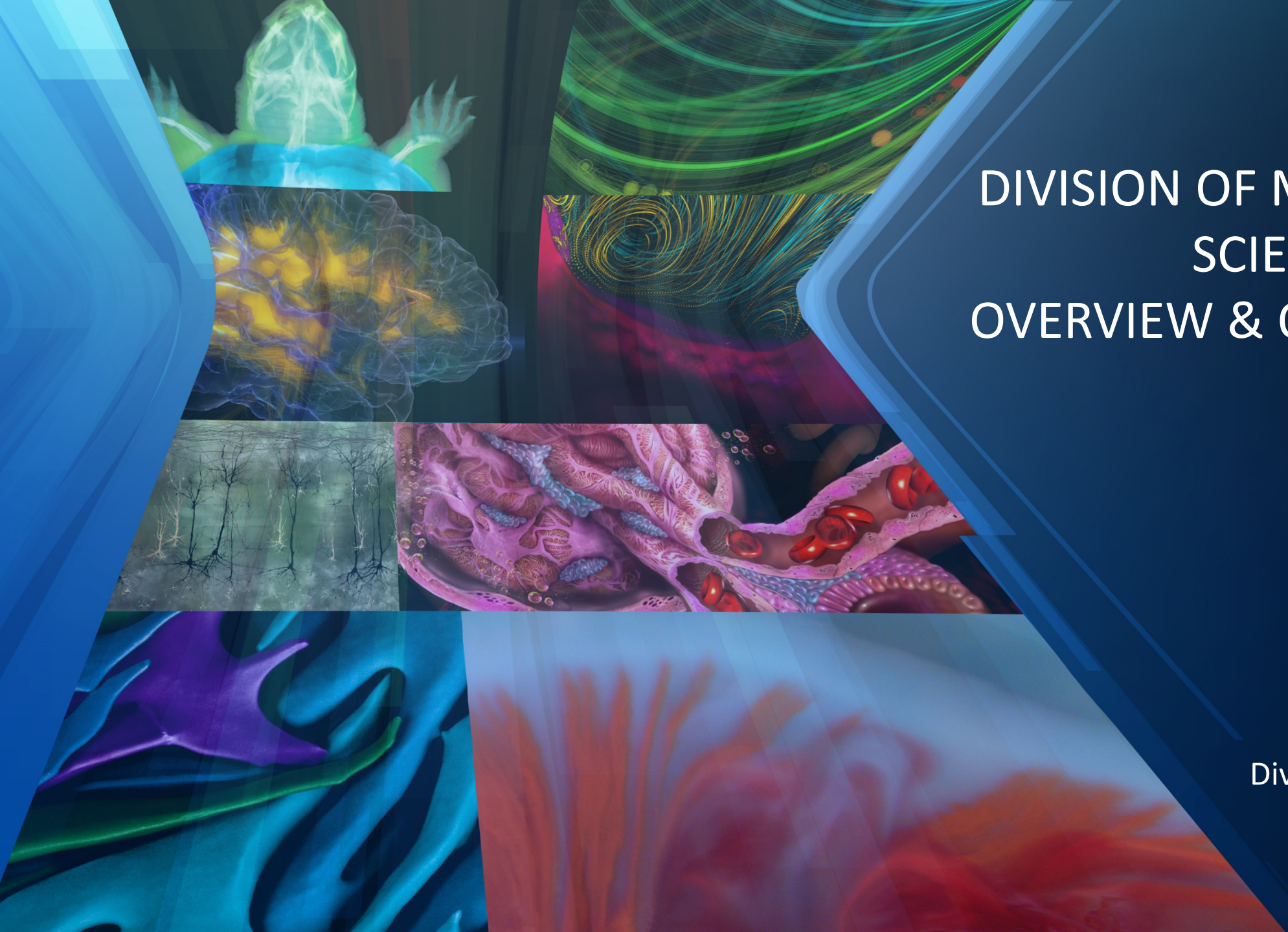


DIVISION OF MATHEMATICAL SCIENCES: OVERVIEW & OPPORTUNITIES

Juan C. Meza
Division of Mathematical Sciences
April 2018

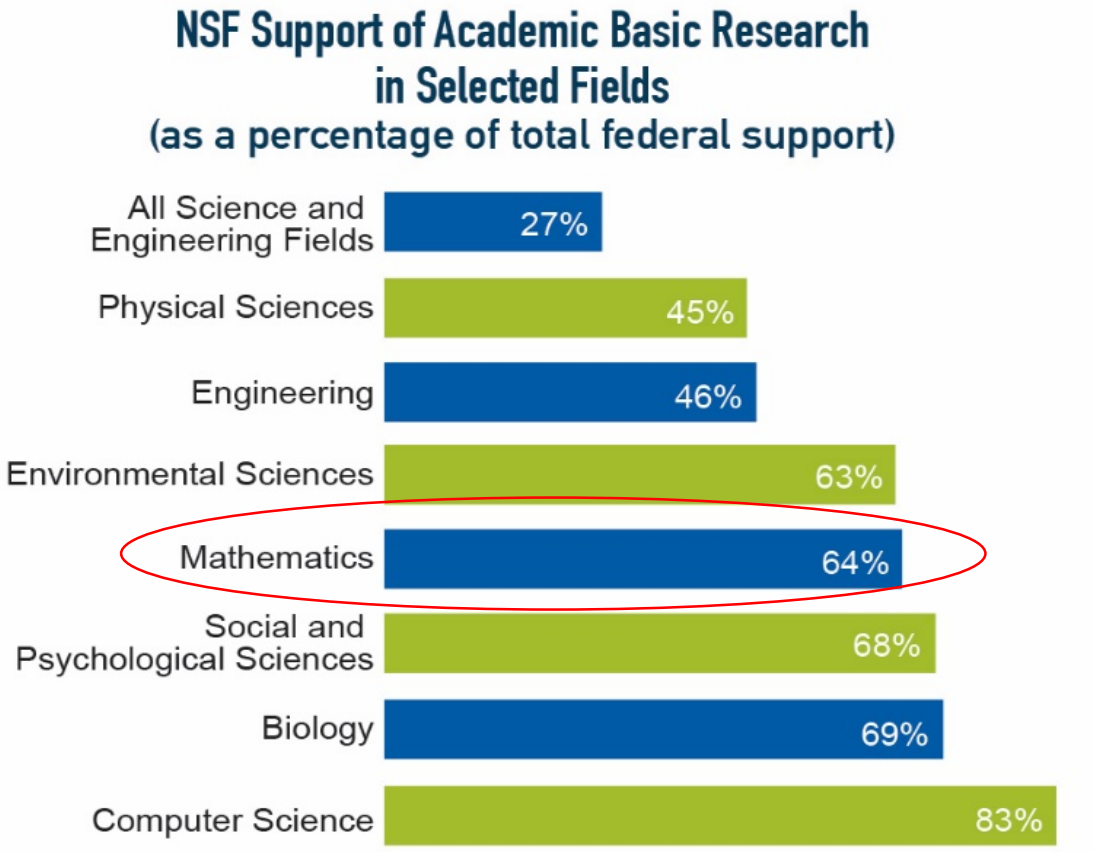
DMS Highlights
and
Sample Activities

DMS Quick Facts

$233M	FY17 Budget
64%	Support of US Basic Math Research
~3000	Proposals reviewed each year
24%	Average Funding Rate
28	Program Directors

NSF/DMS funds 64% of Mathematics Basic Research in the US

- DMS is the predominant funder of basic mathematical sciences research in the US
- FY 2017 spending was $233M
- Majority of budget goes toward disciplinary program individual investigator awards



Notes: Biology includes Biological Sciences and Environmental Biology. Biology and Psychological Sciences exclude National Institutes of Health funding from the total amount of federal support.

Source: NSF/National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development, FY 2015.

