National Science Foundation
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Dear Colleague Letter: Computational and Data-Enabled Science and Engineering in Mathematical and Statistical Sciences (CDS&E-MSS)

Dear Colleagues:

The conduct of scientific research is being revolutionized by developments in the availability of computational resources and digital datasets. The last three decades have seen advances of roughly nine orders of magnitude in computing capability, together with deep advances in computational algorithms. These advances allow computational and multiscale simulations of unprecedented scope and accuracy. Simultaneous advances in digital data collection technology are proceeding at an even faster pace, with the result that enormous datasets are now generated routinely by scientific experiments and observations of natural phenomena. The result is a scientific revolution in the scope, use, and production of data.

As did digital computation itself, such data-intensive science is driving revolutionary advances in mathematics and statistics. How are features, let alone new laws of nature, to be found in the vast volumes of data being generated and collected? How can disparate data, from simulations and observations, different instruments and multiple communities, be combined to advance knowledge?

The Division of Mathematical Sciences and the Office of Cyberinfrastructure of the National Science Foundation recognize the importance of fundamental mathematical and statistical research in this field of computational and data-enabled science and engineering (CDS&E) and envision that the mathematical and statistical research communities will play a leading role in the future development of this emerging science. In partnership with the Office of Cyberinfrastructure, the CDS&E-MSS program in DMS supports fundamental mathematical and statistical research at the core of this emerging discipline. The goal of the program is to promote the creation, development, and application of the next generation of mathematical and statistical theories and tools that will be essential for addressing the challenges presented to the scientific and engineering communities by the ever-expanding role of computational modeling and simulation on the one hand, and the explosion in production of digital and observational data on the other. To this end, the program will support fundamental research in mathematics and statistics, including transition to practice, whose primary emphasis will be on meeting the aforementioned computational and data-related challenges. The program has strong interest in multidisciplinary collaboration and the training of next-generation mathematicians and statisticians firmly grounded in CDS&E.

Examples in which mathematical and statistical research enables advances in CDS&E include, but are not limited to:

- Sophisticated computational/statistical modeling for simulation, prediction, and assessment in computation-intensive and data-intensive scientific problems.
- State-of-the-art tools and theory in statistical inference and statistical learning for knowledge discovery from massive, complex, and dynamic data sets.
- General theory and algorithms for advancing large-scale modeling of problems that present particular computational difficulties, such as strong heterogeneities and anisotropies, multi-physics coupling,

multiscale behavior, stochastic forcing, uncertain parameters or dynamic data, and long-time behavior.

- Study of mathematical, statistical, and stochastic properties of networks.
- Mathematical and statistical challenges of uncertainty quantification.
- Development of numerical, symbolic, and statistical theory and tools to uncover and study analytical, topological, algebraic, geometric, and number-theoretic structures relevant for large-scale data acquisition, data security, and cybersecurity.

Subject to availability of funds and quality of proposals, up to $5M will be made available for this program in fiscal year 2012. For the full program description, see http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504687&org=DMS&from=home

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