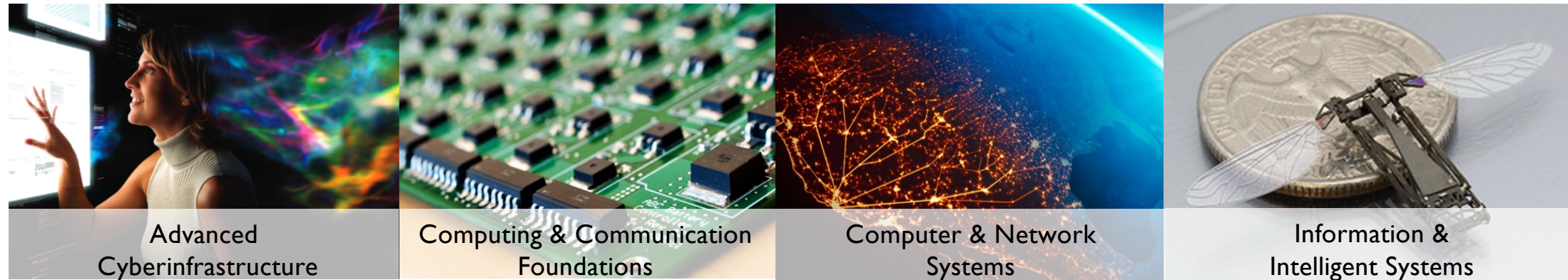


# National Science Foundation Investments in AI



**Jim Kurose**  
**Assistant Director, NSF**  
**Computer & Information Science & Engineering**

**National Security Commission on AI**  
**Working Group on Maintaining Global Leadership in AI Research**

June 28, 2019



# The National Science Foundation's mission

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

# NSF by the numbers

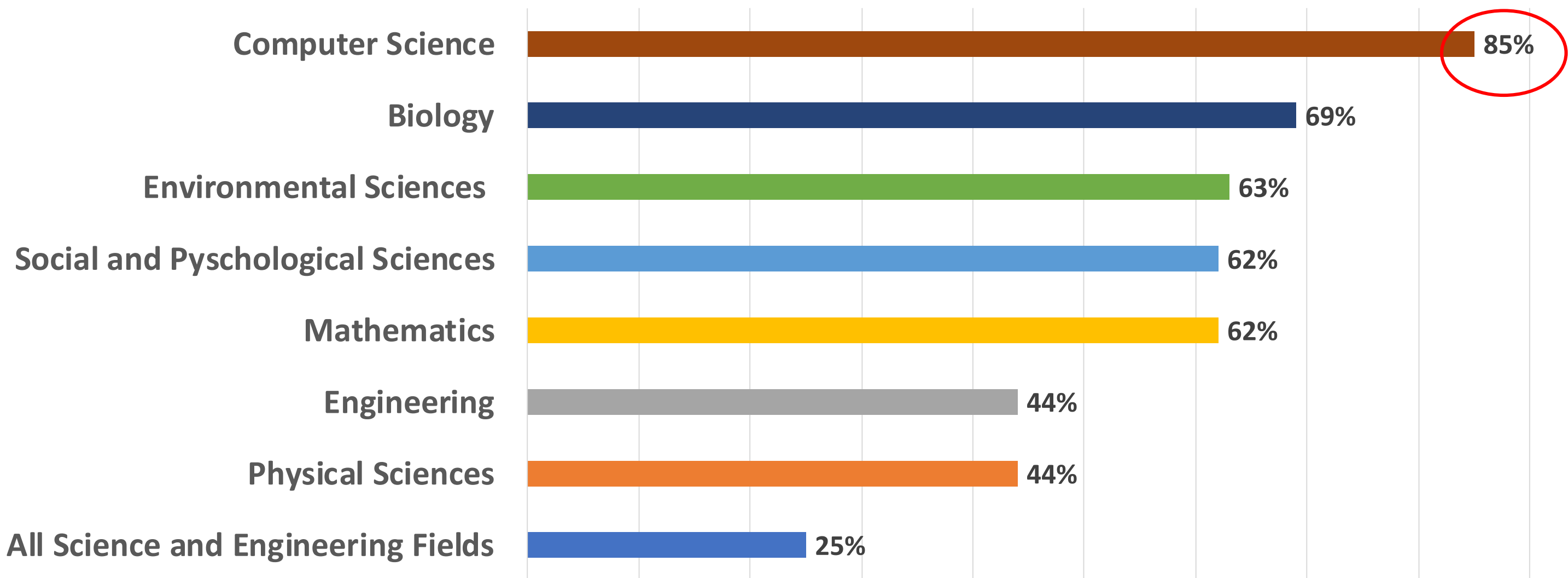


Most numbers based on FY 2018 activities.



# NSF supports all areas of fundamental research

*NSF support as a percentage of total federal support for basic academic research*

