

NSF 23-610: National Artificial Intelligence (AI) Research Institutes

Accelerating Research, Transforming Society, and Growing the American Workforce

Program Solicitation

Document Information

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National Science Foundation



Department of Defense



Office of the Under Secretary of Defense for Research and Engineering



National Institute of Standards and Technology



Capital One Financial Corp.



Intel



Simons Foundation

Preliminary Proposal Due Date(s) (required) (due by 5 p.m. submitter's local time):

October 31, 2023

Themes listed under Group 1 (awards anticipated FY 2024)

January 12, 2024

Themes listed under Group 2 (awards anticipated FY 2025)

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

February 16, 2024

Themes listed under Group 1 (awards anticipated FY 2024)

May 17, 2024

Themes listed under Group 2 (awards anticipated FY 2025)



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Revision Summary

- This solicitation includes funding opportunities pertaining to two funding years. For the institute themes listed in Group 1 (which includes only the theme, *AI for Astronomical Sciences*), NSF anticipates awards to start in FY 2024; and for themes listed in Group 2 (the themes *AI for Discovery in Materials Research* and *Strengthening AI*), NSF anticipates awards to start in FY 2025. Each group has a specific set of due dates and review timeline pertaining only to that group. More detail is found under Due Dates and in the timeline provided in the Program Description.
- New themes for Institute proposals (see Program Description).

- A revised description of "use inspired research" in the Project Description (I.B) improves our emphasis on the intent for research convergence, such that use-inspired research is an expected modality of an Institute's foundational AI goals.
- Agency and Industry partners on this solicitation have changed.

Any proposal submitted in response to this solicitation should be submitted in accordance with the [NSF Proposal & Award Policies & Procedures Guide \(PAPPG\)](#) that is in effect for the relevant due date to which the proposal is being submitted. The NSF PAPPG is regularly revised and it is the responsibility of the proposer to ensure that the proposal meets the requirements specified in this solicitation and the applicable version of the PAPPG. Submitting a proposal prior to a specified deadline does not negate this requirement.

Summary Of Program Requirements

General Information

Program Title:

National Artificial Intelligence (AI) Research Institutes

Synopsis of Program:

Artificial Intelligence (AI) has advanced tremendously and today promises personalized healthcare; enhanced national security; improved transportation; and more effective education, to name just a few benefits. Increased computing power, the availability of large datasets and streaming data, and algorithmic advances in machine learning (ML) have made it possible for AI research and development to create new sectors of the economy and revitalize industries. Continued advancement, enabled by sustained federal investment and channeled toward issues of national importance, holds the potential for further economic impact and quality-of-life improvements.

The 2023 update to the [National Artificial Intelligence Research and Development Strategic Plan](#), informed by visioning activities in the scientific community as well as interaction with the public, identifies as its first strategic objective the need to make long-term investments in AI research in areas with the potential for long-term payoffs in AI. AI Institutes represent a cornerstone Federal Government commitment to fostering long-term, fundamental research in AI while also delivering significantly on each of the other eight objectives in that strategy. The [National Security Commission on Artificial Intelligence \(NSCAI\)](#) identifies AI Institutes as a key component of a bold, sustained federal push to scale and coordinate federal AI R&D funding and to reinforce the foundation of technical leadership in AI.

This program is a multisector effort led by the National Science Foundation (NSF), in partnership with the Simons Foundation (SF), the National Institute of Standards and Technology (NIST), Department of Defense (DOD) Office of the Under Secretary of Defense for Research and Engineering (OUSD (R&E)), Capital One Financial Corporation (Capital One), and Intel Corporation (Intel).

This program solicitation expands the nationwide network of AI Research Institutes with new funding opportunities over the next two years. In this round, the program invites proposals for institutes that have a principal focus in one of the following themes aimed at transformational advances in a range of economic sectors, and science and engineering fields:

- Group 1 - Awards anticipated in FY 2024:
 - Theme 1: AI for Astronomical Sciences
- Group 2 - Awards anticipated in FY 2025:
 - Theme 2: AI for Discovery in Materials Research
 - Theme 3: Strengthening AI

For the institute themes listed in Group 1, NSF anticipates awards to start in FY 2024; and for themes listed in Group 2, NSF anticipates awards to start in FY 2025. Each group has a specific set of due dates and review timeline pertaining only to that group. More detail is found under Due Dates and in the timeline provided in the Program Description.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- AI Research Institutes Program Team, telephone: 703-292-5111, email: AllInstitutesProgram@nsf.gov

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.050 --- Geosciences
- 47.070 --- Computer and Information Science and Engineering
- 47.074 --- Biological Sciences
- 47.075 --- Social Behavioral and Economic Sciences
- 47.076 --- STEM Education
- 47.079 --- Office of International Science and Engineering
- 47.083 --- Office of Integrative Activities (OIA)
- 47.084 --- NSF Technology, Innovation and Partnerships

Award Information

Anticipated Type of Award: Cooperative Agreement

Estimated Number of Awards: 5

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

In Theme 1, NSF and the Simons Foundation expect to co-fund up to two National AI Research Institutes. The Simons Foundation intends to provide up to \$20 million and NSF intends to provide up to \$20 million to support up to two new awards in FY 2024 - FY 2028, subject to the availability of funds. The average total size and duration of a grant will be \$4M per year for 5 years, evenly split between NSF and SF.

NSF and partners plan to make one award in theme 2 and two or more awards in Theme 3, subject to the availability of funds.

Anticipated Funding Amount: \$100,000,000

Institute awards will be made for between \$16,000,000 and \$20,000,000 for four to five years (\$4,000,000 per year on average). Proposals outside this range may be returned without review. Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research laboratories, professional societies and similar organizations located in the U.S. that are directly associated with educational or research activities.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization: 2

An organization may submit no more than two preliminary proposals to this solicitation as lead institution. This limit is solicitation-wide and applies across the groups and themes. An organization may submit up to two full proposals that correspond to preliminary proposals reviewed under this solicitation. In the event that an organization exceeds these limits, preliminary proposals will be accepted based on earliest date and time of preliminary proposal submission, i.e., the first two preliminary proposals will be accepted, and the remainder will be returned without review. A full proposal that does not correspond to a preliminary proposal reviewed in this program will be returned without review.

Limit on Number of Proposals for Senior Personnel: 1

An individual may be designated as senior personnel (which includes but is not limited to PI or co-PI) on at most one preliminary proposal, and at most one full proposal to this solicitation. This limit is solicitation-wide and applies across the groups and themes. In the event that an individual exceeds this limit, proposals will be accepted based on earliest date and time of submission, i.e., the first compliant preliminary or full proposal will be accepted, and the remainder will be returned without review.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions



- **Letters of Intent:** Not required
- **Preliminary Proposals:** Submission of Preliminary Proposals is required. Please see the full text of this solicitation for further information.
- **Full Proposals:**
 - Full Proposals submitted via Research.gov: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
 - Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

Inclusion of voluntary committed cost sharing is prohibited.

- **Indirect Cost (F&A) Limitations:**

Projects in Theme 1 (AI for Astronomical Sciences) will be jointly funded with the Simons Foundation. Half of the total allowed budget (up to \$10M) must be prepared by following the NSF Proposal and Award Policies and Procedures Guide (PAPPG), and the other half of the budget (up to \$10M) must be prepared by following instructions from the Simons Foundation, included with the announcement of this funding opportunity at the Simons Foundation website (<https://www.simonsfoundation.org/grant/nsf-simons-national-artificial-intelligence-ai-research-institutes-in-the-astronomical-sciences/> ) . Note that the Simons Foundation has a specific [indirect cost rate policy](#) .

- **Other Budgetary Limitations:**

Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

- **Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. submitter's local time):

October 31, 2023

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January 12, 2024

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February 16, 2024

Themes listed under Group 1 (awards anticipated FY 2024)

May 17, 2024

Themes listed under Group 2 (awards anticipated FY 2025)

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria. Additional merit review criteria apply. Please see the full text of this solicitation for further information.

Award Administration Information

Award Conditions:

Additional award conditions apply. Please see the full text of this solicitation for further information.

Reporting Requirements:

Additional reporting requirements apply. Please see the full text of this solicitation for further information.

I. Introduction

AI is advancing rapidly, enabled and significantly fueled by federally-funded research. Increasingly sophisticated and integrated approaches for AI systems appear in applications across all sectors of the economy, and new challenges

emerge for advancing, applying, and governing these promising technologies. AI holds the potential to transform lives across our Nation through increased economic prosperity, improved educational opportunities and quality of life, and enhanced security. At the same time, the potential capabilities and complexities of AI, combined with the wealth of interactions with human users and the environment, make it critically important to further advance our understanding of AI, including aspects of transparency, security, and control. Among federal research investments, institute-scale activities enable multidisciplinary, multi-stakeholder teams to focus on larger-scale, longer-time horizon challenges in both foundational and use-inspired AI research, and development of the future AI workforce, as well as addressing some of society's grand challenges. National AI Research Institutes will serve as national nexus points for collaborative efforts spanning institutions of higher education, federal agencies, industry, and nonprofits/foundations in such areas. They should also accelerate the transition of AI innovations into many economic sectors, and nurture and grow the next generation of talent. A long-term, substantive, and highly visible investment in AI research, infrastructure, and workforce development will realize the potential of, and enable the U.S. to maintain global leadership in, AI.

