U.S. NATIONAL SCIENCE FOUNDATION
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ALEXANDRIA, VIRGINIA 22314

NSF 24-039

Dear Colleague Letter: Funding Opportunities for Engineering Research in Artificial Intelligence

December 22, 2023

Dear Colleague:

With this Dear Colleague Letter, the U.S. National Science Foundation (NSF) Directorate for Engineering (ENG) encourages the submission of research and education proposals related to **Artificial Intelligence as an Emerging Industry**.

Artificial intelligence (AI) is advancing rapidly and is increasingly demonstrating its potential to significantly transform our lives. NSF and the Engineering Directorate have 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's AI portfolio spans AI theory, algorithms, robotics, human-AI interaction, and advanced cyberinfrastructure for AI, as well as use-inspired research in neuroscience, design and performance of engineered civil infrastructure systems, electric power grid, intelligent integrated manufacturing systems, intelligent transportation, robotics, and many other areas.

NSF and the Engineering Directorate invest in AI-related research and education activities that align with the needs of the nation and support the National Artificial Intelligence Initiative, the CHIPS and Science Act of 2022, White House strategies (including the Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence), and other policy directives. As a major federal funder of AI research, NSF advances AI breakthroughs that push the frontiers of knowledge, benefit people, and meet societal needs.

ENGINEERING DIRECTORATE INTERESTS

The Directorate for Engineering encourages the submission of all types of research and education proposals related to AI, including proposals in the following areas:

Fundamental engineering AI research: Use of tools and methods from traditional engineering subjects (such as dynamic modeling, control systems, material behavior,

optimization, information theory, communication systems and signal processing) combined with those from theoretical computer science, mathematics, and statistics, resulting in deeper understanding of algorithm performance, complexity, safety, security, explainability, and stability.

Applications of AI to engineered systems: Integration of physics-based models with data-based models of complicated dynamic environments and systems (such as the electric power grid, chemical processing plants, connected manufacturing systems, supply chains, robotics, connected transportation systems, civil infrastructure under service and extreme hazard events) to enable real-time learning and decision-making.

Smart sensing and analytics: Use of data from distributed sources via sensors, sensor networks, and communications for learning and decision-making; novel edge computing capabilities via novel hardware and software for real-time decision-making; considerations include security, privacy, communication costs, handling heterogeneous data, heterogeneous systems, and the network communication architecture, as well as learning algorithms and architectures.

Implementation of AI technologies in electronic, magnetic and optical hardware: Electronic circuit implementation of bio-inspired and neural architectures; faster, more energy efficient processors (electronic, magnetic and optical) for processing data; and hardware and software co-design for processing and learning from data.

Data types - speech, image, and video data: AI-enabled advances in signal processing and communications technology for the processing, recognition and transmission of speech, image, and video data.

Autonomous systems and robots: Integration of control systems, mechanical systems, or other engineering disciplines with AI and machine learning. Applications include autonomous transportation; robots for manufacturing, healthcare, or other applications; and safe and trustworthy human-robot interactions.

Training data for engineering AI: Research to increase understanding of the amount and quality of training data needed to reliably deploy AI tools in engineered systems, where safe operation is a primary concern.

Behavior of engineered and biological materials: AI and machine learning to enable and enhance understanding of the behavior of engineered materials, biological materials, and biomaterials, involving large or sparse data sets from multiple scales and modalities (experimental, computational, and imaging.)

Modeling of transport phenomena: AI-enabled modeling of fluids, particulates, thermal, combustion, and wildfire management with the potential for increased understanding, and

development of new physical models and solvers with greater accuracy.

Human-AI collaboration: Incorporation of principles of cognition, behavior, and/or physiology into machine learning models to improve the ways AI-enabled agents and humans interact and produce knowledge or expectations about each other (for example, through intent detection, trust-building, or social engagement).

Assistive and rehabilitation technologies: AI-enabled technologies for the support, restoration, rehabilitation, and/or substitution of human functional ability or cognition, such as rehabilitation robotics, smart protheses and orthoses, brain-computer interfaces, and other technologies that leverage advanced AI and machine learning.

Computational and AI models of physiological systems: Advanced computational strategies that leverage AI and machine learning to develop validated models of physiological systems; computational representations of biomanufacturing processes for precision monitoring and control.

Bioimaging technologies leveraging AI: Transformative advances that improve biological imaging and monitoring performance across scales through leveraging advances in optics, electronics, magnetics, chemistry, AI, and quantum technologies.