DMS Major Investment Areas

Institutes & Centers

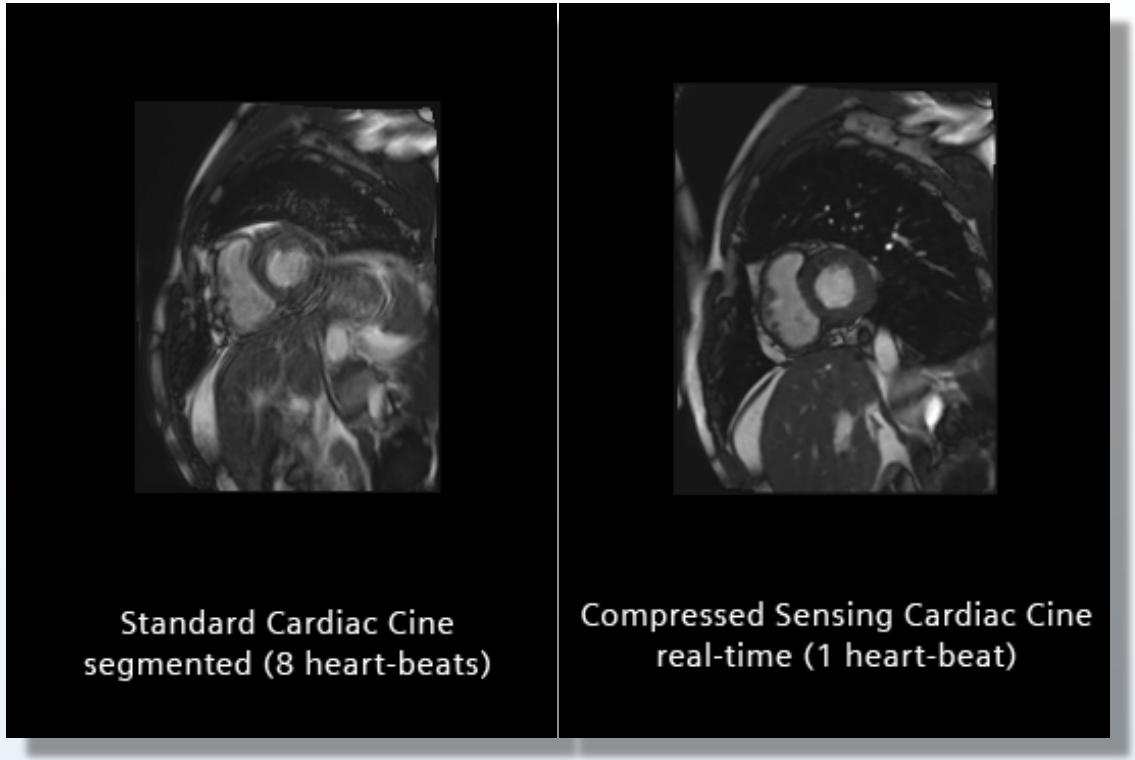
Workforce, Training, MSPRF, CAREER

New Initiatives & Special Programs

Infrastructure

DMS Funded Research Has a BIG Impact

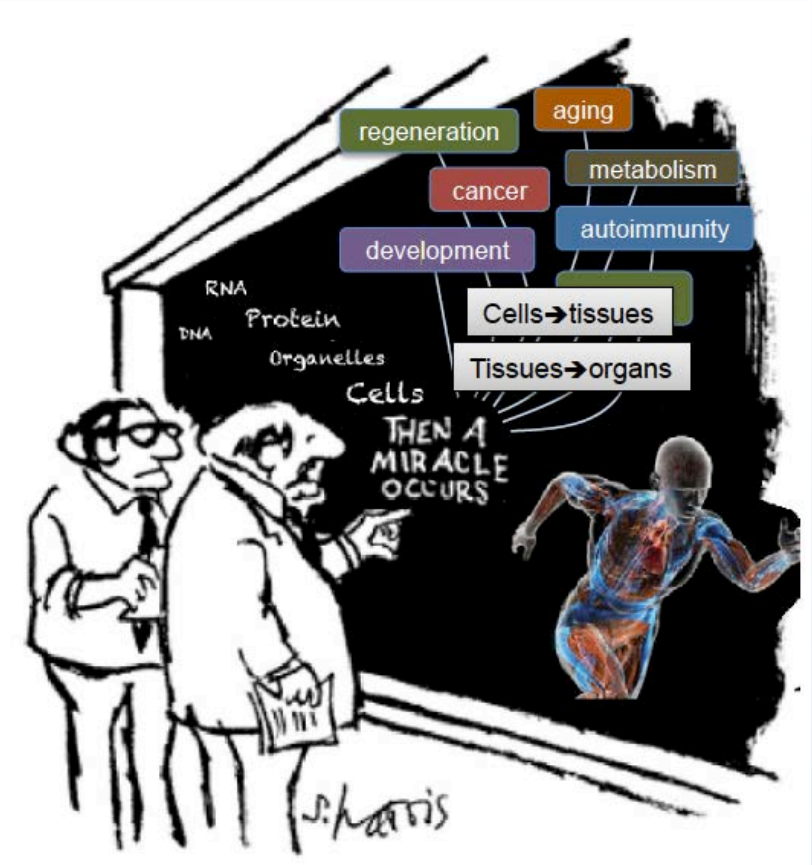
- FDA approved 2 new MRI devices that dramatically speed up scanning, **between 8 and 16 times faster** than conventional methods.
- Both products use **compressed sensing,** a breakthrough technique developed over **10 years ago** by NSF/DMS-supported mathematicians.
- The speedup will **allow more patients to be served at a lower cost per patient**, giving US taxpayers a better return on the tens of billions of dollars in annual MRI charges.



A Focused Research Group on Multiscale Geometric Analysis – Theory, Tools, Applications. DMS – 0140698/Donoho (Lead), DMS – 0140540/Candes, DMS – 0140587/Huo, DMS – 0140623/Jones

