National Science Foundation Investments in AI

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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...”
93% funds research, education and related activities

$8.1B FY 2019 Enacted

50,000 proposals evaluated

2,000 NSF-funded institutions

11,000 awards funded

359,000 people NSF supported

$1.2B STEM education

$100M to seed public/private partnerships

236 NSF-funded Nobel Prize winners

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

- Computer Science: 85%
- Biology: 69%
- Environmental Sciences: 63%
- Social and Psychological Sciences: 62%
- Mathematics: 62%
- Engineering: 44%
- Physical Sciences: 44%
- All Science and Engineering Fields: 25%

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 Programmaticas

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)
CISE “core” programs and AI

Core AI areas
- machine learning
- computer vision
- computational neuroscience
- robotics
- multi-agent systems

Allied AI areas
- reasoning and representation
- speech and language
- human-robot interaction
- augmented human
- intelligent interfaces

Other areas
- data mining
- information extraction
- databases
- bioinformatics
- visual analytics
- social computing
- collaborative systems

NSF/CISE Division of Information and Intelligent Systems
NSF investments in core, cross-cutting AI research

CISE “core” AI

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

“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 investments in core, cross-cutting AI research

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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)

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**“Cross-cutting” AI**
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- National Robotics Initiative 2.0
- Smart & Connected Communities
- Smart & Connected Health
- Cyberlearning
- Computational Neuroscience
- BIGDATA
- Cyber-Physical Systems

**Partners**
- USDA, DOE, DARPA, AFOSR, ONR
- NIH (9 Institutes)
- ANR, BMBF, BSF, NICT, NIH
- Amazon, Google, Microsoft, IBM
- DHS, DOT, NASA, NIH, USDA
**NSF’s 10 Big Ideas for Future Investment**

### RESEARCH IDEAS

- **Harnessing Data for 21st 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**
- **Navigating the New Arctic**
- **Understanding the Rules of Life: Predicting Phenotype**

### PROCESS IDEAS

- **Mid-scale Research Infrastructure**
- **NSF 2026**
- **Growing Convergence Research at NSF**
- **NSF INCLUDES: Enhancing STEM through Diversity and Inclusion**

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"... 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. Córdova, 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

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

Select Committee on AI
Committee on Technology
...
Committee on S&T Enterprise

Machine Learning and AI (MLAI)

Networking and Info. Tech. R&D (NITRD)

AI R&D Interagency Working Group

Subcommittees

Working groups

Lynne Parker
Assistant Director for AI
A convening to envision National AI R&D Institutes

Convening:
- May 29th, 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

Use-inspired

Foundations
- Advanced Manufacturing
- AI in Education
- ... (omitted)
- Healthcare
- Transportation
- Precision Agriculture

Foundations of ML
- Fairness, Accountability, Transparency
- Safety, security
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

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AI R&D Institute Topics Surfaced at Convening

- Pre-decisional Information
For more information


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- Henry Kautz, NSF/CISE Division Director, Information and Intelligent Systems, hkautz@nsf.gov
- Meghan Houghton, NSF/CISE Senior Advisor for Strategic Partnerships, mehought@nsf.gov

www.nsf.gov/cise/ai.jsp
CISE by the Numbers: FY 2018

- $960 M FY 2018 research budget
- 9,151 proposals
- 2,099 awards
- 17,778 people supported
- 7,837 senior researchers
- 1,158 other professionals
- 455 postdoctoral associates
- 6,598 graduate students
- 2,741 undergraduate students
- 21% Research grant success rate
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

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

8 industry partnerships in FY 18
- Joint funding opportunities
- Research infrastructure

30 international partnerships in FY 18*
- Joint funding opportunities
- Research infrastructure
- Workforce training
- Individual projects

57 interagency partnerships in FY 18
- Joint funding opportunities
- Research infrastructure
- Workforce training
- Individual projects

*Estimated
Industry partnerships: value propositions

**NSF**
- accelerating discovery and leveraging resources: financial, expertise, infrastructure
- accelerating translation of discovery to deployment
- growing workforce capacity, including research
- increasing NSF’s visibility to different audiences

**Industry Partners**
- access to national research community
- gold-standard peer-review process
- accelerated discovery and leveraged resources: financial, expertise, infrastructure
- accelerated translation of discovery to deployment
- future workforce access
- potential IP for technical benefit
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)