DIGITALEUROPE

DIGITALEUROPE's views on the Artificial Intelligence, Machine Learning and Robotics

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1. Introduction

DIGITALEUROPE has witnessed the increase in policymakers' interest in topics related to artificial intelligence (AI), machine learning (ML) and robotics.

We think this interest is timely and justified, as these technologies are already being applied in many sectors of our economies and societies. Healthcare, agriculture, transportation, supply chain, cybersecurity, education and many other sectors are embracing them, with consequential benefits to society – through new services and transformational innovation.

Clearly, the potential of AI/ML and robotics is huge. Nevertheless, we also think it is appropriate to acknowledge the challenges these applications pose with regard to civil rights, privacy, security and jobs. AI/ML and robotics are not new. Although we are at a very early stage of this exciting journey, these data-driven systems and products are already a reality.

Automation has been a factor of transformation throughout history, regarded by many as a driver of societal and economic progress. The same is true for software. Many AI/ML and robotics-based applications are used by a significant proportion of society, and are accepted as part of daily life. Still,there is a trend to look at these technologies with diffidence, not just in Europe but worldwide. AI/ML and robotics are discussed in a very emotional context.

DIGITALEUROPE's objective is to contribute to the discussion in Europe by raising awareness of what such systems can do and where their limitations are. We envisage products and services that will help people lead better and smarter lives, increase consumer choice and ultimately help address the world's bigger and more complex challenges. We believe this can only be achieved through a collaborative process that relies upon open research, the exchange of best practices and stakeholder dialogue.

We believe the discussion in Europe should move towards a more factual, rational and evidence-based approach. Best-practices and concrete examples of how AI/ML and robotics can benefit society and drive innovation are the best tools to help policymakers understand these tools and identify better ways forward.

DIGITALEUROPE welcomes the opportunity to contribute to this goal by sharing our members' direct experience. In this paper, we will highlight the potential of AI/ML and robotics, while shedding light on the industry's approach to some of the challenges.

2. Definitions

Artificial Intelligence

Artificial Intelligence (AI) is often used as a general term to describe different technical concepts. We could describe AI as computer science exploring the possibility of emulating human thinking. This includes different branches, which are often used in parallel to create complex systems. When people talk about AI, though, they are usually talking about Machine Learning.

Machine learning

Machine learning (ML) is about training computers to learn from examples. ML allows computers to find insight from data without being explicitly programmed where to look. This means machines do not need to be pre-programmed to carry out a task in a certain way. They make recommendations as to the best course of action by drawing lessons from the data they were trained on. The iterative aspect of machine learning is important because it allows models to adapt as they are exposed to new data. This goes beyond e.g. data mining which is about identifying patterns in a set of data, but without the ambition to be able to predict behaviours in new situations. ML is not a new science, the mathematics having been there for decades. It is now gaining fresh momentum because enough computing power is available to make it work both in terms of the power of machines and of networks.

Robotics

Robotics is the science of making machines that move. There are many definition of what constitutes a "robot". While ISO 8373:2012 defines it as an "actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks", future robots will definitely go beyond this. Robotics technologies, combined with AI and Machine Learning will revolutionize automation. Today, robots are often classified as industrial or service robots, depending on their application. Future "smart machines" actively doing work will assume very different roles and appearances in many application domains.

3. Examples of AI/ML and robotics uses

a. Agriculture and food

Automatic product sorting: The son of two Japanese farmers used machine learning to build a system allowing them to sort the different kinds of cucumbers automatically. This relieved his mother from the task of sorting them manually and allowed to allocate time to more important activities.

Monitoring in dairy industry: Dutch company Connecterra uses sensors and ML to provide a health monitoring service for the dairy industry. A wearable device monitors the herd and transmits the data to a cloud platform for analysis and prediction of behavioural patterns. This allows farmers to free up labour time, improve milk production and save money.

Product safety montoring: Japanese food safety company Kewpie built a system to help workers identify defective food products. An AI-powered video feed alerts the worker when a defect is found, so it can be removed.

Plant and field real-time monitoring: The IoT platform can integrate drone imagery and sensor data from soil and environment sensors. The insights generated from that data can help farmers make better decisions and therefore drive high performance.

