ARTIFICIAL INTELLIGENCE FACULTY

Nina Balcan **Vince Conitzer** **Scott Fahlman** **Zico Kolter** **Pravesh Kothari**

Tai-Sing Lee **Tom Mitchell** **Aditi Raghunathan** **Pradeep Ravikumar** **Roni Rosenfeld**
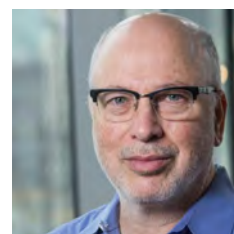
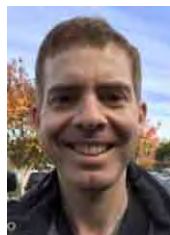**Stephanie Rosenthal** **Feras Saad** **Tuomas Sandholm** **Nihar Shah** **Dave Touretzky**
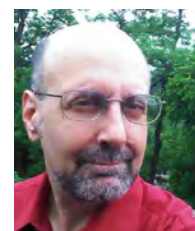
Pat Virtue **David Woodruff** **Steven Wu**

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machine learning and theoretical computer science

Developing foundations and principled, practical algorithms for important modern learning paradigms. These include interactive learning, distributed learning, multi-task learning, and life-long learning. My research formalizes and explicitly addresses all constraints and important challenges of these new settings, including statistical efficiency, computational efficiency, noise tolerance, limited supervision or interaction, privacy, low communication, and incentives.

Vince Conitzer, Professor (CS & MLD)
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game theory; social choice; mechanism design; AI, ethics, and society; cooperative AI; philosophy

I direct the Foundations of Cooperative AI Lab (FOCAL), whose goal is to create foundations of game theory appropriate for advanced, autonomous AI agents – with a focus on achieving cooperation. This also requires understanding the ways in which AI agents can be fundamentally different from human agents, which leads to certain specific, technical philosophical questions. More broadly, I am interested in many topics at the intersection of CS and economic theory, as well as topics in AI, ethics, and society.

Scott Fahlman, Professor Emeritus (LTI & CS)
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Knowledge Representation, Natural Language Understanding

My research group is working on knowledge representation and reasoning (the Scone knowledge-base system) and its applications, especially in the area of natural-language understanding. We are also working on common-sense planning, reasoning about actions and events, and modeling the mental states of multiple agents, all built on top of Scone.

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Machine Learning and Optimization

My work focuses on machine learning and optimization, with a specific focus on applications in smart energy systems. From an algorithmic standpoint, I am interested in fast optimization algorithms for a number of problems and for general convex programs, large-scale probabilistic modeling, stochastic optimization, and reactive machine learning algorithms. On the application side, the focus is on energy disaggregation, probabilistic forecasting for energy systems, and model predictive control techniques for industrial control in the electrical grid.

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Approximation Algorithms/Hardness, Sum-of-Squares Semi-definite Programs, Theoretical Machine Learning

My current research has mostly been about understanding the power of general-purpose convex relaxations such as sum-of-squares semidefinite programs for algorithm design. Surprisingly, this single technique happens to be extremely powerful especially for problems with ``random'' instances that naturally arise in average-case complexity (e..g finding large cliques in random graphs), theoretical machine learning (e.g. separating mixtures of gaussians), cryptography (e.g. attacking security of pseudorandom generators). On the flip side, understanding when such techniques fail can provide us with evidence of hardness or concrete directions for algorithmic progress. This investigation naturally connects to understanding properties of random graphs, phase transitions in statistical physics, Unique Games Conjecture and problems in metric geometry.

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Computer and biological vision, Neural computation

My research interests are: computational neuroscience, computational vision, neurophysiology of the primate visual systems, active and adaptive vision, hierarchical coding and inference, visual development, learning and adaptation, structure of neural codes.

Tom Mitchell, Professor (ML & CS)
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Machine Learning

My research is primarily in machine learning. One primary focus is on never-ending learning, including our Never-Ending Language Learner (NELL) project, which is trying to learn to read the web (http://rtw.ml.cmu.edu). A second primary focus is studying language processing in the human brain, by applying machine learning analyses to brain image data (http://www.cs.cmu.edu/~fmri).

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Machine Learning

I work broadly in machine learning and my goal is to make machine learning more reliable and robust. My work spans both theory and practice, and leverages tools and concepts from statistics, convex optimization, and algorithms to improve the robustness of modern systems based on deep learning. I am currently excited about leveraging self-supervision, human interaction and multimodal learning to improve robustness.

