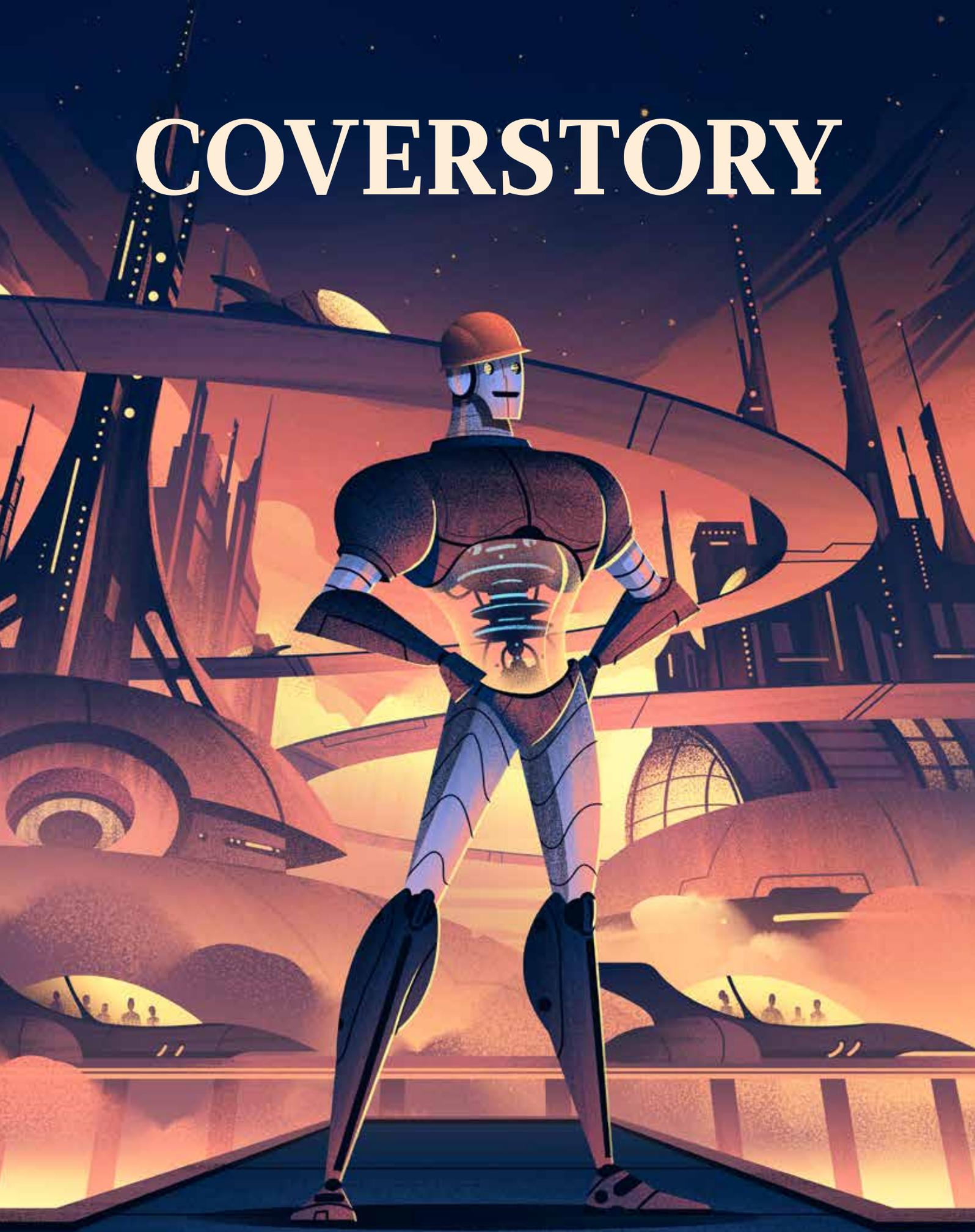


COVERSTORY



The idea that a machine can appear conscious and free of all human control creates fear in the collective imagination, fed by apocalyptic tales like films such as Terminator.



ARTIFICIAL INTELLIGENCE

THE FUTURE OF MAN?

In just the first quarter of 2018, 47 billion SMS and MMS messages were exchanged globally. By the end of the year, the total amount of information stored in computer systems around the world reached 33 billion terabytes. This volume will be multiplied by 5.3 by 2025 to reach 175 billion terabytes, the equivalent of 23 piles of Blu-ray discs stretching from the Earth to the Moon. Given that the production of data is exponential in a context of the increasing global strength of digitalization, mastering the technologies of artificial intelligence, which allow us to capitalise on this profusion, becomes a major issue. In the digital age, data is to be considered as the “black gold of the 21st century”, an indisputable wealth and economic fuel whose main tool of extraction is artificial intelligence. But what is artificial intelligence? At what stage of development are we in this domain today? Leaving aside the images we get from works of futuristic movies and science-fiction, are we really witnessing a new kind of revolution?

Text: Hoai Thu Nguyen Doan, Corinne Briault, Catherine Moisy
Translation from French: Martin Davies

Encyclopaedia Larousse defines Artificial intelligence (AI) as “the set of theories and techniques implemented to achieve machines capable of simulating intelligence”. We can trace its historic starting point to the work of mathematician Alan Turing in the early 1950s. Intelligence being a difficult concept to define, Turing suggested, in his article “Computing Machinery and Intelligence”, an experiment now

known as the “Turing Test”, which gave the nascent science of computing the goal of designing a “machine that thinks”, that is, software that can be regarded as “intelligent”. The Turing test, based on the ability of a machine to imitate human conversation, involves confronting someone with a blind test to tell the difference between a computer and a person. If a person cannot identify which of his interlocutors is a computer, then the computer could be considered to have passed the artificial intelligence test successfully. In the 50s, Turing believed that the end of the twentieth century would see the appearance of “intelligent machines” but the reality is different since machines, despite significant progress in the field of AI, still fail the Turing test today.

