

# UNIMAGINED FUTURES - ICT OPPORTUNITIES AND CHALLENGES PDF, EPUB, EBOOK



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However, data science is much broader and also includes data extraction, data preparation, data exploration, data transformation, storage and retrieval, computing infrastructures, other types of mining and learning, presentation of explanations and predictions, and the exploitation of results... Expand. View on Springer. Save to Library Save. Create Alert Alert. Launch Research Feed Feed. Share This Paper. Figures and Tables from this paper. Citation Type. Has PDF. Publication Type. More Filters. Research Feed. Preventing and facing new crisis and risks in

complex environments. Data Scientist: The Engineer of the Future. Often, the way things turned out exceeded our wildest imaginings, and we can be sure that this will be no different in the times ahead.

While addressing the contemporary challenges facing the ICT community today, the book provides the opportunity to look back to help understand what we now face and identify appropriate future responses to these challenges. As such, the book aims to contribute to the ICT community worldwide, as well as IFIP and its member societies, in setting their policy priorities and agendas for the coming decade. We hope to provoke discussion about appropriate responses to the challenges by individuals as well as by national and international bodies including IFIP. Many topics would have deserved a chapter in the book, but for practical reasons the editors decided to finalize the book with a rich collection of topics divided in 17 chapters by 23 authors.

## “Unimagined Futures” Now Available - IFIP News

Alan Turing proposed the famous test in First generation of AI is linked with the beginning of computers. Some call this period Early enthusiasm— Object programming languages, Natural Language Processing Prolog, various knowledge representation models, Case-based reasoning, Knowledge discovery techniques, constraint programming were born between s and Many successful applications — demonstrated the usefulness of AI that since has been embedded in many applications in all fields [13]. In the middle of the s Internet became the star and AI was temporarily shelved. Some talk about AI Winter — Third generation of AI was born in 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]. However, he forgot to include symbolic machine learning, initiated in the early by Ryszard S. Michalski, John R. Quinlan, Jaime G. Carbonell, Tom M. Mitchell and some others [6].

Figure 1 presents his 3rd generation in fact 4th of AI that will balance all four components. Mercier-Laurent Fig. Mark Gubrud proposed the expression of Artificial General Intelligence in military context [16]. What is the progress from General Problem Solver Newell et al. 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.

Another limitation of deep learning is the exploring of past data to predict the future. 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. 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 s. Automated text generation has been studied and practiced since the invention of Prolog in 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. 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.

Artificial neural network is simple implementation of biological neurons, which are much more complex. The Human Brain Project [23] has begun in 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 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 24 E. 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.

Another trend in AI research and applications is collaborative intelligence humanmachine. Human beings are incredibly slow, inaccurate and brilliant. 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. 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. The future of AI has to consider all these experiences to progress in right direction. Between and today the AI research was awoken to business goals — sell more and quicker.

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. AI powers the cyber physical systems and digital twins [27] Fig. Schneider factory of the future, Vaudreuil, source Schneider Electric [28]. We will still need truly intelligent personal assistants able to learn with the user, not necessary Alexa, Siri or more sophisticated robot. Mercier-Laurent 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. 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. After health, time is probably one of the most important assets. Traditional IT can be smarter with AI inside. Make the IT friendly and intuitive, greening the software, smartening data centers are among the wishes. AI should be able to understand the content of my emails, clean my email box and answer easy ones. The Future of AI or AI for the Future 27 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, e. 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. It may also influence improvement of others. Sustainable development goals, source un.

One of the most repeated is that AI has to be beneficial for humanity. It has to be capable of immediate finding a document in my computer related to the topic I ask, picture or drawing. It is only visible and available for its user wearing special glasses. 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. 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. 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. Many professions change with technology and school has to prepare students for being flexible.

E-learning was introduced in schools at the beginning of 21st 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. 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. 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 The Future of AI or AI for the Future 29 [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. 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. 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 product 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 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.

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. 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.

Mercier-Laurent Greenhouse tomatoes grow in a bed of pulped coconut husks, a nutrient-free environment that allows the growers controlling what goes into the plant. However, this kind of farming requires considerable processing power. Such farmer advisor programmed applying green software principle can be powered with solar energy Fig. Connected farmer, source [35]. Robotic harvesting equipment, partially in response to labor gaps that have left farmers scrambling to harvest crops like fruits and berries. They use sophisticated directed movements to pick precisely [36]. 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].

