

National Artificial Intelligence (AI) Research Institutes

Accelerating Research, Transforming Society, and Growing the American Workforce

PROGRAM SOLICITATION

NSF 20-604

REPLACES DOCUMENT(S):

NSF 20-503



National Science Foundation

- Directorate for Computer and Information Science and Engineering
- Directorate for Biological Sciences
- Directorate for Education and Human Resources
- Directorate for Engineering
- Directorate for Geosciences
- Directorate for Mathematical and Physical Sciences
- Directorate for Social, Behavioral and Economic Sciences
- Office of Integrative Activities



National Institute of Food and Agriculture



Department of Homeland Security, Science & Technology Directorate



U.S. Department of Transportation, Federal Highway Administration



Accenture



Amazon



Google, LLC



Intel Corporation

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

December 04, 2020

IMPORTANT INFORMATION AND REVISION NOTES

This is a revision of NSF 20-503, the solicitation for the National AI Research Institutes. This solicitation continues and expands a multi-agency effort to establish institute-scale AI research with the potential for long-term payoffs in AI.

Revision Summary:

- The list of desiderata (and corresponding solicitation-specific evaluation criteria) for Institutes has been expanded from five to six. The intent is to emphasize separately the goals that Institutes be multidisciplinary and that they be comprised of multiple organizations working together, led by organizations distributed throughout the country to grow new centers of AI leadership.
- Revised themes for Institute proposals (see program description). Please note the following changes in these themes:
 - The Theme “AI-Augmented Learning” is continued, soliciting an institute in response to that broad theme. In addition, an institute is solicited with a primary focus on advancing research in AI techniques to focus on Adult Learning.
 - The Theme “AI-Driven Innovation in Agriculture and the Food System” is continued and includes a new reference to the USDA Science Blueprint for 2020-2025 and the overarching themes that provide a framework for USDA’s science initiatives.
 - The remaining themes are new for this solicitation.
- This solicitation does not invite planning proposals. Planning activities may be a feature of future solicitations in this program.
- Limit on Number of Proposals per Organization: This solicitation imposes a limit on the number of proposals that may be submitted by an organization.
- Limit on Number of Proposals for Senior Personnel: An individual may be designated as senior personnel on at most one project team submitting to this solicitation. Note that this is equivalent to the restriction in the prior solicitation for that competition’s “Institute Track”.
- Agency partners on this solicitation have changed.
- With this solicitation, NSF expands the sponsors to include partners from industry, who share NSF’s commitment to increasing national competitiveness in AI and have indicated an interest in the themes called out in this solicitation. Details of these partnerships are spelled out in the program description.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 20-1), which is effective for proposals submitted, or due, on or after June 1, 2020.

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 2019 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 has published [Recommendations for Strengthening American Leadership in Industries of the Future](#), including AI, and calls for new and sustained research in AI to drive science and technology progress. The National AI Research Institutes program enables longer-term research and U.S. leadership in AI through the creation of AI Research Institutes.

This program is a joint government effort between the National Science Foundation (NSF), U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA), U.S. Department of Homeland Security (DHS) Science & Technology Directorate (S&T), and the U.S. Department of Transportation (DOT) Federal Highway Administration (FHWA). New to the program this year are contributions from partners in U.S. industry who share in the government’s goal to advance national competitiveness through National AI Research Institutes. This year’s industry partners are Accenture, Amazon, Google, and Intel Corporation. This program solicitation invites proposals for full institutes that have a principal focus in one or more of the following themes, detailed in the Program Description:

- Theme 1: Human-AI Interaction and Collaboration
- Theme 2: AI Institute for Advances in Optimization
- Theme 3: AI and Advanced Cyberinfrastructure
- Theme 4: Advances in AI and Computer and Network Systems
- Theme 5: AI Institute in Dynamic Systems
- Theme 6: AI-Augmented Learning
- Theme 7: AI to Advance Biology
- Theme 8: AI-Driven Innovation in Agriculture and the Food System

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 Institutes Program Team, telephone: 703-292-5111, email: AIInstitutesProgram@nsf.gov

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

- 10.310 --- USDA-NIFA Agriculture and Food Research Initiative
- 20.200 --- Highway Research and Development Program
- 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 --- Education and Human Resources
- 47.079 --- Office of International Science and Engineering
- 47.083 --- Office of Integrative Activities (OIA)
- 97.108 --- Department of Homeland Security, Science & Technology Directorate

Award Information

Anticipated Type of Award: Cooperative Agreement

Estimated Number of Awards: 8

NSF plans to make approximately 8 Institute awards.

Anticipated Funding Amount: \$128,000,000 to \$160,000,000

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 labs, professional societies and similar organizations in the U.S. 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 proposals to this solicitation as lead institution. Organizations wishing to contribute to more Institute proposals are encouraged to participate as non-lead organizations in Institute proposals in a manner that helps to create significant new research capabilities in new centers of AI leadership throughout the country. In the event that an organization exceeds these limits, proposals will be accepted based on earliest date and time of proposal submission, i.e., the first two proposals will be accepted, and the remainder 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 project team submitting to this solicitation. In the event that an individual exceeds this limit, proposals will be accepted based on earliest date and time of proposal submission, i.e., the first 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 Proposal Submission:** Not required
- **Full Proposals:**
 - Full Proposals submitted via FastLane: *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:**

The following instructions apply to awards made by USDA-NIFA:

For awards made by USDA-NIFA, Section 1462(a) and (c) of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (NARETPA) limits indirect costs for the overall award to 30 percent of Total Federal Funds Awarded (TFFA) under a research, education, or extension grant. The maximum indirect cost rate allowed under the award is determined by calculating the amount of indirect costs using:

1. the sum of an institution's negotiated indirect cost rate and the indirect cost rate charged by subawardees, if any; or
2. 30 percent of TFFA (TFFA = Field K., Total Costs and Fee, on SF-424 R&R Budget).

The maximum allowable indirect cost rate under the award, including the indirect costs charged by the subawardee(s), if any, is the lesser of the two rates.

If the results of 1), is the lesser of the two, the grant recipient is allowed to charge the negotiated indirect cost rate on the prime award and the subaward(s), if any. Any subawards would be subject to the subawardee's negotiated indirect cost rate. The subawardee may charge its negotiated indirect cost rate on its portion of the award, provided the sum of the indirect cost rate charged under the award by the prime awardee and the subawardee(s) does not exceed 30 percent of the TFFA.

