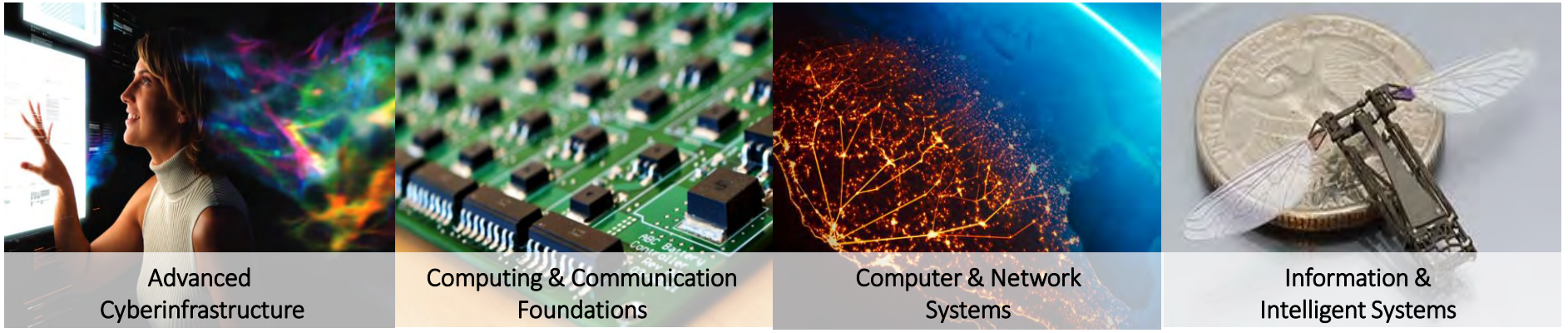
# Computer & Information Science & Engineering (CISE)

