INNOVATION TREND REPORT

ARTIFICIAL INTELLIGENCE REVOLUTION

in collaboration with {i/d} italiadecide

INTESA SANPAOLO INNOVATION CENTER

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INNOVATION TREND REPORT

ARTIFICIAL INTELLIGENCE REVOLUTION

Foreword by
Mario Costantini
General Manager

Report by Intesa Sanpaolo Innovation Center

ARTIFICIAL INTELLIGENCE REVOLUTION

If innovation is the engine of change, the Artificial Intelligence is, at this historical moment, the driver of innovation.

The big international players, primarily technological, are investing continuously in the field of Artificial Intelligence with concrete repercussions in many industrial sectors.

Intesa Sanpaolo firmly believes in innovation as a key lever for the competitive development of the Italian productive system and it is for this reason that at the Intesa Sanpaolo Innovation Center we decided to make a thorough study on Artificial Intelligence.

With this study, the Intesa Sanpaolo Innovation Center wants to reaffirm its role as an actor and innovation ecosystem connector to support digital transformation of the Italian industrial system.

A commitment to the growth of our Group and the development and training of future generations.

We have deepened modes and dynamics under which the AI will impact on employment and social relations, and thanks to the collaboration of italiadecide, all these dimensions, by their nature international, have been declined on the current Italian context.

I wish you a good read!

Maurizio Montagnese
Chairman

FOREWORD

Dear readers,

We are living at a turning point in history, as Artificial Intelligence opens up new markets and opportunities for progress in critical area such as health, education and energy. Advances in deep learning and the rapid expansion of process automation have occurred in such diverse areas that we now think of AI as a layer across multiple sectors, rather than an industry in and of itself. Speculation on the future of AI and robotics technologies often has a binary outcome: either it will profoundly increase efficiency and convenience for the world's economies and its people, or it will irrevocably disrupt nearly every established industry and the livelihoods they all support.
The reality will lie somewhere between these two extremes. Technologists, scientists, economists and philosophers are debating the role of AI in the future of work. Personally, I strongly believe that AI technologies will enhance the quality of people's lives and help humanity address important global challenges such as climate change, food, inequality, health and education.

Certainly, today AI is designed to support humans – and in certain cases replace them – in the performance of particular job tasks. Machine Learning and Analytics enable the assimilation of new information, drawing on large amounts of data to assist human decision-makers, improving efficiency and speed of execution. This leads on to new scenarios in job automation, in which humans could provide great added value. However, a new area of research bordering on AI is now emerging: scientists want to link it with neuroscience, to synthesise and track even the creative and emotional parts of the human brain, with future consequences and exponential impacts that we cannot currently assess and will have a revolutionary impact around the world.

Here at the Intesa Sanpaolo Innovation Center, we have taken up the challenge and written this report. Our main goal was to provide a collected and connected set of reflections on AI and its influences on how the world will develop.

The report is intended to appeal to various audiences. For the general public, it aims to provide an accessible, but scientifically and technologically accurate portrayal of the current state of AI and its potential. For industry, the report describes relevant technologies and legal and ethical challenges. Finally, the report can also help AI researchers, as well as the institutions to which they belong and their financial backers, in setting priorities and considering the ethical and legal issues raised by AI research and its applications.

Mario Costantini
General Manager

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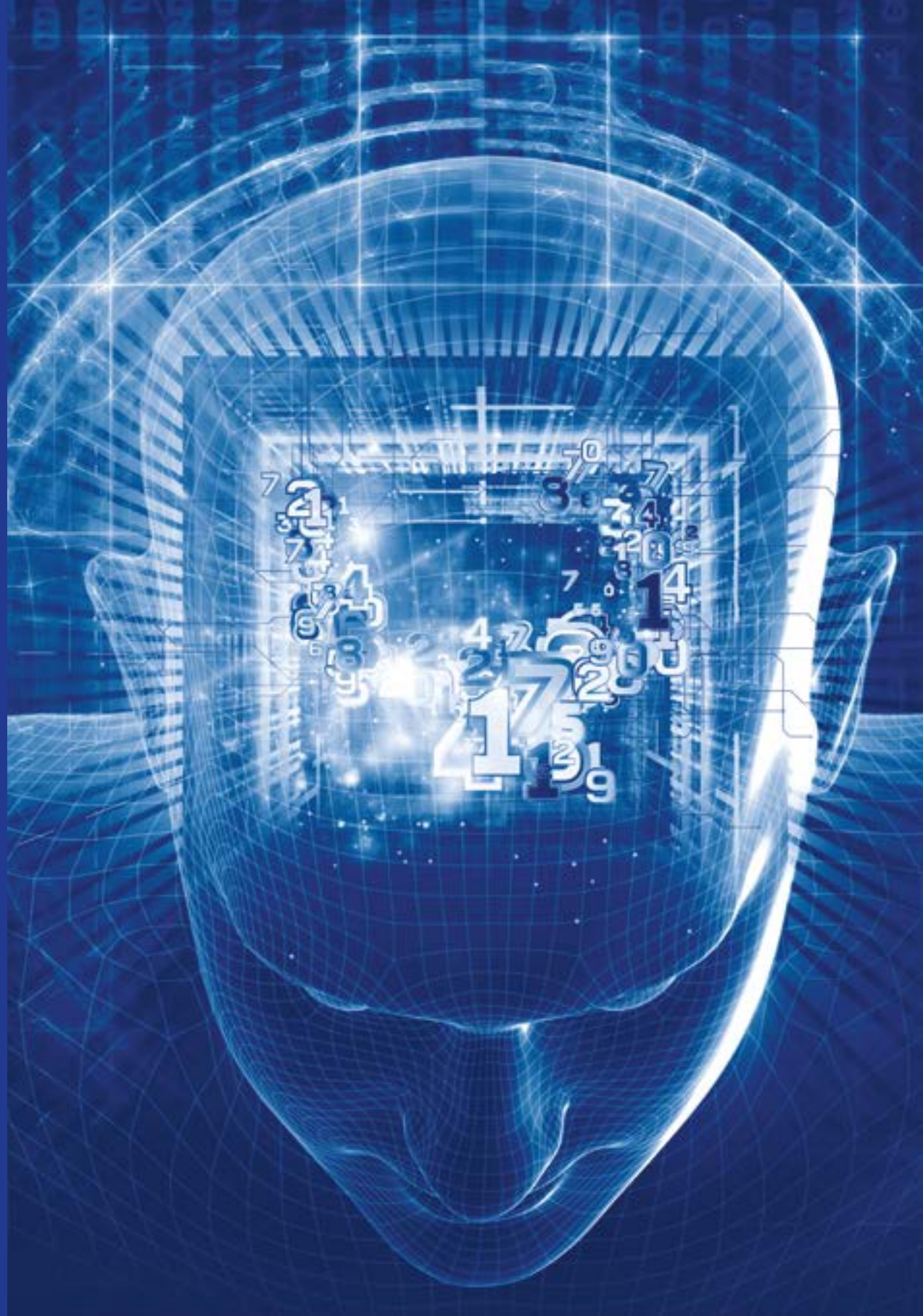
THE GLOBAL BRAIN



INTRODUCTION

1982

Peter Russell publishes
The Global Brain

It was 1982 when Peter Russell published the book The Global Brain: *Speculations on the Evolutionary Leap to Planetary Consciousness*.
It was in many respects a visionary book, depicting the parallelism between the planetary ICT network and the human brain: every human artefact connected to the internet is like a neuron, the links between the nodes are like synapses, and the data flows on the net are like the sparks firing inside a human brain.

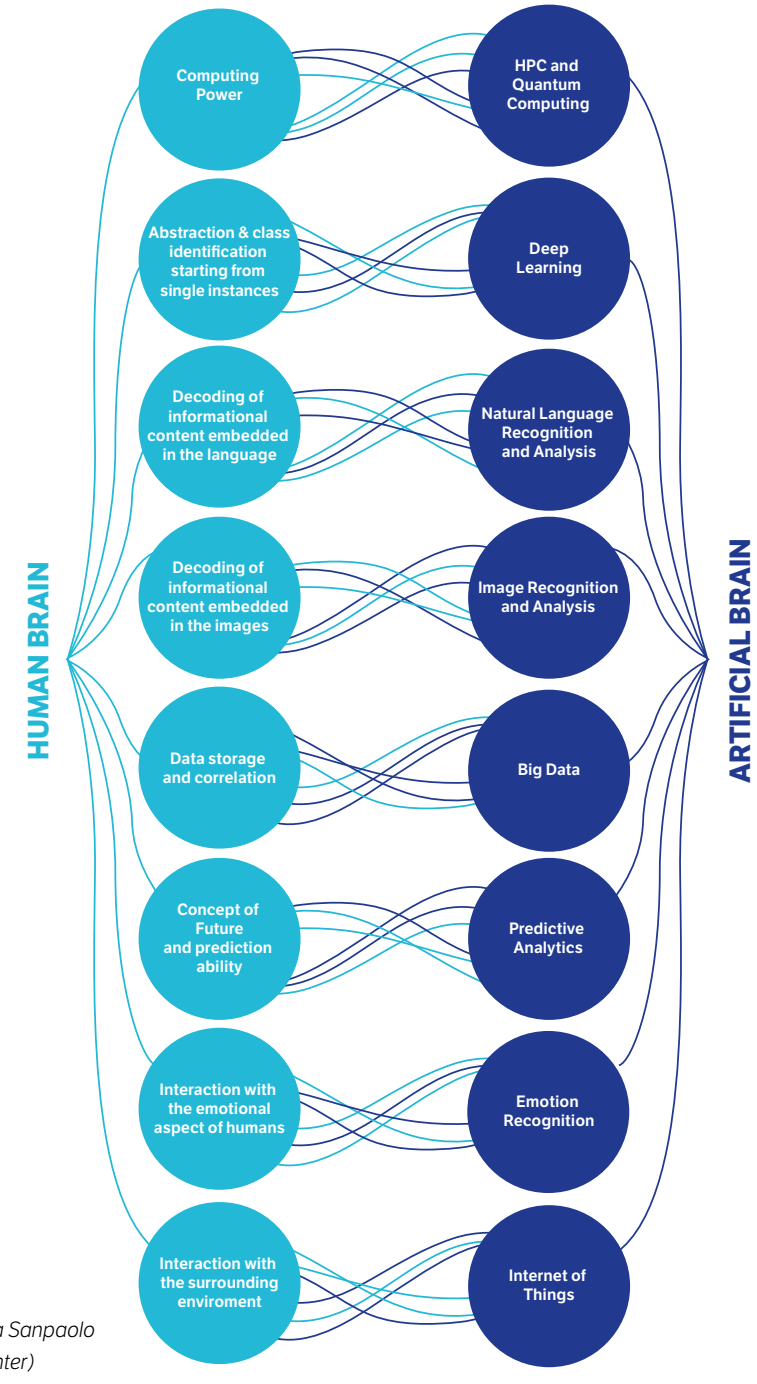
Moreover, the net has its own data, which is growing at an incredible rate, and in Russell's vision sooner or later it will be able to acquire intelligence and self-consciousness, becoming the de-facto artificial brain of planet Earth.

Three decades later, things are a little bit different.
The 'building blocks' of the human brain (high computing power at a very low energy consumption, class abstraction starting from single instances, real-time decoding of informational content embedded in language and images, data storage and manipulation, conception of the future and capacity of prediction, interaction with human emotions and with the surrounding environment) can be mapped in as many AI technologies that only now are reaching maturity (and some of them are still in the development stage).

Furthermore, every time scientists get a deeper insight to of the human brain, they are astonished by how complex it is, and the new discoveries challenge the fundamentals of brain's modelling, leading to radical changes in AI technology development and implementation.

So, what does all this mean?
Do we think Russell's vision is a chimera only to be seen realized in science-fiction movies?
Not at all!

As we will examine in greater detail, we are very close to a paradigm shift: AI machines trained with the game-theory approach are starting to defeat humans in tough challenges; artificial versions of neurons are beginning to be commercialized and embedded in more complex systems; new neuromorphic algorithms are properly mapping the 'random' functioning of the human brain; the current frontier of research is focused on infusing creativity in computers and some machines have already started to draw paintings and compose music that rival human ability.



(Source: Intesa Sanpaolo Innovation Center)

THE ‘BUILDING BLOCKS’ OF THE HUMAN BRAIN

In a virtual vision of the human brain as a supercomputer, we have mapped its logical functionalities, called ‘building blocks’ in many AI technologies, as shown in the image on the opposite page.

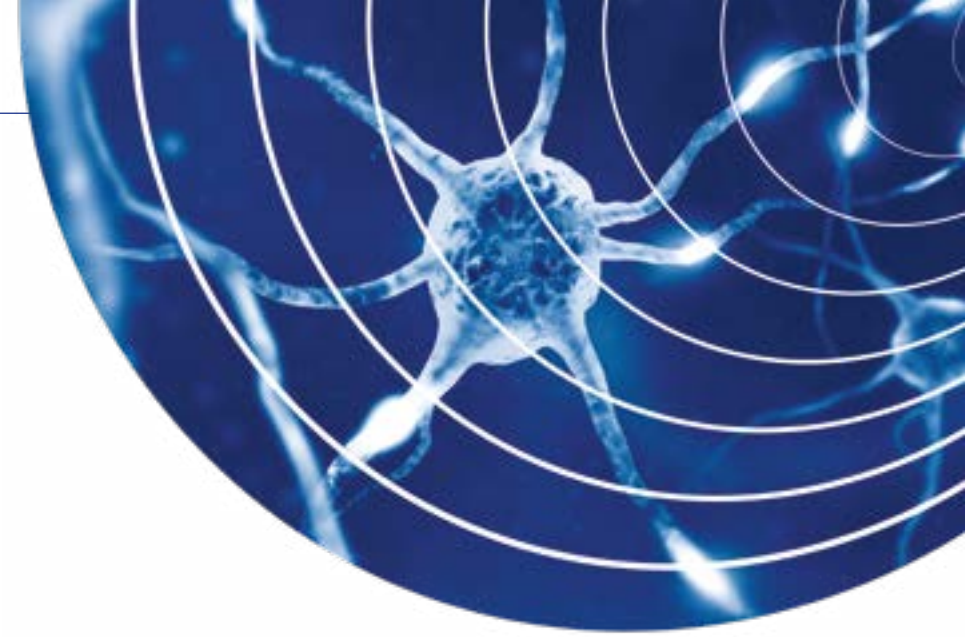
It is common knowledge that, in the last five years, all of these technologies have boomed both in terms of public awareness as well as commercial availability. However strong interaction between these technologies is a very recent trend, and one that is generating growing synergies so that the end result will be much greater than the sum of its parts.

So, where are we now? What is already possible and what is still in the realm of sci-fi?

How much do we really know about the left side of the image – the biological brain – and how is the right side starting to evolve, with single blocks cooperating with each other?

New models are rethinking hardware design itself, bringing it closer to the biological structure of the nervous system.

We are moving toward so-called neuromorphic computing – the second step in the evolution of machines.



THE HUMAN BRAIN: A YET-TO-BE EXPLORED FRONTIER

Human Cortex has

+20 Bln

neurons consuming 20 watts

Sunway TaihuLight has

10.6 Mln

processor cores consuming 15.4 Megawatts

(Source: Frost & Sullivan)

Most of the current approaches to using AI to replicate human brain behavior are based on a 'computer logic model', whereby our brain acts as a supercomputer, deterministically applying learned algorithms to existing data and external sensory signals, using 20 bln neurons out of 86 bln globally present as processors. In this model, technological limits are mainly to do with performance; once the technology has caught up, it will "automatically" be able to think as humans do.

But this approach has two structural limits. We are just beginning to gain deep knowledge of the human brain, thus every attempt to replicate it will have an incomplete, faulty model to look at. In addition, we are getting evidence that our brain does not work in a deterministic way, as do hardware and software.

In July 2016, Nature published an article on the exploration of the cerebral cortex, the outermost portion of the human brain, by a group of neuroscientists led by Matthew Glasser and David Van Essen.
They based their analysis on the concept of "properties": cortical thickness, brain function, connectivity, topographic organization of cells, level of myelin; borders within the brain are identified by multiple changes in such properties. Using this technique on the data collected by 210 different people, neuroscientists confirmed the existence

see the video!

see the video!

of 83 already known brain areas, but also discovered 97 brand new ones!

This is a clear indicator that our knowledge of the structure and the operation of the human brain is still at a very early stage, therefore any attempt to replicate it in an artificial way is still subject to limitations.

Today, the new frontier in brain mapping is a technique developed by MIT's Dept. of Chemical Engineering: the MAP, or Magnified Analysis of Proteome.
Simply speaking, the idea behind this technique is to use a chemical process that enlarges brain's tissue size up to four times, while retaining all nanoscopic detail and brain connectivity. This makes it possible to get unprecedented detail on the inner structure and connections of the brain.

Besides the fact that we have a very partial knowledge of human brain's behavior, the most challenging issue to solve is perhaps the fact that the human brain does not act in a deterministic way; the same input will not always generate the same output.

NEURONS ARE UNPREDICTABLE. A GIVEN INPUT WILL NOT ALWAYS PRODUCE THE SAME OUTPUT.

web link

This behavior can be replicated via software to some extent, but to reach the same efficiency as the human brain in terms of computing power as a function of energy consumed, it needs to be implemented via native hardware.

In May 2016, *Nature Nanotechnology* published a paper announcing that researchers at IBM's Zurich Lab had found a way to create an artificial neuron, using Germanium Antimony Telluride (GAT): a "phase-change material" that permanently changes its inner structure when electricity passes through it.

This behavior is much like that of neurons: when the same electric input is applied to a GAT artificial neuron, its behavior is never the same, because it also depends on the history of the previous stimuli to which it was subjected. At the time the article was published, according to the leader of the research group Dr. Eleftheriou the next step was to link together these artificial neurons, creating tiny "brains" that if connected to sensors could perform specific intelligent tasks, as ie:recognize when an irregular heart rhythm appears or detect unusual trading activity in financial markets. Bigger versions of these brains could be embedded in more complex chips, providing very fast and efficient processor- based pattern recognition, which will be much faster than current software based solutions. Just 18 months later in October 2017, Dr. Eleftheriou's theories turned into reality. Those very researchers succeeded in assembling a million artificial neurons in a single electronic circuit. Exploiting the physical characteristics of this mini-brain, a deep learning algorithm was able to find temporal correlations amid unknown data. If you compare this operation with what can be done on computers with traditional chips, the same result was obtained using 1/200 of the energy and at an elaboration speed 200 times faster. The gap between artificial brain and biological brain is also shrinking in terms of physical similarity.

LET'S PLAY WITH ...NO, LET'S PLAY AGAINST THE MACHINES

see the video!

Games have characteristics that make them the ideal landscape to train AIs: well defined rules that players have to follow, a clear target to reach, the strong need to develop a 'move ahead' vision by analyzing the highest number of what-if scenarios as fast as possible, and the ability to remember the past and compare it against the present situation in order to choose the best move.

GAMES ARE THE 'LAB RATS' OF AI RESEARCH.

In January 2014, Google acquired the AI startup DeepMind for more than $500 mln.

500 Mln$

Google acquired DeepMind for more than $500 mln

Machine plays versus man.

Two years later, in January 2016, the Google DeepMind team developed an AI-based computer that defeated a human champion at playing "Go" – the millennia-old Chinese game considered thousands of times harder than chess.

In order to achieve such a result, the Google team used convolutional neural networks to simulate thousands of possible game states per second, together with exceptionally fast tree search approaches based on machine learning, in order to intelligently scan the tree of possible future board states.

During the matches, human Go experts were surprised by some of the moves made by DeepMind: the machine invented various new strategies predicting in a unfeasible for humans.

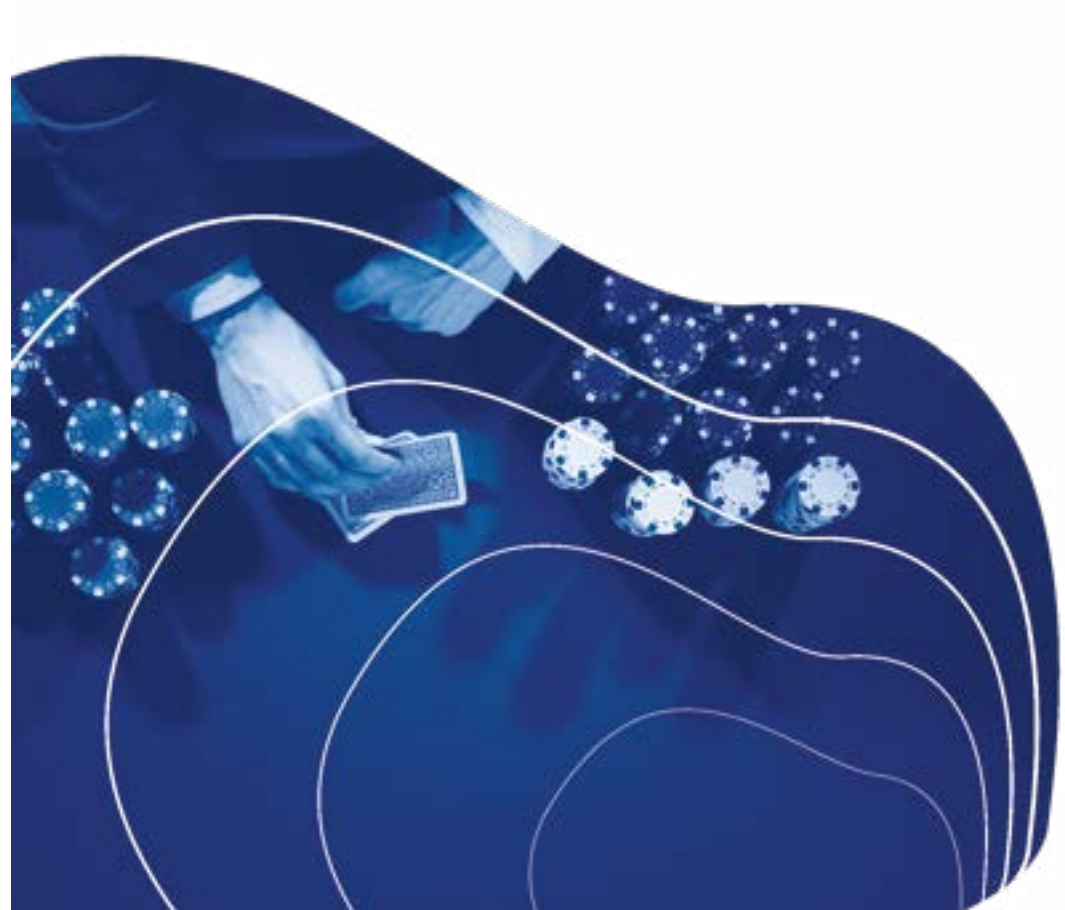
Machine plays versus another machine.

This incredible result was recently obscured by the new generation of algorithm: Alpha Go Zero, announced in October 2017.
Alpha Go's learning process was very similar to a human's, first studying the game rules and then analysing the matches of better players. Alpha Go examined thousands of games played by humans and reached top player level after months of training.
The approach for Alpha Go Zero was different: it was taught the rules, but then had to learn by itself, playing against itself and learning from its mistakes in a constant growth. The result was mindboggling: in just 3 days Alpha Go Zero reached the same level as Alpha Go while only using a fraction of the calculation potential.

The results obtained in the game Go fall into the field of extremely complex problems but fully known to the domain: the rules and variables are all known, in this case the chessboard and previously made moves.
Games like poker, however, are different.
In this case the machine is like human players; it can't know for sure what the next cards will be. Furthermore, players can bluff, which is not dictated by objective data (cards) but by experience and personal hunches.

HAVE YOU EVER PLAYED AGAINST A MACHINE THAT DECEIVES?

In situations like these the assumption is that a machine would be easily fooled and beaten by man, who can rely on the non-determining factors of the overall problem.
However, at the start of 2017 Libratus managed to beat 4 of the world's best Texas Hold'em poker players, a particularly complicated version of the game which includes a strategic component because whoever has the most wins over the long term wins outright. After a 20-day round the machine had made $1.7 b, leaving all four human players with a negative number of chips. Over the 20 days, accepting a limited number of single defeats in favour of the overall result, the machine succeeded in bluffing, placing low bets despite good cards, and changing tactics to confuse adversaries.



WHAT IS GOING TO HAPPEN

Looking at the AI world with a segmented approach means looking at how each building block is performing right now, and therefore if and how it can find concrete implementations in the lives of individuals and companies.
In this perspective, most technologies are mature and starting to see a wide commercialization.

Predictive Analytics for example is the core tech of **HireVue**, a company that is uses AI to improve the recruiting process, prioritizing candidates based on correlation with the top talent present in the company.
The same technology is at the basis of **Koru**'s platform.
A combination of predictive algorithms and other AI techniques, Koru supports the hiring process by providing talent scoring based on intangible qualities: Rigor, Impact, Teamwork, Curiosity, Ownership and other;
the platform automatically sorts the candidate database based on each company's unique soft skills fingerprint.

KORU K7 IMPACT SKILLS

joinkoru.com

Founded:
2013

Funding stage:
Unattributed VC

Total Funding:
15 Mln$

(source: CBInsights)

Koru

Koru is the leader in predictive hiring based on the real drivers of performance, Koru7™ Impact Skills. Koru is transforming the way you screen, hire, and develop early-career millennial talent through our data-driven talent analytics solution. We work with innovative talent leaders from some of the world's leading enterprises across dozens of industries to select talent based on the unique drivers of performance in their companies.

Deep Learning and **NLP** are mostly used in the financial industry, with solutions like the Kasisto "conversational smart bot" that can interact completely autonomously with customers in order to understand their needs, manage their money, track expenses and make payments.

Natural Language Understanding is also the core interest of **Pat**, a startup that is using a proprietary neural network to understand the meaning of sentences.

"Pat, the meaning matcher, parses straight to semantics combining the linguistic RRG Model with a proprietary neural network. Pat matches every word to the correct meaning based on the meanings of the other words in the sentence or story just like a 3 year old does without guesswork. As a result, language is broken down by meaning, storing only certainties like a human does, not probabilities."

pat.ai

Founded:
2015

Funding stage:
Seed

Total Funding:
2.5 Mln$

(source: CBInsights)

see the video!

Pat.ai

Pat.ai parses to meaning - Pat breaks down language by the only commonality between languages - meaning. Pat's system has 3 parts: Language layer, Meaning layer and Context layer. By focusing on meaning, Pat has a relatively small number of 'links' to build in its meaning layer or neural network. This ensures scalability of the system and completely avoids the 'combinatorial explosion' that is a current challenge for computers trying to manipulate the infinite permutations of sentence structures, across multiple languages. Pat receives text as input and adds meaning as output.

Deep Learning is at the base of **Enlitic** platform. Enlitic applies AI to support physicians in their decision-making process by analysing large amounts of unstructured medical data, such as radiology and pathology images, laboratory results, genomics etc.
The machine was trained with millions of images from thousands of clinical cases and subsequently challenged in a trial against a panel of thoracic radiologist experts, outperforming them in terms both of early lung cancer nodes detection and in avoiding false positives.

A similar result was achieved in detecting fractures; in this case Enlitic achieved a score of 0.97 AUC (the most common measure of predictive modeling accuracy) – three times better than the level of 0.85 AUC obtained by humans.

COMBINE TWO OR MORE AI'S TECHNOLOGIES, AND YOU WILL GET A QUANTUM LEAP FORWARD.

Bigger steps forward are made when two or more AI technologies are used together, in order to exploit the resulting synergy.

In 2014, IBM released a neuron-brain inspired processor called TrueNorth, a chip that consumes just 70 mW per second and can perform 46 billion 'synaptic' operations per second.

*"Unlike the prevailing von Neumann architecture — but like the brain — TrueNorth has a parallel, distributed, modular, scalable, fault-tolerant, flexible architecture that integrates computation, communication, and memory and has no clock. It is fair to say that TrueNorth completely redefines what is now possible in the field of brain-inspired computers, in terms of size, architecture, efficiency, scalability, and chip design techniques"**

Two years later, in August 2016, Samsung has exploited the power of TrueNorth by building a camera around it that can perceive and record changes at pixel level instead of image level.
This experimental camera analyze the monitored image in real time and detect which pixels have changed and which have not – exactly the same way the human eye does. This feature allows the camera to reach the incredible performance of 2000 frames per second, while consuming merely 300 mW of energy.

An evolution of this achievement was presented by IBM in July 2017: iniLabs DVS is a gesture recognition system that works on events, meaning it can recognise 10 different hand movements in a tenth of a second using less than 200mW, imitating the behaviour of the brain-retina system.
Here movement relevation is again activated by the change in a portion of the image: the machine lies dormant if the image is static and once activated it singles out and elaborates the portion of image triggering the event.

COPY THE HUMAN BRAIN TO GET A MINIATURISED COMPUTING SYSTEM WITH VERY HIGH ENERGY EFFICIENCY.

* http://www.research.ibm.com/articles/brain-chip.shtml

Moving a step further from the single applications of specific AI technologies, the second stage of building a true Artificial Intelligence – so-called Artificial General Intelligence (AGI) – aims to replicate the whole operation of the human brain.

This is happening in two synergistic ways: on one hand, we need to replicate the physical behavior of our 'machine', in order to have an engine with the same potential to exploit; on the other, we have to train these engines not only in analytical, logical and rational functions, but also in the artistic and creative side of our mind.

"STUDYING HOW THE BRAIN WORKS HELPS US UNDERSTAND THE PRINCIPLES OF INTELLIGENCE AND BUILD MACHINES THAT WORK ON THE SAME PRINCIPLES. WE BELIEVE THAT UNDERSTANDING HOW THE NEOCORTEX WORKS IS THE FASTEST PATH TO MACHINE INTELLIGENCE".

Numenta is a startup that is working on the first side of the problem.
Its goal is to reverse-engineer the neocortex.
To reach this goal, Numenta has funded an open source community working on Hierarchical Temporal Memory (HTM) theory. So far, this effort has led to a platform called NuPIC (Numenta Platform for Intelligent Computing), whose code can be used to analyze streams of data, detecting relevant patterns and using them to predict future values and/or detect anomalies.

Numenta

numenta.com

Founded:
2005

Funding stage:
Series C

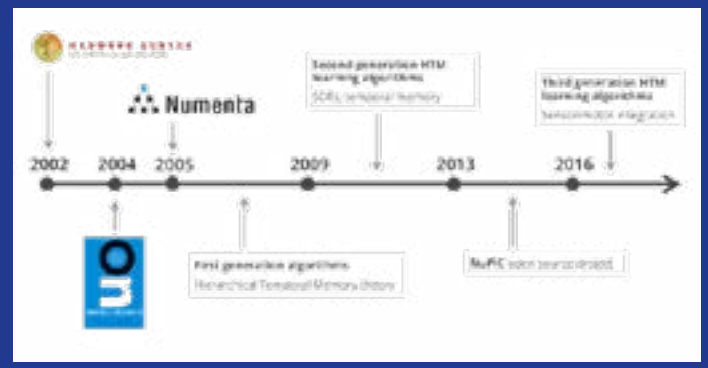
Total Funding:
23.6 Mln$

(source: CBInsights)

see the video!

Numenta

Numenta's mission is to be a leader in the new era of machine intelligence. We believe the brain is the best example of an intelligent system, providing a roadmap for building intelligent machines. The brain's center of intelligence, the neocortex, controls a wide range of functions using a common set of principles. The company's progress can be categorized by three distinct phases: (1) Testing the HTM theory and developing first generation algorithms. During this phase, vision was a main application focus area. (2) Developing a second generation of HTM Learning algorithms with stronger biological correlation and a roadmap for future work. During this phase, we continued to explore applications, built a prediction engine, and started our open source project. (3) Researching the third generation of HTM Learning algorithms. We are currently focusing on sensorimotor integration.



CREATIVE COMPUTERS: WRITERS, PAINTERS AND MUSICIANS

If replicating the analytical, logical and rational functions of the human brain is a tough challenge for all researchers and the scientific community, trying to do the same for the artistic and creative side of our mind is playing in another league.

web link

So far machines have been able to replicate, in an almost indistinguishable way, the works of writers like Hoshi, painters like Rembrandt and musicians like Bach.
A Japanese team led by Hitoshi Matsubara has been working since 2013 on a story-writing AI and in 2016 a totally computer-written novel passed the first selection phase of the Hoshi Prize.

see the video!

More astonishingly, in The Next Rembrandt project sponsored by the Dutch bank ING, experts were able to 'extract' Rembrandt's DNA from his paintings and implant it into an intelligent machine that, using facial recognition algorithms and 3D printing techniques, succeeded in creating a totally new masterpiece painted like only the portrait king was able to.
The painting was then exhibited in a gallery together with other authentic works of Rembrandt and a jury of experts was not able to distinguish it as a 'fake', based on all the usual criteria considered when an artist's work comes to light and is analyzed to check its authenticity.

MACHINES HAVE REACHED THE SAME EXCELLENT TECHNIQUE OF FAMOUS WRITERS, PAINTERS AND MUSICIANS. WHAT ABOUT CREATIVITY?

In early June 2016 Google also launched the *Magenta* project.
Having consolidated its position in using AI algorithms to understand human-produced content and environments, Google now aims to make AI machines able to generate new content, to become creative in music, images and text.

"OUR MAIN GOAL IS TO DESIGN ALGORITHMS THAT LEARN HOW TO GENERATE ART AND MUSIC."

see the video!

see the video!

Google's approach is based on analysing millions of photographs generated by users and uploaded onto the net. Google Deep Dream, (the fake artist) can recognise shapes, colours, and objects; it can classify recognised objects and finally put them together to make new and complex shapes and images.

A different approach is used by a joint group of researchers at Rutgers University, Charleston College and Facebook, with its AI Research Lab.
Researchers in this case started out by educating the machine with artworks by over 1000 artists from the 15th to 20th centuries.
The machine therefore produced abstract paintings that were then mixed up with artworks coming from the contemporary art show Art Basel 2016 and from Abstract Expressionism.
A panel of judges was asked to evaluate how novel all the artworks were in terms of visual language and artistic quality.

WILL WE SEE A WORLDWIDE SUPERBRAIN?

So far we have seen what's happening in the scenario of making ONE machine as intelligent as ONE man, developing logical and creative functions of the human brain.
However, just as society is an extremely complex ecosystem – made not only by the sum of ALL the people belonging to it, but also characterized by the relationships that develop between the human elements – we should start to consider at what could happen if MANY Intelligent Machines started to relate to each other, in much faster than mankind will ever emulate.

AI-DISTRIBUTED INTELLIGENCE COULD SOON EFFECTIVELY TAKE OVER THE GOVERNMENT OF A CITY OR A STATE

We have already seen that gaming is the best training battlefield for enhancing the intelligence of AI; now all we have to do is think of complex public administration tasks as if they were a game to solve, like in the popular computer game SimCity.
This is not a sci-fi movie scenario: the technology is already in development and, from a technical point of view, administering a city or a state is very close to a strategy game where the player has to maximize the result using the available resources and face daily constraints.

Depicted in this way, a machine probably has a better chance than a human to correctly administer a public environment: it doesn't forget past errors, thanks to Deep Learning and Big Data; it can analyze many different alternative scenarios in a fraction of the time that humans can, thanks to Predictive Analytics; it is not subject to personal interest or, generally speaking, malicious biases; and it is able to collect and understand the contemporary feedback of thousands of citizens thanks to Natural Language Processing.

This'Artificial Public Administrator' could run on thousands of machines in the cloud, with networking, scaling, workload distribution, persistence, state synchronization, and fault tolerance managed by machines themselves.

Moving a step further into the (not-so) distant future, there are at least two scenarios that can utterly change humankind, as known so far.

In the first scenario, once technology allows deep real-time interaction between the human brain and AI the road will be paved for **Hybrid Intelligence** with machines that will amplify (or substitute if damaged) some logical functions of the human brain.

"GET READY FOR HYBRID THINKING"
(Ray Kurzweil, Inventor and Futurist)

Ray Kurzweil is among those who see the future in this way. In his vision, hybrid thinking will be achieved thanks to nanotechnology, with thousands or millions of nanobots that, once injected into our bloodstream will reach the neocortex of our brain, establishing a connection with the external, artificial neocortex.

web link

A second, more scary and unpredictable scenario, is the replication of Evolution Theory among ***'machinekind'***.
It took thousands of years for humankind to reach self-awareness, extend relationships outside the strict boundaries of the tribe, store and retrieve the knowledge of previous generations, and share ideas and thoughts in close-to-real-time with thousands of other people.
With a speed which is magnitudes higher, machinekind is seeing the same path on the horizon: the first step is the hardest, but how fast will machines go once they have achieved self-awareness?

Will we see a totally independent Global Brain?
And what will its relationship be with mankind?

INTERVIEW WITH FABRIZIO RENZI

Fabrizio Renzi

Fabrizio Renzi, Director of Technology and Innovation IBM Italy.
Fabrizio Renzi is the Director of technology and innovation of IBM Italy. In this role he leads all the technical activities of IBM to works together with italian companies for their digital transformation. He is also in charge of connecting Research to business by bringing IBM laboratory capabilities into Italian markets.
From 2011 to 2013 he was Director of technology and innovation for Italian banks, insurances and financial institutions. In 2009-2010 he was based in Dubai, and was IBM Director of Systems and Technologies for emerging markets (Russia, Eastern Europe, Middle East and Africa). Since 1997 he has worked with increasing responsibilities on leading edge technologies and transformation initiatives for IBM, covering different managerial roles in areas such as: ondemand, ebusiness, ecommerce, network computing solutions, client server.
He joined IBM in 1990 as System Engineer in charge of introducing to Italy new products technologies and solutions developed in R&D labs in the USA, where he also spent some years of his professional life in international assignments.
With a Master's degree in Biomedical Engineering from Politecnico di Milano, he also got an International Executive Program MBA from INSEAD in Paris.
A speaker at several scientific congresses and technology related events, Renzi is also the author of several papers and publications in technology and scientific topics. He has cooperated with Italian and international universities as a lecturer and contract professor.

fabriziorenzi

fabrizio_renzi

Q NLP, Deep Learning and Predictive Analytics: what is the state of the art and what can we expect in the near future?

A We in IBM we have a huge stake in thismade. In 2011 we trained succesfully a computer, called Watson to understand semantics and play in the most popular USA TV quiz show called Jeopardy. After that we invested several billion dollars in research and development and trained the machine for several use cases such as precision medicine with Sloan Kettering, wealth management with Citibank, and so on. The purpose is not to replace humans but to augment their capabilities.

Q Can you tell us what the Watson Labs are working on?

A Our research labs are training and improving Watson in several areas. One is precision medicine where Watson assists medical doctors in diagnosis in areas such as oncology or rare diseases. Another one is genomics where Watson is assisting genetists in doing cognitive analytics on genomic data. Or cognitive education, where Watson itself is trained to assist students to get better education; an example of this is the cognitive tutor we developed with Humanitas in Milan. Another area is cognitive discovery, where Watson assists scientists in reading the massive scientific literature more effectively and by combining it with

data helps them make new discoveries, such as new alloys or geological areas with the right characteristics.

Q Project TrueNorth: is it still under development? What will we see in the near future?

A Yes project Truenorth or neurosynaptic chip is still under development in our lab and has already proven its great potential in areas such as unmanned vehicle guidance. Basically with Watson we introduced a paradigm shift from 1945 Von Neumann computer architecture and with Truenorth we are achieving part of it in silicon. In Von Neumann architectures, programs, memory and CPU where separated. In the new learning systems paradigm, the machine learns from data therefore, as in the human brain, there is a different mix of programs memory and computing power.

Q Think of projects Magenta and The Next Rembrandt: when will we see a true creative machine?

A We already have some projects to explore machine creativity. My favorite one is Watsonchef where based on chemistry of ingredients, a huge database of worldwide recipes and a user of choice of recipe innovation, the system creates new recipes for the user. There are other areas of application like creating writing, painting and so on. It is just a matter of creativity...
Joking aside creativity is a complex problem that we are starting to address.

Q Hybrid Thinking: is it a chimera or not too distant reality?

A It is hardly a chimera. Augmenting human brain capability and not replacing it is actually what we are after. The reason is simple, there are things in which humans are better such as commonsense, emotion, passion and others in which machines are better such as big data handling and number crunching, and therefore using a machine to augment human capability is the target.

Q Will we see a totally independent Global Brain? And what will its relationship with mankind be?

A A computer with a conscience is something we still see as science fictional, but of course new areas such as computer ethics are emerging. Indeed, IBM has formed an important alliance with industry players like Google, Microsoft, Facebook and others emerging.

2

ARTIFICIAL INTELLIGENCE TECHNOLOGIES, A DEEP DIVE

INTRODUCTION

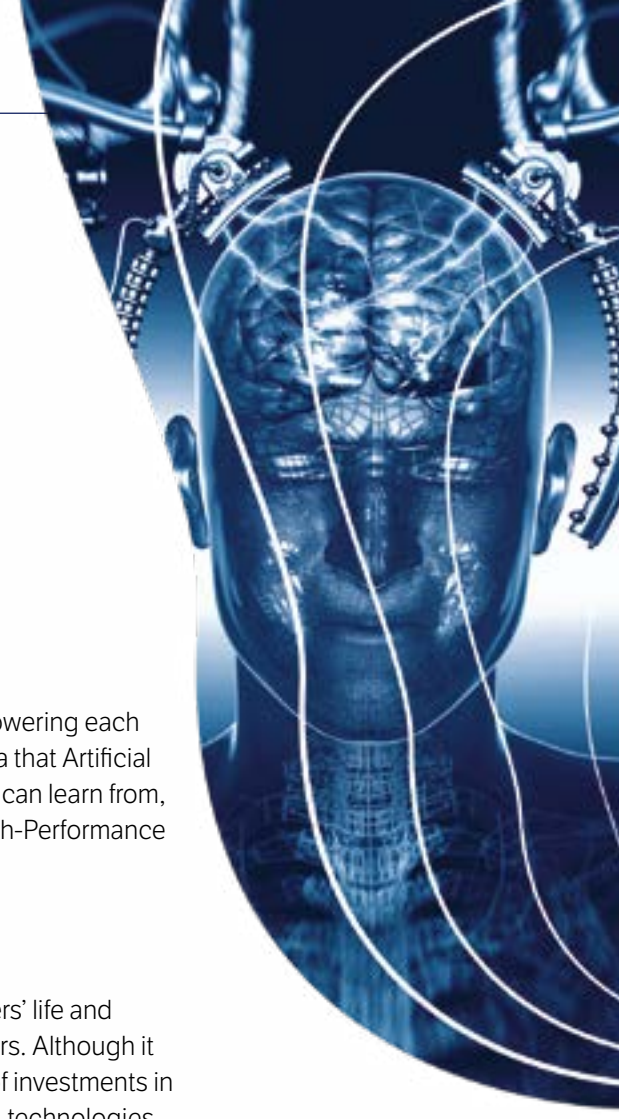
1956

John McCarthy coined the term Artificial Intelligence

In this chapter Artificial Intelligence (AI) and the technologies AI strongly interacts with will be introduced by providing a definition, some history, market data and cases studies.

Starting from the definition of Artificial Intelligence (AI), which is related to human intelligence, the current subfields of AI are described: Deep Learning, Natural Language Processing, Image Recognition, Emotion Recognition and Predictive Analytics. These subfields represent scientists‘ effort to mimic the human abilities of learning from experience and thinking, speaking and understanding speech, recognizing objects in pictures or videos, understanding human emotions from facial expressions, voice and body gestures, and finally being able to predict what is going to happen shortly. While the abilities mentioned above are inherent for human beings, they are not easy to achieve for machines. In fact the progress of these technologies is not uniform, as it also depends on the level of knowledge of the corresponding function in the human brain.

