisations and governing bodies, including the Financial Conduct Authority, Low Pay Commission, Trade Union Congress, and Surrey Business School. Previously, she has received funding from the European Commission to study and investigate the Gender Pay Gap in EU Public Services. She is part of LSE's Employment Relations and Human Resource Management Faculty Group, as well as a chartered member of the Chartered Institute of Personnel and Development (MCPID).

Besides her research, Dr Antunes works closely with the industry. She delivers training to senior healthcare managers in the Leadership Program of the NHS Foundation Trust, is interested in building partnerships with stakeholders, and works corporate volunteering programs to help create a culture of continuous improvement.

Dr Antunes' works have been published in several peer-reviewed academic journals and presented at prestigious conferences, which include Employee Relations: *The International Journal*, *Industrial Relations Journal*, and the *Trade Union Congress Project Report*, to name a few. She is also a contributor to the *Encyclopaedia of Human Resource Management*.

As a mentor, She has taught courses on business management to MBA and executive MBA students as well as to undergraduate students at the University of Surrey. She has also previously held classes on HR management, and organisational behaviour at the London School of Economics and the University of Greenwich.



THE PSYCHOLOGY OF BUSINESS LEADERSHIP

Suitable for students interested in:

SOCIAL PSYCHOLOGY

Industrial Psychology | Human behaviour

BUSINESS

Organisational Behaviour | Management | Leadership

Organisational behaviour is the study of human behaviour in organisations and this course is suited to those interested in people and what makes them think, feel, and behave the way they do at work. **We will examine central issues of organisational behaviour and leadership by applying sociological and social psychological theories and methods.** You will learn key theories as they apply to organisations, and you will gain a solid understanding of human behaviour at work that will help you to become a more effective manager in the future.

This research course aims to balance theory and practical application by focusing on issues that will help you understand how to influence the attitudes, behaviour, and success of people in contemporary organisations (including yourself). The topics in this course will examine the individual in the organisation, motivation, the multicultural workplace, decision-making, and leadership that will contribute to enhancing individual, team, and organisational performance. The ability to understand, motivate, and lead people is key to becoming an effective manager in any industry or sector.

On completion of this research course, students should be able to demonstrate an informed and critical understanding of some of the main theories of organisational behaviour and leadership; to analyse how these theories and empirical evidence can help you understand contemporary workplace issues; and to develop relevant skills to apply theories to practical problems in organisations. Students are also encouraged to conduct their own independent research project throughout the research course.

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DR APARNA VENKATESAN

CURRENT POSITIONS

Fellow, Department of Management, London School of Economics
Associate Teaching Fellow, Higher Education Academy, UK

PREVIOUS APPOINTMENTS

Senior Teaching Fellow, Department of Business and Management, University of Manchester
External Management Consultant, HME Derby

A research scientist specialising in organisational behaviour and bringing her insights to make a real-world impact.

As a researcher, Dr Venkatesan’s research focuses on labour markets and organisational studies. She employs intersectionality-informed multilevel models while simultaneously analysing labour market policies or conditions that impact gender inequality. Her previous research studies the interests of United Nations Development Programme’s Millennium 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.

Dr Venkatesan’s works have been published in a number of prestigious journals. 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, Dr Venkatesan 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.



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.

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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.

DR DILSHAD DAYANI

CURRENT POSITIONS

Associate Professor, *The Morton Deutsch International Center for Cooperation and Conflict Resolution (MD-ICCCR) Center, Teachers College, Columbia University*
Consultant, *United Nations*
Lead Faculty, Consultant, & Journalist, *New York Times*

PREVIOUS APPOINTMENTS

AProgram Developer/Trainer, *International Business Leadership Exchange Program, US Department of State*
Adjunct Summer Faculty Professor, *Georgetown University*
Diversity and Communication Consultant, *IBM*
Vice President of Diversity and Leadership Program, *National Women’s Diversity Council*

A dynamic and influential academic, impactful media figure, and staunch advocate for social justice and gender equity.

As an advocate-academic, Dr Dayani is a multifaceted leader whose impact spans across academia, media, diplomacy, and social advocacy. With a rich background as an award-winning journalist, author, and social impact strategist, she embodies a commitment to empower individuals and communities worldwide.