Precision Crop Management Testbed developed by SkataSeed and an IT company can monitor the plant environment 24/7 in real-time, analyzing drone aerial imagery and sensor data from soil and environment, getting information such as plant health, soil moisture, CO2, sunlight, rainfall, air, humidity and more. It helps farmers to improve crop productivity and operational efficiency by taking strategic actions guided by these insights.

b. Cybersecurity

Every year there are about the 75,000+ documented software vulnerabilities, 10,000+ security research papers published and 60,000+ security blogs published each month. AI is making it possible now to quickly interpret this data — created by humans for humans — and integrate it with structured data from countless sources and locations. This means that action can be taken within minutes that would previously have taken a human analyst hours or days. Cognitive security offered for example by IBM Watson for Security uses intelligent technologies like machine learning and natural language processing to mimic the way the human brain functions. It gets stronger over time, learning with each interaction and getting better at proactively stopping threats.

c. Energy

Gas turbines: Siemens is improving the operation of gas turbines. The system learns from operating conditions and other data and can thus significantly reduce the emissions of toxic nitrogen oxides - without sacrificing the performance of the turbine or shortening its service life.

Wind turbines: AI is also applied to optimize the operation of wind turbines, which adjust the position of the rotors autonomously to the changing wind, so that the yield of a wind park increases.

Data centers: Applying DeepMind's machine learning to Google data centres, machine learning system was able to consistently achieve a 40 percent reduction in the amount of energy used for cooling, which equates to a 15 percent reduction in overall PUE overhead after accounting for electrical losses and other non-cooling inefficiencies.

Oil and Gas: Critical business operations in the oil and gas industry, can't afford to shut down when a network connection is lost, They often can't afford the extra time it takes to send data to the cloud and back. Remote operations — such as an oil platform in the middle of the North Sea or in the Gulf of Mexico or a mine deep underground — can now evaluate their remote sites for hazards, triggering action based on safe operating directives at the edge.

Weather conditions monitoring: External conditions such as weather can be monitored, triggering mitigation plans. And asset performance can be evaluated at the point of monitoring, driving corrective action and reducing wasted work.Companies managing fleets of assets, whether trucks, tankers or oil rigs, will now be able to monitor geographically dispersed assets by choosing precisely what data is best analyzed at the edge and what should be transmitted centrally. IBM and Cisco have taken a very important first step on the path toward helping businesses across the energy industry harness the value of IoT, at the edge, in the cloud or wherever their needs demand.

d. Environment

A university research team teamed up with computer scientists to track the population of sea cows. Using the open source platform Tensor Flow, they built a detector that could learn to find sea cows in photos of the sea surface instead of doing it manually. Tracking threatened animal populations on a large scale can help conservationists identify needs in terms of protecting their habitats.

e. Healthcare

Evidenced-based, patient-centric treatment options: The amount of research and data available to help inform cancer treatments is growing exponentially. Yet the time care teams have to consume this information—locating insights specific to each patient's unique needs to potentially improve treatment outcomes—is more limited than ever. IBM's Watson for Oncology helps physicians quickly identify key information in a patient's medical record, surface relevant articles and explore treatment options to reduce unwanted variation of care and give time back to their patients.

Diabetic retinopathy is one of the fastest growing causes of blindness globally. It's preventable, but developing countries don't have enough ophthalmologists to provide screening and diagnostics. Machine learning can be used to scan pictures of patients' retinas, and flag those that present signs of the illness - and therefore should be examined by a doctor. This ensures people who need treatment seek it, and allows doctors to use resources more efficiently.

Nuritas uses AI to identify and extract from food and co-products of food production components that have a therapeutic potential.

Epimed: By better aggregating data and making use of predictive analytics through Azure Machine Learning, Epimed is helping clinicians define the best care pathways for each patient. In one health system this has resulted in a 21% reduction in Hospital Acquired Infections in the Intensive Care Unit (ICU) and a drop in ICU mortality rates

Medicine dose recognition: Dutch hardware startup Mint Solutions developed a scanning technology that recognizes medicines and allows to reduce errors in dosage or kind of tablets given to patients. This is combined with an analysis of the hospital's workflow and IT infrastructure to improve care and reduce error.

f. Mobility, transportation and automotive

Recall Masters used ML to help dealers recall defective cars from owners. Dealerships are in charge of recalls, but identifying the right car and its current owner is sometimes impossible. Recall Masters provides them with software that - by analysing transactions and other data - identifies the right car and get in touch with its owner.

