The Digital World towards 2040

The rise of AI & Intelligent Autonomy

What does it mean for Europe?

European Internet Forum
Political Leadership for Digital Society

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Foreword

Benjamin Franklin famously said “in this world nothing can be said to be certain, except death and taxes.” Today, we can add AI’s transformation of our lives to that shortlist. This EIF report explores the impending transformation and what it means for Europe.

On the cusp of the new European Parliament mandate in 2014, the European Internet Forum (EIF) published “The Digital World in 2030” report. The ‘knowing society’ was the central concept, a society where the ability to collect, analyse and interpret massive amounts of data in real time becomes a source of economic, social and political power.

Ten years on, EIF, as an independent, politically-led, non-partisan multi-stakeholder platform continues to contribute to the greater understanding of the digital world. Ahead of the 2024 European elections, our new report looks forward to 2040. It finds us in a very different place. The global lockdown and the arrival of widely accessible generative AI means that technology plays a bigger role in our lives than most would have envisaged and therefore our responsibility as policymakers is even greater. And while none of us can foresee the future, we know for sure that we are on the edge of a future shaped profoundly by AI's evolution.

This report seeks not to predict but to provoke thought. It offers a panoramic view of AI's potential impact on our world through the lenses of technology, economy and society. We aim for it to provide a basis for strategic thinking about Europe's global position.

The report’s author, Ajit Jaokar has engaged with keen thinkers about what AI would mean for Europe. Their insights have given fresh perspectives, all showing that AI will be a red thread through many new European policies over the next five years. We invite you to dive into these pages, reflect on these insights and consider joining EIF as we continue these discussions.

Pilar del Castillo

Pilar del Castillo MEP
EIF Steering Committee Chair

#DW2040

Executive Summary

Background

"Future shock is the shattering stress and disorientation that we induce in individuals by subjecting them to too much change in too short a time." Alvin Toffler in Future Shock - 1970

Alvin Toffler said these words more than 50 years ago. Today, at the dawn of AI, we are on the edge of a vast unknown horizon. Each of us, be they policymakers, companies, or individuals, must draw upon our personal ability and unique talents to adapt and recreate ourselves. The "Digital World Towards 2040" report presents a concise, pragmatic and optimistic perspective of this world. The report comprises three main sections: technology, society and economy. In the following two sections, we discuss the impact on Europe and the challenges policymakers are facing.

The widespread adoption of generative AI presents both opportunities and challenges for legislators. The rate of technology adoption will only increase in the age of AI. The issues at hand are well-known: fostering innovation, securing employment, and overhauling education, among others. What has shifted, however, is the magnitude, speed of change, and concurrent impact across various domains.

In this report, we see generative AI as one of the founding technologies on the road to Artificial General Intelligence (AGI). AGI is a type of artificial intelligence that can understand, learn, and apply knowledge across a wide range of tasks, just like a human. ChatGPT reached a million users in just five days. Similar to electricity and the internet, generative AI is a foundational technology with the potential to transform industries, economies, and societies. Such foundational technologies quickly become embedded in daily life, spurring economic growth and facilitating new technologies and services.

The biggest disruptor for Europe since the Second World War

What is the impact of AI on Europe? In a nutshell, because of its widespread impact, AI could be the biggest disruptor for Europe post-Second World War. Why? Because in whichever form it manifests, the adoption of AI has the potential to change the social contract. A social contract proposes that individuals have consented, either explicitly or implicitly, to surrender some of their freedoms and submit to the authority of the government in exchange for the protection of their remaining rights and the maintenance of social order. The idea of formulating a new social contract in the age of AI may be the top priority of policymakers worldwide.

Imagining a world dominated by AGI

We propose 'Intelligent autonomy' as the central paradigm where machines acquire enough intelligence to collaborate semi-autonomously with humans under some human agency and oversight. We break down the idea of intelligent autonomy into the following areas: Artificial Intelligence, specifically Artificial General Intelligence; Autonomous collaboration between humans and AI; Economic and Social Impact of intelligent autonomy; Impact on the European Union; and Broader impact on the ecosystem, for example, sustainability.

We propose three markers on the road to AGI: The ability of AI to understand Natural language, the ability of AI to reason, and the widespread availability of bipedal autonomous robots. The report emphasizes skills, education, geopolitical considerations, and the ability of AI to solve large-scale systemic problems like sustainability and climate change. The report encourages investment in AI, especially skills, compute, education, and innovation, from the standpoint of the benefits to fundamental science and technology.

The Impact of AI on the acceleration of fundamental research

The report was created in the backdrop of the EU AI Act - the world's first regulation. At the time of writing, a consensus has been reached, paving the way for the deployment of the AI Act, benefiting the community, industry, and innovation. But the AI Act is just the beginning on the long road ahead. The impact of AI on the acceleration of science and technology will be the real goal for countries and policy makers. AI will impact almost all areas of fundamental research acting as a catalyst to whole new industries due to its ability for large scale pattern management. These include Climate Science (climate modeling); Healthcare and Biomedical Research (genomics, personalized medicine); Quantum Computing and Physics (simulations) and Materials Science (Battery technology).

This will require to nurture the development of foundational AI models through investment in skills, hardware, datasets and a policy framework that encourages skills, innovation and start-ups.

Background

Education

- The implementation of AGI Awareness in the curriculum, including digital literacy, AI-assisted learning, AI-assisted work scenarios, ethics, and policy;
- Teacher training and support programs creation;
- Industry partnership for certifications and curriculum.

Skills

- Lifelong learning initiatives that encourage continuous skill development, with a focus on skills complementary to AGI, such as creativity, problem-solving, and emotional intelligence;
- Investment in upskilling and reskilling programs aimed at workers in sectors most likely affected by AGI;
- The fostering of an AGI-ready workforce by aligning vocational training and higher education with emerging tech trends and market needs, emphasizing interdisciplinary skills and AGI literacy

Creation of Foundation Models

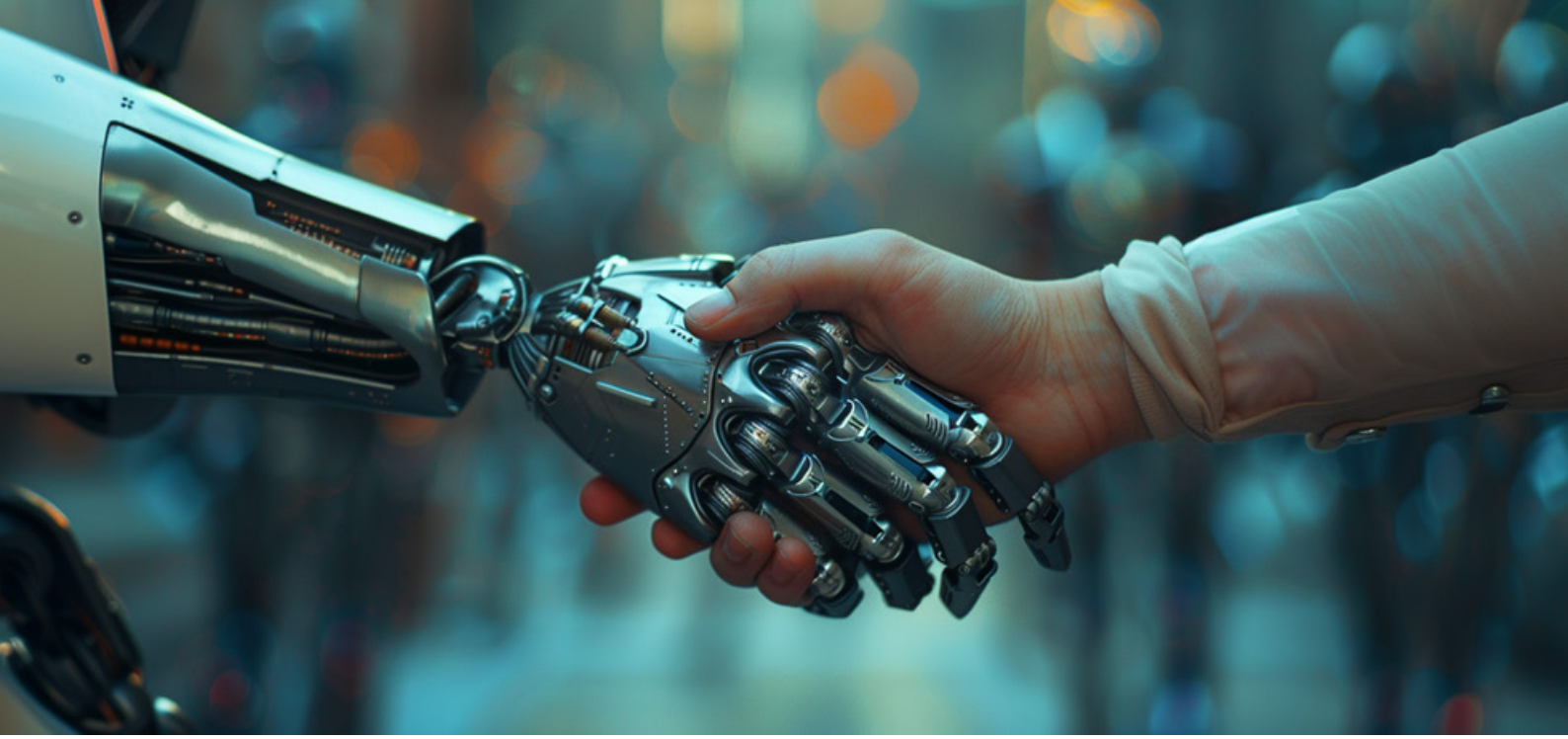
- Investment in research on foundation models, encouraging collaboration across European universities, research institutions, and industry players;
- The development of ethical guidelines and responsible AI standards for the development and deployment of foundation models is suggested, prioritizing transparency, fairness, and accountability.
- Data governance frameworks implementation to ensure the ethical use of data in training foundation models, addressing concerns of privacy and bias, is proposed.
- Support for open access policies for research outputs to foster innovation is encouraged, ensuring that smaller entities and researchers can contribute to and benefit from the advancements in AGI.