I.A. Definition of AI

AI enables computers and other automated systems to perform tasks that have historically required human cognition and human decision-making abilities. Research in AI is therefore concerned with the understanding of the mechanisms underlying thought and intelligent behavior and their implementation in machines. The full AI endeavor is inherently multidisciplinary, encompassing the research necessary to understand and develop systems that perceive, learn, reason, communicate, and act in the world; exhibit flexibility, resourcefulness, creativity, real-time responsiveness, and long-term reflection; use a variety of representation or reasoning approaches; and demonstrate competence in complex environments and social contexts.

What is sometimes referred to as "core AI research" addresses, in general, the theory and methods that give rise to these target abilities and their implementation in machines. It includes research in all matters of learning, abstraction, and inference required for intelligent behavior as well as general architectures for intelligence, integrated intelligent agents, and multiagent systems. Machine learning, that is, methods for solving tasks by generalizing from data, has made great advances in recent years through the combination of new algorithms, increases in computing power, and the growing availability of data. Machine learning does not, however, encompass all of core AI; which also includes research on knowledge representation, logical and probabilistic reasoning, planning, search, constraint satisfaction, and optimization.

In some lines of AI research, computational models and mechanisms of intelligence draw direct inspiration from living systems. Biologically-inspired computing draws from connectionism, behavior, and emergence in living systems to inform algorithm and system design. Computational neuroscience contributes models based on theory and analysis of computational processes in the nervous system. Behavioral and cognitive science informs much of the motivation and design of systems seeking to implement behavior typical of human perceptual, motor, and cognitive processes and their interactions. Also relevant is human-AI interaction, which studies the interface between people and this class of software artifacts to help bring them into more productive alignment.

Perception and communication are critical capabilities associated with intelligent behavior. Where AI is concerned, the field of computer vision studies methods that enable systems to sense and reason about the visual world. Human language technologies (also known as "natural language processing" and "natural language understanding") research enables intelligent systems to analyze, produce, translate, and respond to human text and speech.

Intelligent systems may be able to act upon the world through embodiment. Robotics is closely aligned with but not identical to embodied AI. While an embodied AI may be a robot, not all robots exhibit embodied AI. This solicitation does not include in the scope of this definition teleoperated robots or industrial robots that simply repeat programmed patterns of motion.

As intelligent systems amplify humans' capabilities to accomplish individual and collective goals, research is needed to assess the benefits, effects, and risks of AI-enabled computing systems; and to understand how human, technical, and contextual aspects of systems interact to shape those effects. Relevant research areas therefore include consideration of explainable and trustworthy AI; validation of AI-enabled systems; AI safety, security, and privacy; and the role of ethics in the design and perception of increasingly sophisticated machine intelligence.

Research in AI also encompasses novel software and hardware architectures, as well as methods for carrying out AI algorithms on a variety of computing systems and platforms, including those that operate under additional constraints such as time (e.g., real-time) or energy, or those targeting specific application classes or use cases. Developing hardware further optimized for AI and ML algorithms or hardware offers the potential for even higher levels of performance.


The above definition of AI and its principal disciplines establishes the scope of this National AI Research Institutes program.

I.B. Foundational and Use-Inspired AI Research

Research in foundational AI seeks to develop theory and methods that are independent of any particular domain of application. Use-inspired AI research refers to research that has use for society in mind. Use-inspired research seeks new methods and understanding in AI by situating the research in a domain of application to simultaneously inform progress in AI and solve particular use cases. As an example, foundational research in machine learning gave rise to breakthroughs in deep neural networks motivated by performance in controlled contexts like character recognition. Later, the further investigation of these methods in the intersection of machine learning and linguistics led to the development of recurrent neural networks in AI while also revolutionizing language modeling for speech and text processing. We use the phrase “use-inspired” rather than “applied” to emphasize that use-inspired research is an expected modality¹ of an Institute's foundational AI research. This solicitation seeks to support work that goes beyond merely applying known techniques and adds new knowledge and understanding in both foundational AI and use-inspired domains. Ideally there is a virtuous cycle resulting from deeply integrated convergent research in which AI advances are motivated by domain challenges, and those domains benefit from new AI advances.

I.C. Program Vision

AI has advanced tremendously and today promises personalized healthcare; enhanced national security; improved transportation; and more effective education, to name just a few benefits. Increased computing power, the availability of large datasets and streaming data, and algorithmic advances in ML have made it possible for AI development to create new sectors of the economy and revitalize industries. Continued advancement, enabled by sustained federal investment and channeled toward issues of national importance, holds the potential for further economic impact and quality-of-life improvements.

The 2023 update to the [National Artificial Intelligence Research and Development Strategic Plan](#), informed by [visioning activities in the scientific community](#)  as well as interaction with the public, identifies as its first strategic objective the need to make long-term investments in AI research in areas with the potential for long-term payoffs in AI. The President's Council of Advisors for Science and Technology (PCAST), in [a report issued in 2020](#), identifies AI as requiring new and sustained research to drive science and technology progress. A subsequent [2021 PCAST report](#) builds upon this strategy for convergent AI research, emphasizes the ubiquitous role of AI in societal challenges, and situates this National AI Research Institutes program as a long-term multi-sector initiative to enhance innovation through foundational and use-inspired research.

¹Stokes, D.E., “Pasteur’s Quadrant: Basic science and technological innovation.” Washington, DC, Brookings Institute Press, 1997

II. Program Description

Building upon the nationwide network of AI Research Institutes, this National AI Research Institutes program solicitation will fund Institutes comprised of scientists, engineers, and educators united by a common focus on advancing the research frontiers in AI. The program seeks to build a broader nationwide network to pursue transformational advances in a range of economic sectors, and science and engineering fields. AI Research Institutes will have as their primary focus the advancement of multidisciplinary, multi-stakeholder research on larger-scale, longer-time-horizon challenges in AI research than are supported in typical research grants. They will accelerate the development of transformational technologies by grounding that research in critical application sectors that can serve as motivation for foundational research advances and provide opportunities for the effective fielding of AI-powered innovation.

II.A. AI Research Institutes Scope

The vision of the National AI Research Institutes program is broad and ambitious. It is expected that each AI Research Institute will pursue this vision in ways that are uniquely suited to its selected research focus, facilities, collaborations, and other unique circumstances. Proposers are encouraged to convey the unique qualities of the proposed Institute, while addressing the following desiderata common to all AI Research Institutes proposed to this program:

- AI Research Institutes **advance foundational AI research** that will have broad and lasting impact, contributing new knowledge or methods toward understanding of the mechanisms underlying thought and intelligent behavior and their implementation in machines (see the definition of AI specified above). Institutes aimed at advancing established AI lines of research should demonstrate the potential to radically advance these areas beyond the state of the art. Institutes might also address new foundational AI research priorities that arise from rapid advances in AI and the increasing ubiquity of AI-enabled technology. Institute proposals that do not describe a clear plan to achieve ambitious advances in foundational AI research are not likely to be responsive to this solicitation.
- AI Research Institutes **conduct use-inspired research** that both informs foundational AI advances and drives innovations in related sectors of science and engineering, segments of the economy, or societal needs. Effective use-inspired research achieves synergy among a group of researchers to enable transformative advances in AI, related sectors, and the interfaces between these areas. This dimension of an AI Research Institute will feature clear and compelling goals to advance AI and to accelerate the fielding of AI-powered innovation; it also enhances the transfer of knowledge through the meaningful exchange of scientific and technical information with external stakeholders such as industrial partners, public policy makers, or international organizations, as well as with the broader scientific and educational community. Through use-inspired research, Institutes have the potential to create and share new community infrastructure, including data and software, to further research, promote reproducibility, and support education.
It is critical that proposals clearly specify how the use-inspired context for Institute research reveals the opportunities for *foundational AI* advances and how those *foundational AI* advances in turn contribute to the related sectors that define the use-inspired context.
- AI Research Institutes **actively build the next generation of talent** for a diverse, well-trained workforce. Specifically, AI Research Institutes should leverage the visionary nature of their research foci to drive new and innovative education and development tailored toward, e.g., undergraduates, graduate students, and post-doctoral researchers, as well as through community colleges and skilled technical workforce training and other opportunities as appropriate that advance knowledge and education of AI, including public understanding of AI. This could include innovative pedagogy and instructional materials, advanced learning technologies, project-driven training, cross-disciplinary and collaborative research, industry partnerships, and new career pathways. Institutes should offer broad, deep, and diverse experiences to build the next generation of the AI workforce, with a focus on broadening participation among the full range of groups currently under-represented in science and engineering. AI Research Institutes should maximize their unique position to grow the next generation of talent that will provide new discoveries and leadership.
- AI Research Institutes are coherent **multidisciplinary groups of scientists, engineers and educators** appropriate for a large-scale, long-term research agenda for the advancement of AI and the fielding of AI-powered innovation in application sectors of national importance. The multidisciplinary nature of these Institutes will catalyze foresight and adaptability beyond what is possible in single research projects; further, the individual projects that an Institute carries out should meaningfully integrate into fundamental contributions beyond the sum of the individual projects.
- Each Institute will be comprised of **multiple organizations working together to create significant new research capabilities**. NSF and partner organizations seek to grow the network of National AI Research Institutes in lead organizations distributed throughout the country to grow new centers of AI leadership and leveraging existing centers of excellence as appropriate. Institutes are strongly encouraged to include organizations that can directly contribute to NSF's commitment to broadening participation by engaging a diverse, globally engaged research community, integrating research with education and building capacity, and expanding efforts to include

the participation of the full spectrum of diverse talent in STEM and diverse institutions across all geographical regions. Participants should be meaningfully integrated into a diverse Institute that is more than just the sum of the parts. Each Institute will have a lead PI with demonstrated vision, experience, and capacity to manage a complex, multi-faceted, and innovative enterprise that integrates research, education, broadening participation, and knowledge transfer. Each Institute will also be staffed with a Managing Director or Project Manager (distinct from the lead PI) and a suitable Management Team to oversee the operations of the Institute. An External Advisory Board is required for all AI Research Institutes. (Potential Advisory Board members should not be approached or identified until the Institute is funded.)