Configuring interlocking systems for new train stations: this is complex because so many different possibilities exist. Our system automatically creates an architecture for the hardware and software that verifiably complies with all safety conditions.

Self-driving cars: AI is also a prerequisite for self-driving cars. A number of external key technologies are required for the development and use of AI and autonomous systems that will play a fundamental part in enabling their successful implementation: network infrastructure with minimum latency and high speed connectivity corresponding to 5G, cloud/edge computing for the distributed processing of complex calculations, simulation, certification and testing environments for autonomous systems, Big data analytics. Current human-machine interaction research in the area of communication and collaboration as well as systems engineering is equally important.

g. Online services

'Personal assistant' services rely on ML for speech recognition and providing responses to users' questions and instructions. A future form of AI assistant, such as Samsung's Bixby, will be smarter with more intuitive user interface and context awareness.

Email providers and browsers can rely on ML to protect users from spam and malware. Gmail now blocks over 99.9% of spam, including spam that was never seen before - and that the algorithms is still able to identify.

Translation and speech recognition tools are powered by ML. This includes automatic captioning that makes content accessible to all users.

Services providing ranking of results and recommendations use ML to find the information that is most relevant information for their users and present it in the most useful way. ML is also a key ingredient for image recognition applications.

Collaborative platforms and tools such as Microsoft Cognitive Services, IBM Watson and BlueMix application development platform, the Bot Framework, and Azure Machine Learning, enables that AI capabilities are becoming available to every developer in the world and encouraging its use to create new digital ecosystems that can lead to new jobs. This helps to address concerns about the power of AI being concentrated in the power of a few large U.S. companies. We should consider special projects and hackathons where the focus is on the use of AI to address existing challenges in local communities.

Digital platforms such as LinkedIn, TaskRabbit, and Amazon's Mechanical Turk provide access to a wide range of opportunities with varying skills. Over time, this data can be used to construct analyses such as the LinkedIn Economic Graph to provide transparency into the supply of skills and demands and how they vary over time for a given region, especially if they can be combined with other data held by governments on local demographics and businesses.

4. Policy challenges

a. Labour Markets and Productivity

AI/ML and robotics have the potential to on the one hand improve many aspects of our professional and personal lives and on the other contribute to the continued growth of our economy. According to Accenture, AI/ML has the potential to double annual economic growth rates of developed economies by 2035[1].

AI/ML and robotics are very likely to shift demand on the labour market to other types of skills. This does not mean entire jobs will be wiped out of the market. In the past, such as with Automated Teller Machines, automation actually increased demand for human labour by dropping the costs for services. In the ATM-case the number of tellers needed in one branch decreased, but since ATMs made operating a branch cheaper the number of tellers employed overall actually grew.

Technology can also contribute to a more efficient labour market at a time where European countries are experiencing falling productivity, an aging workforce, and increased global competition. Location, language or other obstacles might cease to be a barrier for workers.

There is no sense in denying that STEM-related skills will be much sought after. Still, the advent of AI/ML and robotics will not make non-technical professions redundant. Human specialists will remain necessary to work alongside and even guide machines.

We have seen significant developments in human/machine collaborative technology and its use in the workplace over the last 10 years. Technological advancement will see associates working in close collaboration with machines to improve the customer's experience, increase productivity, and enhance safety. Innovation and new technologies continue to move apace and it is imperative that any measures reflect all types of collaborative operations.

Industries will continue hiring people to work with automation which is aimed at assisting them to deliver on speed, reliability, cost and convenience. If we look to the future, one apt comparison is the automotive industry. In the 1980s robots were introduced and changed the automotive production line, however, thousands and thousands of people worldwide are still employed within the automotive industry to produce cars

Furthermore, to come up with useful AI/ML or robotics applications, a good understanding of how AI works and domain expertise is critical. Knowledge of a sector and a good sense of the problems to be solved are just as important as engineering skills. here is significant opportunity for growth in developing the interface between machines and humans.

