Stanford | Bulletin
ExploreCourses

Results for AI 325 courses

AFRICAAM 80Q: Race and Gender in Silicon Valley (CS 80Q)

Join us as we go behind the scenes of some of the big headlines about trouble in Silicon Valley. We'll start with the basic questions like who decides who gets to see themselves as "a computer person," and how do early childhood and educational experiences shape our perceptions of our relationship to technology? Then we'll see how those questions are fundamental to a wide variety of recent events from #metoo in tech companies, to the ways the under-representation of women and people of color in tech companies impacts the kinds of products that Silicon Valley brings to market. We'll see how data and the coming age of AI raise the stakes on these questions of identity and technology. How can we ensure that AI technology will help reduce bias in human decision-making in areas from marketing to criminal justice, rather than amplify it?

Last offered: Autumn 2022 | Units: 3 | UG Reqs: WAY-EDP

AFRICAAM 261E: Black Mirror: Representations of Race & Gender in AI (ENGLISH 152E, ENGLISH 261E)

tba

Last offered: Spring 2023 | Units: 3-5

AFRICAAM 389C: Race, Ethnicity, and Language: Black Digital Cultures from BlackPlanet to AI (CSRE 385, EDUC 389C, PWR 194AJB)

This seminar explores the intersections of language and race/racism/racialization in the public schooling experiences of students of color. We will briefly trace the historical emergence of the related fields of sociolinguistics and linguistic anthropology, explore how each of these scholarly traditions approaches the study of language, and identify key points of overlap and tension between the two fields before considering recent examples of inter-disciplinary scholarship on language and race in urban schools. Issues to be addressed include language variation and change, language and identity, bilingualism and multilingualism, language ideologies, and classroom discourse. We will pay particular attention to the implications of relevant literature for teaching and learning in urban classrooms.

Terms: Win | Units: 3-4

Instructors: ; Banks, A. (PI)

AMSTUD 106B: Black Mirror: A.I.Activism (ARTHIST 168A, CSRE 106A, ENGLISH 106A, SYMSYS 168A)

Lecture/small group course exploring intersections of STEM, arts and humanities scholarship and practice that engages with, and generated by, exponential technologies. Our course explores the social ethical and artistic implications of artificial intelligence systems with an emphasis on aesthetics, civic society and racial justice, including scholarship on decolonial AI, indigenous AI, disability activism AI, feminist AI and the future of work for creative industries.

Terms: Win | Units: 3 | UG Reqs: WAY-A-II, WAY-EDP

Instructors: ; Elam, M. (PI)

AMSTUD 115S: Spies, Lies, and Algorithms: The History and Future of American Intelligence (INTNLREL 115, POLISCI 115, PUBLPOL 114)

This course examines the past, present, and future of American espionage. Targeted at first years and sophomores, the class surveys key issues in the development of the U.S. Intelligence Community since World War II. Topics include covert action, intelligence successes and failures, the changing motives and methods of traitors, congressional oversight, and ethical dilemmas. The course pays particular attention to how emerging technologies are transforming intelligence today. We examine cyber threats, the growing use of AI for both insight and deception, and the 'open-source' intelligence revolution online. Classes include guest lectures by former senior U.S. intelligence officials, policymakers, and open-source intelligence leaders. Course requirements include an all-day crisis simulation with former senior officials designed to give students a hands-on feel for the uncertainties, coordination challenges, time pressures, and policy frictions of intelligence in the American foreign policy process.

Terms: Spr | Units: 5 | UG Reqs: WAY-SI

Instructors: ; Zegart, A. (PI); Anand, M. (TA); Chapin, E. (TA); Houle, C. (TA); Tracey, T. (TA)

ARTHIST 168A: Black Mirror: A.I.Activism (AMSTUD 106B, CSRE 106A, ENGLISH 106A, SYMSYS 168A)

Lecture/small group course exploring intersections of STEM, arts and humanities scholarship and practice that engages with, and generated by, exponential technologies. Our course explores the social ethical and artistic implications of artificial intelligence systems with an emphasis on aesthetics, civic society and racial justice, including scholarship on decolonial AI, indigenous AI, disability activism AI, feminist AI and the future of work for creative industries.

| Units: 3 | UG Reqs: WAY-A-II, WAY-EDP

ARTHIST 254: Contemporary Art in the Age of Artificial Intelligence (ARTHIST 344, ARTSINST 242, EASTASN 242)

This course delves into the rapidly evolving landscape of contemporary art as it intertwines with the advancements in artificial intelligence. Students will explore how artists from Asia and its diaspora are harnessing the capabilities of AI to redefine artistic expressions, appropriate traditional media and aesthetics, and interrogate the boundaries between human creativity and machine intelligence. Drawing upon case studies, hands-on experiments, and critical discussions, students will gain a deeper understanding of the sociocultural implications of AI-infused artistry and its impact on society. This course contextualizes its content in a global narrative, discussing challenging themes and existential inquiries AI has evoked worldwide. Situating AI in the long history of machines, automation, and human engagement with technologies, the class encourages students to think critically about the "transformations" AI made to society. Central to our exploration will be the fundamental questions of what it means to be "human" in a world where machines can mimic, and even surpass, human cognition in certain domains. Drawing parallels between diverse cultures and technologies, we will dissect how human-machine collaborations shape our perceptions of reality, authenticity, emotion, and creativity. Through examination of both Asian philosophies and theories of posthumanism, students will reflect upon the broader philosophical implications of a world where artificial and human intelligence coexist, intertwining and reshaping the very fabric of society, culture, and personal experience. Instructor: Gerui Wang.

Terms: Spr | Units: 3-5

Instructors: ; Wang, G. (PI)

ARTHIST 344: Contemporary Art in the Age of Artificial Intelligence (ARTHIST 254, ARTSINST 242, EASTASN 242)

This course delves into the rapidly evolving landscape of contemporary art as it intertwines with the advancements in artificial intelligence. Students will explore how artists from Asia and its diaspora are harnessing the capabilities of AI to redefine artistic expressions, appropriate traditional media and aesthetics, and interrogate the boundaries between human creativity and machine intelligence. Drawing upon case studies, hands-on experiments, and critical discussions, students will gain a deeper understanding of the sociocultural implications of AI-infused artistry and its impact on society. This course contextualizes its content in a global narrative, discussing challenging themes and existential inquiries AI has evoked worldwide. Situating AI in the long history of machines, automation, and human engagement with technologies, the class encourages students to think critically about the "transformations" AI made to society. Central to our exploration will be the fundamental questions of what it means to be "human" in a world where machines can mimic, and even surpass, human cognition in certain domains. Drawing parallels between diverse cultures and technologies, we will dissect how human-machine collaborations shape our perceptions of reality, authenticity, emotion, and creativity. Through examination of both Asian philosophies and theories of posthumanism, students will reflect upon the broader philosophical implications of a world where artificial and human intelligence coexist, intertwining and reshaping the very fabric of society, culture, and personal experience. Instructor: Gerui Wang.

Terms: Spr | Units: 3-5

Instructors: ; Wang, G. (PI)

ARTSINST 20AX: Arts Immersion Independent Study

This 1-unit independent study allows students who have taken an arts immersion as part of the summer Arts Intensive program to further develop the project they began in AI. Successful completion of this course following completion of a summer arts immersion course will fulfill the experiential arts requirement for the Inter-Arts Minor. Must be taken autumn quarter following successful completion of one of these summer quarter courses: ARTSINST 12AX or ARTSINST 21AX. Must be taken for a letter grade.

Terms: Aut | Units: 1

Instructors: ; Pipert, J. (PI)

ARTSINST 242: Contemporary Art in the Age of Artificial Intelligence (ARTHIST 254, ARTHIST 344, EASTASN 242)

This course delves into the rapidly evolving landscape of contemporary art as it intertwines with the advancements in artificial intelligence. Students will explore how artists from Asia and its diaspora are harnessing the capabilities of AI to redefine artistic expressions, appropriate traditional media and aesthetics, and interrogate the boundaries between human creativity and machine intelligence. Drawing upon case studies, hands-on experiments, and critical discussions, students will gain a deeper understanding of the sociocultural implications of AI-infused artistry and its impact on society. This course contextualizes its content in a global narrative, discussing challenging themes and existential inquiries AI has evoked worldwide. Situating AI in the long history of machines, automation, and human engagement with technologies, the class encourages students to think critically about the "transformations" AI made to society. Central to our exploration will be the fundamental questions of what it means to be "human" in a world where machines can mimic, and even surpass, human cognition in certain domains. Drawing parallels between diverse cultures and technologies, we will dissect how human-machine collaborations shape our perceptions of reality, authenticity, emotion, and creativity. Through examination of both Asian philosophies and theories of posthumanism, students will reflect upon the broader philosophical implications of a world where artificial and human intelligence coexist, intertwining and reshaping the very fabric of society, culture, and personal experience. Instructor: Gerui Wang.

Terms: Spr | Units: 3-5

Instructors: ; Wang, G. (PI)

BIODS 221: Machine Learning Approaches for Data Fusion in Biomedicine (BIOMEDIN 221)

Vast amounts of biomedical data are now routinely available for patients, raging from genomic data, to radiographic images and electronic health records. AI and machine learning are increasingly used to enable pattern discover to link such data for improvements in patient diagnosis, prognosis and tailoring treatment response. Yet, few studies focus on how to link different types of biomedical data in synergistic ways, and to develop data fusion approaches for improved biomedical decision support. This course will describe approaches for multi-omics, multi-modal and multi-scale data fusion of biomedical data in the context of biomedical decision support. Prerequisites: CS106A or equivalent, Stats 60 or equivalent.

Terms: Aut | Units: 2

Instructors: ; Gentles, A. (PI); Gevaert, O. (PI)

BIODS 235: Best practices for developing data science software for clinical and healthcare applications

Best practices for developing data science software for clinical and healthcare applications is a new seminar aimed to provide an overview of the strategies, processes, and regulatory hurdles to develop software implementing new algorithms or analytical approaches to be used in clinical diagnosis or medical practice. Upon completing this seminar, biomedical scientists implementing diagnostics, analytical, or AI-driven clinical decision support software should better understand how to protect, transfer, commercialize, and translate their inventions into the clinic. Topics include: Intellectual property strategies and technology licensing challenges; software development and quality best practices for the clinic; regulatory frameworks for clinical decision support and diagnostics informatics applications. It is open primarily to graduate students across Stanford and combines short lectures, guest industry speakers, and workshop sessions to allow participants to receive feedback on current related projects that are undertaking. Enrollment limited to 25 to allow participants present their current projects. Prerequisites: Basic experience in programing and algorithm or software tool development. Ideally, the participant is actively implementing a new method/process/application in software aimed to be used in the clinic.

Terms: Win | Units: 1

Instructors: ; De La Vega, F. (PI); Klein, T. (PI)

BIODS 237: Deep Learning in Genomics and Biomedicine (BIOMEDIN 273B, CS 273B, GENE 236)

Recent breakthroughs in high-throughput genomic and biomedical data are transforming biological sciences into "big data" disciplines. In parallel, progress in deep neural networks are revolutionizing fields such as image recognition, natural language processing and, more broadly, AI. This course explores the exciting intersection between these two advances. The course will start with an introduction to deep learning and overview the relevant background in genomics and high-throughput biotechnology, focusing on the available data and their relevance. It will then cover the ongoing developments in deep learning (supervised, unsupervised and generative models) with the focus on the applications of these methods to biomedical data, which are beginning to produced dramatic results. In addition to predictive modeling, the course emphasizes how to visualize and extract interpretable, biological insights from such models. Recent papers from the literature will be presented and discussed. Experts in the field will present guest lectures. Students will be introduced to and work with popular deep learning

software frameworks. Students will work in groups on a final class project using real world datasets. Prerequisites: College calculus, linear algebra, basic probability and statistics such as CS 109, and basic machine learning such as CS 229. No prior knowledge of genomics is necessary.

Terms: Spr | Units: 3

Instructors: ; Kundaje, A. (PI); Zou, J. (PI)

BIODS 271: Foundation Models for Healthcare (CS 277, RAD 271)

Generative AI and large-scale self-supervised foundation models are poised to have a profound impact on human decision making across occupations. Healthcare is one such area where such models have the capacity to impact patients, clinicians, and other care providers. In this course, we will explore the training, evaluation, and deployment of generative AI and foundation models, with a focus on addressing current and future medical needs. The course will cover models used in natural language processing, computer vision, and multi-modal applications. We will explore the intersection of models trained on non-healthcare domains and their adaptation to domain-specific problems, as well as healthcare-specific foundation models. Prerequisites: Familiarity with machine learning principles at the level of CS 229, 231N, or 224N

Terms: Win | Units: 3

Instructors: ; Chaudhari, A. (PI); Syeda-Mahmood, T. (PI); Zou, J. (PI); Varma, M. (TA); Wu, K. (TA)

BIODS 290: Critical Exploration of Topics in Biomedical Data Science: Generative AI

Each edition of the course focuses on one topic of research or translation. Students read, present and discuss papers from the literature.

Terms: Aut | Units: 1 | Repeatable 4 times (up to 4 units total)

Instructors: ; Sabatti, C. (PI); Zou, J. (PI)

BIODS 295: Generative AI in Healthcare

This project-based course delves into the cutting-edge of Generative Artificial Intelligence (AI) and its transformative applications in the healthcare domain. As technology continues to evolve, so does the potential for AI to revolutionize healthcare practices, from diagnostics to personalized treatment plans. Participants will learn about the latest advances in Generative AI, exploring state-of-the-art models and techniques tailored for healthcare challenges. Students will be introduced to Human-Centered Design methodology -- involving empathy and needs finding, prototyping and iteration. Class projects will focus on deployment of Generative AI using datasets such as population biobanks, and training models from these population-scale datasets. Key topics covered include the utilization of Generative AI in medical image synthesis, enhancing diagnostic capabilities, and using genomes and protein language models for variant effect prediction. The course also navigates the ethical considerations surrounding the use of generative models in healthcare, addressing issues of privacy, bias, and interpretability. Through a combination of theoretical insights and hands-on practical sessions, participants will gain a deep understanding of how Generative AI is reshaping the healthcare landscape, and how they could have a positive impact. Guest speakers from venture capital and industry with real-world examples will illustrate successful applications of generative models in medical imaging, drug discovery, and patient care, and discuss the challenges they see in translation from research to implementation.

Terms: Spr | Units: 3

Instructors: ; Ioannidis, A. (PI); Rivas, M. (PI)

BIODS 388: Stakeholder Competencies for Artificial Intelligence in Healthcare (BIOMEDIN 388)

Advancements of machine learning and AI into all areas of medicine are now a reality and they hold the potential to transform healthcare and open up a world of incredible promise for everyone. But we will never realize the potential for these technologies unless all stakeholders have basic competencies in both healthcare and machine learning concepts and principles - this will allow successful, responsible development and deployment of these systems into the healthcare domain. The focus of this course is on the key concepts and principles rather than programming or engineering implementation. Those with backgrounds in healthcare, health policy, healthcare system leadership, pharmaceutical, and clinicians as well as those with data science backgrounds who are new to healthcare applications will be empowered with the knowledge to responsibly and ethically evaluate, critically review, and even use these technologies in healthcare. We will cover machine learning approaches, medical use cases in depth, unique metrics to healthcare, important challenges and pitfalls, and best practices for designing, building, and evaluating machine learning in healthcare applications.

Last offered: Autumn 2020 | Units: 2-3

BIOE 60: Scalable and Distributed Digital Health

The combination of the internet, phones/wearables, and diagnostic/generative AI allow fundamentally different approaches to healthcare to be conceived. Contemporary healthcare still relies heavily on human doctors, which restricts the number of people that can be helped, limits scaling and quality, and sets a basic cost floor on services. The purpose of this seminar is to explore a potential all-digital tech stack for healthcare, including diagnostic AI, data collection at the edge, and privacy-preserving compute. We will hear from industry experts and startup founders, and consider technical gaps as well as legal/societal barriers to ubiquitous adoption of healthcare provided primarily by computers.

Terms: Win | Units: 1

Instructors: ; Liphardt, J. (PI)

BIOE 177: Inventing the Future (DESIGN 259)

The famous computer scientist, Alan Kay, once said, "The best way to predict the future is to invent it." As such, we are all responsible for inventing the future we hope we and our descendants will experience. In this highly interactive course, we will be exploring how to predict and invent the future and why this is important by focusing on a wide range of frontier technologies, such as robotics, AI, genomics, autonomous vehicles, blockchain, 3D Printing, VR/AR, synthetic meat, etc. The class will feature debates in which students present utopian and dystopian scenarios, and determine what has to be done to inoculate ourselves against the negative consequences. Limited enrollment. Admission by application: dschool.stanford.edu/classes.

Terms: Win | Units: 3

Instructors: ; Endy, D. (PI); Solomon, L. (PI); Grant, C. (TA)

BIOE 214: Representations and Algorithms for Computational Molecular Biology (BIOMEDIN 214, CS 274, GENE 214)

BIOMEDIN 214: Representations and Algorithms for Computational Molecular Biology (BIOE 214, CS 274, GENE 214)Topics: This is a graduate level introduction to bioinformatics and computational biology, algorithms for alignment of biological sequences and structures, BLAST, phylogenetic tree construction, hidden Markov models, basic structural computations on proteins, protein structure prediction, molecular dynamics and energy minimization, statistical analysis of 3D structure, knowledge controlled terminologies for molecular function, expression analysis, chemoinformatics, pharmacogenetics, network biology. Lectures are supplemented

with assignments and programming projects, which allow students to implement important computational biology algorithms. Firm prerequisite: CS 106B. NOTE: For students in the Department of Biomedical Data Science Program, this core course MUST be taken as a letter grade only.

Terms: Aut | Units: 3-4

Instructors: ; Altman, R. (PI); Koodli, R. (TA); McCann, H. (TA); Nayar, G. (TA); Xiong, B. (TA)

BIOE 222: Physics and Engineering Principles of Multi-modality Molecular Imaging of Living Subjects (BMP 222, RAD 222)

Physics and Engineering Principles of Multi-modality Molecular Imaging of Living Subjects (RAD 222A). Focuses on instruments, algorithms and other technologies for non-invasive imaging of molecular processes in living subjects. Introduces research and clinical molecular imaging modalities, including PET, SPECT, MRI, Ultrasound, Optics, and Photoacoustics. For each modality, lectures cover the basics of the origin and properties of imaging signal generation, instrumentation physics and engineering of signal detection, signal processing, image reconstruction, image data quantification, applications of machine learning, and applications of molecular imaging in medicine and biology research.

Terms: Aut | Units: 3-4

Instructors: ; Levin, C. (PI)

BIOE 313: Neuromorphics: Brains in Silicon (EE 207)

While traversing through the natural world, you effortlessly perceive and react to a rich stream of stimuli. This constantly changing stream evokes spatiotemporal patterns of spikes that propagate through your brain from one ensemble of neurons to another. An ensemble may memorize a spatiotemporal pattern at the speed of life and recall it at the speed of thought. In the first half of this course, we will discuss and model how a neural ensemble memorizes and recalls such a spatiotemporal pattern. In the second half, we will explore how neuromorphic hardware could exploit these neurobiological mechanisms to run AI not with megawatts in the cloud but rather with watts on a smartphone. Prerequisites: Either computational modeling (BIOE 101, BIOE 300B) or circuit analysis (EE 101A).

Terms: Spr | Units: 3

Instructors: ; Boahen, K. (PI)

BIOE 450: Advances in Biotechnology (CHEMENG 450)

This course provides an overview of cutting-edge advances in biotechnology with a focus on therapeutic, health-related and agricultural topics. We will hear from academic and industrial speakers from a range of areas including novel anti-infectives, AI tools, quantitative microfluidics biotechnology research, new therapies for the treatment of addiction, neurodegenerative diseases like Alzheimer¿s disease, plant bioengineering, immuno-oncology, science journalism, and venture capital investing in biotechnology. This course is designed for students interested in pursuing a career in the biotech industry.

Last offered: Spring 2023 | Units: 3

BIOMEDIN 214: Representations and Algorithms for Computational Molecular Biology (BIOE 214, CS 274, GENE 214)

BIOMEDIN 214: Representations and Algorithms for Computational Molecular Biology (BIOE 214, CS 274, GENE 214)Topics: This is a graduate level introduction to bioinformatics and computational biology, algorithms for alignment of biological sequences and structures, BLAST, phylogenetic tree construction, hidden Markov models, basic structural computations on proteins, protein structure prediction, molecular dynamics and energy minimization, statistical analysis of 3D structure, knowledge controlled terminologies for molecular function, expression analysis, chemoinformatics, pharmacogenetics, network biology. Lectures are supplemented with assignments and programming projects, which allow students to implement important computational biology algorithms. Firm prerequisite: CS 106B. NOTE: For students in the Department of Biomedical Data Science Program, this core course MUST be taken as a letter grade only.

Terms: Aut | Units: 3-4

Instructors: ; Altman, R. (PI); Koodli, R. (TA); McCann, H. (TA); Nayar, G. (TA); Xiong, B. (TA)

BIOMEDIN 216: Representations and Algorithms for Molecular Biology: Lectures

Lecture component of BIOMEDIN 214. One unit for medical and graduate students who attend lectures only; may be taken for 2 units with participation in limited assignments and final project. Lectures also available via internet. Prerequisite: familiarity with biology recommended.

Terms: Aut | Units: 1-2

Instructors: ; Altman, R. (PI)

BIOMEDIN 221: Machine Learning Approaches for Data Fusion in Biomedicine (BIODS 221)

Vast amounts of biomedical data are now routinely available for patients, raging from genomic data, to radiographic images and electronic health records. AI and machine learning are increasingly used to enable pattern discover to link such data for improvements in patient diagnosis, prognosis and tailoring treatment response. Yet, few studies focus on how to link different types of biomedical data in synergistic ways, and to develop data fusion approaches for improved biomedical decision support. This course will describe approaches for multi-omics, multi-modal and multi-scale data fusion of biomedical data in the context of biomedical decision support. Prerequisites: CS106A or equivalent, Stats 60 or equivalent.

Terms: Aut | Units: 2

Instructors: ; Gentles, A. (PI); Gevaert, O. (PI)

BIOMEDIN 223: Deploying and Evaluating Fair AI in Healthcare (EPI 220)

AI applications are proliferating throughout the healthcare system and stakeholders are faced with the opportunities and challenges of deploying these quickly evolving technologies. This course teaches the principles of AI evaluations in healthcare, provides a framework for deployment of AI in the healthcare system, reviews the regulatory environment, and discusses fundamental components used to evaluate the downstream effects of AI healthcare solutions, including biases and fairness. Prerequisites: CS106A; familiarity with statistics (stats 202), BIOMED 215, or BIODS 220

Terms: Spr | Units: 2-3

Instructors: ; Hernandez-Boussard, T. (PI)

BIOMEDIN 225: Data Driven Medicine

The widespread adoption of electronic health records (EHRs) has created a new source of big data namely, the record of routine clinical practice as a by-product of care. This class will teach you how to use EHRs and other patient data in conjunction with recent advances in artificial intelligence (AI) and evolving business models to improve healthcare. Upon completing this course, you should be able to: differentiate between and give examples of categories of care questions that AI can help answer, describe common healthcare data sources and their relative advantages, limitations, and biases in enabling care transformation, understand the challenges in using various kinds of clinical data to create fair algorithmic interventions, design an analysis of a clinical dataset, evaluate and criticize published

research to separate hype from reality. Prerequisites: enrollment in the MCiM program. This course is designed to prepare you to pose and answer meaningful clinical questions using healthcare data as well as understand how AI can be brought into clinical use safely, ethically and cost-effectively.

Terms: Spr | Units: 3

Instructors: ; Shah, N. (PI)

BIOMEDIN 273B: Deep Learning in Genomics and Biomedicine (BIODS 237, CS 273B, GENE 236)

Recent breakthroughs in high-throughput genomic and biomedical data are transforming biological sciences into "big data" disciplines. In parallel, progress in deep neural networks are revolutionizing fields such as image recognition, natural language processing and, more broadly, AI. This course explores the exciting intersection between these two advances. The course will start with an introduction to deep learning and overview the relevant background in genomics and high-throughput biotechnology, focusing on the available data and their relevance. It will then cover the ongoing developments in deep learning (supervised, unsupervised and generative models) with the focus on the applications of these methods to biomedical data, which are beginning to produced dramatic results. In addition to predictive modeling, the course emphasizes how to visualize and extract interpretable, biological insights from such models. Recent papers from the literature will be presented and discussed. Experts in the field will present guest lectures. Students will be introduced to and work with popular deep learning software frameworks. Students will work in groups on a final class project using real world datasets. Prerequisites: College calculus, linear algebra, basic probability and statistics such as CS 109, and basic machine learning such as CS 229. No prior knowledge of genomics is necessary.

Last offered: Spring 2023 | Units: 3

BIOMEDIN 388: Stakeholder Competencies for Artificial Intelligence in Healthcare (BIODS 388)

Advancements of machine learning and AI into all areas of medicine are now a reality and they hold the potential to transform healthcare and open up a world of incredible promise for everyone. But we will never realize the potential for these technologies unless all stakeholders have basic competencies in both healthcare and machine learning concepts and principles - this will allow successful, responsible development and deployment of these systems into the healthcare domain. The focus of this course is on the key concepts and principles rather than programming or engineering implementation. Those with backgrounds in healthcare, health policy, healthcare system leadership, pharmaceutical, and clinicians as well as those with data science backgrounds who are new to healthcare applications will be empowered with the knowledge to responsibly and ethically evaluate, critically review, and even use these technologies in healthcare. We will cover machine learning approaches, medical use cases in depth, unique metrics to healthcare, important challenges and pitfalls, and best practices for designing, building, and evaluating machine learning in healthcare applications.

Last offered: Autumn 2020 | Units: 2-3

BIOS 226: Web3, AI, and Digital Health

This interdisciplinary course explores the convergence of Web3 technologies, artificial intelligence (AI), and their transformative impact on the field of digital health. Students will examine the potential of decentralized systems, blockchain, and smart contracts to enhance health data privacy, security, and interoperability. Through case studies and hands-on projects, they will gain insights into AI-driven solutions for personalized healthcare, remote patient monitoring, medical image analysis, and clinical decision support. Additionally, students will critically analyze ethical and regulatory considerations in the context of Web3 and AI applications, fostering a deeper understanding of the future of digital health innovation.

Terms: Win, Sum | Units: 1

Instructors: ; Maeda-Nishino, N. (PI)

BIOS 244: Applied Artificial Intelligence in Health Care

Artificial Intelligence (AI) platforms are now widely available, and often require little training or technical expertise. This mini-course focuses on responsible development and use of AI in healthcare. Focus is on the critical analysis of AI systems, and the evolving policy and regulatory landscape. Week one covers modern AI capabilities, including computer vision, natural language processing, and reinforcement learning. Weeks two and three focus on assessing AI systems (including robustness, bias, privacy, and interpretability) and applications (including radiology, suicide prevention, and end-of-life care). Throughout this course students will develop and evaluate a hypothetical AI system. No programming experience is required.

Last offered: Spring 2023 | Units: 2

BMP 254: AI and Data Driven Methods in Biomedical Imaging and Physics

Data-driven biomedical imaging and physics is an emerging interdisciplinary field that combines advanced medical physics concepts, deep learning algorithms, and biomedical imaging technologies to develop new approaches for diagnosis, treatment, and research in the biomedical field. The main goal of this course is to provide background knowledge of biomedical imaging and physics, introduce the fundamentals of deep learning and data-driven techniques, describe the problems and data-driven solutions in imaging and medical physics, and present clinical use cases and successful examples in data-driven biomedical physics. It is anticipated that the students will gain useful knowledge and practical skills to advance the field of data-driven biomedical imaging and physics in the near future.

Terms: Aut | Units: 1

Instructors: ; Islam, M. (PI); Liu, L. (PI); Xing, L. (PI)

BUSGEN 101: The AI-powered Org: Evolution, Rebirth or Death?

What does the AI revolution mean for the future of work, careers and organizations? The course will start with an overview of leading theories of organizations, all of which were effectively modeled on the 20th century firm. We will then turn to understanding recent developments in machine learning and AI, from the point of view of an informed user (rather than a technical developer), ranging from foundation language models to Decentralized Autonomous Organizations (DAO) implemented using blockchain technology. These will form the basis for an ongoing discussion about the future of organizations in the age of AI. Is this merely another phase in the modern organization's evolution, is this a paradigmatic redefinition of its structure and function, or is this a cataclysmic moment heralding the end of organizations as the central building blocks of economic activity? We will (speculatively) discuss these issues from a broad perspective, investigating how AI is already impacting work and organizational structures, as well as these changes' broader social implications (such as their effect on work/life balance, the gendered division of labor in the household, and the structure of community). The implications for business and management are clear: AI is already impacting organizational life, and will continue to do so as technologies mature and their business models are refined. This course may not be audited.

Terms: Spr | Units: 3

Instructors: ; Goldberg, A. (PI); Williams, J. (GP)

CEE 177L: Smart Cities & Communities (CEE 277L)

A city is comprised of people and a complex system of systems connected by data. A nexus of forces IoT, open data, analytics, AI, and systems of engagement present new opportunities to increase the efficiency of urban systems, improve the efficacy of public services, and assure the resiliency of the community. Systems

studied include: water, energy, transportation, buildings, food production, and social services. The roles of policy and behavior change as well as the risks of smart cities will be discussed. How cities are applying innovation to address the unprecedented challenges of COVID-19 will also be explored.

Terms: Sum | Units: 3 | UG Reqs: WAY-SI

CEE 229A: Reinventing the Design & Construction of Buildings

Challenge to students from all departments -- Making buildings is still painfully laborious and expensive. Can you radically rethink how buildings are designed and constructed? This project-based course balances theory, research, design. We will 1) study why/how Architecture and Construction industry are lagging behind other industries, 2) work with leading professionals to analyze roadblocks preventing them from building cheaper, faster, better, and 3) develop solutions to tackle these problems and advance the industry. You will consider questions such as: Why does it take 6-9 months to build a single family home? Can AI accelerate the architectural design process? How can designers leverage data/IoT? Which new materials offer significant savings and can be adopted for global solutions? Where can the supply chain be optimized? How can we design new technologies that tradesmen and luddites will use? The course is two terms (Winter CEE 229A, Spring CEE 229B).

Terms: Win | Units: 2-3

CEE 229B: Reinventing the Design & Construction of Buildings

Challenge to students from all departments -- Making buildings is still painfully laborious and expensive. Can you radically rethink how buildings are designed and constructed? This project-based course balances theory, research, design. We will 1) study why/how Architecture and Construction industry are lagging behind other industries, 2) work with leading professionals to analyze roadblocks preventing them from building cheaper, faster, better, and 3) develop solutions to tackle these problems and advance the industry. You will consider questions such as: Why does it take 6-9 months to build a single family home? Can AI accelerate the architectural design process? How can designers leverage data/IoT? Which new materials offer significant savings and can be adopted for global solutions? Where can the supply chain be optimized? How can we design new technologies that tradesmen and luddites will use? The course is two terms (Winter CEE 229A, Spring CEE 229B).

Last offered: Spring 2019 | Units: 2-3

CEE 277L: Smart Cities & Communities (CEE 177L)

A city is comprised of people and a complex system of systems connected by data. A nexus of forces IoT, open data, analytics, AI, and systems of engagement present new opportunities to increase the efficiency of urban systems, improve the efficacy of public services, and assure the resiliency of the community. Systems studied include: water, energy, transportation, buildings, food production, and social services. The roles of policy and behavior change as well as the risks of smart cities will be discussed. How cities are applying innovation to address the unprecedented challenges of COVID-19 will also be explored.

Terms: Sum | Units: 3

CEE 329: Artificial Intelligence Applications in the AEC Industry

Through weekly lectures given by prominent researchers, practicing professionals, and entrepreneurs, this class will examine important industry problems and critically assess corresponding AI directions in both academia and industry. Students will gain an understanding of how AI can be used to provide solutions in the architecture, engineering, and construction industry and asses the technology, feasibility, and corresponding implementation effort. Students are expected to participate actively in the lectures and discussions, submit triweekly reflection writings, and present their own evaluation of existing solutions. Enrollment limited to 12 students.

Terms: Win | Units: 2-3

Instructors: ; Fischer, M. (PI); CAO, J. (TA); Mayer, K. (TA); Tono, A. (TA)

CEE 329S: Seminar on Artificial Intelligence Applications in the AEC Industry

Through weekly lectures given by prominent researchers, practicing professionals, and entrepreneurs, this class will examine important industry problems and critically assess corresponding AI directions in both academia and industry. Students will gain an understanding of how AI can be used to provide solutions in the architecture, engineering, and construction industry and asses the technology, feasibility, and corresponding implementation effort. Students are expected to actively prepare for and participate in all lectures and corresponding discussions.

Last offered: Spring 2019 | Units: 1

CHEMENG 450: Advances in Biotechnology (BIOE 450)

This course provides an overview of cutting-edge advances in biotechnology with a focus on therapeutic, health-related and agricultural topics. We will hear from academic and industrial speakers from a range of areas including novel anti-infectives, AI tools, quantitative microfluidics biotechnology research, new therapies for the treatment of addiction, neurodegenerative diseases like Alzheimer¿s disease, plant bioengineering, immuno-oncology, science journalism, and venture capital investing in biotechnology. This course is designed for students interested in pursuing a career in the biotech industry.

Terms: Spr | Units: 3

Instructors: ; Barron, A. (PI)

CHINA 171: Utopia, Dystopia, and Technology in Science Fiction: A Cross-Cultural Perspective (CHINA 271, GLOBAL 200)

This course explores how science fiction (sf) narratives from East and West imagine the future of humanity and human-nature relations. The blind faith in technoscientific power has aggravated class disparity, eroded the social fabric, and undermined the humanist legacy of the Enlightenment. Technological fetishism has given rise to apocalyptic futures of dystopia marked by destructive AI, the digital jungle of existential struggle, environmental degradation, climate disasters, class disparity, and posthuman barbarism. On the other hand, sf narratives keep hopes alive by projecting utopias, exposing the pitfalls of technological 'progress' and keeping faith with human sovereignty in renewing social ecology in balance with natural conditions.

Last offered: Winter 2023 | Units: 3-5

CHINA 271: Utopia, Dystopia, and Technology in Science Fiction: A Cross-Cultural Perspective (CHINA 171, GLOBAL 200)

This course explores how science fiction (sf) narratives from East and West imagine the future of humanity and human-nature relations. The blind faith in technoscientific power has aggravated class disparity, eroded the social fabric, and undermined the humanist legacy of the Enlightenment. Technological fetishism has given rise to apocalyptic futures of dystopia marked by destructive AI, the digital jungle of existential struggle, environmental degradation, climate disasters, class disparity, and posthuman barbarism. On the other hand, sf narratives keep hopes alive by projecting utopias, exposing the pitfalls of technological 'progress' and keeping faith with human sovereignty in renewing social ecology in balance with natural conditions.

Last offered: Winter 2023 | Units: 3-5

CME 99: WiDS Datathon Independent Study (DATASCI 197)

This independent study offers students the opportunity to participate in the WiDS Datathon for 1-unit of credit. The WiDS Datathon is an annual and global event that encourages data scientists of all levels to discover and hone their data science skills while solving an interesting and critical social impact challenge. The 2023 Challenge, "Data Science for Subseasonal Forecast", centers on climate change and is in partnership with Climate Change AI (CCAI). Accurate long-term forecasts of temperature and precipitation is crucial for mitigating the effects of climate change (i.e. preparing for droughts and other wet weather extremes). Such forecasts can potentially impact many industries (e.g. agriculture, energy, disaster planning) in countries across the globe. Currently, purely physics-based models dominate short-term weather forecasting. But these models have a limited forecast horizon. The availability of meteorological data offers an opportunity for data scientists to improve subseasonal forecasts by blending physics-based forecasts with machine learning. To learn more, visit: https://www.widsconference.org/datathon.htmlStudents may participate in this independent study in teams of 1-4. To qualify for official participation in the datathon, at least half of each team must identify as women. To receive credit, the team will participate in the Datathon and write a report detailing their submission and reflecting on their experience. Interested students should register for the course, and sign up as a team using this form: https://forms.gle/LyX3yNU7dLnTCux1A. To find other students interested in forming a team, go here: https://docs.google.com/presentation/d/1UvutEFtYFeCkLkwnpU01R5V5WmJeMi4kVkaZYHxSiAY/edit?usp=sharing

Last offered: Winter 2023 | Units: 1 | Repeatable 4 times (up to 4 units total)

COMM 114S: Technologies and Well Being

This course provides an introduction to how the dynamics and properties of computer-mediated communication influence well-being. We will discuss foundational communication theories and research to examine how technologies like social media, smartphones, and AI influence the communication process. Outcomes include both positive and negative effects. Throughout, we will focus on the complexities of developing and executing media effects research.

Terms: Sum | Units: 3

Instructors: ; Lee, A. (PI)

COMM 122: Trust and Safety (CS 152, INTLPOL 267)

Trust and Safety is an emerging field of professional and academic effort to build technologies that allow people to positively use the internet while being safe from harm. This course provides an introduction to the ways online services are abused to cause real human harm and the potential social, operational, product, legal and engineering responses. Students will learn about fraud, account takeovers, the use of social media by terrorists, misinformation, child exploitation, harassment, bullying and self-harm. This will include studying both the technical and sociological roots of these harms and the ways various online providers have responded. The class is taught by a practitioner, a professor of communication, a political scientist, and supplemented by guest lecturers from tech companies and nonprofits. Cross-disciplinary teams of students will spend the quarter building a technical and policy solution to a real trust and safety challenge, which will include the application of AI technologies to detecting and stopping abuse. For those taking this course for CS credit, the prerequisite is CS106B or equivalent programming experience and this course fulfills the Technology in Society requirement. Content note: This class will cover real-world harmful behavior and expose students to potentially upsetting material.

Terms: Spr | Units: 3

Instructors: ; Grossman, S. (PI); Hancock, J. (PI); Stamos, A. (PI)

COMM 159B: Shaping America's Future: Exploring the Key Issues on Our Path to the 2024 Elections (EDUC 64, SOC 64)

Join us for an immersive speaker series that delves into the core of American democracy. Prominent figures from a range of politic, business, foreign policy, academia, and media will analyze the implications of the 2024 elections and the challenges our nation faces. Led by James Steyer, founder and CEO of Common Sense Media, explore topics such as harnessing the power of AI responsibly, addressing climate change at various levels, strengthening commitments to democracy and voting rights, safeguarding youth from the impacts of social media and technology on mental health, and ensuring accountability for wealth disparities. This series will provide you with a comprehensive understanding of the elections and the broader American political landscape.

Terms: Aut | Units: 1

Instructors: ; Steyer, J. (PI); Engel, E. (GP); Stewart, S. (GP)

COMM 281: Exploring Computational Journalism (CS 206)

This project-based course will explore the field of computational journalism, including the use of Data Science, Info Visualization, AI, and emerging technologies to help journalists discover and tell stories, understand their audience, advance free speech, and build trust. This course is repeatable for credit; enrollment priority given to students taking it for the first time.

