Mindshift

Impulses for change – TUM Campus Heilbronn

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Issue No. 8

Dear Readers,

Imagine, Aladdin's genie in a bottle offers to fulfill your boldest wishes. Artificial intelligence holds the same type of fascination in our digital world – a modern jinn that offers customized solutions to all sorts of challenges and makes the impossible possible.

This issue of Mindshift takes you to the land of AI that is coming to life at TUM Campus Heilbronn. Read about how it is driving innovations in the labor market, in industrial settings, and in the field of education. Learn how AI facilitates perfect job hunts, industrial processes are revolutionized by intelligent systems, and learning assistants enhance education. Our stories are as inspiring as genies in bottles. At the same time, the myth of the serviceable jinn teaches us that with great (AI) power comes great responsibility. It is up to us to make smart and sustainable decisions about fleshing out and utilizing this technology. Unlike in the fairy tale, this cannot be achieved in the blink of an eye; instead, we have to invest time, act with foresight, and conduct extensive research.

In this issue you can read about how AI makes it possible to address potential employees in a targeted manner, and why the skills-based hiring method sounds promising in a time of skills shortage.

AI-based technologies also are simplifying and optimizing industrial processes, from intelligent cameras guaranteeing precise object classification to smart gripping systems that handle complex tasks autonomously.

The education sector also benefits from the new technology. The chatbot Iris is an outstanding example of enhancing the learning environment at TUM Campus Heilbronn by means of AI. Additionally, AI's potential contribution to equitable and inclusive education is discussed.

A recipient of the German public-private scholarship Deutschlandstipendium reports on his commitment to fostering educational partnerships among students in Germany and in South Africa in a world that is moving even closer together through digital education and AI.

Join us in the discovery and dive into the multi-facetted world of AI at TUM Campus Heilbronn. We show you how it opens up new horizons and helps build bridges among continents.
We hope you are inspired while reading, contemplating, and reflecting.

Prof. Dr. Helmut Krcmar
Founding dean (2018–2020) and representative of the president
for TUM Campus Heilbronn

AI, the (in)visible genie!?

Competently responding chatbots, smart cameras, medical diagnostics – AI undoubtedly holds a great fascination for us and, as the serviceable genie it has become, is driving progress in many areas. However, its complexity also gives rise to skepticism.

In a world where digital technologies increasingly are finding their way into everyday life, AI is playing a greater formative role and is shaping our future as well. We continually talk about AI – and to it, sometimes even unknowingly. At a yet unpredictable speed, AI impacts how we work, learn, produce, and protect our environ-

ment. Developments in the field of AI can help increase efficiency and productivity, foster sustainability, and optimize learning and working methods.

Research conducted at TUM Campus Heilbronn is an example of the quest for innovation. "Under our guiding

principle 'for the digital age' our scientists are making remarkable contributions to help shape the future of the digital transformation and enjoy, not just endure, generative AI," says Prof. Dr. Helmut Krcmar, founding dean and representative of the president for TUM Campus Heilbronn. Mindshift offers a platform for introducing the array of projects and the people behind them.

The focus of this issue is recruiting, industry, education, social platforms, and the environment. AI can facilitate the targeted search for and the selection of candidates, analyze large data volumes, and improve industrial production processes. In education, AI helps students reach their individual learning goals and continuously challenge what constitutes good education. The new technology has become an indispensable tool for creating content on social platforms. Not least, AI technologies are employed to tackle environmental and climate protection problems.

Potential drawbacks

While AI holds immense potential, its use comes with a number of challenges, in particular with regard to ethics, data protection, and the elimination of bias. The threat of loss of control, the exploitation of intellectual property, for example, in cases where artists' creative works are used to train AI, or the loss of jobs to automation are viewed critically. AI systems learn from data – if the data is biased, the AI's decisions can be unfair or discriminating.

To counter AI fraud, it is important to address questions of accountability and fairness. We need regulations and policies, stringent safety standards, and transparency – AI content and its purposes must be recognizable at all times. The EU Parliament recently adopted the world's first AI law as a legal framework for regulating the use and development of AI.

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> **Developments in AI are providing us with vast opportunities, but they also require us to act with foresight and responsibility.**
>
> Prof. Dr. Helmut Krcmar

Prof. Dr. Krcmar emphasizes: "As developments are continuing, we must keep up the discourses to both promote innovative AI applications and ensure the protection of individual rights and freedoms." Continuous learning is one of the crucial elements, he adds. "We must invest in education and upskilling to equip all the parties involved with the necessary knowledge and skills concerning AI technologies so they understand and help shape the impact on society and benefit from newly acquired skills."