If the result of 2), is the lesser of the two, then the maximum indirect cost rate allowed for the overall award, including any subaward(s), is limited to 30 percent of the TFFA. That is, the indirect costs of the prime awardee plus the sum of the indirect costs charged by the subawardee(s), if any, may not exceed 30 percent of the TFFA.

In the event of an award, the prime awardee is responsible for ensuring the maximum indirect cost allowed for the award is not exceeded when combining indirect costs for the Federal portion (i.e., prime and subawardee(s)) and any applicable cost-sharing (see 7 CFR 3430.52(b)). Amounts exceeding the maximum allowable indirect cost is considered unallowable and will be handled accordingly. See sections 408 and 410 of 2 CFR 200.

- **Other Budgetary Limitations:**

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

C. Due Dates

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

December 04, 2020

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.

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I. INTRODUCTION

AI is advancing rapidly, enabled and significantly fueled by Federally-funded basic 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; that 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.

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, this solicitation does not include in its scope work 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 emotion and affect 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 basic 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, use-inspired research 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 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 between foundational and use-inspired research, where foundational results provide a starting point for use-inspired research, and the results from use-inspired research are generalized and made foundational.

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 2019 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 has published [Recommendations for Strengthening American Leadership in Industries of the Future](#), including AI, and calls for new and sustained research in AI to drive science and technology progress. The National AI Research Institutes program enables longer term research and U.S. leadership in AI through the creation of AI Research Institutes.

II. PROGRAM DESCRIPTION

The National AI Research Institutes program – a joint effort of NSF, USDA-NIFA, DHS S&T, DOT FHWA, and several industry partners – will fund Institutes comprising scientists, engineers, and educators united by a common focus on advancing the research frontiers in AI. 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, adding significant new knowledge and understanding to the disciplinary areas associated with 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. These lines of research should be grounded in and integrated with broader foundational theories, paradigms, and architectures for computing and communication.
- 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 education 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.
- 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 the Nation's undergraduates, graduate students, and post-doctoral researchers, as well as through community colleges and skilled technical workforce training and other opportunities 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 traditionally 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.
- 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 broaden participation from underrepresented groups 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**, creating an organization that encourages the continuing growth of collaborations with external partners to bring together people, ideas, problems, and technical approaches for maximum impact. As nexus points, Institutes have the potential to bring together the best teams and approaches from institutions of higher education, federal agencies, industry, and nonprofits/foundations. They 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

This solicitation will support cooperative agreements of between \$16,000,000 and \$20,000,000 for between four and five years (\$4,000,000 per year on average). Proposals outside this range may be returned without review. Institute proposals must convey clear and concrete plans for foundational AI research, use-inspired motivation and technology transition opportunities, the education and workforce development activities to be undertaken, and plans for multidisciplinary research community building appropriate to the proposed Institute's vision and mission.

In this round of Institutes, proposals are being solicited in the following high-priority areas. Submissions **MUST** have as a principal focus one or more of the following themes. It is advisable that a proposal address multiple themes only in cases where significant activity is planned in the six desiderata for Institutes for each theme addressed.

Theme 1: Human-AI Interaction and Collaboration

AI has significant potential to improve productivity across a growing range of domains. Many of the most impactful uses of AI are in augmenting human abilities; therefore, it is critical to make human and AI collaboration more productive, robust, and fair. To that end, research in the Institute will uphold high standards of scientific excellence and ethics, emphasizing aspects such as inclusive design, being socially beneficial, avoiding unjust bias, and being built and tested for safety, accountability and privacy principles.

An Institute for Human-AI Interaction and Collaboration will support research on all of the modalities through which people can collaborate with intelligent machines toward common goals. Interaction can occur through spoken or written natural language, visual interaction, gesture, body language, affective sensing, tactile and physical interaction, graphical user interfaces, mixed and augmented reality environments, and combinations of these modalities. Most human-AI systems today handle only short, unambiguous exchanges between human and AI. To surpass this limitation, research at the Institute will develop principles and methods for systems that support multi-step interactions and use rich context. This research should encompass multi-user and multi-AI interaction in order to address teamwork in mixed human-AI groups.

AI systems exist across a range of domains, but significant opportunity remains for humans to truly collaborate with AI systems. A key aspect of all work conducted by the Institute will be establishing confidence that AI systems are operating on fair and transparent principles that can be understood and vetted by the community and appropriately modified by stakeholders. Researchers will develop methods for AI systems to learn the goals and preferences of humans during interaction in order to support trustworthy and safe collaboration. Principles include, but are not limited to, ethics, fairness, privacy, lack of deception, explainability, protection of vulnerable and protected populations, and participatory and inclusive design. Research in the Institute should transcend one-size-fits-all solutions for human-AI interaction by, for example, taking an inclusive approach to assessing how personal and social values are embedded in AI systems, accounting for communication conventions that vary among different cultural and linguistic communities, and developing principles and systems that are accessible and adaptive to persons with varying abilities and disabilities.

In addition to developing general methods and technologies, the Institute will include use-inspired research involving multiple domains of human-AI interaction and collaboration. Domains could include healthcare, education, commerce, emergency response, digital assistants, transportation, manufacturing, or any other domain where fluid human-AI interaction and teaming is important.

An important objective of the Institute will be to create new scientific methods, measurement and analysis techniques, effective metrics and engineering best practices for verification, validation, and performance monitoring of human-AI collaboration systems that are robust and generalizable for operation in real-world environments. The research will also demonstrate the effectiveness of these new testing methodologies using one or more domains of real-world applications as described above.

The Institute is encouraged to be broadly multidisciplinary, integrating, as appropriate, fields such as linguistics, robotics, accessibility and human factors, psychology and cognitive science, sociology, ethics, technology studies, and other fields. Fundamental theory, system development, and responsible transition to practice will be supported in the Institute. In addition to research, the Institute will support programs for training students to work effectively in interdisciplinary teams and to go on to become the next generation of leaders in human-AI interaction.

Amazon and Google are each providing partial support for this Institute theme.