Terms: Win | Units: 3 | Repeatable 3 times (up to 9 units total)

Instructors: ; Agrawala, M. (PI); Brenner, R. (PI); Tumgoren, S. (PI); Chiueh, D. (TA)

COMPLIT 126C: Literature, Data, and AI

What kind of data is literature? What different methods are available to scholars who work with it, and what are the philosophical assumptions that underpin those methods? In this course, we will survey major critical approaches to literature from the last century as well as emerging methods from the digital humanities, and try them out for ourselves. Students will construct their own portfolio of texts and each week they will (re)analyze them using a different approach; they will record their findings and reflect on their experiences in a weekly log. The course will comprise asynchronous activities (lectures, presentations, assignments, readings) and one synchronous meeting per week to discuss the readings. Approaches may include: formalism, structuralism, Marxism, psychoanalysis, critical approaches to identity and performance (gender, race, sexuality and disability), network analysis, topic modeling, stylometry, and word embeddings. No prior programming knowledge is expected. This course will not offer detailed training in computational analysis; rather, the focus will be on the theoretical implications of computational tools. All readings will be in English.

Last offered: Summer 2021 | Units: 3-5 | UG Reqs: WAY-A-II

CS 21SI: AI for Social Good

Students will learn about and apply cutting-edge artificial intelligence (AI) techniques to real-world social good spaces (such as healthcare, government, and environmental conservation). The class will balance high-level machine learning techniques? from the fields of deep learning, natural language processing, computer vision, and reinforcement learning? with real world case studies, inviting students to think critically about technical and ethical issues in the development and deployment of AI. The course structure alternates between instructional lectures and bi-weekly guest speakers at the forefront of technology for social good. Students will be given the chance to engage in a flexible combination of AI model building, discussion, and individual exploration. Special topics may include: tech ethics, human-centered AI, AI safety, education technology, mental health applications, AI in policy, assistive robotics. Prerequisites: programming experience at the level of CS106A. Application required for enrollment: http://tinyurl.com/cs21si2024. We encourage students from all disciplines and backgrounds to apply!

Terms: Spr | Units: 2

Instructors: ; Piech, C. (PI)

CS 22A: The Social & Economic Impact of Artificial Intelligence (INTLPOL 200, SYMSYS 122)

Recent advances in Generative Artificial Intelligence place us at the threshold of a unique turning point in human history. For the first time, we face the prospect that we are not the only generally intelligent entities, and indeed that we may be less capable than our own creations. As this remarkable new technology continues to advance, we are likely to entrust management of our environment, economy, security, infrastructure, food production, healthcare, and to a large degree even our personal activities, to artificially intelligent computer systems. The prospect of "turning over the keys" to increasingly autonomous and unpredictable machines raises many complex and troubling questions. How will society respond as they displace an ever-expanding spectrum of blue- and white-collar workers? Will the benefits of this technological revolution be broadly distributed or accrue to a lucky few? How can we ensure that these systems are free of bias and align with human ethical principles? What role will they play in our system of justice and the practice of law? How will they be used or abused in democratic societies and autocratic regimes? Will they alter the geopolitical balance of power, and change the nature of warfare? Are we merely a stepping-stone to a new form of non-biological life, or are we just getting better at building useful gadgets? The goal of this course is to equip students with the intellectual tools, ethical foundation, and psychological framework to successfully navigate the coming age of superintelligent machines. (Note: This course is pre-approved for credit at SLS and GSB. No programming or technical knowledge is required.)

Terms: Win | Units: 1

Instructors: ; Kaplan, J. (PI)

CS 28: Artificial Intelligence, Entrepreneurship and Society in the 21st Century and Beyond

Technical developments in artificial intelligence (AI) have opened up new opportunities for entrepreneurship, as well as raised profound longer term questions about how human societal and economic systems may be reorganized to accommodate the rise of intelligent machines. In this course, closely cotaught by a Stanford professor and a leading Silicon Valley venture capitalist, we will examine the current state of the art capabilities of existing artificial intelligence systems, as well as economic challenges and opportunities in early stage startups and large companies that could leverage AI. We will focus on gaps between business needs and current technical capabilities to identify high impact directions for the development of future AI technology. Simultaneously, we will explore the longer term societal impact of AI driven by inexorable trends in technology and entrepreneurship. The course includes guest lectures from leading technologists and entrepreneurs who employ AI in a variety of fields, including healthcare, education, selfdriving cars, computer security, natural language interfaces, computer vision systems, and hardware acceleration.

Last offered: Autumn 2019 | Units: 2

CS 40: Cloud Infrastructure and Scalable Application Deployment

Trying to launch your next viral programming project and anticipating substantial user growth? This course will help you learn to implement your ideas in the cloud in a scalable, cost-effective manner. Topics will include cloud AI/ML pipelines, virtual machines, containers, basic networking, expressing infrastructure as code (IaC), data management, security and observability, and continuous integration and deployment (CI/CD). Through hands-on learning and practical examples, you'll learn to effectively deploy and manage cloud infrastructure. There is no out-of-pocket cost associated with this class and cloud credits will be provided for all students. Prerequisites: Programming maturity up to CS 107. Familiarity with the command line, version control, and basic development tools to the level of CS 45/CS 104, in particular: Basic Unix command line utilities and administration; Editing code with a TUI editor such as vim, emacs, or nano; Using Git and GitHub for collaborative projects (i.e. branching and pull requests); Basic familiarity with package managers for languages and operating systems (e.g., pip, apt, homebrew); Prior web development or networking experience helpful but not required.

Terms: Win | Units: 3

Instructors: ; Ho, C. (PI); Saligrama, A. (PI)

CS 53N: How Can Generative AI Help Us Learn?

This seminar course will explore the science behind generative AI, the likely future of tools such as DALL-E, ChatGPT, GPT-4, and Bard, and the implications for education, both in and outside of structured school environments. Students in the course will work in teams to each become experts in some aspect of AI and in some way that generative AI could create a new future for education. The background for this course is the public release of ChatGPT, which created new awareness of the potential power of AI to dramatically change our lives. In considering the possible implications for education, ChatGPT has sparked dreams of automated personal tutors, customizable teaching assistance, AI-led collaborative learning, and revolutions in assessment. In addition to optimistic projections, there are clear and significant risks. For example, will AI-assisted learning be culturally appropriate and equally available to all? Can it increase opportunity for underprivileged learners worldwide, or will it accentuate privilege and privileged views? Will it help us learn faster, or distract us from thinking deeply about difficult problems ourselves? As experienced student learners, members of the class will be able to draw on their own educational history and design learning approaches that could change the future of their education and others in college or at other stages of their lives.

Terms: Spr | Units: 3

Instructors: ; Mitchell, J. (PI)

CS 64: Computation for Puzzles and Games

How can we apply computer science to better understand (and have even more fun with) games and puzzles? What can we do when a game is too complex to analyze exhaustively, or when no efficient algorithms exist to solve a logic puzzle? This sampler course will whet your appetite for CS theory and AI as we apply those lenses to both classics (e.g., chess, Scrabble, the Rubik's cube, the Lights Out puzzle) and modern favorites (e.g., Sudoku, Kakuro, Esports, and tool-assisted speedruns). Each week, we will have one lecture and one optional hands-on puzzle/problem solving session, culminating in an (optional) on-foot puzzle hunt around campus. Material of varying technical complexity will be presented, and although some experience with programming and CS theory will be helpful, the course is open to all.

Last offered: Autumn 2022 | Units: 1

CS 80Q: Race and Gender in Silicon Valley (AFRICAAM 80Q)

Join us as we go behind the scenes of some of the big headlines about trouble in Silicon Valley. We'll start with the basic questions like who decides who gets to see themselves as "a computer person," and how do early childhood and educational experiences shape our perceptions of our relationship to technology? Then we'll see how those questions are fundamental to a wide variety of recent events from #metoo in tech companies, to the ways the under-representation of women and people of color in tech companies impacts the kinds of products that Silicon Valley brings to market. We'll see how data and the coming age of AI raise the stakes on these questions of identity and technology. How can we ensure that AI technology will help reduce bias in human decision-making in areas from marketing to criminal justice, rather than amplify it?

Last offered: Autumn 2022 | Units: 3 | UG Reqs: WAY-EDP

CS 81SI: AI Interpretability and Fairness

As black-box AI models grow increasingly relevant in human-centric applications, explainability and fairness becomes increasingly necessary for trust in adopting AI models. This seminar class introduces students to major problems in AI explainability and fairness, and explores key state-of-theart methods. Key technical topics include surrogate methods, feature visualization, network dissection, adversarial debiasing, and fairness metrics. There will be a survey of recent legal and policy trends. Each week a guest lecturer from AI research, industry, and related policy fields will present an open problem and solution, followed by a roundtable discussion with the class. Students have the opportunity to present a topic of interestnor application to their own projects (solo or in teams) in the final class. Code examples of each topic will be provided for students interested in a particular topic, but there will be no required coding components. Students who will benefit most from this class have exposure to AI, such as through projects and related coursework (e.g. statistics, CS221, CS230, CS229). Students who are pursuing subjects outside of the CS department (e.g. sciences, social sciences, humanities) with sufficient mathematical maturity are welcomed to apply. Enrollment limited to 20.

Last offered: Spring 2020 | Units: 1

CS 93: Teaching AI

For graduate students who are TA-ing an AI course. This course prepares new AI section leaders to teach, write, and evaluate AI content. In class, you will be evaluating final projects individually and as a group. You will have discussions criticizing papers and assigning grades to them. You will analyze and solve discussion session problems on the board, explain algorithmsnlike backpropagation, and learn how to give constructive feedback to students. The class will also include a guest speaker who will give teaching advice and talk about AI. Focus is on teaching skills, techniques, and final projects grading. The class meets once a week for the first 6 weeks of the quarter.

Last offered: Autumn 2019 | Units: 1

CS 120: Introduction to AI Safety (STS 10)

As we delegate more to artificial intelligence (AI) and integrate AI more in societal decision-making processes, we must find answers to how we can ensure AI systems are safe, follow ethical principles, and align with the creator's intent. Increasingly, many AI experts across academia and industry believe there is an urgent need for both technical and societal progress across AI alignment, ethics, and governance to understand and mitigate risks from increasingly capable AI systems and ensure that their contributions benefit society as a whole. Intro to AI Safety explores these questions in lectures with targeted readings, weekly quizzes, and group discussions. We are looking at the capabilities and limitations of current and future AI systems to understand why it is hard to ensure the reliability of existing AI systems. We will cover ongoing research efforts that tackle these questions, ranging from studies in reinforcement learning and computer vision to natural language processing. We will study work in interpretability, robustness, and governance of AI systems - to name a few. Basic knowledge about machine learning helps but is not required. View the full syllabus at http://tinyurl.com/42rb2sfv

| Units: 3

CS 123: A Hands-On Introduction to Building AI-Enabled Robots

This course offers a hands-on introduction to AI-powered robotics. Unlike most introductory robotics courses, students will learn essential robotics concepts by constructing a quadruped robot from scratch and training it to perform real-world tasks. The course covers a broad range of topics critical to robot learning, including motor control, forward and inverse kinematics, system identification, simulation, and reinforcement learning. Through weekly labs, students will construct a pair of tele-operated robot arms with haptic feedback, program a robot arm to learn self-movement, and ultimately create and program an agile robot quadruped named Pupper. In the final four weeks, students will undertake an open-ended project using Pupper as a platform, such as instructing it to walk using reinforcement learning, developing a vision system to allow Pupper to play fetch, or redesigning the hardware to enhance the robot's agility. Note: CS123 strives to achieve a balanced distribution of seniority across the undergrad student body. Within each seniority group, enrollment of students will follow a first-come-first-served approach. Please use the form below to enroll in the class. The form will be open on 9/1/2023 9:00AM Pacific Time. Please use this form to apply: https://docs.google.com/forms/d/e/1FAIpQLSdBSUqLjpD-a-GmwhPnRLMi7L1BMMzikl8yqwmQp-stMoDqIg/viewform

Terms: Aut | Units: 3

Instructors: ; Liu, K. (PI); Levine, G. (TA)

CS 124: From Languages to Information (LINGUIST 180, LINGUIST 280)

Extracting meaning, information, and structure from human language text, speech, web pages, social networks. Introducing methods (regex, edit distance, naive Bayes, logistic regression, neural embeddings, inverted indices, collaborative filtering, PageRank), applications (chatbots, sentiment analysis, information retrieval, question answering, text classification, social networks, recommender systems), and ethical issues in both. Prerequisites: CS106B, Python (at the level of CS106A), CS109 (or equivalent background in probability), and programming maturity and knowledge of UNIX equivalent to CS107 (or taking CS107 or CS1U concurrently).

Terms: Win | Units: 3-4 | UG Reqs: WAY-AQR

Instructors: ; Jurafsky, D. (PI); Akintan, M. (TA); Buch, D. (TA); Gurusankar, G. (TA); Kacharia, N. (TA); Lee, H. (TA); Leon, A. (TA); McAvity, J. (TA); Mukherjee, A. (TA); Nabi, F. (TA); Oyeniyi, T. (TA); Phatak, U. (TA); Ryan, M. (TA); Santiago, F. (TA); Wu, J. (TA); Xiao, J. (TA)

CS 131: Computer Vision: Foundations and Applications

Computer Vision technologies are transforming automotive, healthcare, manufacturing, agriculture and many other sections. Today, household robots can navigate spaces and perform duties, search engines can index billions of images and videos, algorithms can diagnose medical images for diseases, and smart cars can see and drive safely. Lying in the heart of these modern AI applications are computer vision technologies that can perceive, understand, and reconstruct the complex visual world. This course is designed for students who are interested in learning about the fundamental principles and important applications of Computer Vision. This course will introduce a number of fundamental concepts in image processing and expose students to a number of real-world applications. It will guide students through a series of projects to implement cutting-edge algorithms. There will be optional discussion sections on Fridays. Prerequisites: Students should be familiar with Python, Calculus & Linear Algebra.

Terms: Win | Units: 3-4

Instructors: ; Gaidon, A. (PI); Niebles Duque, J. (PI); Chang, J. (TA); Chen, H. (TA); Chou, A. (TA); Moore, A. (TA); Qu, C. (TA); Tchapmi, M. (TA)

CS 139: Human-Centered AI

Artificial Intelligence technology can and must be guided by human concerns. The course examines how mental models and user models of AI systems are formed, and how that leads to user expectations. This informs a set of design guidelines for building AI systems that are trustworthy, understandable, fair, and beneficial. The course covers the impact of AI systems on the economy and everyday life, and ethical issues of collecting data and running systems, including respect for persons, beneficence, fairness and justice.

Terms: Spr | Units: 3

Instructors: ; Norvig, P. (PI); Russell, D. (PI)

CS 152: Trust and Safety (COMM 122, INTLPOL 267)

Trust and Safety is an emerging field of professional and academic effort to build technologies that allow people to positively use the internet while being safe from harm. This course provides an introduction to the ways online services are abused to cause real human harm and the potential social, operational, product, legal and engineering responses. Students will learn about fraud, account takeovers, the use of social media by terrorists, misinformation, child exploitation, harassment, bullying and self-harm. This will include studying both the technical and sociological roots of these harms and the ways various online providers have responded. The class is taught by a practitioner, a professor of communication, a political scientist, and supplemented by guest lecturers from tech companies and nonprofits. Cross-disciplinary teams of students will spend the quarter building a technical and policy solution to a real trust and safety challenge, which will include the application of AI technologies to detecting and stopping abuse. For those taking this course for CS credit, the prerequisite is CS106B or equivalent programming experience and this course fulfills the Technology in Society requirement. Content note: This class will cover real-world harmful behavior and expose students to potentially upsetting material.

Terms: Spr | Units: 3

Instructors: ; Grossman, S. (PI); Hancock, J. (PI); Stamos, A. (PI)

CS 154: Introduction to the Theory of Computation

This course provides a mathematical introduction to the following questions: What is computation? Given a computational model, what problems can we hope to solve in principle with this model? Besides those solvable in principle, what problems can we hope to efficiently solve? In many cases we can give completely rigorous answers; in other cases, these questions have become major open problems in computer science and mathematics. By the end of this course, students will be able to classify computational problems in terms of their computational complexity (Is the problem regular? Not regular? Decidable? Recognizable? Neither? Solvable in P? NP-complete? PSPACE-complete?, etc.). Students will gain a deeper appreciation for some of the fundamental issues in computing that are independent of trends of technology, such as the Church-Turing Thesis and the P versus NP problem. Prerequisites: CS 103 or 103B.

Terms: Aut | Units: 3-4 | UG Reqs: GER:DB-EngrAppSci

Instructors: ; Reingold, O. (PI); Correa Dias Godoy, F. (TA); DeMarco, D. (TA); Hardy, A. (TA); Horng, C. (TA); Lee, O. (TA); Mayer, T. (TA); Miranda, N. (TA); Patel, C. (TA); Singh, J. (TA); Venkatesh, R. (TA); Weiner, O. (TA); Yang, L. (TA)

CS 157: Computational Logic

Rigorous introduction to Symbolic Logic from a computational perspective. Encoding information in the form of logical sentences. Reasoning with information in this form. Overview of logic technology and its applications - in mathematics, science, engineering, business, law, and so forth. Topics include the syntax and semantics of Propositional Logic, Relational Logic, and Herbrand Logic, validity, contingency, unsatisfiability, logical equivalence, entailment, consistency, natural deduction (Fitch), mathematical induction, resolution, compactness, soundness, completeness.

Terms: Aut | Units: 3 | UG Reqs: GER:DB-EngrAppSci, WAY-FR

Instructors: ; Genesereth, M. (PI); Hardy, A. (TA)

CS 161: Design and Analysis of Algorithms

Worst and average case analysis. Recurrences and asymptotics. Efficient algorithms for sorting, searching, and selection. Data structures: binary search trees, heaps, hash tables. Algorithm design techniques: divide-and-conquer, dynamic programming, greedy algorithms, amortized analysis, randomization. Algorithms for fundamental graph problems: minimum-cost spanning tree, connected components, topological sort, and shortest paths. Possible additional topics: network flow, string searching. Prerequisite: 106B or 106X; 103 or 103B; 109 or STATS 116.

Terms: Aut, Win, Sum | Units: 3-5 | UG Reqs: GER:DB-EngrAppSci, WAY-FR

Instructors: ; Anari, N. (PI); Charikar, M. (PI); Rubinstein, A. (PI); Conkey, A. (TA); Cussen, H. (TA); Dixit, A. (TA); Garg, R. (TA); Goyal, S. (TA); Hosgur, E. (TA); Ko, J. (TA); Kolichala, P. (TA); Li, W. (TA); Liu, S. (TA); Mayer, T. (TA); Namboothiry, B. (TA); Parada, R. (TA); Patterson, K. (TA); Rivkin, J. (TA); Roghani, M. (TA); Salahi, K. (TA); Singh, A. (TA); Singhal, A. (TA); Stearns, C. (TA); Wang, X. (TA); Z. HaoChen, J. (TA); Zhang, P. (TA); Zhao, J. (TA)

CS 182: Ethics, Public Policy, and Technological Change (COMM 180, ETHICSOC 182, PHIL 82, POLISCI 182, PUBLPOL 182)

Examination of recent developments in computing technology and platforms through the lenses of philosophy, public policy, social science, and engineering. Course is organized around five main units: algorithmic decision-making and bias; data privacy and civil liberties; artificial intelligence and autonomous systems; the power of private computing platforms; and issues of diversity, equity, and inclusion in the technology sector. Each unit considers the promise, perils, rights, and responsibilities at play in technological developments. Prerequisite: CS106A.

Last offered: Winter 2023 | Units: 5 | UG Reqs: WAY-ER

CS 193U: Video Game Development in C++ and Unreal Engine

Hands-on game development in C++ using Unreal Engine 4, the game engine that triple-A games like Fortnite, PUBG, and Gears of War are all built on. Students will be introduced to the Unreal editor, game frameworks, physics, AI, multiplayer and networking, UI, and profiling and optimization. Project-based course where you build your own games and gain a solid foundation in Unreal's architecture that will apply to any future game projects. Pre-requisites: CS106B or CS106X required. CS107 and CS110 recommended.

Last offered: Autumn 2020 | Units: 3

CS 197: Computer Science Research

An onramp for students interested in breaking new ground in the frontiers of computer science. Course format features faculty lectures introducing the fundamentals of computer science research, alongside special interest group meetings that provide mentorship and feedback on a real research project. Lecture topics include reading technical papers, practicing oral communication and technical writing skills, and independently formulating research questions. Any student may enroll for 4 units and select a research area (AI, HCI, Systems, etc.) for a quarter-long team programming project with a Ph.D. student mentor. Space may be limited. Prerequisite: CS106B.

Terms: Aut, Win, Spr | Units: 3-4

Instructors: ; Bernstein, M. (PI); Gandhi, K. (PI); Miranda, B. (PI); Gandhi, K. (TA); Miranda, B. (TA); Nilforoshan, H. (TA)

CS 206: Exploring Computational Journalism (COMM 281)

This project-based course will explore the field of computational journalism, including the use of Data Science, Info Visualization, AI, and emerging technologies to help journalists discover and tell stories, understand their audience, advance free speech, and build trust. This course is repeatable for credit; enrollment priority given to students taking it for the first time.

Terms: Win | Units: 3 | Repeatable 3 times (up to 9 units total)

Instructors: ; Agrawala, M. (PI); Brenner, R. (PI); Tumgoren, S. (PI); Chiueh, D. (TA)

CS 221: Artificial Intelligence: Principles and Techniques

Artificial intelligence (AI) has had a huge impact in many areas, including medical diagnosis, speech recognition, robotics, web search, advertising, and scheduling. This course focuses on the foundational concepts that drive these applications. In short, AI is the mathematics of making good decisions given incomplete information (hence the need for probability) and limited computation (hence the need for algorithms). Specific topics include search, constraint satisfaction, game playing,n Markov decision processes, graphical models, machine learning, and logic. Prerequisites: CS 103 or CS 103B/X, CS 106B or CS 106X, CS 109, and CS 161 (algorithms, probability, and object-oriented programming in Python). We highly recommend comfort with these concepts before taking the course, as we will be building on them with little review.

Terms: Aut, Spr | Units: 3-4

Instructors: ; Anari, N. (PI); Charikar, M. (PI); Koyejo, S. (PI); Liang, P. (PI); Phatak, U. (PI); Sadigh, D. (PI); Camacho, S. (TA); Hejna, J. (TA); Hu, G. (TA); Jeon, H. (TA); Ko, J. (TA); Lee, A. (TA); Li, C. (TA); Lin, K. (TA); Melo, L. (TA); Michaels, J. (TA); Nie, N. (TA); Pandya, D. (TA); Roman, E. (TA); Ryan, M. (TA); Tchapmi, M. (TA); Tchapmi P., L. (TA); Verma, S. (TA); Wornow, M. (TA); Yang, S. (TA); Zhang, P. (TA); Zhang, T. (TA)

CS 223A: Introduction to Robotics (ME 320)

Robotics foundations in modeling, design, planning, and control. Class covers relevant results from geometry, kinematics, statics, dynamics, motion planning, and control, providing the basic methodologies and tools in robotics research and applications. Concepts and models are illustrated through physical robot platforms, interactive robot simulations, and video segments relevant to historical research developments or to emerging application areas in the field. Recommended: matrix algebra.

Terms: Win | Units: 3

Instructors: ; Khatib, O. (PI); Chong, W. (TA); Devmalya, C. (TA); Guo, W. (TA); Kim, B. (TA); Tupuri, S. (TA)

CS 224N: Natural Language Processing with Deep Learning (LINGUIST 284, SYMSYS 195N)

Methods for processing human language information and the underlying computational properties of natural languages. Focus on deep learning approaches: understanding, implementing, training, debugging, visualizing, and extending neural network models for a variety of language understanding tasks. Exploration of natural language tasks ranging from simple word level and syntactic processing to coreference, question answering, and machine translation. Examination of representative papers and systems and completion of a final project applying a complex neural network model to a large-scale NLP problem. Prerequisites: calculus and linear algebra; CS124, CS221, or CS229.

Terms: Win, Spr | Units: 3-4

Instructors: ; Hashimoto, T. (PI); Manning, C. (PI); Yang, D. (PI); Burns, K. (TA); Chang, C. (TA); Chatterjee, S. (TA); Dai, T. (TA); El Boudali, H. (TA); Gao, Y. (TA); Lee, A. (TA); Lee, O. (TA); Lim, D. (TA); Liu, N. (TA); Mahankali, A. (TA); Singh, J. (TA); Sriram, A. (TA); Taori, R. (TA); Verma, T. (TA); Wang, A. (TA); Wang, T. (TA); Zhang, B. (TA); Zhang, H. (TA); Zhang, T. (TA); Zhang, Y. (TA); Ziems, C. (TA)

CS 224S: Spoken Language Processing (LINGUIST 285)

Introduction to spoken language technology with an emphasis on dialogue and conversational systems. Deep learning and other methods for automatic speech recognition, speech synthesis, affect detection, dialogue management, and applications to digital assistants and spoken language understanding systems. Prerequisites: CS124, CS221, CS224N, or CS229.

Terms: Spr | Units: 2-4

Instructors: ; Maas, A. (PI)

CS 224U: Natural Language Understanding (LINGUIST 188, LINGUIST 288, SYMSYS 195U)

Project-oriented class focused on developing systems and algorithms for robust machine understanding of human language. Draws on theoretical concepts from linguistics, natural language processing, and machine learning. Topics include lexical semantics, distributed representations of meaning, relation extraction, semantic parsing, sentiment analysis, and dialogue agents, with special lectures on developing projects, presenting research results, and making connections with industry. Prerequisites: CS 224N or CS 224S (This is a smaller number of courses than previously.)

Last offered: Spring 2023 | Units: 3-4

CS 224V: Conversational Virtual Assistants with Deep Learning

Generative AI, and in particular Large Language Models (LLMs), has already changed how we work and study. But this is just the beginning, as it has the potential of assisting and perhaps eventually automating knowledge workers in all areas, from law, medicine, to teaching and mental health therapists. This course will focus on the general principles and the latest research on methodologies and tools that can be applied to all domains. This is a project-oriented course, where students will gain hands-on experience in either methodology research or applying the concepts to create useful assistants for a domain of their choice. Topics include: (1) growing LLMs' knowledge through a combination of manual supervised learning and self-learning, (2) stopping LLMs from hallucination by grounding them with external corpora of knowledge, which is necessary for handling new, live, private as well as long-tail data, (3) handling external data corpora in different domains including structured and unstructured data, (4) experimentation and evaluation of conversational assistants based on LLMs, (5) controlling LLMs to achieve tasks, (6) persuasive LLMs, (7) multilingual assistants, and (8) combining voice and graphical interfaces. Prerequisites: one of LINGUIST 180/280, CS 124, CS 224N, CS 224S, 224U.

Terms: Aut | Units: 3-4

Instructors: ; Lam, M. (PI); Bruzzese, T. (TA); Jandaghi Semnani, S. (TA); Liu, S. (GP); Singh, A. (TA); Sridhar, A. (TA)

CS 225A: Experimental Robotics

Hands-on laboratory course experience in robotic manipulation. Topics include robot kinematics, dynamics, control, compliance, sensor-based collision avoidance, and human-robot interfaces. Second half of class is devoted to final projects using various robotic platforms to build and demonstrate new robot task capabilities. Previous projects include the development of autonomous robot behaviors of drawing, painting, playing air hocket, yoyo, basketball, ping-pong or xylophone. Prerequisites: 223A or equivalent.

Terms: Spr | Units: 3

Instructors: ; Khatib, O. (PI)

CS 227B: General Game Playing

A general game playing system accepts a formal description of a game to play it without human intervention or algorithms designed for specific games. Hands-on introduction to these systems and artificial intelligence techniques such as knowledge representation, reasoning, learning, and rational behavior. Students create GGP systems to compete with each other and in external competitions. Prerequisite: programming experience. Recommended: 103 or equivalent.

Terms: Spr | Units: 3

Instructors: ; Genesereth, M. (PI)

CS 228: Probabilistic Graphical Models: Principles and Techniques

Probabilistic graphical modeling languages for representing complex domains, algorithms for reasoning using these representations, and learning these representations from data. Topics include: Bayesian and Markov networks, extensions to temporal modeling such as hidden Markov models and dynamic Bayesian networks, exact and approximate probabilistic inference algorithms, and methods for learning models from data. Also included are sample applications to various domains including speech recognition, biological modeling and discovery, medical diagnosis, message encoding, vision, and robot motion planning. Prerequisites: basic probability theory and algorithm design and analysis.

Terms: Win | Units: 3-4

Instructors: ; Ermon, S. (PI); Marx, C. (TA); Patel, C. (TA); Sharma, D. (TA); Thomas, G. (TA); Zalouk, S. (TA)

CS 229: Machine Learning (STATS 229)

Topics: statistical pattern recognition, linear and non-linear regression, non-parametric methods, exponential family, GLMs, support vector machines, kernel methods, deep learning, model/feature selection, learning theory, ML advice, clustering, density estimation, EM, dimensionality reduction, ICA, PCA, reinforcement learning and adaptive control, Markov decision processes, approximate dynamic programming, and policy search. Prerequisites: knowledge of basic computer science principles and skills at a level sufficient to write a reasonably non-trivial computer program in Python/NumPy to the equivalency of CS106A, CS106B, or CS106X, familiarity with probability theory to the equivalency of CS 109, MATH151, or STATS 116, and familiarity with multivariable calculus and linear algebra to the equivalency of MATH51 or CS205.

Terms: Aut, Win | Units: 3-4

Instructors: ; Charikar, M. (PI); Fox, E. (PI); Guestrin, C. (PI); Koyejo, S. (PI); Ng, A. (PI); Agarwal, R. (TA); Agarwala, S. (TA); Chang, C. (TA); Chi, R. (TA); Chow, W. (TA); Chu, S. (TA); Damiani, A. (TA); Deng, R. (TA); Desai, R. (TA); Ding, Z. (TA); Dong, K. (TA); Frausto, J. (TA); Jeon, H. (TA); Khandelwal, P. (TA); Kumbong, H. (TA); Lim, D. (GP); Schaeffer, R. (TA); So, J. (TA); Wang, A. (TA); Wang, R. (TA); Xiao, Z. (TA); Yang, S. (TA); Zhang, E. (TA)

CS 229B: Machine Learning for Sequence Modeling (STATS 232)

Sequence data and time series are becoming increasingly ubiquitous in fields as diverse as bioinformatics, neuroscience, health, environmental monitoring, finance, speech recognition/generation, video processing, and natural language processing. Machine learning has become an indispensable tool for analyzing such data; in fact, sequence models lie at the heart of recent progress in AI like GPT3. This class integrates foundational concepts in time series analysis with modern machine learning methods for sequence modeling. Connections and key differences will be highlighted, as well as how grounding modern neural network approaches with traditional interpretations can enable powerful leaps forward. You will learn theoretical fundamentals, but the focus will be on gaining practical, hands-on experience with modern methods through real-world case studies. You will walk away with a broad and deep perspective of sequence modeling and key ways in which such data are not just 1D images.

Terms: Aut | Units: 3-4

Instructors: ; Fox, E. (PI)

CS 229M: Machine Learning Theory (STATS 214)

How do we use mathematical thinking to design better machine learning methods? This course focuses on developing mathematical tools for answering this question. This course will cover fundamental concepts and principled algorithms in machine learning, particularly those that are related to modern large-scale non-linear models. The topics include concentration inequalities, generalization bounds via uniform convergence, non-convex optimization, implicit regularization effect in deep learning, and unsupervised learning and domain adaptations. Prerequisites: linear algebra (MATH 51 or CS 205), probability theory (STATS 116, MATH 151 or CS 109), and machine learning (CS 229, STATS 229, or STATS 315A).

Terms: Aut | Units: 3

Instructors: ; Schramm, T. (PI); Nair, Y. (TA); Spector, A. (TA)

CS 230: Deep Learning

Deep Learning is one of the most highly sought after skills in AI. We will help you become good at Deep Learning. In this course, you will learn the foundations of Deep Learning, understand how to build neural networks, and learn how to lead successful machine learning projects. You will learn about Convolutional networks, RNNs, LSTM, Adam, Dropout, BatchNorm, Xavier/He initialization, and more. You will work on case studies from healthcare, autonomous driving, sign language reading, music generation, and natural language processing. You will master not only the theory, but also see how it is applied in industry. You will practice all these ideas in Python and in TensorFlow, which we will teach. AI is transforming multiple industries. After this course, you will likely find creative ways to apply it to your work. This class is taught in the flipped-classroom format. You will watch videos and complete in-depth programming assignments and online quizzes at home, then come in to class for advanced discussions and work on projects. This class will culminate in an open-ended final project, which the teaching team will help you on. Prerequisites: Familiarity with programming in Python and Linear Algebra (matrix / vector multiplications). CS 229 may be taken concurrently.

Last offered: Spring 2023 | Units: 3-4 | UG Reqs: WAY-AQR, WAY-FR

CS 231C: Computer Vision and Image Analysis of Art

This course presents the application of rigorous image processing, computer vision, machine learning, computer graphics and artificial intelligence techniques to problems in the history and interpretation of fine art paintings, drawings, murals and other two-dimensional works, including abstract art. The course focuses on the aspects of these problems that are unlike those addressed widely elsewhere in computer image analysis applied to physics-constrained images in photographs, videos, and medical images, such as the analysis of brushstrokes and marks, medium, inferring artists¿ working methods, compositional principles, stylometry (quantification of style), the tracing of artistic influence, and art attribution and authentication. The course revisits classic problems, such as image-based object recognition, but in highly non-realistic, stylized artworks. Recommended: One of CS 131 or EE 168 or equivalent; ARTHIST 1B. Prerequisites: Programming proficiency in at least one of C, C++, Python, Matlab or Mathematica and tools/frameworks such as OpenCV or Matlab's Image Processing toolbox.

Last offered: Autumn 2020 | Units: 3

CS 234: Reinforcement Learning

To realize the dreams and impact of AI requires autonomous systems that learn to make good decisions. Reinforcement learning is one powerful paradigm for doing so, and it is relevant to an enormous range of tasks, including robotics, game playing, consumer modeling and healthcare. This class will briefly cover background on Markov decision processes and reinforcement learning, before focusing on some of the central problems, including scaling up to large domains and the exploration challenge. One key tool for tackling complex RL domains is deep learning and this class will include at least one homework on deep reinforcement learning. Prerequisites: proficiency in python, CS 229 or equivalents or permission of the instructor; linear algebra, basic probability.

Terms: Spr | Units: 3

Instructors: ; Brunskill, E. (PI)

CS 236: Deep Generative Models

Generative models are widely used in many subfields of AI and Machine Learning. Recent advances in parameterizing these models using neural networks, combined with progress in stochastic optimization methods, have enabled scalable modeling of complex, high-dimensional data including images, text, and speech. In this course, we will study the probabilistic foundations and learning algorithms for deep generative models, including Variational Autoencoders (VAE), Generative Adversarial Networks (GAN), and flow models. The course will also discuss application areas that have benefitted from deep generative models, including computer vision, speech and natural language processing, and reinforcement learning. Prerequisites: Basic knowledge about machine learning from at least one of CS 221, 228, 229 or 230. Students will work with computational and mathematical models and should have a basic knowledge of probabilities and calculus. Proficiency in some programming language, preferably Python, required.

Terms: Aut | Units: 3

Instructors: ; Ermon, S. (PI); Agarwal, P. (TA); Cao, S. (TA); Chatterjee, S. (TA); Chen, H. (TA); Chiang, B. (TA); Dodhia, P. (TA); He, J. (TA); Miraoui, Y. (TA); Obbad, E. (TA); Salahi, K. (TA); Sharma, D. (TA); Shih, A. (TA); Xiao, Z. (TA); Xu, M. (TA); Yang, C. (TA); Yuan, S. (TA); Zhou, L. (TA)

CS 236G: Generative Adversarial Networks

Generative Adversarial Networks (GANs) have rapidly emerged as the state-of-the-art technique in realistic image generation. This course presents theoretical intuition and practical knowledge on GANs, from their simplest to their state-of-the-art forms. Their benefits and applications span realistic image editing that is omnipresent in popular app filters, enabling tumor classification under low data schemes in medicine, and visualizing realistic scenarios of climate change destruction. This course also examines key challenges of GANs today, including reliable evaluation, inherent biases, and training stability. After this course, students should be familiar with GANs and the broader generative models and machine learning contexts in which these models are situated. Prerequisites: linear algebra, statistics, CS106B, plus a graduate-level AI course such as: CS230, CS229 (or CS129), or CS221.

Last offered: Winter 2022 | Units: 3

CS 247A: Design for Artificial Intelligence (SYMSYS 195A)

A project-based course that builds on the introduction to design in CS147 by focusing on advanced methods and tools for research, prototyping, and user interface design. Studio based format with intensive coaching and iteration to prepare students for tackling real world design problems. This course takes place entirely in studios; you must plan on attending every studio to take this class. The focus of CS247A is design for human-centered artificial intelligence experiences. What does it mean to design for AI? What is HAI? How do you create responsible, ethical, human centered experiences? Let us explore what AI actually is and the constraints, opportunities and specialized processes necessary to create AI systems that work effectively for the humans involved. Prerequisites: CS147 or equivalent background in design thinking. In the event of a waitlist, acceptance to class based on an application provided on the first day of class.

Terms: Aut | Units: 3-4

Instructors: ; Stanford, J. (PI); Nabi, F. (TA)

CS 270: Modeling Biomedical Systems (BIOMEDIN 210)

At the core of informatics is the problem of creating computable models of biomedical phenomena. This course explores methods for modeling biomedical systems with an emphasis on contemporary semantic technology, including knowledge graphs. Topics: data modeling, knowledge representation, controlled terminologies, ontologies, reusable problem solvers, modeling problems in healthcare information technology and other aspects of informatics. Students acquire hands-on experience with several systems and tools. Prerequisites: CS106A. Basic familiarity with Python programming, biology, probability, and logic are assumed.

Terms: Win, Spr | Units: 3

Instructors: ; Musen, M. (PI)

CS 273B: Deep Learning in Genomics and Biomedicine (BIODS 237, BIOMEDIN 273B, GENE 236)

Recent breakthroughs in high-throughput genomic and biomedical data are transforming biological sciences into "big data" disciplines. In parallel, progress in deep neural networks are revolutionizing fields such as image recognition, natural language processing and, more broadly, AI. This course explores the exciting intersection between these two advances. The course will start with an introduction to deep learning and overview the relevant background in genomics and high-throughput biotechnology, focusing on the available data and their relevance. It will then cover the ongoing developments in deep learning (supervised, unsupervised and generative models) with the focus on the applications of these methods to biomedical data, which are beginning to produced dramatic results. In addition to predictive modeling, the course emphasizes how to visualize and extract interpretable, biological insights from such models. Recent papers from the literature will be presented and discussed. Experts in the field will present guest lectures. Students will be introduced to and work with popular deep learning software frameworks. Students will work in groups on a final class project using real world datasets. Prerequisites: College calculus, linear algebra, basic probability and statistics such as CS 109, and basic machine learning such as CS 229. No prior knowledge of genomics is necessary.