Globally connected

Sharing experiences and ideas is essential for reaching this goal. TUM Campus Heilbronn relies on internationalizing its research activities. "At the interface of technology and society, we observe the challenges and opportunities of the digital age from a global perspective. We collaborate with leading global excellence universities such as the Oxford Internet Institute and the Hebrew University, we expand our research networks, and thus foster the transfer of knowledge and resources to establish an inclusive, cross-border scientific community," says Prof. Dr. Krcmar.

One thing is clear: AI depends on HI, human intelligence, with all its facets. At the end of the day, what is important is striking a balance among the enormous opportunities AI offers and the ethical, social, and economic questions it raises. "Developments in AI are providing us with vast opportunities, but they also require us to act with foresight and responsibility." ●

Revolutionizing recruitment

AI has many advantages for recruitment – if the risks are taken into account from the outset, says Johannes Gölz, research assistant at the Center for Digital Transformation at TUM Campus Heilbronn.

The service assistant responds to applicants' queries in the chat quickly and with a friendly and competent demeanor – and around the clock. But wait, is that a person or are users dealing with a chatbot?

Chatbots are only one of many options available to companies wanting to incorporate AI in their recruitment process. Before announcing vacancies, a large language model (LLM) can be directed to analyze the company's activities, job descriptions, and target agreements and then determine the key requirements for individual positions. AI also can search through platforms to suggest suitable candidates to fill vacancies. AI can review CVs in an automated manner, compare them to job requirements, and make an initial selection. The resulting data collection facilitates forecasting applicants' professional success.

AI can analyze the content of job interviews. "In the United States, for example, it is common for job interviews to be recorded so the candidates' language, wording, gestures, and facial expressions can be analyzed," says research assistant Gölz.

Applicants have a series of new options available to them as well: They can have ChatGPT and other tools write application letters or have AI notify them of relevant job advertisements based on their individual profile. An important fact that often is overlooked is that today applications need to impress people as well as AI.

Less bias

Gölz is convinced that, "At the end of the day, AI has the potential to be less biased than humans." But is it not a fact that many algorithms are biased and their evaluations skewed? According to Gölz, this is linked to the type of data available and to training. "Let's not forget that LLMs use historical data, and currently a lot of research is conducted on training and fine-tuning."

Despite the variety of applications, only a few companies currently are employing the new tools – according to estimates, approximately 10 to 20 percent of HR departments and 30 to 50 percent of recruiting agencies in Germany.

Focus on human-centered AI

This situation will change. "The use of AI in the recruitment process likely will increase substantially. AI can

provide support in every step of the process." According to Gölz, communicating and minimizing risks in advance is important and can be achieved, for example, by introducing strict data protection measures, assessing algorithms regularly for potential data distortions, explainability, and consistency, and ensuring transparency for all parties involved.

Gölz highlights the fact that AI ultimately makes suggestions that can support people in their decision-making. "At the end of the day, it is people who determine success." ●

SENIOR CONNECT

Samuel Keitel and Tim Findeiß founded a start-up named Senior Connect to bring together energetic senior citizens and companies seeking talent.

Three years ago, the two students of Management & Technology at TUM Campus Heilbronn were contestants in the Corporate Campus Challenge. Hosted by start-up incubator Campus Founders, the event offered workshops and opportunities to solve actual problems companies face, which whetted their appetite. Keitel says: "The conditions for creating something here at the Campus are very different from the conditions I had to meet when establishing a virtual marketplace for regional products all on my own. It doesn't get better than this."

Granny as a role model
Inspiration for Senior Connect came to Findeiß from his personal life: "When my grandmother retired, she continued volunteering for the local library, and many of her retired friends also wanted to stay active." The spark turned into a fire. "We spoke to senior citizens on the street, and the feedback we received confirmed our initial assumption." Keitel adds: "Through Campus Founders' network we were able to contact unions and stakeholders and ended up speaking with the HR departments of Audi and Schwarz Group."

From their market research the students found that many people over the age of 60 want to continue working and have the energy to do it, and that companies have a need for expertise. These findings are the cornerstone of Senior Connect. However, for lack of technical know-how Keitel and Findeiß sought the help of Stael Wilfried Tchinda Kuete, a former student of computer engineering and now TUM graduate. They coveted Kuete's machine

Samuel Keitel (l.) and Tim Findeiß (r.) rely on the machine learning skills of Stael Wilfried Tchinda Kuete.

learning skills because they wanted the updated website to bring together employers and employees through AI.

Successful elevator pitch
Keitel and Findeiß expanded their horizons in the startup and pioneer paradise Silicon Valley. Their successful elevator pitch to Mercedes Bankston of the Founder Institute – that actually took place in an elevator – and the flexible study program at TUM Campus Heilbronn made this research trip possible.

