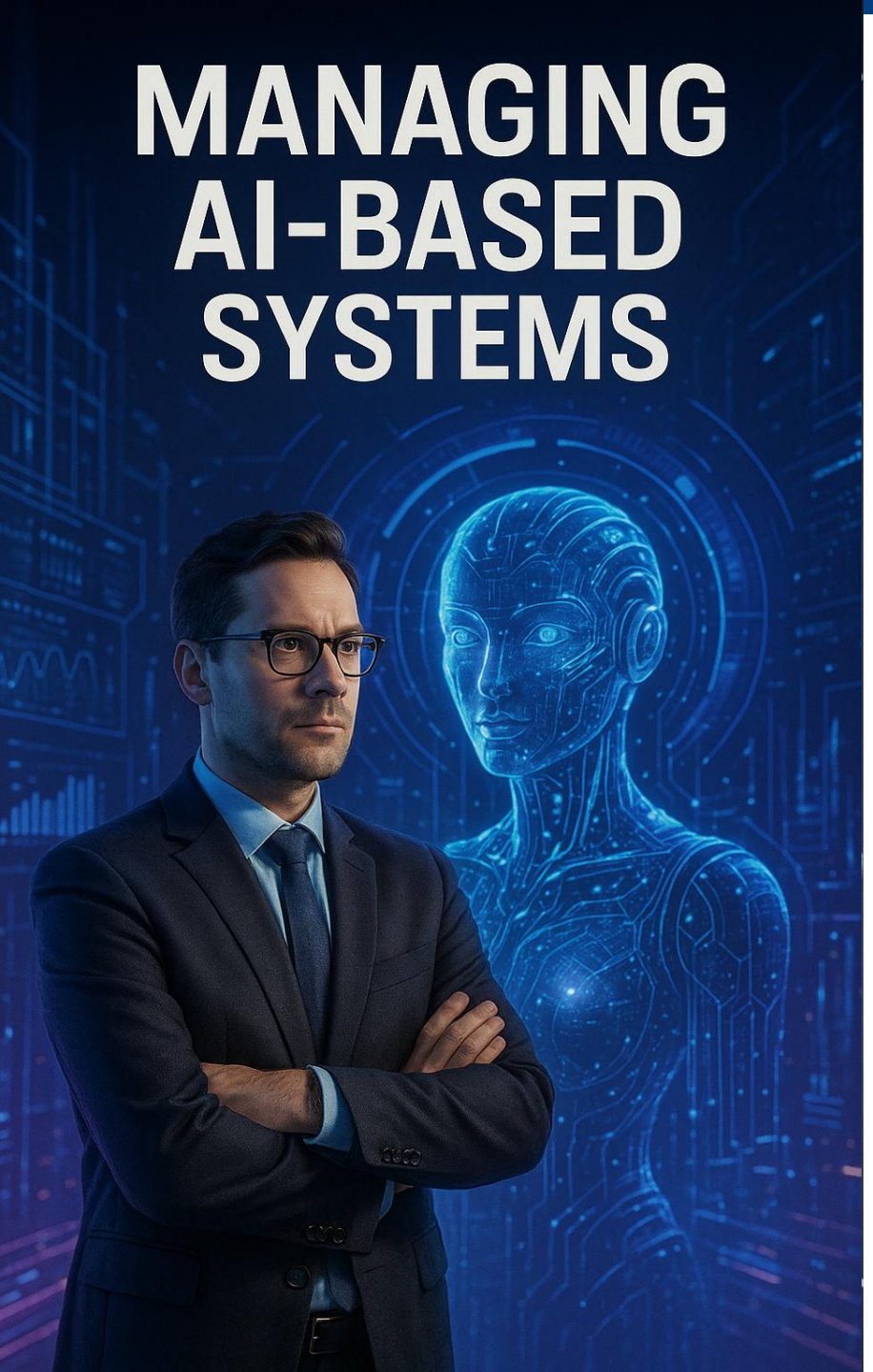


Session 5: Application potentials of AI technologies

Managing AI-based Systems

Prof. Dr. Nils Urbach

Frankfurt University of Applied Sciences,
Research Lab for Digital Innovation & Transformation

FIM Forschungsinstitut für Informationsmanagement

Fraunhofer-Institut für Angewandte Informationstechnik FIT,
Institutsteil Wirtschaftsinformatik

