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Before the
Subcommittee on Research and Technology
Committee on Science, Space and Technology
United States House of Representatives

on
"Artificial Intelligence and The Future of Work"

September 24, 2019

Introduction

Chairwoman Stevens, Ranking Member Baird, and members of the subcommittee, it is a privilege to be with you today to discuss how the National Science Foundation (NSF) is positioning the United States to continue our strong leadership in the development of new technologies and to also respond to the challenges and opportunities those new technologies present for the future of jobs and work.

Established by the National Science Foundation Act of 1950 (P.L. 81-507), NSF is an independent Federal agency whose mission is "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF is unique in carrying out its mission by supporting fundamental research across all fields of science, technology, engineering and mathematics (STEM) and all levels of STEM education. NSF is also committed to the development of a future-focused science and engineering workforce that draws on the talents of all Americans. NSF accounts for approximately 25 percent of the total Federal budget for basic research conducted at U.S. colleges and universities and has been vital to many discoveries that impact our daily lives and drive the economy. NSF is and will continue to be a respected steward of taxpayer dollars, operating with integrity, openness, and transparency.

A vibrant scientific workforce and breakthrough discoveries enabled in part by NSF investments sustain, accelerate, and transform America's globally preeminent innovation ecosystem. A long-term vision, belief in the promise of fundamental research, and commitment to pursuing risky, yet

potentially extraordinary discoveries are the hallmarks of NSF. NSF's investments empower discoverers to ask the questions and develop the technologies that lead to the next big breakthroughs.

NSF Leadership in Artificial Intelligence Research

The landscape of jobs and work is changing at unprecedented speed, enabled by advances in computer and information science and engineering, including data analytics, artificial intelligence (AI), and robotics, together with new conceptions of work and workplaces. This scientific and technological revolution presents a historical opportunity to the Nation through the creation of new industries and occupations, enhanced productivity and quality of life, and the potential for more people to participate in the workforce. However, these changes also bring challenges, such as the possibility of jobs lost to automation and increased demand for workers with higher skills. Other equally important challenges include new security threats, potential for algorithmic biases, and workplace policies and practices that have not kept up with rapid changes in the nature of work.

NSF has a long and rich history of supporting transformative research in AI, machine learning, robotics and data science. NSF also plays an important role in both measuring the STEM workforce through the National Center for Science and Engineering Statistics, as well as growing it through investing in human capital. NSF leadership is helping to drive and coordinate AI research and development efforts across the federal government. The NSF Director co-chairs the National Science and Technology Council's (NSTC) Select Committee on AI, which advises the White House on interagency AI Research and Development (R&D) priorities and establishes structures to improve government planning and coordination. In addition, the NSF Assistant Director for Computer & Information Science & Engineering co-chairs the NSTC Machine Learning and AI Subcommittee and also co-chairs the NSTC Networking and Information Technology Research and Development Subcommittee, both of which serve to coordinate federal R&D investments in AI as well as other related information technology areas. For example, NSF was a key contributor to the *National Artificial Intelligence Research and Development Strategic Plan: 2019 Update* published in June of this year.

NSF also invests significant resources, nearly $450 million in Fiscal Year 2019, in fundamental research, workforce development, and advanced, scalable computing resources that collectively advance AI. Indeed, many of the transformative uses of AI that we are witnessing today are founded in Federal government investments in fundamental AI research that reach back over decades. For example, NSF-funded researchers began working on what is now known as collaborative filtering, pairing AI research with the growth of the Internet in the 1990s. This work fuels the recommender engines on popular websites like Netflix and Amazon and propel a significant proportion of e-commerce activity.

NSF has also launched several special-emphasis programs through various public-private partnerships. The NSF Program on Fairness in Artificial Intelligence in Collaboration with Amazon, will explore building trustworthy AI systems that are readily accepted and deployed to tackle grand challenges facing society. Specific topics of interest include transparency, explainability, accountability, bias, mitigation strategies, validation, and inclusivity. NSF has also joined with the Partnership on AI to understand the social challenges arising from AI technology and enable scientific contributions to overcome them. Within the Federal government, NSF and

the Defense Advanced Research Projects Agency have teamed up to explore high-performance, energy-efficient hardware and machine learning architectures that can learn from a continuous stream of new data in real time.