Drawing from three decades of civic leadership experience, Dr Dayani has curated training programmes for conflict-prone regions, particularly in South Asia. Notably, her programme on Conflict Resolution and Faith-Based Interventions has fostered peaceful transformation through strategic dialogue. She has also dedicated tremendous efforts to promoting gender equity, notably through her founding roles in organisations like the World Women Global Council and Lead 2 Empower platforms.

In addition to her academic and advocacy roles, Dr Dayani has made significant contributions to media, having produced and hosted over 400 award-winning talk shows aimed at empowering immigrant families. Through her work, she has bridged cultural gaps, advocated against domestic violence, and promoted cross-cultural understanding.

Dr Dayani has been recognised nationally for her contributions, including receiving the “Obama’s Immigrant Journey Award” for professional excellence. She has also founded the Lead 2 Empower institute, dedicated to leadership training and economic empowerment.

As an active member of various advisory boards and a consultant for UN projects, Dr Dayani continues to mentor and advocate for global causes.

As a mentor, Dr Dayani’s commitment to education is reflected in her instructed courses on Immigration in NYC, Diverse Voices, and Inside The UN Journalism at the New York Times. At Columbia, she teaches courses in Social-Organisational Psychology.



THE PSYCHOLOGY OF NEGOTIATIONS:

CONFLICT AND COMMUNICATION IN BUSINESS WORLD

Suitable for students interested in:

BUSINESS AND ENTREPRENEURSHIP

Power Structure | Conflict Navigation | Communications

PSYCHOLOGY

Organisational Psychology | Decision-making | Emotion Regulation

Negotiation is the most common activity in the business world, whether one is a startup founder seeking funding or striving to build up a strong team. In these negotiations and communications, sometimes conflicts might arise.

In this research course, we will explore frameworks and strategies for interpersonal and organisational conflict and its resolution as applied to personal and business contexts. Students will discuss the meaning, types, and different strategies of intercultural negotiation with an emphasis on an integrative, collaborative, and win-win approach, turning challenging situations into opportunities. They will also develop a deep understanding of conflict dynamics and learn how to leverage strategic communication techniques to de-escalate tensions, build consensus, and promote constructive dialogue. Students will also make connections surrounding the significance of leadership in managing organisational conflict resolution.

In this course, students would encounter real-world examples, and they would be encouraged to think about conflict, strategies for diagnosing conflict situations, power, culture, diversity, and emotional regulation within psychological and social contexts. Along the way, they may apply theoretical and practical frameworks of these topics into their research projects.

By honing intercultural communication skills and mastering the art of conflict resolution, students will emerge as adept global negotiators capable of bridging cultural divides, forging strong partnerships, driving success in today’s interconnected business landscape, and elevating personal negotiation prowess to new heights.

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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

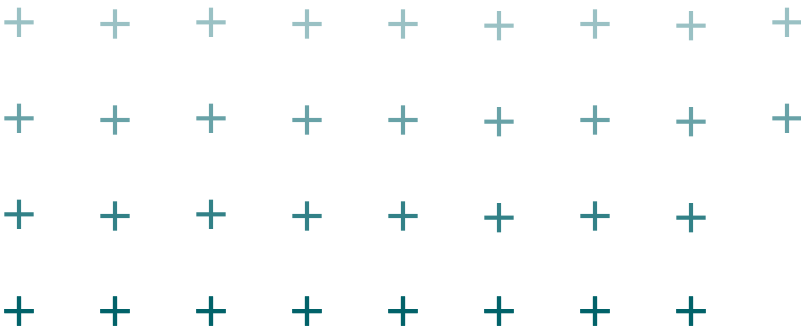
PREVIOUS APPOINTMENTS

- 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 undergraduates, as well as PhD students in politics and history, on a wide range of issues including the politics of memory and political anthropology.



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.

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.

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.



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.



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.



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.

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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 APPOINTMENTS

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.



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

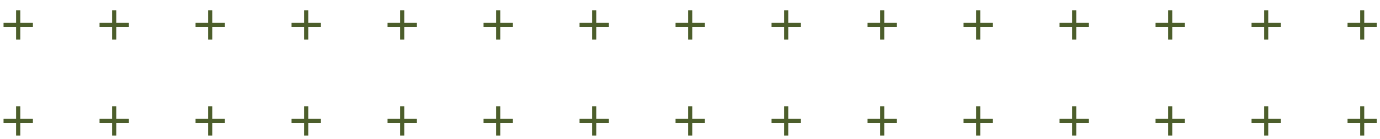
LAW

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.