Geopolitics

- Engagement in international dialogues and agreements on AGI governance, sharing European values and experience in governance;
- The pursuit of strategic autonomy in critical AGI technologies, while ensuring European values are embedded in AGI development;
- Strengthening cybersecurity defenses and developing AGI capabilities for national defense, while promoting peace and stability in cyberspace through diplomatic efforts, is suggested;
- Advocacy for the equitable distribution of AGI benefits and research globally, especially in developing countries, to prevent widening the digital divide across nations and ensuring global stability;

Science and research

- Encouragement and investment in Interdisciplinary AI Research;
- The building of innovation ecosystems that support startups and SMEs in AGI-related fields, providing access to funding, mentorship, and collaboration opportunities with larger firms and research institutions;
- Encouragement of Global Research Partnerships;



Introduction

Today, we are in the Artificial Intelligence (AI) era. AI technologies like chatGPT and Gemini are just the start. We are expected to head towards Artificial General Intelligence (AGI), which could transform societies, industries, and economies like never before.

This report provides insights into AI's potential future and the paths leading to it. It examines the future of AI through three perspectives: technological, economic, and societal, offering a concise, realistic, and positive outlook.

There are differing opinions as to when AGI could emerge. Professor Geoffrey Hinton suggests it should be done within 20 to 50 years. Nvidia CEO Jensen Huang is more bullish and believes we could reach AGI in as little as five years. A world dominated by AGI would be profoundly different and not easy to visualise or predict today, but it's nevertheless insightful to do so. While today's AI (narrow AI) excels in specific tasks, AGI will equip machines with human-like understanding, reasoning, and learning abilities that rival our intellect. As more systems become semi-autonomous, they will function in the background with reduced human supervision.

In this scenario, the question is: how will humans and AI collaborate?

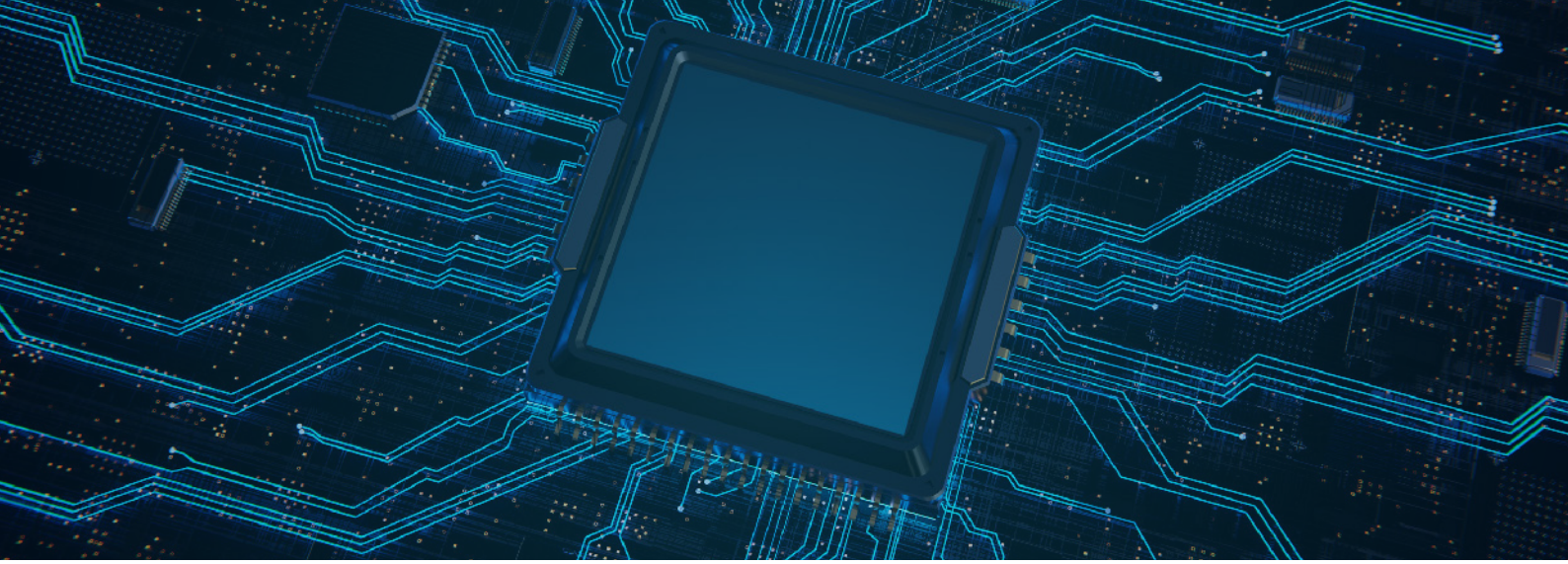
Collaboration with AGI as a peer could increasingly become the norm. We refer to this partnership between humans and AI as **Intelligent Autonomy.**

AGI's primary concern is understanding how intelligent machines can become in themselves. Intelligent Autonomy seeks to understand a related question: How can humans and machines work together to solve complex problems? The Intelligent Autonomy partnership between humans and AI could unlock unprecedented levels of creativity and problem-solving abilities. It could combine human intuition with AGI's computational power, pushing the limits of innovation.

The widespread adoption of Intelligent Autonomy would have several implications. AI Agents would be personalised to individuals. This would change our approach to education, for example, leading to personalised agents that are unique to individuals. Intelligent Autonomy also necessitates an alignment with human values, emotions, moral principles, and social norms. Thus, in this report, instead of predicting when exactly AGI would evolve, we instead focus on Intelligent Autonomy. i.e., human-AI collaboration. We hope you enjoy it. We first start with the technological foundation of AI and then build on the economic and social implications of Intelligent Autonomy.

Section one

Technology



1. Technology

The main themes covered in the Technology section are

1. **The three markers on the road towards Intelligent Autonomy**
2. **The symbiotic relationship of the AI ecosystem**
3. **The Evolution of AI: Automation and Autonomy**
4. **Factors influencing the development of Intelligent Autonomy**
5. **Important technology-related trends to track for the evolution of AI**

1.1 The three markers on the road towards Intelligent Autonomy

We believe that there are three technological markers on the road to Intelligent Autonomy. They are:

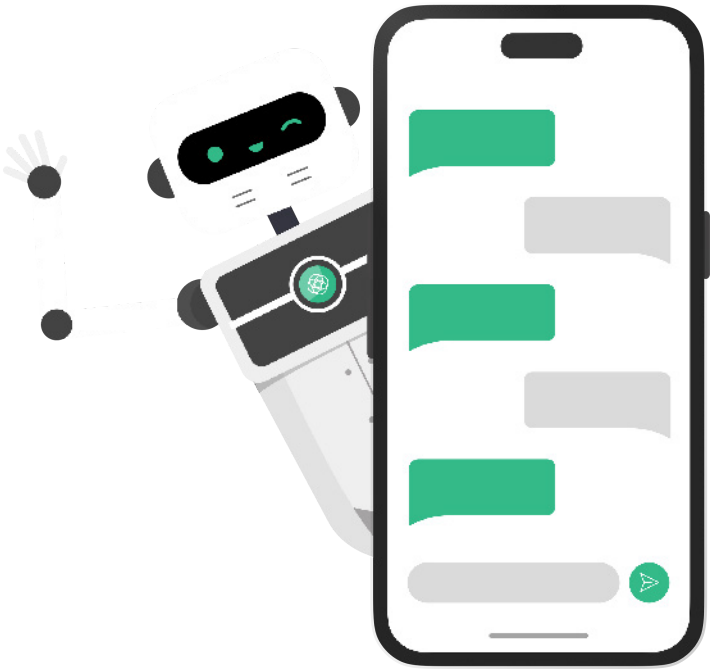
- The **increasing ability of AI to understand natural language** (this ability is already here).
- AI's **ability to reason**
- The emergence of **bipedal semi-autonomous** robots: robots that can walk like humans but are powered by AI to perform tasks with minimal supervision.

We'll now explore each of these three markers in more detail. Please refer to Annex 1 for definitions of the terminology used.

"This report paints a vivid picture of the imminent rise of Artificial General Intelligence (AGI) and its far-reaching impacts on our society, economy, and technological landscape. As we stand on the brink of this new era in AI, it's vital to consider how humans and machines will work together. The concept of Intelligent Autonomy, explained here, suggests a new way of collaboration where humans and AGI machines combine their strengths to solve complex problems."