www.ditlab.org
www.fim-rc.de
www.wirtschaftsinformatik.fraunhofer.de

Creative Commons Copyright

Course navigator

2 3 4 Basic understanding of AI and its business potential

AI Ideation

5 **Application potentials of AI technologies**

6 Identification, design and evaluation of AI use cases

AI Strategizing

7 Evaluation an organization's AI readiness

8 Management and governance of AI

AI Design & Development

10 Architectures of AI applications

11 Data Management and Model Transparency

12 Design of human-AI interactions

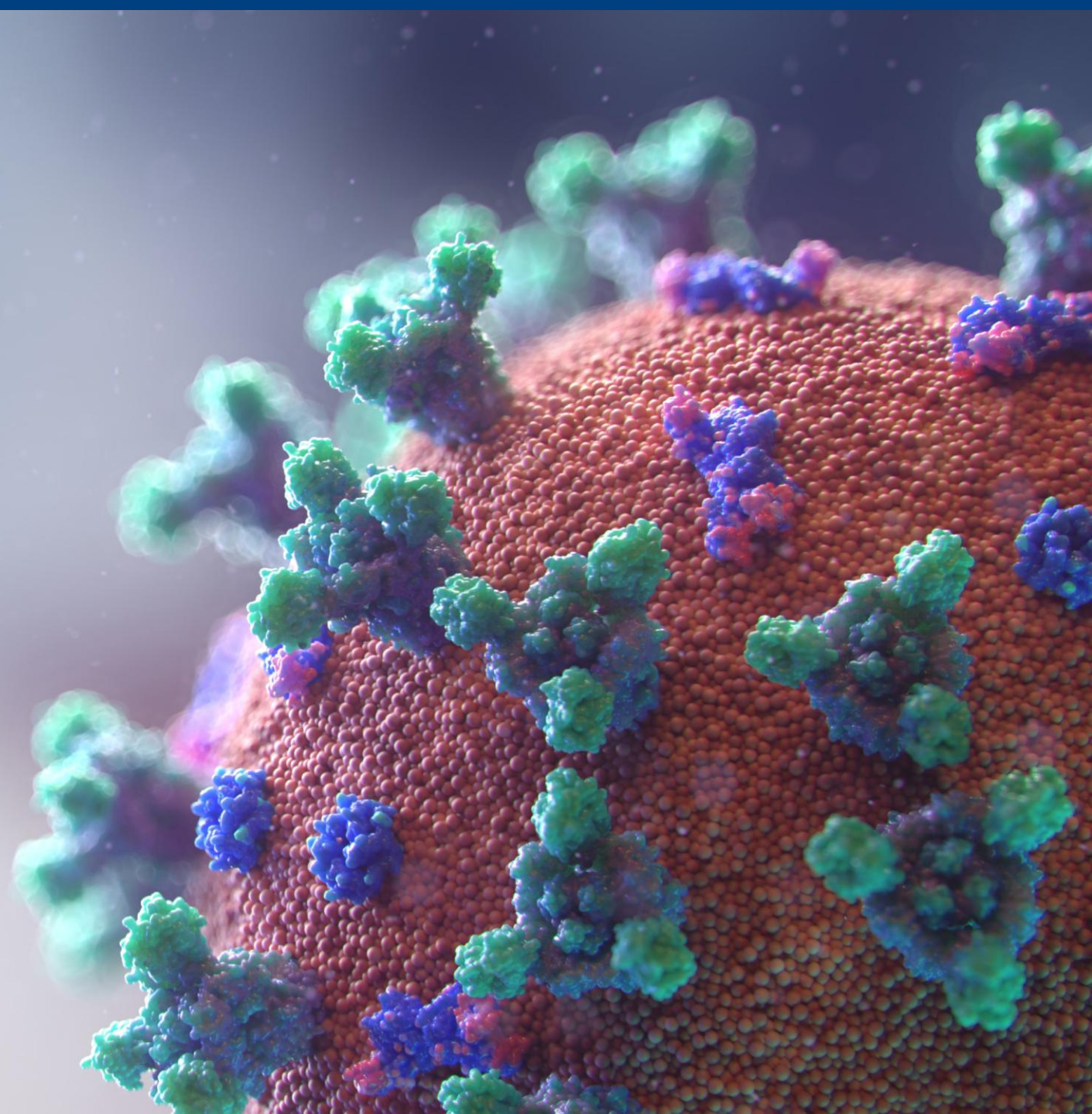
AI Operations at Scale

13 Monitoring and KPI-based control

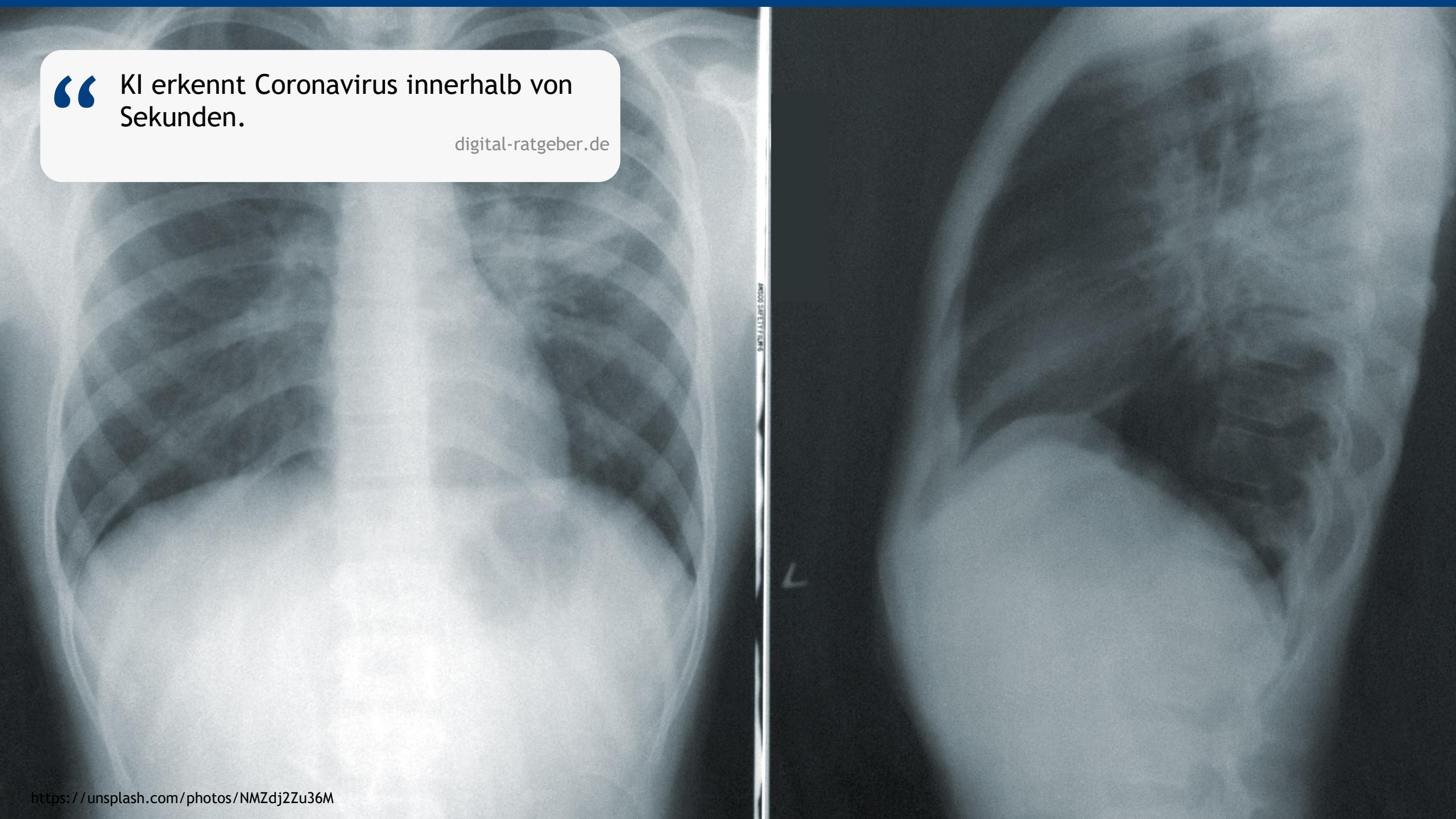
14 Ethical, legal and social implications of AI

Implementation

> AI detected the coronavirus long before the world's population really knew what it was.
>
> Forbes



https://unsplash.com/photos/npjP0dCtoxo



> KI erkennt Coronavirus innerhalb von Sekunden.
>
> digital-ratgeber.de

https://unsplash.com/photos/NMZdj2Zu36M

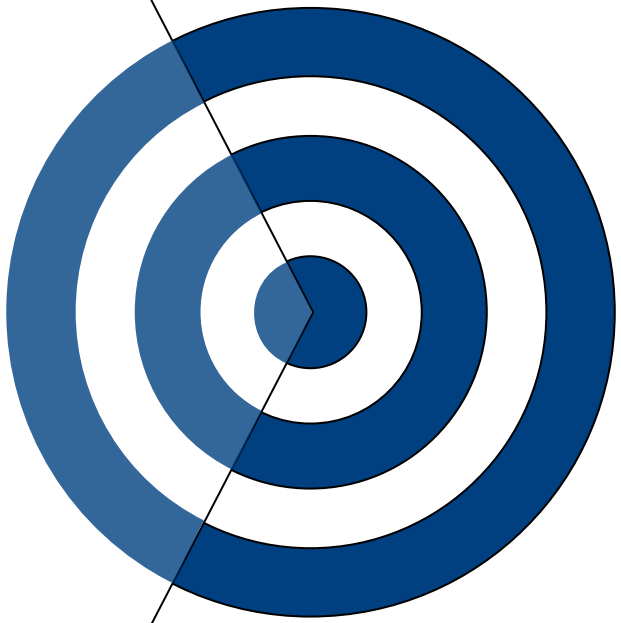
https://unsplash.com/photos/OFEvgVfr6iU

> Digitalisierter Rennsport: Mit KI fast eine Minute schneller je Runde
>
> Frankfurter Allgemeine FAZ

https://unsplash.com/photos/9L10l2pTVMw

Objectives of today's lecture

1. Understand the different functions that AI systems can fulfill
2. Experience these functions with possible AI use cases
3. Get to know the interaction dimensions between human and AI
4. Discover the interface of AI with other technologies



Agenda

01 | Operational use of AI

02 | AI use cases in different sectors

03 | Human-AI interaction

04 | AI-based process optimization and automation

05 | Cross-technology AI innovation

Agenda

01 | Operational use of AI

02 | AI use cases in different sectors

03 | Human-AI interaction

04 | AI-based process optimization and automation

05 | Cross-technology AI innovation

Recent AI news

Germany's BioNTech to buy London AI startup InstaDeep for £562m

Artificial Intelligence . Latest News

The Future of Sports Betting: AI-Powered Predictive Analytics

Citizen Smartwatch Uses AI

JPM23: Butterfly Network, Viz.ai aim to 'democratize healthcare' with imaging technologies

Interesting Ways the AI Is Affecting the 2022 FIFA World Cup Sports

Death of the narrator? Apple unveils suite of AI-voiced audiobooks

IBM Renews Commitment to Rome Call for AI Ethics

The Greenest Generation: NVIDIA, Intel and Partners Supercharge AI Computing Efficiency

AI during Covid-19

66% adoption rate

2/3 of German companies have implemented ML applications in their daily business

Increasing budget

74% of companies increased their budget for AI applications during the Covid pandemic

More projects

67% of all companies implemented more AI projects during the pandemic

Quick value added

In more than 60% of all cases, AI projects already have added value after 3 months

Product and processes

AI is used to develop new products and business models as well as for internal process optimization