Terms: Spr | Units: 3

Instructors: ; Kundaje, A. (PI); Zou, J. (PI)

CS 274: Representations and Algorithms for Computational Molecular Biology (BIOE 214, BIOMEDIN 214, GENE 214)

BIOMEDIN 214: Representations and Algorithms for Computational Molecular Biology (BIOE 214, CS 274, GENE 214)Topics: This is a graduate level introduction to bioinformatics and computational biology, algorithms for alignment of biological sequences and structures, BLAST, phylogenetic tree construction, hidden Markov models, basic structural computations on proteins, protein structure prediction, molecular dynamics and energy minimization, statistical analysis of 3D structure, knowledge controlled terminologies for molecular function, expression analysis, chemoinformatics, pharmacogenetics, network biology. Lectures are supplemented with assignments and programming projects, which allow students to implement important computational biology algorithms. Firm prerequisite: CS 106B. NOTE: For students in the Department of Biomedical Data Science Program, this core course MUST be taken as a letter grade only.

Terms: Aut | Units: 3-4

Instructors: ; Altman, R. (PI); Koodli, R. (TA); McCann, H. (TA); Nayar, G. (TA); Xiong, B. (TA)

CS 277: Foundation Models for Healthcare (BIODS 271, RAD 271)

Generative AI and large-scale self-supervised foundation models are poised to have a profound impact on human decision making across occupations. Healthcare is one such area where such models have the capacity to impact patients, clinicians, and other care providers. In this course, we will explore the training, evaluation, and deployment of generative AI and foundation models, with a focus on addressing current and future medical needs. The course will cover models used in natural language processing, computer vision, and multi-modal applications. We will explore the intersection of models trained on non-healthcare domains and their adaptation to domain-specific problems, as well as healthcare-specific foundation models. Prerequisites: Familiarity with machine learning principles at the level of CS 229, 231N, or 224N

Terms: Win | Units: 3

Instructors: ; Chaudhari, A. (PI); Syeda-Mahmood, T. (PI); Zou, J. (PI); Varma, M. (TA); Wu, K. (TA)

CS 281: Ethics of Artificial Intelligence

Machine learning has become an indispensable tool for creating intelligent applications, accelerating scientific discoveries, and making better data-driven decisions. Yet, the automation and scaling of such tasks can have troubling negative societal impacts. Through practical case studies, you will identify issues of fairness, justice and truth in AI applications. You will then apply recent techniques to detect and mitigate such algorithmic biases, along with methods to provide more transparency and explainability to state-of-the-art ML models. Finally, you will derive fundamental formal results on the limits of such techniques, along with tradeoffs that must be made for their practical application. CS229 or equivalent classes or experience.

Terms: Spr | Units: 3-4

Instructors: ; Guestrin, C. (PI)

CS 288: Applied Causal Inference with Machine Learning and AI (MS&E 228)

Fundamentals of modern applied causal inference. Basic principles of causal inference and machine learning and how the two can be combined in practice to deliver causal insights and policy implications in real world datasets, allowing for high-dimensionality and flexible estimation. Lectures will provide foundations of these new methodologies and the course assignments will involve real world data (from social science, tech industry and healthcare applications) and synthetic data analysis based on these methodologies. Prerequisites: basic knowledge of probability and statistics. Recommended: 226 or equivalent.

Terms: Win | Units: 3

Instructors: ; Syrgkanis, V. (PI); Lan, H. (TA); Young, J. (TA)

CS 294A: Research Project in Artificial Intelligence

Student teams under faculty supervision work on research and implementation of a large project in AI. State-of-the-art methods related to the problem domain. Prerequisites: AI course from 220 series, and consent of instructor.

Last offered: Winter 2012 | Units: 3 | Repeatable for credit

CS 320: Value of Data and AI

Many of the most valuable companies in the world and the most innovative startups have business models based on data and AI, but our understanding about the economic value of data, networks and algorithmic assets remains at an early stage. For example, what is the value of a new dataset or an improved algorithm? How should investors value a data-centric business such as Netflix, Uber, Google, or Facebook? And what business models can best leverage data and algorithmic assets in settings as diverse as e-commerce, manufacturing, biotech and humanitarian organizations? In this graduate seminar, we will investigate these questions by studying recent research on these topics and by hosting in-depth discussions with experts from industry and academia. Key topics will include value of data quantity and quality in statistics and AI, business models around data, networks, scaling effects, economic theory around data, and emerging data protection regulations. Students will also conduct a group research projects in this field.nnPrerequisites: Sufficient mathematical maturity to follow the technical content; some familiarity with data mining and machine learning and at least an undergraduate course in statistics are recommended.

Last offered: Winter 2022 | Units: 3

CS 322: Triangulating Intelligence: Melding Neuroscience, Psychology, and AI (PSYCH 225)

This course will cover both classic findings and the latest research progress on the intersection of cognitive science, neuroscience, and artificial intelligence: How does the study of minds and machines inform and guide each other? What are the assumptions, representations, or learning mechanisms that are shared (across multiple disciplines, and what are different? How can we build a synergistic partnership between cognitive psychology, neuroscience, and artificial intelligence? We will focus on object perception and social cognition (human capacities, especially in infancy and early childhood) and the ways in which these capacities are formalized and reverse-engineered (computer vision, reinforcement learning). Through paper reading and review, discussion, and the final project, students will learn the common foundations shared behind neuroscience, cognitive science, and AI research and leverage them to develop their own research project in these areas. Recommended prerequisites: PSYCH 1, PSYCH 24/SYMSYS 1/CS 24, CS 221, CS 231N

Last offered: Winter 2022 | Units: 3

CS 323: The AI Awakening: Implications for the Economy and Society

Intelligent computer agents must reason about complex, uncertain, and dynamic environments. This course is a graduate level introduction to automated reasoning techniques and their applications, covering logical and probabilistic approaches. Topics include: logical and probabilistic foundations, backtracking strategies and algorithms behind modern SAT solvers, stochastic local search and Markov Chain Monte Carlo algorithms, variational techniques, classes of reasoning tasks and reductions, and applications. Enrollment by application: https://digitaleconomy.stanford.edu/about/the-ai-awakening-implications-for-the-economy-and-society/

Terms: Spr | Units: 3-4

Instructors: ; Brynjolfsson, E. (PI)

CS 323A: The AI Awakening: Implications for the Economy and Society

This course offers an overview of blockchain governance and DAOs, including the governance of layer-1 blockchains, DAO tooling, on-chain and off-chain voting, delegation and constitutional design, identity, and privacy. We will cover these topics both from a technical perspective and from a social scientific perspective, and will include a range of guests from the web3 space.

| Units: 3

CS 324: Advances in Foundation Models

Foundation models (FMs) are transforming the landscape of AI in research and industry. Such models (e.g., GPT-3, CLIP, Stable Diffusion) are trained on large amounts of broad data and are adaptable to a wide range of downstream tasks. In this course, students will learn fundamentals behind the models and algorithms, systems and infrastructure, and ethics and societal impacts of foundation models, with an emphasis on gaining hands-on experience and identifying real-world use-cases for FMs. Students will hear from speakers in industry working on foundation models in the wild. The main class assignment will be a quarter-long final project, involving either researching the capabilities of FMs or building an FM-powered application.

Last offered: Winter 2023 | Units: 3

CS 329: Topics in Artificial Intelligence

Advanced material is often taught for the first time as a topics course, perhaps by a faculty member visiting from another institution. May be repeated for credit.

| Units: 3 | Repeatable for credit

CS 329M: Machine Programming

The field of machine programming (MP) is concerned with the automation of software development. Given the recent advances in software algorithms, hardware efficiency and capacity, and an ever increasing availability of code data, it is now possible to train machines to help develop software. In this course, we teach students how to build real-world MP systems. We begin with a high-level overview of the field, including an abbreviated analysis of state-of-the-art (e.g., Merly Mentor). Next, we discuss the foundations of MP and the key areas for innovation, some of which are unique to MP. We close with a discussion of current limitations and future directions of MP. This course includes a nine-week hands-on project, where students (as individuals or in a small group) will create their own MP system and demonstrate it to the class. This course is primary intended for graduate students (it is not recommended for undergraduate students without first reviewing that the course prerequisites are met).

Terms: Aut | Units: 3-4

Instructors: ; Gottschlich, J. (PI); Verma, T. (TA)

CS 329T: Trustworthy Machine Learning

This course will provide an introduction to state-of-the-art ML methods designed to make AI more trustworthy. The course focuses on four concepts: explanations, fairness, privacy, and robustness. We first discuss how to explain and interpret ML model outputs and inner workings. Then, we examine how bias and unfairness can arise in ML models and learn strategies to mitigate this problem. Next, we look at differential privacy and membership inference in the context of models leaking sensitive information when they are not supposed to. Finally, we look at adversarial attacks and methods for imparting robustness against adversarial manipulation.Students will gain understanding of a set of methods and tools for deploying transparent, ethically sound, and robust machine learning solutions. Students will complete labs, homework assignments, and discuss weekly readings. Prerequisites: CS229 or similar introductory Python-based ML class; knowledge of deep learning such as CS230, CS231N; familiarity with ML frameworks in Python (scikit-learn, Keras) assumed.

Terms: Aut | Units: 3

Instructors: ; Datta, A. (PI); Mitchell, J. (PI); Taly, A. (PI); Bao, M. (TA); Singla, A. (TA)

CS 330: Deep Multi-task and Meta Learning

While deep learning has achieved remarkable success in supervised and reinforcement learning problems, such as image classification, speech recognition, and game playing, these models are, to a large degree, specialized for the single task they are trained for. This course will cover the setting where there are multiple tasks to be solved, and study how the structure arising from multiple tasks can be leveraged to learn more efficiently or effectively. This includes: goal-conditioned reinforcement learning techniques that leverage the structure of the provided goal space to learn many tasks significantly faster; meta-learning methods that aim to learn efficient learning algorithms that can learn new tasks quickly; curriculum and lifelong learning, where the problem requires learning a sequence of tasks, leveraging their shared structure to enable knowledge transfer. This is a graduate-level course. By the end of the course, students should be able to understand and implement the state-of-the-art multi-task learning algorithms and be ready to conduct research on these topics. Prerequisites: CS 229 or equivalent. Familiarity with deep learning, reinforcement learning, and machine learning is assumed.

Terms: Aut | Units: 3

Instructors: ; Finn, C. (PI); Khurana, A. (TA); Lee, Y. (TA); Sobol Mark, M. (TA); Sun, A. (TA)

CS 333: Algorithms for Interactive Robotics

AI agents need to collaborate and interact with humans in many different settings such as bots operating on social media and crowdsourcing platforms, AI assistants brokering transactions on electronic marketplaces, autonomous vehicles driving alongside humans, or robots interacting with and assisting humans in homes. Our goal in this class is to learn about and design algorithms that enable robots and AI agents to reason about their actions, interact with one another, the humans, and the environment they live in, as well as plan safe strategies that humans can trust and rely on. This is a project-based graduate course that studies algorithms in robotics, machine learning, and control theory, which can improve the state-of-the-art human-AI systems. nnRecommended: Introductory course in AI (CS 221) and Machine Learning (CS 229).

Last offered: Winter 2022 | Units: 3-4

CS 335: Fair, Accountable, and Transparent (FAccT) Deep Learning

Deep learning-based AI systems have demonstrated remarkable learning capabilities. A growing field in deep learning research focuses on improving the Fairness, Accountability, and Transparency (FAccT) of a model in addition to its performance. Although FAccT will be difficult to achieve, emerging technical approaches in this topic show promise in making better FAccT AI systems. In this course, we will study the rigorous computer science necessary foundations for FAccT deep learning and dive into the technical underpinnings of topics including fairness, robustness, interpretability, accountability, and privacy. These topics reflect state-of-the-art research in FAccT, are socially important, and they have strong industrial interest due to government and other policy regulation. This course will focus on the algorithmic and statistical methods needed to approach FAccT AI from a deep learning perspective. We will also discuss several application areas where we can apply these techniques. Prerequisites: Intermediate knowledge of statistics, machine learning, and AI. Qualified students will have taken any one of the following, or their advanced equivalents: CS224N, CS230, CS231N, CS236, CS273B. Alternatively, students who have taken CS229 or have equivalent knowledge can be admitted with the permission of the instructors.

| Units: 3

CS 336: Language Modeling from Scratch

Language models serve as the cornerstone of modern natural language processing (NLP) applications and open up a new paradigm of having a single general purpose system address a range of downstream tasks. As the field of artificial intelligence (AI), machine learning (ML), and NLP continues to grow, possessing a deep understanding of language models becomes essential for scientists and engineers alike. This course is designed to provide students with a comprehensive understanding of language models by walking them through the entire process of developing their own. Drawing inspiration from operating systems courses that

create an entire operating system from scratch, we will lead students through every aspect of language model creation, including data collection and cleansing for pre-training, transformer model construction, model training, and evaluation before deployment. Application required, apply at https://docs.google.com/forms/d/e/1FAIpQLSdW0HgT8MHzdM8cgapLWqX2ZPP1yHSX52R_r5JzF52poqXsHg/viewform

Terms: Spr | Units: 3-5

Instructors: ; Hashimoto, T. (PI); Liang, P. (PI)

CS 337: AI-Assisted Care (MED 277)

AI has been advancing quickly, with its impact everywhere. In healthcare, innovation in AI could help transforming of our healthcare system. This course offers a diverse set of research projects focusing on cutting edge computer vision and machine learning technologies to solve some of healthcare's most important problems. The teaching team and teaching assistants will work closely with students on research projects in this area. Research projects include Care for Senior at Senior Home, Surgical Quality Analysis, AI Assisted Parenting, Burn Analysis & Assessment and more. AI areas include Video Understanding, Image Classification, Object Detection, Segmentation, Action Recognition, Deep Learning, Reinforcement Learning, HCI and more. The course is open to students in both school of medicine and school of engineering.

Terms: Aut | Units: 1-4

Instructors: ; Adeli, E. (PI); Milstein, A. (PI); Schulman, K. (PI); Kaushal, A. (SI); Li, F. (SI)

CS 339H: Human-Computer Interaction and AI/ML

Understanding the human side of AI/ML based systems requires understanding both how the system-side AI works, but also how people think about, understand, and use AI tools and systems. This course will cover how what AI components and systems currently exits, along with how mental models and user models are made. These models lead to user expectations of AI systems are formed, and ultimately to design guidelines to avoid disappointing end-users by creating unintelligible AI tools that are based on a cryptic depiction of how things work. We'll also cover the ethics of AI data collection and model building, as well as how to build fair systems.

Last offered: Autumn 2022 | Units: 3

CS 347: Human-Computer Interaction: Foundations and Frontiers

(Previously numbered CS376.) How will the future of human-computer interaction evolve? This course equips students with the major animating theories of human-computer interaction, and connects those theories to modern innovations in research. Major theories are drawn from interaction (e.g., tangible and ubiquitous computing), social computing (e.g., Johansen matrix), and design (e.g., reflective practitioner, wicked problems), and span domains such as AI+HCI (e.g., mixed initiative interaction), accessibility (e.g., ability based design), and interface software tools (e.g., threshold/ceiling diagrams). Students read and comment on multiple research papers per week, and perform a quarter-long research project. Prerequisites: For CS and Symbolic Systems undergraduates/masters students, CS147 or CS247. No prerequisite for PhD students or students outside of CS and Symbolic Systems.

Terms: Spr | Units: 3-4 | Repeatable for credit

Instructors: ; Agrawala, M. (PI)

CS 348I: Computer Graphics in the Era of AI

This course introduces deep learning methods and AI technologies applied to four main areas of Computer Graphics: rendering, geometry, animation, and imaging. We will study a wide range of problems on content creation for images, shapes, and animations, recently advanced by deep learning techniques. For each problem, we will understand its conventional solutions, study the state-of-the-art learning-based approaches, and critically evaluate their results as well as the impacts to researchers and practitioners in Computer Graphics. The topics include differentiable rendering/neural rendering, BRDF estimation, texture synthesis, denoising, procedural modeling, view synthesis, colorization, style transfer, motion synthesis, differentiable physics simulation, and reinforcement learning. Through programming projects and homework, students who successfully complete this course will be able to use neural rendering algorithms for image manipulation, apply neural procedural modeling for shape and scene synthesis, exploit data-driven methods for simulating physical phenomena, and implement policy learning algorithms for creating character animation. Recommended Prerequisites: CS148, CS231N

Terms: Win | Units: 3-4

Instructors: ; Liu, K. (PI); Wu, J. (PI); Deng, C. (TA)

CS 349D: Cloud Computing Technology

The largest change in the computer industry over the past twenty years has arguably been the emergence of cloud computing: organizations are increasingly developing their workloads to be cloud native, using global-scale compute, storage, and communication services that were simply not possible with private infrastructure. This research seminar covers the latest technical advances and open issues in cloud computing, including cloud infrastructure for AI inference and training, cloud databases and data lakes, resource management, serverless computing, confidential computing, multi-cloud computing, and AI for cloud management. Students will propose and develop an original research project in cloud computing. Prerequisites: Background in computer systems recommended but not required (CS 111/240, 144/244, 244B or 245).

Terms: Spr | Units: 3

Instructors: ; Kozyrakis, C. (PI)

CS 362: Research in AI Alignment

In this course we will explore the current state of research in the field of AI alignment, which seeks to bring increasingly intelligent AI systems in line with human values and interests. The purpose of this course is to encourage the development of new ideas in this field, where a dominant paradigm has not yet been established. The format will be weekly lectures in which speakers present their current research approaches. The assignment structure will be slightly unusual: each week students will have a choice between a problem set and a short research assignment based on the weekly guest speaker's research area. For the research assignment, students will start with the abstract of a relevant AI alignment paper or blog post and create a blog post or Github repository describing how they would continue the paper. The final weekly assignment will be an extension of one of the previous weeks' work. Therefore this course requires research experience, preferably using mathematical and programming tools (e.g. Python, PyTorch, calculus), and is a graduate level course, open to advanced undergraduates.

Last offered: Spring 2023 | Units: 3

CS 372: Artificial Intelligence for Precision Medicine and Psychiatric Disorders

Artificial intelligence, specifically deep learning, stands out as one of the most transformative technologies of the past decade. AI can already outperform humans in several computer vision and natural language processing tasks. However, we still face some of the same limitations and obstacles that led to the demise of the first AI boom phase five decades ago. This research-oriented course will first review and reveal the limitations (e.g., iid assumption on training and testing data, voluminous training data requirement, and lacking interpretability) of some widely used AI algorithms, including convolutional neural networks (CNNs),

transformers, reinforcement learning, and generative adversarial networks (GANs). To address these limitations, we will then explore topics including transfer learning for remedying data scarcity, knowledge-guided multimodal learning for improving data diversity, out of distribution generalization, attention mechanisms for enabling Interpretability, meta learning, and privacy-preserving training data management. The course will be taught through a combination of lecture and project sessions. Lectures on specialized AI applications (e.g., cancer/depression diagnosis and treatment, AI/VR for surgery, and health education) will feature guest speakers from academia and industry. Students will be assigned to work on an extensive project that is relevant to their fields of study (e.g., CS, Medicine, and Data Science). Projects may involve conducting literature surveys, formulating ideas, and implementing these ideas. Example project topics are but not limited to 1) knowledge guided GANs for improving training data diversity, 2) disease diagnosis via multimodal symptom checking, and 3) fake and biased news/information detection.

Terms: Spr | Units: 3

Instructors: ; Chang, E. (PI)

CS 375: Large-Scale Neural Network Modeling for Neuroscience (PSYCH 249)

The last ten years has seen a watershed in the development of large-scale neural networks in artificial intelligence. At the same time, computational neuroscientists have discovered a surprisingly robust mapping between the internal components of these networks and real neural structures in the human brain. In this class we will discuss a panoply of examples of such "convergent man-machine evolution", including: feedforward models of sensory systems (vision, audition, somatosensation); recurrent neural networks for dynamics and motor control; integrated models of attention, memory, and navigation; transformer models of language areas; self-supervised models of learning; and deep RL models of decision and planning. We will also delve into the methods and metrics for comparing such models to real-world neural data, and address how unsolved open problems in AI (that you can work on!) will drive forward novel neural models. Some meaningful background in modern neural networks is highly advised (e.g. CS229, CS230, CS231n, CS234, CS236, CS 330), but formal preparation in cognitive science or neuroscience is not needed (we will provide this).

Terms: Win | Units: 3

Instructors: ; Yamins, D. (PI); Kotar, K. (TA)

CS 381: Sensorimotor Learning for Embodied Agents (EE 381)

This is an advanced course that will focus on modern machine learning algorithms for autonomous robots as an embodied intelligent agent. It covers advanced topics that center around 1. what is embodied AI and how it differs from internet AI, 2. how embodied agents perceive their environment from raw sensory data and make decisions, and 3. continually adapt to the physical world through both hardware and software improvements. By the end of the course, we hope to prepare you for conducting research in this area, knowing how to formulate the problem, design the algorithm, critically validate the idea through experimental designs and finally clearly present and communicate the findings. Students are expected to read, present, and debate the latest research papers on embodied AI, as well as obtain hands-on experience through the course projects. Prerequisites: Recommended EE 160A/EE 260A /CS 237A or equivalent.

| Units: 3

CS 421: Designing AI to Cultivate Human Well-Being

Artificial Intelligence (AI) has the potential to drive us towards a better future for all of humanity, but it also comes with significant risks and challenges. At its best, AI can help humans mitigate climate change, diagnose and treat diseases more effectively, enhance learning, and improve access to capital throughout the world. But it also has the potential to exacerbate human biases, destroy trust in information flow, displace entire industries, and amplify inequality throughout the world. We have arrived at a pivotal moment in the development of the technology in which we must establish a foundation for how we will design AI to capture the positive potential and mitigate the negative risks. To do this, building AI must be an inclusive, interactive, and introspective process guided by an affirmative vision of a beneficial AI-future. The goal of this interdisciplinary class is to bridge the gap between technological and societal objectives: How do we design AI to promote human well-being? The ultimate aim is to provide tools and frameworks to build a more harmonious human society based on cooperation toward a shared vision. Thus, students are trained in basic science to understand what brings about the conditions for human flourishing and will create meaningful AI technologies that aligns with the PACE framework: 1) has a clear and meaningful purpose, 2) augments human dignity and autonomy, 3) creates a feeling of inclusivity and collaboration, 4) creates shared prosperity and a sense of forward movement (excellence). Toward this end, students work in interdisciplinary teams on a final project and propose a solution that tackles a significant societal challenge by leveraging technology and frameworks on human thriving.

Last offered: Winter 2021 | Units: 2

CS 448P: Hacking the Pandemic

This timely project-based course provides a venue for students to apply their skills in computing and other areas to help people cope with the Coronavirus Disease 2019 (CoViD-19) pandemic. In addition to brief lectures, guest speakers, and moderated discussions and brainstorming sessions, the course will primarily consist of self-organized team projects where students find creative ways to contribute by leveraging any and all computational tools at our disposal (e.g., algorithms, app development, HCI, remote interaction and communication, data visualization, modeling and simulation, fabrication and 3d printing, design, computer games, VR, computer systems and networking, AI, statistics, bioinformatics, etc.). Prerequisite: CS106B.

Last offered: Spring 2020 | Units: 3

CS 470: Music and AI (MUSIC 356)

How do we make music with artificial intelligence? What does it mean to do so (and is it even a good idea)? How might we design systems that balance machine automation and human interaction? More broadly, how do we want to live with our technologies? Are there - and ought there be - limits to using AI for art? (And what is Art, anyway?) In this "critical making" course, students will learn practical tools and techniques for AI-mediated music creation, engineer software systems incorporating AI, HCI and Music, and critically reflect on the aesthetic and ethical dimensions of technology.

Terms: Win | Units: 3-4

Instructors: ; Wang, G. (PI); Zhu, A. (TA)

CS 481: Digital Technology and Law: Foundations

Taught by a team of law and engineering faculty, this unique interdisciplinary course will empower students across the University to work together and exercise leadership on critically important debates at the intersection of law and digital technology. Designed as an accessible survey, the course will equip students with two powerful bases of knowledge: (i) a working technical grasp of key digital technologies (e.g., AI and machine learning, internet structure, encryption, blockchain); and (ii) basic fluency in the key legal frameworks implicated by each (e.g., privacy, cybersecurity, anti-discrimination, free speech, torts, procedural fairness). Substantively, the course will be organized into modules focused on distinct law-tech intersections, including: platform regulation, speech, and intermediary liability; algorithmic bias and civil rights; autonomous systems, safety, and tort liability; "smart" contracting; data privacy and consumer protection; "legal tech," litigation, and access to justice; government use of AI; and encryption and criminal procedure. Each module will be explored via a mix of technical and legal instruction, case study discussions, in-class practical exercises, and guest speakers from industry, government, academe, and civil society. Law students will

emerge from the course with a basic understanding of core digital technologies and related legal frameworks and a roadmap of curricular and career pathways one might follow to pursue each area further. Students from elsewhere in the University, from engineering to business to the social sciences and beyond, will emerge with an enhanced capacity to critically assess the legal and policy implications of new digital technologies and the ways society can work to ensure those technologies serve the public good. All students will learn to work together across disciplinary divides to solve technical, legal, and practical problems. There are no course prerequisites, and no prior legal or technical training will be assumed. Students will be responsible for short discussion papers or a final paper. After the term begins, students electing the final paper option can transfer from section 1 to section 2, which meets the R requirement, with consent of the instructor. This class is cross-listed in the University and undergraduates and graduates are eligible to take it. Consent Application for Non-Law Students: We will try to accommodate all students interested in the course. But to facilitate planning and confirm interest, please fill out a consent application (https://forms.gle/hLAQ7JUm2jFTWQzE9) by March 13, 2020. Applications received after March 13 will be considered on a rolling basis. Elements used in grading: Attendance, Class Participation; Written Assignments or Final Paper.

Last offered: Spring 2020 | Units: 3

CS 498D: Design for Learning: Generative AI for Collaborative Learning (DESIGN 292, EDUC 449)

Would you like to design ways to use generative AI to help humans learn with other humans? In this course, you will develop creative ways to use generative AI to support collaborative learning, also learning more about AI as researchers continue to improve tools like ChatGPT. In creating new learning activities that could be used at Stanford or in other courses, you will build experience with fundamentals of design, including the design abilities of learning from others, navigating ambiguity, synthesizing information, and experimenting rapidly. You will do this by tackling real design challenges presented by our project partners, which include several Stanford programs, while drawing on your own first-hand experience as students. This class is open to all students, undergraduate and graduate, of any discipline. No previous design experience or experience with AI is required. Just a collaborative spirit and hard work.

Terms: Aut | Units: 3

Instructors: ; Fajardo, G. (PI); Langer-Osuna, J. (PI); Mitchell, J. (PI)

CS 520: Knowledge Graphs

Knowledge graphs have emerged as a compelling abstraction for organizing world's structured knowledge over the internet, capturing relationships among key entities of interest to enterprises, and a way to integrate information extracted from multiple data sources. Knowledge graphs have also started to play a central role in machine learning and natural language processing as a method to incorporate world knowledge, as a target knowledge representation for extracted knowledge, and for explaining what is being learned. This class is a graduate level research seminar and will include lectures on knowledge graph topics (e.g., data models, creation, inference, access) and invited lectures from prominent researchers and industry practitioners. The seminar emphasizes synthesis of AI, database systems and HCI in creating integrated intelligent systems centered around knowledge graphs.

Last offered: Spring 2022 | Units: 1

CS 521: Seminar on AI Safety

In this seminar, we will focus on the challenges in the design of safe and verified AI-based systems. We will explore some of the major problems in this area from the viewpoint of industry and academia. We plan to have a weekly seminar speaker to discuss issues such as verification of AI systems, reward misalignment and hacking, secure and attack-resilient AI systems, diagnosis and repair, issues regarding policy and ethics, as well as the implications of AI safety in automotive industry. Prerequisites: There are no official prerequisites but an introductory course in artificial intelligence is recommended.

Last offered: Spring 2023 | Units: 1

CS 522: Seminar in Artificial Intelligence in Healthcare

Artificial intelligence is poised to make radical changes in healthcare, transforming areas such as diagnosis, genomics, surgical robotics, and drug discovery. In the coming years, artificial intelligence has the potential to lower healthcare costs, identify more effective treatments, and facilitate prevention and early detection of diseases. This class is a seminar series featuring prominent researchers, physicians, entrepreneurs, and venture capitalists, all sharing their thoughts on the future of healthcare. We highly encourage students of all backgrounds to enroll (no AI/healthcare background necessary). Speakers and more at https://tinyurl.com/cs522-stanford

Terms: Aut | Units: 1

Instructors: ; Dror, R. (PI); Chan, Z. (GP)

CS 523: Research Seminar in Computer Vision + X

With advances in deep learning, computer vision (CV) has been transforming all sorts of domains, including healthcare, human-computer interaction, transportation, art, sustainability, and so much more. In this seminar, we investigate its far-reaching applications, with a different theme chosen as the focus each quarter (e.g. the inaugural quarter was CV + Healthcare; the theme for the quarter will be listed on the class syllabus). Throughout the quarter, we deeply examine these themes in CV + X research through weekly intimate discussions with researchers from academia and industry labs who conduct research at the center of CV and other domains. Each week, students will read and prepare questions and reflections on an assigned paper authored by that week's speaker. We highly encourage students who are interested in taking an interactive, deep dive into CV research literature to apply. While there are no hard requirements, we strongly suggest having the background and fluency necessary to read and analyze AI research papers (thus MATH 51 or linear algebra, and at least one of CS 231x, 224x, 221, 229, 230, 234, 238, AI research experience for CV and AI fundamentals may be helpful).

Last offered: Spring 2022 | Units: 1-2

CS 523: Research Seminar in Computer Vision and Healthcare

With advances in deep learning, computer vision (CV) has been transforming healthcare, from diagnosis to prognosis, from treatment to prevention. Its far-reaching applications include surgical assistants, patient monitoring, data synthesis, and cancer screening. Before these algorithms make their way into the clinic, however, there is exciting research to develop methods that are accurate, robust, interpretable, grounded, and human-centered. In this seminar, we deeply examine these themes in medical CV research through weekly intimate discussions with researchers from academia and industry labs who conduct research at the center of CV and healthcare. Each week students will read and prepare questions and reflections on an assigned paper authored by that week's speaker. We highly encourage students who are interested in taking an interactive, deep dive into medical CV research literature to apply. While there are no hard requirements, we strongly suggest having the background and fluency necessary to read and analyze AI research papers (thus MATH 51 or linear algebra, and at least one of CS 231x, 224x, 221, 229, 230, 234, 238, AI research experience for CV and AI fundamentals may be helpful).

| Units: 1

CSRE 106A: Black Mirror: A.I.Activism (AMSTUD 106B, ARTHIST 168A, ENGLISH 106A, SYMSYS 168A)

Lecture/small group course exploring intersections of STEM, arts and humanities scholarship and practice that engages with, and generated by, exponential technologies. Our course explores the social ethical and artistic implications of artificial intelligence systems with an emphasis on aesthetics, civic society and racial justice, including scholarship on decolonial AI, indigenous AI, disability activism AI, feminist AI and the future of work for creative industries.
| Units: 3 | UG Reqs: WAY-A-II, WAY-EDP

CSRE 385: Race, Ethnicity, and Language: Black Digital Cultures from BlackPlanet to AI (AFRICAAM 389C, EDUC 389C, PWR 194AJB)

This seminar explores the intersections of language and race/racism/racialization in the public schooling experiences of students of color. We will briefly trace the historical emergence of the related fields of sociolinguistics and linguistic anthropology, explore how each of these scholarly traditions approaches the study of language, and identify key points of overlap and tension between the two fields before considering recent examples of inter-disciplinary scholarship on language and race in urban schools. Issues to be addressed include language variation and change, language and identity, bilingualism and multilingualism, language ideologies, and classroom discourse. We will pay particular attention to the implications of relevant literature for teaching and learning in urban classrooms.

Terms: Win | Units: 3-4

Instructors: ; Banks, A. (PI)

DATASCI 197: WiDS Datathon Independent Study (CME 99)

This independent study offers students the opportunity to participate in the WiDS Datathon for 1-unit of credit. The WiDS Datathon is an annual and global event that encourages data scientists of all levels to discover and hone their data science skills while solving an interesting and critical social impact challenge. The 2023 Challenge, "Data Science for Subseasonal Forecast", centers on climate change and is in partnership with Climate Change AI (CCAI). Accurate long-term forecasts of temperature and precipitation is crucial for mitigating the effects of climate change (i.e. preparing for droughts and other wet weather extremes). Such forecasts can potentially impact many industries (e.g. agriculture, energy, disaster planning) in countries across the globe. Currently, purely physics-based models dominate short-term weather forecasting. But these models have a limited forecast horizon. The availability of meteorological data offers an opportunity for data scientists to improve subseasonal forecasts by blending physics-based forecasts with machine learning. To learn more, visit:
https://www.widsconference.org/datathon.htmlStudents may participate in this independent study in teams of 1-4. To qualify for official participation in the datathon, at least half of each team must identify as women. To receive credit, the team will participate in the Datathon and write a report detailing their submission and reflecting on their experience. Interested students should register for the course, and sign up as a team using this form:
https://forms.gle/LyX3yNU7dLnTCux1A. To find other students interested in forming a team, go here:
https://docs.google.com/presentation/d/1UvutEFtYFeCkLkwnpU01R5V5WmJeMi4kVkaZYHxSiAY/edit?usp=sharing

Last offered: Winter 2023 | Units: 1 | Repeatable 4 times (up to 4 units total)

DESIGN 259: Inventing the Future (BIOE 177)

The famous computer scientist, Alan Kay, once said, "The best way to predict the future is to invent it." As such, we are all responsible for inventing the future we hope we and our descendants will experience. In this highly interactive course, we will be exploring how to predict and invent the future and why this is important by focusing on a wide range of frontier technologies, such as robotics, AI, genomics, autonomous vehicles, blockchain, 3D Printing, VR/AR, synthetic meat, etc. The class will feature debates in which students present utopian and dystopian scenarios, and determine what has to be done to inoculate ourselves against the negative consequences. Limited enrollment. Admission by application: dschool.stanford.edu/classes.

Terms: Win | Units: 3

Instructors: ; Endy, D. (PI); Solomon, L. (PI); Grant, C. (TA)

DESIGN 264: Design for Health (PEDS 219)

How might we design a product or service that helps each person to navigate the system to meet their health needs? This course aims to blend the best methods of co-design with key insights from digital product design and foundational AI to create novel solutions to population-health challenges, working alongside people from communities that have been historically underserved. Responsive to real-world challenges from a healthcare partner, students will work with patients with chronic illness (and their caregivers) to co-design solutions that reimagine the future of primary care. To understand these challenges, we will explore the intersections among epidemiology of chronic illness, fiscal and policy constraints, and social well-being. We will place a special emphasis on the practical challenge of delivering the right care, at the right place and time. Stakeholders will include clinicians, community experts, technologists and payers. Students will work in teams to design, prototype and test concepts that reflect the worlds in which their co-design partners live and work, all with an eye to helping our healthcare system work better for them.

Last offered: Autumn 2022 | Units: 3-4

DESIGN 282: Designing with Machine Learning

Machine learning is everywhere - but where is it in your design practice? You are the next generation of creators to harness the potential of machine learning and also to understand its implications. Expect to explore and deepen your design abilities by leveraging generative AI tools while navigating the benefits and tradeoffs as you build out your AI toolbox for design. This class invites a mix of designers, data scientists, engineers, business people, and diverse professionals of all backgrounds to help create a multi-disciplinary environment for collaboration. Through a mixture of hands-on guided investigations and design projects, students will learn to design WITH machine learning and create lasting value within their human contexts and environments.

Terms: Win | Units: 3

Instructors: ; Callaghan, E. (PI); Carney, M. (PI)

DESIGN 283Q: Tinkering with Inequity in Emerging Tech

A historically-informed and multidisciplinary approach to designing emerging technologies like AI, the metaverse, NFTs, IOT, and the systems in which they exist to be equitable.Throughout history, innovations in science and technology, while bold and visionary, have often resulted in catastrophic consequences for Indigenuous, Black, immigrant and other historically oppressed communities, and the environment. Today's emerging technologies, which span everything from deep fakes to self-driving vehicles, have incredible capabilities, and at the same time are plagued with algorithmic bias and lack accountability. What can we learn from our precarious past that we are not learning today, but need to? This class welcomes the curious and the creative, from interdisciplinary fields including design, computer science, art, history, political science, ethics, feminist and gender studies and professionals of diverse backgrounds. Through a variety of hands-on design projects including historical excavations, speculative fiction and world building, students will learn how to create prototypes of emerging technologies and evaluate their implications on diverse communities, the environment, and our past and future selves.

Terms: Win | Units: 3

Instructors: ; Mogos, A. (PI)

DESIGN 292: Design for Learning: Generative AI for Collaborative Learning (CS 498D, EDUC 449)

Would you like to design ways to use generative AI to help humans learn with other humans? In this course, you will develop creative ways to use generative AI to support collaborative learning, also learning more about AI as researchers continue to improve tools like ChatGPT. In creating new learning activities that could be used at Stanford or in other courses, you will build experience with fundamentals of design, including the design abilities of learning from others, navigating ambiguity, synthesizing information, and experimenting rapidly. You will do this by tackling real design challenges presented by our project partners, which include several Stanford programs, while drawing on your own first-hand experience as students. This class is open to all students, undergraduate and graduate, of any discipline. No previous design experience or experience with AI is required. Just a collaborative spirit and hard work.

Terms: Aut | Units: 3

Instructors: ; Fajardo, G. (PI); Langer-Osuna, J. (PI); Mitchell, J. (PI)

DESIGN 809E: AI For Legal Help

Can AI increase access to justice, by helping people resolve their legal problems in more accessible, equitable, and effective ways? What are the risks that AI poses for people seeking legal guidance, that technical and policy guardrails should mitigate? In this course, students will conduct research to identify key opportunities and risks around AI's use by the public to deal with common legal problems like bad living conditions, possible evictions, debt collection, divorce, or domestic violence. Especially with the launch of new AI platforms like ChatGPT, Google Bard, and Bing Chat, more people may turn to generative AI platforms for guidance on their legal rights, options, and procedures. How can technology companies, legal institutions, and community groups responsibly advance AI solutions to benefit people in need? Students will explore these questions about AI and access to justice through hands-on interviews, fieldwork, and design workshops with different stakeholders throughout the justice system. They will run interview sessions online and on-site at courts, to hear from various community members about whether they would use AI for legal help and to brainstorm how the ideal AI system would behave. Students will also observe how participants use AI to respond to a fictional legal problem, to assess how the AI performs and understand how people regard the AI's guidance. Students will be required to complete ethical training for human subjects research, which takes approximately 2 hours through the CITI program online. They will then conduct community interviews according to an approved IRB research protocol. Students will synthesize what they learn in these community interviews, observations, and brainstorm sessions, in a presentation to legal and technical experts. They will hold a multi-stakeholder workshop at to explore how their findings may contribute to technical and legal projects to develop responsible, human-centered AI in the legal domain. Students will develop skills in facilitating interdisciplinary policy discussions about how technology and regulation can be developed alongside each other. The students¿ final report will contribute to policy and technology discussions about the principles, benchmarks, and risk typologies that can guide the ethical development of AI platforms for access to justice. Students are asked to enroll in both Fall and Winter quarters of the class. The class may be extended to Spring quarter, depending on the issues raised. Elements used in grading: Attendance, Performance, Class Participation, and Written Assignments. CONSENT APPLICATION: To apply for this course, students must complete and submit a Consent Application Form available at SLS Registrar https://registrar.law.stanford.edu/.

| Units: 3

DLCL 103: Future Text: AI and Literatures, Cultures, and Languages (ITALIAN 103)

How do AI language models work and what is their impact on education? In this course we will: Experiment with translation; Experiment with textual analysis of specific texts from different contexts and historical periods and cultures; Experiment with large data questions that are very hard to do by a single person; Experiment with ways to fact-check an AI generated work: we know AI creates false assertions, and backs them up with false references; Experiment with collaborating with AI to write a final paper, a blog, a newspaper article, etc.

