Harnessing the Data Revolution (HDR): Institutes for Data-Intensive Research in Science and Engineering

PROGRAM SOLICITATION
NSF 21-519

National Science Foundation

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

January 21, 2021

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 20-1), which is effective for proposals submitted, or due, on or after June 1, 2020.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Harnessing the Data Revolution (HDR): Institutes for Data-Intensive Research in Science and Engineering

Synopsis of Program:

In 2016, the National Science Foundation (NSF) unveiled a set of "Big Ideas," 10 bold, long-term research and process ideas that identify areas for future investment at the frontiers of science and engineering (see https://www.nsf.gov/news/special_reports/big_ideas/index.jsp). The Big Ideas represent unique opportunities to position our Nation at the cutting edge of global science and engineering by bringing together diverse disciplinary perspectives to support convergent research. When responding to this solicitation, even though proposals must be submitted through the **Office of Advanced Cyberinfrastructure (OAC) within the Directorate for Computer and Information Science and Engineering (CISE)**, once received the proposals will be managed by a cross-disciplinary team of NSF Program Directors.

NSF's *Harnessing the Data Revolution (HDR) Big Idea* is a national-scale activity to enable new modes of data-driven discovery that will allow fundamental questions to be asked and answered at the frontiers of science and engineering.

This solicitation will establish a group of HDR Institutes for data-intensive research in science and engineering that can accelerate discovery and innovation in a broad array of research domains. The HDR Institutes will lead innovation by harnessing diverse data sources and developing and applying new methodologies, technologies, and infrastructure for data management and analysis. The HDR Institutes will support convergence between science and engineering research communities as well as expertise in data science foundations, systems, applications, and cyberinfrastructure. In addition, the HDR Institutes will enable breakthroughs in science and engineering through collaborative, co-designed programs to formulate innovative data-intensive approaches to address critical national challenges.

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.

- Amy L. Walton, telephone: (703) 292-4538, email: HDR-DIRSE@nsf.gov
- Christopher W. Stark, telephone: (703) 292-4869, email: HDR-DIRSE@nsf.gov
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- Pui S. Ho, telephone: (703) 292-7054, email: HDR-DIRSE@nsf.gov
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- Sylvia J. Spengler, telephone: (703) 292-8930, email: HDR-DIRSE@nsf.gov
- Patricia Van Zandt, telephone: (703) 292-7437, email: HDR-DIRSE@nsf.gov
- Eva E. Zanzerkia, telephone: (703) 292-4734, email: HDR-DIRSE@nsf.gov

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

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.050 --- Geosciences
- 47.070 --- Computer and Information Science and Engineering
- 47.074 --- Biological Sciences
- 47.075 --- Social Behavioral and Economic Sciences
- 47.076 --- Education and Human Resources
- 47.079 --- Office of International Science and Engineering
- 47.083 --- Office of Integrative Activities (OIA)

Award Information

Anticipated Type of Award: Cooperative Agreement

Estimated Number of Awards: 4 to 7

4-7 awards in FY 2021 pending availability of funds and the type, scale, and variety of project ideas proposed.

Anticipated Funding Amount: $70,000,000

Up to a total of $70 million is anticipated to be available for 4-7 five-year awards.

Award size is contingent upon the scope, scale, and complexity of the proposed project, with a minimum total budget of $10 million. The size and complexity of any individual request should be justified by the amount and complexity of the work to be accomplished, and expected impact on the research community. 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:

Any individual who will serve as PI or Co-PI on the NSF award pursuant to the HDR: Coordination Hub (HDR Central) program solicitation will not be eligible to serve as PI or Co-PI on any award resulting from this solicitation.

Limit on Number of Proposals per Organization:

Although there is no limit on the number of proposals per organization, no organization will receive more than one Institute award as the lead organization.