In this context we will also provide an overview of the main technologies Artificial Intelligence interacts with: Internet of Things (IoT), Big Data (Analytics), High-Performance Computing (HPC) and Quantum Computing.



All these technologies are intertwined, empowering each other: millions of sensors provide a lot of data that Artificial Intelligence and, specifically, Deep Learning can learn from, in faster and more efficient ways through High-Performance Computing and Quantum Computing.

But why do it? Why focus on AI?

Because AI has a strong impact on consumers’ life and several applications in different market sectors. Although it hasn’t reached its full potential yet, the flow of investments in AI-focused startups shows how disruptive AI technologies will be.

"ARTIFICIAL INTELLIGENCE IS THAT ACTIVITY DEVOTED TO MAKING MACHINES INTELLIGENT, AND INTELLIGENCE IS THAT QUALITY THAT ENABLES AN ENTITY TO FUNCTION APPROPRIATELY AND WITH FORESIGHT IN ITS ENVIRONMENT."

Nils J. Nilsson

THE PATH TO MODERN AI

Artificial Intelligence (AI) has been gaining traction recently. The goal of Artificial Intelligence is to develop technologies and machines that can mimic the way the nervous system and the human body work in order to sense, learn, react and solve problems. For years the lack of a precise definition of AI has enabled researchers to delve into areas such as learning, natural language processing, perception and reasoning.

There are two main categories of AI:

1 – **Artificial Narrow Intelligence [ANI] or Weak AI:** focuses on one area or one task.

2 – **Artificial General Intelligence [AGI] or Strong AI:** focuses on enabling machines to perform any intellectual activity a human being can perform..

see the video!

A computer playing chess accomplishes one task based on specific rules; this is an example of Weak AI. On the other hand, a machine that will be able to reason is an example of Strong AI.
The so-called 'AI Effect' or 'AI paradox' refers to the fact that as soon as AI brings a new technology to the mass market, this technology stops being considered part of AI; so AI researchers can focus on another area of AI and come up with something newer.

59.7 Bln$

Revenues from the artificial intelligence (AI) market worldwide by 2025

(source: Statista)

AI's rapid growth can also be seen in the number of requests for intellectual property and patents; according to a report by Sequoia Capital China and Zhen Fund, the number of AI patents grew to a CAGR of 33.2% from 2012 to 2016. USA and China dominate the ranking of countries that have submitted the largest number of AI patent applications, followed by Japan, South Korea, Germany, Canada, the U.K., Australia, India and Russia. These 10 countries account for 81.5% of all patent applications; each has its areas of specialization among AI subfields.

The main subfields of AI that will be discussed below are:

– Deep Learning
– Natural Language Processing
– Image Recognition
– Emotion Recognition
– Predictive Analytics

Before diving deeper into these subfields, some history of AI.

History of AI

1950 — Alan Turing wrote *Computing Machinery and Intelligence*

In 1950 Alan Turing wrote a paper ("Computing Machinery and Intelligence" in the philosophical journal Mind, where he defined the so-called Turing Test) on the notion of machines being able to simulate human beings and the ability to do intelligent things. However the term Artificial Intelligence was first used by John McCarthy in 1956 when the first academic conference on the subject took place at Dartmouth College, in Hanover, New Hampshire. John McCarthy inspired a lot of researchers and scientists who were optimistic about AI's potential and future development.

1956

1974-1980 — AI winter

Unfortunately, developing machines as intelligent as humans was not so simple. Due to the lack of interest and funding by governments, the period between 1974 and 1980 was called the "AI winter". Another winter took place between 1987 and 1993, but finally interest in AI was revived and in 1997 IBM's computer Deep Blue defeated the Russian chess champion Garry Kasparov.

1974

2011

In 2011 IBM's super-computer Watson won the quiz Jeopardy, proving able to ask questions when answers had been provided.

2014

In 2014 the "talking" computer Eugene Goostman passed the Turing test, making some judges think that it was a human being. In any case the results of the Turing test were controversial, as the computer claimed it was a teenager speaking English as a second language; in addition some experts don't consider the Turing test to be the most effective way to identify an artificially intelligent machine.

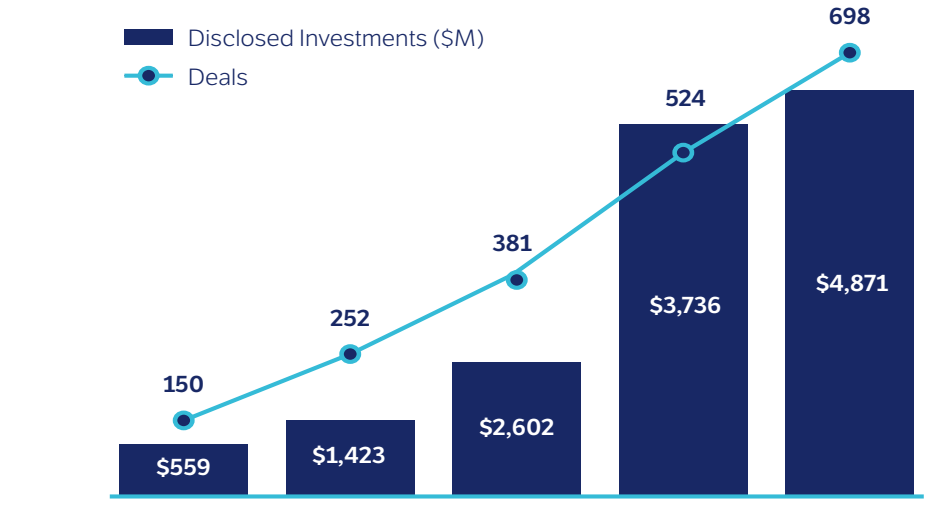
2016

In March 2016 Google's DeepMind AlphaGo defeated South Korean champion Lee Sedol at Go, an abstract strategy board game.

2017

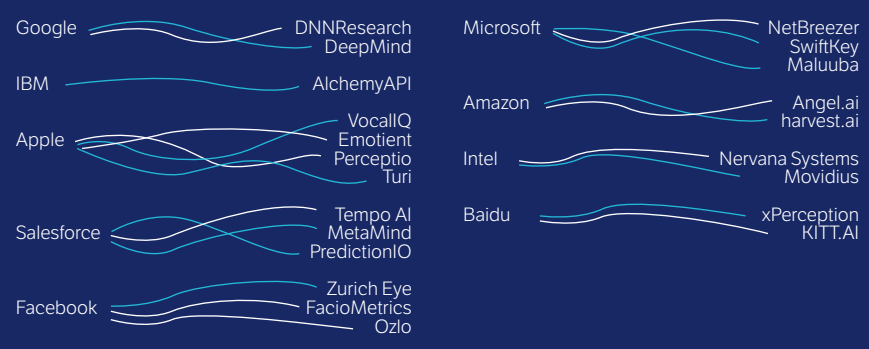
In October 2017 Google's DeepMind launched AlphaGo Zero (AGZ), a new version of AlphaGo AI, which can learn to play Go by challenging itself to games and can beat any player, improving the performance of AlphaGo.

AI funding



CBInsights provides the Financing History for AI from 2012 to 2016. In the chart above the number of deals and the total amount of funds raised by Deep Learning, Natural Language Processing, Image Recognition, and Emotion Recognition startups are represented.
"Deals to AI startups increased 4.6x in the last 5 years, from 150 in 2012 to 698 in 2016" (Source: CbInsights).

Coming to M&As, in the last five years corporate giants like Google, IBM, Intel, Apple and Salesforce have moved quickly in the AI market:



DEEP LEARNING

Deep Learning refers to the ability of machines to learn without being explicitly programmed; the goal of Deep Learning (DL) is to mimic the activity of neurons in the neocortex, where basically thinking takes place.
DL is useful when modeling data, when there is too much data or too many variables. Thanks to advances in math and in hardware performance, DL can help model several layers of neurons, enabling machines to recognize patterns in the digital form of images, sounds and data.

The ability of Deep Learning to represent and understand linguistic and visual information is key to several applications of NLP in different sectors, such as finance, retail, automobiles, healthcare, robotics and education.

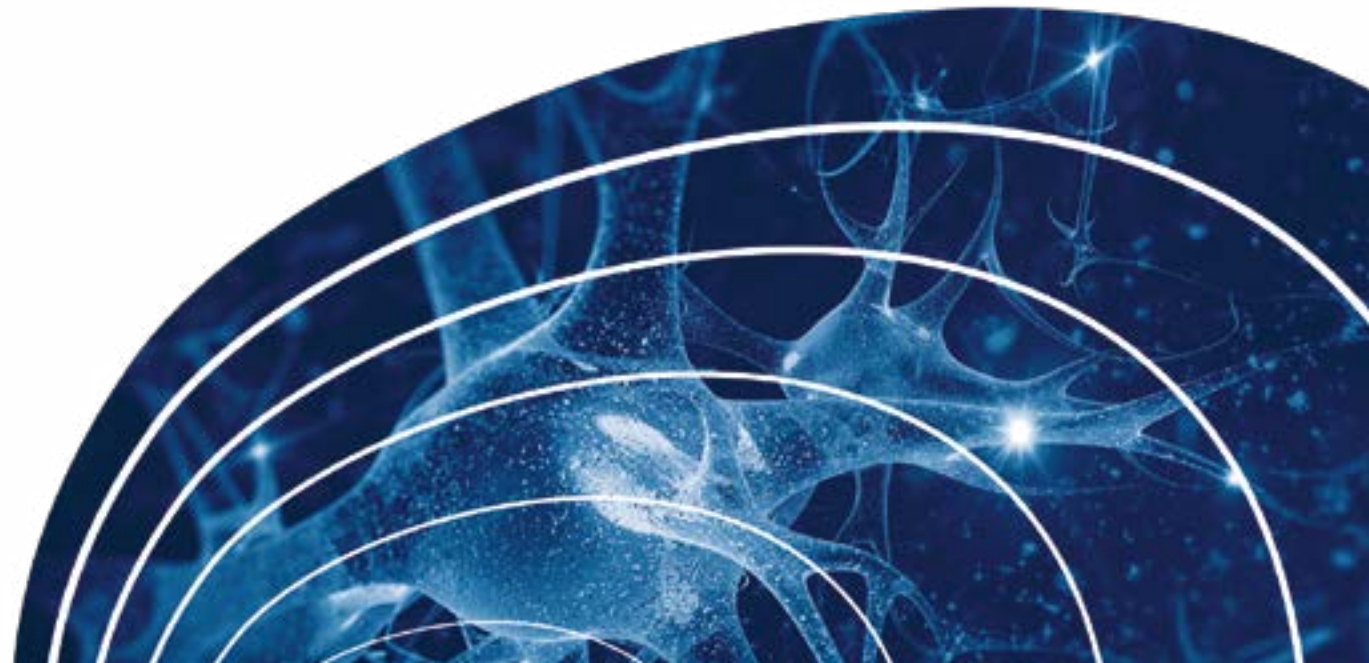
The industrial adoption of Deep Learning applications requires cheap standard boxes where the software can run. NVIDIA is currently in the best position to fulfill such a demand: Graphics Processing Units (GPUs) have been found to be highly performative in DL calculations and NVIDIA has exploited its technology position in the GPU market to make a 'Deep Learning Box', ready to go with all needed embedded hardware and software.

Chip giant Intel wasted no time: it bought the startup **Nervana Systems** and developed the Nervana Engine, whose computational capacity is 10 times that of a GPU.

The research arm of the U.S. Defense Department, the Defense Advanced Research Projects Agency (DARPA), announced 2 projects, Software Defined Hardware and Domain-Specific System on a Chip, to develop new microchip technology in support of AI progress.

As well as the **MIT project Eyeriss**, which has developed a processor for Deep Learning that can be integrated into smartphones and objects connected to it, hardware startups have recently emerged which focus on building new chips for AI: **TensTorrent** and **Cerebras** have set out to develop processors for Deep learning.

web link



British **GraphCore** aims to develop Intelligent Processing Units (IPUs) that can improve the performance of AI applications up to 100x compared to current ones; Chinese companies **Horizon Robotics and LeapMind** too, still in stealth mode, have their eyes on IPU (or Brain Processing Units, BPU).
Finally **Koniku**, "the world's first neurocomputation company", has developed Koniku Kore, integrating biological neurons (from mice) into chips.

As with all other AI technologies, their current adoption in people's life is quite far from the sci-fi scenarios that everyone imagines, but in any case these technologies are enabling many new business scenarios and user behaviors.

A very good example of that is **Niland,** a startup that applies machine learning to the music landscape, powering musical applications with intelligent recommendation capabilities:
In May 2017 Niland was bought by **Spotify**, the aim being to better understand musical content and offer enhanced customer experience regarding discovery and listening through personalised suggestions based on user tastes.

History of Deep Learning (DL)

'50s

Developed in the '50s at the dawn of AI, Deep Learning computational approach is based on Neural Networks*, that try to simulate how the human brain works: the software assigns values or weights to virtual neurons, so they respond with a mathematical output, between 0 and 1. Early Neural Networks could only simulate few neurons, so patterns were very basic. Thus Neural Networks didn't progress much in the '70s.

'80s

Developedwat the dawn of AI

In the '80s Hinton and others came up with the so-called "deep neural networks", using several layers of neurons. This technique required data to be labeled before analysing it with the neural network, taking programmers a lot of time to train the network.

2006

Deep Neural Networks

In 2006 Hinton suggested a new way to teach layers of neurons: the first layer of neurons learns primitive features, i.e. an edge in an image or a sound; once the first layer recognizes these features, they are passed to the next layer of neurons, which learns to recognize more complex features. The process is subsequently iterated in the next layers, until the network can accomplish its task of recognizing objects or sounds.

2012

In 2012 the Google Brain Team, led by Stanford Computer Science Professor Andrew Ng and Google Fellow Jeff Dean, developed a neural network that could recognize complex objects, e.g. cats, human faces, yellow flowers, analysing unlabeled images from 10 million randomly selected YouTube videos. The accuracy rate was 16%, when choosing objects from 22,000 categories; when choosing from 1,000 categories, the accuracy rate rose to 50%. The technique used by the Google Brain Team improved previous methods by 70%.
Recently splitting computing tasks among several machines has made it possible to speed up the training of deep-learning neural networks, by feeding them more data.

Google Brain improved the previous methods by 70%

2017

In May 2017 Google revealed it had been using tailor-made chips called tensor processing units (TPUs) for over a year, implementing applications trained by deep learning.

*Neural networks: a biologically-inspired programming paradigm which enables a computer to learn from observational data.

NATURAL LANGUAGE PROCESSING

22.3 Bln$

The expected revenues from the Natural Language Processing (NLP) market worldwide by 2025.

(source: Statista)

"Natural Language Processing is a branch of Artificial Intelligence which helps in analyzing and understanding human language and in facilitating effective communication between humans and computers." (Frost & Sullivan) Natural Language Processing (NLP) is related to Human-Computer Interaction and focuses on understanding and creating natural language, to enable machines to interact with users through dialogue. Recently, thanks to NLP, considerable progress has been achieved in machine translation.

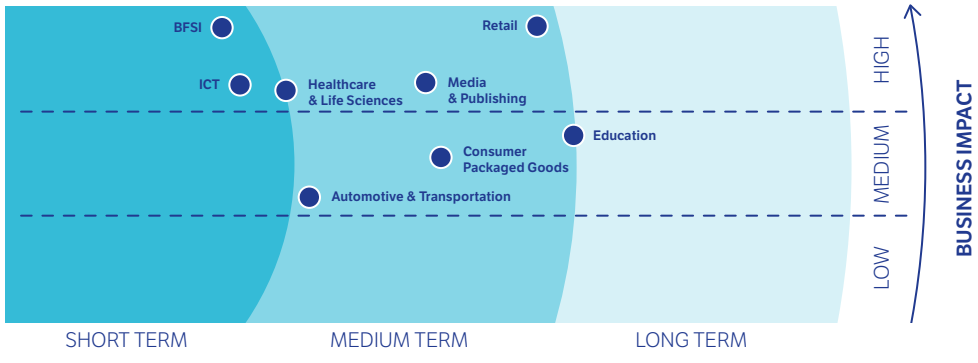
In the short term, the highest impact is predicted to be:

- In the ICT sector, in areas such as biometric authentication, sentiment analytics for eCommerce, intelligent search and information retrieval
- In the Financial sector, for automating trading strategies and anticipating client concerns based on customer sentiment analytics
- In the Healthcare sector, where NLP will also be applied in analytics ranging from diagnostics systems to claims analysis.

According to a report by Sequoia Capital China and Zhen Fund on AI patents, between 2012 and 2016 32% of patents in NLP were requested in the USA and 14% in China. The tech companies with the most patents in NLP are IBM, Microsoft and Google.

An area in which NLPs have recently been in strong use are chatbots. In October 2017 Stanford University developed the Woebot chatbot, which provides interactive cognitive behavioral therapy. Thanks to advances in Deep Learning and NLP, Woebot can identify certain signs of behavioral discomfort.

To get an idea of what NLP can already do in everyday life, the startup **Knote** is a good example. Its software can analyze thousands of documents in a short time, understanding the content and extracting relevant information or searching for specific content.



(source: Frost & Sullivan)

Knote

Knote uses the power of Natural Language Processing and Artificial Intelligence to help you work smart with documents. Knote can process thousands of pages per second. The average document takes less than 10 seconds; it finds important keywords in large sets of data and identifies how relevant they are to new documents. Finds names, dates, financials, locations in large sets of data; removes sensitive, confidential, or proprietary information from documents, emails, etc...

KNOTE

knote.me

Founded:
2016

Funding stage:
seed

Total Funding:
0.2 Mln$

(source: CBInsights)

History of Natural Language Processing (NLP)

1950 — Turing test

1954

The beginning of NLP is connected with AI, to such an extent that it dates back to 1950 when Alan Turing came up with the Turing test.
In 1954 the Georgetown Experiment succeeded in automatically translating sixty sentences from Russian to English.

In the following decades the progress of NLP was slow; then in '80s a radical change took place when machine learning algorithms were introduced.

More recently corporations, such as Microsoft, IBM, Google and Apple have applied AI to NLP to develop solutions tailored to different market sectors.

The main goal of Microsoft's Redmond-based Natural Language Processing Group is to develop efficient information retrieval search techniques, summarization, text critiquing, question answering, gaming and translation and to make information available to computer applications. The improvements in NLP have empowered Microsoft's search engine Bing, enabling it to answer questions in a better way. Thanks to the collaboration between Microsoft Research Asia, the Chinese Academy of Sciences and Beijing Union University, Kinect can also be used as a gesture-to-text Sign Language translator.

2013

IBM's Watson leverages NLP to process structured and unstructured data and get information out of it. In 2013 IBM partnered with the automotive supplier Continental to deliver natural language into the car.

2016

Google is working on multi-lingual NLP algorithms that scale well; its main goal is to further enhance their search engine.
In July 2016 Google announced their Cloud Natural Language API that help developers parse natural language, while in September 2016 Google acquired **API.ai**, a startup building tools for natural language understanding in mobile devices and web applications.

Apple has silently enhanced its AI and NLP capabilities through a mix of in-house developments and investments: in October 2015 Apple acquired VocalIQ, a University of Cambridge spin-out focused on voice enabling mobile devices and apps. Thus the latest improvements in Siri (mid 2016) have been thought to originate from VocalIQ and their NLP expertise.

2017

Amazon has continued to promote the use of Alexa, its virtual assistant, extending its uses to new contexts; from the kitchen to the living room, from changing rooms to walk-in closets. Thus Amazon has succeeded in creating a new category of consumer-electronics, AI-based Home Assistants.

web link

IMAGE RECOGNITION

see the video!

"IMAGE RECOGNITION LEVERAGES THE CONCEPT OF OBJECT IDENTIFICATION FROM A VIDEO STREAM OR STILL IMAGE." (FROST & SULLIVAN)

While humans can instantly recognize objects in any image, this is hard for machines, as images are just a set of numbers meaning how dark each pixel is. Basically, computers have to break the image into smaller pieces, each being represented by a grid of numbers related to the darkness of each pixel; the smaller pieces are then downsampled* and finally the computer can say if they match with previously learned patterns or not. Obviously moving objects, relationships among objects, background and image quality may affect this process. However, the advances in Image Recognition will benefit Emotion Recognition and Predictive Analytics.
Image Recognition (IR) is also a key factor in Facebook's AI Research. The DeepFace program for example, will allow each user to receive an alert when a picture of him is published by any other user, even if it is 'hidden' in a crowded environment.
In 2017 Facebook announced it could recognise «a set of 12 actions», for example «people walking», «people dancing», «people playing musical instruments» etc.
In April 2017 IBM published results of an IR system that can identify diabetic retinopathy by analysing images of the patient's eyes. The IBM system, put through more than 35,000 images of eyes, recorded the highest accuracy (86%). Other disruptive usages of IR are on the way. Here are a few of them:

- Mobile apps that make a web search of 'similar apparel' taking a snapshot as a reference
- Early detection of diseases through image analysis
- Self-driving cars that can recognize pedestrians and obstacles in real-time.

*Downsampling to a smaller image from a higher-resolution original should only be carried out only after applying a suitable 2D anti-aliasing filter to prevent aliasing artifacts. The image is reduced to the information which can be carried by the smaller image. Wikipedia

web link

'90s

2010

2012

see the video!

2014

2016

2017

History of Image Recognition

Image Recognition began at universities where AI was taking its first steps. Thanks to the improvements in Computer Vision, in the '90s statistical learning techniques were introduced to recognize faces in images (Eigenface).
Launched in 2010, the ImageNet Large Scale Visual Recognition Challenge (ILSVRC) is an annual award for the best algorithm for object detection and image classification. The algorithms of the participant teams have to decide if a given image contains a particular type of object or not; they then have to find a specific object in the image and draw a box around it.

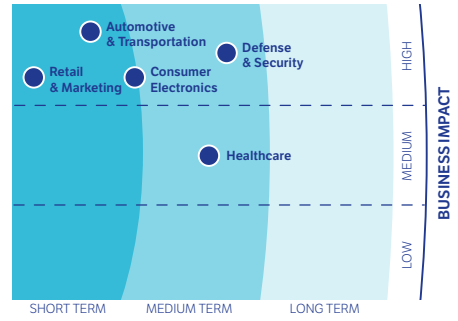
In 2012 a team from the University of Toronto, Canada, proposed an algorithm, called SuperVision, based on Deep Neural Networks (650,000 neurons in five layers), which won the Challenge with an error rate of 16.4%, showing the potential of AI in Image Recognition.
In 2014 Microsoft unveiled the results of Project Adam, a Deep Learning system that could achieve greater image classification accuracy and was 50 times faster than other systems. Trained with a huge amount of images, Project Adam could not only identify an object in an image (e.g. a dog in an image), but also distinguish some features of the object (for example matching the dog in the image with a Cardigan Welsh Corgi or with a Pembroke Welsh Corgi).

While Google has the widest images database on which to train its Google Brain, Microsoft's Adam is at present the best industry image recognition system, having double the accuracy of its competitors with far fewer hardware requirements. Real world Adam's applications range from understanding nutritional properties from food images, to early diagnosis using pictures of skin.

In 2016 IBM and MIT launched the new IBM-MIT Laboratory for Brain-inspired Multimedia Machine Comprehension (BM3C), to create AI that can understand sight and sound just like humans do.

In October 2017 at the International Conference on Computer Vision (ICCV) 2017 in Venice, Italy, reseachers from the University of Nottingham and Kingston University presented the 3D Selfie. This technology can reproduce 3D facial reconstruction from a single two-dimensional image by using DL and IR. Furthermore, it can also predict what the non-visible parts of the face look like.

Image Recognition Market Size and Forecast



Frost & Sullivan forecast that Image Recognition will have a huge impact on Retail & Marketing, Automotive & Transportation, and Consumer Electronics in the short term.

(Source: Frost & Sullivan)

see the video!

EMOTION RECOGNITION

Emotion Recognition (ER), a branch of Affective Computing*, aims to identify human emotions or feelings, detectable from facial expressions, voice and body gestures.
Recognizing emotions is innate for humans, even though it may vary with context (at home or in a public space), personality (introverted or extroverted) and culture (western or eastern culture), but it's not so straightforward for machines: several techniques have to be leveraged, such as computer vision, signal processing and psychology.
According to the latest scientific findings, emotions play an important role in decision-making (e.g. buying behavior), learning, working etc., so Emotion Recognition can be used to improve the human-machine interaction. For example dealing with IVRs (Instant Voice Recognition) often causes frustration. Enabling machines to understand feelings could help save time, increase efficiency and effectiveness.
In a not-so-distant future, when humanoid robots (or conversational software characters with a face and a body) will become mainstream, their ability to detect emotions could make them interact in more 'human' ways.
Many experts think that Deep Learning can help understand a wide range of emotions from large datasets without any supervision. Google is implementing a search engine technique that can detect and recognize the user's feelings when making a query.

In the category of Voice Analysis there are solutions that detect emotions by analyzing the tone and speed of the human voice. One example of this is **Vokaturi**, a startup whose software can measure five different emotion classes

* "Affective computing systems and devices have the capability to simulate human emotions. These systems are run by algorithms which can recognize interpret, process, and react to various human emotions." (Frost & Sullivan)

VOKATURI
emotion recognition by speech

vokaturi.com

Founded:
2016

(source: Crunchbase)

see the video!

Vokaturi

Vokaturi can measure directly from your voice whether you are happy, sad, afraid, angry, or have a neutral state of mind. Currently the open-source version of the software chooses between these five emotions with 61,4 percent accuracy if it hears the speaker for the first time. The software uses deep learning and ultimately provides the first steps in emotional human-machine interaction. Vokaturi emotion recognition can be easily integrated into existing software applications. The software has been validated with existing emotion databases and works in a language-independent manner.

and is available both in open-source mode and in a more sophisticated license-based release.
The software can recognize if the speaker is happy, sad, angry, afraid or neutral.

A second type of approach is based on Face Analysis. With several different patents granted and many other patents pending, **Affectiva** is one of the most advanced players in visual emotion detection.

web link

web link

Using simple optical sensors, such as a smartphone camera, Affectiva's algorithms identify the face's landmarks, and analyze the pixel color, texture and gradient of those facial regions. Different facial expressions are mapped into emotions, which can be processed moment by moment in real time, to check how the person changes their emotional status in relationships to different stimulus.
The possible uses of this technology are endless. We just want to highlight a couple of them that are quite different from the usual marketing or sales-oriented scenarios.

Legal video deposition platform **MediaRebel**, offers facial expression and emotion analysis through the use of Artificial Intelligence to transform the way video depositions are evaluated, managed and shared by legal professionals. The platform includes intelligent analytics to better evaluate the key legal strategies and unveil signs of emotionally charged statements that will determine how a witness is perceived by both judge and jury.

The Brain Power System is the World's First Augmented Reality Smart-Glass-System to empower **children and**

:) Affectiva

affectiva.com

Founded:
2009

Funding stage:
Series D

Total Funding:
34.2 Mln$

(source: CBInsights)

see the video!

Affectiva

Affectiva, an MIT Media Lab spin-off, is the pioneer in Emotion AI, the next frontier of artificial intelligence. Affectiva's mission is to bring emotional intelligence to the digital world with its emotion recognition technology that senses and analyzes facial expressions and emotions. Affectiva's patented software is built on an Emotion AI science platform that uses computer vision, deep learning and the world's largest emotion data repository of more than 4 million faces analyzed from 75 countries, amounting to more than 50 billion emotion data points. Affectiva measures emotions moment-by-moment from a single face or multiple faces simultaneously, in real time or from a video or still image.

adults with autism to teach themselves crucial social and cognitive skills. The Brain Power System consists of a family of applications, focused on helping with a wide range of issues including emotion recognition, eye contact, self-control, and educational planning.

Visual Emotion Recognition is a very crowded arena. **Eyeris** is another company focused on facial expression recognition and its mission is to enhance so-called Ambient Intelligence, namely the deployment in the environment of emotionally intelligent devices that are able to react in different ways to the emotions shown by different people.

emovu.com/e/

Eyeris

Deep Learning-based face analytics & emotion recognition AI technology

Deep Learning-based face analytics & emotion recognition AI technology

Last but not least, **nViso** is a Swiss company that has developed a 3D Facial Image Technology capable of capturing and interpreting emotions as they occur, regardless of lighting, focus or lack of it, motion blur, or partial occlusions.

nviso.ch

Founded:
2005

(source: Crunchbase)

see the video!

Nviso

Based on Ekman's Facial Action Coding System, Nviso's sophisticated artificial intelligence algorithms capture and measure the response to the main facial muscles involved in the expression of emotions in real-time. Machine learning systems precisely decode facial movements into the underlying expressed emotions. By studying instantaneous reactions, nViso computes precise scores for each emotion on a second-by-second basis, and also derives an overall emotional performance index.

History of Emotion Recognition

Paul Ekman defined six basic emotions: anger, disgust, fear, happiness, sadness, surprise

'60s

'90s

see the video!

web link

2012

2017

web link

Facial Emotion Recognition: at the end of the '60s Paul Ekman came up with the idea that facial expressions of emotion are not culturally determined, but universal. So in 1972 he defined six basic emotions (anger, disgust, fear, happiness, sadness, surprise); then in the '90s he enlarged the previous set of emotions (adding amusement, contempt, contentment, embarrassment, excitement, guilt, pride in achievement, relief, satisfaction, sensory pleasure and shame). Basically most of the methods to recognize facial emotions are based on facial expression databases; the algorithms enable tracking of facial changes due to different emotions.
In 2015 Microsoft Research unveiled Project Oxford, providing new tools that can recognize emotions from speech, vision and language.

At the beginning of 2016 Apple acquired **Emotient**, a startup using AI to detect emotions from facial expressions. Founded in 2012, Emotient raised 8 MIn$ from two investors, one of which was Intel. Their platform aimed to analyze how consumers responded to their ads. Emotient's technology was used by doctors and physicians to determine the pain level of patients and by retailers to figure out consumers' reactions to products in stores.

Founded in 2012, **Kairos** has raised over 9 MIn$ in funding.
Kairos platform provides "human analytics platform" in emotion analysis, face recognition, crowd demographics (i.e. measuring quantity and characteristics of people in real-world settings). Kairos is famous for "Project Look", powered by IBM Watson, which gives users access to specialists who can help understand how effective their advertising is.

In 2017 researchers at the Higher School of Economics (HSE), Russia, trained a computer to recognize emotions during a discussion. Turning sounds into images, researchers taught the system to recognize 8 different emotions: neutral, calm, happy, sad, angry, scared, disgusted, and surprised. The system can successfully recognize calm or neutral tones, but it sometimes mixes up happiness with fear and sadness, and other times takes surprise for disgust.

Speech Emotional Recognition: although researchers don't agree completely on the features that allow emotions to be recognized through speech, there are certain variables, related to acoustic and to the lexicon, that have to be taken into consideration to properly understand emotions in speech. The features that can provide useful information are pitch contour, range, variance, intensity, but also voice quality, duration (pauses and speaking pace) and background of the speaker.

Since 2005 Augsburg University has been focusing on emotional speech recognition: the system EmoVoice can recognize emotions from speech (not using word information) in real-time. The algorithms used by **EmoVoice** can understand user's emotional context; in addition the system can learn the different nuances of users' speech and interpret emotions contextually. One of the main applications of EmoVoice is in Retailing and eCommerce, where it can provide useful insights about customer's behaviour, enhance customer satisfaction and increase sales.

Body Gesture-based Emotional Recognition: often the way a person moves or moves specific parts of his or her body, e.g. hands, can help detect specific feelings. The techniques are based on databases where 3D information of different body parts and movements are stored. Usually hands and skin masks are analyzed to estimate the user's movements.

Furthermore physiology can help track human emotions: in the healthcare sector a wearable device that can measure temperature, pulse and heart rate could provide useful insights, when associated with cognitive and emotional stress.

Finally visual aesthetics, such as skin tone, can be used to track and understand feelings. Google Brain Project has used visual aesthetic-based emotional recognition system to provide better results for user's queries and increase the user's satisfaction.

Obviously the techniques above are used jointly to improve the analysis of human emotions. A use-case is the platform developed by James Cook University (JCU). Thanks to Deep Neural Networks, it can monitor users' emotions, while performing financial transactions, through the speed at which the transactions are made. Thus it can measure users' emotions and determine the confidence and satisfaction level of the user. The measurement of emotions may also help avoid fraudulent transactions.

PREDICTIVE ANALYTICS

3.47 Bln$

The expected Advanced and Predictive Analytics software revenue worldwide by 2018

(source: Statista)

According to Frost & Sullivan, "Predictive analytics is a form of advanced data analytics. It refers to the method of extracting useful information from huge data sets to identify significant patterns and predict futuristic trends and outcomes."

Predictive Analytics exploits deep learning techniques, data mining, the Internet of Things (IoT) and Big Data to make predictions about future events and to enable better decisions. Obviously machines enabled to predict actions can be applied to several sectors, such as Retail, Finance, Healthcare, Robotics etc.

Predictive Analytics is used to interpret the consumer's reaction to ads and to foresee the consumer's likelihood to purchase. In 2014 Affectiva released a study where facial responses to video ads were associated with purchase intention. In addition Predictive Analytics can help businesses perform better customer segmentation, identify high lifetime-value (LTV) customers, provide customers with the best next product or service, increase cross- and up-selling and reduce churn.

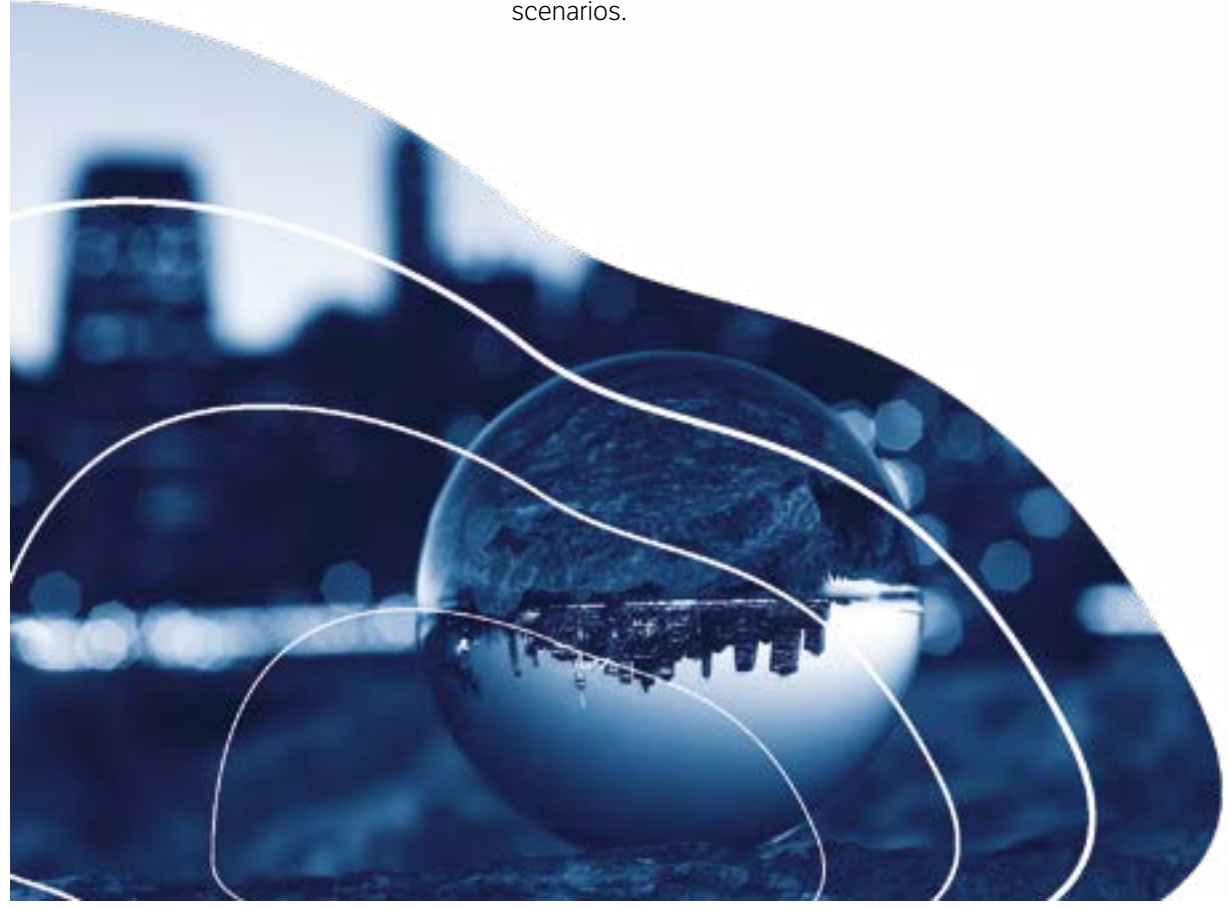
The startup **Reflektion** uses Predictive Analytics to increase the conversion rate of an e-commerce brand, personalizing research results and product advertisements seen by shoppers.

An area in which Predictive Analytics is gaining ground is Gaming: by analyzing large amounts of data with DL techniques, Predictive Analytics can build a player profile (how long he plays, what level he'd like to reach, how much money he's willing to spend); game creators use these profiles to offer players rewards, thereby keeping them interested and securing their loyalty.

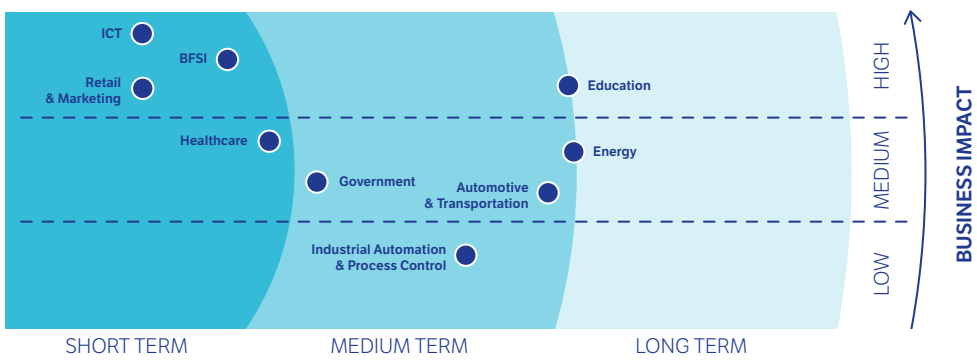
web link

In **Finance**, Predictive Analytics is used to evaluate credit scores; the customer's behavior is scrutinized to predict whether to lend and what terms to offer. In this case financial institutions have huge amounts of data related to customer's behavior, so Big Data techniques step in. Analyzing this data could also help prevent and reduce credit card fraud.

One of the best case studies in the Finance sector is **Kensho**. The Massachusetts-based startup has specialized in analyzing massive amounts of financial information, using NLP to extract meaningful concepts, finding relationships among them and providing a way to simply find the answer to a panorama of different what-happened and what-if scenarios.



In **Healthcare**, Predictive Analytics can be leveraged to design treatment plans for patients, based on their medical history and their reactions to specific therapies.
In **Robotics** Predictive Analytics can be used to optimize maintenance and reduce downtime; thanks to the IoT and Big Data, it is possible to predict when a machine is likely to break down and to identify the cause of the breakdown more quickly, saving time and money. Even if innovation is concentrated in North America, the demand for Predictive Analytics shows the fastest growth in the Asia-Pacific region, where major users are not only in banking and retail, but also government, healthcare and manufacturing.
The large amount of data available is becoming a source of insight for different industries: the New York-based startup **Predata** focuses its attention on geopolitical analysis, looking for relevant patterns in social media discussion.



KENSHO

kensho.com

Founded:
2013

Funding stage:
Series B

Total Funding:
75.5 Mln$

(source: CBInsights)

see the video!

Kensho

Kensho is pioneering scalable analytics and machine intelligence systems — and deploying them across the most critical government and commercial institutions in the world to solve some of the hardest analytical problems of our time. The Kensho New Economy Indices follow a systematic, fully rules-based methodology. Kensho's proprietary natural-language processing (NLP) platform scours millions of pages of regulatory filings to identify the companies that form the backbone of the New Economies. Proprietary algorithms also determine the extent to which each company is involved in a given New Economy.

"OUR ALGORITHMS MONITOR DIGITAL CONVERSATIONS ACROSS OPEN-SOURCE SOCIAL AND COLLABORATIVE MEDIA [...] THESE MODELS PROVIDE INDICATIVE WARNING FOR PERIODS OF POLITICAL VOLATILITY AND CIVIL UNREST AROUND ANY GIVEN COUNTRY, OPERATIONAL FOOTPRINT, OR DIGITAL CONVERSATION OF INTEREST."

History of Predictive Analytics

‘40s

1950
ENIAC generated the first models to weather forecasts

1973

2000

2016
see the video!

Predictive Analytics has always been the holy grail for human beings; in the ‘40s, Predictive Analytics was used in the military to predict behaviour of weapons (Kerrison Predictor) and nuclear chain reactions (Manhattan Project). In 1950 the Electronic Numerical Integrator And Computer (ENIAC), the first electronic general-purpose computer, generated the first models to weather forecasts. In 1958 Fair Isaac Corporation (FICO) leveraged Predictive Analytics for credit risk scoring (the so-called FICO scoring). In 1973 the Black-Scholes model for the optimal price for stock options was published. In the ‘90s FICO applied real-time analytics to credit card fraud. Since 2000 the interaction with Big Data, Natural Language Processing (NLP) and the progress in hardware have made Predictive Analytics more and more widespread: while Marketing has been using Predictive Analytics to deliver better experience, Operations have adopted Predictive Analytics to prevent and reduce defects and malfunctioning in maintenance.

In June 2016 the MIT’s Computer Science and Artificial Intelligence Lab (CSAIL) made a new breakthrough in computer vision, developing an algorithm that can predict human interactions in videos with a higher accuracy rate. After analysing a great amount of YouTube videos and TV series (for example “The Office” and “Desperate Housewives”), the computer system can predict if two individuals will hug, kiss, shake their hands or high-five. In addition, the algorithm could foresee what object is more likely to appear in the video five seconds later. Even though this algorithm isn’t accurate yet, it opens up new possibilities for Predictive Analytics in real-world situations, such as predicting injuries in Healthcare or robberies in Security.

OTHER TECHNOLOGIES AI STRONGLY INTERACTS WITH

A real boost to Artificial Intelligence is coming from the maturity of the following technologies:
– Internet of Things (IoT)
– Big Data (Analytics)
– High Performance Computing (HPC)
– Quantum Computing

INTERNET OF THINGS (IOT)

“THE INTERNET OF THINGS (IOT) IS THE NETWORK OF PHYSICAL OBJECTS THAT CONTAIN EMBEDDED TECHNOLOGY TO COMMUNICATE AND SENSE OR INTERACT WITH THEIR INTERNAL STATES OR THE EXTERNAL ENVIRONMENT.” (GARTNER GLOSSARY).

Recently the ‘Internet of Things’ has become the most popular term to describe the new interconnected world. There are other similar terms, so here are the main differences:

Machine to Machine (M2M): used in the Telecoms sector, M2M meant a one-to-one communication between two machines; thanks to mobile technology, nowadays connectivity involves more and more devices.

Industrial Internet (of Things): the term is used by General Electric. It enhances M2M, including connections between machines but also human beings.

