



The Computing & Information Science & Engineering Landscape: A look forward
Margaret Martonosi
NSF Assistant Director for Computer and Information Science and Engineering (CISE)
January, 2021



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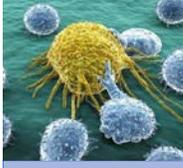
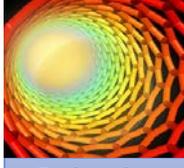
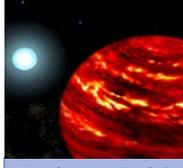
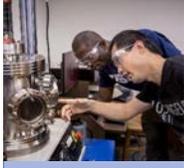


National Science Foundation's Mission

"To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense..."

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NSF Champions Research and Education across all Fields of Science and Engineering

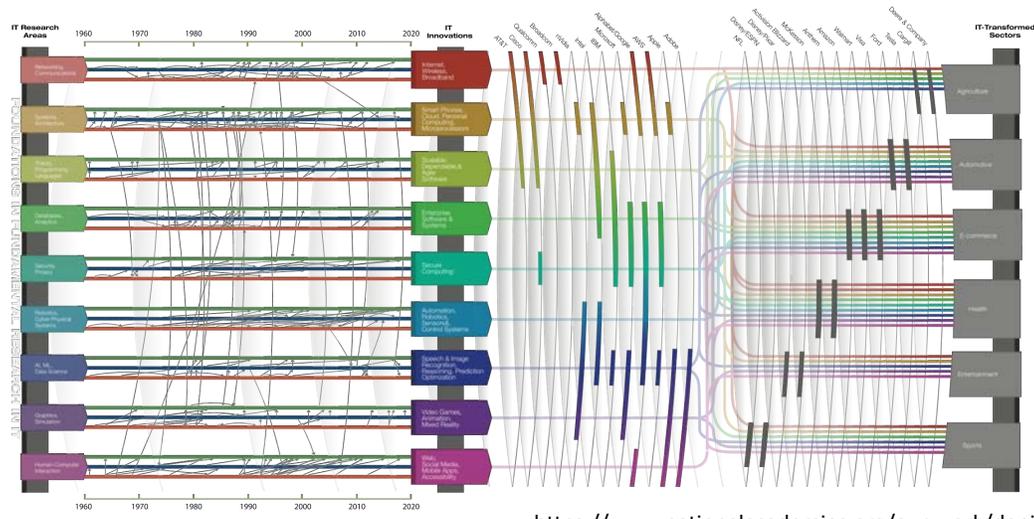
 Biological Sciences	 Engineering	 Mathematical & Physical Sciences	 Computer & Info Science & Engineering	 Geosciences (including Polar Programs)
 Integrative Activities	 Education & Human Resources	 Social, Behavioral & Econ. Sciences	 International Science & Engineering	

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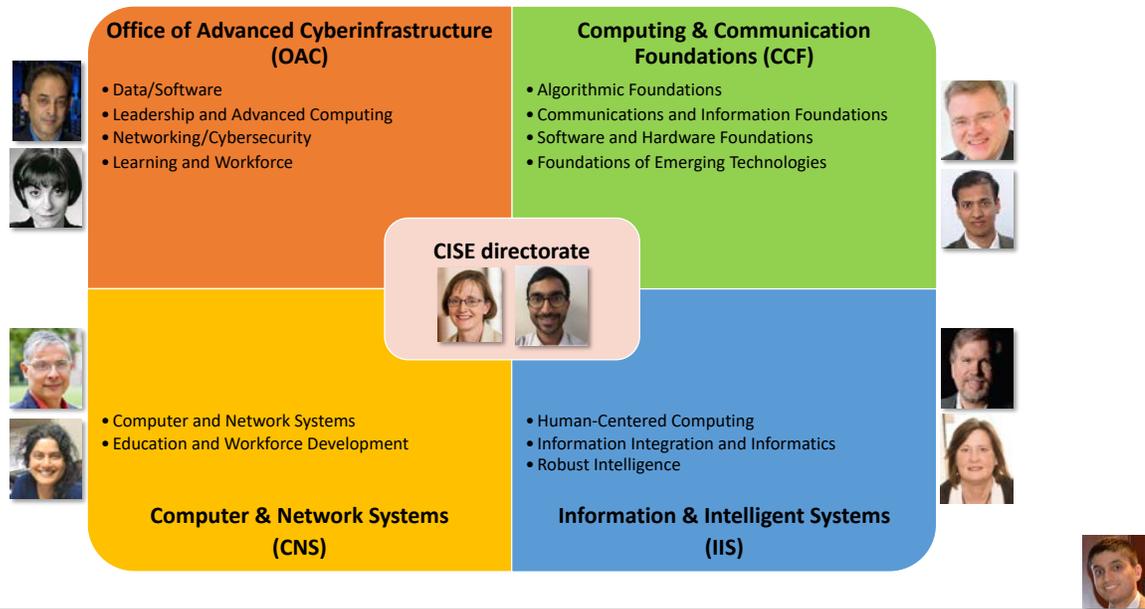
The 2020 “Tire Tracks” Update