1 https://www.accenture.com/lv-en/_acnmedia/PDF-33/Accenture-Why-AI-is-the-Future-of-Growth.pdf

The future of work will be about AI/ML human collaboration, rather than outright replacement. The idea is to use robotics to empower people and enable them to be more productive. Jobs will be shared, with some tasks delegated to AI and monitored by humans. According to McKinsey[2], very few occupations—less than 5 percent—are candidates for full automation. However, almost every occupation has partial automation potential, as a proportion of its activities could be automated- the repititive tasks- enabling employees to focus on strategic tasks and priorities. On top, new labor roles may emerge where experts will be needed to design, operate, and manage intelligent systems.

There is however no doubt these technologies will be disruptive. To mitigate the risks, we think technology must be deployed in a thoughtful way. And in this not only industry, but also governments must play their parts.

To an increasing extent the European Union and its Member States should start putting forward policies that leave all stakeholders involved (employees, employers, …) greater flexibility to adapt to the ever faster evolution of the labour market and shift their attention to safeguarding fundamental principles. Such policies will be characterised by:

- a high involvement of industry on supporting existing best-practices and joint initiatives
- promote STEM education and digital skills training and commit to computer science (encourage girls to participate in STEM classes; certification programs for computer science teachers)
- encourage innovative uses of AI – for creation of new jobs through growth of the digital ecosystem, encourage use of AI in addressing workforce and economic development issues.
- promote education and literacy on AI/ML and robotics among the workforce and people without technical education
- a far more prominent place / increased attention for fostering cultures of empowerment, responsibility and permanent education of people to enable them to bounce back and adapt more easily
- open debate in a forward looking spirit about what policy options will help society take full advantage of the potential opportunities presented by AI/ML and robotics
- prepare for the consequences of technological development, by identifying and setting up new models for enabling social safety nets instead of regulating technology for fear of risk
- modernize tax and labour laws to consider task workers and understand better the needs of task workers

b. Liability

A common question is whether we need to change the EU liability framework to cover AI/ML and robotics. We see no need to create new rules for each new technology, algorithm or mathematical formula. When it comes to individual risks, these should be subject to the same norms, rules and ethical frameworks that exist in the domains where they are applied. Existing insurance schemes and liability rules are absolutely fit for this purpose.

2 https://www.researchgate.net/publication/287200513_Mastering_the_Robot_The_Future_of_Work_in_the_Second_Machine_Age

Liability is a more complex subject when we look at systemic risk and broader societal impact. Products or services might work as intended and not cause direct harm, but could have unintended consequences on other factors. How to address that unintended damage is a difficult question. Institutions, regulators and courts must find an appropriate balance between several sometimes-competing goals. The ideal solution must be one that: protects consumers; ensures businesses have an incentive to design and provide safe technologies and products; provides flexibility for businesses to innovate; and does not create unnecessary impediments that slow innovation.

Technological change is often met with a regulatory or legislative response. We believe it is more efficient to look for solutions which are based on a broad societal discussion. Governments and EU institutions should act as a convenor of the different stakeholders interested by the transformation. They should strive to gather information from different perspectives and agree on a truly collective solution. This must be an ongoing process. AI/ML is in its very early stages, and the current state of the art is likely to evolve in the future. As our understanding of the mathematical models increase, we will become better at assessing the impact of these technologies when it comes to liability.

We think an observatory could be helpful in this case, but only if it was true to its name - a place to closely follow developments in technology to identify where a societal choice is needed.

c. Responsible technology development

As with any technology, it is important to maximize the positives and minimize concrete harms. The rapid advance of these technologies raised concerns over safety and fairness. Technological development has been fast but it is not an uncontrollable force. We have the ability and the responsibility to shape the way these tools are applied, in order to maximize the benefits of this technology for everyone. Still, no system is perfect, and errors will emerge. We must be ready to identify and correct them.

With growing penetration of machines into our lives, ethical questions will emerge in growing numbers and significance. With a constantly evolving society , the ethical challenges we are confronted with will also continue to change. In that light it is obvious that human judgment must and will remain a key component of AI/ML and robotics applications.

The ethical principles to be applied by these technologies in the future will, to a large extent, be determined by the people researching and developing them today. With a view on reducing bias and embedding the principles of pluralist societies and human values in these technologies we should on the one hand e.g. encourage people from a variety of backgrounds to develop an interest in computer sciences. On the other hand, advances in technical capabilities e.g. will strengthen the ability to meet the increasingly complex challenge. Rigorous engineering research can provide the developers of these technologies with approaches and tools they can use to tackle these problems.

