The Artificial Intelligence (AI) program at the University of Michigan comprises a multidisciplinary group of researchers conducting theoretical, experimental, and applied investigations of intelligent systems. Current projects include research in rational decision making, distributed systems of multiple agents, machine learning, reinforcement learning, cognitive modeling, game theory, natural language processing, machine perception, healthcare computing, and robotics.

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

COGNITIVE ARCHITECTURES & COMPUTATIONAL COGNITIVE SCIENCE

CSE Faculty: John Laird, Satinder Singh Baveja, Emily Mower Provost

Affiliated Faculty: Richard Lewis (Psychology), Thad Polk (Psychology)

Research in cognitive architecture studies the fixed structures underlying cognition. At Michigan, 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 is unique in the breadth of cognitive architecture research it supports, including active groups in Soar, EPIC, Act-R, Cognitive Constraint Modeling, and neutrally-inspired architectures.

MULTIAGENT & ECONOMIC SYSTEMS

CSE Faculty: Edmund Durfee, Michael Wellman, Jacob Abernethy, Satinder Singh Baveja, Grant Schoenebeck

Affiliated Faculty: Jeffrey MacKie-Mason (SI)

Environments with multiple autonomous agents present special opportunities and pose distinct challenges for design and analysis of AI systems. An individual agent may coordinate with others to improve performance through intelligent selection of physical, communicative, and/or computational actions. The agent may also reason strategically, to predict what the other agents may do based on their presumed self-interests. 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 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
CSE Faculty: Honglak Lee, Jacob Abernethy, Satinder Singh Baveja, Zeeshan Syed, Jenna Wiens, Jia Deng, Dragomir Radev, Emily Mower Provost, John Laird
Affiliated Faculty: Clayton Scott (ECE), Susan Murphy (Statistics), Al Hero (ECE), Ji Zhu (Statistics), Ambuj Tewari (Statistics)

Research in machine learning at Michigan encompasses reinforcement, unsupervised, and supervised learning. In reinforcement learning, we focus on building autonomous agents that can learn to act in complex, sequential, and uncertain environments. In particular, 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. In unsupervised learning, we focus on developing methods for automatically constructing deep and hierarchical feature representations of high-dimensional data with applications to computer vision and more generally to sensory information processing and perception. Other areas of interest include: 1) the integration of multiple learning methods into the cognitive architecture Soar; 2) developing specialized reinforcement learning methods for behavior-change and treatment-design in healthcare settings; 3) developing specialized methods for learning in large-scale games and other multiagent problems; and 4) developing unsupervised, semi-supervised, and supervised learning algorithms for information retrieval and natural language processing as well as for computational biomarkers in medical domains.

HEALTHCARE COMPUTING
CSE Faculty: Zeeshan Syed, Jenna Wiens, Satinder Singh Baveja, Emily Mower Provost, Honglak Lee, Edmund Durfee

The shift towards data driven medicine will have a transformative impact on healthcare. Massive-scale analytical methods are needed for real-time disease tracking and for discovering new markers to risk stratify patients for adverse outcomes. The EECS Department and the Health System at Michigan provide a unique opportunity to carry out collaborative research at the cutting edge of machine learning, data mining, and medicine.

ROBOTICS & COMPUTER VISION
CSE Faculty: Edwin Olson, Jia Deng, Benjamin Kuipers
Affiliated Faculty: Ella Atkins (Aero), Jason Corso (ECE), Ryan Eustice (NAME)

We are 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.

NATURAL LANGUAGE PROCESSING AND INFORMATION RETRIEVAL
CSE Faculty: Dragomir Radev, Rada Mihalcea
Affiliated Faculty: Steve Abney (Linguistics), Qiaozhu Mei (SI)

We are interested in large-scale natural language processing, including information extraction, text summarization, question answering, and applications to other fields such as political science, bioinformatics, and social science. Our techniques range from semantic analysis and parsing to semi-supervised learning and graph-based methods. Some current projects include the automatic generation of surveys of scientific literature, protein network extraction from text, the extraction of attitude and sentiment in online social network discussions, the study of rumor propagation on Twitter, the dynamics of political speeches in US congress, and the creation of networks of genes, diseases, and vaccines.
FACTOR IN ARTIFICIAL INTELLIGENCE

AFFILIATED FACULTY

Steven Abney - Linguistics
Ella Atkins - Aerospace Engineering
Laura Balzano - Electrical and Computer Engineering
Michael Cafarella - Computer Science and Engineering, Software Systems
Jason Corso – Electrical and Computer Engineering
Georg Essl – Computer Science and Engineering, Interactive Systems
Ryan Eustice – Naval and Marine Engineering
Alfred Hero – Electrical and Computer Engineering
John Holland – Psychology
Matthew Johnson-Roberson – Naval and Marine Engineering
Richard Lewis – Psychology and Linguistics

Jeffrey MacKie-Mason - School of Information
Qiaozhu Mei - School of Information
Susan Murphy - Statistics
Thad Polk – Psychology
Martha Pollack - Computer Science and Engineering
Karem Sakallah - Computer Science and Engineering
Grant Schoenebeck - Computer Science and Engineering, Theory
Clayton Scott - Electrical and Computer Engineering
Ambuj Tewari - Statistics
Ji Zhu – Statistics