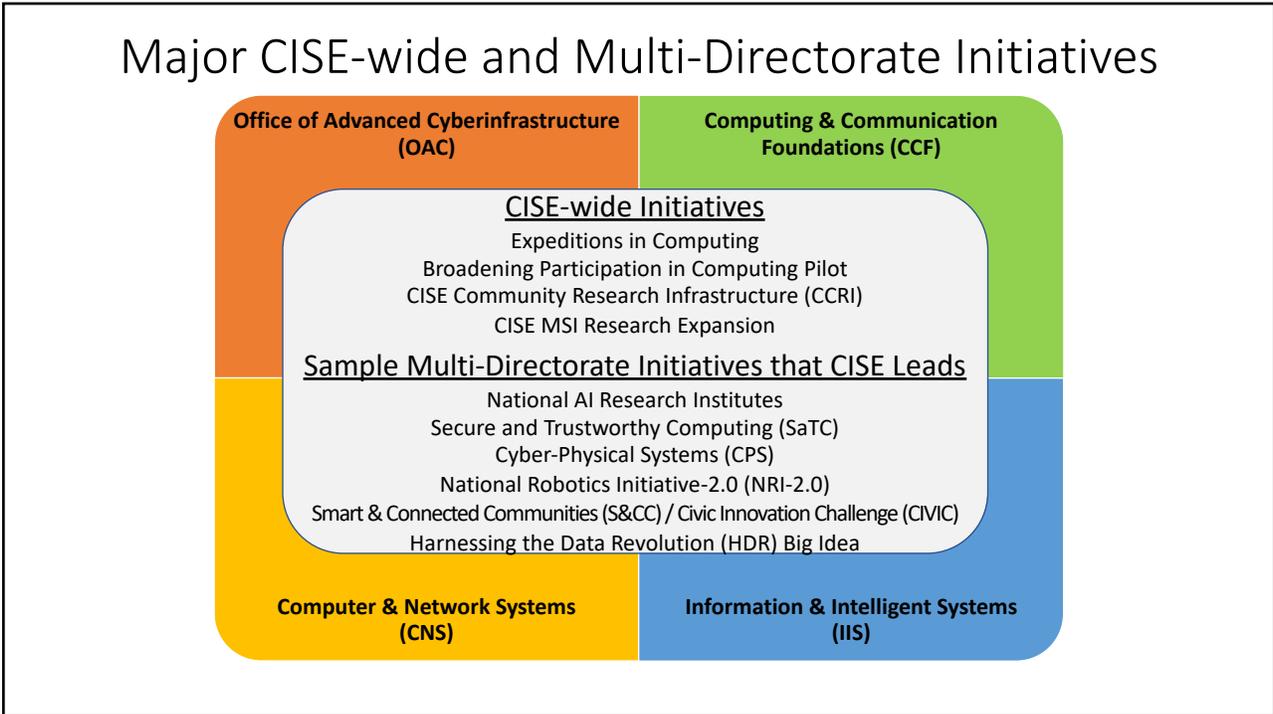
<https://www.nationalacademies.org/our-work/depicting-innovation-in-information-technology>

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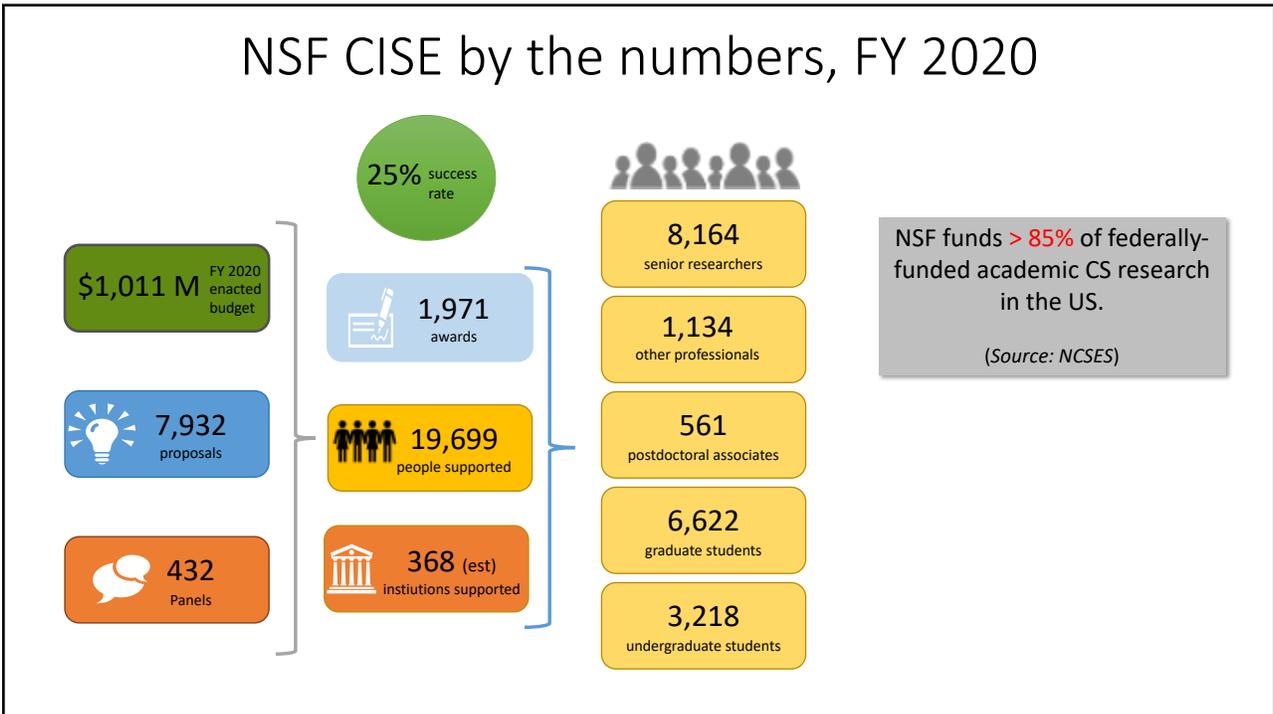
CISE Organization and “Core” Programs