Sources: Machine Learning (2021), Lufthanse, Microsoft, Datalab

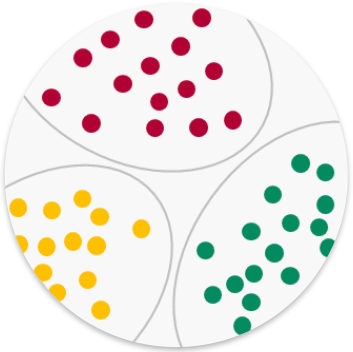
Artificial intelligence provides various functions for products, processes and services

Perceive

e.g., night mode in smartphones

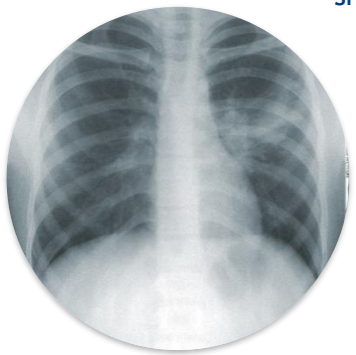
Recognize

e.g., recognition of traffic signs



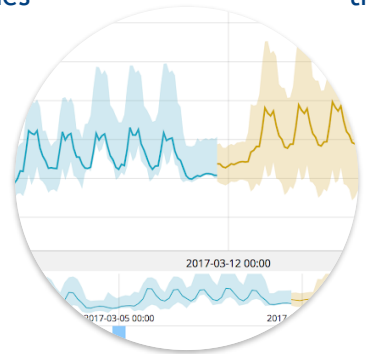
Explain

e.g., identify customer clusters



Decide

e.g., diagnosing a disease



Predict

e.g., predicting demand for products

Generate

e.g., create texts or images

Act

e.g., playing AlphaGo

Source: Hofmann et al. (2020)

Artificial intelligence provides various functions for products, processes and services

AI functions	Description	Example
Perceive	Capture and process signals from the real world	Noise reduction in images
Recognize	Identify objects or understand concepts	Recognizing a specific person in an image
Explain	Identify cause-effect relationships and draw conclusions	Grouping customer segments to explain underlying relationships and structures
Decide	Select between known discrete alternatives	Deciding whether a product is defective or not
Predict	Forecast future events or conditions	Predicting stock prices
Generate	Produce or create something new	Generating text responses for chatbots
Act	Take actions to achieve a specific purpose or cope with a situation	Autonomous forklift trucks

AI knows no department boundaries

Corporate Infrastructure | Contractual analyses

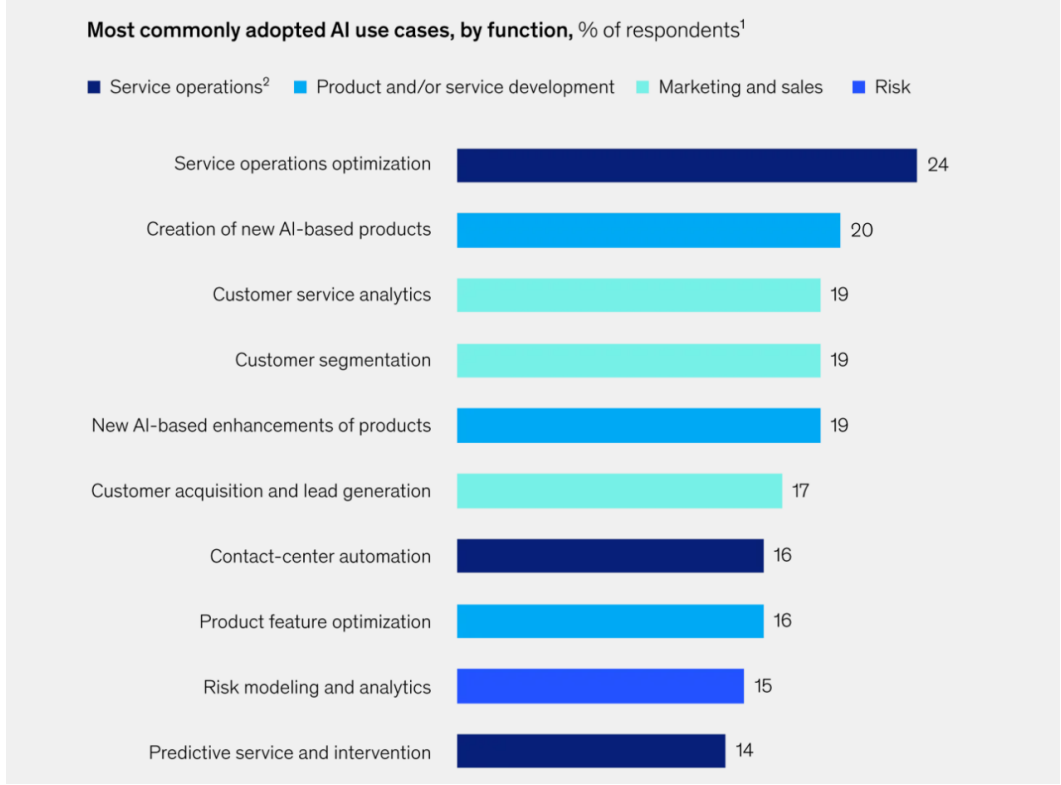
Human Resources | Candidate and resume matching

Research and Development | Improve reproducibility of results

Procurement | Digitalization of strategic procurement tasks

Inbound logistics	Production/ Operation	Marketing/ Distribution	Outbound Logistics	Customer Service
Recommendations for stocking	Intelligent industrial robots	Sales forecasts	Warehouse worker administration	AI-powered chatbots

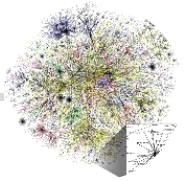
Statistics on the use of AI



The most popular AI use cases involve a range of functional activities. Most adopted AI use cases are in service operation, marketing and sales, as well as product and service development.

Source: McKinsey (2022)

AI as the next general-purpose technology?

Fire	Wheel	Steam engine	Electricity	Internet
				
ca. 700.000 BC	4000-3000 BC	18th century	19th century	20th century

Characteristics of a general-purpose technology

Widespread use

Influence on technical change and productivity gains in a wide range of applications and industries

Constant improvement

Wide range of further development and improvement over time

Bringing out innovation

Enabler of a wide range of product and process innovations in a variety of applications and industries

Images: Wikipedia
Sources: Bresnahan & Trajtenberg (1995), Brynjolfsson et al. (2017)

Steam engine and AI as examples of general-purpose technologies

	Widespread use	Constant improvement	Bringing out innovation
Steam engine	• Water pump • Production • Transport • …	• From the water pump for coal mines to the drive for steamships and railways	• Invention of more effective factory machinery and means of transport (e.g., railways) • Change in the supply chain, mass marketing etc.
AI	• Autonomous driving • Diagnoses in medicine • Product recommendations • Writing songs • …	• Continuous development of new algorithms and approaches • Possibility for self-improvement	• Performance of various cognitive skills • e.g., machine vision: perceiving and recognizing objects

Sources: Bresnahan & Trajtenberg (1995), Brynjolfsson et al. (2017)

Agenda

01 | Operational use of AI

02 | AI use cases in different sectors

03 | Human-AI interaction

04 | AI-based process optimization and automation

05 | Cross-technology AI innovation

Source: Youtube (2018)

AI in the mobility sector

AI is being used in a variety of ways, including **autonomous driving** (e.g., ML is used to interpret data from cameras, radar, other sensors, and decide about how to navigate the vehicle), **predictive maintenance** (algorithms are used to identify patterns and predict when a vehicle requires maintenance), **routing and navigation** (analyze real-time data to optimize routes and travel time) and many more such as smart traffic management or intelligent transport systems.

Uber

Example

- **Bridging supply and demand:** Uber can estimate the time and location of demand using archival data to alert drivers of the regions with high demand
- **Driver routing:** AI assists drivers to avoid crowding areas and enable speedy rides

Image: Marvin Ancian

Source: Uber (2021)

AI in the healthcare sector

The healthcare sector can benefit from the usage of AI, e.g., in the areas of **medical imaging analysis**, **drug discovery**, and **virtual health assistants**. AI can help in the early **detection** of diseases and assist in the development of personalized treatment plans (e.g., **predictive analysis**). The usage of AI in the healthcare sector can increase efficiency, reduce costs, and improve patient outcomes by **process automation**.

