U.S. National Science Foundation

NATIONAL ARTIFICIAL INTELLIGENCE RESEARCH INSTITUTES

Accelerating Research, Transforming Society, Growing the American Workforce

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In an era marked by the convergence of human ingenuity and machine learning, it is impossible to overlook the revolutionary impact of artificial intelligence. The world of AI is no longer confined to the realms of science fiction. AI-powered technologies are revolutionizing industries, healthcare, education, transportation and the way we interact with our world. Yet beneath the surface of AI's awe-inspiring capabilities lies a complex ecosystem of research, innovation and collaboration.

As we peer into the excitement and curiosity-driven conversation around AI, this booklet highlights the National Artificial Intelligence Research Institutes, or AI Institutes. The institutes are the result of a collaborative effort between the U.S. National Science Foundation and funding partners comprised of federal agencies and industry leaders, establishing a nationwide ecosystem of AI research that enhances the leadership of the U.S. in AI discovery and innovation.

Funded at about $20 million each over an initial five years, these institutes, supported by significant multi-year funding totaling over half a billion dollars, represent one of the biggest single public investments to date in AI research and development.

As AI's possibilities expand, so does our responsibility to harness this power for the greater good. In addition to serving as epicenters of cutting-edge research and collaboration among the brightest teams in the country, the AI Institutes address complex challenges, actively tackling issues like ethics, fairness, transparency and security.

The foundational research cultivated in these institutes advances the frontiers of science and technology. In addition, these institutes are bridging the gap between theory and practice, facilitating the translation of AI research into practical applications across sectors, from precision agriculture to the next generation of cybersecurity intelligence.

As you read this booklet, we encourage you to learn about the stories, teams and network of collaborators that are driving discoveries of AI's infinite possibilities.

NSF especially thanks its funding partners for their support in developing the AI Institutes research ecosystem:

Federal partners

- U.S. Department of Agriculture's National Institute of Food and Agriculture (USDA NIFA).
- U.S. Department of Commerce's National Institute of Standards and Technology (NIST).
- U.S. Department of Education's Institute of Education Sciences (ED IES).
- U.S. Department of Defense's Office of the Undersecretary of Defense for Research and Engineering (DoD OUSD (R&E)).
- U.S. Department of Homeland Security's Science and Technology Directorate (DHS-S&T).

Industry partners

- Accenture
- Amazon
- IBM
- Intel
- Google
- Simons Foundation

ACCESS TO ONLINE INFORMATION

All links in this booklet can be accessed by scanning the QR code on this page

LIST OF INSTITUTES

AI INSTITUTE FOR AGENT-BASED CYBER THREAT INTELLIGENCE AND OPERATION (ACTION)

Principal investigator:
Giovanni Vigna, Ph.D.
Leading institution:
University of California, Santa Barbara

Institute vision statement

The evolving cybersecurity landscape demands innovative solutions. With increasingly sophisticated cyberattacks affecting schools and hospitals, power plants and military bases, the need for proactive defenses is paramount. Traditional cyber-defense tactics are largely reliant on human expertise. However, the sheer pace and complexity of modern threats challenge human capabilities.

The AI Institute for Agent-based Cyber Threat Intelligence and Operation (ACTION) creates a future where artificial intelligence-driven security agents work alongside human experts. Unlike in static security systems, ACTION's agents continuously learn and adapt, both independently and in collaboration with human counterparts. They become progressively adept at countering evolving cyber threats and crafting defense mechanisms, even in uncertain scenarios. ACTION offers an opportunity to out-scale, out-pace and outwit cyber adversaries.

Bridging theoretical AI and practical cybersecurity applications, ACTION will push AI's boundaries, enhancing proactive and reactive cyber defense automation, scalability and cost-effectiveness. The institute's research will unveil new challenges, further fueling foundational AI exploration and forming a beneficial feedback loop between security-inspired AI and AI-powered security.

Finally, ACTION is committed to education and workforce development to ensure the U.S. is well-equipped for future cybersecurity challenges. By collaborating with various organizations and industry leaders, the institute aspires to be a nexus for both AI and cybersecurity communities.

FUNDING PARTNERS

- NSF
- DHS-S&T
- IBM

INNOVATIONS

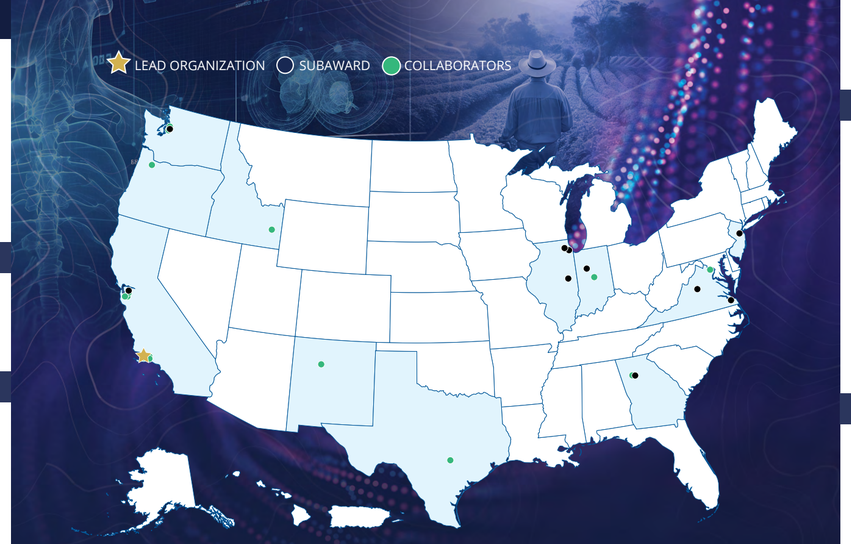
- AI stack for collaborative agents that aid humans in detecting and responding to sophisticated attacks.
- A knowledge base for security threats modeling and reasoning.
- New AI security training for students and the workforce.

IMPACTS

- Establishment of intelligent security agents as a new paradigm for cybersecurity.
- Development of an integrated learning and reasoning approach to address complex attacks.
- Breakthroughs in seamless human-agent interaction throughout the cyber defense life cycle.

PRESS LINKS

- NSF News
- Salud Carbajal press release
- UC Santa Barbara News



The map reflects the approximate location of the lead organizations, subawards and collaborators.
Note: Collaborators related to an Institute may be represented with a single plot due to space limitations.

Classroom of students.
***Photo credits**: Giovanni Vigna (AI Generated Images).*

Military in front of a screen.
***Photo credits**: Giovanni Vigna (AI Generated Images).*

SUBAWARD

- Georgia Tech
- Multi-campus UC Berkeley award
- Norfolk State University
- Purdue University
- Rutgers University
- University of Chicago
- University of Illinois Chicago
- University of Illinois Urbana-Champaign
- University of Virginia
- University of Washington

COLLABORATORS

- Boeing Research and Technology
- CISPA, Helmholtz Center for Info Security
- Google
- Idaho National Laboratory
- Infosys
- Institute Eurecom
- Intel
- Lawrence Livermore National Laboratory
- ManTech International
- MasterCard
- Novim
- Palo Alto Networks
- Politecninco de Milano
- Sandia National Laboratories
- Spelman College
- UCSB Early Academic Outreach Program
- UT-Austin Institute for the Foundation of ML
- UW AI Institute on Dynamical Systems
- UW eScience Institute
- UW Institute for Foundations of Data Science

AI INSTITUTE FOR COLLABORATIVE ASSISTANCE AND RESPONSIVE INTERACTION FOR NETWORKED GROUPS (AI-CARING)

Principal investigator:
Sonia Chernova, Ph.D.

Leading institution:
Georgia Tech

Institute vision statement

The mission of the AI Institute for Collaborative Assistance and Responsive Interaction for Networked Groups (AI-CARING) is to develop the next generation of personalized collaborative AI systems that improve the quality of life and independence of aging adults living at home.

Presently, there are over 13 million Americans aged 65 and older living with Mild Cognitive Impairment (MCI). These individuals rely in their majority on millions of unpaid caregivers. AI-CARING is committed to serving people with MCI and their network of caregivers, which includes family members, friends, community members and healthcare and social service providers, by promoting patient independence and alleviating substantial caregiving responsibilities.

The institute's vision is to create a range of AI services that enhance daily activities and are ultimately capable of discerning personalized, long-term models of human behavior. The researchers at AI-CARING expect these systems will adapt to the evolving needs of older adults to support their healthcare and independence goals. They envision harmonized teams of interconnected AI agents that offer personalized assistance not only for patients but also their caregivers, ultimately improving interpersonal relationships that maximize the wellbeing of the end users.

AI-CARING fosters collaboration between academia and industry. The institute's team is dedicated to advancing workforce development through comprehensive initiatives that encompass education, outreach, accessibility and knowledge transfer programs. The aim is to contribute to the development of next generation of talent in this field.

AI CARING

FUNDING PARTNERS

- Amazon
- Google
- NSF

INNOVATIONS

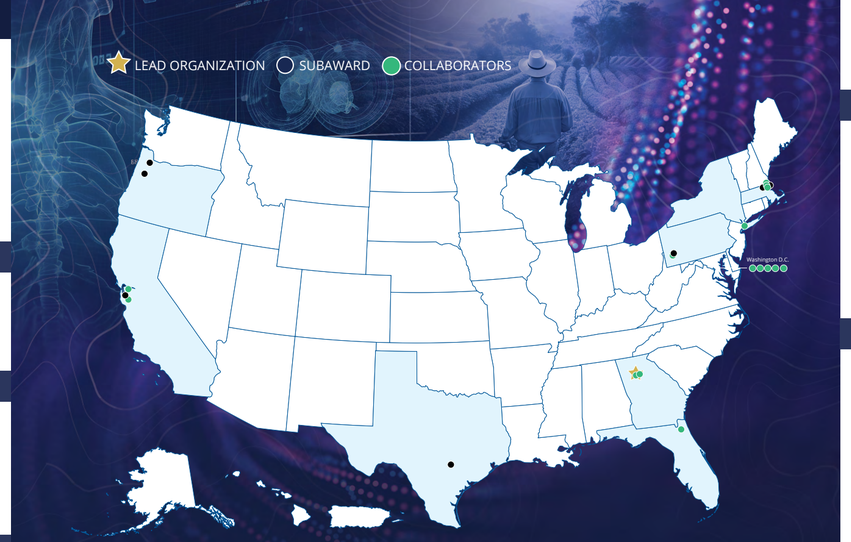
- Personalized human-centered AI capable of meaningful interaction with aging adults and their caregivers.
- Ethical support and long-term sustainable care.
- STEM workforce development focus.

IMPACTS

- Pioneering collaborative AI with longitudinal focus.
- Empowering MCI patients for independent living via reinforced daily routines, recognition of behavioral changes and personalized assistance.
- Providing personalized and intelligent caregiver support.

PRESS LINKS

- Biz Journals
- Discover Magazine
- Tech Xplore



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A clinician assisting an older adult in the setup of in-home smart devices. ***Photo credit****: Georgia Tech.*

Older couple and a family member use intelligent devices in the Aware Home, situated on the Georgia Tech campus. The home serves as a testbed for new devices and methods.
Photo credit*: Georgia Tech.*

SUBAWARD

- Carnegie Mellon University
- Northeastern University
- Oregon Health & Science University
- Oregon State University
- Stanford University
- University of Mass Lowell
- University of Texas San Antonio

COLLABORATORS

- AI4GA
- American Association of Retired Persons (AARP)
- Bartlett Community Partnership School
- Care Daily
- Emory University
- Evolving Homes
- Facebook
- Georgia Department of Education
- HelloRobot
- Howard University
- Jewish Healthcare Foundation
- KDDI Research
- National Center for Women & Information Technology
- Naval Research Lab
- Northern Essex Community College
- Toyota Research Institute
- University of Pittsburgh Medical Center
- U.S. Department of Veterans Affairs

AI INSTITUTE FOR INCLUSIVE INTELLIGENT TECHNOLOGIES FOR EDUCATION (INVITE)

Principal investigator:
H. Chad Lane, Ph.D.

Leading institution:
University of Illinois Urbana-Champaign

Institute vision statement

The AI Institute for Inclusive Intelligent Technologies for Education (INVITE) is driven by a fundamental question: How can AI be leveraged to help achieve education for all? Just as exceptional educators adapt to the individual needs, behaviors and development of diverse learners, INVITE envisions technologies in school that are similarly adaptive.

To realize this vision, INVITE is committed to developing AI tools and approaches that directly address the Education for All initiative. The institute will deliver a new generation of tools that will be radically more responsive to the needs of individual learners and educators.

INVITE technologies will address key skills and underlying beliefs that are essential for successful learning, all while empowering teachers and families to support children in more nuanced and meaningful ways.

INVITE will foster three pivotal skills crucial for effective learning: persistence, academic resilience and collaboration. INVITE's use-inspired research will focus on how children learn to become effective collaborators, persist through challenging tasks and bounce back from learning hurdles. To accomplish this, INVITE teams will engage in research and outreach activities in partnership with the INVITE K-12 partner network to reach a community of learners comprised of almost 96,000 students across 24 school districts and nonprofits across eight states.

Furthermore, the institute seeks to build national capacity for AI research and expand participation in computing through nationwide partnerships, professional development programs and outreach and community activities.

INVITE

FUNDING PARTNERS

- ED IES
- NSF

INNOVATIONS

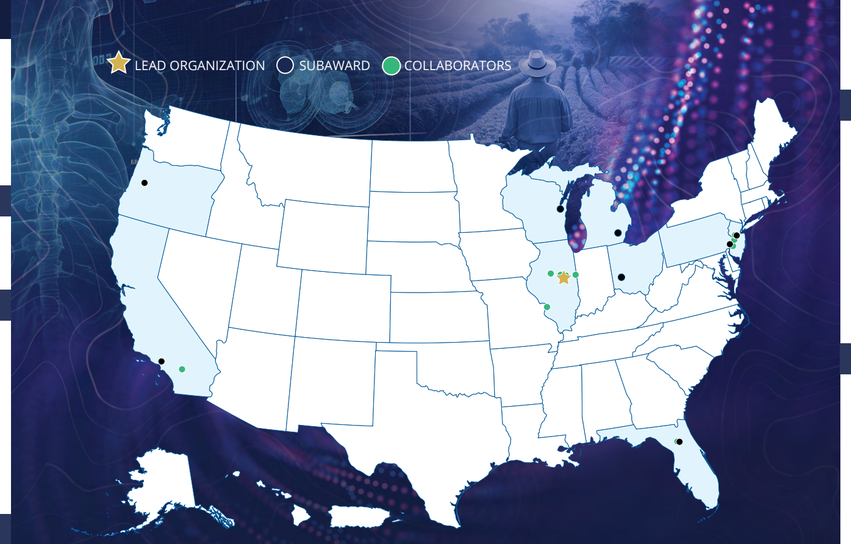
- AI-based tools for assessment, teaching and learning.
- Large-scale educational data sets for machine learning research.
- Community, teacher and professional engagement with AI.
- AI-powered tools for interactive learning and whole-learner support.

IMPACTS

- AI-based insights on classroom performance.
- Improved understanding of children's engagement during STEM learning.
- Increased participation in computer science and AI.
- Increased awareness, interest, and pursuit of computer science and AI careers.

PRESS LINKS

- Country Herald
- Insight Into Diversity
- University of Florida News
- University of Illinois Urbana-Champaign News
- University of Southern California News



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INVITE Principal Investigator H. Chad Lane helps students learn to code at Western Center Academy in Hemet, California.
Photo credit: *Illinois News Bureau.*

College students take action to broaden participation in computing, teaching K12 students how to code in an activity organized by their local STARS Computing Corps chapter.
Photo credit: *STARS Computing Corps.*

SUBAWARD

- Balance Studios
- Educational Testing Service
- Temple University
- University of Florida
- University of Michigan
- University of Oregon
- University of Southern California
- Wright State University

COLLABORATORS

- Alachua County Public Schools
- Camden Dream Center
- Champaign Unit 4 Schools
- Danville School District 118
- East St. Louis School District 189
- Hispanics Inspiring Students' Performance and Achievement (HISPA)
- Pennsbury School District
- Peoria Public Schools
- Urbana Neighborhood Connections Center
- Urbana School District #116
- Western Center Academy

NATIONAL AI INSTITUTE FOR EXCEPTIONAL EDUCATION (AI4EXCEPTIONALED)

Principal investigator:
Venu Govindaraju, Ph.D.

Leading institution:
University at Buffalo

Institute vision statement

The National AI Institute for Exceptional Education (AI4ExceptionalEd) aims to advance artificial intelligence to help speech language pathologists (SLP) practice at their full potential, ensuring no child in need of speech and language services is left behind.

Currently, nearly 3.4 million children, more than half of those served under the Individuals with Disabilities Education Act, require speech and language services. These children face communication challenges that place them at risk for suboptimal social-emotional and academic outcomes. An alarming shortage of SLPs, combined with delays in identification of needs and unmet services during the COVID-19 pandemic, has likely exacerbated this gap.