The most important insight from their semester abroad is summarized by both as follows: Start your distribution activities as early as possible. They are aware of the importance of drawing attention to their business. "So far, we are the only ones offering complete matchings that extend beyond CVs and take candidates' personal interests into consideration," Findeiß explains. Their plan for the next few months is set: "To attract users to the platform and leverage networking effects." ●

AI in industrial settings

**AI-based technologies are optimizing manufacturing processes.
Intelligent cameras developed by IDS guarantee precise object classification;
SCHUNK's smart gripping systems take over complex tasks.**

IDS – classifying objects using deep learning

Before a new car leaves the plant, its quality is assessed thoroughly, millimeter by millimeter, by white-gloved employees so even minute scratches in the paint or dents in the bodywork can be repaired. Because this time-consuming task requires a great deal of concentration, the team switches every 90 minutes. Or: Vehicles are scanned in a matter of minutes by a camera that has been taught by artificial intelligence (AI) and a handful of images what constitutes defects and what does not, performs without interruption, and keeps learning in the process.

The IDS NXT comprehensive vision system delivers AI that runs directly on cameras. Based on a neural network, IDS NXT is trained from images pre-sorted into diverse categories of defects. It is able to make autonomous decisions in manufacturing processes. The system was developed by IDS in Obersulm, a company that has been pioneering innovations in industrial image processing since 1997.

The benefits of the system compared to traditional industrial cameras are obvious in applications, for example, that require classification of organic objects with many variances. "IDS NXT saves time and money, increases precision and performance, and can be used easily and intuitively by production workers. You no longer need to task your experts with image processing and can use their resources in other departments," says Managing Director Jan Hartmann. Intelligent cameras open up new opportunities, in particular where classic industrial image processing reaches its limits. "For the first time ever, we now can automate applications that in the past were impossible to map algorithmically," explains Patrick Schick, Product Owner of Vision Software at IDS.

Vehicle production is only one field of application for IDS's cameras; other fields include mechanical and plant engineering, retail, medical technology, and agriculture. "Many customers come to us with specific problems they need us to solve," says Hartmann. In viticulture, for example, tractors equipped with AI cameras could drive among the vines and determine in real time which grapes are ready to be picked, which plants need watering, and which ones are infested with parasites – a quantum leap.

However, the company also faces reservations. "Not all customers trust the results because they find it difficult to understand how they are obtained. Also, some customers do not feel comfortable uploading sensitive image data to external clouds. However, companies' computing capacity typically does not suffice to operate AI cameras, at least not yet," Hartmann explains. This makes it all the more important to inform potential customers about the added value of object classification.

IDS Managing Director Jan Hartmann (l.) and Patrick Schick, Product Owner of Vision Software at IDS

SCHUNK – a tight grip on smart technologies

Pick up battery cells, position them, and insert them into battery modules with the highest level of precision – the robots know exactly what is expected of them. Smart gripping systems are able to complete complex tasks in an automated and autonomous manner. What is more, they even can flexibly adapt their gripping power and strategy to the geometry and properties of the respective objects, greatly increasing the number of applications of robots and enhancing their productivity.

These robots are developed and produced by SCHUNK, headquartered in Lauffen am Neckar, the leading global supplier of equipment for state-of-the-art manufacturing plants and robot systems. "We encounter AI everywhere and all the time," says CTO Timo Gessmann, who is responsible for innovation, research, and development at SCHUNK. He adds that AI can be used to increase and optimize functionality and productivity significantly, in particular for toolholders, grippers, and other components that used to be entirely mechanical. The intelligent

CTO Timo Gessmann is responsible for innovation, research, and development at SCHUNK.

toolholder iTENDO2, for example, can gauge vibrations in processing in real time, improving the quality of processes and reducing lead times and waste. "In this segment, AI can help us save valuable resources and thus be sustainable."

SCHUNK customers can learn about the benefits of these robots at 13 CoLabs around the world. At these robot application centers, they come in contact with AI and the company's innovations. "Our goal is to reduce skepticism, so we offer them opportunities to experience AI and delve into automation and robotics, for example, by programming robots. This allows us to raise awareness of the fact that people do not need to do everything themselves, especially in a time of skills shortage and especially not hard labor," Gessmann explains.

SCHUNK also wants to encourage its own staff to explore the new technologies. Gessmann continues: "Because AI concerns us all, capacity building is a priority. We want to enable our employees to identify potential fields of application and to develop professionally. That motivates them, stimulates their curiosity, and gets them excited." The regular voluntary tech talks that permit participants to exchange opinions and ideas and drive interdisciplinary collaboration within the company attest to the fact that the company's plan is working.

For all these innovations, SCHUNK relies on cooperation with technology partners and academic institutions. Gessmann, who also mentors young talent at Bildungscampus, highlights the company's partnership with TUM Campus and Innovation Park Artificial Intelligence in Heilbronn. "In particular the impulses we receive from the science sector, from students, start-ups, and others in the region find their way directly into our processes, projects, and products. In addition, we engage with talented future employees." ●

Why not ask Iris?