Theme 2: AI Institute for Advances in Optimization

The AI Institute for Advances in Optimization will bring together researchers in constraint satisfaction and search, machine learning, operations research, theoretical computer science, and related fields (such as automated design, signal processing, circuits and systems, etc.) to develop powerful new tools for solving previously "impossible" large-scale problems in planning, resource allocation, strategic reasoning, network and system design and optimization, hardware and software design and verification, and general combinatorial optimization and search. The Institute will support a virtuous cycle of fundamental and use-inspired research such that work on challenging real-world problems will inspire the creation of new general approaches that in turn will find applications in diverse domains.

Researchers will explore ways to integrate perspectives from both classical constrained and unconstrained optimization, such as branch and bound and cutting planes, algorithms and modern data-driven approaches such as reinforcement learning. These methods, along with recent theoretical breakthroughs in AI, theory of computing, and operations research, will enable highly efficient combinatorial search to tackle foundational challenges that include, but are not limited to, highly non-linear constraints and objective functions (including complex logical constraints, mixed discrete and continuous actions, and novel objective functions); very large state spaces and action spaces; multiple objective functions; uncertainty over the state of the world or the objective function itself; constraint-driven design; multiple agents, including antagonistic settings; communication-efficient distributed optimization; and optimization on multiple time scales and time-varying graphs. Research on data-driven optimization methods will tackle the central problem of improving generalization within and between problem domains to drastically reduce the amount of training data required. The research may include rigorous analysis and provable performance guarantees. The Institute may also include work on human-assisted design and optimization, in which algorithms can include human interaction or can learn from human demonstration.

End use-cases that inspire these challenges include but are not limited to automated chip design and verification, automated machine learning, infrastructure management, production planning, design of wireless networks, transportation and logistics, and allocation of physical or natural resources. In order to ensure generality of results, an Institute should include work on multiple use cases, where at least some of the use cases involve automated design or management of computer systems, software, or hardware.

Researchers from computational and mathematical disciplines will work closely with domain experts in order to understand the limitations of current modeling and solution approaches and to propose new approaches. They will seek to develop methods that ensure security, safety, and reliability in order to support mission-critical applications. The Institute will propose ways to capture the value of newly developed algorithms in reproducible tools or platforms that enable the broader community to apply these methods to multiple domains.

The Intel Corporation is providing partial support for this Institute theme.

Theme 3: AI and Advanced Cyberinfrastructure

Advanced cyberinfrastructure (CI) has become an essential component of modern scientific discovery. A next-generation advanced CI tightly integrated with artificial intelligence technologies can transform the way science is performed and accelerate the ability to address pressing grand challenges in science and engineering (S&E). Advanced CI is also a key enabler for advancing AI research and practice. Translational research activities at an Institute for AI and Advanced CI will seek the acceleration and transformation of AI research and practice enabled by advanced CI, and the integration of AI technologies toward a smarter, robust, and more effective CI ecosystem.

Activities of an Institute for AI and Advanced CI might be in one or both of the following focus areas:

- *Development of next-generation advanced CI powered by AI technologies.* AI has the potential to significantly improve and transform advanced CI in terms of its performance, scalability, interoperability, robustness, security, usability, maintainability, and energy efficiency. AI-integrated advanced CI can also support increased transparency and reproducibility and enable novel S&E application formulations. Translational research activities at this Institute may focus on how AI technologies (including, but not limited to, machine learning, deep learning, knowledge representation, logical and probabilistic reasoning, and AI-based decision-making mechanisms) can inform and transform the design and operation of all aspects of advanced CI, including computing, software, data, networking, and application workflows.
- *Acceleration and transformation of AI research enabled by advanced CI.* Revolutionary advances in CI capabilities and services can significantly reduce the time and effort required for the complex computations and the demanding data management requirements of AI research and can enable novel AI methods and applications. Advanced CI components that are carefully tailored and tuned for AI workloads potentially offer orders of magnitude improvement in the performance and scale of AI computations. Advanced CI can also provide support for transparency and explainability of AI methods and enable novel AI-based S&E application formulations. Translational research activities at this Institute may focus on how the nation's advanced CI, including computing, software, data, networking, and application workflows, can be used to accelerate and transform AI research and its applications.

The above list is provided only as an illustration of the potential scope of an Institute for AI and Advanced CI. AI innovations are likely to be transferable to other advanced CI components, and advanced CI can likely transform AI in other potential ways. Proposers are encouraged to consider other aspects of an Institute under this theme based on their vision, expertise, and collaborations, and driven by S&E use-cases. The Institute should also include an integrated component focused on the development of a skilled workforce at the intersections of AI and advanced CI that can bridge CI design and development to AI research and its application to different domains. Proposers should note that the translational nature of CI research is emphasized by this Institute — that is, building on basic research results and spanning the design to practice stages. Foundational research on computing systems and networking is not within the scope of this Institute.

Theme 4: Advances in AI and Computer and Network Systems

This theme considers both how AI techniques can be used to advance computer and network systems, and how advances in computer and network systems can improve AI applications. Research in this theme should put forward transformative ideas that address both long-standing and emerging challenges in computer and network systems, broadly defined. Computer systems can range from cloud computing systems and datacenters, to edge-computing systems and embedded and real-time systems with networks ranging from wireless cellular and sensor networks to datacenter and Internet-scale networks.

AI innovations may be applied to the design and deployment of computer and network systems across one or more domains. For example, AI techniques may address issues of performance, reliability, and security in networked computer system components such as operating systems, middleware, storage systems, and multi and many core processors. Innovations in AI may inform how to partition, schedule or replicate software processes to improve system utilization and real-time performance where applicable and dictated by target applications. Research may employ AI innovations on re-architecting hardware systems to remove computing, memory, storage, and networking performance bottlenecks for target applications. AI may be harnessed for management and control systems of wired and wireless networks, or integration thereof. Of interest are AI-driven autonomous network systems for network configuration and robustness. These include autonomous systems that dynamically enable efficient resource management while meeting stringent and diverse application requirements and ensuring network and service resilience. AI innovations may be used to design resiliency to deal with hardware and service interruptions and outages. Innovative approaches to computer and network security in existing networked systems or new secure-by-design systems enabled by the application of AI are of interest. Solutions may improve data and user privacy to prevent information leakage to unauthorized applications, services, or humans, and enhance resiliency against adversarial attacks. New systems and architectures employing AI should be scalable, explainable, responsive, and self-correcting while avoiding system instability.