Terms: Aut | Units: 4 | UG Reqs: WAY-A-II, WAY-EDP

Instructors: ; Dombrowski, Q. (PI); Wittman, L. (PI); Kim, E. (TA); Nepomuceno, A. (TA)

EALC 402A: Topics in International Technology Management (EASTASN 402A, EE 402A)

Autumn 2023 Theme: "The Emerging Digital Economy in Context: US-Asia Cooperation and Competition." This course will examine ways in which new digital technologies, business models, and data governance frameworks are addressing problems and opportunities at the interface between the digital economy and the external world, with special attention to new patterns of competition and cooperation between Asia and the U.S. Individual sessions will focus on topics such as live commerce, new models of AI governance, the role of digital transformation in addressing climate change, cross-border data sharing in an era of heightened concern for privacy and security, digital platforms for supply chain integration, and AI competition. Distinguished speakers and panels from industry and government.

Terms: Aut | Units: 1 | Repeatable for credit

Instructors: ; Dasher, R. (PI)

EARTHSYS 139A: Designing Regenerative Societies (STS 139)

The world is changing in contradictory ways. Emerging technology, the evolving geopolitical economy, and ecological challenges present opportunities but also cascading risks. The pathway from our current destructive and extractive economy towards a more regenerative economy is unclear. There is a stark tension between gigascale opportunities such as AI, fusion energy, nanotech, quantum tech, space colonization, and biomanufacturing on the one hand, and degrowth necessities such as rethinking growth and using less resources on the other. This tension is steeped in political choices constrained by industrial power dynamics and conditioned by inequality. To what extent do visions and incentives align across industry, government, and social movements? What would the choice to scale or descale entail in each case - and are they mutually exclusive? The course introduces empirically driven systems thinking with in-depth modules on both emerging tech and degrowth, and scenario-based tech foresight. We combine the tools of technology foresight, gaming, scenarios, speculative fiction, and worldbuilding, exploring and assessing utopian or dystopian trends, visions, and projects (e.g. the Eden project, biomanufacturing at scale, smart cities, the Metaverse, generation spaceships, space colonization, human longevity, mega-disruptive startups, global health governance, radical longtermism, and religious `heavens'). The goal of the course is to gain clarity on the innovation boundaries within which the next 50 years might develop. The course prepares students to become disruptors of governance principles, strategies, and leadership of corporations, philanthropies, economies, and civilizations.

Terms: Spr | Units: 3-4

Instructors: ; Undheim, T. (PI)

EASTASN 242: Contemporary Art in the Age of Artificial Intelligence (ARTHIST 254, ARTHIST 344, ARTSINST 242)

This course delves into the rapidly evolving landscape of contemporary art as it intertwines with the advancements in artificial intelligence. Students will explore how artists from Asia and its diaspora are harnessing the capabilities of AI to redefine artistic expressions, appropriate traditional media and aesthetics, and interrogate the boundaries between human creativity and machine intelligence. Drawing upon case studies, hands-on experiments, and critical discussions, students will gain a deeper understanding of the sociocultural implications of AI-infused artistry and its impact on society. This course contextualizes its content in a global narrative, discussing challenging themes and existential inquiries AI has evoked worldwide. Situating AI in the long history of machines, automation, and human engagement with technologies, the class encourages students to think critically about the "transformations" AI made to society. Central to our exploration will be the fundamental questions of what it means to be "human" in a world where machines can mimic, and even surpass, human cognition in certain domains. Drawing

parallels between diverse cultures and technologies, we will dissect how human-machine collaborations shape our perceptions of reality, authenticity, emotion, and creativity. Through examination of both Asian philosophies and theories of posthumanism, students will reflect upon the broader philosophical implications of a world where artificial and human intelligence coexist, intertwining and reshaping the very fabric of society, culture, and personal experience. Instructor: Gerui Wang.

Terms: Spr | Units: 3-5

Instructors: ; Wang, G. (PI)

EASTASN 402A: Topics in International Technology Management (EALC 402A, EE 402A)

Autumn 2023 Theme: "The Emerging Digital Economy in Context: US-Asia Cooperation and Competition." This course will examine ways in which new digital technologies, business models, and data governance frameworks are addressing problems and opportunities at the interface between the digital economy and the external world, with special attention to new patterns of competition and cooperation between Asia and the U.S. Individual sessions will focus on topics such as live commerce, new models of AI governance, the role of digital transformation in addressing climate change, cross-border data sharing in an era of heightened concern for privacy and security, digital platforms for supply chain integration, and AI competition. Distinguished speakers and panels from industry and government.

Terms: Aut | Units: 1 | Repeatable for credit

Instructors: ; Dasher, R. (PI)

ECON 152: The Future of Finance (ECON 252, PUBLPOL 364)

This 2-credit course will examine vast changes driven by innovation both from within traditional finance and from new ecosystems in fintech among others. Breathtaking advances in financial theory, big data, machine learning, artificial intelligence, computational capability, IoT, payment systems (e.g. blockchain, crypto currencies), new products (e.g. robo advising, digital lending, crowd funding, smart contracts), new trading processes (e.g. algorithmic trading, AI-driven sales & trading), and new markets (e.g. ETFs, zero-cost products), among others are changing not only how financial and non-financial firms conduct business but also how investors and supervisors view the players and the markets. nWe will discuss critical strategy, policy and legal issues, some resolved and others yet to be (e.g. failed business models, cyber challenges, financial warfare, fake news, bias problems, legal standing for cryptos). The course will feature perspectives from guest speakers including top finance executives and Silicon Valley entrepreneurs on up-to-the-minute challenges and opportunities in finance. nWe will discuss slowing global growth against the backdrop of ongoing intervention and wildcards in the capital markets of the U.S., Europe, Hong Kong, Singapore, China, India, Japan, the Middle East and Latin America. We will look forward at strategic opportunities and power players appearing and being dethroned in the markets to discuss who is likely to thrive ¿ and not survive ¿ in the new global financial landscape. nnPrerequisites: If you are an undergraduate wishing to take this course, apply by completing the course application and provide a brief bio here: https://forms.gle/9BGYr8brdYwPS8Cu8

Last offered: Winter 2020 | Units: 2

ECON 160: Game Theory and Economic Applications

Introduction to game theory and its applications to economics. Topics: strategic and extensive form games, dominant strategies, Nash equilibrium, subgame-perfect equilibrium, and Bayesian equilibrium. The theory is applied to repeated games, oligopoly, auctions, and bargaining with examples from economics and political science. Prerequisites: Working knowledge of calculus and basic probability theory.

Last offered: Spring 2023 | Units: 5 | UG Reqs: WAY-FR, WAY-SI

ECON 252: The Future of Finance (ECON 152, PUBLPOL 364)

This 2-credit course will examine vast changes driven by innovation both from within traditional finance and from new ecosystems in fintech among others. Breathtaking advances in financial theory, big data, machine learning, artificial intelligence, computational capability, IoT, payment systems (e.g. blockchain, crypto currencies), new products (e.g. robo advising, digital lending, crowd funding, smart contracts), new trading processes (e.g. algorithmic trading, AI-driven sales & trading), and new markets (e.g. ETFs, zero-cost products), among others are changing not only how financial and non-financial firms conduct business but also how investors and supervisors view the players and the markets. nWe will discuss critical strategy, policy and legal issues, some resolved and others yet to be (e.g. failed business models, cyber challenges, financial warfare, fake news, bias problems, legal standing for cryptos). The course will feature perspectives from guest speakers including top finance executives and Silicon Valley entrepreneurs on up-to-the-minute challenges and opportunities in finance. nWe will discuss slowing global growth against the backdrop of ongoing intervention and wildcards in the capital markets of the U.S., Europe, Hong Kong, Singapore, China, India, Japan, the Middle East and Latin America. We will look forward at strategic opportunities and power players appearing and being dethroned in the markets to discuss who is likely to thrive ¿ and not survive ¿ in the new global financial landscape. nnPrerequisites: If you are an undergraduate wishing to take this course, apply by completing the course application and provide a brief bio here: https://forms.gle/9BGYr8brdYwPS8Cu8

Last offered: Winter 2020 | Units: 2

ECON 254: Economics of Digitization

Examines the transformation of the economy enabled by digital technologies, including AI, networks, and the digitization of information, goods and services. Topics include the economics of information, two-sided networks and platforms, power laws, intangible assets, organizational complementarities, incomplete contracts, growth theory, and design of empirical studies. Extensive reading and discussion of research literature with relevant guest speakers. Students will complete a final research paper and presentation. Primarily for doctoral students.

Last offered: Spring 2022 | Units: 3-5

ECON 295: The AI Awakening: Implications for the Economy and Society

This course will explore how the advances in AI can and will transform our economy and society in the coming years. Each week, we will learn from a guest speaker at the frontier of AI, economics, government or industry, read the relevant research, and discuss the implications. Primarily for graduate students in economics, business or computer science. Enrollment by application, opening in February 2024: https://digitaleconomy.stanford.edu/about/the-ai-awakening-implications-for-the-economy-and-society/

Terms: Spr | Units: 3

Instructors: ; Brynjolfsson, E. (PI)

EDUC 64: Shaping America's Future: Exploring the Key Issues on Our Path to the 2024 Elections (COMM 159B, SOC 64)

Join us for an immersive speaker series that delves into the core of American democracy. Prominent figures from a range of politic, business, foreign policy, academia, and media will analyze the implications of the 2024 elections and the challenges our nation faces. Led by James Steyer, founder and CEO of Common Sense Media, explore topics such as harnessing the power of AI responsibly, addressing climate change at various levels, strengthening commitments to democracy and voting rights, safeguarding youth from the impacts of social media and technology on mental health, and ensuring accountability for wealth disparities. This series will provide you with a comprehensive understanding of the elections and the broader American political landscape.

Terms: Aut | Units: 1

Instructors: ; Steyer, J. (PI); Engel, E. (GP); Stewart, S. (GP)

EDUC 234: Curiosity in Artificial Intelligence (PSYCH 240A)

How do we design artificial systems that learn as we do early in life -- as "scientists in the crib" who explore and experiment with our surroundings? How do we make AI "curious" so that it explores without explicit external feedback? Topics draw from cognitive science (intuitive physics and psychology, developmental differences), computational theory (active learning, optimal experiment design), and AI practice (self-supervised learning, deep reinforcement learning). Students present readings and complete both an introductory computational project (e.g. train a neural network on a self-supervised task) and a deeper-dive project in either cognitive science (e.g. design a novel human subject experiment) or AI (e.g. implement and test a curiosity variant in an RL environment). Prerequisites: python familiarity and practical data science (e.g. sklearn or R).

Terms: Spr | Units: 3

Instructors: ; Haber, N. (PI)

EDUC 236: How Will AI Change the EdTech Industry? Challenges & Opportunities Based on Real Business Cases

Is Artificial Intelligence really disrupting the EdTech industry or do its business impacts remain elusive? Despite booming interest around AI, concrete examples of how this is actually changing the way EdTech businesses operate remain scant. In this course, students will have the opportunity to engage with EdTech entrepreneurs, board members and venture capitalists around real business cases that illustrate the opportunities and challenges linked to incorporating AI into their product when it comes to driving sales, market share, and profitability.

Terms: Spr | Units: 1-2 | Repeatable 2 times (up to 4 units total)

Instructors: ; Lichand, G. (PI); Sassaki, C. (PI)

EDUC 295: Entrepreneurship and Innovation in Education Technology Seminar

(Same as GSBGEN 591) The last few years have created significant educational challenges and opportunities, especially given the emergence of Artificial Intelligence (AI); there has never been a more pressing and urgent need in our history to foster entrepreneurship in education by leveraging new technologies. This course will help you develop the skills and strategies necessary to effectively create and evaluate educational services and education technology startups, much like educators, entrepreneurs, philanthropists, and venture capital investors do. Some questions we will discuss include: How do entrepreneurs, educators, and VCs evaluate and grow successful education and edtech startups? Why do most startups in edtech fail, and what are the critical ingredients for success, especially in today's challenging times? What does it take to get venture capital financing in edtech? Why now? Each week will feature a different entrepreneur as a guest speaker; these leaders hail from a variety of innovative for-profit and non-profit startups. As we hear from the speakers, we'll evaluate all aspects of their invention, particularly in the context of AI, distance learning and hybrid learning ecosystems. A fundamental question we'll explore in this course is how educators and technologists can better collaborate to leverage the scale and impact of technology to improve educational equity and access. This course will be taught in person; attendance at each session is required. The maximum capacity is 60 students. Juniors, Seniors and graduate students of all Stanford schools are welcome. Syllabus can be viewed here: https://monsalve.people.stanford.edu/courses-and-seminars

Terms: Spr | Units: 2 | Repeatable 2 times (up to 6 units total)

Instructors: ; Monsalve, S. (PI); Brennan, R. (TA); Yan, J. (GP)

EDUC 389C: Race, Ethnicity, and Language: Black Digital Cultures from BlackPlanet to AI (AFRICAAM 389C, CSRE 385, PWR 194AJB)

This seminar explores the intersections of language and race/racism/racialization in the public schooling experiences of students of color. We will briefly trace the historical emergence of the related fields of sociolinguistics and linguistic anthropology, explore how each of these scholarly traditions approaches the study of language, and identify key points of overlap and tension between the two fields before considering recent examples of inter-disciplinary scholarship on language and race in urban schools. Issues to be addressed include language variation and change, language and identity, bilingualism and multilingualism, language ideologies, and classroom discourse. We will pay particular attention to the implications of relevant literature for teaching and learning in urban classrooms.

Terms: Win | Units: 3-4

Instructors: ; Banks, A. (PI)

EDUC 449: Design for Learning: Generative AI for Collaborative Learning (CS 498D, DESIGN 292)

Would you like to design ways to use generative AI to help humans learn with other humans? In this course, you will develop creative ways to use generative AI to support collaborative learning, also learning more about AI as researchers continue to improve tools like ChatGPT. In creating new learning activities that could be used at Stanford or in other courses, you will build experience with fundamentals of design, including the design abilities of learning from others, navigating ambiguity, synthesizing information, and experimenting rapidly. You will do this by tackling real design challenges presented by our project partners, which include several Stanford programs, while drawing on your own first-hand experience as students. This class is open to all students, undergraduate and graduate, of any discipline. No previous design experience or experience with AI is required. Just a collaborative spirit and hard work.

Terms: Aut | Units: 3

Instructors: ; Fajardo, G. (PI); Langer-Osuna, J. (PI); Mitchell, J. (PI)

EDUC 468: Robotics, AI and Design of Future Education (ME 268)

The time of robotics/AI is upon us. Within the next 10 to 20 years, many jobs will be replaced by robots/AI (artificial intelligence). This seminar features guest lecturers from industry and academia discussing the current state of the field of robotics/AI, preparing students for the rise of robotics/AI, and redesigning and reinventing education to adapt to the new era.

Terms: Win | Units: 1 | Repeatable 10 times (up to 10 units total)

Instructors: ; Jiang, L. (PI)

EDUC 484: Philosophy of Education for the Digital Age

Students in school today will live most of their lives in a world that will be radically changed by technologies such as AI, virtual reality, and smart devices. How should we think about civic values, moral responsibility, epistemic agency, and personal fulfilment in a future increasingly shaped by technology? How will the aims of education evolve in the digital future? This course will explore these and other questions through the work of contemporary philosophers of education and technology.

Terms: Win | Units: 3

Instructors: ; Cox, G. (PI)

EE 207: Neuromorphics: Brains in Silicon (BIOE 313)

While traversing through the natural world, you effortlessly perceive and react to a rich stream of stimuli. This constantly changing stream evokes spatiotemporal patterns of spikes that propagate through your brain from one ensemble of neurons to another. An ensemble may memorize a spatiotemporal pattern at the speed of life and recall it at the speed of thought. In the first half of this course, we will discuss and model how a neural ensemble memorizes and recalls such a spatiotemporal pattern. In the second half, we will explore how neuromorphic hardware could exploit these neurobiological mechanisms to run AI not with megawatts in the cloud but rather with watts on a smartphone. Prerequisites: Either computational modeling (BIOE 101, BIOE 300B) or circuit analysis (EE 101A).

Terms: Spr | Units: 3

Instructors: ; Boahen, K. (PI)

EE 243: Photonic Devices and Circuits

Introduction to integrated photonics, and in particular to silicon photonics at the devices and circuits levels. Operating principles of practical photonic devices: waveguides, filters, wavelength and mode multiplexers, optical detectors, lasers, modulators, switches. Design and implementation of photonic circuits, with focus on applications including optical interconnects, AI (matrix multiplication), and quantum computing. Introduction to photonics inverse design. Prerequisites: EE 42 and EE 65. Recommended: EE 142 and EE 216

| Units: 3

EE 263: Introduction to Linear Dynamical Systems (CME 263)

Applied linear algebra and linear dynamical systems with applications to circuits, signal processing, communications, and control systems. Topics: least-squares approximations of over-determined equations, and least-norm solutions of underdetermined equations. Symmetric matrices, matrix norm, and singular-value decomposition. Eigenvalues, left and right eigenvectors, with dynamical interpretation. Matrix exponential, stability, and asymptotic behavior. Multi-input/multi-output systems, impulse and step matrices; convolution and transfer-matrix descriptions. Control, reachability, and state transfer; observability and least-squares state estimation. Prerequisites: Linear algebra and matrices as in ENGR 108 or MATH 104; ordinary differential equations and Laplace transforms as in EE 102B or CME 102.

Terms: Aut, Sum | Units: 3

Instructors: ; Lall, S. (PI); Bolo, T. (TA); Holt, G. (TA); shankar, s. (TA)

EE 292J: Designing for Authenticity

The Internet is at an inflection point. As mis/disinformation abounds and AI and synthetic media explode, the world's digital knowledge faces unprecedented threats. At the same time, a new generation of web technologies known as "Web3" offer new opportunities to protect the security and integrity of data. Our class jumps into this high-stakes moment and equips students with a new framework to understand and deploy methods to restore trust in digital content whether it's news and information, legally admissible evidence, or tamper-proof archives. Open to students of all experience levels, this class will provide an introduction to how advances in cryptography and the decentralized web can allow users to establish the provenance and veracity of data as it moves online. Students will create end-to-end technical prototypes and emerge with a new understanding that authenticity isn't a guaranteed part of information systems. You have to design for authenticity.

Terms: Win | Units: 1

Instructors: ; Dotan, J. (PI); Grimes, A. (PI); Huffman, N. (PI)

EE 364A: Convex Optimization I (CME 364A)

Convex sets, functions, and optimization problems. The basics of convex analysis and theory of convex programming: optimality conditions, duality theory, theorems of alternative, and applications. Least-squares, linear and quadratic programs, semidefinite programming, and geometric programming. Numerical algorithms for smooth and equality constrained problems; interior-point methods for inequality constrained problems. Applications to signal processing, communications, control, analog and digital circuit design, computational geometry, statistics, machine learning, and mechanical engineering. Prerequisite: linear algebra such as EE263, basic probability.

Terms: Win, Sum | Units: 3

Instructors: ; Ayazifar, B. (PI); Boyd, S. (PI); Bell, L. (TA); Hofgard, J. (TA); Holt, G. (TA); Johansson, K. (TA); Parshakova, T. (TA); Tse, D. (TA); Yang, A. (TA)

EE 364B: Convex Optimization II (CME 364B)

Continuation of 364A. Subgradient, cutting-plane, and ellipsoid methods. Decentralized convex optimization via primal and dual decomposition. Monotone operators and proximal methods; alternating direction method of multipliers. Exploiting problem structure in implementation. Convex relaxations of hard problems. Global optimization via branch and bound. Robust and stochastic optimization. Applications in areas such as control, circuit design, signal processing, and communications. Course requirements include project. Prerequisite: 364A.

Terms: Spr | Units: 3

Instructors: ; Pilanci, M. (PI)

EE 376B: Topics in Information Theory and Its Applications (STATS 376B)

Information theory establishes the fundamental limits on compression and communication over networks. The tools of information theory have also found applications in many other fields, including probability and statistics, computer science and physics. The course will cover selected topics from these applications, including communication networks, through regular lectures and student projects. Prerequisites: EE276 (Formerly EE376A)

Last offered: Spring 2019 | Units: 3

EE 381: Sensorimotor Learning for Embodied Agents (CS 381)

This is an advanced course that will focus on modern machine learning algorithms for autonomous robots as an embodied intelligent agent. It covers advanced topics that center around 1. what is embodied AI and how it differs from internet AI, 2. how embodied agents perceive their environment from raw sensory data and make decisions, and 3. continually adapt to the physical world through both hardware and software improvements. By the end of the course, we hope to prepare you for conducting research in this area, knowing how to formulate the problem, design the algorithm, critically validate the idea through experimental designs and finally clearly present and communicate the findings. Students are expected to read, present, and debate the latest research papers on embodied AI, as well as obtain hands-on experience through the course projects. Prerequisites: Recommended EE 160A/EE 260A /CS 237A or equivalent.

Terms: Aut | Units: 3

Instructors: ; Song, S. (PI); Zhao, M. (TA)

EE 392B: Industrial AI

The seminar features guest lectures from the industry. The Industrial AI (I-AI) computing applications are at the center of on-going digital transformation. Known as the Fourth Industrial Revolution, or Industry 4.0, this is a multi-trillion-dollar transformation of economy. The I-AI is related to Internet of Things (IoT), where 'things' include man-made systems and business processes: industrial, transportation, operations and support, and supply chains. I-AI applications are mission critical with large cost of error compared to AI apps for the Internet of People. The lecturers from technology (e.g., computing) companies, consultancies, AI vendors, OEMs, and end users of the I-AI will discuss business and 'big picture' technical issues. Example vertical industries are energy, transportation, oil and gas, data centers, and manufacturing.

Terms: Spr | Units: 1 | Repeatable for credit

Instructors: ; Gorinevsky, D. (PI); O'Neill, D. (PI)

EE 402A: Topics in International Technology Management (EALC 402A, EASTASN 402A)

Autumn 2023 Theme: "The Emerging Digital Economy in Context: US-Asia Cooperation and Competition." This course will examine ways in which new digital technologies, business models, and data governance frameworks are addressing problems and opportunities at the interface between the digital economy and the external world, with special attention to new patterns of competition and cooperation between Asia and the U.S. Individual sessions will focus on topics such as live commerce, new models of AI governance, the role of digital transformation in addressing climate change, cross-border data sharing in an era of heightened concern for privacy and security, digital platforms for supply chain integration, and AI competition. Distinguished speakers and panels from industry and government.

Terms: Aut | Units: 1 | Repeatable for credit

Instructors: ; Dasher, R. (PI)

ENGLISH 17Q: After 2001: A 21st Century Science Fiction Odyssey

In 1968, Stanley Kurick's 2001: A Space Odyssey imagined the future in the then distant year of 2001. Now that year is more than 20 years in the rearview and his science fiction future is now our past (with fewer PanAm flights to the moon and a stunning dearth of murderous AI). What is science fiction in the 21st century? What does it do? Who writes it? And, importantly, who is it for? In this class we will explore the questions of topic, author, audience, and community through the lens of the Hugo winning short stories since 2001. Hugo Awards are chosen by the fans, so this will allow us to examine the ways in which fandom and popular culture have changed in the last two decades in ways that has made the genre broader and more inclusive of writers and readers of every gender, race, and sexuality, while at the same time provoking a reactionary response in a minority of writers and fans who consider themselves decentered by these developments. Readings will include the Hugo winning short stories, some classic science fiction stories, and contemporary reports about the annual science fiction convention where these awards are given (WorldCon), and articles about science fiction fan culture. We will also view some of the science fiction visual works that have been important or influential in the past two decades. Timing and health permitted we will attend a local science fiction convention. This course will be reading- and writing-intensive but will also offer opportunities for spirited discussion. We will be engaging with sensitive subjects such as race, class, gender, and sexuality. Assignments include weekly short essays, discussion leadership, individual presentations, and a final research paper.

Terms: Spr | Units: 3 | UG Reqs: WAY-A-II, WAY-EDP

Instructors: ; Stevenson, M. (PI); Wolfenstein, G. (GP)

ENGLISH 24N: New Technologies of Literature

Technology changes how and what we read. In this course we will study how digital technology has changed literature: the ways in which it is written, to how it is distributed, and what we can do with it. Our readings will include literature produced collaboratively within fan fiction communities, literature written and distributed in social media posts, interactive fiction that borrows from innovations in games, and fiction 'written' by AI language models.

Last offered: Winter 2023 | Units: 3

ENGLISH 90QN: Quantum Narratives:Writing Fiction about Science, Philosophy and Human Experience in the Quantum Age

Classical modes of storytelling have served writers and readers for centuries, but with mainstream recognition of the complexities and uncertainties that underpin reality, might there also exist less traditional, but perhaps truer, modes of storytelling? Shouldn't our narrative approaches be updated to incorporate quantum realities such as uncertainty, superposition and 'spooky action?' Can characters become entangled or exist in many worlds? What are the narrative implications of a black hole? This course hopes to examine the assertion by Cixin Liu, in his novel The Three-Body Problem, that 'Science fiction is a literature that belongs to all humankind,' as it transcends culture, language and individual experience. Designed for writers and readers interested in exploring the narrative implications and possibilities of science, computing and AI, this workshop-focused course will combine readings, writing exercises and story crafting. Open to writers of all levels and backgrounds, the focus will be on research/science-based narrative rather than fantasy/folkloric writing. (i.e. wormholes, okay; elves and dragons, not so much.)

Last offered: Spring 2023 | Units: 5

ENGLISH 106A: Black Mirror: A.I.Activism (AMSTUD 106B, ARTHIST 168A, CSRE 106A, SYMSYS 168A)

Lecture/small group course exploring intersections of STEM, arts and humanities scholarship and practice that engages with, and generated by, exponential technologies. Our course explores the social ethical and artistic implications of artificial intelligence systems with an emphasis on aesthetics, civic society and racial justice, including scholarship on decolonial AI, indigenous AI, disability activism AI, feminist AI and the future of work for creative industries.

Terms: Win | Units: 3 | UG Reqs: WAY-A-II, WAY-EDP

Instructors: ; Elam, M. (PI)

ENGLISH 152E: Black Mirror: Representations of Race & Gender in AI (AFRICAAM 261E, ENGLISH 261E)

tba

| Units: 3-5

ENGLISH 261E: Black Mirror: Representations of Race & Gender in AI (AFRICAAM 261E, ENGLISH 152E)

tba

Last offered: Spring 2023 | Units: 3-5

ENGR 205: Introduction to Control Design Techniques

Review of root-locus and frequency response techniques for control system analysis and synthesis. State-space techniques for modeling, full-state feedback regulator design, pole placement, and observer design. Combined observer and regulator design. Lab experiments on computers connected to mechanical systems. Prerequisites: 105, MATH 103, 113. Recommended: Matlab.

Terms: Aut | Units: 3

Instructors: ; Rock, S. (PI); Hadfield, B. (TA); Taneja, Y. (TA)

ENGR 209A: Analysis and Control of Nonlinear Systems

Introduction to nonlinear phenomena: multiple equilibria, limit cycles, bifurcations, complex dynamical behavior. Planar dynamical systems, analysis using phase plane techniques. Describing functions. Lyapunov stability theory. SISO feedback linearization, sliding mode control. Design examples. Prerequisite: 205.

Terms: Spr | Units: 3

ENVRES 301: Navigating your PhD in E-IPER

Required core course restricted to first year E-IPER Ph.D. students. Introductory course to welcome new Ph.D. students to Stanford and E-IPER program. All programmatic, administrative and Stanford-specific information will be covered over the course of Autumn quarter.

Terms: Aut | Units: 1

Instructors: ; Pettigrew, A. (PI); Tran, A. (PI)

EPI 220: Deploying and Evaluating Fair AI in Healthcare (BIOMEDIN 223)

AI applications are proliferating throughout the healthcare system and stakeholders are faced with the opportunities and challenges of deploying these quickly evolving technologies. This course teaches the principles of AI evaluations in healthcare, provides a framework for deployment of AI in the healthcare system, reviews the regulatory environment, and discusses fundamental components used to evaluate the downstream effects of AI healthcare solutions, including biases and fairness. Prerequisites: CS106A; familiarity with statistics (stats 202), BIOMED 215, or BIODS 220

Terms: Spr | Units: 2-3

Instructors: ; Hernandez-Boussard, T. (PI)

ETHICSOC 182: Ethics, Public Policy, and Technological Change (COMM 180, CS 182, PHIL 82, POLISCI 182, PUBLPOL 182)

Examination of recent developments in computing technology and platforms through the lenses of philosophy, public policy, social science, and engineering. Course is organized around five main units: algorithmic decision-making and bias; data privacy and civil liberties; artificial intelligence and autonomous systems; the power of private computing platforms; and issues of diversity, equity, and inclusion in the technology sector. Each unit considers the promise, perils, rights, and responsibilities at play in technological developments. Prerequisite: CS106A.

Last offered: Winter 2023 | Units: 5 | UG Reqs: WAY-ER

FEMGEN 44Q: Gendered Innovations in Science, Medicine, Engineering, and Environment (HISTORY 44Q)

Gendered Innovations harness the creative power of sex, gender, and intersectional analysis for innovation and discovery. We focus on sex and gender, and consider factors intersecting with sex and gender, including age, race/ethnicity, socioeconomic status, educational background, disabilities, geographic location, etc. We start with the history of gender in science in the scientific revolution to understand how to transform research institutions so that women, men, and non-binary individuals can flourish. The majority of the course is devoted to considering gendered innovations in AI, social robotics, health & medicine, design of cars and cockpits, menstrual products, marine science, and more. This course will emphasize writing skills as well as oral and multimedia presentation; it fulfills the second level Writing and Rhetoric Requirement (WRITE 2), WAY-ED, and WAY-SI.

Terms: Spr | Units: 4 | UG Reqs: GER:DB-Hum, GER:EC-Gender, WAY-EDP, WAY-SI, Writing 2

Instructors: ; Schiebinger, L. (PI)

FEMGEN 152: Gender, Work, and the Global Digital Economy

How do understandings of gender shape the meaning and organization of work around the world in the digital age? And how is our contemporary digital economy shaped by often intertwined ideas about gender, ethnicity, and race? Feminist scholars have long studied the gendered and racialized dynamics of work, such as the impact of migration flows on the global care industry and the feminization of housework and "service with a smile." Rapid technological change has created new forms of labor in the content moderation industry, the gig economy, transnational surrogacy, online sex work, and automation and AI?all sites where shifting notions of work and the worker challenge existing frameworks around immigration and legal status, national borders, and workers' rights. To investigate these changes, this course takes an interdisciplinary, intersectional, and transnational approach. We will examine key debates in scholarship on reproductive labor, domestic work, and sexuality and political economy to analyze workplaces, conditions, and policies in the Americas, Asia, Africa, and Europe.

Terms: Spr | Units: 3-5 | UG Reqs: WAY-EDP

Instructors: ; Butler-Wall, A. (PI)

GENE 113: AI, Genes and Ethics (GENE 213)

What is AI and why is it sometimes biased ? How will AI affect medicine to help us but also what are the conditions in which it may harm us. 95% of single-gene diseases we know of have no effective treatment yet if we change a defective one how might that affect a species in the long term ? Is DNA 'the code of life?' Or is the 'code of life' the whole living organism in its complex, dynamic relationship with its environment? Will Earth one day be populated by beings who are different from us in their cognitive and physical abilities. This course will look at the intersection of AI and Genetics to analyze advances that could be made but also ethical questions that should be asked. The course is designed to be accessible to many disciplines and there are no pre-requisites.

| Units: 2-3 | Repeatable 6 times (up to 36 units total)

GENE 213: AI, Genes and Ethics (GENE 113)

What is AI and why is it sometimes biased ? How will AI affect medicine to help us but also what are the conditions in which it may harm us. 95% of single-gene diseases we know of have no effective treatment yet if we change a defective one how might that affect a species in the long term ? Is DNA 'the code of life?' Or is the 'code of life' the whole living organism in its complex, dynamic relationship with its environment? Will Earth one day be populated by beings who are different from us in their cognitive and physical abilities. This course will look at the intersection of AI and Genetics to analyze advances that could be made but also ethical questions that should be asked. The course is designed to be accessible to many disciplines and there are no pre-requisites.

Last offered: Autumn 2022 | Units: 2-3 | Repeatable 6 times (up to 36 units total)

GENE 214: Representations and Algorithms for Computational Molecular Biology (BIOE 214, BIOMEDIN 214, CS 274)

BIOMEDIN 214: Representations and Algorithms for Computational Molecular Biology (BIOE 214, CS 274, GENE 214)Topics: This is a graduate level introduction to bioinformatics and computational biology, algorithms for alignment of biological sequences and structures, BLAST, phylogenetic tree construction, hidden Markov models, basic structural computations on proteins, protein structure prediction, molecular dynamics and energy minimization, statistical analysis of 3D structure, knowledge controlled terminologies for molecular function, expression analysis, chemoinformatics, pharmacogenetics, network biology. Lectures are supplemented with assignments and programming projects, which allow students to implement important computational biology algorithms. Firm prerequisite: CS 106B. NOTE: For students in the Department of Biomedical Data Science Program, this core course MUST be taken as a letter grade only.

Terms: Aut | Units: 3-4

Instructors: ; Altman, R. (PI); Koodli, R. (TA); McCann, H. (TA); Nayar, G. (TA); Xiong, B. (TA)

GENE 231: AI for Beginners

How will AI help medicine but how could it harm us. This course will provide a high-level overview of AI techniques. Through pre-built hands-on exercises, we will cover neural networks and their applicability to generative AI and large language models. We will also discuss the societal and ethical issues surrounding the real-world applications of AI. This course is healthare oriented, looking at the intersection of AI and Genetics to analyze advances that could be made but also ethical questions that should be asked. The course is designed to be accessible to many disciplines and there are no pre-requisites.

Terms: Win | Units: 2-3

Instructors: ; Nag, R. (PI); Snyder, M. (PI); Trotsyuk, A. (PI)

GENE 236: Deep Learning in Genomics and Biomedicine (BIODS 237, BIOMEDIN 273B, CS 273B)

Recent breakthroughs in high-throughput genomic and biomedical data are transforming biological sciences into "big data" disciplines. In parallel, progress in deep neural networks are revolutionizing fields such as image recognition, natural language processing and, more broadly, AI. This course explores the exciting intersection between these two advances. The course will start with an introduction to deep learning and overview the relevant background in genomics and high-throughput biotechnology, focusing on the available data and their relevance. It will then cover the ongoing developments in deep learning (supervised, unsupervised and generative models) with the focus on the applications of these methods to biomedical data, which are beginning to produced dramatic results. In addition to predictive modeling, the course emphasizes how to visualize and extract interpretable, biological insights from such models. Recent papers from the literature will be presented and discussed. Experts in the field will present guest lectures. Students will be introduced to and work with popular deep learning software frameworks. Students will work in groups on a final class project using real world datasets. Prerequisites: College calculus, linear algebra, basic probability and statistics such as CS 109, and basic machine learning such as CS 229. No prior knowledge of genomics is necessary.

Last offered: Spring 2023 | Units: 3

GLOBAL 124: Global Algorithmic Development and Ethics

New generative models like ChatGPT have a unique impact on global AI development and deployment. Like other machine and deep learning models, they promise unprecedented potential for growth, education, improved quality of life, healthcare, and communication. Yet, the massive world-wide opportunities of AI also present risks and potentially harmful social impacts. This course explores the promise and peril of AI systems from global, non-Western perspectives, drawing on the expertise of global AI ethicist Dr. Nakeema Stefflbauer, who will lead many course sessions to elaborate on global, relational perspectives of developing and impacted communities. Starting with the scholarship of Stanford HAI researchers, course participants gain an overview of AI growth on a global scale. Students explore non-Western ethics highlighting perspectives of the Global South considering successes like Africa's Masakhane, Lelapa.AI and case studies in the Arab world, Latin America as well as problems of data sovereignty, labor conditions, and inclusion and marginalization. Students lead discussions of readings, write an original research paper, and/or present a poster or presentation on a topic of their choice.

Last offered: Spring 2023 | Units: 3-5

GLOBAL 200: Utopia, Dystopia, and Technology in Science Fiction: A Cross-Cultural Perspective (CHINA 171, CHINA 271)

This course explores how science fiction (sf) narratives from East and West imagine the future of humanity and human-nature relations. The blind faith in technoscientific power has aggravated class disparity, eroded the social fabric, and undermined the humanist legacy of the Enlightenment. Technological fetishism has given rise to apocalyptic futures of dystopia marked by destructive AI, the digital jungle of existential struggle, environmental degradation, climate disasters, class disparity, and posthuman barbarism. On the other hand, sf narratives keep hopes alive by projecting utopias, exposing the pitfalls of technological 'progress' and keeping faith with human sovereignty in renewing social ecology in balance with natural conditions.

Last offered: Winter 2023 | Units: 3-5

GSBGEN 310: Business and AI: Lessons from Entrepreneurs, Executives, and Investors

As AI technology advances at an unprecedented pace, both start-ups and established corporations are racing to harness its potential, aiming to revolutionize every sector with innovative applications. What are these opportunities, and how are these firms creating a sustainable competitive advantage? In this class, the teaching team will guide interactive classroom discussions on adopting AI in business. Guest speakers - CEOs or venture capitalists at the forefront of AI - will tell their stories, offering valuable insights from a myriad of industries and perspectives. The structure for this course will be a combination of: addressing what is different about starting an AI company; asking how AI companies (particularly Generative AI) are being valued and the associated risks; exploring how large companies are rapidly adopting AI; and introducing relevant economic models. Almost all days will have engaging speakers, and 50% of your course grade will be participation, as you interact with them and with your peers. There are two assignments and a group project. The faculty will provide a structured foundation to guide you, and short lectures on a number of topics. Students do not need in-depth technical knowledge of AI; you will be expected to learn the basics along the way, and will be taught about LLM models through examples.

Terms: Spr | Units: 3

Instructors: ; Shaw, K. (PI); Golden, J. (SI); Smeton, K. (GP)

GSBGEN 591: Entrepreneurship and Innovation in Education Technology Seminar

The last few years have created significant educational challenges and opportunities, especially given the emergence of Artificial Intelligence (AI); there has never been a more pressing and urgent need in our history to foster entrepreneurship in education by leveraging new technologies. This course will help you develop the skills and strategies necessary to effectively create and evaluate educational services and education technology startups, much like educators, entrepreneurs, philanthropists, and venture capital investors do. Some questions we will discuss include: How do entrepreneurs, educators, and VCs evaluate and grow successful education and edtech startups? Why do most startups in edtech fail, and what are the critical ingredients for success, especially in today's challenging times? What does it take to get venture capital financing in edtech? Why now? Each week will feature a different entrepreneur as a guest speaker; these leaders hail from a variety of innovative for-profit and non-profit startups. As we hear from the speakers, we'll evaluate all aspects of their invention, particularly in the context of AI, distance learning and hybrid learning ecosystems. A fundamental question we'll explore in this course is how educators and technologists can better collaborate to leverage the scale and impact of technology to improve educational equity and access. This course will be taught in person; attendance at each session is required.