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 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

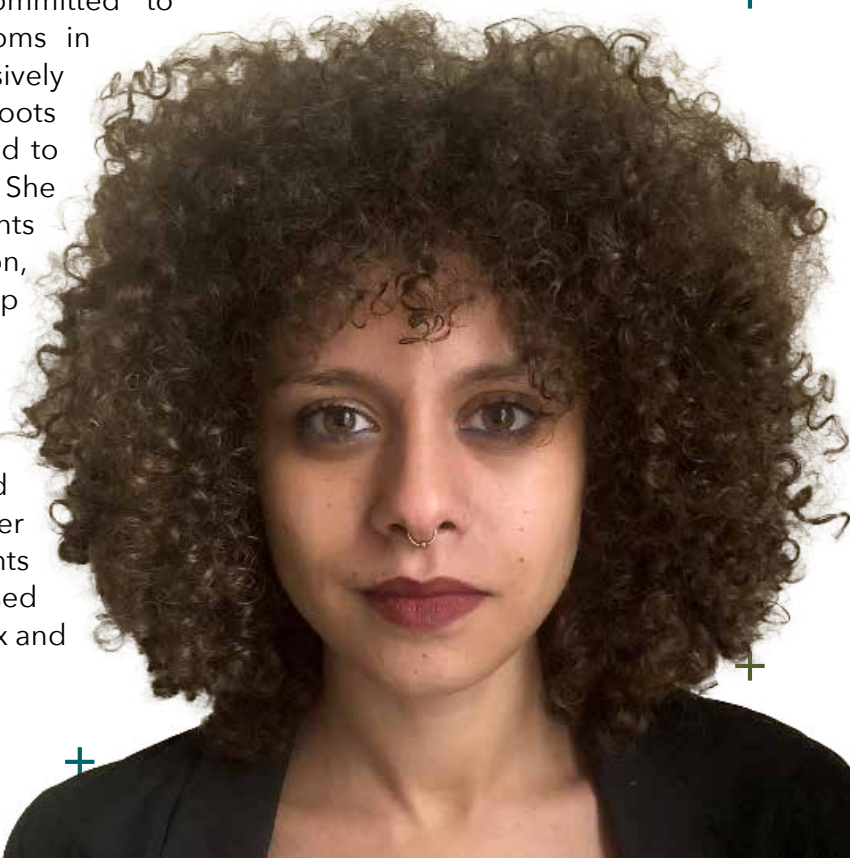
A historian, scholar, and educator specialising in the modern political and cultural history of the Middle East.

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, SEXUALITY, AND POLITICS IN THE MIDDLE EAST

Suitable for students interested in:

POLITICS

Political Economy | Cultural Politics | Political Theory

HISTORY

History of Law | Social History | History of Gender and Sexuality

GENDER STUDIES

Gender Inequality | Gender Variation | Gender Oppression

What is gender? What is sexuality? What do they have to do with biological sex or sex-acts? **This research course examines different gender and sexual identities in the Middle East, and the social, political and cultural contingencies that gave rise to them.** All identities are always-already gendered. We begin with the basic concepts, theories and controversies that underpin this claim. We then grapple with the diversity of ways in which Middle Eastern cultures have constructed and performed genders and sexualities through notions of marriage, fertility, same-sex love and desire, masculinity and femininity, and how these constructions intersected with race, class, morality, respectability, piety, and other norms of ideal or acceptable social behaviour.

Our sources include cartoons and advertising, pre-Islamic poetry, the modern Arabic novel, postcolonial civil codes, Islamic jurisprudence, autobiography and film. From the construction of Arab genders and sexualities we move to how genders and sexualities have, in turn, powerfully constituted Arab and non-Arab Middle Eastern identities and societies through literary and artistic canons like Orientalism and global processes like colonialism, imperialism, decolonisation and capitalism.

The 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.

The research course will consist of lectures and discussions that will cover the themes outlined below. In addition to the in-class engagement with texts, students will be encouraged to engage with the primary sources, films, songs, and poetry provided on a near-weekly basis. Each week, students will participate in a student-led presentation and discussion. Throughout the course, each student will conduct a self-directed research project and gain a deeper understanding of the issues related to gender, sexuality, and politics in the Middle East.

