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THE IMPACT OF THE ARTIFICIAL INTELLIGENCE (AI) ON THE SOCIETY

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Abstract. Artificial intelligence (AI) is the field that studies the synthesis and analysis of computational agents that act intelligently. AI has been around since the 1950s, when it was first discovered. It has had its ups and downs over the years, and today is considered as a key technology going forward. Thanks to new software and ever faster processors, AI is finding more applications than ever. AI is an unusual software technology that all electronic engineers should be familiar with. Here is a brief introductory tutorial for the uninitiated.

Keywords: *Computational agents, software technology, heuristic, cognitive systems, Watson program.*

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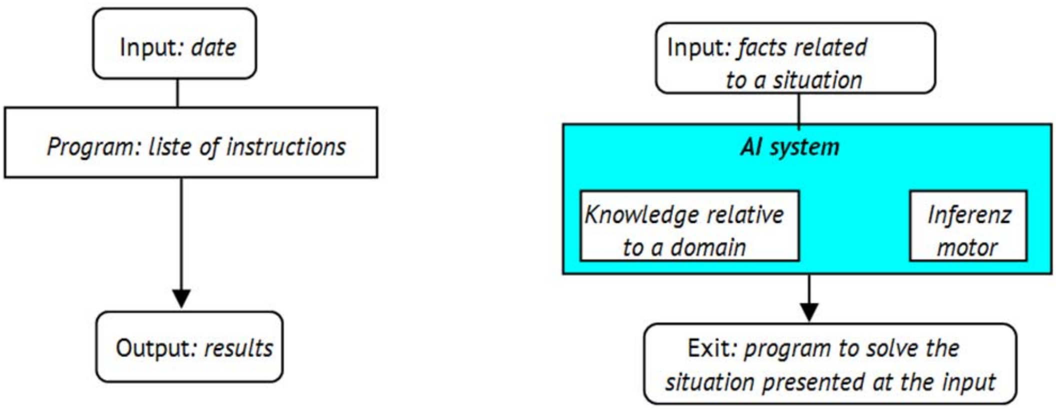
Above all things

Perhaps - before we try to define what artificial intelligence (AI) is - we should know what intelligence is. Unfortunately, defining intelligence is a particularly delicate problem, and dictionaries are not very helpful. It is true that most authors agree that intelligence is "the ability to understand" of the human spirit; when it comes to defining it, we are struggling with extremely varied definitions - such as "sensing meaning," "embracing thinking," "making a clear idea," "understanding through knowledge," etc. And when we want to know what knowledge is, we read that it is what we have learned; what I understand, that ideas are representations that form thought, and that the meaning of a word, for example, is the set of intelligible ideas that it conveys.

We enter into a loop from where we can no longer go out, for in order to define a word we need other words and so on. There is nothing left to do but to consider intelligence as a primitive word that we will not try to define. Why should we talk about artificial intelligence? This term designates a science that has gradually become gradual since the emergence of modern day primers: it is the set of concepts and methods used to make computers behave intelligently, similar to those of people who exercise their intelligence (Figure 1). The domain is vast and is rapidly developing, among other things, because the power of the handlers is growing fast, so it can manipulate masses of information that are increasingly important with the help of more and more elaborate algorithms. Unlike classic programming, AI does not require a priori to know how to solve a problem; the AI programmer must think in terms of objectives, proposing to demonstrate, for example, a theorem, to recognize an image, etc. The AI program is tasked with choosing the right means to achieve the proposed objective, depending on the given assumptions. It is a declarative programming, as opposed to the procedural programming characteristic of classical computer science: it is enough to specify "what" without worrying about "how", because the system is able to find the solution itself, according to the proposed objective. Therefore, programming in AI is called heuristic (from the Greek eurisko: finding, discovering - as Archimedes said). In order for the system to find a solution to a given problem itself, it must have reasoning capacities in a logical form. Instead of integrating all the stages of reasoning into the program, logic will give the system the ability to make reasoning itself, starting from the data (knowledge) that has been provided to it. In the case of "smart" chess machines, there is a surprising phenomenon: the inventor of a heuristic builds on the knowledge gained from chess, based on the study of a very limited number of parties. However, its heuristics is general and can be applied in all cases: it allows obtaining of unexpected results, and even sometimes turns out better than expected by her inventor! She could play chess much better than the inventor. The paradox is only apparent; it is related to the existence of very complex problems, such as the concept of a telephone exchange. Numerous results determine the existence of mathematical problems whose solution cannot be determined by any computer, because the time and space required for the calculation are too important (the speed of the controllers - limited by the propagation velocity of the signals in the conductors - will not be able to increase to infinity). This complexity is not only related to mathematical problems; it also appears clearly when, for example, we are interested in the recognition of speech. Even if we could record sounds of 20,000 syllables and 30,000 words of English (and assuming that they do not vary much depending on the different speakers), we still have to solve the problems of recognizing continuous, chained speech: at the junction of two words occurs acoustic phenomena that greatly disturb the sound spectrum and depend not only on the two words that are chained, but also on the whole phrase and its meaning, which determines the intonations.

