Artificial Intelligence Research, Development and Regulation

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Artificial Intelligence (AI) is the theory and development of computer systems that are able to perform tasks which normally require human intelligence such as, visual perception, speech recognition, learning, decision-making, and natural language processing.

Increasingly, AI applications significantly impact every aspect of American society, including national security and many areas of commerce. Effective AI public policies and government regulations are needed to promote safety, privacy, intellectual property rights, and cybersecurity, as well as to enable the public to understand the potential impact of AI on society. Insufficient attention to AI as a fast-moving, emerging technology could result in high-profile controversies, critical technological failures, or even loss of life. Such events could create the potential for policymakers to react in ways that unnecessarily stifle entire industries or support regulations that do not effectively protect the public.

To ensure that AI best serves the interests of society, IEEE-USA believes the U.S. Government should adopt AI policies that:

- Develop and make available to government, industry, and academia a workforce of well qualified AI personnel;
- Support the R&D needed to ensure continued U.S. leadership in AI;
- Provide effective regulation of AI to ensure public well-being while fostering a robust AI industry; and
- Facilitate public understanding of the rewards and risks of AI.

IEEE-USA specifically recommends:

1. Defining a path towards increased AI technical expertise within the U.S. Government, and increased government access to private-sector technical expertise. The U.S. Government does not yet have sufficient technical expertise to effectively regulate AI. With current levels of technical expertise, policies and regulations may be established that fail to support innovation, adhere to American principles, and protect public safety. This recommendation concurs with the multiple recommendations of the National Science and Technology Council, One Hundred Year Study of Artificial Intelligence, and

others, that more technical expertise is required to create a public policy, legal, and regulatory environment that allows innovation to flourish while protecting the public.[1,2]

2. Removing impediments to research on the fairness, security, privacy, and social impacts of AI systems. Some interpretations of Federal laws are ambiguous regarding whether and how proprietary AI systems may be reverse engineered and evaluated by academics, journalists, and other researchers. In some cases, the interpretations of Federal laws have made illegal in cyberspace what has long been legal in physical space.[3]

   Elimination of these impediments is essential, because such research is needed if AI systems with physical and other consequences are to be properly vetted and held accountable.

3. Convening an interagency panel to determine how AI technology should be coordinated and regulated at the federal level. The Federal Government must ensure consistent and appropriate policies and regulations for AI. With at least 16 different agencies currently governing sectors of the economy related to AI, uniformity may be difficult to achieve.

   The panel should seek expert input from a range of expert stakeholders, including academic, industry, and government officials, to consider questions related to the governance and safe employment of AI. Specifically, the panel should make recommendations on societal implications, public engagement, appropriate levels of investment, economic and national security impacts, trust and safety assurance, ethical, and other legal and regulatory matters. As a well-respected agency, the National Institute of Standards and Technology would be an effective panel lead.

4. Updating intellectual property rights laws to account for unique characteristics of AI. AI has the capability to both infringe on intellectual property (IP) rights and to generate content in such a way that additional intellectual property rights are necessary. Also, property generated by AI may be "invention" or "work" as defined by the current U.S. patent and copyright laws but may be shorter lived than the time required to process a patent or copyright application. Thus, new short-term technology rights consistent with

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[1] In J. Holdren and M. Smith, "Preparing for the Future of Artificial Intelligence," Executive Office of the President, National Science and Technology Council, 2016. https://www.whitehouse.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf.; and "Artificial Intelligence and Life in 2030," One Hundred Year Study on Artificial Intelligence, 2016. http://ai100.stanford.edu/2016-report

[2] "Artificial Intelligence and Life in 2030," One Hundred Year Study on Artificial Intelligence, 2016. http://ai100.stanford.edu/2016-report

[3] E. T. Kim, "How an old hacking law hampers the fight against online discrimination," The New Yorker, Oct. 1, 2016 http://www.newyorker.com/business/currency/how-an-old-hacking-law-hampers-the-fight-against-online-discrimination

fast-moving AI technology may be needed, while maintaining patent, trademark, and copyright rights used today, possibly by expanding the concept of inventor and author to include devices as well as persons.

5. **Doubling the Federal Government's R&D investment in AI**. Greater federal investment in AI research and development is essential to maintain U.S. competitiveness. Federal investment would stimulate the economy, create high value jobs, and improve governmental services to society. The societal benefits warrant doubling federal R&D investment from $225M to $450M.