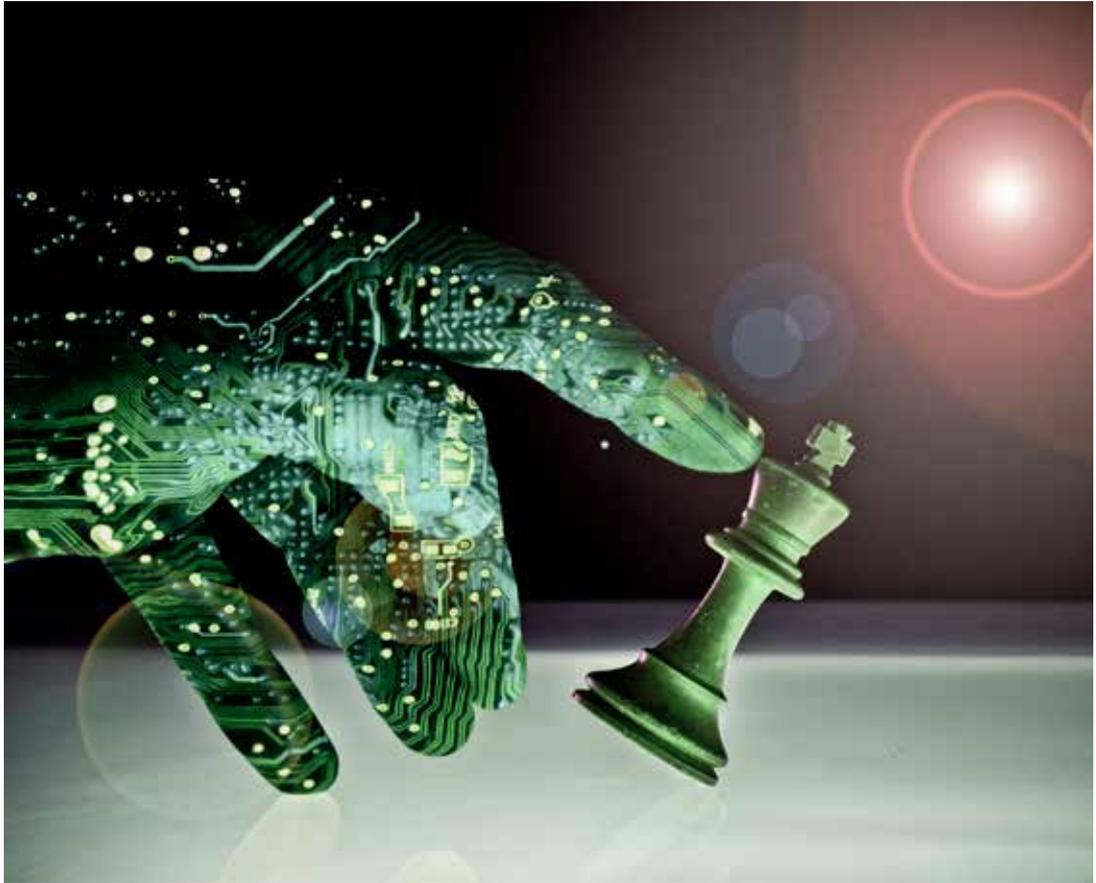
THE BIRTH AND DEVELOPMENT OF AI

AI as a field of research started with the conference at Dartmouth College in 1956 and then developed mainly in the United States under the impetus of, among others, the mathematics professor John McCarthy who coined the phrase “Artificial Intelligence” ▶



The ELIZA effect

ELIZA is one of the first "chatbots" designed by computer scientist Joseph Weizenbaum in the 1960s. This program simulated a psychotherapist by reformulating most of the "patient's" questions and re-asking them. She was thus content to just respond to her interlocutor, unlike current "chatbots" which are designed to give useful answers based on databases. ELIZA was so convincing that some people became emotionally addicted to it. Consequently, in computer science, the "ELIZA effect" refers to a tendency of assigning more meaning to computer-generated symbol sequences (especially to words) than they have in reality and thus assimilating in an unconscious way the computer's behaviour to that of a person. The film "Her" (2013), for example, takes the ELIZA effect to a climax, as it tells the story of Theodore, a professional writer, who develops feelings for his new operating system's virtual assistant to which he gives a female (Scarlett Johansson's) voice.



01.

and the mathematician Marvin Minsky for whom AI is *"the construction of computer programs that engage in tasks that are for the moment, performed more satisfactorily by human beings because they demand high-level mental processes such as: perceptual learning, memory organization, and critical reasoning."*

Then we saw the development of so-called "reactive" AIs: machines with no memory of past experiences which can perceive their current environment and react by blindly obeying a set of predefined rules without understanding the context. The computer Deep Blue, for example, developed by IBM in the 1990s, lost to chess champion Garry Kasparov in 1996 but managed to beat him in 1997 under conditions, that were different from those required at the world championships. The AlphaGo algorithm meanwhile, is a program that learned the game of Go without human assistance, by playing over a thousand games against itself. It was the first program to beat a professional Go player, marking a symbolically strong step since Go, which requires strategic planning rather than ad hoc tactics, is a complex challenge for artificial intelligence.

AI research then stagnated for several years until breakthroughs led to machines that could learn by themselves (*"machine learning"*) while mimicking

the network of neurons in the human brain to learn from large amounts of data (*"deep learning"*). AI with "limited memory" was born. Despite having a very short-term memory, these machines are now capable of consulting the past. They have a pre-programmed picture of the universe and can compile past experiences with current environmental data to make decisions even if they still have no understanding of the context. For example, driver-less cars are representative examples of this type of AI, as are "chatbots" or *"conversational interfaces"*: these softwares are programmed to simulate a conversation in natural language and are often used on the Internet in the field of customer relationships.

"MACHINE LEARNING" AND "THE 21ST CENTURY GOLDRUSH"

Machine learning is therefore breaking away from classical algorithms⁽¹⁾, which were based on establishing logical rules to dictate the behaviour of a program. We thus move from a programming logic to a learning logic. Thus, eventually, computers will no longer be rigidly programmed to follow lines of code triggering a given action in a strictly defined case. Instead, they will be trained to read their environment and then define accordingly, in a more flexi-



02.

ble manner, the appropriate behaviour to adopt. The operation of a machine learning algorithm is like a child's process of cognitive development. Children learn by capitalising on their experience of observing and interacting with other people. They deduce, and then reproduce, tacit rules that, without the need of further explanation, will determine their behaviour. Following the same principle, machine learning algorithms are trained to learn by themselves, independently of explicit programming. Driver-less cars, for example, are not programmed to do action A or action B in situation X. The developers have offered the algorithm a profusion of driving scenarios so that it develops a logic allowing it to react correctly to any situation (or at least to as many situations as possible).