"The knowledge is in the form of packages, of the same type as the phrases" as was believed in the early days of the AI; moreover, it was thought that the best way to instill knowledge of a program would be to develop a simple way to translate the facts into small passive data packets. Everything would then be accessible to the programs that use it. This type of knowledge is illustrated by chess programs in which chess board positions are encoded as matrices or lists and stored - in an efficient way - in memory where they can be retrieved and processed by sub-programs.



a) b)

Figure 1. Comparison between classical informatics (a) and artificial intelligence (b): Two manners to program.

The fact that - in fact - people retain facts in a much more complex way is known for a long time by psychologists; it has been rediscovered by researchers in the AI who are now confronted with "reunified" knowledge issues. The naive hypothesis that all knowledge should be encoded as passive data is contradicted by the fundamental fact of the conception of the computers: their way of gathering, decreasing, multiplying, etc. is not encoded as data stored in memory; in fact it is not stored anywhere in memory, it is found in hardware wiring.

Although the theme of knowledge representation appears more and more frequently in the literature dedicated to AI, it remains - still - confusing, due to the misinterpretation of the words knowledge and information. A file, a book, an article contains information; however, it is not possible to say that a book "knows" the information it contains, knowing that it is an active operation that involves memory capabilities, but also involves the existence of reasoning mechanisms applicable to knowledge memorized. We will never tell anyone that they know a topic if they can only respond to a predefined list of questions. True knowledge therefore presupposes the knowingly use of the information we have, and the problem with IT is to find structures that will not only allow the storage of information but also their use by the machine itself. If today is so much about the representation of knowledge, it is because it has not been possible to establish - so far - any formalism as universal as that of the decimal representation of numbers, for example. As soon as the computer began to play a role in developing reasoning, researchers were forced to quickly find ways of representation based on a series of more or less ad hoc solutions without solving background problems. In fact, this knowledge-based approach of the AI has been progressively enforced lately; it is known today - especially - because it gave birth to expert systems. From the outside, these expert systems behave to a certain extent as specialists in a given field (oncology, integrated circuit design, financial placements, etc.). They diagnose, solve problems, but they are also able to justify their way of doing it. Expert systems do not calculate a result by a predetermined method, but "think" as human experts. They deduct new facts from simpler assumptions, leaning - like human beings - on masses of knowledge more or less important. In other words, expert systems are not simple computer programs (in the usual sense of the word). In order to create a traditional program, the information develops a solving method, an algorithm, describing step by step a "frozen" stereotyped mode, processing the data to reach a certain result; we then speak of an imperative programming to qualify the programs that implement these algorithms. In an expert system, on the contrary, knowledge is expressed as such, in a knowledge base, in a form that - in principle - does not make assumptions about how to use them. They are said to be represented in a declarative form. The knowledge base of an expert system is exploited by a classical program called an interpreter or inference engine. As required, the inference engine will look for knowledge-fragments of knowledge to then assemble them logically and produce an original reasoning for each new issue.

