

Artificial Intelligence Research at UC

The University of California (UC) is a leader in the development of artificial intelligence (AI) technologies and drives cutting-edge research shaping this rapidly growing field. AI shows tremendous promise for health care, national security, agriculture, transportation and education. Advances in AI research have the capacity to solve societal challenges in the U.S. and on a global scale. Federal funding for AI research through the National Institutes of Health and the National Science Foundation, as well as other federal agencies, is essential to advancing critical technologies and research applications. Sustained federal investment is necessary to fully realize all the benefits of AI research, and to train the AI workforce of the future. In addition, data sharing between all of UC's 10 campuses and five medical centers enhances the capability of creating large and diverse data sets for use in training machine learning models, making UC an appealing "real world and data-rich" research environment.

UC supports robust funding for AI research, which enables revolutionary technologies for health care, machine learning, robotics, data science and workforce development.

What is AI?

AI is a branch of computer science, which encompasses machine learning and deep learning, and is devoted to creating computer systems that can perform tasks characteristic of human intelligence, including learning and decision-making. Computer scientists have worked since the 1950s to develop AI, but it is only in the last decade that they have had the technological building blocks necessary to significantly advance this field. In today's economy, more organizations as well as industry, will continue to invest in AI in order to automate processes, develop new products and services, improve quality and increase efficiency. Advances in AI are therefore progressing rapidly, with the potential to grow the U.S. economy, increase national security and improve quality of life.

The Promise of AI

The field of AI as a transformative technology can facilitate the development of innovative products and services to benefit citizens and contribute to a better and safer world. Developing an ecosystem of AI innovation requires both strong federal government investment in research and development (R&D), and the engagement of various sectors of society, including health care, manufacturing, education and finance. In this context, innovations in AI research may lead to advances in hardware, including faster processors and more abundant storage, as well as larger datasets and more capable algorithms. Universities, startups and industry partners may collaborate to train the next generation of researchers and develop a diverse workforce that maintains America's lead in the global AI race.

UC Contributions to AI Research

With 10 campuses, five medical centers and three affiliated Department of Energy national laboratories, UC is leading the way in exploring scientific and technological breakthroughs in several AI research topics. Advancing AI research and education will require the federal government to increasingly focus on four critical areas that span multiple sectors:

- Role of AI in health care;
- Machine learning and robotics;
- Use of data science in AI technologies;
- Workforce development.

Role of AI in health care

- **UC encourages the federal government to fund AI research in the area of health care, where its applications will enable treatments for diseases affecting California and the nation.**

Harnessing AI technology in the area of health care can contribute to breakthrough technologies in biology, health and medicine. These technologies have the potential to improve ways in which doctors and researchers approach treatments. With both world-class research and medical expertise, UC campuses provide the ideal environment for such innovations on the global scale.

Machine learning and robotics

- **UC encourages the federal government to invest in machine learning and robotics, which will fuel technological innovations of the future.**

Giving computers the ability to learn without being explicitly programmed makes machine learning an exciting area to explore in multiple sectors. Important applications of machine learning include speech and image recognition, reasoning and robotics. Research in machine learning and robotics taking place on UC campuses will result in technological innovations that maintain the U.S. as a leader in AI.

Use of data science in AI technologies

- **UC encourages the federal government to invest in efforts utilizing data science to advance AI technologies, leading to an innovative research environment.**

Data science employs computer science disciplines to extract knowledge and insights from large amounts of data. One notable application of AI technologies is providing evidence-based and personalized recommendations related to a patient's medical records. Data science research in AI from UC campuses focused on improved analytics techniques can facilitate an innovative research environment.

Workforce development

- **UC encourages the federal government to invest in developing a strong AI workforce that can both utilize and advance technological breakthroughs in this field.**

Investing in workforce development within the AI field, which has a significant potential to cultivate technological breakthroughs, is critical for the future of jobs in America. UC campuses provide fertile ground for training the next generation of AI researchers in science and technology.

Artificial Intelligence Research at UC

UC Berkeley

AI research at UC Berkeley focuses on the improvement of algorithms and data science in order to improve technical expertise, as well as public interest and curriculum development aimed at training the AI workforce. Within technical expertise there is a need for defining algorithmic standards, establishing AI governance models and identifying AI trustable media. In addition, the UC Berkeley Algorithmic Fairness and Opacity Working Group develops new ideas, research directions and policy recommendations around issues of fairness, transparency, interpretability and accountability in algorithms and algorithmic-based systems. UC Berkeley's new Division of Data Science and Information builds a strong integrative emphasis into its curriculum on human contexts and ethics of data, serving as its curricular model. Many core machine learning techniques were developed at UC Berkeley, including a ubiquitously used open-source computational tool to support interactive data science and scientific computing across all programming languages. In the training spectrum, the Samuelson Law, Technology & Public Policy Clinic trains law and graduate students in public interest work. In addition, the Berkeley Center for New Media explores the emerging possibilities of cultural criticism and democratic participation in a digital world.