- AI Research Institutes are **nexus points for collaborative efforts**. The "nexus point" function in this program is not a mere state of being, but rather an active set of priorities, programs, mechanisms, etc., whereby an AI Research Institute pursues the continuing growth of collaborations with external partners to bring together people, ideas, problems, and technical approaches for maximum impact beyond the members and the boundaries of the Institute itself. As nexus points, Institutes have the potential to continue to connect with new partners with the best teams and approaches from institutions of higher education, federal agencies, industry, nonprofits/foundations, centers/institutes, and national networks. As nexus points, Institutes promote organizational collaborations and linkages within and between campuses, schools, and the world beyond, and further the Institute's mission to broaden participation in research, education, and knowledge transfer activities through a network of partners and affiliates.

II.B. Institute Themes in GROUP 1 Awards anticipated in FY 2024:

Proposals are being solicited in the following high-priority areas for awards anticipated in FY 2024. Due dates listed for Group 1 apply for submissions to the themes in this group.

Theme 1: AI for Astronomical Sciences

With current and future astronomical experiments poised to flood the field with petabytes of high-quality imaging and spectroscopic data over a wide range of wavelengths of light and with a high temporal cadence, AI technology will be essential for mining and analyzing these data. The primary goal of an AI Institute in astronomy is to bring together astronomy and AI experts to tackle important challenges in astronomy, as well as the advances in AI that are needed to overcome these challenges. An AI institute will serve as a hub and resource for the broader astronomical community by making tools publicly available and by promoting the education and training of the astronomical community in AI methods.

Proposals can address any relevant combination of AI use cases. Some examples are provided below. This list is meant to stimulate thought about the many potential application areas and is not prescriptive.

- Clean raw astronomical imaging, spectroscopic, or time series data by removing sources of statistical and systematic noise.
- Derive accurate estimates of physical parameters of objects or extract statistical measurements directly from raw observational data.
- Classify objects on the fly for rapid follow-up observation.
- Find rare events using anomaly detection.
- Estimate physical model constraints directly from raw observational data.
- Predict the behavior of complex theoretical simulations to reduce their computational cost.
- Develop fast and accurate emulators that can be used in statistical modeling of data.
- Create an "AI astronomer" who can assist with exploring multidimensional data sets or who knows the astronomical literature.

Many of these applications may require foundational advances in AI to succeed. For example, advances may be required in dealing with especially large and complex data sets, in adding knowledge of physical laws into AI models, or in developing interpretable AI methods with well understood error properties. Proposals should clearly justify

both the selection of the targeted astronomical use cases and the breakthroughs needed in foundational AI research. Proposals are also encouraged to discuss the potential for those AI advances to benefit AI research more broadly or to impact application fields beyond astronomy.

Proposals are expected to convey a vision and approach that is appropriate for the scale of these Institutes and that produces transformative outcomes. Proposals should also describe how the Institutes will connect with the broader community to disseminate knowledge. The proposed structure, activities, and management of the Institutes to achieve these goals should be clearly described.

This theme is partially funded by the Simons Foundation. Each institute funded under this theme will receive two separate awards of up to \$10M, one in the form of a cooperative agreement at NSF as described in this solicitation, and one award from SF in accordance with SF award procedures and consistent with applicable law. See Proposal Submission Guidelines for detailed procedures on how to structure project plans and budget submissions.

II.C. Institute Themes in GROUP 2 Awards anticipated in FY 2025:

Proposals are being solicited in the following high-priority areas for awards anticipated in FY 2025. Due dates listed for Group 2 apply for submissions to the themes in this group.

Theme 2: AI for Discovery in Materials Research

AI has the potential to revolutionize materials discovery by integrating first principles from materials science, physics, and chemistry with heterogeneous multi-dimensional experimental and synthetic data streams to scale and accelerate development. AI can expand the types and properties of materials considered through augmentation of human intuition and by tailoring discoveries to address societal challenges, such as sustainability and those in emerging industries. A successful Materials AI Institute will transform the materials discovery landscape, enable new AI-based capabilities, and be responsive to societal challenges and industrial needs. Advances in AI have the potential to transform materials research in several ways. Some potential lines of research are provided below. This list is meant to stimulate thought about use-inspired research in the intersection of AI and materials, and is not prescriptive.

- Multi-modal data integration and dataset development: Data streams that describe material properties and behaviors based on different types of variables are ubiquitous in materials science and span different length/time scales and represent a vast set of modalities, such as simulation, synthesis experiments, and characterization experiments. Research in AI-enabled frameworks for materials research have the potential to catalyze the generation of insights by integration of heterogeneous multi-modal data streams across different length/time scales. In addition, tools and mechanisms are needed to accelerate the development of new data sets with appropriate diversity, speed, and volume to empower ground-breaking AI methods for targeted materials science problems.
- Foundational AI advances driven by materials research: Extending and tailoring AI methodologies to materials science and its unique data streams creates an opportunity to develop fundamentally new algorithmic and methodical frameworks in AI for materials discovery. From a bottom up (i.e., data-driven) direction, foundational AI advances in this field should fully capture and incorporate the unique characteristics and interactions evident in materials science. From a top down (i.e., knowledge-guided) perspective, the principles of materials science hold the potential to ground data-intensive operations in the rich mathematical complexity and multi-scale nature of the different physical and chemical relationships inherent to materials. The integration of both data-driven and knowledge-guided AI holds even greater potential to lead to significant advances in materials.
- First synthesis to synthesis at scale: Materials synthesis at scale is a major challenge in materials discovery. The precision and level of understanding required spans various complex phenomenological challenges. Research in the intersection of materials science and AI has the potential to sustainably synthesize materials at scale while mitigating the complex phenomenological challenges related to materials properties, materials processing for reliable synthesis, efficient characterization for measurement of relevant properties, and statistics-based understanding of various stochastic elements present in large-scale systems. Use-inspired AI research for

materials science has the potential to revolutionize materials discovery and lead to new technologies that can address complex societal challenges.

- Human-augmented materials design: While AI holds great potential to automate discovery, it remains critical that this discovery be guided by and responsive to materials scientists who will collaborate with AI systems. The interfaces that mediate AI-driven materials research should be guided by principles for effective human-AI interaction and collaboration. Principled mechanisms of interaction between human experts and AI-augmented technology can change how materials designers think about design challenges and catalyze human creativity in new and unexpected ways—for example, shortening the requirements-design-synthesis-experiment cycle. Effective guidance from domain experts will also help ensure that the design of novel materials is conducted ethically and safely.
- Interpretable materials AI: As AI accelerates new advances and insights in materials science, human understanding of materials will be advanced even further to the extent that the operations of the system are interpretable by materials scientists. A system with transparent and explicable operations will have a higher potential to contribute to the discovery of new fundamental principles in materials science. For example, might successful AI materials models predict the essential ingredients of microscopic Hamiltonians for quantum materials? Can they provide clues to develop new concepts that expand theory and computation to enable humans to reach the same or better solutions? The more interpretable the materials AI system, the greater the opportunity for materials scientists to explore new frontiers of research in this area.

Proposals to this theme can address these or other relevant research areas in any combination. Proposals that promise to significantly advance both foundational AI and domains supported by the Division of Materials Research will be most responsive to this theme.

Intel Corporation is providing partial support for this institute theme.

Theme 3: Strengthening AI

In recent years, AI systems built with multilayer architectures with many parameters trained on massive datasets have become increasingly capable of producing useful and impressive outputs. These developments have found their way into large scale deployment, while their developers continue to strive for higher levels of generality, performance, and trustworthiness. Deep neural networks are increasingly effective in all manner of applications from game playing to consumer recommendations to autonomous driving. Generative models have advanced significantly in their ability to produce constructions in natural language, images and video, leading to applications that automatically edit content or even produce novel images and texts. Unfortunately, these systems are not always reliable and may not exhibit justification for their behavior that is understandable to the people who interact with them. In spite of their limitations, these capabilities are becoming ubiquitous in fielded systems of all kinds. This trend presents the opportunity and necessity to research ways in which AI technologies of all sorts can be improved and integrated toward systems that are reliable and aligned with human intentions and ethical considerations.