Limit on Number of Proposals per PI or Co-PI: 1

An individual may participate as PI, co-PI, and/or other Senior Personnel in at most one Institute proposal pursuant to this solicitation. Note that any individual whose biographical sketch is provided as part of the proposal will be considered as Senior Personnel in the proposed activity, with or without financial support from the project.

In the event that any individual exceeds this limit, any proposal submitted to this solicitation with this individual listed as PI, co-PI, and/or Senior Personnel after the first proposal is received at NSF will be returned without review. No exceptions will be made.

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 Research.gov: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
  - Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

  Inclusion of voluntary committed cost sharing is prohibited.

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

  Not Applicable

- **Other Budgetary Limitations:**

  Not Applicable

C. Due Dates

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

  January 21, 2021

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:

Standard NSF reporting requirements apply.

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I. INTRODUCTION

NSF's *Harnessing the Data Revolution (HDR) Big Idea* is a national-scale activity to enable new modes of data-driven discovery that will address fundamental questions at the frontiers of science and engineering. Through this NSF-wide activity, HDR is generating new knowledge and understanding, and accelerating discovery and innovation. The HDR vision is realized through an interrelated set of efforts in foundations of data science; data-intensive research in science and engineering; and education and workforce development. Each of these efforts is designed to amplify the intrinsically multidisciplinary nature of the emerging field of data science. The HDR Big Idea is establishing theoretical, technical, and ethical frameworks that tackle data-intensive problems in science and engineering, contributing to data-driven decision-making that impacts society.

In 2019, the HDR Program launched three parallel efforts in pursuit of these aims. The *Institutes for Data-Intensive Research in Science and Engineering (I-DIRSE)* activity seeks to create an integrated fabric of interrelated institutes that can accelerate discovery and innovation in multiple areas of data-intensive science and engineering. *HDR: Transdisciplinary Research In Principles Of Data Science Phase I (HDR TRIPODS Phase I)* aims to bring together the electrical engineering, mathematics, statistics, and theoretical computer science communities to develop the theoretical foundations of data science through integrated research and training activities. *HDR: Data Science Corps (DSC)* focuses on building capacity for HDR to help unleash the power of data in the service of science and society. The *DSC* will provide practical experiences, teach new skills, and offer learning opportunities, in a variety of settings, to data scientists and data science students.

A portfolio of awards in each of these tracks (I-DIRSE, HDR TRIPODS Phase I, and DSC) has now formed the beginning of what will become a broad ecosystem for collaboration and synthesis. Interactions among researchers in all three HDR tracks will stimulate convergence among teams that share common scientific themes, and synergies among teams with different skillsets. To maximize and sustain the impacts of the HDR investments, awardees will be further encouraged to leverage resources and engage with collaborators from outside the HDR community, including NSF's investments in advanced cyberinfrastructure, and the science and engineering research activities supported by NSF including the other NSF Big Ideas. NSF recognizes the transformative potential in convergent approaches that bring together researchers with expertise in various science and engineering domains, including data science, to focus on the fundamental challenges of interpreting complex data and maximizing impacts of advanced methods across the breadth of scientific and engineering inquiry. The potential for identifying and solving these challenges is the vision behind the HDR ecosystem.

The success of the HDR ecosystem will depend on how effectively teams funded in the different investment areas can interface and leverage their distinct strengths and contributions to address challenging problems in science and engineering. To coordinate these efforts and amplify the impact of the HDR activities, an HDR Coordination activity, called HDR Central, is being funded under a separate program solicitation (NSF 20-600)[1]. The overarching purpose of HDR Central will be to increase the impact of the HDR Big Idea by coordinating communication and resource sharing among all HDR projects, including sharing the HDR efforts with the public.