nsf.gov/CISE

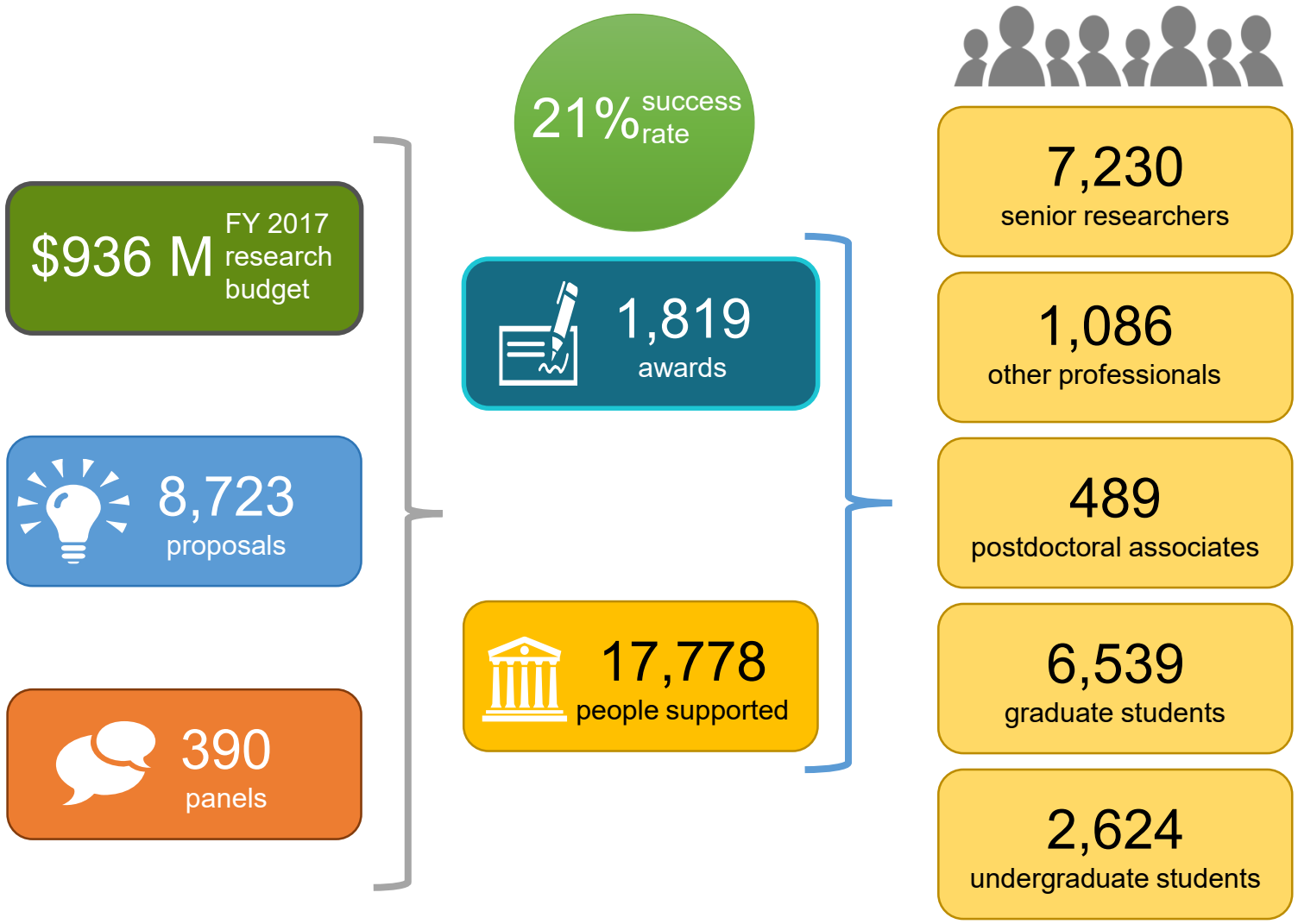
**Fay Cobb Payton, Program Director**

**Division of Computer & Network Systems**

**May 20-21, 2019**

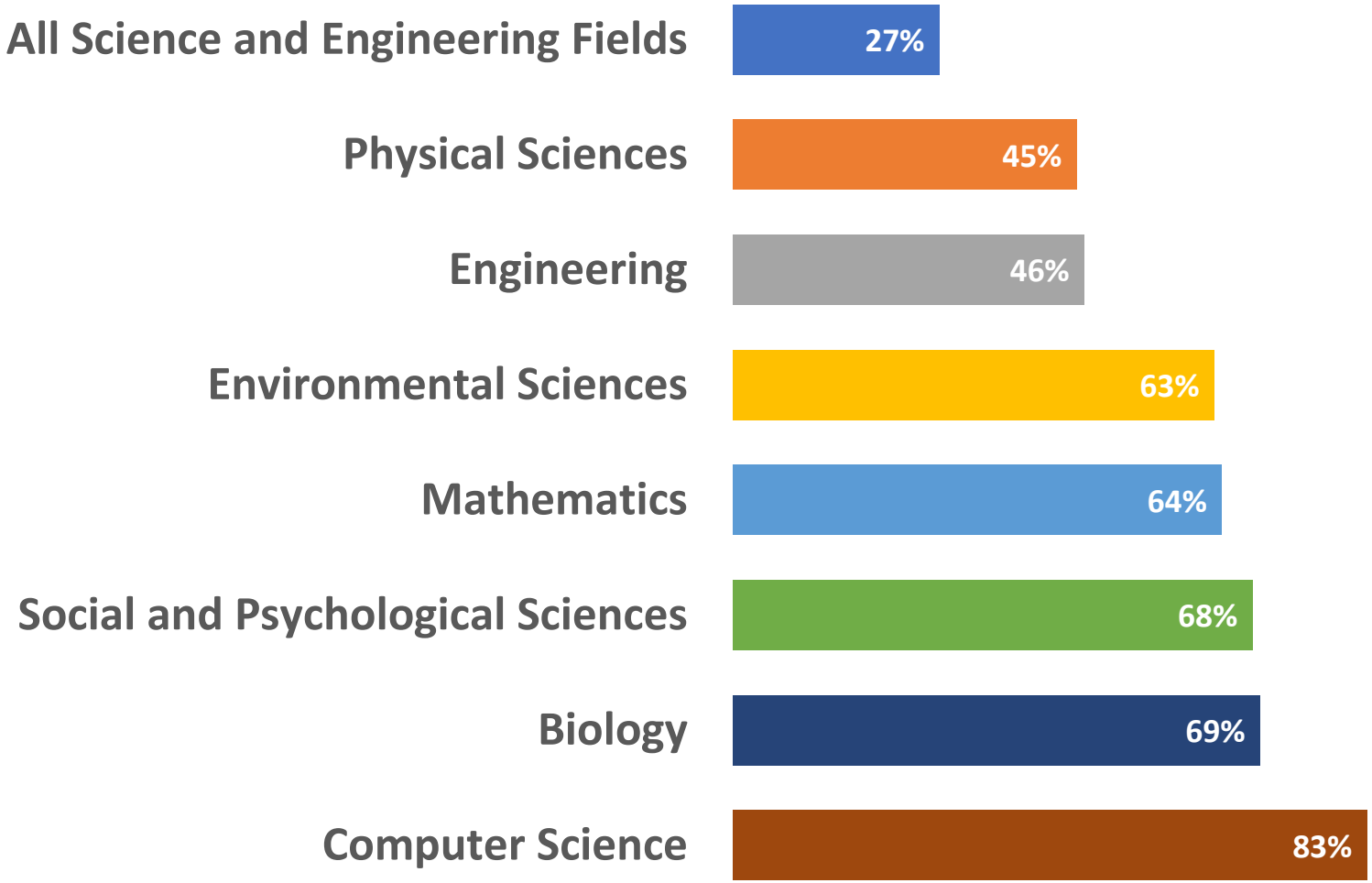


# CISE by the Numbers: FY 2017



# NSF Support of Academic Basic Research

*(as a percentage of total federal support)*



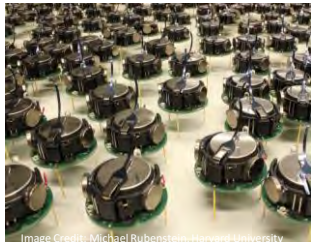

Source: NSF/NCSES, Survey of Federal Funds for Research & Development, FY 2015.

# CISE's Economic and Societal Context

- CISE is at the center of an ongoing societal transformation and will be for decades to come.
- Advances in computing, communications and information technologies, and cyberinfrastructure:
  - accelerate the pace of discovery and innovation; and
  - are crucial to achieving national and societal priorities.

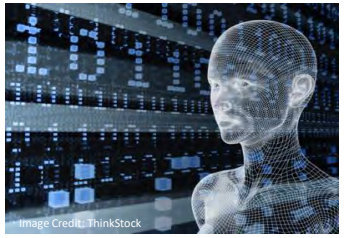
# CISE programs address national priorities