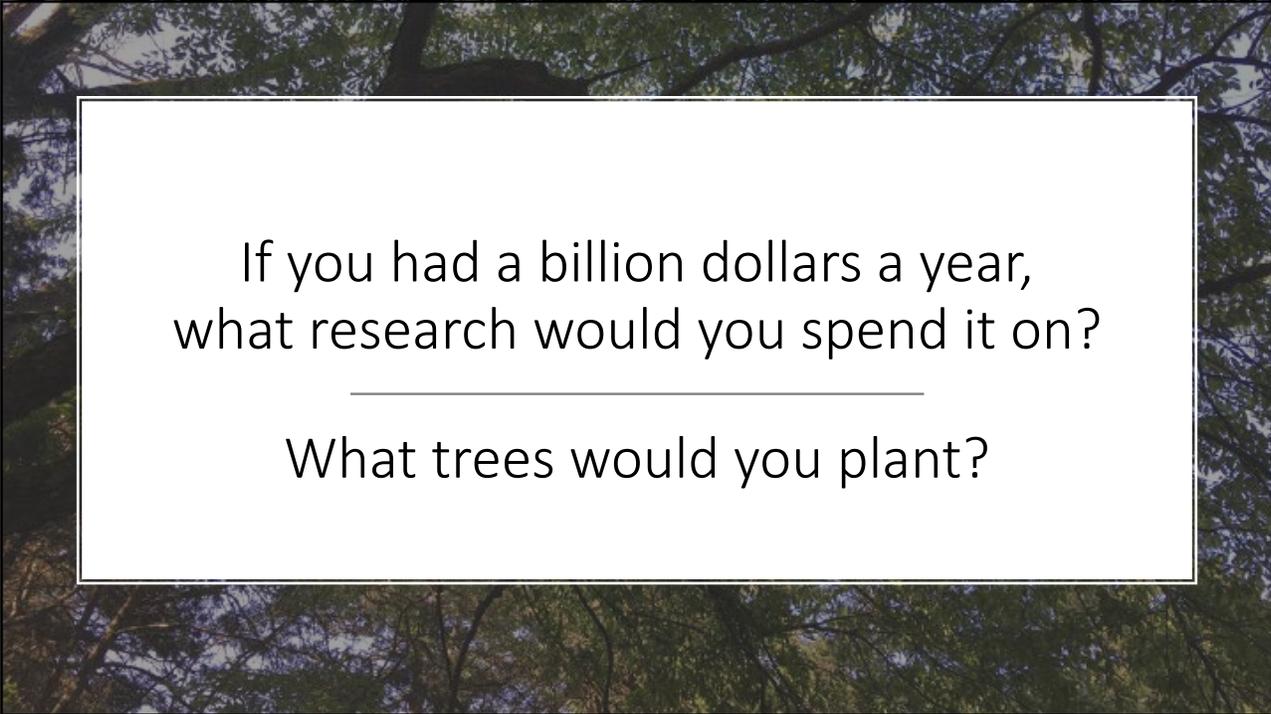
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If you had a billion dollars a year,
what research would you spend it on?

What trees would you plant?

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Today...

- CISE Overview and Technical Themes
- "How to get there": Programs, Infrastructure, People... -> Focusing on People
- Broaden from CISE to NSF as a whole
- Q&A

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CISE:
Inflection
Points ->
Technical
Themes

CISE in a Post-Moore World:
The Seismic Shift

Transcendence of Artificial
Intelligence

CISE's Sociotechnical Frontier

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CISE:
Inflection
Points ->
Technical
Themes

CISE in a Post-Moore World:
The Seismic Shift

End of Moore/Dennard Scaling impacts all aspects of computing: Hardware, Software, Security, Reliability, Curriculum... Opportunity to reinvent!

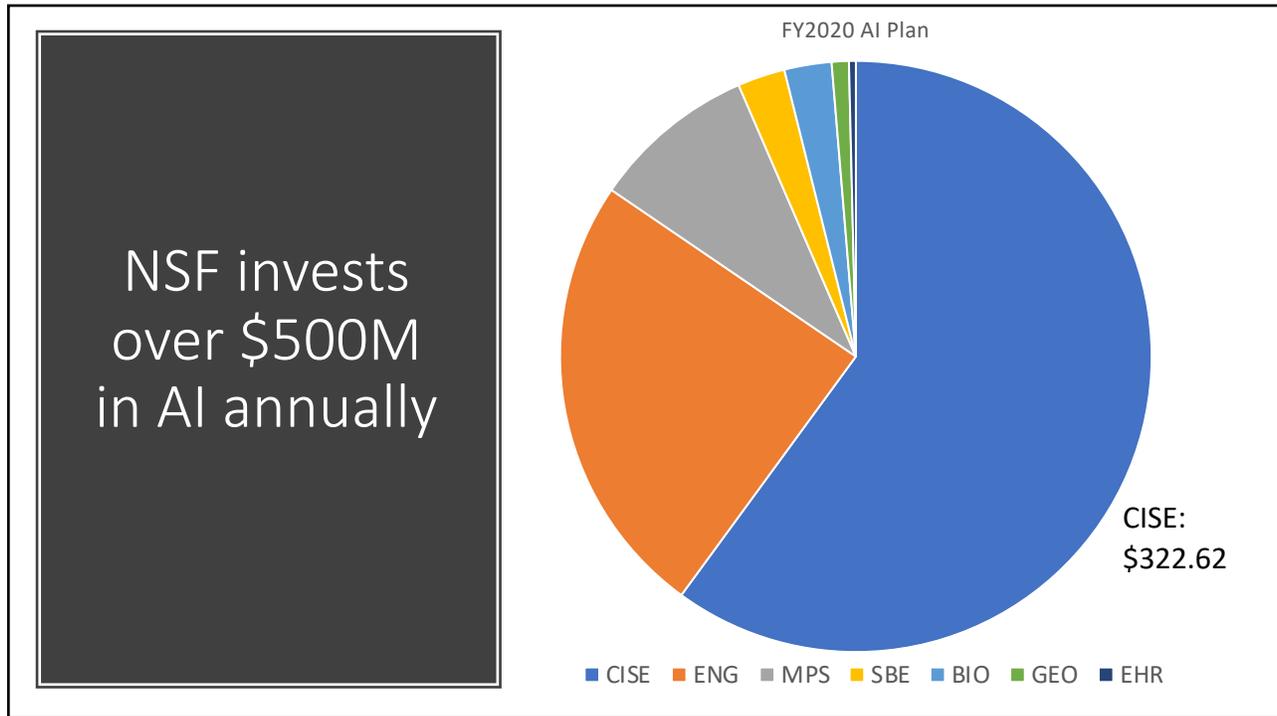
Transcendence of Artificial
Intelligence