   Progress in AI makes it timely to focus R&D investment not only on more capable AI systems, but also on maximizing societal benefits and mitigating any associated risks. Use of AI in computer vision and human-computer interactions will have far-reaching implications. AI-enabled robots will perform difficult and dangerous tasks that require human-like intelligence. Self-driving cars will revolutionize automobile transportation systems and reduce traffic fatalities. AI will improve quality of life through smart cities and decision support in healthcare, social services, criminal justice, and the environment.

   To enable efficient and effective public-sector investment, the National Academies should be commissioned to benchmark the AI state of the art, and identify its most promising future opportunities.

6. **Supporting AI education and retraining opportunities to meet future workforce needs.** The extraordinary growth in AI has created demands for knowledgeable personnel in this field, both in the public and private sectors.[4] Internationally, fierce competition exists for engineering talent with AI expertise, leading to a threat of the loss of AI talent from the US workforce. Addressing workforce needs will help to maintain U.S. technological competitiveness internationally, as well as ensure that the skills acquired by the workforce remain relevant in the future.

7. **Promoting public trust, understanding, and discourse about AI**. Public opinion related to trust, safety, privacy, employment, society, and the economy will drive public policy. AI can both capture the imagination with technology such as self-driving cars, and inspire fear such as that generated in many science fiction entertainment scenarios. Therefore, the public needs to understand the difference between AI technology reality and science fiction if AI applications are to be accepted and trusted as an integral part of modern living.

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[4] "The National Artificial Intelligence Research and Development Strategic Plan," Networking and Information Technology Research and Development (NITRD) Program, 2016 https://www.nitrd.gov/PUBS/national_ai_rd_strategic_plan.pdf

Developing strategies for informing and engaging the public on AI benefits, risks, and challenges will be critical to creating an environment conducive to effective decision making, particularly as more government services come to rely on AI.

This statement was developed by the IEEE-USA Ad Hoc Committee on Artificial Intelligence Policy, and represents the considered judgment of a group of U.S. IEEE members with expertise in the subject field. IEEE-USA advances the public good and promotes the careers and public policy interests of the nearly 200,000 engineering, computing and allied professionals who are U.S. members of the IEEE. The positions taken by IEEE-USA do not necessarily reflect the views of IEEE, or its organizational units.

BACKGROUND

Artificial Intelligence (AI) is the theory and development of computer systems that are able to perform tasks which normally require human intelligence such as, visual perception, speech recognition, learning, decision-making, and natural language processing.

Enhancing AI Workforce Expertise

Among private sector and academic stakeholders there is clear consensus that effectively governing AI and AI-related technologies requires a level of technical expertise that the Federal Government currently does not possess. Numerous public and private organizations have recommended increasing expertise. For example, the National Science and Technology Council recommended that "agency leadership should take steps to recruit the necessary technical talent, or identify it in existing agency staff, and should ensure that there are sufficient technical seats at the table' in regulatory policy discussions."[5] Stanford University's One Hundred Year Study of Artificial Intelligence (AI100) recommended that policy makers "define a path toward accruing technical expertise in AI at all levels of government. Effective governance requires more experts who understand and can analyze the interactions between AI technologies, programmatic objectives, and overall societal values."[6]

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[5] J. Holdren, and M. Smith, "Preparing for the Future of Artificial Intelligence," Executive Office of the President, National Science and Technology Council, 2016. https://www.whitehouse.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf

[6] Stanford University invited leading thinkers from several institutions to begin a 100-year effort to study and anticipate how the effects of artificial intelligence will ripple through every aspect of how people work, live and play. "Artificial Intelligence and Life in 2030," *One Hundred Year Study on Artificial Intelligence*, 2016. http://ai100.stanford.edu/2016-report.

Increased technical expertise is achievable through multiple means, including:

1. Training existing federal employees in AI;
2. Establishing new permanent offices and positions with a specific focus on AI technical expertise (e.g. U.S. Digital Service and ARPA-ED);
3. Recruiting new personnel with relevant technical skills for existing positions that involve AI; and
4. Providing more support for programs that temporarily place technical experts within government (e.g. academic personnel under the Intergovernmental Personnel Act,[7] Presidential Innovation Fellows, and the Science and Technology Policy Fellows program[8]).