DR ALICE BALDOCK

CURRENT POSITION

Research Fellow in Japanese Studies, Nissan Institute, University of Oxford

A dedicated Japanese studies scholar who seeks to examine the intersection between gender studies and performing arts.

As a researcher, Dr Baldock’s research focuses on gender and Japanese studies. She is particularly interested in 20th century Japanese history, gender in postwar Japan, and the transnational circulation of ideas around ‘the body’. Her current research involves tracing the and the transnational circulation and reception of this body of knowledge, to see how and why these ideas about the body - that involved a complete eradication of hierarchies of gender, ability, and class, became so popular in Japan and then across the world.

In prior studies, she delved into the intellectual perspectives of mid-20th-century dancers, particularly their views on the body (especially *Nikutai*, or flesh body) and movement. Through this exploration, she has shown how these dancers reinterpreted post-war Japanese society, enabling them to lead more authentic lives in a world increasingly characterised by codification and consumerism.

Furthermore, Dr Baldock demonstrates a keen interest in fostering interdisciplinary dialogue in the field, having co-organized the international conference “*Missing Bodies, Missing Voices: Ordinary Lives and the Reframing of Postwar Japan*” at Oxford University in March 2023. This event facilitated conversations among scholars, practitioners, and scholar-practitioners worldwide. She has also collaborated on the project “*Breaking Free: A Symposium on the Dancing Body*” which seamlessly combines creative practice, discussion, and writing to explore diverse ideas shaping our lived experiences of our bodies.

Dr Baldock’s recent scholarly contributions include noteworthy publications in the *Journal of Asian Studies* and a forthcoming article titled “Selling Bodies in the Age of the Flesh: Bodies, Dance, and Postwar Japan” in *The Routledge History of Sex Work Around the World*.

As a mentor, Dr Baldock is passionate about teaching and has been supervising students at the University of Oxford. She fosters a creative and inclusive environment to empower students to explore diverse aspects of history, gender, and East Asia.



DR ALICE BALDOCK, UNIVERSITY OF OXFORD

FEMINISMS IN EAST ASIA, 1900-PRESENT

Suitable for students interested in:

HISTORY

History of East Asia | Women’s History | World History

SOCIOLOGY

Social Movements | Social Theory | Grassroots Organisations

GENDER STUDIES

Feminism | Gender Normativity

This research course will allow students to investigate different feminisms that have been employed by feminists across East Asia in the 20th Century and up until the present day.

The course will broadly focus on constructions of femininity, masculinity, non-binary, and other identities in Japan, Korea, and China. Additionally, it will allow students flexibility to explore other areas in the region and take a transnational approach to historical work. We will also look at how these identities and the disparities between them contributed to the emergence of many transformed into many different feminist movements across and between places in this region. These feminisms will include formal protest movements, literary movements, grassroots organisations, and more subtle cultural critiques of gender normativity.

We will take a mainly historical approach, looking at a combination of primary sources and works written by historians. Some weeks will also involve engagement with literature and film, including novel Kim Jiyoung, Born 1982, and Studio Ghibli’s animated film Princess Mononoke. We will learn how to read popular culture as historians and gender studies scholars, in addition to more conventional source material. 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.

There is no requirement to work in any language other than English for this course.

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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

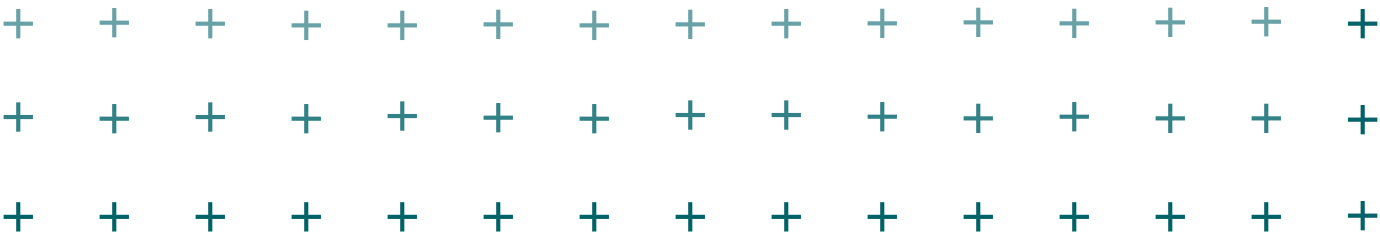
European Imperialism | Ideology | Religion