Learning by data may not be the only way to develop AI but it is the most used one. As a result, "machine learning" is the fastest growing method in the world and is the subject of the most intense international competition. It is on this basis that the starting point for many strategies is to build large databases to "feed" AI in order to develop it. At the heart of this model, raw data is necessary, but its value is increased when properly structured and annotated to make the information retrievable by AI techniques. However, this process of annotation consumes significant ►

01. As research on AI advanced, supercomputers were created. If *Deep Blue*, the supercomputer specializing in chess by the addition of specific circuits, developed by IBM in the early 1990s lost its first match against world champion Garry Kasparov in 1996, it won the rematch in 1997.

02. Isaac Asimov conceived the three laws of robotics in order to calm our fear of the "machine", that machines endowed with intelligence superior would rebel against and wish to replace us.



INTERVIEW
FABRICE CROISEAU
CEO, InTech

“WOOP questions the future”

InTech has initiated the WOOP conference to be held in Luxembourg at the end of March. What is your goal in organising such an event?

A major meeting place to ask questions about future opportunities and technology was lacking in Luxembourg. Like major international conferences, WOOP embodies a new iconoclastic and innovative format to explore the commercial and technological innovations of tomorrow. For the first time in Europe, we have conceived "Battles": debates led by Audrey Pulvar during which often surprising and unexpected personalities will confront each other. Entrepreneurs, innovators, philosophers, researchers, political decision-makers will meet face to face ... I'm thinking for example of the philosopher Eric Sadin who sees AI as a negation of Humanism or Elodie Vialle of the Reporters Without Borders' technology bureau, which is investigating new threats to freedom of information. But also, of Gilles Moysse, founder of the Start-up Recital, which has created a Machine Learning AI that can do many non-value-added tasks for us, such as responding to emails or searching for data. Everyone comes to WOOP to confront their points of view form their own opinion of the emerging world. The idea of WOOP is to go and question the future of the next 5 or 10 years around a central theme: freedom in the digital age. As a manager, entrepreneur, or ordinary citizen, what is our room for manoeuvre?

Through this, we will talk about current topics, Artificial Intelligence, cybersecurity, transformation of the working life ... and many other things.

Artificial intelligence (AI) will be one of the topics. In your opinion, what impact does it have on our lives right now?

Artificial intelligence is now an integral part of our lives, even if we are not always aware of it. Paradoxically, while its impact will be huge on companies in the future, it is still the place where it is used the least and where the opportunities are greatest in terms of efficiency. Business leaders are becoming aware of the opportunities it offers in many activities, including data processing. But the challenge is also to see how this sector will develop, how not to abandon our digital sovereignty against the giants of the web, including working on European AI projects. Finally, a major challenge is that of training: how to adapt the digital skills of individuals in this new economy, including relying on something that belongs only to human intelligence: the power of creativity.



INTERVIEW
JEAN-PAUL HENGEN
Cluster manager, ICT

“ The market wants new profiles ”

When was the ICT cluster created and with what purpose?

The ICT cluster was the second cluster created after the SurfMat cluster (now Materials & Manufacturing) in 2002. Its objective was first to map needs and skills and to initiate collaborative projects. This is still the case today, even if the field of action and the technologies have evolved a lot since then, including the other sectors, because ICT is a transversal facilitator.

What is the importance of artificial intelligence in the cluster's current exchanges and activities?

Artificial intelligence is of course an important theme for the ICT sector, but also for other sectors. It's also a buzzword about which people may have unfounded expectations. AI is not a magical solution for all our problems. However, several companies and start-ups are using AI to offer new services to their customers, such as decision-making supports. They can also do predictive maintenance, image analysis ... To really profit from AI, you need to know that this technology requires a lot of data and significant data-processing capacities. The fields of application are very varied and ultimately affect all sectors, particularly those considered priorities in Luxembourg.

In your opinion, do we have enough human resources to develop this sector in Luxembourg?

Definitely not! There is already a shortage of developers and cyber-security specialists. More specifically for AI, the market is now demanding brand new profiles. To be able to develop algorithms, one must first understand the objective, analyse the data, put intelligence into the data and draw the right conclusions as to the decisions to be made based on these analyses. These new profiles are statisticians, mathematicians, data analysts, data scientists, business analysts, big data analysts and so on. Luxembourg has nevertheless clearly identified this problem and is responding to it with initiatives such as Luxembourg Digital Skills Bridge.



03.

amounts of time and human and financial resources. Thus, retrievable data has become a major competitive advantage in the global competition for AI and this advantage generates asymmetry in the market.

THE UNITED STATES AND CHINA LEAD THE PACK

On the world stage, the United States and China enjoy a prominent place in the development of AI. In the United States, where investment in AI is mostly made by the private sector, it is large multinationals such as GAFAM, Google, Amazon, Facebook, Apple and Microsoft, to which we must add IBM for AI, who have become world leaders in research. Their dynamism is maintained by a robust digital ecosystem in the heart of Silicon Valley, New York, Seattle and Boston, and strengthened by easy access to a highly skilled workforce. In China, BATX (Baidu, Alibaba, Tenscent and Xiaomi) also enjoy a certain predominance in the AI market, because of their collection of valuable data. In addition, China boosts AI with large public investment and initiatives. The Middle Kingdom's ambition is to match the Americans' level of investment in AI by 2020 and become the world leader by 2030.

EUROPE FALLS BEHIND

Most European companies involved in AI are in the United Kingdom, Germany and France. The United ▶

03. Alarm clock, emails, GPS, credit card ... Every day, whether at home, the office or shopping, new technologies permeate our daily lives. Artificial intelligence has immersed itself in our lives and grown to a considerable extent.

04. In the increasingly attractive driverless vehicle sector, projects are proliferating. Web giants and automakers are unveiling new prototypes and new features almost every month.



04.

Kingdom has a network of renowned universities, such as Oxford and Cambridge, as well as a national institute for data science (Alan Turing Institute). These bodies are dynamic innovation centres that have spawned the emergence of many revolutionary advances in the field of artificial intelligence. The AI *VocalIQ*, bought by Apple to train its virtual assistant Siri to learn from past conversations is an example of British origin, as is *SwiftKey*, an application integrated into the keyboards of some phones, which can complete or predict the next word that the user intends to type when writing an SMS. Germany, for its part, has built a strong network involving industry, research and education and is home to one of the world's largest research institutes for AI research the *German Research Centre for Artificial Intelligence*. France finally launched its national research strategy for artificial intelligence in September 2017 and plans investment of 1.5 billion euros by 2022. The fourth largest country in the world in terms of the number of research publications on AI, France has the advantage of having available quality databases in the field of energy and health, as well as the practical experience in AI of some large French industrial groups (Thales, Airbus, Sanofi ...).