Building the foundations of tomorrow's AI innovations will require new interdisciplinary collaborations, resources, and strategic visions — principles that NSF has championed in its support of fundamental AI research. NSF's ability to bring together numerous fields—including computer and information science and engineering, along with cognitive science and psychology, economics and game theory, knowledge of the physical world, engineering and control theory, ethics, linguistics, mathematics, philosophy—gives the agency a unique role in expanding the frontiers of AI and addressing the challenges of the future.

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

In 2016, the National Science Foundation unveiled a set of "Big Ideas," 10 bold, long-term ideas that identify areas for future investment at the frontiers of science and engineering. The Big Ideas represent opportunities to position our Nation at the cutting edge of global science and engineering leadership by bringing together diverse disciplinary perspectives to support convergence research.

The Future of Work at the Human-Technology Frontier (FW-HTF) Big Idea is one mechanism by which NSF is responding to the challenges and opportunities for the future of jobs and work. The overarching vision is to support convergent research to understand and develop the human-technology partnership, design new technologies to augment human performance, illuminate the emerging socio-technological landscape, understand the risks and benefits of new technologies, understand and influence the impact of artificial intelligence on workers and work, and foster lifelong and pervasive learning.

Specifically, the FW-HTF Big Idea will advance our understanding of how technology and people interact, distribute tasks, cooperate, and complement each other in different specific work contexts. Researchers will advance the knowledge base related to worker education and training and formal and informal learning to enable all potential workers to adapt to changing work environments. We will also advance our understanding of the links between the future of work at the human-technology frontier and the surrounding society, including the intended potential of new technologies and the unintended consequences for workers and the well-being of society.

Achieving these goals requires integration and convergence of disciplines across computer science, engineering, learning sciences, research on education and workforce training, and social, behavioral, and economic sciences. A convergent perspective is essential to understand and shape long-term social and economic drivers, so that advanced technology can empower individuals and strengthen the social fabric. A convergent perspective also informs our Nation about how to develop education and re-skilling opportunities that can confer technology's benefits to all citizens.

In FY 2019, NSF began making the first awards under the FW-HTF Big Idea. One such award at the University of Michigan is investigating how humans and robots work together in construction environments. Despite recent advances in robot functionality, many fundamental questions in human-robot interaction remain unanswered. Another award supports a collaboration among

Purdue University, Indiana University and the Massachusetts Institute of Technology to develop simulations that can help manufacturers design factories where workers thrive.

NSF is also funding research in learning technologies that prepare learners for new opportunities ahead. Our Cyberlearning for Work at the Human-Technology Frontier program examines new ways to help learners of all ages gain the STEM skills that will give them new opportunities in tomorrow's workplaces. As an example, researchers at the University of Washington are working on improving the educational tools available to learners of all ages who are studying coding. By leveraging recent advances in computer science and machine learning, the project will create a new online learning technology that automatically generates more personalized practice content for learners with different backgrounds. These activities can create critical tools to support the gender, racial, ethnic, regional and intellectual diversity of our computing workforce.

The Convergence Accelerator

The NSF Convergence Accelerator is designed to identify areas of research where investment in convergent approaches – those bringing together people from across disciplines, united to solve problems – has the potential to rapidly translate to high-benefit results and advance ideas from concept to deliverables. The Convergence Accelerator complements NSF's basic research support by creating dynamic partnerships that can include stakeholders from industry, foundations, government, nonprofits and other sectors.

On September 10th, NSF announced the first awards through its Convergence Accelerator pilot. Forty-three awards totaling $39 million will support projects across the country that will find new ways to leverage advances from across the sciences and engineering to enhance the lives of American workers. Roughly half those awards are focused on the Future of Work and will address subjects such as predictive AI tools and the educational technologies needed for adult learning.

The Convergence Accelerator awards span a wide range of industries, populations, and partnerships. One award to the University of Central Florida will combine the most recent advances in deep learning, semi-structured interviews, surveys, and work-life journal data analysis in building a hybrid framework to predict the multi-dimensional impact of AI on future jobs in the human resources industry.

