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# The Future of AI or AI for the Future

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**Abstract.** The third hype of AI and enthusiasm for applying last techniques in all fields raise great interest and some important questions on the future directions in AI research and applications. Guiding by the principle of combining the best from human and computers capacities this chapter lists some important challenges to face and related directions in AI research. Multiple interrelated crises such as natural disasters, pandemics and other generated by humans require new approaches, combining existing techniques and set new directions for research. This chapter presents briefly the Artificial General Intelligence (AGI) concept and the challenges to face in sustainability, smart resources management, future connectivity, industry, agriculture, health, economy and education. The presented vision for the future of AI includes both researchers' dreams and emergencies.

**Keywords:** Artificial Intelligence, Future, Planet protection.

## 1 Artificial General Intelligence or/and AI for Human Purpose?

The third hype of AI triggered some trends, but above all, new definitions such as narrow AI and large AI, weak and strong AI, unconscious and conscious AI [1,2]. All these new definitions are efforts to split AI into communities, while in fact intelligence is a whole system.

Like the first generation of AI founders, some researchers still work on trying to build a machine more intelligent than humans are. They claim to be able to build Artificial General Intelligence [3]. In his provocative video entitled: Machines playing God, Max Tegmark [4] reduces AI to deep learning. However, what he mentions as future work has been already developed since 1970s by researchers in Machine Learning such as R.S Michalski, R. Quinlan (EBG, generalization from examples) and some others [6].

Some build humanoid robots, but is it a priority in the world today while we have increasing number of unemployed and homeless? Or for super-intelligent killer-robots and drones [7]?

Do we need super-intelligence? What will be the place of humans in the artificial supra-intelligent society [4]?

Can such AI help facing today's complex challenges, mostly generated by human activities or influence people to be respectful?

Fighting Covid 19 pandemic, managing the economic crisis generated by confinement, understanding the new virus and elaborating vaccine are priorities. How can AI assist us in managing the Planet and biosphere protection?

According to experts, we entered to Anthropocene epoch [8] and it is urgent to multiply the efforts to protect our planet Earth. It requires minimizing our footprint by minimizing the use of energy [9] and water and minimizing all kind of pollution in order to preserve the air we breathe, water we drink and quality of food. All fields of human activity are involved: growing cities, transportation, technology with race for performance, agriculture, health, industry, etc. The current situation requires evaluation and monitoring of the impact of human activities.

This chapter discusses two possible futures – AGI and AI for human and planet purpose.

### 1.1 Four generations of AI

While Aristotle, Archimedes, Descartes and Leibnitz have laid theoretical foundations for AI, Norbert Wiener [10], Warren McCulloch, Walter Pitts, Donald Hebb [11] and Ludwig von Bertalanffy [12] have introduced cybernetics, artificial neural networks and a base for evolutionary algorithms before the official birth of AI in 1956. Alan Turing proposed the famous test in 1950.

**First generation** of AI is linked with the beginning of computers. Some call this period Early enthusiasm (1950-1970). First robot, called Perceptron, chess game, LISP, the first AI programming language designed by John McCarthy inspired the work on object programming and triggered the **second generation** of AI, those of Knowledge-based AI that has begun in the 1960s.

Object programming languages, Natural Language Processing (Prolog), various knowledge representation models, Case-based reasoning, Knowledge discovery techniques, constraint programming were born between 1970s and 1990. Many successful applications (1980-1994) demonstrated the usefulness of AI that since has been embedded in many applications in all fields [13].

In the middle of the 1990s Internet became the star and AI was temporarily shelved. Some talk about AI Winter (1995-2012).

**Third generation** of AI was born in 2012 from the necessity of exploring the exponentially growing amount of data generated by among others electronic commerce and social networks. This generation will not be possible without previous research and applications of known AI techniques such as Artificial Neural Networks enhanced with better computer performance, improvement of robots, humanoid robots, drones and Internet of Things (IoT).

**Fourth generation** is coming. It will combine deep learning exploration of unstructured data and knowledge-based AI to obtain the robust AI systems able to provide decision support and AI Systems as a service [14].

In his video John Launchbury (DARPA) illustrates the differences between three generations of AI (he forgot the first) by the capacities of Perceiving, Learning, Abstracting and Reasoning [15]. However, he forgot to include symbolic machine learning, initiated in the early 1970 by Ryszard S. Michalski, John R. Quinlan, Jaime G.

Carbonell, Tom M. Mitchell and some others [6]. Fig. 1 presents his 3rd generation (in fact 4th) of AI that will balance all four components.

