



## COLUMN

# Looking back, looking ahead: Strategic initiatives in AI and NSF's AI Institutes Program

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### Abstract

We introduce U.S. National Science Foundation's groundbreaking National AI Research Institutes Program. The AI institutes are interdisciplinary collaborations that continue the program's emphasis on tackling larger-scale, longer-time horizon challenges in both foundational and use-inspired AI research, and act as nexus points to address some of society's grand challenges.

**Article:** As the massive excitement about recent advances in AI indicates, AI is a transformative technology that likely will have a deep and lasting impact on the national and global economy and security. The recognition of the potential impact of AI of course long predates the recent advances and often has led various countries to launch national strategic initiatives in AI. In the early 1980s, for example, the United States launched the Strategic Defense Initiative (sometimes known as the Star Wars project) even as Japan embarked on its Fifth Generation Computer Systems Project. By now, a few dozen countries have developed national strategic initiatives in AI (AI Index Report, 2021) and recently the United States launched its own National AI Initiative (2021).

The U.S. National Science Foundation's groundbreaking National AI Research Institutes Program is the flagship program in current U.S. AI research strategy, which triggers, enhances, and captures the excitement around the potential for AI and its benefits. With each of the twenty-five institutes funded at about \$20 M each over an initial 5 years, NSF's AI Institutes Program represents a total investment so far of about \$500 M, making this one of the biggest single public investments to date into AI research and development. AAAI will soon bring out a special issue

of AI Magazine focused on the progress of the first two rounds of institutes, which are now entering their third and fourth years. The special issue will include overview articles about the program as well as pull-out articles on the vision and impact to date of each of the first 18 Institutes in addressing social challenges as well as advancing foundational AI.

As we prepare the special issue to report on the flourishing of the first 18 institutes, NSF and its partners have just recently announced the continuing growth of the program with the award of seven new ones. The new AI institutes are interdisciplinary collaborations among top AI researchers and continue the program's emphasis on tackling larger-scale, longer-time horizon challenges in both foundational and use-inspired AI research, development of the future AI workforce, and leading as national nexus points as they address some of society's grand challenges. Here we briefly introduce each of these new institutes.

**TRAILS**—The NSF Institute for Trustworthy AI in Law & Society (TRAILS) was funded by NSF and NIST in response to the ever-increasing need to increase the trustworthiness of AI. Led by the University of Maryland, TRAILS aims to transform the practice of AI from one

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driven primarily by technological innovation to one driven with attention to ethics, human rights, and support for communities whose voices have been marginalized into mainstream AI. TRAILS will be the first Institute of its kind to integrate participatory design, technology, and governance of AI systems and technologies and will focus on investigating what trust in AI looks like, whether current technical solutions for AI can be trusted, and which policy models can effectively sustain AI trustworthiness. The TRAILS Institute is directed by Principal Investigator Hal Daume (University of Maryland, College Park), together with co-principal investigators Thomas Goldstein and Katherine Shilton at UMD and Susan Aaronson and David Broniatowski (The George Washington University).

**ACTION**—The AI institute for Agent-based Cyber Threat Intelligence and Operation (ACTION) was funded by a partnership between NSF, DHS S&T, and IBM in response to the need to develop intelligent agents that can model the actions, beliefs, and goals of machine and human agents involved in next-generation cybersecurity scenarios. ACTION will develop novel approaches that leverage AI to anticipate and take corrective actions against cyberthreats that target the security and privacy of computer networks and their users. The team of researchers will work with experts in security operations to develop a revolutionary approach to cybersecurity, in which AI-enabled intelligent security agents cooperate with humans across the cyber-defense life cycle to jointly improve the resilience of the security of computer systems over time. ACTION is directed by Principal Investigator Giovanni Vigna (University of California, Santa Barbara) together with co-principal investigators Wenke Lee (Georgia Institute of Technology), Dawn Song (University of California, Berkeley), and Dongyan Xu (Purdue University).

**AI-CLIMATE**—The AI Institute for Climate-Land Interactions, Mitigation, Adaptation, Tradeoffs, and Economy (AI-CLIMATE) was funded by USDA-NIFA in response to the call to advance AI together with agriculture and food systems research to realize resilient, climate-smart agriculture and forestry, increased nutrition security, rural economic revitalization, and increased equity and inclusion. AI-CLIMATE aims to advance foundational AI by incorporating knowledge from agriculture and forestry sciences and leveraging these unique, new AI methods to curb climate effects while lifting rural economies. By creating a new scientific discipline and innovation ecosystem intersecting AI and climate-smart agriculture and forestry, institute researchers and practitioners will discover and invent compelling AI-powered knowledge and solutions. Examples include AI-enhanced estimation methods of

greenhouse gases and specialized field-to-market decision support tools. A key goal is to lower the cost of and improve accounting for carbon in farms and forests to empower carbon markets and inform decision-making. The institute will also expand and diversify rural and urban AI workforces. AI-CLIMATE is directed by Principal Investigator Shashi Shekhar (University of Minnesota Twin Cities) together with co-principal investigators Vipin Kumar (U Minnesota), Carla Gomes and Johannes Lehmann (Cornell University), and Keith Paustian (Colorado State University).

**ARNI**—The AI institute for Artificial and Natural Intelligence (ARNI) was funded by NSF and DoD OUSD (R&E) in response to the call to advance the neural and cognitive foundations of AI.

