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National Artificial Intelligence (AI) Research Institutes Accelerating Research, Transforming Society, and Growing the American Workforce

PROGRAM SOLICITATION
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

U.S. Department of Veterans Affairs

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

January 28, 2020

for Institute proposals in one of the six specified themes

January 30, 2020

for Planning proposals

IMPORTANT INFORMATION AND REVISION NOTES

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 19-1), which is effective for proposals submitted, or due, on or after February 25, 2019.

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 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.

This program, a joint effort of 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), U.S. Department of Transportation (DOT) Federal Highway Administration (FHWA), and U.S. Department of Veterans Affairs (VA), seeks to enable such research through AI Research Institutes. This program solicitation describes two tracks: Planning and Institute tracks. Submissions to the **Planning** track are encouraged in any areas of foundational and use-inspired research appropriate to NSF and its partner organizations. Proposals for the **Institute** track must have a principal focus in one or more of the following themes, detailed in the Program Description under "Institute Track":

- Trustworthy AI;
- Foundations of Machine Learning;
- AI-Driven Innovation in Agriculture and the Food System;
- AI-Augmented Learning;
- AI for Accelerating Molecular Synthesis and Manufacturing; and
- AI for Discovery in Physics.

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) 292-8074, 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: Standard Grant or Cooperative Agreement

Estimated Number of Awards: 9 to 14

NSF plans to make 1-6 Institute Awards and approximately 8 Planning Grants.

Anticipated Funding Amount: $24,000,000 to $124,000,000

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:

There are no restrictions or limits.

Limit on Number of Proposals for Senior Personnel: 2

An individual may be designated as senior personnel on no more than TWO project teams submitting to this solicitation. 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 the Institute track. In the event that an individual exceeds these limits, 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):

  January 28, 2020

for Institute proposals in one of the six specified themes

January 30, 2020

for Planning proposals

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 and addressing some of society's grand challenges. Specifically, AI Research Institutes may serve as national nexus points for collaborative efforts spanning institutions of higher education, federal agencies, industry, and nonprofits/foundations in such areas. They may 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 can 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 on 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 (including, for example, AI for security and security for AI), and the role of emotion and affect in the design and perception of increasingly-sophisticated machine intelligence.

Importantly, work in AI 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. For example, this solicitation supports advances in the theoretical explanations for the performance of and justification for use of AI and ML algorithms, including improved algorithms and analysis leading to greater accuracy and resource usage; game theoretic and economic aspects of AI and ML algorithms, such as mechanism design, information elicitation, social choice theory, and notions of equilibrium; information theoretic foundations of AI that seek to remove the guesswork in designing ML algorithms, transitioning from “black box” to “grey/white box” models offering interpretability and affording targeted information extraction; and information authenticity in an era of “deep fakes,” tackling verifying information provenance through forensics, authentication, consistency checks, and natural or engineered watermarks. Further, the performance of AI systems has been heavily dependent on the hardware upon which they run; the current renaissance in ML is directly tied to progress in hardware technology including improved memory, input/output, clock speeds, parallelism, and energy efficiency. Developing hardware further optimized for AI and ML algorithms offers the potential for even higher levels of performance. Research can allow ML algorithms to efficiently learn from high-velocity data, including distributed ML algorithms that simultaneously learn from multiple data pipelines. More advanced ML-based feedback methods can allow AI systems to intelligently sample or prioritize data from large-scale simulations, experimental instruments, and distributed sensor systems.