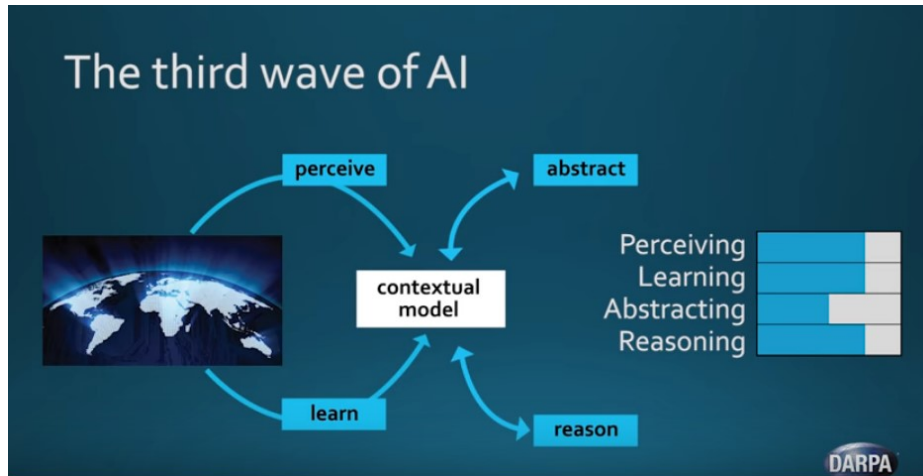


Fig. 1. DARPA Third wave of AI, source [15]

## 2 Artificial General Intelligence

The founders of the AI fields were largely concerned with the creation of hardware and software acting as human, even more intelligent. Mark Gubrud proposed the expression of Artificial General Intelligence in military context [16]. What is the progress from General Problem Solver (Newell et al, 1959)? Certainly, computers' performance allows quicker processing but the available systems still lack intelligence. Forbes states "AI systems that can diagnose cancers with greater accuracy than human doctors, there are many other fields where specialized artificial intelligence is replicating human-like reasoning and cognition." [17]. Did Forbes journalist never try googling image search? The quality of diagnosis however depends on the accuracy of data used for learning model and on the quality of learning algorithm. If the accuracy is similar to the results of available search engines, a diagnosis can be erroneous, while experienced oncologist still diagnoses better than those by the best algorithm. Deep learning combined with expert system may give better results. Some work on this kind of applications was done in the late 1980s in the Faculté de Médecine, Paris.

Another limitation of deep learning is the exploring of past data to predict the future. It may work in linear world, but not in today's dynamic one.

One of the main actors of AGI is Open AI [18]. They focus on the development of highly autonomous systems that outperform humans and will be beneficial for humanity. They aim to build safe and beneficial AGI, but also consider their mission has been fulfilled if their work aids others to achieve this outcome. Among their projects, we find the following:

- a neural network based generator of music; similar work has been done by Sony CSL [19]
- Components of robots, robot hand able to solve Rubik's cube, robots learning dexterity
- exploring multi-agents learning capabilities
- automated text generation
- learning sentiments

They explore mainly various deep learning algorithms. This research lacks examples of overall projects combining all these elements in an artificial intelligent system. Exploring multi-agent learning capability is a topic of research since the beginning of multi-agent systems in the late 1980s. Automated text generation has been studied and practiced since the invention of Prolog in 1970 by Alain Colmerauer team, Marseille.

Military research is more advanced, but most of the projects are confidential. We can only guess what is inside of Kalashnikov robots, UAV and other military advanced equipment [20].

Before designing AGI systems, it is vital to understand what intelligence is and how such systems can effectively collaborate with humans.

In 2005 Kurtzweil states, "Singularity is Near". Robots still have no intuition and are unable to hypnotize human, but is it necessary?

Some researchers focus on the simulation of the brain. Is it possible to simulate something if we have only partial knowledge about it?

Neuroimaging technology can deliver images. Experiments such as specific activity in MRI helps discovering some functionalities [21]. The brain is NOT just a supercomputer, it is much more than that and works in interaction with the other organs. According to multidisciplinary scientists [22], the brain is a system component of our body and interacts with the other organs. Some talk about connection between three "brains" equipped with neurons: brain, heart and gut or stomach, each plays a role in decision making.

Artificial neural network is simple implementation of biological neurons, which are much more complex.

The Human Brain Project [23] has begun in 2013. Sponsored by European Union it connects scientific and industrial researchers to advance our knowledge in the fields of neuroscience, computing, and brain-related medicine. It is composed of following platforms:

- Neuroinformatics (access to shared brain data)
- Brain Simulation (replication of brain architecture and activity on computers)
- High Performance Analytics and Computing (providing the required computing and analytics capabilities)
- Medical Informatics (access to patient data, identification of disease signatures)
- Neuromorphic Computing (development of brain-inspired computing)
- Neurorobotics (use of robots to test brain simulations)

The same year, 2013, White House announced the Brain Initiative. It is supported by several federal agencies as well as dozens of technology firms, academic institutions, scientists and other key contributors to the field of neuroscience [24].