Artificial Intelligence

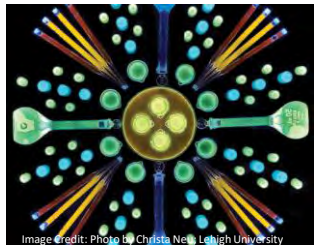


Autonomy & Manufacturing

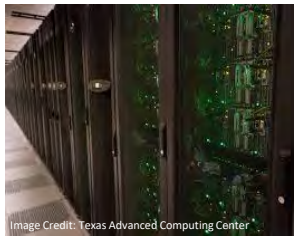

Connectivity




Cybersecurity




Quantum Information Sciences



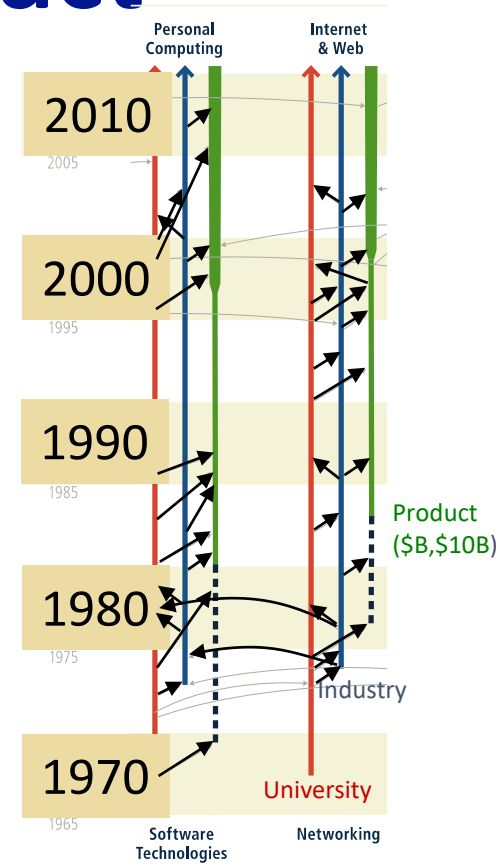

R&D Infrastructure


21st Century Education

# CISE-funded projects have remarkable impact

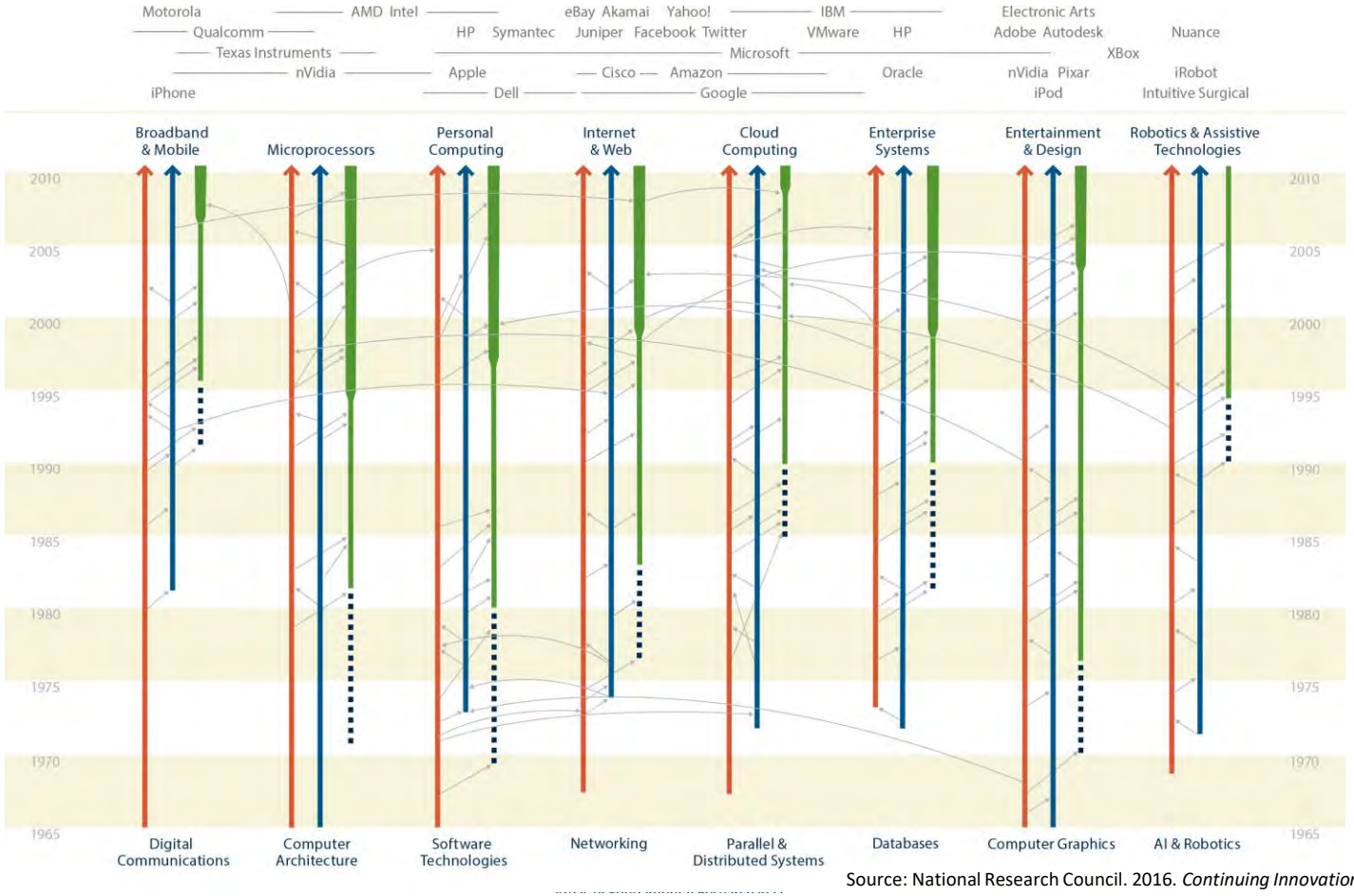
Advances in computing, communications, information technologies, and cyberinfrastructure:

- **drive U.S. competiveness**
  - IT accounts for 25% of economic growth since 1995;
  - resulted in many billion-dollar industries: networking, software, digital communications, computer graphics, AI and robotics, and more
- have profound **impacts on our daily lives**.