Another problem related to the representation of knowledge is that of modularity: is it difficult or easy to introduce new knowledge, to change old knowledge? What is the degree of modularity of the books? Depends! If we remove a chapter from a very structured book (which repeatedly sends from one chapter to another), the rest of the book runs the risk of becoming incomprehensible. But there are also modular books whose chapters are independent of each other. Of course, it would be useful to be able to transplant - in a modular way - our knowledge. For example, to teach English, it would be enough to open the cranial box and make some changes to its neuron structures; after that, our pupil could speak English. (It goes without saying, it is a humorous divagation!) [Hofstadter].

The most interesting issue of the AI is introduced by the combining difficulties; when we listen to a speaker, we understand what he says at the same time as we hear him speak. This understanding of meaning mitigates the defects of purely acoustic communication, for it allows the elimination of the ambiguities that the machine encounters - which does nothing more than analyze spectra. The complete success of speech recognition - such as translation by the coordinator - will only be achieved if the semantic content of the spoken or written discourse can be represented. This is one of the goals of the AI, which is very remote and difficult to reach.

Introduction

The term "artificial intelligence" was created in a proposal for a "two-month, 10-man, artificial intelligence" study by John McCarthy (Dartmouth College), Marvin Minsky (Harvard University), Nathaniel Rochester) and Claude Shannon (Bell Telephone Laboratories). The workshop, which took place a year later in July and August 1956, is generally recognized as the official date of birth of the new domain.

The proposal defined what its authors understood by "artificial intelligence": It will try to determine what needs to be done for cars to use language, to form abstractions and concepts[1], to solve the problems reserved for people and to improve themselves. And they promised results: We believe that significant progress can be made in one or more of these issues if a carefully selected group of researchers will work together for one summer.

In some respects, the research project of the summer of 1956 failed. The participants came at different times and worked on their own projects and, therefore, was not really a collaboration in the usual sense. There was no agreement on a general theory of the field and, in particular, on a general theory of learning. Domain AI was launched not through agreement on the methodology or choice of problems or general theory, but by the common view that computers can be made to perform intelligent tasks.

Artificial intelligence began with "the assumption that every aspect of learning (or any other feature of intelligence) can in principle be so precisely described that a machine can be made to simulate it" [1] and has moved away from it vision of major promises for overall human AI over several decades. This vision of the general AI has now become just an idea of long-term orientation for the latest research in the field of AI that focuses on specific scientific and engineering issues and maintains a distance from cognitive sciences. A minority believes that it is time to follow the AI directly as technical purpose by traditional methods - they usually use the label "artificial general intelligence."

Swedish philosopher Nick Bostrom argues that it is fully justified to dedicate resources to study any kind of threats because - even if they are removed - they are and remain terrible. Eliminating future disasters (assuming this will be possible) would bring much more

[1] The similarity of two concepts allows us to order them in classes and build symbols. But we can not classify any object in any class! In fact, the class rating is quite delicate.

The most difficult level to achieve in terms of recognizing concepts is probably natural language. The symbols are very numerous and semantic; the meaning of a term is indissolubly linked to the context in which it is issued, that is to say language (or part of it).

The problem of artificial intelligence is to make a car behave in ways that might be called intelligent if a man behaves like this.

benefits to a much larger number of people than to solve current problems - such as cancer or extreme poverty. The number of saved lives - in the future - would be many times higher, especially if the "earth civilization" would extend to other stars and galaxies. "We have a special interest in future technologies that could transform the human condition in a fundamental way," says Bostrom. He believes that AI is the greatest opportunity in the world, but also the greatest threat. Scientists believe there have been at least five mass disappearances in our planet's history when a catastrophic number of species has disappeared in a relatively short period of time. Now we are probably living in a sixth - caused by human activity.

Bostrom and his collaborators are not interested in day-to-day disasters; they are dealing only with the great events: "There are a lot of things that went wrong in history - earthquakes, wars, plagues, but there are things that have never gone wrong: we have not destroyed the whole future so far."

Problems related to artificial intelligence are not only technical but also ethical; if one day is able to develop a smarter system than man, how can we guarantee that - technically - he will really do what he should do? For a long time this subject has been neglected. Since the early years of the development of the AI [1], the purpose was to reproduce the general intelligence that characterizes the human spirit.