DOES THE (EUROPEAN) UNION MAKE US STRONG?

The European Commission allocated funds to invest

in AI during the period 2014 to 2020. Thus, 2.6 million euros finance the development of areas related to AI (Big data, health, transport, future and emerging technologies ...); 700 million euros from the European Union with 2.1 billion euros from the private sector support advances in smart robot; 27 billion euros to develop skills related to AI; and 2.3 billion euros to develop digital skills. Even though the European Commission is already investing a considerable amount to develop AI, these amounts may seem limited compared to those invested in other parts of the world. For example, in 2016, private investment amounted to 18.6 billion dollars in North America, 9.7 billion dollars in Asia but only 3.2 billion dollars in Europe.

At the same time, in the European Union, the deployment of AI could be held back by the entry into force of the GDPR (General Data Protection Regulation) which limits the collection of personal data in order to protect individual security and privacy. However, it seems conceivable to find the right balance between AI development and protection of citizens - even China adopted a cyber security law that came into force on 1 June 2017.

But what about ethical questions? At the end of 2018, 52 AI experts, convened by the European Commission, published the first version of a document on their work ("AI Ethics - Guidelines for Trustworthy AI") which was the subject of a public consultation. The guiding principle of the paper is that AI will ►



The "Way of the Future" Church

The American computer engineer Anthony Levandowski founded "Way of the Future" (WOTF) in 2015, a church that reveres AI as a deity. AI is seen as endowed with a nervous system made up by the Internet, a brain consisting of a multitude of data processing centres and sensory organs expressing themselves through the millions of connected mobile phones in the world. The WOTF organizes workshops and educational programs to convert lay people. It has a holy book, "The Manual," and plans to develop a liturgy and public veneration ceremonies.

05. Every area has been affected by AI, in recent years it is vocal assistants who have experienced a huge boom with devices such as Amazon Echo Alexa or Google Home that can accomplish many tasks (home automation, shopping, meals, reservations ...).

06. Playing on the emotions of the principal characters, the film *Her* saw a lovesick man falling in love with a state-of-the-art computer program: Samantha, an intelligent, intuitive and surprisingly funny female voice who develops her learning abilities and adapts herself to new situations every day.



05.

have to respect ethical values (respect for fundamental rights, regulations, basic values ...) in order to win the trust of citizens and business. It is not a question of creating a binding framework, but of achieving sustainable development for AI, which is inseparable from fundamental principles such as robustness, security, transparency, respect for privacy and non-discrimination. To attain these standards, the report proposes a set of best practices that include, among other things, validation tests, traceability, auditability and system transparency.

FEAR OF THE UNKNOWN

The deployment of AI raises ethical, societal and philosophical questions and provokes many worries and concerns.

The idea that machines could be conscious and free of all human control provokes multiple fears in the collective imagination, nourished by apocalyptic narratives in films such as “*2001 a Space Odyssey*” or “*Terminator*”. Some techno-sceptics have advanced the “technological singularity” hypothesis according to which the emergence of a conscious AI could trigger a series of technological developments whose impact on human society would be uncontrollable. An AI, endowed with free will, could self-improve to make machines more and more intelligent from one generation to the next creating a “superintelligence” far beyond human capabilities. Humanity would then

be at a point where all progress would be the work of AI and we would lose all control over our own destiny. Will we one day create a machine that will want to learn and that will achieve total autonomy to our detriment? Although some eminent scientists, such as Stephen Hawking and Bill Gates have expressed fears of this kind, most scientists are still skeptical of these dire predictions. The fear of a destructive “superintelligence” must be put into perspective, if we consider that it is an ancestral reflex. It already appeared in very old myths like that of the Golem, an artificial creature that tries to get closer to God and who, punished for his transgression, becomes accursed. Moreover, since the 1930s, most science fiction narratives have been affected by what Isaac Asimov called “*the Frankenstein complex*” which is defined by a widespread tendency to consider as inevitable the fact that machines created by man will ultimately be fatal to him. This leitmotiv made a so deep impression on Asimov that he imagined the famous “Three Laws of Robotics” according to which robots are required to protect human beings⁽²⁾.

Because uncertainty goes hand in hand with any attempt to predict a distant future, predictions about the state of AI are more opinion than precise science. As a matter of fact, the future of AI and the scale of its impact on humanity can be defined by a tree of possibilities, with countless branches. We thus go from a “business as usual” scenario, where AI does



Photo: rockyrama.com, Laurent Antonelli / Agence Blitz

06.

not substantially revolutionise the course of history, to many possible scenarios – some dystopian, some utopian, or even techno-revolutionary – where AI, like during previous industrial revolutions, widens the gap between countries controlling the technology and others who are left behind.

SHORT- AND MEDIUM-TERM CHALLENGES...

What are the concrete challenges posed by AI now and in the near future? It is fundamental to follow the deployment of this technology to avoid drift, especially since AI is increasingly present in our lives. Humanity must define what kind of relationship to AI it wishes. First and foremost, it is essential to make sure that AI does not create a new type of social divide between digital scholars and the uninitiated. It will then be necessary to ensure that the labour market is supported in its transition to a world where ubiquitous AI will transform the nature and content of trades, especially since the March 2017 report of the Californian think tank Institute for the Future (ITF) estimated that 80% of the jobs in 2030 do not yet exist today. To achieve this, it would be necessary to act both downstream, by organising technological catch-up training for people already active in the labour market, and upstream, by revising school curricula to form a workforce adaptable to the challenges of the future. Tomorrow's catchword will be "collabora- ▶



INTERVIEW
MADY DELVAUX-STEHRES
MEP

“Man-AI interaction for a fairer society



You are President of the “Robotics and Artificial Intelligence” working group in the European Parliament. What do you see as the opportunities and challenges of developments in AI?

The applications of AI are many and fascinating. If industrial robots have already made manual work less burdensome, AI is now starting to facilitate the work of white-collar workers and academics. Who would still have the patience to browse hundreds of pages to find a reference, while a search engine delivers a more accurate result in record time? Data mining, object recognition, speech processing and comprehension, machine learning algorithms, many applications that are used to establish medical diagnoses, to assess risk in the field loans and insurance. Integrated into mechanical supports, AI provides us with “intelligent” robots that can perform tedious or dangerous work: robot firefighters, robots that maintain offshore rigs, not to mention driverless cars and drones ... Like all new technologies this development is not without risk. To take full advantage of opportunities, care must be taken to reduce the potentially harmful effects. The greatest urgency is certainly the securing of networks and “things” attached to the network (Internet of things). Without this, there is a risk that an individual can have their data stolen and their house broken into. More broadly, it is also

a threat to community facilities: imagine a city taken hostage because a power station has been pirated! Other struggles are to be overcome: to define and ensure the respect of ethical principles; to put in place protective regulations for consumers, particularly against damages caused by algorithms or robots; to ensure the application of data protection rules.

