



National Artificial Intelligence (AI) Research Institutes

**Accelerating Research, Transforming Society,
and Growing the American Workforce**

*James Donlon and Rebecca Hwa, CISE/IIS
Program Webinar
November 7, 2019*



National Artificial Intelligence (AI) Research Institutes Points of Contact

Directorate	Contacting Program Directors
CISE	Vipin Chaudhary (OAC), Jim Donlon (IIS), Rebecca Hwa (IIS), Sol Greenspan (CCF), Tracy Kimbrel (CCF), Tanya Korelsky (IIS), Armand Makowski (CCF), Matt Mutka (CNS), Wendy Nilsen (IIS), Ken Whang (IIS)
BIO	Sri Raghavachari (IOS)
EHR	Stephanie E. August (DUE), Amy Baylor (DRL), Chia Shen(DRL), Li Yang (DGE)
ENG	Jordan Berg (CMMI), Edward Berger(EEC), Alexis Lewis (CMMI), Tony Kuh (ECCS) Robert McCabe (CBET), Christina Payne(CBET)
GEO	Steve Whitmeyer (EAR)
MPS	Laura Anderson (CHE), Tomek Bartoszynski (DMS), Jin Cha (CHE), Kathy Covert (CHE), Saul Gonzalez (PHY), John Schlueter (DMR), Nigel Sharp (AST)
OIA	Ann Stapleton (EPSCoR)
SBE	Larry Gottlob (BCS)
Partners	Charlotte Baer/Steven Thomson (USDA NIFA), Gil Alterovitz (VA), Stephen Dennis (DHS S&T), David Kuehn (DOT FHWA)



Welcome

Erwin Gianchandani

Deputy Assistant Director and Acting Assistant Director

Directorate for Computer and Information Science and
Engineering (CISE)



Outline

- Background and overview
- Program scope and structure
- A detailed look at the themes of this solicitation
- Program-wide considerations
- Future plans
- Questions



National Artificial Intelligence (AI) Research Institutes

- **New multi-year, multi-agency national initiative.**
 - Initial year partners: NSF, USDA-NIFA, VA, DOT FHWA, DHS
- **Goals:**
 - Significantly **advance research** in AI and accelerate the development of transformational, AI-powered innovation.
 - Grow a **workforce** of future AI researchers and practitioners.
 - Create national **nexus points** for universities, federal agencies, industries and nonprofits.



National Artificial Intelligence (AI) Research Institutes

- **Institute scale:** allowing researchers to focus on larger-scale, longer-term research.
- **This solicitation:** approximately \$120 million in grants next year (2020) to fund *planning grants* and up to six *research institutes in specific areas* in order to advance AI research
 - NSF anticipates repeating this funding opportunity in future years, subject to the availability of funds.