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. 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. 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. 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, 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. Mercier-Laurent 3. 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. 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. 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. AI is extremely helpful in detecting and identifying fraudulent transactions, learning from past spending behaviors. 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. Customers nowadays expect a more personalized offer of services. 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. Managing finance, AI simply accumulates all the data from your web and other footprints and creates your spending graph. Here predictive analytics and recommendation engines turn into digital advisors that can even fully automate purchase and management of investments.

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. 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. 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. 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. 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.

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? 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? 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. 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. 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. The Future of AI or AI for the Future 35 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.

MIT offers Climat Interactive simulator [56]. We need smart AI-powered search engines. It can be also useful for exploring the available results for quicker progress, for quick and relevant access to references in a given field. 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. 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. I would like to thank Leon Strous for his contribution to paragraph 3. Jajal, T. Bersini, H. Artificial General Intelligence 4. Tegmark, M. Michalski, R. Ten secret military technologies, video, June Mercier-Laurent, E. Wiley, Hoboken 9. Kayakutlu, G. Elsevier, Amsterdam Wiener, N. Houghton Mifflin Company, Boston Johnson, R. Wiley, Hoboken Rauch-Hindin, W. Prentice-Hall, Upper Saddle River Launchbury, J. Gubrud, M. Naveen, J. Forbes Open AI. Accessed 07 June Pachet, F. Military and others robots. Accessed Feb Le Bihan, D. Princeton University Press, Princeton Rajvanshi, A.

Speaking Tree, Gurgaon Deep learning algorithms. Monsone, C. Schneider Future Factory. Linskog, H. In: Mercier-Laurent, E. AI4KM Wang, A. My holo love. Food waste. Accessed May Precision Farming — sowing the seeds of new agricultural revolution. Harvest croo. Accessed 29 May Gonzalez-De-Santos, P. IJMDM 17 2 Evaluation of efficiency of health policy. Amidon, D. Butterworth Heinemann Extreme programming. Infosecurity Group, Oliver Smith, 24 December Maruti Techlabs Akioyamen, P. Accessed 7 June Seth, S. Our regulatory systems have attempted to keep abreast of new technologies by recalibrating and adapting our regulatory frameworks to provide for new opportunities and risks, to confèr

rights and duties, safety and liability frameworks, and to ensure legal certainty for businesses.

These adaptations have been reactive and sometimes piecemeal, often with artificial delineation on rights and responsibilities and with unintended flow-on consequences. Previously, technologies have been deployed more like tools, but as autonomy and self-learning capabilities increase, robots and intelligent AI systems will feel less and less like machines and tools. This chapter provides brief insights on some of the topical developments in our regulatory systems and the current debates on some of the risks and challenges from the use and actions of AI, autonomous and intelligent systems [1]. With the rise of these new technologies we have taken many initiatives to address their consequences by recalibrating and adapting our regulatory frameworks to provide for new opportunities and risks, to confer rights and duties, safety and liability frameworks, and ensure legal certainty for business.

Sector-specific regulation has also been adopted and adapted to address market failures and risks in critical and regulated domains. These changes have often been reactive and piecemeal, with artificial delineation of rights and responsibilities. There have been many unintended consequences. AI and algorithmic decision-making will over time bring significant benefits to many areas of human endeavour. The proliferation of AI systems imbued with increasingly complex mathematical and data modelling, and machine learning algorithms, are being integrated in virtually every sector of the economy and society, to support and in many cases undertake more autonomous decisions and actions. How much autonomy should AI and robots have to make decisions on our behalf and about us in our life, work and play? How do we ensure they can be trusted, and that they are transparent, reliable, accountable and well designed? Previously, technologies have often been deployed more like tools, as a pen or paintbrush, but as autonomy and self-learning capabilities increase, robots and intelligent AI systems feel less and less like machines or tools.

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However, a shared definition of SC is not ... Expand. View 1 excerpt, references background. Earn money by sharing your favorite books through our Affiliate program. Become an affiliate. He taught AP and IB history classes. Grier's television credits are abundant. Grier is well known as being a principle cast member of the acclaimed television series "In Living Color," where he helped to create some of that show's most memorable characters, and also as a co-star on Bonnie Hunt's hit ABC comedy "Life With Bonnie."

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## **Unimagined Futures – ICT Opportunities and Challenges | Leon Strous | Springer**

As such, the book aims to contribute to the ICT community worldwide, as well as IFIP and its member societies, on setting their policy priorities and agendas for the coming decade. We hope to provoke discussion about appropriate responses to the challenges by individuals as well as by national and international bodies including IFIP. The title Unimagined Futures: ICT opportunities and challenges reflects the fact there were many futures in the past that happened without our having envisaged them, and there are multiple futures that we now speculate about.