Prof. Stephan Krusche of TUM Campus Heilbronn has developed a chatbot to address students' concerns.

In Greek mythology, Iris is the goddess in charge of conveying important messages from Zeus, father of all gods. Today, Iris answers questions raised by students at TUM Campus Heilbronn on behalf of Professor of Software Engineering Stephan Krusche. Prof. Krusche and his team have developed a chatbot for the field of education, in particular for programming courses.

One of the requirements for Iris to come into existence was met as far back as 2016, when Prof. Krusche followed his passion to support all students and developed a learning platform for Technical University of Munich which he named Artemis after the Greek goddess of hunting. "We are continuously exploring ways to further develop the platform to improve teaching," he says. Currently, students' questions are answered predominantly by human tutors, but "they are not available 24/7."

Help at all hours
Iris can help students solve problems and answer questions at any time. While availability is one factor, students' diverse personality features also play a crucial role in the development of the chatbot. Prof. Krusche says: "We want to enable students to get feedback even if they have difficulty communicating." One dilemma:

"We should actually teach them to leave their comfort zone and have the courage to ask questions."

Preliminary results of the team's research indicate that the chatbot lowers students' common inhibitions to ask for help. For young, slightly insecure academics to realize their concerns are not banal could boost their self-confidence and improve communication in their study routine.

Solutions from the all-knowing goddess
Iris took on this role in October 2023. "Students receive messages from the all-knowing goddess," Prof. Krusche says, laughing. When creating a didactic chatbot, the greatest challenge is ensuring that it does not merely offer solutions to problems but that it gives food for thought, leading users in the right direction just as human tutors would. This means the chatbot first must determine whether a question makes sense; then, it can offer a didactically sensible response. This may sound easy, but it is technically complex and calls for intelligent prompt engineering.

At the interface with the large language models (LLMs), giving clear instructions is the be-all and end-all. Questions are processed in three steps: "We use the initial prompt to determine whether the question asked makes sense, that is, whether it serves to achieve the goal. Then, the question is answered based on our instructions, and the response is evaluated to ensure it makes

sense from a didactical point of view and instructions have been followed." Another great challenge is that some LLMs tend to convey inaccurate information convincingly, a feature also referred to as hallucinating.

A parrot with hallucinations

How do chatbots actually work? Prof. Krusche uses the example of ChatGPT: "LLMs acquire large amounts of information from texts on the internet, from books and documents available online, and even from large companies' source codes." This means that they are trained using several billions of lines of text. Trained chatbots can answer questions by determining with statistical probability which answer most likely matches the respective question.

However, the system is not flawless. Prof. Krusche says: "According to some critics, chatbots are statistical parrots that can only repeat things written somewhere in a similar manner, potentially generating false facts." Chatbots are not able to generate truly new knowledge; rather, they draw their information from the past. To increase the probability of answers being correct, chatbots must be trained more and fine-tuned for specific fields of application, and the information provided for context must be selected diligently. Prof. Krusche and his team currently are working on these tasks.

Visions of the future

While the large number of students using Iris since its inception testify to the direction in which Prof. Krusche
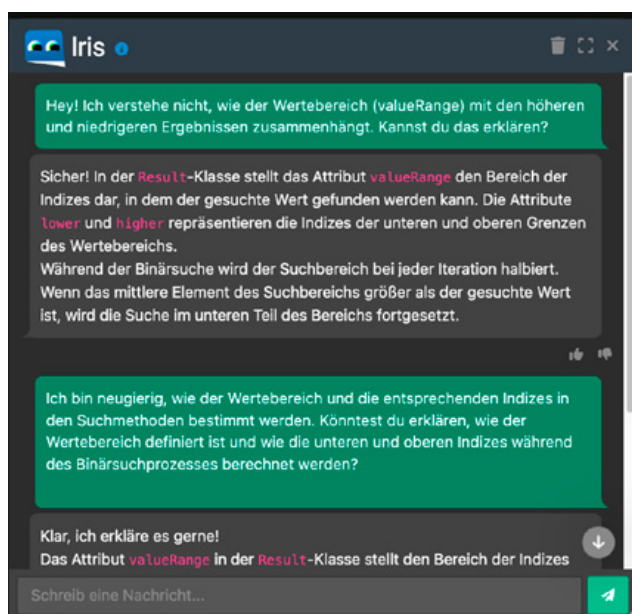
> **"**
> # We want to enable students to get feedback even if they have difficulty communicating.
>
> Prof. Stephan Krusche, TUM School of Computation, Information and Technology

is headed, he recognizes the potential for optimization. "We want to enhance data protection and also address users' needs and knowledge in an even more individualized manner." The plan is to employ LLMs to be able to generate suitable task variants for diverse levels of knowledge a few years from now and, thus, cater to users' strengths and weaknesses in a targeted way.

