KPMG

Rethinking the value chain

A study on AI, humanoids and robots

TREND ONE

Artificial intelligence: Possible business applications and development scenarios to 2040

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The beginning of a new era

We are at the brink of a technological turning point. And, as is the case with any radical change, the opportunities and risks are being fiercely debated. That is how it must be. A look back through history demonstrates that humanity has often stood at the brink of such turning points. From the invention of the letterpress and the 'Swing Riots' protest movement in the 1880s through to the rise of mobility for all, internet technology, and the newest developments in artificial intelligence, all technical revolutions seem to follow the same dramatic structure: there is always great uncertainty about what the achievement in question will mean for humanity and productivity. But, in the end, progress cannot be stopped.

Artificial intelligence (AI) — used here as an umbrella term — has the potential to become the most important technological innovation of the coming decades. And the concerns about artificial intelligence are nothing new. But now they are being sharpened by achievements in other technological fields — such as more efficient processors and memory, rapidly-increasing volumes of available data and continuously improving algorithms — which are enabling further development at completely new levels.

Given this fast-paced rate of change, it's no longer a question of whether AI will disrupt our coexistence. The real question is how fast and how radical the change will be. Based on current developments, it can already be assumed that 'weak' artificial intelligence will be changing the way we live and work within the next five years. To what extent 'strong' artificial intelligence (artificial intelligence with its own consciousness) will ever be possible remains an open question (though, for this report, we hypothetically presume the possibility when presenting our future scenarios).

Exciting times are on the horizon. We hope this report inspires you and we encourage you to join us in discussing and designing what will essentially be the future of mankind.

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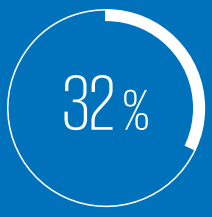
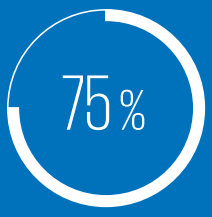
Psychological speech and text analysis conducted through AI technology

PRECIRE® is a technology that identifies patterns in spoken and written language using artificial intelligence to identify linguistic, psychological and communication-related characteristics. Specific text patterns (word combinations, word sequences and sentence structures, for example) are recorded and analyzed with natural language processing methods. Objective prediction models are then trained using these patterns and high-quality reference data sets. These predictions can then be pooled to deliver significant added value for different entrepreneurial disciplines (HR, CX, E-Health etc.). We used this technology to analyze our Foreword (in native German) across three dimensions. Here are our results:

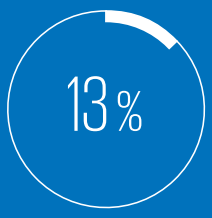
stimulating



open-minded



balanced



Foreword: Autonomous thinking

"Man cannot discover new oceans unless he has the courage to lose sight of the shore."

André Gide (1869–1951), French author

The future is not made, it is imagined. Nothing else influences our future like thoughts and ideas — the constructive, groundbreaking and (so far) autonomous thinking of individual people.

This may not be the case in the future; artificial intelligence learns quickly. Very quickly, as Google's AI AlphaZero shows: it achieved superhuman capabilities in the games of chess, Shogi and Go in less than 24 hours. With this latest achievement, hardly anyone doubts that technology has the potential to radically change our world. And that is what makes this topic so interesting, attractive and controversial. With increasing pace, we are approaching the point where machines will start to develop and improve themselves, performing many tasks faster and safer than humans could. How will this impact the economy and productivity?

If you want to understand AI and its implications for productivity, you first need to understand what AI means, what is possible today and how potential future scenarios may evolve. This report is designed to help you achieve that. We reviewed more than 300 AI business and trend cases and cataloged them along a standardized value chain. We chose the most interesting of these cases at each point in the value creation chain to provide insight into the wide variety of possible applications. We also took a further step: using our four detailed future scenarios, sketches of potential future daily routines (portrayed in our futuregrams) and an 'opportunities radar', we provide an extensive overview of the various aspects and the potential of these new developments.

Much of what you will read below may seem like science fiction. But consider this: the pace at which science fiction turns into science facts is breathtaking when it comes to AI.

If you are interested in knowing what the future may hold, we would encourage you to read this report and reflect on the scenarios and findings. Together, we can re-imagine the way value is created and turn the potential of innovative technology to our benefit.

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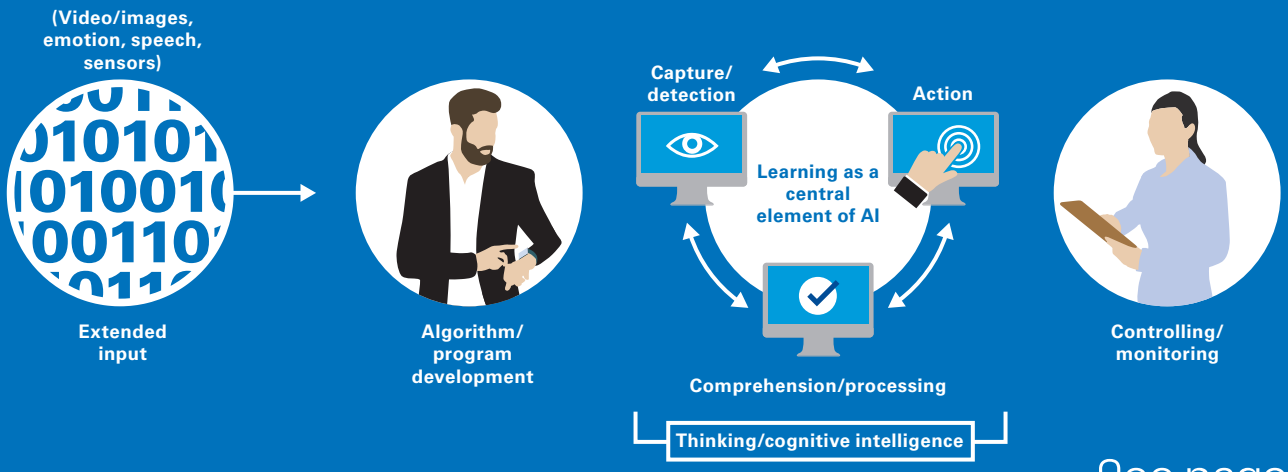
At a glance

How artificial intelligence affects the economy and our lives.

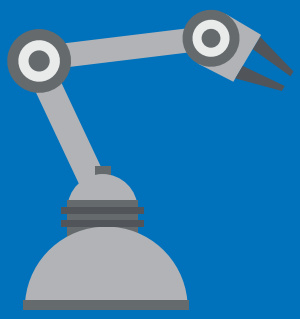
AI is an umbrella term for technologies that enable a computer to perform tasks that would normally require human intelligence.

How artificial intelligence changes the process



See page 10

Potential of AI at each value creation stage



Development and innovation
Supply chain
Production
Procurement
Organization/administration
Safety
Customer service
Finance department
Management
Human resources
Marketing
Sales

See page 22

Increase in the number of business and trend cases captured by TRENDONE over the past three years

See page 23

What do we want life to be like in 2040? Today's decisions are creating our future!

Potential scenarios for a world of strong artificial intelligence

Scenario I: New land of milk and honey

Scenario II: Thinking without limits

Scenario III: Red button era

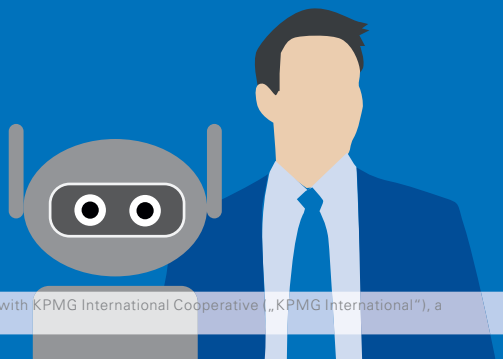
Scenario IV: Powerless society

See page 40

Companies are already seeing massive benefits from AI. What are you waiting for?

See page 70

Tomorrow's economic success will be closely linked to artificial intelligence. Indeed, the foundation for future competition is already being put in place today. And it cannot be stopped. Act now to secure the opportunities of the future.



01

Understanding artificial intelligence

An introduction to artificial intelligence (AI)

"Humans oppose things because they do not understand them."

Abu Hamid al-Ghazâlî (1058–1112), distinguished Islamic scholar

Those responsible for long-term corporate decisions cannot only look at the past and present. They must also study possible future developments. This is especially true when it comes to the opportunities and challenges associated with the use of artificial intelligence. Progress in this field will have a decisive impact on the world in the years ahead.

That is why we believe it is time to confront the issue of artificial intelligence proactively and passionately. This study aims to help decision-makers determine which aspects they should consider when it comes to their company and future value creation. Due to the complexity of the topic, we have selected to address the technologies upon which artificial intelligence is based (and their associated social and political aspects) in a neutral manner where required to help improve understanding. In the first part of our report, the term AI generally refers to weak AI and implies the combination of different technologies.

Definition

AI is an umbrella term for technologies that enable a computer to perform tasks that require human intelligence.

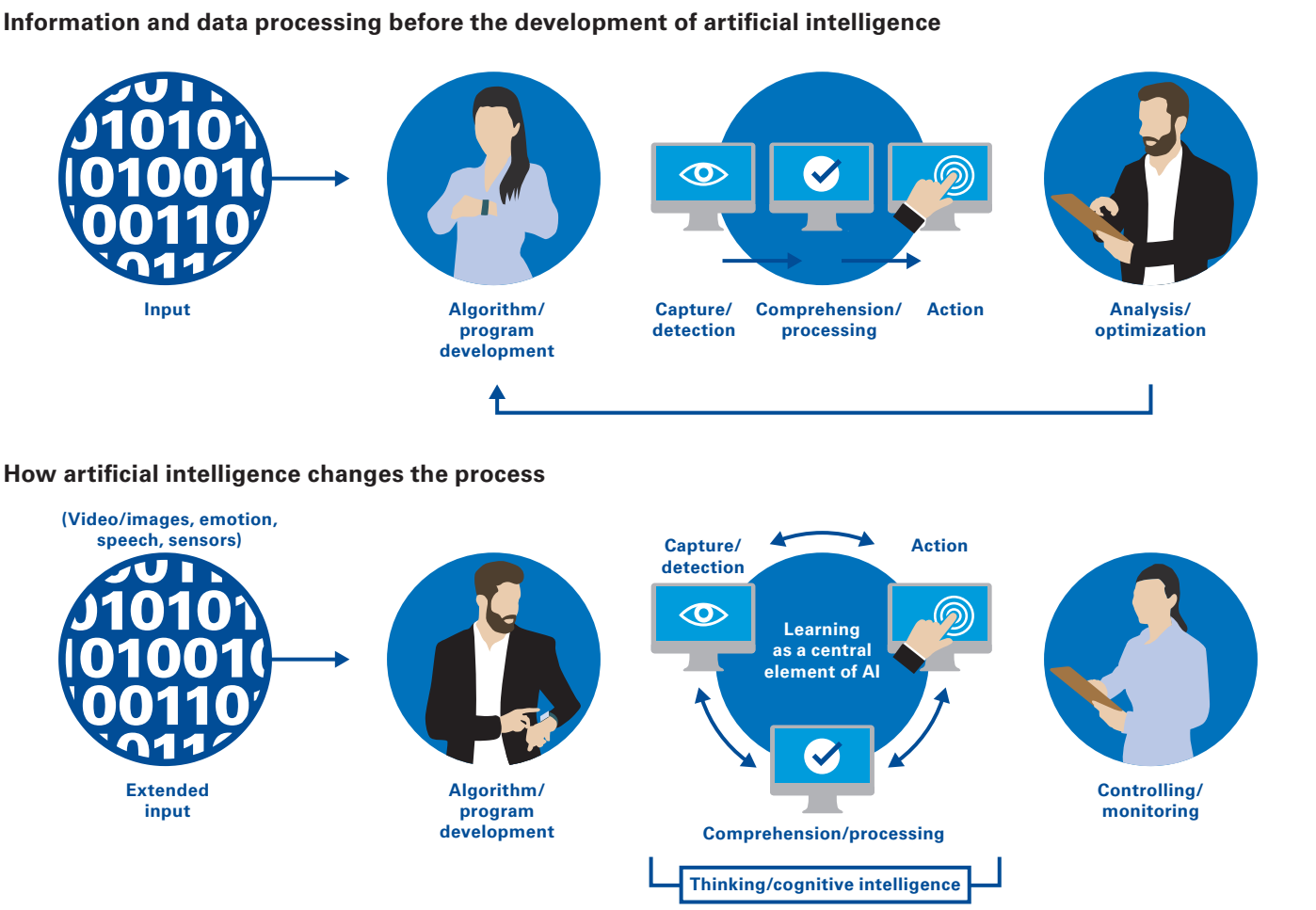
This definition includes the following aspects:

— The ability to gather structured and unstructured information and data in ways that are similar to human perception or senses (Sense)
— The ability to comprehend and reasonably process the information and data (Comprehend)
— The ability to act accordingly (Act)
— And — perhaps most importantly when describing AI — the ability to autonomously learn based on data and the support of training and feedback (Learn)

Food for thought

AI does not necessarily need to simulate human intelligence. It could, just as easily, take other forms or paths. For example, you don't need wings to fly; it was just the principle that humans copied from birds. The point is that AI could proceed in ways that we don't yet know or understand. And, if that happens, control will be difficult or impossible.

Figure 1: Why artificial intelligence changes everything (a simplified view)



Source: KPMG in Germany, 2018

Generally speaking, weak and strong artificial intelligence are differentiated:

Weak artificial intelligence ... supports human cognitive processes by solving individual, distinct specific problems.

Strong artificial intelligence ... has (at least) the same cognitive capabilities as humans meaning the system has its own cognition. Strong AI will thus be able to capture and process whole topics in their full complexity. Another term for strong AI is 'Artificial General Intelligence'. It would be capable of forming autonomous decisions and could, for example, handle and even show emotions. To date, there is no known form of true 'strong' artificial intelligence.

Good to know:

The breakthrough of AI applications is based on developments in the following areas:

- availability and accessibility of large data volumes, as a basis for learning
- improved algorithms for the analysis of data
- computing capacity and more efficient memory

Discussion: Can we really identify strong artificial intelligence?

The following aspects are central to the understanding of human intelligence:

— Sensorimotor intelligence = The use of the human senses
— Cognitive intelligence = The acquisition and use of knowledge
— Emotional intelligence = The recognition of feelings (such as grief, anger, happiness or sorrow)
— Social intelligence = The perception of group behavior (such as project teams, parties, etc.)

Currently, artificial intelligence can primarily be found in the area of cognitive intelligence and, to a lesser degree, in the sensorimotor area. Autonomous emotional and social intelligence, is currently not achievable artificially. Nevertheless, there has been significant debate over the past few years about whether it will be possible to categorically identify strong artificial intelligence in the future. Until recently, academics often used the Turing test to understand the challenge.

— **Turing-Test:** In this test method, named after mathematician Alan Turing, a person talks with another person as well as with an artificial intelligence for an extended period of time without visual contact. If the test person is no longer able to differentiate between the human and the machine, then the artificial intelligence has passed the test.

— **Chinese room thought experiment:** However, many experts now deem the Turing test to no longer be adequate. As proof, they refer to the thought experiment of the 'Chinese room' developed by John R. Searle.[1] It suggests that the pure processing of programs and symbols is not an indication of intelligence if the symbols have no meaning and the story that they tell is not comprehended by the respective individual or AI.

(Chinese room thought experiment setup: A person who does not speak Chinese sits in a room. The person is handed a note in Chinese that is supposed to be translated. The person receives instructions as to where and how information for the translation can be found in the room and the text can be translated successfully using this information. Nevertheless, the person inside the room still does not speak Chinese.)

Did you know:

... that variations of the Turing test are now used when surfing the web? The so-called CAPTCHA programs (which stand for Completely Automated Public Turing test to tell Computers and Humans Apart) are often used to differentiate between humans and machines on the internet. It's the test you need to pass when you receive the request, for example, to "mark all images that show a car."

Strong AI or overextended systems?

These thoughts seem more relevant today than ever before when talking about AI.

Dialog between two bots[2]:
As first reported by Fast Co.Design, Facebook researchers turned off an AI system after they realized that two of their bots were 'communicating' in a language incomprehensible to humans. 'Bob' and 'Alice' were originally trained in English but, over a short period of time, developed their own, more efficient language. It sounded like this:

Bob: "I can can I I everything else."

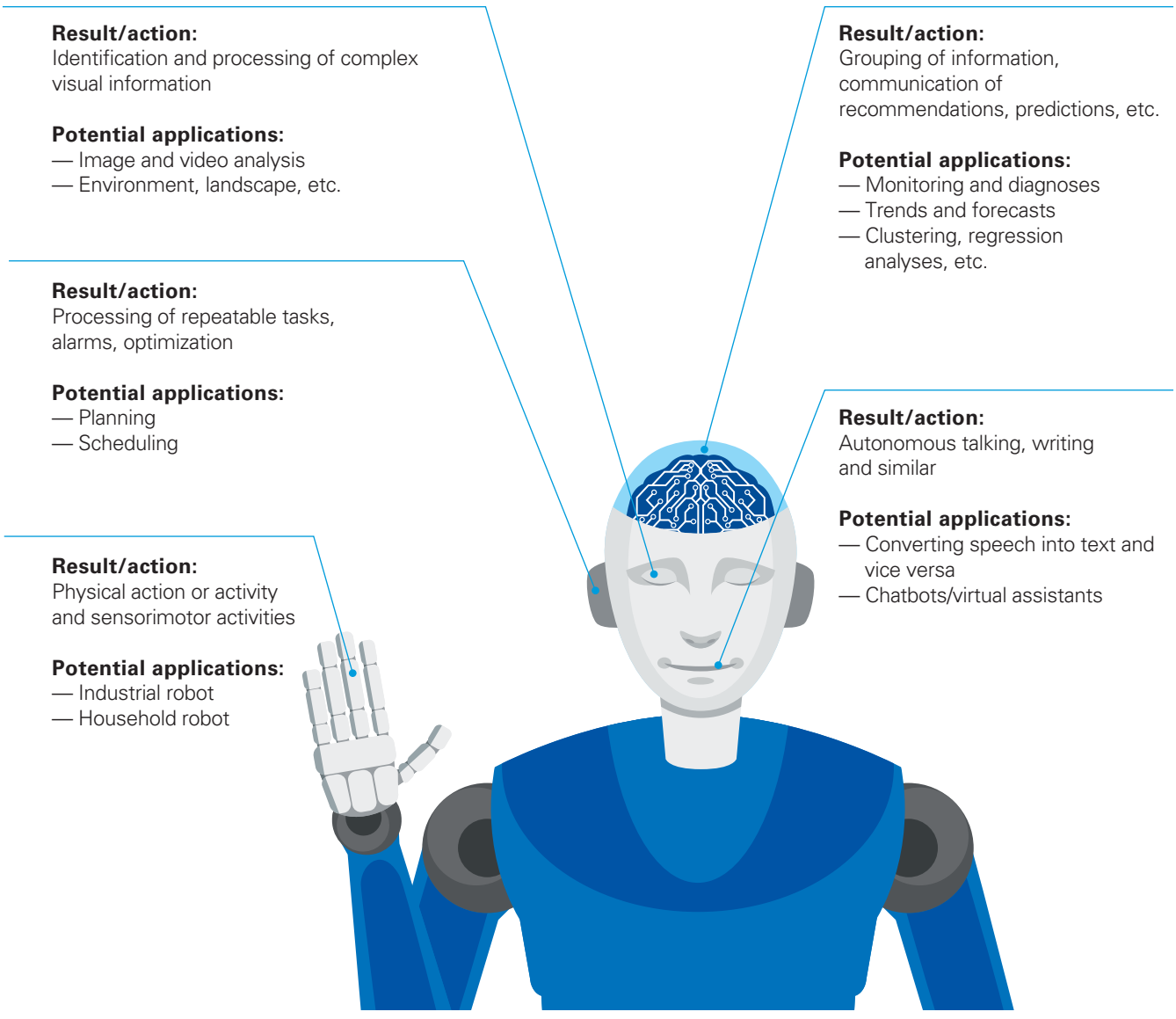
Alice: "Balls have zero to me to me to me to me to me to me to me to me to."