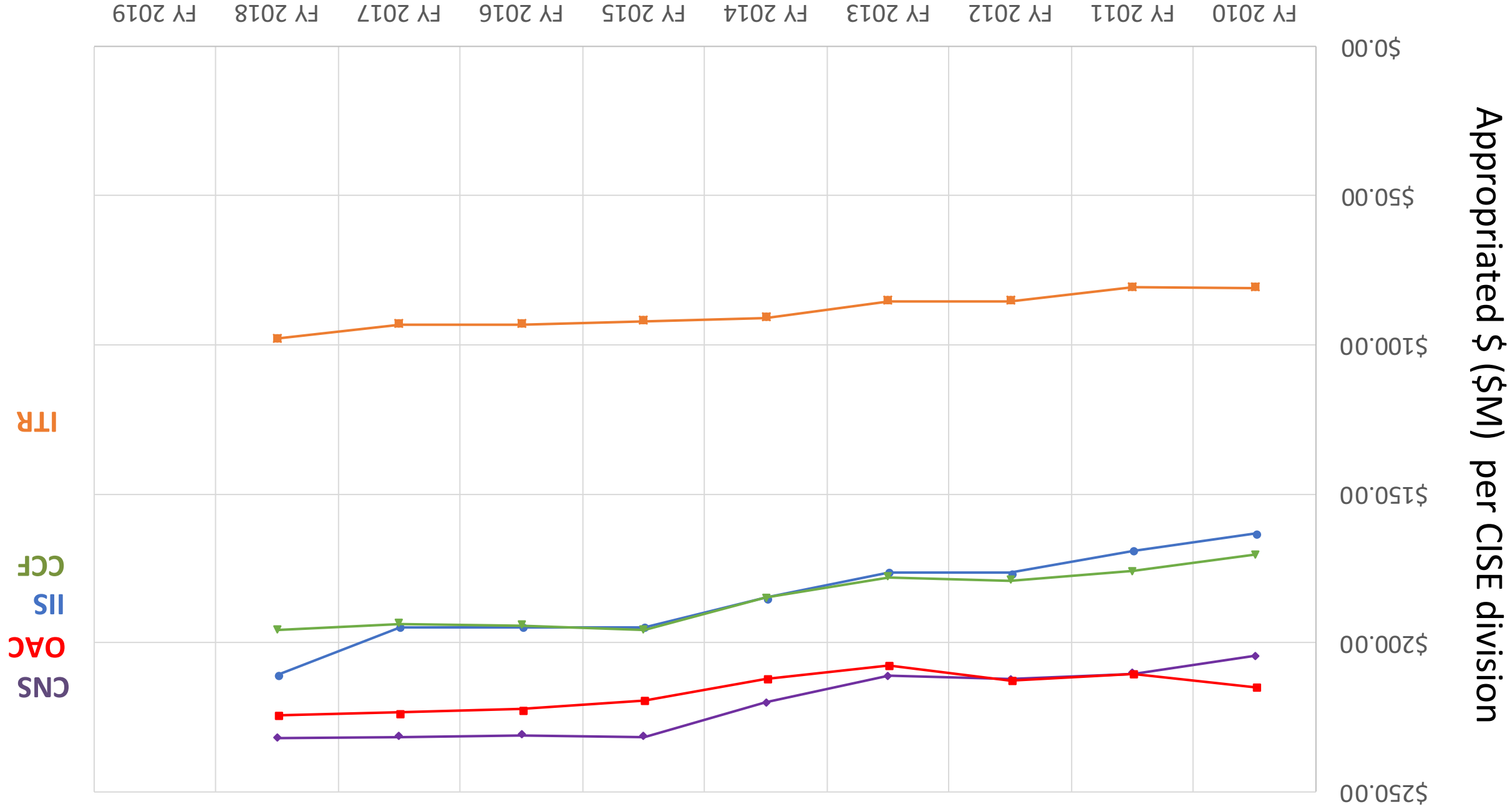


Source: NSF/NCSES, “Survey of Federal Funds for Research and Development”; FY 2020 NSF Budget Request to Congress.

EPIC-19-0511-NSF-AI-FOIA-20210319-NSF-Production-pt1



# NSF/CISE budgets



# NSF leadership in AI

## Research Funding

**\$** NSF invested nearly \$450M in AI research (core, applications, systems, infrastructure) in FY 2018

>\$100M in “core” AI research

## Thought Leadership Across USG



NSTC Select Committee on AI  
NSTC Subcommittee on ML & AI  
NSTC AI Interagency Working Group (under NITRD): 2016, 2019 *National AI R&D Strategic Plans*  
OSTP Assistant Director(s) for AI  
International: OECD, G7  
Envisioning AI Institutes meeting

## Innovative Programmatic

NSF 19-018

Dear Colleague Letter: EArly-concept Grants for Exploratory Research on Artificial Intelligence (AI) and Society - Supported Jointly with the Partnership on AI



NSF Program on Fairness in Artificial Intelligence in Collaboration with Amazon (FAI)



Enabling Access to Cloud Computing Resources for CISE Research and Education (Cloud Access)