UC Davis

AI research at UC Davis focuses on data science, biomedical applications, and identifying larger areas for AI impact in society. Within this goal, the UC Davis Center for Data Science and Artificial Intelligence Research (CeDAR) seeks to effectively respond to the challenges of our society by translating complex data into powerful solutions addressing real-world needs. Some of these needs are: feeding the growing world population; mitigating climate change; combating environmental damage; creating sustainable energy sources; and providing effective, affordable health care for everyone. CeDAR brings together AI and data science foundations, methods and applications in research and education, and partners with faculty from a diverse array of academic backgrounds to identify and address the most pressing problems where AI research can make a difference. In addition, the UC Davis Machine Learning and AI group focuses on natural language processing, deep learning in vision systems, AI applications in game design and biomedical applications of AI research.

UC Irvine

AI research at UC Irvine focuses on building the next generation of intelligent systems, as well as broader applications in health care. UC Irvine's Center for Machine Learning and Intelligent Systems allows for collaborative research addressing a variety of real-world problems, including technical applications related to spam email filtering and image and video data analysis, as well as health care applications including medical diagnostic and microarray genomics. In 2018, UC Irvine launched the Center for AI in Diagnostic Medicine, which aims to focus on translating AI into clinical tools. In addition, with grant funding from the U.S. Department of Education, UC Irvine Informatics Department is studying socially responsible AI, which aims to promote social welfare, inclusiveness, economic progress and justice.

UC Los Angeles

AI research at UC Los Angeles is focused in the health care and medical space, in addition to technical applications related to computer vision. Within the Samueli School of Engineering at UC Los Angeles, the research laboratory on machine learning and AI focuses on providing actionable intelligence, as well as healthcare and medical knowledge to patients, clinicians, medical researchers, health care providers and policymakers. UC Los Angeles signed a license agreement with Theseus AI for technology using AI to interpret MRI scans of patients' spines. UC Los Angeles researchers also developed FocalNet, a new AI system to help radiologists identify and predict the aggressiveness of prostate cancer through MRI scans. Through funding from the Open Philanthropy Project, UC Los Angeles School of Law is studying disruptive societal and legal changes stemming from AI. UC Los Angeles and Stanford University engineers developed a new AI system that mimics how humans visualize and identify objects, a type of technology called "computer vision" which allows computers to learn on their own, make decisions based on reasoning and interact with individuals in a much more human-like way.

UC Merced

AI research at UC Merced focuses on a variety of topics, including virtual reality, as well as algorithms and their use for precision agriculture. UC Merced developed Robot-Assisted Precision Irrigation Delivery (RAPID), an innovative project that brings robotics, AI and precision agriculture together to improve crops and harvests, open a new field of jobs and save water. Research in large-scale resilient Internet-of-Things systems generates data enabling the use of AI algorithms to implement next-generation intelligent control systems for a variety of applications, such as precision agriculture and building energy management. Further examples of AI research at UC Merced include cognitive systems capable of long-term learning and development, as well as motion planning algorithms for specific needs in computer animation, games and virtual reality applications. Additional AI research at UC Merced focuses on an algorithm designed to help machines conduct highly complicated processes faster, easier and more efficiently, similarly to a human brain.

UC Riverside

AI research at UC Riverside largely focuses on data science and robotics. UC Riverside is home to both the Center for Data Science and the Center for Research in Intelligent Systems (CRIS), both of which are spearheading campus-wide efforts for AI and data science research with the goal of developing knowledge for decoding big data, as well as facilitating interdisciplinary collaborations in control and dynamical systems, robotics, and machine intelligence. CRIS also organizes seminars, workshops, and lectures to facilitate the scholarly dissemination of ideas, promote research and educational activities for students, and provide its affiliated members with state-of-the-art computational and robotic facilities. Additionally, UC Riverside's Center for Environmental Research and Technology (CE-CERT) is actively working to address society's most pressing environmental challenges in air quality, climate change, energy, and transportation. Overall, AI and data science research at UC Riverside has attracted significant funding from sponsors including the National Science Foundation, Office of Naval Research, DARPA and the Department of the Navy.

UC San Diego

AI research at UC San Diego is focused on integrating multiple areas to address various societal issues within health care and engineering, among others. The AI Group at UC San Diego is focused on machine learning, reasoning under uncertainty and cognitive modeling. This group is part of the larger campus-wide effort in Computational Statistics and Machine Learning (COSMAL), which catalyzes interdisciplinary collaborations. The Artificial Intelligence for Health Living Center (AIHL) is a joint effort between UC San Diego and IBM with the goal of promoting critical research and applications in healthy aging and the human microbiome. The partnership between Intel, Oregon State University, Stanford and UC San Diego focuses on reinforcement learning, where machines can make choices to optimize potential rewards, or explore their environments in order to gather more data for robust decision-making. The Halicioğlu Data Science Institute (HDSI) integrates data science, AI and machine learning research across campus for basic and applied research, whereas research at The Institute for Neural Computation (INC) spans several areas of AI and computer engineering. In the Jacobs School of Engineering's AI Cluster, students are engaged in most AI sub-fields, as well as involved in applications for machine learning and data mining.

