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NSF-Simons Research Collaborations on the Mathematical and Scientific Foundations of Deep Learning (MoDL)

PROGRAM SOLICITATION NSF 20-540



National Science Foundation

Directorate for Mathematical and Physical Sciences
Division of Mathematical Sciences

Directorate for Computer and Information Science and Engineering
Division of Computing and Communication Foundations

Directorate for Engineering
Division of Electrical, Communications and Cyber Systems



Simons Foundation - Division of Mathematical and Physical Sciences

Letter of Intent Due Date(s) (required) (due by 5 p.m. submitter's local time):

March 27, 2020

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

April 30, 2020

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:

NSF-Simons Research Collaborations on the Mathematical and Scientific Foundations of Deep Learning (MoDL)

Synopsis of Program:

The National Science Foundation Directorates for Mathematical and Physical Sciences (MPS), Computer and Information Science and Engineering (CISE), Engineering (ENG), and the Simons Foundation Division of Mathematics and Physical Sciences will jointly sponsor up to two new research collaborations consisting of mathematicians, statisticians, electrical engineers, and theoretical computer scientists. Research activities will be focused on explicit topics involving some of the most challenging questions in the general area of Mathematical and Scientific Foundations of Deep Learning. Each collaboration will conduct training through research involvement of recent doctoral degree recipients, graduate students, and/or undergraduate students from across this multi-disciplinary spectrum. Annual meetings of the Principal Investigators ("PIs") and other principal researchers involved in the collaborations will be held at the Simons Foundation in New York City. This program complements NSF's [National Artificial Intelligence Research Institutes](#) program by supporting collaborative research focused on the mathematical and scientific foundations of Deep Learning through a different modality and at a different scale.

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.

- Huixia Wang, MPS/DMS, telephone: (703) 292-2279, email: huiwang@nsf.gov
- Radhakisan S. Baheti, ENG/ECCS, telephone: (703) 292-8339, email: rbaheti@nsf.gov

Funda Ergun, CISE/CCF, telephone: (703) 292-2216, email: fergun@nsf.gov

- Tracy Kimbrel, CISE/CCF, telephone: (703) 292-7924, email: tkimbrel@nsf.gov
- Anthony Kuh, ENG/ECCS, telephone: (703) 292-2210, email: akuh@nsf.gov
- Elizabeth Roy, Simons Foundation, Simons Foundation, telephone: (212) 524-6966, email: eroy@simonsfoundation.org
- Christopher W. Stark, MPS/DMS, telephone: (703) 292-4869, email: cstark@nsf.gov

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

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.070 --- Computer and Information Science and Engineering

Award Information

Anticipated Type of Award: Continuing Grant

Estimated Number of Awards: 2

NSF and the Simons Foundation expect to co-fund two projects.

Anticipated Funding Amount: \$20,000,000

NSF estimates that \$10,000,000 will be available to support two projects of five years duration each. The Simons Foundation will contribute up to \$10,000,000 to support the same two projects over the five-year duration of the awards. NSF and the Simons Foundation expect to co-fund each of the two projects, and that each project will have an annual budget of up to \$2,000,000 combined from both sources.

This is a partnership between NSF and the Simons Foundation. Meritorious proposals will be funded jointly by the two organizations. Proposals recommended for funding will be resubmitted by the PIs to the Simons Foundation, in accordance with instructions given by the cognizant Simons Foundation Program Officer. Subsequent grant administration procedures will be in accordance with the individual policies of the awarding agency.

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

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 for the allowable organizations listed above. Federal agencies and federally funded research and development centers (FFRDCs) can only participate as subawardees. FFRDCs and federal agency scientists cannot serve as lead PI. Non-NSF sponsored FFRDCs are required to provide a letter of collaboration from their agency as a Supplementary Document, as described in section V.A of this solicitation.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

An individual may appear as PI, co-PI, or other senior personnel on no more than two proposals submitted in response to this solicitation. Other senior personnel include lead PIs on subawards and named postdoctoral research associates. There is no limitation on unpaid consultants. Please be advised that if an individual's name appears as PI, co-PI, or other senior personnel on more than two proposals, all proposals submitted after the first two proposals (based on the time-stamp) will be returned without review.