The maximum capacity is 50 students. Juniors, Seniors and graduate students of all Stanford schools are welcome. Syllabus can be viewed here: https://monsalve.people.stanford.edu/courses-and-seminars

Terms: Spr | Units: 2

Instructors: ; Monsalve, S. (PI); Brennan, R. (TA); Yan, J. (GP)

GSBGEN 596: Designing AI to Cultivate Human Well-Being

Artificial Intelligence (AI) has the potential to drive us towards a better future for all of humanity, but it also comes with significant risks and challenges. At its best, AI can help humans mitigate climate change, diagnose and treat diseases more effectively, enhance learning, and improve access to capital throughout the world. But it also has the potential to exacerbate human biases, destroy trust in information flow, displace entire industries, and amplify inequality throughout the world. We have arrived at a pivotal moment in the development of the technology in which we must establish a foundation for how we will design AI to capture the positive potential and mitigate the negative risks. To do this, we must be intentional about human-centered design because, 'Only once we have thought hard about what sort of future we want, will we be able to begin steering a course toward a desirable future. If we don't know what we want, we're unlikely to get it.' Thus, building AI must be an inclusive, interactive, and introspective process guided by an affirmative vision of a beneficial AI-future. The goal of this interdisciplinary class is to bridge the gap between technological and societal objectives: How do we design AI to promote human well-being? The ultimate aim is to provide tools and frameworks to build a more harmonious human society based on cooperation toward a shared vision. Thus, students are trained in basic science to understand what brings about the conditions for human flourishing and will create meaningful AI technologies that aligns with the PACE framework:·has a clear and meaningful purpose ·augments human dignity and autonomy ·creates a feeling of inclusivity and collaboration· creates shared prosperity and a sense of forward movement (excellence)Toward this end, students work in interdisciplinary teams on a final project and propose a solution that tackles a significant societal challenge by leveraging technology and frameworks on human thriving.

Last offered: Winter 2021 | Units: 2

GSBGID 500: Building Trustworthy Products in a Divided World

Advances in technology improve our lives but also present many challenges. Today, tech companies wield immense power to shape society, yet face enormous trust deficits. How can leaders design and build new technology products, make decisions, and develop and enforce product policies that society can trust? How can leaders effectively include outside stakeholders in these decisions, and are there cases where leaders can most effectively lead by giving up the power to make certain especially weighty decisions? In this class, we will host a variety of leaders from the tech space and beyond to discuss these questions and to explore how we can harness new developments in AI, AR/VR, social media, and web3 to maximize good outcomes, minimize harms, and rebuild trust between technology and society.

Terms: Win | Units: 1

Instructors: ; Hall, A. (PI); Yan, J. (GP)

HISTORY 44Q: Gendered Innovations in Science, Medicine, Engineering, and Environment (FEMGEN 44Q)

Gendered Innovations harness the creative power of sex, gender, and intersectional analysis for innovation and discovery. We focus on sex and gender, and consider factors intersecting with sex and gender, including age, race/ethnicity, socioeconomic status, educational background, disabilities, geographic location, etc. We start with the history of gender in science in the scientific revolution to understand how to transform research institutions so that women, men, and non-binary individuals can flourish. The majority of the course is devoted to considering gendered innovations in AI, social robotics, health & medicine, design of cars and cockpits, menstrual products, marine science, and more. This course will emphasize writing skills as well as oral and multimedia presentation; it fulfills the second level Writing and Rhetoric Requirement (WRITE 2), WAY-ED, and WAY-SI.

Terms: Spr | Units: 4 | UG Reqs: GER:DB-Hum, GER:EC-Gender, WAY-EDP, WAY-SI, Writing 2

Instructors: ; Schiebinger, L. (PI)

HRP 285: Global Leaders and Innovators in Human and Planetary Health: Sustainable Societies Lab (MED 285, SUSTAIN 345)

Are you interested in innovative ideas and strategies for addressing urgent challenges in human and planetary health and creating sustainable societies? This 7 session lecture series features a selection of noteworthy leaders, innovators, and experts across diverse sectors/topics in health and the environment such as: health innovation and environmental sustainability, social and environmental justice and equality, social innovation and entrepreneurship ecosystems, foundations and venture capital, tech innovation, media and AI, biotech and ag-tech, pandemics, public health and community wellbeing, food systems and agricultural innovation, hunger and nutrition, clean water and air, nonprofits and community action, public policy innovation and systems change, and the role of academia and you. Co-convened and co-designed by faculty, fellows and students collaborating across several Stanford centers, departments, schools, the course invites the discussion of global problems, interdisciplinary perspectives, and systemic solutions for the climate crisis and human health. The course will address root causes of the climate crisis and urgent challenges of human and planetary health, including sociological constraints, political objectives, economic incentives, technological limitations, and preservation of global stability, and suggest models of leadership, innovation and sustainable social change. We will also delve into efforts to catalyze long-term sustainability across the private, nonprofit, and public sectors. Students from all backgrounds are encouraged to enroll - registration is open to all Stanford students and fellows. May be repeated for credit.

Terms: Aut | Units: 1-2 | Repeatable 4 times (up to 8 units total)

Instructors: ; Bloom, G. (PI); Singer, S. (SI)

INTLPOL 200: The Social & Economic Impact of Artificial Intelligence (CS 22A, SYMSYS 122)

Recent advances in Generative Artificial Intelligence place us at the threshold of a unique turning point in human history. For the first time, we face the prospect that we are not the only generally intelligent entities, and indeed that we may be less capable than our own creations. As this remarkable new technology continues to advance, we are likely to entrust management of our environment, economy, security, infrastructure, food production, healthcare, and to a large degree even our personal activities, to artificially intelligent computer systems. The prospect of "turning over the keys" to increasingly autonomous and unpredictable machines raises many complex and troubling questions. How will society respond as they displace an ever-expanding spectrum of blue- and white-collar workers? Will the benefits of this technological revolution be broadly distributed or accrue to a lucky few? How can we ensure that these systems are free of bias and align with human ethical principles? What role will they play in our system of justice and the practice of law? How will they be used or abused in democratic societies and autocratic regimes? Will they alter the geopolitical balance of power, and change the nature of warfare? Are we merely a stepping-stone to a new form of non-biological life, or are we just getting better at building useful gadgets? The goal of this course is to equip students with the intellectual tools, ethical foundation, and psychological framework to successfully navigate the coming age of superintelligent machines. (Note: This course is pre-approved for credit at SLS and GSB. No programming or technical knowledge is required.)

Terms: Win | Units: 1

Instructors: ; Kaplan, J. (PI)

INTLPOL 253: AI and Rule of Law: A Global Perspective

Advances in machine learning, big data, networked communications, and computing are transforming our world and fueling calls for regulation. This course--a joint venture of a Stanford law professor and a former Member of the European Parliament and leading voice on tech regulation--offers a global perspective on the profound legal and governance challenges posed by the new digital technologies. Students will emerge with an understanding of how tech is reshaping the global distribution of political authority, rights, and resources, the existing state of law and regulation in the U.S., Europe, China, and elsewhere, and the new democratic governance models that are emerging in response. Each class session will feature one or more distinguished speakers from around the world drawn from the ranks of government officials, judges, activists, and academics who work in the fields of human rights, privacy, free speech, trade, and national security. There are no course prerequisites, whether in law or otherwise. Students will be responsible for one-page responses to each week's readings and a research paper to be turned in at the spring paper deadline. Students can take the course for 2 or 3 units, depending on research paper length. This class is cross-listed with LAW 4050, and undergraduates and graduates are eligible to take it. Stanford Non-Law students may enroll in INTLPOL 253 directly in Axess. Non-law students wishing to enroll in LAW 4050 should complete the Non-Law Student Add Request form available at https://law.stanford.edu/education/courses/non-law-students/ for a permission number to enroll. Elements used in grading: Attendance, Class Participation, Written Assignments, Final Paper.

Last offered: Spring 2020 | Units: 2-3

INTLPOL 256: Technology and National Security (MS&E 193)

Explores the relation between technology, war, and national security policy with reference to current events. Course focuses on current U.S. national security challenges and the role that technology plays in shaping our understanding and response to these challenges, including the recent Russia-Ukraine conflict. Topics include: interplay between technology and modes of warfare; dominant and emerging technologies such as nuclear weapons, cyber, sensors, stealth, and biological; security challenges to the U.S.; and the U.S. response and adaptation to new technologies of military significance.

Terms: Aut | Units: 3-4

Instructors: ; Lin, H. (PI); Bhaskara, V. (TA); Legrand, A. (TA)

INTLPOL 259A: Research Seminar on Cybersecurity: Topics at the Intersection of Security, Safety, and Privacy

The course will explore the safety, security and privacy implications of the automobile. The modern automobile is a computer on wheels, with processors, sensors and networked connectivity managing hundreds of safety-critical functions. Automation will further drive the evolution of cars from the analog, mechanically-operated vehicles of the 20th century to the digital, AI-driven automobile of the 21st century. Overall, digitization has made cars safer, greener, and more enjoyable to ride in. But this digitization also introduces new risks. Cybersecurity vulnerabilities can expose vehicle occupants, commuters and pedestrians to safety and privacy risks. In addition to the physical, economic and psychological harms experienced by victims of cybersecurity attacks and intrusions, such attacks could undermine consumer and policy-maker confidence in the trustworthiness of digitally-dependent vehicles. The automotive industry and government regulators are in the formative stages of developing regulatory and governance frameworks for these risks, which may have broader implications for regulatory policy concerning digital technologies generally. Students will accompany the instructor on a deep dive into the regulatory, business, and geopolitical dimensions of the automobile. Each student will be expected to use the course to produce a publication-quality research paper on a relevant topic of their choosing (in consultation with the instructor), with mentorship from the instructor and peer support from fellow classmates. (Students may register for 2-4 units with increased research paper word count per unit. 10 slots, graduate students only, undergraduates by permission of instructor.) Note: Topic of course may change from year-to-year. Update in Winter Quarter 2021.

Terms: Spr | Units: 2-4

Instructors: ; Grotto, A. (PI)

INTLPOL 265: AI, Autonomy, and the Future of Warfare (PUBLPOL 119, PUBLPOL 219)

The introduction of artificial intelligence and autonomy into warfare will have profound and unforeseen consequences for national security and human society. This course prepares future policymakers and industry leaders for the complex debate surrounding the developmental, legal, ethical, and operational considerations of creating machines with the ability to apply lethal force. Students will gain a detailed and multi-perspective understanding of the associated opportunities and risk by lectures and discussions with expert guest speakers and a cohort of students from a variety of disciplines and backgrounds. There will be two days of class each week. One day is a lecture session and the other is a discussion session. The lecture session will occasionally have guest lecturers with recent real-world experience in the topic and is intended to expose students to current knowledge and perspectives. The following discussion session will be an opportunity to digest, and reflect on, the ideas from lecture, but will also be a chance for group work on graded assignments. No experience in the content is necessary. Varying perspectives are essential in any conversation on this topic. Undergrads also welcome.

Terms: Spr | Units: 3

Instructors: ; Boyd, B. (PI)

INTLPOL 267: Trust and Safety (COMM 122, CS 152)

Trust and Safety is an emerging field of professional and academic effort to build technologies that allow people to positively use the internet while being safe from harm. This course provides an introduction to the ways online services are abused to cause real human harm and the potential social, operational, product, legal and engineering responses. Students will learn about fraud, account takeovers, the use of social media by terrorists, misinformation, child exploitation, harassment, bullying and self-harm. This will include studying both the technical and sociological roots of these harms and the ways various online providers have responded. The class is taught by a practitioner, a professor of communication, a political scientist, and supplemented by guest lecturers from tech companies and nonprofits. Cross-disciplinary teams of students will spend the quarter building a technical and policy solution to a real trust and safety challenge, which will include the application of AI technologies to detecting and stopping abuse. For those taking this course for CS credit, the prerequisite is CS106B or equivalent programming experience and this course fulfills the Technology in Society requirement. Content note: This class will cover real-world harmful behavior and expose students to potentially upsetting material.

Terms: Spr | Units: 3

Instructors: ; Grossman, S. (PI); Hancock, J. (PI); Stamos, A. (PI)

INTLPOL 340: Technology, Innovation and Great Power Competition (MS&E 296)

This course explores how new technologies pose challenges and create opportunities for the United States to compete more effectively with rivals in the international system with a focus on strategic competition with the People's Republic of China. In this experiential policy class, you will address a priority national security challenge employing the "Lean" problem solving methodology to validate the problem and propose a detailed technology informed solution tested against actual experts and stakeholders in the technology and national security ecosystem. The course builds on concepts presented in MS&E 193/293: Technology and National Security and provides a strong foundation for MS&E 297: Hacking for Defense.

Terms: Aut | Units: 4

Instructors: ; Blank, S. (PI); Brown, M. (PI); Felter, J. (PI); Jonga, S. (TA); Lakhtakia, S. (TA)

INTNLREL 115: Spies, Lies, and Algorithms: The History and Future of American Intelligence (AMSTUD 115S, POLISCI 115, PUBLPOL 114)

This course examines the past, present, and future of American espionage. Targeted at first years and sophomores, the class surveys key issues in the development of the U.S. Intelligence Community since World War II. Topics include covert action, intelligence successes and failures, the changing motives and methods of traitors, congressional oversight, and ethical dilemmas. The course pays particular attention to how emerging technologies are transforming intelligence today. We examine cyber threats, the growing use of AI for both insight and deception, and the 'open-source' intelligence revolution online. Classes include guest lectures by former senior U.S. intelligence officials, policymakers, and open-source intelligence leaders. Course requirements include an all-day crisis simulation with former senior officials designed to give students a hands-on feel for the uncertainties, coordination challenges, time pressures, and policy frictions of intelligence in the American foreign policy process.

Last offered: Spring 2023 | Units: 5 | UG Reqs: WAY-SI

INTNLREL 140B: Navigating New Frontiers in International Law

In this seminar, students will delve into the interplay between international law and international relations, with a focus on understanding the challenges and opportunities presented by emerging technologies, particularly AI. Through examining legal and political theories and case studies, students will gain insights into the role of international law in shaping state behavior, global governance, and cooperation. Key topics include treaty-making processes, soft law, customary international law, state sovereignty, and the impact of new frontiers in international law, such as AI regulation. As AI technologies advance, they pose novel legal, ethical, and practical questions transcending national borders. This class will investigate AI's implications on human rights, privacy, and international security, exploring issues like autonomous weapons, surveillance, and AI-driven decision-making. The course will address central questions such as: How does the intersection of international law and relations shape global challenges? What principles and sources of international law influence state behavior and cooperation? How do emerging technologies, particularly AI, challenge existing legal frameworks? What is the current landscape of AI regulation, and what are the prospects for global governance? This seminar aims to equip students with the analytical and critical thinking skills necessary to engage in shaping the future of international law in a rapidly evolving technological landscape. The course is suitable for advanced undergraduates. Prior coursework in international law or international relations is recommended but not required.

Terms: Spr | Units: 5

Instructors: ; Heller, B. (PI)

ITALIAN 103: Future Text: AI and Literatures, Cultures, and Languages (DLCL 103)

How do AI language models work and what is their impact on education? In this course we will: Experiment with translation; Experiment with textual analysis of specific texts from different contexts and historical periods and cultures; Experiment with large data questions that are very hard to do by a single person; Experiment with ways to fact-check an AI generated work: we know AI creates false assertions, and backs them up with false references; Experiment with collaborating with AI to write a final paper, a blog, a newspaper article, etc.

Terms: Aut | Units: 4 | UG Reqs: WAY-A-II, WAY-EDP

Instructors: ; Dombrowski, Q. (PI); Wittman, L. (PI); Kim, E. (TA); Nepomuceno, A. (TA)

LAW 240L: Discussion (1L): Robot Ethics

We will consider the developing legal and ethical problems of robots and artificial intelligence (AI), particularly self-directed and learning AIs. How do self-driving cars (or autonomous weapons systems) value human lives? How do we trade off accuracy against other values in predictive algorithms? At what point should we consider AIs autonomous entities with their own rights and responsibilities? And how can courts and legislatures set legal rules robots can understand and obey? This discussion seminar will meet four times during the Fall quarter. Meeting dates and times to be arranged by instructor. Elements used in grading: Attendance and class participation.

Last offered: Autumn 2020 | Units: 1

LAW 240T: Discussion (1L): Race and Technology

People like to think of technology as value neutral, as essentially objective tools that can be used for good or evil, particularly when questions of race and racial justice are involved. But the technologies we develop and deploy are frequently shaped by historical prejudices, biases, and inequalities and thus may be no less biased and racist than the underlying society in which they exist. In this discussion group, we will consider whether and how racial and other biases are present in a wide range of technologies, particularly artificial intelligence tools like risk assessment algorithms for bail, sentencing, predictive policing, and other decisions in the criminal justice system; algorithms for medical diagnosis and treatment decisions; AI that screens tenant or credit applications or job applications; facial recognition systems; surveillance tools; and many more. Building on these various case studies, we will seek to articulate a framework for recognizing both explicit and subtle anti-black and other biases in technology and understanding them in the broader context of racism and inequality in our society. Finally, we will discuss how these problems might be addressed, including by regulators, legislators, and courts as well as by significant changes in mindset and practical engagement by technology developers, companies, and educators. Class meets 4:30 PM-6:30 PM on Sept. 21, Oct. 5, Oct. 19, Nov. 2, 2023. Elements used in grading: Full attendance, reading of assigned materials, and active participation.

Terms: Aut | Units: 1

Instructors: ; Malone, P. (PI)

LAW 241Q: Discussion (1L): Rationalism, Contrarianism, and Bayesian Thinking in Politics: How to Think Better?

In the early 2010s, the Bay Area spawned a movement of thinkers obsessed with cognitive biases and "Bayesian reasoning," a way of using statistics and probability to inform beliefs. This group--that later came to be known as "rationalists"--insists on subjecting all spheres of life to scientific scrutiny and probabilistic reasoning. Rationalist takes are often contrarian and challenge mainstream ways of thinking about topics that include everything from science and medicine to philosophy and politics to the rise of artificial intelligence. Rationalist writings in blogs and books can be controversial. For example, some rationalists have discussed the genetics of depression or intelligence. Since 2015, however, rationalism has become a brand in Silicon Valley and hugely influential among pundits and executives. Members of the rationalist movement also overlapped with the growing community of "effective altruism," an effort to remake charity donations by focusing on, and calculating, the actual impact of every dollar on human lives. And the movement is full of quirks and, well, weirdness: a fear of AI armaggedon, polyamory, and group living near Berkeley is common. Politically, rationalists are mostly center-left, but they range from "communist to anarcho-capitalist." What brings them together, however, is that they are careful thinkers, quantitatively-oriented, and contrarians. In this seminar we will explore what the Rationalist movement is all about--what and how they think. We will take both a critical but also inquisitive view. What is to be gained from rationalists? Can their way of thinking improve political debates? We will read several books, including James Scott's "Seeing like a State," Julia Galef's "Scout Mindset," Philip Tetlock's "Superforcasters," blog posts

from a website called "Less Wrong," and a series of blog-posts by the psychiatrist-cum-polymath Scott Alexander on drug arrests, crime spikes, and medical regulations, among others. Class meets 5:30 PM-7:30 PM on Sept. 28, Oct. 12, Oct. 26, Nov. 9.

Last offered: Autumn 2022 | Units: 1

LAW 808X: Policy Practicum: Becoming the Tech Creator and Regulator: Redefining Insurance Solutions

Consumers are often faced with insurance policies that are lengthy, incomprehensible, and incredibly vague. Whether it's healthcare, homeowners or auto insurance, people cannot easily determine the extent of coverage and risk represented in insurance contracts. The contracts alone do not express clearly whether they provide sufficient coverage to the individual and/or how to make use of them when a problem arises. In this Policy Practicum, jointly hosted by Stanford CodeX and the Legal Design Lab, students will research and learn both theoretical foundations and practical tools to develop solutions that solve for transparency, accessibility, and literacy in the insurance industry. Students will gather the technical knowledge of the industry, conduct client interviews, and learn design thinking and product management skills. We will focus on the use case of revolutionizing the insurance ecosystem to address the aforementioned issues. Students will first interview and understand our client's, NAIC, needs in addressing the insurance concerns of various constituents, and identify their most pressing and specific obstacles. Students will act as creators -- in this role, they will learn skills on how to develop technologically driven solutions, gain an understanding of how to apply a suite of AI-driven applications, analyze legal information problems through the lens of computational law, and advise on how to best address clients' needs. Students will also gain insight into methodologies in Science and Technology Studies (STS) to critically analyze their solutions, when they transition into their roles as regulators. Technology-driven solutions are frequently developed in silos and do not have sufficient foresight around the unintended consequences. In applying an STS framework, they will evaluate their solution's policy implications: ethical, regulatory and legal standards; and fairness, accountability, and inclusivity measures. The policy lab aims to help students understand and contribute new insights and communities of practice on how to use, assess, develop, and iterate on technology-driven solutions that are "future-conscious," - weighed against ethical, regulatory and legal concerns, to help address NAIC's challenges in the insurance industry. This class is open to Stanford law students, and available for cross-registration for engineering, computer science, and humanities students. Students will be working together in small teams. Elements used in grading: Attendance, Performance, Class Participation, Written Assignments, Final Paper. CONSENT APPLICATION: To apply for this course, students must complete and submit a Consent Application Form available at https://law.stanford.edu/education/courses/consent-of-instructor-forms/. See Consent Application Form for instructions and submission deadline.

Last offered: Winter 2023 | Units: 2

LAW 809A: Policy Practicum: Governance and Regulation of Emerging Technologies

Policy Client: McCourt Institute, https://mccourtinstitute.org/. This policy lab will provide students an opportunity to learn about and write research reports concerning the governance of the newest technologies. The students will form three teams with each team producing one group report on one of the following technologies: (1) Blockchain (principally non-crypto applications); (2) virtual and extended reality; and (3) Generative AI (Chat GPT, Dall-E, etc.). There will be three classes on each topic -- one to describe the harms presented by the technology, another to investigate private governance solutions and best practices, and a final that will explore options for government regulation. The three group oral presentations and written reports will follow that same structure. The goal is to provide a blueprint for regulators and firms concerning governance of these new technologies. Students are expected to attend all classes. Students will consider the ethical implications of new technologies and the role of lawyers in mitigating risks for firms engaging in these new technologies. The class will be limited to 20 students -- at least half of whom will be law students. The other half will be comprised of graduate students and advanced undergraduates from disciplines across the university and who can demonstrate knowledge and background in the relevant technologies. The class will meet at the Law School on Mondays from 4:15 to 6:15 pm. NOTE: Admission is with consent of the instructor. Interested students should submit a one-paragraph statement describing their background and interest in the class and the particular technology for their focus. Submit statements of interest using the form available at https://forms.gle/DMgc4GVEX6wdKKZNA. Students should also complete the consent application form available at https://registrar.law.stanford.edu. SKILLS TRAINING: Students who enroll in a Law and Policy Lab practicum for the first time are asked to participate in the full-day methods boot camp on the first Saturday of the term. If you wish to earn course credit for developing your policy analysis skills, you may formally enroll in "Elements of Policy Analysis" (Law 7846) for one-unit of additional credit. As you will see from the course description, credit for Law 7846 requires your attendance at the full-day methods boot camp plus at least two additional lunch-hour workshops. If you enroll in a practicum but prefer to audit the supplemental skills class -- rather than receive formal credit -- please let Policy Lab Program Director Luciana Herman (lherman@law.stanford.edu) know and she will contact you with more details. Elements used in grading: Attendance, Performance, Class Participation, Written Assignments, Final Paper.

Last offered: Spring 2023 | Units: 3

LAW 809E: Policy Practicum: AI For Legal Help

The policy client for this project is the Legal Services Corporation (https://www.lsc.gov/): This project works closely with the Legal Services Corporation's Technology Information Grant Program (https://www.lsc.gov/grants/technology-initiative-grant-program) to research how the public interacts with AI platforms to seek legal assistance, and to develop a strategy around how to mitigate risks, ensure quality, and enhance access to justice on these AI platforms. AI increase access to justice, by helping people resolve their legal problems in more accessible, equitable, and effective ways? What are the risks that AI poses for people seeking legal guidance, that technical and policy guardrails should mitigate? In this course, students will conduct research to identify key opportunities and risks around AI's use by the public to deal with common legal problems like bad living conditions, possible evictions, debt collection, divorce, or domestic violence. Especially with the launch of new AI platforms like ChatGPT, Google Bard, and Bing Chat, more people may turn to generative AI platforms for guidance on their legal rights, options, and procedures. How can technology companies, legal institutions, and community groups responsibly advance AI solutions to benefit people in need? Students will explore these questions about AI and access to justice through hands-on interviews, fieldwork, and design workshops with different stakeholders throughout the justice system. They will run interview sessions online and on-site at courts, to hear from various community members about whether they would use AI for legal help and to brainstorm how the ideal AI system would behave. Students will also observe how participants use AI to respond to a fictional legal problem, to assess how the AI performs and understand how people regard the AI's guidance. Students will be required to complete ethical training for human subjects research, which takes approximately 2 hours through the CITI program online. They will then conduct community interviews according to an approved IRB research protocol. Students will synthesize what they learn in these community interviews, observations, and brainstorm sessions, in a presentation to legal and technical experts. They will hold a multi-stakeholder workshop at to explore how their findings may contribute to technical and legal projects to develop responsible, human-centered AI in the legal domain. Students will develop skills in facilitating interdisciplinary policy discussions about how technology and regulation can be developed alongside each other. The students¿ final report will contribute to policy and technology discussions about the principles, benchmarks, and risk typologies that can guide the ethical development of AI platforms for access to justice. Students are asked to enroll in both Fall and Winter quarters of the class. The class may be extended to Spring quarter, depending on the issues raised. Elements used in grading: Attendance, Performance, Class Participation, and Written Assignments. CONSENT APPLICATION: To apply for this course, students must complete and submit a Consent Application Form available at SLS Registrar https://registrar.law.stanford.edu/.

Terms: Aut, Win | Units: 3 | Repeatable 3 times (up to 9 units total)

Instructors: ; Al Haider, N. (PI); Hagan, M. (PI)

LAW 809Q: Policy Practicum: Safeguarding Judicial Independence Around the World

An impartial and independent judiciary is crucial for safeguarding democracy and the rule of law. In this policy practicum, students will work on several important projects for submission to the UN Special Rapporteur on the Independence of Judges and Lawyers, Professor Margaret Satterthwaite. The Rapporteur's UN mandate positions her to have a real-time impact on efforts to defend democracy in a time of authoritarian overreach and democratic backsliding. She executes her mandate through individual case work, reports on spotlighted countries, amicus briefs, and thematic reports on key issues. Under the supervision of the instructor, and in consultation with the U.N. special rapporteur, students will work in small teams to provide carefully researched, time-relevant inputs on one or more of the following crucial topics: 1. The promise and perils of artificial intelligence in judicial systems. Students will prepare case studies and legal analysis of how judges and lawyers are using AI tools in countries around the world. Human rights standards require that all people should be equal before competent, independent and impartial courts established by law. Questions to be explored include: can AI tools reduce cognitive biases and errors in human judgment that harm equality before courts or is bias baked into the AI tools that judges can use? Can AI help extend access to justice by providing tools that make lawyers' work faster and less expensive, or even obviate the need for a lawyer on simple cases? Is there a right to have a human lawyer, or to have a case decided by a human judge? 2. The independence of Indigenous juridical systems. Students will provide case studies exploring how Indigenous peoples have maintained their legal and judicial systems in the United States and countries around the world. The UN Declaration on the Rights of Indigenous Peoples guarantees the right of Indigenous peoples "to promote, develop and maintain their institutional structures," including "juridical systems or customs, in accordance with international human rights standards." Questions to be explored include: what challenges have Indigenous peoples faced in maintaining their legal and judicial systems? Are there good practices for safeguarding the self-determination of Indigenous peoples through their juridical systems? 3. Economic and corporate capture of judicial systems. The right to a fair trial requires independent and impartial courts, and international standards make clear that judges must be free from "improper influences [or] inducements" from "any quarter or for any reason." Students will prepare case studies illustrating the risk to judicial systems emanating from powerful economic or corporate interests. Questions to be explored include: what counts as improper economic inducement of a court or its judges and who decides? What rules exist to limit the influence of corporations or other wealthy actors from influencing the selection or appointment of judges? Do ethical codes and laws effectively shield judges from undue influence by powerful economic actors? Are there policies or practices that ensure a country's judiciary is open to jurists of diverse wealth or class backgrounds? Through this practicum, students will learn to work for and engage with a policy client; have an opportunity to have real-time, practical impact on key problems around the world relating to judicial independence; and also hone their legal research, policy analysis, and writing skills. Elements used in grading: Attendance, Performance, Class Participation, Written Assignments. CONSENT APPLICATION: To apply for this course, students must submit a Consent Application Form at SLS Registrar https://registrar.law.stanford.edu/. See the Consent Application Form for instructions and the submission deadline.

Terms: Spr | Units: 2

Instructors: ; Singh, A. (PI)

LAW 1038: The Future of Finance

This 2-credit course will examine vast changes driven by innovation both from within traditional finance and from new ecosystems in fintech among others. Breathtaking advances in financial theory, big data, machine learning, artificial intelligence, computational capability, IoT, payment systems (e.g. blockchain, crypto currencies), new products (e.g. robo advising, digital lending, crowd funding, smart contracts), new trading processes (e.g. algorithmic trading, AI-driven sales & trading), and new markets (e.g. ETFs, zero-cost products), among others are changing not only how financial and non-financial firms conduct business but also how investors and supervisors view the players and the markets. We will discuss critical strategy, policy and legal issues, some resolved and others yet to be (e.g. failed business models, cyber challenges, financial warfare, fake news, bias problems, legal standing for cryptos). The course will feature perspectives from guest speakers including top finance executives and Silicon Valley entrepreneurs on up-to-the-minute challenges and opportunities in finance. Elements used in grading: Class Participation, Attendance, Final Paper. Cross-listed with Economics (ECON 152/252), Public Policy (PUBLPOL 364), Statistics (STATS 238).

Last offered: Winter 2020 | Units: 2

LAW 3508: Law and Visual Culture

When we represent our experience today, we do so as much through images as language. When we seek to persuade, we offer photographs, charts, videos. When we witness misconduct, we pull out our smartphones. Social media has emerged as a powerful court of public opinion. AI has made it easy to generate realistic images out of thin air. And as images saturate our cultural discourse, they are increasingly part of legal practice. The power of an image often lies in its apparent simplicity: we know it when we see it. But how much of what we see is produced by the biases and expectations -- the habits of viewing -- that we bring to the encounter? What is left out when an infographic distills information for us? Lawyers and judges have historically tended to treat certain kinds of images as unmediated representations of reality, even though neuroscience, empirical research, and cultural theory all refute this so-called reality effect. Such naïve realism maps on to an ideal of definitive proof embedded in the adversary system. And it haunts our efforts to adapt legal practice to visual persuasion in ways that are consistent with our rule of law values. This interdisciplinary seminar tracks the legal reception of modern visual representation from confusion about the admissibility of photographs in the late 19th century (is it like a drawing? is it like eyewitness testimony?) to the trials of O.J Simpson and the police officers that assaulted Rodney King in the 1990s (how does race affect our perception of trails? do judges and jurors decide differently when the proceedings are televised?) to the frequent and strategic deployment of visual media in pretrial and litigation practice today. We will also consider the roles of visual persuasion in areas of doctrine (like privacy, qualified immunity, and freedom of speech) as well as applications in practice (like contracts and client communications). Throughout the quarter, we will attend to the ways American visual culture has resisted and reinforced systemic racism and inequality. Special Instructions: This course can satisfy the Research "R" requirement. The instructor and the student must agree whether the student will receive "R" credit. For "R" credit, the paper is substantial and is based on independent research. After the term begins, students accepted into the course can transfer from section (01) into section (02), which meets the R requirement, with consent of the instructor. Elements Used in Grading: Class Participation. Attendance, Written Assignments, Final Paper. Automatic grading penalty waived for writers.

Terms: Win | Units: 3

Instructors: ; Sassoubre, T. (PI)

LAW 4039: Regulating Artificial Intelligence

Even just a generation ago, interest in "artificial intelligence" (AI) was largely confined to academic computer science, philosophy, engineering research and development efforts, and science fiction. Today the term is widely understood to encompass not only long-term efforts to simulate the kind of general intelligence humans reflect, but also fast-evolving technologies (such as elaborate convolutional neural networks leveraging vast amounts of data) increasingly affecting finance, transportation, health care, national security, advertising and social media, and a variety of other fields. Conceived for students with interest in law, business, public policy, design, and ethics, this highly interactive course surveys current and emerging legal and policy problems related to how law structures humanity's relationship to artificially-constructed intelligence. To deepen students' understanding of current and medium-term problems in this area, the course explores definitions and foundational concepts associated with "artificial intelligence," likely directions for the evolution of AI, and different types of legally-relevant concerns raised by those developments and by the use of existing versions of AI. We will consider distinct settings where regulation of AI is emerging as a challenge or topic of interest, including autonomous vehicles, autonomous weapons, AI in social media/communications platforms, and systemic AI safety problems; doctrines and legal provisions relevant to the development, control, and deployment of AI such as the European Union's General Data Protection Regulation; the connection between the legal treatment of manufactured intelligence and related bodies of existing law, such as administrative law, torts, constitutional principles, criminal justice, and international law; and new legal arrangements that could affect the development and use of AI. We will also cover topics associated with the development and design of AI as they relate to the legal system, such as measuring algorithmic bias and explainability of AI models. Cross-cutting themes will

include: how law affects the way important societal decisions are justified, the balance of power and responsibility between humans and machines in different settings, the incorporation of multiple values into AI decision making frameworks, the interplay of norms and formal law, the technical complexities that may arise as society scales deployment of AI systems, and similarities and differences to other domains of human activity raising regulatory trade-offs and affected by technological change. Note: The course is designed both for students who want a survey of the field and lack any technical knowledge, as well as for students who want to gain tools and ideas to deepen their existing interest or background in the topic. Students with longer-term interest in or experience with the subject are welcome to do a more technically-oriented paper or project in connection with this class. But technical knowledge or familiarity with AI is not a prerequisite, as various optional readings and some in-class material will help provide necessary background. Requirements: The course involves a mix of lectures, in-class activities, and student-led discussion and presentations. Requirements include attendance, participation in planning and conducting at least one student-led group presentation or discussion, two short 3-5 pp. response papers for other class sessions, and either an exam or a 25-30 pp. research paper. After the term begins, students accepted into the course can transfer, with consent of the instructor, from section (01) into section (02), which meets the R requirement. CONSENT APPLICATION: We will try to accommodate as many people as possible with interest in the course. But to facilitate planning and confirm your level of interest, please fill out an application (available at https://bit.ly/2MJlem9) by TBA. Applications received after the deadline will be considered on a rolling basis if space is available. The application is also available on the SLS website (Click Courses at the bottom of the homepage and then click Consent of Instructor Forms).

Last offered: Spring 2021 | Units: 3

LAW 4040: Hot Issues in Tech Policy (Reading Group)

In our hyper-networked world dominated by digital gatekeepers, tech policy implicates the law, business, engineering and --- perhaps foremost --- society. Effective lawyering in the field must be multi-dimensional and incorporate economic, technological, societal and historical perspectives on the issues. This reading group will put these principles into action by examining current tech policy issues through these lenses. Past offerings of the reading group examined breaking issues such as Facebook and Cambridge Analytica (data collection and use); Uber and the Arizona pedestrian death (testing of AI); Amazon and antitrust (competition online); Apple and iPhone encryption (privacy vs. security); and LinkedIn and public user data (platform control and data ownership). Some possible topics this year include AI and facial recognition; social networks and political advertising; and Google, Apple and digital competition. The reading group does not require a technology background --- just interest in gaining a deeper understanding of the issues. It will meet every other week starting week 1 (weeks 1, 3, 5, 7 and 9) on Thursdays, 6:30PM to 8:30PM. Grading (MP/R/F) will be based on attendance and class participation. Enrollment will be limited to 10 students, with consent of the instructor. CONSENT APPLICATION: To apply for this course, students must complete and submit a short Consent Application Form available on the SLS website (click Courses at the bottom of the homepage and then click Consent of Instructor Forms). Applications are due by December 15, though earlier submissions are welcome.

Last offered: Winter 2020 | Units: 1

LAW 4041: Lawyering for Innovation: Artificial Intelligence

In recent years, artificial intelligence (AI) has made the jump from science fiction to technical viability to product reality. Industries as far flung as finance, transportation, defense, and healthcare invest billions in the field. Patent filings for robotics and machine learning applications have surged. And policymakers are beginning to grapple with technologies once confined to the realm of computer science, such as predictive analytics and neural networks. AI's rise to prominence came thanks to a confluence of factors. Increased computing power, large-scale data collection, and advancements in machine learning---all accompanied by dramatic decreases in costs---have resulted in machines that now have the ability to exhibit complex "intelligent" behaviors. They can navigate in real-world environments, process natural language, diagnose illnesses, predict future events, and even conquer strategy games. These abilities, in turn, have allowed companies and governments to entrust machines with responsibilities once exclusively reserved for humans---including influencing hiring decisions, bail release conditions, loan considerations, medical treatment and police deployment. But with these great new powers, of course, come great new responsibilities. The first public deployments of AI have seen ample evidence of the technology's disruptive---and destructive---capabilities. AI-powered systems have killed and maimed, filled social networks with hate, and been accused of shaping the course of elections. And as the technology proliferates, its governance will increasingly fall upon lawyers involved in the design and development of new products, oversight bodies and government agencies. AI is the biggest addition to technology law and policy since the rise of the internet, and its influence spreads far beyond the tech sector. As such, those entering practice in a wide variety of fields need to understand AI from the ground up in order to competently assess and influence its policy, legal and product implications as deployments scale across industries in the coming years. This course is designed to teach precisely that. It seeks to equip students with an understanding of the basics of AI and machine learning systems by studying the implications of the technology along the design/deployment continuum, moving from (1) system inputs (data collection) to (2) system design (engineering) and finally to (3) system outputs (product features). This input/design/output framework will be used throughout the course to survey substantive engineering, policy and legal issues arising at each of those key stages. In doing so, the course will span topics including privacy, bias, discrimination, intellectual property, torts, transparency and accountability. The course will also feature leading experts from a variety of AI disciplines and professional backgrounds. An important aspect of the course is gaining an understanding of the technical underpinnings of AI, which will be packaged in an easy-to-understand, introductory manner with no prior technical background required. The writing assignments will center on reflection papers on legal, regulatory and policy analysis of current issues involving AI. The course will be offered for two units of credit (H/P/R/F). Grading will be determined by attendance, class participation and written assignments. Given the course's multi-disciplinary focus, students outside of the law school, particularly those studying computer science, engineering or business, are welcome. CONSENT APPLICATION: To apply for this course, students must complete and submit a Consent Application Form available on the SLS website (Click Courses at the bottom of the homepage and then click Consent of Instructor Forms). See Consent Application Form for instructions and submission deadline.

