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General Comment

See attached file(s)

Attachments

RFI AI Research and Development Strategic Plan_U of I Response NSF-2025-OGC-0001

Response to Request for Information on the Development of an Artificial Intelligence (AI) Research and Development Strategic Plan

Submitted by: Susan Martinis, Vice Chancellor for Research and Innovation, University of Illinois Urbana-Champaign

Executive summary

- The University of Illinois Urbana-Champaign (U. of I.) has always been on the pioneering edge of AI research and development and continues as a leader in research and innovation around AI, fundamental science, and STEM education in general.

U. of I. alumni include many founders and leaders in major tech firms; we are proud of our contribution to America's economy and technology dominance by providing among the largest number and highest quality STEM graduates of any university in the US.

- The United States has a strong but vulnerable position in AI.
 - Innovation in AI must be supported by creating an environment that stimulates creativity and accelerates the investigation of good ideas.
 - Investment should aim to create an AI that empowers all Americans.
 - We need a multi-part strategy: investing in education, AI research and startups, and computing infrastructure.
 - These impacts require fundamental advances in AI that will not be addressed by the Large Language Model (LLM)-focused industry.
 - This requires increasing investment in and streamlining funding for fundamental research and startups.
 - AI development must also focus on enhancing energy efficiency. Significant energy consumption poses a substantial challenge to AI research and development.
 - New infrastructure is needed to support innovation.
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The University of Illinois is a leader in AI research and infrastructure and in generating STEM talent

University of Illinois Urbana-Champaign (U. of I.) is one of the premier engines for basic science and AI research and one of the top universities for US Federal agencies funding (NSF, DOD, DOE, NIH, USDA, etc.).

1. We are home to the Center for AI, three National AI Research Institutes focusing on Molecular Discovery, Education, and AI Centers on Autonomous Construction and

Manufacturing, Health Data Systems and Analytics, Scientific Modeling, and Advanced Electronics Through Machine Learning, among others. We are a leading provider of computing resources for the National Artificial Intelligence Research Resource (NAIRR) pilot and provide the majority of GPU resources in the NSF ACCESS program.

2. The AI R&D and Education at U. of I. ensures advances in AI technology benefit a wide range of application areas and industries to benefit all Americans across the US.
3. We received the DOE INCITE award, one of two recent DOE awards to fund research in AI and high-energy physics.

The United States has a strong but vulnerable position in AI

America is the birthplace of AI, from the founding Dartmouth Summer Research Project on AI to the inventions of the first neural network by Dr. Rosenblat and the convolutional network by Dr. Yann LeCun. It is also the home of the early great AI and computing startups that grew from universities into giant tech companies. US early dominance is a product of heavy investment in education and research, an entrepreneurial spirit, and a competition-driven business environment where the best ideas are invented, developed, and commercialized.

America's AI leadership requires increased investments.

1. China has surpassed the US in the number of AI research publications.¹ The US is falling behind China in AI development by large margins.²
2. China produces more than 4 times as many STEM graduates as the US, and it is now introducing AI to children in elementary school³.
3. We are not graduating enough of an AI workforce, and we rely heavily on foreign-born individuals for our high-tech workforce, with roughly 20% of the total workforce and STEM graduates coming from other countries.
4. China has developed AI-driven tools for cyber espionage activities

¹ Acharya, A., & Dunn, B. (2022-01). *Comparing U.S. and Chinese contributions to high-impact AI research*. Center for Security and Emerging Technology. <https://cset.georgetown.edu/publication/comparing-u-s-and-chinese-contributions-to-high-impact-ai-research/>.

² Dawson, Gregory S., Kevin C. Desouza, and James S. Denford (2022-09-22). *Understanding Artificial Intelligence Spending by the U.S. Federal Government*. Brookings. <https://www.brookings.edu/articles/understanding-artificial-intelligence-spending-by-the-u-s-federal-government/>.

³ Burleigh, B. (2020, March 10). China's six-year-olds are already being offered AI classes in school in a bid to train the next generation of DeepSeek founders. *Fortune*. <https://fortune.com/2025/03/10/china-school-children-ai-deepseek-liang-wengfeng-estonia-uk-america-south-korea/>

Innovation in AI must be supported by creating an environment that stimulates creativity and accelerates the investigation of good ideas

Innovation cannot be driven top-down, and brilliant ideas are not recognized until they are well-established. To lead in AI, the vehicles of US investment must create an environment that stimulates creativity and accelerates the investigation of good ideas.

1. **Seed funding, with follow-on potential:** Provide broad but limited funding for generating ideas with opportunities for larger follow-on funding where potential is demonstrated.
2. **Computing infrastructure:** Create national infrastructure for AI research, for example, build on NSF's Cloud Bank and simplify use and access.
 - a. The U. of I. has made a \$50 million investment in the National Center for Supercomputing Applications' Illinois Computes initiative that provides extensive computing and data storage resources, technical expertise, and support. This ensures that advanced computing infrastructure is more easily accessible to researchers across the US.
3. **Stable funding:** Maintain the US as the best place to do long-term research by ensuring continued funding across federal research and education agencies, and ensuring the best people are driving R&D investments.
 - a. The U. of I. has been a top recipient of NSF funds, and a great steward of monies received from federal agencies. AI R&D breakthroughs will take place across many disciplines and agencies, and our campus' expertise with NSF, DOE, NIH, DOD, etc. is a real strength.