A lens through which one might view the developments of AI systems is in terms of a continuum from narrow to general (or with similar meaning/intent, weak to strong). “Narrow AI” excels at performing specific tasks for which it has been programmed (or trained). Over the past few decades, these systems have far exceeded expectations in an increasing number of feats previously thought to be dominated by human intelligence. Still, these systems can be brittle in the face of surprising situations, susceptible to manipulation or anti-machine strategies, and produce outputs that do not align with human expectations of truth or human values. In contrast, “strong AI” is the aspirational goal of creating intelligent systems that learn and think as adeptly as humans do. Strong AI is expected to be capable of performing effectively in a diverse range of problems subject to potentially contradictory priorities, gain new conceptual understanding from limited exposure to new domains, and adapt appropriately to the expectations of human users. While such systems in principle would be more robust to situations that challenge narrow AI, no examples of strong AI have been demonstrated to date. Research in AI can no longer distinguish approaches simplistically as either narrow or strong. But AI systems of the future will need to be *strengthened* if they are to be as robust as we would like and if we are to keep such technology well-aligned with society’s intended uses.

Theme Goals:

This theme promotes the development of next generation AI systems that have been *strengthened* to provide greater usefulness, consistency, and robustness by exhibiting both the high performance of narrow AI and the general adaptability of strong AI. Proposals must address the following goals, taking into account the full context of the motivation described above, while remaining relevant to the contemporaneous, rapid progress in the fielding of large, capable AI models. Institutes funded under this theme must lead advances in theory, methods, or integrative approaches that strengthen AI in all three of the goals listed below:

1) **Grounding.** Systems must understand the concepts they reason over and operate with. We refer to this capacity as grounding. Grounding allows AI system to demonstrate connection between its outputs and the abstract concepts that they operate with. It will also enable systems to understand their risks and limitations. Such an improved conceptual understanding should also lead to robust AI that adapt gracefully and quickly to new domains, is robust to surprise, and resists malicious manipulation.

2) **Instructibility.** Taking advantage of this firmer understanding, strengthened AI must be “instructible”. This means that systems can be proven experimentally to change their behavior appropriately in response to explicit feedback provided by even non-expert users. Related is how such instructible systems might invert the mechanisms behind this principle to implement more effective and trustworthy assistance to humans (e.g., in instruction, tutoring, and training) or in explaining their understanding or recommendations.

3) **Alignment.** Strengthened AI systems must be judged by how well their operations align with expectations of objective truths in a domain and correspond to societal expectations and human intentions in their operations. Proposals must include rigorous plans to evaluate this capability.

Any AI approaches that contribute to these three goals are in scope. This might include but is not limited to neuro-symbolic approaches, hybrid integrated architectures, or multi-representational learning methodologies. **Proposals that rely mainly on continuing growth of data-driven models and their access to more data are not responsive to the three goals above unless accompanied by a compelling basis of confidence that true breakthroughs in those areas can be projected and evaluated.** Technical approaches that integrate and process data from multiple sources and in diverse modalities as appropriate to the domain(s) of application are likely to serve the goals of this theme well. Institute concepts whose technical plans do not promise to advance all three of the above goals are unlikely to be competitive in this theme.

Use-Inspired research focus:

Any use-inspired research context may be the basis for an institute proposal to this theme. Institute research plans that strengthen AI in such a way that the techniques are generally applicable to diverse application domains are likely to serve the goals of this theme well. Proposers are encouraged to consider domains of broad significance to collective wellbeing. Examples of such domains include but are not limited to:

- Protecting the environment to ensure human safety and to safeguard natural resources and wildlife.
- Health and wellbeing, including various non-clinical aspects of physical and/or mental health.
- Civic and public good, for example optimization of infrastructure, responsible resource allocation, delivery of public services.
- Improving human flourishing, for example, reducing hunger or coordinating humanitarian assistance.
- AI advances that enable new discoveries in science, mathematics, or engineering.
- Enhancing the economic security of the U.S. through modernization of e.g., manufacturing, infrastructure, or communications.

Multiple awards are anticipated in this theme. Capital One is providing contributions for the partial funding of an award in this theme. Agency partners listed on this solicitation (OUSD (R&E) and NIST) may also elect to provide contributions to NSF for the funding of Institutes under this theme. Submitters to this theme may submit a

supplementary document to indicate relevance of the proposed Institute to one or more partners. Submitters may also stipulate that the proposed Institute should not be considered for funding from specific partner(s) by uploading a single copy document. See Proposal Preparation Instructions.

II.D. Funding Partners in this Solicitation

II.D.1. Agency Funding Partners

Agencies other than NSF listed in this solicitation will participate in the review of proposals as described in Review and Selection Process in this solicitation. Those agencies have not made any firm commitment to fund Institutes. During the proposal review process, agencies may opt to contribute funds to Institutes whose activities align with the priorities of those agencies.

Subsequent to Institute awards, partner agencies contributing to those awards may make collaborative arrangements directly with the funded Institutes(s). NSF will share annual project reports with partner agencies after those reports have been reviewed and accepted by the cognizant NSF Program Officer.

II.D.2. Industry Funding Partners

Companies specifically listed in this solicitation, committed to providing annual unrestricted donations to the NSF for the purpose of funding Institutes in Theme 2. The reference to "industry partners" in this section refers specifically to Capital One and Intel in their role as funding partner in this solicitation. The donations from these partners have been agreed upon on the basis of a shared belief in the importance of making progress in the research, education, and workforce development goals identified in this program.

Prior to award, the partner company will not participate in or observe the merit review of proposals. After completion of the merit review process, NSF may share with representatives of the industry partner the subset of proposals which are under consideration for funding by NSF in the associated theme(s), along with corresponding unattributed reviews, panel summaries, and Reverse Site Visit reports. NSF will take into consideration the input of all funding partners prior to making final funding decisions but will retain final authority for making all award decisions.

NSF will administer awards under the Program in accordance with standard NSF policies and procedures. All awards will be subject to standard NSF terms and conditions. Industry partners will not oversee the activities or use of funds by grantees under this Program but may engage with grantees as outlined below.

Specifically, subsequent to Institute awards, the partner company may make available, at a minimum to all Institutes funded within the respective theme(s), direct contributions of resources including but not limited to software (prototypes or products), data sets, other computing infrastructure. No awardee will be required to use any company's offered contributions.

A company may also arrange to fund its own personnel as researchers-in-residence (RinR) to directly participate, part-time or full-time, with funded Institutes within the theme(s) in which they are participating. These arrangements will be optional and upon the mutual consent of the companies and respective Institutes. No awardee will be required to accept a RinR.

NSF will share annual project reports with partner companies after those reports have been reviewed and accepted by the cognizant NSF Program Officer.

IP Rights and Industry Funding Partners

Awardees with institutes funded by NSF with contributions from industry funding partners shall grant to the sponsoring entities (the Federal Government and the industry partner(s) contributing to the award) a non-exclusive, worldwide, paid-up, non-transferrable, royalty-free license to all intellectual property rights in any inventions or works of authorship resulting from research conducted under the Program. [Note: the Bayh-Dole Act provides similar rights to the U.S. Government for patents on inventions made under federal funding.] The license to the partner company will include its subsidiaries and contractors, at its discretion, to the extent that such use is specifically in connection with the partner

company's products and/or services. Awardees shall grant the license to the partner company unless the partner company opts to decline the license. Such license shall not extend to awardees' background intellectual property; however, individual awardees and the partner company may negotiate, voluntarily, in good faith, a mutually acceptable resolution to background intellectual property, if desired, though NSF shall neither enforce nor participate in any such negotiations between awardees and the partner company, nor will any funds provided by NSF to the awardee be contingent upon such negotiations. No rights or licenses are granted by the partner company. Awardees may delay the publishing of data and software describing inventions to first permit the filing of patent applications. That said, NSF terms and conditions will require that awardees promptly publish all results, data, and software generated in performance of the research.

Guidelines for the Participation of Partner Companies and Affiliated Individuals in Proposals

Guidelines for Partner Companies

A partner company is permitted to participate in proposals to the themes in which it is not a funding partner.

A partner company is not, however, permitted to participate in proposals to the theme(s) in which it is a funding partner, as identified in this solicitation. The company may not participate in such proposals in any way as a collaborator, whether funded or unfunded. For example, the company may not submit a letter of collaboration as part of any proposals to the theme.

Guidelines for Individuals Affiliated with Partner Companies

Individuals affiliated with a partner company may participate in proposals to the themes in which the partner company is not a funding partner.

Individuals affiliated with a partner company may participate in proposals to the theme(s) in which the partner company is a funding partner subject to certain limitations and allowances. These limitations and allowances apply to individuals who are currently employed by, consulting for, or on an active agreement to provide services for the company. Specifically:

- Such individuals may not participate in their capacity with the company.
- Such individuals may participate if they (i) hold a primary appointment at another organization not partnered on the theme (e.g., a primary academic appointment at an institution of higher education), as applicable to and defined by that organization, and (ii) do so strictly in their capacity at that other organization.

II.D.3. Simons Foundation (SF)

SF is committed to co-funding Institutes in Theme 1. Institutes funded in partnership with SF will receive two separate awards of up to \$10M, one in the form of a cooperative agreement at NSF to be administered under the Program in accordance with standard NSF policies and procedures, and one award from SF in accordance with SF award procedures using standard SF award terms, conditions and reporting requirements.

- Award budgets must reflect a clear delineation between NSF-funded effort/activities and SF-funded effort/activities, with no overlap between the two budgets.
- In addition to the NSF PI meetings, SF will organize and fund annual PI meetings at SF in New York City as a part of the report requirements for awards made by SF.
- Individuals affiliated with SF who are participating in proposals to this solicitation are strongly encouraged to consult with SF and ensure compliance with SF's policy on the *Eligibility of SF Employees for External Funding or Resources*.