Often the way things turned out exceeded our wildest imaginings and we can be sure that this will be no different for things to come. Maybe by becoming more imaginative and creative, we can create even better unimagined futures. The ICT workforce since has changed from programmers, analysts, and operators numbering a few tens of thousands worldwide into the highly diverse multi-million strong body we see today. For the end user, there are no longer levels of intermediaries between them and the computer—programmers to create software and operators to run the programs. Users have direct access to their PC or mobile device providing access to applications undreamt of in He went on to observe that telephone technology rapidly set about automating the connection process so that every telephone user was transformed into an operator by giving us all initially a dial and latterly a keypad.

While the contributions were invited and not peer-reviewed like in conference proceedings, all chapters were reviewed by two editors to assure its quality by providing feedback to authors. Historical and even personal aspects may show up. They present internationally relevant technical contributions with a reasonable topical focus. As such, the Festschrifts also contribute to the principal aim of the IFIP AICT series to encourage education and the dissemination and exchange of information about all aspects of computing. The editors accept full responsibility for the choice of topics, realizing that many more topics would have deserved a chapter in the book. We are very pleased with the rich content of the contributions and by making the volume open access, we trust that it will be read and enjoyed by many. His research interests include process mining, Petri nets, business process management, workflow management, process modeling, and process analysis.

Wil van der Aalst has published over articles and books and is typically considered to be in the top 15 of most cited computer scientists with an H-

index of over and more than , citations. In , he was awarded an Alexander-von-Humboldt Professorship. Ron Berndsen Prof. Her main contributions have been in areas like interactive television, games, and x Authors entertainment-oriented applications.

Her special topic is how to allow people to stay in control of a system, but as well as to stay in control over their data privacy and their lives. Today she is the president of this Working Group. She has been actively involved in the TC Interact conference since in various roles and was Papers Chair for Interact in Vinton G. Cerf Vinton G. His research focuses on the use and misuse of information systems, especially with respect to problem solving, guanxi formation, and knowledge management in Chinese organizations. He has published over articles in a variety of the premier IS journals and conferences.

He is particularly known for his scholarship in the domain of action research. Robert seeks to enhance the inclusion of scholars from the global south within our community and frequently visits developing countries where he offers research seminars and workshops, engaging with PhD students and scholars. As a researcher and as an editor, he champions local and indigenous perspectives. Moira de Roche Moira de Roche is an independent consultant. Moira is an accomplished speaker and has presented at conferences around the world, including South Africa, on diverse subjects such as Technology and Learning, IT Leadership, Future Skills, and more. Her speaking engagements on behalf of IP3 have seen her speaking on Professionalism, Trust, and the Duty of Care in Digital, as well as people-related issues with Industry 4. She has attended and presented at the World Summit for Information Society since He worked at Bell Laboratories on hypercube parallel computers, Ansoft Corporation now Ansys developing the sparse matrix solver for the High Frequency Structure Simulator HFSS, mentioned in the article , and in a project management role.

He later joined Sandia National Laboratories performing research on supercomputers, cryogenic computers, quantum computing, and spacecraft computing. He is now the principal of Zettaflops, LLC. His main research interests are topics related to technology, sustainability, and ethics, and he is teaching ethics, and sustainability to engineering students. Roger Johnson Dr. He published extensively on database management and later the history of computing. Springer ; and Technology and Intimacy: Choice or Coercion? He was Editor of the proceedings for all three conferences, including the eBook of HCC14, which went ahead. His research interests include the interactions among science, technology, and culture. She has organized several international and national conferences, and has been, and still is, Chair of several Program and Editorial Committees.

Among her research topics are: Knowledge and Eco-innovation Management Systems, methods and techniques for innovation, knowledge modeling and processing, complex problem solving, AI for sustainability, and eco-design and impacts of AI. She is representative of TC in France since Before his retirement in he was a Director of Charteris plc for 18 years and before that a Partner in Deloitte Consulting for He practised as a management consultant and as an expert witness in large scale IT disputes. She played an important role in the development and growth of the company and its market research in different sectors like services, channels, and networks. In the beginning she worked closely with Paul Strassmann and Tom Pisello. Topics LRWA addressed lay in the area of the added value of IT, how to achieve that within organizations, and how to deliver as an IT company added value. It became more and more clear that skills, attitude, and competences of human capital within organizations were the differentiator between a positive or negative result.