Last offered: Spring 2019 | Units: 2

LAW 4043: The Social & Economic Impact of Artificial Intelligence

Recent advances in computing may place us at the threshold of a unique turning point in human history. Soon we are likely to entrust management of our environment, economy, security, infrastructure, food production, healthcare, and to a large degree even our personal activities, to artificially intelligent computer systems. The prospect of "turning over the keys" to increasingly autonomous systems raises many complex and troubling questions. How will society respond as versatile robots and machine-learning systems displace an ever-expanding spectrum of blue- and white-collar workers? Will the benefits of this technological revolution be broadly distributed or accrue to a lucky few? How can we ensure that these systems are free of algorithmic bias and respect human ethical principles? What role will they play in our system of justice and the practice of law? How will they be used or abused in democratic societies and autocratic regimes? Will they alter the geopolitical balance of power, and change the nature of warfare? The goal of CS22a is to equip students with the intellectual tools, ethical foundation, and psychological framework to successfully navigate the coming age of intelligent machines. Elements used in grading: Attendance. Cross-listed with Computer Science (CS 22A) and International Policy (INTLPOL 200).

Last offered: Winter 2022 | Units: 1

LAW 4045: Digital Technology and Law: Foundations

Taught by a team of law and engineering faculty, this unique interdisciplinary course will empower students across the University to work together and exercise leadership on critically important debates at the intersection of law and digital technology. Designed as an accessible survey, the course will equip students with two powerful bases of knowledge: (i) a working technical grasp of key digital technologies (e.g., AI and machine learning, internet structure, encryption, blockchain); and (ii) basic fluency in the key legal frameworks implicated by each (e.g., privacy, cybersecurity, anti-discrimination, free speech, torts, procedural fairness). Substantively, the course will be organized into modules focused on distinct law-tech intersections, including: platform regulation, speech, and

intermediary liability; algorithmic bias and civil rights; autonomous systems, safety, and tort liability; "smart" contracting; data privacy and consumer protection; "legal tech," litigation, and access to justice; government use of AI; and encryption and criminal procedure. Each module will be explored via a mix of technical and legal instruction, case study discussions, in-class practical exercises, and guest speakers from industry, government, academe, and civil society. Law students will emerge from the course with a basic understanding of core digital technologies and related legal frameworks and a roadmap of curricular and career pathways one might follow to pursue each area further. Students from elsewhere in the University, from engineering to business to the social sciences and beyond, will emerge with an enhanced capacity to critically assess the legal and policy implications of new digital technologies and the ways society can work to ensure those technologies serve the public good. All students will learn to work together across disciplinary divides to solve technical, legal, and practical problems. There are no course prerequisites, and no prior legal or technical training will be assumed. Students will be responsible for short discussion papers or a final paper. After the term begins, students electing the final paper option can transfer from section 1 to section 2, which meets the R requirement, with consent of the instructor. This class is cross-listed in the University and undergraduates and graduates are eligible to take it. Consent Application for Non-Law Students: We will try to accommodate all students interested in the course. But to facilitate planning and confirm interest, please fill out a consent application (https://forms.gle/hLAQ7JUm2jFTWQzE9) by March 13, 2020. Applications received after March 13 will be considered on a rolling basis. Elements used in grading: Attendance, Class Participation; Written Assignments or Final Paper. Cross-listed with Computer Science (CS 481).

Last offered: Spring 2020 | Units: 3

LAW 4047: Ethics, Public Policy, and Technological Change

Examination of recent developments in computing technology and platforms through the lenses of philosophy, public policy, social science, and engineering. Course is organized around four main units: algorithmic decision-making and bias; data privacy and civil liberties; artificial intelligence and autonomous systems; and the power of private computing platforms. Each unit considers the promise, perils, rights, and responsibilities at play in technological developments. Prerequisite: CS106A. Elements used in grading: Attendance, class participation, written assignments, coding assignments, and final exam. Cross-listed with Communication (COMM 180), Computer Science (CS 182), Ethics in Society (ETHICSOC 182), Philosophy (PHIL 82), Political Science (POLISCI 182), Public Policy (PUBLPOL 182).

Last offered: Winter 2020 | Units: 4

LAW 4050: AI and Rule of Law: A Global Perspective

Advances in machine learning, big data, networked communications, and computing are transforming our world and fueling calls for regulation. This course--a joint venture of a Stanford law professor and a former Member of the European Parliament and leading voice on tech regulation--offers a global perspective on the profound legal and governance challenges posed by the new digital technologies. Students will emerge with an understanding of how tech is reshaping the global distribution of political authority, rights, and resources, the existing state of law and regulation in the U.S., Europe, China, and elsewhere, and the new democratic governance models that are emerging in response. Each class session will feature one or more distinguished speakers from around the world drawn from the ranks of government officials, judges, activists, and academics who work in the fields of human rights, privacy, free speech, trade, and national security. There are no course prerequisites, whether in law or otherwise. Students will be responsible for one-page responses to each week's readings and a research paper to be turned in at the spring paper deadline. Students can take the course for 2 or 3 units, depending on research paper length. This class is cross-listed with International Policy (INTLPOL 253) and undergraduates and graduates are eligible to take it. Stanford Non-Law students may enroll in INTLPOL 253 directly in Axess. Non-law students wishing to enroll in LAW 4050 should complete the Non-Law Student Add Request form available at https://law.stanford.edu/education/courses/non-law-students/ for a permission number to enroll. Elements used in grading: Attendance, Class Participation, Written Assignments, Final Paper.

Last offered: Spring 2020 | Units: 2-3

LAW 4052: Governing Artificial Intelligence: Law, Policy, and Institutions

Even just a generation ago, interest in "artificial intelligence" (AI) was largely confined to academic computer science, philosophy, engineering, and science fiction. Today the term is understood to encompass not only long-term efforts to simulate the general intelligence associated with humans, but also fast-evolving technologies (such as elaborate neural networks leveraging vast amounts of data) with the potential to reshape finance, transportation, health care, national security, advertising and social media, and other fields. Taught by a sitting judge, a former EU Parliament member, and a law professor, and conceived to serve students with interest in law, business, public policy, design, and ethics, this interactive course surveys current and emerging legal and governance problems related to humanity's relationship to artificially-constructed intelligence. To deepen students' understanding of legal and governance problems in this area, the course explores definitions and foundational concepts associated with AI, likely pathways of AI's evolution, different types of law and policy concerns raised by existing and future versions of AI, and the distinctive domestic and international political economies of AI governance. We will consider discrete settings where regulation of AI is emerging as a challenge or topic of interest, among them: autonomous vehicles, autonomous weapons, labor market decisions, AI in social media/communications platforms, judicial and governmental decision-making, and systemic AI safety problems; the growing body of legal doctrines and policies relevant to the development and control of AI such as the European Union's General Data Protection Regulation and the California Consumer Privacy Act; the connection between governance of manufactured intelligence and related bodies of law, such as administrative law, torts, constitutional principles, civil rights, criminal justice, and international law; and new legal and governance arrangements that could affect the development and use of AI. We will also cover topics associated with the design and development of AI as they relate to law and governance, such as measuring algorithmic bias and explainability of AI models. Cross-cutting themes will include: how law and policy affect the way important societal decisions are justified; the balance of power and responsibility between humans and machines in different settings; the incorporation of multiple values into AI decision-making frameworks; the interplay of norms and formal law; technical complexities that may arise as society scales deployment of AI systems; AI's implications for transnational law and governance and geopolitics; and similarities and differences to other domains of human activity raising regulatory trade-offs and affected by technological change. Note: The course is designed both for students who want a survey of the field and lack any technical knowledge, as well as students who want to gain tools and ideas to deepen their existing interest or technical background in the topic. Students with longer-term interest in or experience with the subject are welcome to do a more technically-oriented paper or project in connection with this class. But technical knowledge or familiarity with AI is not a prerequisite, as various optional class sessions and readings as well as certain in-class material will help provide necessary background. Requirements: The course involves a mix of lectures, practical exercises, and student-led discussion and presentations. Elements used in grading: Requirements include attendance, participation in a student-led group presentation and a group-based practical exercise, two short 3-5 pp. response papers, and either an exam or research paper. After the term begins, students accepted into the course can transfer, with consent of the instructor, from section (01) into section (02), which meets the R requirement. CONSENT APPLICATION: We will try to accommodate as many people as possible with interest in the course. But to facilitate planning and confirm your level of interest, please fill out an application available at https://docs.google.com/forms/d/e/1FAIpQLSfwRxaM1omTsJmK9k0gksdS5jBPRz-YCuYhRUpDlVXXglDHjg/viewform by March 12, 2021. Applications received after the deadline will be considered on a rolling basis if space is available. The application is also available on the SLS website (Click Courses at the bottom of the homepage and then click Consent of Instructor Forms). Cross-listed with International Policy (INTLPOL 364).

Last offered: Spring 2021 | Units: 3

LAW 7020: Ethics On the Edge: Business, Non-Profit Organizations, Government, and Individuals

The objective of the course is to explore the increasing ethical challenges in a world in which technology, global risks, and societal developments are accelerating faster than our understanding and the law can keep pace. We will unravel the factors contributing to the seemingly pervasive failure of ethics today among organizations and leaders across all sectors: business, government, non-profit, and academia. A framework for ethical decision-making underpins the course. There

is significant space for personal reflection and forming your own views on a wide range of issues. Prominent guest speakers will attend certain sessions interactively. The relationship between ethics and culture, leadership, law, and global risks (inequality, privacy, financial system meltdown, cyber-terrorism, climate change, etc.) will inform discussion. A broad range of international topics might include: designer genetics; civilian space travel (Elon Musk's Mars plans); social media (e.g. Facebook Cambridge Analytica, on-line sex trafficking, monopolies); new devises (e.g. Amazon Alexa in hotel rooms); free speech on University campuses; opioid addiction; AI (from racism to the work challenge and beyond); corporate and financial sector scandals (Epi pen pricing, Theranos, Wells Fargo fraudulent account creation, Volkswagen emissions testing manipulation); and non-profit sector ethics challenges (e.g. NGOs engagement with ISIS and sexual misconduct in humanitarian aid (Oxfam case)). Final project in lieu of exam on a topic of student's choice. Attendance required. Class participation important (with multiple opportunities to earn participation credit beyond speaking in class). Strong emphasis on rigorous analysis, critical thinking and testing ideas in real-world contexts. Elements used in grading: Class Participation, Attendance, Written Assignments, and Final Paper. Cross-listed with Public Policy (PUBLPOL 134, PUBLPOL 234). CONSENT APPLICATION: Interested SLS students may apply to enroll in this class by sending a request to Dr. Susan Liautaud at susanliautaud@googlemail.com. Please CC the course TA, Allie O'Keefe, at aokeefe@stanford.edu. NOTE: This course does NOT meet the SLS Ethics requirement.

Last offered: Spring 2021 | Units: 2

LAW 7073: Antidiscrimination Law and Algorithmic Bias

Human decision making is increasingly being displaced by algorithms. Judges sentence defendants based on "risk scores;" regulators take enforcement actions based on predicted violations; advertisers target materials based on demographic attributes; and employers evaluate applicants and employees based on machine-learned models. A predominant concern with the rise of such algorithmic decision making (machine learning or artificial intelligence) is that it may replicate or exacerbate human bias. Algorithms might discriminate, for instance, based on race or gender. This course surveys the legal principles for assessing bias of algorithms, examines emerging techniques for how to design and assess bias of algorithms, and assesses how antidiscrimination law and the design of algorithms may need to evolve to account for the potential emergence of machine bias. Admission is by consent of instructor and is limited to 20 students. Student assessment is based on class participation, response papers, and a final project. CONSENT APPLICATION: To apply for this course, students must complete and submit a Consent Application Form available on the SLS website (https://law.stanford.edu/education/courses/consent-of-instructor-forms/). See Consent Application Form for instructions and submission deadline.

Last offered: Autumn 2022 | Units: 3

LAW 7106: Judging in the 21st Century

Since your first week of law school, you have been reading legal opinions written by judges. Who were those judges and did their identities affect their views? From a judge's perspective, what makes a case hard or easy? Did the process by which the judge was selected--or could be removed from office--influence her or his decision? How do judges make choices about the larger legal ecosystem in which you will practice law? After all, judges determine many aspects of the legal environment in which lawyers operate, from whether you can livestream a court hearing from your phone to whether you will take the bar exam in person or online. Taught by a Justice on a California Court of Appeal, this seminar explores judicial decision making about cases and the court system from a variety of perspectives. It draws from accounts by social scientists, lawyers, and judges themselves, analyzing what judges do and critiquing how they do it. The seminar examines systems of judicial selection, evaluation, and removal in both the federal and state court systems and their potential effects on judicial decision making. We will take up questions such as whether the identity of judges matters to their decisions, how heuristics or implicit biases might influence outcomes, how communities try to choose "good" judges and what they do when those choices go wrong, evaluate efforts to diversify the bench, and consider what lessons might be learned from the experiences of various states in evaluating and electing judges. One theme of the seminar involves the interaction of judges with litigants, the public, and other government actors--on twenty-first-century terms. We will ask how courts should manage questions related to transparency, privacy, access to justice, and technology. We will think about how judges might choose or be compelled to rely on emerging automation technologies, whether simple algorithms or advanced machine learning. We also will consider the extent to which judges do and should take into account the views of executive officials, legislators, nongovernmental organizations, and members of the general public when deciding cases and structuring the legal system. In addition, we will look at ethics rules governing what judges can learn and what they can say. For example, can or should a judge run an experiment that tests a litigant's factual assertion, or, in her free time, write an online product review, lead a religious group, or participate in a commission to improve state government? The seminar will pursue these questions from both theoretical and practical perspectives. Sitting judges from a variety of courts will share their insights with seminar participants. Students will write a research paper on a relevant topic of their choice, and will be encouraged to think critically about how judges make decisions and how courts can be improved in realistic ways. We will think together about how judges and courts can best deliver justice in a changing, contested, unequal, and increasingly complex world. Elements used in grading: Attendance, Class Participation, Written Assignments, Research Paper.

Last offered: Autumn 2022 | Units: 2

LAW 7510: Empirical Legal Studies: Research Design

Empirical legal studies have become trendy in the U.S. and are now spreading to law faculties in other countries as well. The popular image of an empirical study is that it involves sophisticated statistical analysis of quantitative data. Often the author of the study starts with a handy dataset and then tries to figure out what question he or she can answer using those data. Useful empirical studies of law and other topics don't start this way. Instead the researcher has a question, derived from theoretical literature or policy debate (or both) and faces the challenge of deciding what types of empirical data, collected and analyzed in what fashion, will best answer that question. The possibilities range from "big data" analyses of hundreds or thousands of documents, tweets or something similar to lengthy, intensive interviews with a few well-placed officials or informants, with just about any other way one might collect factual data -- e.g. online surveys, courtroom observations -- in between. What all of these approaches have in common is not that they involve numeric data but that they attempt to arrive at as objective a view of social, economic, or political reality as is possible. Learning how to design and conduct a survey or how to estimate a regression model or apply AI to vast numbers of texts is (relatively speaking) easy. There are lots of courses at Stanford that you can take on these methods. Learning what approaches are most appropriate to answer the research questions you are interested in is much harder. This seminar is directed at helping you think through the design of an empirical research project -- whether quantitative, qualitative or both -- from identifying researchable questions to collecting and analyzing data to presenting your results to academic or policy audiences. You will start with a broad question (or several questions) of interest to you, based on your previous experience, other studies or reading. By the end of the seminar you will have identified questions you can investigate empirically (perhaps in addition to theoretically) and figured out what research approach(es) will work best for you. The product of the seminar will be a preliminary research proposal, whether for your master's thesis this year or some other purpose in the future. Although plans for the fall quarter are still somewhat in flux, I expect to teach this seminar online with the assistance of the SPILS teaching fellow. I hope it will be possible to meet in person at the beginning of the quarter for a few introductory sessions to begin to get to know each other. In any event, I will be available throughout the quarter for one-on-one zoom sessions to discuss your research. Special Instructions: JD students can take the class with consent of the instructor. After the term begins, JD students accepted into the course can transfer from section (01) into section (02), which can potentially satisfy the R requirement, with consent of the instructor. Consent Application for JD students: To apply for this course, JD students must e-mail the instructors for permission to enroll. This course is REQUIRED for all SPILS fellows and BY CONSENT for all other students. Interested students should email the instructor for consent to enroll. Elements used in grading: Class participation, attendance, written assignments and final paper.

Terms: Aut | Units: 3-4

Instructors: ; MacCoun, R. (PI); Nascimento dos Reis, T. (PI)

LAW 8004: Law, Science, and Technology Colloquium

The Law, Science & Technology Colloquium offers students in the Law, Science & Technology LLM Program the opportunity to discuss cutting-edge legal issues at the intersection of law and technology. The colloquium is held in the Fall and Spring quarters and aims to give the LST LLM students a broad overview of the many areas within Law, Science and Technology, as well as the connections between areas. In Fall, we will focus on Internet Law and Intellectual Property, including sessions on privacy, free speech, copyright, and patents, with extra focuses on biotechnology and bioscience. In Spring, we will broaden our scope to a selection of issues including potentially AI, dark patterns, more on biotechnology & bioscience, telecommunications regulation, or legal practice. Furthermore, we will discuss how the law of science and technology is made in the United States, and how lawyers can effect change in these laws. The class will feature several guest speakers who are experts in the field, including potentially Stanford faculty, visiting scholars, technology and IP lawyers, entrepreneurs, and executives from Silicon Valley technology companies. Students are expected to have carefully read the assigned materials in advance of each session, and to actively participate during class. Students will also write a capstone paper on a topic of their choice, in consultation with the instructor. There will also be oral presentations on their capstone papers and on current events in LST. Grades for the colloquium are based on students' papers and their classroom performance (e.g., preparation, participation, attendance, etc.). This course is restricted to students in the Law, Science, and Technology LLM program, and satisfies their "colloquium requirement" for the fall and spring quarter. In fall and spring students will be graded on an Honors/Pass/Restricted Credit/Fail basis. Class will meet in-person unless the Law School's policies state otherwise.

Terms: Aut, Spr | Units: 2 | Repeatable 3 times (up to 4 units total)

Instructors: ; Rosenbloom, M. (PI)

LINGUIST 180: From Languages to Information (CS 124, LINGUIST 280)

Extracting meaning, information, and structure from human language text, speech, web pages, social networks. Introducing methods (regex, edit distance, naive Bayes, logistic regression, neural embeddings, inverted indices, collaborative filtering, PageRank), applications (chatbots, sentiment analysis, information retrieval, question answering, text classification, social networks, recommender systems), and ethical issues in both. Prerequisites: CS106B, Python (at the level of CS106A), CS109 (or equivalent background in probability), and programming maturity and knowledge of UNIX equivalent to CS107 (or taking CS107 or CS1U concurrently).

Terms: Win | Units: 3-4 | UG Reqs: WAY-AQR

Instructors: ; Jurafsky, D. (PI); Akintan, M. (TA); Buch, D. (TA); Gurusankar, G. (TA); Kacharia, N. (TA); Lee, H. (TA); Leon, A. (TA); McAvity, J. (TA); Mukherjee, A. (TA); Nabi, F. (TA); Oyeniyi, T. (TA); Phatak, U. (TA); Ryan, M. (TA); Santiago, F. (TA); Wu, J. (TA); Xiao, J. (TA)

LINGUIST 188: Natural Language Understanding (CS 224U, LINGUIST 288, SYMSYS 195U)

Project-oriented class focused on developing systems and algorithms for robust machine understanding of human language. Draws on theoretical concepts from linguistics, natural language processing, and machine learning. Topics include lexical semantics, distributed representations of meaning, relation extraction, semantic parsing, sentiment analysis, and dialogue agents, with special lectures on developing projects, presenting research results, and making connections with industry. Prerequisites: CS 224N or CS 224S (This is a smaller number of courses than previously.)

Last offered: Spring 2023 | Units: 3-4

LINGUIST 280: From Languages to Information (CS 124, LINGUIST 180)

Extracting meaning, information, and structure from human language text, speech, web pages, social networks. Introducing methods (regex, edit distance, naive Bayes, logistic regression, neural embeddings, inverted indices, collaborative filtering, PageRank), applications (chatbots, sentiment analysis, information retrieval, question answering, text classification, social networks, recommender systems), and ethical issues in both. Prerequisites: CS106B, Python (at the level of CS106A), CS109 (or equivalent background in probability), and programming maturity and knowledge of UNIX equivalent to CS107 (or taking CS107 or CS1U concurrently).

Terms: Win | Units: 3-4

Instructors: ; Jurafsky, D. (PI); Akintan, M. (TA); Buch, D. (TA); Gurusankar, G. (TA); Kacharia, N. (TA); Lee, H. (TA); Leon, A. (TA); McAvity, J. (TA); Mukherjee, A. (TA); Nabi, F. (TA); Oyeniyi, T. (TA); Phatak, U. (TA); Ryan, M. (TA); Santiago, F. (TA); Wu, J. (TA); Xiao, J. (TA)

LINGUIST 284: Natural Language Processing with Deep Learning (CS 224N, SYMSYS 195N)

Methods for processing human language information and the underlying computational properties of natural languages. Focus on deep learning approaches: understanding, implementing, training, debugging, visualizing, and extending neural network models for a variety of language understanding tasks. Exploration of natural language tasks ranging from simple word level and syntactic processing to coreference, question answering, and machine translation. Examination of representative papers and systems and completion of a final project applying a complex neural network model to a large-scale NLP problem. Prerequisites: calculus and linear algebra; CS124, CS221, or CS229.

Terms: Win, Spr | Units: 3-4

Instructors: ; Hashimoto, T. (PI); Manning, C. (PI); Yang, D. (PI); Burns, K. (TA); Chang, C. (TA); Chatterjee, S. (TA); Dai, T. (TA); El Boudali, H. (TA); Gao, Y. (TA); Lee, A. (TA); Lee, O. (TA); Lim, D. (TA); Liu, N. (TA); Mahankali, A. (TA); Singh, J. (TA); Sriram, A. (TA); Taori, R. (TA); Verma, T. (TA); Wang, A. (TA); Wang, T. (TA); Zhang, B. (TA); Zhang, H. (TA); Zhang, T. (TA); Zhang, Y. (TA); Ziems, C. (TA)

LINGUIST 285: Spoken Language Processing (CS 224S)

Introduction to spoken language technology with an emphasis on dialogue and conversational systems. Deep learning and other methods for automatic speech recognition, speech synthesis, affect detection, dialogue management, and applications to digital assistants and spoken language understanding systems. Prerequisites: CS124, CS221, CS224N, or CS229.

Terms: Spr | Units: 2-4

Instructors: ; Maas, A. (PI)

LINGUIST 288: Natural Language Understanding (CS 224U, LINGUIST 188, SYMSYS 195U)

Project-oriented class focused on developing systems and algorithms for robust machine understanding of human language. Draws on theoretical concepts from linguistics, natural language processing, and machine learning. Topics include lexical semantics, distributed representations of meaning, relation extraction, semantic parsing, sentiment analysis, and dialogue agents, with special lectures on developing projects, presenting research results, and making connections with industry. Prerequisites: CS 224N or CS 224S (This is a smaller number of courses than previously.)

Last offered: Spring 2023 | Units: 3-4

MATH 113: Linear Algebra and Matrix Theory

Algebraic properties of matrices and their interpretation in geometric terms. The relationship between the algebraic and geometric points of view and matters fundamental to the study and solution of linear equations. Topics: linear equations, vector spaces, linear dependence, bases and coordinate systems; linear

transformations and matrices; similarity; dual space and dual basis; eigenvectors and eigenvalues; diagonalization. Includes an introduction to proof-writing. (Math 104 offers a more application-oriented treatment.) Prerequisites: Math 51

Terms: Aut, Win, Spr | Units: 4 | UG Reqs: GER:DB-Math, WAY-FR

Instructors: ; Malinnikova, E. (PI); Swaminathan, M. (PI); Vondrak, J. (PI); Amar, S. (TA); Niu, J. (TA)

MATH 275C: Topics in Applied Mathematics III: The Mathematics of AI

This course introduces the mathematics knowledge involved in machine learning and artificial intelligence on two levels. In the first half of the quarter, we introduce math needed to understand machine learning practices, i.e. data, models, and algorithms. Topics include advanced notions in linear algebra, probability, statistics, and optimization theories. In the second half of the quarter, we focus on math used to study and analyze machine learning in scientific research. Topics include approximation theory, concentration inequalities, functional analysis, and optimization. This course focuses on the mathematical tools for studying machine learning, rather than implementations of machine learning methods. May be repeated for credit. NOTE: Undergraduates require instructor permission to enroll. Undergraduates interested in taking the course should contact the instructor for permission, providing information about relevant background such as performance in prior coursework, reading, etc.

Last offered: Spring 2023 | Units: 3 | Repeatable for credit

ME 268: Robotics, AI and Design of Future Education (EDUC 468)

The time of robotics/AI is upon us. Within the next 10 to 20 years, many jobs will be replaced by robots/AI (artificial intelligence). This seminar features guest lecturers from industry and academia discussing the current state of the field of robotics/AI, preparing students for the rise of robotics/AI, and redesigning and reinventing education to adapt to the new era.

Terms: Win | Units: 1 | Repeatable 10 times (up to 10 units total)

Instructors: ; Jiang, L. (PI)

ME 344S: HPC-AI Summer Seminar Series

Get ready to explore the future of high-performance computing (HPC) and artificial intelligence (AI) and its influence on the way we live, work and learn, with the HPC-AI Summer Seminar Series by Stanford High Performance Computing Center and the HPC-AI Advisory Council. This 1-unit course is designed to provide practical insights and thought leadership and discuss topics of great societal importance. One such theme this year is the impact of Generative AI. You will have the opportunity to hear from renowned industry experts and influencers who are shaping our HPC-AI future and even ask them your questions. This engaging course is open to students with any academic background looking to upskill themselves. So don't hesitate, register now! No prerequisites required.

Terms: Sum | Units: 1

Instructors: ; Jones, S. (PI)

MED 18SI: Artificial Intelligence in Medicine and Healthcare Ventures

The face of healthcare is changing - innovative technologies, based on recent advances in artificial intelligence, are radically altering how care is delivered. Startups are offering entirely new ways to diagnose, manage, treat, and operate. Few ever reach the patient - those that do have much more than an idea and an algorithm; they have an intimate understanding of the healthcare landscape and the technical knowhow to successfully integrate AI solutions into the medical system. In this course, we tackle the central question: How can young students find feasible and impactful medical problems, and build, scale, and translate technology solutions into the clinic. Together, we will discover the transformative technologies of tomorrow that we can build today. Please see the syllabus for more information. We encourage students of all backgrounds to enroll- the only prerequisite is a strong passion for technology in healthcare. Syllabus: rebrand.ly/aihealth

Last offered: Spring 2021 | Units: 1-2

MED 180: Artificial Intelligence in Medicine and Healthcare Ventures

The face of healthcare is changing - innovative technologies, based on recent advances in artificial intelligence (AI), are radically altering how care is delivered. Startups are offering entirely new ways to diagnose, manage, treat, and operate. However, few ever reach the patient - those with much more than an idea and an algorithm; they have an intimate understanding of the healthcare landscape and the technical know-how to integrate AI solutions into the medical system successfully. In this course, we tackle the central question: How can young students find feasible and impactful medical problems, and build, scale, and translate technology solutions into the clinic? Together, we will discover the transformative technologies of tomorrow that we can build today. Please see the syllabus for more information (https://t.ly/PpM2). We encourage students of all academic backgrounds to enroll; the only prerequisite is a strong passion for technology in healthcare. Course may be taken for one unit (lecture only, 11:30AM-12:30PM); or two units, which entails attending discussion section (12:30PM-1:20PM) and completing a project. The second half of each session will involve a discussion about team building, AI/Healthcare business ideas, and idea presentations. Grading criteria for 1-credit students will be based on attendance and weekly reports regarding the summary of each week's lectures (assignments). In addition to these criteria, 2-credit students will submit a business idea report and will deliver a pitch presentation in the last session in front of an invited panel.

Last offered: Spring 2023 | Units: 1-2

MED 213: The Digital Future of Health Care

Digital health tools, technologies, and services are poised to fundamentally reshape how patients and physicians interact. COVID-19 has only accelerated this transformation. In this weekly seminar series led by clinicians, digital health investors, and entrepreneurs, students will explore various digital health technologies and their impacts across the entire healthcare ecosystem, today and tomorrow. Application areas include: telemedicine, AI, wearables, social/behavioral interventions, and healthcare at home. In addition, discussions will cover the creation process of digital health solutions, the stakeholders involved (ranging from individual patients to healthcare enterprises), and the opportunities and challenges in the implementation of these solutions within healthcare's unique regulatory, organizational, cultural, and ethical contexts.

Terms: Win | Units: 1 | Repeatable 10 times (up to 10 units total)

Instructors: ; Lin, B. (PI); Norden, J. (SI); Shah, N. (SI)

MED 216: Generative AI and Medicine

This seminar course will explore the applications of Generative AI Technologies (ChatGPT, DALL-E, and many others) to medicine and healthcare. Course meetings will include a mix of outstanding speakers from health, business and technology as well discussions of burgeoning commercial and research projects in the space. We will ask students to brainstorm and informally pitch their own ideas for Generative AI projects to their peers and select faculty from academia and venture capital. All students are welcome. There are no prerequisites, but this course will be of interest to students who have taken MED 213, "The Digital Future of Healthcare".

Terms: Spr | Units: 1

Instructors: ; Lin, B. (PI); Norden, J. (SI)

MED 277: AI-Assisted Care (CS 337)

AI has been advancing quickly, with its impact everywhere. In healthcare, innovation in AI could help transforming of our healthcare system. This course offers a diverse set of research projects focusing on cutting edge computer vision and machine learning technologies to solve some of healthcare's most important problems. The teaching team and teaching assistants will work closely with students on research projects in this area. Research projects include Care for Senior at Senior Home, Surgical Quality Analysis, AI Assisted Parenting, Burn Analysis & Assessment and more. AI areas include Video Understanding, Image Classification, Object Detection, Segmentation, Action Recognition, Deep Learning, Reinforcement Learning, HCI and more. The course is open to students in both school of medicine and school of engineering.

Terms: Aut | Units: 1-4

Instructors: ; Adeli, E. (PI); Milstein, A. (PI); Schulman, K. (PI); Kaushal, A. (SI); Li, F. (SI)

MED 285: Global Leaders and Innovators in Human and Planetary Health: Sustainable Societies Lab (HRP 285, SUSTAIN 345)

Are you interested in innovative ideas and strategies for addressing urgent challenges in human and planetary health and creating sustainable societies? This 7 session lecture series features a selection of noteworthy leaders, innovators, and experts across diverse sectors/topics in health and the environment such as: health innovation and environmental sustainability, social and environmental justice and equality, social innovation and entrepreneurship ecosystems, foundations and venture capital, tech innovation, media and AI, biotech and ag-tech, pandemics, public health and community wellbeing, food systems and agricultural innovation, hunger and nutrition, clean water and air, nonprofits and community action, public policy innovation and systems change, and the role of academia and you. Co-convened and co-designed by faculty, fellows and students collaborating across several Stanford centers, departments, schools, the course invites the discussion of global problems, interdisciplinary perspectives, and systemic solutions for the climate crisis and human health. The course will address root causes of the climate crisis and urgent challenges of human and planetary health, including sociological constraints, political objectives, economic incentives, technological limitations, and preservation of global stability, and suggest models of leadership, innovation and sustainable social change. We will also delve into efforts to catalyze long-term sustainability across the private, nonprofit, and public sectors. Students from all backgrounds are encouraged to enroll - registration is open to all Stanford students and fellows. May be repeated for credit.

Terms: Aut | Units: 1-2 | Repeatable 4 times (up to 8 units total)

Instructors: ; Bloom, G. (PI); Singer, S. (SI)

MLA 373: Artificial Intelligence and Society

Artificial Intelligence (AI) has the potential to transform society in a way that has not been seen before. AI can bring many positive benefits, such as allowing ideas to more flexibly cross language barriers, improve medical outcomes, and enhance the safety and efficiency of our transportation systems. However, as with the introduction with other technologies, there is the potential of negative consequences, such as job insecurity and the introduction of vulnerabilities that come with greater levels of automation. We will delve deeply into the core issues at stake that come with the greater integration of AI into society.

Last offered: Spring 2023 | Units: 4

MS&E 10SC: Artificial Intelligence and Deliberative Democracy

Deliberative democracy is a political theory that holds that democracy should be based on informed, respectful, and inclusive public deliberation. In this SoCo course, we explore the relationship between artificial intelligence (AI) and deliberative democracy, and examine how AI can be used to support and enhance the democratic process through deliberative democracy. This course will focus on the use of AI in the Stanford Online Deliberation Platform (a collaboration between the Crowdsourced Democracy Team and Deliberative Democracy Lab, both at Stanford), the ethics of AI and democracy, and the potential for AI to support deliberation and participation. The course will also explore the challenges and limitations of using AI in a democratic context and the need for effective regulation and governance of AI.

Terms: Sum | Units: 2

Instructors: ; Goel, A. (PI); Siu, A. (PI)

MS&E 75: Redefining Creativity: Designing Human Connections in an AI World

With the recent developments in generative AI, the value in human creativity is increasingly a focus. Course draws from lessons from creativity in the arts to teach engineering students methods for creativity derived from musicians and artists. For our engineering students to learn creativity as a skill that is distinguishable and differentiated from generative artificial intelligence, this course explores, for instance the anatomy of a Hollywood pop song and the process behind the creation of globally impactful art. Students learn how to transfer these skills into the creation of engaging entrepreneurial solutions, for effective storytelling, and in developing their unique personal and professional stories. Students learn skills to unlock creative power which they will apply in the course as a design vehicle for a wide range of applications in engineering, self-expression, technological exploration, and the development of solutions that are centered around human connection and emotional engagement with the user. Sessions are practical, drawing tools and lessons from interdisciplinary individuals with wide-ranging careers. No artistic or entrepreneurial experience necessary.

Terms: Sum | Units: 3

Instructors: ; Hwang, R. (PI)

MS&E 193: Technology and National Security (INTLPOL 256)

Explores the relation between technology, war, and national security policy with reference to current events. Course focuses on current U.S. national security challenges and the role that technology plays in shaping our understanding and response to these challenges, including the recent Russia-Ukraine conflict. Topics include: interplay between technology and modes of warfare; dominant and emerging technologies such as nuclear weapons, cyber, sensors, stealth, and biological; security challenges to the U.S.; and the U.S. response and adaptation to new technologies of military significance.

Terms: Aut | Units: 3-4 | UG Reqs: WAY-SI

Instructors: ; Lin, H. (PI); Bhaskara, V. (TA); Legrand, A. (TA)

MS&E 228: Applied Causal Inference with Machine Learning and AI (CS 288)

Fundamentals of modern applied causal inference. Basic principles of causal inference and machine learning and how the two can be combined in practice to deliver causal insights and policy implications in real world datasets, allowing for high-dimensionality and flexible estimation. Lectures will provide foundations of these new methodologies and the course assignments will involve real world data (from social science, tech industry and healthcare applications) and synthetic data analysis based on these methodologies. Prerequisites: basic knowledge of probability and statistics. Recommended: 226 or equivalent.

Terms: Win | Units: 3

Instructors: ; Syrgkanis, V. (PI); Lan, H. (TA); Young, J. (TA)

MS&E 233: Game Theory, Data Science and AI

The course will explore applied topics at the intersection of game theory, data science and artificial intelligence. The first part of the course will focus on computational approaches to solving complex games, with applications in developing successful algorithmic agents and explore recent successes in the games of Go, Stratego, Poker and Diplomacy. The lectures will provide the foundations of the methods that underlie these computational game theory methods (rooted in the theory of learning in games) and the assignments will explore implementation of simple variants. The second part of the course will explore the interplay between data science and mechanism design. We will overview topics such as optimizing auctions and mechanisms from data and explore applications in optimizing online auction markets. We will also overview methodologies for learning structural parameters in games and econometrics in games and how these can be used to analyze data that stem from strategic interactions, such as auction data. The third part of the course will explore topics that relate to deploying machine learning and data science pipelines in the presence of strategic behavior. Topics will include A/B testing in markets, with applications to A/B testing on digital platforms such as Uber, Amazon and other matching platforms.

Terms: Spr | Units: 3

Instructors: ; Syrgkanis, V. (PI)

MS&E 279: Disruptive Innovations in New Globalization Era

The pandemic and geopolitics present a new inflection point that all industries and countries need to manage properly in order to survive the crisis and create new opportunities for growth. The globalization structure that we have taken for granted in the past fifty years is gone and a new globalization structure is slowly emerging. Instead of global supply chains and global markets, we may have strong regional supply chains and regional markets and weak connections between regions. It is not clear what the final structure will be, but one thing for sure is that the dynamic formation of the new globalization structure will be shaped by how companies and countries respond and manage the new inflection point through disruptive innovations. In this new globalization era, we need to re-think innovation factoring the unquantifiable pandemic and geopolitical risk into product development and business expansion decisions. For emerging technology businesses like clean energy, one needs to develop a resilient supply chain structure that would provide a proper balance between cost and risk exposure to unexpected disruption due to pandemic and geopolitics. For an established industry, like semiconductor, there will be new risk exposure in the current supply chain structure. New supply chain structures will emerge as companies respond to the disruptions caused by pandemics and geopolitics. We discuss the possible changes in the supply chain structure and how companies in the related industries should establish proper risk management policies and procedures to increase the chance of successfully managing the inflection point and creating new opportunities for their growth. To support developing a resilient supply chain, we identify new 0-1 innovation opportunities and discuss the important role that government can play in this new changing era that would shape the structure of new globalization and spur new national economic growth. We pick the following specific industries to focus our discussions: semiconductor, clean energy, mobile communication, robotics and AI.

Terms: Spr | Units: 3

Instructors: ; Tse, E. (PI); Yan, J. (TA)

MS&E 296: Technology, Innovation and Great Power Competition (INTLPOL 340)

This course explores how new technologies pose challenges and create opportunities for the United States to compete more effectively with rivals in the international system with a focus on strategic competition with the People's Republic of China. In this experiential policy class, you will address a priority national security challenge employing the "Lean" problem solving methodology to validate the problem and propose a detailed technology informed solution tested against actual experts and stakeholders in the technology and national security ecosystem. The course builds on concepts presented in MS&E 193/293: Technology and National Security and provides a strong foundation for MS&E 297: Hacking for Defense.

Terms: Aut | Units: 4

Instructors: ; Blank, S. (PI); Brown, M. (PI); Felter, J. (PI); Jonga, S. (TA); Lakhtakia, S. (TA)

MS&E 338: Aligning Superintelligence

Within a couple of decades, or less, it is plausible that humans will create an AI that is much smarter than humans in practically all domains of human activity. We refer to such an AI as a superintelligence. The alignment problem is how to make sure that such a superintelligence acts according to its creator's intent. This course is intended for a technical audience interested in thinking about this problem. Prerequisites: one graduate-level machine learning course and one course that studies agents (e.g., AI, RL, decision analysis, economics).