**PROGRAM SOLICITATION**  
NSF 19-510

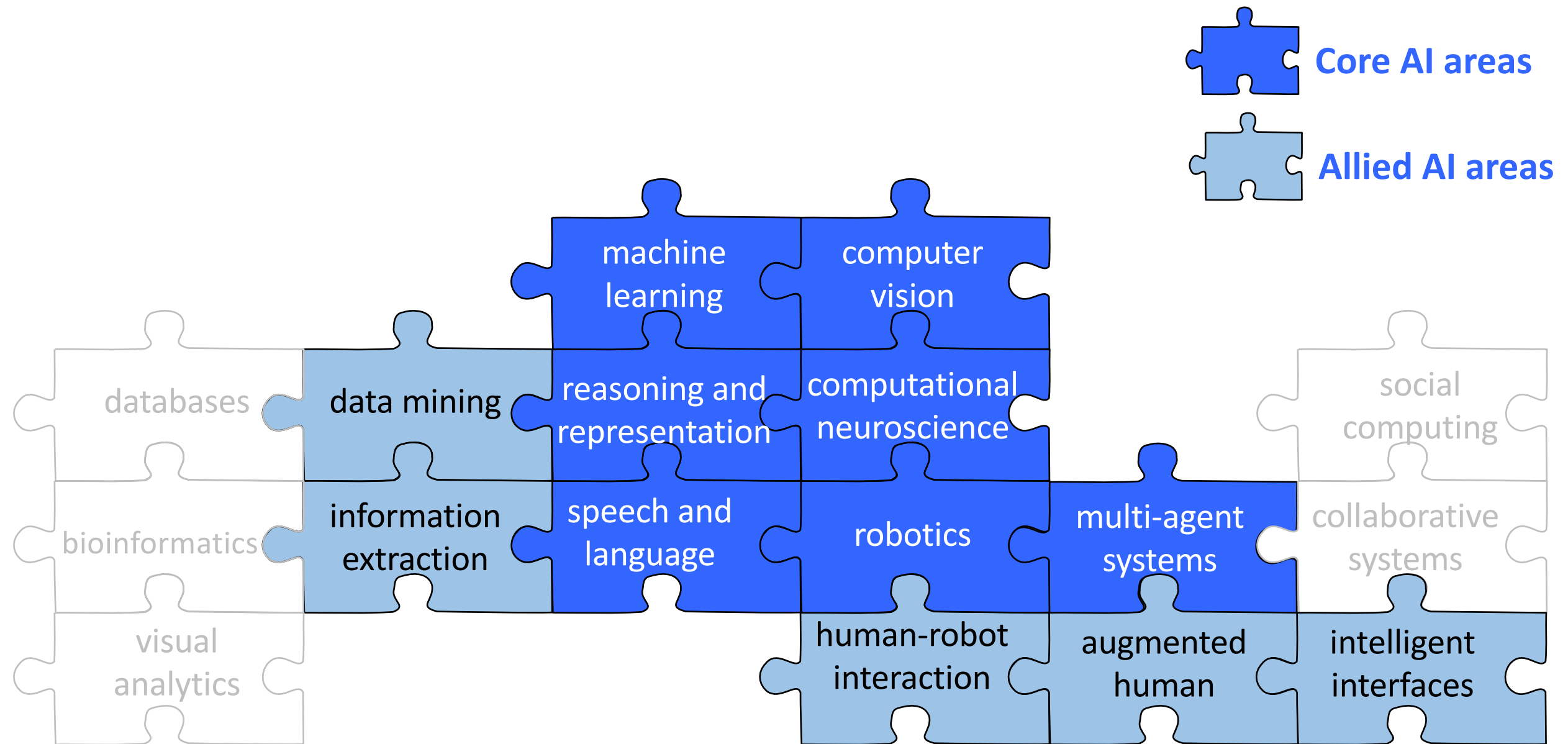


**National Science Foundation**

Directorate for Computer & Information Science & Engineering  
Division of Computing and Communication Foundations  
Division of Information & Intelligent Systems  
Division of Computer and Network Systems  
Office of Advanced Cyberinfrastructure



# CISE “core” programs and AI





# NSF investments in *core, cross-cutting* AI research

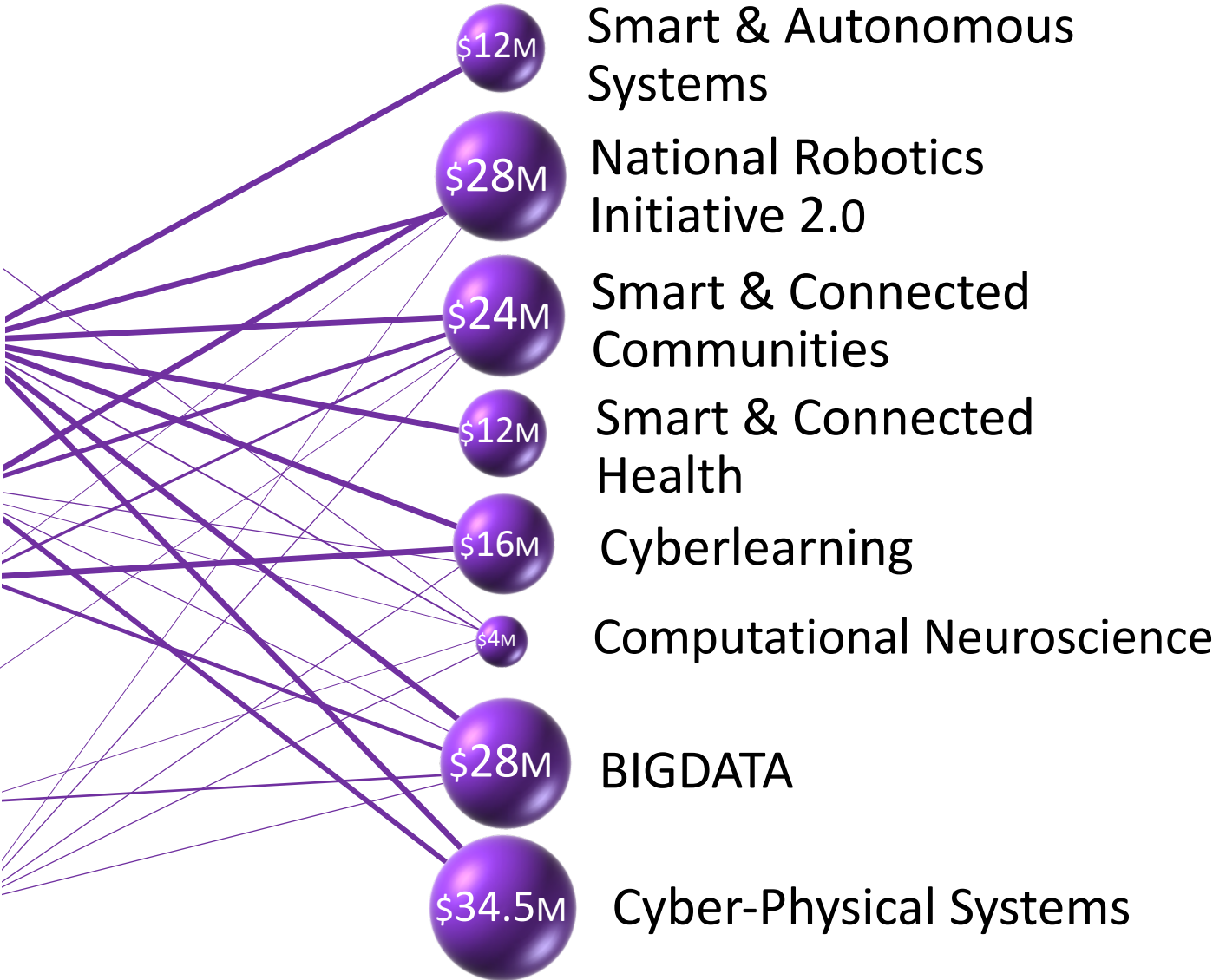
## CISE “core” AI



- Robust Intelligence (RI)
- Information Integration and Informatics (III)
- Cyber-Human Systems (CHS)