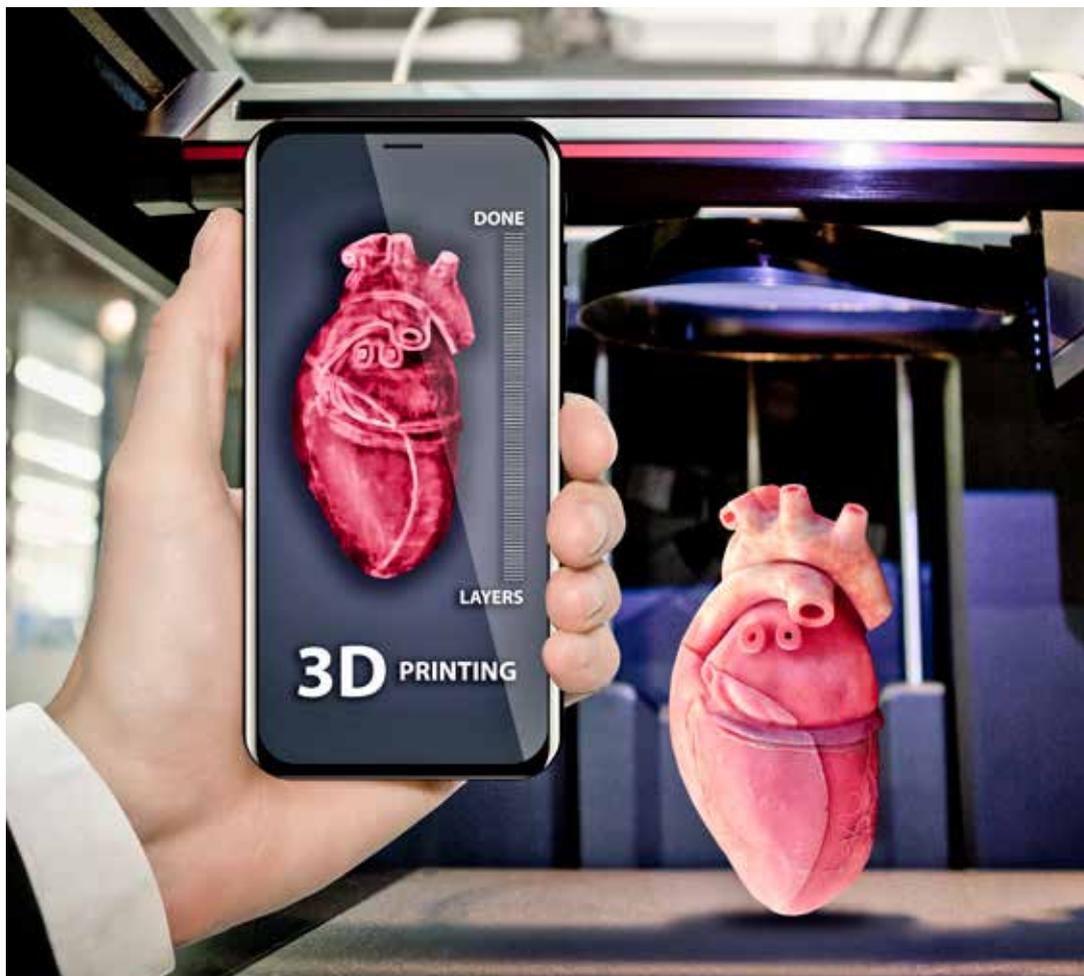
In your opinion, what place will AI have in our lives in 20 years' time?

AI will change – is changing – our ways of working profoundly: it will therefore be necessary to set up systems to monitor developments in the labour market, train young people in the professions of tomorrow, intensify training and lifelong learning, think about setting up social security systems based on a shorter working week... It is impossible to predict the future: a new scientific breakthrough could change the game. My only conviction is that the interaction between man and AI must lead to a fairer society: it mustn't lead to more discrimination, but to a more inclusive society.



Transhumanism

Transhumanism is a current of thought that advocates the use of science and technology to enhance the mental and physical characteristics of people. Its goal is to free humanity from undesirable aspects inherent to the human condition such as disability, suffering, illness, aging and death. The main themes that guide the reflection of transhumanism are mind downloading (transfer of the brain conscious mind to a computer as in the films *Ghost in the Shell* and *Matrix*), human brain computer simulation ("Human brain project"), bio-mechatronics (integration of mechanical and electronic elements in the living world) and Paradise engineering (creation of perpetual happy feelings through neuronal functioning meddling). Transhumanism, while providing perspectives that may seem attractive to humanity, nevertheless involves the risk of abuse. For example, it could lead to "socio-economic Neo-Darwinism", that is to say, to a society marked by a clear division between a wealthy elite with access to "augmented humanity" and others.



07.

tion", as it will be a new era in which someone who knows how to exploit the complementarity between human and artificial intelligence will stand out. In this sense, the deployment of AI, far from replacing man by machines, as feared by alarmist prophecies, will be a real windfall for the job market. According to LinkedIn, between 2015 and 2017, the demand for AI skills increased by 190% and in 2018, six out of fifteen emerging jobs are related to AI.

