Artificial and or

Intelligent

What does the future have in store?

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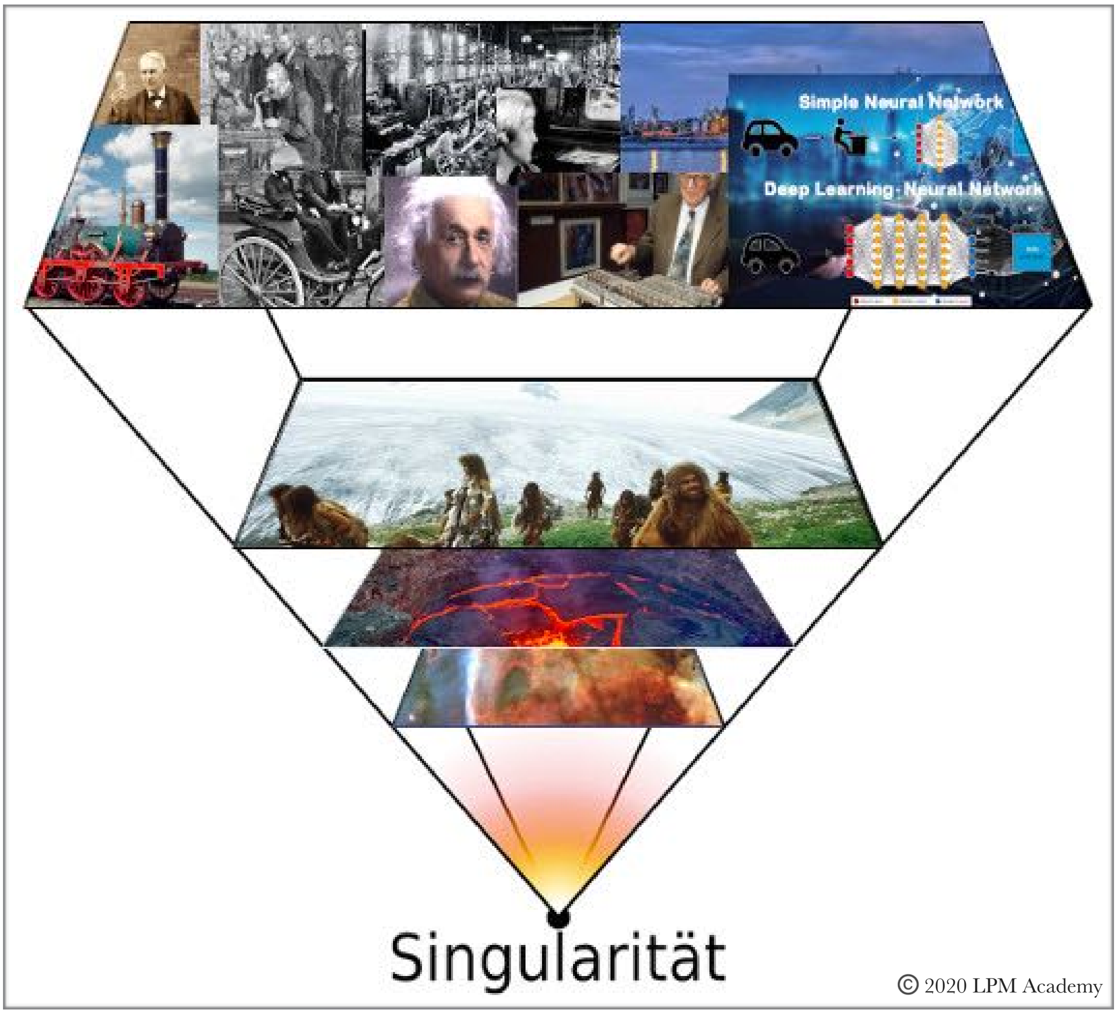
Version 1.1

Retrospective

Vom Urknall bis heute

Time travel of quantum leaps

To understand the TODAY and the FUTURE, let us start with the Big Bang.