The impact of such research may be beneficial in medicine, to cure serious diseases such as Alzheimer, other brain defects and in psychiatry.

In science fiction, AGI is associated with consciousness, sentience, sapiens and self-awareness. The current research is in its infancy for such capacities. Marketing is much more interested in “sentiment” analysis and eye tracking than in providing us with products that we really need. They never ask if someone did not find what he/she looked for. Is it so difficult to do or are they not interested?

Considering that it is more important to empower humanity by combining the best of human and best of computer we focus on AI for human and planet purpose.

### 3 AI for Human and Planet Purpose – what we expect from future AI?

Another trend in AI research and applications is collaborative intelligence human-machine. *“Computers are incredibly fast, accurate and stupid. Human beings are incredibly slow, inaccurate and brilliant. Together they are powerful beyond imagination”*. This citation attributed to Einstein proposes certainly better future than those transforming human into slave of “intelligent” systems or into “shopping machine”.

Years ago AI researchers and practitioners invented and have since experimented with various AI techniques such as natural language programming, expert systems, case based reasoning, constraint programming and multi-agent systems.

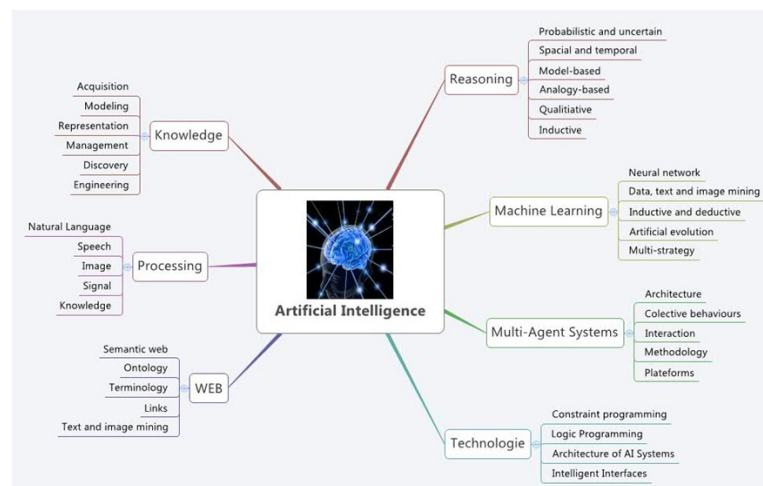


Fig. 2. Available AI techniques, source [9]

These techniques combined into hybrid systems and applied knowingly and wisely, allow solving the majority of complex problems generated by present challenges. However, it requires prior deep problem understanding and experience in applying the adequate AI techniques.

Today AI is “inside” numerous applications in all fields. The future of AI has to consider all these experiences to progress in right direction.

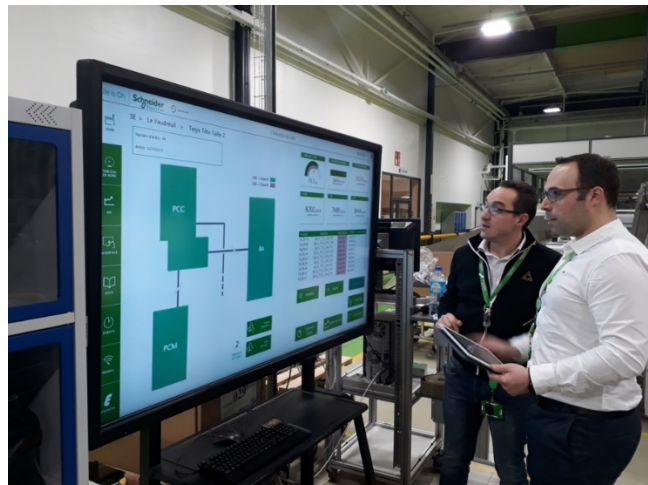
Between 1995 and today the AI research was awoken to business goals – sell more and quicker. This engine motivated development and improvement of various deep learning algorithms [25]. Most believe that it is possible to solve all kind of problems using deep learning; it has become “general problem solver” of the moment. Applied to navigation data to deduce client experience, for face recognition, eye tracking, chat bots, automated translation these algorithms give satisfactory results if the training set is correctly elaborated and if the algorithm is able to improve itself. For example, DeepL translator can learn from users who can correct the provided result if they know well a given language.