BIO  
CISE  
ENG  
EHR  
GEO  
MPS  
SBE

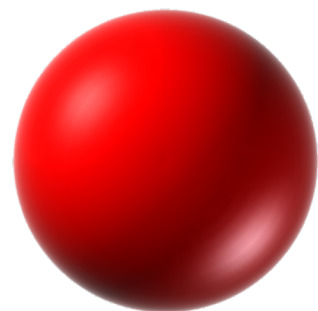
## “Cross-cutting” AI



FY 2018 data

# NSF investments in *core, cross-cutting* AI research

## CISE “core” AI



- Robust Intelligence (RI)
- Information Integration and Informatics (III)
- Cyber-Human Systems (CHS)

## Partners

USDA, DOE, DARPA,  
AFOSR, ONR

NIH (9 Institutes)

ANR, BMBF, BSF,  
NICT, NIH

Amazon, Google,  
Microsoft, IBM

DHS, DOT, NASA,  
NIH, USDA

## “Cross-cutting” AI



Smart & Autonomous  
Systems



National Robotics  
Initiative 2.0



Smart & Connected  
Communities



Smart & Connected  
Health



Cyberlearning



Computational Neuroscience



BIGDATA



Cyber-Physical Systems

FY 2018 data

# NSF's 10 Big Ideas for Future Investment

## RESEARCH IDEAS

MATHEMATICAL, STATISTICAL, COMPUTATIONAL FOUNDATIONS, OPEN ACCESS, EDUCATION WORKFORCE, DATA SCIENCE, ANALYTICS, DISCOVERY, MACHINE LEARNING, DATA, CYBERINFRASTRUCTURE, MODELING, DATA MINING, INTERPRET OF THINGS, STATISTICS, FUNDAMENTAL RESEARCH, CHALLENGES, DOMAIN, SCIENCE, CYBERSECURITY, SYSTEMS, INFRASTRUCTURE, HUMAN DATA INTERFACE.

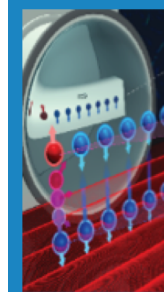
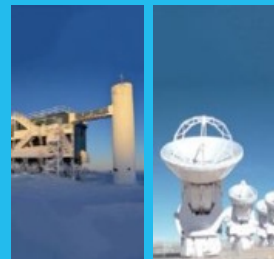
**HARNESSING THE DATA REVOLUTION**

Harnessing Data for 21<sup>st</sup> Century Science and Engineering

Work at the Human-Technology Frontier: Shaping the Future



Windows on the Universe: Multi-messenger Astrophysics



Quantum Leap: Leading the Next Quantum Revolution

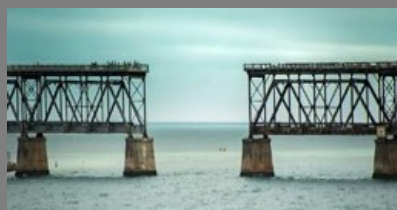
Understanding the Rules of Life: Predicting Phenotype



Navigating the New Arctic

## PROCESS IDEAS

Mid-scale Research Infrastructure



NSF 2026



Growing Convergence Research at NSF



NSF INCLUDES: Enhancing STEM through Diversity and Inclusion

“ ... bold questions that will drive NSF's long-term research agenda -- questions that will ensure future generations continue to reap the benefits of fundamental S&E research. ”



“AI is the universal connector that interweaves all of our Big Ideas; data science is changing the very nature of scientific inquiry, and AI's use of data has the potential to revolutionize everything we do in science.”

*F. Córdoba , Director, NSF, Sept. 2017*

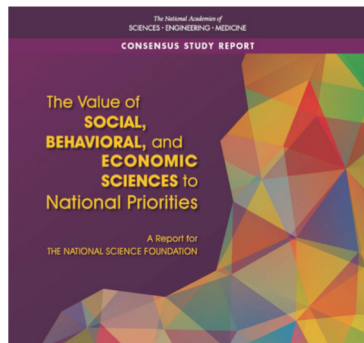


# NSF's AI investments: defense and security

**Basic research.** NSF-funded basic academic research (e.g., machine learning, vision, speech, social sciences) builds the foundation for AI application in defense and security.



“NSF is where all interesting research gets started...” - Eric Schmidt



“The role of the NSF [SBE] in securing the national defense largely involves funding some of the basic research that its federal partners—such as DARPA, ARL, ONR, NRL and DHS—later use to develop mission-specific tools and applications.” NASEM, 2017

**Use-inspired research.** NSF also funds individual PIs, and center-scale activities, with direct application to national defense and security, e.g.:

## Center for Trustworthy Machine Learning:

- “develop[ing] a rigorous understanding of the vulnerabilities inherent to machine learning, and to develop the tools, metrics, and methods to mitigate them.”
- \$10M (5 yrs) in Secure & Trustworthy Cyberspace (SaTC) program. [SaTC: 78M/yr portfolio]



