Growing Federal Support for Al Research

Henry Kautz Division Director, Information & Intelligent Systems (III) Computer & Information Science & Engineering (CISE) National Science Foundation

AAAI Fall Symposium 2018





FROM:

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

MICK MULVANEY DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET

MICHAEL KRATSIOS TY ASSISTANT TO THE PRESIDENT OFFICE OF SCIENCE AND TECHNOLOGY POLICY

SUBJECT: FY 2019 Administration Research and Development Budget Priorities

FY 2019, 2020 R&D Budget Priorities Memo

"Continued leadership in AI, quantum information science (QIS), and strategic computing is critically important to our national security and economic competitiveness. Agencies should invest in fundamental and applied AI research, including machine learning, autonomous systems, and applications at the human-technology frontier."



DECEMBER 2017



"prioritize emerging technologies critical to economic growth and security, such as data science, encryption, autonomous technologies,... advanced computing technologies, and artificial intelligence. "





NSF: National Leadership in Al

Office of Science & Technology Policy (OSTP)

National Science and Technology Council (NSTC)





National AI Research & Development Strategic Plan

- NITRD Working Group of 40+ Federal Funding Agencies
- Co-Chairs: Henry Kautz (NSF) and Jeff Astott (IARPA)
- April 2019: Update to 2016 Plan and Implementation Report
- AI Request for Information published in Federal Register – comments were due Oct 26



Request for Information on Update to the 2016 National **Artificial Intelligence Research and Development Strategic** Plan



CCC Artificial Intelligence Roadmap

https://cra.org/ccc/visioning/visioning-activities/2018-activities/artificial-intelligence-roadmap

- Computing Community Consortium with support from NSF
- Chairs: Yolanda Gil (USC), Bart Selman (Cornell)
- Major goals
 - 10 20 year research roadmap
 - Guidance for funding agencies and Congress
 - Benchmark US to international AI initiatives
- Timeline
 - 3 small by-invitation workshops (Nov-Jan)
 - Townhall at AAAI (Feb 1)
 - Draft report (Feb)
 - Final report (April)





Computing Research Association



US AI Roadmap Process

- W1: Integrated Intelligence
 - Chairs: Marie desJardins and Ken Forbus
 - Understanding the mind
 - Composing intelligent capabilities
 - Open repositories of knowledge
- W2: Interaction (Jan 8-9)
 - Chairs: Kathy McKeown and Dan Weld
 - Interactions that matter
 - Trust and responsibility
 - People interacting online

- W3: Learning and Robotics (Jan 17-18)
 - Chairs: Tom Dietterich and Fei-Fei Li
 - Deeper learning
 - Integrating statistical learning and symbolic representations
 - Diversified learning modalities
- AAAI Town Hall (Jan 28)
- Draft of final report ready for reviews and feedback (February)

Societal Drivers

- Boost Health and Quality of Life: Prevention of illness and elderly ailments, 1. mental/behavioral health, reducing cost (25+% feasible) while improving care, remote patient care.
- **Lifelong education and training:** Personalized, scalable education support. 2. Improve the AI knowledge and skills of people who will lose jobs
- **Reinvent Business Innovation:** Evidence-driven companies, which would 3. increase productivity and value and open new sectors/products. Lead in **Competitiveness -- Keep US #1 in Information Technology:** Training next generation of AI specialists, data scientists, and software engineers (difficult race) with China)
- **Accelerate Scientific Discovery and Technological Innovation:** Biomedical, 4. environmental, new materials, personalized services, robotics, self-driving cars, etc.
- **Transform Cyber Defense and Security:** Al driven systems can compensate for a 5. relatively small cyber defense workforce, adversarial reasoning

Other Topics To Be Mentioned in the Report

- What is Al
- Who should speak for AI (too many so-called experts who have little expertise/credibility)
- Overview of AI strategies/investments in other countries
- The need for sustained investments to attack core AI challenges
 - Past US government investments in AI have payed off
- Al ethics
 - Al automation and the future of jobs
 - Al safety
- Workforce training
 - Meeting the needs for AI experts (industry, government)
 - Creating capability at universities

Reference Documents

- US National AI R&D Strategic Plan, 2016
 - <u>https://www.nitrd.gov/news/national_ai_rd_strategic_plan.aspx</u>
- CCC Robotics Roadmap, revised 2016:
 - https://cra.org/ccc/wp-content/uploads/sites/2/2016/11/roadmap3-final-rs-1.pdf
- 100 year study of AI, 2016 report:
 - https://ai100.stanford.edu/sites/default/files/ai100report10032016fnl singles.pdf
- Al strategies/investments abroad:
 - https://medium.com/politics-ai/an-overview-of-national-ai-strategies-2a70ec6edfd



CISE Division Budgets (Millions)