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

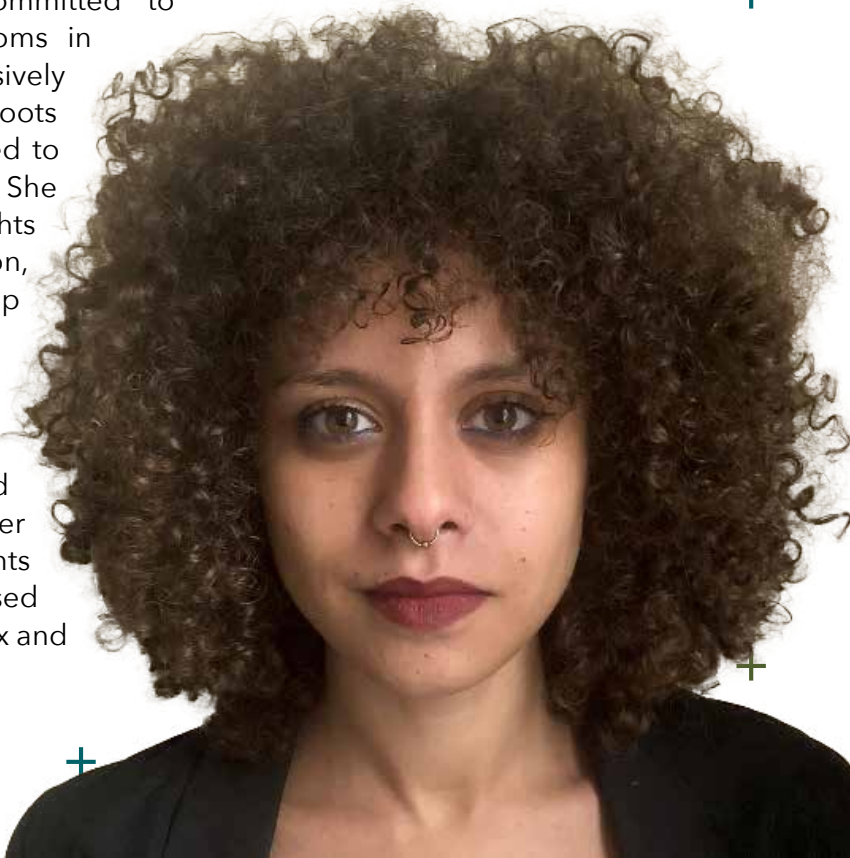
A historian, scholar, and educator specialising in the modern political and cultural history of the Middle East.

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.



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.



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.

DR HERMANN HUDDE

CURRENT POSITION

Lecturer in Ethnomusicology, Herb Alpert School of Music, UCLA

PREVIOUS APPOINTMENTS

Lecturer, University of California, Riverside

Lecturer, Scripps College

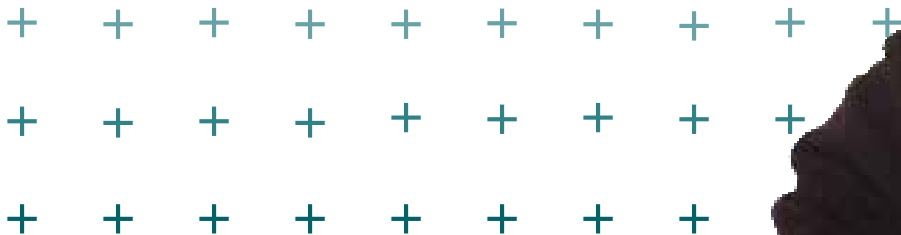
Lecturer, Sierra University

A cultural musicologist exploring the intersections of music and the social sciences.

As a researcher, Dr Hudde explores how the geocultural and epistemological category of Latin American art music, despite possessing its own musical and cultural history, must constantly negotiate aesthetics and politics in relation to the ethnocentric and epistemological hierarchies of Western modernity. These themes were the central topics of his recent book *Modernism to Avant-Garde: Latin American Art Music at Tanglewood (1940-2020)*. Notably, he received the Otto Mayers Serra Award in 2021 for his research contributions to the field of music. Furthermore, Dr Hudde is currently a member of the Center for Iberian and Latin American Music at the University of California, Riverside.

