

Stimulating Collaborative Advances
Leveraging Expertise in the
Mathematical and Scientific
Foundations of Deep Learning
(SCALE MoDL)
NSF 21-561

Webinar
March 5, 2021

NATIONAL SCIENCE FOUNDATION



Agenda

- Introduction
- Overview of the Program
- Questions from Registration
- Q&A
 - Submit your questions via the Q&A box
 - Questions can be submitted anonymously
 - Q&A session goes live at the end of the webinar



What is SCALE MoDL?

- Mathematical and Scientific Foundations of Deep Learning (MoDL)
- **A collaboration** of five divisions across three NSF Directorates:
 - CISE/CCF, CISE/IIS, ENG/ECCS, MPS/DMS, SBE/SES
- **Cross-disciplinary activity:** computer science, electrical engineering, mathematics, statistics



NSF-SF MoDL Working Group

MPS/DMS



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CISE/CCF



Funda
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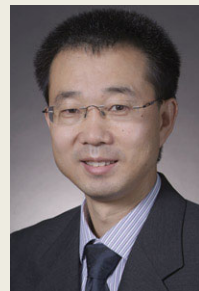
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SBE/SES



Henry Kautz
CISE/IIS



Juan Meza
MPS/DMS

Need for Theory

- Many unknowns about deep learning:
 - When do they work/fail, and why?
 - Use-inspired viewpoints (small data sets, adversarial learning, etc.)
 - Privacy safeguards, inference, fairness, etc.
 - ...
- Understanding deep learning requires a unified theory

Background

FY20: NSF-Simons MoDL Program

- **MoDL:** NSF-Simons Research Collaborations on the Mathematical and Scientific Foundations of Deep Learning (MoDL)
- **A collaboration** of three divisions across three NSF Directorates and the MPS division of Simons Foundation (SF)
- Resulted in two large-scale awards (each \$10M across 5 years)



■ Collaboration on the Theoretical Foundations of Deep Learning (2031883)



Berkeley
UNIVERSITY OF CALIFORNIA



TOYOTA
TECHNOLOGICAL
INSTITUTE
AT CHICAGO



EPFL



האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

■ Transferable, Hierarchical, Expressive, Optimal, Robust, Interpretable NETWORKS (2031985, 2031849, 2031895, 2031899, 2032014)



JOHNS HOPKINS
UNIVERSITY

DUKE



LMU
LUDWIG-
MAXIMILIANS-
UNIVERSITÄT
MÜNCHEN

Motivation for FY21 SCALE MoDL

- Enhance our understanding, and expand the applicability, of deep learning
- Increase diversity and broaden participation:
 - Broad array of approaches, including use-inspired viewpoints
 - High-risk-high-reward projects, better suited to smaller, more agile teams

SCALE MoDL (NSF 21-561)

- Proposal deadline: **May 12, 2021**
- Anticipated total funding: \$15,000,000
- Anticipated number of awards: 15-20
- Award size: varies, up to \$1,200,000
- Duration: up to 3 years



Goals of SCALE MoDL

- Support smaller collaborative teams to build the theoretical foundations and advance the understanding of deep learning
- Bring together theory and analysis from computer science, electrical engineering, mathematics, and statistics
- Workforce training, foreseeing relevance to application domains and industry



Eligibility

- PI teams must collectively possess appropriate expertise in three disciplines:
 - computer science, electrical engineering, and mathematics/statistics.
- Limit on number of proposals per PI/co-PI:
2
- Proposals from or involving Minority Serving Institutions are especially welcome



Candidate Topics

- Theory and approaches: geometric, topological, Bayesian, game theory, optimal transport, optimization, approximation, information theory, dynamical systems, partial differential equations, mean field theory, etc.
- Use-inspired viewpoints: small data sets, adversarial learning, closing the decision-action loop, etc.
- Many others: privacy, fairness, evaluation, causal inference, etc.



Required Documents

- Required sections (PAPPG II.C.2)
- Supplementary document
 - Project Management Plan (PMP ≤ 2 pages): duties and expected contributions, the expertise in the appropriate disciplines, and logistics of working together
 - PMP must be provided and will be evaluated



Review Process

- Submit through MPS/DMS, to be managed by the cross-disciplinary MoDL PD team
- Review process: panels and ad-hoc reviews
- Standard two NSF review elements:
 - Intellectual Merit
 - Broader Impacts



Final Comments

- Competitive proposals should:
 - Focus on challenging theoretical questions;
 - Target at least one key technical obstacle;
 - Describe an actionable approach;
 - Have convincing research and collaboration plans;
 - Demonstrate appropriate expertise in three disciplines – computer science, electrical engineering, mathematics/statistics
 - Address relevance to application domains and/or industry
- Workforce development: projects with plans for the involvement of students and/or postdoctoral associates with diverse backgrounds are encouraged.



Questions from Registration

- Can a MoDL proposal address theoretical foundations of learning in the brain?
- How many PI/Co-PI-s are allowed for each proposal?
- Must the team have at least three PIs to cover all the three disciplines (CS, EE, Math/Stat)?
- Can an unpaid collaborator cover one of the three disciplines?
- Can the program provide support to foreign partners?



Q & A



Thank You!

- Contact: modl@nsf.gov
- Program homepage:
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505873
 - Webinar slides
 - FAQ
- Reviewer survey: coming soon