AI4ExceptionalEd aims to provide SLPs with time-saving tools and insights, allowing them to deliver tailored interventions to children during a fundamental period of growth. This approach mitigates the risk of them falling further behind in their academic and social development. The institute will develop AI technologies complemented by human expertise to inform two innovative solutions: the AI Screener and the AI Orchestrator. These solutions will not only enable the scaling of SLPs' expertise but also provide culturally sensitive universal screening and ability-based intervention. By enhancing the quality of speech and language services for children, AI4ExceptionalEd seeks to instigate a fundamental shift in how these services are delivered. Ultimately, this investment in youth will create a pathway for long-term economic impact as they grow and contribute to the workforce.

NATIONAL AI INSTITUTE
for Exceptional Education

FUNDING PARTNERS

- NSF
- ED IES

INNOVATIONS

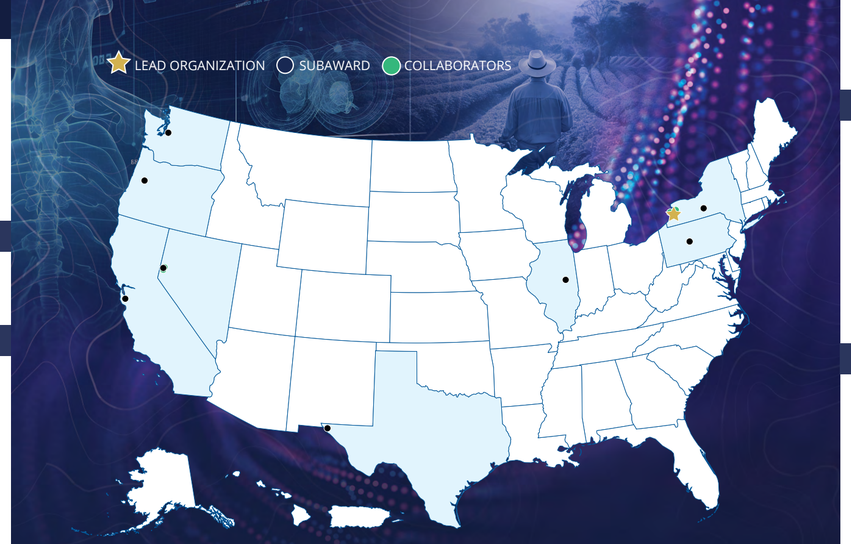
- Early evidence-based screening for speech and language needs.
- Culturally sensitive solutions.
- Tailored interventions for individual needs.
- Workforce development in underserved communities.
- Development of the AI Screener & AI Orchestrator.

IMPACTS

- Equips SLPs with timesaving AI tools to scale speech and language services.
- Improves children's academic performance and long-term social-economic prospects.
- Identifies and assists more children earlier.
- Advances science and foundational AI scholarship.

PRESS LINKS

- Forbes
- Buffalo News
- Buzzsprout
- Nation World News
- NSF News



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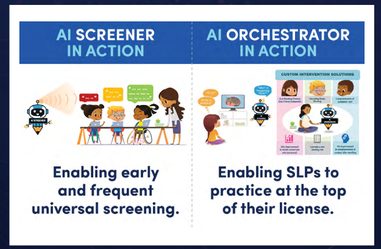


***Photo credit**: University at Buffalo.*

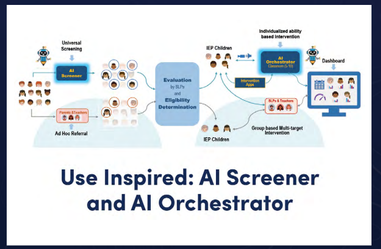


***Photo credit**: University at Buffalo.*

SUBAWARD

- Cornell University
- Pennsylvania State University
- Stanford University
- The University of Texas at El Paso
- University of Illinois Urbana-Champaign
- University of Nevada, Reno
- University of Oregon
- University of Washington

COLLABORATORS

- Amherst Central School District
- Buffalo-area Engineering for Minorities
- Buffalo Public Schools
- Desert Research Institute Nevada Robotics
- GiGi's Playhouse Buffalo
- Sweet Home Central School District of Amherst and Tonawanda
- The Summit Center
- Washoe County School District
- WNY STEM Hub

NSF AI INSTITUTE FOR ADULT LEARNING AND ONLINE EDUCATION (NSF AI-ALOE)

Principal investigator:
Ashok Goel, Ph.D.

Leading institution:
Georgia Tech

Institute vision statement

The NSF AI Institute for Adult Learning and Online Education (NSF AI-ALOE) is developing novel artificial intelligence theories, techniques and tools for enhancing the proficiency of adult online education in STEM disciplines, making it comparable to in-person education. This vision is based on two goals:

- Fix known problems in online education: NSF AI-ALOE researchers understand the main problems with online education — such as lack of cognitive engagement, teacher presence and social interactions — and use AI to address these problems.
- Use vast amount of available data for personalization of learning: NSF AI-ALOE researchers recognize the wealth of data available on adult learners and their learning experiences. They leverage this data to personalize online education on a large scale.

AI-ALOE seeks to foster a vibrant community of researchers and practitioners to engage in responsible AI research that is grounded in theories of human cognition and learning. The institute's work will be supported by evidence from extensive datasets and evaluated across diverse testbeds.

FUNDING PARTNERS

- NSF
- Accenture

INNOVATIONS

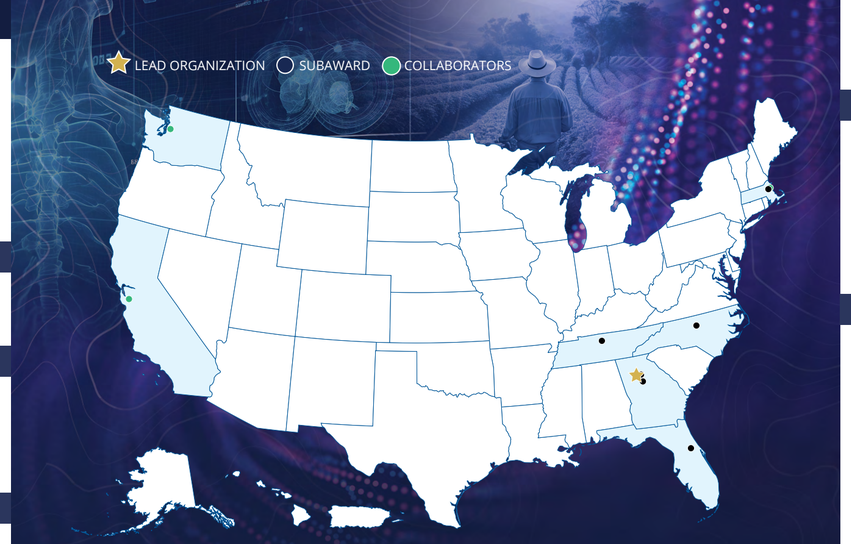
- Conversational textbooks and videos.
- Interactive environments for personalized learning.
- Repository of adult learning data.

IMPACTS

- Reskilling and upskilling adults with different life circumstances, including age, health, work and family.
- Development of testbeds that include the Technical College System of Georgia to serve demographic diverse groups.

PRESS LINKS

- AI-ALOE News
- Georgia Tech News
- The Times Higher Education podcast: "Is AI in higher education worth the hype?"
- The Times Higher Education podcast: "The AI university is coming."



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NSF AI-ALOE is focused on using AI technologies to make adult learning more available, affordable and achievable.
***Photo credit**: TCSG Adult Education Program.*

NSF AI-ALOE's aspiring graduate students, postdocs and research scientists contributing to research in AI and education.
***Photo credit**: NSF AI-ALOE.*

SUBAWARD

- 1EdTech
- Georgia State University
- Harvard University
- Technical College System of Georgia (TCSG)
- University of North Carolina at Greensboro
- Vanderbilt University

COLLABORATORS

- Boeing
- IBM
- Wiley

NSF AI INSTITUTE FOR ADVANCES IN OPTIMIZATION (NSF AI4OPT)

Principal investigator:
Pascal Van Hentenryck, Ph.D.

Leading institution:
Georgia Tech

Institute vision statement

The NSF AI Institute for Advances in Optimization (NSF AI4OPT) is dedicated to leading a new era of automated decision-making at massive scales. By fusing the fields of AI and mathematical optimization (MO), NSF AI4OPT seeks to deliver scientific breakthroughs that cannot be achieved by either discipline alone. The institute addresses pressing societal and technological challenges in energy, supply chains, sustainability and chip design and manufacturing. NSF AI4OPT focuses on how the fusion of AI and MO enables novel real-time, risk-aware, AI-assisted decision-making tools to transform these disciplines.

Recognizing the significance of narrowing job opportunity gaps, AI4OPT also develops longitudinal educational pathways and workforce development initiatives. This endeavor focuses on Historically Black Colleges and Universities (HCBUs) and Minority-Serving Institutions (MSIs), propelling them to the forefront of AI and optimization.

Through innovative internship programs with national laboratories and industrial partners, as well as long-term collaborations with world-leading corporations, AI4OPT creates an ecosystem that fuels innovation through technology transfer and entrepreneurship.

These activities in scientific research, education, engineering and entrepreneurship create a vibrant nexus that benefits all segments of society in areas of great national significance.

AI Institute for Advances in Optimization

FUNDING PARTNERS

- NSF
- Intel

INNOVATIONS

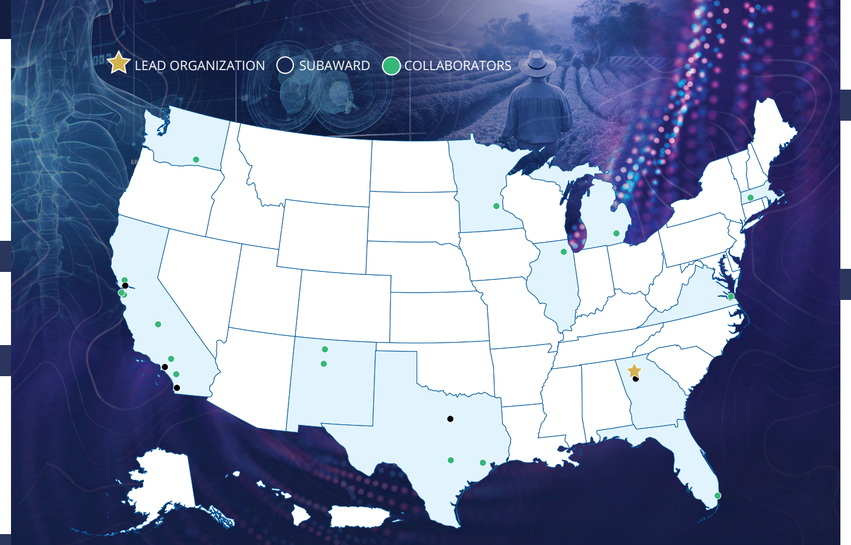
- Fuses AI and optimization to support decision-making in supply chains, energy systems, chip design and sustainable food systems.
- Pioneers real-time decision-making.
- Creates inclusive AI education pathways.
- Innovates collaborative internship programs.

IMPACTS

- Evaluation of real-time risk for renewable-powered grids.
- Novel optimization proxies that reduce costs and boost sustainability.
- Hundreds of high schoolers empowered through AI training.
- Initial HBCUs and MSIs faculty cohort establishes AI and data science programs.

PRESS LINKS

- Businesswire
- Metro Atlanta CEO
- Montreal AI Ethics Institute



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First cohort of the Faculty Training Program. ***Photo credit****: The Faculty Training Program of NSF AI4OPT at Georgia Tech.*

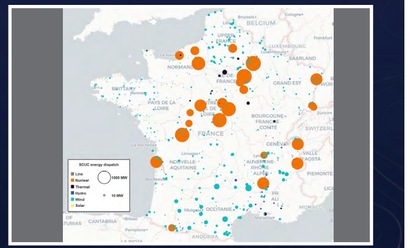


Image of simulation of the French power grid using a digital twin. ***Photo credit****: The Faculty Training Program of NSF AI4OPT at Georgia Tech.*

SUBAWARD

- Clark Atlanta University
- The University of Texas at Arlington
- University of California, Berkeley
- University of California, San Diego
- University of Southern California

COLLABORATORS

- Argonne National Laboratory
- Banneker High School
- Best Buy
- Center for Machine Learning at Georgia Tech
- College of the Sequoias
- Drew Charter High School
- Google
- Hampton University
- HerWILL
- Huston-Tillotson University
- Intel
- ISO New England
- IVADO
- Keysight Technologies
- Kids Teach Tech
- Kinaxis
- Los Alamos National Laboratory
- Moreno Valley College
- Pacific Northwest National Laboratory
- Partnership for Inclusive Innovation
- PDI Software
- Physical Internet Center at Georgia Tech
- Ryder
- Sandia National Laboratory
- Seth Bonder Foundation
- Southern Company
- Texas Southern University
- United Parcel Service
- University of Waterloo
- Victor Valley College
- Westlake High School
- Zuse Institute Berlin

NSF AI INSTITUTE FOR ARTIFICIAL AND NATURAL INTELLIGENCE (NSF ARNI)

Principal investigator:
Richard Zemel, Ph.D.

Leading institution:
Columbia University

Institute vision statement

Humans have remarkable cognitive abilities that they leverage for their advantage. In contrast, despite recent advancements, machine intelligence still lags behind human brains in important dimensions, including emotional and social intelligence, efficiency and adaptability.

The NSF AI Institute for Artificial and Natural Intelligence (NSF ARNI) aims to gain insight into artificial and natural intelligence to advance our understanding of the brain and algorithms of machine intelligence. NSF ARNI's success will be measured by its ability to make precise scientific predictions about the brain and the extent to which the institute's novel algorithms adapt to unpredictable scenarios.

While researchers have long pursued this objective, the recent explosion of progress in both fields offers promise for significant discoveries. The last decade has seen remarkable advances in AI, yielding solutions with impressive abilities. For instance, current language models can convincingly mimic human's conversational abilities in text-based interactions. However, we are facing "Moravec's paradox," where AI excels in tasks that challenge humans but fails in tasks humans find effortless. For example, computers outperform humans in chess, yet a 3-year-old can move chess pieces better than a robot. AI has shown the greatest triumphs in what is known as higher domains — such as language and difficult games like Go and Chess — while lower tasks like navigation and running are areas where humans significantly outperform AI and robots.

NSF ARNI seeks to bridge the gap between artificial and natural intelligence to develop artificial systems capable of directly integrating neural recordings and insights into neural processing. This integration is expected to yield algorithms that improve on these challenging tasks and support neuroscientists and cognitive scientists in their understanding of the brain.

Artificial and Natural Intelligence

FUNDING PARTNERS

- NSF
- DoD OUSD R&E

INNOVATIONS

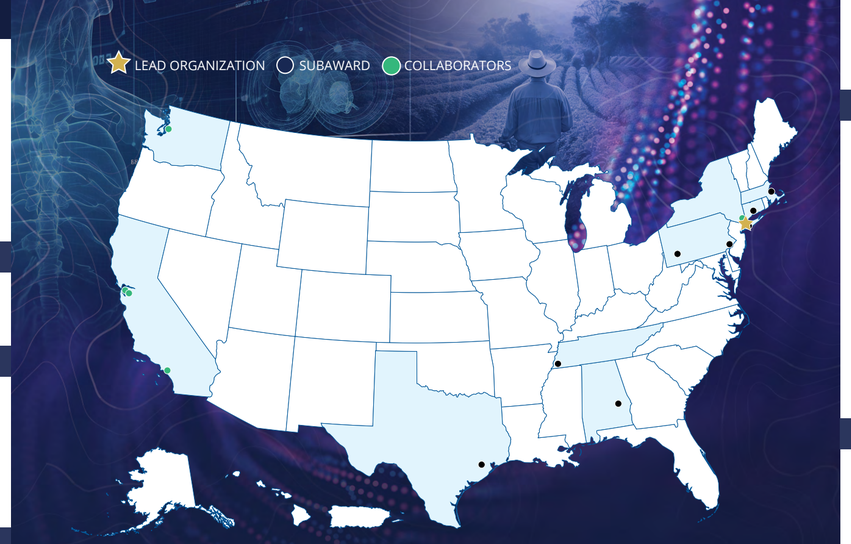
- New technologies that bridge gaps between artificial and biological networks.
- Trustworthy and adaptive AI.
- Educational and research opportunities for students at the interface of AI, neuroscience and cognitive science.

IMPACTS

- Robust, interpretable medical decisions.
- Smarter home assistants.
- Assistive multimodal systems for vulnerable and underserved users.
- Understanding of the brain circuits that learn and make informed decisions.