# NSF national leadership in AI

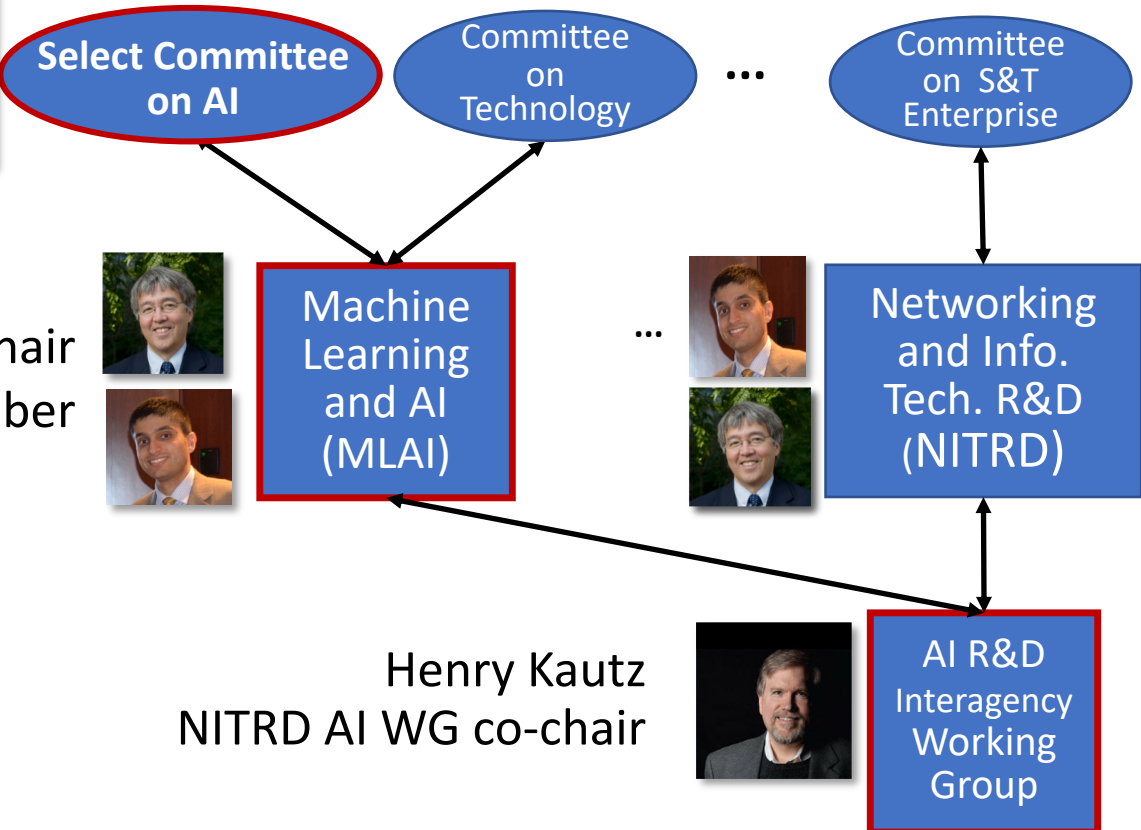
Office of Science & Technology Policy



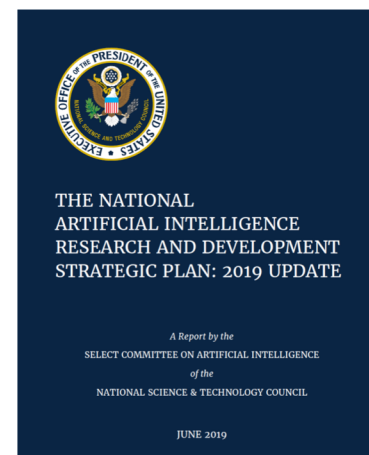
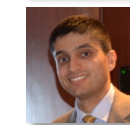
Lynne Parker  
Assistant Director for AI

## National Science and Technology Council (NSTC)

France Cordova  
AI Select Committee  
Co-chair (with DARPA,  
OSTP)



Jim Kurose, co-chair  
Erwin Gianchandani, member



Henry Kautz  
NITRD AI WG co-chair



Subcommittees

Working groups

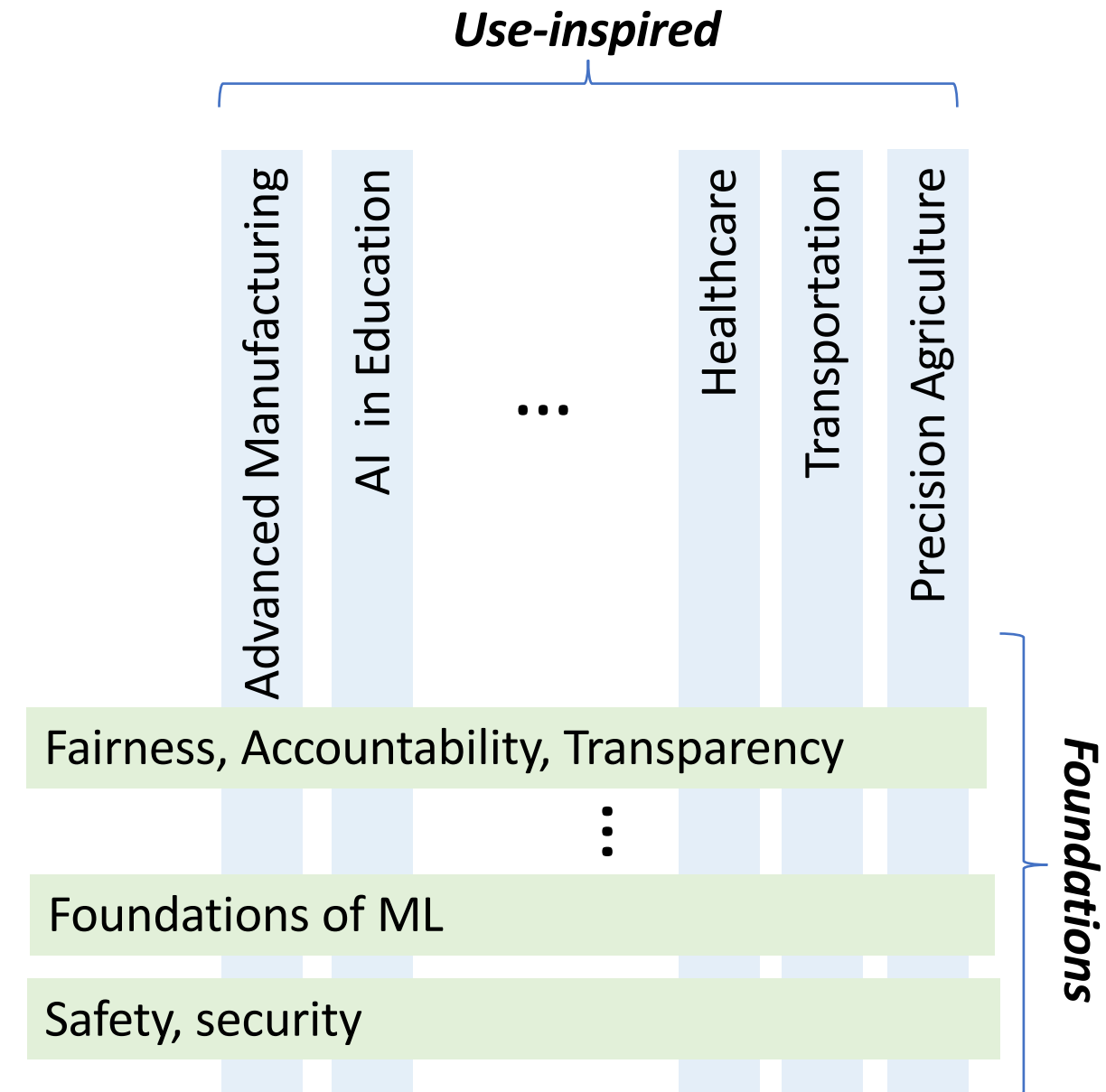
# A convening to envision National AI R&D Institutes