But no one has dealt seriously with the ethical aspects of that moment, when the intended purpose will have been achieved. We can assume that the AI specialists believed that the aim pursued would soon be a reality, or supposed that it would take hundreds of years to complete it.

The current technologies used by AI are good enough to achieve a large number of applications. It is supposed that the AI field will attract many and important investments due to the needs in the field of research engines, speech recognition or autonomous cars. In many cases, there are already commercial applications or are about to appear. It is time not only for industry, but also for research institutes, universities, governments, ONGs to ensure the ethical use of future acquisitions of the IA. That is why we need to understand exactly where there are dangers, so we can avoid them. In the medium term, positive aspects predominate, but positive scenarios and negative scenarios are possible in the long run.

For the time being, future cars equipped with AI will not have a significant impact on the labor market. It will be essential to make a difference between the ability of machines to perform different tasks and their ability to take up certain jobs.

For example, in the case of an autonomous car, in 90% of cases he is self-propelled, but he will need a driver.

Let us imagine a 100% autonomous car; the difference may seem minimal, but the impact on the labor market is enormous: either you need a driver or you do not need it.

Not to mention that it will take a long time for them to set up and perform all the prescribed tasks so that they can "overturn" the labor market.

In the future, technology will not only transform the external world, but will provide possibilities for transforming human nature, expanding human capabilities.

Learning

She is currently the queen of methods, which rejuvenated the old concept of AI, born in the post-war period, with informatics. Prior to this invention, for a machine to recognize the presence of a tumor in an image, for example, it was necessary to follow a list of pre-established rules by the specialists (color, contrast, location, shape...). It involved important biological knowledge and... it worked badly.

Now thousands of pathological or normal images are shown to the machine; and she is "sanctioned" if she is wrong. "Sanction" is to change thousands of parameters so that the car approaches the good solution, just as the painter looks for the right mix by adding more or less color to his mix. At the end of this procedure, the system classifies any image correctly.

There are several learning methods, but in 2012, one of them has been forced into an image recognition computing competition: deep neural networks (deep learning or deep learning). By analogy with the operation of real neurons, connections are digitally amplified when they lead to the correct response. Since then, these networks are used to analyze not only images, but also texts, voices, translation.

The learning successes of the machine are made through algorithmic advances.

Big data

Data is the solution but also the problem. Learning with neural networks does not work if there are too few examples, but there are other techniques to overcome these shortcomings, such as exploring random decision trees or classic linear regression (finding the best straight line joining multiple points).

Cognitive systems

Cognitive systems are complex systems of information processing, capable of acquiring, using and transmitting knowledge.

Cognitive sciences appeal to phenomena such as perception, intelligence, computation, language, reasoning and consciousness. They have many branches of science and engineering: linguistics, anthropology, psychology, neuroscience, philosophy and artificial intelligence. Many practical applications are currently deployed and the potential exists for an almost unlimited number of future applications.

Cognitive informatics – the third age of computing

If we consider that the first computational era was that of sign and table alignment systems (1900), the second of programmable systems (1950), cognitive computing is the third computing age. In more than a century we have moved from numbers to data and then from data to knowledge. We are not in the logic of replacement, but of enrichment. The programmable systems made it possible to create data by number processing, cognitive informatics allows the use of data by giving meaning. The meaning makes it possible to move from raw data to actionable data.

For a long time, it has been said that cars are used to do well what bad people do, so today we are trying to use cars to do what people do well. Cognitive informatics also introduces a revolution in our thinking systems and in the relationship we have with computer science. Until now, the copter has given absolute answers, tomorrow the answer he will give will no longer be "true or false", but most likely "likely." The cognitive system proposes a list of responses that they refine according to user interactions. It often does not give the "answer" (because it does not exist in absolute terms) but the most acceptable solution, which is most likely to function in a given context.

Practically speaking, applied to customer relationships, here is how the change materializes: Before we have a response (a product) that we try to "push" towards the customer, we try to identify the customers that best fit the target. Tomorrow the system will try to understand the customers' need and build the solution. In terms of marketing, we move from a caution marketing (attract the customer's attention to making an offer) to intentional marketing (understand the customer's intent and propose a personalized solution).

