Artificial Intelligence

The Public Policy Opportunity

Intel and Artificial Intelligence

Intel powers the cloud and billions of smart, connected computing devices. Due to the decreasing cost of computing enabled by Moore's Law[1] and the increasing availability of connectivity, these connected devices are now generating millions of terabytes of data every day. Recent breakthroughs in computer and data science give us the ability to timely analyze and derive immense value from that data. As Intel distributes the computing capability of the data center across the entire global network, the impact of artificial intelligence is significantly increasing. Artificial intelligence is creating an opportunity to drive a new wave of economic progress while solving some of the world's most difficult problems. This is the artificial intelligence (AI) opportunity. To allow AI to realize its potential, governments need to create a public policy environment that fosters AI innovation, while also mitigating unintended societal consequences. This document presents Intel's AI public policy recommendations.

What is Artificial Intelligence?

While artificial intelligence is often equated with science fiction, it is not something looming on the horizon. It is already here, all around us, from the commonplace (talk-to-text, web searches, photo tagging, fraud detection) to the cutting edge (precision medicine, injury prediction, autonomous cars). Encompassing compute methods like advanced data analytics, computer vision, natural language processing, semantic graphs, and machine and deep learning, AI is transforming the way businesses operate and how people engage with the world.

The **Collaborative Cancer Cloud**, a partnership between Intel, Oregon Health & Science University, Ontario Institute for Cancer Research and the Dana-Farber Cancer Institute, is enabling institutions to use distributed machine learning to speed up the discovery of new variants and biomarkers associated with cancer progression.

While there isn't a commonly accepted definition for AI, Intel views it as a computerized system that performs tasks we normally associate with people. But in spite of the remarkable advances

---

[1] According to Moore's Law, the number of transistors on a chip roughly doubles every two years. As a result, the scale gets smaller and transistor count increases at a regular pace to provide improvements in integrated circuit functionality and performance while simultaneously decreasing costs.

1

of computing power and sophisticated algorithms, there is still a long way to go before what is called General AI becomes a reality. General AI refers to the ability of a computerized system to portray human-like intelligence across a multitude of tasks.

In contrast, Narrow AI, which addresses a specific task or set of tasks, is commonplace and its use in many sectors of society will only increase. These are the technologies that help scientists gain novel insights into cancer diagnosis and aid in the design of new therapies, help physicians identify risks and predict the onset of diseases, allow interacting with our phones or vehicles' navigation systems through speech recognition, power household cleaning robots, help financial institutions fight against fraud, assist us with driving our cars and make manufacturing safer and more productive. Many other examples exist and the important point is that AI will transform many aspects of our lives.

> Intel is a founding partner of *Hack Harassment*, a cooperative effort with the mission of reducing the prevalence and severity of online harassment. The initiative is evaluating AI technology and is working to develop an intelligent algorithm to detect and deter online harassment.

Before considering the public policy impact of AI, it is crucial to introduce "machine learning," an important technique behind many of the recent advances of AI. Machine Learning is the development and application of algorithms to build and continually improve models from data.

It allows computers to "learn" without being explicitly programmed. It is particularly useful when it is hard for humans to explain their innate ability to infer one thing from another; for example, how to distinguish a cat from a dog? Or how to understand speech? It is also useful when the amount of data is enormous in relation to human reasoning abilities (in examples such as ranking web pages through a search engine). By providing large datasets as input (for example, millions of videos) the computer starts to recognize patterns such as images of cats, without anyone instructing the computer on what a cat looks like. Another example is machine learning's ability to analyze many spam email messages, thereby "learning" to differentiate normal mail from spam.

> The Australian Government has funded an AI solution known as **Nadia**, an online virtual assistant who can speak, write, and chat online to interact with disabled persons. Nadia uses actress Cate Blanchett's voice and is programmed to improve its knowledge while answering thousands of questions asked in many different ways by people with diverse intellectual capabilities.

To take advantage of AI, all stakeholders must engage to understand the technology, debate how it will impact society and address concerns, as well as amplify its benefits and help society adjust.