In order to better understand the current high-speed development of artificial intelligence and the circumstances that have led to it, we must take a look back. A look back, at the most influential inventions of the last hundred years, which the journal Nature compiled in 1999 in a list. And what was the number one invention made in Ludwigshafen? It was an invention that contributed significantly to the population explosion of 1.6 billion people in 1900 and soon 10 billion people today? It was the Haber-Bosch process, named by the German chemists Fritz Haber and Carl Bosch. The central process, which uses ammonia synthesis at high pressure and high temperatures to extract nitrogen from the air. The nitrogen that the plants need to grow. Without this process, we would not be able to meet the demand for 5 million tons of artificial fertilizer per year today, and the food supply would perhaps be sufficient for 3.5 billion people, rather than the almost 8 billion already. Two out of three people could not exist without this unique invention. It was one of the most important triggers of all trends, the population explosion, and yet, in this century, the explosion of artificial intelligence will be even more dramatic.

Let us imagine the series of numbers 2,4,6,8 ... Which number will follow? The correct answer on an IQ test might be 34, as this is a polynomial. Therefore the nth number is n4-10n3+35n2-48n+24 instead of 2n. Why is it possible that, even if you answer 34 correctly, you will not get any points on an intelligence test? This is because most of the manufacturers of these AI tests judge who finds the simplest descriptions of the data and that would be 2n.

Data analysts from all over the world and the scientific community are working hard to extract simple rules from the ever-increasing amounts of data. For example, it has been shown that each individual shows a sequence of movements when walking that can be clearly assigned to him or her, so that on the basis of this regularity the corresponding person can be assigned precisely. This and many other examples suggest that the history of the entire universe will converge in the near future, namely in the year 2050.

> On the basis of the Omega point described by the philosopher Teilhard de Chardin around 1920, the US physicist Frank J. Tipler concludes with the Omega point theory that the universe, or rather its intelligent civilizations, will be able to increase its information processing capacities exponentially over time before the Big Crunch in the final singularity occurs.

Let us call the year 2050 Omega, a point in which mankind will perhaps experience a new leap in time. The theory of singularity has its origin Omega, about 13.8 billion years ago with the Big Bang.

Now we always take Ω - 1/4 of this time

 ? Ω - 3,5 billion years ➡️ Development of life on earth

 ? Ω - 0,9 billion years ➡️ Development of the first animal-like living being

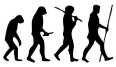
 ? Ω - 200 mil. years ➡️ Development of the first mammals

 ? Ω - 55 mil. years ➡️ Development of the first primates

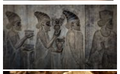
 ? Ω - 13 mil. years ➡️ Development of the first humanoids

 ? Ω - 3,25 mil. years ➡️ Humanoids use first stone tools

 ? Ω - 850 000 years ➡️ Homo erectus uses fire for the first time

 ? Ω - 210 000 years ➡️ The anatomically modern man exists

 ? Ω - 50 000 years ➡️ Today's man

 ? Ω - 13 000 years ➡️ Neolithic Revolutio

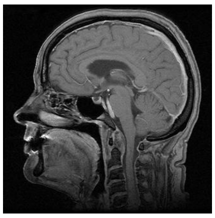
 ? Ω - 3 300 years ➡️ Iron Age

 ? Ω - 800 years ➡️ Invention of gunpowder

 ? Ω - 200 years ➡️ Industrial Revolution

 ? Ω - 50 years ➡️ Information Revolution (2000)

From now on, we'll be in the realm of predictions



❓ Ω - 12 years (2030)
➡️ Very small computers with the brain power of a ... (probably a primate)

Making a prediction here of what all of humanity will do in the future would be like expecting a single neuron in my brain to predict what my brain will think next. To understand each of us, we have about 10 billion neurons in our brains and there are about 10 billion people on this earth.

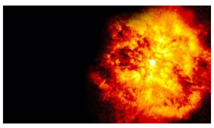
One thing, however, can already be stated with a high degree of probability that we will experience an acceleration of computer performance in every future decade, corresponding to a factor of 100/€.
Ergo:

- in 30 years 1 Billion times faster (at the same price).
- 10 billion times faster in 50 years
- already in the foreseeable future, but it will still take some time, we will have the smallest computers that can do as much computing as a human brain.
- 50 years later, if this development continues, these small computers will be able to calculate as much as all human brains combined. And we will have many of these computers …

🤷‍♂️ Ω - 3 years ?