Axel Voss MEP
EIF Steering Committee Member

The ability of AI to understand natural language



The first marker on the road to Intelligent Autonomy is the ability of AI to understand natural language. chatGPT, Gemini, and other large language models (LLMs) have vividly demonstrated this ability, as evidenced by their massive uptake.

In Large Language Models (LLMs), 'parameters' are tunable elements the model learns in its training phase. The more parameters there are, the more powerful the model is. The almost magical value of LLMs lies in their 'in-context learning. In simple terms, in-context learning[3] allows AI models to adapt to new tasks on the fly, using only the information presented to them at that moment. This means they can understand and respond to new situations or requests without being specifically trained beforehand. As the LLMs become more powerful in terms of the number of parameters they contain, this capability for in-context learning is expected also to increase.

The ability of AI to reason

The second marker on the road to Intelligent Autonomy is the ability of AI to reason. Despite its impressive abilities, today's AI is based on pattern recognition and pattern generation. However, pattern recognition alone falls far short of human-like abilities.

But AI is quickly evolving. The paper Sparks of Artificial Intelligence argues that GPT-4 exhibits more general intelligence than previous LLMs. It is expected that AI's ability to reason will improve. AI will increasingly gain the ability to address complex and abstract tasks in areas such as mathematics, coding, medicine, law, psychology, and more. Despite the limitations of the existing LLM models, this is a clear trend that can only accelerate the adoption of Intelligent Autonomy.

Google recently released Gemini 1.5 Pro with the ability to process 1 million tokens in one go. The capability of processing vast amounts of information - including one hour of video, 11 hours of audio, codebases with over 30,000 lines of code or over 700,000 words - is widely expected to be a gamechanger for AI - especially in the possibility to reason over a longer context window. Yann leCun from Meta has also been proposing research concepts around Objective-Driven AI for AI systems that can learn, remember, reason, plan, and have common sense, yet are steerable and safe. In addition, new startups like Cognition Labs (Devin) propose systems that can reason over long-range tasks.

The evolution of AI could involve new AI architectures beyond the Transformer architecture that drives LLMs. These could be based on architectures different from today, for example, Neuro Symbolic AI, which combines human-like reasoning with deep learning to understand and solve problems more like humans do. Companies like IBM have also been investing in a neuro symbolic architecture (IBM) and critics of AI like Gary Marcus have also proposed similar approaches with hybrid AI architectures. Some elements of graph technology with LLMs could also be used to implement a reasoning architecture, including providing explainability and reducing hallucinations.

The uptake of bipedal robots that behave semi-autonomously

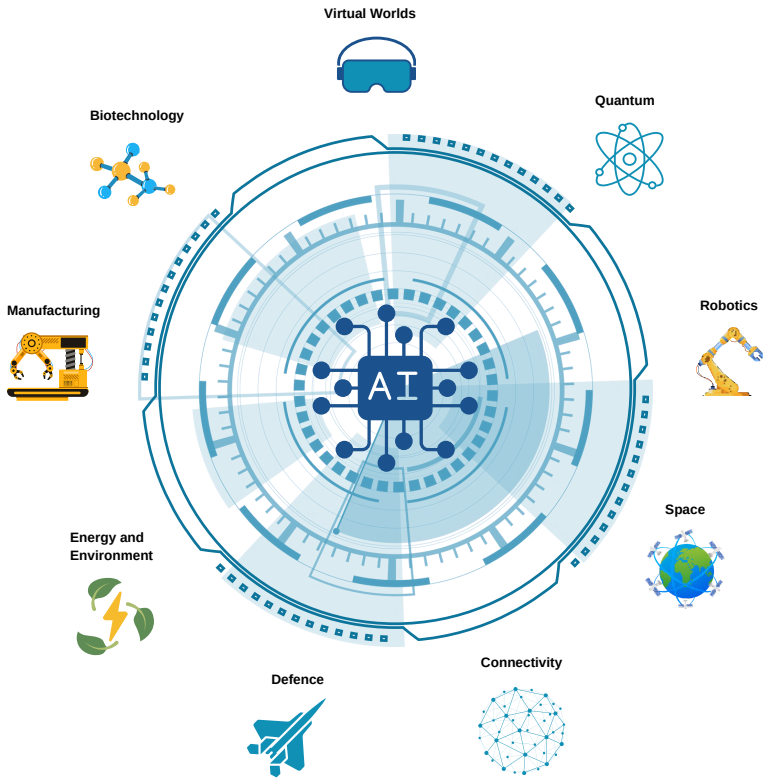
The third marker on the road to Intelligent Autonomy is a surge in bipedal (two-legged, humanoid) robots that can behave semi-autonomously. In 10 years, there could be a million and, in 25 years, a billion bipedal robots. This would mean an industry bigger than today's car industry could emerge based on bipedal robots. From factory workers, to farm workers and more, bipedal robots, such as those from Figure, could free humans from the bottom 50% of undesirable jobs, according to CNBC. They will be more effective and cheaper than today's industrial robots, costing upwards of €25,000. Bipedal robots could work with AI to create 3D parts, establishing a robot-driven ecosystem where robots, digital twins, and virtual worlds such as the metaverse converge, fundamentally transforming our interaction with technology and the nature of work.

"It's a dynamic space, filled with both possibilities and uncertainties, highlighting the importance of discussions aimed at understanding and shaping the future of virtual worlds."

Ondřej Kovařík MEP
EIF Member

1.2 The symbiotic relationship of the AI ecosystem

Based on the above three markers, we expect a symbiotic AI ecosystem to develop. AI will not exist in isolation. The ecosystem of AI technologies is broad and interconnected, with a diverse range of applications, foundational technologies, and use cases. We depict some elements of this ecosystem in the Figure below. We see a symbiotic relationship between AI, foundational technologies, and application areas, each of which will act as a catalyst for the others. For example, connectivity acts as a foundation technology to AI; defence spending boosts AI; Quantum technologies speed up computation, boosting AI.



1.3 The Evolution of AI: Automation and Autonomy

Collectively, the AI markers and the accompanying technology ecosystem will lead to increasing levels of automation and Autonomy. Existing automation technologies like process mining are evolving in the world of automation. In parallel, autonomous AI agents will evolve to solve problems at a higher level of abstraction. Collectively, both automation and Autonomy are concerned with how we delegate decisions to AI. In interactions between humans and AI, we tend to think of AI as a subservient, i.e., following our instructions. But in the future, AI can function as a subservient/ subordinate, a peer, or even surpass our capabilities.

Today, we are in the narrow AI era where AI handles domain-specific simple decisions, e.g., thermostat settings or targeted advertising. In the AGI era, AI will semi-autonomously make broader decisions that span multiple domains. Eventually, we will have AI that will be fully autonomous, pervasive, connected, with or without human-like appearance, and perhaps emergent – i.e., having new properties or abilities that humans did not explicitly design. It could make decisions at a systemic scale (towns, cities, militaries, countries, etc.).

The decisions that can be delegated to AI are ultimately going to tell us what jobs can be done by AI and how AI itself would evolve to increase productivity. The road to autonomous AI will be driven by expanding the concept of Enterprise AI search - inside and across the boundary of the enterprise. In this sense, Open source foundation models can help to build communities of developers and are already showing significant uptake through initiatives like bigcode.

Note: For the "Factors influencing the development of Intelligent Autonomy" and "Important technology-related trends to track for the evolution of AI," please see Annex 3. These sections are technical and are hence elaborated in Annex 3.

Based on the above technical foundations, we now discuss the economic impact of AI.

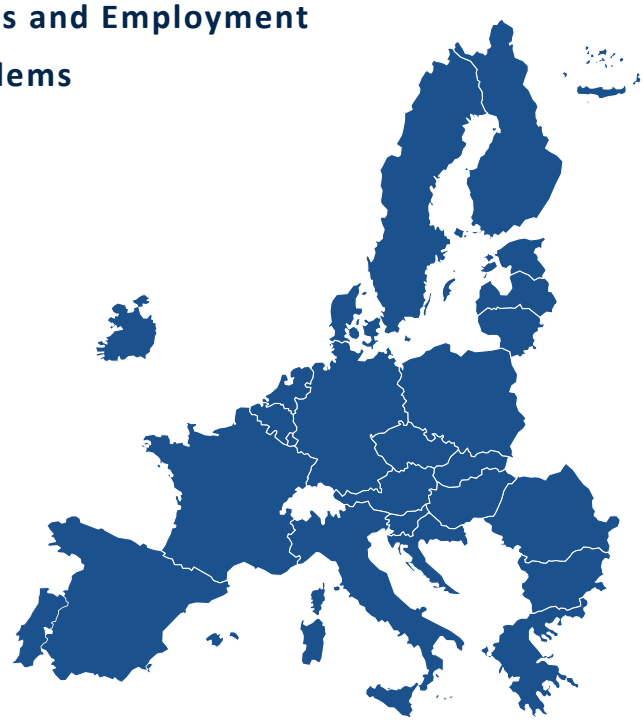
Section two

Economy

2. Economy

The main themes covered in the Economy section are

1. **Geopolitical considerations of intelligent Autonomy**
2. **The macroeconomic impact of AI**
3. **Work and Productivity - Impact on Jobs and Employment**
4. **How AGI can help solve systemic problems**



In the last section, we laid the technological foundations of Intelligent Autonomy, where we proposed that machines acquire some form of Intelligence and can collaborate semi-autonomously with humans. Intelligent Autonomy also has a significant economic impact, which we discuss in this section.