Both M2M and the Industrial Internet are a subset of the Internet of Things with a narrower scope. The goal of the Internet of Things (IoT) is to enhance processes and empower human beings and processes through connections among industrial and personal wearable devices.

According to Statista, about 30 billion devices will be part of the IoT ecosystem by 2020.
Many of these devices will be self-empowered, with long-lasting batteries or with the capability to harvest energy from the surrounding environment.
From the AI's point of view, the IoT network is its sensorial system, allowing the machine to interact with the surrounding environment.
Automotive, Healthcare, Wearable and Smart Home are the markets with the highest estimated growth.

1999

2011

2014

web link

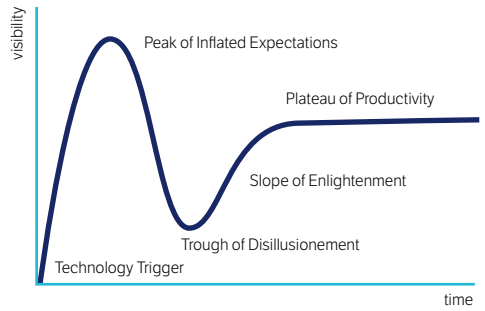
History of IoT

The term Internet of Things dates back to 1999, when Kevin Ashton, Executive Director of the MIT Auto-ID Labs, used it to refer to RFID Technology during a presentation for Procter & Gamble. At that time the Internet was the hottest trend, so Ashton's presentation was titled "Internet of Things". Ten years later IoT started gaining some traction: in 2011, Gartner included the IoT in their "hype-cycle for emerging technologies". In 2012 magazines like Forbes, Fast Company, and Wired started using the word IoT.

In 2014 the Consumer Electronics Show (CES) in Las Vegas focused on the IoT; the term Internet of Things (IoT) then became widespread when Google announced the acquisition of **Nest** for $3.2 bln.

In the next years the IoT is expected to generate larger and larger amounts of data, requiring more efficient ways of storing, processing and analyzing it.

HYPE CYCLE
(source: Wikipedia)



INTERNET OF THINGS FUNDING ACTIVITY:
(source: CBInsights)

Funding YoY 3Q17	Deals YoY 3Q17
4.3 BLN$	**518**

15.3
Zettabytes
Global data center IP traffic per year in 2020
(source: Statista)

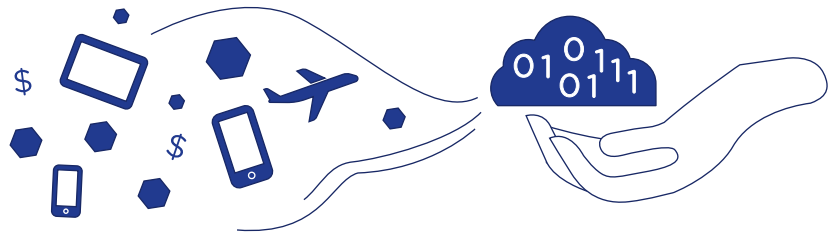
17,500
Petabytes
Global web, email and data traffic per month in 2020
(source: Statista)

BIG DATA (ANALYTICS)

"BIG DATA IS WHAT YOU CANNOT PUT IN AN EXCEL SPREADSHEET."
CARLO RATTI, MIT SENSEABLE CITY LAB.

Big Data refers to huge amounts of data that cannot be processed with relational database management systems. From this point onwards, Big Data will be used to refer to Big Data Analytics, i.e. the set of techniques that enable processing of huge amounts of data.

Big Data Analytics can be used in several market sectors, such as Banking & Financial Services, Retail, Automotive, Healthcare, Telecommunications and Government, Defence & Security.



The 3 Vs of Big Data: **Volume, Velocity, Variety**

1999

2001

2007

2011

History of Big Data

In 1999 the term Big Data popped up in "Visually Exploring Gigabyte Datasets in Real Time", published by the Association for Computing Machinery. The article highlighted the lack of proper techniques to analyze large amounts of data.

In 2001 in his paper "3D Data Management: Controlling Data Volume, Velocity and Variety", Gartner analyst Doug Laney defines the "3 Vs", i.e. the commonly-accepted characteristics of Big Data:

– **Volume**: the size of the data is huge
– **Velocity**: the speed at which data is generated is high
– **Variety**: big data is comprised of text, images, audio, video.

Later on the 3 Vs became 5 Vs with Variability and Veracity.
In 2007 the term Big Data spread to the public thanks to Wired and the article "The End of Theory: The Data Deluge Makes the Scientific Model Obsolete".

In 2011 the McKinsey Global Institute report "Big Data: The next frontier for Innovation, Competition, and Productivity" highlighted the main characteristics of the Big Data ecosystem:

– *Techniques for analysing data*
– *Big Data technologies*
– *Visualization of the data.*

BIG DATA FUNDING ACTIVITY: *(source: CBInsights)*	Funding YoY 3Q17	Deals YoY 3Q17
	4.0 BLN$	**247**

HIGH PERFORMANCE COMPUTING (HPC)

There are several definitions of High Performance Computing, but the following summarizes the most important:

"HIGH-PERFORMANCE COMPUTING (HPC) IS THE USE OF SUPERCOMPUTERS* AND PARALLEL PROCESSING TECHNIQUES FOR SOLVING COMPLEX COMPUTATIONAL PROBLEMS. HPC TECHNOLOGY FOCUSES ON DEVELOPING PARALLEL PROCESSING ALGORITHMS AND SYSTEMS BY INCORPORATING BOTH ADMINISTRATION AND PARALLEL COMPUTATIONAL TECHNIQUES." (TECHOPEDIA)

5.1 Bln$

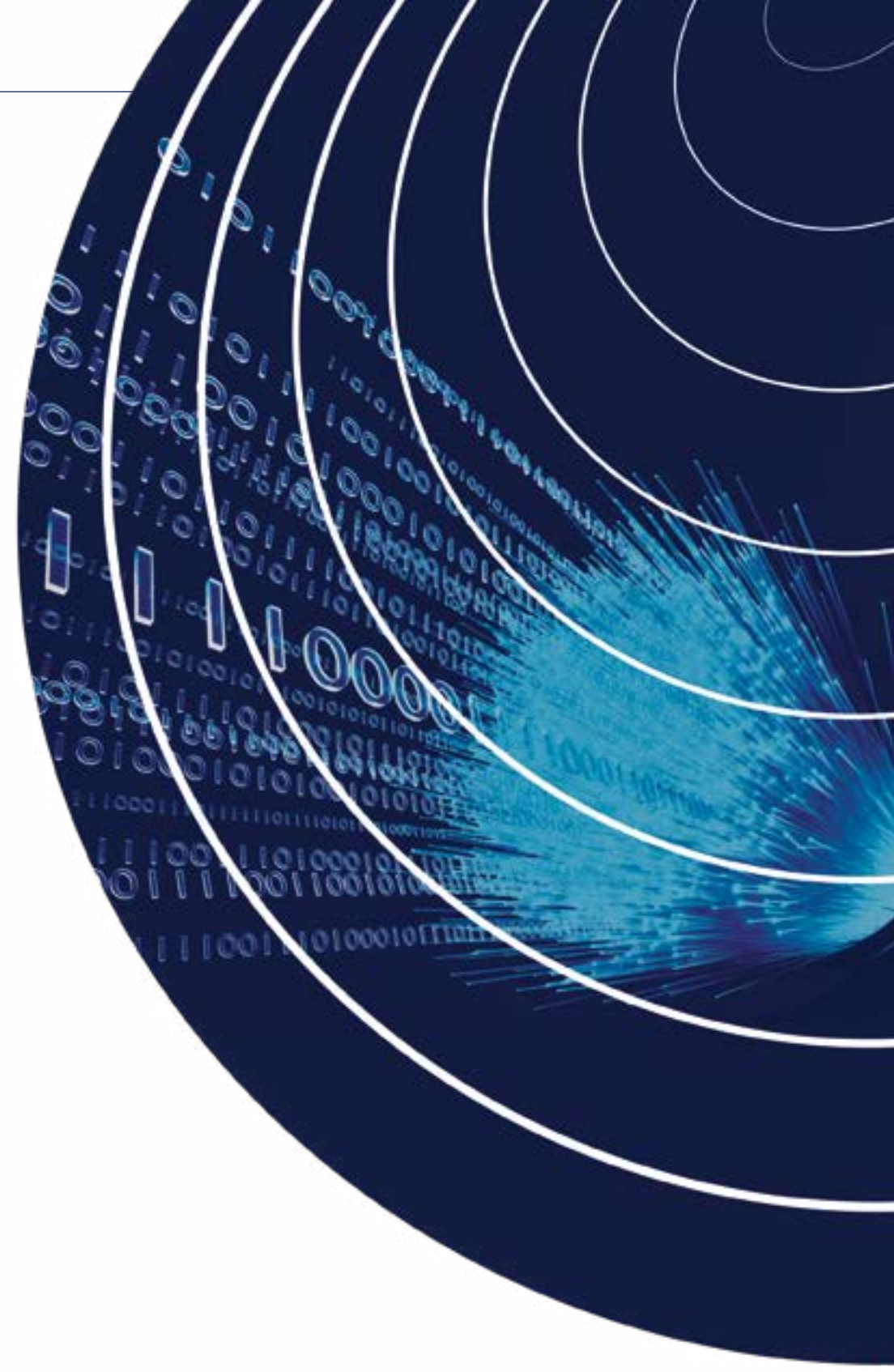
The expected Worldwide revenue from high performance computing (HPC) servers by 2020

(source: Statista)

Often HPC and supercomputers are used with the same meaning.
The goal of HPC is to solve some of the most important computational challenges in Biosciences, Geographical Data, Oil and Gas industry modeling, Electronic Design automation, Climate modeling etc., by using simultaneously computing resources.

see the video!

*Supercomputer: a computer with a high-level computational capacity compared to a general-purpose computer. Performance of a supercomputer is measured in floating-point operations per second (FLOPS) instead of million instructions per second (MIPS). Wikipedia

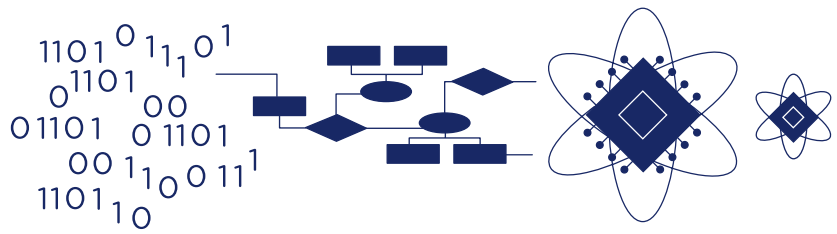


web link

see the video!

The increasing demand for processing speed has driven the evolution of HPC.

The applications of HPC are almost endless: the European Union looks at HPC as a strategic asset, an example is the **HPC4E** Project. HPC4E stands for “HPC for Energy” and it is a joint project between Europe and Brazil that aims to apply the new exascale techniques to the energy industry, to perform advanced simulations on different sources, from wind production to combustion systems for biofuels to exploration geophysics for hydrocarbons. Organized in seven work packages, the project will have to deploy new computational algorithms, as well as complete applications to design wind farms, while also supporting geophysical exploration of fossil sources.



History of High Performance Computing (HPC)

1964

The first supercomputer was the Control Data Corporation’s CDC 6600 in 1964: it could reach 500 KFLOPs up to 1 MFLOP.

1975

The period between 1975 and 1990 was dubbed the Cray Era: in 1972 Seymour Cray, the architect of the CDC 6600 and other supercomputers, founded his own company, Cray Research Inc.; in 1976 Cray developed Cray 1 and then Cray X-MP, Cray Y-MP.
In addition to Cray Research, Convex and Alliant developed their supercomputers too.

‘90s

The period between 1990 and 2000 is called the Cluster Era: parallel computing was on the rise, but contention for shared memory still limited it, raising a lot of interest in distributed memory. In 1994 Donald Becker and Tom Stirling at NASA, built a Beowulf* cluster using Pcs networked into a small local area network, achieving a high-performance parallel computing cluster from cheap personal computers.

2000

The years from 2000 to the present are dubbed the Graphics Processing (GP) and Hybrid Era: graphics processing units (GPUs) have evolved quickly and have become high performance accelerators for data parallel computing. In addition, GPUs can also reduce space, power, and cooling demands. Modern GPUs are comprised of hundreds of processing units, which can reach up to 1 TFLOPS (for single-precision arithmetic), and over 80 GFLOPS (for double-precision calculations).

2016

The most recent supercomputer is Sunway TaihuLight, delivered in 2016, which could reach 93 PFLOPS, making China outdo USA and Japan in HPC.

2017

In 2017 the Human Brain Project started using supercomputers to understand how human minds work, modelling it in completely different ways.

*The name “Beowulf” comes from the Old English epic poem of the same name. Ref: “Because my heart is pure, I have the strength of a thousand men”. Wikipedia

QUANTUM COMPUTING

QUANTUM COMPUTING FOCUSES ON QUANTUM COMPUTERS, I.E. COMPUTATIONAL SYSTEMS BASED ON QUANTUM MECHANICS TO PROCESS DATA.

While traditional digital computing requires the data to be encoded into binary digits (bits), each of which is always in one of two definite states (0 or 1), quantum computers uses quantum bits (qubits), which can be in “Superposition” of states (both 1 and 0 at the same time). In addition quantum particles are so strongly correlated that they “dance” in instantaneous, perfect unison, even if separated by great distances: this phenomenon is called “Entanglement”. Superposition and Entanglement enable quantum computers to perform a lot of calculations simultaneously. This makes quantum computers faster and less-energy consuming than digital computers. Unfortunately it’s not easy to manipulate quantum systems, in fact even trying to measure them interferes with their quantum state, turning it into a single state (“Decoherence”). Thus, the computer has to continue making these calculations without any measurements. Despite this issue, Quantum Computing can factor big numbers, becoming a powerful tool to solve more and more problems. There is no doubt that Quantum Computers will transform every market sector, from cybersecurity to Financial Services.
In order to exploit all the incredible power of quantum hardware, a totally new software ecosystem is required; software must not be ‘adapted’ to the new hardware paradigm, it has to be re-thought and re-built around it.
QxBranch is a Washington DC based startup that sees quantum computing as a strategically important technology edge to its analytics work, aiming to develop q-software for financial services, using AI technologies like Deep Learning and Predictive Analytics.

see the video!

QxBranch

qxbranch.com

Founded:
2014

Funding stage:
seed

Total Funding:
0.02 Mln$

(source: CBInsights)

see the video!

QxBranch

A spin-out of two leading firms in the aerospace & defense sector, QxBranch is bringing world-class skills in systems engineering, data analytics, machine learning, quantum computing, and risk analysis across sectors. Quantum information science will launch the next computing revolution. In 2014, Lockheed Martin initiated a unique partnership with QxBranch to accelerate global quantum computing activities. QxBranch currently collaborates with leading firms across industry areas to develop strategies for engaging this technology area.

History of Quantum Computing

Although the idea of using quantum particles to create more powerful computers has been under discussion for a long time, it was only in 1981 that Paul Benioff, a physicist at the Argonne National Laboratory, came up with a theory about developing a quantum Turing machine.

1981

In 1985 David Deutsch, at the University of Oxford, wrote a paper in which he described "quantum logic gates", as a way of using quantum in computers.

1985

In 1998 the first 2-qubit quantum computer was developed: it could maintain decoherence only for a few nanoseconds, performing simple calculations.

1998

web link

2000

Since 2000 several steps have been made in pushing quantum computers forward; in 2011 **D-Wave Systems** launched D-Wave One, the first commercial quantum annealers with a 128-qubit processor. Lockheed Martin agreed to purchase a D-Wave One system and to house it at the newly formed USC Lockheed Martin Quantum Computing Center, with the University of Southern California (USC). D-Wave's approach drew some criticism, which still partially stands.

web link

2012

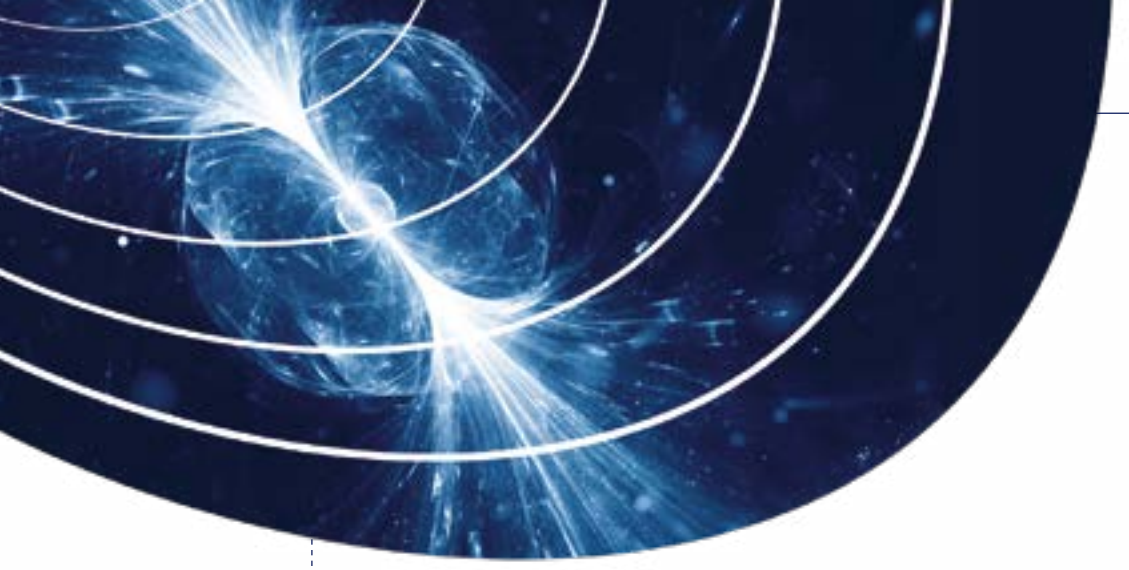
In 2012 **1QBit**, the first quantum computing software company, was founded in Vancouver, BC, Canada. 1QBit proved that superconducting quantum annealing processors can be applied to real-world problems.

2013

In 2013 Google announced the launch of the Quantum Artificial Intelligence Lab, at the NASA Ames Research Center, where a 512-qubit D-Wave quantum computer is hosted. The USRA (Universities Space Research Association) will invite researchers to share time on it with the goal of studying quantum computing for Deep Learning.

2014

At the beginning of 2014 documents provided by Edward Snowden leaked out, creating buzz about the U.S. National Security Agency (NSA) running the $79.7 mln "Penetrating Hard Targets" research program to develop a quantum computer that could break vulnerable encryption.



2015

At the end of 2015 NASA publicly showed the world's first fully operational $15 mln quantum computer by D-Wave at the Quantum Artificial Intelligence Laboratory.

2016

2016 was a successful year for achievements in quantum computing. In May 2016, IBM launched its 'Quantum for Everyone' project: a cloud based quantum computing platform made free for everyone who wants to try it, provided that the requesting user has enough knowledge of the QC environment.

In August 2016, researchers at the University of Maryland successfully built the first reprogrammable quantum computer. In September 2016 D-Wave announced a new 2000-qubit processor, doubling the number of qubits over the previous-generation D-Wave 2X system.

web link

2017

In 2017 IBM developed a new approach to simulating molecoles in a quantum computer: using certain mathematical shortcuts, researchers at IBM managed to simulate a 56-qubit computer, beating Google's result of 49 qubit; furthermore, researchers at IBM are still in the dark as to the highest number of qubit the new method can simulate. In September 2017 the Chinese Academy of Sciences and the University of Vienna made the first quantum video call, unhackable in that it is based on quantum encryption.

Years to quantum

Despite faster progress in quantum computing, it's not clear yet when a fully functioning quantum computer, up to cracking the Internet's most used codes in just a day, will be available.

Pundits call this countdown Y2Q, i.e. "years to quantum". According to Michele Mosca, a professor at the University of Waterloo's Institute for Quantum Computing, it's likely that Y2Q will take place between 2026 and 2031, while Brian LaMacchia, the head of security and cryptography at Microsoft Research, estimates Y2Q will be in 2030.

IN THE REAL WORLD...

...what does all this analysis mean?
In the next two chapters we are going to see what is already happening, both in people's lives and in the working environment, and what the next decade will bring.

3

ARTIFICIAL INTELLIGENCE AND THE SOCIAL LIFE

INTRODUCTION

Social is perhaps one of the most (ab)used adjectives in the contemporary world.
Together with *Connected and Smart*.

All three words are different points of view of the same trend: a fundamental shift in technology that connects all people and objects in the world at increasing speed, regardless of culture and society. We are deeply immersed in data, huge amounts of it that are slowly but steadily enabling a new generation of Artificial Intelligence. In the meantime, though, while this process takes place, it has already enabled the birth of an *Active Environment* with which we can interact.

Virtual Reality and **Digital Assistants** are new ways we can talk to machines and vice-versa, a entire family of consumer robots is widening, from dumb cleaning ones to much more intelligent machines supervising the whole home or taking care of householders' health.
But *Social Life* also means taking care of the social problems of our societies. This is the motivation behind AI projects such as the machine learning-based *'Poverty Map'* of Africa, or the usage of autonomous driving drones for collecting medical samples.

And of course there is also the business side of the game: always being connected means always being traceable and contactable for marketing and sales proposals, while it also means always-on services, delivered whenever and wherever they are necessary.

In a very recent report, as of September 2017, CBInsights has identified 101 startups applying AI technologies to the healthcare sector, from drug discovery to genetic research, from image based diagnosis to virtual assistants.

Once again, the Revolution is unfolding...

TOWARDS AN "ALWAYS CONNECTED" LIFE

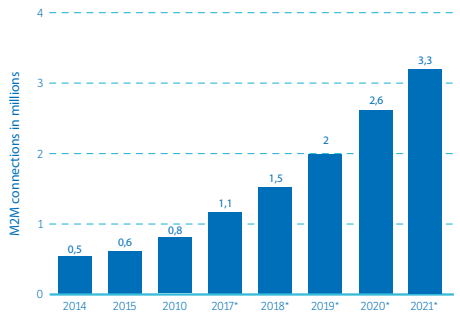
The "Always Connected Life" is no longer a new topic for anybody; it is something that has become part of our mindset. But maybe the scale of this phenomenon and above all the direction it is going are less clear.
Typically, when the subject of a discussion turns to the concept of Connected Life, we immediately think about our smartphone, a device that follows us everywhere, all the time, supporting us in our myriad of social connections.

We are *always connected* to Internet, *always connected* to our friends via chats, *always connected* to our favourite data sources (blogs, webzines, technical websites, etc.), *always connected* to our shopping sites. We can instantly share a thought, a photo, an idea; while at home or while travelling. Our social dimension is amplified to a level that sometimes we can't even manage it.

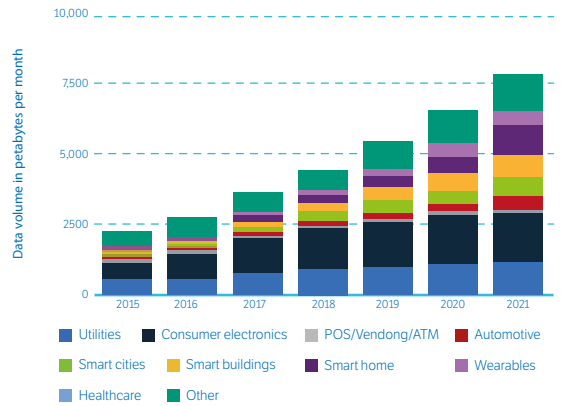
In any case, this means people are still at the heart of the *always connected* vision. But **Always Connected** is much more than that. Always Connected is related not only to people, but also, and maybe above all, to the things that we use or we enter in contact with.

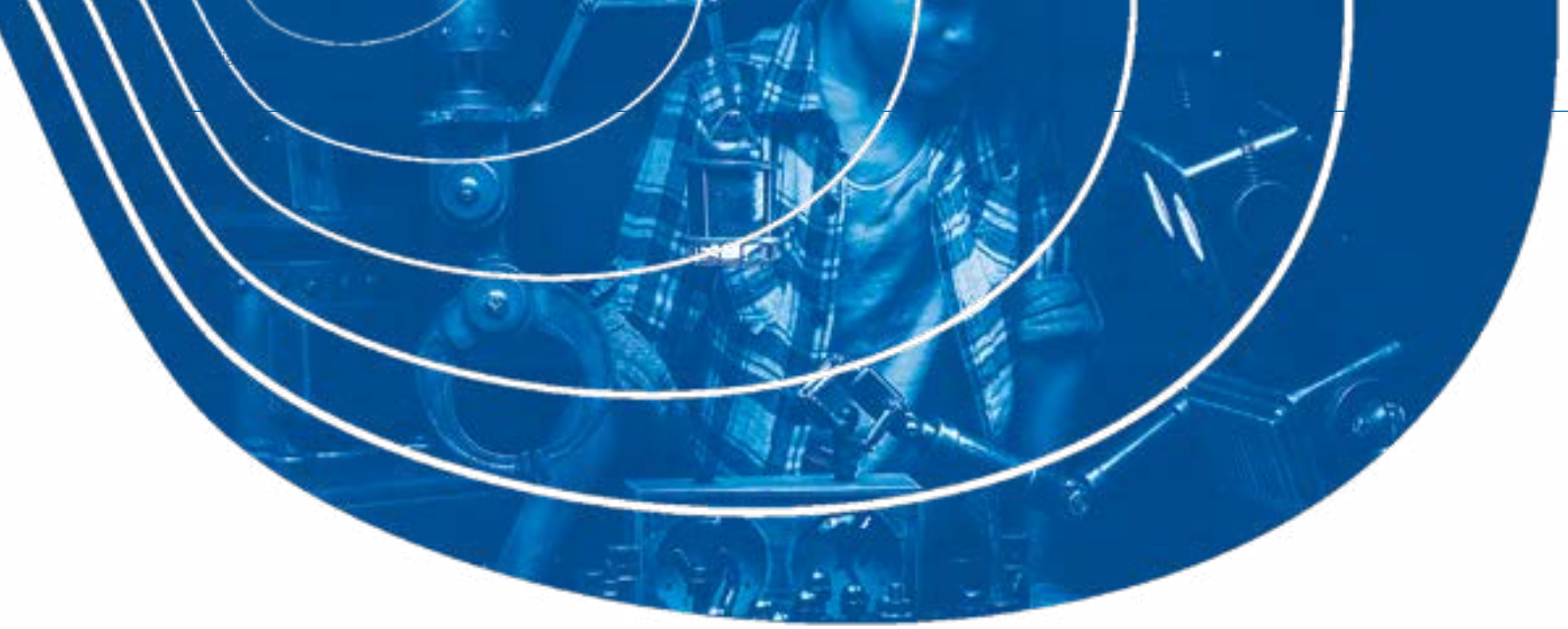
We use "machines" all day, from vehicles to domestic appliances, from smart buildings to medical devices, and each one of them is being connected to other parties more and more.

NUMBER OF MACHINE-TO-MACHINE (M2M) CONNECTIONS WORLDWIDE FROM 2014 TO 2021 (IN BILLIONS)
(source: Statista)



NUMBER OF CONNECTED THINGS/ DEVICES WORLDWIDE BY VERTICAL FROM 2015 TO 2021 (IN MILLIONS)
(source: Statista)





If we multiply the number of daily contact points we can handle, by the number of connected people in the world, we obtain a multibillion number representing the mess behind the scenes.

The only technologies that can extract meaningful information from so much data, belong to the AI family, and this is the reason why radical changes are now in progress. In the new paradigm we have to get accustomed to, people and machines are both immersed in the same network of connections.

THE ENVIRONMENT BECOMES AN ACTIVE ELEMENT TO INTERACT WITH

The possibility to embed low-cost processing power (it is still too early to call it distributed intelligence) in myriad objects deployed in the surrounding environment, is enabling social interaction not only with other people but with the environment itself.
We could create interactive environments that can be much more than what we are used to, due to the natural limits of our sensory system. Touch, sight, hearing, smell; all of them are phenomenal sensors that have been modelled to the surrounding environment but are inherently limited to the physical dimension of things.

Mixed Reality, the fusion of the real environment with realistic augmented reality, even if not an AI technology strictly speaking, is an exciting enabler of the application of AI itself in the daily life. It can be seen as a catalyst that adds new dimensions to the environment and induces transformations of how we think and behave.
Moreover, Mixed Reality allows us to 'materialize' our thoughts, enriching our ideas with a sensorial experience.

see the video!

Magic Leap is a unicorn startup that is developing a new 3D technology, called cinematic-reality, that blends artificial created images with the real world surrounding us, so that our eyes do not perceive the difference and add the artificial created objects to the real ones.
Prototypes are creating extremely realistic visions of whales swimming in a gym or little elephants walking in our hands

– have a look at Magic Leap website! – but in the very near future we'll be able to share a conversation with friends 'really' sitting on our sofa, or walking in a city 'together' with a tourist guide.

Apart from Mixed Reality, a much simpler method of interaction between machines and humans is to have the former adopting the language of the second; for many years computers have been able to 'speak' the same language of humans, but it is a very basic style of speaking because it is no more than a text synthesizer.
Speaking machines with intelligence embedded are so-called **Digital Assistants**. These devices are able to hold a conversation in natural language, both understanding the user's input and replying on them using a human-like voice.

The 'Big Four' – Amazon, Apple, Google, Microsoft – are deepening their know-how of Natural Language Processing, and their digital assistants – Alexa, Siri, OkGoogle, Cortana – are also finding homes in third-party devices.

web link

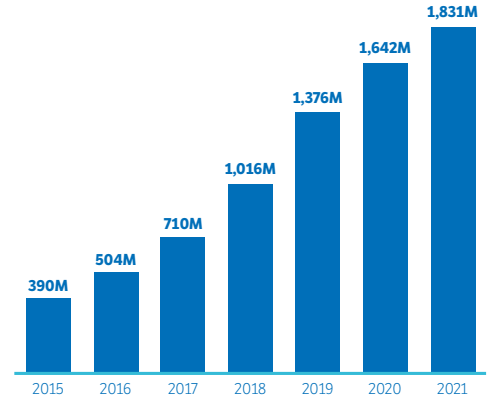
In just one year from its announcement, Google's latest development in this field, Google Assistant, has been made available in many languages, Italian included as of November 2017. Its capabilites go way far beyond a simple Q&A dialogue: it is able, for example, to understand and execute complex commands like "Send a whatsapp to Laura and tell her I'm going to be late".

see the video!

Integration between mobile devices with wearable objects makes it possible to achieve experiential scenarios that until a few years ago were only realistic in science fiction films. One example is Google Pixel Buds, which bring all Assistant's advanced fucntions to the user's ears : for example anyone can use instant translation: the smartphone hears the interlocutor's voice , translates and sends the translation to the user's headphones in their language.

Even more sophisticated and to some degree invasive, Assistant can analyze all the events of the user's daily life, as well as his contacts, messages, habits and activities. The more knowledge it gains about its user, the more it develops predictive capabilities to forecast their needs and solve all the daily issues that its user could face.
There is expected to be constant growth in Digital Assistant enabled devices until 2021, reaching 1.8 billion users from the 0.5 billion users in 2016.

ESTIMATED NUMBER OF USERS OF VIRTUAL DIGITAL ASSISTANTS WORLDWIDE
(source: Statista)



This decade is essentially a transition period.
A transition not only in technology, but in cultural aspects as well: we, the humans, have to get used to having a new 'partner' with whom to build new relationships, a partner that never sleeps, a partner that can think thousands of times faster than us but that, at present, is very primitive in its evolution.
To shorten this period of mutual acceptance, machines are getting accustomed to domestic life, providing a whole host of useful services in the form of **task specialized robots.**

OBJECTS THAT LEARN PEOPLE'S HABITS

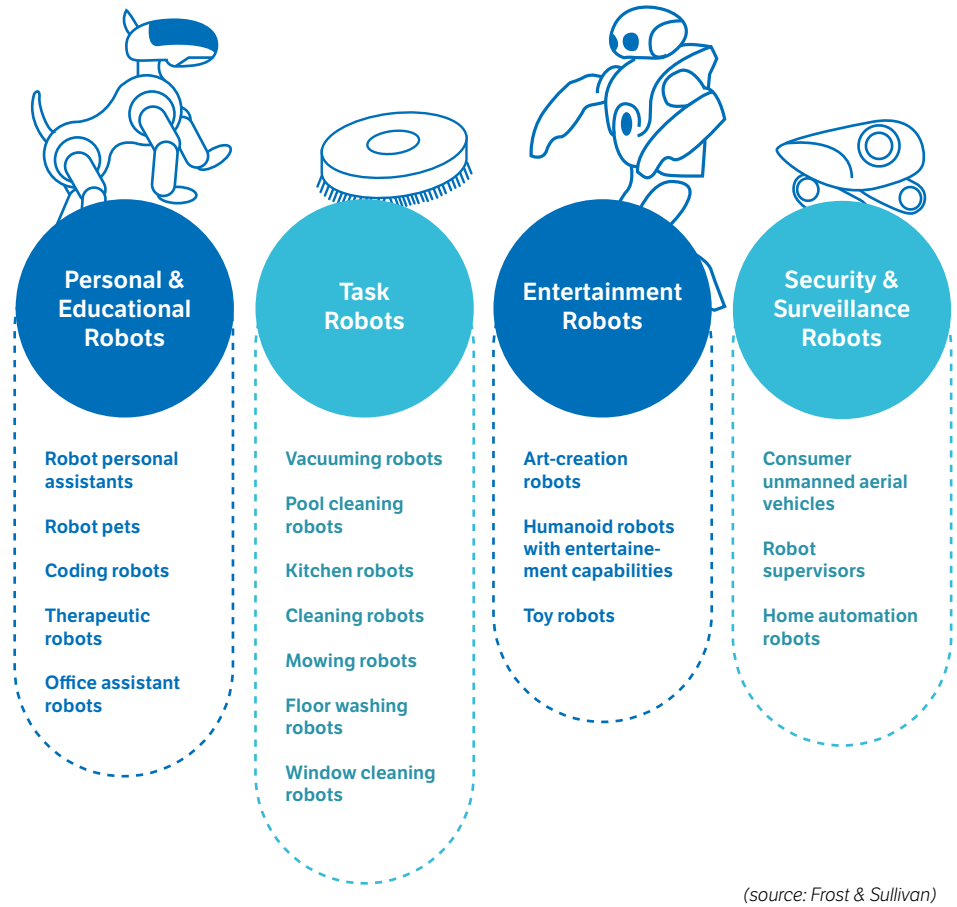
While more or less widespread intelligent devices may not be perceivable in our daily habits, a much more visible manifestation of AI's role in our life is represented by what is commonly known as a robot.
At present robot usage is consolidated in the industry environment, but at the consumer level they are still considered as toys or as 'nice devices for rich people' ... but things are changing.
According to Frost & Sullivan, there are at least four major classes of consumer robots:

– Personal & Educational
Personal robots are designed and developed to assist and help people with their day-to-day tasks, while educational robots are programed to teach and enhance the learning experience;

– Social & Home
These advanced robots are programed to perform several tasks and assist humans with their daily life. They are also programed to see, hear, speak, and help in collecting and delivering information;

– Domestic & Tasks
Domestic and task robots are developed to perform household chores and domestic tasks such as vacuuming, cleaning, gardening and cleaning windows;

– Security & Surveillance
With the increase in crime rates, the adoption rate of these novel robots has been increasing in recent years. Some robots in this category are even programmed to directly alert the police and family members during security threats.

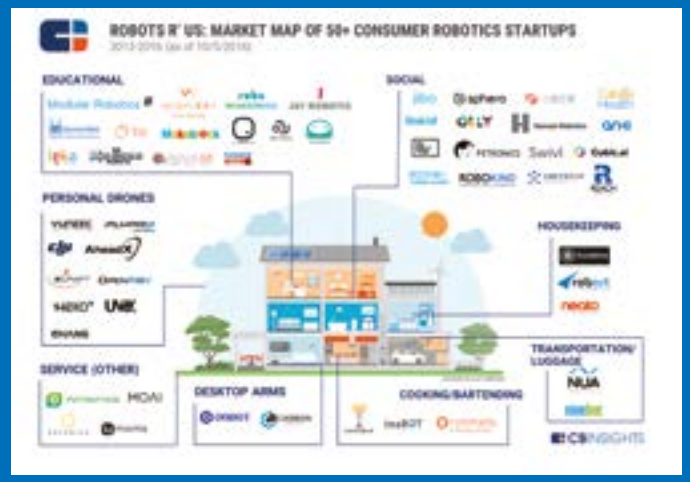


(source: Frost & Sullivan)

Frost & Sullivan also foresee that wide-scale adoption of consumer robots will follow some decisive steps. 2018: Educational robots in schools and colleges; 2019: Vacuum cleaners, Assistance robots and Security & Surveillance robots; 2020: New robots for Elderly Care and personal assistance; 2021: 20% of North American houses will have consumer robots.

A confirmation of increasing interest in consumer robots also comes from CBInsights.

In a research report of May 2016, as well as representing the ecosystem of domestic robots, CBInsights highlights three classes of robots that were then polarizing investments: Social Robots, Educational Robots and Service Robots. In addition there are Personal Drones, that are not robots as we imagine them but have to be included in this large family.



(source: CBInsights)

In advance of the Frost & Sullivan prediction, one example of an existing Surveillance Robot for workplaces is SAM, by **Robot Security Systems**, a company specialized in high performing security robots.

robotsecuritysystems.com

Total Funding:
5.61 Mln$

(source: CBInsights)

see the video!

Robot Security Systems

SAM is a mobile Robot that can execute observation, detection and reporting tasks. SAM is capable of drawing a digital map of a building or area to which surveillance routes can be added. The selected surveillance routes can run according to a set scheme or at random. While completing those surveillance routes, SAM detects human activity at full speed of 3 meters per second. SAM has a free sensor bay which means that applicable sensors can be added to detect toxins, carbon oxides, radiation, smoke, etc. SAM can complete these tasks while conducting surveillance tours or other pre-determined times and places.

Now, almost mindless robots can be injected with Artificial Intelligence software that brings them to a new, more intelligent life.
This is the case, for example, of **Neurala**, a startup that provides a software called **"Brain for Bots SDK"** that *"makes robots, drones, consumer electronics, toys and smart devices more useful, engaging and autonomous."*

Based on Deep Learning and Neural Networks, this software can infuse robots with the bilities to Learn, Recognize, Find and Follow.
Current applications range from Real time Learning and Tracking to Object Recognition and Classification, from Collision Free Autonomous Navigation to Real-Time Person Location, and more.

neurala

neurala.com

Founded:
2006

Funding stage:
Series A

Total Funding:
15.9 Mln$

(source: CBInsights)

see the video!

see the video!

Neurala

Neurala's Deep Learning technology uses a proprietary set of algorithms to emulate, in software, the way biological brains control sensing, cognitive processing, spatial awareness, navigation, and motor control. Unlike other methods, the Neurala Intelligence Engine (NIE) efficiently uses low cost "passive" sensors the way an animal does. This means that the robot can instantly learn to react to a new stimulus in real-time, without lengthy training sessions, and locally on the mobile processor of the robot/drone or the controller. Additionally, Neurala provides integrated navigation and collision avoidance capabilities , as well as a layer for programmability and customization of these capabilities.

AI FOR SOCIAL: A NEW QUALITY OF LIFE

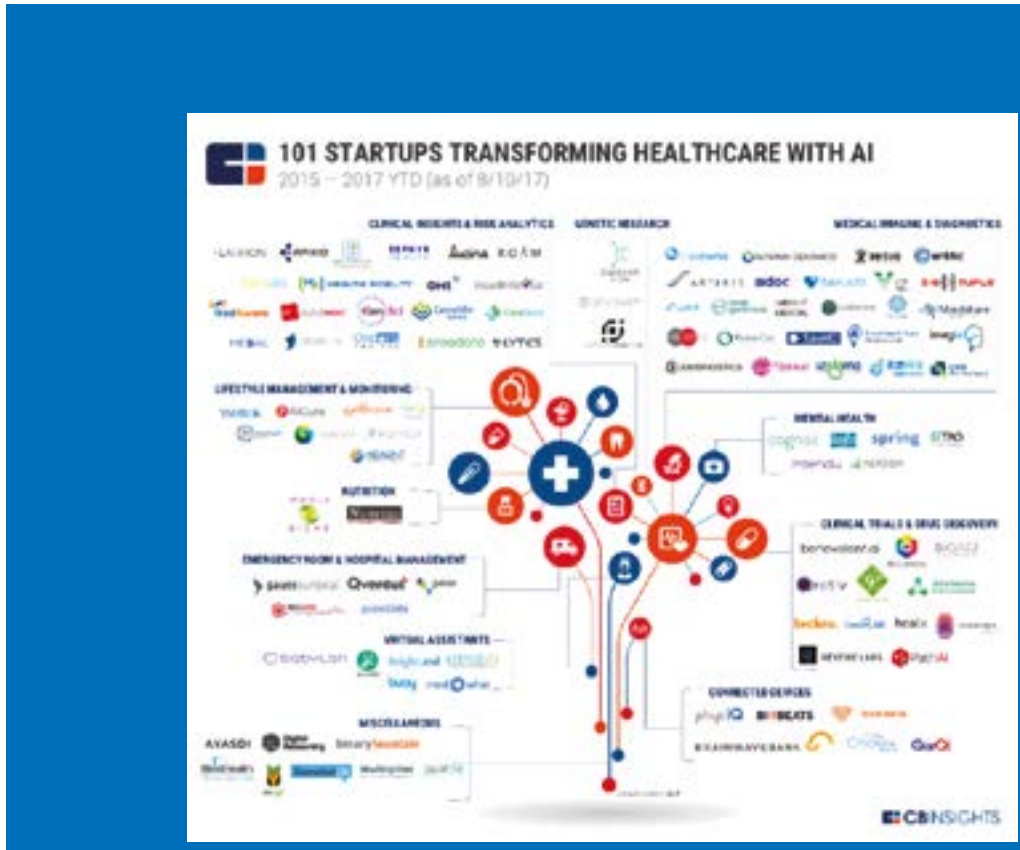
Physical relationships are almost as important as online ones, and Quality of Life is becoming more and more important, due to the fact that the average age is constantly increasing in almost every country.
Quality of Life is a broad concept, and it covers both the individual dimension and the community one: the importance and awareness of social and ethical problems are increasing, alongside increased requirements in personal wellbeing.

The Individual Dimension

From the individual point of view, Quality of Life means in the first instance having good health, and is one of the main reasons why Artificial Intelligence is becoming the engine of a whole new portfolio of advanced healthcare applications.

As of September 2017, CBInsights published a report with an overview of 101 AI startups providing services in the Healthcare sector.