Public Policy Considerations

The main drivers of public policy towards AI should be solving large societal problems and fostering economic progress. Accordingly, public policy must support industry efforts to bring AI benefits to the economy, to address citizens' concerns, and to identify needs for regulatory intervention.

As AI innovation is just beginning, it is crucial now to shape the public policy environment. Oversight by regulators will be essential for society to *trust* AI. Public policy should lower or remove any barriers standing between AI and its enormous potential to benefit our lives. Industry collaboration through groups like the Partnership on Artificial Intelligence[2] are important to further study the issues and develop specific solutions.

Intel proposes the following AI public policy principles, and offers specific recommendations for government implementation:

- **Foster Innovation and Open Development** – To better understand the impact of AI and explore the broad diversity of AI implementations, public policy should encourage investment in AI R&D. Governments should support the controlled testing of AI systems to help industry, academia, and other stakeholders improve the technology.

- **Create New Human Employment Opportunities and Protect People's Welfare –** AI will change the way people work. Public policy in support of adding skills to the workforce and promoting employment across different sectors should enhance employment opportunities while also protecting people's welfare.

- **Liberate Data Responsibly –** AI is powered by access to data. Machine learning algorithms improve by analyzing more data over time; data access is imperative to achieve more enhanced AI model development and training. Removing barriers to the access of data will help machine learning and deep learning reach their full potential.

- **Rethink Privacy –** Privacy approaches like The Fair Information Practice Principles and Privacy by Design have withstood the test of time and the evolution of new technology. But with innovation, we have had to "rethink" how we apply these models to new technology.

---

[2] https://www.partnershiponai.org/#

- **Require Accountability for Ethical Design and Implementation –** The social implications of computing have grown and will continue to expand as more people have access to implementations of AI. Public policy should work to identify and mitigate discrimination caused by the use of AI and encourage designing in protections against these harms.

Foster Innovation and Open Development

The potential of AI is enormous.[3] AI can enhance human capabilities, automate tedious or dangerous tasks keeping humans in safer conditions, unleash scientific discovery, and alleviate challenging societal problems. Doctors will be able to diagnose conditions earlier and more accurately, leading to quicker treatments and lives saved.[4] Automated vehicles will result in safer driving, and more efficiency and productivity. Farmers will increase crop yield based on real-time insights from weather and soil data, producing higher yields and more stable food supply even in unpredictable climates.

Realizing the potential of AI requires advances in core AI technologies. Governments must play a significant role in promoting those advances. Government investment in AI, public-private collaborations, and measures to incentivize adoption by society are public policy actions that will enable AI to develop and mature.

Equally, governments should gain expertise in AI in order to make effective public policy, to benefit from efficiency gains, and to champion AI adoption. Moreover, a new generation of AI specialists and data scientists should be on the radar of schools and universities when preparing new curricula.

> **Foster Innovation and Open Development – Recommendations**
> - **Fuel AI innovation**: Public policy should promote investment, make available funds for R&D, and address barriers to AI development and adoption.
> - **Address global societal challenges:** AI-powered flagship initiatives should be funded to find solutions to the world's greatest challenges such as curing cancer, ensuring food security, controlling climate change, and achieving inclusive economic growth.

---

[3] The global AI and robotics market is estimated to grow to $153 billion by 2020 (Robot revolution – Global robot and AI primer, Bank of America Merrill Lynch, Dec 2015.)

[4] The market for AI system in healthcare is estimated to grow from $633 million in 2014 to $6 billion in 2021 (From $600 M to $6 billion, AI systems poised for dramatic market expansion in healthcare, Frost & Sullivan, Jan 2016.)

- **Allow for experimentation:** Governments should create the conditions necessary for the controlled testing and experimentation of AI in the real world, such as designating self-driving test sites in cities.
- **Prepare a workforce for AI:** Governments should create incentives for students to pursue courses of study that will allow them to create the next generation of AI.
- **Lead by example:** Governments should lead the way on demonstrating the applications of AI in its interactions with citizens and invest sufficiently in infrastructure to support and deliver AI-based services.
- **Partnering for AI**: Governments should partner with industry, academia, and other stakeholders for the promotion of AI and debate ways to maximize its benefits for the economy.