AI today draws from all-of-CISE Inflection Point: Algorithms, data, systems. Likewise, AI broadly fuels advances across our field and society.

CISE's Sociotechnical Frontier

More so than ever, our field is shaped by integrated perspectives on our technologies and on how humans use them and are shaped by them.

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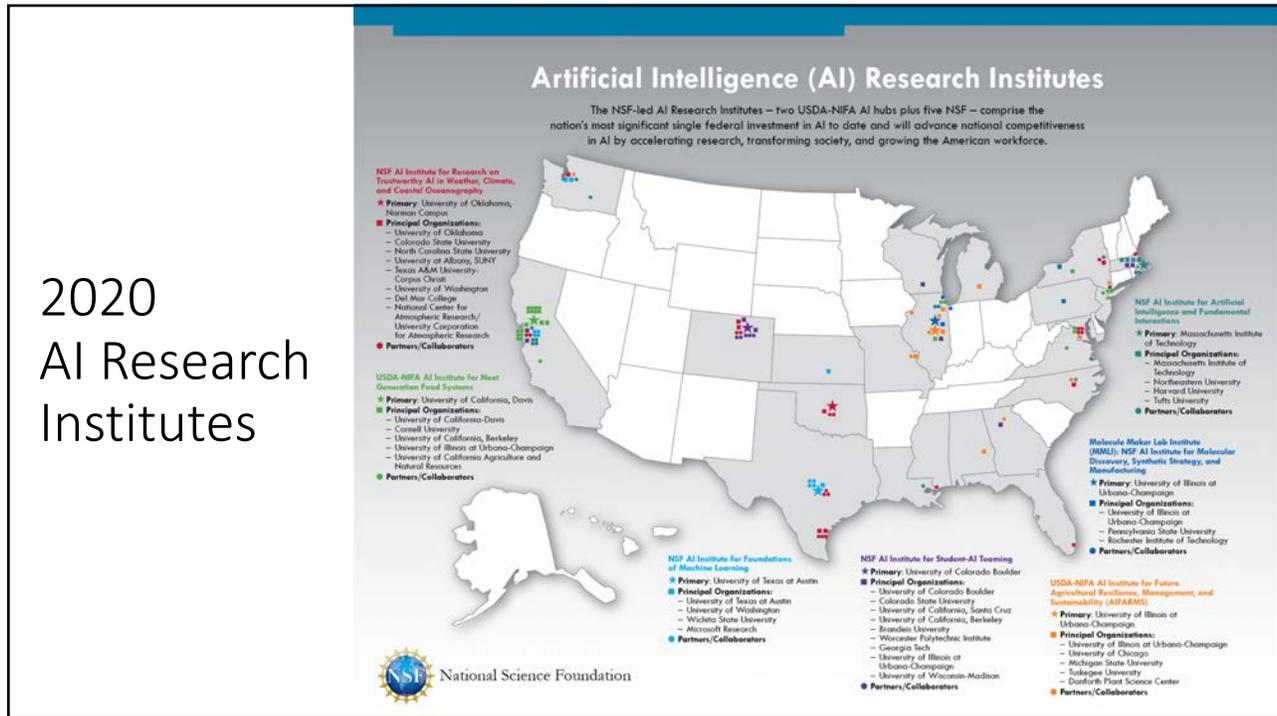
NSF-led National AI Research Institutes

National hubs for universities, government, industry and nonprofits to advance AI research and education

- \$20M over five years per Institute
- First round of awards announced Aug. 26, 2020
 - Launched seven new Institutes nationwide (\$140 million)

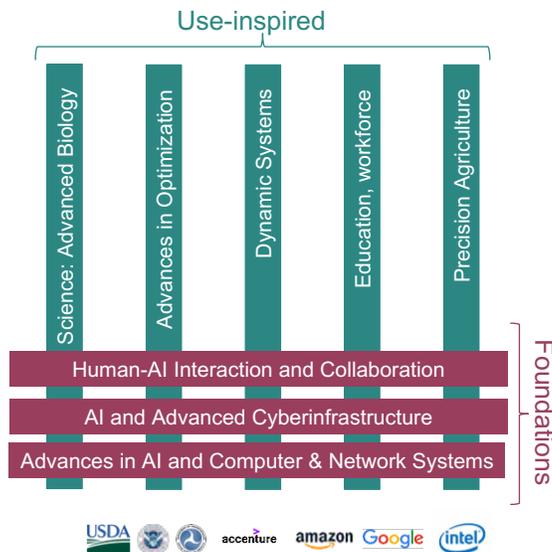
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2020 AI Research Institutes