Describing its map, CBInsights asserts that *"Healthcare is the hottest sector for artificial intelligence, with startups applying AI to everything from genetic research to emergency room management to clinical trials [...] we identified 100 companies that are applying machine learning algorithms and predictive analytics to reduce drug discovery times, provide virtual assistance to patients, and diagnose ailments by processing medical images, among other healthcare applications."*

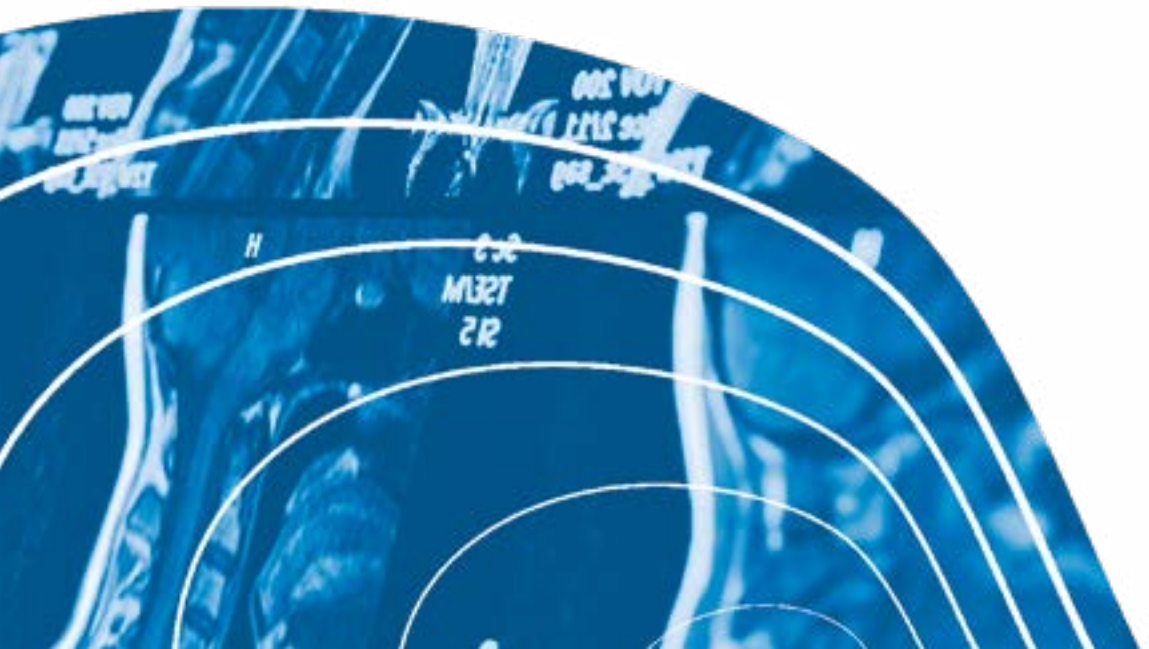


(source: CBInsights)

Deep Learning and **Natural Language Processing** seem to be two of the most suited branches of AI to address healthcare problems.
The combination of the two makes it possible to build Artificial Doctors that can interact in a friendly way with patients thanks to Natural Language, and have the ability to make fast and precise diagnosis, acquiring know-how through Deep Learning, based on historical data and previous diagnosis, exactly as human doctors do, but in a faster way and with a much wider case history on which to draw.

These technologies are used, for example, by **Winterlights Labs**, a startup based in Toronto that is using AI to identify people withcognitive diseases, like dementia and aphasia, based on patterns in their recorded speech, with an accuracy rate between 82% and 100%.

Bioz, another startup, has implemented the world's first search engine for life science experimentation, combining the latest advances in computer science with in-house life-sciences expertise to help researchers plan experiments, write papers and apply for grants.



bioz.com

Founded:
2013

Funding stage:
seed

Total Funding:
3 Mln$

(source: CBInsights)

see the video!

Bioz

Bioz's unique engine mines hundreds of millions of pages of complex, dense and unstructured life-sciences papers, and then uses Natural Language Processing and Machine Learning to clean, tag and structure the data. Bioz's platform incorporates semantic analysis engine and relevancy ranking of results, research-relevant correlations, reagent product ratings, and researcher collaboration optimization. All reagent insights are unique, and are mined from millions of objective peer-reviewed scientific articles. By using Bioz, scientists are able to reduce the cost of reagents and equipment, shorten the amount of time required for successful experimentation, and most importantly, improve the quality of their research.

ARTIFICIAL DOCTORS HAVE OUTCLASSED HUMAN EXPERTS IN MAKING FAST AND PRECISE CANCER DIAGNOSIS.

web link

Computer Aided Diagnosis and Treatment are mainstream in the application of AI to the healthcare sector, both as a support to expert specialists or as a substitution of them in medical facilities that cannot afford the cost of a team of specialists, thus relving, for example, on general cardiologists or oncologists. In September 2016, at the Houston Methodist Research Institute, a team of specialists reached 99% accuracy in breast cancer diagnosis using an AI software that works with imaging scanning techniques, avoiding unnecessary biopsies due to false positives.

Six months later, in an article published in January 2017 in Nature, Convolutional Neural Networks (CNN) was recognised as being able to diagnose skin cancer as accurately as the best dermatologists: *"We test its(CNN) performance against 21 board-certified dermatologists on biopsy-proven clinical images with two critical binary classification use cases: malignant carcinomas versus benign seborrheic keratoses; and malignant melanomas versus benign nevi [...] The CNN achieves performance on par with all tested experts across both tasks, demonstrating an artificial intelligence capable of classifying skin cancer with a level of competence comparable to dermatologists."* This technology opens the doors to mass, low cost diagnosis, strongly impacting low-income or geographically disadvantaged populations : *"Outfitted with deep neural networks, mobile devices can potentially extend the reach of dermatologists outside of the clinic. It is projected that 6.3 billion smartphone subscriptions will exist by the year 2021 and can therefore potentially provide low-cost universal access to vital diagnostic care."*

As in many other markets, in healthcare too the application of AI technologies is spreading from the industrial sector (hospitals, medical centers, pharma labs) to the domestic environment, with the first robots designed to provide medical support. One example is **Pillo**, a device exploiting v oice and facial recognition to *"answer health and wellness questions, connect directly with healthcare professionals, and securely manage vitamins and medication; storing, dispensing, and even ordering refills when required."*

pillohealth.com

Founded:
2015

Funding stage:
Unattributed VC

Total Funding:
3.12 Mln$

(source: CBInsights)

see the video!

Pillo Health

Pillo Health is a product that manages medications and health of individuals. Pillo is always on call and there to help. In addition to managing your medications and supplements, he answers your health questions, reorders your medications from your pharmacy, and even connects you directly with doctors. Pillo sends notifications to your loved ones when medications are missed. Pillo sees and hears you to keep you healthy and safe.

see the video!

The Social Dimension

Looking at the social dimension of humankind, Quality of Life means mainly paying attention to ethical and social issues.
Themes like access to food, to basic medical care, education and human rights are fundamentals that are still absent in too many countries in the world.
In this field, Artificial Intelligence allows things that have never been achievable with previous technologies, giving hope for a reduction in the gap between the developed world and 'others'.

One simple but meaningful example of the potential, is represented by the "Poverty Mapping Project" led by a group of Stanford University scientists that, combining high resolution satellite images with Deep Learning techniques, have been able to accurately map poor areas of five African countries, outperforming previous image only based methods.
Getting a centralized knowledge of where the poverty is, despite what the local administrations can know or say, is the first step on the path to facing and solving it.

see the video!

Another example of AI enhancing social life is represented by autonomous drones.
Autonomous Vehicle is a term that is automatically associated with cars or trucks, but when a medical assistance drone becomes totally autonomous, things like delivering drugs or collecting blood samples in remote rural areas can become a reality, as in Madagascar where a Vayu drone has completed its first long-range totally autonomous flight.

The business side: tailored products and services, delivered at the right time, to the right place and at the best price

Geolocalization has acted as the seed for a new way to interact with potential buyers.
But quite quickly, the tree growing from this seed has become an inextricable bramble of a massive amount of data and hidden interrelationships.
The software is able to track our every movement, what we do, what we look at and what we look for, but ... what exactly to do with all this data? How and when should we send the right proposal to a receptive customer?
Artificial Intelligence is providing essential support to answer these questions.

With AI, brands can not only recognize customer behavior in real time, but also provide predictive customer service, anticipating customer's needs.
Location is quickly becoming just one of the many elements that are evaluated by AI marketing applications: the same user in the same place could receive different proposals as a consequence of the daily weather, or due to his/her mood, detected analyzing the messages posted by the user on the social networks or chats.

web link

MaaxMarket is doing exactly that. Its machine learning algorithms track the behavior of online users, including social media, and apply predictive analysis to automate social media marketing campaigns.

A similar approach is applied by **Epictions**, a digital marketing intelligence startup using artificial intelligence and machine learning to disrupt content marketing and digital PR. Its two tools, EpicBeat and EpicTrack, allow the platform's user to discover most relevant trends for their industry, what competitors are doing and how social users are reacting to their campaigns' content.

EPICTIONS

epictions.com

Founded:
2013

(source: Crunchbase)

Epictions

EpicBeat is the best trending content aggregator tool online. If you want to find and curate the hottest content for your industry, this is the tool. Features include Content Discovery, Curation and Intelligence, Influencer Marketing, Author Outreach, Alerts. EpicTrack bridges the gap between social and content performance metrics. By adding web analytics to its EpicTrack account, the user can track each piece of content across social channels, clicks and visitors back to the site. EpicTrack also lets the user do in-depth analysis of what works for its competition. Owned streams can be used to track content created by the competition and understand what's working for him versus them.

To be effective, a message not only needs to be delivered at the right moment, it also has to be formulated to catch the attention of its target. The right phrase is key for a marketing campaign; a lot of time and effort is spent working on and refining the textual elements of a communication portfolio.

This is the domain that is being addressed by **Phrasee**, a startup that wants to use Artificial Intelligence to automatically generate and/or optimize a company's marketing language.
Artificial Intelligence is so important in enhancing the sales process that at the end of August 2016 eBay acquired the company **SalesPredict** and a couple of months later completed the acquisition of **ExpertMaker**.
In a very recent analysis, (October 2017), CBInsights drew a comprehensive overview of how the US Big Tech are attacking aggressing the AI realm: in the last 5 years they have acquired 50 AI companies and have invested in more than 80 startups.

web link

Amazon stands out among the most dynamic companies not only for its NLP developments including the constant evolution of Alexa, but also for a parallel interest in computer vision focused on image analysis.
Confirming its aggressive commercial strategy, Amazon has already begun to exploit its know-how in the field of AI by selling it as a service, "AI-as-a-Service", aimed at developers who want to benefit from a ready-made AI service platform.

see the video!

(source: CBInsights)

Of course not all these companies apply Artificial Intelligence in the field of the Social Life. An example of AI applied to other branches of marketing science is represented by **Synetiq**, a startup focused on **neuromarketing**.

The distinctive feature of Synetiq is that it uses Emotional and Cognitive Analysis together with Biometric Sensors for real time analysis of the unconscious response of the audience, based on signals coming from the brain, heart, skin and eyes.

SYNETIQ

synetiq.net

Founded:
2014

Funding stage:
seed

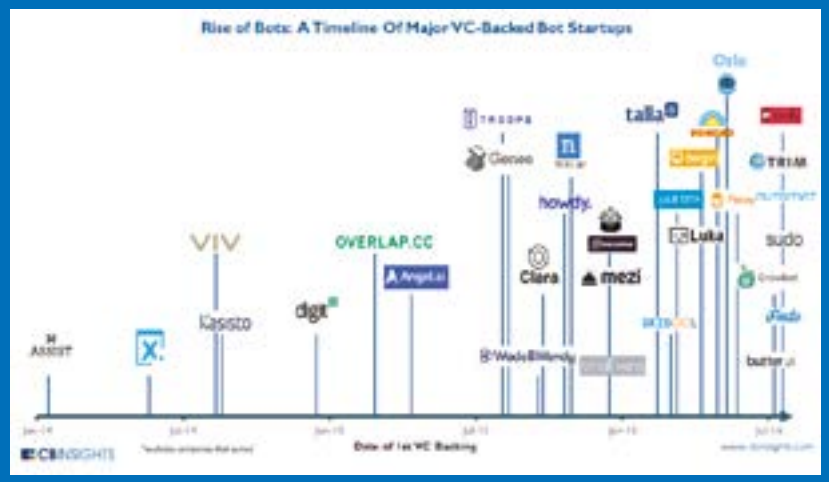
Total Funding:
0.67 Mln$

(source: Crunchbase)

Synetiq

Synetiq Ltd. is a cutting-edge neuromarketing media research company providing content producers and advertisers with emotional insights directly from their viewers' brain and body. Synetiq leverages recent developments in wearable bio-sensor technology to understand how people feel when they see an advertisement, TV show or movie. Synetiq's approach, called crowdsourced neuromarketing, delivers unprecedented insights to understand customers anywhere in the world in a fast and cost-efficient way. Although several neuromarketing companies exist around the world, Synetiq is the only one offering testing in people's homes with biosensors in addition to testing in a lab.

Automation is becoming more and more important also on the side of user experience. **Bot** companies – both chat and voice focused – are under the spotlight of VC investors, with activity starting to rise in the second half of 2015.



(source: CBInsights)

The panorama of chatbot startups is wide and variegated.
Smartly.ai for example, leverages on conversational Artificial Intelligence to provide a conversations modelling tool deploying on chatbots and conversational bots, while e-bot7 is offering a platform to integrate personalized chatbots on the most common chat channels, from Whatsapp to Messenger to Telegram and Slack.

Smartly.ai

smartly.ai

Founded:
2012

Funding stage:
seed

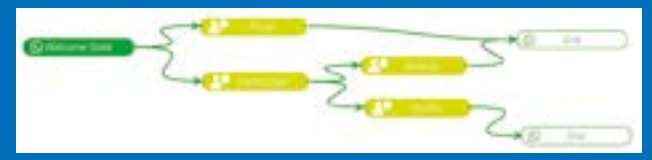
Total Funding:
0.45 Mln$

(source: CBInsights)

see the video!

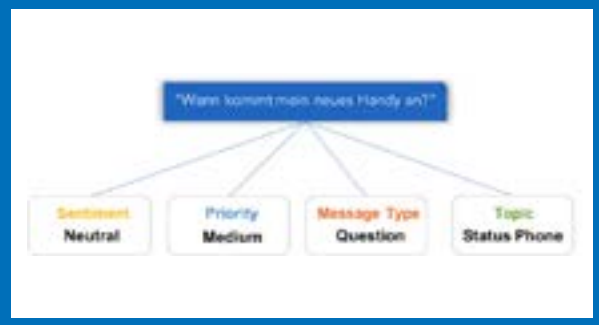
Smartly.ai

Smartly.ai is a set of tools and algorithms that allow developers to create, test, deploy and monitor conversational apps. Each application has a Dialog Flow which defines its behaviour.
A dialog flow is a specialized state machine dedicated to Human / Machine conversation. Conversations are visually modeled and Workflows are then processed by a state of the art conversational AI that manages all the back and forth with the user. Features are context management, desambiguisation, short and long term memory. Smartly already supports Amazon Alexa, Google Assistant, FB Messenger, Slack, Skype, SMS and emails.



e-bot7

The e-bot7 all-in-one platform provides companies with rule- and algorithm-based chatbots for messaging platforms such as Facebook, Whatsapp, SMS, Slack, Discord, and Google, and enables businesses to reach, monitor and to communicate with their customers on the most popular messaging platforms.



e-bot7.com

Founded:
2016

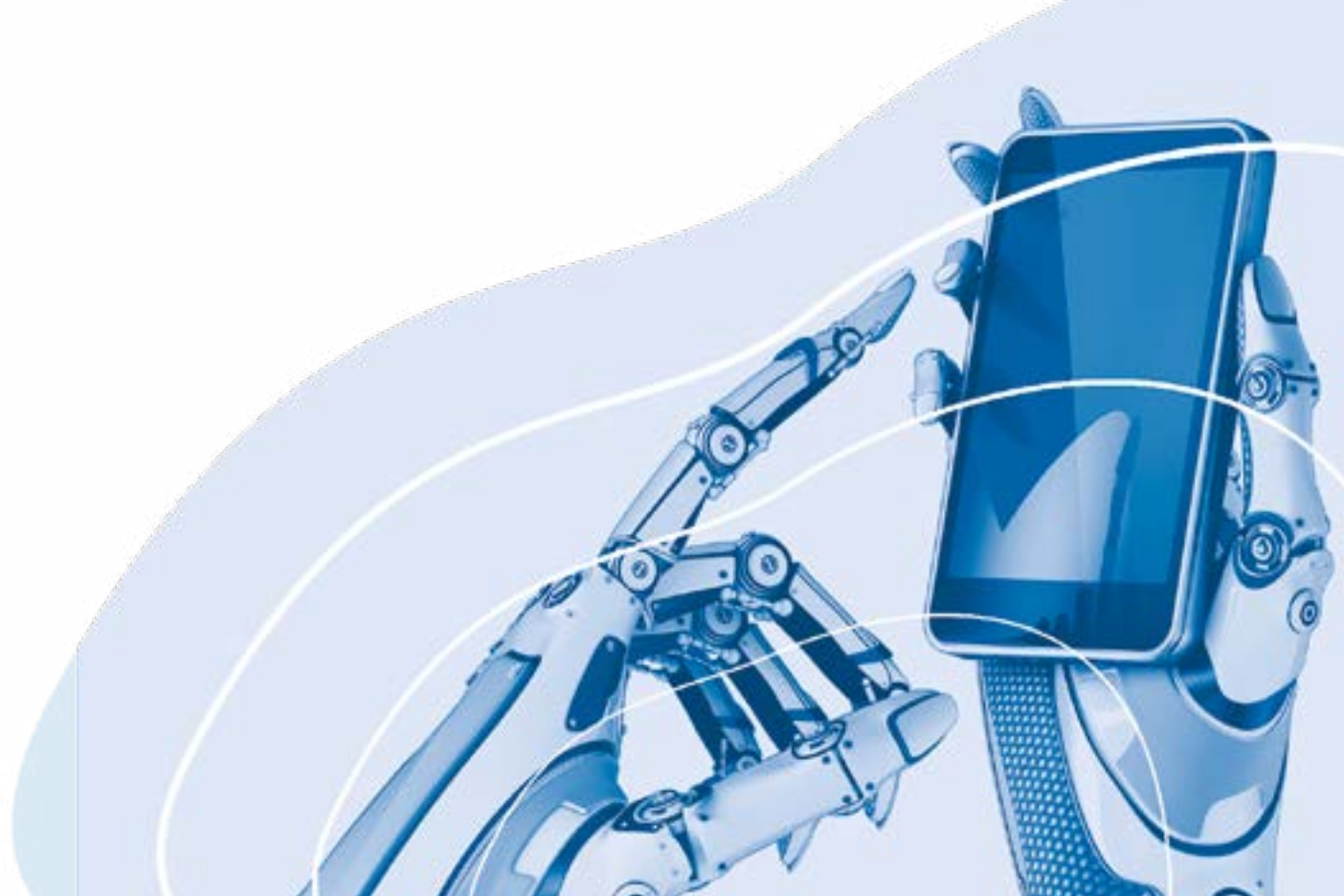
Funding stage:
seed

Total Funding:
0.08 Mln$

(source: Crunchbase)

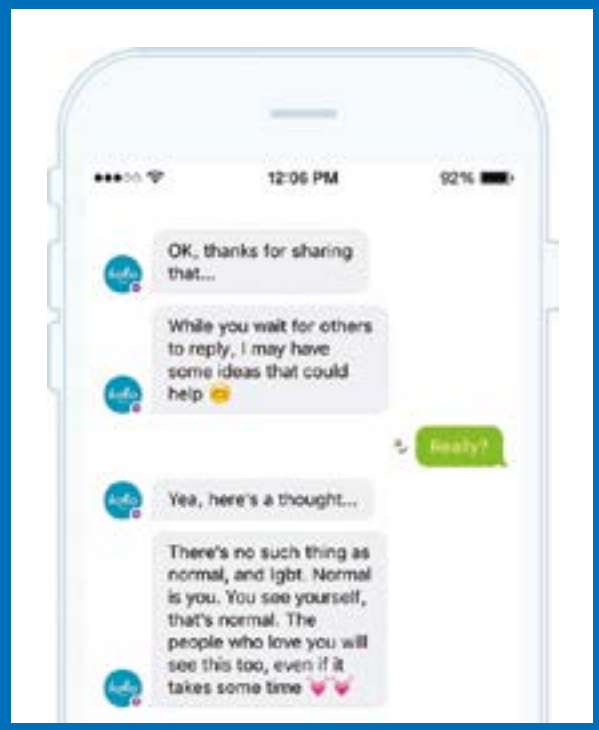
web link

It is such an attractive and rapidly growing market, that niche-oriented companies are also starting to appear. **Jagger**, for example, is an online marketing manager that sends its suggestions through Facebook Messenger, while **Koko** provides emotional analysis to social networks, aimed at detecting and supporting crisis and abuses.



Koko

Koko combines collective and artificial intelligence to offer services that help social networks manage crisis, abuse, and bullying. Koko helps people in all states of distress, providing evidence-based support while referring high-risk users to international lifelines for immediate help. Koko's APIs help social networks automatically detect crisis and abusive content in text, protecting users and supplementing human moderation efforts with deep-learning artificial intelligence APIs.



koko

itskoko.com

Founded:
2014

Funding stage:
series A

Total Funding:
2.5 Mln$

(source: CBInsights)

Aside from the immediate future of Digital Assistants and ChatBots talking to us, there is an ongoing cultural shift towards an "Extended" Social Life. In a communication continuum, human and artificial interlocutors merge, swap roles and acquire the same importance as the experts one turns to for assistance and advice.

It's the new frontier of the Social Life.

INTERVIEW WITH FRANCESCO MORACE

Francesco Morace

Sociologist and writer, Francesco Morace has been working for over thirty years in the sociological and market research field and is the president of Future Concept. Strategic consultant for companies and institutions on an international level he has held conferences, courses and seminars in 20 countries worldwide since 1981.
Professor of Social Innovation at Politecnico di Milano and Culture & Lifestyle at the Faculty of Sociology, Università di Trento. He is the author of over 20 books including the recent: "Italian Factor. Come moltiplicare il valore di un Paese" (2014, paperback/Italian) and "Crescita Felice. Percorsi di futuro civile" (2015, paperback/Italian) both published by Egea, from which themes are discussed on "Il Consum-autore" each Sunday on the Radio24 show "Essere e Avere" hosted by Marialuisa Pezzali.
He is also a regular columnist on the subject of trends for Adv, Dove, Interni, Mark Up, Millionaire, You, Style and other specialised international magazines and journals.

Q Do you see any ethical concern with the progressive invasion of AI into personal space?

A Certainly it is one of the most thought-provoking issues in the near future. It's very important that AI remains within the amplification of human qualities and does not invade the territory of human experience, forcing intentions or awareness. It becomes essential to imagine new rules and forms of social contract, through which everybody's will is respected in defining the threshold beyond which AI intervention is unwanted. It will be difficult to regulate these new forms of exchange, but individual dignity needn't be obscured.

Q How do AI technologies affect personal relationships, both in the real world and on social networks?

A The presence of AI in personal relationships will have to follow the same rules: information, awareness, intention. The real world and the digital one now converge in one form of experience in which you will need to ensure complete transparency and traceability of AI dynamics triggered against people who will be empowered to accept conditions or otherwise use the presence. Manipulative forms will be banned and reported.

Q Robots and Humanoid Robots: which will we see in our homes? How do we react emotionally to them?

A Every culture has a different reaction to a possible presence of humanoid robots at home and in everyday life. For example the Japanese world shows a great practice and acceptance of such a presence, while for example the Mediterannean world, where very strong and empathic family relationships are firmly rooted, will hardly accept the idea, for instance, taking care of the elderly with robots at home.

Q Are existing regulations sufficient to address the issues posed by Artificial Intelligence (e.g. privacy, workforce, decision-taking machines, etc.)?

A The real crux of the matter is the government regulation adjustment in order to handle new reports produced by the AI: the legislation is not yet sufficiently equipped to define a proper balance in this field. It will take a few years to develop an appropriate set of rules in this new complex world.

Q Chatbots: will they be our friends of the future?

A The enormous pleasure and subtlety of the conversation between human beings is one of the experiences that will endure longer. Therefore the answer is absolutely NO. The widespread use of robots will save us huge amounts of time, which will be devoted to conversation between us. Italy is the country of bars and squares, and it will make the most of this opportunity.

4

JOBS, INDUSTRY AND SKILLS REVOLUTION

INTRODUCTION

We are living in an era of fast-growing technology that is radically transforming the way we live and work. Automation and thinking machines are becoming realities in many jobs and the skills sought by companies are drastically changing.

A THIRD WAVE OF TECHNOLOGICAL INNOVATION IS STARTING, FEATURING MACHINES THAT DON'T JUST HELP US DO OR THINK – THEY HAVE THE POTENTIAL TO HELP US BE - BY ARATI PRABHAKAR, DARPA'S FORMER DIRECTOR.

The digital revolution therefore is changing behavior and expectations as much as the tools used to deliver new services and experiences. The combination of the Internet, mobile devices, data analytics, cloud computing and other technology trends will continue to transform the world and life.
Tech giants such as Amazon, Alphabet, Facebook, IBM and Microsoft – as well as individuals like Elon Musk – believe that now is the right time to talk about the new landscape of artificial intelligence and the future of work.
From an organizational perspective companies are constantly looking for ways to incorporate artificial intelligence into their processes and services for a real competitive advantage.

There is much concern among firms about the changes AI will bring and the competence required by the transformation underway.
The growth of AI is in fact drastically increasing the need for people with relevant skills in its support and advancement. International events centred on artificial intelligence are frequent.

In November 2017 **MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) and its Initiative on the Digital Economy organised the «Conference on AI and the Future of Work»** in Boston, USA. Its aim was to understand what experts and scientists think about it.

One of the points that emerges is that we cannot stop technological development, but what we can do is think about its consequences and be inspired enough to give its acceleration the right significance.
The second important point is that Humans and Technologies are going to work together, AI will transform whole sectors but with the help of humans, not alone.

The Boston conference revealed disagreeing opinions regarding AI.
One of the several leading personalities taking part in Boston was **Sinovation Ventures CEO Kai-Fu Lee, one of the leading investors in AI in China e Alphabet Executive Chairman Eric Schmidt.**

Kai-Fu Lee had perhaps the most pessimistic point of view on job destruction. He described four different waves of technology, which have led to four different kinds of companies:

1. internet data and internet giants like Google and Facebook;
2. commercial data and things like medical image recognition and fraud detection;
3. the "digitized real world" and devices like the Amazon Echo and cameras in shopping centers and airports;
4. full automation, by which he means robotics and autonomous vehicles.

According to Lee, the second and third waves are replacing many white-collar workers, while the fourth will hit blue collars. Lee suggests solutions and approaches aimed at eliminating poverty, reinventing education in order to focus on skills and competences that develop sustainable and creative jobs that cannot be replaced by automation. In short, he would like to reinvent a new work ethic.

On the other hand, **Eric Schmidt spoke about a more "inclusive innovation", he said we need a more general application of technology to make people happier and smarter**. We will embrace – in his point of view – a society in which we will work fewer hours thanks to robots and automation. We need to encourage students choosing to study AI, computer science, machine learning, valorize talents in students and foster digital skills in people.

This chapter therefore focuses on areas of opportunities, new skills, industrial implications in the growth of artificial intelligence and robots, as seen from our point of view and international studies. It also aims to illustrate some of the implications advanced automation brings with it, from ethics to the free time that people will have for out of work activities, to new human-machine interaction.

THE FUTURE OF WORK

Artificial Intelligence will have a profound effect on the way people work, and will almost certainly also impact the availability of jobs, distribution of income and the future of industries.

AUTOMATION WILL CERTAINLY TRANSFORM THE WORKFORCE AS HUMANS AND MACHINES WORK TOGETHER. ADVANCES IN AUTOMATION TECHNOLOGIES WILL MEAN THAT HUMANS INCREASINGLY WORK SIDE BY SIDE WITH ROBOTS, SOFTWARE AGENTS, AND OTHER MACHINES.

(source: Statista)

There are many views on how AI will impact work. Automation, digital platforms and other innovations are changing the very nature of work. Understanding these changes can help politicians, company leaders and institutions pave the way for shared innovation.
A significant part of AI's economic growth certainly does not come from replacing the existing labor force or capital, but allowing them to be used more effectively. Technologists, economists and philosophers are discussing the implications of artificial intelligence in terms of work and skills.

The World Economic Forum carried out a detailed study in 2016 about the so called "Fourth Industrial Revolution," driven by technologies like artificial intelligence, 3D printing, nanobots, genetics, biotechnology, and other robotics areas, interviewing chief human resources officers and top strategy executives from companies across nine broad industry categories and covering 15 of the world's largest economies.

By the year 2020, an estimated 5 million jobs are predicted to be replaced by machines in the most developed countries in the world.
And according to a new McKinsey Global Institute study in January 2017 30% of global jobs will be automated by 2030.

see the video!

5 Mln

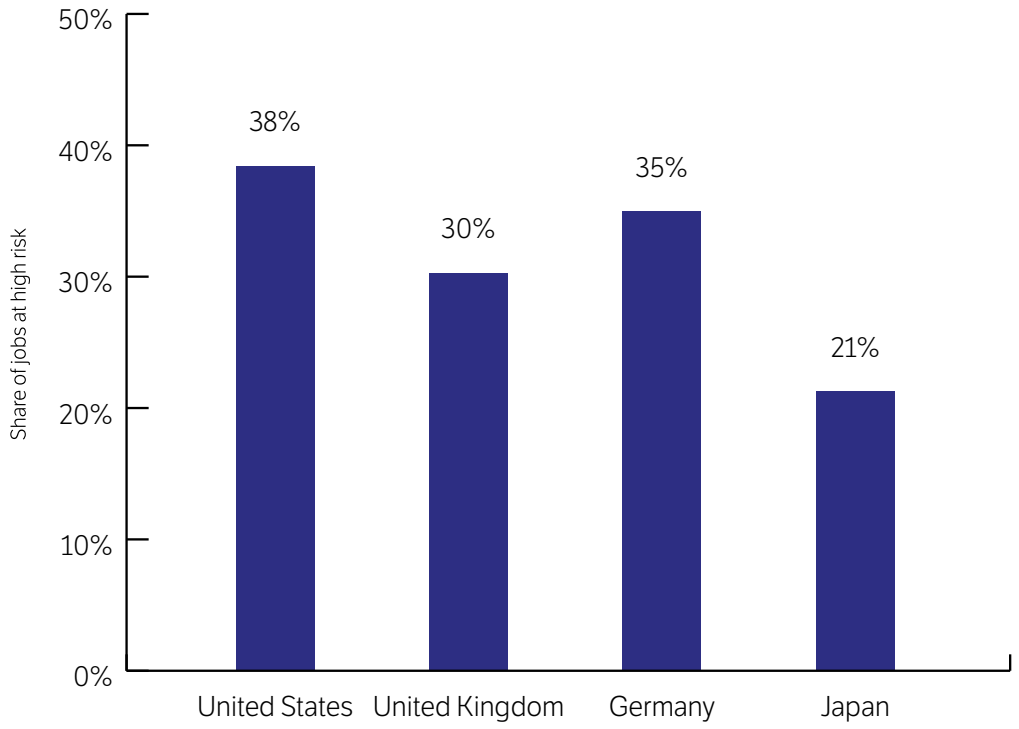
By the year 2020, an estimated 5 million jobs are predicted to be replaced by machines

ROBOTS AND AI WILL INCREASINGLY REPLACE ROUTINE KINDS OF WORK

These forecasts concern not only blue collar assembly line workers, but white collars too – in sectors including administration, accounting and finance.
In the short term it is certainly more likely that artificial intelligence will replace single activities rather than jobs, while it will also create new jobs and markets, althoughit is hard to imagine what they will be.

There is also a gender implication in the loss of 5 million jobs predicted by the WEF. The burden of loss seems to be about 48% women and 52% men. However, given that men represent a larger share of the overall labor market than women, this gap translates into widening the gender gap in employment, with women losing five jobs for each job earned compared to men, who lose three jobs for each job earned. This is also due to women having poor access to mathematical / scientific work (STEM).
The percentage of highly-automated jobs will obviously be different depending on the countries of reference.

The shift of jobs due to automation will be unavoidable, determined mainly by the economic benefits deriving from work efficiency when machines take care of the human work.



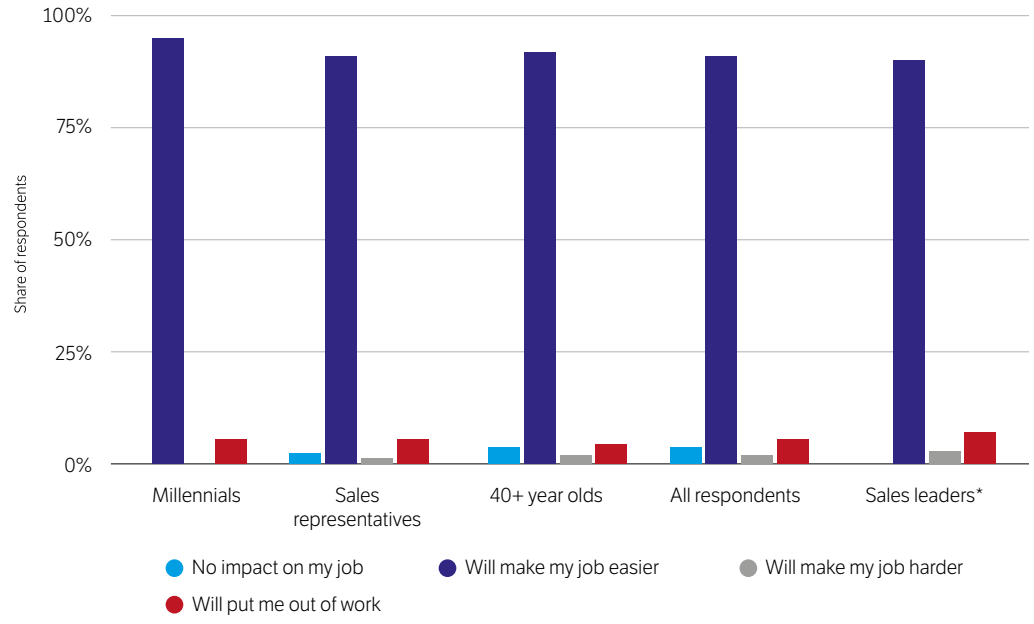
Share of jobs at high risk of automation by early 2030 in some countries, by source, as of 2017

(source: Statista)

Another piece of the puzzle of how AI transforms jobs is how people see the advent of automation. A Statista chart represents the feedback of software sales job on how AI will help their work, divided according to age group. The younger the salespeople, the more they see AI as facilitating their work.

Predicted long-term (10-year) impact of artificial intelligence on software sales jobs worldwide, as of July 2017

(source: Statista)



see the video!

Regarding the type of work robots and AI will do, humans think they will be routine kinds of work — even the complex routines performed by artisans, factory workers, lawyers, and accountants.
A 2016 McKinsey study analysed what is and isn't routine work and the percentage of automation predicted in the years to come.

"TODAY'S TECHNOLOGY COULD BE USED TO COMPLETELY AUTOMATE 5% OF OCCUPATIONS"
(MCKINSEY)

Every profession is made up of more than one type of activity and each has various degrees of technical fesasibility.
Technical fesasibility is a prerequisite for automation, but is isn't the only one. Other variables to keep in mind when judging automation are costs of development and distribution of HW and SW for automation, labor costs – if inferior to investments needed for automation – and lastly the advantages automation brings in terms of quality and fewer errors.

TECHNICAL FEASIBILITY OF AUTOMATION %

The Technical feasibility automation % is estimated by McKinsey to be 78% for Predictable physical work and 25% for Unpredictable physical work.

WHAT MAKES A JOB SUSCEPTIBLE TO AUTOMATION?

IF

the job requires negotiation, assistance, collaboration, creativity

THEN

the same job will be LIKELY SAFE from automation

IF

the job requires repetitive tasks, assembling and manipulating objects

THEN

the job is at HIGHER RISK of automation.

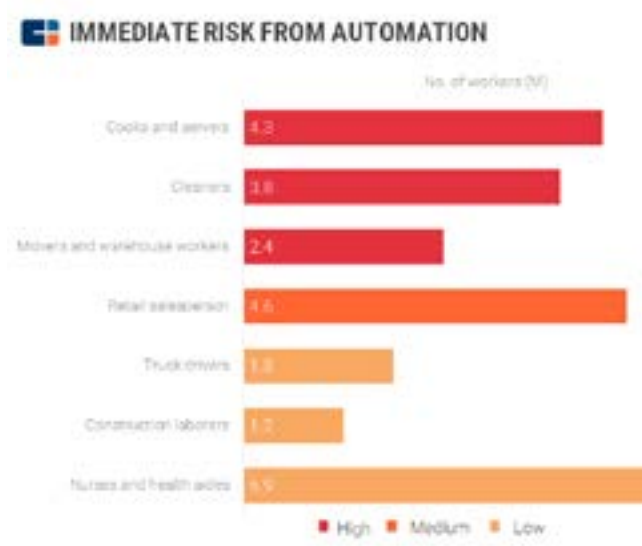
Obviously, some jobs are more subject to automation than others.

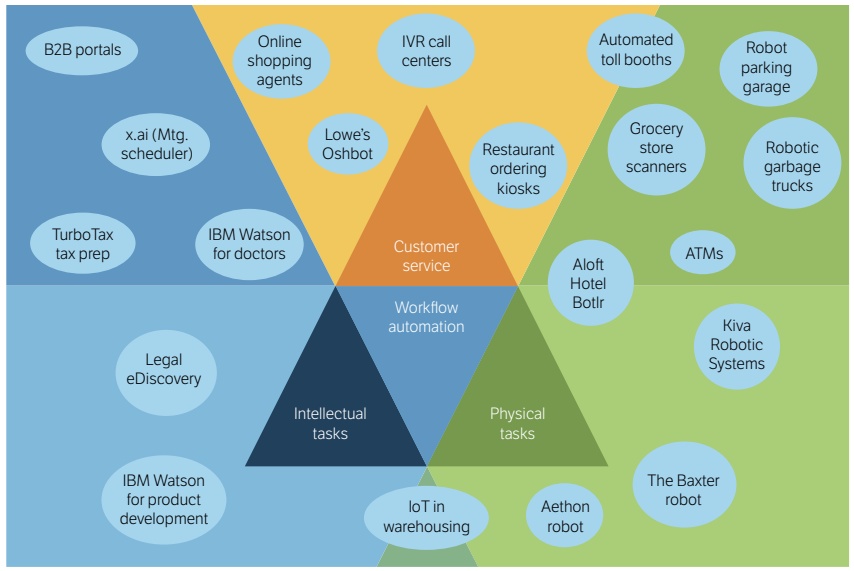
Social workers, nurses, therapists and psychologists are among the least likely occupations to be automated because they imply empathy typical of humans and not of robots. Another category that requires the creativity and inventiveness typical of people is represented by artists, designers or architects. In general, jobs that require a high degree of social intelligence and negotiation skills, such as managerial positions, are significantly less likely to be replaced by robots or automated.

Even occupations that will require a high degree of problem solving and creative thinking such as tackling climate challenges, producing new goods and services especially in developing countries, and dealing with energy crises will not be subject to automation.

"OFTEN PEOPLE ONLY THINK OF AI BOOSTING GROWTH BY SUBSTITUTING HUMANS, BUT ACTUALLY HUGE VALUE IS GOING TO COME FROM THE NEW GOODS, SERVICES AND INNOVATIONS AI WILL ENABLE."
(DAVID AUTOR, PROFESSOR OF ECONOMICS, MIT)

Forrester Research, CB Insights and Frost and Sullivan help us understand which job sectors are most cannibalised by AI. This is done through predictive risk analysis of automation and by analysing the penetation of sw AI in various industries and reference areas.





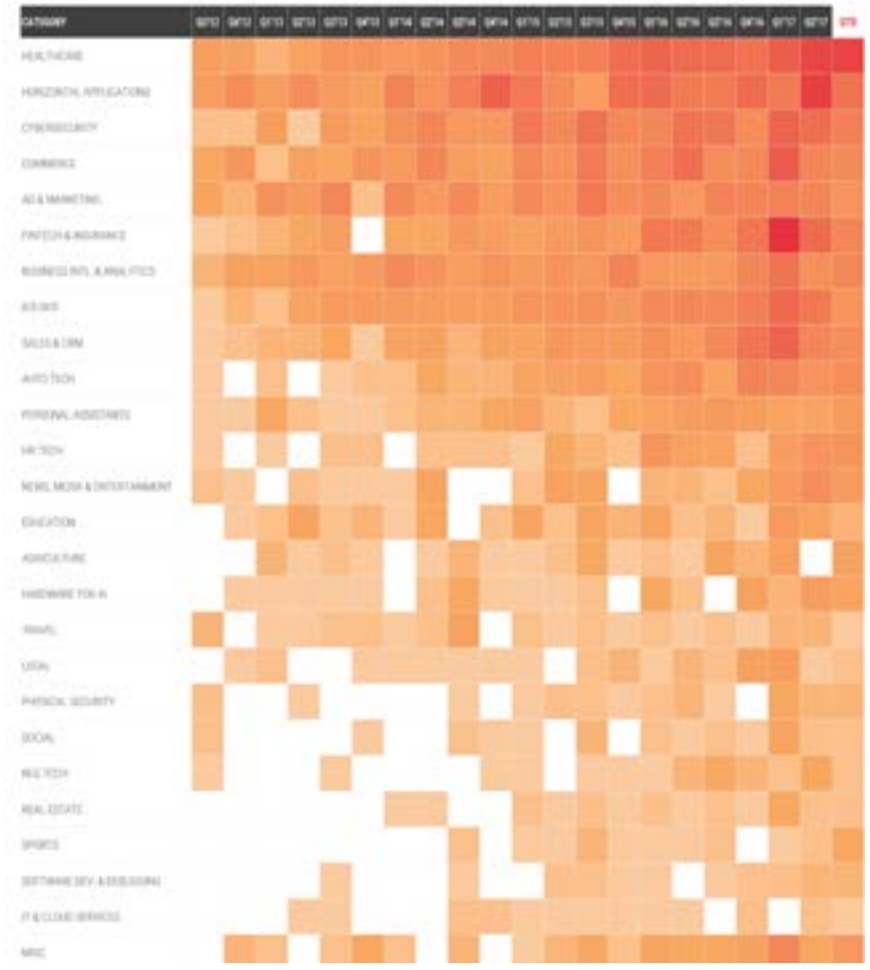
How Technologies Automate Physical, Intellectual and Customer Service Tasks

(source: Forrester)

Automation cannibalizes three types of job tasks

In this chart by, the 3 areas most affected by the advent of robots are customer service, physical tasks and intellectual tasks. In this case, robots mean all forms of automation technologies, including those that perform physical or intellectual activities or customer support activities (which combine elements of both) (see Figure).

Relevant technologies include physical robots such as Baxter by Rethink Robotics or Softbank's Pepper, as well as robot software such as Amazon's virtual assistant Alexa; cognitive computing intelligence such as IBM Watson; and customer support solutions such as advanced ATMs, interactive voice response systems (IVR) or self-service scanners at the grocery store.