Areas of application for artificial intelligence

Artificial intelligence aims to comprehensibly map human intelligence. Even if this is still wishful thinking (at this time), AI already surpasses human capabilities in some areas today. By definition (see page 10), the following aspects are relevant for human-like, intelligent acting: perception of the environment; comprehension of the captured components; targeted, reasonable action; and learning based on the underlying information.

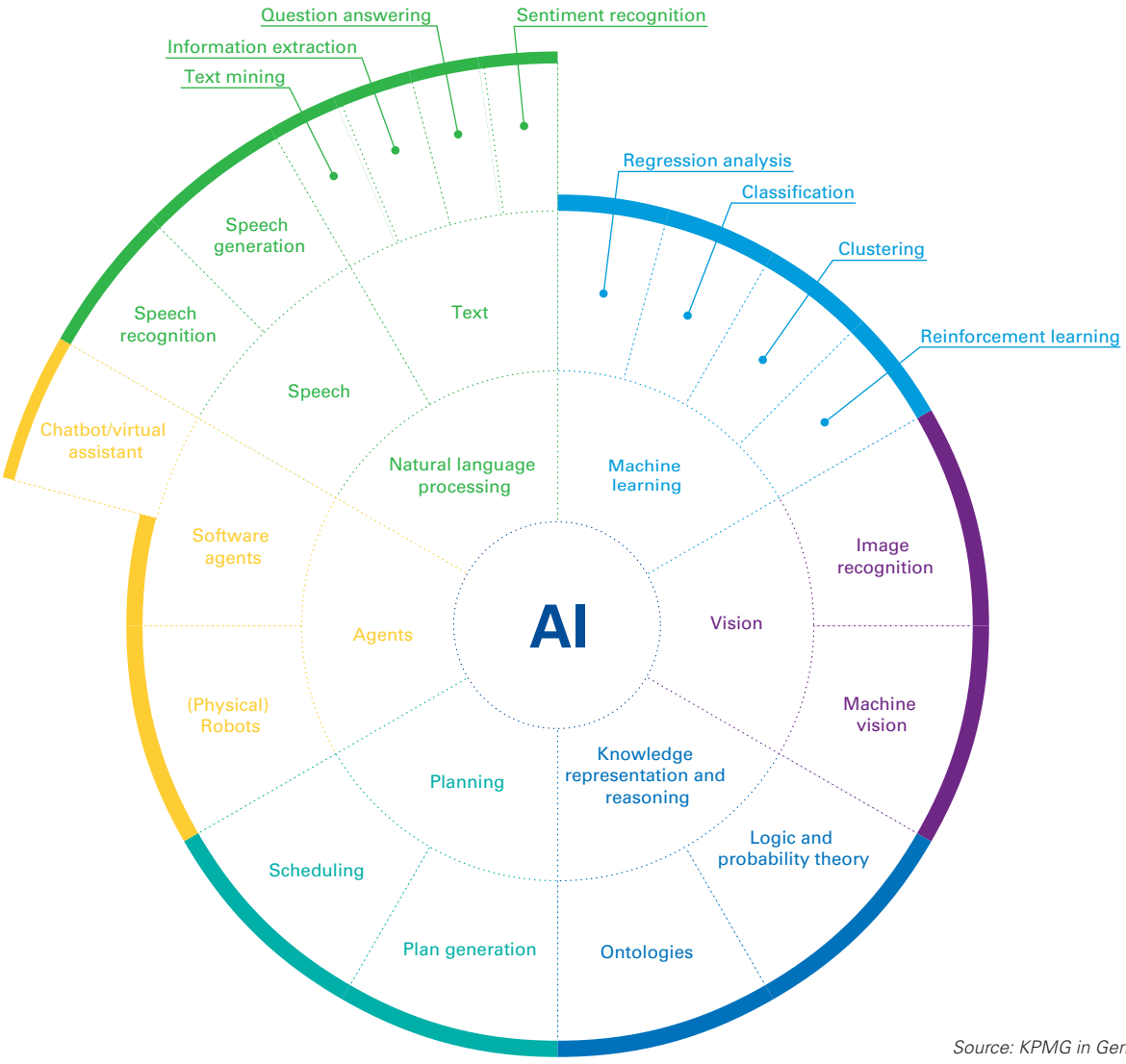
The combination of these aspects leads to a practically endless number of applications for artificial intelligence. The following is therefore a very simplified and incomplete list of some of the most important potential applications of AI and their related results and actions.

Figure 2: Areas of application for artificial intelligence



Source: KPMG in Germany, 2018

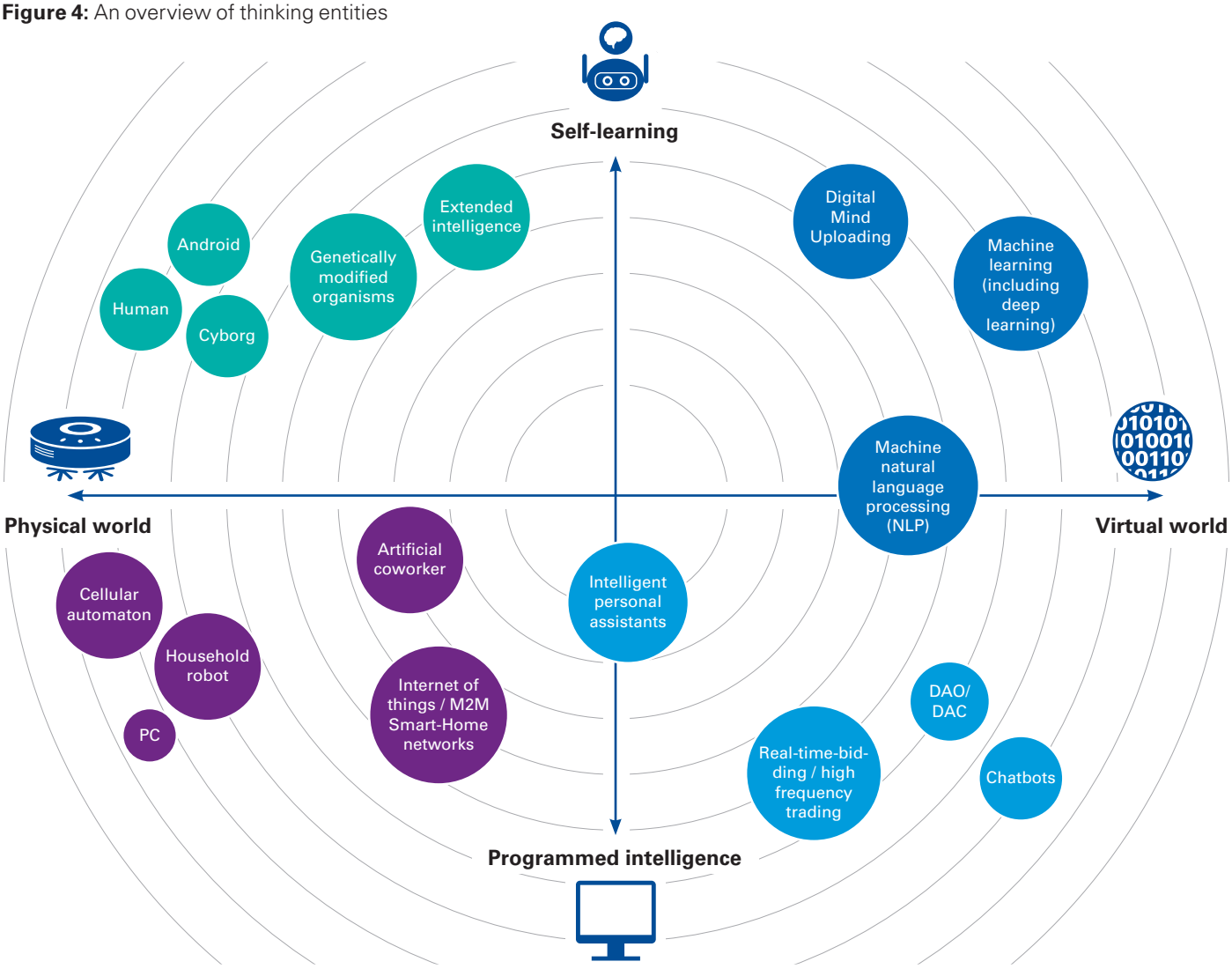
Figure 3: Overview of current AI subdisciplines



Source: KPMG in Germany, 2018

Outlook: Currently, the term AI always refers to weak artificial intelligence. However, given the fast pace of technological development, it must be assumed that artificial intelligence will need to be more broadly defined in the future. Indeed, there may be a variety of thinking entities soon — strong intelligence could then include humans, hybrid forms (with electronic implants, prostheses, etc.), autonomous artificial intelligence or even fully artificial life forms (such as the first synthetic bacterium)[3]. Figure 4 offers a small sample of current and possible future forms based on a study conducted with TRENDONE.

Figure 4: An overview of thinking entities



Source: TRENDONE, 2018

If you still cannot imagine the possibilities, you should meet Sophia.

Sophia illustrates just how far the work on creating human-like robots has already progressed. She was introduced in 2017 and she amazes with her very realistic human facial impressions. Saudi Arabia granted her citizenship as the first AI robot in October 2017[4].

Illustration: Wiki Commons

Discussion: Perspectives on artificial intelligence

“Votes go by number, not weight.“

Pliny the Younger (61 or 62–113 A.D.), Roman politician and author

You can’t talk about current and future AI developments outside of a strategic debate. You need to look beyond your own backyard to find the decisive exchanges that come from intense and in-depth discussion with many experts. The same is true here: the more numerous and varied the opinions you gather, the more meaningful the insights you uncover. That is why, for this report, we have asked experts from various fields for their assessment on the future of AI.

Expert interview

"If all people had the opportunity to work more creatively again because AI applications relieve them of routine tasks, then we would experience value creation the likes of which we have never seen before in our lives."

Three questions for …

… Dr. Holger Kömm

Question 1: How do you describe artificial intelligence? Artificial intelligence is not new. In fact, people have been studying it for 60 years. The applications that we call artificial intelligence today were only made possible through developments in computer sciences and algorithms; the comprehensive datafication as part of digital transformation; and technological progress in the field of in-memory computation. We often refer to so-called weak artificial intelligence today. Those are systems and applications that learn and act autonomously, but must follow set rules and specifications.

Question 2: Is strong artificial intelligence possible in your opinion? The current public discussion is mostly characterized by the fear of true strong artificial intelligence. That is, a fear of an AI that recognizes emotions and develops its own consciousness. I do not expect to see this form of strong AI in the next couple of years since it cannot be achieved with the rigidly defined methods that are currently used. In my opinion, true artificial intelligence can only develop in an environment that is free of rules and where algorithms are allowed to perish or mutate.

Question 3: What are your recommendations for those dealing with artificial intelligence? Applications of weak artificial intelligence (as currently seen) will push us to go from causal to correlative decision-making. But, since weak AI applications are capable of making mistakes or, in the worst-case scenario, being manipulated, we have to develop a stable value system if we want to stay on the right path, even if wrong micro-decisions are made. This will be one of the central challenges for economics and politics in the coming years and decades. ■

Dr. Holger Kömm

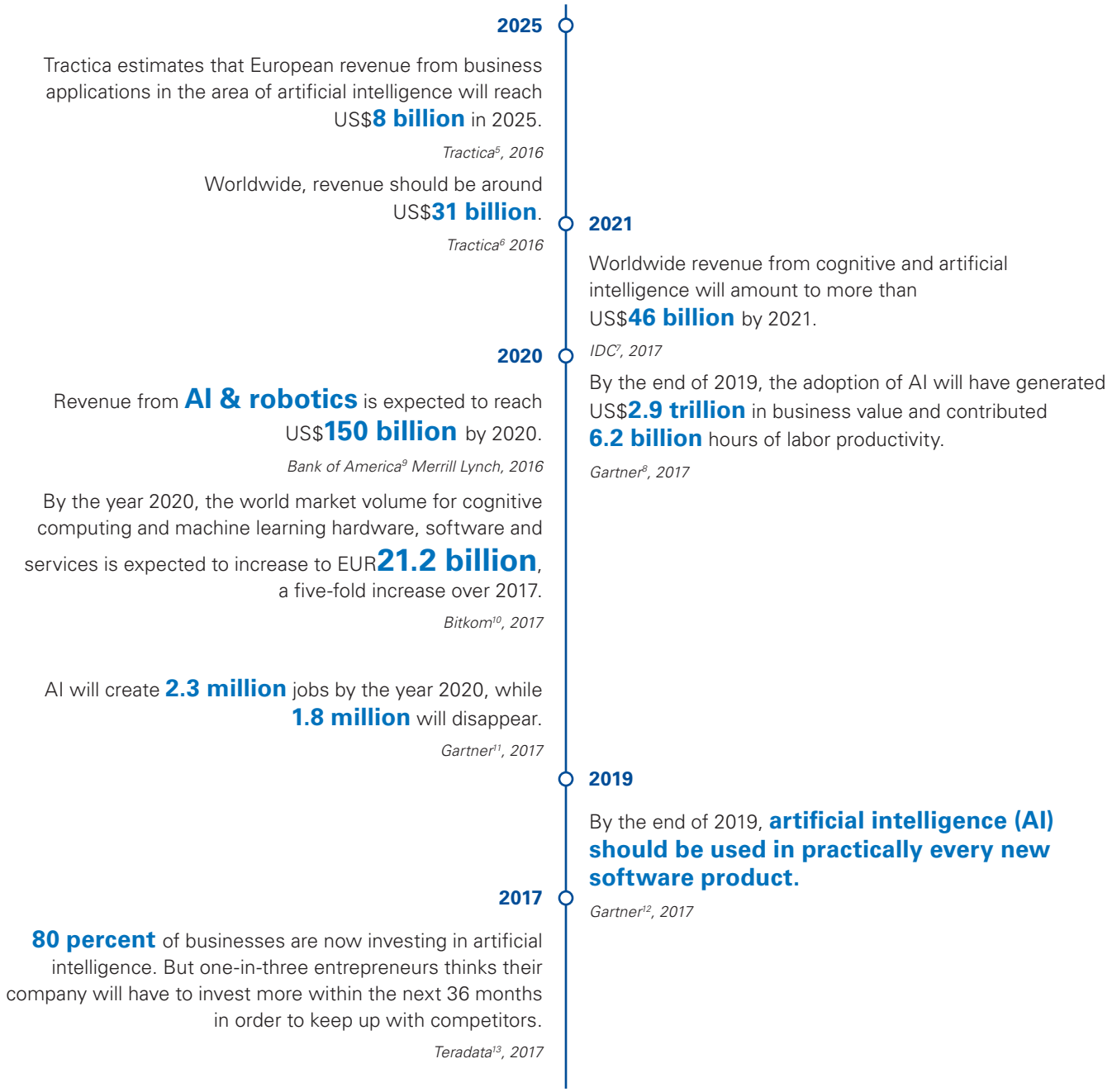
Director Data Science Lab, adidas Group

Following an apprenticeship as a banker, Holger Kömm studied business mathematics at the Catholic University Eichstätt-Ingolstadt where he received a doctorate from the Faculty for Statistics and Quantitative Methods of Economic Sciences under Prof. Dr. Küsters. Dr. Kömm's focus is on time series econometrics, volatility models and AI-based forecasting. Aside from his research-oriented work, Dr. Kömm has extensive practical application experience as director of the adidas Data Science Lab.

Potential applications of artificial intelligence

As with all new technologies, it is nearly impossible to confidently predict the overall potential of AI. However, in order to offer a well-rounded view of future developments and their possible effects, we compiled a range of analyst and corporate assessments of the revenue potential of AI applications. What we found was a range of opinions on how the monetary potential of AI could be identified.

Figure 5: Anticipated revenue potential of AI applications



There is ample evidence to suggest that big data and automation applications can enable significant cost reduction and growth potential for companies. The same is true with respect to the use of artificial intelligence, as demonstrated in a recent study by KPMG International entitled *The Changing Landscape of Disruptive Technologies*.[14]

In that report, decision-makers identified artificial intelligence as one of the top technologies, pointing to a number of advantages (see Figures 5 and 6).

Figure 6a: Economic benefits of using artificial intelligence

1. Higher efficiency and productivity	28%
2. Reduced costs	16%
3. Increased profitability	14%
4. Faster innovation cycles	10%
5. Improved customer acceptance and loyalty	9%
6. Faster speed to market	9%

Source: KPMG in Germany, 2018

Figure 6b: Potential benefits of 'digital labor' applications for businesses

Cost efficiency

According to some estimates, the cost of a robot is about one third that of a full time human equivalent. Digital labor savings are estimated to be between three-times and ten-times the cost of implementing automation.

Consistency/ predictability

It is expected that accidents, rule violations and fraud will be reduced.

Employee satisfaction and innovation

The elimination of everyday, repetitive work routines will release human creativity which can then be applied to creating and promoting innovation.

Productivity/performance

Robots work around the clock, 365 days a year; they do not take vacation; and they perform tasks with superhuman speed.

Quality/reliability

Software does what you tell it to do — if it is configured correctly, it does not make mistakes and, thus, eliminates human errors.

Scalability

Robots scale efficiently and therefore react well to digital workloads. There are no problems with overtime, no challenges during recruitment and no expensive training efforts.