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 machine learning (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. This funding opportunity seeks to enable such research through a set of new 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 the VA – 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 such as planning, machine learning, knowledge representation and reasoning, optimization, perception, natural language understanding, and embodied agents 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. This might include (but is not limited to) new paradigms for investigating and modeling machine intelligence, the principled integration of AI components into more robust system architectures and platforms, research on the human-technology implications of AI including human-AI collaboration and human-centered design and general ethical considerations for AI, or novel hardware and software system approaches to support AI in a variety of contexts. These lines of research should be grounded in and integrated with broader foundational theories, paradigms, and architectures for computing and communication. Whatever its foundational AI research focus, the Institute must address areas in clear need of larger efforts over longer timeframes. The new directions charted by AI Research Institutes might indeed challenge disciplinary divisions that result from the current state of specialization, or promote the establishment of new science, engineering and educational communities that better reflect the long-term research needs for future AI.
- AI Research Institutes **leverage use-inspired research** to inform foundational research priorities, accelerate the fielding of AI-powered innovation, and meet the challenges and complexity of critical domain or application problems. The sectors for such use-inspired research are many, and may be aligned with an area of science and engineering (for example, chemistry or materials synthesis), segment of the economy (for example, transportation or healthcare), or societal good (for example, wildlife protection or clean air and water). Ultimately, AI technologies are critical for addressing a range of long-term challenges in many areas of societal importance. The use-inspired dimension of an AI Research Institute's mission will promote the transfer of knowledge through the meaningful exchange of scientific and technical information with internal participants and external stakeholders such as industrial partners, public policy-makers, or international organizations, as well as with the broader scientific and education community. Finally, AI Research Institutes create the potential for the creation and sharing of 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. Institutes will consist of a network of multiple organizations under the leadership of a single lead organization. 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 (potentially 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**, bringing together people, ideas, problems, and technical approaches for maximum impact. They 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, broadening participation in research, education, and knowledge transfer activities through a network of partners and affiliates. NSF encourages institutes comprising a range of organization Participants should be meaningfully integrated into a diverse Institute that is more than just the sum of the parts.

II.B. Funding Tracks

Planning Track: This track will support planning grants for durations of up to two years, and for up to a total of $500,000 to enable teams to develop communities and capacity for full Institute operations through diverse and sustained activities. While novel approaches are encouraged, it is anticipated that such planning activities might include workshops, development of partnerships, preliminary research and analysis, and engagement of stakeholders most appropriate for the Institute vision. These activities may also include exploratory collaborative research needed to demonstrate a basis of confidence for new convergent approaches central to the Institute vision.

Submissions to the Planning track are encouraged in **any areas of foundational and use-inspired research appropriate to this solicitation, NSF, and partner organizations**. This includes Planning proposals targeting the specific themes noted for the Institute track. Future solicitations in AI Research Institutes are expected to provide an opportunity for the submission of full institute proposals stemming from, but not limited to, these planning activities.

Institute Track: This track will support cooperative agreements of between $16,000,000 and $20,000,000 for between four and five years (up to $4,000,000 per year). 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 first year of the program, Institute track proposals are being solicited in six high-priority areas. These themes represent a subset of research areas that NSF supports, and future solicitations may target additional themes or even invite Institute proposals in areas not specifically called out, or offer open tracks. Future solicitations may continue the use of such themes (in these and other areas), invite unrestricted proposals for institutes, or both.

Submissions to this track MUST have as a principal focus one or more of the following themes:

Theme 1: Trustworthy AI

Increasing trust in AI technologies is a key element in accelerating their adoption for economic growth and future innovations that can benefit society. Today, the ability to understand and analyze the decisions of AI systems and measure their trustworthiness is limited. It is vital to develop AI technology

that is not only powerful but also trustworthy. Aspects of trustworthy AI include the following:

- An AI system can be trusted to function reliably. Reliability in AI needs to go far beyond today's common practice of simply reporting performance on a particular set of test problems. Mission-critical applications may require strong formal guarantees of worst-case solution quality and time to solution. For applications with some room for error, it may be appropriate to provide probabilistic guarantees – but for safety-critical applications, the nature of that probabilistic guarantee needs to be made precise and explicit. For example, an algorithm may be reliable in the face of random noise, but not in the face of an adversarial attack. Research challenges include detecting malicious inputs designed to fool systems, gaining a better understanding of model characteristics that might be taken advantage of by malicious attackers, developing richer measures of reliability, and methodologies for verifying robustness of an AI system both formally and experimentally. Richer measures of reliability and methodologies for verifying robustness of an AI system both formally and experimentally are desired.
- An AI system can be trusted to be able to adequately explain its conclusions in terms understandable to human users. Interpretable explanations are vital when AI is used in decision making, because establishing human trust in the outcome requires the exchange of reasons for that outcome. Explanations provided by AI systems must be able to convey explanations and confidence assessments in both quantitative and qualitative terms as appropriate to the task and as needed by users. Further, complete explanations help AI system developers pinpoint errors in algorithms or data that lead to erroneous outputs. Research challenges include finding ways to make "black box" AI systems explainable; developing models and frameworks for learning and reasoning that are both inherently explainable and powerful; and integrating the traditions of psychology, cognitive science, philosophy, and other disciplines to better understand the interpretability and acceptability of an explanation.
- A machine learning system can be trusted not to violate the privacy of the people whose data are used to train the system by leaking personal information during or after training. Approaches to enhancing privacy in machine learning currently include federated learning, homomorphic encryption, differential privacy, and synthetic datasets, but these far from exhaust the topic. Solutions are needed that will allow people to confidently negotiate and establish boundaries on the use of their personal data by AI systems of all kinds. Investigators are encouraged to respond to the priorities of the National Privacy Research Strategy.
- An AI-based decision-making system can be trusted to not exhibit biases that are socially harmful. Harmful biases can arise in an AI system from incorrect assumptions used in designing the system; when training data does not reflect the full domain; or when the system fails to respect legal and social norms. Research challenges include creating statistical and individual notions of fairness in algorithmic decisions, and understanding of contexts in which they are achievable or provably impossible; detecting and measuring data bias; preventing "amplification" of bias by learning algorithms; and teaching AI systems human rules against unlawful forms of bias.

It is important to note that trustworthiness is an issue for all subfields of AI and is not limited to machine learning. Essentially any AI technology, including planning, optimization, automated reasoning, autonomous systems, and physical and virtual embodied agents, can also raise problems of trustworthiness. Research at an Institute for Trustworthy AI may focus on one subarea of AI or many. Furthermore, achieving trustworthy AI will require both technological advances and the development of policies for the governance of AI technologies. An Institute for Trustworthy AI should therefore include a component for the study of governance and ethics as well as technology-driven research.

Theme 2: Foundations of Machine Learning

Despite dramatic advances in machine learning over the past two decades, the field remains as much an art as a science. Research at an Institute for Foundations of Machine Learning will seek general, rigorous principles for the theory and use of machine learning. Questions that an Institute will address might involve some or all of the following:

- There are a number of successful methods for machine learning, including neural networks, support vector machines, and probabilistic graphical models. Why and under what conditions does each method work? Is there a general theory of machine learning that subsumes several or all popular approaches?
- Most research in machine learning aims to model statistical correlations between events. In order to take action on the basis of a model, however, it is necessary to understand the causal relationships that underlie the correlations. There is growing interest and research on causal inference and discovery. How can causal relations be learned and distinguished from mere statistical associations?
- AI systems traditionally modeled knowledge symbolically, using recursively constructed data structures involving symbols for concepts, relationships, entities, and connectives. Research in deep learning has demonstrated the power of representing concepts as numeric vectors rather than symbols. Can the advantages of vector and symbolic representations be combined in a neuro-symbolic framework for learning?
- With the exception of reinforcement learning, research in machine learning has focused on the context of a single agent observing and learning. How should learning be formalized for dynamic multi-agent environments, possibly including adversarial learning agents?
- Machine learning algorithms are usually evaluated only with respect to accuracy or similar measures such as their AOC curve. However, other characteristics of a learning method may be vital for many applications, such as time or data requirements. How should we formalize and compare methods with respect to such broader criteria?
- The field is in the midst of an explosion of deep learning architectures, such as various architectures for memory, transformation, and generation. New models are typically justified by a combination of intuition and empirical success. What general principles govern deep learning architectures?
- Many approaches to machine learning assume that learning begins from a blank slate; that is, all knowledge is in the data. In many domains, however, a small amount of explicit knowledge can replace a large amount of data. For example, Newtonian physics can be captured by a few equations, but a huge amount of data and computational effort would be needed for a system to learn to approximate Newtonian physics. How can rich, general prior knowledge be incorporated in machine learning?