Please note: All materials should be submitted to NSF. NSF will share all submitted materials with the Simons Foundation. Additionally, the Simons Foundation does not use the role of co-PI. Individuals on the Simons Foundation budget must be designated as PI, co-Investigator ("co-I"), or other role (as defined in <https://www.simonsfoundation.org/funding-opportunities/policies-and-procedures/>).

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required. Please see the full text of this solicitation for further information.
- **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:**

Awards will be jointly made with the Simons Foundation. Half the budget must be prepared by following the NSF Proposal and Award Policies and Procedures Guide (PAPPG), and the other half of the budget must be prepared by following instructions from the Simons Foundation, included with the announcement of this funding opportunity at the Simons Foundation website (<https://www.simonsfoundation.org/funding-opportunities/>). Note that the Simons Foundation has a specific indirect cost rate policy (<https://www.simonsfoundation.org/funding-opportunities/policies-and-procedures/>).
- **Other Budgetary Limitations:**

Not Applicable

C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):

March 27, 2020
- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

April 30, 2020

Proposal Review Information Criteria

Merit Review Criteria:

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

Award Administration Information

Award Conditions:

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

Reporting Requirements:

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

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I. INTRODUCTION

Deep Learning has been a major driving force in the recent surge of interest in Artificial Intelligence (AI), both in academia and in industry. In addition to industrial applications, Deep Learning algorithms are playing important roles in fundamental scientific discoveries. While there has been spectacular empirical success with Deep Learning, the theoretical understanding of Deep Learning remains an important emerging research field. To address critical issues, such as the interpretability, reliability, stability, validation, and fairness of algorithms, a convergent effort from mathematicians, statisticians, electrical engineers, and theoretical computer scientists is needed. New mathematical and statistical theories are essential in efficiently dealing with problems, such as approximation, causal inference, convergence, and optimization in high dimensions that are ubiquitous in Deep Learning. Multiple learning paradigms including supervised, unsupervised, and reinforcement learning are in scope. Connections to applications should be addressed. The outcome of such efforts will not only provide Deep Learning with a much-needed theoretical underpinning as a scientific field and as an important tool for other scientific discoveries, but will also have enormous economic and societal impacts. Another critical component of the program is workforce development through training the next generation of scientists, an important need in the Mathematical and Scientific Foundations of Deep Learning.

II. PROGRAM DESCRIPTION

The NSF-Simons Research Collaborations on the Mathematical and Scientific Foundations of Deep Learning (MoDL) is a new program that expects to fund two projects of up to five years duration from this one-time call for proposals. The National Science Foundation Directorates for Mathematical and Physical Sciences (MPS), Computer and Information Science and Engineering (CISE), Engineering (ENG), and the Simons Foundation Division of Mathematics and Physical Sciences will jointly sponsor up to two new research collaborations consisting of mathematicians, statisticians, electrical engineers, and theoretical computer scientists. Please note that the order of the communities is arbitrary and is not meant to emphasize any one discipline over another. This program complements NSF's [National Artificial Intelligence Research Institutes](#) program by supporting collaborative research focused on the mathematical and scientific foundations of Deep Learning through a different modality and at a different scale.