Nevertheless, sometimes the challenge is to find what is not in data. Life and intelligence is not about data.

In parallel, research in robotics progressed thanks to the innovation in electronics and miniaturization. The disasters such as Tchernobyl and Fukushima demonstrated the need for small flying robots able to evaluate the damage and act in the places that human cannot access. Similarly, for other risk management such as earthquakes and typhoons, where drones and flying robots provide great help to the human.

Surgical robots equipped with vision systems are also of significant help, especially in the situation when high precision is required. Disinfecting robots and vehicles demonstrated their usefulness during Covid 19 pandemics.

Industry 4.0 implemented the principle of collaboration human-machine in co-bots [26] and some factories of the future, such as those of Schneider Electric in Vaudreuil. AI powers the cyber physical systems and digital twins [27].



**Fig. 3.** Schneider Factory of the Future, Vaudreuil, source Schneider Electric [28]

Intuition and imagination combined with quick access to world base of problem solving give certainly better results than asking Sophia robot. We will still need truly intelligent personal assistants able to learn with the user, not necessary Alexa, Siri or more sophisticated robot.

In the nearest future, the AI approach to problem solving and combining deep learning with knowledge-based AI may bring significant help in many fields. It is very important and much more useful and ethical to build systems combining the best of human and of computer capacities instead of trying to reproduce human intelligence.

Deep understanding of inter-influences of human activity on environment may help finding acceptable co-designed solutions for preserving our biosphere and decelerating the Planet decline. (AI for sustainability)

Competition promoted by various ranking systems and research limited to a given field only are the barriers to progress by more collaborative and multidisciplinary research.

Technological innovation makes our lives easier. However, the progress without considering the impacts of human activities led to degradation of our living conditions. Many factors affect the sustainability. One of them is quick technological progress, considered as powerful engine of economy. It brings many benefits for humanity, but contributes also to Planet Crisis. Computers, smartphones, IoT and other devices are quickly outdated. The combination of various communicating software requires “up-to-date” hardware to run correctly. Most of hardware are not eco-designed and need raw material that has become scarce. Despite the large introduction of Corporate Social Responsibility, some companies still practice planned obsolescence to generate more revenues.

Social networks and various applications generate an exponential amount of data stored in data centers that need cooling. Fortunately, some apply circular energy to reduce impact on environment, but still those in Scandinavian countries clearly contribute to the rise of temperature and melting of ice.

What do we have that can be reused/improved and what needs to be invented?

### 3.1 Challenges to face

Among the challenges for humans and for planet: fix existing disaster and make IT smarter and greener.

After health, time is probably one of the most important assets. Traditional IT can be smarter with AI inside. In her invited talk to 6<sup>th</sup> AI4KM, Helena Lindskog pointed out the importance of being “time rich” today and set up the challenge for AI is to help us have more time for innovation, for family, to discover and enjoy nature and other activities [29]. Make the IT friendly and intuitive, greening the software, smartening data centers are among the wishes. Computer learning with its user, his/her interests is the opposite of what we have today - pushing all kind of advertisement. AI should be able to understand the content of my emails, clean my email box and answer easy ones. I dream about intelligent assistant helping me find the file talking about a given topic or drawing/image to illustrate what I am writing.



Intelligent electronic commerce with immediate association of offer and demand, without categories; client describes his/her wishes or present a picture to “say” what I want.

Association of offer and demand such as job searching for me in my place, like restaurant on google map, service provider, spare pieces, repair café, 3D printer close to my place.

Imagine I switch on my computer or other device and immediately I get the results of relevant search proposed by embedded intelligence, knowing my profile.

Intelligent translator exists already, eg <https://www.deepl.com/translator>. The pronunciation of the translated text will be beneficial. When traveling, the real-time accurate conversation translator is of considerable help. Can such translators in the long term prevent us from learning languages (and using our brain)? Will our brain become lazy?

Today we have to face important challenges, such as those of UN for sustainability. AI can directly improve goal 6, 7, 9, 11 and next from Fig. 4. It may also influence improvement of others.



Fig. 4. Sustainable Development Goals, source un.org

According to Anthony Wang [30] it is over 70 various principles for AI ethics. One of the most repeated is that AI has to be beneficial for humanity. I add “and the planet”.

### 3.2 From “intelligent” assistants to helping the user

Intelligent assistants can take several forms:

- personal, working for one user
- for children protection
- linked to a company website or a platform answering the clients questions
- “street” assistant helping visitors/tourists

- in shop assistant, especially in big one guiding clients to the products they need
- inside of museum, expositions
- for people with disabilities

All have access to available resources and are designed to provide the user with immediate and relevant information, help, advice or a solution to a given problem. They have to “know” what the users do not know.