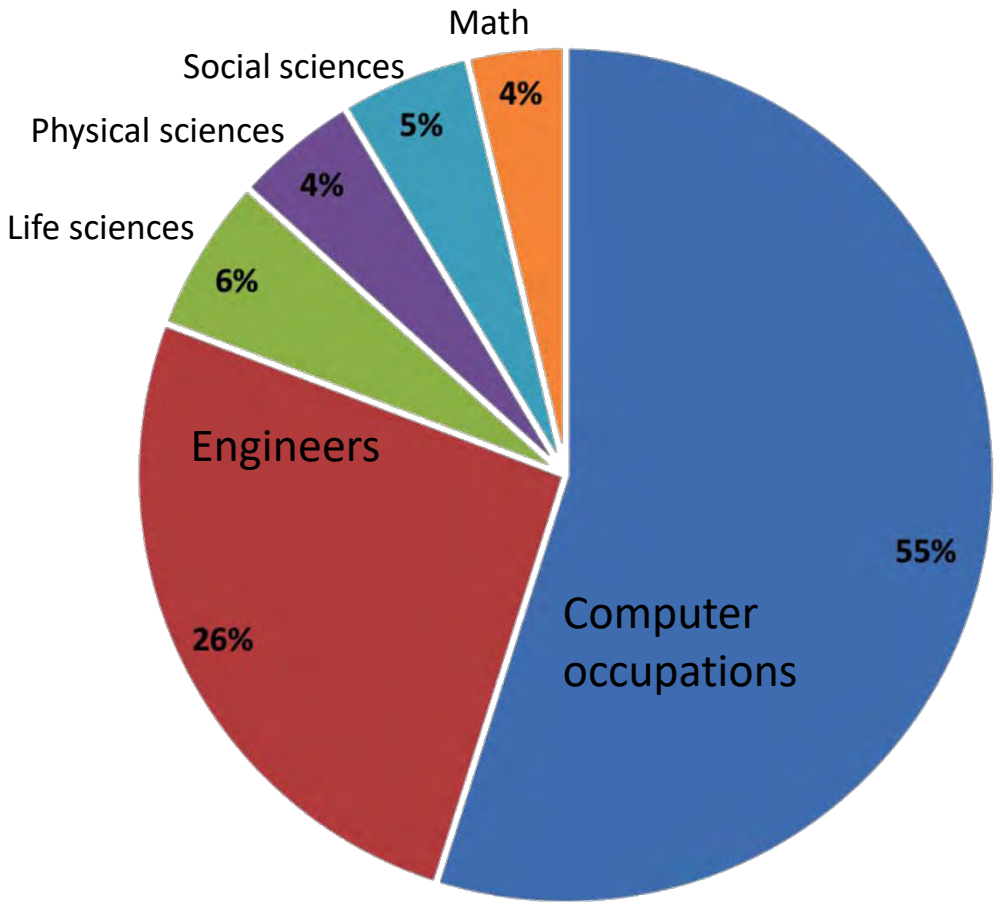

Source: National Research Council. 2016. *Continuing Innovation in Information Technology*.

# From Federally-funded research to billion-dollar industries




Source: National Research Council. 2016. *Continuing Innovation in Information Technology*.

# Many STEM jobs are in computing




Job Openings 2014 – 2024 (growth and replacement)

US Bureau of Labor Statistics

Data from the spreadsheet linked at http://www.bls.gov/emp/ind-occ-matrix/occupation.xlsx

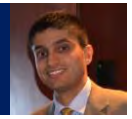
# CISE Organization

Senior Advisor
*Howard Wactlar*

Senior Advisor
*Irene Qualters*

Senior Advisor for Data Science

**CISE Directorate**
*Jim Kurose, AD*
*Erwin Gianchandani, DAD*



**Office of Advanced Cyberinfrastructure (OAC)**
*Manish Parashar, OH*

- Data
- High Performance Computing
- Networking/ Cybersecurity
- Software

**Computing and Communication Foundations (CCF)**
*Rance Cleaveland, DD*

- Algorithmic Foundations
- Communication and Information Foundations
- Foundations of Emerging Technologies
- Software and Hardware Foundations

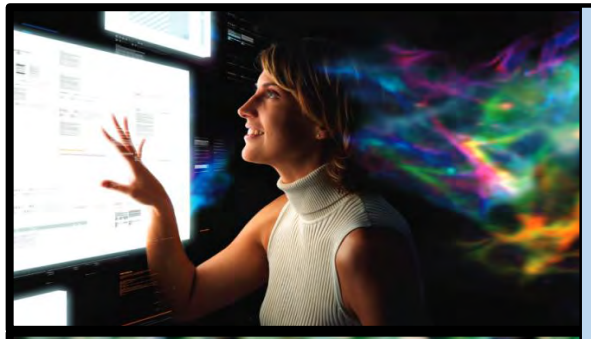
**Computer and Network Systems (CNS)**
*Ken Calvert, DD*

- Computer and Network Systems
- CISE Research Infrastructure
- Education and Workforce Development

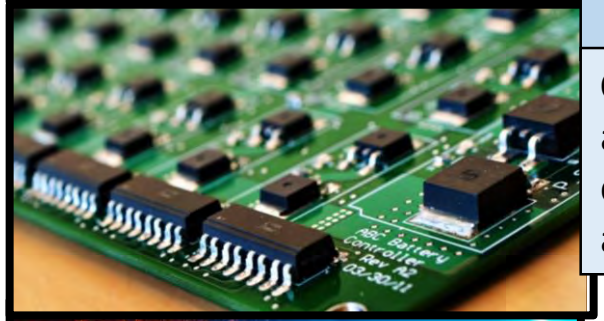
**Information and Intelligent Systems (IIS)**
*Henry Kautz, DD*

- Cyber Human Systems
- Information Integration and Informatics
- Robust Intelligence

## CISE Divisions



**Office of Advanced Cyberinfrastructure** supports and coordinates the development, acquisition, and provision of state-of-the-art cyberinfrastructure resources, tools and services essential to the advancement and transformation of science and engineering.



**Computing and Communication Foundations** advances computing and communication theory, algorithms for computer and computational sciences and architecture and design of computers and software.

**Computer and Network Systems** invent new computing and networking technologies and finds new ways to make use of current technologies.

**Information and Intelligence Systems** studies the interrelated roles of people, computers, and information to increase our ability to understand data, as well as to mimic the hallmarks of intelligence in computational systems

# Computing & Communication Foundations (CCF)

http://www.nsf.gov/div/index.jsp?org=CCF

**Supports research and education projects that explore the foundations of computing and communication devices.**

- *Algorithmic Foundations (AF):* Innovative research characterized by algorithmic thinking and algorithm design, accompanied by rigorous mathematical analysis.
- *Communications and Information Foundations (CIF):* Transformative research addressing the theoretical underpinnings and current and future enabling technologies for information acquisition, transmission, and processing in communication and information networks.
- *Foundations of Emerging Technologies (FET):* Transformative research at the intersection of computing and biological systems, nanoscale science and engineering, quantum information science, and other nascent areas.
- *Software and Hardware Foundations (SHF):* Foundational research essential to advance the capability of computing systems, including software and hardware components, systems, and other artifacts.

# Computer and Network Systems (CNS)

http://www.nsf.gov/div/index.jsp?div=CNS

**Supports research and education activities inventing new computing and networking technologies and exploring new ways to make use of existing technologies.**

- *Computer Systems Research (CSR):* Transformative research on fundamental scientific and technological advances leading to the development of future generation computer systems, including new architectures; distributed real-time embedded devices; pervasive, ubiquitous and mobile computing; file and storage systems; operating systems; reliable, fault-tolerant and secure hard/middle/software.

- *Networking Technology and Systems (NeTS):* Transformative research on fundamental scientific and technological advances leading to the understanding, development, engineering, and management of future-generation, high-performance computer networks.

# Information and Intelligent Systems (IIS)

http://www.nsf.gov/div/index.jsp?div=IIS

**Supports research and education activities that study the inter-related roles of people, computers, and information.**

- *Cyber-Human Systems (CHS):* Research to accelerate the creation and understanding of the complex and increasingly coupled relationships between humans and computing with the broad goal of advancing human capabilities: perceptual and cognitive, physical and virtual, social and societal.