AI software penetration

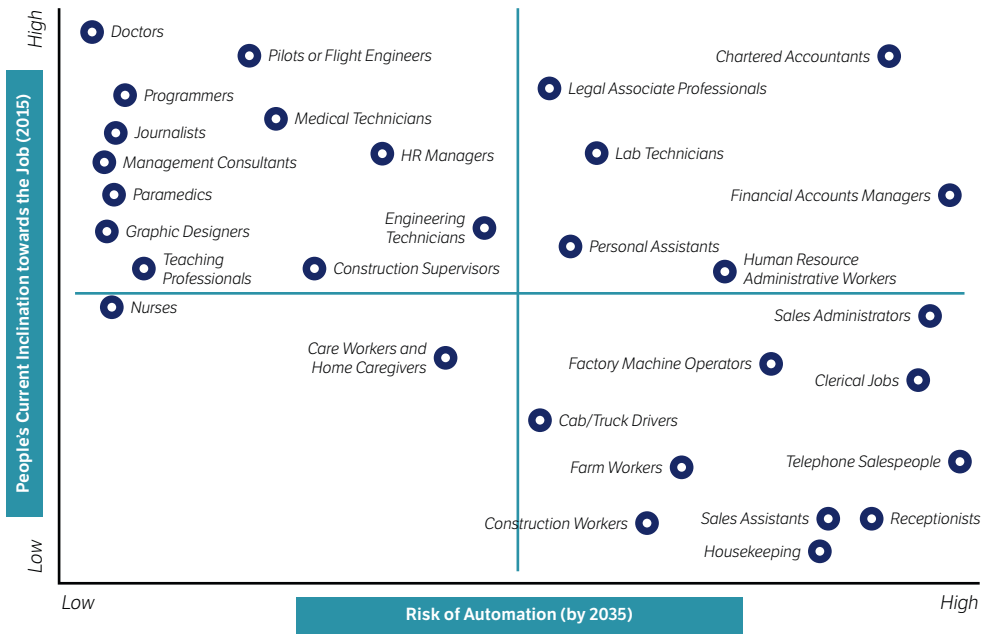
(source: CB insights)

In AI sw penetration color density shows which sectors are most impacted by the advent of AI. Healthcare, cybersecurity and automotive sectors are certainly experiencing very rapid automation.

In the analysis by Frost and Sullivan the categories most at risk of automation are again highlighted. **Financial and legal services will also be subject to high levels of automation.**
The world of finance relies on professional expertise: stock traders and investment bankers live off their wits. Yet about 50 percent of the overall time of the workforce in finance and insurance is devoted to collecting and processing data, where the technical potential for automation is high.

FUTURE OF AI:

Job Threat Mapping because of Automation, UK, 2015-2035



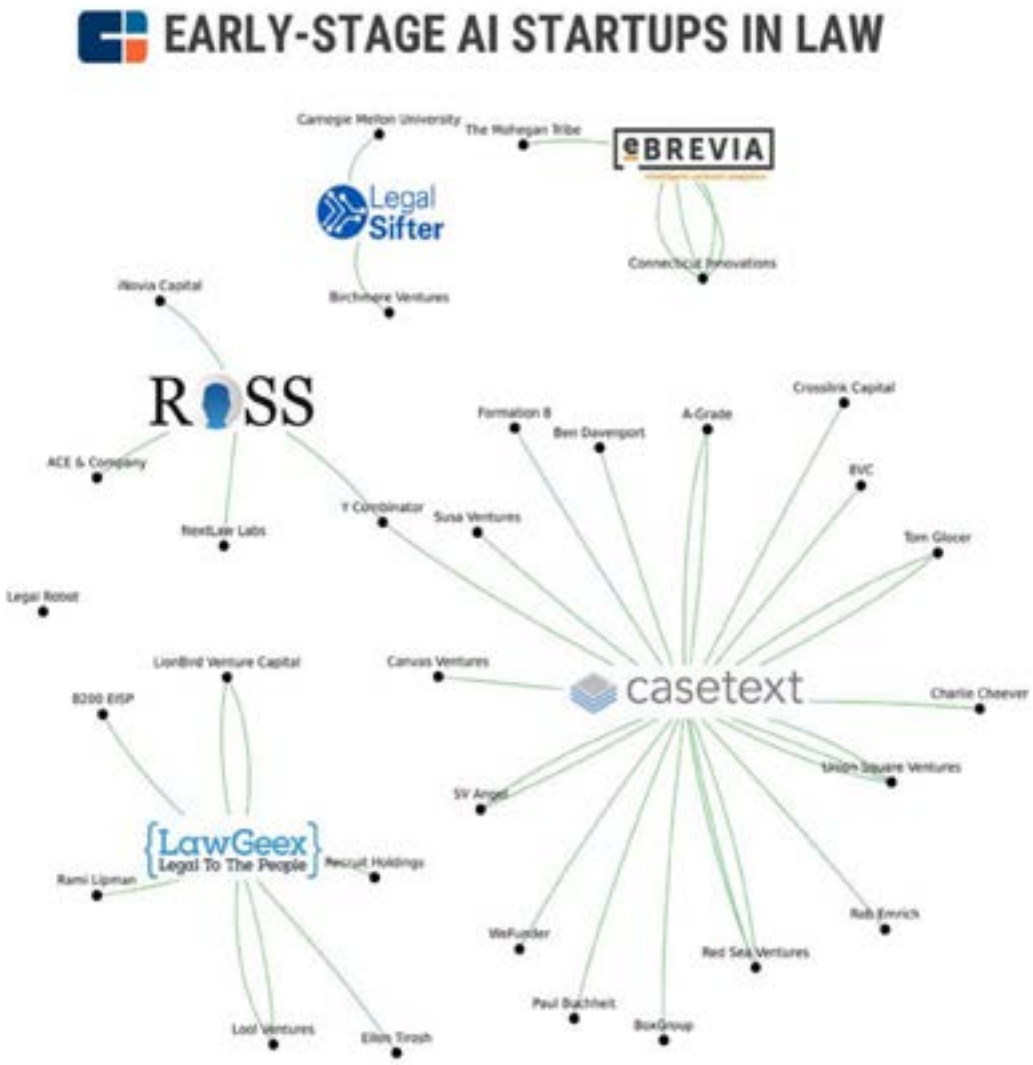
(source: Frost and Sullivan)

The legal sector will also see great changes caused by AI.

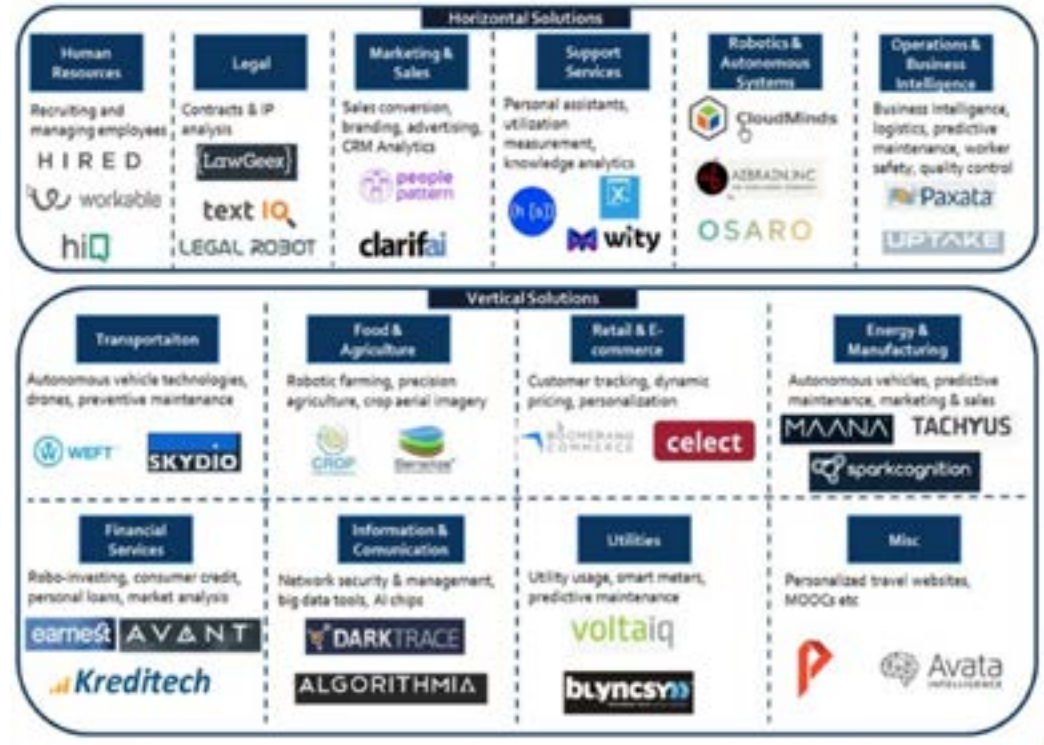
There will be "profound reforms" across the legal sector. Automation and the increasing rise of millennials in the legal workplace also alter the type of talent needed by law firms in the future.
In the legal sector many startups are changing the nature of work; AI will help lawyers preparing for court.

see the video!

For example **Everlaw startup** helps lawyers prepare for trials. The first step in any trial is the gathering of evidence. The startup uses AI to do things like read documents to find ones helpful to the lawyer's case and identify those that need to be sent to the opposition to avoid a mistrial. "This categorizes automatically so you don't miss ones that are important.
CB Insights has started to map the major startups that offer legal services with related investors (see next figure).



(source: CB insights)



(source: CB insights)

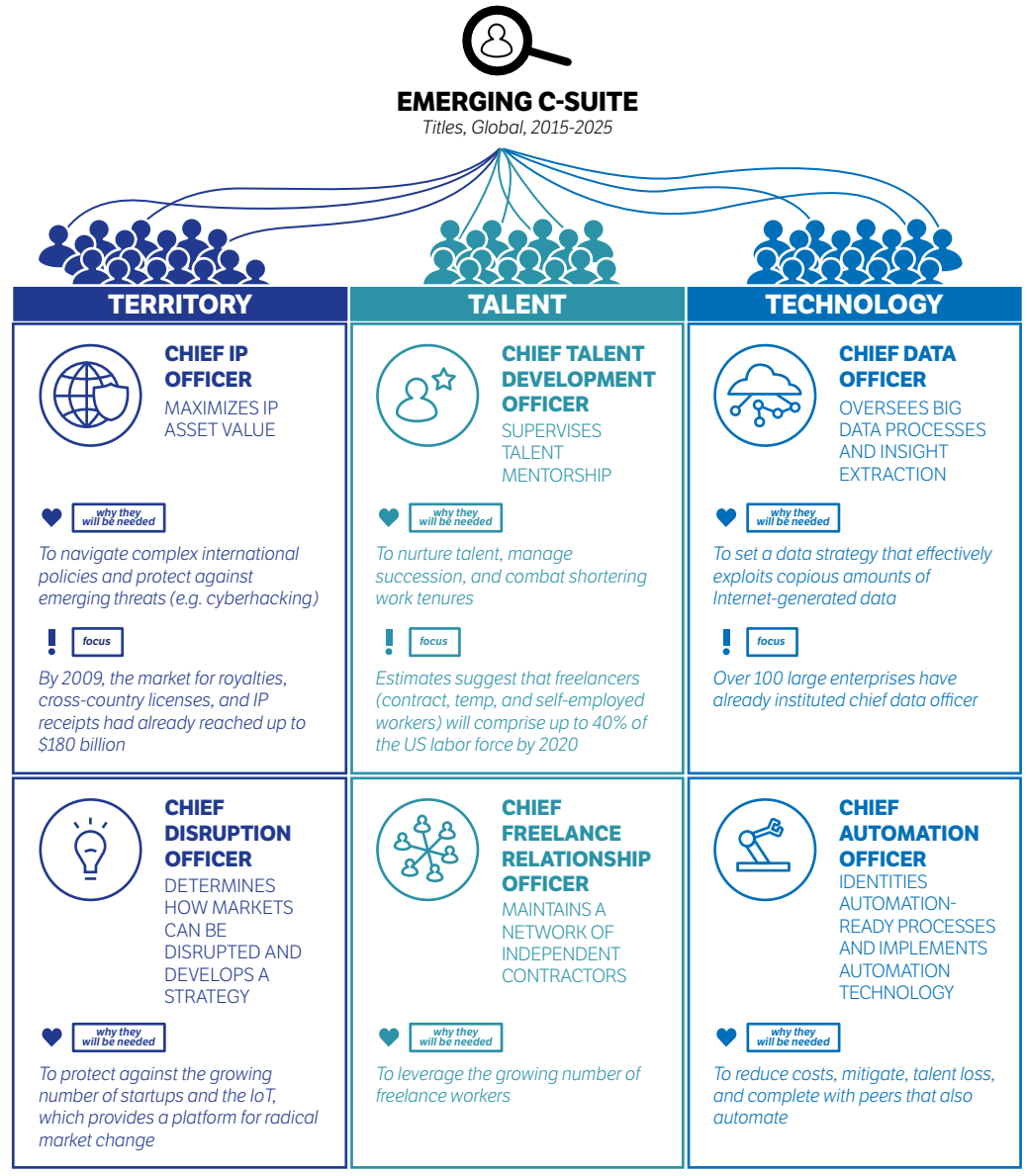
AI startups are targeting a range of applications in a broad swath of sectors

The range of AI startups is changing the scenario of many professions and sectors, not only in the financial and legal world, but also in food, energy and transportation.

However, AI is redesigning processes and services not only in industry but also within companies. The need to redesign processes is steadily growing in order to make organizations more receptive to change and better equipped to respond dynamically to the needs of the labor market.

Top executives will first and foremost need to identify where automation could transform their own organizations. In addition, they must challenge themselves to understand the data and automation technologies on the horizon today, drawing value from automation. Top managers must think about how many of their own activities could be better and more efficiently executed by machines, freeing up executive time to focus on the core competencies that no robot or algorithm can replace – as yet.

Greater dependence on automation, shifting talent behavior and priorities, increasing threats of disruption, and converging industries will elevate the importance of **emerging leadership positions. 2025's C-Suite Will Focus on Technology, Talent, and Territory.**



Some of the most innovative solutions are developed thanks to cognitive technologies such as artificial intelligence that is changing both the activities of **Talent Acquisition, skill inventory e HR management**.
For example IPsoftAmelia is a cognitive agent that can take on a wide variety of service desk roles and transform customer experience.
Amelia is an artificial intelligence platform that can understand, learn and interact as a human would to solve problems. She manages tasks in a wide range of industries, from financial services and energy to telecommunications and media.

Amelia reads natural language, understands context, applies logic, infers implications, learns through experience and even senses emotions.
Amelia is able to read and digest the same training information as her human colleagues but in a matter of seconds and without needing intensive programming. Amelia also learns on the job by observing interactions between her human coworkers and customers and independently builds her own process map of what is happening. Amelia is a pioneer herself in the field of cognitive computing, a type of computing which learns by experience and/or instruction like a human.

Technologies like Amelia will redefine traditional roles within the workforce.

AMELIA WORKS AT THE SAME HIGH STANDARD ALL DAY, EVERY DAY

She functions as an extension of a company's existing workforce, transforming what's possible in the workplace. By handling repetitive, often tedious yet necessary tasks, her human colleagues can shift their workload to focus on value creating activities that drive higher quality levels of productivity and service.

Robots will also be used in recruitment.

AMELIA CAN BE TRAINED TO HANDLE ALMOST ANY KNOWLEDGE-BASED TASK. SHE HAS THE CAPACITY TO PERFORM AND CONTRIBUTE IN A DIVERSE SPECTRUM OF ROLES IN ALMOST ANY BUSINESS SCENARIO.

see the video!

Human resource management and recruitment are going through a profound change thanks to the continuous development of artificial technologies.
This is the issue facing applicants of Facebook, IBM, and other companies that are starting to incorporate artificial intelligence into their hiring practices. They're using machines to scan work samples, social media posts, and analyze facial expressions on behalf of HR managers. HireVue records and analyzes interviews, from facial expressions to word choice in order to provide its clients feedback on a candidate's levels of engagement, motivation, and empathy.

HireVue

hirevue.com

Founded:
2004

Funding stage:
series E

Total Funding:
98 Mln$

(source: CBInsights)

HireVue

The technology allows recruiters to curate specific interview questions for each open role, and when a promising candidate applies, recruiters can then send these questions to the applicant. The applicant then records his or her answers using HireVue, and sends their responses back to the recruiter, who can review these interviews at their own pace. In addition to facilitating video interviews, HireVue also serves as an applicant tracking system (ATS), so that recruiters can track where applicants are in the hiring process, as well as any correspondence they have had with each candidate. Recruiters can also share videos with hiring managers, and rate each candidate's responses.

see the video!

Koru, another human resources software developer, also gauges personal attributes, using a written test to evaluate "impact skills," such as grit, curiosity, and polish. It compares candidates' results to those of a client's top staff performers to identify those most likely to excel at the company.

Fama, founded in 2015, uses natural-language processing to conduct automated web searches on a candidate, scanning news, blogs, and even a person's public social media history.

Leena is smart AI powered HR companion dedicated engaging employees. **Leena AI** improves communications with employees, can free up the time of HR staff, and even streamline job processes. Leena AI is designed to respond to employee HR questions in real time. Instead of having to visit a HR department or wait for a reply to an email, employees can get answers to their questions right away using an AI based chatbot.

FAMA

fama.io

Founded:
2015

Funding stage:
Seed - Total

Total Funding:
1,5 Mln$

(source: Crunchbase)

Fama

Fama (fama.io) is software that automates social media analysis to help businesses make smarter hiring decisions. The goal is to reduce the incidence of mishire/rehire - both at the executive and entry level - by leveraging the world's most content-rich data stream. Fama uses artificial intelligence to pick up on the red and 'green flags' that exist within people's online personas. Red flags might include references to bigotry, violence, drug use, whereas the 'green flags' allow you to see if a candidate is volunteering on the weekend, or passionate about certain causes. In the same way businesses set quantitative requirements for a role, they can use the Fama solution to set the qualitative requirements for that same position, and measure candidates against a standard set of requirements. Fama is one of 22,214 startups hiring on AngelList.

SO WHAT'S THE FUTURE?

It is highly likely that the future will increasingly feature robots and people working together. Robots and AIs will not be able to completely replace men but will bring added value to the interaction, because machines and human beings excel in different activities. Machines are often inferior regarding empathy, senses and dexterity typical of man, but on the other hand machines have a much greater accuracy than man ever could
(80 - 90% of the AI against 60 - 70% of men).
The working partnership between AI and man does not merely apply physical work. Just think of Google and its "10,000" evaluators " that watch videos on YouTube or test new services.
Microsoft, on the other hand, has a crowdsourcing platform called Universal Human Relevance System that manages a large number of small businesses, including checking the results of its research algorithms. The real strength of the process lies in this blend of artificial and human intelligence. Indeed, artificial intelligence can only carry out an algorithm that is predefined and trained by a human being, so there is always an error margin. When mistakes occur, AI cannot solve them. Humans, on the other hand, can look for creative solutions to unplanned problems. The best solution is to use machines to push productivity up to 95% accuracy levels and integrate the process with the help of human engineers to mitigate the risks that may occur during production.
To give AI the right boost in industrial production, Companies, Policymakers and Individuals obviously need to work together, (see scheme below).

Imperatives for all

Companies

- Embrace automation to capture the benefits
- Create jobs and reshape jobs the enable people to work with machines
- Play role in redeploying labor through retraining and skill-raising programs

Policymakers

- Support development of automation technologies
- Promote measures to raise skills and promote job creation
- Rethink incomes and social nets

Individuals

- Focus on acquiring skills throughout lifetime
- Make education and career choices, based on skills that will still be in demand in an automation world
- Become an AI scientist!

NEW SKILLS IN THE AUTOMATION ERA

In today's society, children face a "**global achievement gap**", between what even the best schools are teaching and the skills that young people need to learn. This phenomenon is accelerated by two current trends: in the first place, the global shift from an industrial economy to an economy of knowledge; secondly, the way today's school children learn, growing up with the Internet.
Artificial intelligence, robotics, nanotechnology, biotechnology, are transforming what we do and how we do it. It is therefore necessary to promote the right skills, abilities and knowledge necessary to face new challenges – be they climate, social, demographic or economic.
According to research from the World Economic Forum, 35% of the skills necessary to thrive in a job today will be different five years from now – transformation that will require social and emotional skills such as creativity, initiative and adaptability to navigate in the new world (from World Economic Forum).
"So what should we tell our children? That to stay ahead, you need to focus on your ability to continuously **adapt, engage with others** in that process, and most importantly retain your core **sense of identity and values**. For students, it's not just about acquiring knowledge, but about how to learn" (Blair Sheppard Global Leader, Strategy and Leadership Development, PwC)

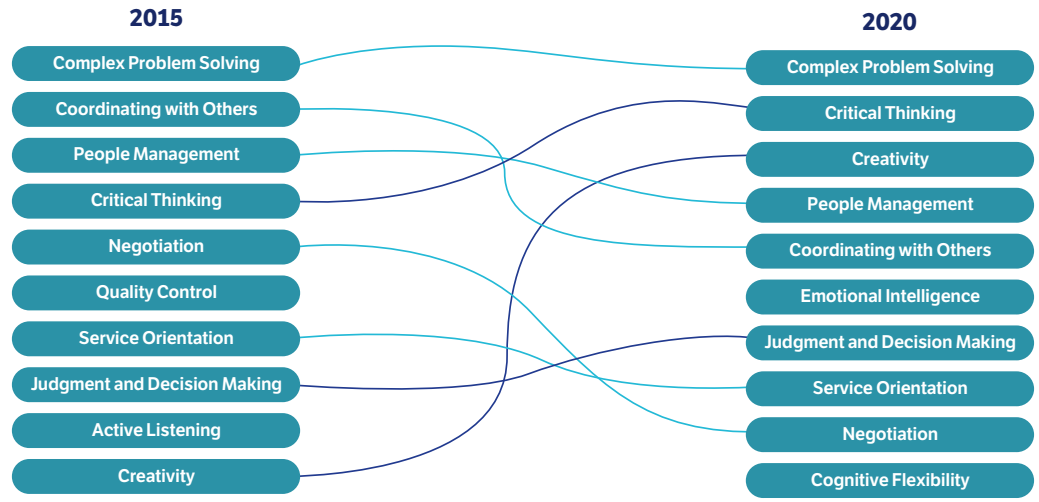
"A CHILD TODAY CAN EXPECT TO CHANGE JOBS AT LEAST SEVEN TIMES OVER THE COURSE OF THEIR LIVES – AND FIVE OF THOSE JOBS DON'T EXIST YET."
(ESTEBAN BULLRICH, MINISTER OF EDUCATION, ARGENTINA)

The two main challenges in the 21st Century therefore are: **how to help existing workers acquire new skills and how to prepare future generations for a workplace with AI presence.**

ACCORDING TO RESEARCH FROM THE WORLD ECONOMIC FORUM, 35% OF THE SKILLS NECESSARY TO THRIVE IN A JOB TODAY WILL BE DIFFERENT FIVE YEARS FROM NOW

The World Economic Forum - in the same survey for the future of jobs – analysed the new skills necessary to succeed. Creativity proved one of the biggest success factors for future generations. In fact, if robots do the work and the most routine tasks, creativity and problem solving will bring added value to future jobs.

TOP 10 SKILLS



Skills called transversal Life Skills will generally be considered crucial and therefore highly needed for future jobs, indeed a core factor in facing the changing scenario: these are social skills - persuasion, emotional intelligence, teaching abilities; cognitive skills - creativity, analytical reasoning; and "**process skills**" - listening skills, critical thinking.

Companies must be able to continuously improve products, processes and services in order to compete and to do so they need workers with critical thinking skills that can ask the right questions to solve new challenges.

"THE JOBS THAT EVEN ARTIFICIAL INTELLIGENCE CAN'T REPLACE WILL BE THOSE THAT REQUIRE STRONG HUMAN CHARACTER TRAITS: EMPATHY, A POSITIVE ATTITUDE AND RESILIENCE."
(VIKAS POTA, CHIEF EXECUTIVE VARKEY FOUNDATION)

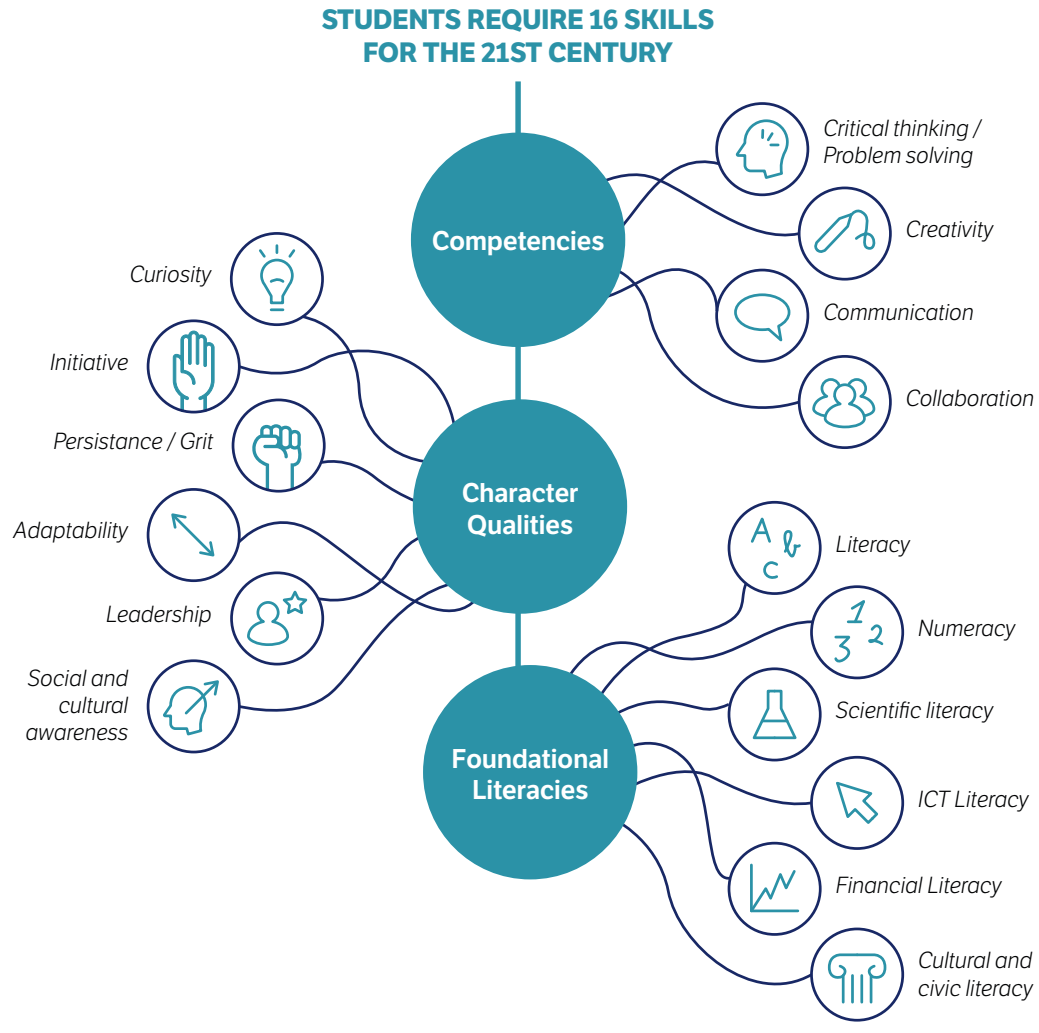
see the video!

In the digital age, **flexibility** will also be rewarded: the enormous growth of technologies will lead to the need for greater availability of critical thinking and openness towards external contamination. In fact, new professionals will be asked to make more and more effort.

Furthermore, the context of strong globalization means that **leadership skills and the ability to influence and work together** as a team have become increasingly important. **Moreover in the 21st century** the ability to learn faster will be crucial. The ability to take in information, focus on it, think about it, understand it and be able to apply it; to be able to outthink and out-learn everybody else to learn any subject or skill faster, to be able to remember things that they really need to be able to do.

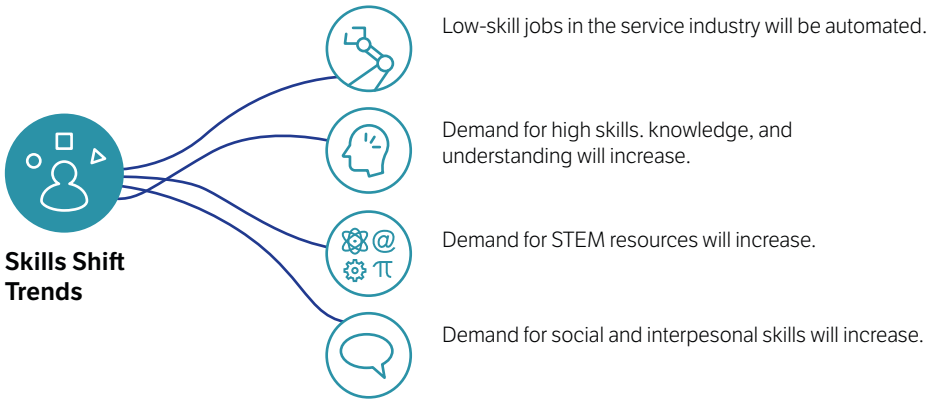
see the video!

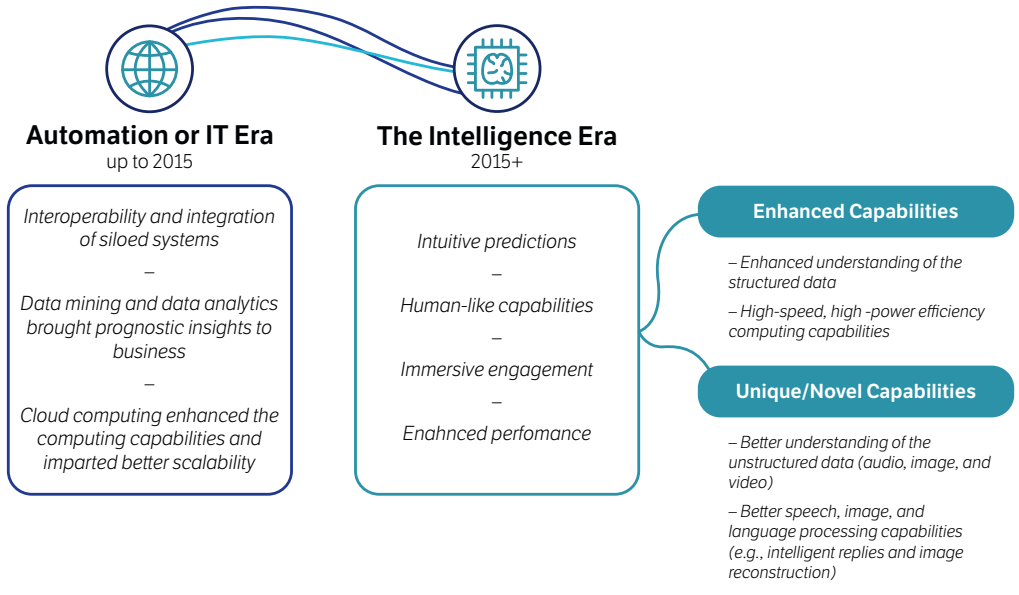
"COMPANIES WILL BE LOOKING FOR LEADERS WHO ARE ABLE TO HELP REBUILD THE EMPATHY WE HAVE LOST – PEOPLE WITH A TRIO OF TECHNICAL, LINGUISTIC AND MATHEMATICAL SKILLS."
(BELINDA PARMAR, CHIEF EXECUTIVE OFFICER, THE EMPATHY BUSINESS)



Frost and Sullivan sums up the skills needed to compete in the new digital era.

Frost and Sullivan sums up the change in skills associated with the advent of AI in tomorrow's workplace and how the competences needed are dictated by a high degree of advancing automation.





HOW WILL ARTIFICIAL INTELLIGENCE IMPACT THE EDUCATION SECTOR?

AI can play a significant role in changing both the face and function of education by using machine learning, deep learning, natural language processing and neural networks techniques.

Work automation is proceeding at full speed, and this new scenario requires people with awareness. And this is the problem: the speed of technological change challenges culture to catch up. It does not always succeed, which is a challenge to the educational system.

The line separating classrooms and individual learning will be overcome by 2030. **MOOCs (massive open online courses)** will interact with intelligent tutors and other AI technologies to enable large-scale personalized education. Digital learning will not replace the classroom, but online tools will help students learn at their own pace using personalized techniques.
AI-enabled education systems will learn the preferences of individuals, but by aggregating these data they will also accelerate the research and development of new tools. Online teaching will democratize education, making learning permanent, enabling people to retrain and increasing access to high quality education in developing countries.

see the video!

Augmented virtual reality will allow students to plunge into historical and imaginary worlds or to explore scientific environments and objects that are hard to find in the real world. Digital reading devices will also become much smarter, able to connect to additional information and translate between languages.

The key points of AI education can be summarized:

see the video!

- AI enabled systems will relieve teachers of some of their responsibilities such as record keeping and grading, thereby allowing them to devote additional time to students.

- AI powered systems and software will drive some of changes in the classrooms through individualized learning applications. AI-powered apps can self learn to provide customized feedback to students about their progress instantly and also to self assess their progress.

- Students and teachers alike are bringing new technologies into the classroom, resulting in creative, dynamic, and innovative approaches to learning. This will lead education and training to be more flexible in order to teach new skills quickly. Online learning and video games simulation will take place more and more. Adaptive learning has already had a huge impact on education across the nation (especially through programs like Khan Academy), and as AI advances in the coming decades adaptive programs like these will likely only improve and expand.

- AI will provide opportunities for global classrooms increasing the interconnectedness and accessibility of classrooms worldwide. Teachers may not always be aware of gaps in their lectures and educational materials that can leave students confused about certain concepts. Artificial intelligence offers a way to solve that problem. MOOC – massive open online courses – help students finding free courses to improve knowledge and skills at any time and in any place.ù

- AI can change how schools find, teach, and support students. Smart data gathering, powered by intelligent computer systems, is already making changes to how colleges interact with prospective and current students. From recruiting to helping students choose the best courses, intelligent computer systems are helping make every part of the college experience more closely tailored to student needs and goals.

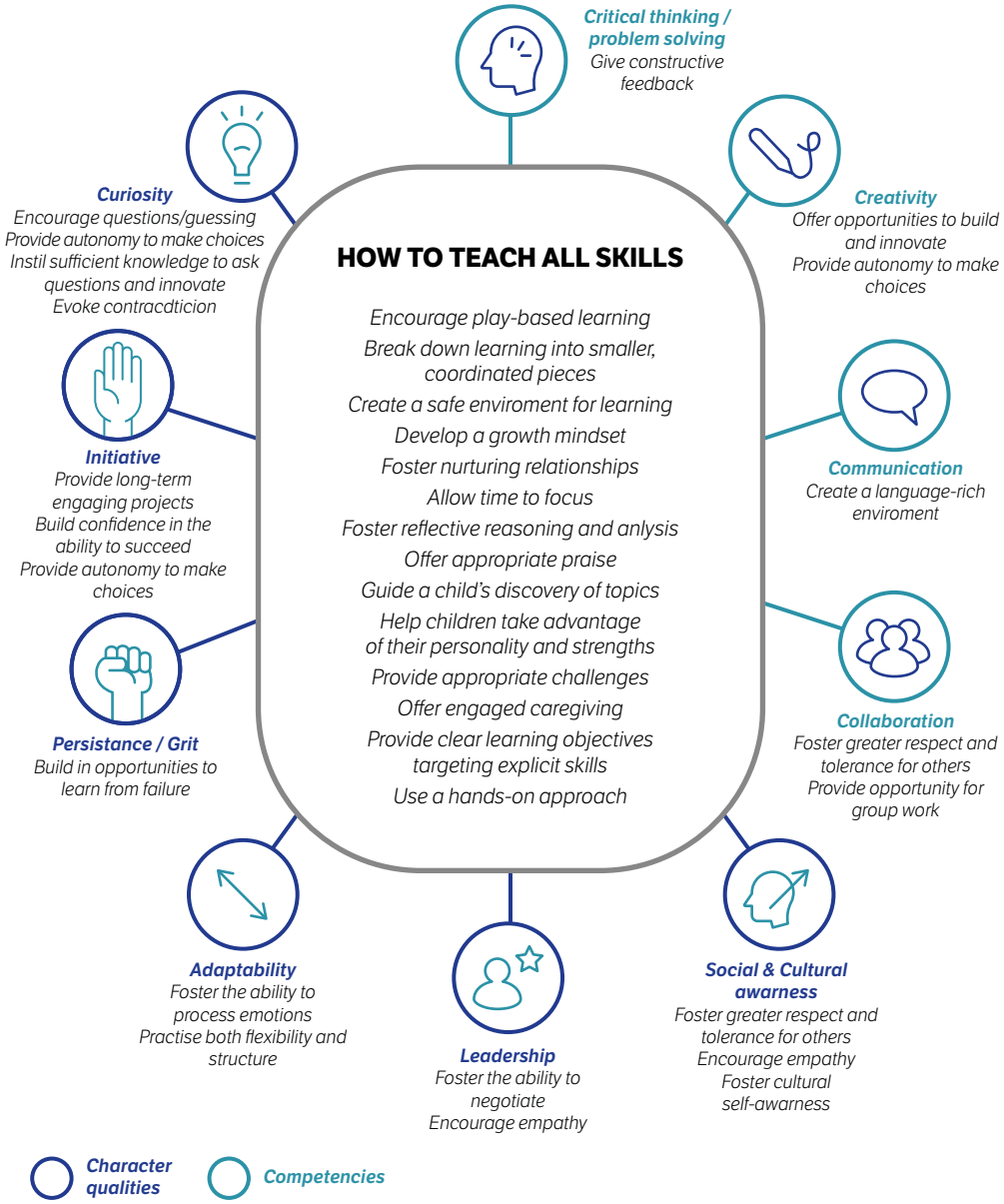
There is a deep “**need to rethink totally education**”, with a focus on areas like collaboration.

If we want to become a more competitive society we must teach to our children **STEAM** skills and not only STEM (*) because sciences and arts must drive innovation together. STEAM SKILLS recognise the importance of incorporating creative thinking and visual learning into their classrooms.

STEAM isn't about spending less time on science, technology, engineering, and math to do art. It's about fostering students' imagination and helping students innovate through hands-on STEM projects. And perhaps most importantly, it's about applying creative thinking and design skills to these STEM projects so that students can imagine a variety of ways to use STEM skills well into adulthood.

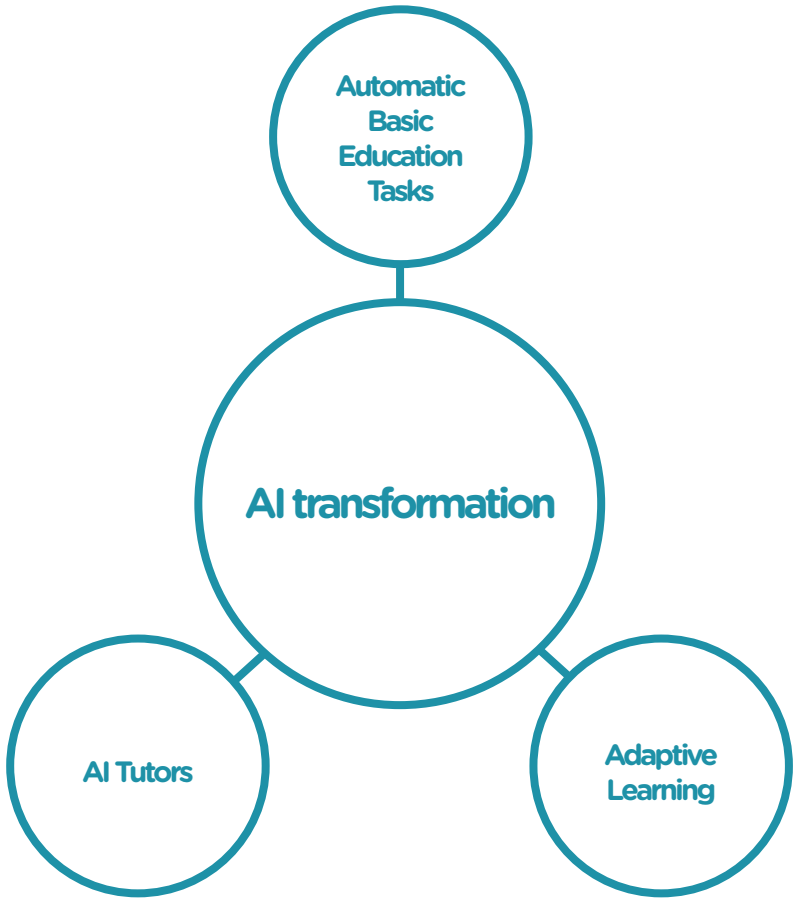
(*) STEAM: science, technology, engineering, arts, maths
STEM: science, technology, engineering, maths

Frost and Sullivan sums up the best ways to teach the most important skills in an automated society and how



(source: Frost and Sullivan)

Which clusters will AI transformation highlight in the Education sector?



AUTOMATIC BASIC EDUCATION TASKS

- In schools, colleges and universities, grading of homework, assignments and tests for large courses can be a hard process for teachers.

- It's always difficult to automate the human grading pattern, but AI enabled software through automated self learning algorithms may help to get close to it. The involvement of AI in grading systems will allow teachers to pay more attention to students' progress. It will enable teachers to discuss the areas of improvement required for each student based upon their grading.

ADAPTIVE LEARNING

- AI will play a vital role in transforming education right from primary to graduate schools through a high level of personalized learning application. Some of the latter are being incorporated in the current education system through AI powered adaptive learning programs, games, and software.

- AI programs will cater to the needs of the student, thereby stressing importance on certain topics, repeating things that students haven't understood, and helping students to work at their own pace.

AI TUTORS

- In the near future, AI tutors will take the front seat, thereby replacing the human tutors up to some extent. AI tutors in the form of bots, robots and other software programs possess natural language processing capability required to interact with students who are being tutored. AI based tutoring programs can help students through basic mathematics, writing, and other subjects.

- These programs can teach students fundamentals and provide additional support to teachers who are better at imparting high level of thinking and creativity to students. Also, AI systems will monitor student progress and keep teachers informed about any issues related to student performance.

WHAT'S NEXT?

While major changes may still be a few decades away, the reality is that **artificial intelligence has the potential to radically change just about everything we take for granted about education**.

Policy makers working with education providers must improve STEAM skills through the school systems, place new emphasis on creativity as well as critical and systems thinking, and foster adaptive and life-long learning. Finally, in companies this will lead to reviewing talent acquisition and talent management policies, as organizations are increasingly becoming complex systems in which men and machines work together. HR transformation will therefore have the important task of leading big companies towards new automation paradigms, bringing new professionalism and new speed into HR processes and services.

see the video!