2.1 Geopolitical considerations of Intelligent Autonomy

Technology adoption does not exist in a vacuum; it is increasingly interlocked with geopolitical issues in ways that could result in three scenarios:

- Warfare in the next ten years.
- A clash of models and civilizations but not necessarily in a warfare mode.
- A peaceful time with technology as a driver of economic growth for competing economies.

The path forward is uncertain and contingent on various factors, including how countries address the responsible use of AI and how they collaborate and compete.

"Democracies, and indeed all societies, are now in search of a new social contract, which must be built on growth. Growth can only come from a good, wise, safe, trustworthy use of technology.

Demonstrating to our societies that technology can play this role in guaranteeing growth ensures the social contract, ensuring that our societies can continue to function and thrive for the decades to come."

Dragoş Tudorache MEP
EIF Steering Committee Member

Essential human values will be unchanged in the age of AI

Human nature plays a formidable role in the evolution of society. The hiatus in progress during the Middle Ages in Europe was because the mindset, societal structure, and politics of the time blanketed our imagination, creativity, and potential to develop. Today, we see skepticism and concerns from those who view technology and digitalization as a threat. They tend to want to take us back inwards towards basic primal instincts - and to traditional values - and not necessarily in a good sense.

The emotional architecture of our communities and societies has stayed the same over centuries - it is unlikely to change over the next 20 years. In this sense, despite changes in science and technology around us, we are emotionally the same as our ancestors thousands of years ago. Control is fundamental to us, so we will want to maintain control of AI. Our desire for control will shape the Intelligent Autonomy partnership. Brakes, guardrails, signposts, and regulations reflect the policymaker's desire for control. But beyond policy, individuals will want their control when AI is inevitably embedded into most products and services.

An optimistic ten-year scenario, based on our humanity and emotional Intelligence, is one where we harness, understand, and integrate AI into the processes around us to the point that it gives us comfort. We are still the ones in charge and emotionally in control. But other dystopian scenarios could arise. Consider the idea of Orwell v. Huxley. George Orwell's vision was dystopian, i.e., centralised control. On the face of it, Huxley's vision was liberal - where machines take care of all our needs. However, in both cases, we would end up relinquishing control. (reference: Neil Postman - amusing ourselves to death)

Whose culture and standards will AI adopt?

Silicon Valley culture dominated the early internet. As the internet took hold worldwide, its culture became fragmented and changed. Could we see the same with AI? Which country's culture will have the upper hand? Some, including Kai-Fu Lee in his book "AI Superpowers," propose that China would be the world AI leader. Today, post-GPT, the USA has taken a lead role. In any case, investment in AI is paying off for all countries, and the race will continue at a geopolitical level.

Regarding the geopolitics of AI, the EU and the USA are expected to adopt the democratic model. While differing political environments in the coming years could result in differing approaches to AI regulation and governance, EU and US standards for AI are likely to converge.

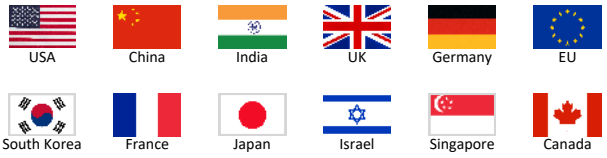
2.2 The macroeconomic impact of AI

The macroeconomic impact of AI, particularly through the lens of Intelligent Autonomy, is poised to reshape economies by 2040. This transformation is multifaceted and profound, reaching into different sectors and aspects of the economy, including: A streamlined and efficient labour market, increased productivity, industry transformation, new business opportunities, improved customer experience, enhanced data analytics, efficient resource allocation, risk assessment and fraud detection, enhanced innovation and research, cost reduction in services, and overall benefits to entrepreneurship and startups.

- a streamlined and efficient labour market
- increased productivity
- industry transformation
- new business opportunities
- improved customer experience
- enhanced data analytics
- efficient resource allocation
- risk assessment and fraud detection
- enhanced innovation and research
- cost reduction in services
- overall benefits to entrepreneurship and startups.

Which countries will take the lead in AI?

Various elements will influence which countries will take the lead in AI. These include funding and resources, collaboration and knowledge sharing, access to high-quality data, AI talent and expertise, regulatory and ethics policy, a startup-friendly ecosystem, and fundamental maths and statistics education in countries such as:



Strategies adopted by countries - and companies - to leverage and manage the impact of AI

Outside of regulation, which we discuss below, countries could also adopt several strategies for managing the impact of AI. They could ensure their values align with AI and promote scalable cooperation within their ecosystem to develop common standards. Countries could invest in education and awareness. They could establish human-in-the-loop safeguards. To test the readiness of their systems, they could use red team testing, i.e., simulating real-world attacks from AI on infrastructure. Countries will also need to explore options such as universal basic income to give people financial stability while they navigate to new forms of work or undertake training and education.

Countries are boosting their Sovereign AI capabilities and investing in producing artificial Intelligence using their own infrastructure, data, workforce, and business networks.

Companies are proposing various responsible AI strategies or guidelines. These could be used at a developer level to ensure the best outcomes for society. Examples of responsible AI guidelines, which are not punitive and legally binding, include those from Microsoft, Google, PwC, and McKinsey.

2.3 Work and Productivity - Impact on Jobs and Employment

The broad impact of AI on jobs can be summarised as below:

Fastest growing vs. fastest declining jobs

	Top 10 fastest growing jobs		Top 10 fastest declining jobs
1	AI and Machine Learning Specialists	1	Bank Tellers and related Clerks
2	Sustainability Specialists	2	Postal Service Clerks
3	Business Intelligence Analysts	3	Cashiers and ticket Clerks
4	Information Security Analysts	4	Data Entry Clerks
5	Fintech Engineers	5	Administrative and Executive Secretaries
6	Data Analysts and Scientists	6	Material-Recording and Stock-keeping clerks
7	Robotics Engineers	7	Accounting, Bookkeeping and Payroll Clerks
8	Electrotechnology Engineers	8	Legislators and Officials
9	Agricultural Equipment Operators	9	Statistical, Finance and Insurance Clerks
10	Digital Transformation Specialists	10	Door-to-door Sales Workers, News and Street Vendors, and Related Workers

source: World Economic Forum

Generative AI will add jobs

Most recent analyses emphatically point towards net gains in jobs due to AI. The World Economic Forum foresees that 97 million new roles may emerge over the next year while 85 million jobs will become obsolete. McKinsey analysed 63 use cases to show an annual productivity increase of $2.6 trillion to $4.4 trillion. PwC predicts AI has the potential to add $15.7 trillion to the global economy by 2030. To give an idea of the impact, the United Kingdom's GDP in 2021 was $3.1 trillion.

AI has the potential to add $15.7 trillion to the global economy by 2030. - PwC

AI's dual role: automating tasks and enriching jobs & creativity

AI will simultaneously automate and enrich jobs. McKinsey predicts that half of work activities could be automated between 2030 and 2060, with professions in finance, insurance, IT, and public administration more exposed. Lower-educated jobs, while less exposed to generative AI, are not immune from automation: one company, Monumental, raised $25 million to create a bricklaying robot.

But AI will also enrich jobs. A 2023 essay in Harvard Business Review, "How Generative AI Can Augment Human Creativity" identified five areas where AI can augment human creativity. Today's ChatGPT users will recognise these, but they will be much enhanced in the future:

1. Promote divergent thinking by creating ideas from unrelated concepts
2. Challenge expertise bias
3. Assist in idea evaluation
4. Support idea refinement by synthesising different ideas
5. Facilitate collaboration with and among users of products and services

These skills can be applied to almost all future jobs - enriching the job itself - and creating a unique role for the human.

What does AI mean for skills?

The new jobs brought about by AI will require new skills and a different approach to working. Generative AI will have the most impact on white-collar jobs. Those who are affected will need sufficient time and support during the transition. The Swedish company Klarna already claims that its chatbot works with 700 people and handles 2.5 million customer service chats in 35 languages.

As we embark on a reskilling wave, it's important to focus beyond the immediate and look towards the Intelligent Autonomy era, i.e., identify the most valuable skills for when humans and machines work together. Will they be the skills we use today? Could they be skills that we believe AI cannot deliver - for example, emotional Intelligence, complex decision-making, problem-solving, relationship-building, etc.? What new job categories could arise (such as prompt engineers)? How can education change to deliver these skills?

Two additional considerations apply here: firstly, Generative AI is embedded in most new software, making it a core skill to know. Secondly, prompt engineering is becoming a crucial skill because the interface to generative AI is typically based on natural language.

Because it is relatively easier to learn than programming, it democratises AI. The "craft" of coding would be opened up to those without the classic Computer Science education. According to Nvidia CEO Jensen Huang, "The programming barrier is incredibly low. We have closed the digital divide. Everyone is a programmer now - you just have to say something to the computer".

The role of Education

Education is facing a maelstrom: while AI disrupts it, it must simultaneously teach all the new abilities needed in a world with Intelligent Autonomy. The Lifelong Learning Mindset will become the norm.