Research at an Institute for Foundations of Machine Learning will seek answers to these and similar questions, thereby deepening the theoretical foundations for the science of machine learning. Researchers will study use cases in so far as they lead to general fundamental results. An Institute may focus on a particular method, such as deep learning or Bayesian models, or explore a number of approaches. The research team will consist of researchers from several disciplines, including some or all of AI, statistics, computer science theory, mathematics, and information theory.

Theme 3: AI-Driven Innovation in Agriculture and the Food System

Agricultural production is a user-inspired enterprise. Farmers have long been the example of innovators and user-inspired production processes. 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, data-driven research methods and algorithm development to the food and agricultural sector to yield meaningful insights and possibilities for producers, labor, food handling and processes, 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 provide a 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 untended 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.

There are critical challenges associated with the adoption of AI in agriculture. The success of AI will depend on engaging and connecting stakeholders. AI is unlike most other technologies applied in this sector in that it is often less transparent and can indirectly influence the attitudes and decision making of the producers and consumers who have important ties to the food they eat. 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:

- 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.
- Development and implementation of smart, digitally driven science and technology, targeted at precision agriculture, food production and processing, and improved consumer health and food safety.
- Forge collaborative solutions across sectors to the barriers and gaps in AI technology applications in agriculture.
- Address labor shortages, alternatives, and enhanced labor productivity.
- Engage farmers, laborers, and consumers in AI-based technology development, adoption and diffusion to aid embracement of AI-based technologies throughout the food system.
- Address methods to enhance, preserve, and protect environmental and natural resources associated with agriculture and food production.
- Develop novel approaches to the different types of education and training that are needed for K-12, undergraduate, and graduate learners. Develop learner approaches for training and retraining of operators and agricultural labor forces.
- Enhance and expand critical methods and use of AI agricultural sciences (e.g., plant, animal, agronomic, economics).

The above list is intended only as 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.

Proposals submitted to this theme MUST designate USDA-NIFA as the intended funding agency.

Theme 4: AI-Augmented Learning

The primary focus of an institute in the theme of AI-Augmented Learning includes research and development of AI-driven innovations *to radically improve human learning and education writ large* – in formal settings (e.g., preK-12, undergraduate, graduate, vocational education), 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. 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, drawing upon multimodal and smart and connected data such as from sensors and other cyber-physical systems. Projects should include systematic plans to address algorithmic bias, provide model transparency and support data privacy and security in the support of learning.

Theme 5: AI for Accelerating Molecular Synthesis and Manufacturing

The primary focus of this theme is the development of AI advances and AI-based tools to drive molecular discovery and identify chemical transformation pathways that support energy-efficient, sustainable chemical manufacturing. Research opportunities will impact new molecule discovery as well as the development of alternatives to existing chemical processes. End-use products include: small molecules, pharmaceuticals, specialty chemicals, biochemicals and biomaterials, macromolecules and nanomaterials, and commodity chemicals; while impacted technologies include: clean energy technologies, advanced manufacturing, and sustainable processes.

Current discoveries and production of chemicals (including nanomaterials) are largely experience- and/or intuition-driven, requiring labor-intensive syntheses, separations, and characterization. The subsequent iterative design and test cycles often yield incremental progress towards targeted molecules and processes for desired uses and applications. This Institute track seeks to develop AI tools and approaches that increase the pace of discovery of new molecules and promote alternative, energy-sustainable processes for the production of chemicals. These goals will be achieved through the development of closed-loop systems that integrate tools for extracting knowledge from existing databases and text, executing autonomous experimental measurements and optimization, and incorporating computational and machine-learning approaches to develop physics- and/or descriptor-based predictive tools.