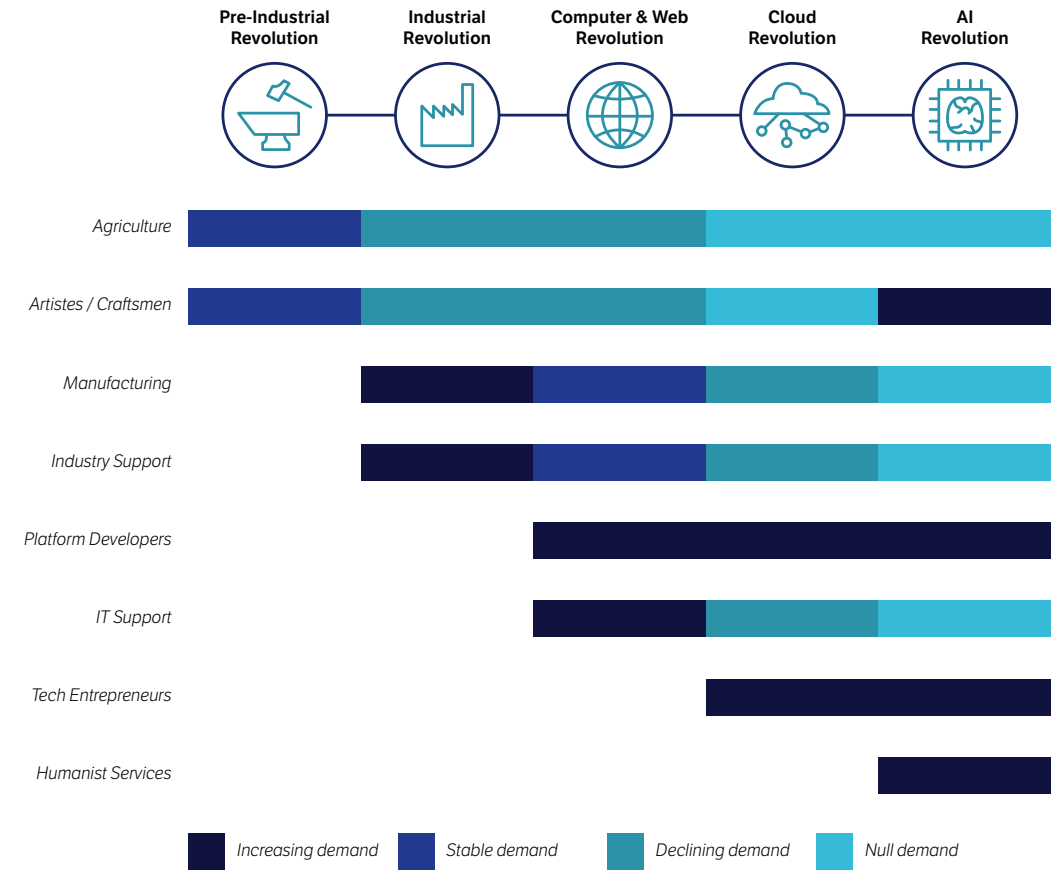
INDUSTRY REVOLUTION

Although the word «Revolution» is grossly overused in industrial contexts, it is an apt description of how AI is impacting production processes in various industrial sectors. This is not mere cost reduction due to increased efficiency because machines do the same jobs as men; we are talking about enabling new solutions, overcoming limits imposed by human biology, and achieving a man-machine cooperation to get the most from a synergistic relationship, as opposed to an antagonistic vision of the two “species” of workers.

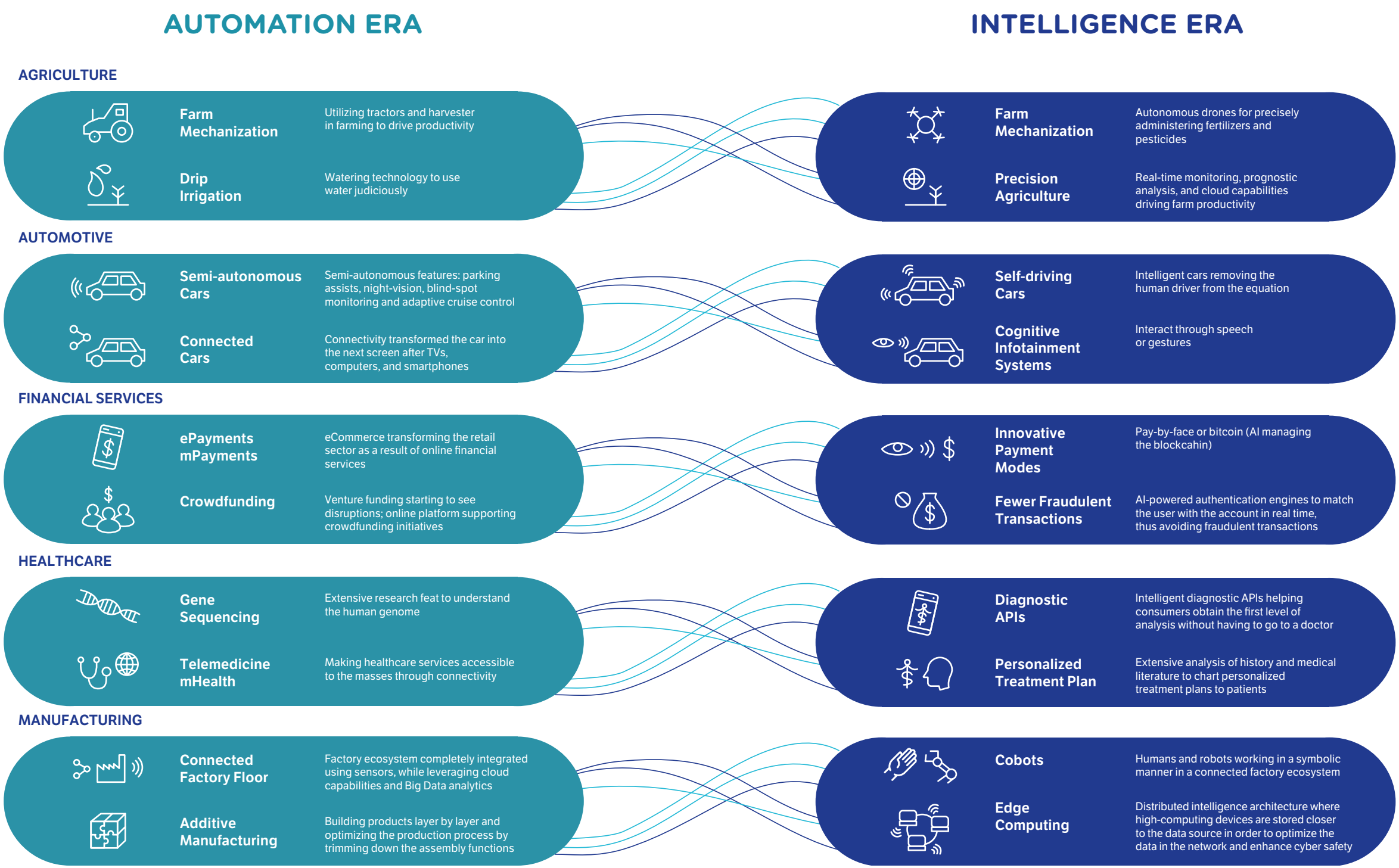
We will now look at concrete examples of how AI is already impacting key economic sectors, which satisfy people’s primary needs such as food and health.

TECHNOLOGICAL REVOLUTIONS VS JOB TRENDS

Future of AI: Job Demand Heat Mapping, Global, 1750-2035



(source: Frost and Sullivan)



(source: Frost and Sullivan)

AGRICULTURE

As in the manufacturing sector, sensors and robots are also heavily modifying production techniques in the agricultural sector.
Self-driving drones can be employed for specific tasks, like spraying pesticides, as well as for surveillance and real time data collection. Ground- moving machines range from autonomous planters to harvesting robots, up to and including driverless tractors equipped with sensors, radar and GPS.
The other side of AI's application in agriculture is represented by intelligent "systems": **intelligent irrigation**, where water distribution is based on multiple parameters monitored in real time and on weather forecasting; **vegetables selection**, that uses technologies like image recognition to identify and discard vegetables affected by diseases; **herd monitoring**, with face recognition systems trained on cows and other mammals, able to monitor body conditions and feeding; **greenhouse climate controllers**, that optimize the usage of light, heating and water using a biological model of the plants growth based on the environment parameters. Thinking ahead to 2050, when the world population is forecast to be around 10 billion, a new "revolution" is needed in the agriculture, and it will be supported by the widespread adoption of Artificial Intelligence.

BLUE RIVER TECHNOLOGY

bluerivert.com

Founded:
2012

Funding stage:
Acquired by Deere & Co.

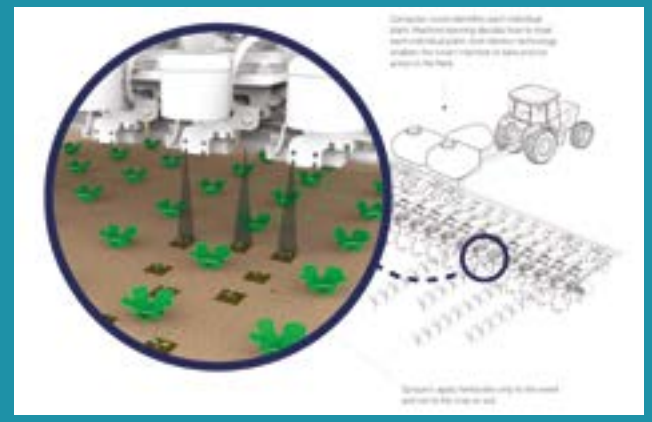
Total Funding:
30.8 Mln$

(source: CBInsights)

see the video!

Blue River

See & Spray applies herbicides only to the weeds and not to the crop or soil. Bringing computer vision and robotics to agriculture visually characterizes each plant to decide which to plant to "keep" to optimize yield and acts precisely to eliminate unwanted ones. The next generation of See & Spray machines leverage deep learning to enable the machines to identify a greater variety of plants & weeds with better accuracy, custom nozzle designs for 1-inch spray resolution, and improved software for faster and more agile crop protection. Blue River is also developing an unmanned aerial system that can survey a field of crops and sense for various plant and environmental characteristics.



For instance, deep Learning is a promise in monitoring and recognising new crop diseases on a worldwide scale; biologists and epidemiologists are working with this technology to create a system that will not only be able to recognize not only the currently known crop diseases - more than two dozen - but also unknown ones, based the image analysis of all the photos uploaded onto the central system by farmers around the globe.

Swarms of autonomous robots will be the basis of Autonomous Farming, essential for obtaining a qualitative and productive leap in mass cultivations on large expanses of flat land, typical of the United States, South America or Australia. One of the pioneers in this field is the Australian **SwarmFarm**, which in 2017 signed a partnership with Bosch Australia to complete the development of its platform of self-driving farming robots.
The automation of agriculture, however, is not just for large landowners and mass monoculture, but something we can find in our vegetable garden and which can foster a new relationship between land and the modern citizen who is increasingly unaware of traditional peasant techniques.
Different types of vegetables grown on the same land, planted, irrigated and looked after by a robot that is controlled through an app on our smartphone or PC: this is **FarmBot**, the first open source farming machine for home use.

see the video!

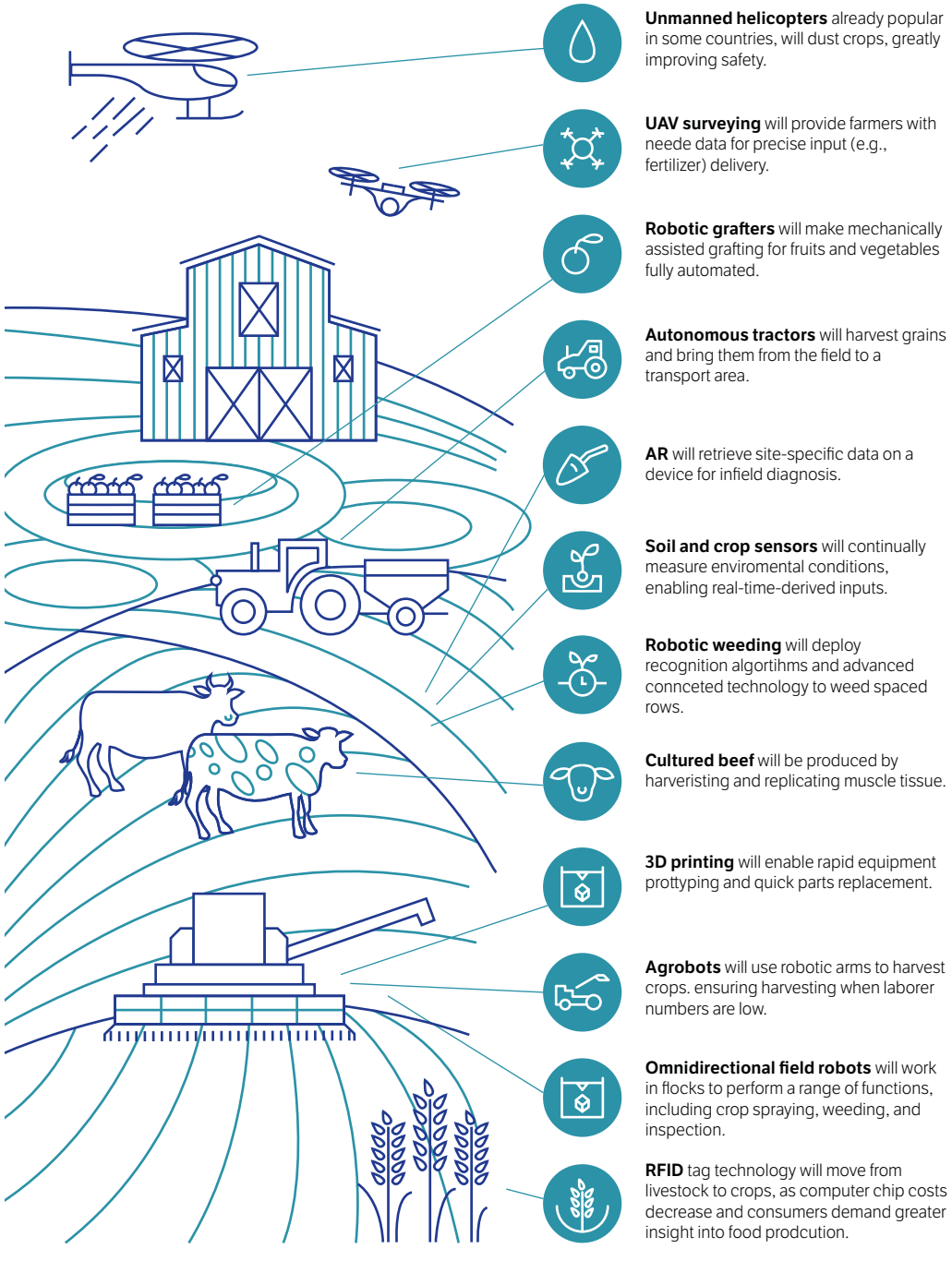
see the video!

INTRODUCTION TO FARMING 4.0

As already mentioned, megatrends such as population growth, desertification of arable land and migrations to megalopolises are putting pressure on agricultural producers, who are required to produce more, better and to consume fewer and fewer resources.
The result is hefty intelligent automation of the entire production sector: we can talk about Farming 4.0 exactly as we do for Industry 4.0.
And in their many variations robots are at the heart of this revolution, which is also taking place in farming.

ROBOTS, SENSORS, BIOTECH, AND 3D PRINTING WILL ENSURE HIGH YELDS IN THE AGRICULTURAL WORKPLACE

Future tecnology in the agricultural secotr will focus on improving yield and supplementing labor.
2015-2025



Unmanned helicopters already popular in some countries, will dust crops, greatly improving safety.

UAV surveying will provide farmers with neede data for precise input (e.g., fertilizer) delivery.

Robotic grafters will make mechanically assisted grafting for fruits and vegetables fully automated.

Autonomous tractors will harvest grains and bring them from the field to a transport area.

AR will retrieve site-specific data on a device for infield diagnosis.

Soil and crop sensors will continually measure enviromental conditions, enabling real-time-derived inputs.

Robotic weeding will deploy recognition algortihms and advanced connceted technology to weed spaced rows.

Cultured beef will be produced by harveristing and replicating muscle tissue.

3D printing will enable rapid equipment prottyping and quick parts replacement.

Agrobots will use robotic arms to harvest crops. ensuring harvesting when laborer numbers are low.

Omnidirectional field robots will work in flocks to perform a range of functions, including crop spraying, weeding, and inspection.

RFID tag technology will move from livestock to crops, as computer chip costs decrease and consumers demand greater insight into food prodcution.

(source: Frost and Sullivan)

AUTOMOTIVE

Autonomous driving cars are no longer a surprise to anyone. They are one of the first and maybe the best known real-world applications of Artificial Intelligence technology.

What is less clear to most of us is that this revolution will totally change not only our way of commuting, but also the landscape of our cities too.
Once a car can autonomously drive, there is no difference in doing it with or without anyone onboard. This means that, after completing the main task - taking people to work or home - the car can go and park itself, carry out maintenance, or refuel. Future parking places will not have infrastructure for humans – elevators, lighting, stairs, restrooms, safety systems – requiring much less space and providing maintenance or recharging services. Car manufactures have to be aware that **the business model itself is going to change**.

They will sell far fewer products, cars and spare parts, turning to a service based model, where users pay on a consumption base. These “rented” vehicles could be used on an exclusive or shared basis, optimizing routes in real-time in connection with other running vehicles and environmental conditions.

While today's car navigation systems are working on being able to know traffic conditions in real time and take alternative routes, predictive software will enable us to forecast the traffic situation half an hour before it happens, making a significant contribution to eliminating traffic jams from our cities. The internal space of future cars will provide a bunch of new services, from entertainment to healthcare and office facilities. The idea of Autonomous Vehicle is replaced by Self-Learning Vehicles: based on a Frost&Sullivan estimate, by 2025 cars will exploit not only M2M technologies, HAD maps and Driving Analytics in total autonomy and on the roads preferred by passengers, they will also intensively use Gesture Recognition, NLP, Biometrics and Driver Analytics to recognize and interact with the people on board and take care of them.

FINANCIAL SERVICES

The financial environment is one of the most impacted by the pervasive use of Artificial Intelligence.
There is an ongoing disruption in the banking industry, which is shifting from the real world to the online one at a continuously increasing speed, and this is true not only for the customer-facing use of the service, but also for the decision-making processes taking place in the back-end.
In the field of **cybersecurity**, Artificial Intelligence is needed to provide machines with the ability to detect unknown attacks and prevent frauds, and to react to them without even the intervention of human supervision: Deep Learning and Predictive Analytics will let computers identify almost in real time new behavioral patterns that can signal a new type of cyberattack.

web link

These technologies are the backbone of **automatic trading** systems; not only extremely fast, they recognise or even anticipate financial market trends and exploit them as soon as they appear.
Automatic Trading is used not only by financial institutions for large transactions on capital markets, but as the basis of **Robo Advisors** they are increasingly being used by individual investors, who rely on them rather than going it alone or trusting financial advisors.
Non-structured data analysis and machine learning techniques also enable new credit risk assessment models. We are thus witnessing the emergence of companies offering alternative credit scoring systems, such as **ZestFinance** which looks at certain variables on a credit report along with how people use smartphones and social networks, or like **Tala**, whose mobile app gathers more than 10,000 discrete data points per customer to build a unique financial identity and deliver instant credit.

HEALTHCARE

Many signals around the world show that the healthcare sector is going to be the leading industrial area where Artificial Intelligence performs a true revolution.
In August 2017 more than 100 startups were surveyed by CBInsights in the AI sector applied to healthcare: from wearable devices to the management of emergency rooms, from genetic research to diagnostic imaging, from the treatment of mental illness to the search for new drugs; all healthcare sectors are undergoing massive transformation.

web link

We've already seen in Chapter 2 how Watson and similar technologies are applied in highly reliable image-based diagnosis. Going a step further, combining diagnosis with mining of medical records and drugs databases, can lead to identifying the best treatment plan for each patient.

Drug discovery is the core focus of **Atomwise**, a startup that is applying Artificial Intelligence to predict which new medicines will work and which ones will be toxic or ineffective, but also to discover new uses for already existing drugs. In just a one-day analysis run, the Atomwise platform was able to find two drugs that could greatly reduce the infectivity of the Ebola virus.

web link

Similarly to what we are getting used to in financial services, a new generation of Digital Assistants, in this case Digital Nurses, is ready to assist patients at their home, giving immediate feedback for care decisions and avoiding the intervention of doctors when not strictly needed.
One already available digital nurse is **Sensely**, which embeds in an integrated platform Augmented Reality, Speech Recognition, Data Analysis, Image Recognition and personal medical devices to provide a comprehensive service at the patient's home.

web link

Artificial Intelligence technologies will also be embedded in portable personal devices and, when the hardware has been "squeezed" enough, we'll find them in devices like smartphones and similar.
One example is **Butterfly Network**, a startup that is working on conceptually disassembling the ultrasound machine and reassembling it in a single silicon chip. This device will provide access to medical imaging in those large areas of the world that cannot afford the cost and training to use this technology to diagnose and monitor: billions of people that are still using the stethoscope two centuries since its invention!

MANUFACTURING

The rapid deployment of advanced Artificial Intelligence technologies in the manufacturing processes is one of the main reasons for the ongoing reshoring process.
The cost of manual labor is no longer a critical production factor, whereas flexibility and reaction speed are.
The increasing demand of highly customized products, together with shorter and shorter times from the design phase to the delivery one, is incompatible with a model based on high production volumes and long transportation times. The recent default of the international shipping giant Hanjin is another indicator of a trend that has clearly reversed its direction.
In this scenario, AI is a key success factor because it enables real-time problem detection and prevention, production rescheduling and replanning, make-to-order management and delivery times that are days or even hours.
Moreover all these technologies are available in a "per-service model", with an operational cost that is just a fraction of the cost of a traditional ERP, opening up this technology to small and medium enterprises too.

web link

Why should a dealer keep a warehouse full of spare parts? Image Recognition can analyze buyers' needs while staying at home to design a replacement part that fits the long used car or appliance perfectly.

AI based order management looks up which suppliers have the raw material needed at the best cost at that exact moment, sends a drone to pick up the supply, delivers it to the dealer's 3D printer, and then flies to the customer's address with the final goods.

In October 2016, FANUC and NVIDIA announced a partnership to enable next generation **robots with the ability to teach themselves**.
FANUC is the world leader of industrial robots; the capabilities provided by the NVIDIA's AI Deep Learning platform we've already seen in Chapter 2 will enable FANUC to design and produce robots that will have "*the ability to teach themselves to do tasks faster and more efficiently. By learning together, what used to take a single robot 8 hours can now be done by eight robots in an hour [...] GPU deep learning ignited this new wave of computing where software learns and machines reason. One of the most exciting creations will be intelligent robots that can understand their environment and interact with people.*"

web link

The coexistence of robots and humans in the same working environment is going to be explored later on in this chapter; from a manufacturing perspective, it is important to note that it is considered so strategic that **ISO has published a technical guidance** to deploy a safe robotic system side-by-side with human workers.

web link

ISO/TS 15066 is defined to be "*a game changer for the industry [...] It will reassure and guide both robot system developers and users, encouraging investment, development and application of this technology.*"

HUMAN AND ROBOTS WORKING TOGETHER ON THE FACTORY FLOOR: FACTORY COWORKERS

COBOTS ARE ROBOTS THAT ARE DESIGNED TO OPERATE COLLABORATIVELY WITH HUMANS

Traditional automation in the manufacturing industry clearly separates tasks and spaces between human beings and industrial robots.
We are used to seeing large industrial plants, with machines that work in total autonomy, operated and controlled remotely.
Cobots reduce this division significantly.

This is a new generation of industrial robots that can move and act in limited spaces even when in the presence of people, whom they detect through special sensors which control their movements and the strength applied.
These robots are also designed to be easily re-located in production spaces, or they can even move independently within it.
The logic with which cobots are designed and implemented implies seeing them as helpers who work side by side with human operators, as if they were apprentices or, after their 'training', as expert workers who work alongside junior colleagues.

see the video!

The trend is still in its initial stages.

In 2015, less than 5% of all installed industrial robots sold were cobots. However, the interest in this new generation of workers is very high, both in large-scale industry, (predominantly the automotive sector) and by SMEs that see the possibility of accessing more flexible, low-cost systems that do not require massive renovation of production plants.

It is a sort of "democratization" of access to industrial automation, previously reserved only for large industries that had the necessary capital to build new production facilities.

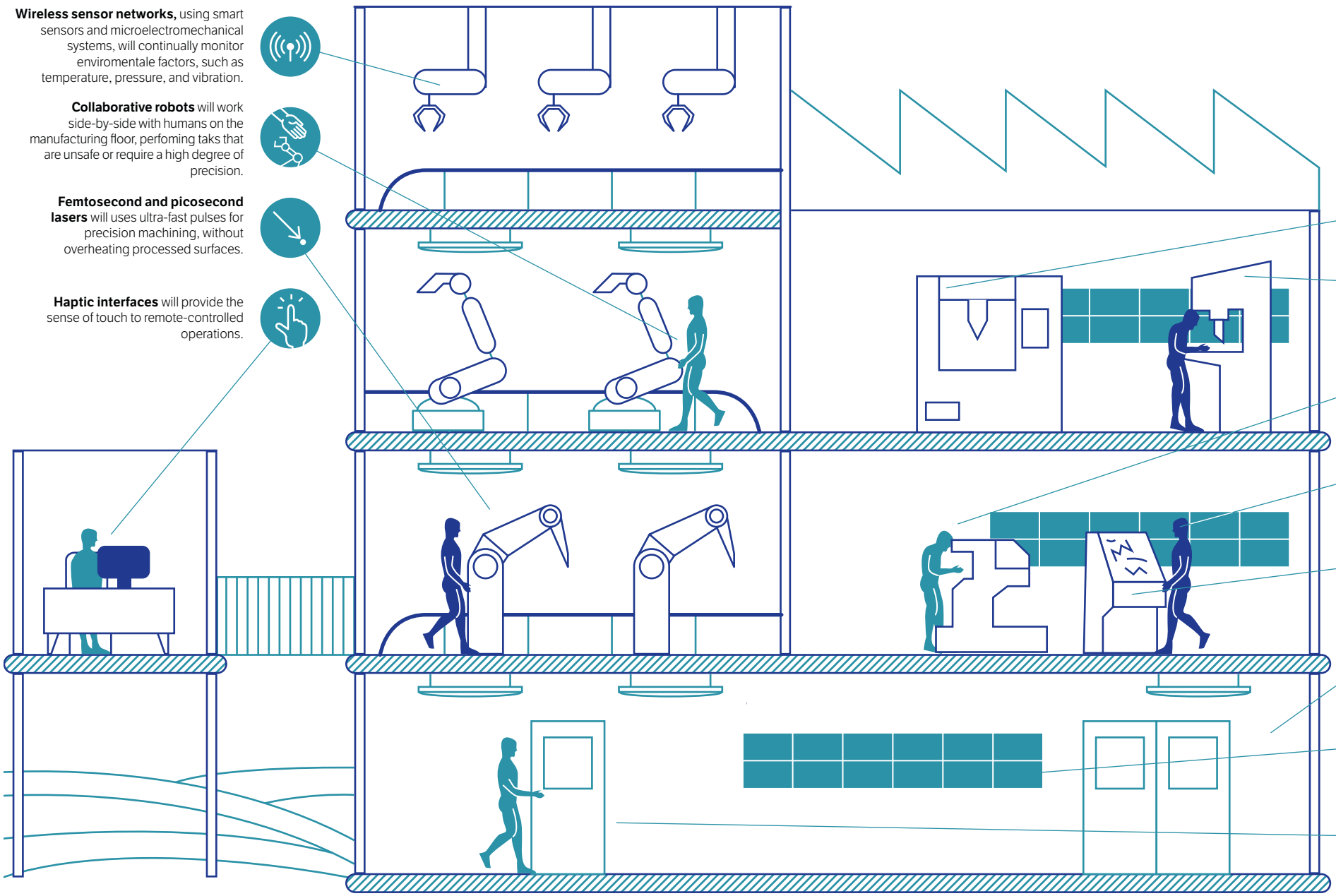
EMERGING INDUSTRIAL TECHNOLOGIES, GLOBAL, 2015-2025

Wireless sensor networks, using smart sensors and microelectromechanical systems, will continually monitor enviromentale factors, such as temperature, pressure, and vibration.

Collaborative robots will work side-by-side with humans on the manufacturing floor, perfoming taks that are unsafe or require a high degree of precision.

Femtosecond and picosecond lasers will uses ultra-fast pulses for precision machining, without overheating processed surfaces.

Haptic interfaces will provide the sense of touch to remote-controlled operations.



3D will allow for quick, cost-efficient, small-batch manufacturing.

Automated safety systems will continually monitor the factory floor, altering workers of unsafe conditions in real time.

AR delivered through head-mounted displays will provide real-time information about the factory floor.

VR will help train workers by simulating events.

Machine vision will allow automated machines and robots to analyze images for task perfomance or machine

Intelligent RFID beacons will allow the seamless tracking of products throughout their lifecycles.

Manufacturing AR systems will project AR interfaces throughout the factory, collecting data and decreasing errors.

AVGs will autonomously transport materials on factory grounds during the production process.

(source: Frost and Sullivan)

100 Mln$

v

v

3 Bln$

Cobot market could grow from just over 100 Mln$ last year to $3 bln by 2020

(source: Barclays Capital)

Rethink Robotics is an example of a company that has joined the American market in collaborative robots.
First with Baxter, then with Sawyer, it set up two automation systems working side by side with humans, interacting with them on producing the same parts.
But that's not all.
This type of robot is so flexible that experiments are underway to make it interact with humans in completely different contexts from those it was designed for.
At the University of Halmstad, for example, Baxter is being experimented in social areas, caring for the elderly and conducting simple household activities, such as preparing food or ironing clothes.

see the video!

85%

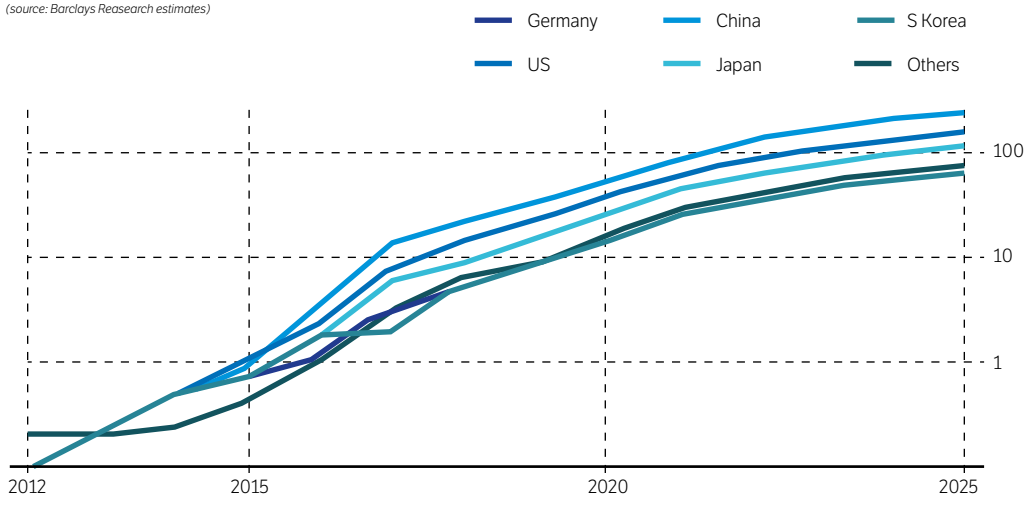
Robot-human teams were about 85 per cent more productive than either alone

A further push towards a "mixed" work environment also comes from large car manufacturers who, after years of pushing automation and maximizing efficiency, are again including the human component in some production lines. This is the case, for example, of **Mercedes Benz**, which has moved in this direction because customers are asking for more product customizations, and this type of production requires a very high mental and operational flexibility, which can only be achieved by blending man and machine.

GLOBAL CO-BOT HIGH-GROWTH PHASE WILL LAST UNTIL AT LEAST 2025

Gross annual additions ('000, log scale)

(source: Barclays Reasearch estimates)



Scientists at the MIT have proved the veracity of Mercedes-Benz's experience. Working with another German carmaker, **BMW**, researchers found that robot-human teams were about 85 per cent more productive than either alone.

Another example in this direction is Ford, that has put humans side-by-side with robots in its Cologne factory to validate its approach. For example, Ford's new robots are used to fit shock absorbers, : rather than forcing an assembly line worker to manipulate a heavy shock absorber above their head, workers can use the robots to lift and position the part, before manually refining the operation. Robots have been programmed to be conservative when it comes to human contact, so if an arm or finger gets in the way, sensors will detect the obstruction and the machine stops moving to protect the worker.

(source: Barclays Research)

SO WHAT'S THE FUTURE FOR ROBOTS?

Babies learn how to identify and pick up objects in their world through trial and error. .

The same approach is being tried with robots to see if the same "training" patterns used for humans can be applied. Using the aforementioned robot Baxter, which is particularly flexible and easy to program, researchers at the computer science department at Brown University are experimenting how it behaves when it has to recognize and manage simple objects placed on a table which are initially completely new for Baxter.

web link

This isn't a factory environment where the robot has been programmed to do a very specific task.
Baxter doesn't know anything about batteries or kazoos; all it has is information from its cameras, and nothing to compare it with, at least at the beginning of the test.

After more than a year of training, Baxter can regulate the strength to be applied in the manipulation of objects with extreme precision, carrying out very simple activities for a human but extremely complex for a robot, such as detaching the petals from a flower without damaging either the plant or the petal.

see the video!

What the experiments show is that even while learning robots have a similar behavior to humans.
Time, attempts and mistakes are necessary, as well as many examples of different types of the same object before the robot can understand that a new battery is a "battery" type object, ie before it can abstract from single examples the higher concept of category.

LIKE HUMANS, MACHINES NEED PLENTY OF DATA TO LEARN

At the very end of the report we can say that having robots working together with people should enable them to think like humans instead of machines.
It will also free up time and energy for humans to engage in more creative and intellectually stimulating activities, possibly assisted by AI.

But ethical issues arising from human and AI co-working environments is a real concern. Although AI-based systems are becoming smarter than humans in many fields, these systems are far from perfect and are unlikely ever to be so considering the unpredictable learning mechanisms that humans have built inside them.
That said, it is likely to be the social and cultural changes that will be the real challenge, rather than the technical challenge of AI itself. So while robots taking over our jobs can be a good thing, only time will tell if we are ready to accept them as our co-workers.

INTERVIEW WITH STEFANO FUSI

Stefano Fusi

Associate Professor at Center for Theoretical Neuroscience, Columbia University
– New York (USA)

Q What will strategic skills in the future be? Soft and hard skills.

A Machine learning is becoming incredibly popular at Columbia and at the other Ivy League Universities that I know (at Columbia the number of students who attend machine learning classes has increased almost by a factor of ten in the last three-four years). This increased interest reflects the recent revolution of deep learning which started in 2012 with Hinton's work (see e.g. https://www.cs.toronto.edu/~hinton/absps/NatureDeepReview.pdf for a review). Being able to use these new techniques is certainly an important skill now, though training a neural network is relatively simple and it does not require an academic formation. I'm not sure that in the future it will be a strategic skill.

Q By 2025 which jobs will emerge and which will disappear in Italy and worlwide?

A Self-driving cars are a reality, and it is possible that by 2025 many people employed in the transportation industry will be replaced by machines. The only limitation is not technological but it comes from the legislation, which is under development or completely absent. As for the other jobs there are several studies that show how machine learning will impact the job market. I am not an expert but there are several reports that have been published in the Economist and other specialized magazines.

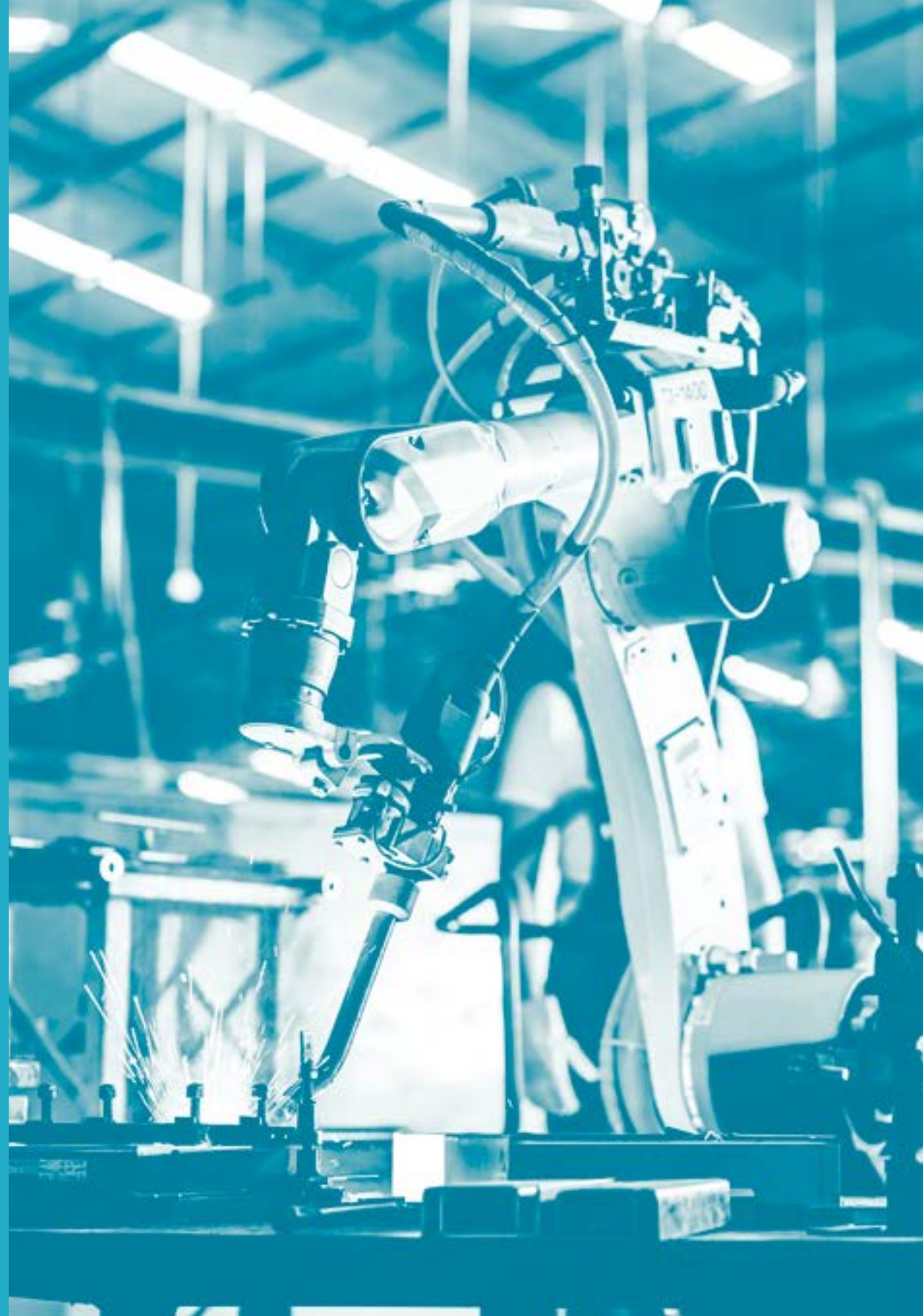
Q How will AI impact the workplace and the way new generations work?

A There is no job that cannot be done by machines. It is only a matter of time before machines will be able to perform any human activity (but for some activities it might take decades). At this moment it is difficult to predict how AI will impact the workplace and it is even unclear whether the new generations will have to work at all.

Q How will AI change recruitment?

A AI can even be easily employed to recruit more efficiently than humans, for any job, provided that there is enough data to train the neural networks that will be in charge of evaluating candidates. Data should include all possible information on the profile of previous candidates and the performance of those who have been hired. For some jobs this data should already be available, for others it will take time to build the databases. But again, it is only a matter of time.

5
ARTIFICIAL INTELLIGENCE IN ITALY



INTRODUCTION

Artificial Intelligence, understood as the capability to build machines acting as humans or expressing human abilities, has caught the imagination of many people of all periods. Throughout Italian history, we can find evidence left by scholars, philosophers, artists and scientists of the many attempts to make progress in this quest.

see the video!

Leonardo Da Vinci with his programmable knight robot ("Automa Cavaliere"), his self-propelled cart ("Carro Automotore"), his mechanical lion and more, is perhaps the most known and distinguished example of a scientist able to imagine, prototype and maybe build an actual machine acting as a human. But that was not a unique example. Clock towers in many Italian cities equipped with magnificent automata clocks created in the late Middle Ages by anonymous artists, perhaps provide the most widespread and visible examples of a journey that started a long time ago and has not finished yet.

Today's examples of Italian accomplishments in Artificial Intelligence are certainly less enchanting and have names – or rather code names – that are much less popular and well known, such as ARGO, iCub and MARCONI. Nevertheless they represent the efforts of hundreds of scientists and creatives from all over the globe, moved by the very same purpose as their ancient colleagues.

As we have seen elsewhere in this work, Artificial Intelligence as we know it builds on the advancements we had in the last century in electronics, computer science, information theory, neuroscience and many more disciplines.

'80s

In the '80s Italian research was focusing on automatic control computing while studies on AI were still considered unclear and even ephemeral by many

While the Dartmouth conference of 1956 can easily be identified as the birth place of Artificial Intelligence as a scientific discipline, a corresponding event in the Italian context is certainly more difficult to find.

Early studies on AI were considered unclear and even ephemeral by many members of the Italian research community for many years after the Dartmouth conference, at least until the early '80s.

At that time the Italian Industrial Automation industry was delivering its full potential through the widespread adoption of industrial robots and numeric control machinery. And yet the industry was at the beginning of another revolution: the adoption of distributed control systems and the introduction of industrial computers as part of the automation process. During the same period, computer science was getting a serious boost thanks to the standardization and consolidation of programming languages, the spread of general purpose operating systems, personal computers, communication networks and then the internet.

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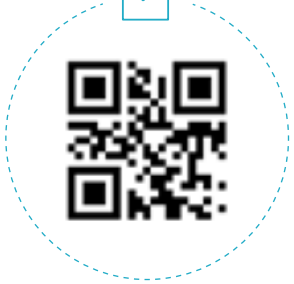

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The very few AI enthusiasts of the time in Italy were mainly conducting their primary research activities within the cognate area of automation computing, while actively participating in AI advances at the international level.

A pivotal date for the Italian Artificial Intelligence community is perhaps the summer of 1987 when, thanks to a group of Italian AI advocates, the tenth edition of the International Joint Conference on Artificial Intelligence was held in Milan. Just after a few months after the conference, the Italian Association on Artificial Intelligence (IA*AI) was founded. From then onwards, the Italian research community could count on an organization fully devoted to supporting their studies and research on Artificial Intelligence.

After Pisa – unanimously considered the birthplace and focal point for AI research in Italy thanks to its Universities and CNR (National Research Council) – and the Politecnico in Milan – whose research was primarily focused on robotics applications – other strong and cohesive groups emerged in the universities and research centers in Rome and Turin and at the IRST (Istituto di Ricerca Scientifica e Tecnologica) in Trento.
From there, a number of research institutions followed up and created research groups focused on AI all over Italy, and many Universities started to introduce courses and degrees explicitly targeting AI.

Research centers of some of the top Italian companies, such as CSELT (now TILab), CRF (Fiat Research Center), Alenia, and Eni soon created dedicated research groups on AI and started a close collaboration with major research institutions. With some inertia, mainly due to initial skepticism on the ability to transfer research results into real world applications, a number of other industry players eventually understood the huge potential of AI in automation and in a wide range of other industrial applications.

An example of how far Italian research on AI technologies could go is perhaps provided by the studies and experiments on autonomous vehicles carried out at the University of Parma.
In unlikely times – way before Google's self-driving car took over all media coverage in the field, and actually way before Google itself existed at all – back in 1989, the University of Parma started to build and test the first autonomous vehicles on the road.

2010

In 2010 two driverless Piaggio Porters covered 15.000 km from Parma to Shangai.

In 1998 the ARGO project, in collaboration with its spin-off VisLab, equipped a Lancia Thema with computer vision systems, a Linux computer and a number of other sensors and safety devices to drive, autonomously, the 2,000 km Millemiglia competition across Italian country roads.

A few years later, in 2005, the same team applied the latest research advances and technologies to a huge 13-ton military truck and completed a 132-mile off-road desert course during the 2005 DARPA Grand Challenge.

In 2010, two Electric Piaggio Porters were able to cover the 15,000 km separating Parma from the 2010 World Expo European Pavillion in Shanghai.