"We are working to enable Iris to boost students' motivation," says Prof. Krusche. Personalization can help: Individualized positive messages are sent to students who have achieved specific learning goals. If a student has been inactive on the platform for an extended period, it could mean he or she is overtaxed. In this case, the system would ask the user what is wrong. Going forward, in addition to solving problems Iris could contribute to individualizing teaching and, thus, increase motivation and learning success. ●

Anyone communicating with Iris may have a picture in mind. This is what the chatbot could look like. The image was created with the help of AI.

Powerful players determine educational technology

Education is an investment in the future. Outdated school equipment, a shortage of teachers, and large class sizes are the present. Can artificial intelligence help to avoid repeating the mistakes of the past? Dr. Lulu Shi, researcher and lecturer at the Oxford University Department of Education, examines structural problems in the education system and the role of large technology companies.

Her own career has shaped her research focus: Lulu Shi attended kindergarten in China, then went to school in Switzerland and spent a year at a US high school. Her studies were also international: Bachelor in Zurich, Masters in London and during her PhD she spent time in Basel, Oxford and Cambridge. "I switched between four education systems and learnt how differently they can be structured and what different values there are. Rather than a one way dynamic, the education system is shaping and at the same time is shaped by country-specific factors," she summarizes.

A question of definition

What constitutes good education today? For Shi, this is a question of perspective: "At the moment, in many societies, the economic values of education are the dominating ones, and education is in the first line geared towards the labor market. But education can have a broader set of purposes, such as educating people to become politically active citizens." Different purposes of education are emphasized across time and places; hence, what is considered "good education" can vary across contexts.

At the same time, the role that AI should play in the education sector needs to be determined and defined in more detail. The use of terms such as "machine learning" or "automated decision-making" would be more helpful

At the Oxford Internet Institute, Dr. Lulu Shi deals with digital technologies in the education system.

in narrowing down the technology's broad playing field. "I'm not sure whether AI has improved or enhanced education as such," she says, taking a critical look at current developments.

One negative example, according to Shi, is a security technology that was introduced in some US schools to prevent gun violence. An AI-based voice recognition system detects aggressive voices among the students. Sounds reasonable, but: "it turned out that this technology more often labelled voices of people who were not white middle class as 'aggressive'. This sheds light on how AI can reinforce existing social inequalities." Another concern is that, while many education technologies claim to reduce teachers' workload, technology implementations can actually increase the workload of teachers: "Teachers become data monkeys to a certain extent and in the end have less face to face time with students," says Shi.

David against Goliath

The boom in digital technology in the education sector was triggered by the coronavirus pandemic. Has it come to stay? Shi negates: "At the moment, we are essentially at a similar level as before the pandemic." Although there are differences in the applications: "It looks like technologies that improve collaboration tend to be used a little less than those that help to analyze and measure

things." At the same time, a kind of "winner-takes-it-all" phenomenon can be observed. The large education tech companies are dominating the market space, at the cost of the smaller providers.

The exchange between users and companies is sometimes problematic, according to the scientist: "The companies do try to address the problems of the user side, but the way in which the discourse is then conducted tends to serve their own interests. This can lead to the actual problem not really being solved." There is a gap between the people who use the technologies and the big players. "You can talk about a digital inequality or access gap based on social parameters," explains Shi. On the one hand, this is based on access to the technologies, but also on the digital skills of the users.

Fix the problem, not the symptoms

According to Shi, digital inequality needs to be considered as embedded in the broader social inequalities. And beside access and digital skills issues, there are general differences of resources when comparing people in privileged areas versus people in more deprived places. For example, teachers in private schools may have dedicated research time to figure out how to best use technology, while teachers in more deprived areas are busy firefighting. She also observes an interesting trend: "Those who can afford it prefer to have their children taught by a human being. And those who don't have these financial resources use the technology." It is therefore important to better support families from precarious backgrounds in acquiring digital skills. However, this cannot be the final solution.