In summary, realizing the full potential of AI/ML and robotics, we believe, will require collaboration between industry, governments, civil society and the research community to shape a future in which people from a variety of backgrounds and from multiple disciplines work together.

CASE STUDIES

Future of Life Institute

The FLI catalyzes and support research and initiatives for safeguarding life and developing optimistic visions of the future, including positive ways for humanity to steer its own course considering new technologies and challenges. In 2015 FLI published an open letter on AI setting out the an approach to avoid discrimination / research priorities https://futureoflife.org/ai-open-letter/.

The Leverhulme Centre for the Future of Intelligence

The Centre spans institutions, as well as disciplines. It is a collaboration led by the University of Cambridge with links to the Oxford Martin School at the University of Oxford, Imperial College London, and the University of California, Berkeley. It is supported by Cambridge's Centre for Research in the Arts, Social Sciences and Humanities (CRASSH). As Professor Price put it, "a proposal this ambitious, combining some of the best minds across four universities and many disciplines, could not have been achieved without CRASSH's vision and expertise."

Partnership on AI

In September 2016, Amazon, DeepMind/Google, Facebook, IBM, Apple and Microsoft formed the Partnership on AI. Its mission is to "study and formulate best practices on AI technologies, to advance the public's understanding of AI, and to serve as an open platform for discussion and engagement." The majority of votes in the board goes to research institutions and other non-private groups, to limit the influence of private interests. While the corporate members are currently mostly US companies, most of the researchers and scientists representing them are European.

B20 recommendations on artificial intelligence

A multi-stakeholder process ahead of the G20 resulted in a policy paper on digitisation addressing AI. It includes a series of recommendations to embrace the technology, including an OECD multi-stakeholder initiative and "adjusting regulations to facilitate the use of emerging technologies, such as big data, and foster related investment and innovation".

d. Transparency and trust

Industry and policy-makers share the same objective - ensure users are comfortable with and understand the way technology works. The choices of how best to attain this objective should hinge on the specifics of each use case depending also on the underlying technologies. A one-size-fits-all transparency obligation doesn't seem to be a feasible option. The fast-paced development of these technologies requires a flexible approach, allowing the industry to respond to evolving consumers' needs.

AI/ML and robotics applications are data-heavy. This naturally raises concerns about the potential implication of privacy rules. To the extent that personal data are collected and processed and individuals' privacy is impacted in AI and robotics applications, the recently updated EU data protection framework with the adoption of the GDPR applies. This framework is technologically neutral and was reviewed precisely with the aim to cover technology advancement. In particular, the GDPR provisions on automated individual decision-making will be relevant in certain AI/ML and robotics environment as well as the provisions that relate to transparency and the right to information.

To reap the societal benefits of AI systems, we as members of society first need to trust them. The right level of trust will be earned through repeated experience, in the same way we learn to trust that an ATM will register a deposit, or that a road vehicle will stop when the brake is applied. Put simply, we trust things that behave as we expect them to.

Trust is built upon accountability. We must ensure visibility into how automated decisions are taken to mitigate risks of bias, discriminations and harm. Public institutions and the private sector share the common objective of making information available in a user-friendly and user-understandable way. But simply providing the information is not always the best solution. In the case of AI/ML and robotics, it seems unlikely people would extract any meaning from technical descriptions of complex mathematical models. We believe accountability will be best achieved by making systems interpretable and auditable. Users should be able to interpret the outcomes of an AI-based process and evaluate how such outcomes were reached. Focusing on the outcome and not on the mechanics of the process seems to be the most appropriate way to ensure technology is safe, ethical and fair.

One of the primary reasons for including algorithmic accountability in any AI system is to manage the potential for bias in the decision-making process. This is an important and valid concern among those familiar with AI. Bias can be introduced both in the data sets that are used to train an AI system, and by the algorithms that process that data. Biases of AI systems can not only be managed, but also that AI systems themselves can help eliminate many of the biases that already exist in human decision-making models today.

AI systems should function according to values that are aligned to those of humans, so that they are accepted by our societies and by the environment in which they are intended to function. This is essential not just in autonomous systems, but also in systems based on human-machine collaboration, since value misalignment could preclude or impede effective teamwork. It is not yet clear what values machines should use, and how to embed these values into them. Several ethical theories, defined for humans, are being considered (deontic, consequentialist, virtue, etc.) as well as the implications of their use within a machine, in order to find the best way to define and adapt values from humans to machines.