The US must invest in AI innovation. All breakthrough ideas in AI (e.g., convnets, deep networks, diffusion, transformers, ImageNet) have come from university, non-profit, and industry research labs by scientists aiming to crack the fundamental problems in machine learning and general intelligence. To ensure US leadership going forward, the federal government must continue to support basic, use-inspired, and applied research across the federal government.

Our experience suggests a multi-part strategy: investing in education, AI research and startups, and compute infrastructure.

To maintain AI leadership, the US urgently must invest in all levels of education.

1. The US must grow an AI-ready workforce, a generation of leaders and doers that are proficient in math, computing, and digital communication, and have the drive to invent, create, and set up the great AI companies of the future.

2. The US should invest in partnerships with states and universities that already possess world-class facilities and computing infrastructure – of particular importance are investments by agencies like DOE, NSF, NIH in funding graduate fellowships and early career research programs in STEM disciplines.

The need for STEM investments includes all areas of science and engineering.

1. Future progress in AI will require new materials, computer designs, bioengineering, crop science, transportation systems, building technologies – in short, innovation and economic development across sectors.
2. The U. of I. leads ARPA-E funding for investigators in the Grainger College of Engineering to develop an innovative cooling paradigm capable of both minimal energy use and maximum cooling power for future servers, and The Center for Advanced Semiconductor Chips with Accelerated Performance (ASAP) that is working to strengthen US leadership in critical technologies including high-performance computing, advanced manufacturing, 5G and beyond. Federal investments in these kinds of research will help maintain US leadership in this space.

Educational investment is also needed outside of STEM degrees.

1. Investments in elementary and secondary education are needed to provide more high school graduates with mastery of math, critical thinking, and language.
2. AI is now a fundamental technology, and all students in all majors in US two-year and four-year college programs should have a general education in AI.
3. Immigration is a critical talent resource. we do not have enough qualified and interested students graduating from US high schools to meet the need for STEM talent.

Investment should aim to create an AI that empowers all Americans

We highlight three application domains that industry is unlikely to address, with a focus on empowering individuals, rather than profit-driven solutions.

- 1. Healthcare.** Empower with more knowledge and control over their own health, including home diagnosis through sound, vision; reported symptoms; home assistants; and question and answer about symptoms, conditions, and treatment.
 - b. The U. of I.'s Health Care Systems Engineering Center (HCSEC) and Center for Artificial Intelligence Driven Health Data Systems and Analytics are already harnessing AI to improve outcomes in many health areas.
- 2. Education.** Make world-class primary, secondary, and professional educations available to all Americans through personalized learning, automated reading specialists, automated math specialists, interactive writing coaches, and professional skills development.

- c. The U. of I.'s Inclusive and Intelligent Technologies for Education (INVITE) based in the College of Education invents and deploys new artificially intelligent learning technologies to accelerate achievement in science, technology, engineering, and math.
- 3. Creative Expression.** Remove barriers between ideation and creation for digital and physical assets in visual and audio arts, multimedia experience, 3D printing, and crafts.

These impacts require fundamental advances in AI that will not be addressed by the LLM-focused industry

1. **Trustworthy AI.** AI currently tells us what it thinks we want to hear and often does not know the sources of its information. Data provenance needs to be addressed through new training paradigms and memory systems that can recall the context in which information was learned.
2. **Experiential Learning.** AI needs to break free from the confines of curated data to discover and learn from its own experiences. The potential economic impact of human-like robots is monumental, but fundamental research is needed to address the fundamental problems in manipulation, lifelong learning, and gaining experience through direct observation.
3. **Human-AI Team.** Good teammates learn from each other and how to interact with each other. Currently, AI is limited by the limitations of its baked-in training and memorized context and by its turn-based text-centric mode of interaction. Breakthroughs are needed to create a more dynamic and multimodal AI, both in the way it learns and in how it interacts.

Increase and streamline funding for fundamental research and startups

1. NSF programs, such as CAREER, the Graduate Research Fellowship Program (GRFP) Robust Intelligence, and DOD programs, such as MURIs and Long Range grants, are crucial for supporting fundamental research and training graduate students.
2. Other DOD programs, such as DARPA, which focus on translational research are successful when they specify an audacious problem and evaluation framework and leave the solution to investigators. The US should continue these programs with an emphasis on well-defined objectives, independent solutions, and efficient and effective reporting processes.
3. SBIRs are a valuable resource for startups, supporting early-stage commercialization of AI breakthroughs. SBIR programs should be expanded in funding with fewer restrictions and obligations, and follow-on funding based on commercial traction.

AI development must also focus on enhancing energy efficiency. Data centers already consume 4% of US energy. AI use cannot grow by orders of magnitude without becoming orders of magnitude more efficient

Efficient AI. Industry will make powerful models more efficient. Academia will make efficient models more powerful. Both are needed.

Alternative hardware, GPUs were initially designed for graphics, not AI. We need to rethink computation and data devices from the ground up with, e.g., neuromorphic computing, optical I/O, and quantum computers, as well as ways to take better advantage of ASICs and other low-power devices for training and inference.

New infrastructure is needed to support innovation

1. The computing costs of AI research have grown tremendously, far outstripping grant support. Funding the deployment and operation of AI-ready computational infrastructure at academic research institutions and providing researchers with access to the industrial-scale facilities is crucial for research and for successfully training the future STEM workforce.

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