This solicitation contributes to this ecosystem by encouraging an explicitly science-driven approach to ensure that advances in data science are applied where they will have significant and transformative impact in domains of research covered by NSF. Proposals should address science and engineering questions that: (1) are at a "tipping point" where a timely investment in data-intensive approaches has the maximum potential for a transformative effect; (2) have needs that can benefit from interdisciplinary investments in data analytics infrastructure; and (3) represent investment priorities for NSF during, and beyond, the lifetime of the HDR Big Idea. Specific outcomes expected for the HDR Institutes include identification of frontier science and engineering challenge problems and the associated data and data-science barriers or tipping points, as well as development of new approaches and innovative applications of data to foster scientific breakthroughs involving researchers from diverse scientific backgrounds.

This solicitation launches the second half of a two-phase process involving conceptualization followed by convergence. The conceptualization phase was implemented in FY 2019 via two complementary funding opportunities: HDR I-DIRSE-Ideas Labs which engaged individual applicants to self-organize into teams with the aim of developing innovative, collaborative research proposals through an Ideas Lab process; and HDR I-DIRSE-Frameworks which received applications from existing teams of researchers. These competitions resulted in two-year awards aimed at building communities, defining research priorities, pursuing initial interdisciplinary fundamental research advances, and/or developing interdisciplinary prototypes of systems/cyberinfrastructure solutions.

Proposals are now invited for broader and more comprehensively-scoped HDR Institutes that bring together multiple and new science and engineering communities with computer and computational scientists, mathematicians, statisticians, and information scientists around data science approaches. While it is expected that many of the teams funded under the conceptualization phase may be involved in proposals to this next phase, the competition is open to any team that can put together a proposal that meets the vision, scope, and readiness called for in the Program Description.

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[1] https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf20600

II. PROGRAM DESCRIPTION

The HDR Big Idea builds upon and expands advances in data-driven research developed under other NSF programs. The challenge for proposals submitted to this solicitation is to find novel approaches for applying these technological capabilities to realize their potential to transform the pace and potential for discovery across all areas of science and engineering.

HDR Institutes will foster convergent approaches that will transform how major questions in science and engineering are framed and addressed through data-intensive research. Institutes will consist of interdisciplinary teams to conceptualize and pilot new modalities for collaboration and convergence that go beyond traditional disciplinary boundaries and organizational walls, to build innovative connections between scientific groups and data scientists and engineers, and to integrate research infrastructure and education infrastructure.

HDR Institutes must have the following attributes:

A ***vision*** for transformative outcomes in science and engineering through data-intensive research. Proposals must demonstrate readiness to ramp up prototypes or preliminary designs that form the basis for the vision and present a conceptual design that is well beyond the level of a pilot study, capable of scaling in some significant dimension. The proposals should address science and engineering questions that: (1) are at a "tipping point" where a timely investment in data-intensive approaches has the maximum potential for a transformative effect in science and engineering; (2) have needs that can benefit from interdisciplinary investments in data analytics infrastructure; and (3) represent investment priorities for NSF during, and beyond, the lifetime of the HDR Big Idea. The proposal should clearly articulate the scope of the science that will be addressed and specific science problems that will be engaged. The importance and challenging nature of the problems should be presented lucidly, together with a discussion of the plan for how the problem will be addressed. The required expertise and the potential of a collaboration among data-scientists and domain scientists and/or engineers to transform the problem should be evident in the discussion.

Convergence among domain scientists, data scientists, and cyberinfrastructure experts to form novel frameworks, synergies, and concepts to implement the vision and to frame data-analytic challenges in new ways. The interdisciplinary breadth of the vision and the synthesis arising from meaningful interaction among multiple disciplinary perspectives are critical to an effective Institute. Disciplinary breadth should be determined by the anticipated needs to address the science; it should encompass the scientific and data science concepts, techniques, and computational methods and tools required to form the basis for addressing the problem in a way that is beyond that of traditional disciplinary research.