In industries like healthcare and finance, the relevant professional ethical principles are explicitly encoded and practiced by professionals in the field already. In AI systems designed to help professionals in these domains, these best practices and principles could form the core of the ethics module for such systems. Ethics modules, however, should be constantly adapted to reflect humans' best practices in their everyday profession.

The use of algorithms in decision-making should be grounded in a core set of principles to ensure that technology is built with intelligence that is transparent and secure, and that sets the highest bar for privacy protections, while also being inclusive and respectful of all.

CASE STUDIES

European and global iniatives on Ethics and Machine Learning applied to identify and correct bias

AI systems can help eliminate many of the biases that already exist in human decision-making models today. Companies are working with civil society groups and others to identify the risks and steps to be taken to mitigate them. There is also potential to use these systems to help mitigate bias: for instance, the Geena Davis Institute created a machine learning tool with Google to easily measure gender representation in movies.

At the global Neural Information Processing Systems (NIPS) conference in Barcelona last year, a research team laid out an approach for avoiding bias in algorthims.

Privacy and transparency instruments

Google offers a number of tools to webmasters and users to have visibility on how the services they use work. For example, the How Search Works page and Webmasters Guidelines shed light on the inner workings of search. Made public are guidelines for its search quality evaluators - real people who assess the quality of search results. Users have full visibility and control on how their information is used in different applications through My Account.

Digital Ethics Lab/ European Ethical Code for Data Donation

Convening the relevant stakeholders to tackle issues such as "The Ethics of Medical Data & Advanced Analytics" is essential if we are to unlock the vast potential of data, which is fast becoming a most valuable resource. Within the Oxford Internet Institute at the University of Oxford newly established Digital Ethics Lab, there is an opportunity to collaborate on new projects such as the one supported by Microsoft on developing a European ethical code for data donation and encouraging data philanthropy. The goal is to explore ways in which citizen participation in research efforts may be supported via 'data donations', and to shape best practice with regards to respecting individuals' rights as well as ensuring proper regulatory oversight of existing and future data exchange partnerships between governments and tech companies.

The IEEE Global Initiative for Ethical Considerations in Artificial Intelligence and Autonomous Systems

The mission of this initiative is "To ensure every technologist is educated, trained, and empowered to prioritize ethical considerations in the design and development of autonomous and intelligent systems." The first deliverable of this effort - *Ethically Aligned Design* - gathers the collective input of over one hundred global thought leaders in the fields of AI, law and ethics, philosophy, and policy from the realms of academia, science, and the government and corporate sectors. It identifies issues and candidate Recommendations in fields comprising AI and Autonomous Systems.

5. What can policy-makers do?

- *Facilitate fact based stakeholder dialogue*

Policies should be grounded on current state of the art and research within a foreseeable timescale. DIGITALEUROPE is ready to identify and provide any necessary input.

- *Ensure flexibility and protect innovation*

Many exciting new AI based approaches and technologies are still nascent. We encourage a cautious and flexible policy approach that will allow innovative uses to flourish and reach their full potential. We believe consensus-driven and self-regulatory processes are the best way forward and should be encouraged.

- *Create channels for multi-stakeholder dialogue*

It is of the utmost importance to ensure a continuous exchange among a broad range of stakeholders, including the privacy and public sectors, the academic community, NGOs and civil society. This effort should not be confined within national borders - an EU wide and international approach is needed, as these are truly global technologies. This may also include discussion about standards and certification, including possible gap analysis, when appropriate and provided the industry is involved in the discussion from the outset.

- *Promote data-driven innovation and free data flows*

These technologies rely on data to be useful and deliver progressively better results. The EU and Member States should create an environment that is conducive to free flow of data in all sectors of society and the economy. Public institutions should encourage the creation and sharing of high-quality data sets.

- *Support research and academic institutions*

Public institutions should be a driving force in promoting research into the novel application of these technologies, to ensure they meet social challenges and address potential limits and shortfalls. Supporting international exchange should constitute a big part of this effort. In order to secure the technological edge, achieve long-term technology leadership, provide decent working conditions and rapidly leverage competitive advantages, innovation labs/hubs for AI and autonomous systems should be established to support projects geared towards implementation and technology migration to the industrial environment.