Successful projects are expected to have a cohesive set of goals and a convincing plan that shows that substantial progress will be made in research activities focused on explicit topics involving some of the most challenging questions in the general area of Mathematical and Scientific Foundations of Deep Learning. Projects are required to bring together theories and approaches from theoretical computer science, electrical engineering, mathematics, and statistics and each project must clearly demonstrate substantial collaborative contributions from members of these four communities. Each project team will conduct training through the research involvement of recent doctoral degree recipients, graduate students, and/or undergraduate students from across this multi-disciplinary spectrum. While the scientific focus must be on the theoretical foundations, relevance to application domains and industry is also important. Projects are encouraged to leverage, as resources, existing NSF investments such as [Big Data Regional Innovation Hubs](#), [Mathematical Sciences Research Institutes](#), [Engineering Research Centers](#), [Science and Technology Centers](#), [Cyberinfrastructure for Sustained Scientific Innovation \(CSSI\)](#), and [Transdisciplinary Research in Principles of Data Science \(TRIPODS\) Institutes](#) as appropriate through collaborations or partnerships. Proposers are encouraged to carefully consider the solicitation-specific review criteria specified in Section VI.A. of this document as they prepare their proposals.

Annual meetings of these collaborations will be held at the Simons Foundation in New York City to help facilitate collaboration and cooperation between these and related projects. PIs, co-PIs (co-Is), and other senior personnel from each collaboration are required to attend. The costs for these annual meetings will be paid directly by the Simons Foundation.

III. AWARD INFORMATION

NSF estimates that \$10,000,000 will be available to support two projects of five years duration each. The Simons Foundation will contribute up to \$10,000,000 to support the same two projects over the five-year duration of the awards. NSF and the Simons Foundation expect to co-fund each of the two projects, and that each project will have an annual budget of up to \$2,000,000 combined from both sources.

This is a partnership between NSF and the Simons Foundation. Meritorious proposals will be funded jointly by the two organizations. Proposals recommended for funding will be resubmitted by the PIs to the Simons Foundation, in accordance with instructions given by the cognizant Simons Foundation Program Officer. Subsequent grant administration procedures will be in accordance with the individual policies of the awarding agency.

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

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 for the allowable organizations listed above. Federal agencies and federally funded research and development centers (FFRDCs) can only participate as subawardees. FFRDCs and federal agency scientists cannot serve as lead PI. Non-NSF sponsored FFRDCs are required to provide a letter of collaboration from their agency as a Supplementary Document, as described in section V.A of this solicitation.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

An individual may appear as PI, co-PI, or other senior personnel on no more than two proposals submitted in response to this solicitation. Other senior personnel include lead PIs on subawards and named postdoctoral research associates. There is no limitation on unpaid consultants. Please be advised that if an individual's name appears as PI, co-PI, or other senior personnel on more than two proposals, all proposals submitted after the first two proposals (based on the time-stamp) will be returned without review.

Please note: All materials should be submitted to NSF. NSF will share all submitted materials with the Simons Foundation. Additionally, the Simons Foundation does not use the role of co-PI. Individuals on the Simons Foundation budget must be designated as PI, co-Investigator ("co-"), or other role (as defined in <https://www.simonsfoundation.org/funding-opportunities/policies-and-procedures/>).

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Letters of Intent (required):

Potential proposers may not submit a full proposal without first submitting a corresponding Letter of Intent (LOI), compliant with the instructions below, by the LOI submission deadline. Submitting a Letter of Intent does not obligate potential proposers to submit a full proposal. If a collaborative proposal is planned, a single LOI should be submitted by the lead institution only. LOIs are not subject to merit review but instead are used for internal planning purposes. Investigators should not expect to receive any feedback on their Letters of Intent.

Each LOI must include the following information:

In the Synopsis section, include a one-paragraph overview of the plans for a research collaboration. This should be followed by the heading "Keywords" and a list of 6-12 keywords describing specific topics of research.

In the Project PI and Senior Personnel section, list the full names and institutional affiliations for the PI and up to 4 co-PIs and Senior Personnel on the planned project, including any intended collaborative proposals or subawardees.