UC Santa Barbara

AI research at UC Santa Barbara is strongly interdisciplinary and spans several departments, with the goal of utilizing machine learning to improve AI systems, language processing and robotics. The Mind and Machine Intelligence Academic Initiative is a cross-disciplinary campus effort to study the relationship between humans and intelligent machines. The Center for Responsible Machine Learning reflects the university's commitment to define and build the future of machine learning algorithms and human-aware AI systems. UC Santa Barbara researchers have successfully demonstrated that a simple artificial neural circuit of 100 synapses can perform image classification (taking an input and outputting a class or probability that the input is a particular class), and that AI technology can be used to spot misinformation online through natural language processing, taking incentives into account and examining textual patterns in social media posts and articles. UC Santa Barbara researchers have also shown that AI technology can help ecologists identify wildlife through machine learning-based computer vision. Moreover, by using AI technologies for both vision and language, they have shown that it is possible to develop virtual robots that navigate a scene and perform tasks using real-time environmental cues and human concepts. Additional AI research on campus focuses on understanding the pitfalls of adversarial machine learning, as well as ways in which robots, machine learning and AI are changing how we train the workforce in this field.

UC Santa Cruz

AI research at UC Santa Cruz focuses on big data, smart devices, and other larger scale questions. UC Santa Cruz's data science center, Data, Discovery and Decisions (D3), provides a platform for collaboration between industry and academia where big data can be used to train the future workforce in computing and AI. Graduate programs in computer science and biomolecular engineering offer students and faculty opportunities to engage in cutting-edge research in several areas such as bio-sensing devices, smart power, AI, data science, genomics and cyber-physical systems. The Expressive Intelligence Studio at UC Santa Cruz explores the intersection of AI and art and design, and examines the use of AI for videogames, including autonomous characters and interactive storytelling. The Applied AI Initiative (AAIL) is a new effort focused on the applications of AI, and an interdisciplinary initiative working with

industry to apply machine learning to a broad range of problems, including modelling human inferences about linguistic meaning, analyzing astronomical time-series data, and self-driving cars.

UC San Francisco

AI research at UC San Francisco focuses on neuroscience applications for a variety of disorders. UC San Francisco teamed up with GE Healthcare to develop a U.S. Food and Drug Administration-approved AI algorithm that works with portable X-rays to rapidly screen for collapsed lung (pneumothorax), a serious condition that can be treated with quick intervention. Researchers at UC San Francisco have also programmed a machine-learning algorithm to accurately diagnose early-stage Alzheimer's disease from brain scans taken on average of six years before patients were clinically diagnosed, potentially allowing for earlier diagnosis and treatment. In addition, UC San Francisco researchers have used machine learning algorithms to turn data from electrodes surgically placed on the brain into computer-generated speech in hopes of one day restoring natural communication to individuals who have lost their ability to speak after a stroke or other neurological injury. In a collaboration between UC San Francisco and UC Berkeley, scientists developed an algorithm that performed better than two out of four expert radiologists at finding tiny brain hemorrhages in head scans – an advance that may one day help doctors treat patients with traumatic brain injuries, strokes and aneurysms.

Lawrence Berkeley National Laboratory (Berkeley Lab)

AI research at Berkeley Lab focuses on data science and machine learning to improve transportation networks, crop yields, and various areas of science. With more than 100 multidisciplinary projects using machine learning across Berkeley Lab, computer scientists, mathematicians and domain scientists are collaborating to turn large and expanding datasets into scientific insights to inform scientific discovery. Berkeley Lab researchers are analyzing subatomic particles and applying machine learning techniques to track and classify them. Berkeley lab researchers are also searching for better, safer materials to create smaller, stronger, more efficient batteries, as well as modeling large-scale urban transportation networks to relieve congestion and dynamically rerouting commuters. In addition, they are researching the role of microbes in the health of soil to improve crop yields, pinpoint extreme weather in climate simulations to make it possible to predict storm timing, size, and impact, and piece together metagenomic puzzles from billions of DNA fragments to help the U.S. Veterans Administration address a host of medical and psychological challenges affecting many of the nation's 700,000 military veterans. As a U.S. Department of Energy national laboratory, Berkeley Lab also develops and openly shares the algorithms, software, tools and libraries that are foundational to scientific machine learning. Berkeley Lab gathers, organizes, stores and makes openly available huge scientific datasets in areas such as materials, energy, environment, biology, genomics and astronomy, and further develops tools and advanced networking facilities to make these datasets more searchable and accessible.