She currently spends most of her time ensuring that professionalism of the ICT world and digital skills of professional users and citizens are taken seriously, and adequate actions are taken. He has lectured about the Management of Technology and Systems Thinking and is a regular commentator in the trade media. Adrian has spent more than 30 years promoting standards and growth in the ICT sector. Leon Strous Leon has a background in business economics, business informatics, and a postgraduate degree in IT-Audit. He worked eight years for Philips Electronics in The Netherlands with a focus on internal control and information security. Previous positions in the internal audit department, in the oversight department, and in a policy department of the cash and payments division. Leon was awarded Knight of the Order of Orange-Nassau in Doron Swade Doron Swade is an engineer, historian, and museum professional. He has studied physics, mathematics, electrical engineering, control engineering, philosophy of science, and man-machine studies at various universities including University of Cape Town, University of Cambridge, University of Essex, and University College London.

He designed digital hardware for 10 years and consulted for the microcomputer industry in the UK and USA. He lectures widely and has published four books one co-authored and many scholarly and popular articles on history of computing, curatorship, and museology. He founded the Computer Conservation Society in , which is dedicated to the preservation and restoration to working order of historic computing machines. He was awarded an MBE in for services to the history of computing. Ulrika H. Westergren Ulrika H.

She specializes in the digitalization of society with a focus on organizational change, new business models, value creation, and issues of trust, in relation to the introduction of new technology. She is passionate about creating knowledge about Authors xvii new technology and the opportunities and challenges that digitalization offers, both in terms of the emergence of new business logic and in the social implications that follow. Ulrika holds an A. He has also held senior management positions in multinational corporations and government. He is a regular commentator and presenter on topical issues on various print and online media, radio, and TV, as well as a speaker at various national and international forums. Wil M. Erik P. An Application to Digital Payments. Leon Strous, Robert M. Telegraphy and telephony are well established.

Common forms of transportation include ships, canals, railroads, horses and horse drawn carts. Automobiles are still a rarity but mass production lies about a decade ahead. A year ago, Guglielmo Marconi demonstrated short range radio transmission and this year has just shown that it works at ranges over two miles. Six years from now, he will demonstrate trans-Atlantic transmission and in , the sinking of the Titanic will underscore the enormous importance of wireless telegraphy. Henri Becquerel is about to discover radioactivity. The Wright Brothers heavier-than-air Kittyhawk flight is only 8 years away. Charles Lindbergh will make his famous trans-Atlantic flight in People, practices, laws and norms adapted to these new technologies and the products and services they enabled.

Nor should we be surprised. Thinking of fire, the wheel, roads and aqueducts, water wheels, windmills and electric power, reaching back thousands of years in some cases, humanity has managed to accommodate and adapt to a wide range of inventions. When you are living in the maelstrom, however, it is not hard to feel as if change is overwhelming. This is especially true of inventions that serve as the basis for a cornucopia

of consequential inventions. Digital technology, first with mechanical calculators, vacuum tubes but more recently with semiconductors since the invention of the transistor, has created an unprecedented opportunity for the creation of new products and services.

The animating force behind these products is software. Programmable devices appear to have infinite malleability - limited only by what human intellect can program. Some forms of AI may even take over some of that task in the future! By the early 70s, packet-switched networks of computers emerged in the form of the ARPANET<sup>2</sup> which became the progenitor of the Internet<sup>3</sup> which was formally launched 1969. Brownian motion, photo-electric effect, special relativity and mass-energy equivalence. Stroustrup et al. Cerf into operation in January after a ten year development cycle. That, in turn, morphed into the Netscape Navigator<sup>10</sup> made popular by the Netscape Communications Corporation. At this point in time, years after our starting point in this essay, Internet-related companies, applications and technologies were rapidly proliferating. This came to an abrupt halt in April when most of these companies ran out of capital and had no revenue.

But the Internet continued to grow. Companies like Google<sup>11</sup>, Yahoo! Going back into history, Martin Cooper, then at Motorola, demonstrated a handheld mobile phone in April 1973. Of course, mobile telephony had a long history by that time, but this was the first handheld unit, thanks to miniaturization of components. There must have been something in the air in 1973! These two technologies, Internet and the smartphone, were hypergolic. But the most notable expansion has been the library of applications available for downloading. There are millions of applications.

A recent statistic says there are 2.5 million apps. It is surely tempting to say so, but perhaps it just feels that way. The ease with which apps are built for smartphones, pages created for the World Wide Web, software is produced for Internet-enabled devices Internet of Things<sup>20</sup> all contribute to the feeling that we are rushing into a future in which we are being overwhelmed with change. There is some truth to this. New features can be added to software without necessarily changing hardware and that adds to the feeling and reality of rapid change. There is something Einsteinianly relative about this feeling.