🤷‍♂️ Ω - month ?

🤷‍♂️ Ω - weeks ?



No one knows where this development will ultimately lead to.

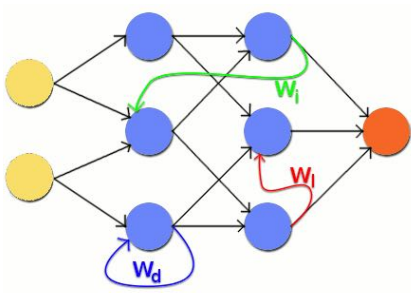
DEEP LEARNING

How and why the AI works

Deep learning is actually just a new term for artificial neural networks. It deals with networks that are structured in a similar way to our brain. Actually, these are rather simple models, but they can require enormous computing power as the model size increases.

A neural network was first presented in 1894 by Olaf Breidbach, a German philosopher, biologist and brain researcher. Today you can read under "Draft for a physiological explanation of mental phenomena" Reprint: Wissenschaftlicher Verlag Harri Deutsch, Frankfurt am Main 1999. The development of models gained momentum in the 80's and 90's when physicists also became involved in this topic. Certainly also because since those years the computing power was at a level where it made sense to consider the first useful applications. Above all, because it was precisely at this time that more and more areas of application for fuzzy logic in the consumer sector became available.

Most neural computers today are so-called recurrent neural network computers.



RNN (Recurrent Neuronal Netzwerk) are learning programs with weighting matrix.

🟡 Input cells
🔵 Feedback cells
🔴 Output cells

In recurrent neural networks, the neurons of the same layer 🔵 or of different layers 🔵 are fed back. These feedbacks allow time-coded information to be extracted from data.

Neuronal networks are very similar to the neuron circuits of the human brain.

With the help of these interconnections it is possible to obtain time-coded information from a set of output data.

The individual neurons (blue memory cells) have an input 🟡, through which they receive information from outside or from other neurons 🔵. Via their output 🔴 they pass on the evaluated or modified information as a result or as input 🟡 to other neurons 🔵.

The output neurons 🔴 are responsible for the transfer of the results to the outside world and can thus directly cause changes in the state of the organism (e.g. changes in state, movements, etc.).

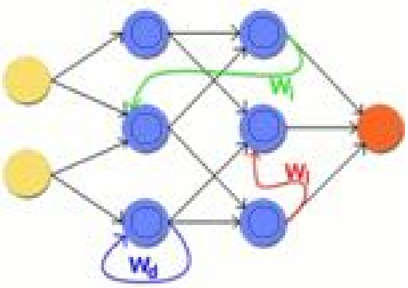
The connections between neurons are called edges. The edges have weightings (hence the term weighting matrix) that control the influence on another neuron. In a recurrent neural network, feedback is also possible between neurons of the same layer 🔵 or previous layers 🔵. The feedback creates circular structures.

Transferred figuratively to the human brain, these artificial feedbacks can be compared to a kind of memory.
The complexity of neural networks is usually due to suitable training methods, because these often require the use of special mathematical procedures. This means that recurrent artificial neural networks can hardly be trained by machine learning methods. For this reason, training increasingly focuses on reading out the network rather than on the actual neural network itself.

Here, too, a comparison can be made with the human learning process, because depending on the task and school subject, there are several ways of imparting knowledge in order to make it more comprehensible. And as in practical school life, one or the other method, more or less, will often lead to the desired success.

As already mentioned, the training of recurrent neural networks is difficult and cannot be mapped by simple methods of machine learning. Thus, local optima can arise from the feedback, which leads to confusing network states. Recurrent neural networks are not able to link distant or distant information.

In order to make these connections possible, the so-called LSTM cells Long Short Term Memory (LSTM cells) are used, as these cells have 🔵 an input and output, a memory and a forgetting gate. This creates a short-term memory that can retain information for a relatively long time and thus remembers earlier experiences. This makes neural networks much more efficient.