To complement the increase of technical expertise within government, agencies and offices governing sectors of the economy related to AI should establish relationships with technical experts outside government. A prominent and successful example of establishing access to technical expertise is the four White House Office of Science and Technology Policy's public workshops on AI.[9] Each workshop focused on a specific theme, and brought together experts from academia, industry, and government, with the goal of laying a foundation for informing future policy decisions.

Concern for the potential stifling of innovation is driving these calls for increased technical expertise within the policy-making process. The A100 Panel states, "Some interpretations of federal laws such as the Computer Fraud and Abuse Act (CFAA) and the anti-circumvention provision of the Digital Millennium Copyright Act are ambiguous regarding whether and how proprietary AI systems may be reverse engineered and evaluated by academics, journalists, and other researchers. Such research is critical, if AI systems with physical and other material consequences are to be properly vetted and held accountable". In other words, interpretations of federal laws have made illegal in cyberspace what has long been legal in physical space.[10]

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[7] Office of Personnel Management, Intergovernmental Personnel Act, https://www.opm.gov/policy-data-oversight/hiring-information/intergovernment-personnel-act/#url=Provisions.

[8] "Science and Technology Policy Fellowships Program," American Association for the Advancement of Science and http://www.aaas.org/program/science-technology-policy-fellowships

[9] J. Holdren, and M. Smith, "Preparing for the Future of Artificial Intelligence," Executive Office of the President, National Science and Technology Council, 2016. https://www.whitehouse.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf

[10] E. T. Kim, "How an old hacking law hampers the fight against online discrimination," *The New Yorker,* Oct. 1, 2016. http://www.newyorker.com/business/currency/how-an-old-hacking-law-hampers-the-fight-against-online-discrimination

The Need for New Laws and Regulations

AI-controlled autonomous systems have capability both to infringe on intellectual property (IP) rights and to generate content in such a way that additional intellectual property rights are necessary. (Common examples of violating rights include illegal copying of software or protected material.) Therefore, law-makers will need to determine how to assign liability in those instances where an AI has learned independently of its creator and used that knowledge in a way that violates other's IP rights.[11] Alternatively, AI may generate intellectual property which could be called "invention" or "creation" as defined in current U.S. patent and copyright laws, but may be shorter lived than the time required to process a patent or copyright application. Thus, US laws must be updated to address various short-term technology rights that are based on fast-moving technology, while also maintaining currently granted IP rights (patent, trademark, and copyrights).

Stakeholders are concerned that policies governing AI will remain a patchwork that stifles innovation. Currently, at least 16 agencies govern sectors of the economy related to AI.[12] Distributing oversight responsibilities across diverse agencies challenges the federal government to ensure consistent and appropriate policies and regulations. Convening academic, industry, and government officials to conduct a formal study of the status quo would help answer questions related to the governance of AI. In attempting to answer similar questions, some researchers have called for a Federal Robotics Commission,[13] while others have provided analyses of governance options for robotics, specifically,[14] or for emerging technologies, generally.[15]

Furthermore, it is important to consider harmonizing policy internationally to reduce barriers to trade. For example, one-time certification of self-driving vehicles will increase access to international markets.

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[11] G. Hallevy, "AI v IP - Criminal Liability for Intellectual Property Offenses of Artificial Intelligence Entities," 2015. http://dx.doi.org/10.2139/ssrn.2691923

[12] "Artificial Intelligence and Life in 2030," One Hundred Year Study on Artificial Intelligence, 2016. http://ai100.stanford.edu/2016-report

[13] R. Calo, "The Case for a Federal Robotics Commission," The Brookings Institution, 2014. https://www.brookings.edu/research/the-case-for-a-federal-robotics-commission/

[14] A. Mannes, "Institutional Options for Robot Governance," in We Robot 2016, Miami, FL, pp. 1–40, 2016. http://robots.law.miami.edu/2016/wp-content/uploads/2015/07/Mannes_RobotGovernanceFinal.pdf

[15] G. E. Marchant, K. W. Abbott, and B. Allenby, *Innovative Governance Models for Emerging Technologies,* 2014.