The extraction of information from the chemical literature requires mining and use of sparse and noisy data from various sources (figures, spectra, tables, and text), relationship extraction between text and images, overcoming the lack of negative data, and the use of non-standard terminologies. Beyond the chemical literature, both classical and *ab initio* computational methods, in combination with machine learning, provide opportunities to screen vast arrays of molecular structures and to develop phenomenological insight from complex datasets. These tasks challenge the current state of the art in multimodal

information retrieval. A successful AI Research Institute in the theme of Accelerating Molecular Synthesis and Manufacturing will develop methods to extract useful information from many sources to provide a knowledge-based user database, available in a machine-readable format, of predictable reactivity patterns informed by reaction rules, kinetic and selectivity data, thermodynamics, and materials properties. The execution of autonomous experimental measurements and optimizations will be determined by prioritization of key attributes such as known, active substructures; product characterization and testing; product yields; considerations of sustainability principles; etc. Automated synthesizers are expected to provide improved reproducibility and repeatability as well as safer, more secure, and more sustainable methods of chemical manufacturing that are less time- and effort-intensive.

Moderate equipment purchases to enable the testing of automated routes of synthesis and characterization are anticipated.

Successful AI Research Institutes in this theme will consider the workforce of the future and how student training can and will be affected by the integration of data mining, machine learning and automation.

Proposers are reminded that NSF does not support disease-related research; proposals focused on drug discovery and testing toward specific disease targets will be returned without review. However, research in information technology that applies engineering or computer science principles to problems in biology and medicine while advancing engineering or computer science knowledge within the scope of this program is eligible for support.

Theme 6: AI for Discovery in Physics

An AI Institute in Physics will incorporate novel techniques to accelerate discovery and extend the frontier in AI by addressing domain-specific challenges in Physics. Realizing the full potential of AI for Discovery in Physics will improve the operations and exploitation of Division of Physics facilities, promote the integration and interpretation of heterogenous datasets, accelerate model-building and quantification of uncertainties, and enable novel ways to interrogate high-dimensional features of complex data sets.

NSF encourages AI Research Institutes in Physics that advance AI and accelerate discovery in the physical sciences. Examples of this might include: (i) improving and optimizing operations, real-time event selection, classification, feature extraction, reconstruction, and analysis at dataflow-intensive facilities; (ii) accelerating multi-scale, multi-physics simulations for multi-messenger astrophysics, quantum chromodynamics, cosmology, and plasma physics; (iii) exploring the very large space of potentially viable string theories ("string landscape"); (iv) developing and validating predictive dynamical models of complex, far-from-equilibrium systems; (v) improving the understanding of the physics principles behind genome packing and the resulting genome architecture and dynamics; (vi) and co-developing improved physical models of brain function and new AI architectures.

Proposals may address any range of ideas that demonstrate how the Institute will advance both AI and domains supported by the Division of Physics.

II.C. Webinar Information

NSF will hold an informational webinar in October 2019. Additional information about the webinar will be announced via Dear Colleague Letter to follow this solicitation.

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:

There are no restrictions or limits.

Limit on Number of Proposals for Senior Personnel: 2

An individual may be designated as senior personnel on no more than TWO project teams submitting to this solicitation. 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 the

Institute track. In the event that an individual exceeds these limits, 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.

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.

Planning Track

Even if 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. Separate proposals from each partner will not be accepted.

The guidance below augments the general guidance provided by the PAPPG. The full proposal must include the main documents and supplementary documents described in Sections 1-7, below.

1. Cover Sheet: The title of the proposal must be preceded by the letters "AI Institute: Planning: ". 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. Include a concise overview of the proposed major planning activities.
3. Project Description: The Project Description must include Sections (3.a) through (3.d) described below and cannot exceed 15 pages including tables and illustrations. The PAPPG-required sections of intellectual merit and broader impacts resulting from the proposed project must be addressed and described within this narrative and have the required identifying headings. In addition to these and other PAPPG requirements, the Project Description for a planning proposal must include the following clearly-marked sections. The page numbers listed (in parentheses) for the different sections are suggested guidelines; the actual page numbers for different sections may deviate from the guidelines, provided the total number of pages does not exceed 15 pages.