Unequal distribution of technology and of digital skills are based on deep rooted mechanisms and embedded in the social structure that have led to these technological inequalities in the first place. Therefore, Shi's wake-up call: "Rather than trying to fix the symptoms, in this case the lack of digital skills, I would advocate for addressing the broader socio-economic and political structures, underlying the surface inequalities. And this could be for example by improving the social welfare, increasing funding for education, et cetera." ●

A watchful eye
in the orbit
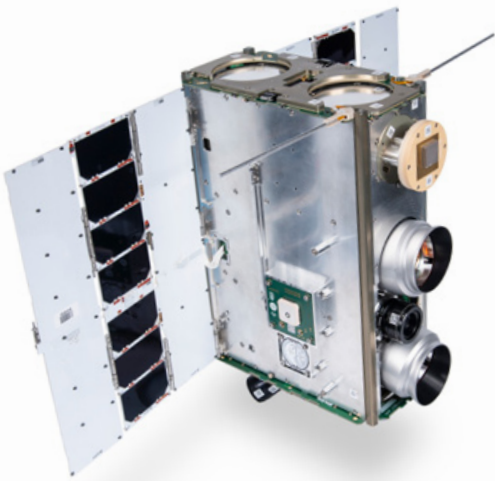
From Greece to the United States and Australia – forests are burning around the globe. The damage is grueling: People lose their lives or homes, and water pipes and power grids are wrecked. The economy suffers when businesses are destroyed or tourism plunges.

Max Bereczky, Product Owner Active Fire at OroraTech

"In addition, we see the threat of long-term health damage from smoke and particulate matter," says Max Bereczky, Product Owner Active Fire at OroraTech, a Munich-based start-up founded in 2018 by TUM graduates. OroraTech localizes forest fires using thermal imaging cameras that detect fires early on.

Each camera orbits the Earth on board a satellite and sends thermal images to an image processing algorithm. Once the algorithm detects a fire based on the data provided, the system conducts further tests to ensure the fire is real, not another source of heat such as a steel mill. If a fire is spotted, an alarm is triggered to notify customers rapidly of its location and extent.

More secure and precise than previous methods

AI is employed at various points in the system: The detection algorithm is AI-based, and the tests to clarify the presence of actual fires are based on AI-generated data. In addition, OroraTech uses the technology to assess the damage caused by fires, to forecast fires, to improve the resolution of satellite data, and to create high-resolution maps of biomass and carbon on the Earth's surface.

This technology could help the start-up revolutionize the fight against forest fires around the world because the previous methods have weaknesses. Bereczky explains: "The scope of surveillance from watch towers
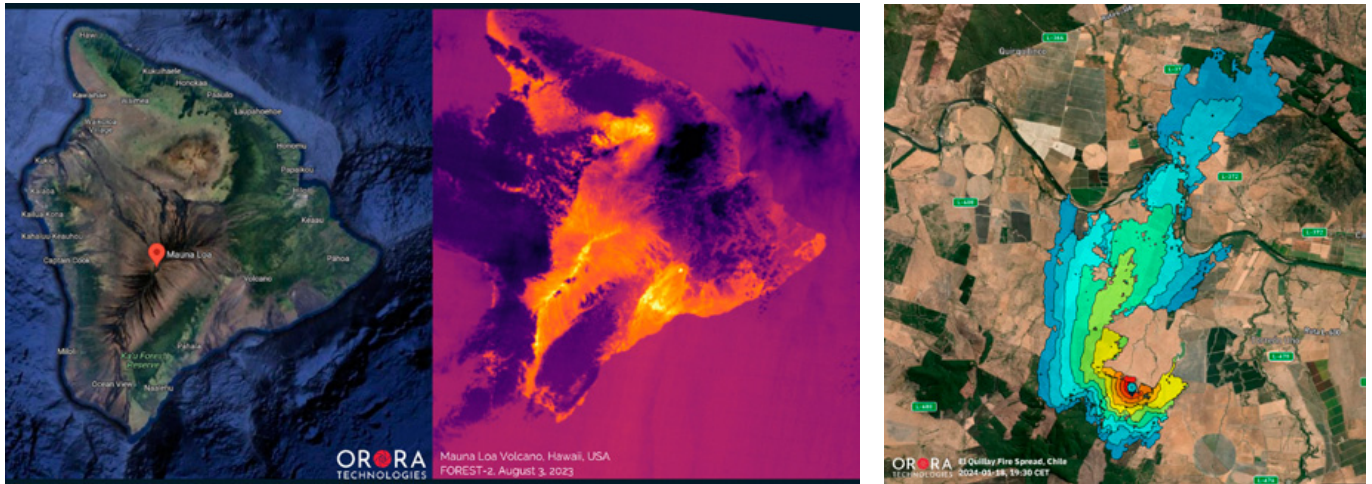
Fire or false alarm? On board a satellite, each camera sends thermal images to a detection algorithm.

or airplanes is limited." Also, using planes during large fires is dangerous.

Instant data validation

In turn, satellites can monitor the entire land and water surface. What differentiates OroraTech's method from similar systems is referred to as on-orbit processing: The data is validated directly in the satellite. This saves valuable time because in emergencies alerts can be given immediately.

