

## 2021 Research Tracks

### Track 1 – Hacking the Simulation

#### *Engineering the Circuits of the Brain*

**Disciplines:** Neuroengineering, Neurobiology of Disease, Neural Circuits, Neurobehavioral Methods

The human brain is a complex system able to represent the world around it to permit action. This complexity relates to our neurons, or the informational units with their own logic that make up our brains. In scaling those basic units, our brains allow us the abilities of perception, memory and learning, and goal-directed behaviors within various environments. While injury and disease can damage this unique setup, they can also provide a window into comprehending the guiding design principles that undergird the brain, and it is these principles that provide a blueprint for engineering neural circuits. In this class, students will be introduced to the basic principles of neuroscience to guide them in their exploration of the logic of the brain. In doing so, students will be empowered to engineer solutions to both current and future problems in neuroscience.

### Track 2 – Hindsight's 2020

#### *Examining the Tumultuous Year That Changed the World*

**Disciplines:** History, Sociology, Political Science, Feminist Studies, Black Studies, Chicanx Studies

A global pandemic, worldwide protests against police brutality, and the most critical election in US history: 2020 is a watershed year that will have profound repercussions for years to come. In this class, students will craft a concise history of 2020 that will critically examine the mind-boggling year we have just lived through. By employing historical tools including oral history interviews and primary source documents, students will deconstruct the events of 2020, investigate their origins, and analyze their significance. Along the way, students will gain exposure to the practices that historians use to study and make sense of 21st century American life. Lectures will cover topics ranging from the history of racial justice, white supremacy, and Confederate monuments to the role of women in politics since women's suffrage. Students will leave the class with a deeper understanding of the past, a set of versatile skills in interdisciplinary humanities research, and a sense of their own potency as change-makers today.

### Track 3 – Surfing the Stars

#### *A Flight Into the Night Sky and Astrophysics*

**Disciplines:** Physics, Astrophysics, Computer science, Mathematics, Statistics

Astrophysics is the study of nearly everything beyond Earth: stars, planets in our solar system and others, space dust, and even interstellar microwaves. The list of phenomena that have been investigated is vast. The tools with which we study those phenomena and argue our newfound hypotheses lie within the intersection of art, mathematics, and data science. This course aims to develop the coding, data analysis, and artistic data presentation skills that underlie most successful modern astrophysics research. Students will apply the tools they develop here to their own research project in astrophysics. Projects might include: analyzing archival Kepler data to find the sizes of exoplanets from transits; using machine learning to classify stars; or measuring the motions of stars in the sky to look for planets. By the end of the course, students will have designed, written, and published a preliminary version of their own astronomical software package on the free package index PyPi. Students will leverage the software they have developed to either confirm a finding or develop their own conclusion.

## Track 4 – Borders & Fences

### *International Laws, Economics, and Ethics of Global Migration*

**Disciplines:** Political Science, Economics, Sociology, Immigration, Global Studies

Why do people leave their homes? How do they decide where to settle? What role do they play in the politics of their new residence and do they continue to influence the politics of their homeland? These questions have become more and more urgent in the face of global refugee crises and accelerating cross-border movement. To answer them, students will examine the mounting politicization of immigration and its globally polarizing effects. Weaving together economic, sociological, and political science approaches, this course will attempt to explain the phenomenon of migration by exploring its drivers, the effects of laws and treaties, the impact on receiving communities and home countries, and changing attitudes towards immigration. Students will develop multidisciplinary research skills that encompass everything from close readings of international and domestic policy to quantitative data analysis using the programming language R. They will leave the class with a diverse set of critical and technical skills, as well as a nuanced and comprehensive understanding of one of today's most pressing issues.