Guidelines for Participation of SF and affiliated personnel in proposals to this solicitation:

- SF (the organization) may not submit proposals to Theme 1, AI for the Astronomical Sciences, or participate as a collaborator in proposals to that Theme.

- SF (the organization) is permitted to participate in proposals to the other Themes of the Program solicitation in which it is not a funding partner.
- Participation of individuals affiliated with SF (i.e., employed by, consulting for, or on an active agreement to provide services for SF) in proposals to this solicitation:
 - Individuals affiliated with SF may participate in proposals to Theme 1, AI for the Astronomical Sciences, subject to certain limitations and allowances. Specifically, such individuals may only participate on an unfunded basis in a proposal if they (i) hold another appointment at another organization (e.g., an academic appointment at an institution of higher education), as applicable to and defined by that organization, and (ii) do so strictly in their capacity at that other organization. Individuals may not participate in a proposal to Theme 1 in their capacity with SF
 - Individuals affiliated with SF may participate in proposals to the other themes in this solicitation (in which SF is not a funding partner).

II.D.4. Miscellaneous

- Proposers are not restricted from making use of the widely accessible products or services of partner organizations.
- Proposers to Theme 1 may contact the theme contacts listed in this solicitation from SF to address questions about SF-specific budget preparation instructions. Otherwise, proposers to this program may not directly contact partners with questions pertaining to the solicitation and their participation in it. Proposers with questions about eligibility and partnerships in general should contact the program leads using the program-wide email address in this solicitation.
- **Proposals that violate the above restrictions may be returned without review.**

II.E. Webinar

NSF will hold an informational webinar in August 2023. The date and registration information for this webinar will be posted on the Program Web page on or before July 31, 2023.

II.F. Program Timeline for this AI Research Institutes competition:

NSF provides the timeline below for planning purposes for proposers to this program. While NSF will make every attempt to adhere to this timeline, circumstances beyond NSF's control may affect the specific dates/activities outlined. ☑

- Webinar announcement: Jul 31, 2023
- Group 1 Preliminary proposals due: October 31, 2023
- Results of Group 1 preliminary proposal review to teams: December 2023
- Group 2 Preliminary proposals due: January 12, 2024
- Results of Group 2 preliminary proposal review to teams: Feb 2024
- Group 1 Full proposals due: February 16, 2024
- Group 2 Full proposals due: May 17, 2024
- Group 1 Reverse Site Visit (RSV) notifications and scheduling: Apr-May 2024
- Group 1 RSVs conducted: May-June 2024
- Group 1 Declined proposers informed, and recommended awards announced: Estimated August 2024
- Group 1 Anticipated start date of awards: Oct 1, 2024.
- Group 2 Reverse Site Visit (RSV) notifications and scheduling: Oct 2024
- Group 2 RSVs conducted: Nov 28-Dec 20, 2024
- Group 2 Declined proposers informed, and recommended awards announced: Estimated April 2025

- Group 2 Anticipated start date of awards: June 1, 2025

III. Award Information

NSF plans to make two awards in Theme 1, one award in theme 2, and two or more awards in Theme 3, subject to the availability of funds. Institute awards will be made for between \$16,000,000 and \$20,000,000 for four to five years (\$4,000,000 per year on average). Proposals outside this range may be returned without review.

In Theme 1, NSF and the Simons Foundation expect to co-fund up to two National AI Research Institutes. The Simons Foundation intends to provide up to \$20 million and NSF intends to provide up to \$20 million to support up to two new awards in FY 2024 - FY 2028, subject to the availability of funds. The average total size and duration of a grant will be \$4M per year for 5 years, evenly split between NSF and SF.

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

IV. Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research laboratories, professional societies and similar organizations located in the U.S. that are directly associated with educational or research activities.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization: 2

An organization may submit no more than two preliminary proposals to this solicitation as lead institution. This limit is solicitation-wide and applies across the groups and themes. An organization may submit up to two full proposals that correspond to preliminary proposals reviewed under this solicitation. In the event that an organization exceeds these limits, preliminary proposals will be accepted based on earliest date and time of preliminary proposal submission, i.e., the first two preliminary proposals will be accepted, and the remainder will be returned without review. A full proposal that does not correspond to a preliminary proposal reviewed in this program will be returned without review.

Limit on Number of Proposals for Senior Personnel: 1

An individual may be designated as senior personnel (which includes but is not limited to PI or co-PI) on at most one preliminary proposal, and at most one full proposal to this solicitation. This limit is solicitation-wide and applies across the groups and themes. In the event that an individual exceeds this limit, proposals will be accepted based on earliest date and time of submission, i.e., the first compliant preliminary or full proposal will be accepted, and the remainder will be returned without review.

V. Proposal Preparation And Submission Instructions

A. Proposal Preparation Instructions

Preliminary Proposals (required): Preliminary proposals are required and must be submitted via Research.gov, even if full proposals will be submitted via Grants.gov.

Preliminary proposals must be submitted in accordance with the instructions below. The NSF decision made on the preliminary proposal is advisory (non-binding) and may include feedback on proposed activities and the responsiveness to program and theme. Submission of a Preliminary Proposal is required in order to be eligible to submit a Full proposal.

As a multi-organization activity, the proposal must be submitted as a single, integrated proposal by the lead organization; information about other participating institutions, partners, and PIs should be given in section "E. Key Personnel and prospective organization" as described below. Separately submitted collaborative proposals from multiple organizations will be returned without review.

Required components of the preliminary proposal are given below. **Page limitations given here will be strictly enforced, and preliminary proposals that are not compliant with this solicitation will be returned without review.** It is the submitting organization's responsibility to ensure that the preliminary proposal is compliant with all applicable requirements.

Preliminary Proposal Set-Up: Select "Prepare New Preliminary Proposal" in Research.gov. Search for and select this solicitation title in Step One of the Preliminary Proposal wizard. Select "Single proposal (with or without subawards)." Separately submitted collaborative proposals will be returned without review.

Title: The title of the proposal must be preceded by "Theme *n*: ", where *n* is the theme number that is the primary theme to which you are submitting. The title should describe the project in concise, informative language that is understandable to a technically-literate reader.

Preliminary proposals consist of sections as listed below. No sections other than the listed required and optional elements listed below are permitted:

1. Cover Sheet. Start date: Oct 1, 2024 should be shown as the start date for proposals to Group 1. June 1, 2025 should be shown as the start date for proposals to Group 2.

2. Project Summary (1-page limit): The Project Summary consists of an overview, a statement on the intellectual merit of the proposed activity and a statement on the broader impacts of the proposed activity. The project summary for a preliminary proposal should summarize appropriately the elements required in the Project Description and is not expected to summarize a fully developed institute concept. At a minimum the summary should provide an overview of the Institute vision and rationale, its research objectives, and broader impacts. Proposals may incorporate a Keywords section as the last line of the Project Summary. You may use the keywords section to highlight any special emphasis in sectors relevant to partner agencies, or to identify relevance to themes other than the one to which the proposal is submitted.

3. Project Description (6 pages maximum). The project description is brief and should focus on the scope of proposed research activities and the suitability of assembled personnel to make the proposed advances. Detailed research plans are not appropriate. Results from Prior NSF Support should not be included. The project description must consist of the following sections, in the order shown and using the headings indicated.

A. Vision and integrated research goals of the Institute. (*Suggested length: 1/2 page*). Provide a brief, holistic description of the motivation and vision for the proposed Institute, and a high-level description of the proposed research areas/themes.

B. Foundational AI research. (*Suggested length: 1 to 2 pages*). Address the following questions using the underlined headings:

- Limitations. What are the specific limitations in the current state of AI revealed in the Institute's vision for use-inspired research and societal impact?

- Foundational AI contributions. In which of those areas of AI research will the Institute investigate/develop *significant new knowledge or methods* to overcome those challenges?
- Basis of confidence. What special conditions or prior work make the proposed Institute uniquely suited for addressing these AI research challenges?

C. Use-Inspired Research. (*Suggested length: 1 to 2 pages*). Address the following questions using the underlined headings:

- Use-inspired research contributions. In what use-inspired research areas will the Institute make advances, and what is the role of AI in those advances?
- Areas of additional AI application. In addition to the areas of AI research identified for advancement under *Foundational AI contributions*, what other areas of AI are expected to be applied in the use-inspired research?
- Concept for use-inspired research. How does the institute plan to structure its activities to best leverage the use-inspired research context to establish a virtuous cycle of inquiry and discovery across all research activities?

D. Broader Impacts. (*Suggested length: up to 1 page*). How will the Institute make a lasting strategic impact beyond its research outcomes? Highlight intent or preliminary plans for new activities in any or all of Education and Workforce Development, Broadening Participation, Collaboration, and Knowledge Transfer.

E. Key Personnel and prospective organization. (*Suggested length: 1 to 2 pages*).

- Organization. Describe the preliminary network of organizations comprising the Institute and their relationships to one another.
- Key Personnel. Identify key contributors to the Institute's prospective research activities, their primary research thrusts related to the institute goals and how this demonstrates their suitability to drive and disseminate the research advances AI and associated disciplines/sectors presented in this preliminary proposal.

Deviations from the PAPPG:

- You may omit the PAPPG-required section on Results from Prior NSF Support.