- *Information Integration and Informatics (III):* Information technology research on the processes and technologies involved in creating, managing, visualizing, and understanding diverse digital content in circumstances ranging from individuals through groups, organizations, and societies, and from individual devices to globally-distributed systems, and that can transform all stages of the knowledge life cycle.

- *Robust Intelligence (RI):* Research that encompasses all aspects of the computational understanding and modeling of intelligence in complex, realistic contexts to advance and integrate the traditions of artificial intelligence, computer vision, human language research, robotics, machine learning, computational neuroscience, cognitive science, and related areas.

# Office of Advanced Cyberinfrastructure (OAC)

http://www.nsf.gov/div/index.jsp?div=ACI

## Supports cyberinfrastructure resources, tools, and services for science and engineering research and education.

- *Data:* Support scientific communities in the sharing and archiving of, as well as computing with data by creating building blocks to address common community needs in data infrastructure.
- *High Performance Computing:* Enable petascale computing; provide open-science community with state-of-the-art HPC assets ranging from loosely coupled clusters to large scale instruments; develop an integrated scientific HPC environment.
- *Networking and Cybersecurity:* Invest in campus network improvements and re-engineering to support a range of activities in modern computational science. Support transition of cybersecurity research to practice.
- *Software:* Transform innovations in research and education into sustained software resources that are an integral part of cyberinfrastructure.
- *Learning and Workforce Development:* Invest in research, educational and training programs to meet current and future needs of CI professionals, developers, and users.
- *OAC Core program* - translational research and education activities in advanced cyberinfrastructure (CI) that lead to deployable, scalable, and sustainable systems capable of transforming science and engineering research. OAC seeks to foster the development of new knowledge in the innovative design, development, and utilization of robust research CI.

# CISE is committed to supporting early-career faculty


## Faculty Early Career Development (CAREER) Program

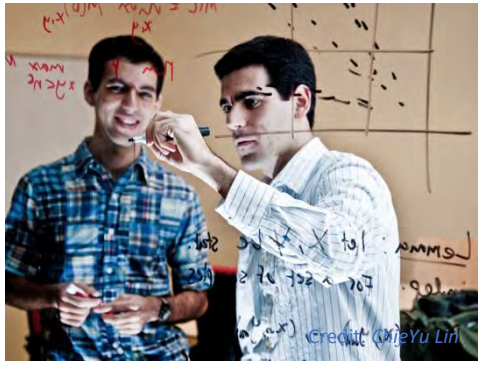
***Integrating research and education efforts***

*One of NSF's most prestigious awards for faculty beginning their independent careers who exemplify the role of teacher-scholars.*

## CISE Research Initiation Initiative (CRII)

***Jumpstarting research independence***

*Open to faculty in first three years of an independent academic position to recruit and mentor undergraduate and graduate students, enabling a subsequent stream of discoveries and innovations. First awards in FY15.*





## Proposal Writing Workshops, Aspiring PI Meetings, and Early-career Workshops

***Strengthening research and education activities through community***

*Introduces early-career faculty to NSF, merit review process, and peers and senior researchers in their field.*

# Computing Research Initiation Initiative (CRII)

*Enabling early research independence*

- Aims to contribute to the growth and development of future generations of scientists and engineers who will dedicate their careers to advancing CISE research and education.
- Provides the opportunity for individuals who are in their first academic position post-PhD to recruit and mentor their first graduate students.
  - Allows for a full budget for grad student salary (and some travel, equipment) and at least ½ month PI salary.
  - Chairs letter to certify PI's eligibility and that PI lacks the resources requested.

# Faculty Early Career Development (CAREER) Program

- The National Science Foundation's most prestigious awards in support of junior faculty who exemplify the role of teacher-scholars through:
  - outstanding research,
  - excellent education, and
  - the integration of education and research within the context of the mission of their organizations.
- Since its inception in 1996:
  - More than 200 programs have reviewed CAREER proposals.
  - More than 7,000 awards.
- PIs are allowed only one submission between CAREER and CRII per competition. – CAREER more open to NTT faculty since FY18.

***CISE CAREER Proposal Writing Workshops***

- Generally held in Spring each year
- For more information see: http://www.nsf.gov/cise/workshops/career
- Presentations from past workshop at: http://carch.seas.gwu.edu/cise-career/NSF_2016.html

# Support for Graduate and Undergraduate Students

- ***Graduate Research Fellowship Program (GRFP)***
  - Foundation-wide programs with substantial CISE participation.
  - Deadlines in late Oct. but differ for each Directorate.
- ***Research Experiences for Undergraduates (REU)***
  - **REU Sites**
    - Typically in summer.
    - 8-10 students in a cohort environment.
    - Deadline in August.
  - **REU Supplements**
    - Support for 1-2 students to work on existing project.
    - Best to submit request by March but no strict deadline.

# Other NSF-wide Opportunities for the CISE Community

- Innovation Corps (I-Corps)
- Grants for Rapid Response Research (RAPID)
- EArly-concept Grants for Exploratory Research (EAGER)
- Conferences, Summer Schools, and Workshops
- International Collaborations

For a comprehensive list of NSF funding opportunities, visit:
http://www.nsf.gov/funding/

# RAPID and EAGER Proposals

- ***Grants for Rapid Response Research (RAPID)*:**
  - Supports quick-response research on natural or anthropogenic disasters and similar unanticipated events.
  - Up to $200K and one year duration.
  - Project descriptions are expected to be brief (two to five pages) and include clear statements as to why the proposed research is of an urgent nature.
- ***EArly-concept Grants for Exploratory Research (EAGER)*:**
  - Supports high-risk, exploratory and potentially transformative research.
  - Up to $300K and two years duration.
  - Project description is expected to be brief (five to eight pages) and include clear statements as to why this project is appropriate for EAGER funding.

# Conferences, Summer Schools, and Workshops

- ***Conferences***
  - Student Travel Support
  - Doctoral Consortia
- ***Summer Schools***
  - Intensive program for doctoral students on emerging research topics.
  - Require faculty expertise not available at any single institution.
- ***Workshops***
  - Bring the community together to reflect on, and identify emerging research opportunities and challenges.