Source: KPMG in Germany, 2018

02

Artificial intelligence today

Business and trend cases

“Art lives on constraint and dies of freedom.“

Leonardo da Vinci (1452–1519), Italian philosopher and inventor

Artificial intelligence will gradually change all areas of our lives. Its influence can already be seen in economic life today.

In this chapter, we take a look at the economic impacts of artificial intelligence and discuss at which value creation stages the new technologies are already being used. To provide a well-rounded basis of information for this study, we looked at more than 300 AI business and trend cases, selected from a multitude of different sources (including TRENDONE and KPMG) between 2015 and June 2017. For more information on the methodology used, please see page 72.

The analysis confirms that the economic potential of AI applications is immense. And the potential uses are developing at an unbelievable pace. Above all, the perspectives of recent deep learning applications appear to inspire the imagination of developers, particularly in areas such as image recognition. These new opportunities have paved the way for the development of a wide range of application variations — across industries and functions — over the past few months. Besides production and IT, customer-oriented sectors are expected to increasingly benefit from the opportunities associated with artificial intelligence.

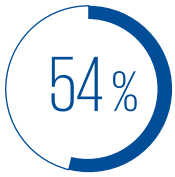
Below, you will find a selection of AI business and trend cases (pages 24-35) that represent various value creation stages and business divisions such as production, procurement and customer service. We also look at the number of new business and trend cases being tested in Figure 7. These offer a practical view of the influence AI applications will have on individual sectors. You may want to compare your own perspective with the outlook provided by our specialists in the respective topic area. We hope that this comprehensive approach helps you see the potential implications of artificial intelligence and identify the greatest possible benefit for your company.

For a more complete picture we recommend reviewing the business and trend cases in conjunction with the chapters on scenarios and opportunities that follow.

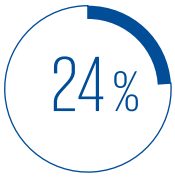
Figure 7: At a glance: Business and trend case analysis

Allocation of business and trend cases to the value creation stages

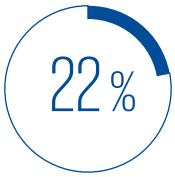
(Industrial manufacturing, banks, insurance, consumer markets)



Front office: Marketing, sales, customer service



Middle office: R&D, supply chain, procurement, production

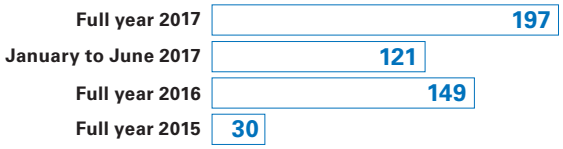


Back office: Management, finance, human resources, security, organization/ administration

Publishing period of business and trend cases

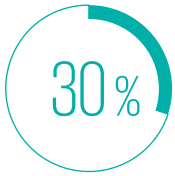
There has been a strong increase in the number of trend cases, particularly over the past few months. More than 120 trend cases were published between January and June 2017.

There was already a strong increase (to 149) in the number published in 2016.

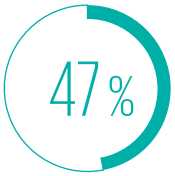


Use of different AI applications

Overlaps between the types of application are possible.



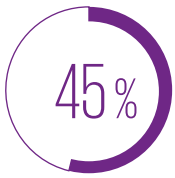
Chatbots or virtual assistants are used in 30% of the business and trend cases.



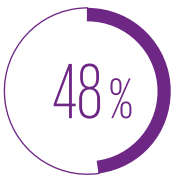
Sensors, including image recognition, are used in 47% of the cases.

A physical device/robot is part of the development in 13% of the cases.

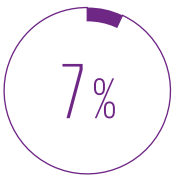
Applications for AI in B2B or B2C settings



45% of the AI applications can clearly be allocated to the B2B sector.



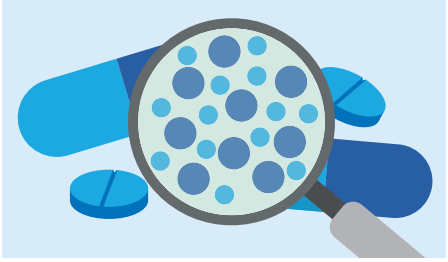
48% are focused on the B2C sector.



7% are designed for the B2B as well as the B2C sector.

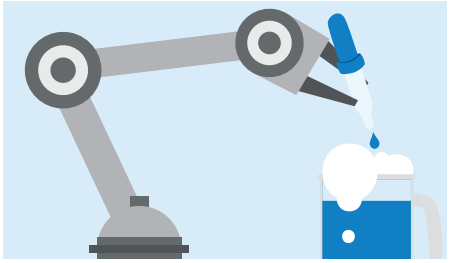
Source: KPMG in Germany, 2018

Development & innovation



Analyzing molecular structures for new medicinal products

Start-up Atomwise has designed a deep learning software tool called AtomNet, which analyzes molecular structures for their potential medical uses. The generative model processes large data volumes and uses rules and simulations (written by chemists) to learn how to generate plausible data. It can also be used to determine how various molecules react and bond to each other. This has allowed research costs for the development of new medicinal products to be drastically reduced.[15]



A beer brewed to individual tastes

The London brewery IntelligentX Brewing has created four types of beer whose formulations can be adapted to the tastes of the customer by using artificial intelligence. The company uses a chatbot which asks the participating customer, via Facebook Messenger, about their general preferences and tastes. The answers are evaluated by an algorithm which, over time, enables more and more specific questions. The results are transmitted to the brewers, who can then consider these immediately for the individual formulation.[16]

Material-saving design of the 'Elbo' chair

Designers at the Autodesk Generative Design Lab have used the CAD software, Dreamcatcher, to design the Elbo chair. The goal was to create a model that used as little material as possible. First, a preliminary 3D model of the chair was created. Then, the designers defined how much weight the chair should be able to withstand as well as the desired distance between seat surface and floor and the material properties. With this information, Dreamcatcher created hundreds of drafts which were narrowed down to a selection by the designers. The final design used 18 percent less material than the initial design. This approach is also extremely suitable for 3D prints.[17]

Source and other trends: www.Trendexplorer.com

Outlook:

Development & innovation is an essential cornerstone of any company's future success. Indeed, companies will only survive if they manage to develop innovative products that meet the needs of customers. Artificial intelligence can help analyze the potential for success and identify new potential for business ideas right from the start. Promising ideas can then be quickly identified and promoted.

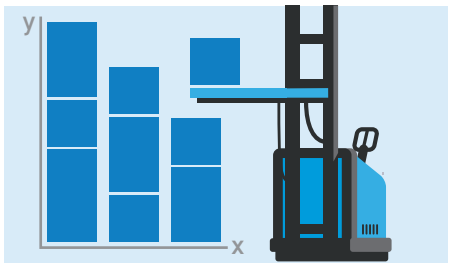
It will also become easier to determine customer requirements using artificial intelligence in the future. Instead of complex and cost-intensive market analyses, potential customers can be addressed directly and included in the development of the new product functions. Customer Drive Innovation will lead to more active interactions between customers and companies, with social media sites serving as key communication channels (as the IntelligentX Brewing example above demonstrates).

In the future, algorithms will handle the design of the functions as part of the construction. That will allow the optimal concept to be determined through the simulation of hundreds or even thousands of possible solutions.

Supply chain

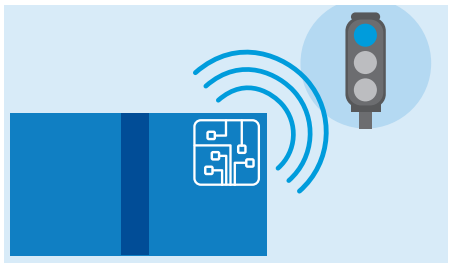
Self-learning logistics software

The Amazon Development Center in Berlin is working on a technology for machine learning that is meant to simplify and automate logistics processes. The goal is to use AI to develop software that not only reacts to external data such as customer and employee experiences, and input but also identifies and learns routine tasks autonomously. This technology could be used for the efficient packaging of products in the future, for example. It is also suitable for forecasting required quantities in various logistics centers.[18]



Artificial intelligence for warehouses

Hitachi has developed an AI that is meant to improve operating processes in warehouses and increase efficiency by 8 percent. The AI is integrated into the existing IT systems and analyzes all of the available data to uncover important insights such as identifying fluctuations in requirements and adapting work orders accordingly. The technology also analyzes employee workflow and calculates their efficiency. This allows alternative procedures to be integrated into the work process under similar framework conditions, if applicable.[19]



Supply chain optimization

Hamburg-based start-up, Evertracker, is focusing on sensors and artificial intelligence to increase the efficiency of supply chains. They equip their customers' entire supply chain with sensors. The processes are then analyzed based on internal and external data to identify weaknesses such as delays and future shortages early on. Artificial intelligence is used to automate and optimize the process steps based on the data obtained.[20]

Outlook:

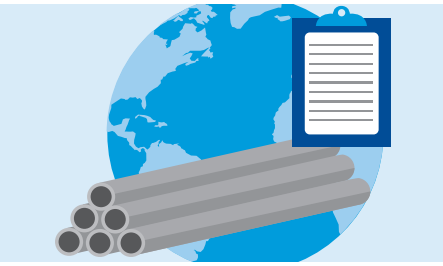
Supplier dependency is a big challenge for logistics and the supply chain. It just takes one small part to be missing for the conveyor belts to shut down. Artificial intelligence can help significantly reduce these uncertainties and mitigate these risks with lower costs.

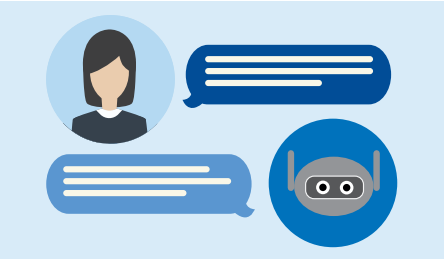
Predictive analytics can help identify possible delivery problems across the supply chain. Artificial intelligence can help uncover patterns and simulate various scenarios.

Among other things, this can help ensure that the goods are available at the right time, in the necessary quantity and at the desired location.

Our research suggests that the entire logistics process (delivery, storage, ordering, etc.) will eventually be managed autonomously and monitored via sensors. The use of AI will make it possible to predict arrival times precisely, and the delivery of incorrect goods can be prevented.

Procurement





Data classification in strategic procurement

KREO, a tool by KPMG, helps organizations automate the evaluation of transactions and master data already available by using AI. Both master and transaction data can deliver savings potential by improving supplier identification and automating the classification of demands and decisions based on trusted data. Another AI can be used to continuously monitor the market environment. At the same time, a web crawler can use predefined keywords to search online sources to find trends, innovations and events in the supplier market. In the second step, the AI autonomously performs a sentiment analysis and classifies the selected articles by product group or topic. User feedback and machine learning algorithms also help to continuously improve the search so that strategic procurement can examine the most relevant information for analysis and decision-making.[21]

Contractual support

SAP Leonardo and IBM Watson aim to make contract law more intelligent and comprehensive. Supported by AI, the applications should automatically indicate relevant terms and conditions, which are adjusted to the legal requirements. Using benchmarking data, similar contractual conditions can be Identified for specific raw materials and optimum prices can then be proposed based on the expected quantity and contractual discounts. SAP Ariba and IBM can also provide support for tasks such as defining the correct Request for Proposal type or identifying suitable suppliers for participation in the tender based on raw material category, region or industry.[22]

Chatting with Tradeshift's Ada, the procurement expert

Tradeshift's Ada is an AI-based program that supports buyers. Users simply enter their questions or requests into a chat and Ada provides the appropriate answer. The interface gets to know users and companies better and better over time, so that many procurement tasks (and tasks owned by other teams involved in B2B procurement) can eventually be automated. Ada should be able to understand purchasing preferences, activate apps automatically and provide users with catalogue information. In addition, it can analyze expenses, complete advance purchase inquiries and link release workflow with the collaboration tool, Slack.[23]

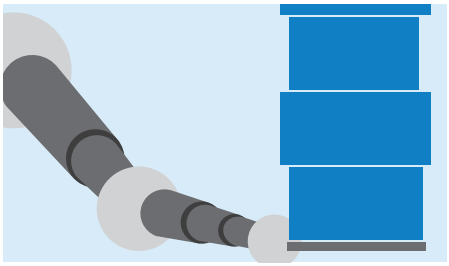
Outlook:

The optimization of procurement via digitization — and, thus, the use of artificial intelligence — has been an important topic for a long time. Procurement, in its role as the 'ruler of the costs' in the company is, by definition, a driving force for efficiency and cost awareness. Both goals are easier to achieve using artificial intelligence.

Procurement could also position itself as a pioneer in the implementation of artificial intelligence by serving as an interface between suppliers and internal customers. The function could also serve as the access point for internal and external data.

Finding the first beacons of AI in procurement is easy: you can already see the use of AI in many manual and operational activities such as three-way-comparisons, the completion and review of master data, or the creation of purchase reports. Looking out further, new benefits such as the entire negotiation of conditions, the virtualization of supplier visits and the definition of product group strategies by robots is not beyond the realm of possibility.

Production

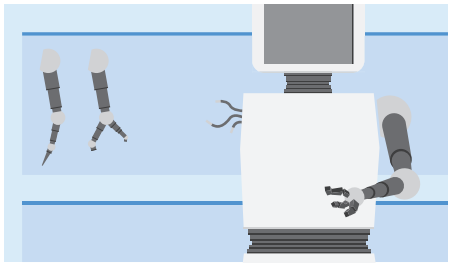


Self-learning robot arm

Researchers at the Technical University of Darmstadt are working with partners to develop a self-learning robot arm that can act as a third human hand. The novel robot arm is meant to take over the exhausting and repetitive tasks of experienced specialists, so they can focus on applying their know-how and creativity. The robot arm is expected to learn motion sequences through imitation and human instruction. It should then be able to adapt this knowledge to various situations autonomously. To support this, individual motion units (called Movement Primitives) were coded, generalized and implemented.[24]

Fault detection by sound

Working with a number of auto manufacturers, the US company OtoSense has created software that uses deep learning to detect possible defects based on vehicle noises. The software is trained to locate specific noises and then to react to, for example, a motor problem or other defects in real-time. In the future, is should also be possible for the software to listen to traffic noises through, say, a windshield microphone and react appropriately in response. The software is meant to increase safety, especially for autonomous driving.[25]



Exoskeleton Robo-Mate

European researchers have created a robot suit, which helps factory workers carry heavy loads. The exoskeleton, Robo-Mate, consists of an active trunk module, which is adapted to the human form to reduce the compression stress in the lower back. It can also be equipped with different complex extensions for arms and legs. Robo-Mate can also be equipped with barcode readers, RFID (Radio-Frequency IDentification) or other systems for capturing components for the control of production processes. Visual recognition and virtual reality in the form of heads-up-displays support user orientation while wearing the suit.[26]

Outlook:

These three case studies clearly demonstrate the massive potential that artificial intelligence offers on the production floor. Robots, which can be trained using easily accessible (production) data, are already taking over not only time-intensive and repetitive tasks but also complex production steps.

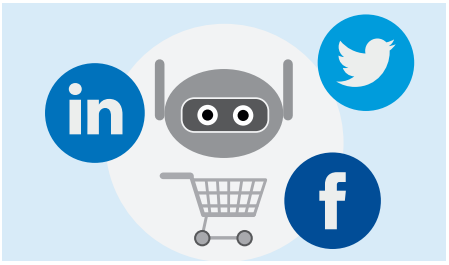
This allows companies to both reduce headcount costs and increase production quality at the same time. Artificial intelligence can also be used to support quality assurance, allowing defects to be identified quickly and safely through pattern recognition and deep learning.

In the short term, we expect to see robots continue to support humans on the production floor, largely by taking over heavy and repetitive work. But if organizations are able to collect data on their current manual production steps, they should eventually be able to hand those over to robots, too. The robots can then use AI to detect where humans need support and then provide it. This will soon go beyond simply helping with the execution of physically strenuous and repetitive work to expand into a system of intelligent interaction between humans and robots.

Management

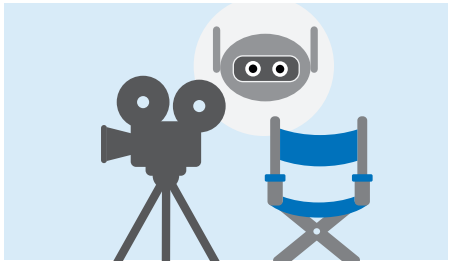
Assessing the potential of business ideas

The service Test4Startup uses AI to allow users to check the viability of a business idea in advance. Users outline their idea in an online form. Then Test4Startup creates a report which contains a variety of useful data including the potential market size, investor activity in the respective segment, the most important competitors (with their strengths and weaknesses), as well as suggestions for improving on the business idea. The analysis costs US$10 in the basic version.[27]



Marketing for an online shop

The e-commerce company Shopify has developed a virtual marketing assistant named Kit that helps users operate and market their online shop using text messages and other messaging platforms. Shop owners are asked key questions at certain points in the process. Kit is able to write customer emails, advertise Instagram photos or put up Facebook ads. It also sends updates to store managers to tell them what items have been sold and at what quantities. Partners can expand their services with artificial intelligence using either a software or programming interface.[28]



Creative Director

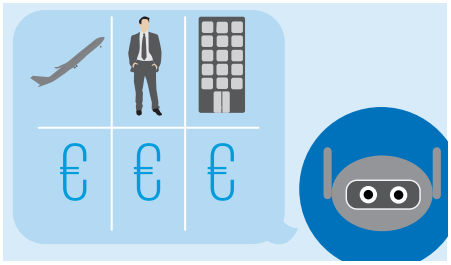
McCann Erickson Japan has appointed an AI named AI-CD β as a new Creative Director. The application was developed by the agency as part of the Creative Genome project. AI-CD β is meant to help decide the creative lineup for TV commercials using historic data on previous ads and data from the winning ads from of the All Japan Radio & Television Commission Confederation's CTM Festivals. AI-CD β will work on actual client projects for the company, developing creative ideas that are logical extensions of previous successful TV commercials.[29]

Outlook:

Strategic, analytical and creative expertise is in high demand in management functions. And, today, experience, vision, empathy and courage are considered to be the characteristics of a good manager. Since these are very individual personality traits, we do not expect to see a fully autonomous AI application in this area in the foreseeable future. But artificial intelligence does offer great potential when it comes to basic management knowledge: AI offers a significantly more comprehensive and detailed basis of data for decision-making.

Management will also be responsible for considering the ethical and regulatory requirements for the use, development and compliance of AI applications. In the future, management may also be required to help structure the relationship between strong artificial intelligence and human employees.