Watson

Launched in the early 2000s, the Watson program (Figure 1) has gained worldwide reputation after becoming the champion of the American *Jeopardy!*[2] TV game in 2011! - the American version of the well-known French TV game "*Questions pour a champion*". Watson won a new stage in the race against the human being. Many years ago, IBM's specialist computer, Deep Blue, had succeeded in 1997 to beat Gary Kasparov, world chess champion. However, the "*Deep Blue*" computer did not teach us anything about how a great chess master thinks. Earning *Jeopardy!*, IBM researchers have demonstrated the progress made by natural language and semantic analysis, although the difficulties were greater than chess: you must understand subtleties of language, popular or arrogant expressions, ironies, or an image. The obstacles were greater: speed and risk management.

IBM analyzed the strategy of the best candidates who gave the right answers in over 85% of cases, but who also knew their weak points. At *Jeopardy!*, a good answer allows the candidate to increase his earnings, a bad answer leads to the loss of money. That's why you have to learn to shut up if you're not sure of yourself.

Starting in 2009, IBM baptised its "Watson" project - a special name for its collaborators. In order to successfully compete with *Jeopardy!* IBM designs a computer, starting from 90 servers running under Linux, which "swallowed" 15,000 Gigabytes of information (encyclopedias, novels, dictionaries, blogs, etc.). For weeks, Watson is trained using 55 test sessions against old competitors. Rejoicing in complicated questions or wandering due to subtlety of language, Watson is able to learn from mistakes, improves contextual analysis algorithms, and marks the emergence of cognitive systems and learning programs. In February 2011, the match against the best competitors, Ken Jennings and Brad Rutter, which Watson earns a detachment (despite the fact that at the end of the contest, a question in the "*American cities*" category, he answers Toronto, although the city is in Canada). Morality: It was not necessarily 100% best, but well prepared to beat the other two.

Unlike *Deep Blue*, from the beginning, IBM gives Watson a concrete task; its technology has the potential to overturn the way in which decisions are made in businesses. The first to have benefited from his help were cancer therapists from several hospitals. From a thousand cases that were presented to him in a study by North Carolina University, Watson gave a diagnosis that matches that of cancer doctors in 99% of cases.

[2] In this classical American television, the presenter reads an answer, and the participants have to guess the question about it. After two days of contest, Watson defeated his competitors, making him a good reputation among the general public.

Yet, in 30% of cases, Watson proposed an alternative solution based on a reading that doctors could not do. Watson can accurately diagnose cancer with four times better accuracy than the diagnosis formulated by human doctors. Until 2030, computers will probably be supreme to people.

Watson has expanded his skills and financial services; in France, *Crédit Mutuel*, for example, helps the 20,000 employees who take care of the clientele to sort out their emails. In Munich, it helps industrialists to make the right decisions; Watson's skills have expanded across most business sectors and generated $ 500 million in revenues for IBM last year. Watson's exploitation is expensive to collect and prepare data.

The fight with Net giants will be tough because the algorithms matter less; only the data are the ones that allow development in the future.

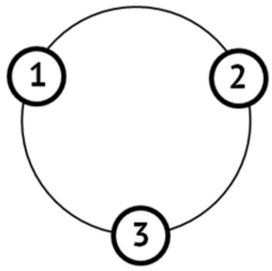


Figure 2. Watson combines transformation technologies to help computers understand and deal with us:
1 - Understands natural language and human communication;
2- Generates and evaluates evidence based assumptions;
3 - It adapts and learns from user selection and responses.

The IBM supercomputer answers Watson's natural language questions (which also contains the Urban dictionary). He performs a text analysis, as well as audio and video analyzes, allowing his voice, facial recognition and images to be recognized. Watson does not translate a computer-based question to answer; he seeks to find meaning in the question asked in relation to what he taught and stored in his memory. He then emits hypotheses through reflection algorithms that he validates from what he knows by assigning them a trusted result. In this way he can argue his answer.