This Institute draws together top researchers across the country to focus on connecting the major progress made in AI systems to the revolution in our understanding of the brain. ARNI will meet the urgent need for new paradigms of interdisciplinary research between neuroscience, cognitive science, and AI. This will accelerate progress in all three fields and broaden the transformative impact on society in the next decade. ARNI is directed by Principal Investigator Richard Zemel (Columbia University) together with co-principal investigators Kathleen R McKeown, Liam Paninski, and Christos Papadimitriou (Columbia) and Xaq Pitkow (Baylor College of Medicine).

**AI-SDM**—The AI-Institute for Societal Decision Making (AI-SDM) was funded by NSF in response to the need to overcome the limitations of commonplace simplistic and non-mathematical models to make breakthroughs at the intersection of AI and decision making, developing novel methodologies in support of real-world use cases AI-SDM seeks to create human-centric AI for decision making to bolster effective response in uncertain, dynamic, and resource-constrained scenarios like disaster management and public health. By bringing together an interdisciplinary team of AI and social science researchers, AI-SDM will enable emergency managers, public health officials, first responders, community workers, and the public to make decisions that are data-driven, robust, agile, resource-efficient, and trustworthy. The vision of AI-SDM will be realized via the development of AI theory and methods, translational research, training, and outreach, enabled by partnerships with diverse universities, government organizations, corporate partners, community colleges, public libraries, and high schools. The institute is directed by Principal Investigator Aarti Singh (Carnegie-Mellon University) together with co-principal investigators Cleotilde Gonzalez and Jeff Schneider (CMU), Terri Adams-Fuller

(Howard University), and Sham Kakade (Harvard University).

**INVITE**—The AI institute for Inclusive Intelligent Technologies for Education (INVITE) is funded by a partnership between NSF and the Department of Education Institute of Education Sciences (IES) to fundamentally reframe how educational technologies interact with learners by developing AI tools and approaches to support three crucial noncognitive skills known to underlie effective learning: persistence, academic resilience, and collaboration. The institute's use-inspired research will focus on how children communicate STEM content, how they learn to persist through challenging work, and how teachers support and promote noncognitive skill development. The resultant AI-based tools will be integrated into classrooms to empower teachers to support learners in more developmentally appropriate ways. INVITE is directed by Principal Investigator H. Chad Lane (University of Illinois Urbana-Champaign) together with co-principal investigators Kristy Boyer (University of Florida), Jamie Payton (Temple University), Diego Zapata (Educational Testing Service), and ChengXiang Zhai (UIUC).

**AI4ExceptionalEd**—The AI Institute for Exceptional Education (AI4ExceptionalEd) is funded by a partnership between NSF and the Department of Education IES to work toward universal speech and language screening for children. The institute's framework, the AI screener, will analyze video and audio streams of children during classroom interactions and assess the need for evidence-based interventions tailored to the individual needs of students. The institute will serve children in need of ability-based speech and language services, advance foundational AI technologies and enhance understanding of childhood speech and language development. AI4ExceptionalEd is directed by Principal Investigator Venugopal Govindaraju (University at Buffalo) together with co-principal investigators David Feil-Seifer (University of Nevada, Reno), Pamela Hadley (University of Illinois Urbana-Champaign), Julie Kientz (University of Washington), and Jinjun Xiong (University at Buffalo).

**AIVO, the network of networks**—By design, every AI institute is itself a significant network of collaborators and partners, forming what NSF calls a national nexus point in their areas of research and impact. As the program continues to grow, a unifying vision for the program is to further connect these institutes into a broad “network of networks.” The AI Institutes Virtual Organization (AIVO) was formed from within the AI Institutes Community with funding from the NSF to bring this vision into reality. Launched in Summer of 2022, AIVO has established itself

as a communications and collaboration hub among AI institutes and with the broader public. AIVO worked with the community to host the first program-wide summit of AI Institutes Leadership in December 2022, and plan the next such convening for October 2023. To connect program-wide activities into a whole that is greater than the sum of all institutes, AIVO has created coordination hubs for connecting AI research community to cyberinfrastructure resources and to support the formation of new collaborations between minority-serving institutions and the AI institutes through their ExpandAI Navigator page. The enabling of collaborations is a significant focus for AIVO, which has led to the establishment of new NSF/AIVO-funded special interest groups and related workshops, a new International Engagement Support program to fund the coordination of fledgling international partnerships, and a new public outreach event to be collocated with the next SAIL meeting. AIVO's active engagement over social media such as the AIVO LinkedIn group supports public outreach to diverse communities and stakeholders through their LinkedIn group. The AIVO Twitter feed amplifies institute and related communication, further promoting engagement and awareness. We encourage the reader to follow and participate in these groups as we seek to grow the institutes community further.

AIVO is directed by Principal Investigator Stephen Brown (University of California, Davis; Associate Director of the AI Institute for Next Generation Food Systems [AIFS]) together with co-principal investigator Jeffrey Krolik (Duke University; Managing Director of the AI Institute for Edge Computing Leveraging Next-generation Networks [Athena]).

**Looking ahead**—We congratulate the new AI institutes on their new awards, and we commend the AIVO for developing a broad, interconnected community. We eagerly anticipate sharing the successes of the previously founded Institutes in our upcoming special issue. The continued growth of the AI institutes and their interconnectedness as an ecosystem of innovation, infrastructure, technology, education, and partnerships will both enlarge and bring together a robust AI research community.

## CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict.

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