

New Frontiers at the intersection of Continuous and Discrete Optimization

Project Summary

Overview

Traditionally, the fields of discrete and continuous optimization have largely evened out as disconnected silos with a few intermittent overlaps dubbed as sparse optimization. Most algorithms in sparse optimization can be broadly grouped under two umbrellas – convexification of the sparsity constraint, or use of thresholding operators on gradient descent steps to ensure sparsity. In this work, we intend to leverage techniques and results from discrete optimization studies to aid in development of new algorithms, analyses and applications for sparse continuous optimization.

At the heart of these new explorations is a novel recent result by the PI that provides worst-case approximation guarantees for the classic greedy forward selection algorithm for support selection in continuous functions. The result generalizes and combines proof techniques from the study of submodular functions in discrete optimization and gradient-descent algorithms in continuous optimization. The fundamental result further leads to several auxiliary results

Intellectual Merit

The project will develop new fundamental algorithms and analyses for sparse optimization with far-reaching applications. This project will create novel synergies in the fields of discrete and continuous optimization, drawing inspirations and advancing both the fields for far-reaching impacts. Specifically, we will develop new provably convergent algorithms for the combinatorial support selection problem. We will leverage these findings to develop new techniques for faster and fairer training through generalized data and communication coresets. For black-box interpretability, we will apply these methods for model compression techniques.

Broader Impacts Of The Proposed Work

The PI intends to integrate the study of sparsity in machine learning into current and future course offerings at Purdue. Through various diversity promoting initiatives at Purdue, the PI will disseminate and encourage increased participation from underrepresented minorities.

Project Description

Introduction

Proposed Study

The Project Description should provide a clear statement of the work to be undertaken and must include: objectives for the period of the proposed work and expected significance; relation to longer-term goals of the PI's project; and relation to the present state of knowledge in the field, to work in progress by the PI under other support and to work in progress elsewhere.

The Project Description should outline the general plan of work, including the broad design of activities to be undertaken, and, where appropriate, provide a clear description of experimental methods and procedures. Proposers should address what they 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. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified. These issues apply to both the technical aspects of the proposal and the way in which the project may make broader contributions.

Broader Impacts Of The Proposed Work

The Project Description must contain, as a separate section within the narrative, a section labeled "Broader Impacts of the Proposed Work". This section should provide a discussion of the broader impacts of 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 the 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.

Results From Prior NSF Support

If any PI or co-PI identified on the project has received NSF funding (including any current funding) in the past five years, information on the award(s) is required, irrespective of whether the support was directly related to the proposal or not. In cases where the PI or co-PI has received more than one award (excluding amendments), they need only report on the one award most closely related to the proposal. Funding includes not just salary support, but any funding awarded by NSF. The following information must be provided:

Name of PI: NSF-Program (Award Number) "Title of the Project" (\$AMOUNT, PERIOD OF SUPPORT). **Publications:** List of publications resulting from the NSF award. A complete bibliographic citation for each publication must be provided either in this section or in the References Cited section of the proposal); if none, state: "No publications were produced under this award."

Research Products: evidence of research products and their availability, including, but not limited to: data, publications, samples, physical collections, software, and models, as described in any Data Management Plan.

Budget Justification

A. Senior Personnel

A1. Includes PI at 10% CY.

B. Other Personnel

B3. Includes stipend for one graduate student for each calendar year of the project.

C. Fringe Benefits

Fringe benefits are calculated at a rate of X% for faculty, Y% for graduate students.

E. Travel

1) all travel (both domestic and foreign) must now be justified. 2) temporary dependent care costs above and beyond regular dependent care that directly result from travel to conferences are allowable costs provided that the conditions established in 2 CFR § 200.474 are met.

G. Other Direct Costs

1) Includes coverage on costs of computing devices 2) The charging of computing devices as a direct cost is allowable for devices that are essential and allocable, but not solely dedicated, to the performance of the NSF award **G5.** Includes tuition for graduate students participating in the program.

H. Indirect Costs

Overhead at a rate of X% is charged on all direct salaries and wages, applicable fringe benefits, materials and supplies, services, travel and subawards up to the first \$X of each subaward. Excluded are equipment and the portion of each subaward in excess of \$X.

Current & Pending Support

Investigator:

Project Title: Put your Proposal title here

Project Location:

Source of Support: NSF

Total Award Amount:

Total Award Period:

Status: Pending (this project)

Facilities, Equipments, & Other Resources

This section of the proposal is used to assess the adequacy of the resources available to perform the effort proposed to satisfy both the Intellectual Merit and Broader Impacts review criteria. Proposers should describe only those resources that are directly applicable. Proposers should include an aggregated description of the internal and external resources (both physical and personnel) that the organization and its collaborators will provide to the project, should it be funded. Such information must be provided in this section, in lieu of other parts of the proposal (e.g., budget justification, project description). The description should be narrative in nature and must not include any quantifiable financial information. Reviewers will evaluate the information during the merit review process and the cognizant NSF Program Officer will review it for programmatic and technical sufficiency.

Data Management Plan

Proposals must include a supplementary document of no more than two pages labeled “Data Management Plan”. This supplementary document should describe how the proposal will conform to NSF policy on the dissemination and sharing of research results (see AAG Chapter VI.D.4)