Just like a child, Watson can learn from his mistakes with an automatic learning program. He also takes into account the possible human contributions, which allows him to approach human understanding, making errors of about 4%. Watson does not intend to replace man, but to make him more efficient by providing answers tailored to his demands.

Watson is a cognitive technology that can be applied to a number of services (personalized or broad-based), each of which can adapt Watson's technology to its project.

Watson centralizes, analyzes and streamlines tournament statistics: players, site traffic, attendance, etc. For example, Watson performs a semantic and cognitive analysis of players tweets to personalize their personality: adventurous, spontaneous, angry, generous, etc. This can be a great tool for brands that want to use the services of a "star" that matches their values. The supercomputer analyzes real-time trends on social networks - for tweets posted by participants - about the reputation of some players to determine their reputation based on the percentage of positive or negative tweets.

As for predictive analysis, Watson will not determine which sportsman will win the tournament, but - based on his statistics - will tell which player has the best chance of winning. For example, in the case of a tennis match, whenever a player A has won the second ball and made nearly 60% of the forehand, in 62% of cases he will win the match. If the player applies these keys provided by Watson, he has every chance of winning the match. A little pedagogy for those who might think it's enough for Watson to look for something in his memory. Unlike systems that we know, designed to restore information that was given - provided that they have been properly ordered, to be told where they stood and that the question is posed precisely associated information - Watson works differently. Information has not been "introduced", but information bases have been provided, especially unstructured. There is no box containing the Henry IV and White horses, but "free" texts such as the contents of a blog, reports of a meeting, etc. If a text says that Henry IV is the king of Navarre and that a Navarre king has a white horse, Watson understands that Henry IV has a white horse. Watson combines transformation technologies to help computers understand and be able to handle us; he has *(1)* The ability to understand human language; *(2)* Generate hypotheses and evaluate their own confidence level in each hypothesis; *(3)* It adapts and learns according to the user's reactions.

Experience *Jeopardy!* was a launch event meant to mark the audience for IBM's centenary; Watson has evolved since then and is being used in real business cases in different sectors.

The future of artificial intelligence

Just a few months after Elon Musk founded Neuralink - which aims to create interfaces between the human brain and the machine - he drew attention to the dangers of IA and proposed laws to prevent these dangers. "IA is one of the rare cases in which I think we need to be proactive in regulating problems rather than being reactive; because the time it takes for us to react will be long and will be too late." Musk, pessimistic, says there will come a time when artificial intelligence will destroy mankind, while Zuckerberg, optimistic, says that IA will greatly improve our lives.

The power of the human brain

The most complex living structure in the universe is that of the human brain. The storage and processing power of human brain memory vary in humans because of several internal and external factors.

• It has been estimated (in three different ways) the human brain's calculation power to be about 1 ... 10 Exaflops and 4 ... 5 Petabytes

• A digital computer with this performance will probably be available in 2024 with a power consumption of at least 20 ... 30 MW (the project's goal of Exascale)

• The human brain needs 20 W.

Dimensions of intelligence from the following points of vision:

1. Verbal-linguistic

- Ability to think in words and use language to express and appreciate complex concepts;

2. Logic and mathematics

- Makes it possible to calculate, quantify, analyze proposals and hypotheses, and perform complex mathematical operations;

3. Recognize patterns

- The ability to recognize and think about the common model in all dimensions of the environment;

4. Corp-kynestesy

- Ability to manipulate objects and adjust their physical abilities;

5. Musical

- Sensitivity to melody, rhythm, step and tone;

6. Interpersonal

- Ability to understand and interact effectively with others [Howard].

Historical perspective

- Outstanding longevity: 60 years of large-scale computerized physical applications that have led to the development of computers.
- Application-adapted architecture: von Neumann architecture with floating point focusing, ideal for large-scale, 2D or 3D computerized physical applications.
- For intensive computing tasks, cloud will continue to be used, so connectivity is crucial, but local processing is becoming increasingly important, so system architects are looking for accelerators that in many cases deviate from von Neumann's traditional architecture.
- Today we use the traditional basic architecture for social networks, web searches, music, photography, etc.
- Five complementary approaches to neuromorphic computers (massive parallel, asynchronous, configurable communication):
- Product Microprocessors (SpiNNaker[3], Human Brain Project HBP);
- Fully customized digital (IBM Almaden);
- Personalized Mixed Signal (BrainScaleS[4], Human Brain Project HBP);
- Customized sub-threshold analogue cells (Stanford, Zurich Polytechnic ETHZ);
- Custom yybrid (Qualcomm).