- *Build a bigger and more diverse tech community*

Governments should encourage access to STEM education and careers. They should take diversity very seriously, to ensure AI/ML and robotics are developed in an unbiased and inclusive way:

- Government agencies, associations and industrial enterprises should also be encouraged to make anonymised big data available for training of machine learning systems.
- Fund research into automated action planning in autonomous systems with focus on the robustness of current AI methods in real-life scenarios
- Supported development of standardized interfaces and reference architecture models, together with comprehensive, reliable and certified knowledge bases.

- *Identify the challenges for employment, training and professional development policy*

Evaluate public policy approaches to mitigate any impact on jobs and to promote the inclusion of all citizens in reaping the benefits of AI. Identify the required skill sets and develop roadmaps for attaining the necessary skills based on industrial use cases.

ANNEX – List of relevant articles and reports

1. McKinsey Global Institute study on Automation and its impact on the economy (Jan 2017)
2. Lisbon Council discussion paper - AI/Machine Learning: Opportunities + Challenges (Nov 2016)
3. ITI - "ITI Decodes: Artificial Intelligence" (Oct 2016)
4. Center for Data Innovation - "The Promise of Artificial Intelligence" (Oct 2016)
5. MIT Tech Review - "Are the Experts Worried about the Existential Risk of Artifical Intelligence?" (Sept 2016)
6. Forbes - "Artificial Intelligence Is Helping Doctors Find Breast Cancer Risk 30 Times Faster" (Aug 2016)
7. New Yorker - "The Hype - and Hope - of Artificial Intelligence" (August 2016)
8. Wall Street Journal - "The Robots are Coming. Welcome Them" (August 2016)
9. Morning Consult - "Skynet Is Not Coming: The Myths and Realities of Artificial Intelligence" (August 2016)
10. Center for Data Innovation - "Artificial Intelligence Is Key To Using Data For Social Good" (July 2016)
11. ITIF - "It's Going To Kill Us! - And Other Myths About the Future of AI" (June 2016)
12. OECD - The Risk of Automation for Jobs in OECD Countries (May 2016)
13. Analysis Group - "The Global Economic Impacts Associated with Artificial Intelligence" (Feb 2016)
14. Netherland's Scientific Council for Government Policy - Mastering the Robot; The Future of Work in the Second Machine Age (Dec 2015)
15. Another great resource to point to is mapping of European AI startups, coming from An extensive list of European AI tech startups to watch in 2017
16. PWC analysis on the UK (labor) market http://www.pwc.co.uk/services/economics-policy/insights/uk-economic-outlook.html
17. Report on ML from The Royal Society
18. IoE, Understanding the Future of Work (March 2017)
19. http://www.juridicum.su.se/user/masc/analyzethis.pdf
20. Accenture: Why Artificial Intelligence is the Future of Growth

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ABOUT DIGITALEUROPE

DIGITALEUROPE represents the digital technology industry in Europe. Our members include some of the world's largest IT, telecoms and consumer electronics companies and national associations from every part of Europe. DIGITALEUROPE wants European businesses and citizens to benefit fully from digital technologies and for Europe to grow, attract and sustain the world's best digital technology companies.

DIGITALEUROPE ensures industry participation in the development and implementation of EU policies. DIGITALEUROPE's members include 61 corporate members and 37 national trade associations from across Europe. Our website provides further information on our recent news and activities: http://www.digitaleurope.org

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National Trade Associations

Austria: IOÖ
Belarus: INFOPARK
Belgium: AGORIA
Bulgaria: BAIT
Cyprus: CITEA
Denmark: DI Digital, IT-BRANCHEN
Estonia: ITL
Finland: TIF
France: AFNUM, Force Numérique, Tech in France
Germany: BITKOM, ZVEI
Greece: SEPE
Hungary: IVSZ
Ireland: TECHNOLOGY IRELAND
Italy: ANITEC
Lithuania: INFOBALT
Netherlands: Nederland ICT, FIAR
Poland: KIGEIT, PIIT, ZIPSEE
Portugal: AGEFE
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Spain: AMETIC
Sweden: Foreningen Teknikföretagen i Sverige, IT&Telekomföretagen
Switzerland: SWICO
Turkey: Digital Turkey Platform, ECID
Ukraine: IT UKRAINE
United Kingdom: techUK