4. References Cited: Section. List only references cited in the Project Description. See PAPPG for format instructions.

5. Biographical Sketches (3-page limit per person): Biographical sketches are required for the PI, any co-PIs, and each of the participating Senior Personnel. All biographical sketches submitted in response to this solicitation are expected to follow the NSF-approved format in accordance with the policy in the PAPPG.

No other sections or documents are permitted. This includes Budget and Budget Justification, Data Management Plan, Postdoctoral Researcher Mentoring Plan, Current and Pending (Other) Support, Collaborators and Other Affiliations Information, Facilities, Equipment, and Other Resources, and Letters of Collaboration.

Optional Supplementary Document

Relevance of the proposed Institute to partners (Optional, for Theme 3 only, 1 page). Submitters to Theme 3 may submit a supplementary document to indicate relevance of the proposed Institute to one or more partners. The entire submission is limited to one page, regardless of the number of partners the document wishes to address.

Optional Single Copy Document

Objection to partner funding (1 page). Submitters to Theme 3 who wish to stipulate that the proposed Institute should not be considered for funding from specific partner(s) may upload a single copy document stating this preference. The statement should be limited to one sentence, stating, "The submitting organization intends to decline an award that includes funding transferred to NSF from [partner(s)]."

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via Research.gov or Grants.gov.

- Full Proposals submitted via Research.gov: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. The Prepare New Proposal setup will prompt you for the program solicitation number.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

See PAPPG Chapter II.D.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

The solicitation addresses deviations from the PAPPG, addressing program-specific considerations for certain sections. Where not otherwise addressed, proposals must conform fully with the guidance contained in Chapter II.D.2 of the PAPPG.

Important Instructions: Full proposals will be accepted only if they are based on a preliminary proposal submitted to this program (whether "encouraged" or not). Due to the complexity of the proposals being submitted, use of Research.gov to prepare and submit proposals is strongly encouraged. When preparing a full proposal for this competition, proposers are advised to review the Program Description and the Proposal Review Information found in this solicitation for general information pertinent to this program.

As a multi-organization activity, the proposal must be submitted as a single, integrated proposal by the lead organization, with proposed subawards to the other partner organizations. Separately submitted collaborative proposals from multiple organizations will be returned without review.

Proposal Set-Up: Select "Prepare New Full Proposal" in Research.gov. Search for and select this solicitation title in Step One of the Full Proposal wizard. In the proposal details section, select "Single proposal (with or without subawards)." Separately submitted collaborative proposals will be returned without review.

Title: The title of the proposal must be preceded by "Theme n: ", where n is the theme number that is the primary theme to which you are submitting. The title should describe the project in concise, informative language that is understandable to a technically-literate reader.

1. Cover Sheet. Start date: Oct 1, 2024 should be shown as the start date for proposals to Group 1. June 1, 2025 should be shown as the start date for proposals to Group 2. The proposed duration should be 60 months.

Include the number for the related preliminary proposal.

2. Project Summary (1-page limit): The Project Summary consists of an overview, a statement on the intellectual merit of the proposed activity and a statement on the broader impacts of the proposed activity. Include an overview of the Institute description and rationale, its research objectives, education and workforce development activities, and community building activities. Proposals may incorporate a Keywords section as the last line of the Project Summary. You may use the keywords section to highlight any special emphasis in sectors relevant to partner agencies, or to identify relevance to themes other than the one to which the proposal is submitted.

3. Project Description: The Project Description must include the sections described below and must not exceed 25 pages including tables and illustrations. In addition to these and other PAPPG requirements, the Project Description for an Institute proposal must include the following clearly-labeled sections.

Deviations from the PAPPG:

- You may omit the PAPPG-required section, "**Results from Prior NSF Support**". If omitted from the Project Description, the required information must be submitted, if applicable, as a supplementary document (described below).

3.a. Overview and Rationale for Institute Approach: Provide a description of the challenge that engendered the proposal and the importance of specific aspects of this challenge that you aspire to solve. Include timeliness of addressing this problem. Discuss why the National AI Research Institutes program is particularly suited to support this effort. Discuss the long-term strategic goals and potential impact of an Institute.

3.b. Description of the Research Plan of the Institute: State the overall vision and long-range research goals of the Institute. Describe the proposed research areas/themes, how this plan synergistically advances foundational AI research and use-inspired research, and how these efforts will be integrated in service of the Institute's research vision. Clearly specify the areas of foundational AI research in which significant new knowledge or methods will contribute to an understanding of the mechanisms underlying thought and intelligent behavior and their implementation in machines, why those areas are selected, and the institute's unique capabilities to advance and disseminate those outcomes to the broader AI research community. Convey how those advances benefit from and contribute to the related sectors in the chosen use-inspired research context. Identify key contributors to these research activities and demonstrate their suitability to drive and disseminate the research advances in AI and associated disciplines/sectors. Provide a five-year timeline for the implementation activities. Indicate the specific role of each partner organization or participant in each research topic/goal area. The research plan should provide sufficient detail to allow assessment of the scientific merit and to justify the necessity for the proposed mode of operation. Explain how the proposed research relates to other state and national research capabilities (including related centers, institutes, facilities and national laboratories) as well as international programs in the proposed fields of research. If the Institute plans include the development of shared research facilities, describe plans to build, manage, and sustain such facilities.

3.c. Broader Impacts: The Project Description must contain, as a separate section within the narrative, a section labeled, "Broader Impacts". This section should include, at a minimum, the following three subsections.

3.c.1. Education and Workforce Development: With the goal of advancing AI knowledge and education, present plans to actively build the next generation of talent for a diverse well-trained workforce through new and innovative approaches to education and workforce development. Participants may include undergraduate and graduate students, community colleges and post-doctoral researchers, skilled technical workforce, K12 students, and/or professionals looking to shift career focus. Describe plans for the mentoring and professional development of participants involved in institute activities. Describe how the institute will integrate research and education. Describe all proposed activities in sufficient detail to allow assessment of their intrinsic merit, potential effectiveness, and their anticipated contribution toward a highly competent new generation of AI workforce. Plans may also include mechanisms to engage participants in informal settings (e.g., museums, nature centers, libraries; TV/film; citizen science; and other on-line experiences).

3.c.2. Broadening Participation Plans: Describe the broadening participation objectives and outline evidence-based strategies for achieving them, based on relevant literature. Describe plans for increasing diversity including the participation of the full spectrum of diverse talent in STEM at all organizational levels of institute activities. Describe the contribution/role of partner organizations in the broadening participation plans. Describe plans, if appropriate, for partnerships with minority-serving institutions, women's colleges, and/or organizations that primarily serve persons with disabilities. Explain why these organizations were selected and what they will contribute to the project. Indicate the role of students and faculty from these organizations and how they will be fully integrated and engaged into institute activities. Explain how progress will be measured and how strategies will be adapted, if necessary.

Describe the proposed activities in sufficient detail to allow assessment of their intrinsic merit and potential effectiveness.

3.c.3. Collaboration and Knowledge Transfer: Describe how the Institute will function as a nexus point for collaborative efforts, including plans to link organizations, people, ideas, problems, and technical approaches for maximum impact. Present plans to integrate partner organizations and participants into a diverse Institute that is more than just the sum of its parts. Include here plans to effect knowledge transfer. Knowledge transfer involves the exchange of scientific and technical information between the Institute and external non-academic stakeholders (such as industrial partners or public policy-makers) with the objective of applying that knowledge. State the specific goals for knowledge transfer and the expected impact of the activities. Linkages should involve significant intellectual exchange and could involve, for example, mechanisms such as internships or novel use of cyberinfrastructure to enhance connections.

3.d. Key Personnel, Management and Integration Plan: Describe the multidisciplinary group of scientists, engineers and educators comprising the Institute and their suitability to conduct large-scale, long-term research agenda for the advancement of AI and the fielding of AI-powered innovation in application sectors of national importance. Describe the network of organizations comprising the Institute and their relationships to one another. Include a diagram to explain the organizational relationships and reporting structure among the key areas of responsibility. Identify key members of the Institute Management Team and explain their specific roles and areas of responsibility, including in the day-to-day management and operations of the Institute. Describe the relevant experience and qualifications of the lead PI, Managing Director/Project Manager (required, and distinct from PI), and other key members of the management team to lead and manage a complex, multifaceted, and innovative enterprise that integrates research, education, broadening participation, and knowledge transfer. Describe the processes to be used to prioritize institute activities; to select and integrate research projects with one another and with other institute activities; to identify and sunset projects that cease to align with institute goals; to allocate funds and equipment across institute activities and among partners; resolve conflict; and to select a replacement for key leaders if needed. An External Advisory Board is required for all AI Research Institutes. Your plan may describe your plan to form the board, but potential members should not be approached or identified unless the Institute is funded.



4. References Cited: Section. List only references cited in the Project Description. See PAPPG for format instructions.

5. Budget and Budget Justification: Provide a budget for each of the five years. Research.gov or Grants.gov will automatically provide a cumulative budget. The proposed budget should be consistent with the needs and complexity of the proposed activity. The budget and budget justification should reflect start-up activities at the commencement of the institute activities. Funds allocated for research, education, broadening participation, and knowledge transfer areas must be discernible. Be careful not to include inappropriate entries under Participant Support Costs (e.g., most employee costs, speakers and trainers, incentive payments to research subjects, contracted services). Guidance on participant support is available in PAPPG Chapter II.D.2. Funds also should be included for attendance at up to three site visits (and/or reverse site visits) as well as other planned cross-Institute meetings, to include the retreat required in Special Award Conditions.