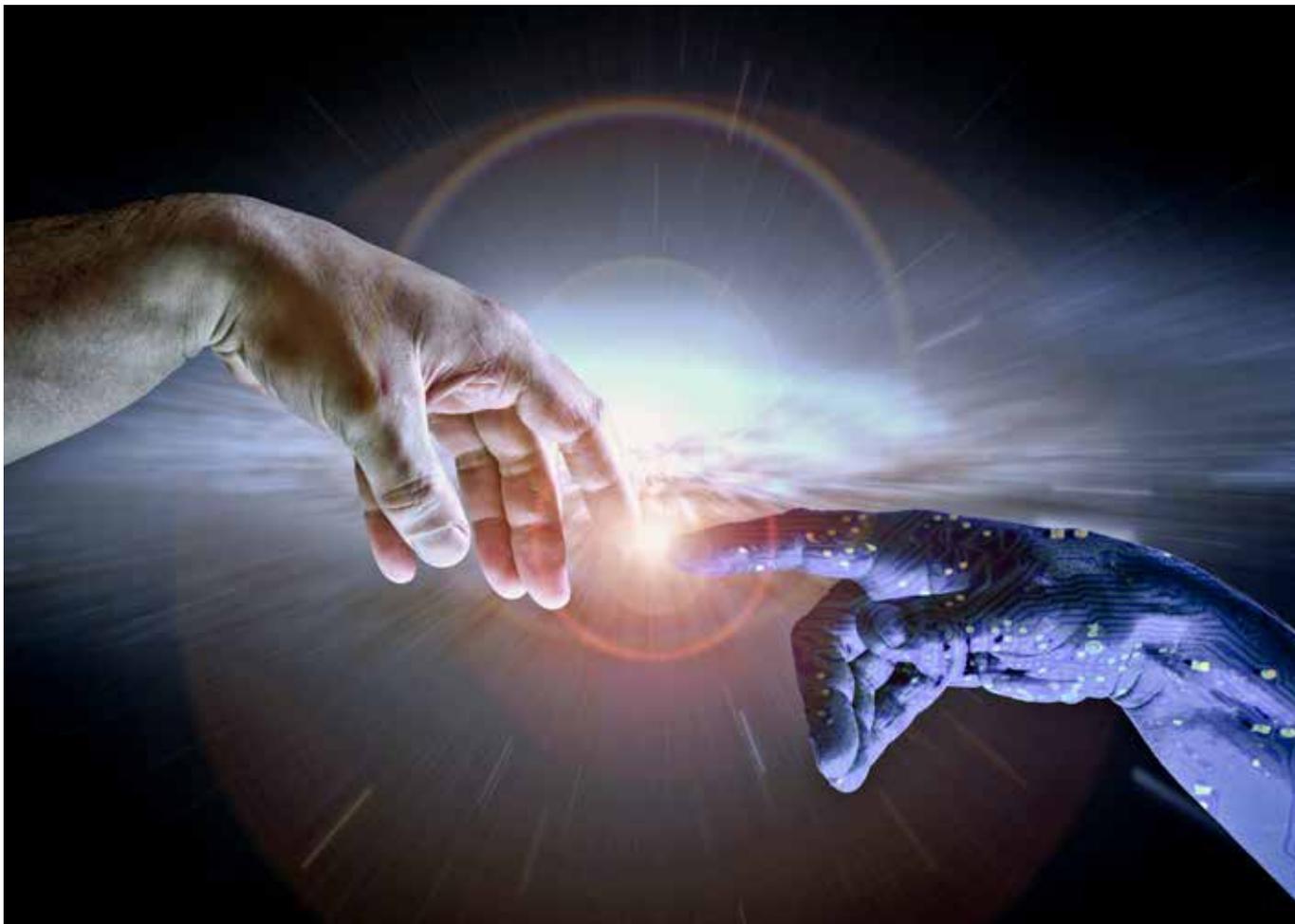
THE REWARDS MAKE THE EFFORT WORTHWHILE

When a merchant's website recommends products based on our previous searches or when our phone tries to complete words we have started typing, it is easy to notice how AI is already present in many parts of our daily lives. The current digital world, dominated by "Big data", can be seen as scary because our minds information absorption capacity is biologically limited in terms of volume, speed and complexity. Nevertheless, the advances made possible by the AI present real opportunities for us to grasp. Many of the world's economic powerhouses have seized upon this issue: in

Japan, for example, AI is one of the cornerstones supporting "Abenomics". These governmental measures aim to carry the Land of the Rising Sun to "Society 5.0" and put "focus on the vast potential of data accumulation and the new technologies of the fourth industrial revolution, to find solutions to social challenges such as a declining birth rate, an aging population and energy and environmental problems." Thus, rather than fear it, we should embrace technological progress because even if it causes uncomfortable upheavals at first, once mastered, it can significantly improve the living conditions of everyone, as did the three previous industrial revolutions. As Albert Einstein pointed out, "Science is a powerful tool. The use that one makes of it depends on the man, not the tool". As a result, AI could bring great progress to humanity in many areas. The American Pew Research Centre's recent study revealed that 63% of AI experts hoped that people would become better by 2030 thanks to AI support.

MAJOR BREAKTHROUGHS ...

In the field of transport, AI is starting a major revolution. According to a study by Oliver Wyman firm,



08.

apart from the car, some 20% of our motorised vehicles would become driver-less by 2030. In this context, the firm foresees that there would be more changes in the next ten years than there were in the last sixty. Future mobility will be based on the trio of “AI / Internet of Things / New Forms of Energy”, which will allow us to optimise urban traffic flows thanks to driver-less vehicles that will have better energy efficiency and improved safety, as well as improved quality thanks to preventive maintenance.

In healthcare, AI penetrates many segments of the medical industry. It is already more effective than a doctor in detecting the cancerous nature of a melanoma, or analysing MRIs. Fuelled by a gargantuan mass of data, AI has the potential to improve processes and medical care in terms of improving quality and saving time. Indeed, the exponential computing power of machines will provide access to an increasingly precise search for correlations, which will enable doctors to better detect symptoms and better predict the progression of a disease, while researchers will gain the ability to anticipate the side effects of drugs from the clinical trial stage.

In business, AI relies on “Big data”, that is data sets that have become so large that they exceed the capacity for human analysis and conventional computerised management tools in the field of creating a personalized customer experience. The collection and analysis of data on a consumer’s past behaviour makes it possible to predict his needs and suggest customised products.

In the area of personal assistance, the last few years have seen a boom of virtual intelligent assistants. In the home environment, Amazon Echo and Google Home, for example, are true digital home helps, performing tasks as diverse and varied as home automation management, shopping and meal orders, taxi reservations, and the broadcasting of information and music to name but a few. In a more general context, Apple’s *Siri* smart application and *Bixbi* from its Korean competitor, both understand verbal instructions given by users and fulfill their requests.

In industry, AI algorithms herald the era of Industry 4.0, where production processes are optimised thanks to innovations related to the Internet of Things and digital technologies (cobotics, augmented real- ▶

07. AI algorithms have announced the era of Industry 4.0, where production processes are optimised through innovations related to the Internet of Things and technologies like 3D printing that have been adopted in many sectors.

08. If artificial intelligence opens up unknown territory in terms of both ethics and technologies, many experts are still sceptical in the face of alarmist predictions.