LSTM (Long Short Term Memory)

- 🟡 Input cells
- 🔵 Semi-volatile memory cells
- 🔴 Output cells

Semivolatile memory cells consist of:

- Input Gate,
- the memory and forgetting gate (Forget Gate),
- the output gate and
- the interior of the cell with its linking logic.

The entry gate 🔵 determines how and to what extent new values flow into a cell. The memory and forgetting gate 🔵 controls whether information remains in a cell or is forgotten again. The output gate determines the extent to which values present or determined in the cell are to be output. Inside the cell it is regulated how the components interact with each other and how information flows and storage processes are to be controlled. The logic is implemented via neural functions with vector and matrix operations.

Training with large amounts of data and the use of powerful computers with graphic processors have contributed to the success of LSTMs since 1997. Especially neural networks with many layers benefit from Long Short-Term Memory and have helped artificial intelligence to achieve a breakthrough.

A neural network, comparable to the human brain, should not have to start from scratch for every task or problem. It should have the possibility to fall back on already acquired knowledge and already made experiences. For this purpose, the principle of recurrent neural networks was designed. They have feedback loops through which information and already learned knowledge is stored in the neural network. The more layers and complexity a network has and the longer it has been trained, the more interlinked feedback loops are present. In the worst case, this leads to the fact that certain information and experiences in deep layers can no longer be found efficiently. The recurrent neural network virtually forgets them. A Long Short-Term Memory solves this problem. It creates a kind of long-lasting memory of former experiences that can be easily found in the neural network.

In contrast to recurrent neural networks, Long Short-Term Memory LSTM must be constructed and be so "intelligent" that it knows how long an old piece of information is to be stored, when something is to be forgotten, what the cell is to remember and how links are established between stored knowledge and new information. To do all this, the LSTM cell consists of four individual components.

These semi-volatile memory cells therefore consist of:

- Input Gate,
- the memory and forgetting gate (Forget Gate),
- the output gate and
- the interior of the cell with its linking logic.

Over time, different types of Long Short-Term Memory architectures have evolved, which I will not go into here in detail.

The recurrent neural network model and Long Short Term Memory presented here therefore represent only two of the 27 most common network models, but they are probably the most widely used ones at present.

Today, almost every mobile phone has a fully functional and sophisticated neural network for speech recognition integrated into it by Siri or Alexa, depending on the operating system provider.

Typical applications of recurrent neural networks are:

Recurrent neural networks are suitable for simple pattern recognition. They are able to process more complex sequences, such as handwriting recognition, speech recognition, translations, tumor recognition, and predictions of weather or stock prices.

Typical applications for Long Short Term Memory are:

In the field of Artificial Intelligence, there are numerous applications that make use of neural networks with Long Short-Term Memory. For some years now, large technology groups such as Microsoft, Apple, Google or Baidu have been using LSTMs very intensively. Various products are based on basic LSTM components.

Google applications and products with Long Short-Term Memory are for example speech recognition on smartphones, smart wizards and the intelligent translation program Google Translate.

On Apple devices, applications such as intelligent keyboard functions or the personal voice-controlled assistant Siri benefit from LSTM technology.

Amazon uses the Long Short-Term Memory for its Alexa Assistant.

A very well known example of the use of LSTMs is the gaming software AlphaGo from Google. It was developed by Google DeepMind and was the first to beat professional go players with artificial intelligence.

Google's TensorFlow Processing Units (TPUs - TensorFlow Processors) are specifically designed to accelerate machine learning by efficiently processing LSTMs..