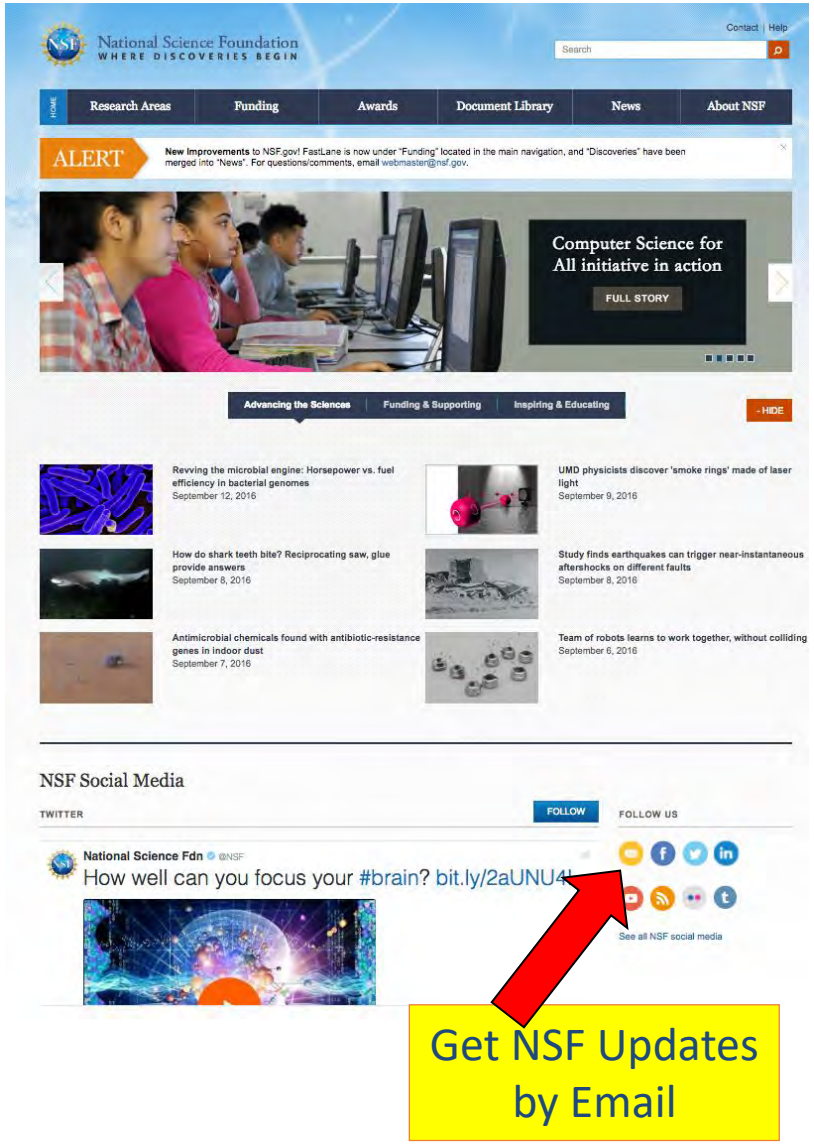
Must consult with a program director before submission.

# Broadening Participation in Computing (BPC)

- CISE is expanding its BPC pilot effort started in 2017
- A 1–3 page plan of BPC activities is **strongly encouraged** as a Supplementary Document at time of submission
- For CORE and SaTC programs, each Medium & Large project **must, by the time of award**, have in place an approved BPC plan
- More information: nsf.gov/cise/bpc/

# Stay Informed

- Subscribe to get NSF updates by email at www.nsf.gov.
- Subscribe to receive special CISE announcements:
  - Send a message to: join-cise-announce@listserv.nsf.gov with no text in the subject or message body.
  - To subscribe to *OAC Mailing List:* email to: OAC-ANNOUNCE-subscribe-request@listserv.nsf.gov
- Visit the CISE website often: http://www.nsf.gov/CISE
- Talk to Program Directors: http://www.nsf.gov/staff/staff_list.jsp?org=CISE&from_org=CISE.
- Follow CISE on Twitter @NSF_CISE.



# Get Involved

- Serve as a Panelist - Proposal merit review
- Serve in CISE as a “rotator” Program Director: Shape future directions of the field and priorities for the nation; formulate a research and education agenda to address societal challenges
- Program review - Committee of Visitors
- CISE Advisory Committee (Subcommittees and Working Groups)
- Community Visioning Activities
- CCC, CRA, CSTB, and ACM Interactions
- Studies with the National Academies

# *Thanks!*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FOLLOWING
66
FOLLOWERS
3,748
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1
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Exploring the frontiers of computing
Arlington, Virginia · nsf.gov/dir/index.jsp?...

# Additional Slides

# CISE Core Research Investments

- Strong commitment to core/fundamental research – *the heart of what we do*
- Cast a broad net and let the best ideas surface
- Engage with our community to develop new research directions

# CISE Core Research Investments

- Strong commitment to core/fundamental research – *the heart of what we do*
- Cast a broad net and let the best ideas surface
- Engage with our community to develop new research directions


- CCF - NSF 18-568
  - Algorithmic Foundations
  - Communications and Information Foundations
  - Software/Hardware Foundations
  - Foundations of Emerging Technologies (FET) – DCL NSF 18-099
- CNS - NSF 18-569
  - Computer and Network Systems
- IIS - NSF 18-570
  - Cyber-Human Systems
  - Information Integration and Informatics
  - Robust Intelligence
- OAC - NSF 18-567
  - Research Core Program

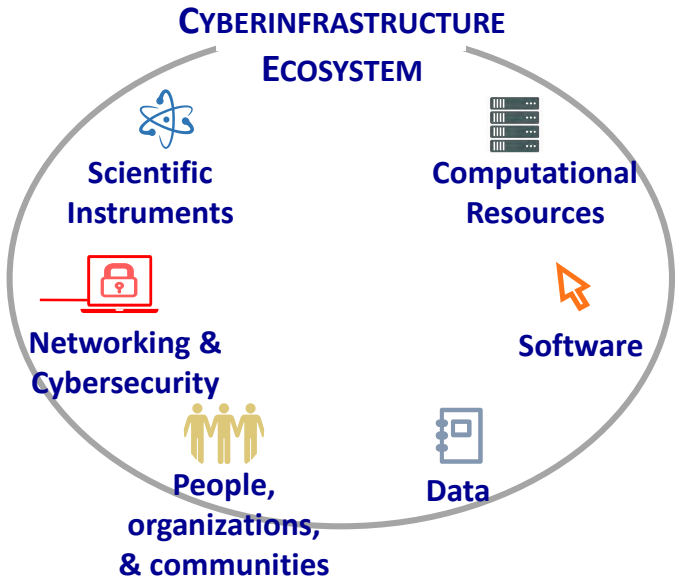
# CISE Research Infrastructure Investments