Create New Employment Opportunities and Protect People's Welfare

Productive work is a fundamental component of individual wellbeing and high functioning societies. In the same way that AI needs to be designed to function properly, so should society be prepared to leverage AI's benefits while mitigating its impact on the workforce. While AI has the potential to improve many aspects of our lives and to spur economic growth, AI and robotics will bring automation to broad categories of jobs (e.g. fully autonomous vehicles will reduce the need for trucking and taxi drivers). Concurrently, new tasks and jobs will be created requiring entirely different sets of skills. Governments need to understand how AI will impact employment and have a plan to encourage employment in ways that allow technology to assist humans in the pursuit of their work.

From more timely, more accurate medical diagnostics to intelligent, safer transportation, AI will affect all facets of the economy, including the public sector. The economic benefits of AI should be inclusive, accessible, and broadly shared by society. Public policies must be enabled to mitigate inequalities, protect citizens' welfare, and help with the transition to a more data-driven economy.

> **Create New Employment Opportunities and Protect People's Welfare – Recommendations**
>
> - **Encouraging Human Employment:** Governments should implement programs to mitigate AI's impact on jobs and devise policies that promote employment. These programs should particularly focus on the effectiveness of incentives in government funded infrastructure projects.
> - **Retraining:** Governments should implement policies that support the up-skilling and the re-skilling of the workforce, particularly in job areas that are less likely to be automated, such as positions focused on person to person interaction and the need for "guided computation" where individuals direct and oversee the operation of the technology.

Liberate Data Responsibly

AI does not exist without data. Machine learning based algorithms are trained with existing data and those data relate to specific usage domains. For instance, if AI is to be used to fight cancer, then deidentified data from medical records, genomic information, state of the art treatments and many other domains should be made available. Of particular interest are solutions that allow for the federated access to data from distributed repositories held in different sites, while preserving privacy and security.

Governments are also solicitors, creators and repositories of data. As long as no personal or sensitive information is involved, many of these datasets should be made available for public use. If personal or sensitive information is a requirement to solve critical societal problems (like making breakthroughs in personalized medicine), governments should partner with the private sector to find solutions to use AI while still delivering privacy protections. One example of such protection is the use of AI algorithms that analyze data in several encrypted yet separate datasets, but never require sharing of the data outside the encrypted area. These mechanisms for "raw data", instead of aggregated inferences, are much more useful for training data analytics necessary for AI. As explained before, AI requires data to function and public sector data is a valuable source of information to develop AI solutions to societal challenges.

> **Liberate Data Responsibly – Recommendations**
>
> - **Keep data moving:** Governments should eliminate unwarranted data localization mandates and enable secure international data transfers through international agreements and legal tools.
> - **Open public data:** While protecting privacy, governments should make useful datasets publicly available when appropriate and provide guidance to startups and small and medium businesses for its reuse.
> - **Support the creation of reliable data sets to test algorithms:** Governments should explore non-regulatory methods to encourage the development of testing data sets.
> - **Federate access to data[5]:** Governments should partner with industry to promote AI tools to access encrypted data for analysis, while not requiring transfer of the data.

Rethink Privacy

Where the data used for AI originates from identifiable individuals, appropriate protections should be implemented to ensure that data is deidentified, lawfully accessed, processed, and kept safe. Robust privacy regulatory frameworks for the protection of personal data and cybersecurity should also apply to AI implementations. Intel is a proponent of technology neutral comprehensive privacy laws based on the Organization for Economic Cooperation and Development's Fair Information Practice Principles (the FIPPs), which are the global common language of privacy.

Intel has long supported and implemented Privacy by Design.[6] Intel has previously demonstrated through our Rethinking Privacy[7] project, that the FIPPs can be implemented during Privacy by Design processes to better protect individuals.