Scaling of AI applications in manufacturing: AI methods, implementation software, and data collection and protocols suited to manufacturing operations in order to source data from networks of manufacturers, build algorithms, and update algorithms as additional data becomes available; research to enable and deploy data sourcing, aggregation, classification, and service delivery infrastructure for manufacturing solutions at the network scale.

AI for resilience and sustainability of civil infrastructure and infrastructure systems. Materials, structural, and system data collection; AI algorithms for structural health monitoring and real-time damage detection; AI approaches for the design of optimal sustainable and resilient infrastructure materials; AI and automation for structural repair and retrofitting.

PROGRAMS AND CONTACTS

The Engineering Directorate encourages the submission of AI-related proposals to the ENG core and cross-NSF programs listed below, and to other relevant programs. To determine which program best fits a project idea, Principal Investigators are encouraged to read the program descriptions and reach out to program contacts with questions.

- **Advanced Manufacturing**: AdvancedManufacturing@nsf.gov
- **Biomechanics and Mechanobiology**: bmmb@nsf.gov
- **Biophotonics**: Adam Wax, awax@nsf.gov
- **Civil Infrastructure Systems**: Siqian Shen, siqshen@nsf.gov

Communications, Circuits, and Sensing-Systems: Jenshan Lin, jenlin@nsf.gov
- **Disability and Rehabilitation Engineering**: Steven Zehnder, szehnder@nsf.gov
- **Dynamics, Control, and Systems Diagnostics**: Yue Wang, yuewang@nsf.gov
- **Energy, Power, Control and Networks**: Tony Kuh, akuh@nsf.gov
- **Engineering Design and Systems Engineering**: Kathryn Jablokow, kjabloko@nsf.gov
- **Engineering for Civil Infrastructure**: Joy Pauschke, jpauschk@nsf.gov
- **Engineering of Biomedical Systems**: Stephanie George, stgeorge@nsf.gov
- **Fluid Dynamics**: Ronald D. Joslin, rjoslin@nsf.gov
- **Foundational Research in Robotics**: Jordan Berg, jberg@nsf.gov
- **Human Disasters and the Built Environment**: Daan Liang, dliang@nsf.gov
- **Manufacturing Systems Integration**: Janis P. Terpenny, jterpenn@nsf.gov
- **Mechanics of Materials and Structures**: moms@nsf.gov
- **Mind, Machine and Motor Nexus**: Alexander Leonessa, aleoness@nsf.gov; Alexandra Medina-Borja, amedinab@nsf.gov
- **Operations Engineering**: Georgia-Ann Klutke, gaklutke@nsf.gov; Reha Uzsoy, ruzsoy@nsf.gov
- **Particulate and Multiphase Processes**: Shahab Shojaei-Zadeh, sshojaei@nsf.gov
- **Thermal Transport Processes**: Sumanta Acharya, sacharya@nsf.gov

The Engineering Directorate also encourages proposals for research centers, which tackle grand challenges and spur industrial innovation, and for workforce development, which provides experiential learning opportunities and opens new career paths.

- **Engineering Research Centers (ERC)**: nsferc@nsf.gov
- **Industry–University Cooperative Research Centers (IUCRC)**: Prakash Balan, pbalan@nsf.gov
- **Non-Academic Research Internships for Graduate Students (INTERN)**: Prakash Balan, pbalan@nsf.gov
- **Research Experiences for Teachers (RET)**: Amelia Greer, agreer@nsf.gov
- **Research Experiences for Undergraduates (REU)**: reu.eng@nsf.gov (REU for ERCs: reu.eng.erc@nsf.gov)

SUBMISSION GUIDANCE

Proposals submitted in response to this DCL should focus on scientific research and education relevant to the topical area of AI. Proposal titles should begin with "**ENG-AI:**" followed by any other relevant prefixes and the project name.

For consideration during fiscal year 2024, proposals to programs without deadlines should be submitted by April 30, 2024; proposals submitted later will be considered for fiscal year 2025.

NSF welcomes proposals that broaden geographic and demographic participation to engage

the full spectrum of diverse talent in STEM. Proposals from minority-serving institutions, emerging research institutions, primarily undergraduate institutions, two-year colleges, and institutions in EPSCoR-eligible jurisdictions, along with collaborations between these institutions and those in non-EPSCoR jurisdictions, are encouraged.

This DCL does not constitute a new competition or program. Proposals submitted in response to this DCL should be prepared and submitted in accordance with guidelines in the NSF Proposal & Award Policies & Procedures Guide (PAPPG) and instructions found in relevant program descriptions.

Sincerely,

Susan Margulies
Assistant Director, Engineering