My dream is to have personal assistant able to learn my interests, scan all available and fake checked resources and provide me with the timely relevant information and this way participate in opportunity “hunting”. It has to be capable of immediate finding a document in my computer related to the topic I ask, picture or drawing. Producer of Korean TV series “My holo love” imagined such an assistant, able to learn from user and improve its “knowledge”. It is only visible and available for its user wearing special glasses. The only problem to solve is to preserve the user’s intimacy when he/she is talking to invisible assistant [31].

The relevance of answers from automated assistant depends today on the quality of data and of learning algorithm. Both chat bots and connected assistants are involved. However, assistants available today need the capacity of “understanding” the question and provide relevant and verified answer. Equipped with multimodal interface it should follow me in my travels and “talk” languages that I do not talk, help finding the right word or expression in languages I talk, provide help for writing in other than the languages I master. Many comparator applications are available such as for tourism or insurance, but no one provides the optimal offer for the end user, because they work for their clients.

Having the access to medical cases, an intelligent assistant can provide the basic help before going to the doctor. It can also teach the user the preventive actions.

### 3.3 AI in school

Deep learning facilitated the development of intelligent assistants. For the most, they are helpful; however, they do not encourage people to think. Thinking and ability to use alternative cognitive approaches makes the difference between someone who just follow the school program and those able to solve problems using knowledge and limited resources. Thinking “without borders between fields” and ability to find alternative, greener solutions. Many professions change with technology and school has to prepare students for being flexible.

E-learning was introduced in schools at the beginning of 21<sup>st</sup> century. Many courses (MOOC) are now available online opening access to large knowledge at all levels and providing education to the rural zones without schools and to developing countries.

Digitalization of educational activities introduced tablets and now robots in schools. Educational games make learning more fun and attractive. What is missing is a sort of “super professor” able to evaluate a level of the student and to propose the best suited material from the web matching to the student profile and request. Still intelligent assistants can provide help explaining topic or exercise.

During Covid19 lockdown children had to learn at home. An i-teacher detecting difficulties of each, explaining and challenging is certainly helpful. It requires AI not only tracking activity but able to “understand” what child is doing and when he/she needs help. Challenging assistant – not switching off the brain, but stimulating thinking and suggesting various approaches.

Most of schools follow the teaching program, but few take care of the specific children talents with the aim of helping them to choose their professional future. We can imagine an AI –based Future Advice office combining the adequate AI techniques to evaluate talents, propose a game to test some professions with projection how it will evolve during the next ten or more years. Several years ago, the entertainment park Kidzania [32] was open for children to make them try various professions. The IT and AI-related professions have to be added to the spectrum of those proposed.

### 3.4 AI & food

In the age of processed food, the related industry aims to produce more food for less price regardless of nutritional quality. Pesticides and artificial fertilizers are massively used on the pretext of a duty to nourish the planet. Doing this they destroy and impoverish the soil, pollute water and pests become more resistant. Globalization allowed pests to travel long distances hidden in goods; some are very harmful for local environment and difficult to fight with, because they are often unknown, as COVID is. According to Intel and some others, the world will need to produce 50 percent more food by 2050. Nevertheless pushed by food business, the food waste today is evaluated around 50% only in the United States [33]. Food is lost or wasted for a variety of reasons: bad weather, processing problems, overproduction and unstable markets cause food loss long before it arrives in a grocery store, while overbuying, poor planning and confusion over labels and safety contribute to food waste at stores and in homes. Uneaten food also puts unneeded strain on the environment by wasting valuable resources like water and farmland. Reducing food waste by just 15 percent could provide enough sustenance to feed more than 25 million people, annually. Food loss occurs on farms for a variety of reasons. To hedge against pests and weather, farmers often plant more than consumers demand. Food may not be harvested because of damage by weather, pests and disease. Market conditions off the farm can lead farmers to throw out edible food because the shape is out of the norms. If the price of produce on the market is lower than the cost of transportation and labor, sometimes farmers will leave their crops un-harvested. This practice, called dumping, happens when farmers are producing more of a product that people are willing to buy, or when demand for a product falls unexpectedly.

During the COVID-19 pandemic, for example, farmers lost a major portion of their business due to restaurant and school lunchroom closures as well as a lack of workforce for gathering.

In the recent video entitled Sustainability European Space Agency (ESA) shows-up the satellite images demonstrating how far COVID affects the food production. They deplore the impact of border closures on the harvesting of fruits and vegetables [34]. Yet, because of the economic crisis, many people are partially unemployed and this

workforce is not correctly managed. AI can help manage all kind of resource, but this potential is underused today.