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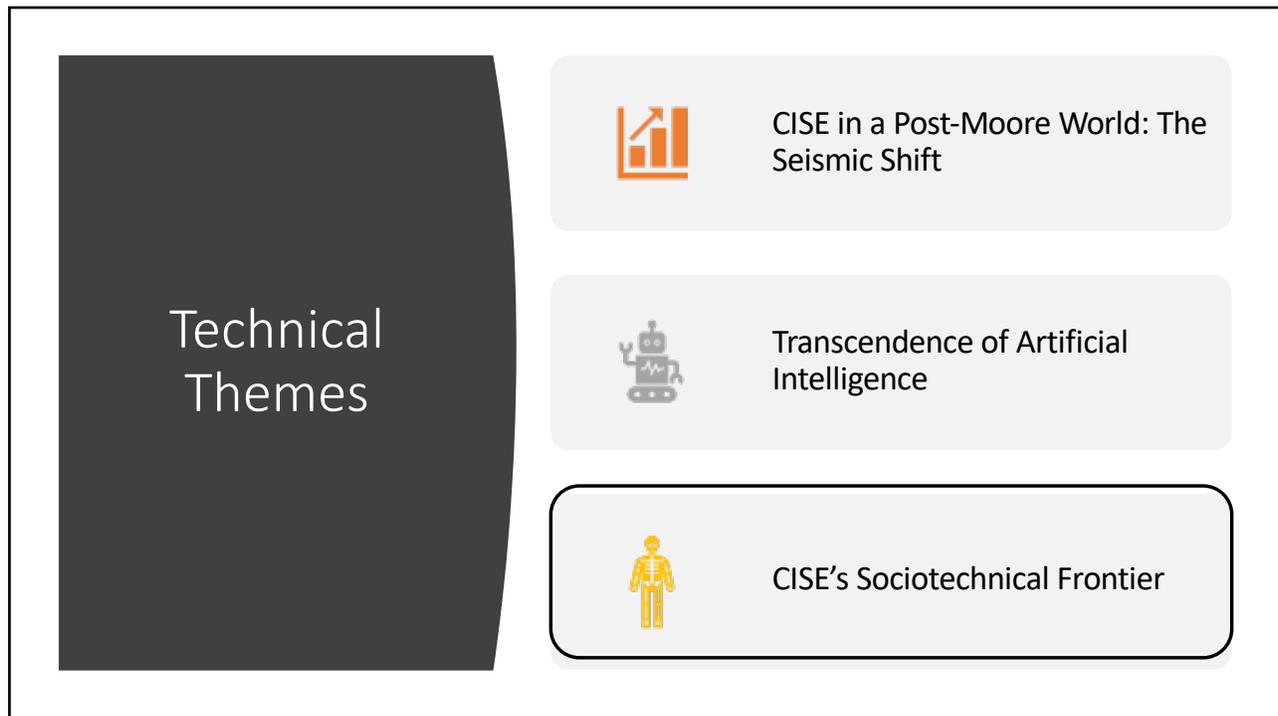
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- FY 2021 solicitation (NSF 20-604). Deadline Dec 4!

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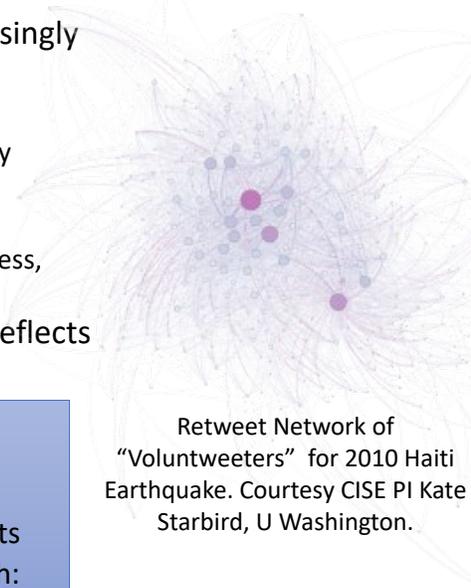
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CISE's Sociotechnical Frontier

- Cyber-Physical and Cyber-Human interactions increasingly shape our society and economy
- At all levels and in many forms:
 - Health, connectivity, community, fair access to trustworthy information...
- Responsibility Meets Opportunity
 - Reshape computation to “bake in” notions of equity, fairness, security, trust, verifiability, privacy, ...
- Example: 2020 Economics Nobel (Milgrom/Wilson) reflects long track record of SBE AND CISE funding

Highlights

- CIVIC Innovation Challenge
- Project Overcome
- CISE/SBE workshops look ahead toward future investments
- NASEM Study Launched: Responsible Computing Research: Ethics and Governance in our Research and its Applications

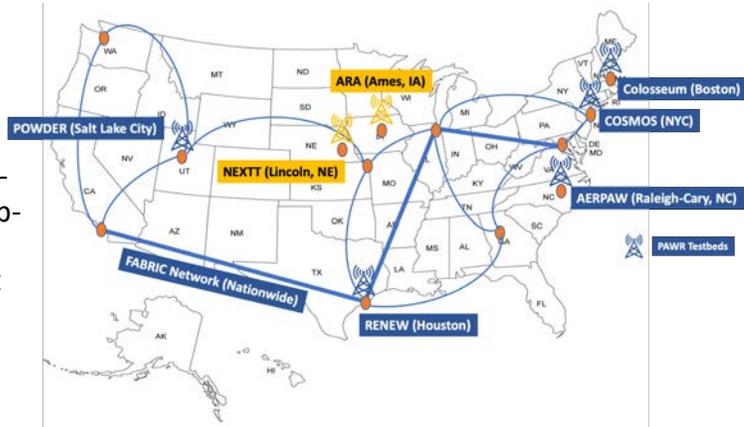


Retweet Network of “Voluntweeters” for 2010 Haiti Earthquake. Courtesy CISE PI Kate Starbird, U Washington.