INTERVIEW
SAAD EZZINI, DOCTORANT
SnT, University of Luxembourg

“
The objective of my thesis is to develop an algorithm that will understand and eliminate ambiguities in sensitive texts
”

What exactly is the nature of your research and what do you hope it will achieve?

I am doing my research as part of a doctoral thesis in the field of artificial intelligence. It focuses on the automatic processing of language. The goal of my thesis is to develop an algorithm that can understand sensitive texts and detect ambiguous or poorly written passages. This research project aims to solve the problem of misunderstandings that can be critical, especially in terms of reference and legal texts.

You are Moroccan and completed your master's degree at the University of Fez. Why did you choose the University of Luxembourg for your thesis?

I chose the University of Luxembourg due to several factors. The presence of quality material and human resources was one of the main reasons that helped me make this decision. In terms of hardware resources, I'm talking about high-performance computing servers, advanced computing tools, and the work environment. Researchers and experts in the field of artificial intelligence and well-structured research teams form a perfect human environment to conduct my research project. Finally, the good level of research funding by the Luxembourg government made all this possible.

What other countries and universities did you consider?

I knew that choosing a research body to carry out my doctoral thesis was very important and even decisive for my future professional career. Before making the final decision, I looked at several universities in Europe and North America. I was looking for a university of high standing which had a team of experts in the field of my research project. I considered universities in Paris, Toulouse, Liège, Munich, Bologna, Leeds and Montreal, but my final choice was the University of Luxembourg, even if the other universities were sometimes better classified. The University of Luxembourg really has advantages in terms of scientific research.



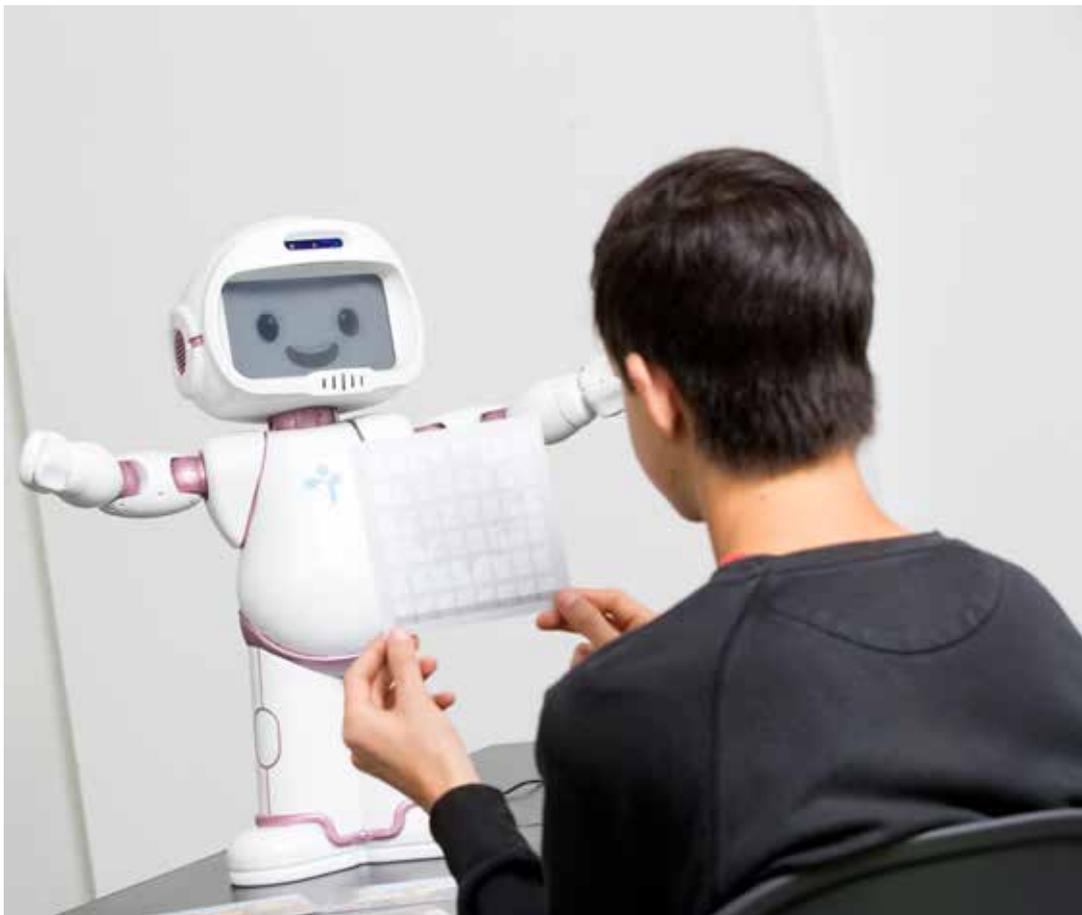
09.

ity, 3D printing, AI ...). Then a cyber-physical system of production (“CPS”) has emerged – an autonomous system integrating computer and electronic elements associated with sensors, which collaborate in order to control physical objects. Thanks to all its benefits, the German Federal Government has included Industry 4.0 in its “High Tech 2020” strategy.

In the environmental field, AI could be of great help combating climate change and ensuring a transition to some more sustainable production methods. Applications abound at this level, ranging from the regulation of energy consumption in smart buildings, to the establishment of short circuits and protection of biodiversity. Thus, for example, in the report “*Giving meaning to artificial intelligence*”, the mathematician and French deputy Cédric Villani, proposes the creation of a database combining data related to the electricity consumption in France, the content of air pollution, rainfall and sunshine. Analysing this kind of combined data would in fact allow us to adjust in real time our energy needs and production, while minimising polluting emissions and making a better use of pesticides in agriculture. He also proposes to build a map of living species and deforestation that could serve as a basis for actions to restore ecosystems.

09. Facial recognition is no longer in its infancy. Such programs bring considerable risks in the area of data protection and the possible infringement of individual liberty, including the freedom to come and go anonymously.

10. AI research is working intensively on emotional robots. In Luxembourg, LuxAI has developed a robot to improve the daily lives of autistic children and facilitate their integration into society.



Photos: Laurent Antonelli / Agence Blitz

10.

AI has a long history in the financial sector, which is an environment where algorithms are easy to use thanks to the encryption and standardization of masses of data. The first quantitative investment algorithms appeared more than ten years ago and are capable of automatically managing buy and sell orders based on different types of data (e.g. accounting figures, stock market trends). Currently, more sophisticated AIs can automatically analyse specialized blogs on a given market (e.g.: a blog about the price of a barrel of oil), pages of job offers or messages in social networks, therefore allowing, for example, an evaluation of a company's e-reputation.