Coordination and Management that crosses institutional boundaries in new ways, such as virtual or distributed organizations; leverages existing research infrastructure and resources; and remains adaptive to new challenges and participation throughout the lifecycle of the Institute. Proposals must define and justify their organizational structures and responsibilities, governance, and communication plans to encourage and facilitate collaboration across disciplinary and geographically separated members. The processes that will be used to enable collaboration for broad, interdisciplinary groups – for example, through internal “ideas labs,” travel coordination, virtual collaboration, and/or summer schools and meetings – must be defined. Institutes are encouraged to involve underrepresented groups [e.g., women, persons with disabilities, individuals underrepresented in science, technology, engineering, and mathematics (STEM), veterans of the U.S. Armed Forces, and those from areas geographically underrepresented in STEM] as Institute participants. The Institute should have a strategic plan that integrates the research, education, broadening participation, and knowledge transfer activities across all levels.

A **collaboration strategy** for how the Institute will be an effective member of the broader HDR ecosystem. A proposal should clearly delineate how the Institute will contribute to the HDR community and how it will remain open in its organizational structure and activities to accommodate new partnerships, new scientific partners, and share expertise and infrastructure within the ecosystem as well as outside of it. The proposal should describe the resources and expertise the project hopes to leverage through collaboration.

A plan for ***transforming communities of practice*** in how data-intensive approaches can advance science and engineering beyond the participants of the proposed Institute. A proposal should describe how the Institute will serve as an agent of change for how research questions are conceived and addressed through interdisciplinary collaboration such that the impacts of the Institute will propagate and evolve beyond the lifetime of the award.

A common means of openly ***sharing outcomes***. The Institute should have a vision for how its activities will have impacts both within the HDR ecosystem and beyond the science communities around which it is organized, including a range of potential stakeholders. Dissemination of scientific outcomes, data, code, software, and other products must be an essential deliverable.

III. AWARD INFORMATION

Up to a total of $70 million is anticipated to be available for 4-7 five-year awards.

Award size is contingent upon the scope, scale, and complexity of the proposed project, with a minimum total budget of $10 million. The size and complexity of any individual request should be justified by the amount and complexity of the work to be accomplished, and expected impact on the research community. Estimated program budget, number of awards, and average award size/duration are subject to the availability of funds.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

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

Who May Serve as PI:

Any individual who will serve as PI or Co-PI on the NSF award pursuant to the HDR: Coordination Hub (HDR Central) program solicitation will not be eligible to serve as PI or Co-PI on any award resulting from this solicitation.

Limit on Number of Proposals per Organization:

Although there is no limit on the number of proposals per organization, no organization will receive more than one Institute award as the lead organization.

Limit on Number of Proposals per PI or Co-PI: 1

An individual may participate as PI, co-PI, and/or other Senior Personnel in at most one Institute proposal pursuant to this solicitation. Note that any individual whose biographical sketch is provided as part of the proposal will be considered as Senior Personnel in the proposed activity, with or without financial support from the project.

In the event that any individual exceeds this limit, any proposal submitted to this solicitation with this individual listed as PI, co-PI, and/or Senior Personnel after the first proposal is received at NSF will be returned without review. No exceptions will be made.

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

See PAPPG Chapter II.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.

Even if the project is 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.

Special instructions for submitting to this Big Idea solicitation:

FastLane Users: Proposers are reminded to identify the program solicitation number (located on the first page of this document) in the first block on the NSF Cover Sheet. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Please note that even though proposals must be submitted to CISE/OAC, once received the proposals will be managed by a cross-disciplinary team of NSF Program Directors.

Research.gov Users: The Prepare New Proposal setup will prompt you for the program solicitation number (located on the first page of this document). Compliance with this requirement is critical to determining the relevant proposal processing guidelines. As stated previously, even though proposals must be submitted to CISE/OAC, once received the proposals will be managed by a cross-disciplinary team of NSF Program Directors.

Grants.gov Users: The program solicitation number will be pre-populated by Grants.gov on the NSF Grant Application Cover Page, however you will need to locate the Division Code, Program Code, Division Name, and Program Name for the specific solicitation you are applying to by visiting https://www.fastlane.nsf.gov/pgmannounce.jsp . As stated previously, even though proposals must be submitted to CISE/OAC, once received the proposals will be managed by a cross-disciplinary team of NSF Program Directors.