Questions may arise regarding the enforceability of privacy protections when a machine uses data autonomously. In these circumstances, accounting for privacy principles when designing technology will help protect individuals.

"Security Safeguards" is one of the FIPPs and is particularly critical in protecting the trustworthiness of AI implementations. AI can be used to foster both privacy and security by predicting the spread of cybersecurity attacks and helping organizations protect their data and

---

[5] Instead of centralizing data from several institutions, federated access to data allows each institution to keep control of their data while enabling joint data analytics across all institutions.

[6] *Privacy by Design* refers to the philosophy and approach of embedding privacy into the design specifications of various technologies.

[7] http://blogs.intel.com/policy/files/2015/01/RethinkingPrivacy.pdf

AI algorithms/models. A critical component of allowing AI to better protect privacy and security will be the use of cybersecurity data to better predict future attacks. As the compute power of the data center is distributed across the entire network, the potential for AI to stop cyberattacks before they do significant harm will be greatly increased. This is one of many reasons why governments should promote the use and sharing of data for cybersecurity purposes.

> **Rethink Privacy – Recommendations**
>
> - **Adopt Robust Privacy Laws:** Based on the OECD Fair Information Practice Principles.
> - **Implement Privacy by Design:** Follow Intel's Rethinking Privacy approach to implement Privacy by Design into AI product and project development.
> - **Keep data secure:** Policies should help enable cutting-edge AI technology with robust cyber and physical security to mitigate risks of attacks and promote trust from society.
> - **It takes data for AI to protect data:** Governments should adopt policies to reduce barriers to the sharing of data for cybersecurity purposes.

Require Accountability for Ethical Design and Implementation

Trust in AI requires organizations to demonstrate to the public and government regulating bodies that the technology is designed, implemented, and operated responsibly.

The Information Accountability Foundation (IAF [8]) has spent considerable time articulating the essential elements of what is required to demonstrate the responsible handling of information. The IAF's five principles are:

1. Organization commitment to accountability and adoption of internal policies consistent with external criteria.
2. Mechanisms to put privacy policies into effect, including tools, training and education.
3. Systems for internal ongoing oversight and assurance reviews and external verification.
4. Transparency and mechanisms for individual participation.
5. Means for remediation and external enforcement.

With only small adjustments (amending the word "privacy" in the second principle to cover broader categories of automated decision making), this work can and should apply more broadly to AI. Organizations that develop and implement AI solutions will benefit from working through the principles as the resulting policies, processes, and resources put in place will

---

[8] http://informationaccountability.org/

demonstrate responsible behavior to both regulators and individuals who are impacted by AI solutions.

Applying the principles to AI requires new thinking. As an example, transparency may be more difficult for some AI approaches than with traditional data processing. Some algorithms use hundreds of millions of adjustable parameters to function and may be continually updated based upon real-time data. In some cases this makes it impossible to deconstruct how a particular result was produced by the algorithm to accurately trace back a cause. In other words, it may be impossible to understand how a result is achieved, consequently making AI less accountable to the user. However, there is ongoing research to derive rules from deep neural networks, and these algorithms are being used successfully, for example for sensory recognition (like image recognition and natural language speech interfaces) and fraud detection by financial institutions. There are also new approaches to AI such as memory-based reasoning that can better warrant outputs, including reference back to relevant prior episodes of similar persons, places, and things as raw evidence in the explanations to the user. More symbolic approaches to AI also claim transparency in backtracking of inferential logic chains.

Ensuring fairness of AI results depends upon how the algorithms were developed, and in the case of AI-based machine learning, also upon the data that was utilized for their training. Noting that AI algorithms have the potential to make less biased decisions than people, there is still a risk for unintended bias, and therefore unintended discrimination of individuals. This may happen, for example, when the data used to train the algorithm was not representative of the problem space in question. One example of this situation could be when the training datasets were not free from bias themselves. Means to mitigate bias include using algorithms and data models that account for bias, well-curated training sets, extensive verification and validation of AI systems, and alertness to possible ethical or fairness implications from AI-based decisions. Government and the private sector should continue to work together to study and develop solutions to regulate discrimination caused by AI implementations.