Example

- **Image Analysis:** Analyzing medical images to detect abnormalities or diagnose conditions
- **Treatment Personalization:** Using patient data to recommend personalized treatment plans

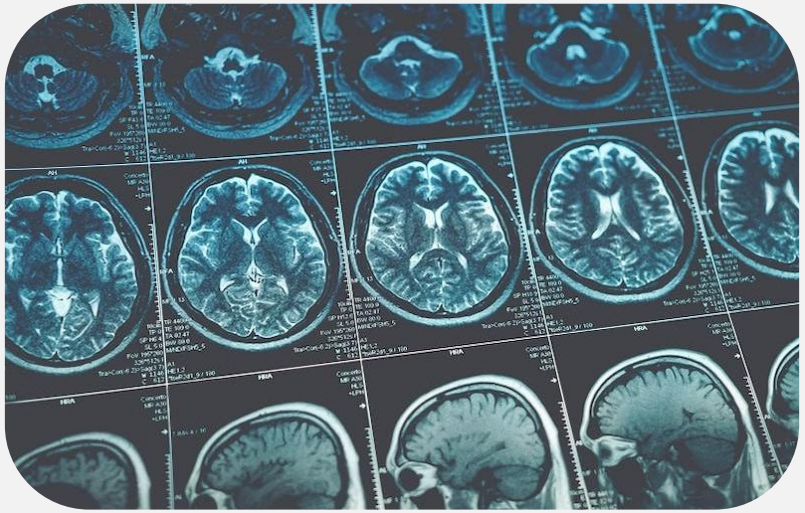


Image: IDTechEx

Source: Merative (2023)

AI in the Industry 4.0

In industry 4.0, AI can be used to improve efficiency, reduce costs, and increase productivity across various industries. Thereby, AI is used for **predictive maintenance**, process and supply chain **optimization**, **robotics** (e.g., RPA), **automatization**, as well as **advanced analytics**.

Example

- **Correlation Identification:** AI can identify correlations between seemingly unrelated events, such as simultaneous failures of non-connected components
- **Autonomy:** Siemens is leveraging AI to automate various processes and reduce human intervention

Image: Artificial Finance

Source: Siemens Energy (2023)

AI in the sport sector

AI can be used to analyze data from sports matches and training sessions (**image** and **video recognition**) to identify areas of improvement and predict the outcome of future matches. Furthermore, AI can be used to increase fan engagement by providing **personalized recommendations** or quick responses via **chatbot**.

FIFA

Example

- **Semi-Automated Offside Technology:** This technology combines limb- and ball-tracking data. The system can make more accurate offside decisions in real-time
- **Enhancing Viewer Experience:** Providing accurate and insightful data, which can be used for in-game analysis

Image: TheVerge

Source: FIFA (2022)

Agenda

01 | Operational use of AI

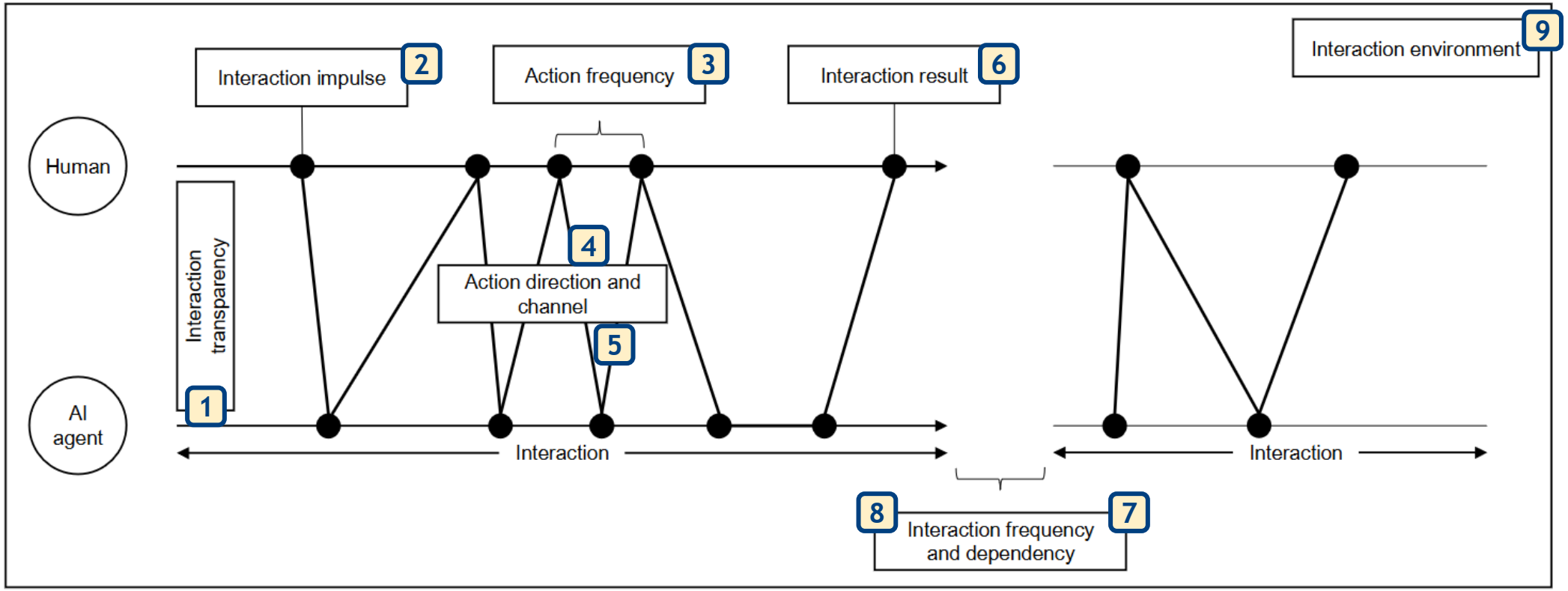
02 | AI use cases in different sectors

03 | Human-AI interaction

04 | AI-based process optimization and automation

05 | Cross-technology AI innovation

Human-AI interaction dimensions



When a company designs an AI-based solution, the consideration of human-AI interaction facilitates the creation of intuitive, user-centric solutions

Source: Hinsen et al. (2022)

Nine human-AI interaction dimensions

1 Interaction transparency
Degree of consciousness with which a person interacts with an AI agent; spectrum between perfect consciousness and perfect unconsciousness

2 Interaction impulse
Beginning of a new human-AI interaction as well as the reason for it; targeted, searching or play/creative origin

3 Action frequency
Number of actions in an interaction; simple action frequency (one action) or multi-action frequency

4 Action direction
Direction of the individual actions in an interaction; one direction or bidirectional

5 Action channel
Sensory forms of perception through which an interaction partner can perceive external stimuli; info can be exchanged acoustically, optically or haptically

6 Interaction result
Result influences the environment; Monitoring, informing, assisting, advising, or experiential character