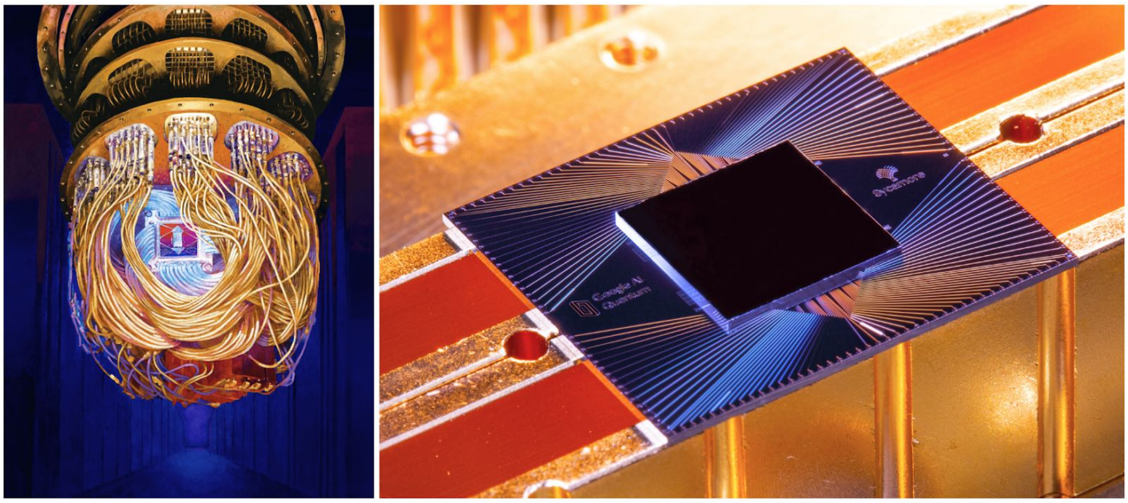
Quantum Computing

The unstoppable leap into the future

Google has made a great leap into the future of AI with its approach to test a first usable quantum computer for its reliability and resilience.

For over 30 years, physicists have been talking about the power of the quantum computer, but the questions have always been: Will it ever do anything useful and is it worth investing in? The extremely pragmatic approach of American corporations, namely to formulate short-term goals, was beneficial to this request. Short-term goals that show whether designs are heading in the right direction. To this end, Google has set itself important milestones to answer these questions in an experiment. The project, described by Google as a quantum superiority experiment, set the direction for the team. It had to overcome the many technical challenges of quantum systems technology and design a computer that would be programmable and powerful enough. To test the overall system performance, a sensitive computational benchmark was chosen that would fail immediately if only a single component of the computer was not good enough.

The impressive results of this quantum superiority experiment were published in October 2019 in the Nature article "Quantum Supremacy Using a Programmable Superconducting Processor" by authors Frank Arute, Kunal Arya, John M. Martinisim.



Source: Google AI Blog Oct. 2019

The result was a new 54-qubit processor called "Sycamore", which consists of fast, high-resolution quantum logic gates. In the benchmark test, "Sycamore" performed the target calculation in 200 seconds, and from measurements in the experiment it was determined that the world's fastest supercomputer would take 10,000 years to achieve a similar performance.

What will happen after this successful project?

The team around Frank Arute, Kunal Arya and John M. Martinisim has two new main goals for the future. These are aimed at finding useful applications in quantum computing. **First,** Google will make these processors available to top-class collaborative partners and academic researchers and companies interested in developing algorithms and finding applications for today's Noisy Intermediate-Scale Quantum (NISQ) processors.

After all, creative researchers are the most important resource for innovation now and in the future.

With this first NISQ processor, Google hopes to attract researchers to enter this new field to find applications.

Secondly, Google is investing in this technology to build a fault-tolerant quantum computer as quickly as possible and expects to develop a number of valuable applications from such devices.

Examples:

Quantum computers could help in the development of new materials to create lightweight batteries for cars and airplanes. Another goal is to develop new catalysts that could make fertilisers even more efficient (a process that currently accounts for over 2% of global carbon emissions). We are also currently experiencing the complexity of producing more effective drugs for the CONVID-19 virus. Here, too, the new hyper-fast quantum processors are expected to lead to significant progress.

In order to achieve the necessary computing capacities, there are certainly years of hard engineering and scientific work ahead of us. But we can now see how rapidly the journey is moving forward and where it could take us.

