Research@CSE

AI LAB

Michigan AI

About Us

Artificial Intelligence (AI) research at the University of Michigan is comprised of a multidisciplinary group of researchers conducting theoretical, experimental, and applied investigations of intelligent systems.

Current projects include research in cognitive architectures, distributed systems of multiple agents, machine learning, data mining, computer vision, natural language processing, robotics, computational healthcare, human computing, and computational social science, and others.

Research in the Michigan AI laboratory tends to be highly interdisciplinary, building on ideas from computer science, linguistics, psychology, economics, biology, controls, statistics, philosophy etc.

In pursuing this approach, laboratory faculty and students work closely with colleagues throughout the University. This collaborative environment, coupled with our diverse perspectives, leads to a valuable interchange of ideas within and across research groups.

https://ai.engin.umich.edu

Research@CSE Artificial Intelligence

COGNITIVE ARCHITECTURES & COMPUTATIONAL COGNITIVE SCIENCE

AI Faculty: Nikola Banovic, Satinder Singh Baveja, Emily Mower Provost, Xu Wang
Affiliated Faculty: Richard Lewis (Psychology)

At Michigan AI, we are exploring architectural structures to support human-level AI systems, as well as computational models of human behavior and the structure of the human brain. All these efforts draw from AI, psychology, and neuroscience, so that our research is inherently interdisciplinary. Michigan AI is unique in the breadth of cognitive architecture research it supports, including active groups in Soar, EPIC, Act-R, Cognitive Constraint Modeling, and neurally-inspired architectures.

MULTIAGENT & ECONOMIC SYSTEMS

AI Faculty: Satinder Singh Baveja, Mithun Chakraborty, Sindhu Kutty, Michael Wellman
Affiliated Faculty: Grant Schoenebeck (SI)

Environments with multiple autonomous agents present special opportunities and pose distinct challenges for design and analysis of AI systems. Agents may take actions, reason strategically, and coordinate with other agents. A multiagent environment is effectively a social system, and thus analyzing multiagent behavior can often be informed by social science.

Multiagent systems research at Michigan AI considers all perspectives, from individual agent to social designer. We design planning and learning algorithms suitable for multiagent contexts, and methods for analyzing networks of agents as organizations, economies, and societies.

Our work also spans the range from theory to practice. We conduct fundamental research in distributed coordination, algorithmic game theory, and social computing, and apply our techniques to real-world problems in areas such as healthcare, electronic commerce, and finance.

MACHINE LEARNING

AI Faculty: Satinder Singh Baveja, Elizabeth Bondi-Kelly, Mithun Chakraborty, Joyce Chai, Michał Dereziński, Benjamin Fish, Wei Hu, Justin Johnson, Danai Koutra, Benjamin Kuipers, Sindhu Kutty, Honglak Lee, Maggie Makar, Rada Mihalcea, Emily Mower Provost, Edwin Olson, Lu Wang, Jenna Wiens
Affiliated Faculty: Long Nguyen (Statistics), Atul Prakash, Ambuj Tewari (Statistics), Ji Zhu (Statistics)

Research in machine learning at Michigan AI encompasses unsupervised and supervised learning, as well as deep learning and reinforcement learning. A number of research projects derive from an interest in building long-lived and flexibly-competent agents rather than the more usual agents that perform one complex task repeatedly.

We work on deep learning and representation learning, where we learn abstract representations of the data by exploiting its hierarchical and composition structure. In reinforcement learning, we focus on building autonomous agents that can learn to act in complex, sequential, and uncertain environments.

We are also interested in the application of these algorithms to problems in computer vision and language processing, and more generally to sensory information processing and perception, to analyses of large-scale interconnected data (including social, communication, brain networks), and downstream tasks in medical domains or social sciences.

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COMPUTATIONAL HEALTHCARE & ASSISTIVE TECHNOLOGIES

AI Faculty: Nikola Banovic, Satinder Singh Baveja, Joyce Chai, Anhong Guo, Dhruv Jain, Danai Koutra, Honglak Lee, Rada Mihalcea, Emily Mower Provost, Veronica Perez-Rosas, Jenna Wiens
Affiliated Faculty: Kayvan Najarian (CMB), Satish Narayanasamy

The recent increase in the availability of clinically relevant datasets provides unique opportunities for improving patient care. Such data arise from diverse sources including, but not limited to, individual patient health records, genomic data, data from wearable sensors, clinical notes, and medical imaging. Michigan AI research in this area encompasses computational methods from machine learning, computer vision, and natural language processing, and spans the entire learning pipeline from problem formulation, to model learning and output.

Working in close collaboration with clinicians, we address important healthcare problems ranging from patient risk stratification and clinical time-series prediction to models of medication adherence and methods for AI-enhanced counseling. We also create assistive technologies by employing automated planning, constraint-based and temporal reasoning, and probabilistic inference.

We build systems that help cognitively-challenged people with complex healthcare needs to schedule and remember daily activities; that monitor the behavior of a person at home; or that adapt computer interfaces to meet the needs of persons with visual or fine-motor impairment.

With its strong ties to Michigan Medicine and unparalleled computational and data resources, Michigan AI provides a collaborative environment for carrying out high-impact research at the cutting edge of machine learning, data mining, and medicine.

AI IN HUMAN ENVIRONMENTS

AI Faculty: Nikola Banovic, Satinder Singh Baveja, Elizabeth Bondi-Kelly, Joyce Chai, Benjamin Fish, David Fouhey, Anhong Guo, Benjamin Kuipers, Edwin Olson, Xu Wang

Michigan AI is innovating technologies that improve how AI systems act with and among people. As examples: driverless vehicles that encounter people (as drivers, pedestrians, etc.) need to anticipate, and sometimes influence their behaviors. A robotic healthcare assistant needs to communicate and learn about a human's evolving needs. AI systems acting autonomously on behalf of users (e.g., financial transactions or telepresence) need to understand bounds on permissible behavior in different social contexts. To address such needs, we conduct research in areas including human-robot interaction (HRI), human behavior recognition, and safety and ethics in AI.