Require Accountability for Ethical Design and Implementation – Recommendations

- **Standing for "Accountable Artificial Intelligence":** Governments, industry and academia should apply the Information Accountability Foundation's principles to AI. Organizations implementing AI solutions should be able to demonstrate to regulators that they have the right processes, policies and resources in place to meet those principles.

- **Transparent decisions:** Governments should determine which AI implementations require algorithm explainability to mitigate discrimination and harm to individuals.

SUMMARY OF RECOMMENDATIONS

FOSTER INNOVATION AND OPEN DEVELOPMENT

- **Fuel AI innovation**: Public policy should promote investment, make available funds for R&D, and address barriers to AI development and adoption.
- **Address global societal challenges:** AI-powered flagship initiatives should be funded to find solutions to the world's greatest challenges such as curing cancer, ensuring food security, controlling climate change, and achieving inclusive economic growth.
- **Allow for experimentation:** Governments should create the conditions necessary for the controlled testing and experimentation of AI in the real world, such as designating self-driving test sites in cities.
- **Prepare a workforce for AI:** Governments should create incentives for students to pursue courses of study that will allow them to create the next generation of AI.
- **Lead by example:** Governments should lead the way on demonstrating the applications of AI in its interactions with citizens and invest sufficiently in infrastructure to support and deliver AI-based services.
- **Partnering for AI**: Governments should partner with industry, academia, and other stakeholders for the promotion of AI and debate ways to maximize its benefits for the economy.

CREATE NEW EMPLOYMENT OPPORTUNITIES AND PROTECT PEOPLE'S WELFARE

- **Encouraging Human Employment:** Governments should implement programs to mitigate AI's impact on jobs and devise policies that promote employment. These programs should particularly focus on the effectiveness of incentives in government funded infrastructure projects.
- **Retraining:** Governments should implement policies that support the up-skilling and the re-skilling of the workforce, particularly in job areas that are less likely to be automated, such as positions focused on person to person interaction and the need for "guided computation" where individuals direct and oversee the operation of the technology.

LIBERATE DATA RESPONSIBLY

- **Keep data moving:** Governments should eliminate unwarranted data localization mandates and enable secure international data transfers through international agreements and legal tools.
- **Open public data:** While protecting privacy, governments should make useful datasets publicly available when appropriate and provide guidance to startups and small and medium businesses for its reuse.
- **Support the creation of reliable data sets to test algorithms:** Governments should explore non-regulatory methods to encourage the development of testing data sets.
- **Federate access to data**[9]**:** Governments should partner with industry to promote AI tools to access encrypted data for analysis, while not requiring transfer of the data.

RETHINK PRIVACY

- **Adopt Robust Privacy Laws:** Based on the OECD Fair Information Practice Principles.
- **Implement Privacy by Design:** Follow Intel's Rethinking Privacy approach to implement Privacy by Design into AI product and project development.
- **Keep data secure:** Policies should help enable cutting-edge AI technology with robust cyber and physical security to mitigate risks of attacks and promote trust from society.
- **It takes data for AI to protect data:** Governments should adopt policies to reduce barriers to the sharing of data for cybersecurity purposes.

REQUIRE ACCOUNTABILITY FOR ETHICAL DESIGN AND IMPLEMENTATION

- **Standing for "Accountable Artificial Intelligence":** Governments, industry and academia should apply the Information Accountability Foundation's principles to AI. Organizations implementing AI solutions should be able to demonstrate to regulators that they have the right processes, policies and resources in place to meet those principles.
- **Transparent decisions:** Governments should determine which AI implementations require algorithm explainability to mitigate discrimination and harm to individuals.

---

[9] Instead of centralizing data from several institutions, federated access to data allows each institution to keep control of their data while enabling joint data analytics across all institutions.