Current research and development:

In July 2020, a Spanish, Italian research team led by Francesco Giazotto from the National Enterprise for nanoScience and nanoTechnology (NEST) in Pisa realized for the first time a quantum-phase battery, an essential component for quantum computers. With the quantum-phase battery technology, which was theoretically predicted as early as 2014, the qubits (i.e. the information carriers) in quantum computers with superconducting circuits can not only be switched individually to different states by phase differences, but also combined to form quantum gates. These quantum gates correspond to the logic gates of classical computers. They generate output signals from input signals according to certain rules and thus perform basic logical operations.

The basic principle is similar to that of a classical battery, in that a permanent phase difference is created between two points in a superconducting circuit. Just like a voltage is generated in a normal electric circuit.

Giazotto's team now wants to improve the component so that the phase shift can be specifically adjusted and the quantum-phase battery can be easily integrated into circuits.

This is another important step towards making quantum computers easier to use.

Even the US company Honeywell, which actually mainly produces building technology and aircraft parts, attracted attention in March 2020 with a functioning quantum chip. Honeywell's team in Boulder near Denver plans to present the "most powerful quantum computer in the world" as early as summer 2020.

IBM has even made it out of the laboratory with its quantum computer: The IT company is offering the first commercial quantum computer, which is soon to be installed at the company's German headquarters near Böblingen.

Until now, many quantum chips have only functioned just above zero temperature. This barrier is also moving up a bit.

The first prototypes, such as Google's Sycamore quantum computer, are still stuck in vacuum chambers and huge cooling units that cool the hardware to minus 273.05 degrees. This means that they operate just 0.1 degrees above absolute zero.

The journal Nature reports from two groups around Andrew Dzurak from the University of New South Wales and Menno Veldhorst from Delft University of Technology that they have now made quantum chips work at a temperature 10 to 15 times higher. This means that they still need extremely frosty minus 271 to 272 degrees, but this would make it possible to reduce the size of the cooling units considerably.

Instead of superconducting circuits (Google) or atomic hulls trapped by magnetic fields (IBM), the researchers use the spins of electrons as the basis of their quantum computer.

This has the advantage that the chips can be made of silicon. They could therefore be combined comparatively easily with ordinary computer hardware in the future.

AI stirs up fear of the unknown

According to the IW trend report of spring 2019, in which 686 managing directors from industry and industry-related service companies in Germany were interviewed, companies using AI have invested an average of one percent of their turnover in the technology in the last two years.

However, the IW trend report also shows that 71 percent of the companies surveyed are not currently working with AI and do not intend to do so in the future. 40 percent of companies that do not use artificial intelligence even consider AI to be a threat to their own business model.

However, companies that have experience with the technology are much more receptive to AI than others, notes study author and digitisation expert Vera Demary in the report.

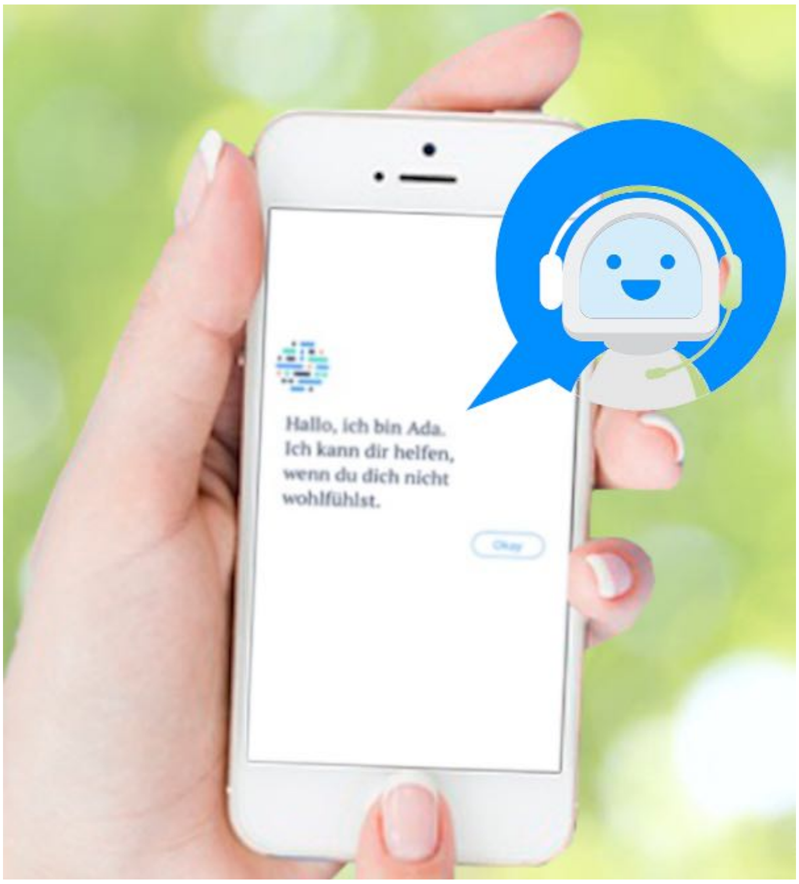
The Deloitte study "Intelligent Automation" from spring 2019 also attests to a high degree of unused potential in terms of Artificial Intelligence (AI). Although 58 percent of the executives surveyed with automation strategies stated that they use intelligent automation solutions, AI plays no relevant role in their automation strategy for almost half of the respondents. The study shows that companies that actively include artificial intelligence in their automation strategies achieve greater sales growth (8.5 percent) than companies that rely solely on robotics process automation (2.9 percent).