Terms: Spr | Units: 3 | Repeatable 4 times (up to 12 units total)

Instructors: ; Van Roy, B. (PI)

MS&E 447: Blockchain Technologies & Entrepreneurship

This course offers a concise, in-depth exploration of entrepreneurship in decentralized computing, focusing on the rapid advance of decentralized blockchain technology since Bitcoin's release in 2009. We'll examine relevant technological advancements and their market opportunities in finance, AI, social media, gaming, and open computing. Discussions will differentiate lasting innovations from transient trends, helping students sort real advances from headline-grabbing volatility, speculation, and fraud. The course features guest speakers from top blockchain startups and venture capital firms, fostering actionable real-world insights. Key topics include blockchain foundations, emerging trends in scalable infrastructure, AI, verifiable computation, Decentralized Finance (DeFi), Real World Assets (RWA), decentralized governance (e.g. DAOs), and Decentralized Physical Infrastructure (DePIN). The course will equip students with foundational knowledge for potential entrepreneurial ventures based on distributed computing.

Terms: Spr | Units: 1 | Repeatable 12 times (up to 12 units total)

Instructors: ; Pelger, M. (PI)

MUSIC 18N: Musical Dishonesty: Fakes, Forgeries, Counterfeits, Hoaxes, Deceptions, Illusions, and Artifice

Dishonesty is everywhere. Is anything still honest? To answer we examine the myriad types of musical dishonesty, some harmless and fanciful, others deliberate and pernicious: artfully misleading deceptive cadences and fake endings; evident frauds (the fictional band Spinal Tap) and purposely obscured ones (the lip-syncing of Milli Vanilli); psychoacoustic illusions (infinitely ascending Shepard tones); biographical deceptions of "dangerous" rappers and metal bands; fake Mozart manuscripts; ghost composers and AI generated music; the question of sampling; self-mythologized artists from KISS to P-Funk; and so on. Students will also explore examples beyond music, such as current political events and contemporary conspiracy theories.

Terms: Aut | Units: 3 | UG Reqs: WAY-A-II

Instructors: ; Applebaum, M. (PI)

MUSIC 223A: Composing Electronic Sound Poetry

Poets, lyricists, rappers, composers, intermedia experimentalists, and others curious about combining words and sounds are invited to explore the exciting world of sound poetry. Students will make electronic works, musique concrète soundscapes, songs, or audio essays featuring their voice or that of others, with vocal sounds produced by singing, speaking, or speech synthesis, and employing digitally processed or collaged words. Our words can be original, collaboratively composed, quoted, or AI-generated. Students will complete several short creative etudes that build to a public concert featuring original multi-channel works, pieces with video, or live performances. No prerequisites.

Terms: Aut | Units: 2-3 | UG Reqs: WAY-CE | Repeatable 2 times (up to 6 units total)

Instructors: ; Applebaum, M. (PI)

MUSIC 356: Music and AI (CS 470)

How do we make music with artificial intelligence? What does it mean to do so (and is it even a good idea)? How might we design systems that balance machine automation and human interaction? More broadly, how do we want to live with our technologies? Are there - and ought there be - limits to using AI for art? (And what is Art, anyway?) In this "critical making" course, students will learn practical tools and techniques for AI-mediated music creation, engineer software systems incorporating AI, HCI and Music, and critically reflect on the aesthetic and ethical dimensions of technology.

Terms: Win | Units: 3-4

Instructors: ; Wang, G. (PI); Zhu, A. (TA)

OB 673: Perspectives on the Social Psychology of Organizations

Dawn of the Machines: Behavioral Approaches to Artificial Intelligence. In Spring 2022, this seminar will explore how psychologists and micro-OB scholars can engage with the emergence of AI. Noting that the treatment of AI varies widely in behavioral research (as a social phenomenon, a target of judgment, a statistical tool, a model for humans, etc.), we will discuss recent papers and identify opportunities for research. No lecturing. Instruction is based entirely on reading and discussing published papers. Prerequisites: Requires no technical expertise in AI or programming, but familiarity with social psychological concepts and methods is needed. Enrollment in a PhD Program required. Cannot be audited or taken Pass/Fail.

Last offered: Spring 2022 | Units: 3

OIT 248: Optimization And Simulation Modeling - Advanced

This course is an advanced option in the menu of classes satisfying the Core requirement in Optimization and Simulation Modeling (OSM). It is an advanced version of OIT 245 and OIT 247 and it covers a similar (but slightly expanded) set of concepts pertaining to prescriptive analytics, including static optimization, Monte-Carlo simulation, decision trees and dynamic optimization, and reinforcement learning. The main differences are in the pace and depth, with OIT 248 covering each topic significantly faster and at a deeper level. Additionally, OIT 248 leverages Python instead of Excel for implementation and devotes more time to discussing practical issues that arise in real-world, data-driven implementations. By the end of the course, students should develop an in-depth mental framework of the topics and leave with a good understanding of how they fit within modern machine-learning / AI pipelines that aid decision-making in complex problems. The class is taught in an interactive style, focusing on a variety of applications drawn from advertising, healthcare, finance, supply chain management, revenue management and pricing, scheduling, and risk management. We emphasize that OIT 248 uses Python to teach analytics, but is not a course on Python or coding per se. Some prior coding experience is helpful but is not a strict requirement for the course.

Terms: Aut | Units: 3

Instructors: ; Iancu, D. (PI); Alvarez, K. (GP)

OIT 249: MSx: Data and Decisions

Data and Decisions teaches you how to use data and quantitative reasoning to make sound decisions in complex and uncertain environments. The course draws on probability, statistics, and decision theory. Probabilities provide a foundation for understanding uncertainties, such as the risks faced by investors, insurers, and capacity planners. We will discuss the mechanics of probability (manipulating some probabilities to get others) and how to use probabilities to make decisions about uncertain events. Statistics allows managers to use small amounts of information to answer big questions. For example, statistics can help predict whether a new product will succeed or what revenue will be next quarter. The third topic, decision analysis, uses probability and statistics to plan actions, such as whether to test a new drug, buy an option, or explore for oil. In addition to improving your quantitative reasoning skills, this class seeks to prepare you for later classes that draw on this material, including finance, economics, marketing, and operations. At the end we will discuss how this material relates to machine learning and artificial intelligence.

Terms: Aut | Units: 3

Instructors: ; Somaini, P. (PI); Kankolongo Ngoba, N. (GP)

OIT 272: Online Marketplaces

The course studies one of the most impactful business models in recent decades. We will study what makes an online marketplace successful, from network effects to reducing search and matching frictions, fostering trust, and effective ways to monetize. Students will explore both strategic decisions and the inner operations of these platforms, getting hands-on with the analytical and data science tools that power them. We will look at well-known models like those of Amazon, Google, Uber, and Airbnb, while also touching on the latest trends in the space. A particular emphasis will be on how AI is reshaping the way online marketplaces interact with users and the broader changes it might bring. Overall, the course will provide basic business knowledge for future investors, entrepreneurs, product managers, and anyone interested on online marketplaces.

Terms: Spr | Units: 2

Instructors: ; Weintraub, G. (PI); Lumagui, S. (GP)

OIT 281: Operations, Innovation, and Technology II

This course is the second part of the two-quarter course series (OIT 280 & OIT 281) and expands on the learnings developed in Part I: OIT 280. Students will learn how to structure business models and innovation processes and will apply the frameworks in a team project. A team project on an innovation challenge selected by students will provide a real world experience applying these frameworks. We encourage diverse innovation challenges that could lead to one of the following: a concept for a new venture, a critical evaluation of an existing business model with a recommendation for a change, a critical evaluation of operational processes for an existing organization with recommendations for changes. Students will develop a project proposal as part of OIT280 and they will launch and implement the project in OIT281. In addition, students will examine through a series of case studies how organizations develop operating models that implement innovative business models and integrate operations, innovation and technology. Key Topics: business model analysis and design, design thinking, lean startup, precedent-based innovation, technology readiness level assessment, AI and 3D printing, value chain innovation, innovation process applications.

Terms: Spr | Units: 3

Instructors: ; Mendelson, H. (PI); Plambeck, E. (SI); Zenios, S. (SI); Alvarez, G. (GP)

OIT 351: AI and Data Science: Strategy, Management and Entrepreneurship

How can one best put AI and Data Science to work in a modern company and manage data science teams effectively? Leaning on the emerging theory and best practices, we will examine companies at various sizes and stages, from seed through IPO, and study real-life cases to understand how companies should leverage AI, data science and machine learning to build effective teams, core competencies, and competitive advantages. We will draw similarities and contrasts between regular technology and data-science-heavy companies in terms of management, technical risks, and economics, and more. The students will learn how to reason about the cost and benefits of building up a data science capability within a company, how to best manage teams to maximize performance and innovation, as well as how to evaluate the value creation through data and AI from the perspective of investors. We will have several AI entrepreneurs, executives, and investors participating in discussions. This is a 3-unit version of OIT 551. An up-to-date syllabus for OIT 351 can be found on this site: https://www.aistanford.org/.

Terms: Win | Units: 3

Instructors: ; Xu, K. (PI); Voloch, L. (SI); Smeton, K. (GP)

OIT 551: Data Science: Management, Strategy and Innovation

How can one best put data science and AI to work in a modern company and manage data science teams effectively? Leaning on the emerging theory and best practices, we will examine companies at various sizes and stages, from seed through IPO, and study real-life cases to understand how companies should leverage data, data science and machine learning, build effective teams, core competencies, and competitive advantages. We will draw similarities and contrasts between regular technology and data-science-heavy companies in terms of management, technical risks, and economics, and more. The students will learn how to reason about the cost and benefits of building up a data science capability within a company, how to best manage teams to maximize performance and innovation, as well as how to evaluate the value creation through data and AI from the perspective of investors. We will have several AI entrepreneurs, executives, and investors participating in discussions.

Last offered: Spring 2023 | Units: 2

OIT 655: Foundations of Supply Chain Management

Driven by technology, data insights, and collaborations, supply chains have evolved from traditional cost centers to vital sources of competitive advantage for leading global companies. Yet, as recent events like pandemics, wars or severe (climate-change induced) weather events serve to remind us, such advancements have also led to heightened complexities and management challenges. Correspondingly, supply chain research has transitioned during the past 60+ years from addressing primarily operational questions related to production, inventory, or logistics to examining strategic issues on information sharing or incentive alignment among the many stakeholders involved in today¿s global supply chains, and to understanding the role of regulation or technology in improving designs and processes. Reflecting these trends, this course sets two main learning objectives. First, to survey some of the foundational tools and techniques used to model and understand supply chains, leveraging ideas from operations research, decision sciences, economics, and computer science. Second, to identify knowledge gaps and research opportunities by covering emerging topics such as supply chain financing, designing and operating socially responsible and environmentally sustainable supply chains, or using technology (AI, online platforms, distributed ledgers, remote sensing) to improve designs and processes. The precise selection of topics varies by year, depending on instructor and student interest. The course is structured as a combination of formal lectures covering some of the foundational topics and seminar-style discussions involving student presentations.

Terms: Aut | Units: 3

Instructors: ; Iancu, D. (PI); Alvarez, K. (GP)

OSPCPTWN 88: Computational Education

In 2022 there is a unique opportunity to build better learning experiences that serve more students. In this research-level course we explore ways to leverage; modern AI, online platforms and large datasets to address challenges in education for learners around the world. Imagining and contributing to education's digital future is an open challenge and as such this course is designed to encourage your creativity.

Last offered: Spring 2022 | Units: 4

OSPHONGK 32: Fintech and Entrepreneurship in China

Introduction to the concepts essential to the entrepreneurial process and a look at the role of the individual and teams within high-impact ventures, intended for sophomores, juniors, and seniors of all majors. Case studies, lectures, workshops and mentor-guided team projects cover high-growth ventures involving technology, with special emphasis on the significance of entrepreneurship, blockchain/AI/ML related to financial innovation and opportunities in Hong Kong and China more broadly. Explore both financial innovation for high net worth as well as "bottom of the pyramid" individuals and ethical issues in startups. No prerequisites. Also enroll in CUHK course # EPIN4010. Enrollment limited.

Terms: Aut | Units: 4 | UG Reqs: WAY-SI

Instructors: ; Eesley, C. (PI)

OSPHONGK 33: Comparative Analysis of Entrepreneurship and Innovation: Fintech in Hong Kong and Silicon Valley

Independent research and analysis of the historical, current, and future potential for high-growth entrepreneurship in Hong Kong, China and its surrounding region. How entrepreneurship in China compares to Silicon Valley and other similar innovation clusters today around the globe. Special emphasis on financial innovations such as bitcoin, blockchain, AI/ML applications in finance and insurance. Role of context with respect to entrepreneurship and innovation through direct contact with entrepreneurs, interviewing potential customers, professional investors, innovation education centers, policy makers, government officials, and any NGOs involved with entrepreneurship.

Last offered: Autumn 2022 | Units: 1-2

OSPOXFRD 29: Artificial Intelligence and Society

Artificial Intelligence (AI) has the potential to transform society in a way that has not been seen before. AI can bring many positive benefits, such as allowing ideas to more flexibly cross language barriers, improve medical outcomes, and enhance the safety and efficiency of our transportation systems. However, as with the introduction with other technologies, there is the potential of negative consequences, such as job insecurity and the introduction of vulnerabilities that come with greater levels of automation. We will delve deeply into the core issues at stake that comes with the greater integration of AI into society. The course will be composed of discussion and guest lectures from industry leaders and academics associated with Oxford. Assignments include readings, class presentations, individual research projects, and essays. Field trips will include visits to London and Edinburgh.

Last offered: Autumn 2022 | Units: 4-5 | UG Reqs: WAY-ER

OSPOXFRD 48: Causality, Counterfactuals and AI

The ability to reason about what might have been is one of the most central aspects of intelligence, and is a key part of what enables people to generalize from prior experience to inform their future decisions. This issue has captivated multiple communities and also is central to areas from healthcare to economics. In this course we will introduce the dominant approaches in machine learning and AI, with also reference to statistics and econometrics. Classes will combine lectures and discussions. Assignments will involve reasoning about the alternate frameworks and the questions they can address, using presented approaches to infer treatment effects in existing datasets, and essays arguing in favor of one of the particular frameworks for causal and counterfactual reasoning.

Last offered: Spring 2022 | Units: 4-5 | UG Reqs: WAY-AQR

OSPOXFRD 85: Practical Ethics for Artificial Intelligence

AI has attracted significant attention in the last year, initially due to the release of ChatGPT, followed by backlash and efforts at creating effective regulation. Questions of ethics underlie every aspect of AI, beginning with the question of whether it is even coherent to speak of an intelligence other than humans. This course presents current ethical issues in the development and application of artificial intelligence through a series of recent case studies. We will spend the first part of the course studying major ethical frameworks (consequentialism, deontology, virtue ethics) and closely-linked research areas within AI and machine learning. In the second part of the course, we will apply these principles to case studies from major areas of debate in AI, with a focus on the translation of ethical principles into practical decisions.The first examples from AI we will cover are existential risks in the context of utilitarianism, the "hidden" labour force of AI in the context of deontology, and the problem of replacing humans in the context of virtue ethics. For the case studies, we will first study fairness and bias in the training and deployment of machine learning models. We will ask what it means for an AI system to be "fair", and how to regulate models which are not interpretable. This is followed by the problems of copyright and large scale training datasets for generative AI models, where we will ask what constitutes unfair use of existing material when it is only being used to train. We continue in a more hypothetical lens with a discussion of whether or not an AI system could be a moral agent or patient, and what rights a non-human intelligence might have. Finally, we conclude with the alignment problem, where we focus on the practical challenges of value alignment and the plausibility of finding a set of values which could be universally accepted. In the last week of the course, students apply their learnings with group presentations on published academic research, unpacking the ethical questions underlying technical developments

Terms: Win | Units: 4-5 | UG Reqs: WAY-ER

Instructors: ; Bean, A. (PI); Solywoda, S. (GP)

OTOHNS 206: Augmenting Human Senses: Enhancing Perception with Technology and Bioscience

This course will introduce the neuroscience of human sensory perception (hearing, balance, vision, smell, taste, touch) and explore avenues by which technology and bioscience will enhance and augment these human senses. Employing artificial intelligence, emerging devices with embedded sensors may afford perceptual and cognitive abilities beyond the limits of our biological systems. We will consider emerging multi-functional devices with capabilities beyond their sensory functions via connection within an ecosystem of technologies to characterize activities (e.g., physical, social), enhance safety (e.g., fall alerts, balance improvement), track health (e.g., multi-sensory biometric monitoring), enhance communication (e.g., speech enhancement, language translation, virtual assistant), augment cognition (e.g., memory, understanding), and monitor emotional wellbeing (e.g., sentiment, depression). We will also review simulated multisensory stimuli towards achieving immersive experiences with virtual and augmented reality technologies.

Terms: Aut | Units: 3

Instructors: ; Bhowmik, A. (PI); Jackler, R. (PI)

PEDS 219: Design for Health (DESIGN 264)

How might we design a product or service that helps each person to navigate the system to meet their health needs? This course aims to blend the best methods of co-design with key insights from digital product design and foundational AI to create novel solutions to population-health challenges, working alongside people from communities that have been historically underserved. Responsive to real-world challenges from a healthcare partner, students will work with patients with chronic illness (and their caregivers) to co-design solutions that reimagine the future of primary care. To understand these challenges, we will explore the intersections among epidemiology of chronic illness, fiscal and policy constraints, and social well-being. We will place a special emphasis on the practical challenge of delivering the right care, at the right place and time. Stakeholders will include clinicians, community experts, technologists and payers. Students will work in teams to design, prototype and test concepts that reflect the worlds in which their co-design partners live and work, all with an eye to helping our healthcare system work better for them.

Last offered: Autumn 2022 | Units: 3-4

PHIL 20N: Philosophy of Artificial Intelligence

Is it really possible for an artificial system to achieve genuine intelligence: thoughts, consciousness, emotions? What would that mean? How could we know if it had been achieved? Is there a chance that we ourselves are artificial intelligences? Would artificial intelligences, under certain conditions, actually be persons? If so, how would that affect how they ought to be treated and what ought to be expected of them? Emerging technologies with impressive capacities already seem to function in ways we do not fully understand. What are the opportunities and dangers that this presents? How should the promises and hazards of these technologies be managed?Philosophers have studied questions much like these for millennia, in scholarly debates that have increased in fervor with advances in psychology, neuroscience, and computer science. The philosophy of mind provides tools to carefully address whether genuine artificial intelligence and artificial personhood are possible. Epistemology (the philosophy of knowledge) helps us ponder how we might be able to know. Ethics provides concepts and theories to explore how all of this might bear on what ought to be done. We will read philosophical writings in these areas as well as writings explicitly addressing the questions about artificial intelligence, hoping for a deep and clear understanding of the difficult philosophical challenges the topic presents.No background in any of this is presupposed, and you will emerge from the class having made a good start learning about computational technologies as well as a number of fields of philosophical thinking. It will also be a good opportunity to develop your skills in discussing and writing critically about complex issues.

Terms: Win | Units: 3

Instructors: ; Etchemendy, J. (PI)

PHIL 24C: Tutorial: Ethics for the Wild Robot Frontier

Tutorial taught by grad student. Enrollment limited to 10. Robots and artificial intelligence present a new sort of Wild West. AI programs drive cars without a license; robots offer sexual services in exchange for payment; autonomous weapons systems roam around, looking to kill with impunity. With this new frontier comes significant ethical issues. There are several clusters of questions for us to consider, including most pressing: which technologies are permissible to develop and implement? Second, under the heading of what philosophers sometimes call moral 'agenthood': what would make robots themselves count as agents, and to what standards are they responsible? Finally, under the heading of moral 'patienthood': in what ways can robots be benefited or harmed, and how does this impact humanity's ethical obligations? Each week, our discussion will be framed around a pair of assignments: a short story, TV episode, or video; and a philosophical text. As we move through the course, the questions above will be tackled in the context of specific emerging technologies, such as self-driving cars, autonomous weapons, sex robots, and more. This tutorial is graded Satisfactory/Unsatisfactory. In order to receive credit, students must read all of the assigned readings, participate in all class meetings, and submit a short reading response for most weeks.

Last offered: Autumn 2022 | Units: 2

PHIL 82: Ethics, Public Policy, and Technological Change (COMM 180, CS 182, ETHICSOC 182, POLISCI 182, PUBLPOL 182)

Examination of recent developments in computing technology and platforms through the lenses of philosophy, public policy, social science, and engineering. Course is organized around five main units: algorithmic decision-making and bias; data privacy and civil liberties; artificial intelligence and autonomous systems; the power of private computing platforms; and issues of diversity, equity, and inclusion in the technology sector. Each unit considers the promise, perils, rights, and responsibilities at play in technological developments. Prerequisite: CS106A.

Last offered: Winter 2023 | Units: 5 | UG Reqs: WAY-ER

PHIL 134: Phenomenology: Husserl (PHIL 234)

(Graduate students register for 234.) Neuroscience, psychology, linguistics, artificial intelligence, and other related fields face fundamental obstacles when they turn to the study of the mind. Can there be a rigorous science of us? German philosopher Edmund Husserl (1859-1938), founder of phenomenology, devised a method intended to disclose the basic structures of minds. In this class, we will read one of Husserl's major later works, Cartesian Meditations, as well as companion essays from both his time and ours. A guiding question for us will be how phenomenology is applied outside of philosophy, specifically, how has it influenced discussions of the mind in the sciences? Prerequisite: one prior course in philosophy, or permission of instructor.

Last offered: Spring 2020 | Units: 4 | UG Reqs: GER:DB-Hum

PHIL 152: Computability and Logic (PHIL 252)

Kurt G¿del's ground-breaking Incompleteness Theorems demonstrate fundamental limits on formal mathematical reasoning. In particular, the First Incompleteness Theorem says, roughly, that for any reasonable theory of the natural numbers there are statements in the language that are neither provable nor refutable in that theory. In this course, we will explore the expressive power of different axiomatizations of number theory, on our path to proving the Incompleteness Theorems. This study entails an exploration of models of computation, and the power and limitations of what is computable, leading to an introduction to elementary recursion theory. At the conclusion of the course, we will discuss technical and philosophical repercussions of these results. Prerequisite: 151/251.

Terms: Spr | Units: 4 | UG Reqs: GER:DB-Math

Instructors: ; Sommer, R. (PI)

PHIL 154: Modal Logic (PHIL 254)

(Graduate students register for 254.) Syntax and semantics of modal logic and its basic theory: including expressive power, axiomatic completeness, correspondence, and complexity. Applications to classical and recent topics in philosophy, computer science, mathematics, linguistics, and game theory. Prerequisite: 150 or preferably 151.

Terms: Spr | Units: 4 | UG Reqs: GER:DB-Math, WAY-FR

Instructors: ; van Benthem, J. (PI)

PHIL 194D: Capstone Seminar: How Virtual is Reality, and Vice Versa

We will pursue questions of metaphysics and epistemology through a focus on the nature of virtual realities and their relationships to non-virtual realities. Readings will be chosen from historical and contemporary sources, including David Chalmers'n book "Reality+."

Last offered: Spring 2022 | Units: 4

PHIL 234: Phenomenology: Husserl (PHIL 134)

(Graduate students register for 234.) Neuroscience, psychology, linguistics, artificial intelligence, and other related fields face fundamental obstacles when they turn to the study of the mind. Can there be a rigorous science of us? German philosopher Edmund Husserl (1859-1938), founder of phenomenology, devised a method intended to disclose the basic structures of minds. In this class, we will read one of Husserl's major later works, Cartesian Meditations, as well as companion essays from both his time and ours. A guiding question for us will be how phenomenology is applied outside of philosophy, specifically, how has it influenced discussions of the mind in the sciences? Prerequisite: one prior course in philosophy, or permission of instructor.

Last offered: Spring 2020 | Units: 4

PHIL 350: What makes a good explanation? Psychological and philosophical perspectives (PSYCH 293)

Explanation is a topic of longstanding interest in philosophy and psychology, and has recently attracted renewed attention due to novel challenges in interpreting and interacting with relatively opaque AI systems. In this graduate seminar, we will study the science and engineering of explanations, combining perspectives from philosophy, psychology, AI, and the legal sciences. We will ask questions like: When do we ask for explanations? What makes a good explanation? How can we build machines that can understand and explain? This interdisciplinary seminar is co-taught by Thomas Icard (Philosophy) and Tobias Gerstenberg (Psychology). We will meet twice a week (Tuesdays and Thursdays 10:30am-11:50am) to discuss research articles from a range of disciplines. Students are expected to write responses based on their readings, lead the discussion on one of the papers, and actively participate in the discussion otherwise. As a final project, students will outline a novel study on explanation that makes an empirical, modeling, or theoretical contribution. Participation is restricted to a maximum of 12 graduate students (by application). The course website, with information about application, can be found here: phil350.stanford.edu

Last offered: Autumn 2020 | Units: 4

POLISCI 115: Spies, Lies, and Algorithms: The History and Future of American Intelligence (AMSTUD 115S, INTNLREL 115, PUBLPOL 114)

This course examines the past, present, and future of American espionage. Targeted at first years and sophomores, the class surveys key issues in the development of the U.S. Intelligence Community since World War II. Topics include covert action, intelligence successes and failures, the changing motives and methods of traitors, congressional oversight, and ethical dilemmas. The course pays particular attention to how emerging technologies are transforming intelligence today. We examine cyber threats, the growing use of AI for both insight and deception, and the 'open-source' intelligence revolution online. Classes include guest lectures by former senior U.S. intelligence officials, policymakers, and open-source intelligence leaders. Course requirements include an all-day crisis simulation with former senior officials designed to give students a hands-on feel for the uncertainties, coordination challenges, time pressures, and policy frictions of intelligence in the American foreign policy process.

Last offered: Spring 2023 | Units: 5 | UG Reqs: WAY-SI

POLISCI 182: Ethics, Public Policy, and Technological Change (COMM 180, CS 182, ETHICSOC 182, PHIL 82, PUBLPOL 182)

Examination of recent developments in computing technology and platforms through the lenses of philosophy, public policy, social science, and engineering. Course is organized around five main units: algorithmic decision-making and bias; data privacy and civil liberties; artificial intelligence and autonomous systems; the power of private computing platforms; and issues of diversity, equity, and inclusion in the technology sector. Each unit considers the promise, perils, rights, and responsibilities at play in technological developments. Prerequisite: CS106A.

Last offered: Winter 2023 | Units: 5 | UG Reqs: WAY-ER

PSYC 20Q: Human versus Machine: Artificial intelligence through the lens of human cognition

This course will explore the promise and limits of artificial intelligence (AI) through the lens of human cognition. Amid whispers of robots one day taking over the world, it is tempting to imagine that AI is (or soon will be) all-powerful. But few of us understand how AI works, which may lead us to overestimate its current (and even its future) capabilities. As it turns out, intelligence is complicated to build, and while computers outperform humans in many ways, they also fail to replicate key features of human intelligence at least for now. We will take a conceptual, non-technical approach (think: reading essays, not writing code). Drawing upon readings from philosophy of science, computer science, and cognitive psychology, we will examine the organizing principles of AI versus human intelligence, and the capabilities and limitations that follow. Computers vastly outperform humans in tasks that require large amounts of computational power (for example, solving complex mathematical equations). However, you may be surprised to learn the ways in which humans outperform computers. What is it about the human brain that allows us to understand and appreciate humor, sarcasm, and art? How do we manage to drive a car without hitting pedestrians? Is it only a matter of time before computers catch up to these abilities? Or are there differences of kind (rather than degree) that distinguish human intelligence from AI? Will robots always be constrained to the tasks that humans program them to do? Or could they, one day, take over the world? By the end of this course, you will be able to discuss the current capabilities, future potential, and fundamental limitations of AI. You may also arrive at a newfound appreciation for human intelligence, and for the power of your own brain.

Terms: Spr | Units: 3

Instructors: ; Chick, C. (PI)

PSYC 63Q: Artificial Intelligence in Mental Health

Over 900 million individuals worldwide suffer from a mental health disorder. Human and financial costs associated with the management of individuals with mental health disorder are substantial and constitute a growing public health challenge. Yet there are presently no objective markers used to determine which individuals have a mental health disorder and predict the progression of the disorder. Furthermore, there are presently a limited number of effective treatments for mental health disorders, as well as considerable heterogeneity in treatment response. The lack of access to mental health care is yet another challenge in developed as well as developing countries. Newly available technologies such as Artificial Intelligence offer an unprecedented opportunity for developing solutions that address the aforementioned challenges and problems. In this interdisciplinary seminar, students will learn about (i) psychopathology, (ii) state-of-the-art in diagnosis and treatments of mental health disorders, (iii) unaddressed challenges and problems related to mental health, (iv) artificial intelligence and its potential through real-world examples, (v) recent real-world applications of artificial intelligence that address the challenges and problems related to mental health, and (vi) ethical issues associated with the application of artificial intelligence to mental health. Diverse viewpoints and a deeper understanding of these topics will be offered by a mix of hands-on educational sessions and panel discussions with psychiatrists, computer scientists, lawyers, and entrepreneurs. Students will also spend guided time working in small teams to develop innovative (artificial intelligence based) solutions to challenges/problems related to mental health.

Terms: Spr | Units: 3

Instructors: ; Supekar, K. (PI)

PSYC 180: Artificial Intelligence in Medicine and Healthcare Ventures

The face of healthcare is changing - innovative technologies, based on recent advances in artificial intelligence (AI), are radically altering how care is delivered. Startups are offering entirely new ways to diagnose, manage, treat, and operate. However, few ever reach the patient - those with much more than an idea and an algorithm; they have an intimate understanding of the healthcare landscape and the technical know-how to integrate AI solutions into the medical system successfully. In this course, we tackle the central question: How can young students find feasible and impactful medical problems, and build, scale, and translate technology solutions into the clinic? Together, we will discover the transformative technologies of tomorrow that we can build today. Please see the syllabus for more information (https://t.ly/PpM2). We encourage students of all academic backgrounds to enroll; the only prerequisite is a strong passion for technology in healthcare. Course may be taken for one unit (lecture only, 11:30AM-12:30PM); or two units, which entails attending discussion section (12:30PM-1:20PM) and completing a project. The second half of each session will involve a discussion about team building, AI/Healthcare business ideas, and idea presentations. Grading criteria for 1-credit students will be based on attendance and weekly reports regarding the summary of each week's lectures (assignments). In addition to these criteria, 2-credit students will submit a business idea report and will deliver a pitch presentation in the last session in front of an invited panel.

Last offered: Spring 2023 | Units: 1-2

PSYCH 225: Triangulating Intelligence: Melding Neuroscience, Psychology, and AI (CS 322)

This course will cover both classic findings and the latest research progress on the intersection of cognitive science, neuroscience, and artificial intelligence: How does the study of minds and machines inform and guide each other? What are the assumptions, representations, or learning mechanisms that are shared (across multiple disciplines, and what are different? How can we build a synergistic partnership between cognitive psychology, neuroscience, and artificial intelligence? We will focus on object perception and social cognition (human capacities, especially in infancy and early childhood) and the ways in which these capacities are formalized and reverse-engineered (computer vision, reinforcement learning). Through paper reading and review, discussion, and the final project, students will learn the common foundations shared behind neuroscience, cognitive science, and AI research and leverage them to develop their own research project in these areas. Recommended prerequisites: PSYCH 1, PSYCH 24/SYMSYS 1/CS 24, CS 221, CS 231N

Last offered: Winter 2022 | Units: 3

PSYCH 240A: Curiosity in Artificial Intelligence (EDUC 234)

How do we design artificial systems that learn as we do early in life -- as "scientists in the crib" who explore and experiment with our surroundings? How do we make AI "curious" so that it explores without explicit external feedback? Topics draw from cognitive science (intuitive physics and psychology, developmental differences), computational theory (active learning, optimal experiment design), and AI practice (self-supervised learning, deep reinforcement learning). Students present readings and complete both an introductory computational project (e.g. train a neural network on a self-supervised task) and a deeper-dive project in either cognitive science (e.g. design a novel human subject experiment) or AI (e.g. implement and test a curiosity variant in an RL environment). Prerequisites: python familiarity and practical data science (e.g. sklearn or R).

Terms: Spr | Units: 3

Instructors: ; Haber, N. (PI)

PSYCH 247: Topics in Natural and Artificial Intelligence (SYMSYS 206)

We will read a selection of recent papers from psychology, computer science, and other fields. We will aim to understand: How human-like are state of the art artificial intelligence systems? Where can AI be better informed by recent advances in cognitive science? Which ideas from modern AI inspire new approaches to human intelligence? Specific topics will be announced prior to the beginning of term. "Registration is limited to graduate students except by instructor consent. Please write to mcfrank@stanford.edu with a one-paragraph justification if you are an undergraduate interested in registering"

Terms: Win | Units: 3

Instructors: ; Frank, M. (PI); Goodman, N. (PI)

PSYCH 249: Large-Scale Neural Network Modeling for Neuroscience (CS 375)

The last ten years has seen a watershed in the development of large-scale neural networks in artificial intelligence. At the same time, computational neuroscientists have discovered a surprisingly robust mapping between the internal components of these networks and real neural structures in the human brain. In this class we will discuss a panoply of examples of such "convergent man-machine evolution", including: feedforward models of sensory systems (vision, audition, somatosensation); recurrent neural networks for dynamics and motor control; integrated models of attention, memory, and navigation; transformer models of language areas; self-supervised models of learning; and deep RL models of decision and planning. We will also delve into the methods and metrics for comparing such models to real-world neural data, and address how unsolved open problems in AI (that you can work on!) will drive forward novel neural models. Some meaningful background in modern neural networks is highly advised (e.g. CS229, CS230, CS231n, CS234, CS236, CS 330), but formal preparation in cognitive science or neuroscience is not needed (we will provide this).

Terms: Win | Units: 3

Instructors: ; Yamins, D. (PI); Kotar, K. (TA)

PSYCH 293: What makes a good explanation? Psychological and philosophical perspectives (PHIL 350)

Explanation is a topic of longstanding interest in philosophy and psychology, and has recently attracted renewed attention due to novel challenges in interpreting and interacting with relatively opaque AI systems. In this graduate seminar, we will study the science and engineering of explanations, combining perspectives from philosophy, psychology, AI, and the legal sciences. We will ask questions like: When do we ask for explanations? What makes a good explanation? How can we build machines that can understand and explain? This interdisciplinary seminar is co-taught by Thomas Icard (Philosophy) and Tobias Gerstenberg (Psychology). We will meet twice a week (Tuesdays and Thursdays 10:30am-11:50am) to discuss research articles from a range of disciplines. Students are expected to write responses based on their readings, lead the discussion on one of the papers, and actively participate in the discussion otherwise. As a final project, students will outline a novel study on explanation that makes an empirical, modeling, or theoretical contribution. Participation is restricted to a maximum of 12 graduate students (by application). The course website, with information about application, can be found here: phil350.stanford.edu

Last offered: Autumn 2020 | Units: 4

PUBLPOL 103E: Ethics on the Edge Public Policy Core Seminar (PUBLPOL 203E)

This seminar-style course will explore additional foundational readings on organizational ethics (business, non-profit, and governmental organizations) and policy ethics. Themes will include, among others: AI and policy considerations; social media and policy considerations; race and police brutality incidents; national security (including cyber threats); the Iran nuclear agreement; non-profit organizations in the policy and US landscape; and various corporate matters. Organizing themes include, among others: ethics of leadership; ethics of persuasion and compromise; influence of bias in organizational and policy ethics; ethics of social movements; discrepancies between discourse and action; emotion and ethics; and interpreting and explaining ethics. In addition, the course will offer training in a wide variety of skills for effective communication of ethics for policy purposes (developing succinct arguments, presentations, website discourse, commenting in meetings and conferences, interviews, statement of personal views, interacting with the media and social media, and mapping complex ethical analysis). Most of the assignments allow students flexibility to explore topics of their choice. The objective is to engage actively and improve skills in a supportive environment. A short, analytically rigorous final paper in lieu of final exam. Attendance required. Grading will be based on short assignments, class participation, and the short final paper. The course is open to undergraduate and graduate students. Undergraduates will not be at a disadvantage. Everyone will be challenged. Students wishing to take the course who are unable to sign up within the enrollment limit should contact Dr. Susan Liautaud at susanl1@stanford.edu. Distinguished Career Institute Fellows are welcome and should contact Dr. Susan Liautaud directly at susanl1@stanford.edu. This three-credit seminar accompanies PUBLPOL 134 Ethics on the Edge but can also be taken as a stand-alone course. *Please note the course is being offered for two units and therefore is ineligible for Ways credit in the 2019-20 academic year. Please note that this course will require one make-up evening session on a Monday, Tuesday or Wednesday in April in lieu of the final class session the first week of June, so the course ends before Memorial Day.

Last offered: Spring 2020 | Units: 2

PUBLPOL 103F: Ethics of Truth in a Post-Truth World (PUBLPOL 203F)

This course will explore changing notions of truth in a world in which technology, global risks, and societal developments are blurring the boundaries of humanity and boring through traditional notions of nation states, institutions, and human identity. It will also offer a parallel journey to consider truth in your own life and how truth contributes to your own resilience in the face of life challenges. We will ask one over-arching question: Does truth matter anymore? If so, why and how? If not, why not? Either way, how does truth relate to ethical decision-making by individuals and institutions and to an ethical society? How does truth relate to a life well lived? Seven themes will organize our exploration of more specific topics: science and subjectivity; identity; memory; authenticity; artificial intelligence; imagination; and a life well-lived. Examples of topics to be explored include, among others: truth and technology (from ChatGPT to home devices); white supremacy; DNA testing and the 'identify as' movement, and identity; University history (Rhodes, Georgetown slavery, Yale Calhoun College, Junipero Serra...); the connections among truth, memory, and history; new questions in gender and racial identity; Chinese beautifying app Meitu and other social media "truth modifiers"; the sharing economy; the impact of AI and DNA testing sites on legal truth. We will consider how we determine and verify the truth; how we "do" truth; the role of truth in ethical decision-making; the importance of truth to effective ethical policy; and the relationship of the truth to a life well lived. An analytically rigorous short final paper in lieu of exam. This three-credit seminar may be taken as a stand-alone course or may accompany PUBLPOL 134 Ethics on the Edge to fulfill the Public Policy major ethics requirement. The course is open to undergraduate and graduate students. Undergraduates will not be at a disadvantage. Everyone will be challenged. Distinguished Career Institute Fellows are welcome and should contact Dr. Susan Liautaud directly at susanliautaud@googlemail.com. Students wishing to take the course who are unable to sign up within the enrollment limit should contact Dr. Susan Liautaud at susanliautaud@googlemail.com. *Public Policy majors taking the course to complete the core requirements and students taking the course for Ways credit must obtain a letter grade. Other students may take the course for a letter grade or C/NC. To satisfy a Ways requirement, this course must be taken for at least 3 units.

Terms: Spr | Units: 2-3 | UG Reqs: WAY-ER

Instructors: ; Liautaud, S. (PI); Chun, R. (TA)

PUBLPOL 114: Spies, Lies, and Algorithms: The History and Future of American Intelligence (AMSTUD 115S, INTNLREL 115, POLISCI 115)

This course examines the past, present, and future of American espionage. Targeted at first years and sophomores, the class surveys key issues in the development of the U.S. Intelligence Community since World War II. Topics include covert action, intelligence successes and failures, the changing motives and methods of traitors, congressional oversight, and ethical dilemmas. The course pays particular attention to how emerging technologies are transforming intelligence today. We examine cyber threats, the growing use of AI for both insight and deception, and the 'open-source' intelligence revolution online. Classes include guest lectures by former senior U.S. intelligence officials, policymakers, and open-source intelligence leaders. Course requirements include an all-day crisis simulation with former senior officials designed to give students a hands-on feel for the uncertainties, coordination challenges, time pressures, and policy frictions of intelligence in the American foreign policy process.