PRESS LINKS

- Columbia News
- Fox News
- TechTarget



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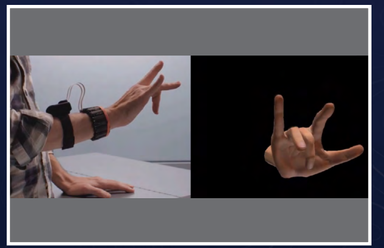
Visualization of the AI Institute ARNI, which aims to gain insight into both artificial and natural intelligence, and to develop systems and theories that will lead to an improved understanding of the brain as well as better algorithms of machine intelligence. ***Photo credit****: Kiel Mutschelknaus, Columbia University.*



ARNI is collaborating with CTRL-Labs/Meta, who have developed a wristband capable of transmitting electrical signals from the brain into computer input, which can control a virtual hand. ***Photo credit:*** *Reality Labs.*

SUBAWARD

- Baylor College of Medicine
- Baruch College
- Carnegie Mellon University
- CUNY Graduate School University Center
- Hunter College
- Harvard University
- McGill University
- Tuskegee University
- University of Pennsylvania
- University of Memphis
- Yale University

COLLABORATORS

- Amazon
- Google
- IBM
- Meta
- Neuromatch Academy

NSF AI INSTITUTE FOR ARTIFICIAL INTELLIGENCE AND FUNDAMENTAL INTERACTIONS (NSF IAIFI)

Principal investigator:
Jesse Thaler, Ph.D.

Leading institution:
Massachusetts Institute of Technology

Institute vision statement

Artificial intelligence is transforming many aspects of society, including the ways that scientists are pursuing groundbreaking discoveries. For many years, physicists have been at the forefront of applying AI methods to investigate fundamental questions about the universe. Building on these successes, the primary goal of the NSF AI Institute for Artificial Intelligence and Fundamental Interactions (NSF IAIFI) is to develop and deploy the next generation of AI technologies based on the transformative idea that AI can directly incorporate physics intelligence. NSF IAIFI researchers are using these new AI technologies to tackle some of the most challenging problems in physics, from precision calculations of the structure of matter to gravitational wave detection of merging black holes. Simultaneously, they are leveraging physics principles to drive AI innovation, from developing a better understanding of deep learning theory to improving robot locomotion.

NSF IAIFI is establishing the Boston area — where there is a critical mass of leading AI and physics researchers — as a hub for state-of-the-art research and interdisciplinary collaborations. By pioneering interdisciplinary research, empowering the next generation of AI and physics talent, and building a dynamic community, IAIFI is redefining the future of AI and physics.

Together, IAIFI researchers are creating a common language that transcends the intellectual borders between physics and AI to facilitate groundbreaking discoveries. In doing so, IAIFI is tackling two of the greatest mysteries of science: how our universe works and how intelligence works. By linking these challenges and using physics to improve AI and AI to improve physics, IAIFI is advancing physics knowledge and galvanizing AI research innovation. More broadly, a revolution is brewing in AI and science, and IAIFI is a leader in this emerging field.

The NSF Institute for Artificial Intelligence and Fundamental Interactions

FUNDING PARTNERS

- NSF

INNOVATIONS

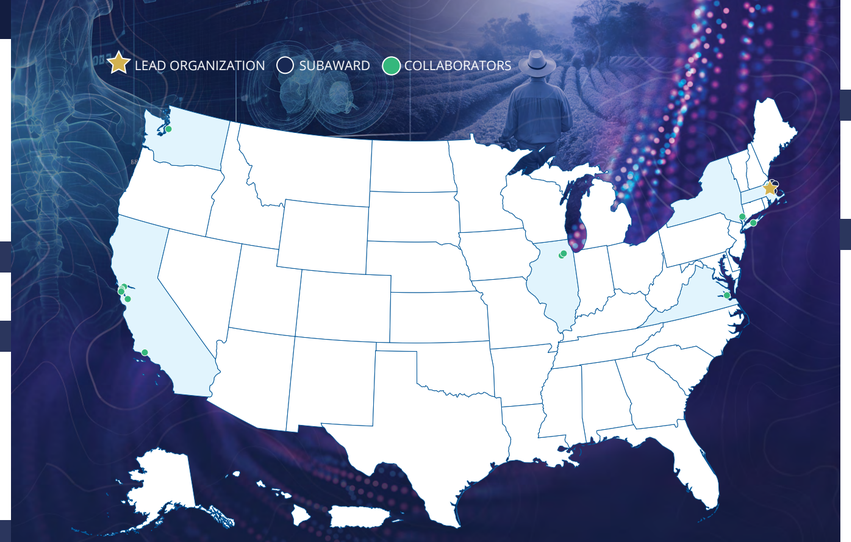
- Robust and interpretable AI innovation through physics principles.
- Novel AI tools for physics calculations and experiments for a deeper understanding of the universe.
- Fusion of physics education, machine learning and data science.

IMPACTS

- Groundbreaking physics discoveries from the smallest (e.g., particles) to the largest (e.g., cosmology) scales.
- Empowerment of early-career, interdisciplinary researchers.
- Facilitation of physics and AI collaborations.

PRESS LINKS

- MIT News
- MIT News
- Nature
- The New York Times
- NSF YouTube



The map reflects the approximate location of the lead organizations, subawards and collaborators.
Note: Collaborators related to an Institute may be represented with a single plot due to space limitations.

MIT Postdoc Harold Erbin demonstrates machine learning for interpreting cosmological data at the 2022 Cambridge Science Festival.
***Photo credit**: Marisa LaFleur, NSF IAIFI.*

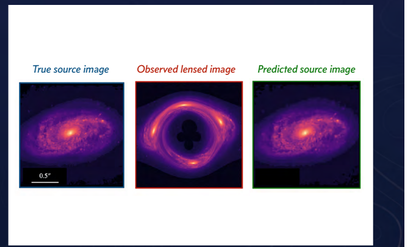


Image of galaxy NGC2906 (left). Simulated effect of gravitational lensing on this galaxy when viewed from Earth (middle). AI prediction for what galaxy NGC2906 looks like given only the middle image (right). ***Photo credit**: IAFI Fellows Siddharth Mishra-Sharma and Ge Yang.*

SUBAWARD

- Harvard University
- Northeastern University
- Tufts University

COLLABORATORS

- Argonne National Lab
- Brandeis University
- Brookhaven National Laboratory
- CERN
- Deep Mind
- Fermilab
- Frontier Development Lab
- Generally Intelligent
- Google AI Quantum
- Google Research
- IBM
- Jefferson Lab
- Lawrence Berkeley National Laboratory
- LIGO Scientific Collaboration
- Microsoft Research
- MIT-Bates Computing Center
- MIT-Harvard Center for Ultracold Atoms
- MIT-IBM Watson AI Lab
- MIT-Social and Ethical Responsibilities of Computing
- MIT Laboratory for Nuclear Science
- MIT Statistics and Data Science Center
- NVIDIA
- OpenAI
- QuEra
- SalesForce
- Sony
- Toyota Research Institute
- Unlearn

NSF AI INSTITUTE FOR EDGE COMPUTING LEVERAGING NEXT GENERATION NETWORKS (NSF ATHENA)

Principal investigator:
Yiran Chen, Ph.D.

Leading institution:
Duke University

Institute vision statement

Edge computing systems connect sensors, electronic devices and individuals, enabling each entity to gather information, gain knowledge, respond to their surroundings and collaboratively engage with each other. Developing powerful and intelligent edge devices like smartphones, laptops, vehicles, drones and surveillance sensors allows data to move from the cloud to its source (the “edge”), enhancing the speed, efficiency and security of computing processes.

The NSF AI Institute for Edge Computing Leveraging Next Generation Networks (NSF Athena) aims to revolutionize the fundamental aspects of artificial intelligence technologies, as well as the software and hardware designs of future edge computing systems. This includes the development of novel AI solutions with versatile functionalities and reasoning capabilities, cost effective and environmentally friendly AI computing systems, and use-inspired AI services and applications characterized by high efficiency, scalability, security, privacy and trustworthiness.

NSF Athena is committed to delivering next-generation edge computing systems using data-driven, AI-powered approaches to create Big AI for Small Devices. In addition, the institute is dedicated to the development of a comprehensive suite of educational and workforce initiatives like the innovative Inclusive AI Initiative. This initiative was designed by NSF Athena to strengthen the expertise of young students, researchers and professionals on ethical AI, and to foster principles of equity and fairness within research communities.

ATHENA

FUNDING PARTNERS

- NSF
- DHS-S&T

INNOVATIONS

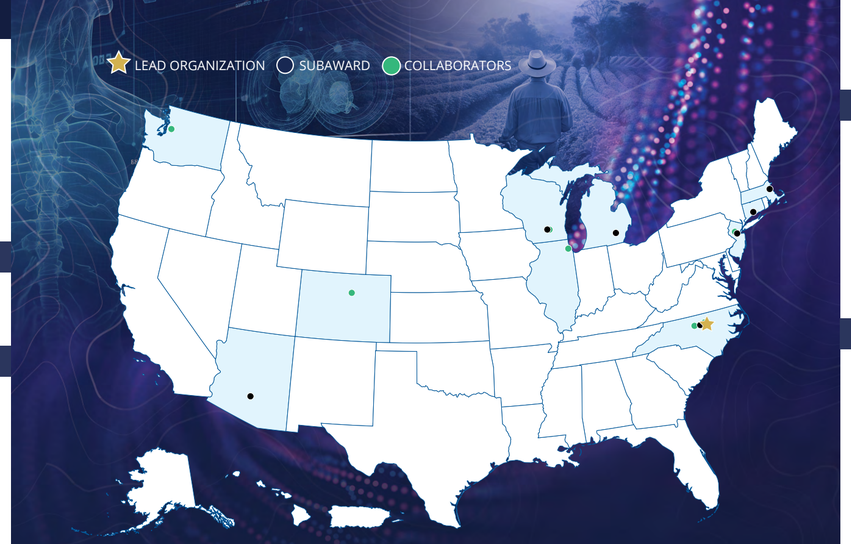
- AI models three to four orders of magnitude smaller.
- Edge AI computing systems that are 100 times more energy efficient and 10 times cheaper.
- Enabled real-time decision making.
- AI and performing arts fusion to create immersive AI experiences.

IMPACTS

- Developing an edge computing system for DHS.
- Creating spin-off companies, including one bought by NVIDIA.
- Engaging over 400 students in grades 3-12.

PRESS LINKS

- Duke University News
- StartupHub.ai
- WRAL Tech Wire



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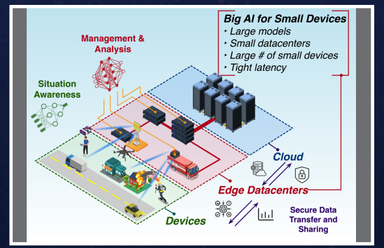

Big AI for Small Devices.
***Photo credit**: Younghyun Kim, Athena.*

NSF Athena’s augmented reality-assisted neurosurgical system provides guidance to surgeons, enhances the accuracy of surgical tasks and maximizes patient safety.
***Photo credit**: Maria Gorlatova, Duke University.*

SUBAWARD

- Arizona State University
- Massachusetts Institute of Technology
- North Carolina A&T
- Princeton University
- University of Michigan
- University of Wisconsin
- Yale University

COLLABORATORS

- 5NINES
- AT&T
- EdgeMicro
- Microsoft
- Motorola Solutions
- North Carolina School of Science and Mathematics
- The STEM Early College at N.C. A&T
- Town of Cary

NSF AI INSTITUTE FOR ENGAGED LEARNING (NSF ENGAGEAI)

Principal investigator:
James Lester, Ph.D.

Leading institution:
North Carolina State University

Institute vision statement

The NSF AI Institute for Engaged Learning (NSF EngageAI) is at the forefront of innovation, harnessing the power of AI to revolutionize K-12 STEM education. The institute's cutting-edge learning technologies create captivating STEM experiences featuring AI-generated narratives with dynamic plots, including interactive science problem-solving scenarios, characters and dialogues.

The institute's work drives foundational AI breakthroughs in natural language processing, computer vision and machine learning tailored to specific educational settings. Ultimately, the institute seeks to empower science educators by providing curriculum design support and innovative classroom practices that meet the needs of diverse students. The goal of the institute is to ignite a passion for STEM in students and deepen their understanding of science through AI-enabled, narrative-centered learning, enhancing education in schools and museums.

Furthermore, the AI-enabled learning technologies created by the institute hold significant promise for promoting effective collaborative learning. These innovations adaptively support students as they explore STEM concepts, engage in problem-solving and communicate.

EngageAI Institute

FUNDING PARTNERS

- NSF

INNOVATIONS

- Novel narrative-centered learning environments that support K-12 STEM education.
- Interactive science problem-solving scenarios.
- Adaptive collaborative learning technologies that make STEM learning effective and engaging.

IMPACTS

- New generation of AI-enabled learning technologies that operate at scale to significantly improve K-12 student learning.
- Novel AI-enabled teacher support tools that empower them to create effective and engaging learning experiences.

PRESS LINKS

- Communications of the ACM
- World Bank EduTech Podcast
- Indiana Public Media
- Smithsonian Magazine
- U.S. Department of Education Office of Educational Technology

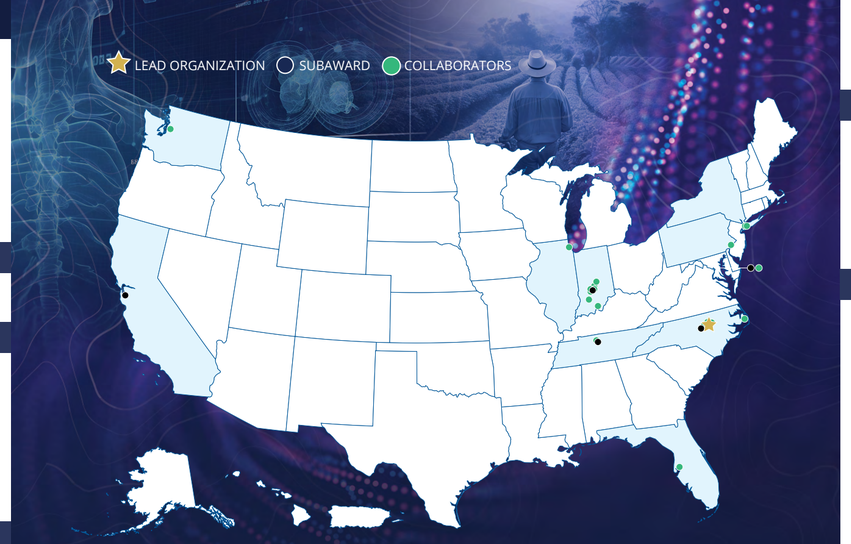

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***Photo credit**: Jonathan Rowe, North Carolina State University.*

Photo of students interacting with the Ecojourneys narrative-centered learning environment in a middle school science classroom.
***Photo credit**: Kirby Culbertson, North Carolina State University.*

SUBAWARD

- Digital Promise Global, D.C.
- Digital Promise Global, CA
- Indiana University
- University of North Carolina at Chapel Hill
- Vanderbilt University

COLLABORATORS

- AI for Teachers
- Boys & Girls Clubs of Bloomington
- Boys & Girls Clubs of the Coastal Plain
- Brown County Schools
- Code.org
- Computer Science Teachers Association
- Computing Research Association
- CSforALL
- Dare County Schools
- EngageCSEdu
- Greater Clark County Schools
- Indiana School for the Deaf
- Loogootee Community School Corporation
- Metro Nashville Public Schools
- Metropolitan School District of Wayne Township
- Monroe County Community School Corporation
- Nextech
- North Carolina Department of Public Instruction
- North Carolina Museum of Natural Sciences
- STARS Computing Corps
- Wake County Public School System
- WonderLab Museum of Science, Health and Technology

NSF AI INSTITUTE FOR FOUNDATIONS OF MACHINE LEARNING (NSF IFML)

Principal investigator:
Adam Klivans, Ph.D.

Leading institution:
The University of Texas at Austin

Institute vision statement

The NSF AI Institute for Foundations of Machine Learning (NSF IFML) is the foremost academic center for developing cutting-edge algorithms and data sets that power generative artificial intelligence. The research team is dedicated to creating advanced techniques for fine-tuning deep networks and optimizing foundation models that impact fields like imaging, video, navigation and biochemistry.

Headquartered at The University of Texas at Austin, NSF IFML researchers collaborate across an ecosystem that spans University of Washington, Microsoft Research and Wichita State University. Together, the teams conduct foundational research that has the potential to positively impact the lives of every person on the planet.

NSF IFML's tools for deep learning are critical in shaping the future of next-generation healthcare and biologics, revolutionizing areas like imaging techniques (MRI) and novel therapeutics. These innovations are not just about advancing technology; they are about saving lives and enhancing the well-being of people worldwide.

In recognition of the growing need for a highly skilled AI workforce, IFML has played a pivotal role in developing the coursework for a new Master of Science in Artificial Intelligence (MSAI) degree program at The University of Texas at Austin. Featured in *The New York Times* due to its potential to reshape the landscape of AI education, the MSAI is explicitly designed to deliver affordability, accessibility, and scalability — the same traits that make this a uniquely valuable tool for workforce development.