I hope that my contribution and the many examples of best practice attached will help to overcome the remaining fears of contact and build up acceptance, in order to encourage companies to consider the possibilities of using AI in their companies already today. According to the two studies quoted, this seems to be the very reason why industry is still waiting and sometimes even rejecting AI.

Best practice examples for AI from all industries

Medizin - „Googeln“ was yesterday:

As the authors Kuhn, Sebastian; MME; Jungmann, Stefanie Maria; Jungmann, Florian in PP 17, issue July 2018 already reported, chat bots based on artificial intelligence, available as smartphone apps, will revolutionize anamnesis and diagnosis in medicine in many ways.



AI chatbots can serve as decision support in the diagnosis and therapy process or take on a pilot function in the health care system. Photo: LPM Academy

The systems already available today, such as Ada Health, Babylon, Buoy etc. will bring about an even greater change in the medical profession, which is already increasingly undergoing digital transformation. A special use will be given to artificial intelligence in the context of anamnesis and diagnosis. Above all, AI chatbots can access the entire stored medical knowledge that is being researched. In addition, both the data of the digital fitness meters already available today and the medically oriented speech and image analyses will provide valuable additional parameters already during anamnesis, which will enable even better diagnostics.
After all, a survey among radiologists revealed that 72 percent of those surveyed said they regularly use their smartphone or tablet for medical research. Satisfaction with the current range of products available in popular app stores was also indicated as still relatively low.

ADA for doctors and systems with connection to laboratory parameters, as well as systems with automatic recognition of X-ray images or MTR evaluations are currently being tested in studies.
Cross-institutional examples such as data mining and radiomics, histological and genetic evaluations for diagnosis or prognosis are also already being tested in studies.

A wide range of applications will affect the entire medical field and change it dramatically.

In general, it is worth considering the additional use of simple font bots or complex digital voice support with access to back-end systems (Conversational AI) at all touch points where requests or information are often repeated.

Application fields of artificial intelligence		
Area	AI applications for...	Best practices
Production	Smart factoring: networked computerization of manufacturing technologies	Siemens: Electronics plant Amberg Kuka: Model factory for robots Bosch: self-learning system for the production of brake control systems
Services	Customer service: improvement and/or simplification as well as automation and/or do-it-yourself concepts of services	IBM: Chatbot Watson Talanx: Voice Analytics for personnel selection Ailira: legal advice system Weather Online Bot: individualized weather information Language assistants Alexa, Siri, Bixby etc.: perform digital actions