If software were delivered in the air from a fan, we could be standing still and the fan increasing in its speed making us feel like we are moving faster and faster when, in fact, we are standing still but the world is rushing past. There are many reactions to this phenomenon. But see the opening paragraphs of this essay! Some people see this as a challenge to learn more and more quickly. Just-in-time learning is a skill and we can see interesting evidence of this phenomenon.

I tried this out recently when my wife and I decided we wanted to make Chinese eggplant, a spicy and delicious dish. Instantly we found a 12 min video<sup>21</sup> showing us exactly how to do it. We followed directions. It was delicious! This notion of just-in-time learning has implications that are relevant for our future. If our life spans are increasing, this implies that our work lives may extend for sixty or seventy years. We are not likely to learn enough in the first couple of decades of our lives to sustain our productivity and relevance for such a long period. We will have to learn new things if only to adapt to the new technologies that arise at a steady if not increasing pace. Learning online as needed has the advantage of immediate utility and relevance. This is not to say that a more organized form of learning is irrelevant. Rather, it suggests that online learning may be increasingly relevant. In mid-life it may not be feasible to drop everything and go back to school full time.

Short courses and certificate training are useful alternatives. Self-guided and paced learning is increasingly feasible and available. Universities are adapting to this. It is the same program as is taught in residential settings but costs much less per student because class sizes can be much larger. New universities have been created for online, large scale learning such as Udacity<sup>23</sup> and Coursera. A quick search of the WWW for online degrees produces a plethora of responses. Universities are adapting rapidly to these new formats. With high probability, these systems will evolve to be increasingly student-centric with self-pacing and adaptive remediation becoming the norm.

So, where does that leave us in this debate over the pace of change? I think digital technology has enabled more rapid discovery and development in virtually all disciplines. The consequence is that we really are experiencing more rapid evolution of knowledge, tools, techniques, products and services. This need not lead to despair! This same technology is also helping us cope with the need for adaptation and learning. We will become all the more productive in consequence. Data science technology is rapidly changing the role of information technology in society and all economic sectors. However, data science is much broader and also includes data extraction, data preparation, data exploration, data transformation, storage and retrieval, computing infrastructures, other types of mining and learning, presentation of explanations and predictions, and the exploitation of results taking into account ethical, social, legal, and business aspects.

This year we celebrate the 60th anniversary of IFIP. IFIP was created in because of the anticipated impact and transformative power of information technology. However, the impact of information technology over the past 60 years has been even larger than foreseen. Information technology has dramatically transformed the lives of individuals and businesses. Over the last 60 years, data science, i. Data may be structured or unstructured, big or small, static or streaming. Value may be provided in the form of predictions, automated decisions, models learned from data, or any type of data visualization delivering insights. Data science includes data extraction, data preparation, data exploration, data transformation, storage and retrieval, computing infrastructures, various types of mining and learning, presentation of explanations and predictions, and the exploitation of results taking into account ethical, social, legal, and business aspects.

The term is not new. Clearly, the notion of what is large has changed dramatically since the early seventies, and will continue to change. Overview of the key ingredients of data science [4]. The diagram shows the interdisciplinary nature of data science. As an example, take a self-driving car. To build a self-driving car one needs an infrastructure The Data Science Revolution 7 composed of sensors camera, lidar, radar, etc. The self-driving car has to be economically feasible and may require new business models. While creating such a car, one also needs to consider legal and ethical implications. Who is responsible when the car crashes? What decisions should be taken when a crash is unavoidable e. Who owns the data collected by the self-driving car? As Fig. Big data seems to be out of fashion and AI and ML are the new buzzwords used in the media.

AI may mean everything and nothing. This means that everything in Fig. The same applies to the term ML. However, ML is also used to refer to only deep learning. Experts systems tend to use symbolic AI to make deductions and to determine what additional information it needs i. The main disadvantage of symbolic AI is that the rules and knowledge have to be hand-coded. Non-symbolic AI does not aim for human-readable

representations and explicit reasoning, and uses techniques imitating evolution and human learning.

Example techniques include genetic algorithms, neural networks and deep learning. The two main disadvantages of nonsymbolic AI are the need for a lot of training data and the problem of understanding why a particular result is returned. Symbolic AI is still not widely adopted in industry. Although non-symbolic AI performed worse than symbolic AI for many decades, by using back-propagation in multi-layer neural networks, non-symbolic AI started to outperform conventional approaches [13,17].