## Convening:

- May 29<sup>th</sup>, 2019 at NSF
- ~75 attendees (20 industry, 6 foundation/non-profit, 50 USG attendees)

## Why AI R&D Institutes?

- Breadth, scale of challenges demand center-scale, multi-disciplinary, multi-institutional collaborative efforts
- Sustained investment: in-depth, extended focus; prototyping, living labs; longer time horizons
- Nurture the next generation of talent
- Facilitate accelerated transition of innovations into many economic sectors





# National AI R&D Institutes: Next steps



- Ongoing conversations with interested agencies, including:
  - Privacy: DHS, DOJ, IARPA
  - Health: VA, NIH
  - Agriculture: USDA/NIFA
  - Several intra-NSF multi-directorate
- Developing partnership mechanism, solicitation
  - Institutes: envisioning up to \$20M over 5 years, supporting research and workforce development
  - FY 2020: Initial round of Institutes launch

Foundational and Cross-Cutting	Use-Inspired
AI Security and Privacy	AI Workforce Development and AI- Enabled Learning
Assured AI (e.g., safety, verifiability)	AI for Health and Wellbeing
AI Fairness and Explainability	AI for Agriculture
The Human-AI Interface	AI for Transportation
Biological & Artificial Modes of Intelligence	
AI Infrastructure	

AI R&D Institute Topics Surfaced at Convening

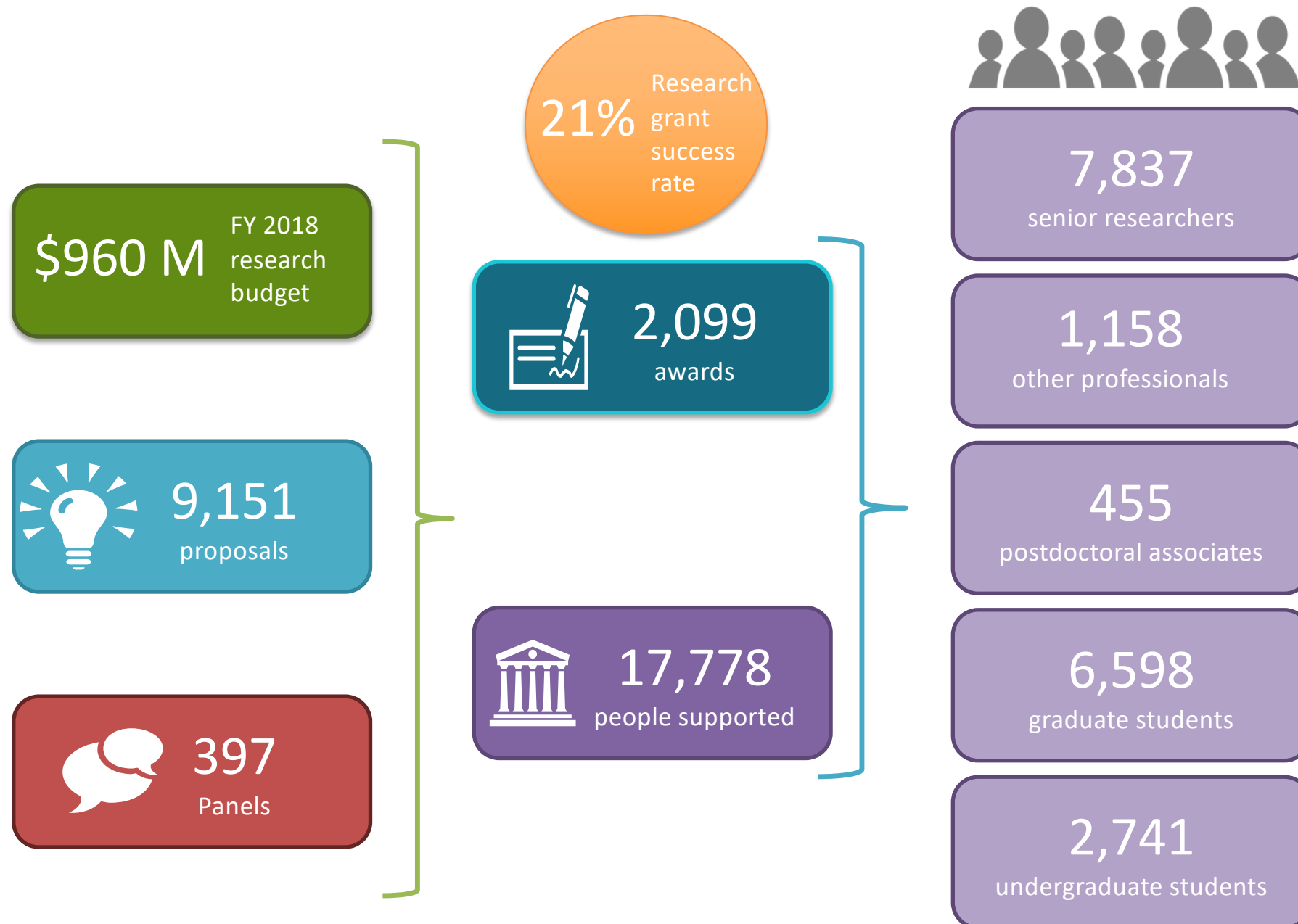
# For more information

- White paper: “A Meeting to Envision National Artificial Intelligence Research and Development Institutes,” June 2019.
  - White paper: “NSF and Artificial Intelligence: Research Foundations, Education and Workforce, Computing and Data, Government Leadership,” April 2019.
  - White paper: “NSF’s Investments in Computer Science Education,” Feb. 2019.
  - Jim Kurose, NSF/CISE Assistant Director, [jkurose@nsf.gov](mailto:jkurose@nsf.gov)
  - Erwin Gianchandani, NSF/CISE Deputy Assistant Director, [egiancha@nsf.gov](mailto:egiancha@nsf.gov)
  - Henry Kautz, NSF/CISE Division Director, Information and Intelligent Systems, [hkautz@nsf.gov](mailto:hkautz@nsf.gov)
  - Meghan Houghton, NSF/CISE Senior Advisor for Strategic Partnerships, [mehought@nsf.gov](mailto:mehought@nsf.gov)
- [www.nsf.gov/cise/ai.jsp](http://www.nsf.gov/cise/ai.jsp)