He is a recipient of several grants and fellowships, the most recent being the UCLA Center for the Advancement of Teaching grant, the Future of Music Faculty Fellowship, and the American Musicology Society's Sustainable Mentorship Program. He has also published and was invited to present his works in research journals and conferences, such as the *Journal of the Society for American Music*, *Diagonal: An Ibero-American Music Review*, and the Massachusetts Foreign Language Association, to name a few. Furthermore, he serves as a peer reviewer in the *Journal of the Society for American Music* by the Cambridge University Press. Dr Hudde authored a chapter in a forthcoming book entitled *Bernstein in Context* to be published by the Cambridge University Press.

As a mentor, Dr Hudde teaches music courses in Western Art Music, Musical Cultures, Latin American Music, Global Popular Music, Music and Politics, and Music, Media, and Cultural Studies at UCLA. He is committed to mentoring undergraduate and graduate students in both musicology, music theory, and beyond.



MUSIC AND WELLNESS:

CULTURAL IDENTITY AND HEALTH IN GLOBAL PERSPECTIVES

Suitable for students interested in:

MUSICOLOGY

Musical Culture | History of Music | Ethnomusicology

SOCIAL SCIENCE

Music and Society | Political Economy

ART HISTORY

Musical Criticism | Western Musical Culture | Aesthetics

Since ancient times in humankind history, sound, music and health have been intertwined. People around the world have realised and experienced the health-enhancing effects of sound and music. Traditional music therapy uses music to support healing and improve well-being, addressing various physical, emotional, and cognitive needs. Therapists employ music elements to aid in communication, reduce stress, and enhance overall quality of life, often in healthcare or therapeutic settings.

The intention of this course is to examine the synergy between music, sound, and health holistically. This course studies how different cultures use sound and music in healing rituals around the world.

The second part of the course examines the use of sound and music in music therapy with Western civilization. In the third part of the course, we will examine the relationship and impact between sound, music, and neuroscience. Music therapy uses music to address various needs in individuals, improving emotional, physical, cognitive, and social well-being. Trained therapists employ music elements like rhythm and melody to assist in healing and enhance overall quality of life, often in settings like hospitals, schools, or mental health facilities. It helps with communication, stress reduction, motor skills, emotional expression, and more.

This course will introduce students to a current and fascinating topic that embraces the humanities, social sciences, and sciences in an interdisciplinary approach. No previous musical experience is necessary. and the course is open to anyone who has an interest in interdisciplinary learning and curiosity!

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AROUND THE WORLD IN 80 TUNES:

A GLOBAL LOOK AT POPULAR MUSIC

Suitable for students interested in:

MUSICOLOGY

Musical Culture | History of Music | Ethnomusicology

SOCIAL SCIENCE

Music and Society | Political Economy

ART HISTORY

Musical Criticism | Western Musical Culture | Aesthetics

Delve into the rich tapestry of popular music’s profound influence on identities throughout history. **This interdisciplinary research course offers a comprehensive examination of popular music from diverse regions including Africa, Europe, Asia, America, and Oceania, fostering inclusivity and cultural appreciation.**

Throughout history, popular music has played a significant role in shaping identities. From an interdisciplinary and inclusive perspective, this research course examines popular music from Africa, Europe, Asia, America, and Oceania. Through hands-on musical activities and participatory exercises, students will hone their ability to connect music with a myriad of social, cultural, and historical contexts. From ethnicity and gender to globalisation, politics, economics, and technology, students will explore the multifaceted dimensions of popular music, transcending boundaries of genre and geography.

Central to the course is the exploration of nuanced events and phenomena that intersect with disciplines such as anthropology, sociology, history, and economics, illuminating the dynamic interplay between music and society. By studying a wide range of popular music traditions including rock, mbalax, salsa, khaleeji pop, reggae, K-pop, hip-hop, R & B, bachata, afrobeats, and Latin jazz, students will gain a deep understanding of the diverse sounds, genres, musicians, and cultural paradigms that have shaped musical landscapes globally.

Through engaging readings, discussions, and research projects, students will develop a solid foundation in popular music history and culture, enhancing their critical thinking and analytical skills. This course welcomes students from all backgrounds, regardless of previous music experience, and encourages an interdisciplinary approach to understanding the vibrant tapestry of global popular music and how popular music has shaped our society and the way we see the world.