Services	Marketing and sales: Predictive analytics, recommendation algorithms, context marketing, conversational commerce, website analysis/optimization, social listening, media planning, dynamic pricing, content creation and distribution	Netflix: Recommendation algorithms and personalized content Eye Quant: Evaluation of the visual impact of websites ArgumenText: Text evaluation Otto Group: Aggregated Reviews Lucy: AI platform for media planning Wise Athena: AI agent for award and promotion decisions
Office	Sales: Order management, contract analysis portfolio of products and services: Data analysis, in the search for digital twins, customer value analysis, credit checks and AB tests. Project management: risk analysis	Watson: Analyzes legal contracts Siri, Alexa: Voice input simplifies work and reduces effort AnyLogic: Product portfolio management, production simulation
Governance	Treasury Department: Patent Office: BKA:	Analyses for wage and income tax Automation in search and patent administration processes Project Integer: AI to support police analysis
Retail	Promotion management, product range design, procurement and logistics	SO1: Data-driven promotion campaigns Amazon: Anticipatory Shipping Amazon Go: cashless shopping Zalando app: digital object recognition/photo search and matching with Zalando shop

Public Health	Support and replacement of classical diagnostics, support and replacement of classical therapies	Watson for Oncology: cancer detection Digitsole: smartphone controlled shoes Panasonic: HOSPI Robot Ada Health: Diagnostics Ada for doctors: Diagnostics
Energy / Smart Home	All stages of the energy supply value chain, smart grids, smart meters, smart homes, smart cities	Google/Deep Mind: Prediction of supply and demand peaks Viessmann/Haustechnik: Heat subscription IBM/Elderly Care: Elderly care supported by IoT sensors Zen City: Evaluating/transferring citizens' statements into urban decision-making processes
Mobility / Transport	Intelligent logistics solutions for efficient, resource-conserving, low-emission transport as well as transport infrastructure and mobility	About: Linking vehicles in use Door Dash/Marble: Restaurant delivery service with robot support JD, Amazon and DHL: Parcel delivery by drone
Service and maintenance	Predictive maintenance, predictive servicing	TÜV Nord: Monitoring of bridges and pipelines using sensor-based strain gauges Nespresso app: machine remote control, capsule order, maintenance reminder
Security / Social Scoring	Face/image recognition for control/monitoring/scoring purposes, predictive analytics for police work	Face++ Cognitive Services: User recognition for presence/liveliness/admission/legitimacy/behavioral checks Predictive Policing Software
Education and Human Resource Management	Training and further education, personnel management	Carnegie Speech: Language learning system Linkedin/Lynda: Online training for managers Thyssenkrupp: Data glasses for service technicians MoBerries: Chatbot-based job platform

Financial Services	Workflow automation: consulting, verification processes, contracts, credit scoring, fake/fraud detection, robo-adviser, high-frequency trading	JP Morgan Chase: Contract Intelligence Platform Gini Machine: credit assessment BKA: Prognosis systems for fraudulent behaviour Deutsche Bank/Robin: automated asset management
Marketing	Eyetracking for landing pages as well as for video verification (refineAI)	Google: Analytics Facebook: Trend
Creative industry	New creation, support of creative processes, translation systems, imitation and style transfer, reconstruction of destroyed art and cultural assets	Lexus: AI-based commercial First-person shooter game "Fear":AI-based opponents Amper Music: AI-composed utility music Prism: Style Transfer App TensorFlow: digital face transfer Amazone: AWS from Translate to RoboMaker Google AI: Developer Platform and others Deepfake detection E-Puzzler: Document reconstruction Deepl: translation software

Ethics

One more train of thought is allowed at the end. Nobody wants to stop this development, because it would be useless anyway and maybe even negligent. For we are facing challenges of unprecedented proportions if we are to take the results of climate research seriously and reduce the unavoidable effects to a level that can be influenced.

But these developments are progressing so rapidly that we should be careful to give society the opportunity to follow these events. For science, this means preparing and communicating its findings in such a way that even those who are not so deeply initiated can understand the basic principles. Only if society as a whole is able to follow the basic principles to a large extent will it be possible to set the right political and educational course.

Thus, a multitude of ethical questions arise, which are waiting for an answer from our society. These answers will tell us whether we will enter a new artificial and - or intelligent era of human history.

The extra-occupational LPM Academy focuses on the Lean Program approach to support companies in integrating new available methods, techniques and foreseeable developments quickly and effectively into corporate strategies.

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