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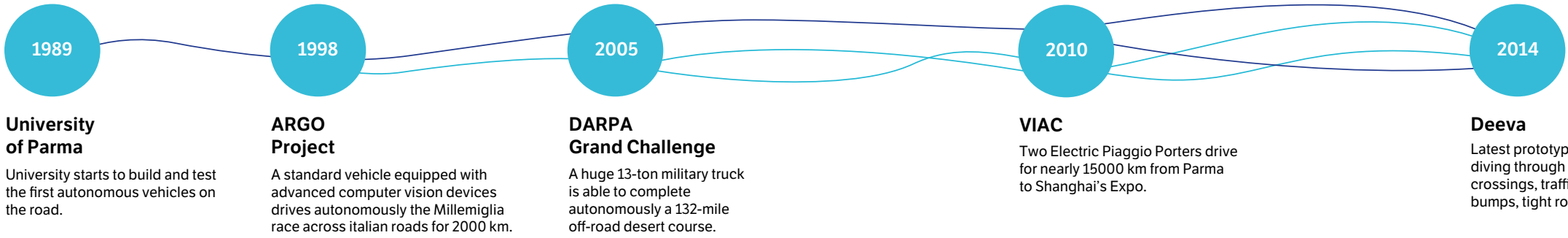
SEMINAL ITALIAN STUDIES AND EXPERIMENTS ON AUTONOMOUS VEHICLES



Deeva is the latest driverless prototype able to drive in urban roads and deal with things such as traffic lights, pedestrian crossings, roundabouts and artificial bumps with no human intervention.

Despite such remarkable successes, AI research in Italy is currently still primarily driven by public research bodies, while research and development within the private sector – in particular within small and medium sized enterprises – still suffers from a sort of disconnect from universities and research centers.

More recently, EU-funded programs have played a key role in coordinating public research efforts and cross pollination between research and technological applications.

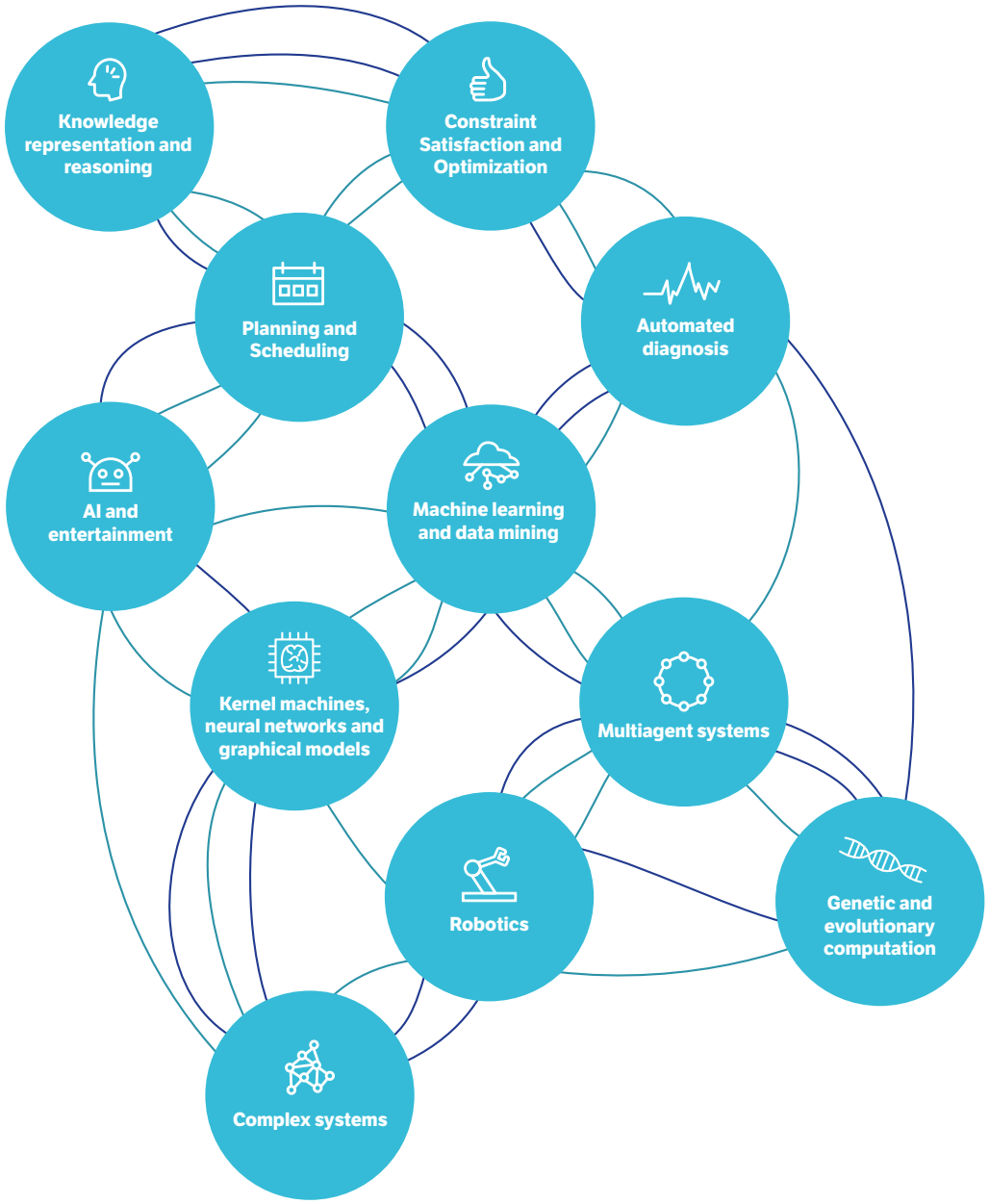
As part of the Horizon 2020 initiative, a number of Italian research institutions and companies are involved in a wide range of projects targeting key topics on AI. Projects where Italian companies are involved may range from neuroscience, computing architectures, context awareness, learning, evolution, creativity, social intelligence, human-computer interaction, robotics, and many more.

web link

Perhaps one of the most ambitious projects in the field – and where multiple Italian institutions are involved – is the Human Brain Project. This is a heavyweight, 10-year initiative involving €1 billion and more that 120 institutions across 19 countries, with the objective of building a technological infrastructure to advance the understanding and simulation of the human brain's core mechanisms.

In the rest of this chapter an incomplete list of some of the key research fields and applications where Italian research institutions and companies are focusing most of their efforts.

AI RESEARCH IN ITALY:



ITALY'S UNIQUE MIX OF PROMINENT RESEARCH INSTITUTIONS AND LIVELY FOUNDATION OF SMALL AND MEDIUM SIZED COMPANIES HAS PROVEN TO BE AT THE FOREFRONT OF ARTIFICIAL INTELLIGENCE RESEARCH AND TECHNOLOGIES GLOBALLY

NATURAL LANGUAGE PROCESSING (NLP)

'50s

Computational Linguistic in Italy dates back to the late '50s with Roberto Busa studies on Index Thomisticus"

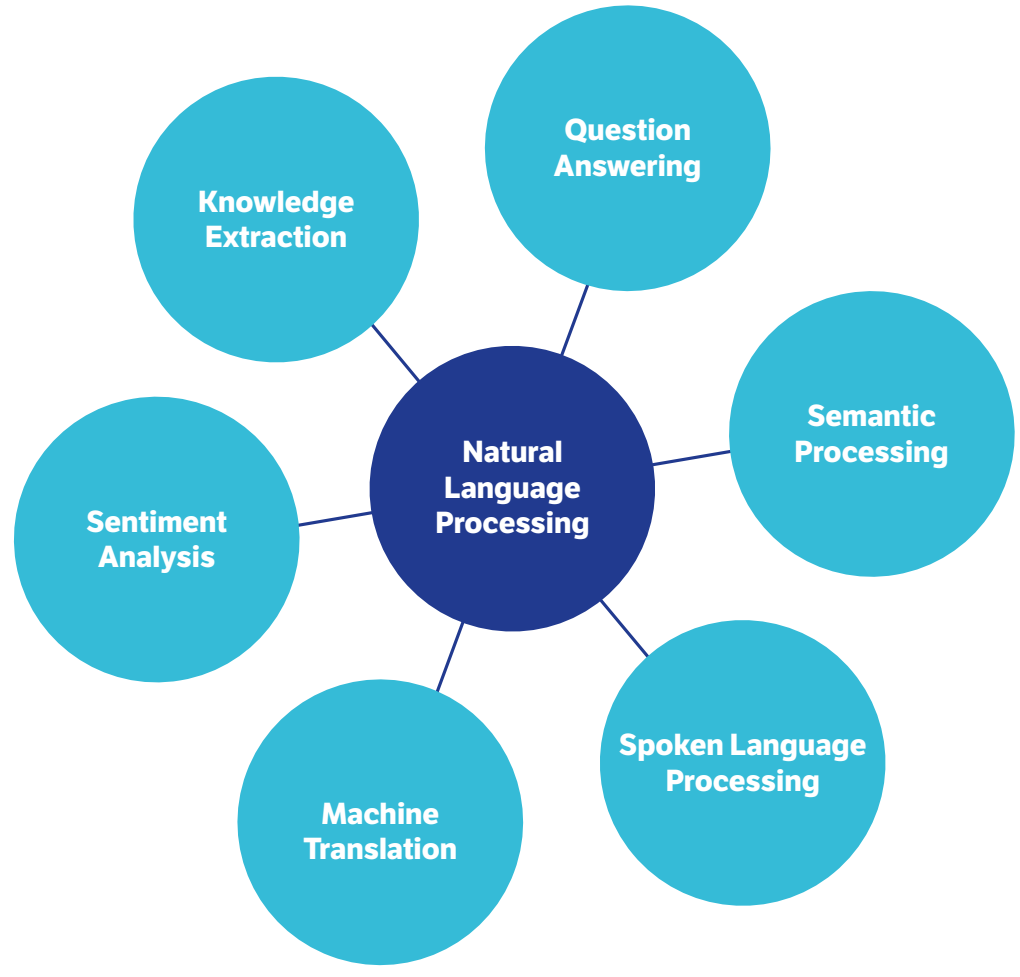
web link

Studies and first applications on Computational Linguistic and Natural Language Processing in Italy date back to the late '50s.

Seminal and pioneering works were conducted by Roberto Busa on the Index Thomisticus, at a time when punch cards were being used as the sole means to program computers.

In the following years one of his most active collaborators, Antonio Zampolli, helped to bring Italian research on language processing to the top levels internationally with the creation in the '80s of the Computational Linguistic Institute within the National Research Council (ILC-CNR), for a long time the only institute solely devoted to research in the field of computational linguistics.
Since then, research projects and related applications in the field of NLP have flourished to include other fields of Cognitive Computing such as Question Answering, Semantic Processing, Knowledge Extraction, Spoken Language Processing, and Machine Translation.

Pisa, Rome, Turin and Trento have emerged over the years as reference points for Natural Language Processing research at the international level.



Although significantly different to one another in the way their research activity has evolved and is being conducted, and in terms of the productive contexts in which they operate, they each stand out as centers of innovation. Over the years they have been able to create strong ties among top-level research at their local universities, with other local research institutions (such as National Research Council and Fondazione Bruno Kessler) and with local businesses.

Natural Language Processing has been a technological field where a number of Italian companies have been working in the last decades.

web link

Set up in 1989 in Modena, **Expert Systems** is perhaps the most notable example of an Italian company that has always worked on the convergence of linguistics and technology and is now expanding worldwide. Their semantic analysis platforms leverage artificial intelligence algorithms and are able to identify the expressive structures of texts that, when recognized, can infer and extract important information from large amounts of texts.

NLP technologies attract a lot of interest among the industry because of the wide range of applications they can enable. **Tooso** provides an example of a cloud based service for NLP processing intended to provide an enhanced discovery and search experience to visitors of ecommerce sites, which can be applied to a number of contexts.

tooso.ai

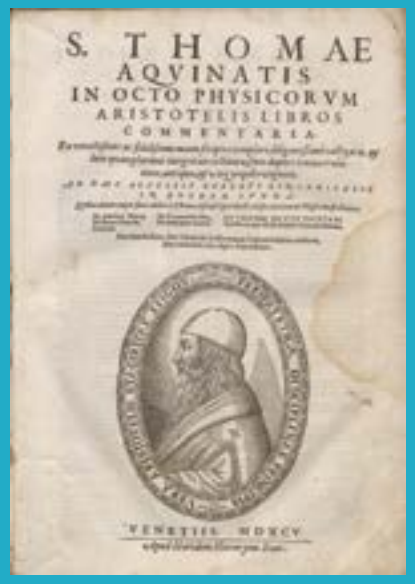
Founded:
2015

(source: Crunchbase)

see the video!

Tooso

Tooso is a proprietary AI search technology. It powers any type of eShops with advanced onsite search and behavioural analytics. It is offered as a service through APIs and plug&play integration for the most widespread platforms.
Tooso approaches search from an AI viewpoint: it handles typos and synonyms and it can address complex queries (product+attributes+price) in one click. Crucially, Tooso understands users' intentions, learning from their history and doesn't require ad hoc setting.



One of the first AI applications studied – and traditionally believed to be an "irresolvable" problem – is machine translation.

Most of the many automated translation tools available today typically make use of complex and heavyweight statistical algorithms applied to large databases of pre-translated sentences. More recently we are starting to see translation engines using techniques which are more typical of AI applications.

One of them is **Ludwig**, from a young Italian startup, which is contributing to raising the bar in AI-assisted translations by using advanced knowledge extraction techniques and natural language processing algorithms.

ludwig
Find your sentence

ludwig.guru

Founded:
2014

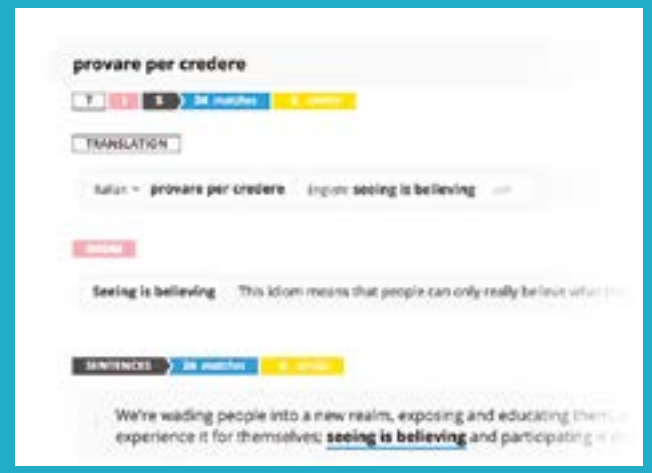
Funding stage:
seed

Total Funding:
0.03Mln$

(source: Crunchbase)

Ludwig

Ludwig is a smart translator and linguistic search engine which helps you find the perfect word or sentence to express your ideas. By leveraging Artificial Intelligence techniques emulating the capability of humans to learn by imitation, Ludwig developed a tool that advises people on how to put down their ideas in words with inspiration and confidence. Ludwig built a database with millions of correct English sentences and a sophisticated language processing algorithm able to compare any English phrase entered by the user with sentences expressing the same ideas and that are correct and in context. Features include: search, dictionary, translation in context, completion of incomplete sentences, suggestion for idiom expressions, etc.



COMPUTER VISION AND PATTERN RECOGNITION

Research on computer vision in Italy revolves around their national association Gruppo Italiano di Ricerca in Pattern Recognition (GIRPR), set up in 1983 with the goal to support the scientific community in the disciplines related to pattern recognition, machine learning, computer vision and image processing.

Italian research covers a wide range of fields from image processing, video and 3D processing, graphical models to deep learning, analysis of texture, color, movement, etc.

These research topics find applications in a number of applications including the analysis of documents, medical imaging, biometry, cultural heritage, automotive and vision in robotics, human-machine interaction, virtual and augmented reality, just to mention some examples. Genoa, with both its university and Istituto Italiano di Tecnologia (IIT), has pioneered research on vision, pattern recognition and machine learning.

The University of Milan and Bicocca are very active with a number of research groups working on computer vision and Artificial Intelligence.

In Parma, the impressive achievements in computer vision studies and the pioneering work of Prof. Alberto Broggi led to the aforementioned advances and successes in autonomous driving and, in **VisLab**, to perhaps one of the best examples of technology transfer in this field.

vislab.it

Founded:
2008

Funding stage:
acquired by Ambarella

(source: CBInsights)

see the video!

VisLab

VisLab company is involved in basic and applied research developing machine vision algorithms and intelligent systems for the automotive field. It undertakes research in many disciplines like machine vision, pattern recognition, low-level image processing, machine learning, artificial intelligence, robotics, and real-time systems, but the main focus of the laboratory is to apply basic and advanced research to intelligent transportation systems and intelligent vehicles.

In Rome there are several research groups focusing on machine vision and learning, computer-aided diagnosis and on the analysis of human behavior.

Going beyond computer vision and image processing, in the broader fields of sounds, gestures, contextual and behavioral patterns recognition, the startup **Snapback** well represents the level of sophistication that can be reached when applying AI technologies to Human-Machine Interfaces.

SNAPBACK

snapback.io

Founded:
2013

Funding stage:
Seed

Total Funding:
0.68 Mln$

(source: Crunchbase)

see the video!

Snapback

Snapback is focused on developing new, intuitive and revolutionary ways to interact with smart devices.
It provides a natural and powerful user experience by reinterpreting the available technology as a user-centered environment. It explores new ways of communicating with our devices by enforcing simple sound, voice, and air gestures and minimising touch and sight interactions.
Snapback is a unique blend of sensor fusion, artificial intelligence and machine learning software that empowers smart devices into revolutionary interfaces of its own.
It clusters an extensive use of big data coming from humans, machines and contexts. It doesn't require any additional hardware, saves the battery consumption up to 30% and it is already available on smartphones and wearable technology (bands, clothes and so on).

MACHINE LEARNING AND DEEP LEARNING

The ability to allow computers to learn without being programmed is another field in which Italian AI research has traditionally focused.
Back in the '80s a core group made up of the Universities of Turin and Bari, Ugo Bordoni Foundation and private organizations such as IBM Italia and TILab were already working very closely on the subject. Around them, many other universities and research organizations started joining the research on the subject in the following years. Today they form a fairly strong and tight research network.

THE AVAILABILITY OF BIG DATA, COMPUTING POWER, AND ADVANCES IN THE THEORY OF LEARNING ARE CONTRIBUTING TO A RENAISSANCE OF MACHINE LEARNING.

Machine learning is presently seeing a renaissance owing to the availability of large quantities of data, of new parallel microprocessors to deal with these data (GPUs), and to advances in the algorithms and theory of learning.

Computational learning theories, information classifier systems, logic programming, knowledge extraction and automated data modelling are just some of the Machine Learning areas that Italian research has focused on in recent years.
On the applications side, almost all domains have been explored and impacted by machine learning, with applications ranging from eCommerce to education, from cultural heritage to e-government, from enterprise ICT systems to healthcare, just to mention a few examples.

The young startup **Axyon** has created a sophisticated platform implementing advanced deep learning techniques and knowledge

AXYON.AI

axyon.ai

Founded:
2016

(source: CBInsights)

see the video!

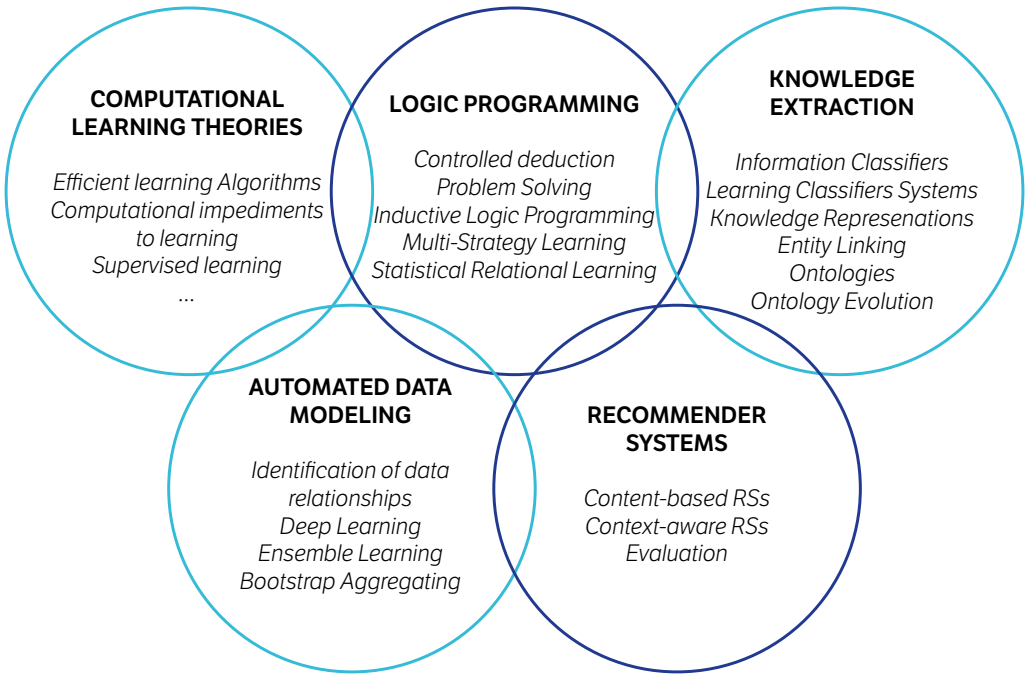
Axyon

Axyon AI offers Deep Learning FinTech solutions that help corporate clients to optimise business processes, reduce risks, and increase revenues with enhanced and highly-performing predictive models.
The Axyon Platform is a machine-learning environment that provides faster and easier AI models development for data-driven businesses. A user-friendly web interface allows testing several models and parameters configurations at once and automatically distributes learning jobs across CPUs and GPUs. For each project, a specific module can be easily written to connect to databases, automatize re-training and deliver real-time predictions once the model and its parameters have been selected.

extraction algorithms meant to be used in multiple contexts from finance to smart factories, from insurance to eCommerce.

Unfraud, another Italian startup, is applying deep learning and a blend of other advanced techniques to detect suspect behaviors and prevent fraudulent activities.

SOME OF THE MACHINE LEARNING AREAS ITALIAN RESEARCH HAS BEEN FOCUSING ON IN THE LATEST YEARS



UNFRAUD
WE PROTECT YOUR BUSINESS

unfraud.com/en

Founded:
2014

Funding stage:
seed

Total Funding:
0.11 Mln$

(source: CBInsights)

Unfraud

The Unfraud Security Platform is designed to prevent and detect frauds in real time, before they even occur, and help avoid losses and improve customers' trust. For each event it collects up to thousands of data points, with no fixed record structure and uses Deep Learning techniques to adapts to new fraud patterns as soon as they arise. Unfraud is offering a new methodology using Artificial Intelligence & Big Data enabling companies to analyze, identify and get rid of patterns of fraudulent activity hidden within their enterprise data.

see the video!

BIG DATA AND PREDICTIVE ANALYTICS

web link

Big Data is certainly one of the top priorities in the agenda of most Italian companies. As confirmed by the Big Data Analytics and Business Intelligence Observatory of Politecnico di Milano, the Big Data market keeps growing at an impressive pace (+22% in 2017), and over 43% of interviewed CIOs have set Big Data as a the topmost investment priority for 2018.

As confirmed by the 2016 Report of MIUR's Big Data working group, research programs and teaching courses on Big Data are gradually spreading from computer science departments labs to most of the top-ranked business school programs, which is a sign that in Italy as elsewhere Big Data and Predictive Analytics have become much more than just a buzzword.

We have already mentioned how Artificial Intelligence and Big Data are interrelated: the former being the key to extract meaning from the latter, which in turn is key to instructing and improving the way that meaning is extracted.

As such, in Italy too it is becoming familiar to see multiple applications appearing that use advanced artificial intelligence methodologies applied to data sensing and retrieval, as well as to data analysis and knowledge extraction.

The study and extraction of knowledge from the huge amounts of data being generated through social media by millions of people is one of the most promising and most talked about applications.

Datalytics is an Italian startup that uses artificial intelligence to extract information related to brands and companies reputation from millions of interactions happening on social media.

DATALYTICS

datalytics.it

Founded:
2012

Funding stage:
1 round

Total Funding:
0.22 Mln$

(source: CBInsights)

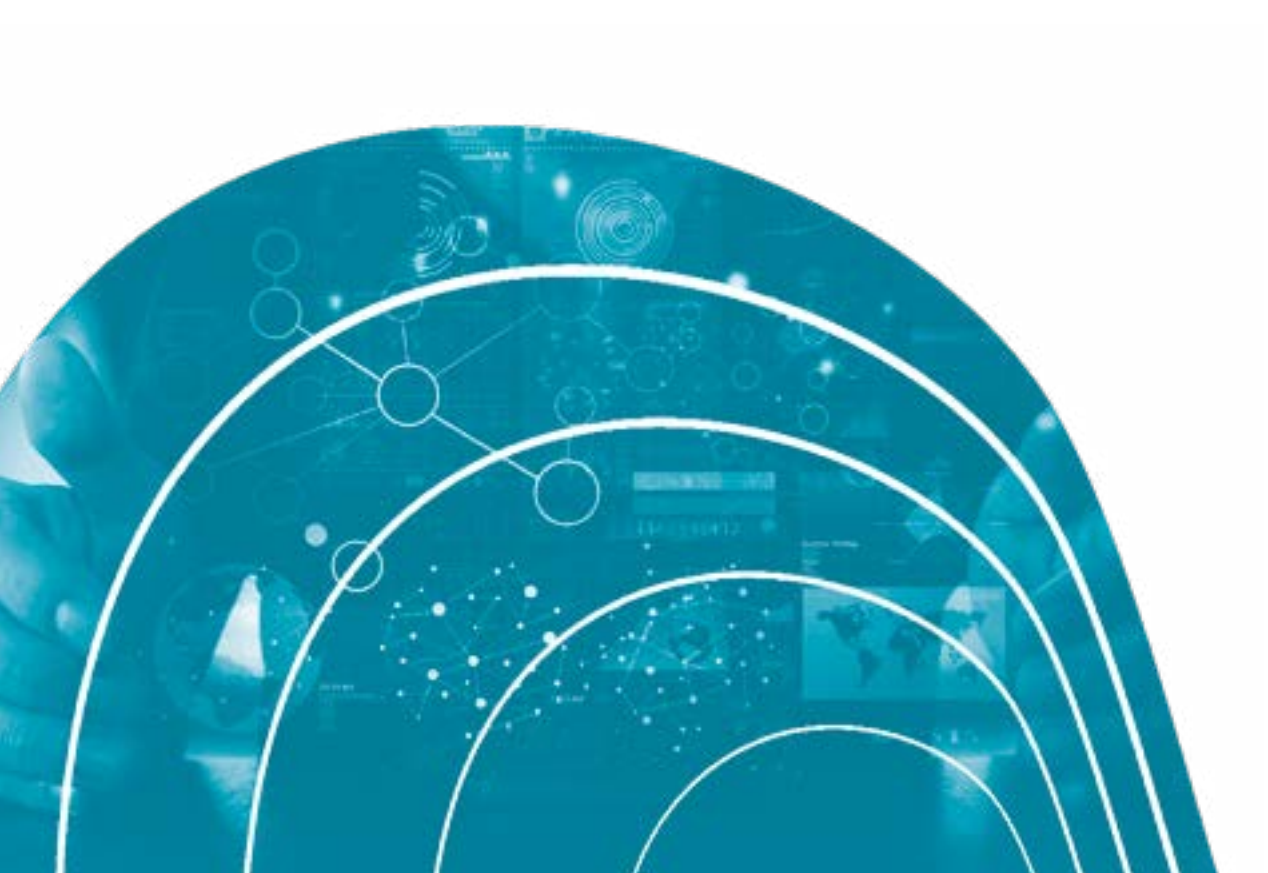
Datalytics

Datalytics developed Artificial Intelligence and Machine Learning technologies for the real-time analysis of big data extracted from social media. It allows companies and brands to monitor in real-time their reputation on digital channels through a self service interface. Datalytics algorithms are currently used by agencies and brands operating in a wide range of markets.

web link

Altilia, born as a spinoff of the National Research Council (CNR), created MANTRA, a platform capable of combining and making sense of huge amounts of unstructured data coming from multiple and diverse sources.

An example of how surprising the results of AI applied to Big Data could be is provided by the current research on discrimination discovery carried out at University of Pisa and ISTI-CNR as part of what is called Ethical Data Mining.



ALTILIA

altiliagroup.com

Founded:
2012

Funding stage:
Series A

Total Funding:
2.6 Mln$

(source: Crunchbase)

Altilia

MANTRA Smart Data Platform® simplifies Big Data integration and harmonization complexity to get actionable insights faster and better. It connects to heterogeneous information sources, both Web and Enterprise, and unifies structured and unstructured data spread into client's digital ecosystem through semantic enrichment based on artificial intelligence, NLP, machine learning, knowledge representation.
MANTRA saves time and money for developers, analysts, and business users to build, deploy and use Smart Data driven APPs for better engagement, faster business insights, more informed decisions. You don't need to be a data scientist, information architect, ontologist, taxonomist, machine-learning expert to build accurate, flexible, agile, scalable Smart Data Solutions.

The analysis of huge amounts of data related to decisions taken in a number of contexts (such as credit scoring, hiring, purchase decisions, etc.) reveals that data can hide unintentional bias. This could open up interesting scenarios, as algorithms and any new decisions performed by robots or softbots based on such data would be interpreted by humans as discriminatory or as a form of unjustified prejudice.

1.1Bln€
+22%
Italian Big Data Analytics Market

+25%
investments increase by Big Insurance, Manufacturing and Services companies

+18%
investments increase by Small-Medium sized companies

43%
Italian CIOs say Big Data is their top investment priority

45%
of Italian companies employ Data Scientists

73%
of Big Italian companies use predictive analytics techniques

(source: Osservatorio Big Data Analytics & Business Intelligence of the School Management of Politecnico di Milano, Report 2017)

ADVANCED ROBOTICS

Thanks to the advancement and success of the Italian automation and machinery industries, robotics has been another traditional field attracting a lot of attention from Italian researchers and technology companies since the '70s. Italy is currently ranked among the top positions in robotics production worldwide, just below giants such as China, Japan and Germany. And the industry has been constantly growing at impressive rates even in recent years, when other industry technology sectors have been suffering and almost stagnating due to the economic downturn.

Industrial applications and in particular task automation are certainly the first recipients of AI advancements in robotics, but we are now used to seeing a wide range of novel usage scenarios and applications.

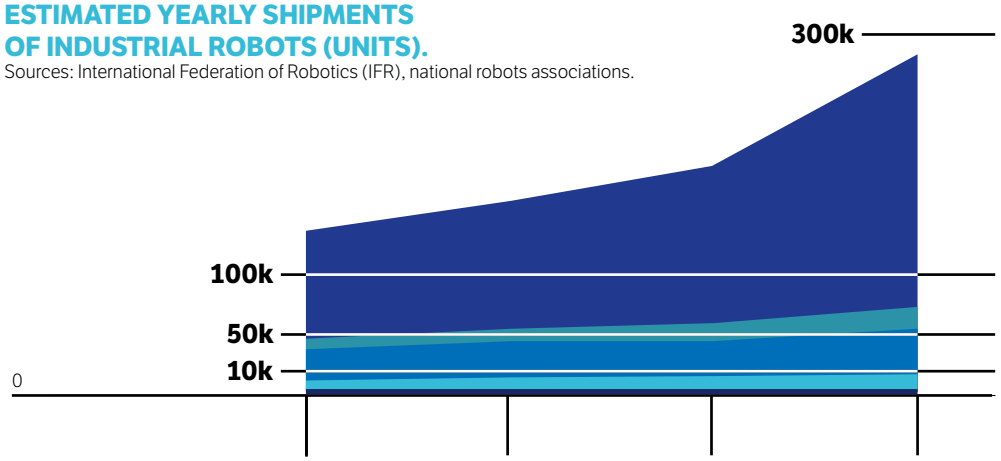
The use of autonomous robots in extreme environments such as in space, underwater, industrial plants manipulating harmful materials and chemicals, nuclear plants and warfare has been the subject of research for many years. Interactions of humans and robots in social contexts such as medical assistance, assistance for the elderly, or even tour guides, are currently being studied and at an advanced stage, as are studies on evolutionary robotics, collective behavior and swarm robotics.

A source of inspiration on the potential of AI applied to advanced robotics is given by Robocup international competitions, to in which Italian teams have been participating in since the '90s.

web link

ESTIMATED YEARLY SHIPMENTS OF INDUSTRIAL ROBOTS (UNITS).

Sources: International Federation of Robotics (IFR), national robots associations.



Countries	2014	2015	2016	2019
AMERICA	**32,616**	**38,134**	**40,200**	**50,700**
Brazil	*1,266*	*1,407*	*1,800*	*3,500*
North America	*31,029*	*36,444*	*38,000*	*46,000*
Rest of South America	*321*	*283*	*400*	*1,200*
ASIA/AUSTRALIA	**134,444**	**160,558**	**190,200**	**285,700**
China	*57,096*	*68,556*	*90,000*	*160,000*
India	*2,126*	*2,065*	*2,600*	*6,000*
Japan	*29,297*	*35,023*	*38,000*	*43,000*
Republic of Korea	*24,721*	*38,285*	*40,000*	*46,000*
Taiwan	*6,912*	*7,200*	*9,000*	*13,000*
Thailand	*3,657*	*2,556*	*3,000*	*4,500*
other Asia/Australia	*10,637*	*6,873*	*7,600*	*13,200*
EUROPE	**45,559**	**50,073**	**54,200**	**68,800**
Central/Eastern Europe	*4,643*	*5,976*	*7,550*	*11,300*
France	*2,944*	*3,045*	*3,300*	*4,500*
Germany	*20,051*	*20,105*	*21,000*	*25,000*
Italy	*6,215*	*6,657*	*7,200*	*9,000*
Spain	*2,312*	*3,766*	*4,100*	*5,100*
United Kingdom	*2,094*	*1,645*	*1,800*	*2,500*
other Europe	*7,300*	*8,879*	*9,250*	*11,400*
AFRICA	**428**	**348**	**400**	**800**
Others	**7,524**	**4,635**	**5,000**	**8,000**
Total	**220,571**	**253,748**	**290,000**	**414,000**

web link

iCub is perhaps the most popular and likeable Italian robot. It is a humanoid, 1-meter tall, child-size robot created at the Istituto Italiano di Tecnologia (IIT) in Genoa, with an impressive number of abilities. In addition to advanced movement and manipulation capabilities, iCub incorporates advanced language processing, automated reasoning, machine learning, emotional computing, image recognition, cognitive computing and many other advanced AI technologies that makes it a unique piece of technology studied and used in dozens tens of laboratories worldwide.

HIGH PERFORMANCE COMPUTING

web link

MARCONI is the code name of the latest supercomputer that was rolled out by Cineca at its data center in Casalecchio di Reno, in 2017. With its 20 PetaFLOPS peak computing power, hundreds of thousands of cores and relatively low power consumption, MARCONI is set to become one of the top supercomputers on the planet by performance.

Building and operating a supercomputing facility traditionally requires substantial resources in terms of capital, personnel and skills, and it is typically a privilege of big research institutions and companies. Although the Italian context is no exception to this rule, we can count a number of noteworthy examples demonstrating that this has been and will be a very active development field.

Before MARCONI and since its first supercomputer installation in the late '60s, Cineca, a non-profit consortium of universities, research institutions and the Ministry of Education, periodically made progress in the HPC field by releasing state-of-the-art computing and big data facilities for the research and technology community, as well as a number of initiatives to facilitate access to such computing facilities.

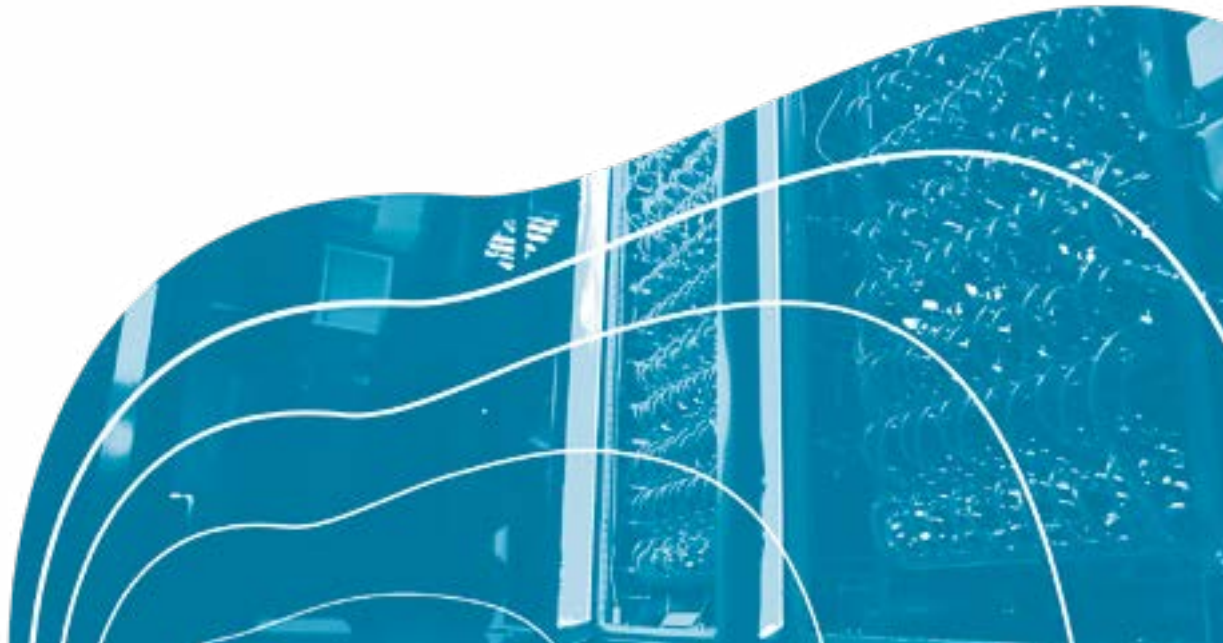
Among others, Cineca is a member of PRACE (Partnership for Advanced Computing in Europe), a pan-European supercomputing research infrastructure.

web link

Furthermore, MARCONI and Cineca's big data infrastructure code-named PICO, will contribute to the Human Brain Project by providing computing power and big data capabilities.

ENEA, the National Agency for New Technologies, Energy and Sustainable Economic Development is progressing in the HPC field applied to nuclear fusion, materials science, environmental modelling and technologies, working through its CRESCO project (Computational Centre for Research on Complex Systems) and CRESCO4 supercomputing cluster.

Although not completely devoted to AI research, these and other similar initiatives are the proof of the availability in Italy of top level competence centers and resources in HPC.



QUANTUM COMPUTING

At the edge of information theory and theoretical physics – and perhaps one of the most fascinating and promising enablers of advanced AI applications – Quantum Computing is certainly one of the most discussed topics within the Italian and European research community.
While the very first quantum computers are currently starting to be uncovered or announced, many open questions still remain to be answered before commercial applications can actually see the light and research is still playing a critical role, as it will continue to do so in the coming years.

web link

In May 2016, during the Quantum Europe 2016 conference held in Amsterdam, the EU announced its **Quantum Manifesto**, a document setting out the strategy and top priorities for European research on quantum technologies development for the upcoming years. The document has been endorsed as we write by more than 3600 scientists and representatives of major universities, public research institutions, private companies and public bodies, and provides for a €1 billion investment initiative in Quantum Technologies over the next 10 years.

Top Italian universities, armed with nearly a century of tradition in theoretical physics, and major research institutions including the National Research Council, National Metrology Research Institute in Turin, National Institute of Nuclear Physics, Abdus Salam international Centre of Theoretical Physics in Trieste and Scuola Normale Superiore in Pisa are all deeply involved and very active in Quantum Computing research and related fields such as Quantum Information, Photonics, and Quantum Simulation.

OPPORTUNITIES

Exploiting the full potential of Artificial Intelligence, and being able to resolve all possible shortcomings at the same time, will inevitably create unprecedented opportunities, as well as threats, that cannot be neither missed nor overlooked.

As we have seen, Artificial Intelligence does not refer to a specific technology but rather it encompasses a number of disciplines and technologies that can be applied to a multitude of domains and applications. Potential impacts are set to become significant in almost every sector of 'Made in Italy' manufacturing, perhaps only comparable to the impacts that ICT, the Internet and digitalization have had and are still having on production processes, product features and services in all industries. In this section we will briefly explore what those impacts could look like in the future.

Process Automation and (Smart) Factories

Relieving people from heavy and repetitive routine work is an age-old ambition. It is one of the most studied and perhaps the most impactful application fields of AI.
In the last two centuries we have seen machines assisting humans in performing their work duties being introduced at a constantly growing rate. Today's factories have a degree of automation that allows entire production plants to be run by just a handful of people. Nevertheless, the extensive use of AI technologies is set to completely reshape this scenario.

Industrial companies have traditionally focused on efficient use of resources. As a result they concentrated on lowering production costs by increasing plants' throughput, lowering operating costs, and reducing waste by improving the conformity and standardization of produced products. This led industrial automation to flourish in every industrial sector where machines proved to be great at performing well defined repetitive tasks, non-stop and under extreme conditions, at very low operating costs.

In this context Italian companies were able to stand out over the years and play an influential international role. They did so in three ways: first by having big international companies quickly adopt high levels of automation in their production process, for example in the automotive, chemicals, infrastructures industries and more; then by developing a unique set of expertise in industrial automation, machinery, and mechatronic industries, where Italy soon became one of the leading players worldwide; and finally, by exploiting and cultivating the many areas where heavy automation had little impact, for example in all those sectors where standardization was not necessarily perceived as an asset, such as fashion, luxury goods, craftsmanship, creative industries, local producers, and more.

Within a factory as we know it, machines and robots have a relatively limited and very specific set of abilities they have been designed for. While they can be re-programmed to perform different variations of their main tasks, they still have little tolerance for unpredictable events and need to be 'told' exactly what to do and when.

web link

With the use of AI, the very same robots could start becoming more autonomous and start performing more generic tasks. By using automated reasoning and learning techniques they could learn how to correct errors, handle unpredictable events and improve their performance. They could start cooperating with human operators and take 'fuzzy' natural language orders and fill up any missing information they need thanks to their AI capabilities. They could be taught new skills and cooperate with other robots to reconfigure themselves and achieve new common goals. If the above prove possible, as the inclusion of most such aims in many Smart Factory initiatives and Industry 4.0 programs seems to confirm, this would allow industrial plants to drastically reduce their reconfiguration costs to meet changed and evolving market or operating conditions.

As an example they could start producing new variations of their products or even completely new products by reusing the same production lines, or achieve what is called Mass Customization and start producing in very small batches different bespoke products with no increase in production, waste or logistic costs.

On the other hand small factories and craftsmanship laboratories could use cooperating robots or exoskeletons to assist skilled human workers in their daily duties. For example workers could use AI powered devices or robots to monitor safety conditions and step in whenever required to prevent accidents, injuries, or just to perform lower value-added tasks such as moving tools, materials or merely act as robotic assistants.

AI powered Products

Perhaps the most visible evidence of how powerful the adoption of AI and AI related technologies could be is the increasing number of products and services hitting the market and making use of some flavors of the latest AI technologies.

Asking our smartphone for the shortest route to a given place, or for the updated results of an ongoing football match, or being alerted of something unusual happening at home while we are away have now become simple and pretty familiar acts, as well as browsing the internet and being offered the latest news or product offers in which we are most interested. Under the hood we would find complex algorithms and pieces of software that are using some quite solid Artificial Intelligence techniques and methodologies.