FY 2010 FY 2011 FY 2012 FY 2013 FY 2014 FY 2015 FY 2016 FY 2017 FY 2018 FY 2019

Computer & Networked Systems Advanced Cyberinfrastructure Info & Intelligent Systems Comp. & Comm. Foundations

Information Tech. Research

Computer & Networked Systems Advanced Cyberinfrastructure Info & Intelligent Systems Comp. & Comm. Foundations 2018: \$25 Million Al Bump \$11 Million in IIS \$14 in AI-Related Crosscutting Programs





NSF Support for Al

- Information & Intelligent Systems (CISE/IIS) Core Programs
 - Robust Intelligence machine learning, knowledge representation
 - Cyber Human Systems human computer interaction, human augmentation
 - Information Integration & Informatics data science, data mining
- 50% of the CISE budget is in Crosscutting Programs!
 - National Robotics Initiative / Smart & Autonomous Systems / Cyber-Physical Systems
 - Collaborative Research in Computational Neuroscience (with NIH)
 - Smart and Connected Health (with NIH)
 - Smart and Connected Communities
 - Big Data

NSF 10 Big Ideas

- New investments at the frontiers of science and engineering
 - \$30 million each for crosscutting programs
 - \$30 million each for convergence accelerators
- Harnessing the Data Revolution
 - Fundamental research in machine learning and data science
 - Applications in science and engineering
 - Education and workforce development
 - Solicitations coming in 2019



The Future of Work at the Human-Technology Frontier

2018:

- Foundations for Augmenting Human Cognition
- Embodied Intelligent Cognitive Assistants
- 2019:
 - Expanded solicitation coming out in a few days!





I-Act Cognitive Assistant

Machine Learning Bayesian Regression Probabilistic Graphical Models Deep Neural Networks

Educational Data Mining

Stealth Assessment Affect Recognition

Data Fusion

Data Selection Data Integration Feature Distillation

Don't Overlook EAGERS!

- EAGER: Early-Concept Grants for Exploratory Research
- Up to \$230,000 over two years
- High risk / high reward:
 - Radically different approaches
 - New interdisciplinary perspectives
- Can be submitted at any time to any CISE program!
- Must contact a program director to discuss your EAGER idea before submission
- Many EAGERS are funded quickly on the recommendation of a program director (panels not required)





DARPA Artificial Intelligence Strategy

July 2018

Distribution Statement "A" (Approved for Public Release, Distribution Unlimited)



AIE will enable DARPA to fund pioneering AI research to discover new areas where R&D programs may be able to advance the state of the art

- The pace of discovery in AI science and technology is accelerating worldwide
- The AI Exploration (AIE) program is part of DARPA's \bullet broader AI investment strategy that will help ensure the U.S. maintains a technological advantage in this critical area
- Program Announcement (PA) release: July 20, 2018 \bullet
 - https://www.fbo.gov/spg/ODA/DARPA/CMO/DARPA-PA-18ullet02/listing.html

This new approach enables DARPA to go from idea inception to exploration in fewer than 90 days!



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Physics of AI (PAI)

- Novel AI architectures, algorithms and approaches that incorporate prior knowledge, such as known physical laws, to augment sparse data and ensure robust operation
 - Demonstrate AI approaches that make optimal use of both observational and experimental data, simulated data, and prior knowledge
 - Demonstrate an AI prototype system using simulated and/or real data in a representative DoD-relevant systems application
 - Address the fundamental performance limits (robustness, generalizability, etc.) compared to current SoA AI approaches
- Disruptioneering Special Notice posted July 6, 2018; awards in process

Automating Scientific Knowledge Extraction (ASKE)

- Approaches to build, maintain, and reason over rich models of complex systems (physical, biological, social, engineered or hybrid systems)
 - Interpreting and exposing scientific knowledge and assumptions in existing model code and documentation
 - Identifying new data and information sources automatically extracting useful information (causal relations, correlations, context, parameters, etc.)
 - Integrating useful information into machine-curated expert models and executing models in robust ways
- AIE Special Notice posted August 8, 2018; proposals due September 17, 2018

Learning with Less Labels (LLWL)

- Make the process of training machine learning models more efficient
 - Reduce the amount of labeled data required to build a model by 6 or more orders of magnitude
 - Reduce the amount of data needed to adapt models to new environments to tens to hundreds of labeled examples
- I2O BAA posted August 6, 2018; proposals due October 2, 2018

- I'm always interested in hearing your ideas, questions, and concerns about NSF programs – hkautz@nsf.gov
- We welcome visitors at our new home in Alexandria!
- Consider joining NSF as a program director, either as an academic rotator or a permanent employ^^'
 - It's a great gig!
 - Openings every year!
 - Greatest current need: Robotics!



Al is the New Electricity – Andrew Ng

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We're on the verge of new technological revolutions that could improve virtually every aspect of our lives, create vast new wealth for American workers and families, and open up bold, new frontiers in science, medicine, and communication."

President Donald J. Trump