   3a. Overview: A clear description of the objectives and a summary of major activities in pursuit of the development of a compelling AI Research Institute proposal. (1 page)

   3b. Research Theme Areas and Team Selection: A discussion of the potential research theme areas demonstrating coverage of both foundational and use-inspired AI research to be explored in the planning project; names and affiliations for the team members and rationale for their selection for the project. A description of the planned major activities to engage and coordinate synergistic, multidisciplinary research communities in pursuit of the envisaged Institute. (6 pages).

   3c. Education and Workforce Development: A description of the planned new and innovative approaches for education and workforce

development of the Nation's undergraduate and graduate students, post-doctoral researchers, community colleges and skilled technical workforce training, as well as other opportunities to advance knowledge and education of AI. This should include plans to broaden participation of underrepresented groups and increase diversity. (2 pages)

3d. Management and Integration Plan: Plans to develop all aspects of an AI Research Institute, including initiation of multidisciplinary research, planning for workforce development, identification and refinement of infrastructure needs, and exploration of strategic and synergistic partnerships with industry, nonprofits/foundations, other federal agencies, national labs and any international partners. Describe the relevant experience and qualifications of the lead PI and other key personnel of the management team to build and manage a complex, multi-faceted, and innovative enterprise that integrates research, education, broadening participation, and knowledge transfer. Provide a clear timeline with major activities, expected outcomes or milestones, and identification of team members who are providing leadership in each area. (4 pages)

4. References Cited: List only references cited in the Project Description.
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.
6. Supplementary Documents:

   In the Supplementary Documents section, upload the following information:

   - *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:

   - Mary Smith; XYZ University; PI
   - John Jones; University of PQR; Senior Personnel
   - Jane Brown; XYZ University; Postdoctoral Researcher
   - Bob Adams; ABC Community College; Paid Consultant
   - Susan White; DEF Corporation; Unpaid Collaborator
   - Tim Green; ZZZ University; Subawardee

7. Single Copy Documents

   - *Collaborators and Other Affiliations Information (required):*

   Proposers should follow the guidance specified in Chapter II.C.1.e of the NSF PAPPG.

   Note the distinction to the first item under Supplementary Documents above: the listing of all project participants is collected by the project lead and entered as a Supplementary Document, which is then automatically included with all proposals in a project. The Collaborators and Other Affiliations are entered for each individual identified as Senior Personnel within each proposal and, as Single Copy Documents, are available only to NSF staff. Collaborators and Other Affiliations information for participants listed in the first item under Supplementary Documents above who are not PIs, co-PIs, or Senior Personnel can be uploaded under Additional Single Copy Documents using Transfer File.

Institute Track

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. 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 track theme to which the proposal is submitted: Trustworthy AI; Foundations of Machine Learning; AI-Driven Innovation in Agriculture and the Food System; AI-Augmented Learning; AI for Accelerating Molecular Synthesis and Manufacturing; or AI for Discovery in Physics. If the proposal responds to multiple themes, list them all, with the most relevant one first.
3. Project Description: The Project Description must include Sections (3.a) through (3.f) described below and cannot exceed 25 pages including tables and illustrations. The PAPPG-required sections of intellectual merit and broader impacts resulting from the proposed project must be addressed and described within this narrative and have the required identifying headings. In addition to these and other PAPPG requirements, the Project Description for an Institute proposal 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; crowd-sourcing and citizen science; 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 policy-makers) with the objective of applying that knowledge. State the specific goals for knowledge transfer and the expected impact of the activities. Linkages should involve significant intellectual exchange and could involve, for example, mechanisms such as internships or novel use of cyberinfrastructure to enhance connections.