As a result, these techniques are now also used in industry for tasks such as speech recognition, automated translation, fraud detection, image recognition, etc. The successes of non-symbolic AI are amazing. It extends the corresponding keynote paper [4]. The remainder is organized as follows. Section 3 discusses the shift from modeling and programming to data-driven learning enabled by the abundance of data. Due to the uptake of data science, traditional jobs and business models will disappear and new ones will emerge. Data science can make things cheaper, faster, and better. Therefore, Sect. Section 6 concludes this paper. According to Empedocles, all matter is comprised of these four elements. Other ancient cultures had similar lists, sometimes also composed of more elements e.

Note that Fig. The exponential growth of data and data processing capabilities since the establishment of IFIP in is evident: — Things are getting exponentially cheaper, e. The Data Science Revolution 9 Fig. The reductions in price and size and the increase in speed apply to processing i. A GPU may have thousands of processors and a company like Google has over one million servers. The above numbers illustrate our increased capabilities to process large amounts of data. These are used to align the digital world and the physical world. Events may take place inside a machine e. The uptake of the so-called Internet of Things IoT resulted in many connected devices ranging from light bulbs to wearable heart monitors [18].

These may be stored in traditional relational databases e. The term Internet of Events IoE, coined in [1], refers to the omnipresence of event data in all application domains. In many applications, it has become impossible to store all data and process it later. Such streaming data needs to be handled immediately. Structured data may be augmented by unstructured data e. At the same time, there are also great concerns about the use of data. Increasingly, customers, patients, and other stakeholders are concerned about irresponsible data use. Automated data-based decisions may be unfair or non-transparent. When IFIP was created sixty years ago, one could not foresee the possible risks related to data science. However, legislation such as GDPR may also inhibit certain applications. Hence, technological solutions involving distribution and encryption are needed. In Sect. Storing and processing data is typically not a goal in itself.

Data are there to support processes. This applies to logistics, production, transport, healthcare, banking, insurance, and government. Data science can be used to improve tasks within the process; e. Data science can also be used to improve the design or management of the whole process, e. Data science can also be used to create new products The Data Science Revolution 11 and services, e. Giving up privacy concerns may lead to better processes, services, and products.

Education in every sense of the word is one of the fundamental factors in the development of data science. Data science education is needed at all levels. Some examples of phenomena that illustrate the need for education. It may be that ice cream sales and crime rates strongly correlate. However, this does not imply that one causes the other. The so-called hidden variable is the weather. Higher temperatures lead to higher ice cream sales and higher crime rates. It makes no sense to try to reduce crime by putting a ban on ice cream sales. For example, in each study program, females are more likely to pass. However, when considering all students, males are more likely to pass. However, when looking at all patients, there is a negative correlation between exercising and health. The same applies to speech recognition. It is possible to do computations on encrypted ciphertexts such that the encrypted result, when decrypted, matches the result of the operations as if they had been performed on the non-encrypted data.

It is possible to jointly compute a function over multiple parties that all keep their data private. Hence, one can apply data science techniques without sharing the actual data. To remain competitive, countries should invest in data science capabilities. This can only be realized through education and research. A new generation of scientists emerges that focuses on the analysis and interpretation of data rather than models detached from data. This shift is caused by the availability of data and easy-to-use data-science tooling. Natural, social, and applied sciences heavily depend on observations of natural phenomena, people, and systems.

In inductive research, the goal of a researcher is to infer models and theories i. In deductive research, the goal of the researcher is to test models and theories using new empirical data. This is a direct result of our ability to observe natural phenomena, people, and systems much more directly. Consider, for example, the social sciences with research methods such as surveys i. Traditional surveys may have low response rates and a sample bias the set of participants that was invited and accepted may not be representative.

Laboratory experiments are often too small and also have a sample bias. Interviews and case studies tend to be subjective. Therefore, younger social science researchers prefer to use research methods that use objective larger-scale observations. Another example is the uptake of computational biology and bioinformatics where large collections of biological data, such as genetic sequences, cell populations or protein samples are used to make predictions or discover new models and theories.

There seems to be less emphasis on theoretical computer science due to the desire to relate models and theories to real-world phenomena. Instead, sub-disciplines related to data science are rapidly growing in the The Data Science Revolution 13 number of students and researchers. Automated learning e. Rules are no longer programmed but learned from data. This is changing computer science.