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. **The 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.



ART AND COLONIALISM IN MEDITERRANEAN HISTORY

Suitable for students interested in:

ART HISTORY

Artistic Production | Cultural Studies | Historical Analysis

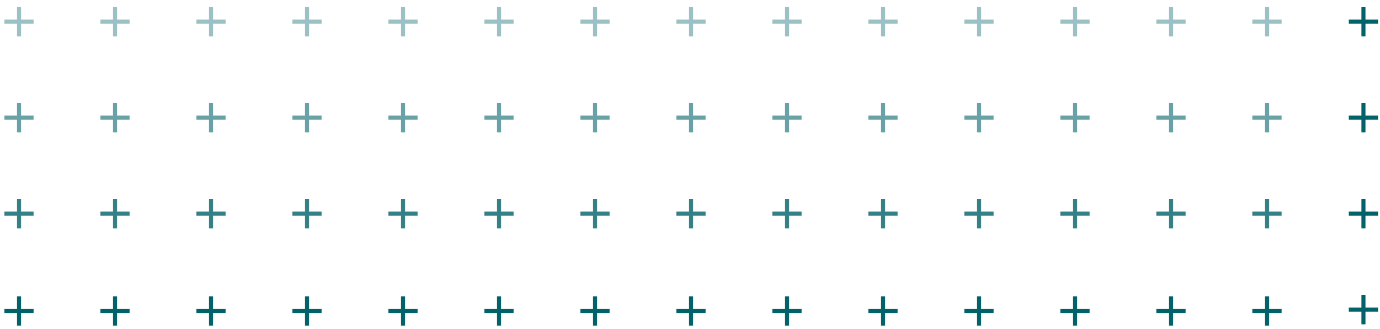
HISTORY

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.



DR HANDE GÜZEL

CURRENT POSITIONS

- Research 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.



GENDER REPRESENTATIONS IN MEDIA AND CONTEMPORARY CULTURE

Suitable for students interested in:

SOCIOLOGY

Cultural studies | Gender and Beauty | Political Sociology

MEDIA STUDIES

New Media Studies | Media and Cultural Studies

In current societies, it is nearly impossible to not engage with a form of media. Yet, the impact of media on the ways we perceive ourselves and others, especially when it comes to gender, can go easily unnoticed. To address this contested area, this research course invites students to critically assess the relationship between gender and media.

Throughout the research course, we will explore topics such as how ‘old’ and ‘new’ media impact gender roles and identities similarly and/or differently, the political economy of gender and media, the impact of mobile phone applications on the construction of ideals around gender and beauty, social media trends such as ‘girl dinner’ and ‘tradwife’, dating applications and their implications for the future of gender roles, and how media can be a means to create solidarity through digital cultures. To discuss these, we will explore the portrayals of gender in various forms of media including, but not limited to feature films, advertisements, print media, and social media.

This research course is inclusive in several ways. It encompasses a wide geographical region, and discusses examples of portrayals of different genders in different parts of the world such as the Middle East, East Asia, and South America, compared to the dominant Anglo-American portrayals. The course also does not limit itself to the representation of women, and includes men’s and LGBTQI+ individuals’ depictions. Finally, our discussions will encourage taking an intersectional perspective, taking into consideration interlocking categories such as class, ‘race’, age, and disability.

By the end of the research course, students will complete an original research paper that focuses on the relationship between gender and a particular media platform or source, be it archival work on old newspapers or an analysis of a series of TikTok videos. 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.

ADMISSIONS

EARLY ADMISSION DEADLINE : 1 MAY 2024

REGULAR ADMISSION DEADLINE: 15 MAY 2024

PROGRAMME START DATE: June 2024 (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

SUMMER 2024 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

Successful 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

FALL 2024 / SPRING 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

FALL 2024 / SPRING 2025 PRE-APPLICATION POOL

3

CONDITIONAL OFFER & DEPOSIT **TWO TO 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 RESEARCH COURSE SELECTION **SUMMER - APR 2023** **FALL - AUG 2023**

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 **SUMMER - APR/MAY 2023** **FALL - OCT 2023**