NSF-Simons Research Centers for Mathematics of Complex Biological Systems

- Five year, $30M program funded equally by NSF and Simons Foundation
- 3 NSF Divisions: Mathematical Sciences, Integrative Organismal Systems, Molecular and Cellular Biosciences
- Support mathematical approaches aimed at understanding:
  - the complex causal relationships leading to emergent properties of molecular, cellular and organismal systems, or
  - to the emergent properties resulting from the complex integration across these levels of organization at different time scales
- Close, sustained collaborations between biologists and mathematical scientists that leverage their complementary expertise



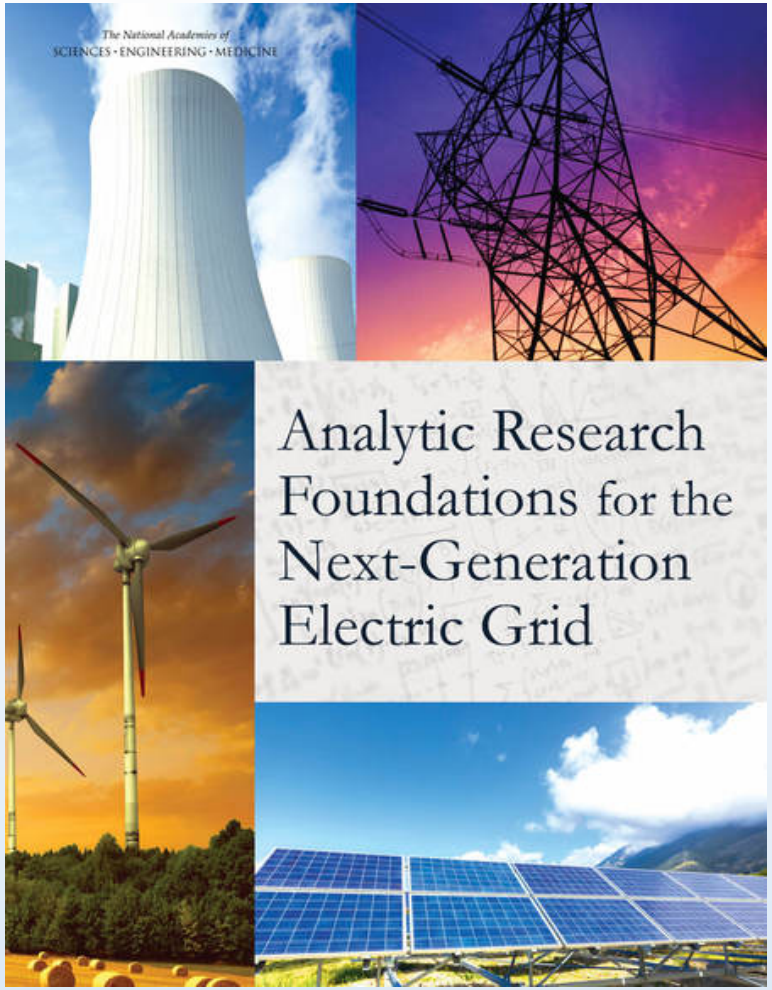
"I think you should be more explicit here in step two."