Improved computer and network system designs may facilitate an expansion of the usage and impact of AI applications. Advances in network and storage system approaches to improve the scalability, security and performance of AI applications are of interest. These include innovations to deploy AI applications on distributed environments, resource constrained systems, and real-time distributed systems. Advances in heterogeneous architectures for AI accelerations may be considered, as well as the programming environments needed for advanced heterogeneous AI systems. Designs may improve performance of AI applications across many metrics and consider many tradeoffs, including performance, accuracy, timeliness, and energy usage. Advances in computer and network systems to enable AI applications to operate with integrity, confidentiality, resilience, and robustness are of interest.

Proposals may address any range of ideas that demonstrate how the Institute will advance both AI and research areas supported by the Division of Computer and Network Systems. Proposals may identify use cases that demand the capabilities explored in the proposed research and should describe a substantial evaluation plan, including datasets to be used, modeling and simulation techniques and platforms, and prototypes to demonstrate feasibility. Where appropriate, such as where use cases and/or applications interact with people or human systems, proposals should explore human, social, policy or ethical considerations in formulating the research problems, making design decisions, developing use cases and applications, and anticipating the potential social and societal impacts of the research. In such cases teams should include researchers from the relevant areas of social sciences, ethics, and/or policy.

Theme 5: AI Institute in Dynamic Systems

An AI Institute in Dynamic Systems supports research and education in fundamental AI and ML theory, algorithms, and use-inspired engineering and science for real-time sensing, learning, decision making and predictions that lead the way towards safe, reliable, efficient, and ethical data-enabled engineering and science systems. Many natural and human-built systems are described by complex physical dynamics, and the combination of data-driven approaches with physics-based models and experiments can enhance understanding of these systems and facilitate intelligent decision making.

The AI Institute in Dynamic Systems will balance foundational advances in data science, machine learning, and AI with innovative domain research to enable transformative new capabilities for dynamic engineering systems. Challenges to the deployment of AI for these applications include requirements for safety and reliability, the desire to respond to uncertain and time-varying conditions in real-time with performance and stability bounds, and the need to make appropriate decisions based on small amounts of data over short time horizons. Perspectives of interest may include control theory, optimization, probability, statistics, signal processing, and information theory. Data-driven methods that make effective use of experiments and analytical models are of particular interest.

AI models may be used for engineering design, prediction, and decision making. Failure of AI-powered engineering systems may result in significant human and economic losses. Safety and reliability of AI are therefore of critical importance in such applications. Uncertainty quantification and sensitivity analysis need to be made explicit for data of high sparsity, variations, and diverse types, as well as with noise. The ability to handle sparse datasets and improved measures of reliability for verifying robustness and correctness of an AI system are desired. Interpretability and physical consistency are a priority in engineering applications, where ethics, trust, and understanding bias are also key considerations.

The AI Institute in Dynamic Systems may be built around a specific core set of application domains; however, it is expected that the Institute will serve as a research and education resource for external groups seeking guidance on the use of AI methods to address difficult problems in data-driven dynamic real-time decision making. The Institute structure should include clear mechanisms to facilitate collaborations to bring the unique capabilities of AI to engineering and scientific application areas critical to the national health, prosperity, and infrastructure. These include, but are not limited to, electric power transmission, transportation and mobility, water and food distribution, biomedical devices, human-machine interfaces, healthcare logistics and delivery systems, advanced

manufacturing, chemical and biological processes, transport processes, energy conversion and storage systems, sustainable built and natural environment, smart and connected communities, and geophysical systems.

Successful proposals for the AI Institute in Dynamic Systems will promote a beneficial integration of foundational and use-inspired AI research, in which a close coordination between the real-time sensing, learning, and decision-making research will have the most impact. Successful proposals will also include a synergistic approach for integrating research and training of future experts in the field. The proposals should describe a plan to make the datasets generated within the Institute publicly available and accessible to the research community.

Theme 6: AI-Augmented Learning

The primary focus of an AI-Augmented Learning institute includes research and development of AI-driven innovations to radically improve human learning and education writ large – in formal settings (e.g., undergraduate, graduate, vocational education, K-12), training, on-the-job, and across the lifespan as well as informal settings (e.g., museums, nature centers, libraries; TV/film; crowd-sourcing and citizen science; on-line experiences). This could be in support of cognitive, neural, perceptive and affective processes as well as well-defined learning outcomes in STEM fields, and STEM-enabling content such as literacy, self-regulation, creativity, curiosity, communication, collaboration and social skills. Augmentation at the level of the individual learner could include intelligent support for personalized and adaptive learning with a focus on learner agency, engagement, and interest-driven exploration. In addition to standard implementations, this could include, for example: AI augmentation for persons with disabilities to provide image interpretation and description while learning; natural language technologies that automatically adapt technical material to the learner's level of understanding; explanatory machine learning to facilitate learners in exploring new environments; and augmented perception to support learning and communication.

Augmentation in support of collaborative learning could include both human-human and human-computer partnerships with careful attention to the role of human teachers/educators, mentors, and collaborators in complex ecosystems. Such collaborative intelligent learning systems could include, for example, research on the design of conversational agents, intelligent cognitive assistants, supportive multimodal dashboards, or social robots.

An important purpose of this Institute is also to work toward a grand challenge of "Education for All" through research of AI-supported learning systems to radically expand access of learning to all Americans and in response to the rapidly changing landscape of jobs and work. This is aligned with a key recommendation from [America's Strategy for STEM Education](#) to "Expand Digital Platforms for Teaching and Learning" through next-generation learning architectures. Here, research could include the design and implementation of AI technologies through highly adaptable and distributed systems to expand access, equity, and depth of learning across diverse people, institutions, and settings. Advances in data science could provide diagnostic information to support formative, continuous, and summative assessments, as well as skill and aptitude discovery, drawing upon multimodal and smart and connected data. Projects should include systematic plans to address algorithmic bias, provide model transparency and support data privacy and security in the support of learning.

In addition to soliciting an Institute that reflects any of the above learning-related themes, we are also soliciting an institute that has a primary emphasis in AI-Augmented Adult Learning. Proposals with this focus could advance research in AI techniques to focus on adult learning in the context of technologies and work environments of the future, including the spectrum of AI fields. This could include AI-driven research in adult learning for specific industries or more broadly to address reskilling/upskilling and workforce trajectories.

Accenture is providing partial support for this Institute theme.