AI system is able to detect from satellite images the zones to harvest or infected ones. Thinking – They have images of underexplored zones that can be cultivated to produce food locally. Some use harvesting robots; however, it should be cost effective.

Various AI techniques are already used to help farmers. Drones “decide” when coffee and oranges are ripe enough for picking (Hawai, Bresil). They can also detect pests’ invasion. Hopefully in the near future, we will have devices not only detecting, but selectively (pest recognition) absorbing them instead of using pesticides. Logistics planned with constraints programming to optimize time and trucks should be more widely used. Sensors connected to automated watering help optimizing the use of water.

Greenhouse tomatoes grow in a bed of pulped coconut husks, a nutrient-free environment that allows the growers controlling what goes into the plant. Sensors monitor the fruit’s progress toward perfect ripeness, adjusting light to accelerate or slow the pace of maturation. However, this kind of farming requires considerable processing power.

We can imagine another approach combining the knowledge about soil and environment with knowledge about crop rotation, association of vegetable/fruits to avoid pests attack, chose the right period for sow and plant in function of available seeds. Such farmer advisor programmed applying green software principle can be powered with solar energy.



**Fig. 5.** Connected Farmer, source [35]

While the harvesting machines have been used for years, they are now replaced by robots. Robotic harvesting equipment, partially in response to labor gaps that have left farmers scrambling to harvest crops like fruits and berries. Harvest Croo berry picker operate on the basis of machine vision and sensor fusion to “see” where harvest fruits and berries are. They use sophisticated directed movements to pick precisely [36].

Unmanned aerial vehicles or drones being outfitted with precision sensors, in order to run the fields and get the data that’s needed. These airborne surveillance devices can look for stunted crops, signs of pest or weed damage, dryness and many other variables that are part of the difficulty of farming in general. With all of this data in hand, farmers can enhance their production models and their strategies across the lay of the land to decrease risk, waste and liability [37].

Main challenge is still protecting plants against weeds and various kinds of pests outdoors. Another alternative is to grow in greenhouses, which is being done as well, but some of the most amazing farming technology is being deployed outside. The “See & Spray” machines are an excellent example of combining artificial intelligence and computer vision [38]. Deploying mobile technologies with AI and computer vision built in, farmers can find weeds and eradicate them, instead of blanket spraying an entire crop. That makes the food cleaner, and it saves enormous amounts of money. It’s just another example of real new technologies that are having a dramatic impact on yields and everything else.

The transition from conventional agriculture practices into a sustainable mode of growing food can lead to social and economic equity and a healthy environment. In the nearest future we expect connecting the modern, AI powered systems with ancestral knowledge about how to cultivate without pesticides and with natural fertilizers. Maybe the future agriculture will be not about large farms but smart ones. Autonomous houses and farms can be monitored by AI ensuring optimized use of locally available resources and minimized impact on the planet.

### **3.5 AI for risks/crisis management**

Irresponsible human activities have led to Planet disaster. The increased frequency and magnitude of natural risks and those caused by humans requires new, quicker and more effective ways of managing them. Frequent fires mostly of criminal origin destroy forest, our lungs and its ecosystem. In many cases, AI demonstrated its potential to help managing these disasters [39, 40]. Earth observation systems can be applied for various risk management, whether caused by humans or natural risks. Fukushima, tsunami, earthquake, flooding require quick organizing of emergency actions involving people, hospitals, vehicles and other resources aligned to given disaster.

Facing Covid19 pandemic has multiple effects on health, on jobs, on economy, education, agriculture and environment. The researchers and medical staff are learning from examples and experiments. Handling such crises require related knowledge and smart managing of existing resources, real-time planning of hospital staff, equipment and quick finding of vaccine. Existing AI techniques can help in first stage diagnosis online to refer the patient to the right doctor. AI can optimize the allocation of beds,

equipment, staff in function of their competencies and specialties. AI support exploration of clinical trials and accelerate finding of vaccine. Evaluation of efficiency of health policy [41] can be used as model for pandemic management and evaluation of induced risks.

In his TED Talk from 2015, Bill Gates states that pandemics are the greatest threat we will have to face in the future [42]. He said we need global alert system, technology, expertise, collaboration medical-military, simulation and diagnostic. Alternative is the understanding of real causes of pandemics and other serious risks in aim of avoiding and preventing them. Investments are necessary to fix the problem once it happens, but informed prevention avoids human, economic and environmental losses.