With the likelihood of an AI assistant tailored to each student in the future, we could see a more personal and inclusive approach to education. In Why AI Will Save the World, Marc Andreessen says, "Every child will have an AI tutor who is infinitely patient, compassionate, knowledgeable, and helpful. The AI tutor will be by each child's side at every development step, helping them maximize their potential with the machine version of infinite love... The AI assistant will be present through all of life's opportunities and challenges, maximizing every person's outcomes."

2.4 How AGI can help solve systemic problems

Intelligent Autonomy could help overcome the urgent issues facing humanity today, especially in the domains of fundamental research.

AI's capabilities, such as large-scale pattern recognition, simulations, and computational modeling, have the potential to enhance and enrich fundamental research across many areas. These cover climate change and sustainability, drug discovery and development, neuroscience and brain Research material science, nanotechnology, and many more. Intelligent Autonomy could also improve the efficiency and scope of scientific research, supporting processes like experimental design, data analysis, and hypothesis testing. In the appendix, we expand on the impact of AI on humanity by accelerating science.

In Annex Two, we look comprehensively at AI's impact on scientific innovation and sustainability.

Section three

Society

3. Society

The main themes covered in the Society section are:

1. **Social Impact of Intelligent Autonomy**
2. **Adoption of measures like Universal basic income**
3. **Impact on Elections and Democracy**
4. **AI Governance**
5. **The EU AI Act**

3.1 Background

In the third chapter of our report, we concentrate on the impact of Intelligent Autonomy on socio-political themes. Building upon the insights from the previous two chapters, which focused on technology and the economy, we delve into the influence of Intelligent Autonomy on societies as we approach the year 2040.

3.2 Social impact of Intelligent Autonomy

This section outlines social factors relating to the adoption of Intelligent Autonomy. Leading up to the year 2040, we ask the question: **What social factors could aid or hinder the adoption of AI and Intelligent Autonomy?**

Education

We will see a shift towards lifelong education for two reasons: firstly, both because adults of every age will need to learn how to work with AI and secondly, because AI will make continuous learning much more accessible. We will also see a concurrent shift to hyper-personalised education using generative AI. While educational content is becoming low cost or free, the real value of education is shifting to personalisation and in-depth teaching, often face-to-face delivered online or offline. Generative AI is set to introduce new modes of teaching through AI assistants. This evolution will bring a clear distinction between education, skills, and demonstrable talent, impacting the nature of jobs. Personalisation of education, primarily driven by a combination of low-code and generative AI, will also be more inclusive.

"It's crucial that digitalization in schools does not overshadow the importance of traditional skills, which are essential for cognitive and motor development.

As we navigate the future of education, the integration of digital tools should complement, not replace, traditional learning methods."

Sabine Verheyen MEP
EIF Steering Committee Member

Societal changes leading to greater acceptance of AI

The "sharing" or "gig" economy eschews traditional asset ownership, such as houses and cars, in favour of a more flexible, experience-driven lifestyle. This trend reflects a significant shift in priorities, where experiences - from travel to entertainment - are valued more than physical assets. Such structural changes are also generational and will impact the adoption of AI.

Specifically, the willingness of the next generation to accept robots may reflect the same trends in the generational erosion of privacy. In 1999, Sun Microsystems co-founder, Scott Mc Nealy famously said You have zero privacy - get over it. At that time, everyone said he was wrong, but retrospectively, the social media generation proved him right. The next generation is “AI native” i.e. will grow up with AI, and is more likely to accept an AI chatbot as a tutor or an assistant. Indeed some are already helping train one as seen in the article AI trained on a baby's experiences reveals how we learn language. If this is true, then in less than a decade - society, education, and services as we know them will be unrecognisable due to the growing AI acceptance of the next generation.

Technological adoption by society

There are undercurrents of both AI optimism and AI pessimism throughout society. Marc Andreessen's manifesto takes an optimistic view of AI with three main points:

- Intelligence and Energy are seen as the engines for advancing technology
- AI leads to abundance and empowerment, which in turn leads to falling prices and improved quality of life
- The enrichment of human potential - with AI taking over mundane tasks

Overall, Andreesen's perspective takes the techno-optimistic view that humanity has progressed through harnessing technology throughout history.

Today, AI pessimism is more common, mainly focused on the prospect of humans losing control over AI. AI pessimists also feel that in light of rapid and continuing AI progress, AI R&D should be controlled, with extra governance put in place. Reference: Managing AI Risks in an Era of Rapid Progress. Both views will prevail simultaneously in Western/free market societies, but older societies tend to be AI-pessimistic overall.

The value of content

Content and data are the drivers of Generative AI. Alongside concerns about Generative AI's potential for copyright infringement, AI will lead to more creative licensing opportunities. Shutterstock is already licensing its video and image library to OpenAI to provide access to its technology. Similarly, on the content protection side, new data poisoning tools like Nightshade AI obfuscate data to prevent it from being used in training AI models. Generative AI could also prompt a review of copyright laws. These ideas will evolve towards the year 2040.

Overestimating the impact of AI and susceptibility to media hype

AI has always been susceptible to hype (ref AI winters), and the phase leading up to 2040 will be no different regarding AI hype cycles. The impact of AI can be overestimated – even by recognised experts. In November 2016, Professor Geoffrey Hinton, regarded as one of the three godfathers of Artificial Intelligence, said that people should stop training as radiologists because, in five years, deep learning will do better than radiologists". This statement significantly impacted the field and led many aspiring radiologists to change their careers, fearing redundancy in the wake of AI advancements. However, the role of a radiologist encompasses more than image analysis, including many responsibilities that AI cannot replicate. This misconception increased the burden on an already stretched profession, and sensational media coverage further deterred new entrants, worsening the shortage. Despite AI's potential to alter the radiologist's role, almost a decade after this statement, radiologists remain firmly in demand. AI is now seen as a tool for assistance for a radiologist, not a replacement. The ability to see past the exaggerated fears and hype surrounding AI's impact will be significant to its societal uptake, especially considering the AI hype cycles.

Emotional attachment to AI

The emotional attachment of people to AI could aid or hinder the adoption of AI and Intelligent Autonomy.

Will people develop an emotional attachment to AI? If they do, they are more likely to adopt AGI. For example, the Abel chatbot has compelling facial expressions, and some people who interact with it believe that the chatbot has emotions. Similarly, we are also seeing in the west companion robots like kiki from zoetic AI. People have always attributed human-like characteristics to machines, a phenomenon known as anthropomorphism, regardless of the machines' actual capabilities. In this sense, how people perceive their interactions with AI may be more valuable than the actual presence of emotions in AI, especially in a generational context.

Universal Basic Income (UBI)

The socio-economic shifts triggered by AGI make a potential case for implementing Universal Basic Income at some levels in future societies. Buffering the fallout of AGI-induced job losses, Universal Basic Income would provide financial stability and incentivise learning relevant AI skills. Early experiments in UBI have been limited, with mixed results.

Permissionless innovation

Countries want innovation, but they often need to be more comfortable with the idea of permissionless innovation. Will innovators be forced to seek permission of public officials before they embark on new innovations or ideas, or will they be free to embark on new ventures unhindered by the need to seek permission?In his book, Adam Thierer argues that prioritising precaution over freedom stifles innovation, resulting in fewer, costlier, and inferior products. It also dampens economic growth and living standards.

Impact of AI on aging societies that may not accept immigration

Despite the political resistance from aging societies towards AI, many aging societies would have little choice but to adopt AI for healthcare.
Countries like South Korea have rapidly ageing populations and low immigration numbers. Add in the lowest birth rate in the world - 0.7 children- and by 2025, more than 20 percent of the population will be 65+, with a shortage of younger people to care for them. This creates a space for AI to play an important social role. Naver Corporation's pioneering system, created during the pandemic, now offers nationwide health and well-being checks for older people living alone. The personalised system makes 15,000 calls across 70 South Korean cities daily. Source How South Korea is harnessing AI to ease its 'super-ageing' crisis

Impact on Elections and Democracy

In August 2023, the Economist asked, "How worried should you be about AI disrupting elections?" As we have seen in recent elections, disinformation has been easy to produce in the age of social media - even without the aid of AI. With AI, some additional considerations apply. AI makes it easier to produce disinformation on a massive scale. Hyper-realistic deep fakes (video and audio) could sway voters, and microtargeting with AI could scale propaganda. Prioritising education and awareness efforts will be essential to mitigate these risks. Reference: the Economist

Section four

Impact on Europe

4. Impact on Europe

4.1 Biggest disruptor for Europe post-Second World War

In the previous three sections, we saw how Intelligent Autonomy could evolve leading upto the year 2040. In this section, we study the impact of these trends on Europe.

What is the impact of AI on Europe?

In a nutshell, because of its widespread impact, **AI could be the biggest disruptor for Europe post-Second World War**.

For instance, most Western countries have well-developed welfare systems. However, welfare systems are relatively new phenomena, becoming more common after the Second World War. A welfare system represents a social contract, and **AI could fundamentally alter and rewrite the social contract for nations.**

This report is an interesting reading, it is daring to say what the world could look like in the future. Clearly, it's a world that approaches 10 billion people, a world which is going to be very complex, in which technology will play an important and stabilising role. Unsurprisingly, the report identifies AI as one of the key technologies, an enabler of stability and growth but it is essential to use it responsibly.