The following instructions supplement guidelines in the PAPPG and NSF Grants.gov Application Guide:

Title of Proposed Project: The title of the proposed project should begin with the term: "HDR Institute:". The proposal title should be descriptive of the project and avoid acronyms or proper names that merely identify, rather than describe, the research project.

Project Summary (1 page): Each Project Summary must include the following sections labelled as they are here:

- *Overview*: **This section should begin with a comma-separated list of keywords as the first sentence.** It should then provide a brief overview of the proposed activities, planned deliverables, and the anticipated impacts on the research community.
- *Intellectual Merit*: This section should include a brief description of the proposed activities and the anticipated impacts on science and engineering research.

- *Broader Impacts*: This section should include a brief description of the potential impacts beyond the intended research community, including general science, educational, or public audiences.

Project Description. The Project Description is limited to 15 pages and must comply with all formatting requirements of the most current PAPPG II.C.2.d. In addition to the requirements outlined in the NSF PAPPG, proposals must address the following elements in the 15-page project description:

- The first paragraph of the project description should provide a concise, clear summary of the concept of the Institute, including the vision, scientific questions addressed, the integration of the data science approaches, the proposed Institute's organization, and its plan for participation in the HDR ecosystem.
- *Broader Impacts.* The Project Description must contain, as its own distinct element within the narrative, a section labeled "Broader Impacts". General guidance is provided in the NSF PAPPG Chapter II.C.2.d(i). For all activities or outcomes described under broader impacts, demonstrate how they will benefit from the proposed infrastructure.
- *Results of Prior Support*. The Project Description must contain, as its own distinct element within the narrative, a section labeled "Results of Prior Support". General guidance is provided in the NSF PAPPG Chapter II.C.2.d(iii). In addition to the reporting requirement format described by the PAPPG, this section must include evidence of deposition of code, data, and/or data products in recognized, accessible, community-accepted repositories by listing such repositories and, if appropriate, metadata.

The remainder of the Project Description should provide a detailed and compelling discussion of the six attributes identified in the Program Description above.

Supplementary Documents: Supplementary documents listed in the PAPPG or NSF Grants.gov Application Guide as required should be appended in the Supplementary Document section.

- Each proposal is required to include a ***Management and Coordination Plan*** (3-page limit, to be submitted as a Supplementary Document). Every Institute proposal must contain a clearly labeled "Management and Coordination Plan" which includes: 1) the specific roles of the PI, co-PIs, other senior personnel, and paid consultants at all organizations involved; 2) how the project will be managed across organizations and disciplines; 3) identification of the specific coordination mechanisms that will enable cross-organization and/or cross-disciplinary scientific integration; 4) metrics that will be used to assess and demonstrate the effectiveness of the Institute, including a timeline of anticipated milestones; 5) pointers to the budget line items that support these management and coordination mechanisms; and 6) a strategic plan that integrates the research, education, broadening participation, and knowledge transfer activities across all levels. **Proposals without this Supplementary Document will be returned without review.**
- **List of all identified institutions and/or participants.**

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

The budget should include a request for funds to cover the cost of attendance of the PI or other appropriate HDR Institute personnel to participate in annual awardee meetings in the Washington, D.C. area.