Last offered: Spring 2023 | Units: 5 | UG Reqs: WAY-SI

PUBLPOL 119: AI, Autonomy, and the Future of Warfare (INTLPOL 265, PUBLPOL 219)

The introduction of artificial intelligence and autonomy into warfare will have profound and unforeseen consequences for national security and human society. This course prepares future policymakers and industry leaders for the complex debate surrounding the developmental, legal, ethical, and operational considerations of creating machines with the ability to apply lethal force. Students will gain a detailed and multi-perspective understanding of the associated opportunities and risk by lectures and discussions with expert guest speakers and a cohort of students from a variety of disciplines and backgrounds. There will be two days of class each week. One day is a lecture session and the other is a discussion session. The lecture session will occasionally have guest lecturers with recent real-world experience in the topic and is intended to expose students to current knowledge and perspectives. The following discussion session will be an opportunity to digest, and reflect on, the ideas from lecture, but will also be a chance for group work on graded assignments. No experience in the content is necessary. Varying perspectives are essential in any conversation on this topic. Undergrads also welcome.

Terms: Spr | Units: 3

Instructors: ; Boyd, B. (PI)

PUBLPOL 134: Ethics on the Edge: Business, Non-Profit Organizations, Government, and Individuals (PUBLPOL 234)

(PUBLPOL 134, PUBLPOL 234 - 3 credits; Ways - ER; Same as LAW 7020) The objective of this course is to explore cutting-edge ethical challenges in a world in which technology, global risks, and societal developments are accelerating faster than our understanding and the law can keep pace. The course also offers a parallel personal journey: an opportunity to explore your own ethics and increase your own resilience when life throws challenges your way. We will unravel the ethics challenges and problem-solve across sectors: business, government, non-profit, and academia. A framework for ethical decision-making underpins the course. However, there is significant space for forming your own views on a wide range of issues. Prominent guest speakers will attend certain sessions interactively. The relationships among ethics and technology, culture, leadership, law, and global risks (AI, synthetic biology, inequality, privacy, financial system meltdown, cyber-terrorism, climate change, diversity and inclusion, etc.) will inform discussion. A broad range of topics might include: designer genetics; civilian space travel; generative AI; the Supreme Court case on University affirmative action; new wearable devices; free speech on University campuses; opioid addiction; corporate and financial sector scandals (Theranos, FTX, currency); and non-profit sector ethics challenges (e.g. medical humanitarian aid in Gaza). Final project in lieu of exam on a topic of student's choice. Attendance required. Class participation important, with multiple opportunities to earn participation credit beyond speaking in class. Strong emphasis on rigorous analysis, critical thinking, and testing ideas in real-world contexts. Note that this course will require one make-up evening session on a Wednesday or Thursday in early May in lieu of the final class session in June. Enrollment will be decided via application, which can be found at https://forms.gle/xw9bPh5wjxPZZcwf6. **The form will open on 3/6 at 5pm and close on 5/13 at 5pm.** The course offers credit toward Public Policy core requirements (if taken in combination with PUBLPOL 103F) and it satisfies the undergraduate Ways of Thinking - ER requirement. The course is open to undergraduate and graduate students. Undergraduates will not be at a disadvantage. Everyone will be challenged. Students taking the course for Ways credit and Public Policy majors taking the course to complete the core requirements must obtain a letter grade. Others may take the course for a letter grade or C/NC. Students seeking credit for other majors should consult their departments.

Terms: Spr | Units: 3 | UG Reqs: WAY-ER

Instructors: ; Liautaud, S. (PI); Jiang, D. (TA)

PUBLPOL 182: Ethics, Public Policy, and Technological Change (COMM 180, CS 182, ETHICSOC 182, PHIL 82, POLISCI 182)

Examination of recent developments in computing technology and platforms through the lenses of philosophy, public policy, social science, and engineering. Course is organized around five main units: algorithmic decision-making and bias; data privacy and civil liberties; artificial intelligence and autonomous systems; the power of private computing platforms; and issues of diversity, equity, and inclusion in the technology sector. Each unit considers the promise, perils, rights, and responsibilities at play in technological developments. Prerequisite: CS106A.

Last offered: Winter 2023 | Units: 5 | UG Reqs: WAY-ER

PUBLPOL 203E: Ethics on the Edge Public Policy Core Seminar (PUBLPOL 103E)

This seminar-style course will explore additional foundational readings on organizational ethics (business, non-profit, and governmental organizations) and policy ethics. Themes will include, among others: AI and policy considerations; social media and policy considerations; race and police brutality incidents; national security (including cyber threats); the Iran nuclear agreement; non-profit organizations in the policy and US landscape; and various corporate matters. Organizing themes include, among others: ethics of leadership; ethics of persuasion and compromise; influence of bias in organizational and policy ethics; ethics of social movements; discrepancies between discourse and action; emotion and ethics; and interpreting and explaining ethics. In addition, the course will offer training in a wide variety of skills for effective communication of ethics for policy purposes (developing succinct arguments, presentations, website discourse, commenting in meetings and conferences, interviews, statement of personal views, interacting with the media and social media, and mapping complex ethical analysis). Most of the assignments allow students flexibility to explore topics of their choice. The objective is to engage actively and improve skills in a supportive environment. A short, analytically rigorous final paper in lieu of final exam. Attendance required. Grading will be based on short assignments, class participation, and the short final paper. The course is open to undergraduate and graduate students. Undergraduates will not be at a disadvantage. Everyone will be challenged. Students wishing to take the course who are unable to sign up within the enrollment limit should contact Dr. Susan Liautaud at susanl1@stanford.edu. Distinguished Career Institute Fellows are welcome and should contact Dr. Susan Liautaud directly at susanl1@stanford.edu. This three-credit seminar accompanies PUBLPOL 134 Ethics on the Edge but can also be taken as a stand-alone course. *Please note the course is being offered for two units and therefore is ineligible for Ways credit in the 2019-20 academic year. Please note that this course will require one make-up evening session on a Monday, Tuesday or Wednesday in April in lieu of the final class session the first week of June, so the course ends before Memorial Day.

Last offered: Spring 2020 | Units: 2

PUBLPOL 203F: Ethics of Truth in a Post-Truth World (PUBLPOL 103F)

This course will explore changing notions of truth in a world in which technology, global risks, and societal developments are blurring the boundaries of humanity and boring through traditional notions of nation states, institutions, and human identity. It will also offer a parallel journey to consider truth in your own life and how truth contributes to your own resilience in the face of life challenges. We will ask one over-arching question: Does truth matter anymore? If so, why and how? If not, why not? Either way, how does truth relate to ethical decision-making by individuals and institutions and to an ethical society? How does truth relate to a life

well lived? Seven themes will organize our exploration of more specific topics: science and subjectivity; identity; memory; authenticity; artificial intelligence; imagination; and a life well-lived. Examples of topics to be explored include, among others: truth and technology (from ChatGPT to home devices); white supremacy; DNA testing and the 'identify as' movement, and identity; University history (Rhodes, Georgetown slavery, Yale Calhoun College, Junipero Serra...); the connections among truth, memory, and history; new questions in gender and racial identity; Chinese beautifying app Meitu and other social media "truth modifiers"; the sharing economy; the impact of AI and DNA testing sites on legal truth. We will consider how we determine and verify the truth; how we "do" truth; the role of truth in ethical decision-making; the importance of truth to effective ethical policy; and the relationship of the truth to a life well lived. An analytically rigorous short final paper in lieu of exam. This three-credit seminar may be taken as a stand-alone course or may accompany PUBLPOL 134 Ethics on the Edge to fulfill the Public Policy major ethics requirement. The course is open to undergraduate and graduate students. Undergraduates will not be at a disadvantage. Everyone will be challenged. Distinguished Career Institute Fellows are welcome and should contact Dr. Susan Liautaud directly at susanliautaud@googlemail.com. Students wishing to take the course who are unable to sign up within the enrollment limit should contact Dr. Susan Liautaud at susanliautaud@googlemail.com. *Public Policy majors taking the course to complete the core requirements and students taking the course for Ways credit must obtain a letter grade. Other students may take the course for a letter grade or C/NC. To satisfy a Ways requirement, this course must be taken for at least 3 units.

Terms: Spr | Units: 2-3

Instructors: ; Liautaud, S. (PI); Chun, R. (TA)

PUBLPOL 219: AI, Autonomy, and the Future of Warfare (INTLPOL 265, PUBLPOL 119)

The introduction of artificial intelligence and autonomy into warfare will have profound and unforeseen consequences for national security and human society. This course prepares future policymakers and industry leaders for the complex debate surrounding the developmental, legal, ethical, and operational considerations of creating machines with the ability to apply lethal force. Students will gain a detailed and multi-perspective understanding of the associated opportunities and risk by lectures and discussions with expert guest speakers and a cohort of students from a variety of disciplines and backgrounds. There will be two days of class each week. One day is a lecture session and the other is a discussion session. The lecture session will occasionally have guest lecturers with recent real-world experience in the topic and is intended to expose students to current knowledge and perspectives. The following discussion session will be an opportunity to digest, and reflect on, the ideas from lecture, but will also be a chance for group work on graded assignments. No experience in the content is necessary. Varying perspectives are essential in any conversation on this topic. Undergrads also welcome.

Terms: Spr | Units: 3

Instructors: ; Boyd, B. (PI)

PUBLPOL 234: Ethics on the Edge: Business, Non-Profit Organizations, Government, and Individuals (PUBLPOL 134)

(PUBLPOL 134, PUBLPOL 234 - 3 credits; Ways - ER; Same as LAW 7020) The objective of this course is to explore cutting-edge ethical challenges in a world in which technology, global risks, and societal developments are accelerating faster than our understanding and the law can keep pace. The course also offers a parallel personal journey: an opportunity to explore your own ethics and increase your own resilience when life throws challenges your way. We will unravel the ethics challenges and problem-solve across sectors: business, government, non-profit, and academia. A framework for ethical decision-making underpins the course. However, there is significant space for forming your own views on a wide range of issues. Prominent guest speakers will attend certain sessions interactively. The relationships among ethics and technology, culture, leadership, law, and global risks (AI, synthetic biology, inequality, privacy, financial system meltdown, cyber-terrorism, climate change, diversity and inclusion, etc.) will inform discussion. A broad range of topics might include: designer genetics; civilian space travel; generative AI; the Supreme Court case on University affirmative action; new wearable devices; free speech on University campuses; opioid addiction; corporate and financial sector scandals (Theranos, FTX, currency); and non-profit sector ethics challenges (e.g. medical humanitarian aid in Gaza). Final project in lieu of exam on a topic of student's choice. Attendance required. Class participation important, with multiple opportunities to earn participation credit beyond speaking in class. Strong emphasis on rigorous analysis, critical thinking, and testing ideas in real-world contexts. Note that this course will require one make-up evening session on a Wednesday or Thursday in early May in lieu of the final class session in June. Enrollment will be decided via application, which can be found at https://forms.gle/xw9bPh5wjxPZZcwf6. **The form will open on 3/6 at 5pm and close on 5/13 at 5pm.** The course offers credit toward Public Policy core requirements (if taken in combination with PUBLPOL 103F) and it satisfies the undergraduate Ways of Thinking - ER requirement. The course is open to undergraduate and graduate students. Undergraduates will not be at a disadvantage. Everyone will be challenged. Students taking the course for Ways credit and Public Policy majors taking the course to complete the core requirements must obtain a letter grade. Others may take the course for a letter grade or C/NC. Students seeking credit for other majors should consult their departments.

Terms: Spr | Units: 3

Instructors: ; Liautaud, S. (PI); Jiang, D. (TA)

PUBLPOL 353B: Regulating Emerging Technology: Risks, Opportunities, and Reality

Geared towards graduate students and advanced undergraduates, this course aims to provide students with an interdisciplinary framework for thinking about both why and when new technology should be regulated, as well as how to create effective regulations and policies when the pace of technological innovation often far exceeds the pace at which laws and public policies can be made. Through case studies involving specific areas of emerging technology, we will explore the opportunities that new technologies provide for improvement to a broad range of human domains - including the physical and social sciences, healthcare, economics, equity/justice, and national security. At the same time, we will consider risks presented by those same technologies, learn about policies and regulatory structures (both public and private) aimed at mitigating those risks, and reflect on potential risks and opportunities associated with the regulatory process itself. Readings and discussions will touch on the nature of relationships among scientific and technological experts, public officials, activists, and ordinary citizens - including problems of science literacy and communication between policymakers and practitioners. Students from all schools are encouraged to enroll, with the aim of creating opportunities for students to engage in the type of cross-discipline dialogue we will be discussing in class. Specific case studies may include: consumer data privacy, facial recognition, election-related misinformation and disinformation, regulation of the metaverse, automation and machine learning in military technology.

Terms: Spr | Units: 3

Instructors: ; Boyd, B. (PI)

PUBLPOL 364: The Future of Finance (ECON 152, ECON 252)

This 2-credit course will examine vast changes driven by innovation both from within traditional finance and from new ecosystems in fintech among others. Breathtaking advances in financial theory, big data, machine learning, artificial intelligence, computational capability, IoT, payment systems (e.g. blockchain, crypto currencies), new products (e.g. robo advising, digital lending, crowd funding, smart contracts), new trading processes (e.g. algorithmic trading, AI-driven sales & trading), and new markets (e.g. ETFs, zero-cost products), among others are changing not only how financial and non-financial firms conduct business but also how investors and supervisors view the players and the markets. nWe will discuss critical strategy, policy and legal issues, some resolved and others yet to be (e.g. failed business models, cyber challenges, financial warfare, fake news, bias problems, legal standing for cryptos). The course will feature perspectives from guest speakers including top finance executives and Silicon Valley entrepreneurs on up-to-the-minute challenges and opportunities in finance. nWe will discuss slowing global growth against the backdrop of ongoing intervention and wildcards in the capital markets of the U.S., Europe, Hong Kong, Singapore, China, India,

Japan, the Middle East and Latin America. We will look forward at strategic opportunities and power players appearing and being dethroned in the markets to discuss who is likely to thrive ¿ and not survive ¿ in the new global financial landscape. nnPrerequisites: If you are an undergraduate wishing to take this course, apply by completing the course application and provide a brief bio here: https://forms.gle/9BGYr8brdYwPS8Cu8

Last offered: Winter 2020 | Units: 2

PWR 1SBB: Writing & Rhetoric 1: The Rhetoric of Robots and Artificial Intelligence

PWR 1 courses focus on developing writing and revision strategies for rhetorical analysis and research-based arguments that draw on multiple sources. This course takes as its theme robots and AI. What is the impact of automation on particular kinds of work, including writing? What will human beings do with themselves when machines do more of the work? How will the introduction of increasingly satisfying robot or AI companions alter how we relate to each other in a variety of settings? A full course description and video can be found here: pwrcourses.stanford.edu/pwr1/pwr1sbb For the PWR course catalog please visit https://pwrcourses.stanford.edu/. Enrollment is handled by the PWR office.

Terms: Aut | Units: 4 | UG Reqs: Writing 1

Instructors: ; Brawn, S. (PI)

PWR 2KDC: Writing & Rhetoric 2: The Stories We Tell: Restorying Possible Futures

PWR 2 courses focus on developing strategies for presenting research-based arguments in both written and oral/multimedia genres. This course takes as it theme ancient world myths and questions what they have to tell us about our current world. What do these stories say about AI, Genetic Engineering, Climate Change, and Social Justice? How does the difference of old perspectives offer us fresh takes on the new? A full course description and video can be found here: pwrcourses.stanford.edu/pwr2/pwr2kdc For the PWR course catalog please visit https://pwrcourses.stanford.edu/ Enrollment is handled by the PWR office. Prerequisite: PWR 1.

Terms: Win, Spr | Units: 4 | UG Reqs: Writing 2

Instructors: ; DiPirro, K. (PI)

PWR 2MAA: Writing & Rhetoric 2: The Rhetoric of Generative AI

PWR 2 courses focus on developing strategies for presenting research-based arguments in both written and oral/multimedia genres. Is ChatGPT and other LLMs the most revolutionary technology since personal computers? Will the social, political and economic impacts of generative AI be as transformative as the industrial revolution? In this course we will ponder these and other questions. For full course description and video see https://pwrcourses.stanford.edu/pwr2/pwr2maa. For the PWR 2 course catalog visit https://pwrcourses.stanford.edu/pwr-2. Enrollment is handled by the PWR office. Prerequisite: PWR 1.

Terms: Win, Spr | Units: 4 | UG Reqs: Writing 2

Instructors: ; Anwar, M. (PI)

PWR 2STA: Writing & Rhetoric 2: Ethics and AI

PWR 2 courses focus on developing strategies for presenting research-based arguments in both written and oral/multimedia genres. This course explores the so-called killer machines of our era that, thanks to the growth of machine learning, are both amazing and remarkably mundane. For full course description and video, see https://pwrcourses.stanford.edu/pwr2/pwr2sta. For PWR 2 course catalog visit https://pwrcourses.stanford.edu/pwr-2. Enrollment is handled by the PWR office. Prerequisite: PWR 1.

Terms: Win, Spr | Units: 4 | UG Reqs: Writing 2

Instructors: ; Starkman, R. (PI)

PWR 194AJB: Race, Ethnicity, and Language: Black Digital Cultures from BlackPlanet to AI (AFRICAAM 389C, CSRE 385, EDUC 389C)

This seminar explores the intersections of language and race/racism/racialization in the public schooling experiences of students of color. We will briefly trace the historical emergence of the related fields of sociolinguistics and linguistic anthropology, explore how each of these scholarly traditions approaches the study of language, and identify key points of overlap and tension between the two fields before considering recent examples of inter-disciplinary scholarship on language and race in urban schools. Issues to be addressed include language variation and change, language and identity, bilingualism and multilingualism, language ideologies, and classroom discourse. We will pay particular attention to the implications of relevant literature for teaching and learning in urban classrooms.

Terms: Win | Units: 3-4 | UG Reqs: WAY-A-II, WAY-EDP

Instructors: ; Banks, A. (PI)

PWR 194KD: Topics in Writing and Rhetoric: Technology and Human Values

Pining for a job in Google X but a little afraid of what disrupting the next social system will do to humans when all is said and done? Unsure where the real conversation is happening at Stanford about how to think more carefully and thoughtfully about the tech we are being trained to make? Curious to know what underlying common ground might link fuzzies with techies, humanists with engineers, scientists with philosophers? These are some of the issues we¿ll address in this seminar. You will be able to choose your own current topic¿drones, tech and medicine, Big Data, Cloud applications, AI and consciousness, cybersecurity, tech and the law¿for which you will choose readings and write a seminar paper and then co-lead discussion. The class goals are to know better the ethical value of one¿s tech work and research and to be able to express to scientists and non-scientists alike the ways in which this work contributes to the greater human good (beyond strict convenience or short-term profit). Prerequisite: first two levels of the writing requirement or equivalent transfer credit. For topics, see https://undergrad.stanford.edu/programs/pwr/courses/advanced-pwr-courses.

Last offered: Winter 2016 | Units: 4 | UG Reqs: WAY-ER

RAD 271: Foundation Models for Healthcare (BIODS 271, CS 277)

Generative AI and large-scale self-supervised foundation models are poised to have a profound impact on human decision making across occupations. Healthcare is one such area where such models have the capacity to impact patients, clinicians, and other care providers. In this course, we will explore the training, evaluation, and deployment of generative AI and foundation models, with a focus on addressing current and future medical needs. The course will cover models used in natural language processing, computer vision, and multi-modal applications. We will explore the intersection of models trained on non-healthcare domains and their adaptation to domain-specific problems, as well as healthcare-specific foundation models. Prerequisites: Familiarity with machine learning principles at the level of CS 229, 231N, or 224N

Terms: Win | Units: 3

Instructors: ; Chaudhari, A. (PI); Syeda-Mahmood, T. (PI); Zou, J. (PI); Varma, M. (TA); Wu, K. (TA)

SOC 64: Shaping America's Future: Exploring the Key Issues on Our Path to the 2024 Elections (COMM 159B, EDUC 64)

Join us for an immersive speaker series that delves into the core of American democracy. Prominent figures from a range of politic, business, foreign policy, academia, and media will analyze the implications of the 2024 elections and the challenges our nation faces. Led by James Steyer, founder and CEO of Common Sense Media, explore topics such as harnessing the power of AI responsibly, addressing climate change at various levels, strengthening commitments to democracy and voting rights, safeguarding youth from the impacts of social media and technology on mental health, and ensuring accountability for wealth disparities. This series will provide you with a comprehensive understanding of the elections and the broader American political landscape.

Terms: Aut | Units: 1

Instructors: ; Steyer, J. (PI); Engel, E. (GP); Stewart, S. (GP)

SOC 167VP: Justice + Poverty Innovation:Create new solutions for people to navigate housing, medical, & debt

How can emerging technologies and human-centered design be used to help people going through problems with housing, medical care, and debt? In this class, we will work with local partners to develop new tech and design prototypes to address poverty-related problems. We will explore new digital solutions, as well as how to use emerging technologies like AI and blockchain. At the same time, we will explore policy and legal reforms that could address root causes of the problems.nStudents will work in small, interdisciplinary teams with partners organizations in law, medicine, and policy. They will do design research in the field, propose new solutions and test them, and develop new initiatives that will be piloted. The goal is to incubate promising, feasible public interest technology and design projects.nThe class will be run in parallel to similar classes in Mexico, Guatemala, and Colombia. Students will have the chance to learn about similar innovation efforts in other countries, and will be challenged to think about how their own projects could be replicated and scaled

Last offered: Winter 2020 | Units: 4 | Repeatable for credit

STATS 214: Machine Learning Theory (CS 229M)

How do we use mathematical thinking to design better machine learning methods? This course focuses on developing mathematical tools for answering this question. This course will cover fundamental concepts and principled algorithms in machine learning, particularly those that are related to modern large-scale non-linear models. The topics include concentration inequalities, generalization bounds via uniform convergence, non-convex optimization, implicit regularization effect in deep learning, and unsupervised learning and domain adaptations. Prerequisites: linear algebra (MATH 51 or CS 205), probability theory (STATS 116, MATH 151 or CS 109), and machine learning (CS 229, STATS 229, or STATS 315A).

Terms: Aut | Units: 3

Instructors: ; Schramm, T. (PI); Nair, Y. (TA); Spector, A. (TA)

STATS 232: Machine Learning for Sequence Modeling (CS 229B)

Sequence data and time series are becoming increasingly ubiquitous in fields as diverse as bioinformatics, neuroscience, health, environmental monitoring, finance, speech recognition/generation, video processing, and natural language processing. Machine learning has become an indispensable tool for analyzing such data; in fact, sequence models lie at the heart of recent progress in AI like GPT3. This class integrates foundational concepts in time series analysis with modern machine learning methods for sequence modeling. Connections and key differences will be highlighted, as well as how grounding modern neural network approaches with traditional interpretations can enable powerful leaps forward. You will learn theoretical fundamentals, but the focus will be on gaining practical, hands-on experience with modern methods through real-world case studies. You will walk away with a broad and deep perspective of sequence modeling and key ways in which such data are not just 1D images.

Terms: Aut | Units: 3-4

Instructors: ; Fox, E. (PI)

STATS 315A: Modern Applied Statistics: Learning

Overview of supervised learning. Linear regression and related methods. Model selection, least angle regression and the lasso, stepwise methods. Classification. Linear discriminant analysis, logistic regression, and support vector machines (SVMs). Basis expansions, splines and regularization. Kernel methods. Generalized additive models. Kernel smoothing. Gaussian mixtures and the EM algorithm. Model assessment and selection: crossvalidation and the bootstrap. Pathwise coordinate descent. Sparse graphical models. Prerequisites: STATS 305A, 305B, 305C or consent of instructor.

Terms: Win | Units: 3

Instructors: ; Duchi, J. (PI); Chen, Z. (TA); Cheng, C. (TA); Yang, Z. (TA)

STATS 315B: Modern Applied Statistics: Learning II

Modern statistical machine learning topics moving beyond linear regression and classification. Decision trees (boosting, random forests) and deep learning techniques for non-linear regression and classification tasks. Discovering patterns and low-dimensional structure via unsupervised learning, including clustering, EM algorithm, PCA and factor analysis, (variational) autoencoding methods, and matrix factorization. Time series and sequence modeling via state space models and deep learning methods (recurrent neural networks, seq2seq models, transformers). Students entering the course are assumed to have foundational working knowledge in statistics, probability, and basic machine learning concepts, though the course has been designed to provide a broadly accessible treatment of the topics covered.

Last offered: Spring 2023 | Units: 3

STRAMGT 547: Riding The Next Wave in Developing Economies

Today, innovative ventures in developing economies are providing compelling new products and services to a growing middle-class as well as to the lower part of the economic pyramid. These offerings provide consumers ways to better their lives and companies to grow their businesses. As older industries around the world are being disrupted, and entrepreneurial ecosystems in developing economies are evolving, entrepreneurs and investors now have reference points and 'basecamps' to explore unique opportunities. These newly formed networks that include universities, incubators, accelerator programs, angel investor organizations and small venture capital firms are still lacking in breadth and depth, despite their attempts to follow the lead of Silicon Valley. Consequently, investors and founders face distinct and more numerous challenges that they would not encounter in Silicon Valley, such as small local markets, lack of scale-up funding, uncertain exit opportunities, inadequate talent pools and complex legal and political environments.Yet these developing economies are growing and becoming more connected. We are witnessing new technology-based products in these locations allowing problems to be solved at a scale never seen before. AI and machine learning, blockchain, smart sensors, IoT devices, natural language interfaces and AR and VR are just a few of the technologies not only being developed in Silicon Valley, but all over the world. Of course, smartphones, with their multi-faceted sensors, are now becoming ubiquitous. These trends present opportunities such as: replicating business models proven elsewhere; leapfrogging legacy technologies; targeting the base of the pyramid; and starting venture capital firms. Despite this fertile ground for new endeavors, success not only requires an exceptional product/market fit but great execution to start and scale a venture in problematic and sometimes adverse environments.This case-driven course is designed to help students identify new opportunities in developing economies around the world and

across industries and to expose them to the challenges they will face. It is targeted at students who are thinking about creating, joining or investing in new ventures in developing economies.The cases and guests will reveal entrepreneurial challenges through the eyes of founders and investors who have seized these opportunities at different stages of the venture: ideation, launch and scaling. This course is designed to showcase innovative companies in high growth industries such as consumer internet, financial services, health care and education. It will feature the latest trends and opportunities in Asia, Eastern Europe, Middle East, Africa and Latin America. By taking this course, you will be better equipped to observe, explain and participate in developing economy ecosystems and the opportunities and challenges they present.

Terms: Aut | Units: 2

Instructors: ; Antoni, F. (PI); Ciesinski, S. (SI); Alvarez, G. (GP)

STS 10: Introduction to AI Safety (CS 120)

As we delegate more to artificial intelligence (AI) and integrate AI more in societal decision-making processes, we must find answers to how we can ensure AI systems are safe, follow ethical principles, and align with the creator's intent. Increasingly, many AI experts across academia and industry believe there is an urgent need for both technical and societal progress across AI alignment, ethics, and governance to understand and mitigate risks from increasingly capable AI systems and ensure that their contributions benefit society as a whole. Intro to AI Safety explores these questions in lectures with targeted readings, weekly quizzes, and group discussions. We are looking at the capabilities and limitations of current and future AI systems to understand why it is hard to ensure the reliability of existing AI systems. We will cover ongoing research efforts that tackle these questions, ranging from studies in reinforcement learning and computer vision to natural language processing. We will study work in interpretability, robustness, and governance of AI systems - to name a few. Basic knowledge about machine learning helps but is not required. View the full syllabus at http://tinyurl.com/42rb2sfv

Terms: Spr | Units: 3

Instructors: ; Lamparth, M. (PI)

STS 10SI: Introduction to AI Alignment

As we delegate more and more societal responsibilities to Artificial Intelligence, we raise pressing ethical questions about what will happen if these systems aren't aligned with our values. Increasingly many AI experts across academia and industry believe there is an urgent need for both technical and societal progress across AI alignment, ethics, and governance to understand and mitigate risks from advanced AI systems and ensure that their contributions benefit humanity and the world. Intro to AI Alignment explores these questions in lectures and small discussion-based environments led by student facilitators with targeted readings, weekly quizzes and group discussions, and a small final project. After recapping recent advancements in AI development, we will start by exploring two sides of the AI alignment problem that prevent us from building AI systems that reliably understand and follow human-compatible values. Next, we'll discuss current harms from AI as well as risks that future systems could pose and arguments for and against the importance of various AI safety work. Finally, we will learn about existing AI safety technical research, efforts to implement policy and governance measures that reduce AI risk, and how you can personally contribute to AI safety. Basic knowledge about machine learning helps but is not required. Enrollment is by application only. View the full syllabus and apply online at https://linktr.ee/stanfordaialignment by Sunday, Dec 17, 2023 at 9:00 PM PST.

Terms: Aut, Win | Units: 2

Instructors: ; Edwards, P. (PI)

STS 20SI: Advanced AI Alignment

This advanced follow-up to STS 10SI: Intro to AI Alignment explores the frontier of current AI alignment research directions and helps you develop your own inside view on AI safety research. In Advanced AI Alignment, we will first spend 7 weeks discussing readings and completing technical alignment exercises in small groups. Like STS 10SI, you will meet in small discussion groups for up to 1.5 hours each week to discuss the week's content. In weeks 6 and 7, your group will choose between three branches of content: Eliciting Latent Knowledge, Agent Foundations, or Science of Deep Learning. In weeks 8-10, you will develop a literature review or a research proposal on an AI alignment topic of your choice to set yourself up for impactful AI safety research after the class, and you will have the opportunity to present your work at Stanford AI Alignment's quarterly Research Symposium during finals week. Prerequisite: STS 10SI or equivalent intro AI alignment knowledge; a course in AI or ML. Enrollment is limited and by application only. View the full syllabus and apply at https://linktr.ee/stanfordaialignment. Enrollment is only by instructor permission. The deadline to apply is Sunday, March 26, 2023 by 9:00pm

Last offered: Spring 2023 | Units: 1

STS 139: Designing Regenerative Societies (EARTHSYS 139A)

The world is changing in contradictory ways. Emerging technology, the evolving geopolitical economy, and ecological challenges present opportunities but also cascading risks. The pathway from our current destructive and extractive economy towards a more regenerative economy is unclear. There is a stark tension between gigascale opportunities such as AI, fusion energy, nanotech, quantum tech, space colonization, and biomanufacturing on the one hand, and degrowth necessities such as rethinking growth and using less resources on the other. This tension is steeped in political choices constrained by industrial power dynamics and conditioned by inequality. To what extent do visions and incentives align across industry, government, and social movements? What would the choice to scale or descale entail in each case - and are they mutually exclusive? The course introduces empirically driven systems thinking with in-depth modules on both emerging tech and degrowth, and scenario-based tech foresight. We combine the tools of technology foresight, gaming, scenarios, speculative fiction, and worldbuilding, exploring and assessing utopian or dystopian trends, visions, and projects (e.g. the Eden project, biomanufacturing at scale, smart cities, the Metaverse, generation spaceships, space colonization, human longevity, mega-disruptive startups, global health governance, radical longtermism, and religious `heavens'). The goal of the course is to gain clarity on the innovation boundaries within which the next 50 years might develop. The course prepares students to become disruptors of governance principles, strategies, and leadership of corporations, philanthropies, economies, and civilizations.

Terms: Spr | Units: 3-4

Instructors: ; Undheim, T. (PI)

STS 164: Ecosystems of Power: The Ethics and Influence of AI

How does Artificial Intelligence construct and reinforce social orders? How do human biases, values, and cultures shape AI? Starting with a descriptive introduction to different types and kinds of algorithms, we will first establish what AI is and what it does, on a technical level. With this shared framework in mind, we will then investigate how AI shapes, and is shaped by social interactions and imaginaries. Through scholarly works in the digital humanities, philosophy, internet studies, engineering, and popular culture, AI's influence on public perception, privacy, morality, popularity, equity, and justice will be critically examined. This course will feature guest lectures from controls engineers and others involved in using AI to protect science, technology, and society. Performance in this course will be evaluated through a data journalism project that asks students to peek behind the shiny User Interfaces of popular websites and identify how the code exerts power over various actors in the network.

Terms: Win | Units: 4

Instructors: ; Fox, A. (PI)

STS 200W: Are We Really All Cyborgs?: Bodies as Technoscience

This course explores the way humans engage with technoscience through their bodies. Science and biomedicine constantly inform how we understand and approach our bodies, and we routinely integrate technology into our bodies whenever we wear glasses or smartwatches, take medications, or drive. Importantly, technological artifacts and scientific knowledge themselves embody and negotiate human values and politics. We examine the dynamic and intricate interplay of the body, the technical, and the social through the analysis of a variety of domains: from communication, VR and AI to gender, race, and disability to healthcare, pollution, and disasters. The readings address such conceptual lenses as the politics of design, biopower, health and environmental justice, ethical and responsible innovation, cyborgs, and hybridity. Ultimately, we interrogate what kinds of societies and futures we are creating through our practices involving technoscience and the body.

Terms: Win | Units: 4

Instructors: ; Sato, K. (PI); Fox, A. (SI)

SUSTAIN 345: Global Leaders and Innovators in Human and Planetary Health: Sustainable Societies Lab (HRP 285, MED 285)

Are you interested in innovative ideas and strategies for addressing urgent challenges in human and planetary health and creating sustainable societies? This 7 session lecture series features a selection of noteworthy leaders, innovators, and experts across diverse sectors/topics in health and the environment such as: health innovation and environmental sustainability, social and environmental justice and equality, social innovation and entrepreneurship ecosystems, foundations and venture capital, tech innovation, media and AI, biotech and ag-tech, pandemics, public health and community wellbeing, food systems and agricultural innovation, hunger and nutrition, clean water and air, nonprofits and community action, public policy innovation and systems change, and the role of academia and you. Co-convened and co-designed by faculty, fellows and students collaborating across several Stanford centers, departments, schools, the course invites the discussion of global problems, interdisciplinary perspectives, and systemic solutions for the climate crisis and human health. The course will address root causes of the climate crisis and urgent challenges of human and planetary health, including sociological constraints, political objectives, economic incentives, technological limitations, and preservation of global stability, and suggest models of leadership, innovation and sustainable social change. We will also delve into efforts to catalyze long-term sustainability across the private, nonprofit, and public sectors. Students from all backgrounds are encouraged to enroll - registration is open to all Stanford students and fellows. May be repeated for credit.

Terms: Aut | Units: 1-2 | Repeatable 4 times (up to 8 units total)

Instructors: ; Bloom, G. (PI); Singer, S. (SI)

SYMSYS 161: Lessons from the Trenches: Applied Symbolic Systems in Entrepreneurship and Investing

A weekly project-based, seminar style course where students will engage with notable entrepreneurs around lessons learned from building early-stage companies and apply these lessons towards their own entrepreneurial ideas or pursuits. Using real-world examples and practical frameworks from early-stage startup founders and investors, we will help students navigate the idea maze and 0-to-1 journey, with a particular emphasis on products powered by Generative AI (LLMs, GPT-3, Stable Diffusion, DALL-E, Whisper) in some way, shape, or form. Students with a technical, entrepreneurial, or product-building background are encouraged to apply at www.symsys161.com.

Last offered: Spring 2023 | Units: 2 | Repeatable 2 times (up to 4 units total)

SYMSYS 168A: Black Mirror: A.I.Activism (AMSTUD 106B, ARTHIST 168A, CSRE 106A, ENGLISH 106A)

Lecture/small group course exploring intersections of STEM, arts and humanities scholarship and practice that engages with, and generated by, exponential technologies. Our course explores the social ethical and artistic implications of artificial intelligence systems with an emphasis on aesthetics, civic society and racial justice, including scholarship on decolonial AI, indigenous AI, disability activism AI, feminist AI and the future of work for creative industries.

Terms: Win | Units: 3 | UG Reqs: WAY-A-II, WAY-EDP

Instructors: ; Elam, M. (PI)

SYMSYS 195A: Design for Artificial Intelligence (CS 247A)

A project-based course that builds on the introduction to design in CS147 by focusing on advanced methods and tools for research, prototyping, and user interface design. Studio based format with intensive coaching and iteration to prepare students for tackling real world design problems. This course takes place entirely in studios; you must plan on attending every studio to take this class. The focus of CS247A is design for human-centered artificial intelligence experiences. What does it mean to design for AI? What is HAI? How do you create responsible, ethical, human centered experiences? Let us explore what AI actually is and the constraints, opportunities and specialized processes necessary to create AI systems that work effectively for the humans involved. Prerequisites: CS147 or equivalent background in design thinking. In the event of a waitlist, acceptance to class based on an application provided on the first day of class.

Terms: Aut | Units: 3-4

Instructors: ; Stanford, J. (PI); Nabi, F. (TA)

SYMSYS 195Q: What does AI get right and wrong about language?

Do you really trust AI to understand your words and intentions? In this course, we will challenge the hype surrounding AI language processing and dive into what it truly gets right and wrong about language. You will learn not only about the staggering achievements of AI language models, but also about the limitations and biases that threaten their reliability. Through hands-on exercises and real-world case studies, you will explore how AI can struggle with understanding complex sentence structures, cultural nuances, and even basic language usage. You will also examine the ethical implications of relying on AI for language processing, including the potential for perpetuating existing biases and discrimination in society. This course will equip you with the critical thinking skills needed to navigate the complex and rapidly evolving world of AI language technology. Prior experience with linguistics and/or artificial intelligence is encouraged but not required.

Terms: Aut, Win | Units: 3

Instructors: ; Ziegler, J. (PI)

SYMSYS 206: Topics in Natural and Artificial Intelligence (PSYCH 247)

We will read a selection of recent papers from psychology, computer science, and other fields. We will aim to understand: How human-like are state of the art artificial intelligence systems? Where can AI be better informed by recent advances in cognitive science? Which ideas from modern AI inspire new approaches to human intelligence? Specific topics will be announced prior to the beginning of term. "Registration is limited to graduate students except by instructor consent. Please write to mcfrank@stanford.edu with a one-paragraph justification if you are an undergraduate interested in registering"

Terms: Win | Units: 3

Instructors: ; Frank, M. (PI); Goodman, N. (PI)

SYMSYS 208: Computer Machines and Intelligence

It has become common for us to see in the media news about computer winning a masters in chess, or answering questions on the Jeopardy TV show, or the impact of AI on health, transportation, education, in the labor market and even as an existential threat to mankind. This interest in AI gives rise questions such as: Is it possible for a computer to think? What is thought? Are we computers? Could machines feel emotions or be conscious? Curiously, there is no single, universally accepted definition of Artificial Intelligence. However in view of the rapid dissemination of AI these questions are important not only for experts, but also for all other members of society. This course is intended for students from different majors Interested in learn how the concept of intelligent machine is understood by the researchers in AI. We will study the evolution of AI research, its different approaches, with focus on the tests developed to verify if a machine is intelligent or not. In addition, we will examine the philosophical problems associated with the concept of intelligent machine. The topics covered will include: Turing test, symbolic AI, connectionist AI, sub- symbolic Ai, Strong AI and Weak AI, Ai singularity, unconventional computing, rationality, intentionality, representation, machine learning, and the possibility of conscious machines.

Last offered: Winter 2019 | Units: 3

<--- END OF REPORT --->