TRIPODS - Transdisciplinary Research in Principles of Data Science

- Joint DMS & Division of Computing and Communications Foundations
- Bring together the statistics, mathematics, and theoretical computer science communities to develop the theoretical foundations of data science through integrated research and training activities
- 12 phase I awards. Each $500K per year for three years
- First PI Meeting held in Oct. 2017

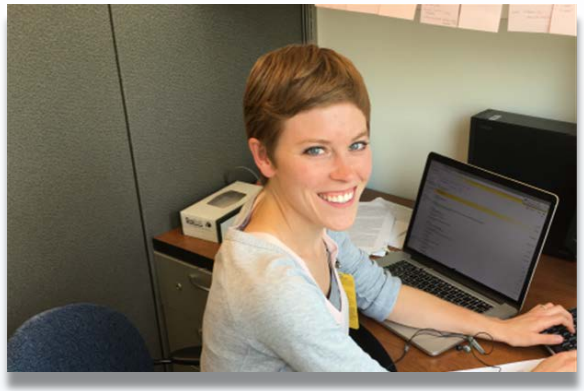
AMPS – Algorithms for Modern Power Systems

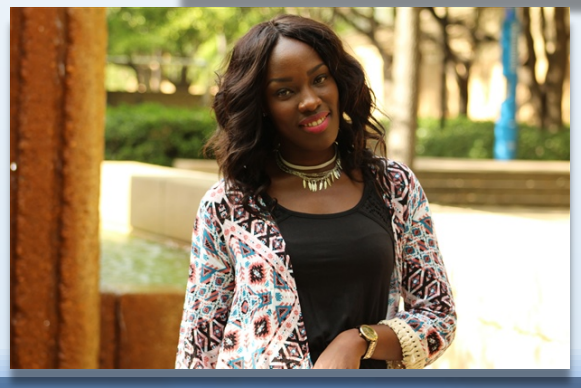
- Collaboration with Department of Energy
- Develop the next generation of mathematical and statistical algorithms for improving the security, reliability, and efficiency of the modern power grid
- 10 projects awarded in FY 2017, PI meeting scheduled in 2018



MATHEMATICAL SCIENCES GRADUATE INTERNSHIP

- Provide an opportunity for mathematical sciences doctoral students to participate in internships at national laboratories, industry and other approved facilities
- Aimed at students who are interested in understanding the application of advanced mathematical and statistical techniques to "real world" problems, regardless of whether the student plans to pursue an academic or nonacademic career
- 40 graduate students from 38 universities worked in 10 National Labs in the Summer of 2017





SIAM News Article (12/01/2017)

Infrastructure Serves the Entire Math Community

- Support for a broad range of conferences, especially those with a focus on broadening participation
- Involvement of students and junior investigators a DMS priority
- Support for professional societies, CBMS, National Academies (BMSA and CATS), and international conferences (ICIAM, ICM)

AMS American Mathematical Society www.ams.org

ASA American Statistical Association Promoting the Practice and Profession of Statistics

AWM Association for Women in Mathematics

American Indian Science and Engineering Society

MAA Mathematical Association of America

CAARMS Conference For African American Researchers in Mathematical Sciences

SACNAS

siam Society for Industrial and Applied Mathematics

The National Academies of Sciences Engineering Medicine

Board on Mathematical Sciences and Analytics
Division on Engineering and Physical Sciences