IFML Institute for Foundations of MACHINE LEARNING

FUNDING PARTNERS

- NSF

INNOVATIONS

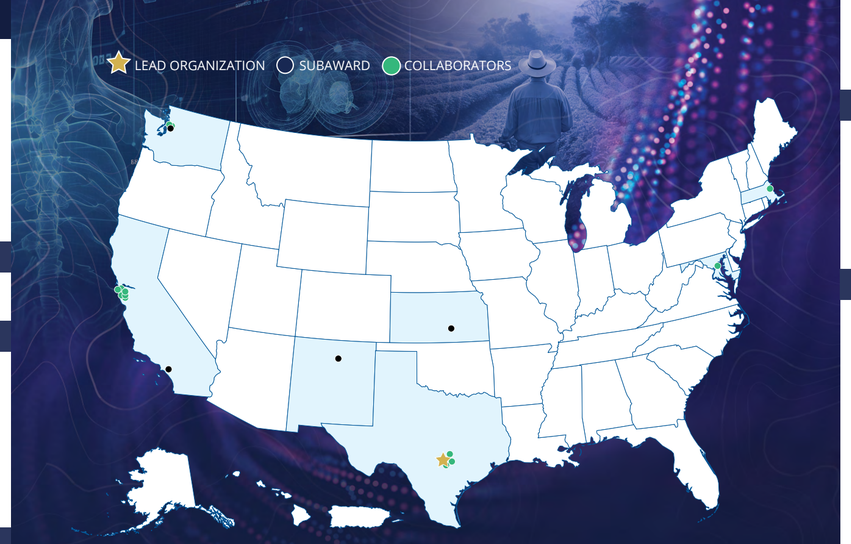
- Algorithms for denoising images with applications in healthcare and MRI.
- Multimodal data sets that power tools like Dall-E2 and Stable Diffusion.
- MAUVE, a powerful new metric for evaluating LLMs.
- Foundation models for protein engineering.

IMPACTS

- Affordable and scalable MSAI program that can train thousands of AI professionals.
- Deep protein research that can lead to new vaccines, therapeutics and enzymes for biomanufacturing.

PRESS LINKS

- The New York Times
- KXAN—NBC Affiliate
- University of Texas News – Plastic Waste
- University of Texas News – Technology behind ChatGPT
- Amazon Science News



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NSF IFML cross-university Matching Events connect undergraduate with meaningful research experiences. ***Photo credit****: NSF IFML.*

High-school students learn about Natural Language Processing (NLP) in machine learning summer academies led by NSF IFML faculty. ***Photo credit****: NSF IFML.*

SUBAWARD

- Stanford University
- Santa Fe Institute
- UCLA
- University of Washington
- Wichita State University

COLLABORATORS

- Apple
- Amazon Prime Video
- City of Austin
- Dell Technologies
- Facebook AI Research
- Google
- Harvard University
- Internet Archive
- Meta
- Microsoft Research
- Netflix
- Siemens
- Sony AI
- YouTube

NSF AI INSTITUTE FOR FUTURE EDGE NETWORKS AND DISTRIBUTED INTELLIGENCE (NSF AI-EDGE)

Principal investigator:
Ness B. Shroff, Ph.D.

Leading institution:
The Ohio State University

Institute vision statement

Networking and AI are two of the most transformative information technologies of our time. They enhance people's lives and contribute to U.S. economic competitiveness, security and defense. The NSF AI Institute for Future Edge Networks and Distributed Intelligence (NSF AI-EDGE) combines networking and AI to design next-generation networks that are highly efficient, resilient and secure. Going far beyond personal communications, these networks of the future will use sensors and communication devices to connect a myriad of intelligent machines such as vehicles, manufacturing equipment, robots, drones and tractors.

NSF AI-EDGE conducts research to facilitate the design of self-healing wireless networks that will learn and adapt to their environment to provide higher bandwidth, lower connection delays and enhanced reliability and security. These characteristics are essential for future services, including providing necessary connectivity during local and national emergencies, facilitating scientific breakthroughs and remote surgical interventions, and supporting virtual reality and entertainment.

NSF AI-EDGE is performing foundational research with AI-enabled demonstration prototypes to realize key use cases, such as: sensing and communication between fast moving devices, simplifying the interplay and interfaces between machines and humans, and creating environments that make it easy to program and simulate complex communication systems. The institute is creating AI technologies to ensure that future wireless networks underpinning these use cases will solve long-standing distributed AI challenges. This effort aims to make AI accessible to all and fuel smart wireless applications in areas like transportation, remote healthcare, robotics and aerospace.

As the nation requires a skillful workforce fluent in AI and networking, NSF AI-EDGE is actively developing and delivering accessible educational programs on a wide scale that are also engaging underserved populations.

AI EDGE Institute

FUNDING PARTNERS

- NSF
- DHS-S&T

INNOVATIONS

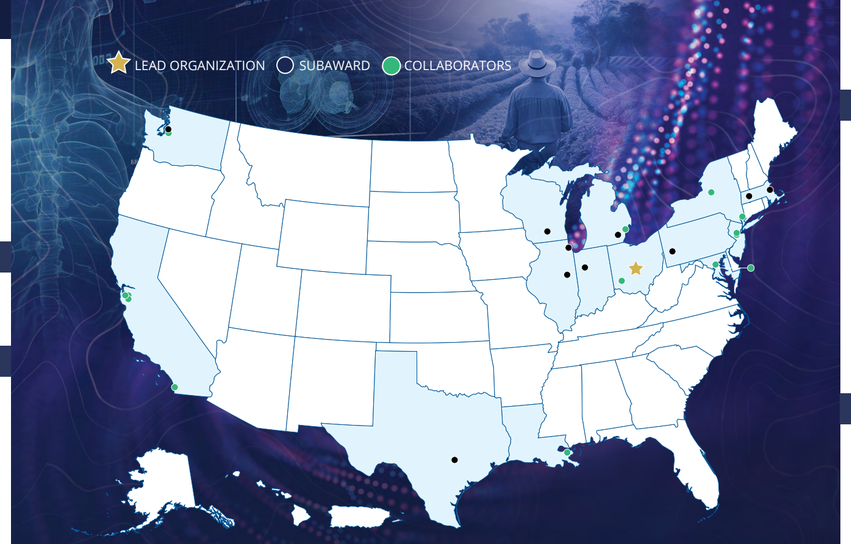
- Novel ML technologies to manage and secure wireless networks.
- AI-enabled test platforms, including the world's largest Open RAN emulator.
- Safe AI for personalized and private services.
- Network-aware AI and AI-aware networks for distributed intelligence.

IMPACTS

- Resilient and self-healing network infrastructure.
- Novel AI methods for future wireless networks.
- Secure future generation wireless systems.
- Accessible AI for urban and rural workforce development.

PRESS LINKS

- Boston Globe
- Neuroscience News
- New Scientist
- VOA News
- Yahoo Finance



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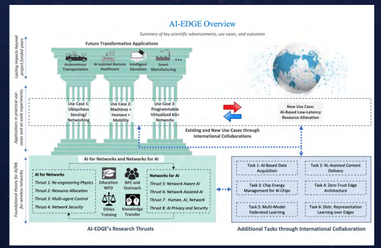


AI-EDGE research and impact extended with global collaboration. ***Photo credit****: Ness Shroff, NSF AI-EDGE.*

NSF AI-EDGE implements cutting-edge technologies on the NSF-funded Colosseum, the world's most powerful wireless radio frequency emulator. ***Photo credit:*** *Kaushik Chowdhury, Northeastern University.*

SUBAWARD

- Carnegie Mellon University
- Northeastern University
- Purdue University
- University of Illinois Chicago
- University of Illinois Urbana-Champaign
- University of Massachusetts Amherst
- University of Michigan
- University of Texas at Austin
- University of Washington
- University of Wisconsin

COLLABORATORS

- Air Force Research Laboratory, NY
- Air Force Research Laboratory, OH
- Army Research Laboratory
- AT&T Labs, NJ
- AT&T Labs, TX
- Cisco
- IBM Thomas J. Watson Research Center
- Indian Institute of Technology-Madras
- Indian Institute of Technology Bombay
- Korea Advanced Institute of Science & Technology (KAIST)
- Korea University
- Microsoft
- Naval Research Laboratory
- NVIDIA
- Open Networking Foundation
- Qualcomm, CA
- Qualcomm, NJ
- Seoul National University
- Tulane University
- Wayne State University

NSF AI INSTITUTE FOR INTELLIGENT CYBERINFRASTRUCTURE WITH COMPUTATIONAL LEARNING IN THE ENVIRONMENT (NSF ICICLE)

Principal investigator:
Dhabaleswar K. (DK) Panda, Ph.D.

Leading institution:
The Ohio State University

Institute vision statement

Artificial intelligence is having a transformative impact on society. Yet its vast potential remains out of reach for many. The fundamental challenge lies in the intricate expertise required to create AI systems tailored for a specific task. These systems demand the use of powerful state-of-the-art computers and immense amounts of data and storage, rendering them inaccessible to the broader population.

Certainly, the impressive advances in AI, such as ChatGPT, have enabled non-experts to use AI for tasks like language translation and text enhancement. However, this accessibility is limited to specific domains, leaving untapped many other scenarios where AI can be beneficial for society.

The fundamental goal of the NSF AI Institute for Intelligent CyberInfrastructure with Computational Learning in the Environment (NSF ICICLE) is to democratize AI, making its advantages accessible to everyone. NSF ICICLE is pioneering a plug-and-play cyberinfrastructure designed for effortless AI integration.

NSF ICICLE is committed to addressing pressing questions, such as: How can we develop AI cyberinfrastructure to help farmers in automating field scouting using drones to detect crops stress? How can we develop AI-powered smart camera traps to detect poachers and alert park rangers? How can we help grocery stores and government agencies identify underserved locations like food deserts?

The ICICLE team is actively engaged with multiple external collaborators and stakeholders, including Conservation-X; the Ohio Soybean Council; Mpala Research Center in Kenya, TIH in Mumbai, India; and the Wisconsin Tribal Program. Together, the team is co-designing, developing and deploying ICICLE cyberinfrastructure and studying its real-world impact.

ICICLE
DEMOCRATIZING AI

FUNDING PARTNERS

- NSF

INNOVATIONS

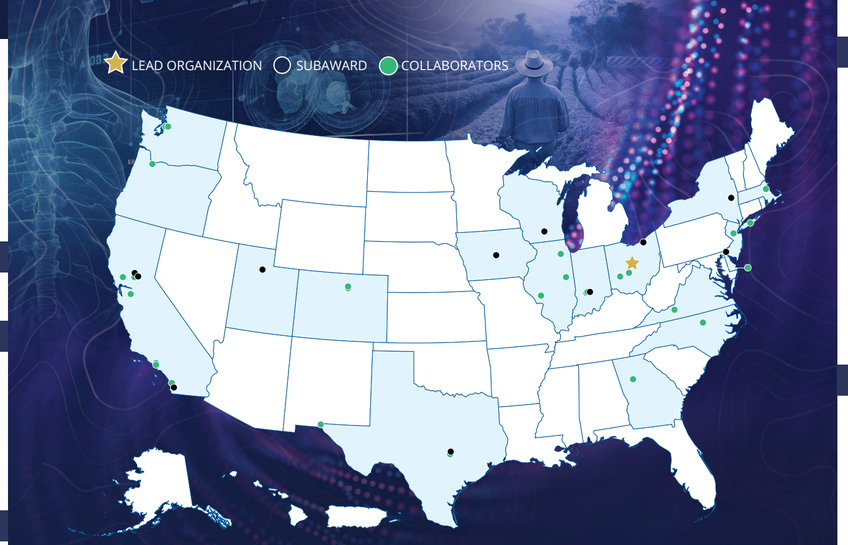
- AI for high performance cyberinfrastructure.
- Interactive knowledge environments.
- Real-time crop and wildlife monitoring.
- Fellowships and next-generation programs open to individuals from a wide range of backgrounds.

IMPACTS

- Cyberinfrastructure for distributed computing.
- Autonomous aerial crop monitoring.
- Drone- and smart camera trap-based monitoring systems for wildlife conservation.
- Integration of knowledge and learning environments to support food security.

PRESS LINKS

- Farm Journal YouTube
- HPC Wire
- Indiana Public Media
- Now at Ohio State
- Ohio State News



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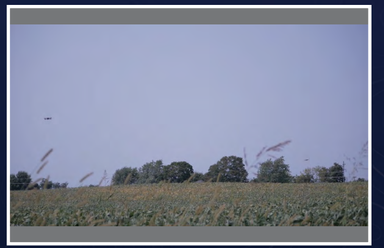
Drone and smart camera trap based monitoring systems for wildlife conservation.
***Photo credit**: Tanya Berger-Wolf, The Ohio State University.*



Autonomous aerial crop monitoring.
***Photo credit**: Jayson Boubin, SUNY Binghamton.*

SUBAWARD

- Case Western Reserve
- IC-FOODS
- Indiana University
- Iowa State University
- Rensselaer Polytechnic Institute
- University of California, Davis
- University of California San Diego
- University of Delaware
- University of Texas at Austin
- University of Utah
- University of Wisconsin-Madison

COLLABORATORS

- AccessComputing
- Agricultural Data Coalition
- AI Institute for Next Generation Food Systems
- Artificial Intelligence for Future Agricultural Resilience, Management, and Sustainability Institute
- Brookhaven National Laboratory
- CNH Industrial
- Computing Alliance of Hispanic-Serving Institutions
- Expanding Pathways in Computing Alliance
- Fermi National Accelerator Laboratory
- I Love Farmers Markets
- Indiana University-Jetstream
- Information Sciences Institute
- Institute for Artificial Intelligence and Fundamental Interactions
- Lawrence Livermore National Laboratory
- Max Planck Society
- Microsoft AI for Earth
- Mid-Ohio Food Collective
- Molecular Sciences Software Institute
- National Center for Women and Information Technology
- National Ecological Observatory Network-Battelle
- Nationwide Children's Hospital
- Princeton University
- Science Gateways Community Institute
- Southern California Earthquake Center
- The Findings Group
- TrustedCI Institute
- University of North Carolina at Chapel Hill
- University of Stuttgart
- U.S. Fish and Wildlife Service
- WildMe

NSF AI INSTITUTE FOR RESEARCH ON TRUSTWORTHY AI IN WEATHER, CLIMATE, AND COASTAL OCEANOGRAPHY (NSF AI2ES)

Principal investigator:
Amy McGovern, Ph.D.

Leading institution:
University of Oklahoma

Institute vision statement

The NSF AI Institute for Research on Trustworthy AI in Weather, Climate, and Coastal Oceanography (NSF AI2ES) is pioneering trustworthy AI focused on high-impact weather, climate and ocean hazards. The institute's team seeks to revolutionize how researchers understand, predict and respond to weather — as well as climate and coastal oceanographic phenomena — using AI that is trustworthy and meets societal needs. NSF AI2ES aims to achieve the highest standards of performance and reliability.

NSF AI2ES' AI algorithms are designed to enhance the prediction of climate-related hazard events and provide critical information for professional decision-makers, such as weather forecasters and emergency managers to make timely and informed decisions. The team actively engages and communicates with diverse decision-makers and AI developers to ensure that AI solutions meet their needs and advance the understanding of trust in AI solutions for high-impact contexts.

In addition, NSF AI2ES addresses key national priorities on AI, environmental extremes, and climate resilience. As identified by the National Oceanic and Atmospheric Administration, developing trustworthy AI is a high priority to better understand the environment and its management. The institute's work on understanding and predicting environmental hazards will help improve life- and property-saving early warnings.

In alignment with the National Artificial Intelligence Research and Development Strategic Plan, which emphasizes the need for a skilled AI workforce, AI2ES has pioneered a unique AI curriculum for community colleges, as well as multiple online trainings and tutorials to help train the existing workforce on AI for the environment.

FUNDING PARTNERS

- NSF

INNOVATIONS

- Creating novel approaches to understanding trust in AI.
- Developing one of the first community college AI programs in the U.S.
- Building a seamless AI pipeline from community college to university.
- Developing novel trustworthy AI methods for weather and climate.

IMPACTS

- Providing critical new understanding of trust in AI for weather and climate communities.
- Creating a nexus for AI research in weather and climate.
- Creating novel workforce development training in AI across all career stages.