In the Other Comments section, list the full names and institutional affiliations for the PI and all co-PIs (co-Is) and Senior Personnel on the planned project, including those listed in the Project PI and Senior Personnel section. These names must be listed in the following format: Last name, first name, email address, affiliation. Commas must separate these four fields; semicolons should separate entries for different individuals. The point of contact for NSF inquiries must be the same as the project PI, and must appear on the first line. Additional text boxes may be used for more space if the Other Comments box is insufficient.

Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through FastLane in response to this Program Solicitation please note the conditions outlined below:

- Submission by an Authorized Organizational Representative (AOR) is not required when submitting Letters of Intent.
- A Minimum of 0 and Maximum of 4 Other Senior Project Personnel are permitted
- Other Senior Personnel is required when submitting Letters of Intent
- Submission of multiple Letters of Intent is not permitted

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=papppg. 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.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

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.

Supplementary Documents

Submit Supplementary Documents containing the following information:

1. Simons Foundation Budget (required)

Awards will be jointly made with the Simons Foundation. Half the budget must be prepared by following the NSF Proposal and Award Policies and Procedures Guide (PAPPG), and the other half of the budget must be prepared by following instructions from the Simons Foundation, included with the announcement of this funding opportunity at the Simons Foundation website (<https://www.simonsfoundation.org/funding-opportunities/>). Note that the Simons Foundation has a specific indirect cost rate policy (<https://www.simonsfoundation.org/funding-opportunities/policies-and-procedures/>). The Simons Foundation does not use the role of co-PI. Individuals on the Simons Foundation budget must be designated as PI, co-Investigator ("co-I") or other role.

2. Management and Collaboration Plan (maximum 5 pages, required)

Provide a list of key leadership personnel, and a brief description of what each person brings to the leadership team. Describe the duties and expected contributions of each individual in the collaboration. This plan must also describe the expertise in the appropriate disciplines provided by the PIs as well as ways for working together to meet the goals of the program.

3. Evaluation Plan (maximum 5 pages, required)

Describe measures to evaluate progress toward the proposed project's goals; and a plan for quantitative and qualitative methods to assess the effectiveness and impact of the proposed institute's activities.

4. Letters of Collaboration

Letters of Collaboration: Letters of collaboration describe collaborative arrangements of significance for the proposed project, including commitments for space, faculty and staff positions, equipment, and access to facilities, and must be limited to stating the intent to collaborate and should not contain endorsements or evaluation of the proposed project or investigators (see PAPPG Chapter II.C.2.j). Non-NSF sponsored FFRDCs are required to provide a letter of collaboration from their agency. The recommended format for letters of collaboration is as follows:

"If the proposal submitted by Dr. [insert the full name of the Principal Investigator] titled [insert the proposal title] is selected for funding by NSF and the Simons Foundation, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment or Other Resources section of the proposal."

The Project Description should document the need for and nature of collaborations, such as intellectual contributions to the project, permission to access a site, an instrument, or a facility, offer of data, samples and materials for research, logistical support to the research and education program, or mentoring of U.S. students at a foreign site. All letters of collaboration must be included at the time of submission as separate Supplementary Documents.

Departure from this format may result in the proposal being returned without review.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Indirect Cost (F&A) Limitations:

Awards will be jointly made with the Simons Foundation. Half the budget must be prepared by following the NSF Proposal and Award Policies and Procedures Guide (PAPPG), and the other half of the budget must be prepared by following instructions from the Simons Foundation, included with the announcement of this funding opportunity at the Simons Foundation website (<https://www.simonsfoundation.org/funding-opportunities/>). Note that the Simons Foundation has a specific indirect cost rate policy (<https://www.simonsfoundation.org/funding-opportunities/policies-and-procedures/>).