# Backup



# CISE by the Numbers: FY 2018



# NSF partners with a range of stakeholders

## 4 foundation partnerships in FY 18

- Simons Foundation: complex bio systems
- Breakthrough Foundation: Green Bank Observatory
- Stand Up To Cancer: IDEAS Lab
- Gates Foundation: BREAD

## 8 industry partnerships in FY 18

- Joint funding opportunities
- Research infrastructure

## 57 interagency partnerships in FY 18

- Joint funding opportunities
- Research infrastructure
- Workforce training
- Individual projects

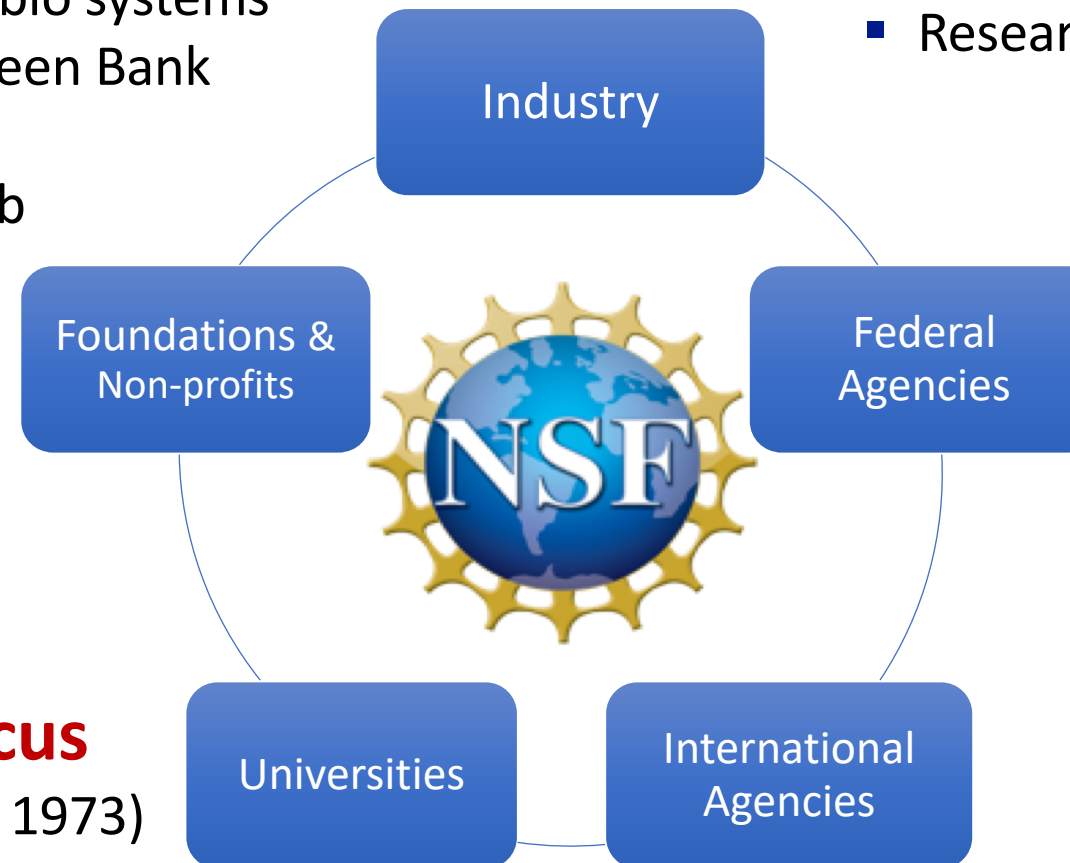
with 34 agencies/departments & 7 also included international partners