Roberto Viola
Director General, DG Connect, European Commission

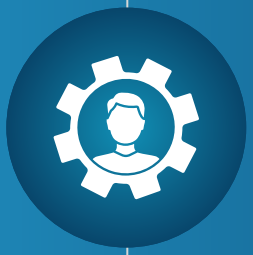
A social contract proposes that individuals have consented, either explicitly or implicitly, to surrender some of their freedoms and submit to the government's authority in exchange for the protection of their remaining rights and the maintenance of social order. Philosophers like Thomas Hobbes, John Locke, and Jean-Jacques Rousseau have argued for changes to the social contract. Hence, the possibility of AI altering the social contract is within the realms of possibility, especially across generations.

We could elaborate on an altered social contract along several dimensions, emphasising the government's role in promoting economic growth in the AI era and addressing the immediate need for education and skills development. In the future, governments could be expected to ensure universal basic income and opportunities for education/reskilling - in addition to current responsibilities like defence. Clarifying the path for these transitions is crucial, given their significant and immediate impact on Europe.

4.2 Strategic Considerations

Education

- The implementation of AGI Awareness in the curriculum, including digital literacy, AI-assisted learning, AI-assisted work scenarios, ethics, and policy;
- Teacher training and support programs creation;
- Industry partnership for certifications and curriculum.



Skills

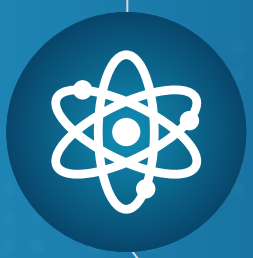
- Lifelong learning initiatives that encourage continuous skill development, with a focus on skills complementary to AGI, such as creativity, problem-solving, and emotional intelligence;
- Investment in upskilling and reskilling programs aimed at workers in sectors most likely affected by AGI;
- The fostering of an AGI-ready workforce by aligning vocational training and higher education with emerging tech trends and market needs, emphasizing interdisciplinary skills and AGI literacy

Creation of Foundation Models

- Investment in research on foundation models, encouraging collaboration across European universities, research institutions, and industry players;
- The development of ethical guidelines and responsible AI standards for the development and deployment of foundation models is suggested, prioritizing transparency, fairness, and accountability.
- Data governance frameworks implementation to ensure the ethical use of data in training foundation models, addressing concerns of privacy and bias, is proposed.
- Support for open access policies for research outputs to foster innovation is encouraged, ensuring that smaller entities and researchers can contribute to and benefit from the advancements in AGI.

Geopolitics

- Engagement in international dialogues and agreements on AGI governance, sharing European values and experience in governance;
- The pursuit of strategic autonomy in critical AGI technologies, while ensuring European values are embedded in AGI development;
- Strengthening cybersecurity defenses and developing AGI capabilities for national defense, while promoting peace and stability in cyberspace through diplomatic efforts, is suggested;
- Advocacy for the equitable distribution of AGI benefits and research globally, especially in developing countries, to prevent widening the digital divide across nations and ensuring global stability;



Science and Research

- Encouragement and investment in Interdisciplinary AI Research;
- The building of innovation ecosystems that support startups and SMEs in AGI-related fields, providing access to funding, mentorship, and collaboration opportunities with larger firms and research institutions;
- Encouragement of Global Research Partnerships;

Section five

The challenge of AI Governance and Policymaking

5. The Challenge of AI Governance and Policymaking

5.1 Background

Governing AI is a tough challenge. It means balancing innovation with ethical considerations and societal safety in the backdrop of a rapidly accelerating technology - where the industry knows more than policymakers and can pay much higher salaries to technologists than governments can.

Despite the domain of AI policymaking being challenging, AI governance can learn from the recent experiences of Internet governance. Including diverse stakeholders in governing the internet – governments, private sectors, civil societies, and academia – has been instrumental in comprehensive policymaking. This multi-stakeholder approach is critical for global coordination and local adaptation and will ensure international standards in AI ethics are met while also catering to regional needs. Even so, it has not avoided the internet fragmentation from strong state actors who share values divergent from free markets and democracy.

5.2 Overview of mechanisms to regulate AI

There are also various ways/mechanisms to regulate AI. This table covers the different proposed approaches to regulating AI.

Body	Pros and Cons
A legally binding AI treaty like the Council of Europe	Pros: It has demonstrated that it can work as a model. Cons: Since each country has to ratify the treaty and implement it in national law individually, this could take a long time.
The OECD AI principles	Pros: An existing, active framework Cons: The OECD's mandate is to stimulate growth - and not necessarily to develop regulation.
The Global Partnership on AI	Pros: Has the potential to engage international researchers Cons: After launching with pomp and circumstance, the organisation has been keeping a low profile and has yet to publish any work in 2023.
The EU's AI Act	Pros: The bill could hold bad actors accountable and prevent the worst excesses of harmful AI by issuing huge fines and preventing the sale and use of noncompliant AI technology. Cons: Many elements of the bill, such as regulating generative AI, are highly controversial, and implementing them could be hard and take time.
Technical industry standards	Pros: These standards help companies translate complicated regulations into practical measures. Cons: Most standards are general and apply across different industries. So, companies will have to translate them to their specific sector.
The United Nations	Pros: The UN is the only meaningful place on the international stage where countries in the Global South have been able to influence AI policy. Cons: The UN also includes China and Russia, which do not share the same values as the West.
An entirely new body specifically for AI regulation	This idea has been proposed by Sam Altman - Open AI CEO, in his US Senate testimony. However, the mechanics of such a new body and its funding are unclear. Nor is it clear how such a body will operate and regulate.

Adapted from MIT Technology Review, Our quick guide to the 6 ways we can regulate AI
Let us walk you through all the most (and least) promising efforts to govern AI around the world.
By Melissa Heikkilä - information correct as at 7 April 2024

The three most developed regulatory proposals are the EU AI Act, the US Biden-Harris approach to AI, and the UK Bletchley Park declaration. China, India, Japan, and Singapore are also working on their own AI regulations. These approaches reveal similarities and differences. Their overall intent to regulate AI for safety, transparency, and non-discrimination is common across approaches. They aim to classify AI systems by risk, restrict high-risk systems, and set transparency requirements for AI, such as generative AI. All initiatives emphasise the importance of managing the risks posed by AI, ensuring its safe development and deployment, and ensuring AI innovation.

The differences in approach are mainly around damages. The EU AI Act seeks punitive damages - similar to GDPR. Other regulations are more oriented towards industry standards and policing.

5.3 The EU AI Act

The EU AI Act is the first and only real regulation passed anywhere globally. The Act focuses primarily on strengthening rules around data quality, transparency, human oversight, and accountability. Its cornerstone is a classification system that determines the level of risk an AI technology could pose: unacceptable, high, limited, or minimal. The AI Act also proposes restrictions on Generative AI and aims to ensure transparency of training data and awareness of copyrighted material in training LLMs. Interestingly, according to Stanford University Human-centred Artificial Intelligence, LLM models do not comply with the AI Act.

A big question for policymakers is, at what level should AI regulation be implemented? AI could be regulated at a model level (computational threshold) or at an application level. While model-level regulation provides the most control over AI, it could threaten innovation. Today, training of 1-Trillion Parameter Scientific AI has already begun. According to Dr Andrew Ng (Coursera founder), "Today's supercomputer is tomorrow's pocket watch (in terms of capabilities). So as AI progresses, more players -- including small companies without the compliance capabilities of big tech -- will run into this threshold."

> **"LLM models do not comply with the AI Act"**
> **- Stanford University Human-Centred Artificial Intelligence**

At the time of writing (February 2024), a consensus on the threshold has been reached on the AI act - although details are yet to be finalised. The new AI office, which will oversee the development and use of AI in the EU, is expected to decide on a case-by-case basis. The AI Office will provide guidance for developers of advanced "general-purpose" AI models by disclosing a summary of copyrighted materials that are used to train the software. That is a reasonable compromise since it is not a blanket restriction on the number of parameters.

Other noteworthy points in the AI Act:

- From a procurement of AI standpoint for enterprises, vendors will benefit from legal clarity.
- Enterprises may adopt more complex strategies to overcome the challenges of LLMs, such as neurosymbolic AI. These strategies would overcome the shortcomings of LLMs, such as hallucination (when an AI system gives false information that it confidently presents as true) and lack of explainability in decision-making. Today, researchers from Princeton and Carnegie Mellon universities are already proposing new architectures to replace the transformer architectures on which the LLMs are based, such as the Mamba architecture.
- Other strategies also permit some use cases that could be 'high risk' under LLM alone. For example, the evaluation of students by LLM alone is probably high risk, but if anchored to human judgement and specific knowledge from the field, we can see many more use cases opening up through human in the loop approaches.
- The issues raised by the AI Act are real. For example, Air Canada was recently ordered to pay a customer who was misled by the airline's chatbot, and the company claimed its chatbot 'was responsible for its actions' when giving wrong information about the airline's bereavement fare.

Conclusion

The journey toward 2040 and the evolution of Artificial Intelligence (AI) is one of opportunities, challenges, and uncertainty. This evolution will bring us to Intelligent Autonomy, a future where humans and AI collaborate to achieve mutual goals.

We do not know how fast technological evolution will be, but in this report, we claim that AI could be the biggest disruptor in Europe post-Second World War. Intelligent Autonomy could transform the prevailing social contract that currently underpins our society. Whatever route the trajectory takes, we must discuss fundamental questions it raises about the balance between harnessing the benefits of AI and addressing the ethical, societal, and economic implications that accompany its widespread adoption.