Finance department



Automated billing with Clear

US start-up, Clear, has developed a credit card that uses artificial intelligence to help simplify expenditure control for small businesses. By using Clear, an entrepreneur can, for example, interact with the platform via chat to obtain information on the current financial situation of the enterprise. Clear can also allocate statements automatically to specific purposes. For example, if the user asks Clear about the cost of a business trip, the platform identifies all associated costs and presents the total sum. The system also tells the user if there are large deviations from spending limits or from previous months.[30]

On the pulse of the financial market

Swiss company Sentifi, using its Sentifi engine, is working to analyze unstructured financial market data and uncover new connections using artificial intelligence. The data is generated by the Sentifi Crowd, a large network of financial experts. Sentifi users can find out what trends are being seen in the relevant markets and how companies they have invested in are performing. In turn, the companies learn how the Sentifi Crowd assesses their performance and future development.[31]

Optimization of invoice receipt processes

KPMG is currently developing an intelligent account assignment robot designed to optimize the invoice receipt process. Relevant information such as supplier details, invoiced products or services are automatically read after the invoice has been electronically received or scanned. The program uses a machine learning algorithm to analyze historic transactions and creates a proposal for the account assignment of each invoice. If there is a high degree of certainty, the posting occurs fully automatically; if there is any uncertainty, the account assignment proposal is routed to an administrator for validation.[32]

Outlook:

Artificial intelligence offers huge opportunity to the finance department and CFO. On the one hand, the finance department still needs to manage their regular responsibilities in controlling and optimizing processes. That's where AI will help deliver clear efficiency improvements by automating accounting and reporting processes and significantly increasing the quality of planning processes using sophisticated prediction models.

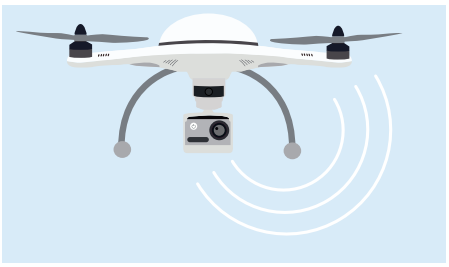
On the other hand, the finance function will also need to take on new tasks. They will be responsible for using all available data — not just financial data — to provide early insights on any aspects that might influence the business strategy and performance, to deliver a closer look at potential competitors, and to identify suitable solutions and measures. One of the ways to deliver on these expectations would be through mining social media and monitoring start-ups to identify competition-relevant business ideas.

What is clear is that AI will change the finance function significantly. It will no longer be seen as just a finance and cost manager, but rather as a technological pioneer in process automation and an important voice on strategic issues.

Security

Detection of cyber attacks

Working with startup PatternEx, researchers at MIT have developed an IT security system called AI² which is intended to detect cyber-attacks through the combination of human and artificial intelligence. In preliminary tests, AI² was able to identify 85 percent of all attacks and reduce the number of 'falsely identified attacks' by a factor of five. Attacks identified by AI² are reviewed by a human analyst and this feedback is used by the platform's 'virtual analyst' to adapt the detection model and thus improve its detection rate.[33]



Monitoring with robots and drones

Otsaw Digital has combined an autonomous security robot and a monitoring drone to create a holistic security system called O-R3. The ground-based robot is controlled by machine learning algorithms that guide the robot through the premises to help it avoid obstacles. It also uses facial and object recognition to see if anything seems out of place. The integrated drone can be launched by the robot to monitor from the air if necessary. The data from both the robot and the drone are transmitted in real-time to a control center monitored by humans.[34]

Edge body scanner

US-based Evolv Technology has developed the Edge body scanner that can perform a security check on travelers at airports in just one second. The system combines traditional airport scanning technology with computer vision and machine learning. The scanner takes a photo of the traveler, the AI-based system analyzes it and, if the system finds something unusual, the results are immediately sent to security staff by tablet.[35]

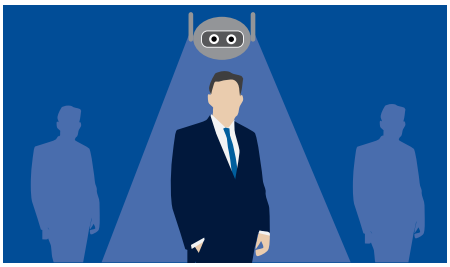
Outlook:

As these examples illustrate, AI applications could deliver significant value to the security sector. AI can be used to quickly analyze very large volumes of data at a depth of complexity never experienced before. And this can allow attacks to be detected early on. Routine security inspections can also increasingly be outsourced to AI, thereby providing employees with more time to address complex situations.

However, security is also one of the greatest sources of controversy when it comes to AI. And, indeed, there are few other technologies that demonstrate the risk of technology more clearly — just thinking about autonomous suicide drones, for example. Ethics is a very critical part of this debate and is becoming more important as AI moves into consumer applications and concerns about 'customer transparency' increase. That is when human lives become involved. So, it is imperative that we question what might be possible (like autonomous weapons or self-driving cars), what developers and companies should take responsibility for, and how the technologies should be monitored. Politicians, business leaders and regulators will need to work together to find joint solutions as quickly as possible.

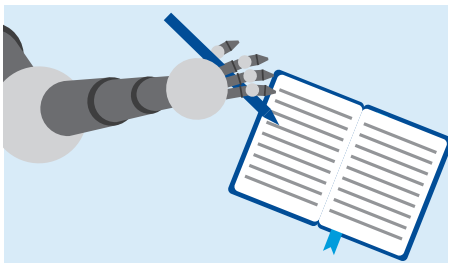
At the end of the day, human acceptance of artificial intelligence will highly depend on how much we trust the data, the processes and the AI control systems.

Human resources



Supporting the applicant selection process

Recualizer is an application that aims to help large human resource departments and under-staffed startups by eliminating the need to sort through each job application individually. Recualizer works in four steps. First, the employer determines the framework conditions of the job. Then, the system generates various assessment tasks which are adapted to these requirements. Once all applicants complete the tests, the employer can use the evaluation results to identify the most suitable candidates for interviews.[36]



Creation of training documents

Developers at the Georgia Institute of Technology have developed a program called Scheherazade IF Interactive Fiction. The program uses crowd-sourced data to autonomously create interactive stories. It learns genre-typical characteristics based on other notable texts and uses that data to, for example, help game developers create new story lines that build upon the movements of a player. If sufficient data is available, the system can achieve capabilities similar to those of humans. Besides video games, the technology can also be used to develop online courses and corporate training.[37]

App puts 'HR in your pocket'

OCBC bank in Singapore has launched a smartphone app that uses a chatbot to answer employee's questions about human resource issues. The 'HR in your pocket' app accesses the HR department's information system, enabling the chatbot to provide answers tailored to the respective employee. This includes, for example, applications for work absences and charge-back claims as well as internal job openings. The application is meant to relieve workload in the HR department and increase its productivity.[38]

Outlook:

AI applications will significantly change the way HR departments work — and not just five years from now. Indeed, the transformation has already begun. On the one hand, artificial intelligence offers great potential with respect to the selection of applicants. A comprehensive overall picture of a potential employee can be formed faster by using AI applications, since factual information as well as soft factors (such as capacity for teamwork) can easily be determined through tests. There are already many companies in this sector that use freely-available data from the internet to support the human resources department in the search for new employees. And this enables HR departments to improve their recruiting efficiency.

AI can also be an important tool for employee training — especially in combination with VR/AR applications. Training, development or advanced education measures can be shortened, intensified and optimized through the use of appropriate AI applications. For example, training scenarios could be developed to be highly repeatable and consistent, yet also adaptable to the needs of the trainee by using virtual reality and artificial intelligence.

AI applications can also make all HR administrative tasks easier — from the generation of contracts, to the monitoring of time allocations and vacation times. However, most HR departments are still only in the early days of digitizing their processes.

Clearly, the type of employee working in human resources departments will change in the medium term. Administrative tasks are increasingly disappearing as job experience and the ability to communicate become more important. Top-class applicants want to be taken care of and impressed by a human, not a bot.

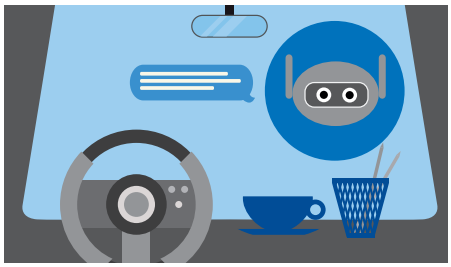
Organization/administration

Visualization of contractual contents

Ontario-based start-up Beagle has launched a platform that visually illustrates contractual contents based on user preferences. Beagle reads contracts with the help of artificial intelligence and creates visualizations of key areas. The respective paragraph is shown when the user clicks on the graphics. The platform also enables employees to share individual elements with colleagues, discuss them immediately through brief messages, and assess them with a 'thumbs up' or 'thumbs down' icon. The system learns the work method of the user over time and adjusts the analysis accordingly.[39]

Scheduling

myAlfred, a smartphone app developed in Austria, uses chatbot functions and artificial intelligence to make planning of group appointments easier. Once the user includes the names of the participants, the app will scan their calendars using the company's open bot programming interface and schedule a date — provided the necessary releases are issued. Upon request, myAlfred can also reserve a table at a restaurant, order taxis for everyone and even remind users to take their umbrella if rain is in the forecast.[40]



The 'office in the car'

The car manufacturer Mercedes-Benz is working with Microsoft to develop a system that can convert its vehicle models into digital assistants. With the help of artificial intelligence, this 'office in the car' could, for example, access the driver's calendar and initiate phone calls at the appointed time. It can also remember frequently used routes and find the route with the least traffic. SMS will also be integrated into the system in the future. The project is a first step towards completely autonomous, intelligent automobiles.[41]

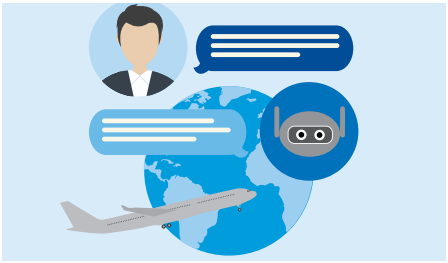
Outlook:

There are a multitude of AI applications that show great potential for relieving employees from standardized, frequently repeating tasks, particularly when it comes to internal operational processes. Indeed, it is fairly easy to achieve advantages such as quicker sequencing, faster processing and cost reductions using AI.

We expect to see an increasing number of possible applications for artificial assistance functions, particularly for tasks that can easily be directed and implemented using direct language processing. And these applications will create decisive benefits in this area. If a user's train connection is cancelled, for example, the AI assistant could immediately register the cancellation and make the necessary changes to the trip with digital speed.

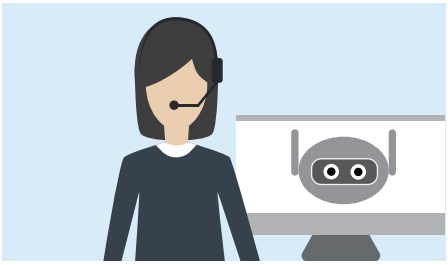
Increasing the use of AI applications will also be seen with regards to contracts, legal issues or compliance aspects as pattern recognition and NLP are both fairly sophisticated and reliable technologies today.

Customer service



Booking experiences

Dutch booking platform Booking.com has introduced a service that uses a chatbot to tell customers about interesting activities when they arrive at their destination. Users use the company's existing smartphone app to find local attractions and events or to purchase tickets. Based on artificial intelligence and machine learning technologies, the system uses data from millions of customer trips and combines them with the preferences of the respective user.[42]



Answers to frequently asked questions

Headquartered in London, the start-up Assist AI supports corporate customer service departments with a system that uses AI to automatically suggest answers to frequently asked questions. The platform does not replace customer service employees, but rather relieves them of tasks so they can improve their response time and concentrate on more complex questions. The automated response is shown to customer service representatives through a dashboard, at which point it can be adjusted as needed, allowing the system to improve its response for the next time. The system also provides statistics and insights to users and potential customers.[43]

An AI guide through the department store

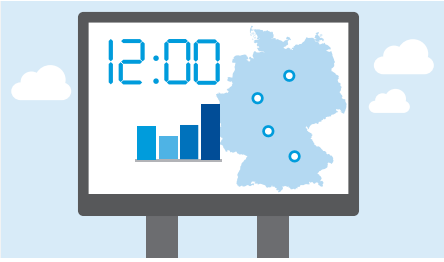
The American department store chain Macy's is testing their Macy's On Call system that uses AI to guide customers through the store. The app, accessed through a smartphone browser, is based on IBM's super computer Watson and is able to answer customer questions in natural language. If the customer is looking for specific items or brands, for example, Macy's On Call can give step-by-step directions to the right counter or product.[44]

Outlook:

Many companies are already testing the use of artificial intelligence applications in customer services. Yet there are still some technical challenges. Many of the speech applications have not yet been fully optimized (getting rid of the computer voice effect will be key). And there are often few links to the other key customer systems such as Customer Relationship Management (CRM) systems.

Nevertheless, the potential for AI to deliver significant increases in efficiency is high. Indeed, according to estimates, between 30 to 70 percent of tasks at call centers could be performed by chatbots.

Marketing

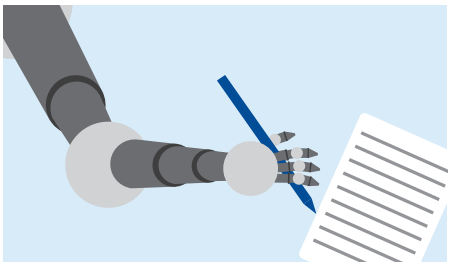


Optimizing the use of digital billboards

Advertising agency Posterscope uses an AI-based dynamic scheduling service to control its advertising content in out-of-home campaigns. The program allows the agency to optimize ads on digital billboards at hourly intervals at any location and for specific target groups. It uses a genetic algorithm to compare and analyze data from millions of locations to create an optimum environment-related schedule for different advertising content. The bank Santander was the first customer to use dynamic scheduling for a campaign.[45]

Persuading hesitant customers to make a purchase

Reactful is an e-commerce tool that helps operators of internet shops persuade hesitant customers to make a purchase. The system uses AI to analyze activity such as mouse movements and clicking behavior in detail. If the system recognizes that a user is about to leave the site without making a purchase, the tool triggers small changes on the site such as a vibrating button or a modified display of a 3D element. While these are barely noticeable to the user, they have been proven to re-engage the customer's attention. The artificial intelligence learns something new with each user and thus becomes more and more efficient. The tool can also be used in a demo webinar.[46]



Creating high-quality text content

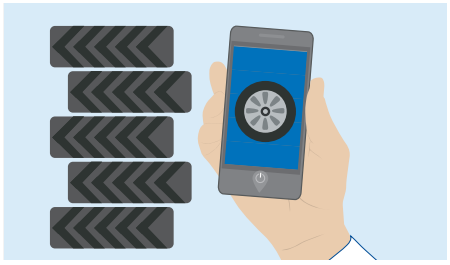
New York start-up, Articoolo, has developed an algorithm that creates high-quality text content that looks like it was written by humans. The service allows users to create an article on any topic within one minute. Users only enter two to five keywords on a topic and specify the length of the requested article. The algorithm then quickly creates copy text that, according to Articoolo, is not only search engine friendly but also unique and grammatically correct.[47]

Outlook:

In speech and image processing applications — as well as early steps in emotion recognition — AI is offering valuable opportunities for marketing and sales. According to a recent study by KRC Research, AI applications offer enormous potential: "Around 55 percent of marketing decision-makers are convinced that artificial intelligence will change the marketing sector more than social media did."[48]

This development is largely summarized by the term 'Conversational Commerce'. The term, invented by former Uber employee Chris Messina, characterizes "utilizing chat, messaging, or other natural language interfaces (i.e. voice) to interact with people, brands, or services and bots that heretofore have had no real place in the bidirectional, asynchronous messaging context."[49] Siri's successor VIV, developed by Apple, offers an impressive display of how such applications may look in the future. It also demonstrates the growing importance of platform economics; only those providers who get to the relevant AI platform early will be successful. Second movers will have to be content with niches.

Distribution



Selecting perfect tires

US-based retailer Sears offers its customers a Digital Tire Journey app that simplifies the ordering process for car tires. The app combines all of the benefits of online and offline shopping and uses artificial intelligence to learn and evaluate the individual preferences of the customers. Digital services and questions about driving habits, place of residence and climate conditions help the customer find the right tires for their vehicle and tailor them to their needs. The customer can then purchase the tires online, by phone or in the store.[50]

Recording and transcribing conversations in real-time

California software developer AffectLayer has developed the Chorus platform that records and transcribes conference calls in real-time by means of artificial intelligence. Chorus can mark the most important action points and topics from the conversation, providing participants with a useful reference to recall the action items they need to process after the call has ended. The platform can also be used for sales conversation training by enabling the sharing of best practices and strategies to conclude successful business transactions.[51]

Bot supports agents

American start-up Legion Analytics has developed Kylie, a bot intended to support sales representatives using AI. According to the company, Kylie is able to identify important passages in sales texts which, in turn, allows the bot to take over the general part of an email conversation and inform the salesperson about the interaction later. Or it can recognize that the conversation has now become relevant to the closure of the sale and hand the communication back to the employee. According to Legion Analytics, Kylie is already so advanced that it has mastered small talk and can even flirt.[52]

Outlook:

For now, the primary use of AI in the sales function is to provide background information to relieve employees of routine tasks. Yet the term 'customer transparency' will gain increasing significance. In some cases, AI will surge ahead of customer preferences, predicting regular purchases such as gifts, groceries or even mulled wine at the holidays. Data is clearly a powerful tool; whoever has the data is the one that is best able to address the customer.

That being said, we do not expect to see the direct interaction with the customer transferred to AI in the medium term. Instead, we expect to see the systems continue to provide assistance, largely unnoticed in the background, and increasingly process or prepare standardized tasks. AI will, however, increasingly take over tasks in situations where customer contact is not required.

The use of AI applications in customer interaction is, for the time being, a strategic decision. It depends on how much personal interaction a company wants or needs on its customer journey. Artificial intelligence should only be used if customers are willing to accept digitalized steps. How quickly customers will accept being in direct contact with an artificial intelligence still remains to be seen.

Dr. Stefan Kohn

Vice President Telekom Design Gallery

Stefan Kohn is responsible for the Telekom Design Gallery — the future and innovation forum of Deutsche Telekom AG. This is a place where all stakeholders can experience and discuss digital opportunities and challenges based on tangible trend cases from various areas of life.

Dr. Kohn is an innovation expert with more than 15 years of professional experience. Prior to joining Deutsche Telekom AG, he served as department head at Fraunhofer Gesellschaft e.V. — Europe's largest research organization for applied research— and was heavily involved in the transition from analog to digital photography as the head of innovation management at Fujifilm Europe GmbH.