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PAWR Rural Broadband “Bakeoff”

- Platforms for Advanced Wireless Research (PAWR):**
 Public-private partnership with 35 companies/associations, totaling \$100M over 7 years, to build 4 city-scale experimental platforms in sub-6 GHz and mmWave frequencies, featuring UASs, IoT, SDN, transport and backhaul solutions
- 2020-2021: Rural Broadband Platform Bakeoff**



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Technical Themes



CISE in a Post-Moore World:
The Seismic Shift



Transcendence of Artificial
Intelligence



CISE's Sociotechnical Frontier

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How to
advance on
those themes?
How to
get there?


Budget and Program Portfolio


Infrastructure


People


Partnerships

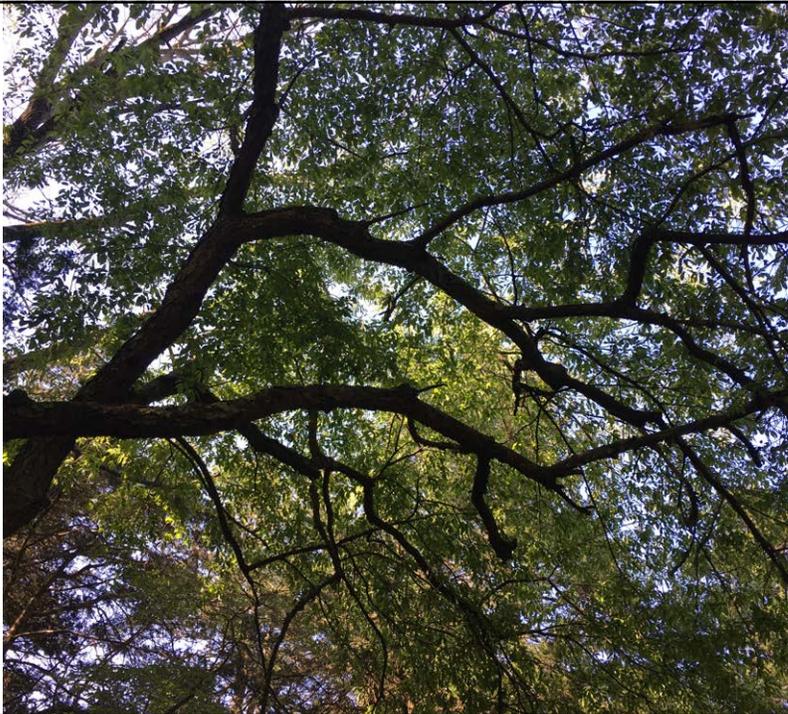
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CISE and BPC

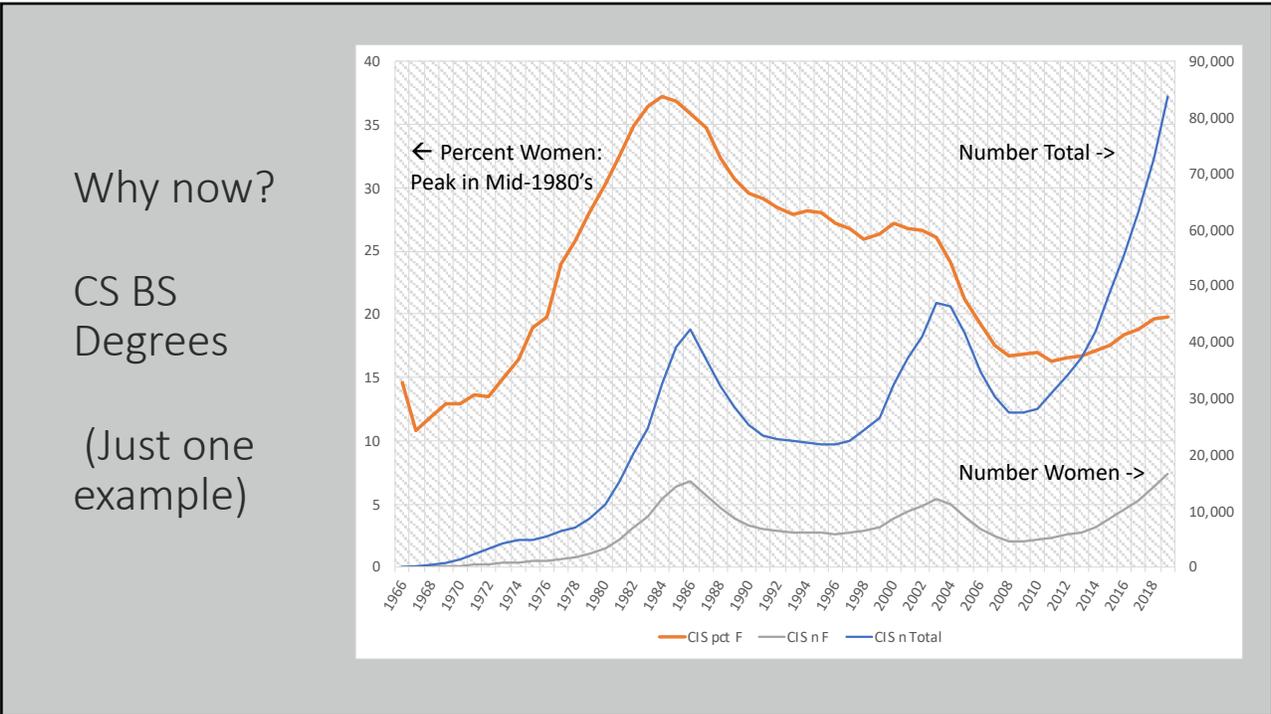
- Women: 20.3% of US CS PhD graduates
- African-Americans, Hispanics, Native Americans: 3.1 % of US CS PhD graduates

=> CS research is missing ~70% of US population's talents.