Background

National Priorities

@NSF



Strategic Priority 1:
Make long-term investments in AI research



Convening of Potential Partners
May 29, 2019



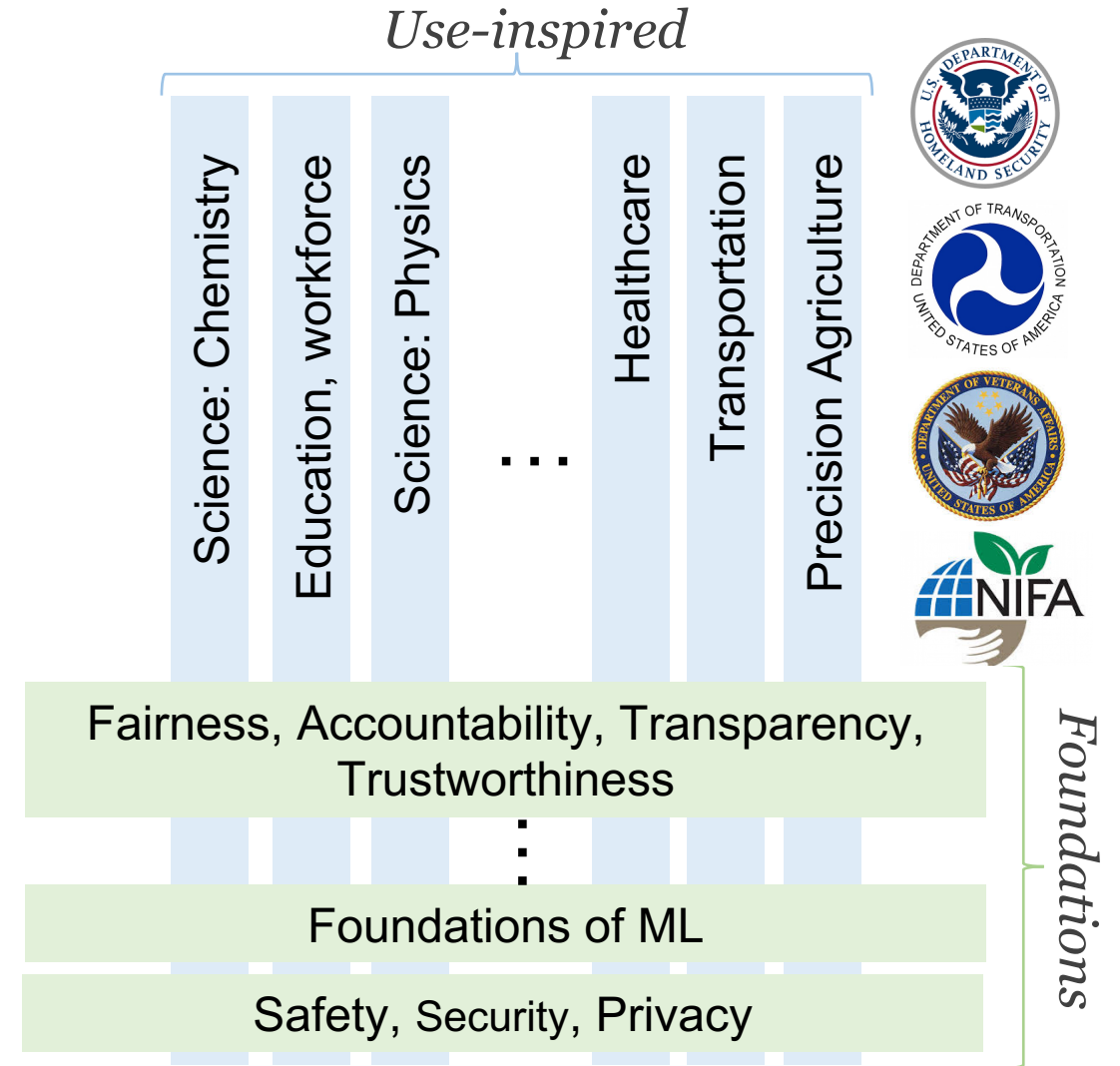
Institute Potential Discussed at “Convening”

- Breadth, scale of challenges demand multi-disciplinary, multi-institutional collaborative efforts
- Sustained investment: in-depth, extended focus; prototyping, living labs; longer time horizons
- Nurture the next generation of talent
- Facilitate accelerated transition of innovations into many economic sectors
- Address both “foundational” challenges and “use-inspired” opportunities



Foundational and Use-Inspired AI Research

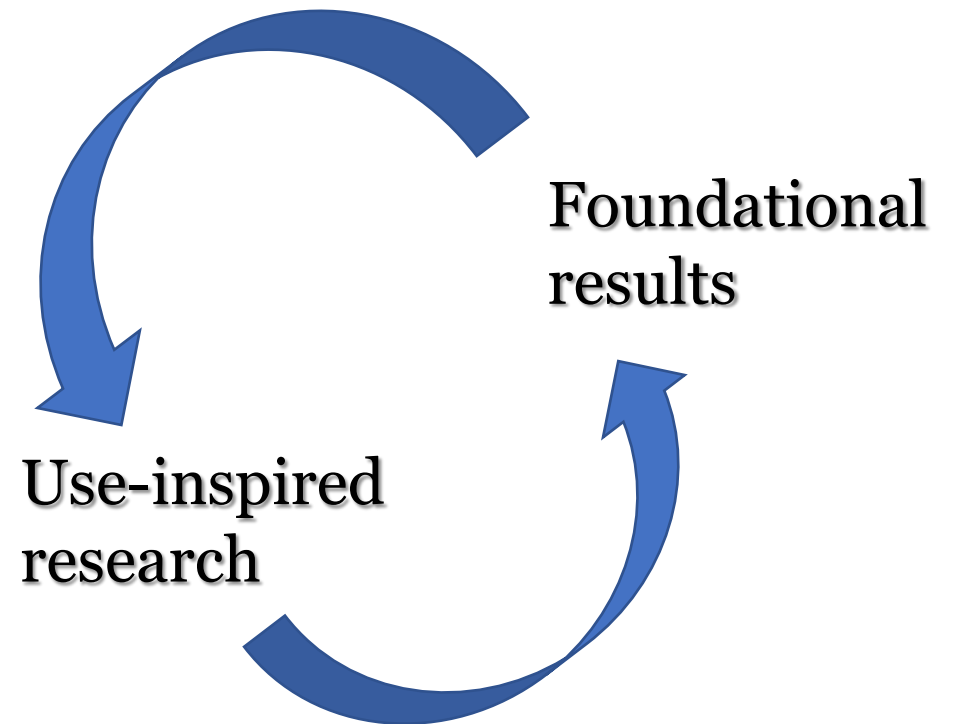
- Foundational AI
 - Theory and methods independent of any particular domain of application.
- Use-inspired AI research
 - Basic research that has use for society in mind.
 - Situating in a domain of application to simultaneously inform progress in AI and solve particular use cases.
 - In contrast to "application-oriented research", the goal is to go beyond applying known techniques, and **adds new knowledge and understanding in both *foundational AI* and *use-inspired research*.**