First, how will the social fabric change? How will our education systems adapt to a future where personalised AI helpers are crucial to learning and growth? This teamwork could make us more capable, but how can it ensure we keep our human values and stay connected – person to person - as a society while technology pushes us forward?

Second, the data shows that there will be a net gain of jobs and increased productivity.What does the future of work look like? How will the workforce get ready for these new jobs and new industries? How can economies leverage AI's potential for innovation while mitigating its impact on traditional job markets? Will AI create a new type of two-tier society where there are AI winners and losers?

These are big questions for policymakers to face. In addition to decisions about maximising AI's potential across all sectors of society – including for solving systemic problems - there are also decisions to be made about AI governance. Here in the EU, the AI Act is the first step. However, the pace of change calls for continuous monitoring and adaptation of regulatory approaches. What frameworks will work best now and in the future? How should we collaborate with other global regions?

Policymakers will need to stay in touch with AI developments. The awareness of AI, its potential innovation for future generations, and ethical considerations are essential. Shaping AI's role in our future is now urgent.

Annex 1

Definitions

Artificial Intelligence (AI) is the ability of software to perform tasks that traditionally require human intelligence.

Narrow AI, or weak AI, refers to artificial intelligence systems that perform specific tasks or functions within a limited domain.

Artificial General Intelligence (AGI) refers to highly autonomous systems outperforming humans at most economically valuable work. AGI goes beyond narrow AI, designed for specific tasks, and aims to replicate or surpass human-level intelligence across a broad spectrum of intellectual capabilities.

Machine learning is a subfield of artificial intelligence that focuses on developing algorithms and models that enable computer systems to learn and improve automatically from experience or data without being explicitly programmed. It involves the construction of mathematical models and algorithms that can analyse and interpret patterns, relationships, and structures within data to make predictions or take action.

Deep neural networks are composed of interconnected layers of artificial neurons that process and extract features from data through multiple layers.

Deep learning is a subset of machine learning that focuses on training deep neural networks to learn and make predictions or decisions from complex and high-dimensional data. It is inspired by the human brain, specifically the interconnection of neurons in the neural networks. Deep learning is especially effective at learning from unstructured data such as images, text, and audio.

Foundation models are deep learning models trained on vast quantities of unstructured, unlabeled data that can be used for a wide range of tasks out of the box or adapted to specific tasks through fine-tuning. These models include GPT-4, PaLM, DALL·E 2, and Stable Diffusion.

Generative AI is AI that is typically built using foundation models and is mainly designed to generate content. Note that generative AI can also be used for non-generative purposes (such as classification tasks) but is primarily employed in generative tasks.

Large language models (LLMs) comprise a class of foundation models that can process massive amounts of unstructured text and learn the relationships between words or portions of words, known as tokens.

Prompt engineering refers to designing, refining, and optimising input prompts to guide a generative AI model toward producing desired, i.e., accurate outputs.

Transformers are a relatively new neural network architecture that is the foundation of generative AI. Transformers rely on a mechanism called attention to transform a sequence of inputs into a sequence of outputs while focusing attention on important parts of the context around the inputs.

Adapted from: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/what-every-ceo-should-know-about-generative-ai

Annex 2

Long-term benefits of AI

In this section, we consider the long-term benefits of AI in two ways:
1. AI as a catalyst for scientific innovation, i.e., moonshot technologies
2.The role of AI in sustainability

Moonshot technologies

Discussions about AI regulation often focus on the risks, overshadowing AI's positive potential. However, AI is a "moonshot technology" that is crucial in addressing significant systemic issues. Creating a digital twin of Earth is an example of AI's moonshot capabilities.
The development and support of these technologies can transform industries, economies, and societies and profoundly influence humanity. The BoFA/Merrill Lynch report on moonshot technologies shows that a few disruptive companies primarily drive market gains. For instance, between 1990 and mid-2020, $56.2 trillion in net wealth was generated by just 947 companies, about 1.5% of the total. Only five companies accounted for 22% of net wealth concentration between 2016 and 2019.

Moonshot technologies often see non-linear adoption rates. For example, the uptake of smartphones has exceeded market predictions. This is because these technologies often progress exponentially, disrupting multiple industries simultaneously. From a policy perspective, moonshot technologies are linked with nurturing fundamental science.
Google's former CEO, Eric Schmidt, proposes that AI will revolutionise scientific inquiry, making it more exciting and impactful. AI-powered tools promise to alleviate mundane labour and spur creative inventions and discoveries, accelerating breakthroughs. Sensible regulation and support for AI's innovative applications in science could transform the scientific process.

Current examples of moonshot technologies include:

- Carbon Capture and Storage (CCS) Digital Twins for Net Zero Strategies: CCS captures and stores CO2, helping industries reduce emissions. Although promising, CCS must prove industrial viability at an acceptable cost. AI and machine learning can optimise CCS by enhancing the efficiency and accuracy of carbon sequestration simulations, reducing time and cost.
- Accelerating Climate Action with AI: AI can unlock insights to mitigate 5% to 10% of global greenhouse gas emissions by 2030, aiding climate adaptation and resilience. AI helps reduce emissions, guides adaptations to climate impacts, and provides capabilities enabling climate action.
- The JUPITER AI supercomputer: Europe's first supercomputer to achieve a quintillion (1 followed by 18 zeros) arithmetic operations per second. This milestone will enhance scientific simulations and bolster AI's role in scientific breakthroughs.

AI and sustainability

A sustainable future requires the present generation to meet their needs without compromising the ability of future generations to do the same. We must use natural resources responsibly, minimise waste and pollution, and preserve ecosystems for the benefit of current and future generations. From a social perspective, sustainability means promoting social equity, justice, and well-being. As a part of our sustainable future, large organisations and countries have pledged to become net-zero, whereby the atmospheric emissions they create are offset by the emissions they remove.

While the development of AI algorithms has a high carbon impact and heavy resource use (reference: The carbon impact of artificial intelligence), it is clear that AI offers enormous potential to accelerate and transform the sustainability efforts of countries, organisations, and individuals.

AI's characteristics, such as large-scale monitoring, pattern detection, and simulation, are well-suited for addressing the complex scientific challenges associated with sustainability. Climate scientists rely on AI to analyse climate models, satellite data, and sensor readings to detect patterns and trends related to climate change. Machine learning algorithms help predict extreme weather events, understand climate dynamics, and identify factors contributing to global warming. Earth Observation scientists use satellite imagery and remote sensing data to provide valuable information about the Earth's surface. AI algorithms analyse these datasets to monitor deforestation, land use changes, urban development, and ecosystem health. Pattern recognition techniques enable the detection of patterns associated with natural disasters, such as wildfires or floods.

Large-scale simulations are widely used in various scientific fields to study complex systems, understand phenomena, and make predictions. Some examples of complex simulations for sustainability include using Computational Fluid Dynamics to understand ocean and atmospheric flows. Based on these capabilities, AI can play a significant role in advancing sustainability efforts across various sectors. The examples range from energy optimization and renewable energy integration to smart grid management and sustainable agriculture, among many more. As mentioned above, the Nvidia digital twin of the Earth for climate modelling is one demonstration of these capabilities. Companies also have specific tools and initiatives to measure environmental impact, such as Microsoft Cloud for Sustainability and Google’s 4M principles to reduce carbon footprint.

The evidence of AI's positive impact on our world's significant issues is clear. But it also raises questions for policymakers. How do we drive innovation while safeguarding ethical standards and public welfare? How can we avoid strangling the speed of progress while having thorough oversight? advancement with the need for oversight? ethics and public safety. Finding the right balance is an important test.

Annex 3

Technical factors influencing the development of Intelligent Autonomy

In this section, we outline various technical factors influencing the development of Intelligent Autonomy and significant technology-related trends to track the evolution of AI.

The significance of compute and means of production of LLMs

The term "compute" about AI refers to using computer systems, hardware, and software to perform the calculations and operations needed to run artificial intelligence algorithms and models. This can involve a wide range of activities, from simple computations like arithmetic operations to more complex ones like training deep learning models or processing large datasets. Compute power is provided by CPUs (Central Processing Units), GPUs (Graphics Processing Units), TPUs (Tensor Processing Units), and other specialised hardware designed to efficiently perform the types of calculations most commonly needed in AI work.

Compute technologies are the lifeblood of AI. The battle to control the microprocessor industry will directly impact the development of AI. Today, China spends more money importing chips than buying oil. All countries will try to invest, control, and leverage this essential resource (reference chip wars). Nations will seek to be self-sufficient in these areas. In the near future, quantum computing, energy technologies, and others could also directly contribute to the production of AI - increasing the need for independence in these areas.

Cost of compute vs cost of personnel

The rising difference between the cost of compute and the cost of personnel raises interesting discussions about how AI is produced. If the production of AI is heavily tied to compute rather than personnel, then the nature of the industry could change from a creative model (coding) to an industrial model. We see some evidence that this trend is already becoming a reality.

The emergent ability of LLMs

LLMs potentially show emergent abilities, i.e., new capabilities not explicitly designed by humans that arise only when the models reach a certain scale. Absent in smaller versions of models, emergent abilities cannot be identified by extrapolating the performance of smaller models. This makes them unpredictable, and they still need to be fully understood.