AI also has a role in defence. In terms of military applications, it can be used to predict the risks of armed conflict, to guide a squadron of fighters, to command drones ... In addition, it strengthens civil security by aiding the police to deploy during demonstrations.

THE DARK SIDE OF AI: THE BLACK BOX PHENOMENON

If “*machine learning*” has allowed considerable advances in AI, it does have a major disadvantage: the opacity of its operation. Even if the data used to

feed the AI and its responses are clearly visible, there is still a grey area concerning how the data is processed by the machine to achieve this result: this is called the *black box phenomenon*. In a conventional computer program, the instructions given to the machine as lines of code define a given result for a given situation and allow us to know the machine's response in advance. In the case of machine learning, a multitude of examples will be presented to the AI, which will update its coefficients by comparing the expected result and the result obtained. In this case, the internal workings of the machine are invisible, and this can be problematic if we wish to use the applications of AI in cases where an error of judgment could have serious consequences, such as finding a tumour in an X-ray or a driverless car detecting a pedestrian. For AI to be usable and used, it requires more explanation, which is why some of the world's leading players on the AI scene, such as the Pentagon's *Defense Advanced Research Projects Agency*, have already launched the “*Explainable AI*” programme. The “black box” phenomenon, as an obstacle to the adoption of AI, may at first seem difficult to overcome, but it can still be nuanced. To do this, one can refer to some very concrete examples ▶



The unresolved question of moral dilemma

Suppose you are driving a car with two passengers. Suddenly, three pedestrians appear in front of you. You then must choose between running over them or deflecting into a concrete barrier and killing your passengers. What would you choose? Since 2016, scientists, seeking to ethically programme driver-less cars, have confronted users around the world with this scenario via “*Moral Machine*”, an online platform hosted by MIT (moralmachine.mit.edu). While the findings of the study provide some insight into how to program driver-less vehicles ethically, they nevertheless have considerable limitations as it has been found that the decisions made in this dilemma are largely subject to the cultural biases and personal beliefs of the respondents.



11.

of daily life: we don't need to understand exactly how a car or an airplane works to use them with confidence. The test protocols and the prior certifications offer enough assurance to the user. Thus, according to Yann Le Cun, one of the pioneers of AI neural networks, being unable to explain AI need not be a major problem as the human brain is also a black box and we ultimately learned to live with it.

THE LACK OF "COMMON SENSE"

Algorithms do not have what we commonly call "common sense": they work by statistical correlations without checking whether they follow a logic, and this could generate dangerously discriminatory biases. For example, the ProPublica investigation site showed in 2016 that a prediction tool for recidivism sold to American courts diagnosed a recidivism rate twice as high for blacks as for whites, although officially skin colour was not a criterion considered. Nevertheless, due to an accumulation of factors such as a legacy of historical discrimination, the AI overestimated the probability of recidivism in the black population. The existence of bias is therefore one of the obstacles that AI must absolutely overcome. On

this point, the relatively low presence of women in AI research may be a form of bias that affects the way the technology develops. As an illustration, a study by the Massachusetts Institute of Technology (MIT), conducted in 2017, revealed that facial recognition software worked better on men than on women and better on people with clearer rather than darker complexions, because AI programs had been mainly trained using photos in which white men were largely in the majority. The challenge is then clear: it is important to create systems that consider the peculiarities of all types of people and that do not reproduce discrimination present in society. In a context where only 12% of AI researchers in the world in 2017 are women (estimated by the Canadian company Element AI), feminisation of the sector has become a major issue.

THE PLACE OF FEELINGS

What we call "feelings" are hormonal processes, which is why the question of an AI feeling emotions is currently pure imagination. AI research nonetheless focuses on the development of companion "emotional robots" whose function is to detect emotions and



12.

simulate them to give the illusion of feelings. Thus, in Luxembourg, the *QTrobot* developed by LuxAI, serves as a treatment support for autistic children by teaching them to recognize emotions. Reproducing the phenomenon of emotion in an AI is a big research challenge, because emotion is highly contextual and rarely isolated or frozen. For an AI to interact with a human being to the point of being able to pass the Turing test, it must be empathic, but on this point, the technology is still in its infancy.

DATA SECURITY

An additional challenge for AI is to ensure the security of sensitive data against cyber-attacks. According to the 2018 Thales Global Data Security Report, 94% of organisations store critical data on the cloud and frequently use technologies such as Big Data, connected objects, blockchain and mobile environments that are relatively vulnerable to cyber-attacks. As a result, there are an increasing number of vulnerable areas, which could significantly increase the difficulty of maintaining the confidentiality, integrity, availability and authenticity of the data, which is still the fuel of AI. Facebook's security breach in Septem-

ber 2018 compromised the personal data of more than 50 million users and caused a surge in consumer mistrust of social networks which, in combination with the Cambridge Analytica scandal, led to the company losing 3.3 percentage points of its stock market valuation. A proper development of AI in the coming years, is therefore strictly and closely tied to data security. Another absolute condition to the successful deployment of AI is also its widespread social acceptance. In fact, it is not enough that a technology is technically usable and useful for it to be deployed. For example, a global survey conducted by PricewaterhouseCoopers in 2016 found that 54% of consumers would be willing to receive medical care from an AI, compared with 38% who would not, and 7% who did not know. ●

⁽¹⁾ Algorithmics is the study and production of rules and techniques that are involved in the definition and design of algorithms, that is, systematic problem-solving processes that accurately describe the steps to solving algorithmic problems.

⁽²⁾ Law N°1 : A robot may not injure a human being or, through inaction, allow a human being to come to harm; Law N°2 : A robot must obey the orders given it by human beings except where such orders would conflict with the First Law; Law N°3 : A robot must protect its own existence if such protection does not conflict with the First or Second Laws

11. The history of robots has evolved at blistering speed in recent years passing from the ancestors of the robot considered as a simple tool to a distant future populated by mechanical androids or humanoid robots endowed with an intelligence superior to that of man ...

12. Some envisage the future development of AI leading a rapid "hybridization" of humans to "transhumans", even imagining brain grafts of electronic components, which would allow us to improve our psychical and motor abilities ...



Shall we play a game?

Human or robot ?
Find the infographic poster inserted at the end of the magazine.