ARTIFICIAL INTELLIGENCE (AI)

Artificial Intelligence Funding[1]
(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request
BIO	$20.00	-	$20.00
CISE	344.00	-	369.80
EDU[2]	29.04	-	50.00
ENG	85.86	-	95.80
GEO	1.00	-	5.00
MPS	110.63	-	71.67
SBE	15.06	-	19.59
TIP[3]	86.79	-	101.55
OISE	0.33	-	-
IA	9.07	-	1.00
Total	**$701.78**	**-**	**$734.41**

[1] Funding displayed may have overlap with other topics and programs.

[2] Formerly known as Directorate for Education and Human Resources (EHR).

[3] FY 2021 funding for TIP is shown for comparability across fiscal years.

Overview

AI is advancing rapidly and holds the potential to vastly transform our lives. NSF has a long and rich history of supporting AI research, setting the stage for today's widespread use of AI technologies in a range of sectors, from commerce to healthcare to transportation. NSF-funded research is now laying the seeds for advances in AI that will transform not just these areas, but essentially every area of human endeavor, including science, education, energy, manufacturing, and agriculture. NSF's AI portfolio spans AI algorithms, robotics, human-AI interaction, and advanced hardware and systems for AI, as well as use-inspired research in neuroscience, biology, chemistry, physics, intelligent transportation, and many other disciplines across the full breadth of science and engineering in which NSF invests.

NSF supports fundamental research, education and workforce development, and access to data and advanced computing research infrastructure that collectively enhance AI. NSF's ability to bring together numerous fields of scientific inquiry uniquely positions the agency to lead the Nation in expanding the frontiers of AI. In FY 2023, NSF will continue support for foundational research in AI, including machine learning (ML) and deep learning, natural language technologies, knowledge representation and reasoning, robotics, and computer vision, along with the fairness, ethics, accountability, transparency, explainability, safety, security, and robustness across all areas of AI. In addition to foundational research in these areas, NSF also supports translational research that links AI innovation with science and the economy, including agriculture, manufacturing, biotechnology, and health. Equally important is NSF's investment in education and learning, which grows the human capital and institutional capacity needed to nurture the next generation of AI researchers and practitioners. Finally, advances in AI rely upon access to data as well as NSF-funded advanced computing research infrastructure.

Through collaboration and coordination with the Office of Science and Technology Policy (OSTP), NSF

leadership is helping to drive and coordinate AI R&D efforts across the Federal Government. For example, the NSF Director co-chairs the National Science and Technology Council's Select Committee on AI, which advises the White House on interagency AI R&D priorities and establishes structures to improve government planning and coordination. In addition, NSF co-chairs the NSTC Machine Learning and AI (MLAI), NSTC Networking and Information Technology R&D (NITRD), and NSTC Future Advanced Computing Ecosystem (FACE) Subcommittees, all of which serve to coordinate federal R&D investments in AI as well as other related information technology areas, including the underlying advanced computing ecosystem that is critical for advancing AI. NSF also co-chairs the National AI Research Resource Task Force (NAIRRTF), which is a Congressionally chartered Federal Advisory Committee charged with developing a roadmap and implementation plan for a shared computing and data infrastructure that would provide the Nation's AI researchers and students with access to a holistic ecosystem of resources to fuel AI discovery and innovation. A key goal of the NAIRRTF is to democratize access to these advanced resources, thereby engaging a broad and diverse population in cutting-edge AI research and innovation.

Goals

1. *Fundamental AI Research:* Sustain long-term investments in fundamental AI research that will give rise to transformational technologies and, in turn, breakthroughs across all areas of science and engineering and across all sectors of society.
2. *Education and Workforce Development:* Develop AI systems that enhance learning for all and grow the next generation of talent to advance the U.S. AI R&D workforce, including those working on AI systems and those working alongside them.
3. *Access to Data and Advanced Computing Research Infrastructure:* Provide access to advanced, scalable computing resources as well as deep, high-quality, and accurate training datasets in order to advance AI research and education.

FY 2023 Investments

Fundamental AI Research
- In FY 2023, NSF will continue support for the National AI Research Institutes program that was initiated in FY 2019 to create national hubs for universities, federal and local agencies, industry, and nonprofits to advance AI research and workforce development in key areas addressing grand challenges. In FY 2020 and FY 2021, NSF funded 14 institutes in themes that included foundations of ML; trustworthy AI; AI-augmented learning; AI for accelerating molecular synthesis and manufacturing; human-AI interaction and collaboration; AI and advanced cyberinfrastructure and AI for discovery in physics. Each AI Institute is expected to receive up to $20.0 million over five years. NSF also partnered with the U.S. Department of Agriculture National Institute of Food and Agriculture (USDA NIFA) to establish two additional institutes in each of FY 2020 and FY 2021, advancing AI-driven innovation in agriculture and food systems; these four AI Institutes are being fully supported by USDA NIFA. NSF issued the latest solicitation in Fall 2021 and expects to make seven awards in FY 2023. This solicitation continues the ongoing collaboration with USDA NIFA as well as new partnerships with the Department of Defense Office of the Undersecretary of Defense for Research and Engineering, National Institute of Standards and Technology, Department of Education Institute for Education Sciences, and IBM Corporation.
- In FY 2023, the HDR Big Idea will continue support for Institutes for Data-Intensive Research in Science and Engineering (I-DIRSE) that will foster innovation by harnessing diverse data sources

and developing and applying new methodologies, technologies, and infrastructure for data management and analysis, notably advances in machine learning.