C. Due Dates

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

  January 21, 2021

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 NSF Merit Review Criteria, reviewers of these proposals will be asked to consider the following:

- How well does the proposal articulate the ***vision*** of the future Institute to contribute transformative new knowledge in relevant science and engineering domains through data-intensive research?
- How well does the proposed Institute support ***convergence*** among domain scientists and data scientists, providing new approaches not possible through individual efforts?
- How does the proposed Institute's ***coordination and management*** allow it to carry out the functions of the Institute, cross organizational and departmental boundaries, leverage existing research infrastructure, and support metrics for success? Does the project have an effective strategic plan that integrates the research, education, broadening participation, and knowledge transfer activities across all levels?
- How well defined is the ***collaboration strategy*** for this Institute to participate in the broader HDR ecosystem?
- What potential does the proposed Institute have to ***transform communities of practice*** in data-intensive research? How will the Institute serve as an agent of change for how research questions are conceived and addressed through interdisciplinary collaboration? To what extent will the impacts of the Institute propagate and evolve beyond the lifetime of the award?
- How does the Institute plan to ***share outcomes***, including but not limited to scientific and education outcomes, data, algorithms, and models?

B. Review and Selection Process

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

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:

HDR Institute awards will be made in the form of a Cooperative Agreement. The Cooperative Agreement will have a section of Special Conditions relating to the period of performance, detailed work description, awardee responsibilities, NSF responsibilities, joint NSF-awardee responsibilities, funding and funding schedule, reporting and evaluation requirements, key personnel, and other conditions.

Grantees will be required to include appropriate acknowledgment of NSF support under the Harnessing the Data Revolution Big Idea in any publication (including World Wide Web pages) of any material based on or developed under the project, in the following terms:

"This material is based upon work supported by the National Science Foundation Harnessing the Data Revolution Big Idea under Grant No. (Grantee enters NSF grant number.)"

Grantees also will be required to orally acknowledge NSF support using the language specified above during all news media interviews, including popular media such as radio, television and news magazines.

For all awards, one or more designated project representatives (PI/co-PI/senior personnel or NSF-approved replacement) must participate in annual HDR PI meetings. Proposal budgets must include appropriate amounts for participation in these meetings once each year.

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.

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:

- Amy L. Walton, telephone: (703) 292-4538, email: HDR-DIRSE@nsf.gov
- Christopher W. Stark, telephone: (703) 292-4869, email: HDR-DIRSE@nsf.gov

- Giovanna Biscontin, telephone: (703) 292-8360, email: HDR-DIRSE@nsf.gov
- Cheryl L. Eavey, telephone: (703) 292-7269, email: HDR-DIRSE@nsf.gov
- Daryl W. Hess, telephone: (703) 292-4942, email: HDR-DIRSE@nsf.gov
- Pui S. Ho, telephone: (703) 292-7054, email: HDR-DIRSE@nsf.gov
- Anthony Kuh, telephone: (703) 292-2210, email: HDR-DIRSE@nsf.gov
- Vyacheslav (Slava) Lukin, telephone: (703) 292-7382, email: HDR-DIRSE@nsf.gov
- Peter H. McCartney, telephone: (703) 292-8470, email: HDR-DIRSE@nsf.gov
- Rebecca Peebles, telephone: (703) 292-8809, email: HDR-DIRSE@nsf.gov
- Nigel A. Sharp, telephone: (703) 292-4905, email: HDR-DIRSE@nsf.gov
- Shahab Shojaei-Zadeh, telephone: (703) 292-8045, email: HDR-DIRSE@nsf.gov
- Finbarr C. Sloane, telephone: (703) 292-8465, email: HDR-DIRSE@nsf.gov
- Sylvia J. Spengler, telephone: (703) 292-8930, email: HDR-DIRSE@nsf.gov
- Patricia Van Zandt, telephone: (703) 292-7437, email: HDR-DIRSE@nsf.gov
- Eva E. Zanzerkia, telephone: (703) 292-4734, email: HDR-DIRSE@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.

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.

Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.E.6 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals

with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at https://www.nsf.gov

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314
- **For General Information** (NSF Information Center)**:** (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**

  Send an e-mail to: nsfpubs@nsf.gov

  or telephone: (703) 292-8134
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See System of Record Notices, NSF-50, "Principal Investigator/Proposal File and Associated Records," and NSF-51, "Reviewer/Proposal File and Associated Records." Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton
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