Theme 7: AI to Advance Biology

Advances in biological instrumentation and technological methodologies continue to spur high-resolution exploration and characterization of biological components, processes and systems leading to increasingly large data sets of disparate forms, types, and scales. Given the unprecedented amount of biological data that continue to be generated, traditional analytical approaches are no longer efficient or scalable. New methods, high-performance computing architectures, modeling tools, workflow design, and data visualization schemes, among others, are needed. This Institute theme seeks bold AI-based advances and information infrastructure to push the frontiers of biology, increase our understanding of complex systems, and provide a theoretical basis for original research across the biological sciences. Examples of challenges and activities under this theme include but are not limited to the following.

- AI-based infrastructure for intelligent data parsing, multimodal and/or multiscale information aggregation and integration of data from disparate scientific communities. Platforms would enable increased cross-disciplinary collaborations to address key challenges in biology.
- Development of algorithms and biocomputing architectures to mine heterogeneous data sources, including semi-structured, spatio-temporal, streaming, literature, and crowd-sourced data, to discover knowledge on biological processes, phenomena, and systems, with a view to support hypothesis generation and testing.
- AI and data-driven methods for exploring and quantifying scale-invariant properties, discovery of causal interactions in biology; biology-driven approaches to solve the critical bottlenecks in AI for biological research such as learning from fewer labelled samples and/or trials, incomplete data sets, learning to reason, and learning to model complex biological action sequences.
- Integration of AI and mechanistic modeling approaches to both facilitate the development of AI/ML models and enhance theory-driven platforms for modeling biology, and to address challenges associated with sparse datasets and biological complexity, which will enable the development of well-parametrized, predictive models across biological scales for the discovery of informative phenotypes and mechanisms.
- Algorithms, methods, and systems that facilitate the interpretability or explanation of AI models for biological data, i.e., "explainable AI" (XAI), which goes beyond traditional AI systems for sample or event prediction or knowledge representation. A goal of such XAI might be to enable modeling and mechanistic interpretation of regulation of biological components within the same or across different scale(s) in order to suggest causal relationships in biology rather than correlations or other statistical associations.
- AI-enabled modeling and analysis platforms for prescriptive design of synthetic systems or controlled perturbation of natural systems, which will expedite the development of biotechnology tools and systems that drive the bioeconomy and enable industries of the future.
- Efficient architectures to optimize the system performance and efficiency without re-training or learning models when dealing with new data types, such as going from tissue next-generation sequencing (NGS) to single cell NGS, or extending the framework to different data modalities.

Since such applications of AI to biological problems will ultimately require observation and hypothesis testing, the Institute should incorporate directed efforts to build transdisciplinary teams made up of researchers led or co-led by biologists with appropriate domain knowledge as well as AI researchers and data scientists. These efforts should be synthetic, with deep and sustained engagement of biological and computer scientists to integrate their expertise and needs in the research focus of the Institute. Finally, the Institute should develop plans to train a unique group of scientists with skills in modern biological sciences and AI who will be capable of leveraging knowledge and technologies of both disciplines to further advance both disciplines and stimulate applications that drive the bioeconomy.

Human biomedical or clinical research is outside the scope of this theme. Proposals focused on biomedical applications of AI or specific human disease targets will be returned without review .

Theme 8: AI-Driven Innovation in Agriculture and the Food System

Food and agricultural enterprise today face major challenges. By 2050, agriculture will need to produce 70% more food over current levels, while also reducing the impact on the environment. Not only is the demand for food growing, so is agricultural system complexity. The USDA [Science Blueprint for 2020-2025](#) presents several themes where technology can meet these challenges, including sustainable intensification, climate adaptation, food and nutrition translation, and value-added innovations; the latter of which includes creation of new domestic supply chains for agriculture. Advancing and deploying new approaches and applications of AI is a natural extension to agricultural production and food security. There are numerous opportunities to apply transformative, user-inclusive data-driven research methods and algorithm development to the food and agricultural sector to yield meaningful insights, predictive tools, and real-time solutions for production; food processing; transportation and storage; wholesale and retail marketing; and high-quality products and information for consumers.

AI applied strategically throughout agriculture and food production systems may spur the next revolution in food and feed production. The Green Revolution of the 1960s greatly enhanced food production and resulted in positive impacts on food security, human health, employment, and overall quality of life for many. There were also unintended consequences on natural resource use, water and soil quality, and pest population expansion. An AI-based approach to agriculture can go much further by addressing whole food systems, inputs and outputs, internal and external consequences, and issues and challenges at micro, meso, and macro scales that include meeting policy requirements of ecosystem health.

There are critical challenges associated with the adoption of AI in agriculture. The success of AI will depend on engaging and connecting stakeholders. Social engagement on the processes and products of AI will be critical for assessing social acceptance and implications of the rapid expansion of the technology. While challenges in methods, data, privacy, and fairness are universal to the broader AI endeavor, these considerations take on particular urgency when associated with a need as fundamental as the food supply. AI Research Institutes that simultaneously advance foundational AI research and agriculture and food systems might address a wide range of research foci, build new multidisciplinary communities, and create the workforce needed for an AI-powered revolution in agriculture. Examples of such activities might include the following.

- Advanced breeding methods and outcomes in plants and animals. AI-powered systems may explore genetic x environment x management x socioeconomic interactions (G x E x M x S) in order to predict economic and environmentally sustainable agricultural production methods.
- Developing and implementing smart, digitally driven science and technology, targeted at precision agriculture, nutrient management, climate adaptation and ecosystem health, food production and processing, improving consumer health, and value-added innovation.
- Forging collaborative solutions across sectors to the barriers and gaps in AI technology applications in agriculture.
- Addressing labor shortages, alternatives, and enhanced labor productivity.
- Engaging farmers, laborers, and consumers through agricultural extension in AI-based technology development, adoption, and diffusion of AI-based technologies throughout the food system.
- Addressing methods to enhance, preserve, and protect environmental and natural resources associated with agriculture and food production. This may include AI supported approaches to meet policy requirements for ecosystem health as affected by Agriculture.
- Developing novel approaches to education and training for K-12, undergraduate, and graduate learners. Developing learner approaches for training and retraining of operators and agricultural labor forces.
- Enhancing and expanding critical methods and use of AI agricultural sciences (e.g., plant, animal, agronomic, economics).