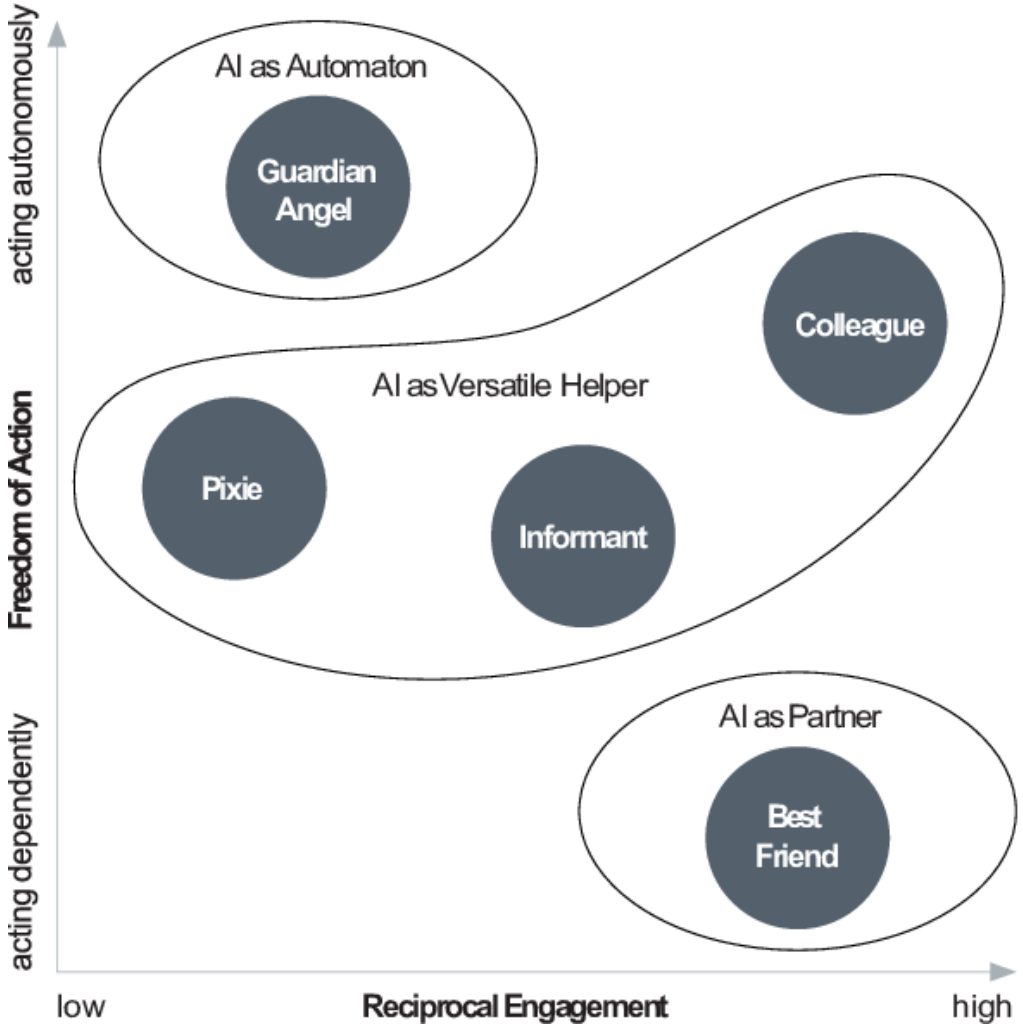
7 Interaction frequency
Number of interactions within a certain period; ranges from one-time, to rare, to frequent

8 Interaction dependency
Measure of the dependency level between one or more interactions; classification of interactions as independent or interdependent

9 Interaction environment
Interaction's current environment; human-AI interactions in private or professional environments

Source: Alan et al. (2019)

Types of human-AI interaction



- **AI as Automaton**: protective character
- **AI as Versatile Helper**: helper character, support in daily lives informative, assisting and advisory results
- **AI as Partner**: companion with pronounced social and emotional intelligence skills

Source: Alan et al. (2019)

Types of human-AI interaction

	Description	Examples	Constituent dimensions
Guardian angel	Entirely unconscious interactions, their results (and beyond)	Vehicle assistance systems (emergency braking)	Interaction impulse: targeted Interaction result: informing, monitoring Interaction transparency: unconscious
Pixie	Performs repetitive basic tasks to reduce human workload	Intelligent software applications in HR management	Interaction impulse: targeted Interaction result: assisting Interaction transparency: conscious
Informant	Also takes over basic tasks with strong focus on obtaining information	AI service robots (reception assistance)	Interaction impulse: targeted, searching Interaction result: informing Interaction transparency: (un)conscious
Colleague	Goal-oriented, delivering an informative, assisting, or consulting result in conscious interactions	Chat-GPT 3 text creation software	Interaction impulse: targeted, searching Interaction result: assisting, informing Interaction transparency: conscious
Best friend	Complex and independant interaction in pre-defined social action framework. Involve consciously experiencing a social exchange.	Social chatbots (like Xiaoice)	Interaction impulse: playful, creative Interaction result: experiencing Interaction transparency: conscious

Source: Alan et al. (2019)

Influencing factors of human-AI interaction

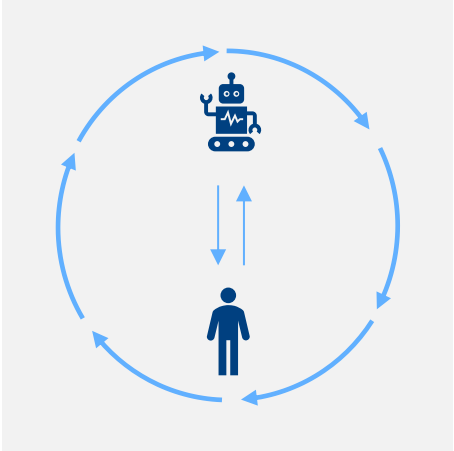
Initial situation

Expectations

Frequently worries and unrealistic expectations from users towards AI

Interaction context

Iterative interaction process



Success factors

Transparency

Understanding and awareness of AI interaction

Anthropomorphism

Human likeness as an ambivalent design variable

Personalization

Assumption-based action adjustment

Resulting situation (positive vs. negative)

Acceptance & Trust

Depending on individual presetting as well as previous experience wit AI

Source: Alan et al. (2019)

Agenda

01 | Operational use of AI

02 | AI use cases in different sectors

03 | Human-AI interaction

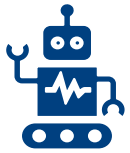
04 | AI-based process optimization and automation

05 | Cross-technology AI innovation

Process optimization and automation

Process optimization:

Examination, analysis and improvement of existing processes within an organization to enhance efficiency, productivity, quality, and overall performance



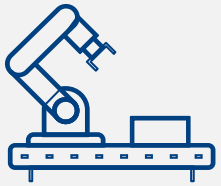
Automation:

Use of technology, software, or machinery to perform tasks or processes with minimal human intervention to replace repetitive tasks with automated systems, reducing human error, increasing accuracy, and speeding up the overall process

Role of AI:

AI brings advanced capabilities to process optimization and automation by leveraging data analysis, predictive analytics, intelligent decision-making, and automation of routine tasks. It helps organizations achieve higher levels of efficiency, productivity, and quality by optimizing processes, reducing costs, and enabling faster and more accurate operations.

Robotic process automation (RPA)



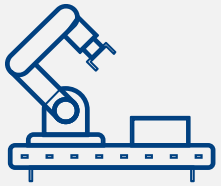
What should be automated and what should be done by humans?

RPA involves tools that automate tasks by operating on the user interface of computer systems, mimicking human actions and performing repetitive tasks. It aims to replace manual labor through an “outside-in” approach, leaving the underlying information system unchanged.

- **Main objective:** increase RoI
- **Dedicated RPA vendors:** AutomationEdge, Automation Anywhere, Blue Prism, Kryon Systems, Softomotive, UiPath
- **Embedded RPA functions** in software with several tools, e. g. Pegasystems

Source: van der Aalst et al. (2018)

Robotic process automation (RPA)



What should be automated and what should be done by humans?