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 agenda for the advancement of AI and the fielding of AI-powered innovation in application sectors of national importance. Describe the network of organizations comprising the Institute and their relationships to one another. Include a diagram to explain the organizational relationships and reporting structure among the key areas of responsibility. Identify key members of the Institute Management Team and explain their specific roles and areas of responsibility. Describe the relevant experience and qualifications of the lead PI, Managing Director/Project Manager (if different), 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 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.
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 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.
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* (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* (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. 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*. The Project Description must fully detail any substantial collaborations and engagements with partner organizations. Letters of Collaboration may be provided in the Supplementary Documents section of the proposal and should follow the format instructions specified in the NSF PAPPG.
    - *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:

        - Mary Smith; XYZ University; PI
        - John Jones; University of PQR; Senior Personnel
        - Jane Brown; XYZ University; Postdoctoral Researcher
        - Bob Adams; ABC Community College; Paid Consultant

- Susan White; DEF Corporation; Unpaid Collaborator
- Tim Green; ZZZ University; Subawardee

9. 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.

   Note the distinction to the first item under Supplementary Documents above: the listing of all project participants is collected by the project lead and entered as a Supplementary Document, which is then automatically included with all proposals in a project. The Collaborators and Other Affiliations are entered for each individual identified as Senior Personnel within each proposal and, as Single Copy Documents, are available only to NSF staff. Collaborators and Other Affiliations information for participants listed in the first item under Supplementary Documents above who are not PIs, co-PIs, or Senior Personnel can be uploaded under Additional Single Copy Documents using Transfer File.

   Optional:

   - List of suggested reviewers or reviewers not to include (with a brief explanation or justification for why the reviewer should be excluded);
   - 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:

Travel budgets for a representative from each participating organization in an Institute or planning activity for attending annual PI meetings should also be

included. Travel and event budget should be included for a retreat of institute personnel as required in Special Award Conditions.

C. Due Dates

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

  January 28, 2020

  for Institute proposals in one of the six specified themes

  January 30, 2020

  for Planning proposals

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 the **Planning** track:

- How well does the proposal incorporate planning activities likely to lead to the development of a viable institute excelling in the five desiderata for Institutes described in the Program Description (See Section II.A)?

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

- 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 **leverage use-inspired research** to inform foundational research priorities and accelerate the fielding of AI-powered innovation?
- 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 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 in either the Planning or Institute track will be advised by a Review Panel augmented as necessary with *ad hoc* reviews. Final selection of new AI Research Institutes will be conducted by NSF in consultation with relevant funding partners named in this solicitation. The named funding partners may act as observers in the review process; and proposals, unattributed reviews, and panel summaries may be shared securely with the funding partners.

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 joint-agency solicitation, which includes program requirements.

DHS S&T, DOT FHWA, and VA 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 VA to NSF, respectively.

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.

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

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 VA 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. 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. This requirement will be detailed in award letter 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) 292-8074, email: AIInstitutesProgram@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 the Institute track:

Theme 1: Trustworthy AI

- James Donlon, jdonlon@nsf.gov, (703) 292-8074
- Steven Whitmeyer, swhitmey@nsf.gov, (703) 292-8552

Anthony Kuh, akuh@nsf.gov, (703) 292-2210
- Sol Greenspan sgreensp@nsf.gov (703) 292-7841

Theme 2: Foundations of Machine Learning

- Tracy Kimbrel, tkimbrel@nsf.gov, (703) 292-7924
- Rebecca Hwa, rhwa@nsf.gov, (703) 292-7148
- Armand Makowski, amakowsk@nsf.gov, (703) 292-9455

Theme 3: AI-Driven Innovation in Agriculture and the Food System

- James Donlon, jdonlon@nsf.gov, (703) 292-8074
- Steven Thomson (USDA/NIFA) steven.j.thomson@usda.gov (202) 603-1053

Theme 4: AI-Augmented Learning

- Amy L. Baylor, abaylor@nsf.gov, (703) 292-5126
- Lawrence Gottlob, lgottlob@nsf.gov, (703) 292-4383
- Tatiana D. Korelsky, tkorelsk@nsf.gov, (703) 292-8930
- Anthony Kuh, akuh@nsf.gov, (703) 292-2210

Theme 5: AI for Accelerating Molecular Synthesis and Manufacturing

- Laura Anderson, laanders@nsf.gov, (703) 292-2934
- Jin Cha, jcha@nsf.gov, (703) 292-2461
- Katharine Covert, kcovert@nsf.gov, (703) 292-4950
- Robert McCabe, rmccabe@nsf.gov, (703) 292-4826
- Christina Payne, cpayne@nsf.gov, (703) 292-2895
- Ying Sun yisun@nsf.gov (703) 292-7443