These 43 awards are just the first step in funding through the Convergence Accelerator. Over the next six months, teams of researchers will participate in an "Innovation Curriculum" that will help them improve their initial ideas, augment their teams through new partnerships, improve communications, and deliver groundbreaking new advances.

The Role of Social Science Research

Understanding the human and social aspects of changing workplaces and technologies give us the opportunity to use these technologies to improve the quality of work and quality of life for all Americans. From neurons to neighborhoods, and from farms to factories, social and behavioral scientists offer a distinct and valuable form of service to help us understand the human component of the changing nature of work.

In recent years, NSF's Social, Behavioral, and Economic Sciences (SBE) Directorate has led NSF's Future of Work effort and supported related research. A few examples include:

- Researchers at Carnegie-Mellon University in Pittsburgh are examining the effects of current and emerging technologies on labor outcomes with a precision that will provide meaningful insights for training programs. This work can help worker education and reskilling programs serve more people more effectively in less time.
- Vanderbilt University's Center for Autism and Innovation is working to improve opportunity and quality of life for people with neuro diverse conditions such as autism, ADHD, and dyslexia by investigating approaches to enhance retention, engagement, and productivity in STEM jobs, and specifically to harness unique capabilities accommodate for individual needs.
- Investigators at Michigan State University are examining the impact of widespread automated vehicle adoption on ride-hailing and truck hauling. Being able to predict changes will allow us to better prepare and retrain drivers, helping both industry and American workers.
- A team at the University of California-Irvine is using real time assessment to develop fair and accurate AI systems that will guide interventions to improve team cohesion, performance, workload, and collaboration and reduce interruptions, to help teams of the future work smarter, better, and happier

Concepts such as lifelong learning and values-based design are key elements of these efforts. Both concepts encourage researchers and entrepreneurs to consider the social consequences of technological change in early developmental stages – rather than after unintended consequences occur. Looking forward, social and behavioral scientists are working with their fellow scientists, engineers, and innovators from across the country to empower America's workers and help America's next generation of job creators better manage the challenges and opportunities of the future of work.

Conclusion

The discoveries and innovations funded by NSF have a long record of improving lives and meeting national needs. With the support of this Committee and the Congress, NSF will continue to invest in the fundamental research and the talented people who improve our daily lives and transform our future. As we look to the Future of Work, we are committed to supporting interdisciplinary research through the Big Ideas, the Convergence Accelerator and our core research programs that bring together all fields of science to ensure that our workers, researchers, students, innovators and industries are best positioned to take advantage of the major technological advancements we see today and will see in the future.

Thank you for the opportunity to testify today and for your continued support of NSF. I will be pleased to answer any questions you may have.

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Dr. Arthur Lupia is Assistant Director of the National Science Foundation. In that capacity, he serves as head of the National Science Foundation (NSF) Directorate for Social, Behavioral, and Economic Sciences (SBE). He also serves the Hal R. Varian Collegiate Professor of Political Science at the University of Michigan and as co-chair of the Office of Science and Technology Policy's Subcommittee on Open Science. Prior to arriving at NSF, he served as Chairperson of the Board for the Center for Open Science, as chair of the National Academies Roundtable on the Communication and Use of Social and Behavioral Sciences, and as a leader of many scientific advisory boards.

Dr. Lupia's research and related public work examines processes, principles, and factors that guide decision-making and learning. His efforts clarify how people make decisions, and choose what to believe, when they lack information or face adverse circumstances. Lupia draws from mixes of mathematics, statistics, neuroscience, economics, psychology and other scientific disciplines to advance these topics. His work on civic competence, information processing, how voters learn and science communication has influenced scholarly practice, public policy, and classroom teaching in many countries.

Dr. Lupia has been a John Simon Guggenheim Fellow, a Andrew Carnegie Fellow, and is a recipient of the National Academy of Sciences Award for Initiatives in Research. He earned his bachelor's degree in economics at the University of Rochester and his social science PhD at the California Institute of Technology.

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