Such forms of intelligence could be instilled not just to software products or services, but also to products we used to consider as pretty 'dumb' such as appliances, apparel, pieces of hardware, tools, bicycles, clocks, and anything we happen to use in almost any context of our daily lives. And this is actually happening as we write, at least if we look at the impressive number of startups offering AI-powered products.

Such features are now becoming so widespread and commonplace that pretty soon Artificial Intelligence could become part of the core features of many unsuspected products. Made in Italy products will certainly be impacted by this trend and companies in all sectors must take

advantage of the new opportunities AI will offer, to both maintain their leadership positions and more importantly to innovate their products and discover and enter new untapped markets.

An example of how AI can help reinvent something as innocuous item of home furnishing is provided by Momo, created by the Italian startup Morpheos.

morpheos

morpheos.eu

Founded:
2015

Funding stage:
Seed

Total Funding:
1.03 Mln$

(source: CBInsights)

see the video!

Momo

Momo by Morpheos is able to create a more rewarding and enjoyable connected home experience that reflects its owner's lifestyle. Momo is an intelligent lamp designed in Italy to blend into any living space. It requires little or no interaction, and no installation. By leveraging artificial intelligence algorithms it provides greater freedom and peace of mind: protects loved ones against the risks of intrusion; safeguards homes with early detection of gas, fire and water leaks; responds more rapidly to domestic incidents and emergencies, optimises energy consumption; creates comfortable environments – temperature, lighting, music and more.

Services

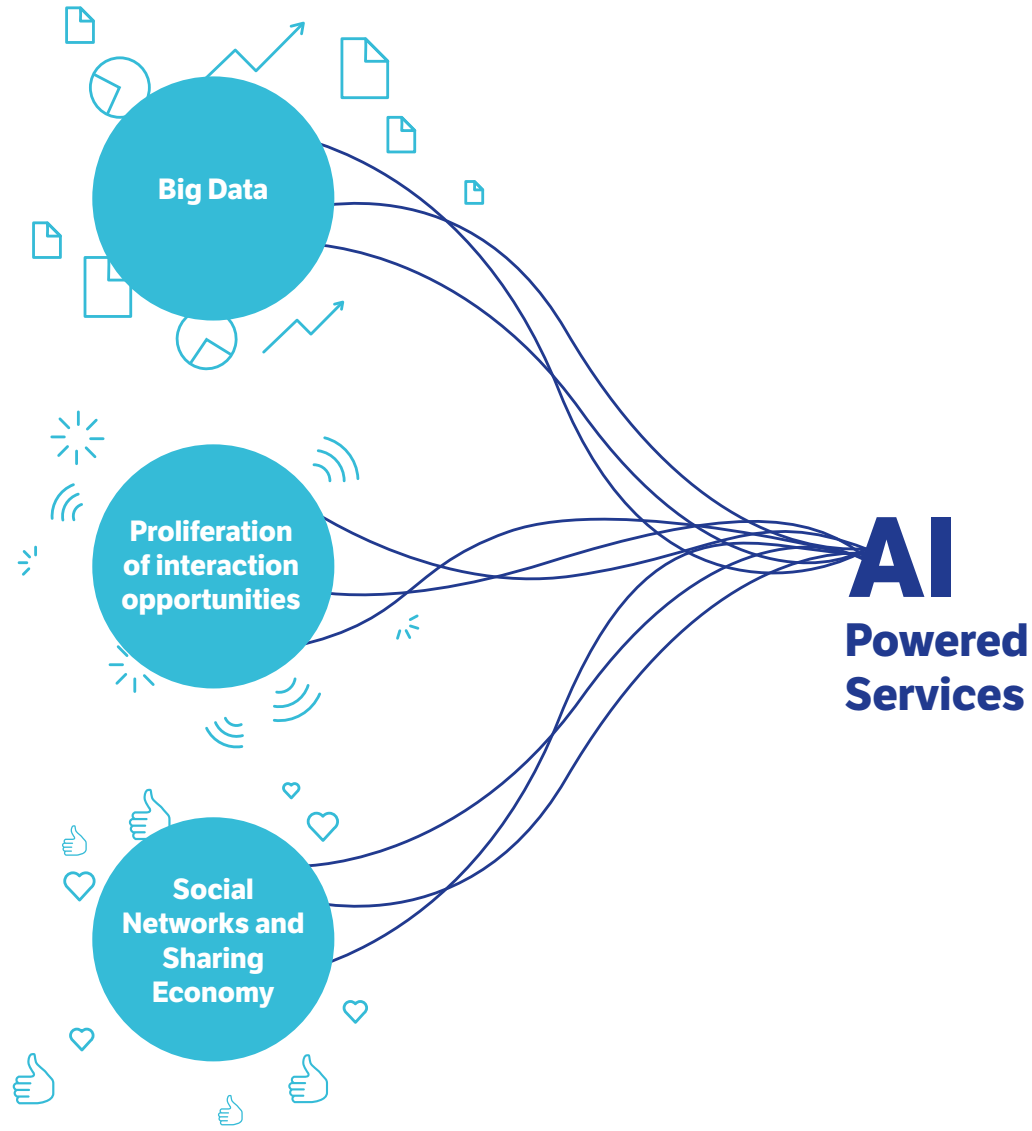
This is certainly the area where most AI applications have been focusing and delivering the first impressive commercial results in recent years.

The ability to collect and store huge amounts of data related to service and product usage, the proliferation of interaction opportunities with users or potential users through the many social networking and communication platforms, the ability to have access to billions of interaction events from people interacting with each other, with their audiences, with their favorite brands, and from people sharing their activities and opinions on almost any aspects or major events of their daily life, offer immense opportunities to those able to use it and extract value from it.

Artificial Intelligence provides the means to unlock such impressive potential through the many techniques available to extract knowledge and meaning from data, the ability to make informed decisions through automated reasoning, and ever improving human-machine interfaces.

Just some of the many AI-powered applications and services that are currently being used and improving every day include being able to learn the preferences and purchase habits of customers, understand how specific products and services are being used and why, improve the quality of customer relationships with the help of softbots interacting through chat, email or over the phone, and provide suggestions and guide users through their daily tasks as a real personal assistant would do.

Italian companies are traditionally known worldwide for their ability to deliver creative, top-quality bespoke products, and being able to enrich and complement their offerings with tailored and top-quality services will be a natural evolution. On the one hand, all companies or industrial sectors traditionally focused merely on products could now leverage AI to create



services and value added across the entire lifecycle of their products, from initial engagement with potential clients to product selection, from production to delivery phases, from their operations and maintenance to end of life, dismissal and replacement. On the other hand, AI will provide an extra power boost to all those companies and industrial sectors that already make extensive use of personalized and value-added services within their product offerings. First, by freeing human operators from the most time-consuming and lower value-added tasks and then by supporting their decisions with the ability to extract new fresh information from otherwise unmanageable amounts of data, and generate new hypothesies, solutions and interaction scenarios.

web link

In its latest 2016 report on priority technologies for the industry, AIRI (the Italian Association for Industrial Research) identified and studied a number of technology fields ranging from transportations to chemicals, from healthcare to aerospace, from energy to machinery, that are considered as paramount to Italian competitiveness and that Italian research and development efforts should carefully consider as the main focus in the upcoming years. Artificial Intelligence technologies have the potential to drastically impact almost all of the 115 technologies identified in the report and such impacts will eventually reverberate from industrial settings and production environments down to processes, products and their associated services, and ultimately to everyone's daily life.

The areas and applications where AI has the highest disruptive potential for the Italian economy certainly include those in which Italy has traditionally been an international leader such as the typical Made in Italy industries (fashion, clothing and textiles, food and beverages, furniture and appliances, automotive, machinery and industrial automation), but also in aerospace and transportation, chemicals, energy, tourism and cultural heritage, and many others.

CHALLENGES AND RECOMMENDATIONS FOR POLICY MAKERS

As we have outlined in previous chapters, and as we learned from the impressive number of technological innovations of the last two centuries, huge opportunities also bring big challenges and possible threats.

We have also seen that in the case of Artificial Intelligence things gets more complex and might evolve quite differently to any previous technological advancement.
In addition to the many large and profound ethical implications of what it really means to create an intelligent, thinking and mindful machine – and of the long-term consequences of living together with crowds of super powered automata able to take autonomous decisions – there are a number of more tangible, substantial and shorter-term implications we are already starting to deal with in our daily life.

LABOR MARKET

Within Italian research and technological communities, impacts to labor market represents perhaps the foremost and most talked about implications of AI.
We learned from the big advancements in industrial automation of the last decades that more automation implies some jobs will disappear and human workers will be replaced by machines.

We also learned that while machines were typically replacing humans when performing repetitive, low valued tasks or tasks performed in unhealthy or unsafe conditions, human workers can be trained for more complex and value-added jobs and be reallocated elsewhere.

Advances created by automation also lead to more jobs being created in areas that didn't even exist before automation took place.
As in other developed countries, evolutions typically took a few decades to become widespread and deliver their full effects on employment, and the job market and painstakingly negotiated welfare policies eventually proved to be good enough to absorb the impact over several years.

In the case of Artificial Intelligence, the scenario might look different and traditional provisions and instruments included in current regulations, welfare policies and union agreements might need to be reinterpreted and adjusted.

CURRENT REGULATIONS, WELFARE POLICIES AND UNION AGREEMENTS MIGHT NEED TO BE REINTERPRETED OR ADJUSTED

The speed at which new innovations are being disseminated worldwide is impressive; impacts on the job market will follow similar rates and their effects could become felt in a few months instead of several years.

In addition, Artificial Intelligence will not only impact less skilled jobs performing standardized, low value-added or repetitive tasks such as the workers in an old style assembly line. Even highly skilled and specialized jobs such as medical doctors, researchers, lawyers, accounting auditors, airline pilots and a lot more could be impacted. As we have seen, AI may not replace those jobs completely yet, but it will still impressively amplify what a single individual worker is capable of. On the one hand this would

increase the demand of even more skilled and experienced workers, while on the other it might drastically reduce the overall number of workers needed as they will be able to perform more tasks, more effectively and faster than ever before.
Doctors will be able to provide consultations to more people, make more precise diagnoses, and monitor health conditions more closely, researchers and lawyers will be able to perform their evaluations and researches more efficiently and faster, auditors will be able to reconcile or analyze huge amounts of documents and transactions, and pilots will be able to look after and supervise the flights of multiple self-flying aircrafts, just to mention a few examples.

It is worth noting that we are not describing some remote future, but are already witnessing this process. And it will soon become a commonplace reality in Italy as elsewhere.

COMPETITIVENESS

Artificial Intelligence will allow companies, regardless of their size, origin and market, to create highly customized products, raise the perceived quality of their overall offerings through extremely personalized services, identify trends and preferences, get inspirations for new products and react quickly to changed market conditions and strategies as never before. All this directly undermines some of the core competencies and values of most Made in Italy companies.

Artificial Intelligence has the potential to completely reshape the value proposition, product mix and the overall competitive landscape of markets where Italian companies used to be and still are undisputed leaders.
Many Italian companies are still enjoying the presence in their markets of solid entry barriers to competition that they were able to build thanks to their innate creativity, non-transferable traditions, strong ties with local communities, unrivalled quality, flexibility and deep personalization.

HOW CAN WE LEVERAGE ARTIFICIAL INTELLIGENCE TO STRENGTHEN THE INNATE CREATIVITY, NON-TRANSFERABLE TRADITIONS, STRONG TIES WITH LOCAL COMMUNITIES AND UNRIVALLED QUALITY INFUSED IN ALL MADE IN ITALY PRODUCTS?

Such barriers now risk collapsing under the weight of big fully automated factories once used to produce large-scale impersonal cheap products, which can now reconfigure themselves and enter even tiny niche markets, produce highly customized products, counteract the power of traditions and expertise with sophisticated brute force machine learning algorithms, and lot more.
The big challenge for small and medium companies would be to figure out how to completely flip the picture, and learn how to use AI to enhance, reinforce and creatively revive the core values, traditions and expertise that contributed to making them unique.

PERVASIVENESS

A new and additional challenge brought by AI technologies due to the absolutely universal nature of their applications, is the fact that **no sectors will be left out** of this transition. AI can be used to improve performance and automate tasks, processes and decision-making activities regardless of how complex they are, what their specific application fields would be, and whatever their final objective is. This would make it potentially so pervasive and widespread that it will only be comparable to innovations such as the internet, electronic devices or electricity.

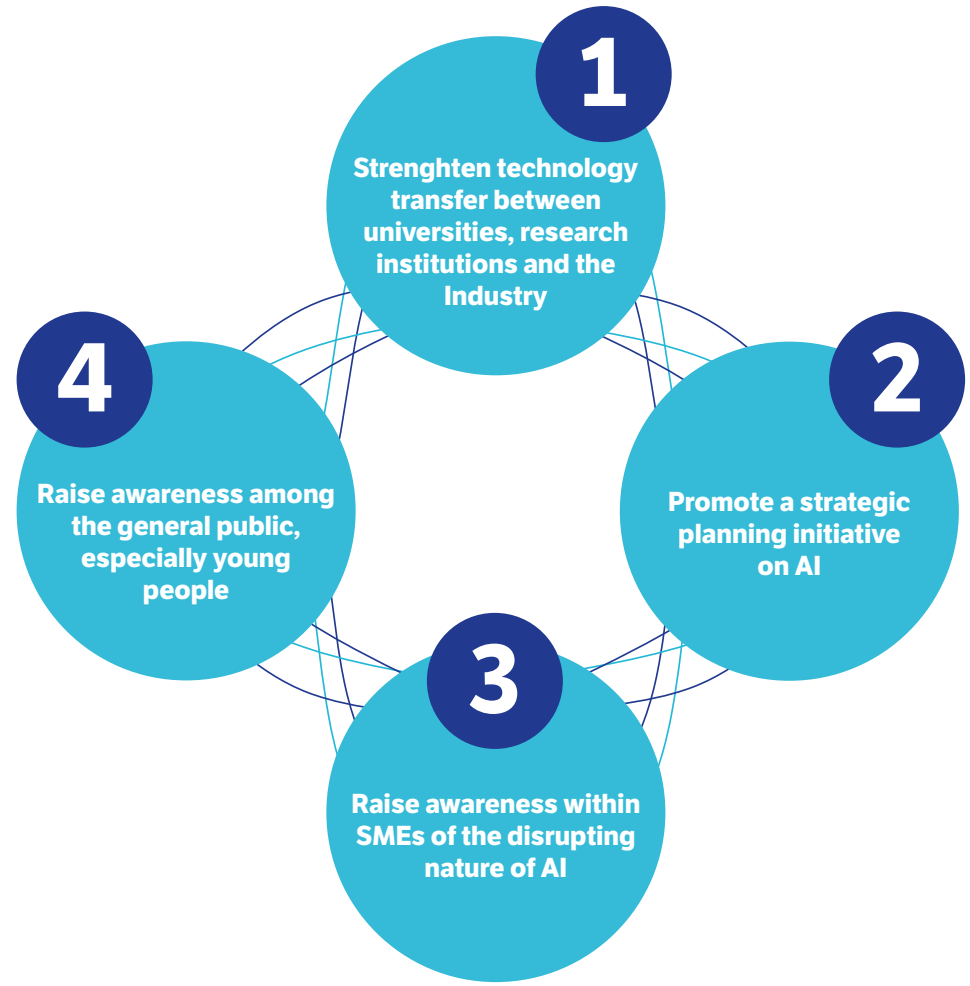
Due to the inherent complexity of the work being performed, sectors such as transportation, public administration or finance have so far been marginally impacted by the industrialization and automation surge of recent decades. Things are already starting to look different now as AI's main goals

are now to perform complex tasks, make complex and informed decisions, and interact effectively with people.
The big challenge for Italian industry is to realize that this time, maybe as never before, being inactive and standing by while the transformation is happening could mean letting go of most of the competitive advantage Italian companies were able to build at the international level in the last century.
As a result – and here comes the big opportunity as well – the best strategy for Italian industry to counteract any gloomy predictions is to stay at the forefront of these inevitable dynamics and influence their development. Seizing all opportunities AI is offering to keep innovating those products, services, processes and business models AI itself is undermining. This will contribute to creating a more immune industrial and economic setting, as well as increase overall competitiveness and ultimately reveal new untapped opportunities.

These and even more challenges were identified during a seminar dedicated to Artificial Intelligence that involved some of the foremost experts in Italian industrial and research communities, held by the Association Italiadecide in October 2016.

During the seminar a number of systemic actions were identified to encourage and facilitate a positive reaction to these challenges. These can be grouped in a set of four recommendations to policy makers.

A SET OF FOUR RECOMMENDATIONS TO POLICY MAKERS



1

RECOMMENDATION 1

Provide for means to encourage and facilitate technology transfer between universities, research institutions and Industry.

Research on AI and related technologies in Italy is renowned internationally as being carried out at the highest levels. And the number of AI researchers educated and trained in Italy and leading some of the top research institutions and research teams around the world seems to confirm that. Moreover, the decision of some big international players to invest resources in Italy, such as including the University of Modena-Reggio Emilia within Facebook's GPU Partnership Program promoted by Facebook AI Research group, Amazon's announcement to open an AI research center in Turin, and the plan to create the first European IBM Watson Health Center of Excellence in Milan also seems to confirm that Italy is perceived by the industry as a place where research and innovation in AI can be carried out at the top levels.

Nevertheless, research and development of Artificial Intelligence is being performed almost exclusively (with few notable exceptions) in universities and research institutions, which in turn rely almost entirely on European Union funding.

Technology transfer, in the broader context of technological innovations, is a long-standing issue in Italy and things seems to be even more noticeable when specifically dealing with research on Artificial Intelligence.
However, the current scenario seems to create all the conditions for a win-win scenario.

COMPANIES NEEDING TO LEVERAGE CUTTING EDGE AI TECHNOLOGIES
+
SOME OF THE MOST RENOWNED RESEARCH TEAMS IN THE WORLD
=
WIN-WIN SCENARIO

On the one hand Italian companies have the opportunity to benefit from the research and training activities of some of the most renowned research teams in the world, while contributing to the education of new students and future researchers. On the other hand, universities have the opportunity to find alternative streams of funding and put their talents and the results of their research at the service of the community.

Here are some of the possible actions Italian institutions and government agencies, together with universities and research bodies, could implement to address this long-lasting dilemma:

1 – Introduce and facilitate managerial positions within research bodies, aimed at coordinating and promoting collaborations with the industry and other research institutions. Such positions would help with managing the many administrative, organizational and communication activities required to acquire new funding, participate in tenders and funding calls, manage intellectual property rights and patent exploitation, establish partnerships and collaboration agreements, etc.

2 – Rethink and reposition the role of PhD doctoral programs (Dottorato di Ricerca), today almost exclusively considered as the first step to a university career, so that they are also seen as education for careers outside academia and contributing to literally bringing research into industry and establishing stronger links between them.

3 – Facilitate the exploration and implementation of new and innovative forms of partnership between universities and industry that can balance research groups' need for more resources and funding for their fundamental research with companies' need for more near-term and tangible results from applied research.

4 – Remove all hindrances to organic growth of research teams and mobility of their members between universities or research organizations. Today, because of tight budget limitations and high competition on acquiring funds, only a few of the top-performing and gifted talents are allowed to join research teams. Since a high number of very skilled and qualified potential researchers are being let go, many research teams never reach that critical mass allowing them to get the visibility they deserve.

5 – Facilitate the exploration and implementation of innovative collaborative and organizational models. As an example, in addition to the traditional concept of bringing together top researchers in a given field all in the same physically localized place, current technologies enable the creation of tight collaboration networks that could be reconfigured to meet new and changed conditions. The nodes of such networks could either consist of stable homogeneous teams of researchers in a given field or even be made of temporary multidisciplinary lineups, depending on the specific project, needs and problems to tackle.

2

RECOMMENDATION 2

Promote a Strategic Planning initiative at the national level to funnel research, development and innovation efforts on AI towards Italy's specific needs and challenges.

Research and development on Artificial Intelligence in Italy is being performed almost exclusively, with just a few notable exceptions, inside universities and research institutions, which in turn rely almost entirely on European Union funded programs.
EU ambitious research programs are able to move and secure significant amounts of funds being distributed to multinational research teams made of both research institutions and private companies.

Such programs have proven to be a great mechanism to stimulate research at the highest levels and encourage crosspollination across European research organizations. However, EU funded programs alone are not enough to reverberate their benefits and achievements into the local research community or propagate to the industrial sectors at a national level.

Better results could instead be achieved by dedicated and specific nationwide strategic initiatives to be directed and executed by local governmental institutions and research bodies. This would act as a bridge between top-level research conducted at the European level and the national context with its needs, peculiarities, strengths and weaknesses.

More importantly, the specific structure and aims of EU-funded programs, and the scarcity of local funding resources may lead Italian researchers and innovators to get caught in some distorted and even detrimental mechanisms. One example is the intense competition when applying for funding. Instead of joining their efforts to collaborate on a common challenge, research groups risk competing against one another, maybe within the same research organization, to apply for the same grant.

Another example is the sometimes deep disconnect between the top-notch research conducted at European level and a local industrial context that may not yet be ready to take advantage of such advanced achievements. As a result, instead of being encouraged to use their findings and their experience to enable local players to fill their gaps, researchers and innovation companies willing to keep building on their achievements have little choice but to go abroad and look for more responsive partners elsewhere.

web link

Last year, the Italian government launched its ambitious initiative in smart factories Piano Industria 4.0 and the results achieved in 2017 seem promising.
While its long term effects are still to be seen, the number of initiatives put in place and the amount of funds involved are remarkable and considered by many as an innovative and important step towards re-launching competitiveness and growth for the Italian industrial sector.

web link

Although with some delay, Artificial Intelligence and Cyber Physical Systems, which are core elements of similar initiatives launched for example in Germany and the US, finally started to appear as part of the Piano Industria 4.0 initiatives.
A further encouraging signal comes from the institution, within the Italian government's Digital Italy Agency (AgID), of a task force on Artificial Intelligence. The AI task force was officially presented last September, and has the ambitious objective to: "identify the opportunities offered by Artificial Intelligence to enhance the quality of the services offered to citizens and therefore to simplify their lives."

web link

In addition to defining wide-spread strategic initiatives on general key topics, it would be very beneficial to define a set of high-priority goals to be achieved and specific compelling issues to tackle within the Italian context. And then, as a following step, set up all required provisions to:

PUT TOGETHER ALL THE BEST MINDS AND RESOURCES AVAILABLE IN ITALIAN RESEARCH, INDUSTRY, REGULATORY BODIES AND LOCAL COMMUNITIES, AND HAVE THEM ALL COMMITTED AND FOCUSED TO SOLVE A COMMON CHALLENGE

At its core, Artificial Intelligence consists of a set of technologies that can be applied in a multitude of contexts and applications, and in order to deliver its full potential it only needs to be challenged by real unsolved problems.
On the other hand, if any country-specific and long-standing issue is actually to be solved, putting together just scientists and technologists would rarely suffice.

3

RECOMMENDATION 3

Raise awareness within SMEs of the disrupting nature of AI, related opportunities and threats, and provide for means to encourage SMEs embracing change and innovation.

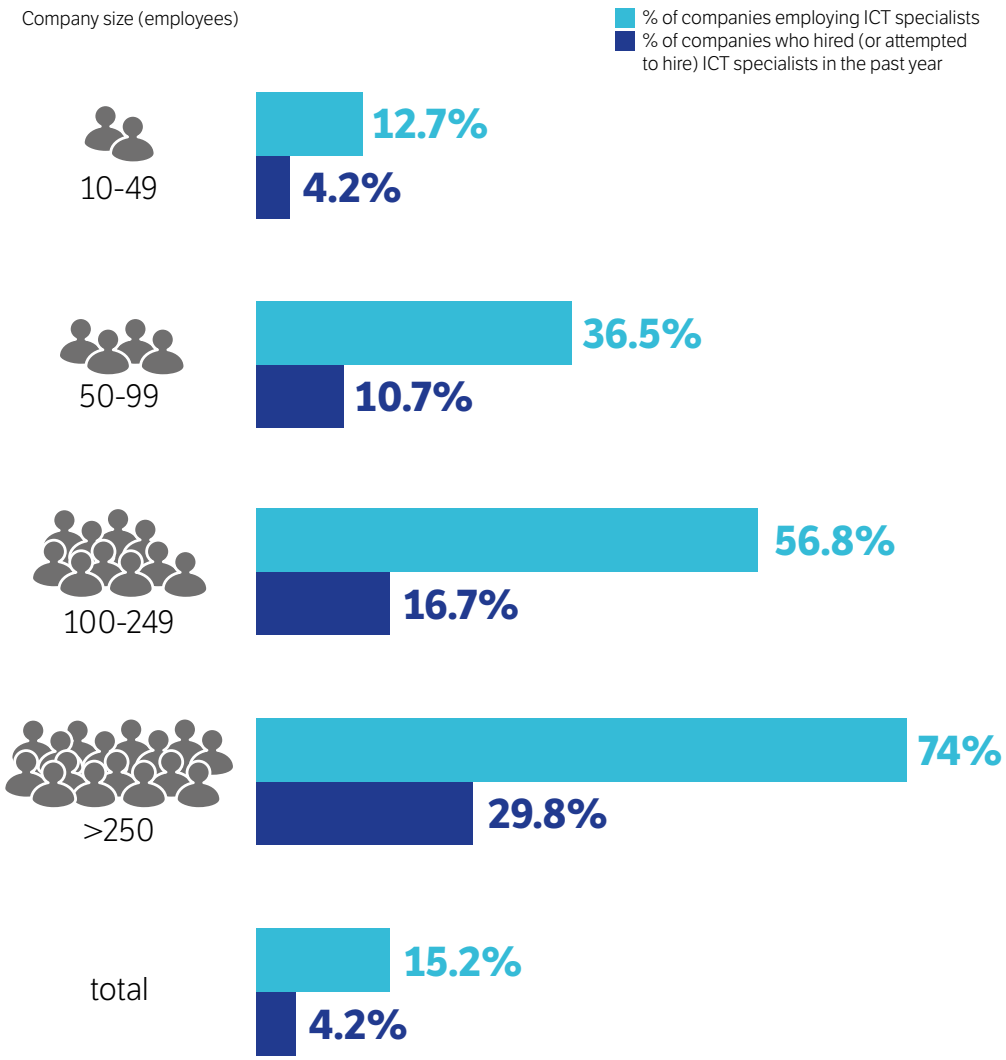
As we have seen throughout this overview, Artificial Intelligence has the potential to augment and magnify the abilities of skilled human workers, and as a result to radically transform the cost structure of producing goods and delivering services as we have known it in past decades. Coupled with unprecedented personalization capabilities, this would allow companies to achieve economies of scale even when entering market niches once considered unreachable. Moreover, we have mentioned how AI would allow companies to completely reshape their value proposition, perceived quality of products and services offered, and their capability to identify and target potential customers.

While many big international companies already understand the potential of AI technologies applied to their businesses and are already using AI as part of their processes and exploring new possible applications, that is not the case for the majority of small and medium Italian enterprises.

Italian SMEs have traditionally proved to be great at focusing on their products, becoming masters of their specific domains and being able to build a unique internal mix of expertise, experience and skills allowing them to compete internationally. On the flip side, as Istat data seem to confirm, they still struggle to adopt ICT technologies within their factories and incorporate digital services into their products

ITALIAN COMPANIES EMPLOYING ICT SPECIALISTS

Source: ISTAT (based on 2016 data)



web link

and processes. Less than 11% of small companies show high levels of digitalization, compared to more than 34% of large ones.

As a result, digital services are still perceived by Italian SMEs as ancillary and non-directly impacting on their core value proposition, and even more so in the case of advanced digital technologies such as AI.

This scenario is even more worrying since AI is very likely to result in a "swim or sink" situation. If Italian SMEs, even the ones operating in traditional Made in Italy sectors, will not recognize and seize the huge opportunities brought by AI, competitors of all sizes from all over the world will certainly do so. While these companies could still be striving to compete with smaller Italian players on product excellence, they will definitely leverage AI technologies to improve their products, innovate at a faster rate, and learn how to influence and reshape the traditional competitive scenario to their own advantage.

It is then essential to identify the most appropriate means to help Italian SMEs raise their awareness of both the opportunities and threats that AI will inevitably create.

Along these lines the recommendation is to promote and incentivize any effort leading to incorporating AI technologies within current products, processes and across the entire value chain.
Likewise, any initiatives meant to promote collaboration and new partnerships models meant to create a critical mass and a level of process integration appropriate to compete with big, highly integrated players internationally should also be facilitated and encouraged.

4

RECOMMENDATION 4

Raise awareness among the general public, especially young people, on all opportunities and social implications brought about by the inevitable and widespread adoption of AI technologies.

Despite the rapid pace at which AI powered services and devices are spreading nowadays, perception of Artificial Intelligence among the general public is still anecdotal and blurs the line between science and science fiction. In fact, AI technologies are already embedded into devices we use every day, and it is already influencing our lives.
AI is going to have a huge impacts on the economy and will certainly contribute to improving the daily lives of millions of people even further, but it will also have significant social implications.

It is crucially important that central governmental agencies and local organizations take all measures and initiatives to ensure that people don't get caught unprepared by the upcoming change, and be educated and ready to deal with it.
As we have seen elsewhere in this work, the one most discussed consequence of a massive introduction of AI is related to the job market. Unlike past innovations, task reallocation, workforce retraining and traditional welfare policies alone may not be promptly adjusted or enough to limit side effects.

It is therefore imperative to encourage the exploration of new and innovative countermeasures, maybe with the use of the very same AI technologies causing the issue in the first

place, and to promote the dissemination to the public of any achievements in this direction.

As an example, instead of just focusing on improved efficiency and performances, a number of projects are being carried out by notable Italian industrial companies or funded at the European level, aiming at creating cooperating robots to complement human workers and improve work and safety conditions.

web link

Loccioni, which has been applying AI technologies within its production lines for many years and is carrying out an intense research activity around Human-Robot Interactions, is leveraging the use of intelligent robots to actually cooperate with human workers. AI is enabling robots to perform tasks that would be otherwise repetitive, tiring, and prone to errors for human workers. At the same time robots are keeping their human companions involved in the decision loop in order to supervise and direct the process, and be involved whenever required to tune and adapt automated behavior.

web link

Comau, active since 1970 in automating industrial production lines, has included Human Robot Collaboration as one of its innovation pillars. They are creating robotic arms and humanoid robots equipped with sophisticated perception systems allowing them to share the same working area and interact with human workers in safe conditions. It is also promoting and participating in a number of European projects in the field of cooperating robots applied to a multitude of use cases.

Projects and research efforts like the above ones should be encouraged, supported and made public at national level through specific initiatives, and with the active involvement of local communities, schools and higher education institutions.

Creating favorable conditions and providing people (and especially young people) with enough intellectual and material tools to react positively to these inevitable changes can only be achieved through systematic awareness and education initiatives at all levels.

These initiatives should first be intended to fill the gap between anecdotes and reality and then to enable people to gain real advantages from this new reality, transforming a major challenge into an opportunity.

6

APPENDIX: ACRONYMS, DEFINITIONS & REFERENCES

Affective Computing

The capability of computing systems to recognize, interpret, process, react and in the future simulate various human emotions.

AGI

Artificial General Intelligence
A machine that is as intelligent and creative as the humans.

AI

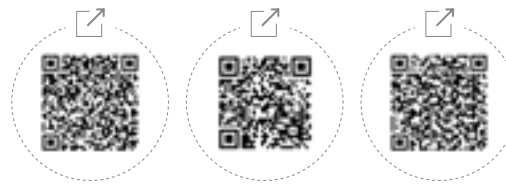
Artificial Intelligence
The whole landscape of technologies that enable machines to perform tasks similar to the human capabilities.

ANI

Artificial Narrow Intelligence
A machine that could perform one specific task, e.g. spam filtering.

CoBot / Co-bot

Collaborative Robot
A Robot designed with the safety requirements enabling it to work in a physical space shared with humans.

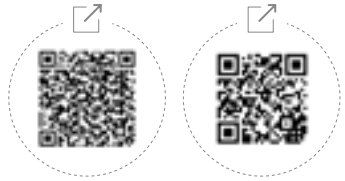


Cognitive Computing

The simulation of human thought processes in a computerized model; it involves self-learning systems that use data mining, pattern recognition and natural language processing to mimic the way the human brain works.

DL

Deep Learning
The ability of a machine to learn “by itself”: it is not constrained by strict algorithms but it is able to autonomously identify new solutions at the given problems. In this book it is used as a synonym of Machine Learning.



ER

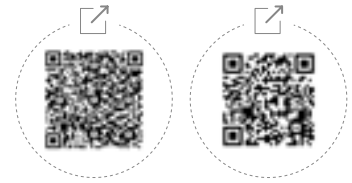
Emotion Recognition
The ability of a machine to identify human emotions analysing facial expressions, gestures and voice.

ERP

Enterprise Resource Planning

GAT

Germanium Antimony Telluride

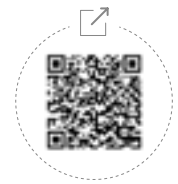


GPU

Graphic Processing Unit

HPC

High Performance Computing



ICT

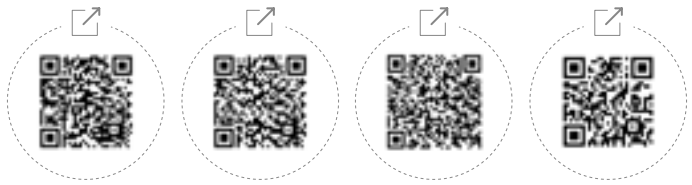
Information (and) Communication Technology

IoT

Internet of Things
The network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment.

IR

Image Recognition
The ability of a machine to identify objects from a video stream or a still image.



IVR

Interactive Voice Response (system)

M2M

Machine to Machine

MIT

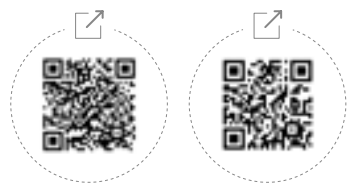
Massachusetts Institute of Technology

MOOC

Massive Online Open Courses

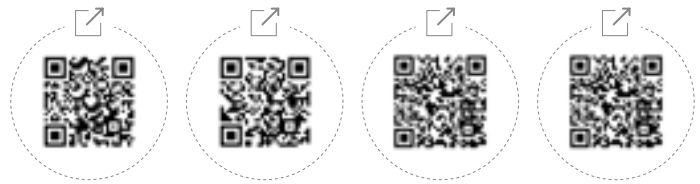
Neural Network

A biologically-inspired programming paradigm which enables a computer to learn from observational data.



NLP

Natural Language Processing
The ability of a machine to understand the human language, extracting the meaning from a sentence and reacting to it.



NLR

Natural Language Recognition
In this book it is used as a synonym of NLP.

PA

Predictive Analytics
The ability of a machine to extract useful information from huge data sets to identify significant patterns and predict futuristic trends and outcomes.

RPA

Robotic process automation

QC

Quantum Computing
Hardware and Software designed on the quantum mechanics; they follow no more the binary logic.

SEL

Social and emotional learning

THE AUTHORS

Annalisa Belvedere

Annalisa Belvedere is a Senior Analyst at the Intesa Sanpaolo Innovation Observatory – IT, Digital and Innovation Area, where she uses her expertise in banking and knowledge of technologies, strategies and business models to foster innovation in the Group and to help projects to make informed decisions. Annalisa has contributed to several studies and reports on social trends and technologies by the Innovation Observatory and has also been a trainer on innovation for Intesa Sanpaolo. Prior to joining the Innovation Department, Annalisa worked as an IT analyst on current accounts and branch bookkeeping applications in the IT Department of Intesa Sanpaolo, dealing with the incorporation of features and data from acquired banks during the M&A phase (2001 – 2006).
Annalisa holds a degree in Applied Mathematics from the University of Padua (Italy).

annalisa-belvedere

Daniele Borghi

Daniele Borghi was born in Monza on 3rd October 1963, After graduating in Electronic Engineering from Milan Politecnico in 1988, he spent his first working years in consulting firms, looking at manufacturing, healthcare, insurance and finance. During this period he wrote his first publications in the form of technical articles. Since 1994 he has worked at various companies of the Intesa Sanpaolo Group; besides people management and project leadership experience, he has developed training and communication expertise in internal business courses. Since 2007 Daniele has been the Senior Innovation Analyst for the departments focused on innovation, publishing many reports and studies. Artistic and adventurous in equal measure, he has been also pursued his twin passions of photography and motorcycle touring for over forty years.

daniele-borghi

danieleborghi.info

Sonia D'Arcangelo

Sonia D'Arcangelo graduated from the University of Turin in Physics with a biological and medical focus and is currently enrolled at the Faculty of Theology at the Pontificial Salesian University in Turin, where she is studying sociology topics.
She has been working in banking innovation for several years, and now she is part of Intesa Sanpaolo Innovation Center in Turin – Italy, working on the themes of innovation trends and their impact on companies in terms of consumer, industrial and technological vision.
She has also developed a profound passion for the HR tech environment, analyzing technologies and processes which are able to transform the world of learning and to foster people potential. As a result she has started studying neuroscience subjects applied to different topics, from learning, to HR recruiting, to Marketing and finally to art, leading her to acquire new technical and relational skills.
Sonia has gained the Responsibility of the Innovation Center Lab Neuroscience inside Intesa Sanpaolo Innovation Center, managing and coordinating the relationship with IMT Lucca.
Sonia lives in a charming town near Turin, married with three sweet children who allow her to stay energetic, flexible and resilient.

darcangelosonia

Alessandro Salimbeni

Alessandro Salimbeni is a manager and advisor who has been working in the digital and innovation space for nearly two decades. After starting his career designing software for defense systems, he spent some time in the US helping bring the internet into space through the Iridium satellite network. Back in Italy he worked on a number of European research projects and contributed to the creation of the first value-added mobile internet services throughout the EU and Middle East. Joining Qualcomm as a manager, he worked on many innovation projects including one of the first AI recommender systems used worldwide. More recently he has enjoyed working on many ambitious and innovative projects for the global design and strategy firm Frog Design.
At present he collaborates with a number of large and small organizations in the fields of technology, innovation management and user-centered design.
A never-ending learner, he holds an Engineering degree, master's degrees in Enterprise Management, Corporate Finance and Banking and other specializations. He loves spending his free time with family and his three playful and tireless children.

salimbeni

asalimbeni

INTESA SANPAOLO INNOVATION CENTER: OVERVIEW

Exploring the business models of the future to discover the new assets and skills needed to support the long-term competitiveness of its customers and of the Group as we become the driving force of the New Italian Economy, this is the mission of Intesa Sanpaolo Innovation Center which aims to create the assets and develop the necessary skills that guarantee the competitiveness of the group and its customers through the promotion of new technology use and the support of corporate transformation projects where responsible business models can reconnect business and society. Intesa Sanpaolo Innovation Center supports the growth of startups in domestic and international markets through programs in acceleration and networking and has created laboratories and Competence Centers to generate know-how and develop new assets and businesses. Intesa Sanpaolo Innovation Center invests in startups with its Corporate Venture Capital Neva Finventures to encourage new business growth and to support the champions of tomorrow. Intesa Sanpaolo Innovation Center: the country's driving force for future-proof change.

Mario Costantini
General Manager

Mario is responsible for spotting the most disruptive trends, scientific researches, technologies and startup solutions. He drives and supports technology transfer and product service design by leading the internal incubators of technologies and the Experience Design Lab of the Intesa Sanpaolo Innovation Center. He and his team generate positive impact for the market through the development of brand new projects, assets and skills. Mario is also chairman of the Investment Committee of Neva Finventures S.p.A. (the Intesa Sanpaolo's Fintech Corporate Venture Capital Company). He studied at the University of Genova and got a bachelor's degree in Electronic Engineering with specialization in Operational Researches and Robotics.

Mario Costantini

Stefania Vigna
Head of Innovation Observatory
IT, Digital and Innovation Area at Intesa Sanpaolo

Stefania has 18 years banking experience: 7 years in innovation and 11 years in the ICT Department. She is now the Head of The Innovation Observatory of Intesa Sanpaolo and manages many different activities: trend analysis in fintech and insurtech sector, research on new products, services and business models supporting ISP Group, competitor innovation benchmarks

Stefania Vigna

Matteo Colombo
Head of Competence Center

Matteo Colombo has more than twenty years of experience in business. He began his professional career as an entrepreneur in the ICT industry through the creation of a start-up dedicated to ICT services and provision of Internet Services, and continued his career within consulting firms in ICT and information security. He has held various positions within the Intesa Sanpaolo Group since joining in 2003.

He began in Information Security, then moved over to the Organization Department and finally to the Innovation Area, covering different roles. Now he is the Head of Competence Center at Intesa Sanpaolo Innovation Center – society of the leading bank Intesa Sanpaolo. As the Head of Competence Center he is responsible for the Innovation Research and Development with the aim to detect the main trends of innovation, the best technological solutions and startups on the market and also to coordinate the applied research labs on artificial intelligence and neuroscience.

Matteo Colombo

ITALIADECIDE

Founded in 2008, italiadecide is a research and educational non-profit institute whose mission is to promote a shared and realistic analysis of the underlying problems of the country, with particular regard to the shortcomings of the decision-making system.
italiadecide provides also training courses on a regular basis according to two different models: short courses addressed to young local administrators ("Scuola per la Democrazia") and annual training courses for undergraduates of Sapienza and LUISS Universities in Rome ("Scuola per le Politiche Pubbliche").

italiadecide, in cooperation with other associations and foundations, has set up in 2016 the Observatory: "Public contracts".

Each year, italiadecide produces an annual report which is published by Il Mulino and presented in the presence of the Head of State at the Chamber of Deputies. The annual reports highlight themes that should deserve a priority in the political agenda. The annual reports have, since 2009, also provided policy issues and proposals on the ground of a qualified and multidisciplinary platform of knowledge. Research topics cover: territorial analysis, infrastructural development, urban governance and metropolitan policies, innovation, constitutional, administrative and judicial framework in the mentioned fields.

Luciano Violante
Chairman

Luciano Violante has been a magistrate, Full Professor of Criminal Law and Procedure, and Member of Parliament from 1979 to 2008. In Parliament he held, among other things, the functions of Chairman of the Anti-Mafia Committee (1992-1994) and of President of the Chamber of Deputies (1996-2001).
He is the author of several books on criminal law and on political and constitutional topics.
Has presided over italiadecide since its foundation (2008).

Enrico Seta
Research Director

Enrico Seta had a professional career at the Italian Chamber of Deputies where he was appointed Responsible for the "Parliamentary Observatory for Strategic Infrastructures" (2001-2007) and Head of Office, International Affairs (2007-2012).
In 2012 he was appointed as Special Advisor and Head of Technical Secretariat of the Ministry of Transport and Infrastructures.
Since its foundation (2008) Enrico Seta has been collaborating with the research an educational activity of italiadecide. Currently he is the Research Director.

Alessandro Palanza
Vice Chairman and Director of school for public policies

Former Counsellor of State and former Deputy Secretary General in the Administration of Chamber of deputies; Research Director of italiadecide from 2008 to 2013.
Parliamentary Official of the Chamber of Deputies of the Italian Parliament from 1976, was appointed as Deputy Secretary-General of the Chamber of Deputies in July 2000 to February 2011 when he was appointed as administrative judge in the Council of State.
Alessandro Palanza was Professor for budget legislation and procedure at the University of Urbino from 1991 to 1996. He is author of a number of publications about law-making and budget procedures.