### 3.6 AI for sustainability

Paradoxically AI needs devices, mostly designed with “planned obsolescence” principle to preserve continuous business. While “green software” has been slowly introduced, few really apply these principles. All fields are concerned and evaluation of impacts before doing should become mandatory. AI may play a greater role in simulation before doing, choosing the right raw material and design easy to update or to recycle [43]. IT and Information Systems should be eco-designed, which is not the case today. The management and storage of big data generated massively can be controlled by using conceptual models instead of storing all data. AI can effectively support optimization of hardware and software design. Neural computers are not new, but with the new hype researchers works again on this architecture. We do not know yet how far it can contribute to sustainability because nobody is in charge of this aspect. Similarly, designers of quantum computers focus on computation power and do not consider the eco-design.

Race for performance and connectivity pushes designers to 5G, which is not necessary the best choice because of the impact on living. AI-based decision support systems connected with innovative design methods such as TRIZ [44] may help designers finding alternative solutions. The trendy design thinking, known longtime before as “innovation with clients” [45] or extreme programming [46], has to integrate these principles.

Maybe researchers and designers by nature (biomimetics) take into consideration these aspects. Nevertheless, AI offers a spectrum of techniques helpful in optimization and verification of environmental and other constraints.

The case of Smart City, mainly based on technology offer a playground for water and energy (including renewable ones) optimization, smart eco-buildings, green and optimized transportation of people and goods, opportunity finding (job, service, training).

All human activity that have affected our biosphere and planet is concerned and AI can help minimizing this impact and do things smarter [8]. Preserving the balance in our biosphere will be beneficial for all living today and tomorrow.

### 3.7 AI and the Financial Service Industry

Without any doubt AI has a huge impact on the future of the financial services industry. This is widely acknowledged and described in many articles and reports [47, 48, 49, 50, 51, 52, 53], labelling it “revolutionizing / transforming / disrupting the industry”. In an already highly digitized sector, AI adds an extra dimension in a number of areas. It offers new opportunities, both for new players and for incumbent institutions. It also brings threats, in particular to the established parties who have a legacy in their infrastructure and services.

Often mentioned areas where AI is transforming the industry are:

- Fraud detection and risk management. AI is extremely helpful in detecting and identifying fraudulent transactions, learning from past spending behaviors.
- Regulatory compliance. The financial services industry is heavily regulated. AI can help an institution to keep up to date with changing regulations and to be compliant with rules like Know Your Customer (KYC), anti-money laundering regulations, etc.
- Customer experience. Customers nowadays expect a more personalized offer of services. Developments like chatbots that, with the help of AI, can identify the individual customer, “understand” and interpret his or her emotions via voice and/or facial recognition and subsequently can offer “tailormade” advice found in existing database.
- Managing personal finances. With the move to mobile banking and the use of wallets, AI offers opportunities to help customers make smart decisions on spending, saving and investing money. This can help improve the “financial health” of many people. Managing finance, AI simply accumulates all the data from your web and other footprints and creates your spending graph.
- Investment advisory. Here predictive analytics and recommendation engines turn into digital advisors that can even fully automate purchase and management of investments. The result is no longer a need for financial advisors / relationship managers.
- Predict stock performance. Trading and investment depend on the ability to predict the future of (stock) markets accurately. Predicting this in a consistent way seems impossible for humans. Deep learning algorithms could perhaps achieve this as a result of using massive amounts of market data complemented with real-time economic and political data.

An example of the trading issue is high frequency trading (HFT). While not new in itself, since a little over a decade the execution time of transactions has moved from seconds to milli- and microseconds. HFT is a form of algorithmic trading which can arguably be labelled as an AI implementation of trading. The profits of HFT however seem to have passed their peak performance. Besides limitations caused by the infrastructure (hardware, networks) also the limitations of the algorithms play a role. Perhaps deep learning could give HFT a new boost. In [54, 55], as in many other articles, benefits but also risks are listed. Algorithms are not infallible, understanding how the algorithms and neural networks predict specific outcomes is difficult if not impossible

(black box), high investments needed which could result in only a few players surviving (compare the world of the big tech firms).

All these developments will have a major effect on the workforce, not only in the number of employees but also in the types of jobs and skills needed for them. Another major impact is a change in the players in the financial landscape. The incumbents (current banks, insurance companies, pension funds, investment companies, etc) already face strong competition from the so-called fintechs in some areas. But also the bigtechs (Amazon, Google, Facebook, Alibaba, ...) are entering the financial services industry. We seem to move towards a platform economy where the bigtechs have an advantage with their strong customer base to easily offer additional (financial) services to their customers, knowing what their customers want thanks to AI.