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

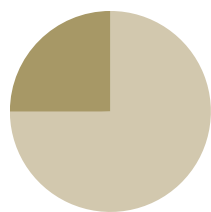
SELECT UNIVERSITY OFFERS OF OUR ALUMNI

Harvard University
MIT
Duke University
London School of Economics
Pomona College

University of California Berkeley
Columbia University
Georgetown University
New York University Abu Dhabi
Stanford University

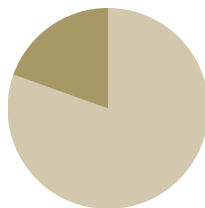
University of Cambridge
Cornell University
University of Hong Kong
University of Pennsylvania
Yale University

FUTURE SCHOLAR ACCEPTANCE

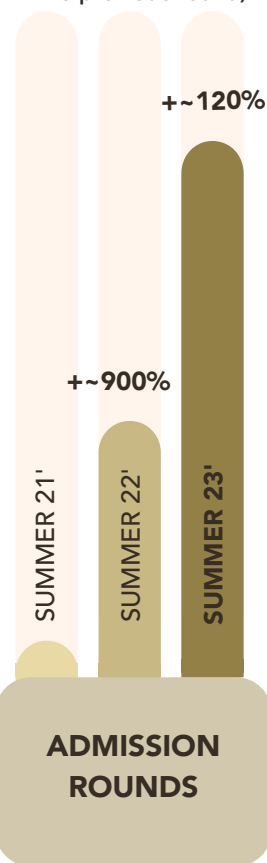


Summer 2023
Percentage of Total Applicants
Received an Invite to Interview
 ~25%

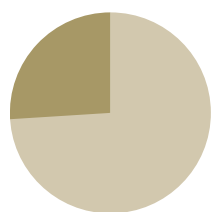
Summer 2023
Percentage of Total Applicants
Received an Offer
 ~19.5%



APPLICATIONS RECEIVED
 (% increase compared to
 the previous round)

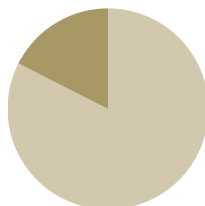


1-ON-1 MENTORSHIP ACCEPTANCE



Summer 2023
Percentage of Total Applicants
Received an Invite to Interview
 ~26%

Summer 2023
Percentage of Total Applicants
Received an Official Offer
 ~17.5%

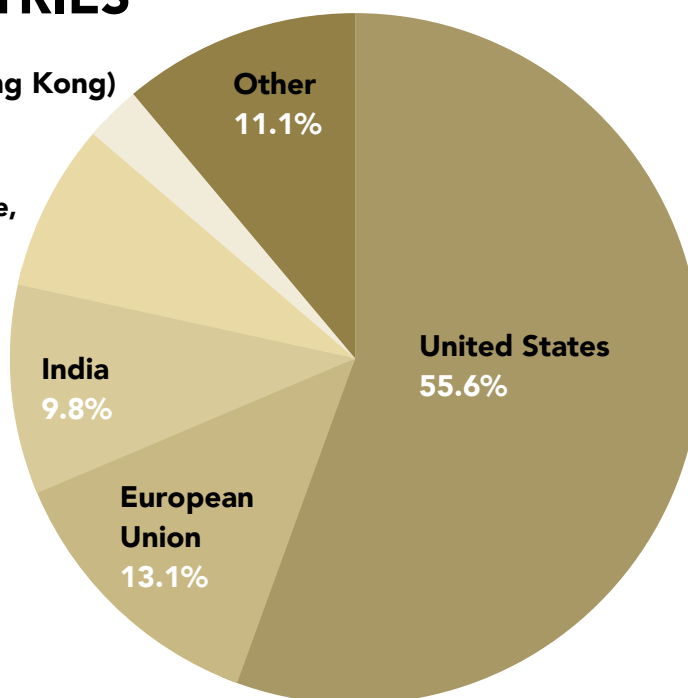


GLOBAL STUDENT COMMUNITY FROM OVER 40 COUNTRIES

**(SPRING 20
 TO SUMMER 23)**

China (inc. Hong Kong)
 2.6%

**Japan, S. Korea, Singapore,
 Malaysia, Indonesia,
 Australia, New Zealand**
 7.8%



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Admissions

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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.

In Spring round of 2023, 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.



CCIR ACADEMY

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](#).