Pradeep Ravikumar, Professor (MLD)
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mathematical and statistical foundations of machine learning

My research is on the foundations of statistical machine learning, with recent focus on representation learning, and neuro-symbolic AI. The goal is to go beyond present-day neural systems towards next-generation statistical machine learning systems that simultaneously satisfy a broad range of "reliable AI" desiderata (explainable, robust to train-time & test-time corruptions, resilient to distribution shifts)

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Epidemic Forecasting

Our group's vision is to make epidemiological forecasting as universally accepted and useful as weather forecasting is today. We develop both machine learning and human-in-the-loop techniques for real-time estimation of geographically detailed epidemic prevalence from diverse data sources, and for forecasting the trajectory of these epidemics across time and space. Our group won most epidemic forecasting competitions run by the CDC to date, and was recently designated a National Center of Excellence for Flu Forecasting.

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Robotics, Human Interaction, Education

My work focuses on developing intelligent agents that seamlessly interact with, learn from and about, and perform tasks for and with humans. These agents leverage their own state as well as knowledge of how people behave around them and can tailor their functionality to improve performance metrics such as task completion time, accuracy, usability, trust, understandability, explainability, and predictability. My current research projects span the domains of robotics, human-computer and human-robot interaction, data science, and learning/education.

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probabilistic programming languages, Bayesian modeling and inference, Monte Carlo methods

My research focuses on developing sound and scalable systems for probabilistic inference, by bringing together ideas from programming languages, artificial intelligence, and statistics. Much of this work centers around new "probabilistic programming" systems that enable us to build and analyze formal models of complex probabilistic computations; automate hard aspects of Bayesian modeling and inference; and improve scalability for modern applications.

Tuomas Sandholm, Angel Jordan University Professor of Computer Science (CS, MLD, ACO, & CBD)
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Mechanism Design, Game Theory, Organ Exchanges, Game Solving , Auctions, Social Choice.

I am interested in market design; optimization; game theory; mechanism design; electronic commerce; artificial intelligence; multiagent systems; auctions and exchanges; automated negotiation and contracting; equilibrium finding; algorithms for solving games; advertising markets; computational advertising; kidney exchange; prediction markets; market making; voting; coalition formation; safe exchange; normative models of bounded rationality; resource-bounded reasoning; multiagent learning; machine learning.

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Machine learning, Game Theory

My research spans the areas of machine learning, statistics, game theory, and information theory. I specifically focus on learning from people, addressing questions such as "How to make sense of noisy and/or subjective data given by people?" and "How to obtain better data through incentives and interfaces?"

Dave Touretzky, Professor (CS, CNBC & RI)
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CS Education, Autonomous Robots, Computational Neuroscience

I'm currently investigating two questions: how to teach computational thinking to young children using a curriculum based on autonomous robots, and how to teach high level robot programming to CS majors. My children's curriculum is based on a novel understanding of Microsoft's Kodu Game Lab. My undergraduate curriculum uses the new Cozmo robot by Anki.

Pat Virtue, Assistant Teaching Professor (CS & MLD)
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Active learning teaching methods, AI/ML curriculum development, AI educational outreach

As teaching faculty, I get to pour my heart and soul into courses, curriculum, and improving educational methods. I'm not running a research lab, but I'm always on the lookout for great TAs and anyone that wants to talk about CS/AI education, teaching careers, or educational outreach!

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Algorithms and Complexity, Machine Learning

My current research interests are communication complexity, data stream algorithms and lower bounds, graph algorithms, machine learning, numerical linear algebra, sketching, and sparse recovery.

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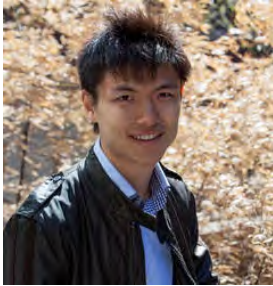
Steven Wu, Assistant Professor (CS, S3D, MLD, HCII)
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Machine Learning, Privacy Algorithmic Fairness, Game Theory

My work builds theoretical foundations for responsible machine learning (ML) and studies both (1) the societal impacts of ML as well as (2) the impacts of social and economic forces on the performances of ML. In studying the societal impacts of ML, I am interested in making ML better aligned with important societal values, especially privacy and fairness. For example, my work on data privacy provides a broad set of tools for privacy-preserving data analyses subject to the rigorous criterion of differential privacy. In studying the impacts of social and economic forces on ML, my work develops methods and models to understand how to ensure ML methods work reliably within social and economic dynamics. A particular focus is to study the effects of strategic manipulations on ML algorithms when they interact with agents who have incentives to manipulate their data and influence automated decisions.