ROBOTICS

AI Faculty: Satinder Singh Baveja, Joyce Chai, Anhong Guo, David Fouhey, Benjamin Kuipers, Edwin Olson, Stella Yu
Affiliated Faculty: Jason Corso (Robotics), Chadwicke Jenkins (Robotics)

Michigan AI is investigating both theoretical and practical aspects of robots, including aerial, underwater, space, and terrestrial systems. Key areas include: 1) integration of strategic and tactical planning and optimization algorithms to enable robust robot control in the presence of system failures and environmental uncertainties; 2) simultaneous localization and mapping for mobile robots; 3) sensor processing algorithms, including feature matching, object detection, classification, and recognition; 4) AI methods from machine learning, cognitive architectures and multiagent systems to build autonomous robots.

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COMPUTER VISION

AI Faculty: Elizabeth Bondi-Kelly, Justin Johnson, David Fouhey, Benjamin Kuipers, Honglak Lee, Edwin Olson, Andrew Owens, Stella Yu

Michigan AI explores a number of critical problems in the area of computer vision. We focus on the analysis and modeling of visual scenes from static images as well as video sequences.

Our research goals include: 1) the semantic understanding of materials, objects, and actions within a scene; 2) modeling the spatial organization and layout of the scene and its behavior in time.

The algorithms developed in this area of research enable the design of machines that can perform real-world visual tasks such as autonomous navigation, visual surveillance, or content-based image and video indexing.

NATURAL LANGUAGE PROCESSING

AI Faculty: Satinder Singh Baveja, Laura Burdick, Mithun Chakraborty, Joyce Chai, Honglak Lee, Rada Mihalcea, Veronica Perez-Rosas, Lu Wang

Affiliated Faculty: Steve Abney (Linguistics), Kevyn Collins- Thompson (SI), David Jurgens (SI), Qiaozhu Mei (SI), Vinod Vydiswaran (LHS), Ying Xu (Learning Sciences)

Michigan AI is interested in large-scale natural language processing, including word representations, text similarity, information extraction, text summarization, question answering, and applications of these methods to a variety of domain problems. Our techniques range from semantic analysis and parsing to semi-supervised learning and graph-based methods.

Some current projects include the automatic identification of similarity relations in text, the development of neural network methods for effective word representations, the development of conversational systems, the extraction of entity relations from text, the automatic detection of deception in text, the identification of attitude and sentiment in online social network discussions.

HUMAN COMPUTATION & CROWDSOURCING

AI Faculty: Anhong Guo, Sindhu Kutty, Xu Wang
Affiliated Faculty: Mark Ackerman (CSE & SI), Ceren Budak (SI), Michael Nebeling (SI), Grant Schoenebeck (SI)

Human computation incorporates human intelligence into algorithmic processes. While workflow, process management, and organizational theory has been developed in great depth previously, the introduction of computer science and computational theory has given us a new lens through which to view organized human efforts, and combine it with the efforts of automated systems.

We explore crowdsourcing — the practice of making an open call to a group of workers to complete a task, often through social computing channels — to create deployable, large-scale human computation systems that are far more capable than current automated systems are alone, but that are still available on-demand, at a moment's notice. Michigan AI is advancing the frontiers of what can be accomplished with human computation and crowdsourcing: exploring how to create intelligent systems that respond intelligently, in real-time, and with consistency over time.

These systems can then be used to train AI and ML systems in real-world environments.

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COMPUTATIONAL SOCIAL SCIENCES

AI Faculty: Nikola Banovic, Mithun Chakraborty, Danai Koutra, Rada Mihalcea, Lu Wang, Michael Wellman
Affiliated Faculty: Ceren Budak (SI), David Jurgens (SI), Daniel Romero (SI)

Michigan AI explores computational solutions to central social sciences problems, targeting diverse fields such as economics, psychology, or political science. We develop temporal models for longitudinal data streams, we work on data- and model-driven approaches for financial markets, we track and disentangle the factors behind observed social effects.

Example projects use computational linguistics to identify cross-cultural differences in values and behaviors, agent-based models to assess stability of the financial system, and various techniques to study social roles across time, dynamics of political speeches in US congress, and rumor propagation on Twitter.

SYSTEMS FOR ARTIFICIAL INTELLIGENCE

CSE Faculty: Reetuparna Das, Michał Dereziński, Jason Mars, Lingjia Tang

Software systems and hardware platforms for scalable, accelerated, and distributed execution of artificial intelligence algorithms.

Michigan AI works on key research challenges, including: 1) designing frameworks to ease implementation and accelerate execution of inference and training; 2) developing distributed and scalable execution platforms for artificial intelligence; 3) investigating hybrid client + edge + data center deployment models for intelligent applications; 4) developing hardware accelerators, including reprogrammable and ASIC hardware designs, for emerging learning algorithms.

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FACULTY IN ARTIFICIAL INTELLIGENCE

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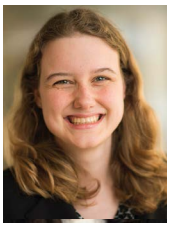

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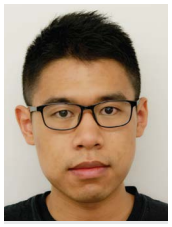

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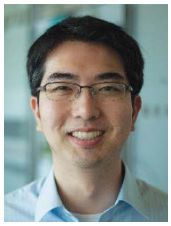

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