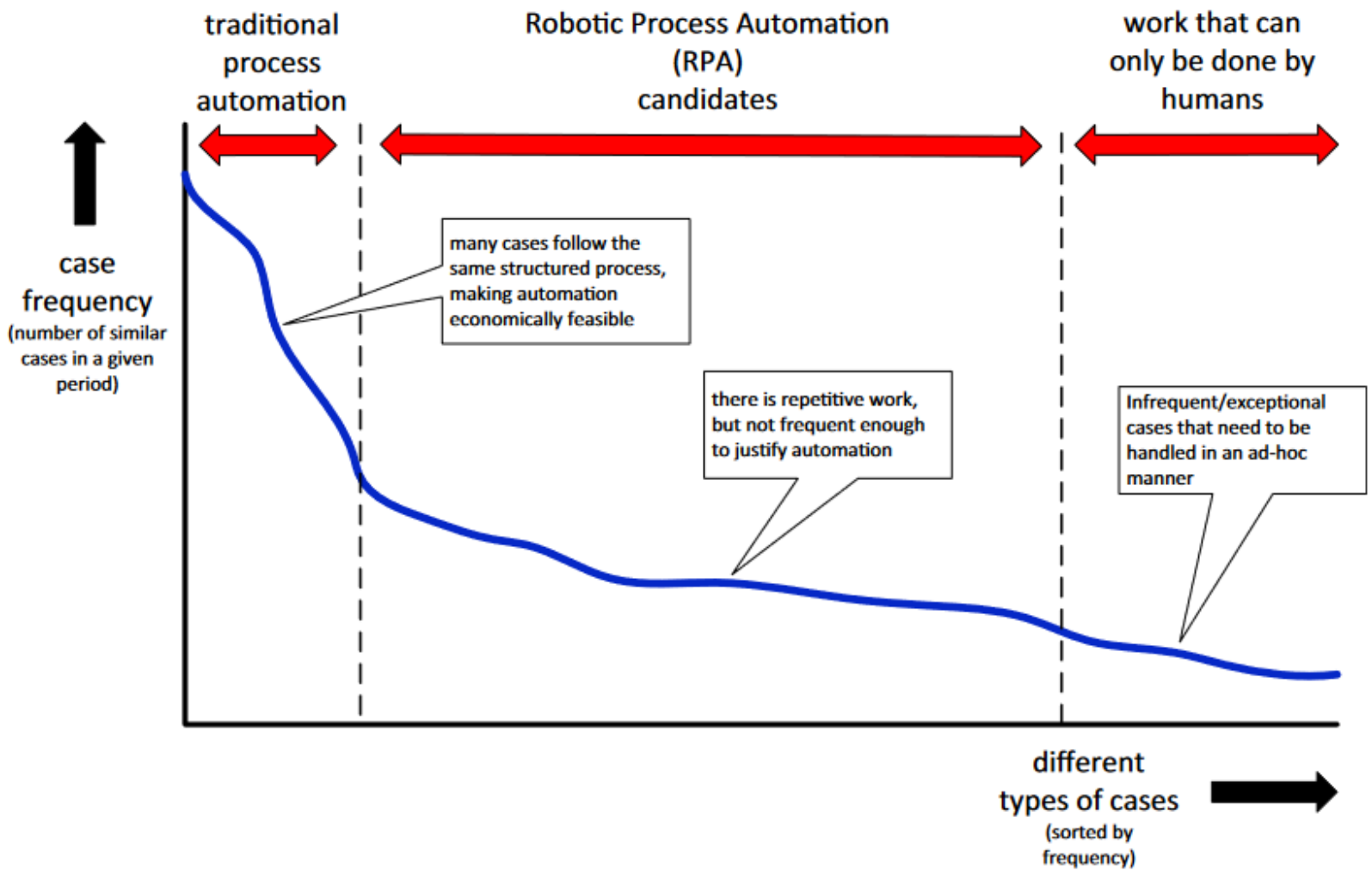
Example: Automation of invoice processing in a company

With RPA, software robots can be deployed to capture invoices, extract data from various sources such as emails, scanned documents, or online portals, enter it into the accounting system, and perform automated payments. To validate, verify and match data with existing information the RPA robots can use rules and algorithms.

Objective: Reduce manual effort accelerate processing time and minimize potential errors. This leads to a more efficient and accurate handling of the invoice process, resulting in cost savings and improved operational efficiency.

Source: van der Aalst et al. (2018)

RPA cases



Source: van der Aalst et al. (2018)

Process mining

Process mining
The use of data recorded during the execution of a process to analyze and improve business processes. This is done by using information from process traces, which represent cases (execution of process instances). Traces consist of sequences of process activities described by their names, timestamps and possibly other information, and are logged by process-oriented information systems (ERP, CRM, WMS, MES, etc.).

Role of AI:
AI can support PM by using advanced analytics and machine learning to predict future process behavior, optimize process performance and support decision making. This can be divided in AI-based strategies that use explicit domain knowledge and auxiliary AI tasks

Source: Mehdiyev & Fettke (2021)

Process mining methods and the role of AI

Process discovery

Automatic data-driven construction of business process models from the event logs

Role of AI: Automatically discover process models from event logs and data by learning patterns, dependencies and variations

Example: Improving the support process by analyzing the interaction of customers with a chatbot through AI; it identifies patterns, customer inquiries and provides relevant information.

Conformance checking

Pursues the objective to examine the real process behavior by comparing the process models with the event log of these processes

Role of AI: Compare models to actual data to check the conformance of the execution of processes and detect deviations, bottlenecks, and non-compliant behavior

Example: A healthcare provider can compare its documented treatment processes with the actual patient data to detect deviations or non-compliant behavior

Process enhancement

Extending the a-priori process models by analyzing the event logs

Role of AI: By applying optimization algorithms or predictive analytics, process performance can be optimized, cycle times reduced, resource allocation improved, and overall efficiency enhanced

Example: In a manufacturing plant, AI identifies that certain machine setups lead to higher production defects; the a-priori model is extended to include machine settings to minimize defects

Source: Mehdiyev & Fettke (2021)

Agenda

01 | Operational use of AI

02 | AI use cases in different sectors

03 | Human-AI interaction

04 | AI-based process optimization and automation

05 | Cross-technology AI innovation

The interaction of AI and Blockchain

Blockchain

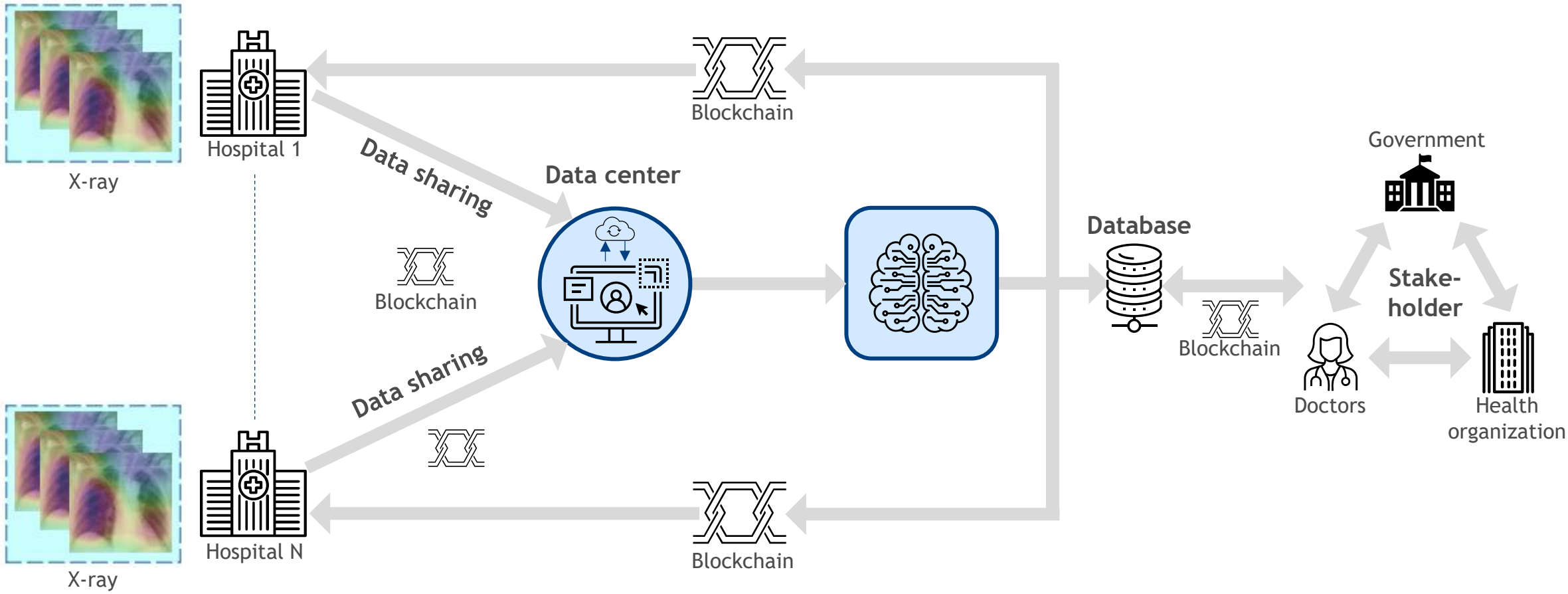
At its core, blockchain is a database with unique advantages, often referred to as “blue ocean” benefits. These benefits include decentralized/shared control, immutability/audit trails, and native assets/exchanges. It is a distributed database that stores information in the form of blocks and connects them in a chronological order to form a chain (for example in the context of cryptocurrencies). Security vulnerabilities prevalent in the current internet landscape can be addressed through the use of blockchain (IoT, payment mechanisms, communication channels, etc.).