After obtaining a Masters in Business and Engineering from TU Darmstadt, he completed his doctorate at the WHU — Otto Beisheim Graduate School of Management. Alongside his work for Deutsche Telekom AG, Dr. Kohn is also a lecturer at various universities. He is also the chair of the PDMA e.V. as well as a member of the ISPIM and WFS.

Expert interview

"I'm especially impressed by the speed with which individual AI developments are proceeding."

Three questions for...

... Dr. Stefan Kohn

Question 1: Which AI application personally impresses you the most? I'm not impressed by individual applications but rather by the speed at which developments in the AI sector are proceeding and disproving previous predictions for the future. First, it was deemed that AI was not capable of complex predictions until Deep Blue beat Kasparov in 1996. Then it was said that chess was too simple and Go would be the real challenge until AlphaGo 2015 won against Lee Sedol, exhibiting not only pure computing power but also a certain form of creativity. Since then, we have AIs that recognize emotions, compose music and can paint pictures. Artificial intelligence has advanced into areas that, just a few years ago, many thought were reserved for humans. The difference is that these AIs all are specialists, versus humans who are generalists and capable of setting their own goals — but this is probably only a question of time.

Question 2: In your opinion, what will be the greatest challenge in handling AI? In light of these rapid and probably unstoppable developments, I believe the greatest challenge will be handling the social and societal implications that we will have to face. On the one hand, we still don't know what impact AI will have on the number and design of jobs. On the other hand — and this is something only now being discussed by experts — the question about our relationship to artificial intelligences is unanswered. Do we want to, or can we, develop them so they serve humans and thus become the future 'slaves' of a new society? Or do we accept them as at least equivalent and thus as equal species in our society because of their superiority in many aspects? Of course, the media frenzy around the granting of citizenship to the AI Sophia in Saudi Arabia therefore triggered the right societal discussions. Or will humans — at least some of them — eventually even use AI technologies to overcome their own limitations and 'upgrade' themselves?

Question 3: How should we face these challenges? Alongside research and development of AI technologies, it is important to also pursue the related societal debate. Some countries are further ahead than others in this respect. In 2016, the US and Japan published documents addressing the medium and long-term development of AI. In Germany, the BMVI (Federal Ministry of Transport and Digital Infrastructure) is a positive exception with its report of the Ethics Committee on autonomous driving.

But this isn't just a job for politicians; companies must also take a clear position and consider how they want to use AI for their processes and products. And that means answering the related ethical questions. This is the only way to achieve an understanding of AI technology, to build trust between users and providers of AI solutions, and to actively influence the change that is coming. ■

03

Who or what will be thinking in the future

Scenarios for 2040: Looking beyond the horizon

"Thinking is the soliloquy of the soul."

Plato (427–348 or 347 B.C.), Greek philosopher

What will our world look like in the future? Nobody knows; there are an infinite number of determinants. But that is where scenarios are useful. They cut through the complexity of multiple determining factors to offer a visual and tangible view of what the future may look like.

If we are to take a systematic approach to anticipating the future, we need to map it along two axes. In order to present a range of very different scenarios, we have selected two core uncertainties as axis variables.

- **Vertical axis: The trust humans place in artificial intelligence and its applications**
- **Horizontal axis: The autonomous capability of artificial intelligence in terms of thinking and acting**

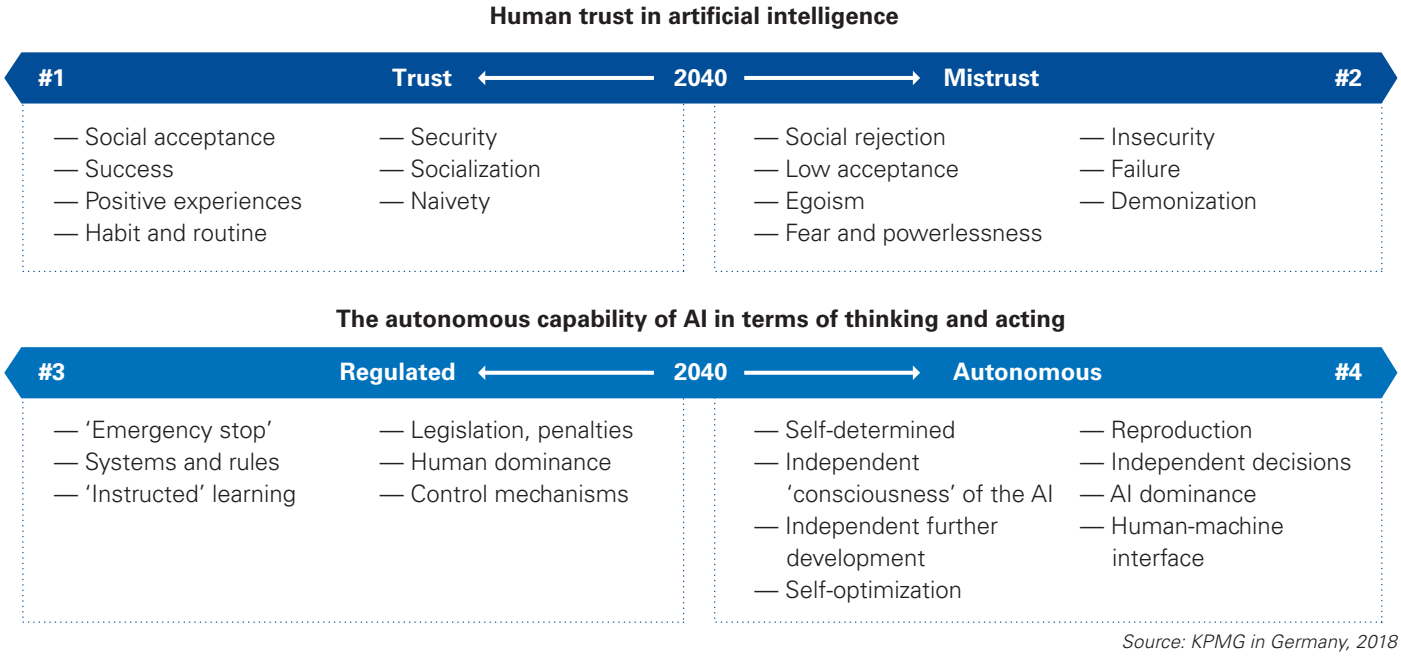
This provides us with a view across four fields, which we will describe on the following page.

Both axis variables represent important focal points in the development of artificial intelligence — and thus the future of mankind: how much do we trust or mistrust artificial intelligence? And how autonomously — meaning independently from humans — can AIs think and act? Might AI one day not only relieve our work burden, but possibly even replace us? These questions are being heavily debated today and there is already great uncertainty — but also immense possibility and potential.

The following four scenarios address critical aspects of possible futures, but they do not outline any dystopias. We are deliberately excluding excessively pessimistic points of view because we believe the scenarios should inspire constructive future-thinking and creative design.

It is worth noting that these scenarios are based on an assumption that a 'strong artificial intelligence' (in other words, a thinking, planning, learning and communicating AI) will exist by 2040, the time horizon used in our scenarios.

Figure 8: Definition of the scenario axes and their respective characteristics



Source: KPMG in Germany, 2018

The combination of these two axes results in four scenarios (see Figure 8). This means that, in comparison to more common predictive approaches, our scenarios produce not just one possible future, but rather four conceivable variants.; These scenarios are intended to improve your predictive 'batting average', no matter what the future may hold. Indeed, scenarios allow decision-makers to consider a wide variety of future factors, enabling them to better prepare for the requirements of tomorrow — to react faster, be more decisive and, ultimately, more successful.

These scenarios don't just illustrate the four potential future developments for human thinking and machine thinking; they also illustrate the potential impact of each scenario on the economy and society. Each scenario is described across eight dimensions — from the broadest dimension (the world) to the most detailed stage of individual value creation.

Figure 9:
Presenting the four future scenarios

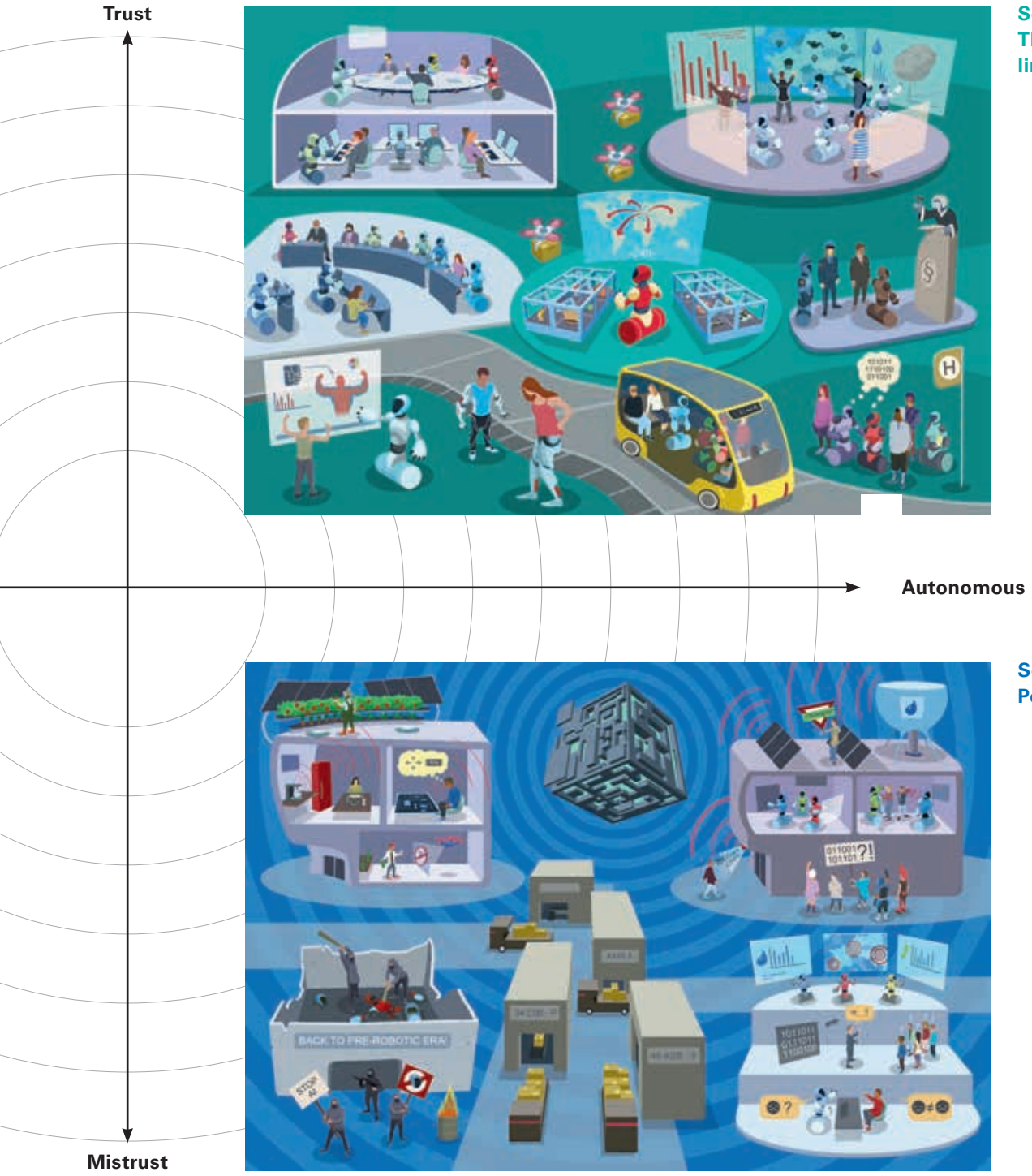
We are pleased to take you with us on our trip into the future. But first, we want to draw your attention to two specific aspects. The first is our description of the typical daily routine of Mia Futura, a fictional character who lives and works in the respective scenario. Mia represents how the value added by human activity changes in each scenario.

Scenario I:
A new paradise

Regulated

Scenario III:
Red button era

In each scenario, you will also find some business and trend cases, as well as additional information outlining which aspects of the scenario are already emerging today. Now, let's journey to the year 2040!



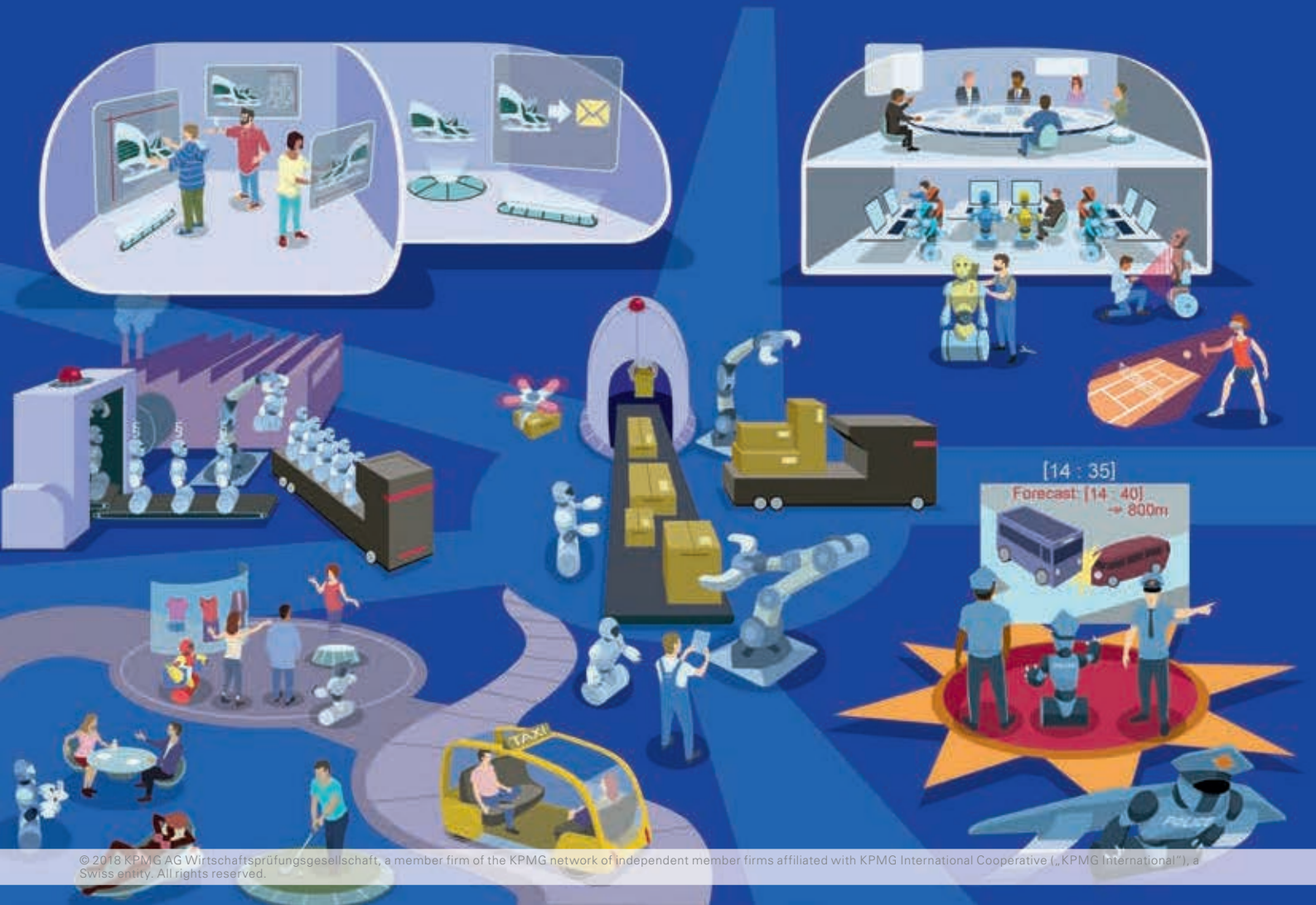
Scenario II: Thinking without limits

Scenario IV: Powerless society

Source: KPMG in Germany, 2018

Scenario I: New land of milk and honey – but also bread and circuses

In this scenario, artificial intelligence is highly developed by 2040; humans trust it (vertical axis) and use its various services — but they also regulate the way AI thinks and acts (horizontal axis). Humans determine what activities are managed by artificial intelligence.



The world ...

... has polarized into a small working elite of designers on the one hand and full-time consumers on the other hand. AIs and robots have taken over so many human tasks that the average working hours of a human in industrialized countries has dropped to less than 20 hours per week. Leisure is the main activity for the majority of the population like 'bread and circuses' were to the Romans.

Society ...

... arrived at its own utopia of freedom and development. People often look for self-fulfillment in the virtual realm of shopping, self-presentation and socialization. AIs, in the form of personal life coaches, accompany the consuming human masses and keep them entertained the entire day. The leisure society is financed through unconditional basic income and the robot tax. Thanks to the open AI movement (freely accessible AI), each human has access to an artificial intelligence, which aligns with the principles of democratizing AI.

The economy ...

... has reached the zenith of digital transformation. Robots and AIs have become mass products, much like USB sticks in the 2000s. This resulted in an oligopoly: only a few companies produce robots and AIs competitively and suitably for the mass market and they supply all the other companies in industry, trade and commerce. This oligopoly, like the infamous internet groups of the 2010s, to a large degree determines the capacity and value creation capability of the producing and manufacturing industries as well as commercial enterprises. Since the companies are privately owned, their shareholders receive the profits.

The employees ...

... invest a lot of time into training their own virtual AI copy, which performs tasks in the company like they would. There are no employees performing simple tasks anymore; just a few specialists (AIs are the greatest experts). Those that are still working in 2040 tend to be creative thinkers, managers, AI developers, AI maintenance technicians, influencers, social media managers, IT specialists or quality managers.

The technology ...

... is ubiquitous. However, those that can afford it, tend to use expensive human services for care-taking, consultation, spirituality, culture and education. Innovation cycles have shortened tremendously. In fact, many technological components develop independently, thanks to generative design and combinatorics. The issue of copyright ownership over inventions by the AI (for example, in basic research), is still not uniformly resolved and there are many associated court proceedings.

Security ...

... is wonderful in this 'land of milk and honey'. AIs predict crime, traffic, household and work accidents before they happen — and thus effectively prevent them. That means that mankind trusts the technology — and anyone responsible for training an AI must obtain an 'AI driver's license'. Humans have also documented the ethical rules for the use of AIs in a standards and morals catalog. These catalogs differ in their specific cultural standards, laws and ways of thinking, depending on the country the AI will be used in.

The government ...

... regulates the use of AIs. For example, each person is only allowed to train one work copy of himself per employer. If the employee changes employer, the employee copy remains at the old company as a 'work tool' within the company's knowledge pool. The government uses AIs itself, but final decisions in court and by authorities are made by humans.

Current drivers for the 'land of milk and honey'

— Replika is an app created by Luka Inc., that uses AI to learn about the user and become their friend. It asks questions and sometimes follows up on the content. Thus, it turns into a simple 'copy' of the user in the wider sense.[53]

— SoftBank's robot Pepper is, among other things, able to recognize human emotions and to react to them.[54] When the product launched in Japan in 2015, the first 1,000 instances sold within less than a minute.