PRESS LINKS

- KRIS 6 News
- Science Magazine
- The New York Times
- The Washington Post

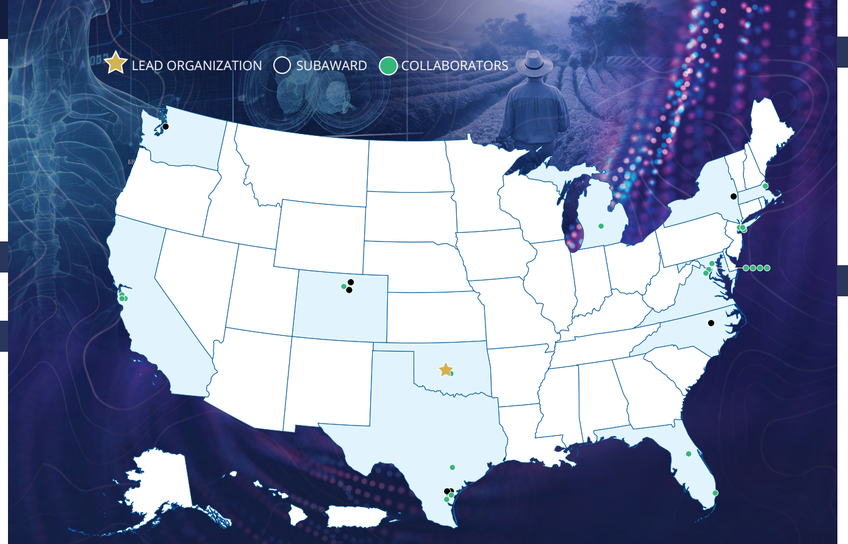


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Photo credits: *Raven Reese, Conrad Blucher Institute, Texas A&M University-Corpus Christi*

SUBAWARD

- Colorado State University
- Del Mar College
- National Center for Atmospheric Research
- North Carolina State University
- Texas A&M University-Corpus Christi
- University at Albany
- University of Washington

COLLABORATORS

- Calhoun County
- Central Michigan University
- City of Corpus Christi
- Department of Homeland Security and Emergency Services
- Disaster Tech
- Department of Transportation, Department of Environmental Conservation
- Google
- IBM (The Weather Company)
- MyRadar
- National Hurricane Center, Joint Typhoon Warning Center
- National Park Service
- National Institute of Standards and Technology (NIST)
- New York Independent System Operator
- New York Power Authority
- New York State Thruway
- NOAA, National Severe Storms Laboratory, Storm Prediction Center National Oceanic and Atmospheric Administration
- NOAA's National Global Systems Laboratory (GSL)
- NOAA Sea Grant
- Nueces County Coastal Parks
- Nvidia
- Oklahoma Climate Survey
- Palo Alto Research Center
- Radiant Earth Foundation
- Texas Coastal Offices of the National Weather Service
- TrueWeather Solutions
- Vaisala

NSF AI INSTITUTE FOR SOCIETAL DECISION MAKING (NSF AI-SDM)

Principal investigator:
Aarti Singh, Ph.D.

Leading institution:
Carnegie Mellon University

Institute vision statement

In recent years, society has witnessed the profound impact of decision-making during public health crises and an increasing number of disasters. These domains present critical challenges as they require complex, often lifesaving decisions in the face of uncertainty, dynamic circumstances and resource-constraints, while accounting for people's perceptions of risk, trust and equity.

Artificial Intelligence advancements can augment human capabilities in navigating this complex decision space, especially when they feel stressed, tired, conflicted or unsafe. The NSF AI Institute for Societal Decision Making (NSF AI-SDM) brings together AI and social science researchers to develop human-centered AI for societal good that harnesses the power of data and improves understanding of human decisions to create better and trustworthy choices.

AI models can simulate the socioeconomic effects of different decisions and recommend choices. This can empower public health officials and emergency managers to make timelier and better-informed decisions. AI-driven personalized interventions, for example, can improve patient engagement with health and emergency services, as well as public compliance with policies, further bolstering societal resilience.

NSF AI-SDM is also reforming the training and upskilling of the workforce at the intersection of AI and liberal arts through targeted engagement with high schools, community colleges, universities and corporate and government partners. NSF AI-SDM also engages with the public to raise awareness about AI and how it can positively impact society.

FUNDING PARTNERS

- NSF

INNOVATIONS

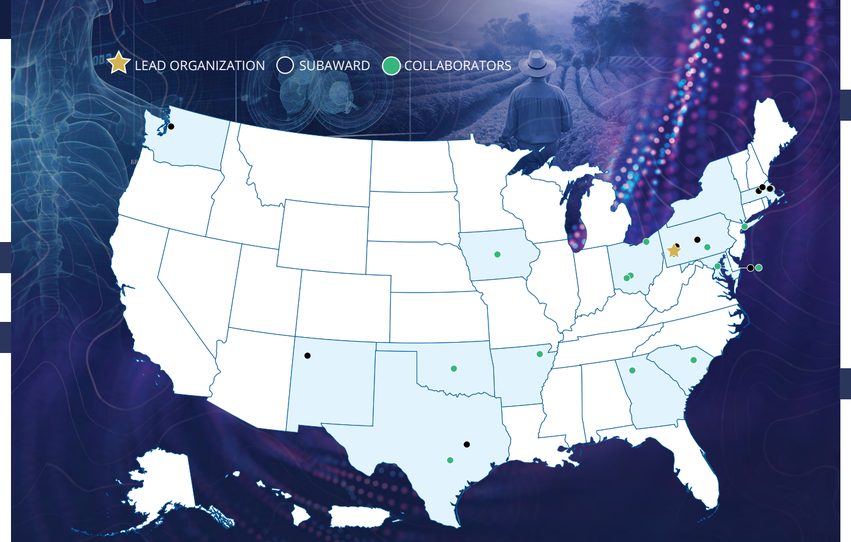
- Models for dynamic, uncertain, resource-constrained decision-making.
- AI recommendation systems for diverse decision makers.
- Interdisciplinary degree in AI and social sciences.
- Modular curriculum for community colleges and high schools.

IMPACTS

- Improvement of 30% in patient engagement with maternal health services using AI interventions.
- Mapped out hazardous and inaccessible disaster zones with AI-enabled drones.
- Data-driven AI recommendations for public health and emergency officials.

PRESS LINKS

- WTAE
- EurekAlert!
- WESA
- WPXI



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CMU researcher working with a Red Cross worker to deploy a snake robot to search for survivors in a collapsed building during the Mexico city earthquake in 2017.
***Photo credit**: Howie Choset, Carnegie Mellon University.*

mMitra subscriber and her child from the Janakipada slums of Mumbai.
***Photo credit**: Kruti Dalal, ARMMAN.*

SUBAWARD

- Boston Children's Hospital
- Harvard University
- Howard University
- Navajo Technical University
- The MITRE Corporation VA
- Texas A&M
- Penn Sate
- University of Washington
- Winchester Thurston School

COLLABORATORS

- AI Institute for Future Design Networks and Distributed Intelligence
- AI Institute for Research on Trustworthy AI in Weather, Climate, and Coastal Oceanography (AI2ES)
- AI Institute for Resilient Agriculture (AIIRA)
- Air Force Reserach Laboratory
- Allegheny County Health Department
- American Red Cross
- Arkansas State University
- Armman
- Artificial Intelligence Institute for Advances in Optimization AI4OPT
- Boston Public Library
- Carnegie Library of Pittsburgh
- Central Carolina Technical College
- Cleveland Clinic
- Google, India
- Government of Madagascar Ministry of Health
- HaSET, Ethiopian Public Health Institute
- Kushibaby
- Massachussets Department of Health
- Microsoft Research
- Naima Health
- Optum
- Pennsylvania Emergency Managment Agency
- Texas Division of Emergency Management

NSF AI INSTITUTE FOR STUDENT-AI TEAMING (NSF ISAT)

Principal investigator:
Sidney D'Mello, Ph.D.

Leading institution:
University of Colorado Boulder

Institute vision statement

The journey of the NSF AI Institute for Student-AI Teaming, or NSF iSAT, began with a fundamental question: How can we foster effective, equitable and engaging learning experiences for all students? NSF iSAT's team is reimagining the role of AI in education as social and collaborative partners (AI Partners) supporting teachers and students to transform classrooms into knowledge-building communities. These communities are designed to promote deep reasoning and knowledge sharing as students collaboratively work to solve complex challenges that are authentic to their interests and societal needs.

AI Partners help facilitate small group discussions, aiding students in constructing their own understanding and helping them develop their collaboration skills. They are socially sensitive and can communicate naturally by understanding students' speech, facial expressions, eye gaze and gestures while avoiding the pitfalls of bias and inequity. They also prioritize the trust and comfort of students by avoiding behaviors that might be perceived as surveillance.

Critically, AI Partners are not replacing teachers — and never will. Rather, they are co-designed in collaboration with educators to complement and augment what teachers to do best: inspire, teach and nurture students.

iSAT
NSF AI Institute for Student-AI Teaming

FUNDING PARTNERS

- NSF

INNOVATIONS

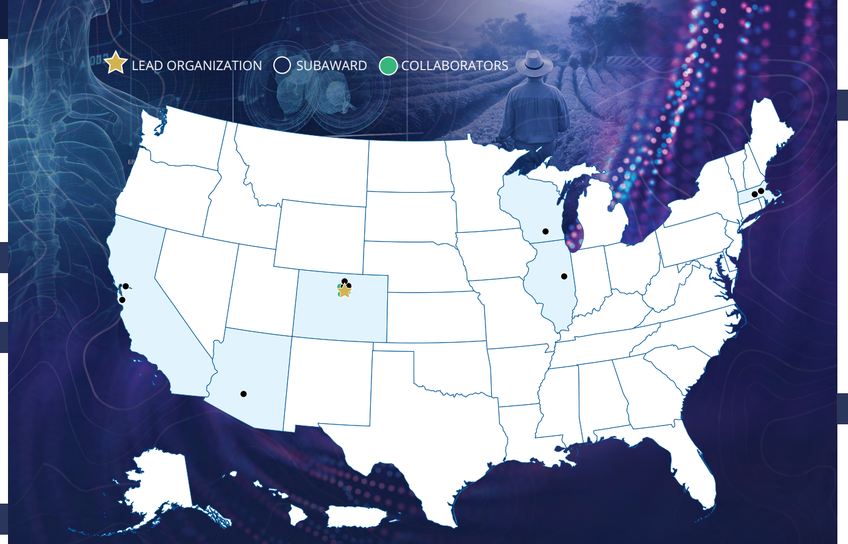
- The Community Builder – a novel AI technology to help students develop collaboration skills.
- New theories, methods and metrics to analyze complex classroom conversations.
- New methods for responsible and innovative design of AI systems with stakeholders.

IMPACTS

- Creating novel AI curriculum involving sensors, games and self-driving cars.
- Learning experiences for 4,000 students from different backgrounds.
- Coordinating opportunities for students and educators to engage in expansive co-design of AI Partners.

PRESS LINKS

- FOX 31
- Longmont Leader
- Longmont Leader
- University of Colorado Boulder News
- The Wall Street Journal



The map reflects the approximate location of the lead organizations, subawards and collaborators.
Note: Collaborators related to an Institute may be represented with a single plot due to space limitations.

Youth working together at one of our Learning Futures Workshops which feature a diverse group of high school students and result in crucial feedback from the participants including what youth want and need our AI Partner to be able to do in the classroom, and—just as important—what they don't want it to do.
***Photo credit**: NSF iSAT.*

Students work with the Sensor Immersion curriculum. These units are designed with the intent to immerse K-12 students in the fundamental concepts of AI, engage in computational thinking, and gather data about the world around them. It also provides our researchers with invaluable data collection.
***Photo credit**: NSF iSAT.*

SUBAWARD

- Arizona State University
- Brandeis University
- Colorado State University
- Denver Public Schools
- St.Vrain Valley Schools District
- University of California, Berkeley
- University of California, Santa Cruz
- University of Illinois Urbana—Champaign
- University of Wisconsin-Madison
- Worcester Polytechnic Institute

COLLABORATORS

- Curve10
- Project VOYCE
- Rigorous Love
- SparkFun

NSF AI INSTITUTE IN DYNAMIC SYSTEMS (NSF DYNAMICS AI)

Principal investigator:
J. Nathan Kutz, Ph.D.

Leading institution:
University of Washington

Institute vision statement

Imagine an advanced robot with a wide range of abilities. This robot functions in the real world, where unexpected changes and shifting conditions occur. To fulfill its tasks, it must respond intelligently to unexpected changes to adjust to these variations effectively. Now consider a smart building that regulates its temperature and lighting based on factors like occupancy and weather conditions. Such systems must detect and respond to alterations — people entering or leaving rooms — by optimizing heating and cooling conditions and lighting.

Artificial intelligence and machine learning can analyze patterns and create predefined guidelines for dynamic systems like robots and smart buildings to navigate and respond to fluctuating environments.

The NSF AI Institute in Dynamic Systems (NSF Dynamics AI) aims to develop the next generation of advanced machine learning tools for controlling complex physical systems, focusing on the evaluation of machine learning algorithms and performance, architectures and optimization, all of which are required in engineering applications.

From a ball rolling down a hill to a sophisticated aircraft soaring through the sky, everything adheres to the laws of physics. Therefore, the work of NSF Dynamics AI reaches a broad set of applications. Leveraging AI and machine learning, the institute seeks to enhance the intelligence of machines and systems while improving their performance. This empowerment allows them to adeptly acclimate, enhance their performance and function more effectively and safely within the complexities of the real world.

AI INSTITUTE IN DYNAMIC SYSTEMS

FUNDING PARTNERS

- NSF
- DHS-S&T

INNOVATIONS

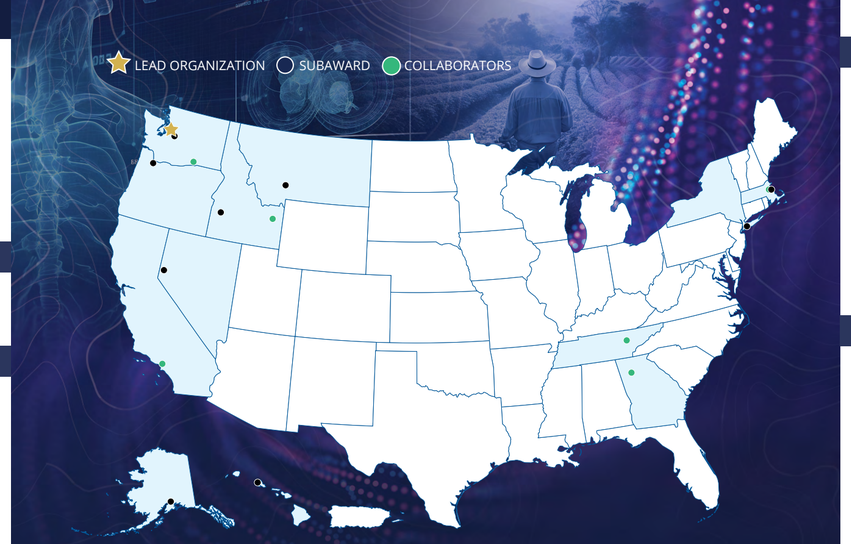
- Automated discovery of latent variables in experiments to represent physics more efficiently.
- Built theoretical foundation of policy optimization for learning control policies.
- Nurtured the next generation of talent with critical machine learning and AI expertise.

IMPACTS

- Created mobile film studio to deliver AI and ML curriculum, promoting diverse content and creators.
- Produced open-source learning materials, including code and data for all.
- Formed common task framework to test methods leading to open-source, reproducible research.

PRESS LINKS

- Columbia University News
- Quanta Magazine
- Senate.gov
- University of Washington News



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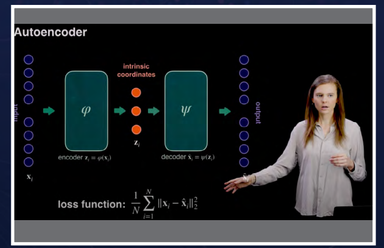


Kathleen Champion filming lightboard lecture on Deep Learning of Dynamics and Coordinates with SINDy Autoencoders.
***Photo credit**: Kathleen Champion.*

Institute students and postdocs attending the Workshop on Machine Learning for Science & Engineering, June 2023.
***Photo credit**: Lauren Lederer.*

SUBAWARD

- Boise State University
- Columbia University
- Harvard University
- Montana State University
- Portland State University
- Seattle University
- University of Alaska Anchorage
- University of Hawaii
- University of Nevada Reno

COLLABORATORS

- Boeing Advanced Research Center
- Idaho National Laboratory
- Mitsubishi Electric Research Laboratories
- Oak Ridge National Laboratory
- Pacific Northwest National Laboratories
- Spelman College
- The Aerospace Corporation

NSF MOLECULE MAKER LAB INSTITUTE (NSF MMLI)

Principal investigator:
Huimin Zhao, Ph.D.

Leading institution:
University of Illinois Urbana-Champaign

Institute vision statement

The mission of the NSF Molecule Maker Lab Institute (NSF MMLI) is to accelerate, advance and democratize innovation at the intersection of molecular sciences. To achieve this, NSF MMLI is creating an open, vibrant and dynamic ecosystem that will bring together interdisciplinary teams with expertise in artificial intelligence, chemistry and bioengineering. This ecosystem will serve as a hub for researchers to collaborate and advance AI-powered solutions that will benefit molecule manufacturing.