Research and Development

Accelerating progress in AI technology makes it timely to focus research and development not only on more capable AI systems, but also on maximizing societal benefits. Use of AI in computer vision and human-computer interactions will have tremendous benefits in facilitating many applications.[16] AI will enable robotic and autonomous systems that perform many difficult and dangerous tasks requiring human-like intelligence. Self-driving cars will revolutionize automobile transportation systems, reducing traffic fatalities and energy consumption. Also, the use of AI will enable smart cities, allowing much more effective delivery of government services, improving everyday life for all Americans by facilitating delivery of healthcare, mental health, and social services, and improving criminal justice systems and the environment. According to a recent study, the projected global economic impact associated with the development and adoption of AI over the next 10 years is between $1.49 trillion and $2.95 trillion.[17]

The NITRD National Coordination Office (NCO) directs all federally-funded R&D in robotics and intelligent systems (RIS). RIS R&D focuses on advancing physical and computational agents that complement, expand, or emulate human physical capabilities or intelligence. This includes robotics hardware and software design, application, and practical use; machine perception; intelligent cognition, adaptation, and learning; mobility and manipulation; human-machine interaction; distributed and networked robotics; increasingly autonomous systems; and related applications. FY16 RIS funding was $225M, or 5 percent of the NITRD budget.[18] The planned RIS investment in FY17 is $220.5M, a decrease of $4.5M. Given the potential significant societal benefits from R&D investment in AI, the federal government should greatly increase not decrease AI R&D funding.

While the US remains the innovative leader, we are not alone in AI R&D. Intense international competition for AI supremacy exists. Japan is well known for using Fuzzy Logic AI to control national railways. The robotics industry is more important in Japan than any other country, and employs over 250,000 industrial robotic devices. Established in 1982, the European Coordinating Committee for Artificial Intelligence (ECCAI) coordinates AI R&D in Europe, and promotes AI study, research, and application. In addition to programming AI to operate in conventional digital computers, the EU is also investing heavily in building artificial brains (i.e., neuromorphic computing) to implement AI.[19,20]

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[16] National Research Council, "Developments in Artificial Intelligence, Funding a Revolution: Government Support for Computing Research," National Academy Press, 1999.

[17] "Estimating Projected Global Economic Impacts of Artificial Intelligence," Report of Analysis Group Team led by L. Christensen, 2016.

[18] The Networking and Information Technology Research and Development Program, "FY2017 Supplement to the President's Budget," NITRD National Coordination Office, April 2016.

[19] S.B. Furber, F. Galluppi, and S. Temple, "The SpiNNaker Project," *Proceedings of the IEEE*, 2014.

[20] H. Markram, "The Human Brain Project," *Scientific American*, 306, pp. 50-55, June 2012.

Chinese technology companies such as Baidu, are also investing heavily in AI technology. China wants to be a world leader in AI due to the strategic importance of AI to national security and economic growth.[21] China also has a massive market for AI adoption. MIT Technology Review cited Baidu's AI work in speech recognition for its low error rate. Massive venture capitalist investment in China is sustaining AI R&D in startup companies. For example, 4Paradigm received funding from more than a dozen banking and insurance companies in China, as well as state lenders like the China Merchant Bank, to help companies develop AI software to provide efficient services. China's AI development is not limited to civilian applications. The country is looking to create a new generation of anti-ship cruise missiles using high level AI technology and automation. These smart cruise missiles will enable fire-and-forget mode and in-flight adaptation to changing conditions.

Addressing Safety and Risk

Despite the benefits of AI, the technology also presents many challenging risks and safety issues that could negatively directly or indirectly impact economic prosperity and national security. AI system failures such as the fatal crash of a Tesla vehicle operating in a partially automated driving mode, could set the technology back many years.

The domestic AI market is expected to grow rapidly, reaching up to $70 billion by 2020 according to Merrill Lynch/ Bank of America, and access to foreign markets may depend on harmonizing international safety standards and regulations. Yet, consumer adoption will depend on the public's perception of safety. The US Government must help assure the public and communicate the safety of AI technology, e.g. how safe is 'safe enough' for a self-driving car that takes your children to soccer practice?

Beyond consumer acceptance, societal acceptance also will depend on system safety. Public understanding of AI safety could drive the policy agenda. Achieving transparency, in terms of how a system is designed and what it is used for, remains a challenge and a hurdle to adoption.