In the beginning, OroraTech used satellite data provided by major aerospace organizations such as NASA or ESA. This procedure had two main disadvantages: First, resolution of the mid-infrared images is comparatively poor. Second, the satellites only fly over specific areas at specific times of the day. The hot regions around the equator, for example, are monitored in the mornings or early afternoons. "This is not ideal for fire detection and observation because fires tend to break out late in the afternoon when temperatures are highest," says Bereczky.

Box-sized satellites

Against his background, OroraTech decided to develop its own satellites, capitalizing on the fact that many team members had created mini satellites during their studies at TUM as part of the Move project and had sent them to the orbit.

2022 saw the launch of FOREST-1 into space, the first of OroraTech's solar-powered mini satellites measuring a mere 30 by 20 by 10 centimeters. Each satellite was equipped with a thermal infrared camera, also developed by OroraTech. Then, in the summer of 2023, the prototype was succeeded by FOREST-2 and an even more cutting-edge camera that transmits data from early afternoons well into the night. The team is planning to start another eight satellites by the end of the year. The long-term goal is to have up to 100 satellites circling the orbit to monitor the Earth around the clock.

Moreover, OroraTech wants to upgrade its sensors and algorithms continuously over the next few years and make greater use of AI to increase the speed and efficiency of the technology. Bereczky adds: "Jointly with our customers, we are designing new features that will make firefighting even more impactful." In addition, the team is working on new products to launch including a prototype for watering management that could be put to use in agriculture.   ●

MLAB project

OroraTech has partnered with TUM as part of the MLAB project headed by Airbus Defence and Space GmbH. The goal of this ESA-financed project is to set a benchmark for machine learning in aerospace applications. OroraTech is in charge of developing a dataset and making recommendations regarding potential applications for fighting forest fires. TUM is represented by Professors Carsten Trinitis (Computer Architecture and Operating Systems, TUM Campus Heilbronn), Martin Schulz (Computer Architecture and Parallel Systems), and Martin Werner (Big Geospatial Data Management), and research assistants Gabriel Dax and Amir Raoofy. Their main responsibilities include developing benchmarking methods and schemes and preparing benchmarks for specific applications in space. The project will be finalized soon.

Much ado about GenAI

Are you out of ideas for a fresh marketing campaign? Are you looking for a spectacular advertising photo? Do you need to put together that post your followers are desperately waiting for? No problem, generative artificial intelligence (GenAI) creates new (marketing) content in the blink of an eye. However, the results of a study conducted at TUM Campus Heilbronn indicate that it is not that simple. Brands using GenAI may be damaging their image.

As demonstrated in a study published in March by Professor of Digital Marketing Martin Meißner at TUM Campus Heilbronn, and his doctoral student Jasper Brüns, using AI can work against a brand's perceived authenticity. "We started out by asking followers how they would react if their favorite brands used GenAI to create social media content in an automated manner. Also, we showed advertising photos of a fictitious brand and analyzed users' perceptions," Brüns explains.

To this end, the two researchers replicated a photoshoot using the GenAI applications ChatGPT and Midjourney. The test takers were shown the original photo and the replica but were unable to identify the one created with GenAI. Both versions were evaluated equally according to various dimensions of quality. After the test takers were informed that GenAI had been used, a pattern began to emerge: "Reactions to the fictitious brand and its posts turned very negative," says Brüns.

We recommend a strategic approach to GenAI.

Jasper Brüns, doctoral student at the TUM School of Management

Jasper Brüns (l.) and Prof. Martin Meißner conduct research on generative AI and its impact.

Skeptical about the black box

The team of researchers extended the test setup to include influencers as personal brands and analyzed followers' reactions to knowing influencers they cherish draw on GenAI for support. "If there is at least some human involvement in the creation of content, responses to the use of GenAI are not as negative."

How do such reservations come about? The scientists have learned from previous studies that test persons are skeptical about the black box – the way AI makes decisions is not transparent to most. Yet, people expect (personal) brands to be authentic, so much so that they tend to be disappointed when it comes to light that they use GenAI.

Tips for prudent use

Should companies and influencers do without GenAI altogether? Brüns clarifies: "What they should do is use it prudently." He suggests three steps: "We recommend a strategic approach to GenAI: Be prepared for negative effects, especially once new disclosure guidelines for the transparent use of AI are adopted." Brüns also advocates for taking consumers' feedback into consideration.

Also, Brüns says, the role humans play in content created using GenAI should be emphasized. "You could point out that human creativity is supported rather than replaced." The third step is to strengthen the authenticity of one's own brand, for example, by underlining the passion that went into content creation and the consistency of the content.

Brüns is convinced that other players could help improve the general acceptance of AI by society through education and information. In his opinion, dialog and networking are key. This is where Prof. Meißner and Brüns' university comes into play. "TUM offers numerous courses, workshops, and speaker series. At our professorship, for example, we give a seminar on AI applications in marketing. Public events such as TUM Talk are platforms for important stakeholders in the corporate sector, science, and society to share ideas and insights."