Advantage of the combination of AI and blockchain

One of the significant advantages is the ability to create decentralized, tamper-proof systems where AI algorithms can securely analyze and process data without compromising privacy. An example can be the management of pandemics, like Covid-19, where blockchain enables early detection of outbreaks, securing the organization of medical information and guaranteeing a dependable supply chain. Meanwhile AI can help identifying symptoms and facilitate drug manufacturing.

Sources: (1) Rabah (2018), (2) Tagde et al. (2021)

Blockchain and AI-based solutions to combat Covid-19



Step 1: Data collection with X-ray images

Step 2: Blockchain enables secure data sharing and reliable storage

Step 3: Data analytics with AI, e.g. neural networks

Step 4: Sharing analyzed outcomes with stakeholders via blockchain

Source: Nguyen et al. (2021)

The interaction of AI and the Internet of Things (IoT)

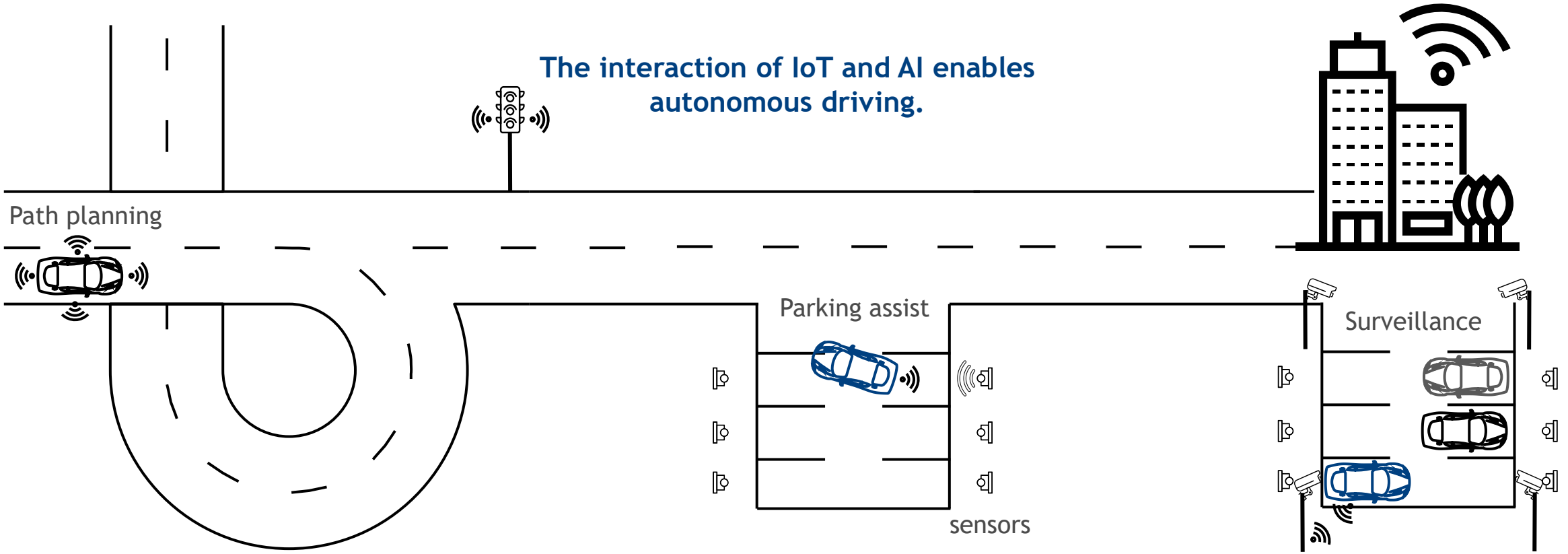
IoT
IoT is a network of connected physical devices with sensors, software and connectivity capabilities that communicate and exchange data over the internet with other devices and users. It is used for data collection to optimize processes, improve efficiency, and enhance decision-making in various domains.

Advantage of the combination of AI and IoT (AIot)
IoT integrating AI can unlock its full potential enabling advanced capabilities and intelligent decision-making processes for complex systems like autonomous vehicles. It enables IoT systems to extract meaningful insights from data, automate processes, deliver personalized experiences, improve security, and optimize operations.

Source: Rabah (2018)

IoT and AI-based solutions to realize autonomous driving

The interaction of IoT and AI enables autonomous driving.

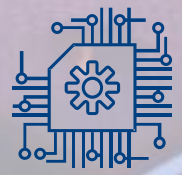


Data collection through car sensors and path planning (manoeuvre and trajectory planning) with AI systems	Data collection through car and movement sensors and parking through intelligent assist	Data collection through cameras and analysis through computer vision

Source: Khayyam et al. (2020)

The interaction of AI and quantum computing

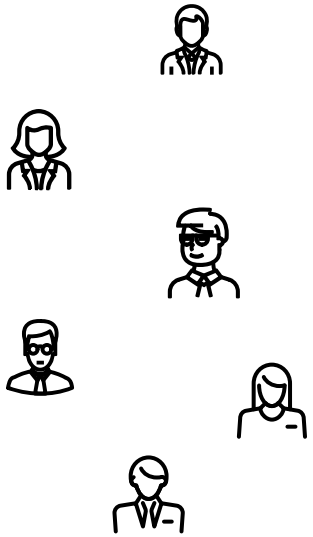
Quantum computing
Quantum computing, like classical computing, stores data in the form of bits (0 or 1), but encodes information in qubits, allowing multiple states of data to be stored simultaneously and far outperforming conventional supercomputers in terms of computation time.



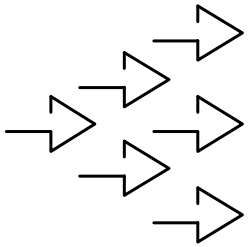
Advantage of the combination of AI and quantum computing
Quantum Computing can help AI with faster training and computational power at a lower price, while AI can equip quantum computers with the required error correction algorithms. An example for the use of this combination is the banking industry with its application in quantum cryptography to secure data within transactions and be prepared for the danger of data theft when quantum computing is usable for end-users.

Sources: (1) Rawat et al. (2018), (2) Abdelgaber & Nikolopoulos (2020), (3) Jürgens (2019)

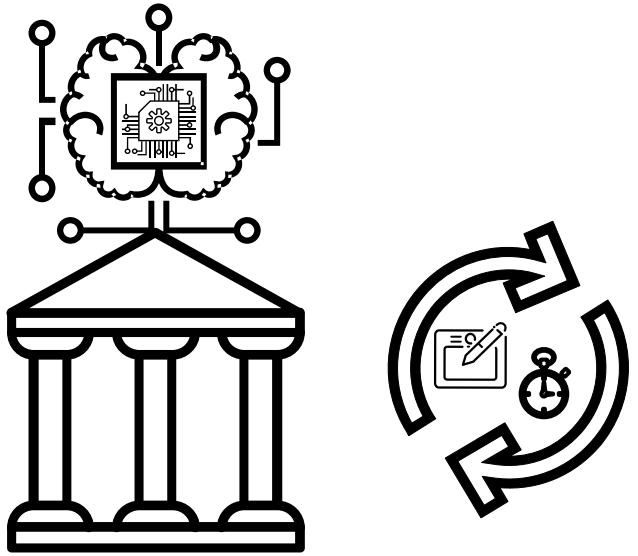
Quantum computing and AI in the banking industry



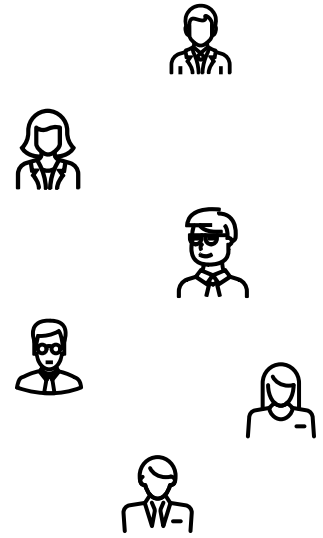
Customers



Sensitive data



Bank using quantum machine learning for applications like encryption keys



Customers

Customers provide bank with sensitive data, that has to be secured via secure access control and encryption keys