AI has powerful implications for national security. Domestically, AI will increasingly be used to control critical infrastructure ranging from the financial sector to the electric grid. Without a clear understanding of the safety challenges and risks, the extent of potential threats and vulnerabilities are unknown. The safety considerations and risks for AI vary considerably across domains, and agencies must establish an understanding of and develop guidance to promote responsible adoption of these technologies that is accepted by the public and

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[21] L. Yuan, "China Gears Up in Artificial-Intelligence Race", Wall Street Journal, 24 August 2016, http://www.wsj.com/article_email/china-gears-up-in-artificial-intelligence-race-1472054254-lMyQjAxMTA2ODI4NTAyNDUxWj

industry. Systems deployed affecting public safety may further be vulnerable to unauthorized access by actors both foreign and domestic having malicious intent.

It is important to note that safety is considered differently in civilian and military domains, and should be addressed separately. The military is keenly aware that AI has the potential to increase its capabilities while reducing U.S. casualties. However, use of AI to support autonomous weapons is controversial. Further to the issue of global safety, AI, especially in combination with robotics, may cause an international arms race, and just as with other powerful weapons, certain international agreements may be necessary to appropriately shape their development and use.

Ensuring Public Acceptance

Perception drives public response. It is imperative for industry, academia, and government to communicate accurately both the positive potential of AI and the areas that require caution. While it may be true that some stories portray inaccuracies about AI, there are legitimate reasons for people to be critical and questioning of the technology. For example, automobiles are evaluated based on performance that includes crash-test ratings. The same expectation should apply to AI-driven vehicles to describe the novel capabilities, but also to explain how the AI vehicle was designed to be robust, transparent, and safe. There are also legitimate reasons to be concerned about American job losses, increased civil liberties violations,[22,23,24] and the uncertain nature of automation's impact.[25]

A societal issue that has been subject to much ongoing debate is ensuring that AI Systems are programmed to prevent misuse and unethical behavior.[26] The programming of AI systems will

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[22] J. Saunders, P. Hunt and J. S. Hollywood, "Predictions put into practice: a quasi-experimental evaluation of Chicago's predictive policing pilot," *J Exp Criminol* 12: 347, 2016. doi:10.1007/s11292-016-9272-0

[23] B. Edelman and M. Luca, "Digital Discrimination: The Case of Airbnb.com." Harvard Business School Working Paper14-054, 2014. http://hbswk.hbs.edu/item/digital-discrimination-the-case-of-airbnb-com

[24] Garvie, C., Bedoya, A., and Frankle, J. "The Perpetual Line-Up: Unregulated Police Face Recognition in America," 2016. https://www.perpetuallineup.org/

[25] M. Chui and J. Manyika,"Automation, Jobs, and the Future of Work," MicKinsey Global Institute, 2014. http://www.mckinsey.com/global-themes/employment-and-growth/automation-jobs-and-the-future-of-work

[26] *Ethically Aligned Design: A Vision for Prioritizing Human Wellbeing with Artificial Intelligence and Autonomous Systems.* IEEE Global Initiative for Ethical Considerations in Artificial Intelligence and Autonomous Systems, 2016.

require a commonly accepted sense of ethical behavior or, at the very least, programming AI to possess behaviors with ethical implications.[27]

To address these and many other societal issues, IEEE-USA believes that that the United States should:

- Encourage development of AI to serve the pressing needs of humanity;

- Conduct media outreach to illustrate the beneficial uses of AI and the important steps being taken to ensure safety and transparency;

- Develop economies that are able to absorb AI systems while providing broad job opportunities to those who might otherwise be alienated or unemployed;

- Promote dialogue and continued debate over the social and ethical implications of AI systems; and,

- Begin an international dialogue to determine the best practices for the use and development of AI systems, and codify this dialogue into international norms and standards.

For additional background with a European perspective, readers can consult the IEEE European Public Policy Initiative's position statement entitled "Artificial Intelligence: Calling on Policy Makers to take a Leading Role in Setting a Long-Term AI Strategy" (http://globalpolicy.ieee.org/wp-content/uploads/2017/10/IEEE17021.pdf), which was developed by IEEE European members as input to the European Union.

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[27] R. Arkin, "Ethics and Autonomous Systems: Perils and Promises [Point of View]." *Proceedings of the IEEE* 104.10, pp. 1779-1781, 2016.
http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7571204