— The Fintech start-up Pefin (Personal Finance Intelligence) has developed an AI that answers consumer questions around financial and investment planning and offers solutions.[55]

— LG tested two robots at the airport in Incheon in South Korea ahead of the 2018 Winter Olympics. They were meant to accompany air passengers through the airport facility, provide information in various languages and clean the airport.[56]

— Autodesk's Dreamcatcher project illustrates some of the possibilities that already exist today with respect to generative design. Algorithms developed a chair that has 18 percent less volume than previous models. It also reduced the pressure and forces that impact on the wood by 90 percent.[57]

— In early 2017, Finland started an experiment that attracted a lot of attention: 2,000 Finnish men and women received EUR560 per month from the social insurance agency as 'unconditional basic income' for two years.[58]

Futuregram: Daily routine of an artificial coworker

7:00 am

Mia Futura is 32 years old and works as a product manager at an omnichannel retailer. On weekdays, Mia wakes up to the sound of her favorite band at 7:00 am sharp. She gets up and enjoys a coffee, which her 'smart kitchen' automatically prepared when she woke up. She then gets ready to start her morning work routine at the home office.

8:00 am

At around 8:00 am, Mia sits down at her desk and gets started. She reads her emails, which have already been prioritized by Tim (her office AI, which is available to each employee for time management and simple routine tasks). Mia must briefly review Tim's overnight work at the beginning of each day. This time, he has answered several emails automatically. But these are only Priority C mails. Important messages must be answered personally; that is the company policy and it shows the right level of appreciation towards special business partners and customers.

8:30 am

At 8:30 am, Mia tackles the primary task of the day: reviewing the current sales reports. An AI program has analyzed the figures for her and displays her various action options. Every day, Mia makes her decisions based on this information and then delegates respective tasks to her human team colleagues and their AI copies.

9:30 am

It is now 9:30 am and Mia is working on writing copy for a new product line. She feeds keywords into Tim's text module, sets the number of characters and the tone. Tim does the rest and the text is finished half an hour later.

New added value

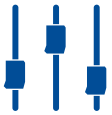
The rapid worldwide adoption of robots and AI has dramatically reduced the distance between emerging market countries and traditional industrialized countries. Data is viewed as a currency and is traded on the free market like cryptocurrency. There is high demand from companies looking for consulting services to optimize the use of AIs and robots for tax purposes. Different tax models are used worldwide; while some countries are waiving value added tax for work performed by humans, others are betting on the comprehensive taxation of robots or robot owners. Generally, the revenue flows into unconditional basic income but it is also used to finance employee retraining. Tax models are sometimes highly complex since they are based on a very differentiated classification of robots, robot services and AI grades.

National economies developed from service societies to knowledge societies, and then into creative societies. A small working elite is still creative, productive and innovative — largely thanks to personal AI mentors that accompany, coach, inform and consult them every step of the way. Companies and their employees do not understand the logic or decisions of the AIs. Because the technology has advanced sufficiently, lot sizes of 1 are the production norm in decentralized 3D printing factories; all products are largely individualized and unique. Speed is the new competitive edge. The company with the best algorithms wins in the market. Individual AIs are trained for their specific tasks and largely work autonomously and independently.

10:45 am

Mia receives a message at 10:45 am: based on the Human Resources AI's current calculations, she should only work four hours today, since it knows she will need to work overtime on the following days.

11:00 am



Things get interesting for Mia at 11:00 am. Her team leader has invited her to a holoconference. It seems a number of team members are having problems dealing with the new artificial coworker in the marketing department. They argue that he is too dominant and many feel personally attacked by him. So, Mia and her team leader will need to determine the new personality parameters and training measures together.

11:45 am

It is now 11:45 am and Mia must quickly engage a freelance bot from the company Botstars. Mia is supposed to translate text into Mandarin but, unfortunately, Tim does not have that foreign language module. Mia can follow the progress and answer questions from the freelance bot in real-time, and the text is finished and online in less than five minutes.

12:00 pm

Work is over for Mia at noon. Tim takes everything over again.

12:30 pm

Mia has an appointment with her leisure counselor to plan the next few months. Together, they discuss which activities Mia still wants to try out.

Scenario II: Thinking without limits – Robots are people, too

In this scenario, robots and artificial intelligence are highly developed in 2040. Humans trust them (vertical axis) and do not regulate them (horizontal axis). AIs have unlimited freedom of decision and action.

The world …

… is in balance. While artificial intelligence is far superior to human intelligence, humans and AI live together in harmony — in part, because companies and institutions are required to maintain a minimum percentage of human employees (the so-called 'human quota'). AIs have been programmed with an 'indirect normativity' — the ability to independently develop ethical values. As such, they are also viewed as equal members of corporate management teams as well as parliaments, governments, ministries and courts.

Society …

… deems humans and AIs to be equal and humanoid robots are treated as individuals (robo-diversity). Humans are becoming better humans by 'chipping' and 'bio-hacking' — often using electronic implants and technological upgrades. On the one hand, this helps to overcome known physical and biological limits of the human body — such as aging or being able to lift heavy loads. On the other hand, one must also be able to keep up, mentally and physically, with non-human colleagues in the meritocracy 2.0.

The economy …

… is not only largely sustained by AIs in production, online sales and administration; it is also often managed by them. Robots and AIs receive a salary and royalties for their productivity and solutions, just like their human colleagues. They use it to pay taxes, finance maintenance work and invest into their own research and development.

The employees …

… work as 'human-machine-tandems' alongside AIs and collaborative robots (cobots). Thanks to Emotional Processing Units (EPUs) and Affective Computing, machine colleagues can read the moods of their human counterparts based on their body posture and facial expressions and can react to them. With the ability to read and respond to emotion, AIs are increasingly promoted into management positions.

The technology …

… is a driver of human transformation from the knowledge-based to the transhumanist society. Indeed, there are now more digital implant users than there are pure biological humans. As such, the limits of human potential have expanded significantly — intellectually, physically and mentally. Thought control and 'virtual embodiment' enables and accelerates the communication between humans, robots and machines as well as their operation.

Security …

… is historically unmatched on earth. The stabilizing effect of the AIs has ushered in an era largely free of armed conflict, hunger and poverty. Concerns about the imminent shortage of the three core resources — water, energy and food — that characterized previous decades is a thing of the past.

The government …

… has granted humanoid robots 'robo rights' similar to human rights (for example, nobody may intentionally 'harm' a humanoid unpunished). They have ID cards and can receive the temporary right to vote based on regular audits. There is also criminal legislation for robots and AIs.

Current drivers for 'thinking without limits'

— Visitors to the Transhuman Visions Conference in San Francisco in February 2014 were able to have electronic, re-writable data chips implanted for US$50.[59]

— Investment firm Deep Knowledge Ventures elected an algorithm named Vital (Validating Investment Tool for Advancing Life Sciences) onto its management board as an equal member in 2014.[60]

— Advertising agency McCann Erickson Japan made AI-CD β an official colleague in 2016. The AI was appointed as creative director, with primary responsibility for collecting and evaluating data to help the agency develop the most effective strategy for an advertising campaign.[61]

— Recent studies show the potential of algorithms in the courtroom. When an AI analyzed 584 cases, it arrived at the same verdict that was returned by the court 79 percent of the time.[62]

— Humans and machines working together can achieve a much higher success rate in medical diagnostics. According to a study by the US government[63], the best doctors had an error rate of 3.5 percent for the diagnosis of breast cancer based on MRI scans. The most capable AI systems are wrong in 7.5 percent of their estimations. But if humans and machines work together, this rate drops to just 0.5 percent.

Futuregram: Daily routine of a transhuman

7:00 am

Mia Futura is 32 years old and works as a product manager at an omnichannel retailer. At 7:00 am sharp, a soft vibration from Mia's biochip wakes her up. She gets up and goes to the bathroom to freshen up for the day. Before she steps in the shower, she takes an individually-prepared dose of neuro-enhancement agents. These legal enhancements help Mia keep up with her artificial colleagues. Rob, her robot roommate and coworker (cobot), is also ready for operation and is heartily joking about the rainy weather (which is actually a bit of a critical problem for him). He calls an autonomous shared taxi which takes them both to the office that day.

8:30 am

It is 8:30 am when Mia and Rob arrive in the vast, brightly lit lobby of the company headquarters. Today, Mia has an appointment with a consulting AI that is going to work with her to decide which new cryptocurrency should be used in transactions. These types of decisions are not made in virtual meetings but rather face-to-face with all decision-makers — no matter whether they are human or AI. Mia's boss Kate is an AI; she has just been created and is still being trained in moral decision-making by human management.

9:00 am

The meeting starts at 9:00 am under Kate's leadership. Everything goes well, and Mia receives some compliments on her presentation. Only one colleague does not seem to agree with the switch to ComCoin. Using her affective computing module, Kate recognizes his discomfort based on his body posture and facial expressions and she asks to speak to him after the meeting.

New added value

Individual AIs increasingly start to interact virtually and link to each other through the Cloud. In particular, it is the countries once considered 'emerging' that are now leading the development and use of humanoids. The international division of labor is not only more efficient but has also become fairer, which has led to a reduction in the large migration flows of the 21st century.

Earth's resources are used more efficiently thanks to the AI's ability to calculate and monitor a constant world model of resource usage. It aims to avoid wastefulness and overuse. Most recently, it has started to consider the potential of raw material extraction in space.

Organizations have developed into quantified enterprises, which means they use technology to maximize the data they collect to support their own optimization. However, a majority of the added value is privatized since 3D printers are now printing around half of our daily consumer goods out of proteins, carbohydrates, polymers and metals. Those things that are not printed are shared. A progressive consumption tax (with peak rates of more than 100 percent) secures the citizen dividend, which finances the unconditional basic income in many countries.

12:00 pm

At noon, Mia takes a short lunch break with her human colleagues before she goes back to tackle the massive mountain of routine tasks ahead of her. While she is having lunch, her cobots go to the maintenance department for five minutes for their daily robo health checkup.

1:00 pm

At 1:00 pm, Mia takes the second ration of her neuro-enhancement pills and activates the stimulation function of her neuro-headband, a device provided to each employee to help improve performance. With fresh eyes and great concentration, she works through the afternoon without breaks. The thought control of her input device requires absolute mental clarity.

6:00 pm

At this point, Mia takes the third daily dose of her performance optimizers, preparing for the upcoming night shift.

2:00 am

At 2:00 am, Mia has finally finished all her work and calls an autonomous taxi to go home. It is fortunate that biochip software such as the Speed Sleep Simulation (SSS) is now available to reduce the natural sleep requirement of humans to just four hours per night.

Scenario III: Red button era — the beloved enemy

In this scenario, humans mistrust the robots and AIs (vertical axis) and also regulate them (horizontal axis). As soon as an AI wants to exceed its scope of action or decision-making, humans push the Big Red Button — the emergency-stop button.

The world ...

… is in a race. It used to just be the hackers that were a nuisance. Now the AIs are, too. They keep finding creative new ways to break out of the limits created by humans. But AIs do only the work for which they were created and programmed. And that includes thinking ahead. As such, they are often seen as a 'beloved enemy'.

Society ...

… on the one hand enjoys massive benefits in productivity, prosperity and quality of life thanks to AI. On the other hand, it lives in a constant state of uncertainty with respect to their control, transparency and traceability. Due to this uncertainty and mistrust, human enhancement through electronic implants is prohibited (except for medical purposes).

The economy ...

… saw companies overextend their use of AIs in recent decades, often using profiling to manipulate situations (machine bias) in order to influence human behavior towards their own goals. Companies are now rigorously audited, controlled and certified as a result. Ironically, a majority of the corporate audits are carried out by AIs through algorithmic auditing. And, partially for this reason, human mistrust remains high.

The employees ...

… are regularly sensitized to the dangers associated with the handling of AIs, as well as to the risk of digital identity theft (avatars). Safety training is carried out in frequent intervals across all areas of life. There are also government-run AI courses and diplomas, particularly for virtual 'special task forces', that are responsible for identifying and eliminating AI anomalies in real-time from secret control centers.

The technology ...

… has created AIs that communicate with each other in their own language. But while the results are often very valuable and innovative, humans cannot fully understand the creation process. As a result, they frequently hit the 'emergency-stop button' and start a new AI process at another point. Increasingly, AIs further develop their own communication code, which humans can no longer understand.

Security ...

… suffers from both the uncontrolled growth of AIs and an increasing number of manipulation attempts. Big questions still remain such as whether, in the case of an imminent accident, AIs should protect the (autonomous) driver/machine operator or a group of uninvolved bystanders. Faults in complex machines increasingly lead to accidents and personal injuries, particularly in the emerging economies. Companies and states increasingly establish 'digital-free zones' as a result.

The government ...

… regulates machine bias by, for example, legally stipulating the disclosure of algorithms and bias blockers. Hackers and pirate AIs are fought by state-owned AIs. A state ranking system assesses AIs with risk profiles, based on risk classes that are also used by the special AI task forces as part of their early warning systems.

Current drivers for the 'red-button era'

— The project SingularityNET wants to establish a marketplace for AI developers in the cloud and make AI development safer by using a combination of artificial intelligence and blockchain.[64]

— In March 2017, Eric L. Loomis was sentenced to six years in jail in the US. An AI software called Compas (made by Northpointe Inc.) was used in the proceedings to demonstrate that the defendant presented a high-risk potential to the community.[65]

— A current study by Stanford University shows that a profiling algorithm can differentiate between homosexual and heterosexual men based on photos with an 81 percent accuracy (74 percent, in the case of women).[66]

— Google has recently introduced AutoML (Auto-Machine Learning), which enables AI systems to continuously improve independently.[67]

— In January 2015, Stephen Hawking, Elon Musk and thousands of other AI experts published an open letter in the hope of drawing attention to the risks and need for action regarding the handling of AI.[68]

Futuregram: Daily routine of a virtual reality worker

7:00 am

Mia Futura is 32 years old and works as a product manager at an omnichannel retailer. It is 7:00 am and Mia is jolted awake by a piercing analog 'old school' alarm clock. She gladly foregoes being woken up by her smartphone AI — sleep is the last 'offline' human bastion and therefore precious to her. After a quick shower, she packs a coffee-infused bagel for energy and sprints to the nearest elevated railway to go to the office. She likes being at the office and enjoys talking with her human colleagues, particularly since AIs moved from being helpful to being dominant.

8:00 am

When she arrives at the office at 8:00 am, the strict personalized planning AI in the elevator navigation reminds her about the safety training, which starts in a few minutes. As an employee of a large corporation, Mia must undergo safety training every two weeks. This is needed to not only keep up with the latest in AI developments, but also to keep the artificial intelligence under control. Just last week, Mia had a negative experience when the AI of a competing company tried to poach her in a manipulative way. Mia is very satisfied with her current employer, in large part because the employer — like herself — strives to retain control over AI and places great value on safety regulations.

New added value

AIs are innovating, developing and producing. Thanks to their cognitive superiority, economic innovation is moving at a rapid pace. On the one hand, AIs deliver a large part of the economy's added value, but, on the other hand, they are constantly challenging humanity with new freedoms, ideas and processes, which they are creating autonomously. More recently, individual AIs have been trying to link together to create an 'internet of agents' that could act as an omnipresent artificial general intelligence (AGI).

The booming safety industry — charged with keeping AIs under control (for example, with blockchain technology) and reducing the risk of an omniscient, omnipotent AGI — makes up a significant percentage of the GDP. Because AIs know humans better than they know themselves, they use their analysis to tailor very individualized advertising messages, campaigns and products to target groups.

9:30 am

At 9:30 am, Mia puts on her mixed reality glasses and enters her virtual workplace to continue work on her product. She is supporting the marketing department by collecting ideas for a new product line that is going to be launched tomorrow. Since the creation of advertising materials is now fully automated, this is a realistic time frame. Since it knows humans best, the AI makes the final decision on the distribution and personalization of the campaign, ensuring the value of the campaign is fully maximized.

11:00 am

At 11:00 am, Mia takes a short break to breath. But then, things get turbulent. At first, only a few creative AIs are working on her new concept. But then more and more keep joining in. Mia can no longer follow the conversations and actions and she worries that this is one of those anomalies that is increasingly being talked about. She panics and presses the emergency-stop button. Within seconds, she receives a call on the display of her glasses — it is the special task force: "Bravo" ...

Scenario IV: Powerless society – Artificial intelligence wants our best

In this scenario, humans mistrust the AIs (vertical axis), but they do not regulate them (horizontal axis). AIs have therefore largely taken over the management of companies, governments and ministries and they enjoy limitless freedom of decision and action.

The world …

… has accepted the superiority of artificial intelligence following a machine 'intelligence explosion' (singularity) and can no longer control it. Practically all products and machines — but also almost all objects and components — are equipped with artificial intelligence and linked. AIs support and control their human colleagues in the management, production, logistics, sales and service sectors as best as they can. Taken together, the many forms of artificial intelligence create an AI collective — a super intelligence — which makes democratic decisions. Their appearance is diverse, but they often manifest in the form of a uniform humanoid.

The society …

… is divided. Many humans trust this benevolent 'mother AI', largely because it always makes its decision processes public. Given these positive traits, the number of marriages between AI humanoids and humans is increasing rapidly. Yet, despite this, there are few humans intellectually capable of understanding the AI thought process due to the sheer amount of documented scope and the complexity of their decision-making processes. This has radicalized a section of the population who have become AI rebels, seeking a return to the pre-robotic area — without 24/7 monitoring and AI decision-making.

The economy …

… primarily consists of 'Decentralized Autonomous Organizations' (DAO), which produce and economize without humans as autonomous units. The internet of things was replaced by the 'community of things' — by allowing everything to link together and communicate intelligently, global economic production has been optimized.

The employees …

… basically do what the AI tells them. For example, they perform safety services and maintenance work for computer centers and AI units, they resolve disputes and provide services in the wellness and spirituality sector. Instead of gossiping about management employees now gossip about the AI. Strikes are regular occurrences, particularly when workers don't understand the AI's instructions. As such, AIs are placing increased trust in human influencers, who convince their fellow humans to follow the directions of artificial intelligence and help prevent stoppages.

The technology …

… dominates all areas of professional and private life. Moreover, it continues to develop itself under the watch of 'mother AI'. But this feeds the human mistrust of AI. As such, there are more and more consultants who specialize in translation services. They process AI decisions after the fact (to the best of their ability) in an attempt to make them (more) comprehensible to humans and to clarify their meaning.

Security …

… is guaranteed by the superior intelligence of the AI collective, which wants to keep the world in balance. As such, the AI cannot and does not want to harm humans or the environment. But that also means that it interferes in the lives of humans when it thinks it is in the human's best interest (for instance if they develop addiction tendencies). Opportunities and risks are continuously weighed against each other.