## University-led, industry-focus

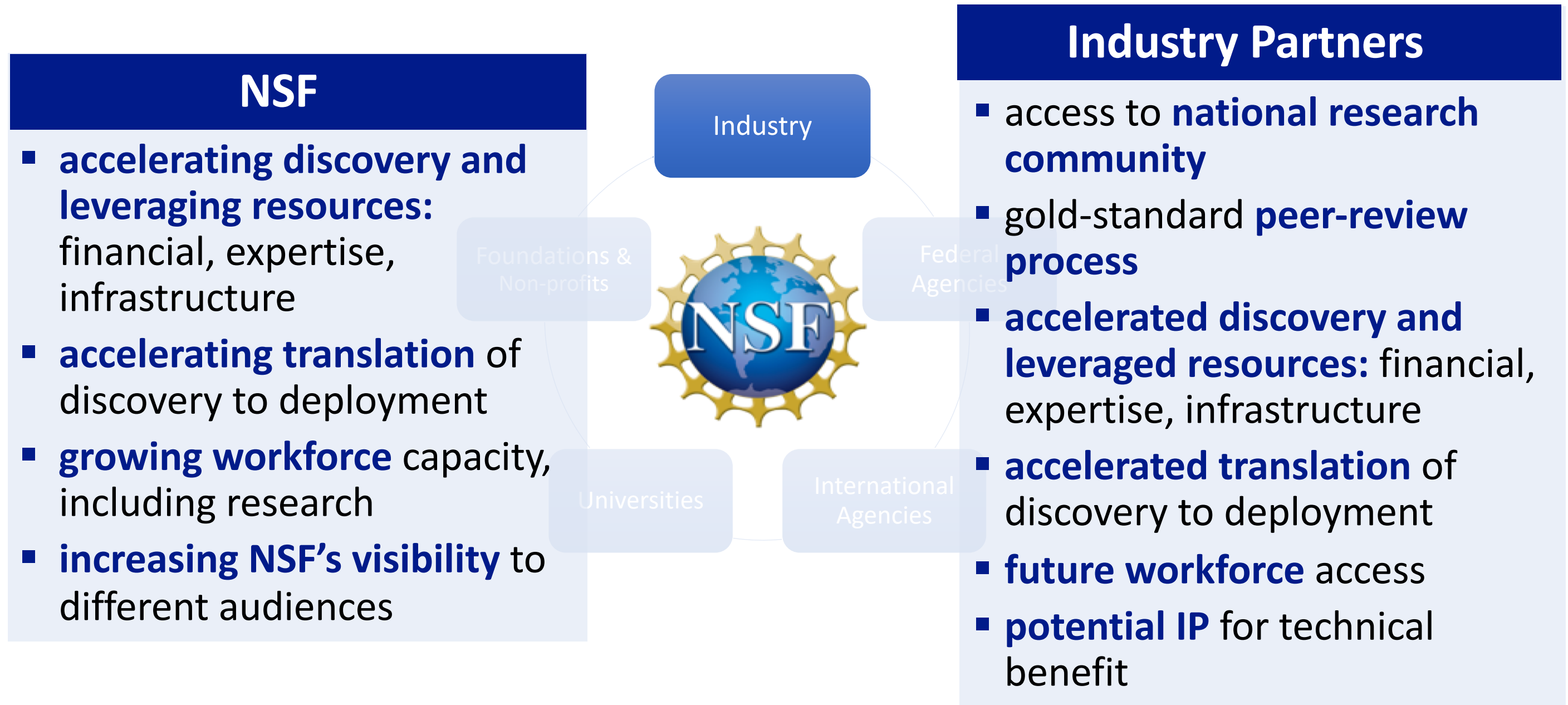
- I/UCRC: center co-funding (since 1973)
- GOALI: faculty, student, industry-researcher exchange
- InTrans: technology-transition co-funding for center-scale projects

## 30 international partnerships in FY 18\*

- Joint funding opportunities
- Research infrastructure
- Individual projects



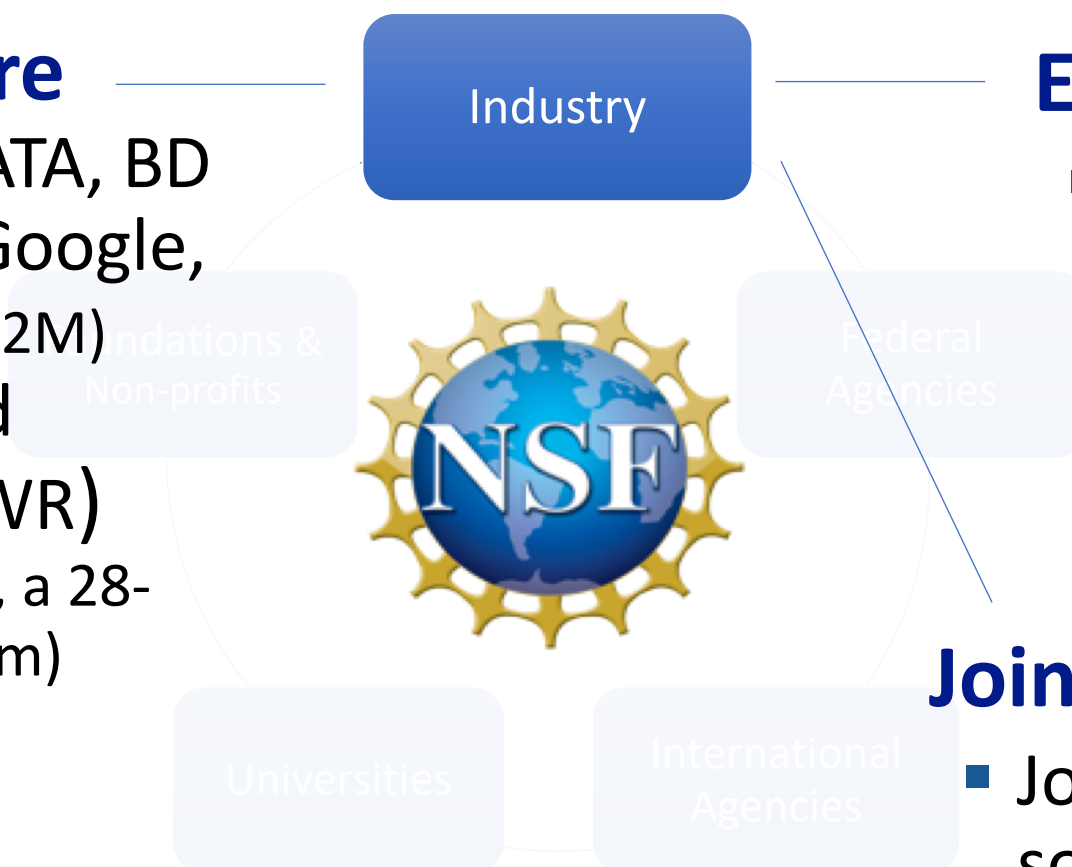
# Industry partnerships: value propositions



# Industry partnerships: recent activities

## Research Infrastructure

- Cloud credits for BIGDATA, BD Hubs & Spokes: AWS, Google, Microsoft, IBM (up to \$12M)
- Platforms for Advanced Wireless Research (PAWR) (up to \$50M each from NSF, a 28-member industry consortium)



## Education and Workforce

- Boeing: accelerated training, online materials in critical STEM skill areas; increase diversity (\$21M total, starting in FY 19)

## Joint Research Solicitations

- Joint NSF/industry research solicitations in targeted areas
- Intel (5), SRC (8), VMware (2), Amazon (1), PAI (1) (typically \$3M – \$10M from each partner)