The above list is intended only to be illustrative of the potential scope of an Institute in this area; it is not to be taken as either prescriptive or limiting. AI innovations are likely to be transferable to, or informative for, other agricultural application areas and to other themes across this overall initiative. We encourage cross collaboration and sharing of information, where possible and through various forums to further enhance expanding opportunities with AI. Efforts resulting from the theme will ideally support the research, education, extension, and economics endeavors designed to advance public knowledge and responsible commercial interests.

II.C. Industry Funding Partners in this Solicitation

Companies specifically listed in this solicitation have committed to providing annual unrestricted donations to the NSF for the purpose of funding Institutes in select themes awarded under this solicitation. The reference to "industry partners" in this section refers specifically to these entities and their role as funding partners 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. Specifically the following partners are contributing equally to support the following themes:

- Accenture: Theme 6, AI-Augmented Learning.
- Amazon: Theme 1, Human-AI Interaction and Collaboration.
- Google: Theme 1, Human-AI Interaction and Collaboration.
- Intel Corporation: Theme 2, AI Institute for Advances in Optimization.

Prior to award, these partner companies 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 partners the subset of proposals which are under consideration for funding by NSF in the associated themes, 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, partner companies 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 AI 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.

Awardees shall grant to the sponsoring parties (the Federal Government and any industry partners involved in funding that awardee) a non-exclusive, worldwide, royalty-free, sub-licensable license to all intellectual property rights in any inventions or works of authorship resulting from research conducted under the joint award. (Note: this requirement is consistent with the Bayh-Dole Act, which provides rights to the US Government for patents on inventions made under federal funding.) The publishing of data and software describing inventions may be delayed to first permit the filing of patent applications. That said, awardees will promptly publish all results, data, and software generated in performance of the research.

Industry partners listed in this solicitation are not permitted to participate in any way as a collaborator (funded or unfunded) in a proposal to this solicitation. (This

restriction does not apply to Institutes funded under other solicitations in which the company was not a funding partner.) Proposals to this program may not list or describe any kind of agreed or assumed arrangement to use the contributions described above or any other collaborative arrangement with this solicitation's partner companies. Proposals that include such arrangements or collaborations with these partners will be returned without review. Exception: this limitation does not restrict the use of the widely-accessible products or services of a company.

Proposers to this program should not directly contact industry partners with questions pertaining to their company's participation in this solicitation. Direct all questions to the program points of contact listed in the solicitation.

II.D. Webinar Information

NSF will hold an informational webinar in September 2020. Shortly after publication of this solicitation, the date and registration information, will be posted on the Program Web page.

III. AWARD INFORMATION

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.

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 labs, professional societies and similar organizations in the U.S. 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 proposals to this solicitation as lead institution. Organizations wishing to contribute to more Institute proposals are encouraged to participate as non-lead organizations in Institute proposals in a manner that helps to create significant new research capabilities in new centers of AI leadership throughout the country. In the event that an organization exceeds these limits, proposals will be accepted based on earliest date and time of proposal submission, i.e., the first two proposals will be accepted, and the remainder 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 project team submitting to this solicitation. In the event that an individual exceeds this limit, proposals will be accepted based on earliest date and time of proposal submission, i.e., the first proposal will be accepted, and the remainder will be returned without review.

Additional Eligibility Info:

For proposals that designate USDA-NIFA as the requested funding agency, in accordance with the guidelines outlined in the Proposal Preparation Instructions, eligible applicants include: (1) State agricultural experiment stations; (2) Colleges and universities (including junior colleges offering associate degrees or higher); (3) University research foundations; (4) Other research institutions and organizations; (5) Federal agencies, (6) National laboratories; (7) Private organizations or corporations; (8) Individuals who are U.S. citizens, nationals, or permanent residents; and (9) any group consisting of two or more entities identified in (1) through (8).

Eligible institutions do not include foreign and international organizations.

The eligibility criteria for all other proposals, including those targeting a specific agency other than USDA-NIFA for sponsorship, are as listed under "Who May Submit Proposals" above. Proposals that do not meet these criteria, and do not explicitly designate USDA-NIFA as the requested funding agency in the Project Summary, will be returned without review.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

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

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal & Award Policies & 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. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.
- 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.C.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.

See PAPPG Chapter II.C.2 for guidance on the required sections of a full research proposal submitted to NSF. The solicitation addresses deviations from the PAPPG, addressing program-specific considerations for certain sections. Where not otherwise addressed, submissions must conform fully to the Proposal Preparation Instructions outlined in the NSF PAPPG, including all required *Sections of the Proposal* (https://www.nsf.gov/pubs/policydocs/pappg20_1/pappg_2.jsp#II.C.2). This includes Budget and Budget Justification; Current and Pending Support; Facilities, Equipment and Other Resources; Collaborators and Other Affiliations (COA); and Results of Prior NSF Support. Important Instructions: Due to the complexity of the proposals being submitted, use of FastLane 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. Linked collaborative proposals from multiple organizations will be returned without review.

1. Cover Sheet: The title of the proposal must be preceded by the letters "AI Institute: ". The title should describe the project in concise, informative language that is understandable to a technically-literate reader.

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. It should include an overview of the Institute description and rationale, its research objectives, education and workforce development activities, and community building activities. **Proposers must incorporate a Keywords section as the last line of the Project Summary, stating the Institute theme to which the proposal is submitted:** Human-AI Interaction and Collaboration; AI Institute for Advances in Optimization; AI and Advanced Cyberinfrastructure; Advances in AI and Computer and Network Systems; AI Institute in Dynamic Systems; AI-Augmented Learning; AI to Advance Biology; or AI-Driven Innovation in Agriculture and the Food System. If the proposal responds to multiple themes, list them all, with the most relevant one first. You may also choose to indicate any special emphasis in sectors relevant to partner agencies by including Keywords in your project summary to both identify those sectors; and you may also call special attention to an agency with e.g. "DHS" or "FHWA".

3. Project Description: The Project Description cannot exceed 25 pages including tables and illustrations. In addition to PAPPG requirements, the Project Description must include the following clearly-marked sections.

3a. 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.

3b. 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 both advances foundational research and leverages use-inspired research, and how these efforts will be integrated in service of the Institute's research vision. 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.

3c. 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 as well as 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).