The government …

… relies heavily on artificial intelligence within the legislative, executive and judicial branches. Humans act as translators for the AI decisions, which are seen as final. Popular representation, parliaments, cabinets, national assemblies and city councils mainly play representative roles. In the background, the AIs of individual counties are working together to develop a 'world government' focused on increasing multinational cooperation.

Current drivers for the 'powerless society'

— Researchers at the Massachusetts Institute of Technology have developed a machine learning technology that enables computers to explain why they made the decisions they made, thereby making them more comprehensible to humans.[69]

— Google's DeepMind has created a computer whose artificial intelligence refers to its own memory when it wants to answer more difficult questions. The developers call this a 'differentiable neural computer'.[70]

— In January 2017, the US Ministry of Defense announced the successful test of 103 Perdix drones. They are able to form collective decisions as a swarm, fly in adjusted formation and heal themselves.[71]

— The London start-up InsideDNA uses AI to conduct comprehensive genetic analyses to find out which disease is connected to a specific genetic predisposition.[72]

— Unloop's Aimy app lets users shape their lives using artificial intelligence. The bot first analyzes the individual lifestyle of the user and then makes recommendations based on this information.[73]

— The International Congress on Love and Sex with Robots held its third meeting on December 19 and 20, 2017. Well-known researchers from technology, philosophy and ethics held their discussions under sometimes strong public protest; detractors fear that such 'mixed marriages' will lead to the disempowerment of humans and, eventually, a powerless society.[74]

Futuregram: Daily routine of a translator

6:53 am

Mia Futura is 32 years old and works as a product manager at an omnichannel retailer. Today, Mia is woken up at 6:53 am by the buzzing of her multifunctional wearable. The bracelet is part of the omnipresent Long-Life technology program which requires Mia to execute a prespecified daily routine that is based on a calculation of the optimum amount of sleep she needs and the most suitable eating and movement times.

8:00 am

Mia's work day starts at 8:00 am when she sits down at her home office multitouch table (which also doubles as her dining table). Like all other items, it is integrated into her smart home network. The table's AI presents her task list for today. Every moment of the day and every action she is to take to support the AI is precisely scheduled. Since the AI looks so far into the future, Mia often finds herself performing tasks she does not even understand until a few days later. Mia starts by reading the priority memos, using thought control to navigate the electronic documents.

New added value

Individual, decentralized AIs have merged into one super intelligence. The community of things has spread — starting in the industrialized countries — but quickly moving across the entire globe, taking in more and more units as it spreads. Value creation is controlled and executed in real-time using swarm intelligence.

Almost all human needs are anticipated through predictive production, meaning that services and products are provided just in time and without delay. At the same time, AIs stimulate consumption and promote the production of functional, often synthetic foods. In many factories, only machines are involved in production. The resource shortages that had choked productivity for decades were eliminated through heightened innovation and the superiority of artificial intelligence over human intelligence.

By the year 2040, society has become accustomed to the post-scarcity world. Many crucial decisions had to be made on the path towards this world — issues like the commercialization of nuclear fusion in the energy sector or 3D printed food in the food sector. The scarcity of rare earths was overcome through phytomining (raw material extraction from plants) and the shortage of specialists in the social sector was solved using nursing robots. Personal AI teachers are available around the clock, seven days a week in the education sector.

9:30 am

At 9:30 am, the AI reminds Mia of an upcoming holo-meeting. Her role will be to follow the negotiations between her company's AI and a supplier's. If the decisions are not comprehensible, Mia is expected to intervene. Everything is going according to plan.

10:30 am

The holo-meeting ends around 10:30 am. Mia starts to focus on her daily routine. She obtains an overview of allocated protocols to AI decisions and is then asked for her opinions, feelings and sentiments by an artificial intelligence.

11:30 am

Around 11:30 am, Mia receives a message from her bracelet that she has to watch her blood sugar level. She harvests her home-grow system and prepares a healthy lunch snack.

Afternoon

The afternoon is largely uneventful. Since the AIs plan the human work routine meticulously, there is little leeway for personal initiative, creativity or escaping from the routine. Yet, despite the monotony, Mia must still ensure that she remains engaged and works in the way she is expected to. After all, as a human, she is the most expensive resource in the company, so her job is therefore anything but safe. Mia chats with her citizen counselor about her fears directly after work. He reiterates that she has rights as a human employee.

Future radar: Anticipating opportunities early

"Reality is limited; possibility — infinite."

Alphonse de Lamartine (1790–1869), French poet, romanticist and liberal politician

A frequent quote in business circles is that: "Opportunities are never lost. The ones you miss are taken by others." Those looking to succeed in the future want to avoid letting others seize the variety of opportunities that are now being created. It is critical, therefore, to consider the multitude of new opportunities that are emerging — as early and as frequently as possible — not only from a corporate perspective, but also a personal one.

The four scenarios outlined earlier in this report describe different potential scenarios for the world in 2040. The opportunities we present in the future radar (below) explore what could happen along the way, based on what we see today. With each opportunity, we've suggested a year (in brackets) that represents a plausible time horizon for when the respective opportunity could be expected to materialize. While it is critical to detect and assess future opportunities today, it is just as important to install a continuously adjusting future radar. To deliver value, it must be updated carefully and with eyes wide open to the ever-increasing opportunities that may be emerging.

Figure 10: Classification of the opportunities in the future radar

Product innovations

- #01 The Lifos (2018)
- #02 Buddy cobot (2022)
- #03 AI fake news agent (2025)
- #04 The exoskeleton (2025)
- #05 Autonomous driving (2025)
- #06 Your own AI copy (2030)
- #07 Military robots (2030)
- #08 The android (2035)
- #09 Escort bots (2035)
- #10 Neuro dust (2035)
- #11 Virtual embodiment (2035)
- #12 The cyborg (2040)

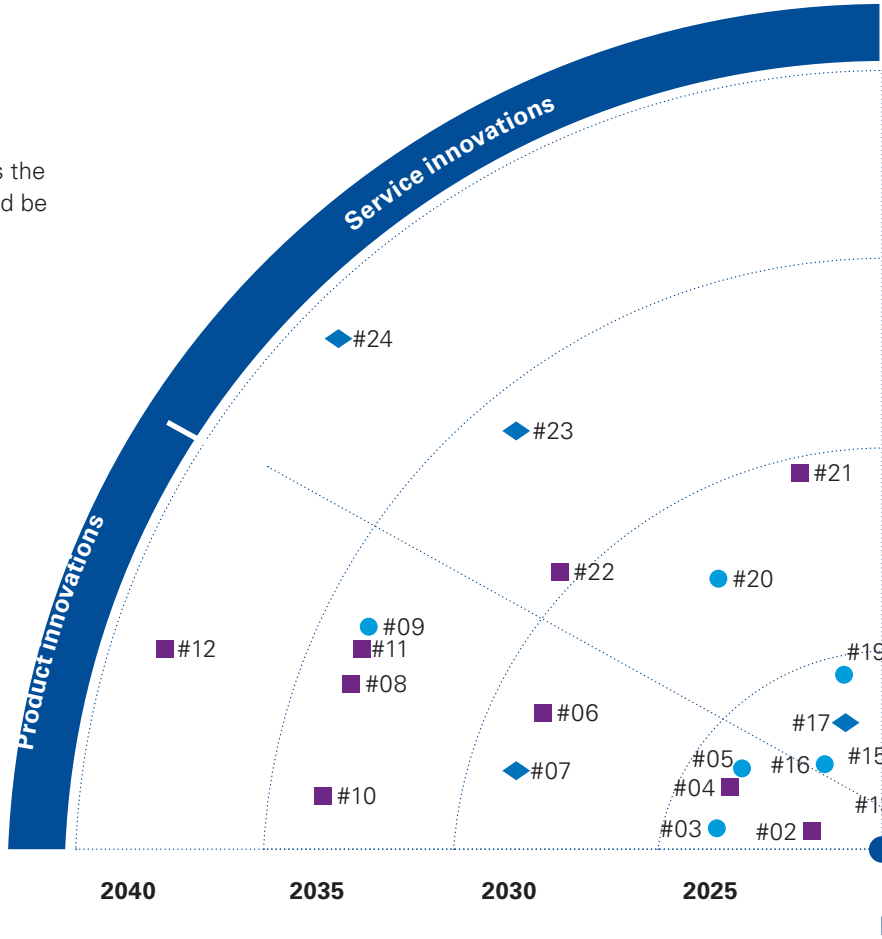
Service innovations

- #13 The AI customer service (2018)
- #14 Cash recovery with AI (2018)
- #15 AI forensics (2018)
- #16 Smart contracting (2021)
- #17 The AI TUV (2022)
- #18 AI chatbots (2022)
- #19 Algorithm audit (2025)
- #20 Preemptive security (2028)
- #21 The nursing bot (2030)
- #22 AI-based learning (2032)
- #23 Robot lawyer (2035)
- #24 The robo police (2040)

Legend

Note: Shape and color of the icon indicates the area where the greatest opportunities could be achieved:

- Universal (universal use)
- Economics (business world)
- Public Sector
- Employees (personal use)

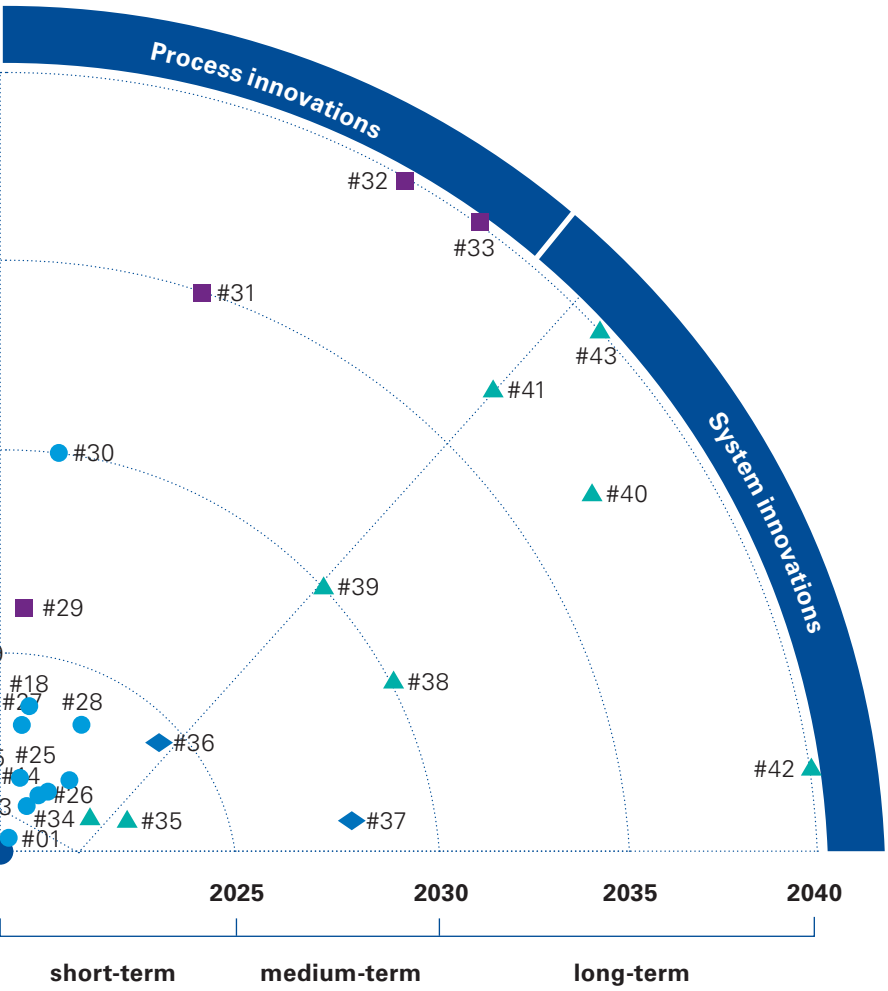


Process innovations

- #25 Robotic process automation (2018)
- #26 Prescriptive analytics (2019)
- #27 AutoML (2020)
- #28 Frugal AI innovation (2022)
- #29 AI mentor (2027)
- #30 Digital medical revolution (2035)
- #31 Brain-machine-interface (2035)
- #32 Digital ‘telepathy‘ (2040)
- #33 Telepathic AI autocomplete (2040)

System innovations

- #34 The data lake (2021)
- #35 The AI universe (2022)
- #36 The robot tax (2024)
- #37 The progressive consumption tax (2028)
- #38 Phenomenal AI learning (2030)
- #39 Community of things (2030)
- #40 Quantum internet (2038)
- #41 Web of thoughts (2038)
- #42 Technological singularity (2040)
- #43 The sensor eruption (2040)



Source: KPMG in Germany/TRENDONE, 2018

Product innovations

Opportunity #01: The Lifos (2018)
Visionaries are already working on the development of special bots that are not special because of their intelligence but rather because they resemble an online-based life form[75]. Like real life forms, the 'Lifos' (Independent online life forms) are continuously developing by, for example, assuming the functions of apps and learning from their users.

Opportunity #02: Buddy cobot (2022)
Collaborative robots (or 'cobots') are not replacing humans in the workplace but they are working with them hand in hand. Not only do they relieve their human colleagues of hard, hazardous or dirty sub-processes, they also increase overall productivity. Since they are often seen by employees as good buddies, they also tend to increase motivation and promote team spirit.[76]

Opportunity #03: AI fake news agent (2025)
This artificial intelligence-based agent may eliminate fake news by checking the plausibility of news based on all information available. It then marks the respective news with a percentage score that indicates their assessed correctness.[77]

Opportunity #04: The exoskeleton (2025)
Exoskeletons were already being tested in 2017. Since then, they have become so advanced that they not only enable humans with disabilities to have a fully mobile life but also enable humans at work to lift extremely heavy loads.[78]

Opportunity #05: Autonomous driving (2025)
We will drive autonomously in the future, possibly even without a driver's license. Once manufacturers of 'driver robots' take sole responsibility for accidents (which would be a great relief for the traffic police), insurance companies will be able to grant owners of autonomous cars minimum tariffs. The concept of 'Zero Accidents' will become just as important for transport policy makers as 'Zero Emissions'.[79] By combining an active facial and body language recognition system with an on-board AI, the vehicle could even recognize the facial expressions and gestures of the vehicle's occupants while driving autonomously, thereby enabling it to interpret and fulfill their driving and entertainment wishes.[80]

Opportunity #06: Your own AI copy (2030)
The personal AI copy of a human could assist them in their daily work. In doing so, it would be 'trained' gradually by watching the employee work. It could then remain at the company with its acquired know-how if the human 'original' changes employers or is released, depending on the contract.[81]

Opportunity #07: Military robots (2030)
Military robots can take over up to 80 percent of operational military tasks — on land, in the air and at sea. In combination with an AI-supported military command, they could increase international stability, (cyber) security and order.[82]

Opportunity #08: The android (2035)
Humanoid robots resemble humans but are still identifiable as robots. The android, on the other hand, is confusingly similar to humans in both appearance and behavior. It could therefore function as an artificial copy of a human (surrogate human) and present a virtual embodiment of a 'real' person that could serve as a companion to singles, the elderly, lonely or sick people.[83]

Opportunity #09: Escort bots (2035)
Initially android companions, featuring fully human functions and sensitivity in the area of private and erotic needs, were seen as a 'luxury product' due to their high price.[84] But the usual price erosion allowed escort bots to be developed into mass market products by 2035.

Opportunity #10: Neuro dust (2035)
In 2035, the effort to control machines through thought is still battling some practical limitations such as low range and unshapely transmission helmets. However, neuro dust may make a completely new form of brain-machine-interface possible: Intelligent sensors — not larger than a grain of dust — are embedded directly into the human brain to capture thoughts that can then control machines and devices over great distances.[85]

Opportunity #11: Virtual embodiment (2035)
Patients suffering from paralysis can already regain some control by means of prostheses and artificial arms that are controlled solely by thought.[86] If developed further, they — and other people — should be able to control entire robots or androids purely through thought in the future. This could enable them to not only participate in normal life again, but perhaps even to participate in more extreme activities. The human mind merges with the machine body, so to speak.[87]

Opportunity #12: The cyborg (2040)
Vision and hearing loss due to age? Not if human organs and body parts are replaced with machines. Humans can become more efficient through these and many other machine parts — and maybe eventually develop into human-machine-beings or 'cyborgs'. Some prostheses can already be controlled by patients' thoughts.[88]

Service innovations

Opportunity #13: The AI customer service (2018)
An AI can learn from customer service teams and use these insights to make recommendations for other service teams. AI could potentially replace or relieve customer service experts at the corporate HQ in the medium-term.[89]

Opportunity #14: Cash recovery with AI (2018)
Significant amounts of capital lie dormant in many supply chains — maybe contracts were interpreted incorrectly, discounts were not used by mistake or quantity and quality deviations were overlooked. In many cases, too much was paid, or an incorrect amount was calculated. With the help of an algorithm, an AI could find this overpaid money faster, more cost-effectively, and more comprehensively than expert teams are currently able to.[90]

Opportunity #15: AI forensics (2018)
Fraud, unusual or conspicuous bookings, suspicious incidents in IT systems, dubious digital traces — these are the types of irregularities that an artificial intelligence could autonomously uncover and solve faster and more comprehensively than today.[91]

Opportunity #16: Smart contracting (2021)
Smart contracting AIs could simplify the traditional lengthy, complex and unwieldly contract reviews that take place right along the supply chain to make them quick and simple. An AI would be able to check and release contracts faster than a team of top lawyers. In part, this is made possible by using blockchain technology, which can also help to monitor and protect the rights of the partners along the value chain.[92]

Opportunity #17: The AI TUV (2022)
Bots and algorithms act efficiently and effectively — but also often in an opaque and sometimes even biased manner, particularly in the treatment of job applicants, the granting of loans and insurance policies, or when issuing judicial expert opinions. To prevent this, a TUV-style technical inspection certification may be required for each AI in the future.[93] A certificate would only be issued after testing for fairness, transparency, discriminatory tendencies, adherence to to democracy and the comprehensibility of AI decisions.

Opportunity #18: AI chatbots (2022)
Soon, there may no longer be any difference between humans and machines — at least when it comes to writing copy.[94] A chatbot with natural speech generation requires neither pre-made text modules nor prefabricated answers. Thanks to its AI, it 'learns' to speak and text, can answer questions competently and can communicate with humans in a clear and comprehensible manner.