- Through the FW-HTF Big Idea, in FY 2023, NSF will continue to support socio-technical research enabling a future where intelligent technologies collaborate synergistically with humans to achieve broad participation in the workforce and provide economic and educational benefits across a range of work settings—including manufacturing floors, hospitals, offices, construction settings, and schools.
- In FY 2020, NSF, in collaboration with the Simons Foundation, funded two five-year collaborative projects on the Mathematical and Scientific Foundations of Deep Learning. Interdisciplinary teams of computer scientists, engineers, mathematicians, and statisticians will advance theoretical and foundational investigations into deep learning, with a view to laying the groundwork for a rigorous science of deep learning. In FY 2023, NSF will continue support for these centers. In addition, beginning in FY 2021 and continuing for three years, NSF is supporting more than a dozen smaller-scale projects seeking to advance the mathematical and scientific foundations of deep learning.
- In FY 2023, through the Foundational Research in Robotics (Robotics) program, CISE and ENG will continue to support robotics research that combines advances in engineering with innovations in computer science. The Robotics program invests in robotics and autonomous systems that exhibit significant levels of computational capability and physical complexity, including research related to the design, application, and use of robotics to augment human function, promote human-robot interaction, and increase robot autonomy.

Education and Workforce Development

- As noted above, in FY 2020, NSF established a five-year National AI Research Institute for AI-augmented learning to radically improve human learning and education writ large in formal (e.g., preK-12, undergraduate, graduate, vocational education) and informal settings. In FY 2021, NSF established two additional five-year National AI Research Institutes in AI and Education. The primary focus of these institutes is to support AI-driven innovation to improve human learning and education. One AI Institute will pursue research to support highly adaptable, personalized, and distributed AI systems to expand STEM learning across diverse learners and settings in the context of preK-12 education. The other Institute will advance AI-driven research and innovations for learners with or at risk for disabilities. Both AI Institutes will address achievement and opportunity gaps, particularly for learners from disadvantaged or underserved communities and pursue outcomes with direct educational impact.
- NSF will address a critical shortage of cybersecurity educators and researchers in priority areas including the cybersecurity aspects of AI as well as AI for cybersecurity, through the Education track in the SaTC program as well as the CyberCorps®: Scholarship for Service (SFS) program.
- In FY 2023, GRFP will continue to encourage applications from students who place a premium on AI-related research. The NSF GRFP recognizes and supports outstanding graduate students in NSF-supported STEM disciplines who are pursuing research-based master's and doctoral degrees at accredited U.S. institutions.
- The NRT program advances graduate education by combining interdisciplinary training with innovative professional development activities to educate the next generation of scientists and engineers capable of solving convergent research problems in areas of national need. In FY 2023, NRT will continue to include a special focus on traineeships in AI and other emerging industries that align with the Administration's priorities.
- In FY 2023, NSF's Computer Science for All (CSforAll) and Innovative Technology Experiences for

Students and Teachers (ITEST) programs will continue to support projects that investigate promising educational approaches at the K-12 level to motivate and prepare a diverse cadre of learners for computationally intensive new industries, including those that that rely on AI.[1]
- In FY 2023, NSF will continue to support the Data Science Corps. This program enables education and workforce development by focusing on building capacity at the local, state, and national levels to unleash the power of data in service to society. In particular, Data Science Corps provides practical experiences, teaches new skills, and offers learning opportunities in a range of settings.

Access to Data and Advanced Computing Research Infrastructure
- NSF supports a range of advanced computing systems and services for the full range of computational- and data-intensive research across all areas of science and engineering, including AI. For example, Frontera, the largest and most powerful supercomputer NSF has ever supported, will enable access to advanced computing resources for AI research.
- In FY 2019, NSF put in place a five-year cooperative agreement for $5.0 million with the University of California-San Diego, University of California-Berkeley, and University of Washington for the establishment and operation of CloudBank, an entity that helps the academic community access and use public clouds for research and education by delivering a set of managed services designed to simplify access to public clouds. CloudBank is specifically enabling new research in AI by broadening the access and impact of cloud computing across many fields of research and education.
- In FY 2020, the NSF Convergence Accelerator (CA) emphasized AI through themes relating to HDR and FW-HTF; this focus is continuing in FY 2023. In FY 2021, the NSF CA added another AI-related theme on AI-Driven Innovation via Data and Model Sharing, ultimately selecting 18 projects for Phase I funding. In FY 2023, the NSF CA will emphasize AI through themes on the development of innovative assistive or rehabilitative technologies to help improve equity, inclusion, and accessibility for persons with disabilities; informatics for sustainable materials; and modeling and prediction to address food and nutrition security.
- For FY 2023, NSF will continue to collaborate with other federal agencies to enable researcher access to deep, high-quality, and accurate federal training datasets for AI systems. For example, NSF is building upon a FY 2021 workshop that explored how researchers might collaborate with federal data stewards to bring the latest security- and privacy-enhancing techniques to bear on unlocking access to federal data sets, while adhering to applicable federal statutes, rules, and regulations.

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[1] www.nsf.gov/pubs/2020/nsf20101/nsf20101.jsp