For example, how to verify the correctness a system that uses neural networks? Consider for example the way that marketing changed. In fact, many professions have become much more data-driven or are about disappear see next section. As a result, many professions will cease to exist [9,10,14]. At the same time, new jobs, products, services, and opportunities emerge. The frontier between the tasks performed by humans and those performed by machines and algorithms is continuously moving and changing global labor markets.

In [9], Frey and Osborne provide predictions for the computerization of occupations. Examples of redundant roles are clerical work e. Of the new roles mentioned in [14], most are related to data science. In [10] three waves of automation are predicted: 1 algorithmic wave replacing simple computational tasks in data-driven sectors such as banking, 2 augmentation wave replacing more complex clerical work and materials handling closed environments such as warehouses, and 3 autonomous wave replacing physical work in transport, construction, and healthcare. The algorithmic wave is currently in full swing. The augmentation wave has started with the uptake of Robotic Process Automation RPA and robots in production and warehouse. This wave is likely to come to full maturity in the next decade.

The autonomous wave uses technologies that are already under development, but, according to [10], will only come to full maturity on an economy-wide scale in the s. Moreover, WFM often failed because of a limited understanding of the complexity of the actual processes performed by people. Instead, software robots interact with the existing information systems in the same way as humans do. RPA software interacts with the pre-existing applications through the user interface directly replacing humans, i. A typical RPA scenario is a sequence of copy-and-paste actions normally performed by a human. As shown in Fig. The software robots need to learn from humans and need to be monitored continuously. Process mining [2] can be used to identify repeating work. Moreover, if a software robot malfunctions due to technical glitches, exceptions, changing user interfaces, or changing contextual factors, then this can be detected using process mining.

For example, tasks are initially performed by robots and are escalated to workers the moment there is a complication or exception. Moreover, the RPA solution may adapt due to changes in the underlying process e. This illustrates that the border between humans and software robots will continue to shift. The Data Science Revolution 5 15 Responsible Data Science in a Platform Economy The distribution of work between humans, machines, and algorithms is changing due to the uptake of data science.

Moreover, the growing importance of data is also changing the economy and leads to new concerns related to privacy and fairness. In recent years we have witnessed the rise of the platform economy [6]. These organizations were able to grow extremely fast due to the digital platforms they provide. Some e. Successful digital platforms have the characteristic that they tend to grow very fast and, in the end, often one winner remains.

For example, Amazon and Alibaba are dominating the way we buy products, Google is controlling the way we search, and Facebook is controlling the way we socialize. See, for example, the current competition to become the leading digital platform for smart homes e. Next to the large-scale economic concerns, there are also smaller-scale concerns impacting individuals. Figure 4 shows the key challenges of RDS: — Data science without prejudice — How to avoid unfair conclusions even if they are true?

Confidentiality - Data Science that ensures confidentiality: How to answer questions without revealing secrets? Transparency - Data Science that provides transparency: How to clarify answers such that they become indisputable? Accuracy - Data Science without guesswork: How to answer questions with a guaranteed level of accuracy? Data science techniques need to ensure fairness: Automated decisions and insights should not be used to discriminate in ways that are unacceptable from a legal or ethical point of view. Ideally, the learned model explains the response variable in terms of predictor variables. However, these may correlate with sensitive attributes such as gender, nationality, age, etc.

Data science techniques also need to ensure accuracy: Most data science techniques return an answer even when there is not enough evidence in the data. This is often referred to as the curse of dimensionality: As dimensionality increases, the number of combina- The Data Science Revolution 17 tions grows so fast that the available data become sparse. The regulations have been criticized for the administrative overhead they generate and the unclear compliance requirements. There are many techniques to anonymize data, e. The problem is that also anonymized data may unintentionally reveal sensitive information, e. There are also more advanced approaches using homomorphic encryption or secure multi-party computation.

Unfortunately, legislation and policy makers are lagging behind. Finally, data science techniques need to ensure transparency: It should be clear how the data were processed and that the stakeholders correctly understand the results. Often results highly depend on data cleaning, selection, and parameters of the techniques used. It is easy to change the outcome by altering the analysis-pipeline. Moreover, users that do not understand the phenomena described in Sect. Black-box machine learning techniques such as deep neural nets provide results e.

In many application domains this is unacceptable e. However, explanations may be very complex and full transparency may not always be possible or required. The above challenges show that there is a need for data science techniques that are responsible i. This will be one of the main data science challenges of the coming years. Data science includes data extraction, data preparation, data exploration, data transformation, storage and retrieval, computing infrastructures, various types of mining and learning, and the presentation of explanations and predictions. Moreover, given the impact of data science, also ethical, social, legal, and business aspects play a major role. The multidisciplinary nature makes data science particularly challenging. Moreover, we zoomed in on the growing importance of learning from data rather than modeling or programming and the transfer of tasks from humans to software robots.