Foundational and Use-Inspired AI Research

- Seeking a virtuous cycle between both foundational and use-inspired research, as appropriate to its focus and goals, i.e.
 - Foundational results provide a starting point for use-inspired research, and
 - Results from use-inspired research are generalized and made foundational





Scope of Program: Artificial Intelligence

- Understanding the mechanisms underlying thought and intelligent behavior and their implementation in machines.
- “Core” theory and methods that give rise to these abilities and their implementation in machines
 - Research in all matters of learning, abstraction, and inference required for intelligent behavior
 - General architectures for intelligence, integrated intelligent agents, and multiagent systems.



Scope of Program: Artificial Intelligence

- AI is a multidisciplinary endeavor
 - Computational methods draw insight from fields such as biology, neuroscience, behavioral and cognitive science.
 - Computer vision and human-language technologies provide critical capabilities to many AI systems.
 - Robotics is closely aligned with but not identical to embodied AI. AI systems may be able to act upon the world through embodiment.



Program Structure: Funding Tracks

- PLANNING Track
 - Grants -- 2 yr/\$500K efforts to develop communities and capacity.
 - Example activities: workshops, development of partnerships, preliminary research and analysis, and engagement of stakeholders.
 - These larger planning grants also allow for the proposal of **exploratory collaborative research**.
 - Proposals may be in any areas of foundational and use-inspired research appropriate to this solicitation, NSF, and partner organizations.
 - Future solicitations may be expected to provide an opportunity for the submission of full institute proposals stemming from, but not limited to, these planning activities.
- Deadline Jan 30, 2020



Program Structure: Funding Tracks

- INSTITUTE Track
 - Cooperative Agreements for 4-5 yr/\$16-20M institutes to be awarded in 2020.
 - **Must respond to one (or more) of six identified themes**
 - Each theme evaluated as ready for Institute-level investment based on
 - Readiness of research community to respond, and
 - Funding commitments from program partners in those themes.
- Deadline Jan 28, 2020



Desiderata for All AI Research Institutes

- Advance foundational research
- Leverage use-inspired research
- Actively build the next generation of talent
- Be multidisciplinary
- Be nexus points for collaborative efforts



Advance Foundational AI Research

- Add significant new knowledge and understanding to artificial intelligence and demonstrate the potential to radically advance areas beyond the state of the art.
- Address new foundational AI research priorities that arise from rapid advances in AI and the increasing ubiquity of AI-enabled technology.
- Address areas in clear need of larger efforts over longer timeframes; the research will have broad and lasting impact.



Leverage Use-Inspired Research

- Inform foundational research priorities.
- Accelerate the fielding of AI-powered innovation.
- Meet the challenges and complexity of critical domain or application problems.
- Promote the transfer of knowledge through the meaningful exchange of scientific and technical information with internal participants and external stakeholders.
- Create the potential for the creation and sharing of community infrastructure, including data and software, to further research, promote reproducibility, and support education.



Next Generation of Talent

- Leverage the visionary nature of the research foci to drive innovative education for multiple kinds of educational institutes:
 - Undergraduates, graduate students, and post-doctoral researchers,
 - Community colleges and skilled technical workforce training,
 - Other opportunities that advance knowledge and education of AI.
- Develop innovative pedagogy and instructional materials, advanced learning technologies, project-driven training, cross-disciplinary and collaborative research, industry partnerships, and new career pathways.
- Offer broad, deep, and diverse experiences with a focus on broadening participation among the full range of groups traditionally under-represented in science and engineering.



Multidisciplinary Groups

- Coherent 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.
- Catalyze foresight and adaptability beyond what is possible in single research projects.
- A network of multiple organizations under the leadership of a single lead organization.
- Will be staffed with a Managing Director or Project Manager (potentially distinct from the lead PI) and a suitable Management Team

Potential Advisory Board members should not be approached or identified until the Institute is funded



Nexus Points for Collaborative Efforts

- Bringing together people, ideas, problems, and technical approaches for maximum impact.
- Best teams and approaches from institutions of higher education, federal agencies, industry, and nonprofits/foundations.
- Broadening participation in research, education, and knowledge transfer activities through a network of partners and affiliates.
- Participants should be meaningfully integrated into a diverse Institute that is **more than just the sum of the parts.**



FY 2020 Institute Themes

This year, Institute track proposals are being solicited in six high-priority areas:

- 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
- AI for Discovery in Physics

** to be funded and managed by USDA NIFA*



Trustworthy AI

- Increase our ability to analyze the decisions of AI systems and measure their trustworthiness, so that they function **reliably**, **explain** conclusions, preserve **privacy**, and exhibit **fairness**.
- Research may focus on one sub-area of AI or many.
- Institutes should include the study of governance and ethics.