3d. 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 through the participation of underrepresented groups, including women, minorities, and persons with disabilities, in all organizational levels of institute activities, and cite the relevant literature on effective practices. This could, for example, intentionally target specific combinations of groups (e.g., by race/ethnicity, gender and/or disability) with an analysis of how institute activities impact their participation in the AI workforce. 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 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.

3e. Collaboration and Knowledge Transfer: Describe how the Institute will be 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 policymakers) 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.

3f. 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 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. Biographical Sketches (2-page limit per person): Biographical sketches are required for the PI, any co-PIs, and each of the participating Senior Personnel listed in the Project Description. **IMPORTANT NOTE:** The NSF-approved format for preparation of the biographical sketch has changed. All biographical sketches submitted in response to this solicitation are expected to follow the NSF-approved format in accordance with the policy found at <https://www.nsf.gov/bfa/dias/policy/biosketch.jsp>.

6. Budget and Budget Justification: Provide a budget for each of the five years. FastLane 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. Funds also should be included 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. For collaborations with foreign organizations, see PAPPG Chapter II.C.2.j.

In accordance with proposal preparation instructions in the PAPPG (https://www.nsf.gov/pubs/policydocs/pappg20_1/pappg_2.jsp#IC2g), if salary and person months are not being requested for an individual designated as senior personnel, they should be removed from Section A of the budget. Their role(s) on the project should be described in the Facilities, Equipment and Other Resources section of the proposal.

7. 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.

8. Special Information and Required Supplementary Documents

- *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.
- *Postdoctoral Researcher Mentoring Plan*. Per the PAPPG, required if funds for postdocs are included on the budget. 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.
- *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. Letters of Collaboration will be provided in the Supplementary Documents section of the proposal and should follow the format instructions recommended in the NSF PAPPG.
 - 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 (https://www.nsf.gov/pubs/policydocs/pappg20_1/index.jsp).
 - As stated in the Program description, Industry partners listed in this solicitation are not permitted to participate in any way as a collaborator (funded or unfunded) in a proposal to this solicitation. Proposals that include letters of collaboration or any other indication of the participation or support of the industry partners listed in this solicitation will be returned without review .
- *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:
 1. Mary Smith; XYZ University; PI
 2. John Jones; University of PQR; Senior Personnel
 3. Jane Brown; XYZ University; Postdoctoral Researcher
 4. Bob Adams; ABC Community College; Paid Consultant
 5. Susan White; DEF Corporation; Unpaid Collaborator
 6. Tim Green; ZZZ University; Subawardee

9. Current and Pending Support. Provide current and pending support information for all senior personnel on the project. All current and pending support documents submitted in response to this solicitation are expected to follow the NSF-approved format in accordance with the policy found at: <https://www.nsf.gov/bfa/dias/policy/cps.jsp>.

10. Single Copy Documents

Required:

- Collaborators and Other Affiliations Information:

Proposers should follow the guidance specified in [Chapter II.C.1.e](#) of the NSF PAPPG.

Optional:

- List of suggested reviewers or reviewers not to include;
- Identification of proprietary or privileged information (if applicable).

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Indirect Cost (F&A) Limitations:

The following instructions apply to awards made by USDA-NIFA:

For awards made by USDA-NIFA, Section 1462(a) and (c) of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (NARETPA) limits indirect costs for the overall award to 30 percent of Total Federal Funds Awarded (TFFA) under a research, education, or extension grant. The maximum indirect cost rate allowed under the award is determined by calculating the amount of indirect costs using:

1. the sum of an institution's negotiated indirect cost rate and the indirect cost rate charged by subawardees, if any; or
2. 30 percent of TFFA (TFFA = Field K., Total Costs and Fee, on SF-424 R&R Budget).

The maximum allowable indirect cost rate under the award, including the indirect costs charged by the subawardee(s), if any, is the lesser of the two rates.

If the results of 1), is the lesser of the two, the grant recipient is allowed to charge the negotiated indirect cost rate on the prime award and the subaward(s), if any. Any subawards would be subject to the subawardee's negotiated indirect cost rate. The subawardee may charge its negotiated indirect cost rate on its portion of the award, provided the sum of the indirect cost rate charged under the award by the prime awardee and the subawardee(s) does not exceed 30 percent of the TFFA.

If the result of 2), is the lesser of the two, then the maximum indirect cost rate allowed for the overall award, including any subaward(s), is limited to 30 percent of the TFFA. That is, the indirect costs of the prime awardee plus the sum of the indirect costs charged by the subawardee(s), if any, may not exceed 30 percent of the TFFA.

In the event of an award, the prime awardee is responsible for ensuring the maximum indirect cost allowed for the award is not exceeded when combining indirect costs for the Federal portion (i.e., prime and subawardee(s)) and any applicable cost-sharing (see 7 CFR 3430.52(b)). Amounts exceeding the maximum allowable indirect cost is considered unallowable and will be handled accordingly. See sections 408 and 410 of 2 CFR 200.

Other Budgetary Limitations:

Cost Sharing Requirements for awards made by USDA-NIFA:

In accordance with 7 USC 450i(b)(9), if a funded applied **Research or Integrated Project** with an applied research component, is commodity-specific and not of national scope, the grant recipient is required to match the USDA funds awarded on a dollar-for-dollar basis from non-Federal sources with cash and/or in-kind contributions.

For Equipment Grants: The amount of Federal funds provided may not exceed 50 percent of the cost of the equipment acquired using funds from the grant, or \$50,000, whichever is less. Grantees are required to match 100 percent of Federal funds awarded from non-Federal sources. The Secretary of Agriculture may waive all or part of the matching requirement if all three of the following criteria are met: (1) applicants must be a college, university, or research foundation maintained by a college or university that ranks in the lowest one third of such colleges, universities, and research foundations on the basis of Federal research funds received (see Additional Eligibility Information for proposals that designate USDA-NIFA as the requested funding agency); (2) if the equipment to be acquired using funds from the grant costs not more than \$25,000; and (3) has multiple uses within a single research project or is usable in more than one research project. If the organization believes it is eligible for the waiver for matching funds, the budget justification must include a letter signed by the organization's administrative representative stating this information. USDA-NIFA will consider this justification when ascertaining final matching requirements or in determining if required matching can be waived. USDA-NIFA retains the right to make final determinations regarding matching requirements.