The institute will focus on developing new AI-enabled tools to accelerate automated chemical synthesis and advance the discovery and manufacture of novel materials and bioactive compounds. Researchers will use data generated from the analysis of these molecules to guide further development of synthesis planning and catalyst design tools using AI and machine learning.

A key application for NSF MMLI's research is finding more efficient ways to create solar cells with desired stability and efficiency. Researchers will also create a search interface that allows scientists and others to search information distilled from research papers using chemical formulas, chemical reactions and keywords. Ultimately, researchers hope to help create cleaner energy to benefit all Americans.

MOLECULE MAKER LAB INSTITUTE

FUNDING PARTNERS

- NSF

INNOVATIONS

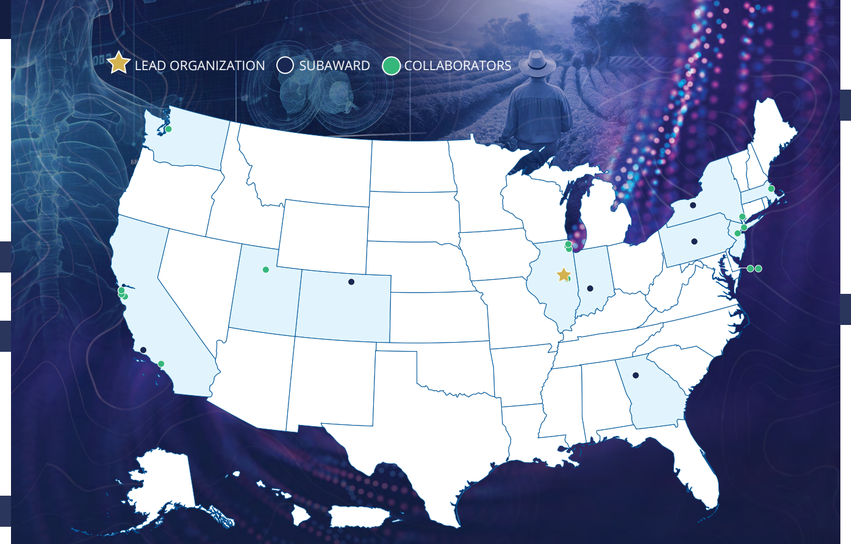
- Development of the Digital Molecule Maker — an education tool for building molecules using Lego-like virtual molecular blocks.
- Development of AlphaSynthesis — a user-friendly research platform with AI tools for molecule synthesis.

IMPACTS

- Reached over 1,900 students through education and outreach activities.
- Developed an AI tool for enzyme function prediction, which has been used by the global research community to make over 7,800 predictions since March 30, 2023 (one prediction every 20 minutes).

PRESS LINKS

- Chemical and Engineering News
- Carl R. Woese Institute for Genomic Biology
- University of Illinois Urbana-Champaign News - Automated Chemistry
- University of Illinois Urbana-Champaign News - Enzyme Function



The map reflects the approximate location of the lead organizations, subawards and collaborators.
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Students explore molecules in the NSF MMLI lab.
***Photo credit**: Sabrina Abdulla.*

NSF MMLI enhances molecule discovery and manufacturing using Artificial Intelligence.
***Image credit**: Martin Burke, Molecule Maker Lab Institute.*

SUBAWARD

- Colorado State University
- Georgia Tech
- Indiana University
- Pennsylvania State University
- Rochester Institute of Technology
- University of California, Santa Barbara

COLLABORATORS

- ADM
- Allchemy, Inc.
- American Chemical Society
- Genentech
- IBM
- Janssen
- LanzaTech
- Merck
- Microsoft
- MIT
- National Academies of Science
- Northwestern University
- NVIDIA
- Pfizer
- Revolution Medicine
- Two Bit Circus
- Ulsan National Institute of Science and Technology
- University High School
- University of Toronto
- University of Utah

NSF-SIMONS AI INSTITUTE FOR COSMIC ORIGINS (NSF-SIMONS COSMICAI)

Principal investigator:
Stella Offner, Ph.D.

Leading institution:
The University of Texas at Austin

Institute vision statement

The NSF-Simons AI Institute for Cosmic Origins (NSF-Simons CosmicAI) is dedicated to advancing AI for a greater understanding of the universe, making astronomy more accessible and engaging for researchers, students and the public alike. By creating cutting-edge AI tools, NSF-Simons CosmicAI seeks to simplify how people interact with vast amounts of astronomical data, accelerating new discoveries about the universe.

NSF-Simons CosmicAI is built on partnerships across universities, national research facilities, nonprofits and industry leaders, fostering innovative AI technologies to support astronomers in their research. These AI tools are designed to be trustworthy, efficient, reliable and interpretable, empowering researchers to confidently use them for their projects. With these capabilities, CosmicAI will enable scientists to delve deeper into their work and push the limits of what we know about the cosmos.

CosmicAI isn't just for experts; it also aims to inspire students and the public, helping them to connect with the wonders of the cosmos. By making astronomical data more accessible, the institute hopes to spark curiosity in new generations of space enthusiasts.

Ultimately, the goal of CosmicAI is to drive discoveries that address humanity's most profound questions, like our origins and our place in the cosmos, harnessing AI to unlock insights that bring us closer to understanding the universe.

CosmicAI
Funded by the U.S. National Science Foundation and the Simons Foundation

FUNDING PARTNERS

- NSF
- Simons Foundation

INNOVATIONS

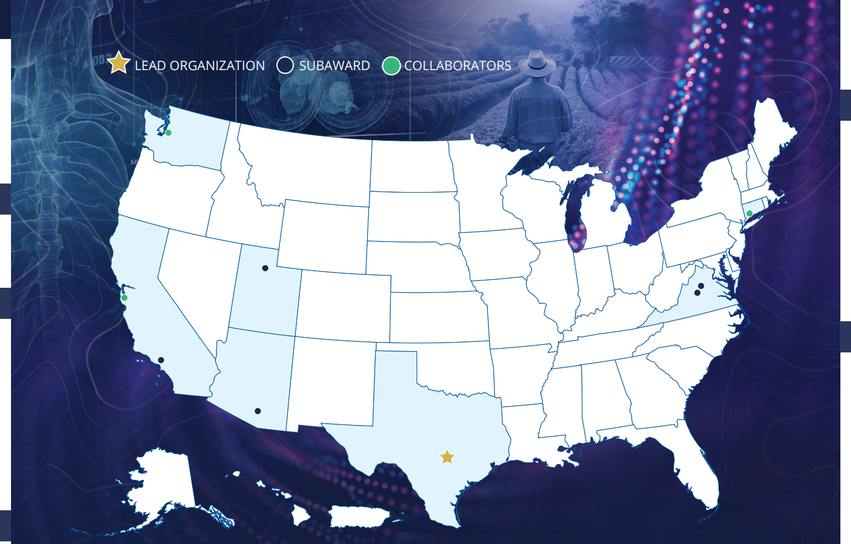
- Workforce development through new AI and astronomy educational programs.
- Computing infrastructure for community data sharing and analysis tasks.
- Public, open-source code and data.
- Methods to automate telescope data collection and processing.
- Methods to accelerate astronomy modeling.

IMPACTS

- Expand AI competency and use in the astronomy community.
- Strengthen the STEM workforce.
- Make access to data and AI resources widely available.
- Advance foundational AI methods.
- Accelerate new astronomical discoveries.

PRESS LINKS

- Forbes
- NSF National Radio Astronomy Observatory
- Oden Institute
- The University of Utah
- University of Virginia



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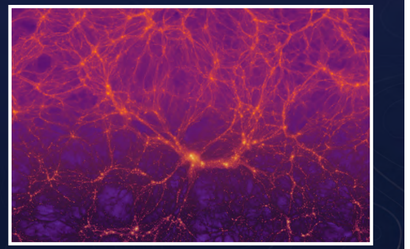
Artist's concept of the next generation Very Large Array.
Photo credit: *NSF/NSF NRAO/AUI/mtex.*



Simulation of the "cosmic web" of dark matter in the universe.
Photo credit: *IllustrisTNG Collaboration.*

SUBAWARD

- Associated Universities, Inc. (NSF National Radio Astronomy Observatory)
- Association of Universities for Research in Astronomy, Inc. (NSF National Optical-Infrared Research Laboratory)
- University of California, Los Angeles
- University of Utah
- University of Virginia, Main Campus

COLLABORATORS

- Allen Institute for AI
- SLAC National Accelerator Laboratory

NSF-SIMONS AI INSTITUTE FOR THE SKY (NSF-SIMONS SKAI)

Principal investigator:
Vicky Kalogera, Ph.D.

Leading institution:
Northwestern University

Institute vision statement

From collecting an unparalleled amount of data from the NSF-DOE Vera C. Rubin Observatory's upcoming Legacy Survey of Space and Time to probing the universe's earliest signals through cosmic microwave background experiments, modern astronomical surveys are set to generate groundbreaking discoveries about stars, black holes, galaxies and the universe. However, analyzing and understanding this vast and complex data presents significant challenges, requiring astrophysicists to develop accurate simulations across vast astronomical scales and design sophisticated astronomical instruments and surveys.

To tackle these challenges, researchers at the NSF-Simons AI Institute for the Sky (NSF-Simons SkAI) are pursuing AI innovations in generative models, astrophysics-informed and interpretable AI, and uncertainty quantification to advance astronomy data, simulations and detector technology. NSF-Simons SkAI serves as a cross-disciplinary hub that accelerates research at the interface between astronomy and AI while also educating the future astronomy workforce in trustworthy AI for scientific inquiry.

Located in Chicago and the Midwest, with research and education partnerships in Georgia, Hawaii and Alaska, NSF-Simons SkAI brings together astrophysicists, foundational AI researchers, educators, AI ethicists, software engineers and artists to:

- Develop innovative, trustworthy AI tools for researchers.
- Train a new generation of interdisciplinary leaders in science and engineering who apply and advance robust AI within and beyond academia.
- Increase public awareness about complex AI and astronomy concepts through collaborations with Illinois-based creatives.

Funded by the U.S. National Science Foundation and the Simons Foundation

FUNDING PARTNERS

- NSF
- Simons Foundation

INNOVATIONS

- Enhanced insights from cosmic survey data.
- AI-accelerated simulations for complex astrophysics.
- Learning-based astrophysical survey and instrument design.
- The SkAI Satellite Network to expand participation in astronomy and AI.

IMPACTS

- Trustworthy AI that solves big astronomy questions.
- Effective and transferable programs that grow the astronomy, AI and STEM workforce.
- Enhancement of local, regional and national research capacity at the interface between astronomy and AI.
- Dissemination of impactful community software.

PRESS LINKS

- Forbes
- Northwestern University News
- Simons Foundation
- University of Chicago News
- University of Illinois Urbana-Champaign News

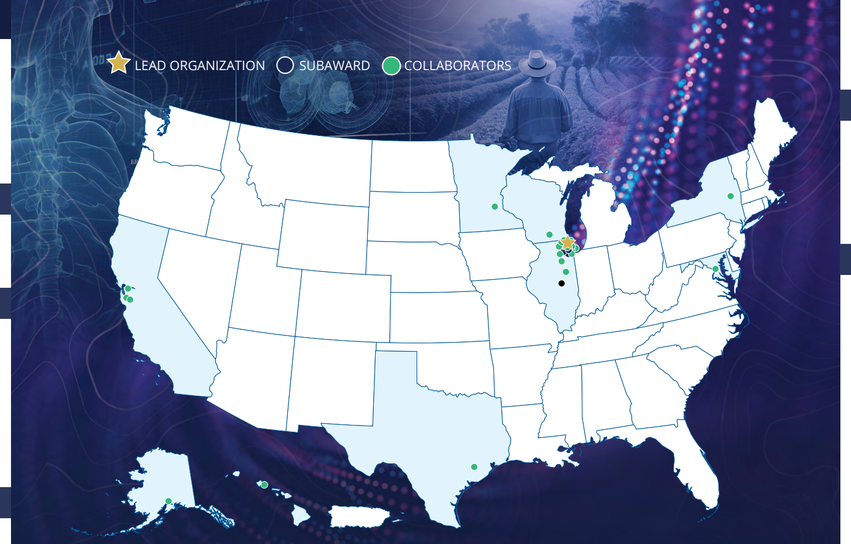


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Photo credit: *University of Illinois at Urbana-Champaign, National Center for Supercomputing Applications Communications.*

SUBAWARD

- Adler Planetarium
- The University of Chicago
- University of Illinois at Chicago
- University of Illinois at Urbana-Champaign

COLLABORATORS

- Argonne National Laboratory
- Cadence Design Systems
- Chicago Public Schools
- Chicago State University
- DePaul University
- Fermilab
- Forward Momentum Chicago
- GlobalFoundries
- Harold Washington College
- Harry S Truman College
- Hewlett Packard Enterprise
- Howard University
- Illinois Institute of Technology
- Jan Pieter Fokkens
- Kennedy-King College
- Malcolm X College
- Northeastern Illinois University
- NVIDIA
- Parkland College
- Richard J. Daley College
- SkyWater Technology
- Star Eyes Initiative
- Toyota Technological Institute at Chicago
- University of Alaska Anchorage
- University of Hawaii at Mānoa
- University of Wisconsin–Madison
- Voltron Data
- Wilbur Wright College

THE INSTITUTE FOR TRUSTWORTHY AI IN LAW & SOCIETY (TRAILS)

Principal investigator:
Hal Daumé III, Ph.D.

Leading institution:
University of Maryland

Institute vision statement

The Institute for Trustworthy AI in Law & Society (TRAILS) is the first of its kind to integrate artificial intelligence participation, technology and governance during the design, development, deployment and oversight of AI systems. TRAILS investigates what trust in AI looks like, how to create technical AI solutions that build trust, and which policy models are effective in sustaining trust.

In the U.S. and internationally, many organizations aim to encourage trustworthy AI systems — iterations of AI that users, developers and deployers see as accountable, responsible and unbiased. However, the researchers at TRAILS believe that there is no trust or accountability in AI systems without the participation of wide range of stakeholders. They will work to ensure that future AI systems enhance human capacity, respect human dignity and protect human rights by:

- Developing new methods that promote AI trustworthiness.
- Empowering users to make sense of AI systems.
- Analyzing and promoting broad governance strategies to build trust and accountability in AI systems.
- Training a multidisciplinary next generation of talent educated in ethical AI.
- Centering perspectives often overlooked in mainstream AI.

TRAILS
Trustworthy AI in Law & Society

FUNDING PARTNERS

- NSF
- NIST

INNOVATIONS

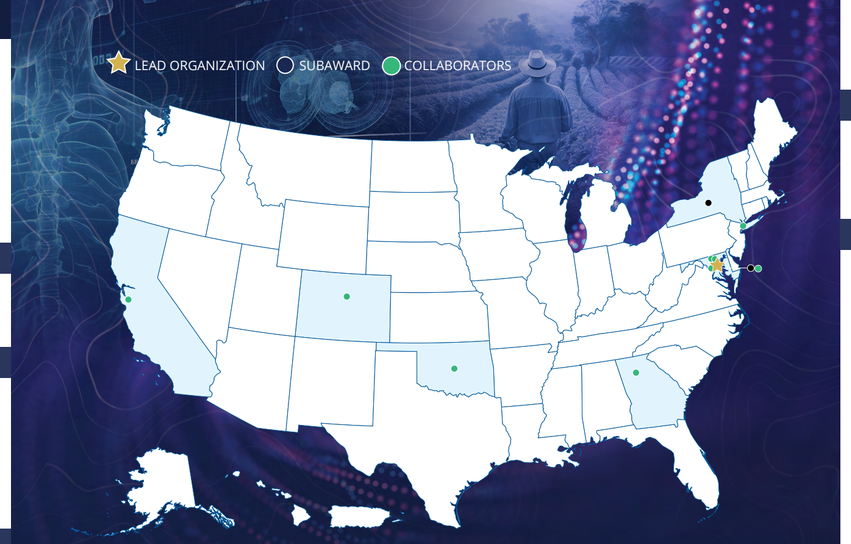
- Multidisciplinary team exploring the intersection of AI and ethical and legal frameworks.
- Expertise in machine learning, education, community outreach, law, and policy.
- Research with a focus on AI for good.

IMPACTS

- New technology that aligns with diverse values and interests.
- Novel methods, metrics and algorithms reflecting stakeholders' values.
- Evaluation of how people understand and trust AI systems.
- Exploration of ways policymakers foster trust and promote broader participation.