C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):

March 27, 2020

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

April 30, 2020

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

For Proposals Submitted Via FastLane or Research.gov:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubmission.html. For FastLane or Research.gov user support, call the FastLane and Research.gov Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov or rgov@nsf.gov. The FastLane and Research.gov Help Desk answers general technical questions related to the use of the FastLane and Research.gov systems. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: <https://www.grants.gov/web/grants/applicants.html>. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

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

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

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURE

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 above criteria, the following will be used in the evaluation process:

- Does the proposal describe a well-integrated research and training program focused on the mathematical and scientific foundations of deep learning and fostering collaboration and interaction among the communities of mathematics, statistics, theoretical computer science, and electrical engineering?
- Synergy: Is the project transdisciplinary, bringing together theories and approaches from theoretical computer science, electrical engineering, mathematics, and statistics? Is there synergy among the project team members from the different communities?
- Vision: Is there a strong case for the project team's ability to identify and articulate a vision for the foundations of deep learning?
- Quality and Value of Collaboration: Is the expertise of the PIs, co-PIs (co-Is) complementary and well-suited to the research and training programs developed in this project? Are the specific roles of each collaborating investigator clear? Does the collective team have expertise representing the four communities (electrical engineering, statistics, mathematics, and theoretical computer science)?
- Does the Management and Collaboration Plan indicate the project leadership has the capabilities to guide and manage a project of this size?
- Does the Evaluation Plan identify clear measures of success along with a plan to evaluate the project with respect to those measures by gathering quantitative and qualitative data?
- Does the Evaluation Plan provide a clear plan for thoughtful, ongoing assessment of all project activities? How will the assessment be used to inform and improve both daily operations and long-range planning?

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.

The program will be managed by program directors from NSF and the Simons Foundation. NSF will take the lead in managing, organizing, and conducting the review process of all proposals. The Simons Foundation program directors will make recommendations for reviewers and will attend NSF review panels as observers. Copies of proposals and unattributed reviews will be shared with the Simons Foundation, as appropriate.

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.

NSF Process: 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:

Proposals selected for funding will be subject to each Foundation's respective award policies and practices. Each award funded by this program will receive two separate awards of equal size in terms of total costs, one from NSF and one from the Simons Foundation (SF). For NSF, standard NSF award conditions apply. SF awards will use standard SF award terms, conditions, and reporting requirements. Award notification and administration will be carried out by NSF with respect to each of its awards, in consultation with SF. Award notification and administration will be carried out by SF with respect to each of its awards, in consultation with NSF.

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.

For NSF, standard NSF reporting requirements apply.

For the Simons Foundation awards, reports shall be submitted in the form and in the manner set forth in the Simons Foundation grant agreement.

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:

- Huixia Wang, MPS/DMS, telephone: (703) 292-2279, email: huiwang@nsf.gov
- Radhakisan S. Baheti, ENG/ECCS, telephone: (703) 292-8339, email: rbaheti@nsf.gov
- Funda Ergun, CISE/CCF, telephone: (703) 292-2216, email: fergun@nsf.gov
- Tracy Kimbrel, CISE/CCF, telephone: (703) 292-7924, email: tkimbrel@nsf.gov
- Anthony Kuh, ENG/ECCS, telephone: (703) 292-2210, email: akuh@nsf.gov
- Elizabeth Roy, Simons Foundation, Simons Foundation, telephone: (212) 524-6966, email: eroy@simonsfoundation.org
- Christopher W. Stark, MPS/DMS, telephone: (703) 292-4869, email: cstark@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.

Important Note: For timely responses to your questions, please direct your email messages to the Program Directors on the MoDL Working Group at modl@nsf.gov

IX. OTHER INFORMATION

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

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

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 (FASSED) 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: nspubs@nsf.gov
 - or telephone: (703) 292-7827
- **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
Reports Clearance Officer
Office of the General Counsel
National Science Foundation
Alexandria, VA 22314

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	National Science Foundation, 2415 Eisenhower Avenue, Alexandria, Virginia 22314, USA Tel: (703) 292-5111, FIRS: (800) 877-8339 TDD: (703) 292-5090 or (800) 281-8749					Text Only