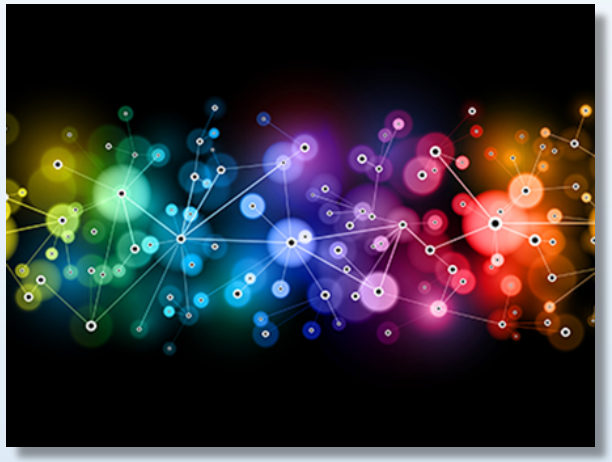
Opportunities Looking Forward

Ten Big Ideas for Future NSF Investment Research

- Harnessing Data for 21st Century Science and Engineering
- Understanding the Rules of Life: Predicting Phenotype
- The Quantum Leap: Leading the Next Quantum Revolution
- Windows on the Universe: The Era of Multi-messenger Astrophysics
- Navigating the New Arctic
- The Future of Work at the Human-Technology Frontier

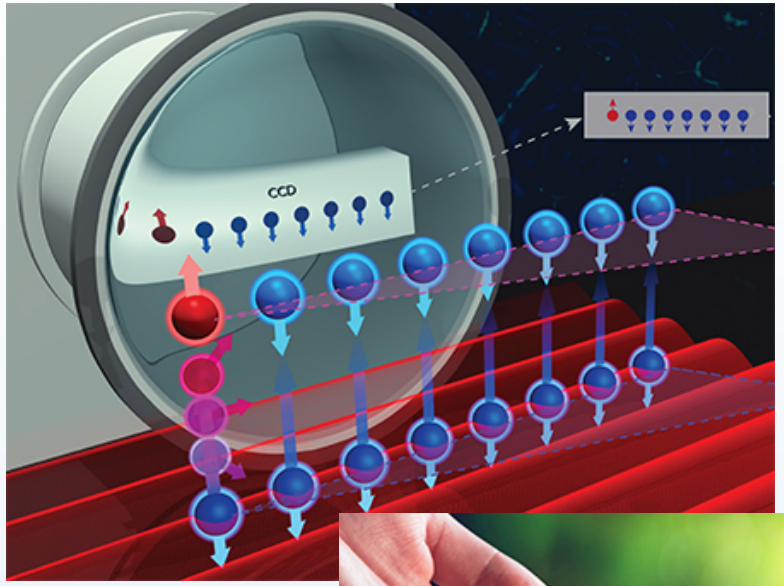
Ten Big Ideas for Future NSF Investment Process

- Mid-scale Research Infrastructure (RFI: NSF 18-013)
- NSF INCLUDES: Enhancing Science and Engineering through Diversity (NSF 17-591 for INCLUDES Hubs)
- NSF 2026: The Integrative Foundational Funds
- Growing Convergent Research at NSF (DCL: NSF 17-065 and NSF 18-058)



On the Horizon – Connections to Big Ideas

- Mathematical aspects of advancing fundamental understanding of quantum phenomena, materials, systems, and information processing methods (DCL NSF 18-035)
- Define the key challenges and research imperatives to understand the organizational principles and rules of living systems. Seeking Conference, EAGER, and RAISE proposals (DCL NSF 18-031)