Banks also have to provide real-time access and digital signatures for their customers

Source: Suriya (2020)

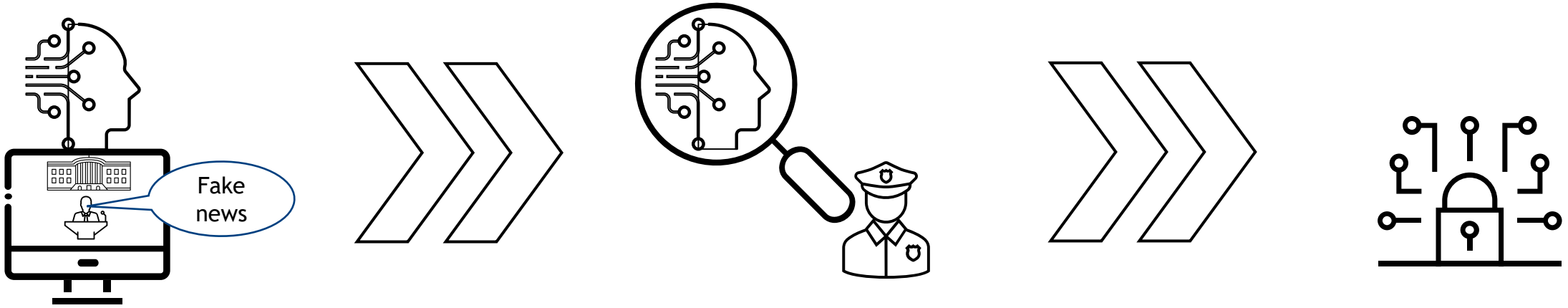
The interaction of AI and self-sovereign identity (SSI)

Self-sovereign identity
SSI is an identity management system which allows individuals to fully own and manage their digital identity. Besides persons, individuals can include also IoT devices. Decentralized Identifiers (DIDs) can be presented to a requester whenever identity proof is needed without a central authority for verification.

Advantage of the combination of AI and self-sovereign identity
SSI present a powerful solution to the challenges posed by generative AI, specifically deep fakes and accountability concerns. If an AI system spreads false information, the distinctive SSI can promptly identify it, hold it responsible and deny its access to prevent any further circulation of deceptive content.

Source: (1) Bartolomeu et al. (2019), (2) Gravity (2023)

Self-sovereign identities and AI in battling deep fakes



GenAI system has a distinctive and verifiable digital identity (SSI)

Prompt identification, accountability and removal of its access to prevent further spread of falsehoods by having an SSI

GenAI system gets more accountable and transparent, which makes it more trustworthy

Source: Gravity (2023)

Today’s lecture at a glance

- We experienced the different functions of AI in real world scenarios
- We learned about the nine human-AI interaction dimensions and which types of interaction can arise from this
- We discussed the opportunities of AI-based process optimization and process automation
- We know how other cutting-edge technologies, like Blockchain, the Internet of Things, or self-sovereign identities interact with AI

Questions, comments, observations

Scientific references

- Abdelgaber, N., & Nikolopoulos, C. (2020). Overview on quantum computing and its applications in artificial intelligence. In 2020 IEEE Third International Conference on Artificial Intelligence and Knowledge Engineering (AIKE), 198-199
- Alan, Y., Urbach, N., Hinsen, S., Jöhnk, J., Beisel, P., Weißert, M., ... & Hofmann, P. (2019). Think beyond tomorrow: KI, mein Freund und Helfer: Herausforderungen und Implikationen für die Mensch-KI-Interaktion. Fraunhofer FIT und EY.
- Bartolomeu, P. C., Vieira, E., Hosseini, S. M., & Ferreira, J. (2019). Self-sovereign identity: Use-cases, technologies, and challenges for industrial iot. In 2019 24th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA), 1173-1180
- Bresnahan, T. F., & Trajtenberg, M. (1995). General purpose technologies 'Engines of growth'?. Journal of Econometrics, 65(1), 83-108.
- Brynjolfsson, E., Rock, D., & Syverson, C. (2018). Artificial intelligence and the modern productivity paradox: A clash of expectations and statistics. In The economics of artificial intelligence: An agenda, 23-57. University of Chicago Press.
- Folino, F., & Pontieri, L. (2021). Ai-empowered process mining for complex application scenarios: survey and discussion. Journal on Data Semantics, 10(1-2), 77-106.
- Gimpel, H., Lahmer, S., Wöhl, M., & Graf-Drasch, V. (2023). Digital Facilitation of Group Work to Gain Predictable Performance. Group Decision and Negotiation, 1-33.
- Hofmann, P., Jöhnk, J., Protschky, D., & Urbach, N. (2020). Developing Purposeful AI Use Cases-A Structured Method and Its Application in Project Management. In Wirtschaftsinformatik, 33-49.
- Hinsen, S., Hofmann, P., Jöhnk, J. and Urbach, N. (2022) How Can Organizations Design Purposeful Human-AI Interactions: A Practical Perspective From Existing Use Cases and Interviews, Proceedings of the 55th Hawaii International Conference on System Sciences (HICSS-55), January 4-7, Maui, Hawaii.
- Jürgens, N. (2019). Quantum Computing – Boost für AI/KI-Technologie. In TheBlueAI. Retrieved from: https://theblue.ai/blog-de/quantum-computing/

Scientific references

- Khayyam, H., Javadi, B., Jalili, M., & Jazar, R. N. (2020). Artificial intelligence and internet of things for autonomous vehicles. Nonlinear Approaches in Engineering Applications: Automotive Applications of Engineering Problems, 39-68.
- Mehdiyev, N., & Fettke, P. (2021). Explainable artificial intelligence for process mining: A general overview and application of a novel local explanation approach for predictive process monitoring. Interpretable artificial intelligence: A perspective of granular computing, 1-28.
- Nguyen, D. C., Ding, M., Pathirana, P. N., & Seneviratne, A. (2021). Blockchain and AI-based solutions to combat coronavirus (COVID-19)-like epidemics: A survey. IEEE Access, 9, 95730-95753.
- Rabah, K. (2018). Convergence of AI, IoT, big data and blockchain: a review. The lake institute Journal, 1(1), 1-18.
- Rawat, B., Mehra, N., Bist, A. S., Yusup, M., & Sanjaya, Y. P. A. (2022). Quantum computing and ai: Impacts & possibilities. ADI Journal on Recent Innovation, 3(2), 202-207.
- Suriya, M. (2022). Machine learning and quantum computing for 5G/6G communication networks-A survey. International Journal of Intelligent Networks.
- Tagde, P., Tagde, S., Bhattacharya, T., Tagde, P., Chopra, H., Akter, R., & Rahman, M. H. (2021). Blockchain and artificial intelligence technology in e-Health. Environmental Science and Pollution Research, 28, 52810-52831.
- Van der Aalst, W. M., Bichler, M., & Heinzl, A. (2018). Robotic process automation. Business & information systems engineering, 60, 269-272.

Non-scientific references

- https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai-in-2022-and-a-half-decade-in-review#/
- https://www.uber.com/en-DE/blog/uber-ai-blog-2019/?uclick_id=f04597d4-e944-4010-a6dd-f264930f2f12
- https://www.merative.com/content/dam/merative/documents/ebook/achieving-the-benefits-of-ai.pdf
- https://www.siemens-energy.com/global/en/news/magazine/2022/unleashing-ai-in-power-plants.html
- https://www.fifa.com/technical/media-releases/semi-automated-offside-technology-to-be-used-at-fifa-world-cup-2022-tm
- https://www.linkedin.com/pulse/navigating-future-generative-ai-accountability-role-self-sovereign/

Pictures

- Wheel – Wikipedia
- Steam engine – Wikipedia
- Electricity – Wikipedia
- Mass production – Wikipedia
- Internet – Wikipedia
- Nanotechnology – Wikipedia
- What is IoT and how can it help your business? - Think Connects
- Self-Sovereign Identity: The Ultimate Guide 2023 (dock.io)