Theme 6: AI for Discovery in Physics

- Saul Gonzalez, sgonzale@nsf.gov, (703) 292-2093

For the Planning track:

Disciplines not named below, please use AIInstitutesProgram@nsf.gov

Biological Sciences

- Sridhar Raghavachari, sraghava@nsf.gov, (703) 292-4845

Computer and Information Science and Engineering

Computing and Communication Foundations

- Tracy Kimbrel, tkimbrel@nsf.gov, (703) 292-7924
- Armand Makowski, amakowsk@nsf.gov, (703) 2929455

Computer and Network Systems

- Matt Mutka, mmutka@nsf.gov, (703) 292-7344

Information and Intelligent Systems

- Wendy Nilsen, wnilsen@nsf.gov, (703) 292-2568
- Kenneth Whang, kwhang@nsf.gov, (703) 292-5149

Advanced Cyberinfrastructure

- Vipin Chaudhary, vipchaud@nsf.gov, (703) 292-2254

Education and Human Resources

Research on Learning in Formal and Informal Settings

- Amy L. Baylor, abaylor@nsf.gov, (703) 292-5126
- Chia Shen, cshen@nsf.gov, (703) 292-8447

Division of Undergraduate Education

- Stephanie E. August, saugust@nsf.gov, (703) 292-5128

Division of Graduate Education

- Li Yang, liyang@nsf.gov, (703) 292-2677

Engineering

Chemical, Bioengineering, Environmental and Transport Systems

- Robert McCabe, rmccabe@nsf.gov, (703) 292-4826
- Christina Payne, cpayne@nsf.gov, (703) 292-2895
- Ying Sun yisun@nsf.gov (703) 292-7443

Civil, Mechanical and Manufacturing Innovation

- Jordan Berg, jberg@nsf.gov, (703) 292-5365
- Alexis Lewis, alewis@nsf.gov, (703) 292-2624

Electrical, Communications and Cyber Systems

- Anthony Kuh, akuh@nsf.gov, (703) 292-2210

Engineering Education and Centers

- Edward Berger, eberger@nsf.gov, (703) 292-7708

Geosciences

- Steven Whitmeyer, swhitmey@nsf.gov, (703) 292-8552
- Eric DeWeaver edeweave@nsf.gov (703) 292-8527

Mathematical and Physical Sciences

Astronomy

- Nigel Sharp, nsharp@nsf.gov, (703) 292-4905

Chemistry

- Laura Anderson, laanders@nsf.gov, (703) 292-2934
- Jin Cha, jcha@nsf.gov, (703) 292-2461
- Katharine Covert, kcovert@nsf.gov, (703) 292-4950

Materials Research

- John Schlueter, jschluet@nsf.gov, (703) 292-7766

Mathematical Sciences

- Tomek Bartoszynski, tbartosz@nsf.gov, (703) 292-4885

Physics

- Saul Gonzalez, sgonzale@nsf.gov, (703) 292-2093

Social and Behavioral Sciences

Behavioral and Cognitive Sciences

- Lawrence Gottlob, lgottlob@nsf.gov, (703) 292-4383

Integrative Activities

EPSCoR

- Ann Stapleton, astaplet@nsf.gov, (703) 292-7231

Other Agency Contacts

- David Kuehn, Program Manager, DOT FHWA, David.Kuehn@dot.gov, (202) 493-3414
- Steven Thomson, National Program Leader, USDA/NIFA, steven.j.thomson@usda.gov (202) 603-1053
- Gil Alterovitz, Director of Artificial Intelligence, VA, Gil.Alterovitz@va.gov, (202) 297-7787
- Stephen Dennis, Program Director, DHS, Stephen.dennis@hq.dhs.gov, (202) 254-5788

IX. OTHER INFORMATION

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to

keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF Grants Conferences. Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on NSF's website.

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

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

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