

Expanding the Frontiers of AI

U.S. National Science Foundation



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NSF has invested in AI research since the early 1960s, setting the stage for today's widespread use of AI technologies. These critical investments led to the development of basic systems that underlie all AI technology, such as:



Credit: Alice Kitterman/U.S. National Science Foundation

Reinforcement learning

A machine-learning approach used widely for applications like training self-driving cars.

Large language models

Which power generative AI systems like ChatGPT.

AI-driven learning

Including virtual teachers (both digital and robotic) that incorporate speech, gesture, gaze and facial expression.

Neural networks

Which underlie breakthroughs in pattern recognition, image processing and natural language processing.

Collaborative filtering

A technique that fuels content recommendation on the world's largest marketplaces and content platforms, from Netflix to Amazon.

NSF AI Investments at a Glance:

- ▶ Largest non-defense federal funder of AI research
- ▶ Approximately \$700M in AI investments annually
- ▶ 25 National AI Institutes
- ▶ NSF AI investments in every U.S. state and territory
- ▶ 66% of current SBIR/STTR awards, totaling approximately \$80M, support AI and machine learning applications
- ▶ 15 Regional Innovation Engines development awards in AI

As the primary non-defense federal funder of artificial intelligence research, the [U.S. National Science Foundation](https://www.nsf.gov) is driving cutting-edge research that expands our understanding of AI concepts and techniques, accelerates trustworthy AI innovation, democratizes AI research resources and prepares the next-generation AI workforce.

AI-driven technologies — such as ChatGPT, image generators and digital assistants like Alexa and Siri — are already transforming Americans' daily lives. AI also holds the promise of driving practical solutions to global challenges, from food production to climate change to healthcare. At the same time, the adoption of AI brings potential risks, like amplifying bias, displacing workers or misuse by malicious actors. Building on over six decades of support for the field, NSF continues to advance AI technology — not only to find opportunities for innovation, but also to avoid potential harm.

At a moment of intense global competition, we must continue to advance AI, translating basic research into leading technologies so that American principles and the U.S. workforce are at the forefront of AI innovation. If investment wanes or training stagnates, then the U.S. will forever be playing catch up with other nations.

Driving AI Innovation

With investments of approximately \$700 million each year, NSF supports multidisciplinary research in AI, including machine learning and deep learning, natural language technologies, human-AI interfaces, robotics and advanced cyberinfrastructure for AI. In addition, NSF supports fairness, ethics, accountability, transparency, reliability, safety and security across all areas of AI, working to advance our ability to protect privacy, civil rights and civil liberties.

The agency also champions translational research that links AI innovation with science and the economy, including agriculture, manufacturing, biotechnology and health. For example, NSF-funded projects are using the power of AI to [design new catalysts](#) that turn raw materials into products and [improve water hazard responses and planning](#). In the health sector, researchers are developing AI tools to [improve fertility potential](#), [monitor patients with lung disease](#) and [alert medical staff to patients at risk for sepsis](#), to name a few.



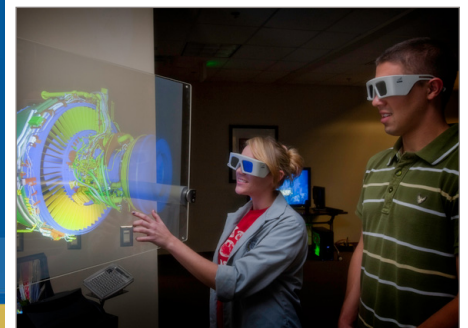
NSF-funded Neuralert produced a pair of smart wristbands using a proprietary algorithm to track arm asymmetry or weakness, which are common symptoms of stroke, in as little as 15 minutes — alerting medical staff at the same time. The device was recognized as one of [TIME magazine's "Best Inventions of 2022"](#).

Neuralert wristband. Credit: Neuralert.

NSF funds a range of [Secure and Trustworthy Cyberspace](#) grants that enhance U.S. cybersecurity capabilities through the use of AI, from combatting [phishing](#), [social engineering](#) and [malware](#) to protecting [privacy](#) and [smart devices](#).

NSF-led National AI Research Institutes

The NSF-led [National AI Research Institutes](#), or AI Institutes, program is the agency's flagship effort focused on use-inspired AI research and is the nation's largest AI research ecosystem, funded through partnerships with other federal agencies and industry leaders. Launched in 2020, the AI Institutes represent a \$500 million investment connecting over 500 funded and collaborative institutions across the U.S. and around the world.



National AI Research Institutes. Credit: NSF.

A person controls a robot to feed himself. Credit: Cleveland State University Center for Human-Machine Systems.

Observing a 3D projection of an aircraft engine. Credit: Photo from ATE Centers Impact 2011 (www.atecenters.org).

Below are some examples of how NSF investments are transforming AI in benefit to the nation:

- ▶ The [NSF AI Institute for Foundations of Machine Learning](#), or IFML, focuses on foundations of machine learning to impact the design of practical AI Systems and investigates threats at the cutting-edge of the technology. Through the institute, The University of Texas at Austin created an online master's program in AI.
- ▶ The [NSF AI Institute for Research on Trustworthy AI in Weather, Climate and Coastal Oceanography](#), or AI2ES, is developing models that improve the accuracy, reliability and clarity of AI techniques that drive weather predictions.
- ▶ The [NSF AI Institute for Agent-based Cyber Threat Intelligence and Operation](#), or ACTION, will accelerate U.S. cyberdefense by changing the way mission-critical systems are protected against sophisticated, ever-changing security threats.
- ▶ The [NSF AI Institute for Trustworthy AI in Law & Society](#), or TRAILS, advances AI development alongside ethics and human rights.
- ▶ The [NSF AI Institute for Adult Learning and Online Education](#), or ALOE, is developing transformative AI-driven resources that target continuing education and radically improve online learning capabilities.