European perspectives

Referring to the report of the Committee on Legal Affairs of the European Parliament and given the great attention that the public is currently attributing to robotics and IA, this report is particularly appropriate as it highlights some crucial issues to be addressed. It highlights the opportunities offered by robotics and IA, indicating the clear need for a coherent European approach for Europe to have a strong presence and investment in this technology in order to maintain its leadership position.

The focus must be on areas where "strengths" are in focus and focus on:

- federated service platforms for convergence,
- Algorithms and software development for convergence,
- analytical methods and tools for convergence,
- Applications and workflows using convergence.

For this reason, SPARC, the Public Private Partnership for Robotics in Europe, was set up to develop a European robotic strategy. With an EU funding of € 700 million - adding private investment - a total investment of € 2.8 billion will be made. In this way SPARC is by far the largest civilian research program in this field in the world. The objective of the European Extreme Data & Computing Initiative (EXDCI) is to support the development and implementation of a common strategy for the European High Performance Computing (HPC) ecosystem.

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[3] SpiNNaker is an *open source, multi-cloud* platform for publishing high-speed software changes and full confidence.

[4] BrainScaleS (*Brain-inspired multiscale computation in neuromorphic hybrid systems*) was an EU-funded EU-Proactive FP7 research project. The project started on 1 January 2011 and ended on 31 March 2015. It was a collaboration of 19 research groups from 10 European countries. The hardware development of the computerized neuromorphic systems is continued in the *Human Brain Project* (HBP) of the *Neuromorphic Computing Platform*.

The most important HPC in Europe, PRACE (Pan European Higher Performance Computing Infrastructure and Services) and ETP4HPC (European Technology Platform for HPC), will join with their expertise in this 30-month project with a budget of 2, 5 million Euros since September 2015. EXDCI aims to support road mapping and monitoring of ecosystem activities, namely:

- Produce and align HPC technology roadmaps and HPC applications;
- Measuring the implementation of the European Strategy for HPC;
- Building and maintaining relationships with other HPC international activities and regions;
- Supporting young talent generation as a key element of the development of the European HPC The EXDCI will complement the demands for Horizon 2020 and the projects for a global competitive HPC ecosystem in Europe. Following the European Commission's vision for HPC, this ecosystem will be based on three pillars: providing HPC technologies, HPC infrastructure, and HPC application resources [Simon].

Conclusions

- Supporters of the rapid development of superintelligence use a direct extrapolation of the current computer performance. They ignore the end of Moore's Law and the multidimensional nature of human intelligence.
- Real-time human cortex simulation will require a computer system with 10 Exaflops, 5 Petabits and 20 MW.
- As the human brain only consumes 20 watts, the current technology is far at least a factor of at least one billion compared to human brain performance.
- We need to explore new architectures if we want to end this gap.
- We need to advance different "brain initiatives" to get the necessary data.
- Supercomputers are an active and prosperous field with global impact. Exascal systems will probably be available in the next decade.
- The current High Performance Computing (HPC) technology is about a factor of 109 relative to real-time human brain performance (106 in power, 103 in count, <10 in memory)
- Technological and architectural innovation is needed to eliminate the gap.
- Starting from what we know today, artificial, sensitive, strong superintelligence is unlikely.
- On the basis of what we know today, a realistic and very precise simulation of brain functions will require major breakthroughs in systems, algorithms and mathematical modeling alongside the progress of neurology (the current AI is far too undeveloped).
- The real danger is the transformation of decisions into systems that we do not understand and control.

Advantages of HPC technology will lead to: improving healthcare; better climate; Prognosis; upper materials; sustainable energy; more competitive industry.

How do we draw a roadmap when the land moves under our feet? We adopt a "modeling strategy" (modeling of forms, platforms, actions and assets) [Simon].

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