- Lead an expansive CI ecosystem driven by research priorities and the scientific process
- Leverage investments by universities, federal agencies, commercial sector
- Support a diversity of computational resources to meet the growing demands of modern science and engineering
- Align with the National Strategic Computing Initiative (NSCI)

# National Strategic Computing Initiative (NSCI)

*Maximizing benefits of HPC for scientific discovery and economic competitiveness*

- NSF/CISE/OAC leads interagency effort to:
  - Increase coherence between technology base used for modeling/simulation and for data analytics;
  - Establish viable path forward for HPC systems in post-Moore's Law era; and
  - Increase capacity, capability, and sustainability of an enduring national HPC ecosystem



# National Strategic Computing Initiative (NSCI)

## Towards a Leadership-Class Computing Facility – Phase 1:

- Acquisition and deployment of a high-performance computing system
- A system for all of S&E
- Led by CISE/OAC
- *Announcement coming soon*

*High-performance computing*

## Scalable Parallelism in the Extreme (SPX):

- Collaborations among researchers representing all areas from the application layer down to the micro-architecture
- All Divisions in CISE
- *Proposal deadline was Jan 9, 2018*

*Architecture*

## Cyberinfrastructure for Sustained Scientific Innovation (CSSI) - Data and Software: Elements and Frameworks:

- Supports the CI ecosystem, spanning all levels of the data and software stacks and scales.
- CISE/OAC, BIO, EHR, ENG, GEO, MPS, and SBE
- *Proposal deadline was Apr 18, 2018*

*Software*

# CISE cross-cutting programs

For a comprehensive list of CISE funding opportunities, visit:
http://www.nsf.gov/funding/pgm_list.jsp?org=CISE

- Cyber-Physical Systems (CPS)
- Computer Science for All (CSforAll)
- Integrative Strategies for Understanding Neural and Cognitive Systems (NCS)
- National Robotics Initiative 2.0
- Secure and Trustworthy Cyberspace (SaTC)
- Smart and Connected Communities (S&CC)
- Smart and Connected Health (SCH)

# Cyber-Physical Systems (CPS)

*Deeply integrating computation, communication, and control into physical systems*

- Cyber-physical systems (CPS) are engineered systems that are built from, and depend upon, the seamless integration of computation and physical components.
- Aims to develop the core system science needed to engineer complex cyber-physical systems.
- Serves multiple key national priority sector areas.
- Includes *Transition to Practice (TTP)* option.
- Cross-Directorate and Cross-Agency Solicitation: NSF CISE and ENG with DHS, DOT/FHA, NIH, USDA.

**Transportation**

**Energy**

**Healthcare**

**Critical Infrastructure**

Stay tuned for deadlines

# Computer Science for All: Research Practitioner Partnerships (CSforAll: RPP)

*Using knowledge gained through research to provide CS and CT education to all*

- **Motivation**: Provide access to computer science (CS) and computational thinking (CT) education to *all* U.S. students
- Provides funding for teacher professional development, instructional materials, preparation, and support, as well as for schools and districts to evaluate pathways in CS and CT
- Supports researcher-practitioner partnerships (RPPs) with the goal of building knowledge from research and development to support efforts
- Cross-Directorate Solicitation: CISE, EHR

Proposal deadline: Feb 12, 2019

# Integrative Strategies for Understanding Neural and Cognitive Systems (NCS)

*Advancing neural and cognitive systems through integrative research*

- Aims to support high-risk, high-payoff approaches for innovative, convergent, boundary-crossing research
- 3 classes of proposals:
  - Foundations – to advance the foundations of one or more focus areas
  - Frontiers – advance and connect multiple integrative research threads
  - Core+ Supplements – Provide additional support to existing funding projects to enable significant new integrative opportunities
- Cross-Directorate Solicitation: CISE, EHR, ENG, SBE

Letter of intent deadline (required): Dec 7, 2018 for Frontiers competition

Proposal deadline: Feb 26, 2019

# National Robotics Initiative 2.0: Ubiquitous Collaborative Robots (NRI-2.0)

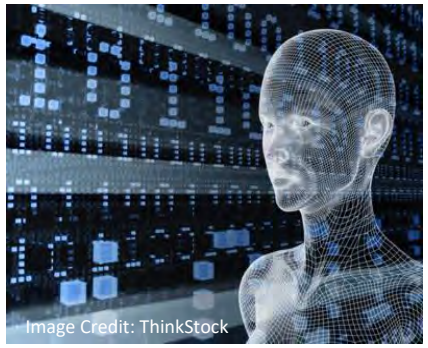
*Integrating the next generation of collaborative robots to assist humans*

- Aims to accelerate the development and use of ubiquitous co-robots
- Four main research thrusts:
  - Scalability
  - Customizability
  - Lowering barriers to entry
  - Societal impact
- Strong coupling with industry and startups.
- Cross-Directorate and Cross-Agency Solicitation: NSF CISE, EHR, ENG, and SBE with DOD, DOE, NASA, NIH, USDA.


Proposals due: Feb 9, 2019

# Secure and Trustworthy Cyberspace (SaTC)

*Securing our Nation's cyberspace*





- Aims to support fundamental scientific advances and technologies to protect cyber-systems from malicious behavior, while preserving privacy and promoting usability.
- Proposals must address cybersecurity from one of the following perspectives:
  - CORE – spans interest of CISE, ENG, MPS, and SBE
  - EDU – cybersecurity education
  - TTP – *Transition to Practice*
- Broadening Participation in Computing plans are strongly encouraged for Medium proposals, and approved plans are required before award.
- Cross-Directorate Solicitation: CISE, EHR, ENG, MPS, and SBE.