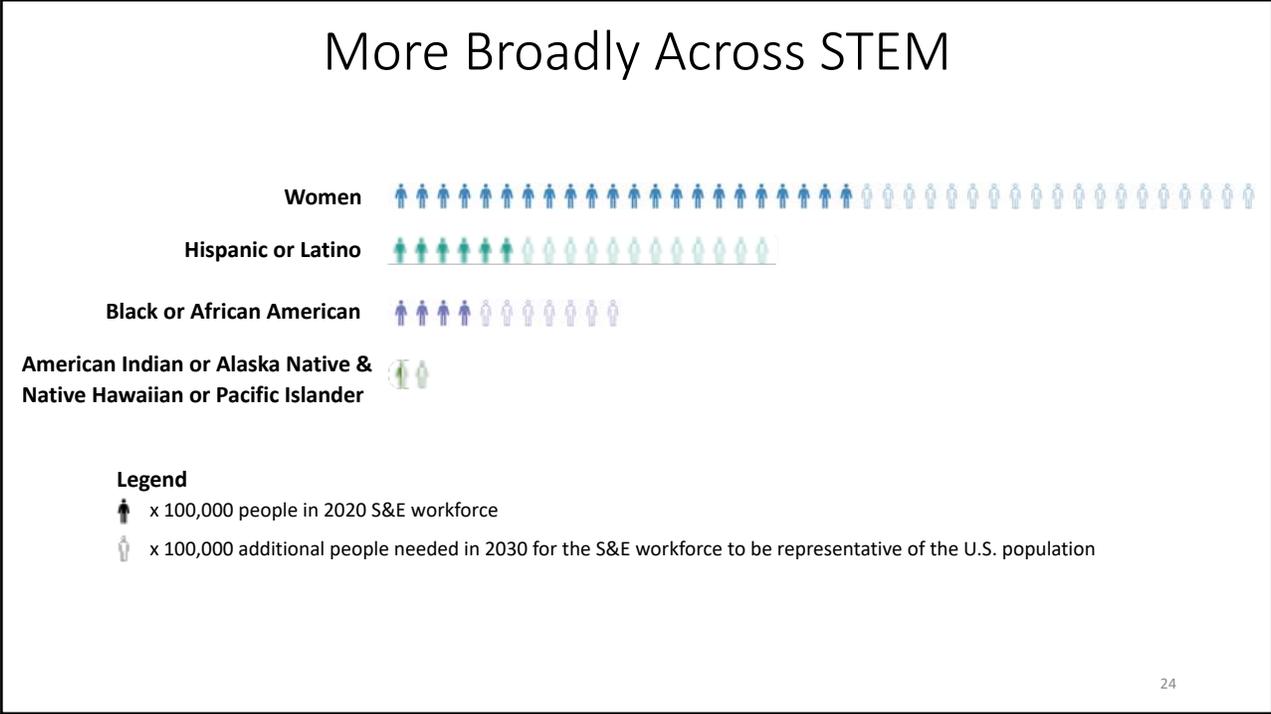
<https://cra.org/2019-taulbee-survey/>



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More Broadly Across STEM



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THE CHRONICLE OF HIGHER EDUCATION



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THE CHRONICLE OF HIGHER EDUCATION



\$3.3M NSF Advance Award, plus local action and engagement

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Pathways to Opportunity



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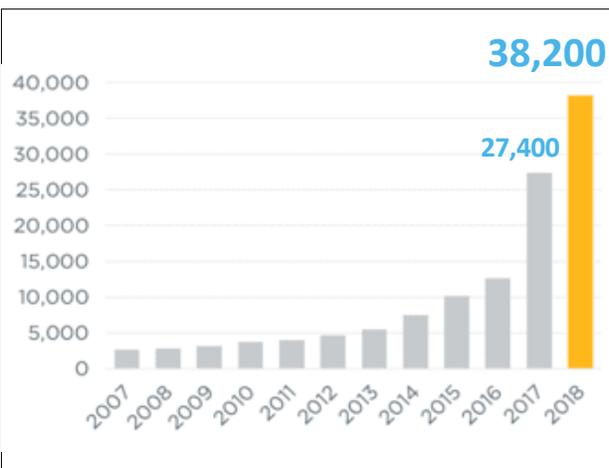
K-12: AP CS Principles Exam

- 2012: CISE funded The College Board to create framework for new exam
 - No specific programming language and stresses principles rather than programming
- 2012-present: CISE funded curricular efforts such as UC Berkeley “Beauty and Joy of Computing”
- 2017: New Exam Launched
- 2017-present: Significant increases in number and diversity of test takers

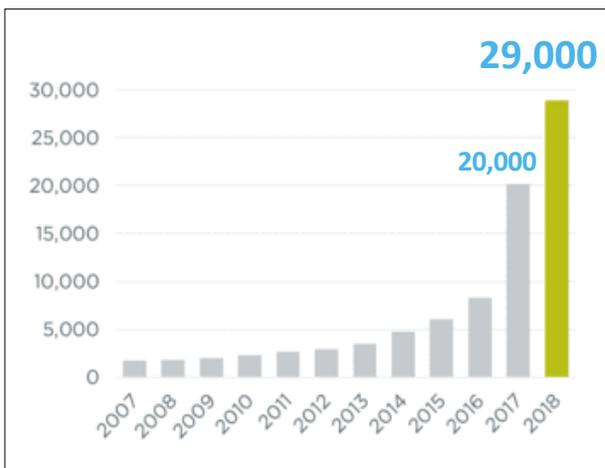
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Dramatic Increase in Number, Diversity of Test Takers

Female students



Underrepresented students



Includes both AP CS-A and AP CSP

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Higher Education

Report finds new AP computer science course is diversifying the field

CSP students are more than three times as likely to major in computer science than similar students who did not take CSP (16.9% vs. 5.2%), and differences are even larger for female and Hispanic students.