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

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

December 04, 2020

D. FastLane/Research.gov/Grants.gov Requirements

For Proposals Submitted Via FastLane or Research.gov:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. 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/ProposalPreparationandSubmission.html. For FastLane or Research.gov user support, call the FastLane and Research.gov Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov or rgov@nsf.gov. The FastLane and Research.gov Help Desk answers general technical questions related to the use of the FastLane and Research.gov systems. 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 the NSF FastLane system for further processing.

Proposers that submitted via FastLane or 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 *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. 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.C.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.C.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 underrepresented minorities 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:

- How well does the proposed Institute **advance foundational AI research** in areas of direct relevance to AI, and in areas in clear need of larger efforts over longer timeframes?
- How well does the proposed Institute **conduct use-inspired research** that both informs foundational AI advances and drives innovations in related sectors?
- How well does the proposed Institute **actively nurture and grow the next generation of talent** for a diverse, well-trained workforce?
- To what extent is the proposed Institute activity **comprised of a multidisciplinary group of scientists, engineers, and educators** appropriate to the project?
- 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?
- How well does the proposed Institute activity serve as a **nexus point for collaborative efforts** meaningfully integrated into 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.

Initial selection of proposals for the award of AI Research Institutes will be reviewed by a Review Panel augmented as necessary with *ad hoc* reviews, and possibly followed by a reverse site visit. 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.

DHS S&T and DOT FHWA Process: Proposals will be selected for funding in accordance with the standard NSF procedures, as described below. Awards will be issued by NSF using funds transferred from DHS S&T and/or DOT FHWA to NSF, respectively.

NIFA Process: Proposals will be selected for funding by NIFA based on the results of the NSF peer review process. Proposals selected for funding by NIFA will be forwarded to the NIFA Awards Management Division for award processing in accordance with the NIFA procedures.

NSF Process: Those proposals selected for funding by NSF will be handled in accordance with standard NSF procedures, as described below. This process begins with drafting and releasing the solicitation, which includes program requirements.

The following text describes further the 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 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 a Grants Officer in the Division of Grants and Agreements. 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.

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.

Acknowledgement of Support

Awardees will be required to include appropriate acknowledgment of NSF and partner agency 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 USDA-NIFA, DHS, DOT, and/or industry 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, and may not receive funding through proposals. (For the purpose of proposals submitted for consideration by USDA-NIFA, this does not apply to USDA ARS. Any other inquiries should be directed to the relevant program contacts). 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.

USDA-NIFA Award Administration and Conditions:

Within the limit of funds available for such purpose, the USDA-NIFA awarding official shall make grants to those responsible, eligible applicants whose applications are judged most meritorious under the procedures set forth in this solicitation. The date specified by the USDA-NIFA awarding official as the effective date of the grant shall be no later than September 30 of the federal fiscal year in which the project is approved for support and funds are appropriated for such purpose, unless otherwise permitted by law. The project need not be initiated on the grant effective date, but as soon thereafter as practical so that project goals may be attained within the funded project period. All funds granted by USDA-NIFA under this solicitation may be used only for the purpose for which they are granted in accordance with the approved application and budget, regulations, terms and conditions of the award, applicable federal cost principles, USDA assistance regulations, and USDA-NIFA General Awards Administration Provisions at 7 CFR part 3430, subparts A through E.

Responsible and Ethical Conduct of Research

In accordance with sections 2, 3, and 8 of 2 CFR Part 422, institutions that conduct USDA-funded extramural research must foster an atmosphere conducive to research integrity, bear primary responsibility for prevention and detection of research misconduct, and maintain and effectively communicate and train their staff regarding policies and procedures. In the event an application to USDA-NIFA results in an award, the Authorized Representative (AR) assures, through acceptance of the award that the institution will comply with the above requirements. Award recipients shall, upon request, make available to USDA-NIFA the policies, procedures, and documentation to support the conduct of the training.

For information about USDA-NIFA's implementation of Responsible and Ethical Conduct of Research requirements, see <https://nifa.usda.gov/responsible-and-ethical-conduct-research>.

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.

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

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 industry activities and progress.

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

USDA-NIFA-specific Reporting Process:

The output and reporting requirements are included in the award terms and conditions (see <https://nifa.usda.gov/terms-and-conditions> for information about USDA-NIFA award terms). If there are any program or award-specific award terms, those, if any, will be identified in the award. PIs must also submit copies of reports directly to the cognizant Program Officers from NSF.

Other USDA-NIFA Requirements: Several federal statutes and regulations apply to grant applications considered for review and to project grants awarded under this program. These may include, but are not limited to, the ones listed on the USDA-NIFA web page: <https://nifa.usda.gov/regulations-and-guidelines>.

The USDA-NIFA Federal Assistance Policy Guide — a compendium of basic USDA-NIFA policies and procedures that apply to all USDA-NIFA awards, unless there are statutory, regulatory, or award-specific requirements to the contrary — is available at <http://nifa.usda.gov/policy-guide>.

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

For questions related to the use of FastLane or Research.gov, contact:

- FastLane and Research.gov Help Desk: 1-800-673-6188
FastLane Help Desk e-mail: fastlane@nsf.gov.
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:

- James Donlon
- Rebecca Hwa

For inquiries related to the responsiveness of your ideas for the Themes listed in this solicitation, please contact the program officers listed below.

Theme 1: Human-AI Interaction and Collaboration

- Balakrishnan (Prabha) Prabhakaran, CISE/IIS, bprabhak@nsf.gov
- Todd Leen, CISE/IIS, tleen@nsf.gov
- Tatiana D. Korelsky, CISE/IIS, tkorelsk@nsf.gov
- Amy L. Baylor, EHR/DRL, abaylor@nsf.gov

Theme 2: AI Institute for Advances in Optimization

- Roger Mailler, CISE/IIS, rmailler@nsf.gov
- Georgia-Ann Klutke, ENG/CMMI, gaklutke@nsf.gov
- Scott Acton, CISE/CCF, sacton@nsf.gov

Theme 3: AI and Advanced Cyberinfrastructure

- Tefvik Kosar, CISE/OAC, tkosar@nsf.gov
- James Donlon, CISE/IIS, jdonlon@nsf.gov

Theme 4: Advances in AI and Computer and Network Systems

- Matt Mutka, CISE/CNS, mmutka@nsf.gov
- James Donlon, CISE/IIS, jdonlon@nsf.gov

Theme 5: AI Institute in Dynamic Systems

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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](#).

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