6. Facilities, Equipment and Other Resources: Provide a synopsis of organizational resources that will be available to the Institute (dedicated space, access to facilities and instrumentation, faculty and staff positions, access to programs that assist with curriculum development or broadening participation, or other organizational programs that could provide support to the Institute). In order for NSF, and its partners, to assess the scope of a proposed project, all resources (including those from collaborating organizations) available to the project, must be described in this section. Note that inclusion of voluntary committed cost sharing is prohibited. The description should be narrative in nature and must not include any quantifiable financial information.

7. Special Information and Required Supplementary Documents

- *Simons Foundation Budget* (Required for proposals to Theme 1, no page limit). Projects will be jointly funded with the Simons Foundation. Half the budget should be prepared by following the NSF PAPPG and submitted in the proposal to NSF as outlined in the instruction above. The other half of the budget must be prepared by following

instructions from the Simons Foundation, included with the announcement of this funding opportunity at the Simons Foundation website (<https://www.simonsfoundation.org/mathematics-physical-sciences/funding/request-for-applications/> ) and submitted as a separate Supplementary Document with the document name, "Simons Foundation Budget". Note that the Simons Foundation has a specific [indirect cost rate policy](#) . Provide a five-year budget for the proposed activity. The budget should reflect a ramp-up of the institute's activities during Years 1 and 2, with a full complement of activities implemented no later than the beginning of Year 3. The Budget Justification section should take whatever space is necessary to provide a breakdown of planned expenditures in composite budget categories such as Researchers and Participant Support Costs, including projected headcounts for participants. Note on personnel roles: The Simons Foundation does not use the role of co-PI. Co-PIs listed in the NSF submission should be designated as co-Investigator ("co-I") in the SF budget submission. Proposers to Theme 1 may contact the theme contacts listed in this solicitation from SF to address questions about SF-specific budget preparation instructions.

- *Relevance of the proposed Institute to partners* (Optional, for Theme 3 only, 1 page). Submitters to Theme 3 may submit a supplementary document to indicate relevance of the proposed Institute to one or more partners. The entire submission is limited to one page, regardless of the number of partners the document wishes to address.
- *Results of Prior NSF Support* (Up to one page). This supplementary document may be used to report Results of Prior NSF Support as required in the PAPPG if applicable to any PI or co-PI per the PAPPG and not addressed in Project Description. This document may also contain results of support from other funding agencies listed in this solicitation following the same content guidelines as given for the NSF requirement.
- *Ethics Plan* (required, up to one page). Provide a clear statement of the proposed Institute's policies on ethics training, responsible conduct of research, and intellectual property rights. Discussion should address the nature of the research, methodologies used, ownership of research and ideas, and roles and responsibilities regarding intellectual property. A program of training in ethics and responsible conduct of research within the cross-disciplinary and multi-organizational context of the Institute, for all Institute and subawardee staff, including faculty, visiting faculty, industrial fellows, postdoctoral researchers, and graduate and undergraduate students is required. Training topics should include the nature of the research, methodologies used, ownership of research and ideas, and roles and responsibilities regarding intellectual property. Proposers are encouraged to address the relationship between the Institute's ethics plan and the broader consideration of ethics in AI.
- *Data Management Plan* (required, up to two pages). In addition to the general elements of the data management plan described in the PAPPG, Institute proposals should address their plans for data-sharing across the team, the role of data management in the Institute's internal integration into a greater whole, and the data considerations for external engagement.
- *Postdoctoral Researcher Mentoring Plan*. As applicable. In addition to the general elements of the postdoctoral mentoring plan described in the PAPPG, address how the activities of the Institute will especially enhance the professional development of postdoctoral researchers (e.g. by virtue of access to multiple projects and organizations comprising the Institute).
- *Letters of Collaboration*. Letters should document collaborative arrangements of significance to the proposal and MUST stay within the PAPPG requirement to state only the intent to collaborate. They should not contain endorsements or evaluation of the proposed project. Note that letters of collaboration are not necessary for subawardee organizations, whose commitment is explicit in the proposal. Letters of Support are not permitted. Consult the PAPPG for instructions on the appropriate content for a letter of collaboration.
- *A list of Project Personnel and Partner Organizations (required):*

Provide current, accurate information for all personnel and organizations involved in the project. NSF staff will use this information in the merit review process to manage reviewer selection. The list **must** include all PIs, co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, and Postdocs. This list should be numbered and include (in this order) Full name, Organization(s), and Role in the project, with each item separated by a semi-colon. Each person listed should start a new numbered line. For example:

- Mei Lin; XYZ University; PI

- Jak Jabes; University of PQR; Senior Personnel
- Jane Brown; XYZ University; Postdoctoral Researcher
- Rakel Adeamas; ABC Community College; Paid Consultant
- Maria Wan; Welldone Institution; Unpaid Collaborator
- Rimone Greene; ZZZ University; Subawardee

8. Single Copy Documents

Required:

- Update since preliminary proposal (1 page maximum). Identify the required preliminary proposal submission for this full proposal and summarize updates in three additional sections as follows:
 - Preliminary proposal #: (NSF-assigned proposal #)
 - Changes to PI/Co-PIs: (listed additions, deletions, changes of role)
 - Changes to funded collaborative organizations: (listed additions or deletions of subawardee or otherwise-funded (i.e., contract) organizations).
 - Summary of significant changes of research scope: (no more than 250 words, bulleted).

Optional:

- List of suggested reviewers or reviewers not to include (with a brief explanation or justification for why the reviewer should be excluded).
- Objection to partner funding (1 page). Submitters to Theme 3 who wish to stipulate that the proposed Institute should not be considered for funding from specific partner(s) may upload a single copy document stating this preference. The statement should be limited to one sentence, stating, "The submitting organization intends to decline an award that includes funding transferred to NSF from [partner(s)]."
- Identification of proprietary or privileged information. Proposers may wish to include proprietary or privileged information as part of their proposals. Per PAPPG Chapter II.E.1, NSF defines such information as "patentable ideas, trade secrets, privileged or confidential commercial or financial information, disclosure of which may harm the proposer." While providing this information is not required, a proposer to this program who wishes to include proprietary or privileged information **must provide any and all such information as a Single-Copy Document** in the Proposal Preparation Module in Research.gov. That is, **this information shall not appear in other parts of the proposal**. In keeping with NSF's practice, the Single Copy Document will not be shared with reviewers or with agency/industry funding partners. In the case that a proposal is transferred to another agency for funding, this document may be included in that transfer of proposal.

While NSF will make every effort to prevent unauthorized access to such material, the Foundation is not responsible or in any way liable for the release of such material.

Note: Because proprietary or privileged information may only be specified in the Single Copy Document, **PIs should not check the "Proprietary or Privileged Information" box on the Cover Sheet**; that box applies only to such content appearing in the body of a proposal.

B. Budgetary Information

Cost Sharing:


Inclusion of voluntary committed cost sharing is prohibited.

Indirect Cost (F&A) Limitations:

Projects in Theme 1 (AI for Astronomical Sciences) will be jointly funded with the Simons Foundation. Half of the total allowed budget (up to \$10M) must be prepared by following the NSF Proposal and Award Policies and Procedures Guide (PAPPG), and the other half of the budget (up to \$10M) must be prepared by following instructions from the Simons Foundation, included with the announcement of this funding opportunity at the Simons Foundation website (<https://www.simonsfoundation.org/grant/nsf-simons-national-artificial-intelligence-ai-research-institutes-in-the-astronomical-sciences/> ) . Note that the Simons Foundation has a specific [indirect cost rate policy](#) .

Other Budgetary Limitations:

Note for proposals submitted to Theme 1:

Note that the Simons Foundation has a specific [indirect cost rate policy](#) .

Budget Preparation Instructions:

Include travel budgets for applicable personnel to attend annual PI meetings, attendance at up to three site visits (and/or reverse site visits) as well as other planned cross-Institute meetings, to include the retreat required in Special Award Conditions.

C. Due Dates

- **Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. submitter's local time):

October 31, 2023

Themes listed under Group 1 (awards anticipated FY 2024)

January 12, 2024

Themes listed under Group 2 (awards anticipated FY 2025)

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

February 16, 2024

Themes listed under Group 1 (awards anticipated FY 2024)

May 17, 2024

Themes listed under Group 2 (awards anticipated FY 2025)

D. Research.gov/Grants.gov Requirements

For Proposals Submitted Via Research.gov:

To prepare and submit a proposal via Research.gov, see detailed technical instructions available at:

https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubm

For Research.gov user support, call the Research.gov Help Desk at 1-800-673-6188 or e-mail rgov@nsf.gov. The Research.gov Help Desk answers general technical questions related to the use of the Research.gov system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: <https://www.grants.gov/web/grants/applicants.html>. In addition, the NSF Grants.gov Application Guide (see link in Section

V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to Research.gov for further processing.