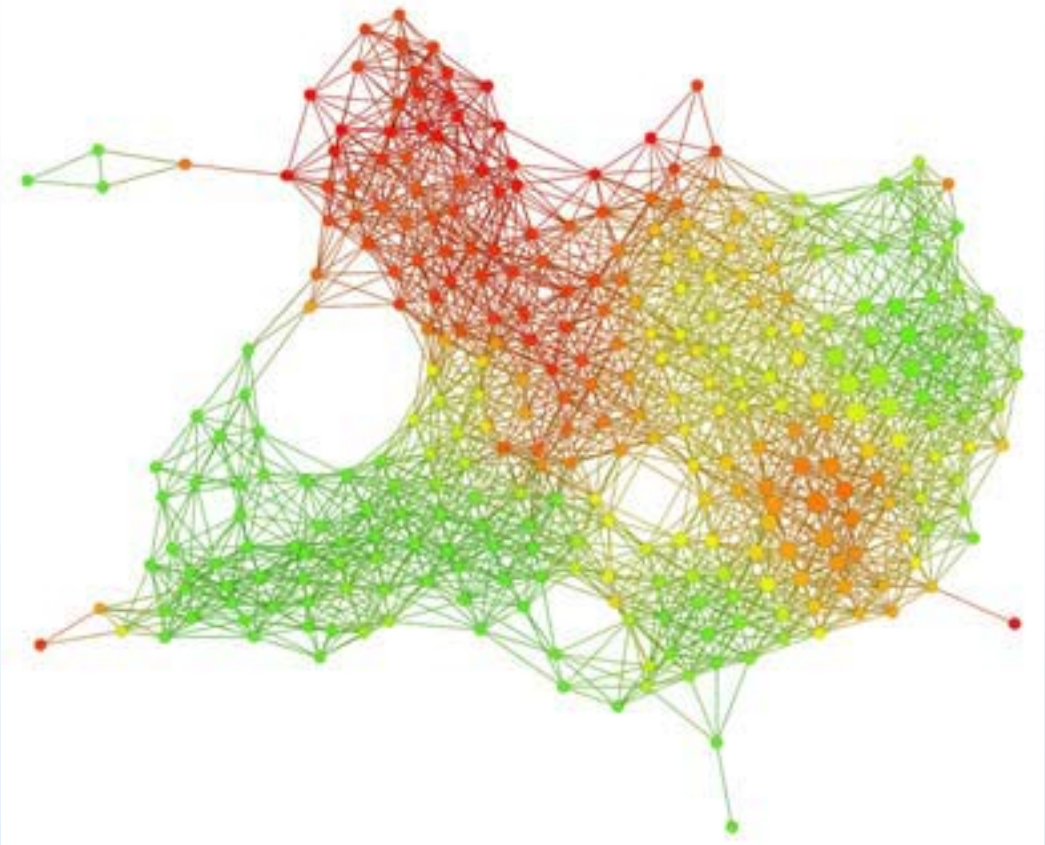


Quantum Leap

Rules of Life

On the Horizon – Expansion of TRIPODS

- **TRIPODS+X**: Partnerships between SCI/ENG Fields and TRIPODS Institutes (NSF 18-542)
- Webinar held on March 20, 2018
- Three tracks: Research, Visioning, and Education
- **TRIPODS Phase II** in FY 2020, anticipated to call for larger Institutes for up to 5 years of funding



Topological view of CT slices for traumatic brain injury. Red nodes represent slices with intracerebral hemorrhage, while green nodes show normal features. Brock, Brown University, CCF-1740741

On the Horizon – Connections to Other Agencies

- **QuBBD** supports research at the intersection of the biomedical and data sciences by encouraging inter- and multi-disciplinary collaborations
- 1 award by NSF (up to 2 more in FY18) and 7 by NIH, **total $8.5M**
- Working on new NSF/DMS and National Library of Medicine MOU for quantitative data science approaches to biomedical data **(FY2019)**

Persistent homology used to develop quantitative morphological descriptors that capture architectural features of prostate glands in pathology images, Wenk, DMS 1664848

On the Horizon – Institutes Recompete

- Mathematical Sciences Research Institutes solicitation (NSF 17-553) issued in FY 2017
- Webinar held Feb 20, 2018 with over 70 participants registered
- Proposals due **March 14, 2019**

SUMMARY

- DMS mathematical sciences research is having a big impact in society, science, engineering
- Moving forward it will be important for DMS to play a role in NSF's 10 Big Ideas
- DMS would like to encourage input from the mathematics and statistics communities

Please help me spread the message

THANK YOU!