Fostering an AI-Ready Workforce

NSF invests in strategic educational and experiential programs to expand the AI workforce and employment opportunities in every sector and career stage.

NSF's [Discovery Research PreK-12](#) program enhances preK-12 teachers' and students' STEM learning that is necessary for U.S. students to excel in AI fields while the [Innovative Technology Experiences for Students and Teachers](#) program increases preK-12 students' interest in careers in STEM through technology-based learning experiences including hands-on AI experiences.

The [Computer Science for All](#) program provides U.S. students with the opportunity to engage in computer science, computational thinking, data science and AI education at the preK-12 levels.

[Advanced Technical Education](#) supports the education of the AI skilled technical worker at 2-year Institutions of Higher Education in response to industry needs and [Computing in Undergraduate Education](#) develops innovative approaches for engaging students interested in computer science at the undergraduate level and broadening participation in the field.

The [Computer and Information Science and Engineering Graduate Fellowships](#) program aims to increase the number and diversity of U.S. graduate students pursuing research and careers in high-demand fields such as AI.

NSF's [Experiential Learning for Emerging and Novel Technologies](#) program supports opportunities that provide diverse cohorts with the skills needed to succeed in AI and other emerging technology fields.

The [Expanding AI Innovation through Capacity Building and Partnerships](#) program will build AI research capacity at minority-serving institutions and create partnerships between those institutions and NSF AI Institutes.

NSF's [Research on Emerging Technologies for Teaching and Learning](#) program is inspiring new ways to approach teaching and learning to accelerate education in AI and other globally competitive industries.

NSF also partners with industry leaders like [Micron](#) and [Intel](#) to train and build a diverse semiconductor manufacturing workforce.

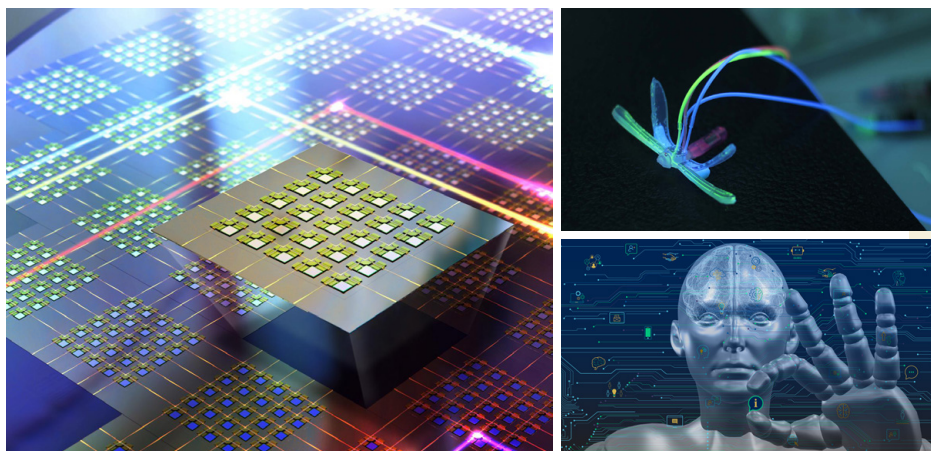


REU student working with mentor and supervisor in the lab.
Credit: Arka Majumdar, University of Washington.

AI and the Future of Work

AI is shifting the future of work, presenting new challenges alongside new capabilities. NSF is focused on developing solutions to enhance current job positions and create new job opportunities, while also mitigating the impact of automation on the existing workforce.

NSF supports a wide range of projects, including [giving firefighters new ways to communicate and make decisions during crises](#), [safely pairing people with robots on construction sites](#) and [providing new approaches to improve trauma care](#).



Researchers from Carnegie Mellon University are teaming up with UNITE HERE, the largest hospitality union in the U.S., to [investigate](#) ways that automation in the hospitality industry can enhance and preserve jobs and mitigate displacement and inequality.

Largest, fastest array of microscopic 'traffic cops' for optical communications. Credit: Younghee Lee graphic.
Soft robotic dragonfly called 'Drabot'. Credit: Vardhman Kumar, Duke University.
How AI translates external stimuli into action. Credit: Alice Kitterman/U.S. National Science Foundation.

Democratizing AI Research Resources

NSF enables access to resources — like computational infrastructure, data, software, testbeds and training — that engage the full breadth of the nation's talent in AI innovation. We partner with other federal agencies, industry and nonprofits to leverage expertise, identify use cases, and improve access to data, tools and other resources.

- ▶ The NSF [Frontera supercomputer](#) at the Texas Advanced Computing Center is the fastest supercomputer at any university campus in the U.S. and the 21st-most powerful system in the world. Frontera is specifically equipped to accelerate AI and machine learning research.
- ▶ [CloudBank](#) enhances the research and education community's access to commercial cloud computing resources. This initiative builds on previous collaborations with Amazon Web Services, Google Cloud Platform, IBM Cloud and Microsoft Azure.



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