Proposers that submitted via Research.gov may use Research.gov to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF Proposal Processing And Review Procedures

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in [Leading the World in Discovery and Innovation, STEM Talent Development and the Delivery of Benefits from Research - NSF Strategic Plan for Fiscal Years \(FY\) 2022 - 2026](#). These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To

identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.D.2.d(i). contains additional information for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.D.2.d(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
 - a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
 - b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and other underrepresented groups in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

Additional Solicitation Specific Review Criteria

In addition to the National Science Board merit review criteria, reviewers will be asked to apply the following criteria when reviewing proposals submitted to this solicitation:

1. **Advance foundational AI:** How well does the proposed Institute contribute new knowledge or methods toward understanding of the mechanisms underlying thought and intelligent behavior and their implementation in machines?
2. **Conduct use-inspired research:** How well does the proposed Institute leverage the use-inspired research context to both advance AI and drive innovations in related sectors of science and engineering, segments of the economy, or societal needs?
3. **Strategic impact:** What is the potential for the Institute to make a lasting strategic impact beyond its research outcomes? Specifically,
 - o How will the proposed Institute actively **nurture and grow the next generation of talent**?
 - o To what extent is the proposed Institute activity **comprised of a multidisciplinary group of scientists, engineers, and educators** appropriate to the project?
 - o How well does the proposed Institute **leverage multiple organizations** to create significant new research capabilities in new centers of AI leadership and create a network for broadening participation from underrepresented groups and diverse institutions?
 - o How well does the proposal exhibit plans to operate as a **nexus point for collaborative efforts** to engage externally and add to a diverse Institute that is more than just the sum of the parts?

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review, or Reverse Site Review.

Preliminary Proposal Determinations: Preliminary proposals will be reviewed by NSF and an advisory determination will be sent to the PI and the organization's SPO (Encourage/Discourage). Feedback may be sent by email to the PI for both Encouraged and Discouraged proposals.

Full Proposal Review Process:

Full proposals will normally be reviewed by a Review Panel augmented as necessary with *ad hoc* reviews, and possibly followed by a reverse site visit, following the *NSF Selection Process* described below. **Some proposals may be selected for a Reverse Site Visit (RSV) prior to final selection of Institutes.** If your proposal is selected, you will be asked to choose key project personnel and make them available to participate in this RSV via video teleconference. In the program calendar (under Program Description) you will find listed the window for these RSVs and the period during which you can expect to be contacted about RSV invitations. If there are changes to this schedule, lead PIs will be notified by email.

Final selection of new AI Research Institutes will be conducted by NSF in consultation with relevant funding partners named in this solicitation. The Agency funding partners may act as observers in the review process. Proposals, unattributed reviews, and panel summaries may be shared securely with both Agency and Industry funding partners.

Federal Agency Partners Process:

Federal agency partners listed in this solicitation will participate as observers in the NSF review process and contribute to award recommendation deliberations. Proposals will be selected for funding in accordance with the *NSF Selection Process* described below. Funds transferred from these partners to NSF will be combined with NSF and other partner funds where applicable to make awards under this Program. These awards are made and managed at NSF.

Simons Foundation (SF) Process:

During the NSF Selection Process, proposals submitted to Theme 1 will be evaluated under the same common review process. NSF will manage and conduct the review as described in this solicitation, NSF Selection Process. During review of Theme 1 proposals, SF program directors may attend review panels as observers. Proposals, Reviews and summaries of review panel recommendations will be made available to SF personnel without attribution. SF personnel will maintain confidentiality of the identity of reviewers and panelists. All confidential information will be shared through a secure file transfer system. Proposals submitted to NSF and related merit review products are protected by the Privacy Act and NSF protects their contents from disclosure to the extent allowed by applicable law.

NSF and SF program directors will jointly discuss the results of the review process to reach concurrence in funding recommendations. Subsequent to the NSF Selection Process, NSF and SF program directors will jointly recommend proposals for funding in Theme 1, AI for the Astronomical Sciences. Each proposal recommended for funding will be subsequently submitted by the PI directly to SF. SF will review those proposals in accordance with its policies and procedures and applicable legal requirements, including those applicable to private foundations.

Industry Partners Process:

Industry funding partners listed in this solicitation as funding partners will not observe or otherwise participate in reviews, panels, or reverse site visits. Following merit review and prior to the award recommendation to the cognizant Division Director (see *NSF Selection Process* described below), the NSF Program Officer may share with industry partners the results of the review process for proposals under final consideration in the partner's sponsored theme(s). Materials shared may include proposals, unattributed reviews, panel summaries, and RSV materials. Industry partners may provide feedback to NSF as input to NSF's final award recommendations.

NSF Selection Process:

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements or the Division of Acquisition and Cooperative Support for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

VII. Award Administration Information

A. Notification of the Award

Notification of the award is made to *the submitting organization* by an NSF Grants and Agreements Officer. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)*; or Research Terms and Conditions* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

Administrative and National Policy Requirements

Build America, Buy America

As expressed in Executive Order 14005, [Ensuring the Future is Made in All of America by All of America's Workers](#) (86 FR 7475), it is the policy of the executive branch to use terms and conditions of Federal financial assistance awards to maximize, consistent with law, the use of goods, products, and materials produced in, and services offered in, the United States.

Consistent with the requirements of the Build America, Buy America Act (Pub. L. 117-58, Division G, Title IX, Subtitle A, November 15, 2021), no funding made available through this funding opportunity may be obligated for an award unless all iron, steel, manufactured products, and construction materials used in the project are produced in the United States. For additional information, visit NSF's [Build America, Buy America](#) webpage.

Special Award Conditions:

AI Research Institute awards are made in the form of cooperative agreements. The cooperative agreements will have an extensive section of Special Conditions relating to the period of performance, statement of work, awardee responsibilities, NSF responsibilities, joint NSF-awardee responsibilities, funding and funding schedule, reporting requirements, key personnel, and other conditions. NSF has responsibility for providing general oversight and monitoring of Institutes to help assure effective performance and administration, as well as facilitating any coordination among the Institutes as necessary to further the objectives of the program. Within the first 90 days of the Award, a retreat of the Institute's key personnel to address strategic planning of the Institute will be required.

Support for each year of the cooperative agreement of a funded AI Research Institute will be contingent upon a satisfactory annual review (possibly including a site visit or reverse site visit) by NSF of the Institute's progress and future plans, with an emphasis on the quality of the research, education, broadening participation, and knowledge transfer activities. All funding is subject to availability.

NSF (or other lead funding agency) may conduct site visits and/or reverse site visits as part of annual review of Institute performance. These visits will be led by lead agency staff, with additional participation from partner agencies and industry partners as applicable to each Institute. These visits may include a panel of external evaluators. The frequency or schedule of site visits and/or reverse site visits for an Institute will be further specified in the award-specific terms and conditions of that Institute's cooperative agreement.

Acknowledgement of Support

Awardees will be required to include appropriate acknowledgment of NSF and partner support in reports and/or publications on work performed under an award. An example of such an acknowledgement would be: "This material is based upon work supported by the AI Research Institutes program supported by NSF [and {partner} per award letter] under Award Title and No. [Recipient enters project title and awards number(s)]."

Role of Partner Agencies in Research

Agency employees may not be included as personnel or collaborators in proposals to Theme 3 and may not receive funding through proposals. Once awarded, at the request of an awardee, or of the funding agency with the awardee's consent, agencies may separately fund their own personnel to participate in research, part-time or full-time, with organizations awarded under the AI Research Institutes program.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

Multi-agency Reporting Process:

PIs must also submit copies of annual and final project reports directly to the cognizant Program Officers from agencies jointly funding the research, if relevant.

Additionally, industry partners will also receive annual reports of Institute activities and progress.

The above requirements will be detailed in the award notice or award-specific programmatic terms and conditions.

VIII. Agency Contacts

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- AI Research Institutes Program Team, telephone: 703-292-5111, email: AllInstitutesProgram@nsf.gov

For questions related to the use of NSF systems contact:

- NSF Help Desk: 1-800-381-1532
- Research.gov Help Desk e-mail: rgov@nsf.gov

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

For general inquiries regarding this program (not theme specific) please email the program leads at:

- AllInstitutesProgram@nsf.gov

Program Leads (Reachable at the above address)

- James Donlon, CISE/IIS
- Erion Plaku, CISE/IIS

For inquiries related to the responsiveness of your ideas for the Themes listed in this solicitation, please contact the program officers listed below. You are advised to address theme-specific questions to all program contacts listed for that theme

Theme 1: AI for Astronomical Sciences

- Andreas Berlind, MPS/AST, aberlind@nsf.gov
- Vladimir Pavlovic, CISE/IIS, vpavlovi@nsf.gov
- Elizabeth Roy, Simons Foundation, telephone: (212) 524-6966, email: eroy@simonsfoundation.org

Theme 2: AI for Discovery in Materials Research

- Serdar Ogut, MPS/DMR, sogut@nsf.gov
- Sylvia Spengler, CISE/IIS, sspengle@nsf.gov

Theme 3: Strengthening AI

- Hector Munoz Avila, CISE/IIS, hmunoz@nsf.gov
- Raj Acharya, CISE/IIS, racharya@nsf.gov
- Tatiana D. Korelsky, CISE/IIS, tkorelsk@nsf.gov
- Eleni Miltsakaki, CISE/IIS, emiltsak@nsf.gov
- Juan Wachs, CISE/IIS, jwachs@nsf.gov

IX. Other Information

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF [Grants Conferences](#). Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on [NSF's website](#).

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at <https://www.grants.gov>.

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