Foundations of Machine Learning

- Seeking general, rigorous principles that deepen the theoretical foundations for the science of machine learning.
- Use cases will be studied in so far as they lead to general fundamental results.
- Addressing questions such as (but not limited to):
 - Is there a general theory of machine learning that subsumes some others?
 - How can causal relations be learned and distinguished from correlations?
 - How should learning be formalized for dynamic multi-agent environments?
 - How can rich, general prior knowledge be incorporated in machine learning?
 - How should we formalize and compare methods with respect to broader criteria such as time, energy, or data requirements?



AI-Driven Innovation in Agriculture and the Food System*

- Advancement of AI and application of transformative, data-driven research methods and algorithm development to the food and agricultural sector.
- AI applied strategically throughout agriculture and food production systems may provide a revolution in food and feed production.
- Address the critical challenges associated with the adoption of AI in agriculture as well as engaging and connecting stakeholders.
- Institutes might address a wide range of research foci, build new multidisciplinary communities, and create the workforce needed for an AI-powered revolution in agriculture.

** to be funded and managed by USDA NIFA*



AI-Augmented Learning

- AI-driven innovations to radically improve human learning and education writ large
- Grand challenge of “Education for All”
- Institutes should include systematic plans to address algorithmic bias, provide model transparency and support data privacy and security in the support of learning.



AI for Accelerating Molecular Synthesis and Manufacturing

- Development of AI advances and AI-based tools to drive molecular discovery
- Identify chemical transformation pathways that support energy-efficient, sustainable chemical manufacturing



AI for Discovery in Physics

- Accelerate discovery and extend the frontier in AI by addressing domain-specific challenges in Physics.
- Improve the operations and exploitation of facilities.
- Promote the integration and interpretation of heterogeneous datasets.
- Accelerate model-building and quantification of uncertainties.
- Enable novel ways to interrogate high-dimensional features of complex data sets.



Education, Workforce and Broadening Participation

- Emphasized for both Planning and Institutes proposals
- Vision for Institutes
 - Actively build toward a diverse well-trained workforce
 - New and innovative approaches to education and development
 - Integration of research and education
 - Encourage mechanisms to engage participants in multiple settings



Notes on Submission and Eligibility

- Proposals are to be submitted from a single organization. Any collaborations will be configured as subawards to that single proposal.
- Institutions who may apply.
 - Institutions of Higher Education (IHEs)
 - Non-profit, non-academic organizations
 - Other organization types MAY be included as subawardees on proposals
- There are no limits on number of submission per institution
- Limit on Number of Proposals for Senior Personnel
 - You may be on at most TWO proposals total
 - An individual may be on at most ONE Institute Track Proposal
 - PI/co-PI are subset of “senior personnel”



Other Frequently-Asked Questions

- **Can I submit an Institute proposal that responds to multiple themes? Is it a good idea?**
 - The solicitation allows for this.
 - It is advisable that relevance to any more than one theme be identified only in cases where significant activity is planned in the five desiderata for Institutes for those additional themes.



Other Frequently-Asked Questions

- **Is it required that an Institute be multi-organizational?**
 - “Institutes will consist of a network of multiple organizations.”
- How important is this?
 - We encourage multi-organizational arrangements comprising a "complex, multi-faceted, and innovative enterprise that integrates research, education, broadening participation, and knowledge transfer;" and which engage diverse institutions.
- How many organizations should comprise an AI Research Institute?
 - How a particular proposal envisions this will be unique to that proposed Institute.



Other Frequently-Asked Questions

- **Can an existing institute or center participate in a proposal to this program?**
 - There is no restriction regarding this.
 - Any AI Research Institute funded in this program is expected to build significant new capacity in the five desiderata outlined in this program.
 - Institutes must be meaningfully integrated in such a way that it creates a capability that is more than just the sum of the parts.



Out-year Opportunities/Plans

- This solicitation is the first step in what is expected to be a longer-range, multi-agency investment in AI research and education.

- Future funding opportunities may:
 - continue the use of identified themes corresponding to high-priority areas,
 - invite unrestricted proposals for institutes,
 - or both.



Questions

- A FAQ list will soon be made available on program website:
- https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505686
- Please send questions via email to:
AllInstitutesProgram@nsf.gov
- Webinar materials (slides, script, and audio recording) will be posted on the program/webinar web page