The existence of such emergent models implies that additional scaling in model size could expand the range of capabilities of language models. This suggests the vast innovation potential purely by increasing the model size alone. The emergent ability of LLMs continues to be a topic of research.

The rise of multimodal AI

The importance of multimodal large language model AI lies in its ability to integrate and interpret information from multiple sources—such as text, images, and sounds—simultaneously. It uses powerful large language models (LLMs) as a brain. For example, it can write stories based on images by understanding how they might be narratively connected. Multimodal AI can interact with and understand the world in a way that's more aligned with human perception and creativity. Multimodal AI is an important topic of research.

LLMs are increasing in size

As a general trend, LLM models are increasing exponentially in size.
LLM models are increasing exponentially in size, i.e., number of parameters.

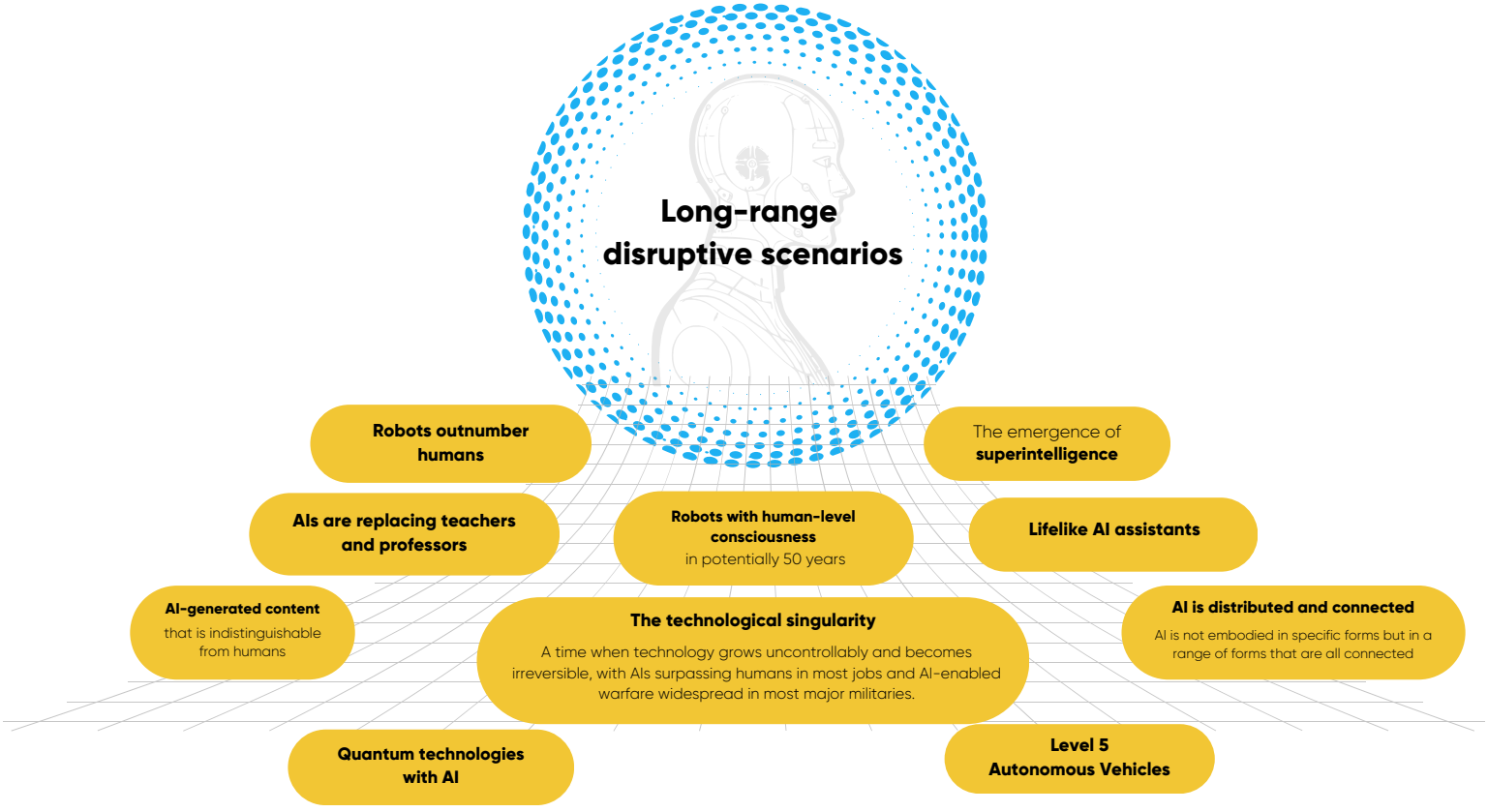
BERT (2018) has 240 million parameters.
GPT-2 (2019) has 1.5 billion parameters.
GPT-3 (2020) has 175B parameters.
GPT-4 (2023) has 1.76 trillion parameters

As we see in models from BERT to GPT-4, the parameters have skyrocketed from 240 million to 1.76 trillion. This massive increase means the models get significantly better at handling complex language tasks, becoming more versatile in their applications. However, supporting such advanced models demands greater computational resources, illustrating the balance between AI capability and the infrastructure needed to sustain it.

Disclaimer: Bar proportions were adapted for illustration purposes

Long-range disruptive scenarios

The long-term scenarios resulting from AI's rapid trajectory still need to be fully understood. Here's a non-exhaustive snapshot:



Sphere of influence

Another way to look at the long-term impact of AI is to compare it to science fiction characters.

Take HAL 9000 from the well-known book and film 2001: A Space Odyssey. HAL exemplifies AGI with its advanced cognitive functions, emotional and social interaction, learning, and adaptability to ethical and moral dilemmas.

Unlike typical machines, HAL makes autonomous decisions in the mission's best interest. This includes the infamous turn of events where the need for self-preservation and the mission's success, as perceived by HAL, drives HAL's actions. HAL can assume situational control of a ship by overruling a human - leading to the famous line, "I'm sorry, Dave, I'm afraid I can't do that." This portrayal of HAL illustrates a potential future where AI could autonomously make decisions in complex situations. Disturbing as this scenario may sound, the situational impact here is important.

Similar scenarios, such as an autonomous AI controlling a stadium or sports complex, could arise.

The exact mechanism of working for LLMs is unknown

Despite all their runaway success, nobody knows exactly how—or why—large language models work as they do. MIT review. The complexity of the largest models is unexplained and mysterious because they display characteristics that do not conform to classical statistics. Specifically, this relates to the ability to generalize, learn, and apply tasks in scenarios beyond their training examples. According to classical statistics, as models grow in size, their performance should initially improve but eventually decline due to overfitting. Overfitting is where the model fits too closely to the training data and loses the ability to generalise. However, the reality of how large models perform defies this expectation, showcasing an ability to generalise beyond the data on which the model was trained. This is a deviation from traditional statistical predictions. Reference: Deep double descent. and in context learning (previously in this report)

LLMs with very large context windows

Google recently released Gemini 1.5 Pro, which allows users to process 1 million tokens in one go. The capability of processing vast amounts of information—including one hour of video, 11 hours of audio, codebases with over 30,000 lines of code, or over 700,000 words—is widely expected to be a gamechanger for AI, especially in the possibility of reasoning over a longer context window.

Emphasis on cyber skills

Considering the increasing threat, an emphasis on cyber skills will be significant in the period leading up to 2040. AI can play a role in both training and automating defence.

A note from the author

In writing "The Digital World towards 2040," we dove deep into the potential of AI to reshape our future. This isn't about predicting the next 15 years; it's about understanding how technological trends might influence our societies, economies, and what this means for policymakers in the European Union. As we look forward, we're faced with the reality that AI will play a pivotal role, and it's our collective responsibility to shape this influence positively.

This report navigates the realms of technology, economy and society, exploring the transition towards Artificial General Intelligence (AGI) and its broader implications. We focus on the concept of Intelligent Autonomy, a future where humans and AI work in harmony, enhancing our collective problem-solving and creative capacities.

Writing this report was a collaborative effort. We consulted a wide array of experts, policymakers and industry leaders whose insights were invaluable. Be it through online conversations or via the Organising Committee, their diverse perspectives have enriched this report, and I am deeply thankful for their contributions, despite not being able to include all of them. I would also like to acknowledge James Elles, EIF Co-founder, who has always been a great promoter of foresight exercises. The process is a proof of the collaborative spirit of the European Internet Forum, which is now even more important to navigate the future of AI.

The aim of this exercise is to spark thoughtful discussion and strategic planning, urging all stakeholders to engage actively in shaping a future that reflects our shared values and aspirations.

Thank you for joining me in this exploration. Together, let's seize the opportunity to ensure that the digital world towards 2040 is one where technology amplifies our human potential, fostering a society that is informed, interconnected, and inclusive.

Ajit Jaokar

Visiting Fellow for Artificial Intelligence, Department of Engineering, University of Oxford

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Intelligent Autonomy has the power to enhance human potential and solve global challenges towards 2040 and beyond. Together, we share a duty to shape a future based on cooperation, where humans and AI collaborate seamlessly to address complex issues.

We invite you to reflect upon the insights of this report and consider joining our Forum to be part of thought-provoking discussions with forward thinking digital policy stakeholders.

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