PRESS LINKS

- Technical.ly
- TRAILS – Building trust in AI
- TRAILS - How to regulate AI? Start with the data



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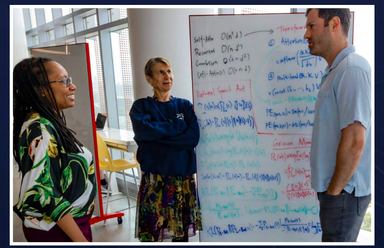
Lead faculty from the Institute for Trustworthy AI in Law & Society (TRAILS) met in June 2023 to brainstorm strategic initiatives moving forward. TRAILS is the first organization to integrate artificial intelligence participation, technology and governance during the design, development, deployment and oversight of AI systems.
***Photo credits**: Stephanie Cordle, UMD.*



(From left) Brandeis Marshall, CEO of DataedX, Susan Ariel Aaronson, a research professor of international affairs at George Washington University, and Tom Goldstein, a professor of computer science at the University of Maryland, discuss ideas during a June 2023 leadership meeting of the Institute for Trustworthy AI in Law & Society (TRAILS).
***Photo credits**: Stephanie Cordle, UMD.*

SUBAWARD

- Cornell University
- George Washington University
- Morgan State University

COLLABORATORS

- Army Research Lab
- AI Institute for Research on Trustworthy AI in Weather, Climate, and Coastal Oceanography (AI2ES)
- ArthurAI
- CheckStep
- DataEdX Group
- Digital Promise
- FinRegLab
- Google
- Institute for Education Sciences
- Integrity Research Institute
- Maryland Center for Computing Education
- National Aeronautics and Space Administration (NASA)
- Planet Word Museum
- TechStars

THE NSF INSTITUTE FOR LEARNING-ENABLED OPTIMIZATION AT SCALE (NSF TILOS)

Principal investigator:
Yusu Wang, Ph.D.

Leading institution:
University of California San Diego

Institute vision statement

Enhanced optimization in critical areas like energy efficiency, safety and robustness holds the promise for enormous societal benefits. However, society stands at a crossroads where the sheer scale and complexity of many real-world optimization challenges often exceed traditional solutions.

The mission of The NSF Institute for Learning-enabled Optimization at Scale (NSF TILOS) is to make "impossible" optimizations possible at scale and in practice. NSF TILOS' success hinges on pioneering breakthroughs that seamlessly fuse artificial intelligence and optimization to catalyze their collaborative evolution. To accomplish this, the institute will integrate foundational research, real world applications, education and broader societal impacts to create an innovative ecosystem where optimization, AI and data-driven learning converge for the greater good.

NSF TILOS aims to discover a new nexus of AI, optimization and the leading edge of practice in three critical areas that directly impact the wellbeing and prosperity of the nation: chip design, communication networks and contextual robotics. The institute's foundational research will serve as the bedrock for the imminent technological revolutions in information and communication technology and cyberphysical systems.

NSF TILOS' ultimate goal is to help create a future where smart mobile devices and autonomous vehicles are powered by AI, advanced chips and 6G networks, seamlessly transforming these tools into personal intelligent agents that securely interact with the world.

FUNDING PARTNERS

- NSF
- Intel

INNOVATIONS

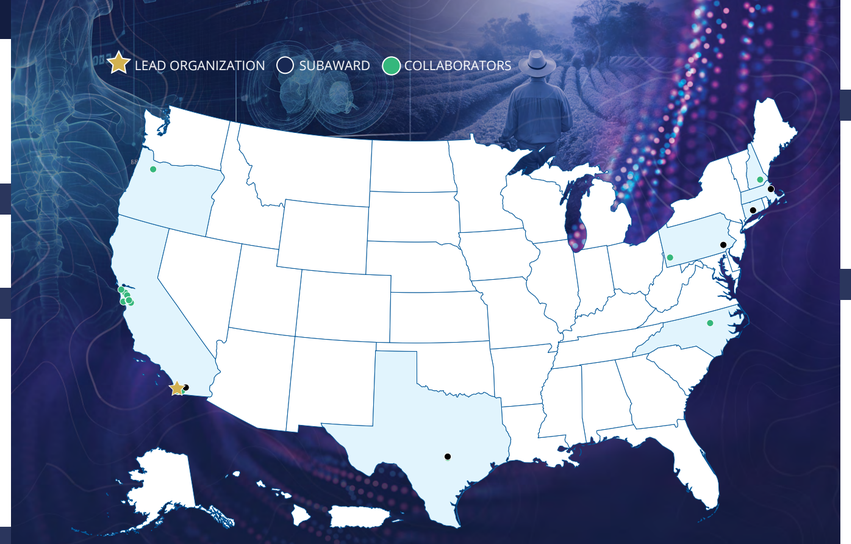
- Optimization in deep learning.
- Use of deep learning for placement in chip design.
- Development of Mobile Wireless Infrastructure on-Demand.
- Innovation in scalable semantic mapping for autonomous vehicles.
- Expansion of AI career pathways through K-12 outreach.

IMPACTS

- Foundations of AI.
- Efficient design of advanced chips.
- On-demand, fast, reliable and secure 6G networks.
- Robust autonomous drones and vehicles that will transform communication, transportation and agriculture.
- Lifelong learning through sharable AI curricula.

PRESS LINKS

- Forbes
- NVIDIA Technical Blog
- Quanta Magazine
- Scientific American
- UC San Diego Today



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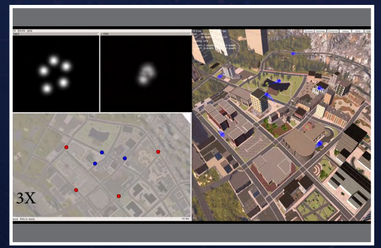


Artificial intelligence developed by NSF TILOS learns to deploy wireless infrastructure on demand. ***Photo credit:*** *D. Mox, V. Kumar and A. Ribeiro, "Learning Connectivity-Maximizing Network Configurations," IEEE Robotics and Automation Letters.*

High school students participate in NSF TILOS Data Science Camp summer program at the University of California, San Diego. ***Photo credit:*** *Saura Naderi, University of California, San Diego.*

SUBAWARD

- Massachusetts Institute of Technology
- National University
- University of Pennsylvania
- University of Texas at Austin
- Yale University

COLLABORATORS

- Advanced Micro Devices, Inc.
- Ansys, Inc.
- A Reason To Survive (ARTS)
- Cadence Design Systems
- FIRST
- Girl Scouts San Diego
- Google
- IBM
- Intel
- Meta
- NVIDIA
- Planck Aerosystem, Inc.
- Qualcomm
- SACNAS
- Samsung Austin R & D Center
- Samsung Strategy and Innovation Center
- Siemens EDA
- Silicon Integration Initiative, Inc.
- Sweetwater Union High School District
- Synopsys, Inc.
- TuSimple, Inc.

USDA-NIFA AI INSTITUTE FOR AGRICULTURAL AI FOR TRANSFORMING WORKFORCE AND DECISION SUPPORT (AGAID)

Principal investigator:
Ananth Kalyanaraman, Ph.D.

Leading institution:
Washington State University

Institute vision statement

Agriculture faces challenges such as changing climate, extreme weather, water scarcity and labor shortages. The USDA-NIFA AI Institute for Agricultural AI for Transforming Workforce and Decision Support (AgAID) was launched in 2021 with support from NSF and the U.S. Department of Agriculture National Institute of Food and Agriculture (USDA-NIFA) to address these challenges. The institute integrates researchers from multiple disciplines to empower agriculture with trailblazing AI-tools to assist in decision-making and workforce development.

At AgAID, researchers harness the combined power of human and AI in three key areas related to perennial specialty crops. They are developing predictive AI models that allow farmers to effectively anticipate and respond to extreme weather like frost and drought. AgAID is innovating inclusive and user-friendly technologies to improve farm workers' experience and productivity in the field in complex tasks such as tree-fruit pruning, harvesting and blossom thinning. The institute is developing machine learning models to improve seasonal and long-term forecasting so that irrigation managers and farmers can better allocate scarce resources like water. The researchers imagine a sustainable future in agriculture, where humans and AI work in harmony to feed a growing population.

They believe that their innovations can be extended beyond high value specialty crops to address a variety of agricultural challenges globally. For that to become a reality, key breakthroughs are still needed in our understanding and design of AI and human systems. AgAID is working on it.

AgAID Institute

FUNDING PARTNERS

- USDA NIFA

INNOVATIONS

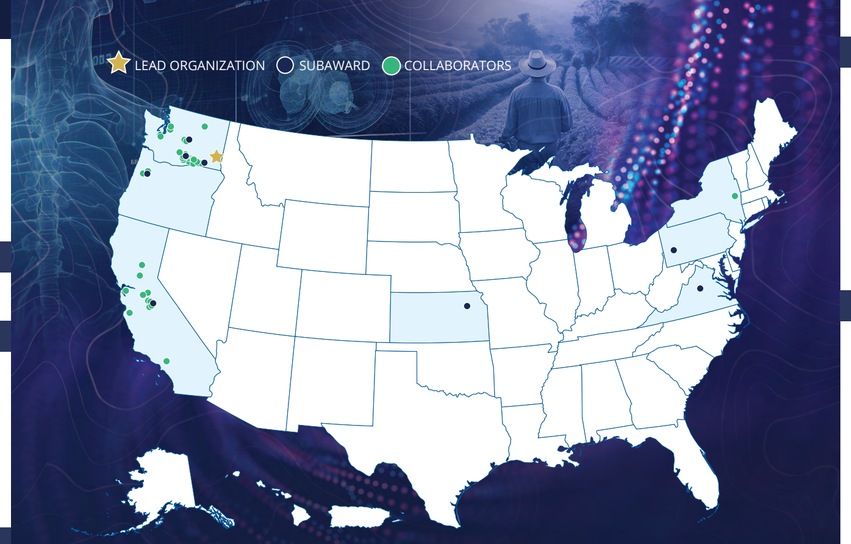
- Science-guided machine learning for improved prediction and interpretation.
- Multitask learning and digital twins for tackling small data.
- Inclusive and interactive human-AI workflows to amplify productivity.
- Community dialogue to accelerate adoption.

IMPACTS

- Site-specific farm decision support that can mitigate risks and reduce uncertainty.
- Human-AI workflows to amplify partnership and empower workers.
- Forecasting and prediction tools to help irrigation districts make optimal water allocations.

PRESS LINKS

- Capital Press
- GeekWire
- Good Fruit Grower
- NBC Right Now
- The Spokesman Review



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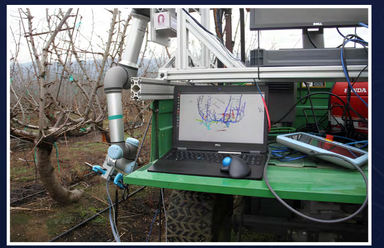
Washington State University faculty member Lav Khot explains to AgAID Institute team members how the drone's sensing technology collects multispectral and thermal imagery data from a "smart farm" in Yakima County.
***Photo credits**: Washington State University.*



A robotic pruning system, including a machine vision system for 3D reconstruction of fruit trees, is being tested at a cherry orchard at the Washington State University's Roza experimental farm. The robotic system was developed by an AgAID Institute team of researchers: Manoj Karkee, Joseph Davidson, and Cindy Grimm, at Washington State University and Oregon State University.
***Photo credits**: Washington State University.*

SUBAWARD

- Carnegie Mellon University
- Heritage University
- Innov8 Ag
- Kansas State University
- Oregon State University
- University of California Merced
- University of Virginia
- Wenatchee Valley College

COLLABORATORS

- AgTech Insight
- AgWeatherNet
- Allan Bros
- Almond Board of CA
- California Department of Water Resources
- Cascadia Innovation Corridor
- Central Valley Community Foundation
- Chemeketa Community College
- Ciel du Cheval Vineyard
- Columbia Basin College
- Columbia Crest Winery
- Dive 4 Agriculture
- Environmental Defence Fund
- First Nations MESA, Heritage University
- Good Fruit Grower
- Grassland Water District
- G S Long
- Hebrew University
- IBM Research
- Leibniz Institute for Agricultural Engeneering and Bioeconomy
- Linn-Benton Community College
- Merced College
- Merced Irrigation District
- Mercer Ranches
- Microsoft
- Microsoft Research
- NCW Tech Alliance
- Okanogan Irrigation District
- Pontificia Universidad Católica de Chile
- Roza Irrigation District
- Turlock Irrigation District
- Universitat Politècnica de València
- University of British Columbia
- University of Technology Sydney
- Verdant Robotics
- Wageningen University and Research
- Walla Walla County Conservation District
- Washington Department of Ecology
- Washington State Mint Commission
- WA Tree Fruit Research Commission
- Wilbur-Ellis
- Wonderful Orchards
- Yakama Nation Tribal School
- Zirkle Fruit Co

USDA-NIFA AI INSTITUTE FOR CLIMATE-LAND INTERACTIONS, MITIGATION, ADAPTATION, TRADEOFFS AND ECONOMY (AI-CLIMATE)

Principal investigator:
Shashi Shekhar, Ph.D.
Leading institution:
University of Minnesota

Institute vision statement

The increasing frequency and severity of weather disasters like the recent Hawaii and Canada wildfires, the 2022 drought and the 2020 Midwest derecho remind us that people's well-being, U.S. global competitiveness and nutritional security are vulnerable to the effects of climate change. These events — which cause significant loss of lives and crops and cost billions of dollars to the economy — have a negative impact on the health of agriculture, grasslands and forest and wetland systems.

The USDA-NIFA AI Institute on Climate-Land Interactions, Mitigation, Adaptation, Trade-offs and Economy (AI-CLIMATE) aims to create a new scientific discipline, establish an innovation ecosystem and foster a community of practice at the intersection of artificial intelligence and climate-smart agriculture and forestry (CSAF). The goal of the institute is to develop and accelerate the use of CSAF practices while simultaneously strengthening the field of AI.

AI-CLIMATE's AI-powered CSAF solutions will provide more accurate estimates of soil emissions and higher accuracy maps of soil moisture, temperature and organic carbon. The institute is also pioneering next-generation field-to-market tools that will enhance decision-making and support equitable adoption of climate adaptation and mitigation strategies.

The significant advances of AI-CLIMATE include knowledge-guided methods for more reliable and precise predictions leveraging satellite data. These innovations span various AI domains like knowledge-guided machine learning, multi-objective optimization, computer vision and digital twins. The teams at AI-CLIMATE seek to reduce costs associated with carbon tracking in agricultural and forested settings, thereby facilitating valuable insights for decision-making.

The institute will upskill and expand the AI-ready CSAF workforce. This proactive approach aims to address labor shortages that are driving growers and foresters to reduce production or switch to practices requiring less labor.

AI-CLIMATE

FUNDING PARTNERS

- USDA NIFA

INNOVATIONS

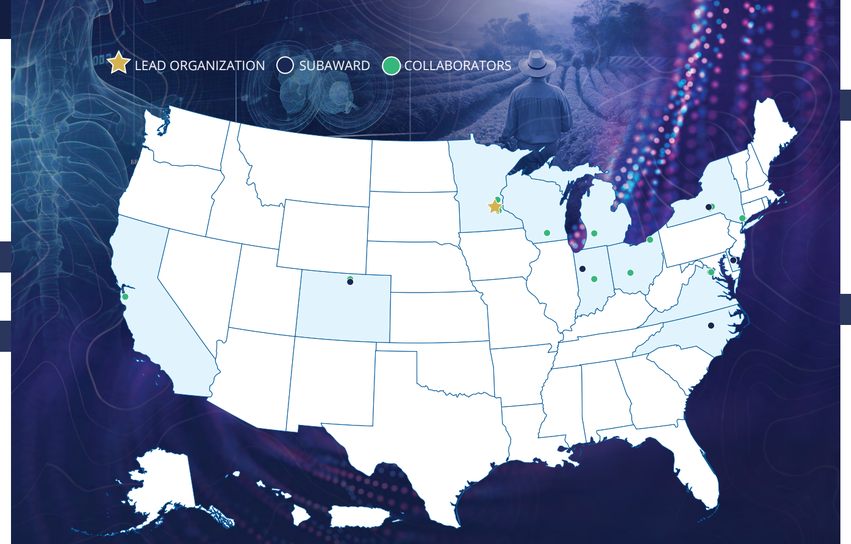
- Improved data (e.g.,finer-resolution soil moisture maps).
- Refined tools for CSAF practice decision-making that accounts for trade-offs.
- More accurate models of soil organic matter and greenhouse gas emissions.
- Faster algorithms for multi-objective optimization.

IMPACTS

- Strengthen AI by incorporating scientific knowledge.
- Acceleration of carbon-sequestration in farms and forests.
- Drought resilience via healthier soil.
- Empowerment of markets by better carbon estimation.
- Expand and upskill AI-ready CSAF workforce.

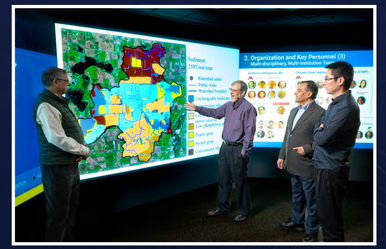
PRESS LINKS

- KARE
- FOX 9
- New Food Magazine



The map reflects the approximate location of the lead organizations, subawards and collaborators.
Note: Collaborators related to an Institute may be represented with a single plot due to space limitations.