## Track 5 – Morphological Computation

### *Exploring Wearable Robots for the Post-Pandemic Era*

**Disciplines:** Biomimicry, Computational Design, and Human-Computer Interaction

Morphological computation in soft robotics draws on morphology, or the biological study of the form and structure of living things, to bring together the body (or mechanics), the brain (or controller), and the environment. In this course, students will explore the emerging field of soft robotics by combining research and applications of wearable technology with a focus on the current issues of the post-pandemic era. Students will be introduced to the concept of biomimicry and computational design using cutting-edge 3D digital modeling tools. Specific topics include body architecture, inflatable structure, origami robots, soft material, wearable sensory, embodied intelligence, machine learning, and control system. Drawing on real applications in art, communication, fashion, healthcare, and sports, students will participate in a series of hands-on activities to learn about 3D scanning, parametric design, computational design, and generative design. By the end of the course, students will design, model, and build a digital wearable device and conclude by analyzing the human-robot interaction.

## Track 6 – The Power of Experts

### *How Science has Shaped Politics in Global Society*

**Disciplines:** Anthropology, History of Science and Technology, Public Health, Area Studies, Climate Change

Is science political? During the COVID-19 pandemic, epidemiologists and physicians have taken center stage in the media and politics, influencing political decisions and prompting observers across ideological divides to decry the politicization of science in the contemporary United States. But the intersection between science and politics has a much longer history. Since the nineteenth century, engineers, doctors, and climatologists across the globe have stoked revolutions, challenged socioeconomic status quos, and fomented anti-colonial uprisings. This course explores these histories to understand how scientific knowledge, political struggles, and social formations have shaped each other in different parts of the globe throughout modern history. Students will be introduced to the interdisciplinary methods and theoretical approaches developed within the field of Science and Technology Studies. Examining ethnographies of laboratories, feminist theories of objectivity, and post-colonial approaches to the history of science, this course offers critical tools to help students better understand and respond to our contemporary moment.

## Track 7 – Human-Computer Interaction

### *Perception and Correlation Development in Virtual Reality*

**Disciplines:** Mixed Reality, Augmented Reality, Redirected Walking, Machine Learning, Sensing Technologies

In the future, Augmented Reality (AR) and Virtual Reality (VR) will become as universal and essential as smartphones and personal computers are today. As computers become more deeply enmeshed in human lives, we must be prepared to push the boundaries of computer engineering as we confront questions that address the extent to which we accept and allow the integration of our experience with technology. The lifelike realism of VR and AR present a host of ethical implications related to identity, privacy, self-image, and the body politic. In this course, students will explore the integration between the virtual world and the physical through hands-on interactive platform development. The course will address fundamental issues in Human-Computer Interaction and perceptual psychology through system-building and design experimentation. Students will gain fresh insights and perspectives that challenge our notions of what human experience with technology can or should be through the use of sensing technologies and new methods of interaction and inquiry.

## Track 8 – Virtual Connections

### *The Psychology of Human Behavior and Communication on Social Media*

**Disciplines:** Communication, Social Psychology, Psychology, Sociology, Statistics

Researchers have been busy examining the impact of technology on wellbeing, relationships, and impression management since before the COVID-19 pandemic pushed most social interactions online. How have people navigated the shift to purely online interactions? What are the consequences for the virtual connections we make and our behavior? In this class, students will study the latest theories and models of online communication to guide them in their own research into the psychology of virtual relationship development. Students will immerse in studies concerning self-disclosure and gain experience in experimental social media stimuli design, survey methodology, and data analysis using R. They will leave the course with insight into several relevant theories including Social Information Processing, Media Psychology, and Self Penetration Theory. Finally, they will gain a greater awareness of their social media footprint and how their online behavior might impact others.

## Track 9 – Machine Intelligence

### *A Dive Into Space Exploration and its Legacies for the Future*

**Disciplines:** An Introduction to Optimization and Machine Learning

Optimization is an integral part of every decision by an individual, organization, or intelligent machine. It is also at the heart of almost all machine learning methods and critical to utilizing advanced artificial intelligence. In fact, in the realm of science and engineering, the task of design, operation, and model calibration can be approached systematically through the application of optimization. This course will provide students with an introduction to a variety of optimization techniques in machine learning including convex optimization, dynamic programming, and evolutionary computation. Students will investigate the connections between optimization and machine learning using approaches such as reinforcement learning, regressions, neural networks, and support vector machines. They will learn how to implement optimization methods to real-world problems through the completion of various labs and a class project, ultimately leaving them with both practical and theoretical understandings of popular optimization and machine learning packages.