<https://www.washingtonpost.com/education/2020/12/13/advanced-placement-computer-science/>

<https://apcentral.collegeboard.org/pdf/ap-csp-and-stem-cs-pipelines.pdf?course=ap-computer-science-principles>

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Pathways to Opportunity



NSF + Community working together

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Vision: Broadening Participation in Computing

- Goal: Measurable progress towards diversifying the CISE Research Community
- Goal: CISE research proposals include a meaningful plan to broaden participation in computing
- **Approach: Individual PIs offer BPC plans for Medium (and larger) proposals in Core, CPS, SaTC**
 - Currently in Year 3 of 3-year BPC Pilot
- Key Concept: Individual PIs plug into departmental and national plans and expertise
- Increase collaboration, coordinate efforts, broaden expertise



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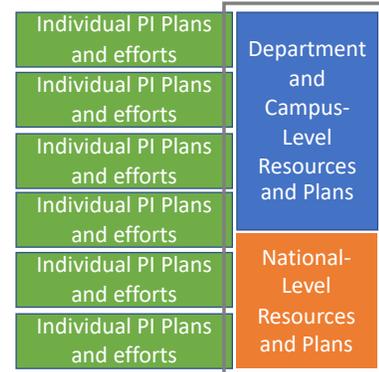


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BPCnet provides resources for CISE PIs

RESOURCE PORTAL

- <https://bpcnet.org>
- Developed and curated by CRA, NCWIT
- Best and promising practices: Evidence-based and vetted resources
 - Not just *What* but *How*
- Departmental and Individual BPC Plan Workshops
 - July - October, 2020
 - + Ongoing 1-1 Consulting Office Hours
 - Vetting, Hosting Departmental Plans in a Single Library



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Pathways to Opportunity



NSF + Community working together

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NSF CISE MSI Convenings: 2019-2020

<https://msi-cise.asee.org/>

- Goal: CISE BPC Efforts should be inclusive of Minority-Serving Institutions
- To increase MSI attendee awareness about CISE Core Programs, as well as proposal submissions & CISE engagement
- Take steps to enhance engagement of HBCUs, HSIs and Tribal/Native Serving Institutions in NSF CISE Core programs

4 Initial convenings/hosts:

- HBCUs: May 2019, Hampton Univ.
- HSIs: July 2019, NSF CASHI INCLUDES
- TCUs: Sept 2019, American Indian Science and Engineering Society (Native/Tribal Colleges)
- Broad MSI Community: Feb. 2020

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MSI Convenings -> Next Steps

- Computer and Information Science and Engineering Minority-Serving Institutions Research Expansion Program (CISE-MSI Program)
 - Deadline: April 15, 2021
- Faculty: Capacity Building and Proposal-writing workshops ("Mini-Labs")
- Infrastructure: Collaborative Multi-MSI opportunities
- Undergrad Students: Enhanced undergraduate research opportunities
 - Fellowships to encourage transition to grad programs



<https://www.nsf.gov/pubs/2021/nsf21533/nsf21533.htm>

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Division of Materials Research (DMR)

Partnership for Research and Education in Materials (PREM)

- To broaden participation in materials research and promote the retention of URMs in STEM fields.
- Award to a Minority Serving Institution (HBCU, HSI, TCU, etc) to partner with a DMR-supported Center or National Facility.
- Since 2004, 38 awards training to date
 - 123 postdocs
 - 498 MS and PhD students
 - 991 BS students
 - 80% of whom pursued careers/higher education in STEM after graduation

University of Puerto Rico, Humacao and UPenn



Sabrina Rosa (PREM 2010)
BS Physics, UPRH 2016
PhD Candidate, EE, USF



Adriana Santiago (PREM 2011)
BS Chemistry, UPRC 2018
Grad Student Bio Chem, PENN

- Partnership with a local high school allows students to begin their materials research careers as early as high school
- 33% of current PREM UGs began their materials research careers while in High School
- UPRH has become a *Top 20 Institution* for producing Hispanic women doctorates in physics (NCSES data)

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THE CHRONICLE OF HIGHER EDUCATION



\$3.3M NSF Advance Award, plus local action and engagement

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Today...

- Technical Themes
- "How to get there": Programs, Infrastructure, People...
- **Recent Events: Impacts and Responses**
- Q&A

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CISE COVID-19 Impact & Response

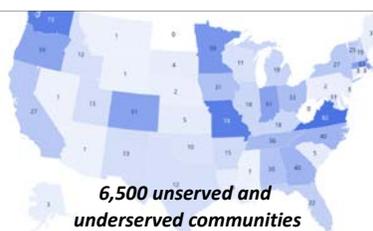
The COVID-19 High Performance Computing Consortium



NSF-funded resources: Frontera, XSEDE, and more

Addressing the need for advanced computing for COVID-19 research

Estimated Cities with Municipal Broadband Programs by State



6,500 unserved and underserved communities

OVERCOME – deploy novel broadband technology solutions to underserved communities, supporting virtual learning

Virtual Organization for Computing Research in Pandemic Preparedness and Resilience



Community Building Activities include:

- Semi-annual events (virtual conferences, workshops, etc.), and meetings
- Final Meeting in Year 3 of collaborators from academia, government and industry

Coordination across COVID-19 RAPIDS and related research

CIFellows 2020

Computing Innovation Fellows



Fellowships for graduating doctorate students impacted by hiring reductions at IHEs

CISE REU Expansion: 1.7X REU Supplements compared to FY19

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Join Us!

Students

- Research Experiences for Undergraduates (REU)
- NSF Graduate Fellowships

Faculty

- Send us your great proposals
- Proposal Writing Workshops
- Tell us your research triumphs
- Be an NSF Panel Reviewer
- Be an NSF Rotator!