Proposals accepted anytime

# Smart and Connected Communities (S&CC)

*Improving quality of life, health, well-being, and learning in communities*

- Smart and connected community - a community that synergistically integrates intelligent technologies with the natural and built environments, including infrastructure, to improve the social, economic, and environmental well-being of those who live, work, or travel within it.
- Projects must include
  - integrative research that addresses the technological and social dimensions of smart and connected communities
  - meaningful community engagement that integrates community stakeholders within the project
- Cross-Directorate Solicitation: CISE, EHR, ENG, GEO

Image Credit: NSF

Image Credit: US Ignite

Stay tuned for deadlines

# Smart and Connected Health (SCH)

*Transforming healthcare knowledge, delivery, and quality of life through IT*

- Supports next-generation multidisciplinary science that encourages breakthrough ideas in a variety of areas of value to health
  - Such as networking, pervasive computing, advanced analytics, sensor integration, privacy and security, modeling of socio-behavioral and cognitive processes and system and process modeling
- Cross-Directorate and Cross-Agency Solicitation: NSF CISE, ENG, and SBE with NIH.

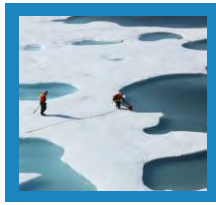

Proposal deadline: Dec 11, 2018

# NSF's 10 Big Ideas

## RESEARCH IDEAS

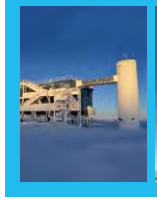

Harnessing Data for 21st Century Science and Engineering

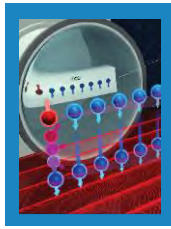
Work at the Human-Technology Frontier: Shaping the Future



Navigating the New Arctic

Windows on the Universe: The Era of Multi-messenger Astrophysics





The Quantum Leap: Leading the Next Quantum Revolution

Understanding the Rules of Life: Predicting Phenotype

## PROCESS IDEAS

Mid-scale Research Infrastructure

NSF 2050: Seeding Innovation


Growing Convergent Research at NSF

NSF-INCLUDES: Enhancing Science and Engineering through Diversity

# Harnessing the Data Revolution (HDR)

*Enabling 21st-century science, engineering, and education to move toward effective use of digital data to advance discovery*

## Research

- Fundamental research in data-centric mathematics, statistics and computation, and computer science
- Fundamental research on data-centric algorithms and systems
- Data-driven research in all NSF research domains

## Advanced cyberinfrastructure

- Data-centric, science-driven, research cyberinfrastructure ecosystem

## Education

- Creation and nurturing a 21st-century data-capable workforce

# Harnessing the Data Revolution (HDR)

## Critical Techniques, Technologies and Methodologies for Advancing Foundations and Applications of Big Data Sciences and Engineering (BIGDATA):

- *Foundations:* fundamental techniques, theories, methodologies, technologies
- *Innovative Applications:* application-driven techniques, methodologies, technologies
- CISE, EHR, ENG, MPS, SBE
- Cloud resources available to funded projects from Amazon Web Services (AWS), Google Cloud, IBM, Microsoft Azure
- *Proposals were due May 14, 2018*

*Systems research*

## Transdisciplinary Research in Principles of Data Science (TRIPODS):

- Brings together statistics, mathematics, theoretical computer science communities to develop theoretical foundations of data science through integrated research, training activities
- CISE, MPS, ENG, GEO, SBE, OIA
- *Proposals were due May 29, 2018*

*Theory research*

## NSF Research Traineeship (NRT):

- Encourages the development and implementation of bold, new, and potentially transformative models for STEM graduate education
- HDR is priority theme for Fiscal Years 2018, 2019, and 2020
- NSF-wide
- *Letters of intent (required) due by Dec 6, 2018 and Full Proposals due Feb 6, 2019*

*Education*

# The Future of Work at the Human-Technology Frontier (FW-HTF)

*Shaping the development and use of technologies to improve the quality of work, while also increasing productivity and economic growth*

## Research Themes:

- Building the human-technology partnership
- Augmenting human performance
- Illuminating the socio-technological landscape
- Fostering lifelong learning

# Future of Work at the Human-Technology Frontier: Advancing Cognitive and Physical Capabilities (FW-HTF)

- **Motivation**: Landscape of jobs and work is changing at unprecedented speed, driven by the development of new technologies that have moved from the factory floor to an expanding array of knowledge and service occupations.

- **Two themes**:
  - Theme 1 - Foundations for Augmenting Human Cognition
  - Theme 2 – Embodied Intelligent Cognitive Assistants

Stay tuned for deadlines

# Cyberlearning for Work at the Human-Technology Frontier


- Expanding and transforming learning and educational opportunities and outcomes for learners and workers of all ages
- Technologies to enable lifelong learning, including adult re-training
- Cross-Directorate Solicitation: CISE, EHR, ENG, SBE

Proposal deadline: Jan 14, 2019

THANKS!

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## Join CISE-ANNOUNCE email

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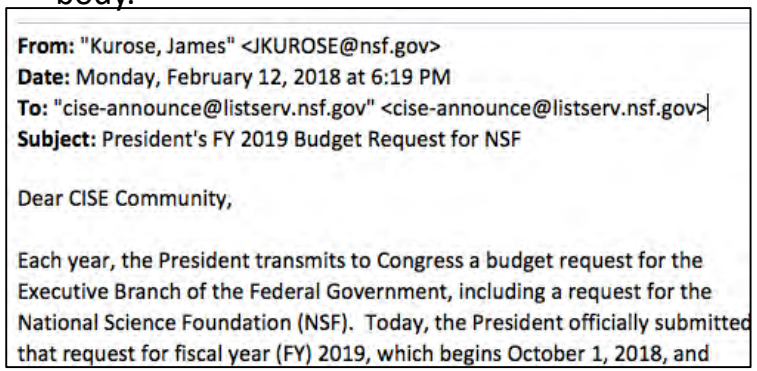

**From:** "Kurose, James" <JKUROSE@nsf.gov>
**Date:** Monday, February 12, 2018 at 6:19 PM
**To:** "cise-announce@listserv.nsf.gov" <cise-announce@listserv.nsf.gov>
**Subject:** President's FY 2019 Budget Request for NSF

Dear CISE Community,

Each year, the President transmits to Congress a budget request for the Executive Branch of the Federal Government, including a request for the National Science Foundation (NSF). Today, the President officially submitted that request for fiscal year (FY) 2019, which begins October 1, 2018, and


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