We also elaborated on the risks associated with data science, e. This illustrates that, in , the year that International Federation for Information Processing IFIP was established, it was impossible to foresee the importance of data science. However, data science has become the main driver of transformation in society and business, and is likely to remain a key topic for IFIP in the next 60 years. References 1. In: Mertins, K. Enterprise Interoperability VI. PIC, vol. Springer, Cham Springer-Verlag, Berlin 3. In: Hammoudi, S. Enterprise Information Systems. Lecture Notes in Business Information Processing, vol. In: Strous, L. IAICT, vol. Scheppeler, B. Informatik Spektrum 43 2 , — Frey, C.

Hawksworth, J. An international analysis of the potential long term impact of automation. Technical report, PricewaterhouseCoopers Ioannidis, J. PLoS Med. Laney, D. Wick, C. Informatik-Spektrum 40 1 , — Leopold, T. Naur, P. Akademisk Forlag, Kobenhaven Crown Publishing Group, New York Rumelhart, D. Nature , — Strous, L. 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 combing 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. 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]. However, what he mentions as future work has been already developed since s by researchers in Machine Learning such as Michalski, 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]? 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? 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. Alan Turing proposed the famous test in First generation of AI is linked with the beginning of computers. Some call this period Early enthusiasm — Object programming languages, Natural Language Processing Prolog, various knowledge representation models, Case-based reasoning, Knowledge discovery techniques, constraint programming were born between s and Many successful applications — demonstrated the usefulness of AI that since has been embedded in many applications in all fields [13].

In the middle of the s Internet became the star and AI was temporarily shelved. Some talk about AI Winter — Third generation of AI was born in 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]. However, he forgot to include symbolic machine learning, initiated in the early by Ryszard S. Michalski, John R. Quinlan, Jaime G. Carbonell, Tom M. Mitchell and some others [6]. Figure 1 presents his 3rd generation in fact 4th of AI that will balance all four components. Mercier-Laurent Fig. Mark Gubrud proposed the expression of Artificial General Intelligence in military context [16]. What is the progress from General Problem Solver Newell et al. 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. Another limitation of deep learning is the exploring of past data to predict the future. 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. 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 s.

Automated text generation has been studied and practiced since the invention of Prolog in 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. 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. Artificial neural network is simple implementation of biological neurons, which are much more complex. The Human Brain Project [23] has begun in 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 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 24 E. 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.

Another trend in AI research and applications is collaborative intelligence humanmachine. Human beings are incredibly slow, inaccurate and brilliant. 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. 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. The future of AI has to consider all these experiences to progress in right direction.

Between and today the AI research was awoken to business goals — sell more and quicker. 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. AI powers the cyber physical systems and digital twins [27] Fig. Schneider factory of the future, Vaudreuil, source Schneider Electric [28]. We will still need truly intelligent personal assistants able to learn with the user, not necessary Alexa, Siri or more sophisticated robot.

Mercier-Laurent 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. 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.

After health, time is probably one of the most important assets. Traditional IT can be smarter with AI inside. Make the IT friendly and intuitive, greening the software, smartening data centers are among the wishes. AI should be able to understand the content of my emails, clean my email box and answer easy ones. The Future of AI or AI for the Future 27 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, e. 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. It may also influence improvement of others. Sustainable development goals, source un. One of the most repeated is that AI has to be beneficial for humanity. It has to be capable of immediate finding a document in my computer related to the topic I ask, picture or drawing.

It is only visible and available for its user wearing special glasses. 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. 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. 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. Many professions change with technology and school has to prepare students for being flexible.

E-learning was introduced in schools at the beginning of 21st 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. 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. 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 The Future of AI or AI for the Future 29 [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. 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. 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. While addressing the contemporary challenges facing the ICT community today, the book provides the opportunity to look back to help understand what we now face and identify appropriate future responses to these challenges. As such, the book aims to contribute to the ICT community worldwide, as well as IFIP and its member societies, in setting their policy priorities and agendas for the coming decade. We hope to provoke discussion about appropriate responses to the challenges by individuals as well as by national and international bodies including IFIP.

Many topics would have deserved a chapter in the book, but for practical reasons the editors decided to finalize the book with a rich collection of topics divided in 17 chapters by 23 authors. Previous Next.

[Talibanistan : Negotiating the Borders Between Terror, Politics, and Religion](#)