Benefits of AI in the financial services industry are clear but so are the risks. Not only for a single financial institution but also for customers, for the trust in the financial system and for the financial stability in a country or even on a global scale. That is why in [48] it is stated that *“Financial firms using artificial intelligence (AI) should adhere to principles of sound and controlled business operations. A responsible use of AI in financial services means that firms should pay due attention to the soundness, accountability, fairness, ethics, skills and transparency aspects of the applications they develop.”*

#### **4 What perspectives for research – what humanity expects from Future AI?**

Throughout this chapter we have already mentioned some needs, expectations and wishes for the future AI. In term of disruptive innovation, the current AI represents a little progress since its beginning. The AI techniques that we have today has been invented before and are recently extended to more powerful and to new applications. The wise combination of them in the hybrid systems allows facing today's challenges. What AI we need today and tomorrow?

Michael Zeldich (Artificial Labour Leasing) designs subjective robots. Such robots used for example for house cleaning learn with their users and are limited to perform what users ask for. He believes that our duty is to create an artificial society able to resist the planet's destruction and preserve our civilization.

Before we invent something else or all die, there are two main options for AI: to continue to progress with AGI or work on the challenges we have to face and then derive new theories and invent new approaches and techniques. The first requires deep understanding of how the human body works, how the organs are connected, how we interact with our environment. What future humans can expect from the AGI world?

According to WEF [53] *“Nevertheless, it is evident that more research needs to be done in order to better understand the opportunities and challenges brought about by the eventual mass adoption of AI in Financial Services. For instance, how can finance firms open up the ‘black box’ of AI and facilitate more explainable and transparent applications? As AI is becoming increasingly autonomous, what will the roles of humans be and how would an effective human-in-the-loop AI system manifest itself? What*



*are some socioeconomic repercussions and ethical implications of AI-induced biases and risks? How can regulators and policymakers harness technology solutions to effectively regulate and supervise AI in finance?"*

These remarks about research trends, regulators and policymakers do not only apply to the financial industry but also to many others if not all sectors where AI is having or will have a major impact. So research is also needed to help regulators and policymakers, especially by providing them with simulators.

The issue of confidentiality of personal data is not easy to deal with. The same applies to our navigation and tracking data. Many websites refuse of access to information if the user does not accept them. However, it is much more relevant to obtain the right information from the user by asking instead bombing him/her with cookies and all sort of add-ons. AI can do much more than just analyze the data. Nevertheless, it requires a different way of thinking.

AI research should be multi- and interdisciplinary because intelligence is. We still need to progress in comprehension of our brain/body capacities.

Future AI research should balance needs and ambitions. The Covid 19 crisis clearly demonstrated that collaboration may lead to better and quicker results. World experience in AI applications for solving complex problems should be available allowing finding immediately the solution for the problem someone has to solve.

Information processing, still conceived using traditional methods such as categorization, "data thinking", processes should evolve not by adding AI layer, but "AI thinking". We need systems able to adapt the configuration automatically working with the user, able to find immediately the file, image or video the user look for.

Hardware and software should be eco-designed and easy to recompose/recycle. AI based simulators help finding right components, minimize and "smartize" the software for the minimal energy use. MIT offers Climat Interactive simulator [56].

We need smart AI-powered search engines. For example, the EU database Cordis is a real "goldmine" containing information about the funded research projects and their results that may inspire researchers, industrial people and investors but it need to be equipped with smart, business free, search engine for immediate finding what visitor is looking for. It can be also useful for exploring the available results for quicker progress, for quick and relevant access to references in a given field.

We need decision support systems rather than fully automated decision making, that are not 100% reliable in case of missing data in critical situations.

Many challenging research problems can be found in sectorial applications such as in agriculture, health, education, banking and others. In the nearest future we expect connecting the modern, AI powered systems with ancestral knowledge about smart farming.

Health offers a great opportunity for AI research, especially in understanding and prevention of new viruses and serious and other diseases.

Education is among the pillars of modern society. Existing MOOC, e-learning and other online teaching and training systems may be improved by interactive e-teacher, however we still need a talent detector able to encourage learners to think and direct them to the area they are gifted for.

Planet protection, smart sustainability, innovation management offer also interesting challenges.

Detecting and tracking cyber and other criminals, identity thieves or global security are just a few fields of exploration for AI.

Multidisciplinary research without “borders” between fields and full exploring of all machine learning techniques, including symbolic, may help in elaborating of general solvers. Of course, this requires evolution of research evaluation criteria.

In this context, is it necessary to build a machine able of consciousness, sentience, sapiens and self-awareness?

Instead of splitting AI lets connect the research fields for more spectacular results and for human purpose.

We expect a global smartening of AI and IT researchers.

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