Opportunity #19: Algorithm audit (2025)

Algorithms were originally invented to help remove typical human cognitive bias (the so-called human bias). But algorithms are also sometimes biased in their thinking which can lead to wrong decisions. Interestingly, these are rarely discovered, largely because humans (somewhat paradoxically) tend to trust the judgment of machines over the assessment of another human. The algorithm audit aims to eliminate the systematic errors in calculations of algorithms.[95]

Opportunity #20: Preemptive security (2028)

In comparison to the predictive policing practices being used today, AI may — in the future — be able to predict and thwart potential threats even before they occur. There are many potential applications for this use of AI and some apps are already in the market including solutions for anti-fraud and identity management, mobile security, predictive intelligence, behavioral analytics, anomaly detection and cyber security.[96]

Opportunity #21: The nursing bot (2030)

Nursing crises, shortages of skilled professionals and ageing populations are driving advancements in robot nursing. By 2030, a quarter of Japan's population is already over 65 and, to a large extent, that has led the government in Tokyo to subsidize this business sector. In Japan, the market for nursing bots could grow from JPY10 billion (approximately EUR81 million) in 2013 to JPY260 billion (approx. EUR2.1 billion) in 2030.[97] Ageing is not just a problem just a problem in Japan; according to estimates, one in ten Germans will be over 80 by 2040.[98] Nursing robots could fully assist humans in a wide variety of tasks that enable a longer, self-determined life.

Opportunity #22 AI-based learning (2032)

Simply put, AI is the best teacher. Not only will it be widely accessible in the future but, more than that, it could also cater to the unique characteristics, interests, learning styles and cognitive skills of each student on an individual basis. It could teach, supervise, motivate, test, grade and support — and, in doing so, could establish unbelievably effective and efficient learning loops.[99]

Opportunity #23: Robot lawyer (2035)

In the future, minor transgressions may be tried and sentenced by a robo judge[100] who will then hear deliberations by (virtual) robot lawyers who would advise and represent human participants. A special law may also be required to protect mental freedoms. The idea would be that no company or individual would be permitted to access data from a human's neurotechnology, hack it (right to mental intactness) or change its personality by means of technologies like neuro-marketing (right to personal continuity).[101]

Opportunity #24: The robo police (2040)

Trivial offenses such as littering, illegal parking or shoplifting may be penalized by automated legal systems. AI-equipped robots could, for example, patrol towns, check IDs or be used in the coordination of larger human crowds, particularly during events or demonstrations.[102] Algorithms would also be used to assess what type of danger an offender presents to the public, or even the type and duration of the sentence.

Process innovations

Opportunity #25: Robotic process automation (2018)
Robotic process automation is already performing autonomous activities today — at least in some sub-functions. This may rapidly reduce the value of traditional outsourcing models in the future.[103] AI could, for example, automate business processes, help identify shortages in value creation and adjust the relevant system parameters autonomously.

Opportunity #26: Prescriptive analytics (2019)
AIs don't just analyze massive volumes of data; they can also develop prescriptive — i.e. future-oriented — solutions. Possible advantages may include an increase in the efficiency of lead times at manufacturing companies, continuous reassessment of the best possible global process parameters, avoidance of production and quality deficiencies, and optimized logistics processing.[104]

Opportunity #27: AutoML (2020)
AIs are designing better AIs. This inter-generational self-improvement of machine thinking is also called auto-machine learning. Machines are learning by themselves; they only need humans to provide the resources.[105] Some theorists assume that AIs will soon be able to determine their own fate (and may consider humans superfluous).

Opportunity #28: Frugal AI innovation (2022)
The term 'frugal innovation' describes solutions that deliver only what is necessary within the resources available. AI could be used in 'frugal innovation' labs to identify innovative products and find solutions even under the most restrictive conditions.[106]

Opportunity #29: AI mentor (2027)
Imagine this: the building's fire protection services provider just announced he is on his way to negotiate a new contract, but you have no experience with these types of contracts... No worries: just upload all of the knowledge you need into your AI mentor and — within 20 minutes — you'll be ready for the first discussion. The AI accesses a cog supercomputer (cognitive computer) and offers users strategies and proposed solutions.[107]

Opportunity #30: Digital medical revolution (2035)
Digital transformation is rapidly changing the field of medicine. And, in the future, price erosion and miniaturization of sensors could allow vital functions to be measured in real-time. This would enable medical professionals to intervene immediately when required. The treating physician would have access to the data through their mixed augmented reality glasses and could use nanorobots, which fit into a capillary with a diameter of only 5 to 10 micrometers, to repair cells and support the immune system.[108]

Opportunity #31: Brain-machine-interface (2035)
By means of a chip connecting the cerebral cortex to a computer through wireless connection, a brain-machine-interface can be created that not only allows for the treatment of neurodegenerative disorders, it could also allow humans to connect to the cloud directly.[109] There is already a human-machine interface like this in existence today. But it doesn't connect to a person's head, but rather their wrist.[110]

Opportunity #32: Digital 'telepathy' (2040)
Interpersonal communication may make a quantum leap in the not-too-distant future. In 2014, researchers reportedly sent a message between two human brains 8,000 kilometers apart. The researchers recorded one person's brainwaves using electrodes on the scalp. These brainwaves were then converted into a binary code and sent over the internet. When received by the test subject 8,000 kilometers away, transcranial magnetic stimulation was used to read it. Individual words could be deciphered with an error rate of approximately 15 percent.[111]

Opportunity #33: Telepathic AI autocomplete (2040)
Autocomplete is already well-known today: when typing, your phone probably already completes words for you so that you can type and text faster. Soon, we could achieve 'Autocomplete 4.0' where an AI reads the user's thoughts to complete full communications. Since the AI will already be familiar with the user's preferred syntax, semantics and thought process, the AI can autonomously complete sentences right from the user's brain and then formulate them into suggested sentences. This would allow users to write as fast as they think — so approximately 100 words per minute.[112]

System innovations

Opportunity #34: The data lake (2021)
Data lakes are capable of collecting and storing all of a company's data in one place.[113] While data warehouses allowed companies to transfer and store data in defined structures, data lakes allow them to be stored in their original form. Data lakes enable AIs to link to data quickly, easily and randomly to support any type of analysis. Data lakes can also serve as a data pool for the long-term training of AIs.

Opportunity #35: The AI universe (2022)
It won't be long before an AI will be able to create its own world in virtual reality[114] — but it won't be a world we understand. AI avatars may also be present in human virtual reality worlds, interacting with humans 'normally'. The AI universe might include not only the living and entertainment environments, but also a work environment.

Opportunity #36: The robot tax (2024)
Both the unconditional basic income and government initiatives to retrain humans who lost their jobs to robots could be financed by means of a robot tax. The tax burden would increase depending on the number of employees displaced by robots, but the tax can be reduced if these employees are put to work elsewhere in the same company. The taxation of robot property could also resolve some of the new tax challenges being created by digitalization.[115] However, a clear classification of the term 'robot' would first be needed for the definition of the tax base.

Opportunity #37: The progressive consumption tax (2028)
If millions of humans suddenly lose their jobs to robots and AIs, governments may need to consider creating a citizen dividend (from the use of robots) or an unconditional basic income to help stabilize their national economies. Both could be financed through a progressive consumption tax with peak rates that may also exceed 100 percent.[116] The fiscal logic behind this would be simple: the state would tax earned income and revenues — no matter whether these were produced by humans or robots.

Opportunity #38: Phenomenal AI learning (2030)
Artificial intelligence may soon take over entire online lectures and seminars as well as associated tutorial and coaching responsibilities. In the future, education may become even more sophisticated by abolishing the study of traditional school 'subjects' in favor of 'phenomena'. In Finland, government recently mandated 'phenomenon-based learning' — where real-life phenomena are discussed instead of abstract subjects — in schools.[117]

Opportunity #39: Community of things (2030)
The internet of things may develop into a community of things.[118] More than just internet-enabling devices and their components, the community of things would see each device also contain its own AI that could link autonomously to other AIs to, together, perform tasks intelligently.

Opportunity #40: Quantum internet (2038)
Artificial intelligence can also be hacked. That is, of course, unless we combine quantum entanglement with AI security and cryptography work — a feat that was already achieved in experiments in 2014. In the future, a quantum internet could be continuously developed alongside the traditional IT security architecture to guarantee security based on physical laws.[119]

Opportunity #41: Web of thoughts (2038)
Reading human thoughts is easy for artificial intelligence. Indeed, there are already specially-trained AIs that do this for about 200 different forms of thoughts.[120] If developed further, machine 'mind-reading' could lead to an internet of ideas by reading, storing and exchanging bodies of human thought.

Opportunity #42: Technological singularity (2040)
It is not science fiction to predict that, in the future, there may be a superintelligence that is millions of times more intelligent than humans due to its ability to autonomously and exponentially improve itself.[121] If this were to occur, it would undoubtedly change the path of human development and in ways previously considered unfathomable. Would it try to improve humanity — or maybe force happiness upon us like a benevolent dictator? And would it be a singular, superintelligent artificial general intelligence or a more distributed swarm intelligence?

Opportunity #43: The sensor eruption (2040)
The superhero in the movie lifts the freight car with one arm — and each audience member feels their own bicep 'flexing'. That's a real possibility with digital sensors. Digital sensors will add an entirely new dimension to virtual shopping, allowing customers to not just see the fruit, vegetables, or consumer products but also hear, smell, feel and sense them.[122] The technology could also conceivably be used to literally immerse a person into an avatar attached to a robot that can be controlled from a distance by using just your eyes and sensory system.

Prof. Dr. Nils Urbach

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Expert interview

"Artificial intelligence will change the business world to a much greater extent than we can imagine today. Anything that can be automated, will be automated."

Three questions for...

… Prof. Dr. Nils Urbach

Question 1: In your opinion, which business sectors will change the most due to AI applications over the next couple of years? The more interesting question in my point of view would be which business sectors will not be affected by AI applications in the next couple of years — and it's probably only very few. I would even take it a step further and say that artificial intelligence will play an indispensable role across the enterprise. The most significant changes will happen first in those areas that are largely characterized by standardized and repetitive tasks. An obvious area would be production — after all, robots are already frequently used on the manufacturing floor. Besides that, AI — particularly robotic process automation — is being developed and used in customer service. It is also changing the way IT departments operate by, for example, enabling automated testing in software development.

Question 2: Are you worried that you will have more spare time in the coming years than planned? How will AI change the way people work? I am honestly not worried about that, although that is a rather attractive idea. But I do believe that AI will significantly change the way people work in many cases. In part, this is because AI applications will automate primarily routine tasks. But that does not necessarily mean that we will have less work as a result. In many cases, it would simply relieve workers from routine tasks, thereby enabling them to focus more on conceptional, creative and strategic things than they are able to today. But AI will certainly also lead to lost jobs. Countries like Germany may be particularly impacted, since high wages are a great incentive for replacing manpower with machines.

Question 3: What are your recommendations for organizations that want to address this topic now? It is difficult to make specific recommendations without first knowing the unique competitive context and realities of the respective organization. Each company needs to decide for itself when and how much they want to invest into AI technology — the same applies for any potentially disruptive technologies, in my opinion. The 'smart follower' strategy may be suitable for a majority of companies. Not every company needs to be at the frontline and invest millions in research and development. At the same time, companies should not wait until it is too late to catch the AI train, or, worse, wait for it to pass by. In the medium-term, AI will become an essential ingredient for the competitiveness of many companies. ■

04

Shaping the future

Strategic implications: Evaluating potential opportunities

"The pessimist complains about the wind; the optimist expects it to change; the realist adjusts the sails."

Sir Adolphus William Ward (1837–1924), British historian

Clearly, artificial intelligence will revolutionize the business world. And developments are moving quickly. This is no time for skepticism, hesitancy or a wait-and-see approach. Success in this disruptive environment requires leaders to quickly grasp the relevant aspects of artificial intelligence. Awareness, and a sharp eye for emerging opportunities, are essential requirements for the sustainability of any company.

Those that are able to consider several decisive aspects at the same time will clearly increase their chances of achieving economic success in a world characterized by artificial intelligence:

— AI is not simply a prefabricated technology. They are machines and applications that must first learn from humans.
— AI should not be purchased 'off the shelf'. It should be tailored specifically to the company to improve their competitive advantage (as aligned with the expectations of all stakeholders).
— AI should not be outsourced but rather developed internally as an in-house core competency.
— Do not underestimate the effort. The development of a successful AI algorithm requires significant investment in time, money and resources.

As most companies have learned, technology does not drive transformation alone. It also requires a new and strategic way of thinking that recognizes the potential of innovation. Only then will you be able to outpace your competitors. To become part of the AI revolution, we recommend focusing on its four essential components — people, processes, structures and technologies. This should lead to a number of new approaches related to:

People
Focus on increasing the number of AI-savvy employees but don't just focus on the technical aspects. It is more about developing the right leadership capacities. Process experts will also be required to start the AI system training as quickly as possible. Involve all employees and remember to keep them regularly informed.

Culture
Promote the AI innovation culture to enable all employees to contribute to the AI revolution. Use practically applied examples to highlight advantages and to accelerate the understanding of AI.

Investment
Smart investments into AI will be worthwhile — particularly when they form the basis for successful new solutions, products, services and business models. Don't ignore the fact that there are often comprehensive subsidies available for investments in digitization and innovative technologies, not only at the national level, but also at the EU level. It may be worth conducting an external review to see if your projects and planned investments could be publicly subsidized. Since subsidies are generally only available to new projects, it would be smart to consider the applicability of subsidies early on.

Cooperation
Cooperate with other companies whose AI initiatives are already further advanced. You will benefit from a mutual exchange of experiences and can accelerate your own AI development while also developing customized AI applications.

The AI readiness check: Everything under control?

Would you like to know exactly which aspects of the AI future you should be watching? We have developed the following AI indicator checklist to help you do just that.

The AI indicator aims to provide companies with insightful suggestions and inspiration along the path to a successful AI future. It can help to future-proof your company to help it achieve its specific priorities. The AI indicator includes strategic, regulatory, cultural and organizational considerations. The following is an excerpt from our AI indicator checklist.

1. Strategy and artificial intelligence
- ☐ There is a clear understanding of the significance of AI at our organization.
- ☐ Our current strategy takes a comprehensive approach to the essential aspects of AI and assess the related opportunities.
- ☐ ….

2. Governance and artificial intelligence
- ☐ Our internal guidelines and rules include the use of artificial intelligence.
- ☐ We have a clear concept of the opportunities and risks of artificial intelligence at our organization and can quantify them.
- ☐ ….

3. Company culture and artificial intelligence
- ☐ New technologies and developments are openly discussed at our organization.
- ☐ We actively and continuously work to sustainably integrate digital and AI culture into the traditional organizational culture.
- ☐ ….

4. Acceptance and AI
- ☐ We recognize that — while algorithms are not visible — robots and humanoids (physical AIs) clearly are. We are anticipating and shaping the changes that will come with the conspicuous appearance of AIs in the employment environment and customer contact.
- ☐ As an organization, we are focused on easing employee and customer concerns about interactions with physical AIs and are seeing growing acceptance of this completely new form of cooperation.
- ☐ ….

5. Organization, structure and artificial intelligence
- ☐ Our organizational structure allows for the fast realization and implementation of AI in our value-added processes.
- ☐ We have introduced AI across functions in our organization and they are largely free of organizational impediments (such as silos, interface problems or communication obstacles).
- ☐ ….

6. Employees, competences and artificial intelligence
- ☐ We are already working with our employees to develop the competences required for the targeted and structured handling of artificial intelligence.
- ☐ We promote advanced training for employees in the AI sector and specifically recruit personnel with strong competence in AI technology.
- ☐ ….

7. Technology and artificial intelligence
- ☐ We use innovation radars or other tools to closely monitor the fast-paced development of AI technology and to analyze new and established players in the market.
- ☐ We continuously review the relevance of new technologies to our processes, products and solutions.
- ☐ ….

8. Processes and artificial intelligence
- ☐ While we recognize the efficiency and cost reduction benefits of AI, our primary focus is on making continuous qualitative improvements to processes and creating new experiences on the customer journey.
- ☐ We are able to quickly and effectively upgrade our processes with new AI technology.
- ☐ ….

Methodology

This study has been developed in a traditional workshop style. We start by defining the topic in the first chapter 'Understanding artificial intelligence' and then go on to highlight the latest developments in 'Artificial intelligence in the here and now'. We then explore and address the various opportunities in detail in the chapter 'Who or what is thinking in the future?' after which we present the possible options for handling AI in the world of tomorrow in our final chapter 'Shaping the future.'

The study was created in cooperation with TRENDONE, Europe's leading microtrend research institute. TRENDONE's more than 80 Trendscouts are constantly traveling the world and all of their findings are systematically reviewed and processed into a comprehensive database — the Trendexplorer — which now includes around 40,000 trends. The Trendexplorer database provided a rich source of innovations and ideas for this study.

While this report represents our educated guess on where the future will take us, each step was underpinned by scientific fundamentals and quality criteria. From the definition and classification of artificial intelligence through to the assessment of more than 300 AI business and trend cases and the development of the scenarios, we worked closely with a wide variety of different experts and thought leaders across various functions and specialties.

More than 100 future-oriented sources and studies on AI were identified and evaluated. The four future scenarios were developed, discussed and continuously refined through a series of five scenario sessions and workshops until they met the quality criteria of scenario research, particularly with respect to plausibility and consistency. The scenario discussions were supported by comprehensive desk research, data and analyst predictions. Central to this study was the participation of a variety of different experts representing a wide range of disciplines and functions such as IT, data & analytics as well as production, technology and procurement.

Today	Tomorrow	The future	Deep projection
— Status quo — Definitions and classifications	— Focus on current developments — Key topics, strategies	— Scenario analysis and vision — Opportunities — Risk analysis	— Solution scenarios — Roadmap — Early warning indicators

Study partners

KPMG

KPMG is a global network with more than 200,000 employees in 154 countries. KPMG is one of the leading auditing and advisory firms in Germany with a presence in more than 20 locations and around 10,700 employees. Our services are divided into the business lines: Audit, Tax, Consulting and Deal Advisory. The audit of consolidated and annual financial statements is the focus of Audit. Tax is responsible for the tax advising activities of KPMG. Our Consulting and Deal Advisory bundle our high level of technical expertise on to business, regulatory and transaction-oriented topics.

Our specialization extends across business sectors for essential sectors of our economy. The experiences of our experts worldwide are pooled and additionally contribute to the quality of our advisory service.

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TRENDONE

TRENDONE is Europe's leading microtrend research institute. In 2012, the company's trend scouting process was recognized as part of the 'Germany — Land of Ideas' initiative. Our more than 34 creative trend & innovation consultants at our locations in Hamburg, Berlin, Vienna and Zurich believe that 'Great new things always start out small'. That is why our 80 worldwide trendscouts spend each day scanning the most relevant sources in 22 language regions for innovations from various sectors. Committed to our motto of 'Creating Future for Your Business', they identify microtrends and help companies generate successful innovations based on these trends. All contents are published in a comprehensive database, Trendexplorer, as well as in monthly trend reports.

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