***Photo credit**: Collaborative Geodesign of 7-mile Creek Watershed. Photo source: Xie, Y.; Runck, B.C.; Shekhar, S.; Kne, L.; Mullo, D.; Jordan, N.; Wiringa, P. Collaborative Geodesign and Spatial Optimization for Fragmentation-Free Land Allocation. ISPRS Int. J. Geo-Inf. 2017, 6, 226. https://doi.org/10.3390/ijgi6070226.*



*A map of Minnesota's Seven Mile Creek Watershed created by the researchers' AI-powered GeoDesign tool shows farming practices that could optimize carbon sequestration and boost soil health.**Photo credit**: Rich Ryan, College of Science and Engineering, University of Minnesota.*

SUBAWARD

- Colorado State University
- Cornell University
- Delaware State
- International Soil Reference and Information Centre
- North Carolina State University
- Purdue University

COLLABORATORS

- GEMS Informatics Center
- Land O' Lakes
- Midwest Big Data Innovaton Hub
- Icicle NSF-AI Institute
- Information Technology Colorado State University
- MnRI (UMN)
- MSI/RC (UMN)
- NVIDIA
- Pepsico
- Precision Ag Center (UMN)
- American Society of Agronomy
- National FFA Organization
- AIHEC
- Sentera
- TNC, The Nature Conservancy
- USDA/Forest Service Northern Research Station
- WEAVE
- CSU computing
- Cornell Climate-Smart Farming Team
- Cornell Institute for Digital Agriculture
- CropLife Media/ Meister Media Worldwide
- DSU Ag-IT

USDA-NIFA AI INSTITUTE FOR FUTURE AGRICULTURAL RESILIENCE, MANAGEMENT, AND SUSTAINABILITY (AIFARMS)

Principal investigator:
Vikram Adve, Ph.D.

Leading institution:
University of Illinois Urbana–Champaign

Institute vision statement

The USDA-NIFA AI Institute for Future Agricultural Resilience, Management, and Sustainability (AIFARMS) is creating AI-driven tools to help farmers be more profitable, productive and sustainable.

The agricultural sector faces several challenges, including unpredictable weather, drought, disease and pests that are damaging crops, as well as labor shortages that are hurting both profitability and animal welfare. Advanced farm equipment and data-driven farming solutions are often out of reach for smallholder farms. Many farmers are tech-savvy but fear the financial risks of advanced technology, hampering adoption. Aging farm demographics threaten the continuity of family farms. AI-driven solutions can help mitigate these challenges but require AI advances delivered via pragmatic, cost-effective tools.

AIFARMS is advancing AI techniques for farming while also bringing down the cost to access AI through extensive collaborations between AI and agriculture researchers. The research spans most aspects of AI, including robotics, computer vision, machine learning and natural language understanding. The institute's robotics research is enabling more efficient and sustainable practices for row crops using low-cost robot teams suitable for both small and large farms. Computer vision innovations are reducing the need for labor in livestock farms. New machine learning techniques are enabling more productive, resilient and environmentally friendly crops and improving understanding of soil properties, which leads to lower chemical costs and pollution.

AIFARMS educational programs, such as a first-of-its-kind master's degree in digital agriculture, a new Research Experiences for Undergraduates program for underserved students, and K-12 educational activities are increasing agricultural technology skills in the workforce and attracting younger generations to career opportunities in agriculture.

AIFARMS
Artificial Intelligence for Future Agricultural Resilience, Management, and Sustainability

FUNDING PARTNERS

- USDA NIFA

INNOVATIONS

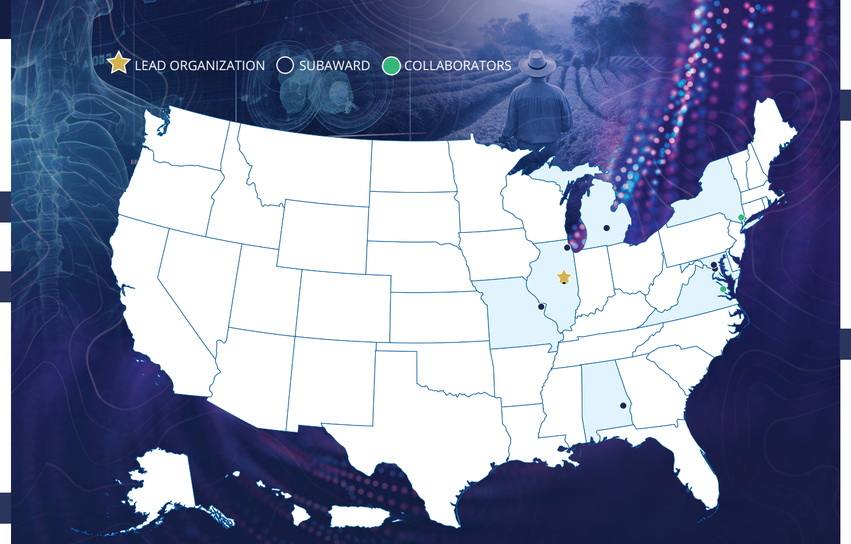
- Improved autonomy for low-cost robots.
- Computer vision with minimal data.
- Methods to measure crop carbon content.
- Greater drought tolerance for crops.
- Datasets to enable AI research for agriculture.
- New K-12, undergraduate and graduate education programs.

IMPACTS

- More profitable, sustainable farming with lower labor costs.
- Food supply less vulnerable to weather and drought.
- Affordable, high-tech solutions for smallholder farms.
- Attracting AI researchers to agricultural challenges.
- Larger skilled workforce in AI for agriculture.

PRESS LINKS

- BBC News
- Center for Digital Agriculture
- Coordinated Science Laboratory
- DepthCharge Podcast
- WIRED



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USDA-NIFA AIFARMS team members with autonomous under canopy robot.
***Photo credit**: University of Illinois Urbana-Champaign's College of Agricultural, Consumer and Environmental Sciences.*

2023 USDA-NIFA AIFARMS REU Cohort.
***Photo credit**: National Center for Supercomputing Applications - University of Illinois Urbana-Champaign.*

SUBAWARD

- Donald Danforth Plant Science Center
- Michigan State University
- Tuskegee University
- University of Chicago
- U.S. Department of Energy's Argonne National Laboratory
- U.S. Department of Agriculture's Agricultural Research Service

COLLABORATORS

- EarthSense
- IBM Research
- Microsoft

USDA-NIFA AI INSTITUTE FOR NEXT GENERATION FOOD SYSTEMS (AIFS)

Principal investigator:
Ilias Tagkopoulos, Ph.D.
Leading institution:
University of California, Davis

Institute vision statement

The vision of the USDA-NIFA AI Institute for Next Generation Food Systems (AIFS) is making society healthier through robust, sustainable and equitable food systems. Its mission is to create artificial intelligence tools and nurture the next generation of talent that will revolutionize the production and distribution of accessible, resource-efficient nutritious food.

With a plant-centric approach, AIFS employs AI solutions that unlock opportunities to create cost-effective, higher-quality goods and services while tackling pressing societal issues like food insecurity, waste and risks in the food supply chains. The institute will use AI to bring together solutions to these challenges in collaboration with industry partners, including ingredient producers, consumer packaged goods companies, and innovative pioneers in fields like vertical farming, nutrition and robotics.

AIFS believes that technologies such as AI can capture the hearts and minds of current professionals and future innovators if it is useful, understood and trustworthy. For that reason, AIFS has established a dynamic and inclusive outreach and training program with the purpose of educating, engaging and influencing practitioners and future innovators. By fostering collaboration and knowledge exchange, AIFS is actively shaping the present U.S. food system and working toward a more sustainable and equitable future.

FUNDING PARTNERS

- USDA NIFA

INNOVATIONS

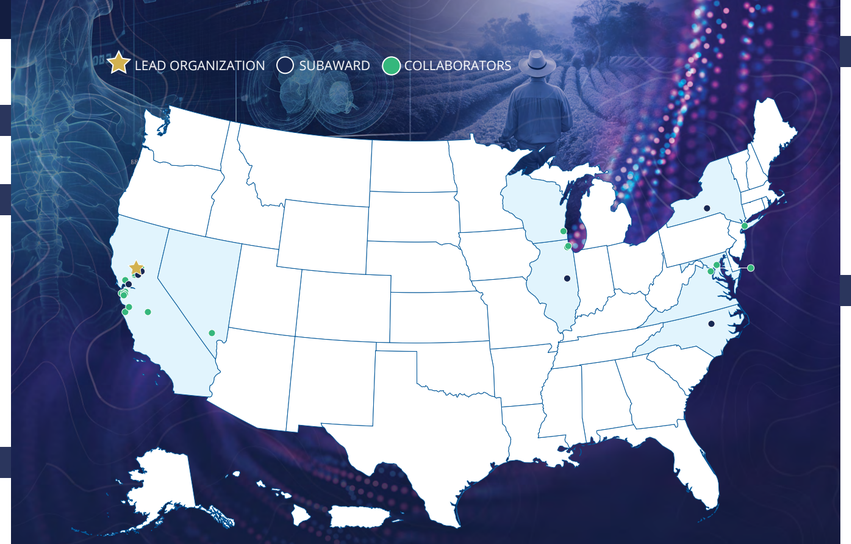
- The Food Atlas: An AI knowledge base of compounds in food and their effects on human health.
- Discovering new ingredients through AI models.
- Making soil sensors affordable.
- Democratizing crop machine learning models.
- Optimizing indoor farming.
- Hosting food-focused Hackathons and AI training courses.

IMPACTS

- Trained 300 students in applied AI.
- Organized workshops with thousands of participants.
- Facilitated AI adoption by food banks and companies.
- Accelerated research and development of food and ingredients.
- Reduced fertilizer run-off.
- More quickly identified food pathogens.

PRESS LINKS

- Fortune
- Science Direct
- National Academies of Sciences, Engineering, and Medicine
- UC Davis
- AIFS YouTube



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Team Amiggie from UC Davis pictured with the Amiga, a modular farm robot developed by Farm-ng. Team Amiggie won the grand prize in the 2023 Farm Robotics Challenge, an event organized by The VINE, an initiative of UC Agriculture and Natural Resources, USDA-NIFA AIFS and Farm-ng.
***Photo credit**: University of California Agriculture and Natural Resources staff.*

USDA-NIFA AIFS graduate students describe the operation of an agricultural drone under development which can apply specific quantities of bio-pesticides to row crops.
***Photo credit**: AIFS staff.*

SUBAWARD

- Cornell University
- Duke University
- University of California Division of Agriculture and Natural Resources
- University of California Berkeley
- University of Illinois Urbana-Champaign
- USDA Agricultural Research Service Western Human Nutrition Center

COLLABORATORS

- ADM
- AgMonitor
- Agricultural Research Service, USDA
- AgStack / Linux Foundation
- BASF
- Better Food Ventures
- Dairy Management Inc.
- Edamam
- Farm_ng
- FIRA-US
- Fraunhofer ISE
- Indoor Ag-Con
- MARS, Incorporated
- MISTA
- Novozymes
- PhenoRob
- Pheronym
- Process Integration and Predictive Analytics
- The Better Meat Co
- The Culinary Institute of America at Copia
- The March Fund
- The Rockefeller Foundation
- The Vine
- U.S. National Science Foundation
- Verdant Robotics
- Wageningen University and Research

USDA-NIFA AI INSTITUTE FOR RESILIENT AGRICULTURE (AIIRA)

Principal investigator:
Baskar Ganapathysubramanian, Ph.D.

Leading institution:
Iowa State University

Institute vision statement

The USDA-NIFA AI Institute for Resilient Agriculture (AIIRA) is committed to speeding the progress, productivity and sustainability of today's agriculture. The institute seeks to harness the full potential of AI and make it accessible to all stakeholders in agriculture. AIIRA is bringing together scientists, farmers and key players from industry and government to adapt and integrate new technologies and meet the needs of a growing population under an increasingly climate-challenged planet.

AIIRA's goal is to enhance the resiliency of the U.S. agricultural ecosystem. AIIRA will profoundly impact the nation's economy, food production and food security. The institute will use the concept of AI-driven predictive digital twins to integrate vast amounts of sensor data with genetic, physiological and agronomic knowledge (domain knowledge) and thereby model agricultural phenomena at the plant (for breeding) and field (for production) scales.

The availability of open-source predictive digital twins will dramatically improve researchers' ability to formulate and test hypotheses, anticipate challenges, strategize for the future, innovate solutions and mitigate undesirable effects in complex agricultural systems.

AIIRA's dedicated social science team is working to ensure that AI innovations are readily embraced by end users within agricultural communities. AIIRA collaborates with diverse groups to understand and address stakeholders' needs to develop solutions with real-world applications and impact.

AIIRA's ultimate goal is to foster smarter, profitable and more sustainable agriculture that is better equipped to meet the demands of future generations.

AIIRA

FUNDING PARTNERS

- USDA NIFA

INNOVATIONS

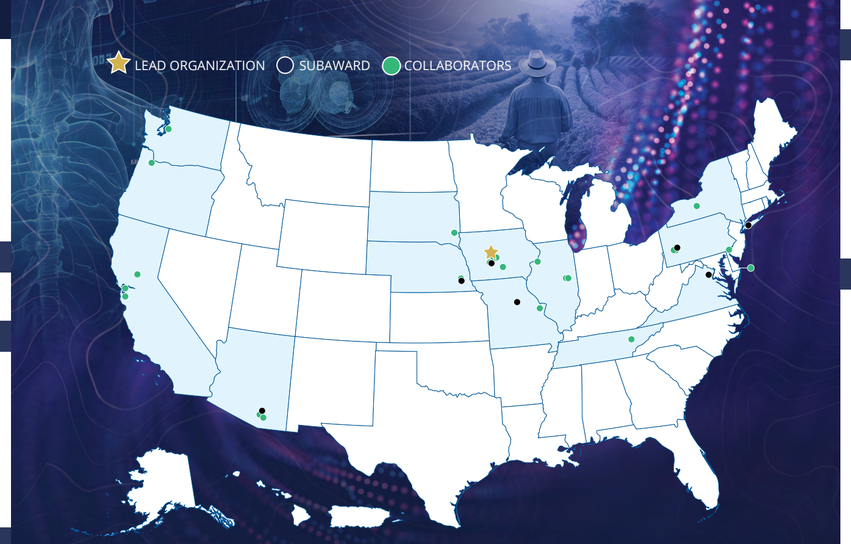
- Digital twins for smarter agriculture.
- AI tools for agriculture at small, medium and large scales.
- Better understanding of barriers and catalysts to adoption of AI tools in agriculture.
- Democratized access to AI tools for agriculture.
- Workforce training and upskilling in AI.

IMPACTS

- Build and foster the discipline of cyber agricultural systems.
- Develop and deploy novel plant breeding technologies.
- Empower farmers to adopt novel techniques and technologies.
- Enhanced precision in agricultural management.
- Support for rural economic growth.

PRESS LINKS

- Grist
- Iowa Soybean Association
- Seed TODAY
- University of Nebraska Report
- University of Missouri News



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Women in Ag and AI discussing drone sensing with Farm Progress Show attendees. ***Photo credit:*** *USDA-NIFA AIIRA.*

AIIRA Robotics Team demonstrating the use of robotics for sensor placement in a corn fields. ***Photo credit:*** *USDA-NIFA AIIRA.*

SUBAWARD

- Carnegie Mellon University
- George Mason University
- Iowa Soybean Association
- New York University
- University of Arizona
- University of Missouri
- University of Nebraska-Lincoln

COLLABORATORS

- Agriculture Genome to Phenome Initiative
- AI Institute: Artificial Intelligence for Future Agricultural Resilience, Management, and Sustainability (AIFARMS)
- AI Institute for Next Generation Food Systems
- Bayer
- Big Data in a Box
- BioConnect Iowa
- Bloomfield Robotics
- Cornell AgriTech
- Corteva Agriscience
- CSIRO, Australia
- CyVerse
- Dryland Genetics
- EarthSense, Inc.
- EnGenious Ag
- ETALYC Inc.
- Federal Statistical Research Data Center (FSRDC) at Iowa State University
- Genomes to Fields Initiative
- Grow Pittsburgh
- International Plant Phenotyping Network
- Iowa Corn Growers Association
- Iowa Economic Development Authority
- Iowa Fruit & Vegetable Growers Association
- Iowa Soybean Association
- John Deere
- Microsoft
- MidWest Big Data Hub
- Mineral Google - X, The Moonshot Factory
- North American Plant Phenotyping Network (NAPPN)
- Oak Ridge National Laboratory
- Omni Analytics Group
- Practical Farmers of Iowa
- Raven Applied Technology
- RocketML, Inc.
- The Data and Software Carpentries
- The University of Tokyo
- University of Arizona TRIPODS
- University of Nebraska–Lincon Institute of Agriculture and Natural Resources Center for Resilience in Agricultural Working Landscapes
- USDA, Agricultural Research Service
- Vermeer Corporation

U.S. National Science Foundation

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- ***Promote the progress of science.***
- ***Advance the national health, prosperity and welfare.***
- ***Secure the national defense.***

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