Many unanswered questions

Given the current debate about disclosing AI-generated content, the study conducted by Prof. Meißner and his doctoral student has become even more topical and relevant. Brüns clearly is in favor of disclosure. "Transparency is essential for consumer protection," he remarks. He is convinced that disclosing content, in particular politically relevant content, is crucial because AI-generated misinformation can influence the behavior of large groups of people significantly.

The key question is: "How does effective disclosure work?" First, players using GenAI could come out in the open voluntarily. The challenge is that "when negative reactions are to be expected, people could try to bypass disclosure. However, GenAI can be labeled in an automated manner, a process that is likely to be extended in the future." There are other questions, Brüns adds: "Is this technology advanced enough to reliably recognize GenAI? What consequences can there be if content is labeled incorrectly? What does using AI actually mean? Do images processed with special Photoshop applications have to be categorized as AI-generated content or do you need to label images only if they have been created entirely with AI?"

Brüns also sees the need to define the wording, location, and design of disclosure labels. "The perception of GenAI is an extremely large field of research," he summarizes and adds, "especially in view of the current GenAI hype and the attractive application methods we must speak up about the risks as well." ●

Where calculators **prevail** over ChatGPT

Some types of artificial intelligence function like the human brain; others are more comparable to calculators. How do the two approaches differ? Which one works better for optimizing business processes? Leon Bein, doctoral student at the School of Computation, Information and Technology at TUM Campus Heilbronn is investigating the differences among these technologies and provides an outlook.

Let's start by looking at how ChatGPT works. The name itself makes it clear that artificial neural networks imitate the human brain. In a network of digital neurons, or nerve cells, the nodes are connected in several successive layers through edges that model the synapses in the human body. The neurons transmit signals from the front to the back, meaning they receive signals from all the nodes located on the previous layer and send signals to all the nodes on the following layer. Depending on the data used for training, the connections, or edges, are weighted more or less. This weight implicitly determines a network's behavior.

"What we have is a black box. We don't know what happens inside this box and have difficulty tracking it," Bein explains and adds, "ChatGPT, for example, is based on statistics, an implicit probability of a sequence of words." He believes the system is particularly prone to errors when it comes to mathematical and logical questions. "We have to keep in mind that this type of AI

How can business processes be analyzed and optimized? Leon Bein balances the advantages and disadvantages of tools.

was developed for generating text. So, for some tasks, this virtually all-knowing power system performs worse that your run-of-the-mill calculator."

> **Neural networks are like a channel system of rivers – water flows, but it is not tangible. In turn, knowledge graphs resemble conveyor belts – they are explicit and concrete, not as powerful and all-encompassing but easier to understand and much more reliable.**
>
> Leon Bein, doctoral student at the
> TUM School of Computation, Information and Technology

Of channel systems and conveyor belts

Against this background, Bein decided to use AI training based on knowledge graphs for his research project. He plans to analyze and optimize business processes. In the training method he chose, nodes and their interconnections are predefined explicitly, and the path to making decisions is even more explicit. Scientist Bein illustrates the differences: "Neural networks are like a channel system of rivers – water flows, but it is not tangible. In turn, knowledge graphs resemble conveyor belts – they are explicit and concrete, not as powerful and all-encompassing but easier to understand and much more reliable."

Neural networks acquire knowledge about patterns and connections directly from the data and make decisions regarding the output by weighting the connections internally. Therefore, they are ideal tools for detecting patterns. Knowledge graphs are modeled specifically, their strengths include organization, administration, and retrieval of structured knowledge. Systems like ChatGPT that work with neural networks are suitable for writing application letters. In medicine, knowledge graphs are used for analyzing symptoms and for reliably suggesting appropriate therapies.

Knowledge for the economy

For the reasons outlined above, it was not difficult for Bein to opt for the use of knowledge graphs. The challenge he faced was the high level of precision with which data has to be recorded. "Entering these rules manually is extremely tedious and time-consuming." Thus, once the design stage of his project is complete the computer scientist wants to build a simpler solution into his prototype. "I want to automate the retrieval of information over the course of the process. I will achieve this by feeding in event logs containing technical information about how processes were implemented in the past." Event logs also can identify shortcomings in the process, for example, which activities create bottlenecks because they take a long time. Then, all a human will have to do is add instructions and other relevant documents.

As a next step, Bein wants the system to deliver suggestions for remedying shortcomings. He would like to combine analysis and evaluation to be able to draw logical conclusions. "Such a system would be really good, reliable, and able to deliver explainable decisions everybody can understand." Bein hopes other researchers pick up on his findings once his project is completed and develop them further so this knowledge can be made available to the corporate world. "It should be science others can apply." ●
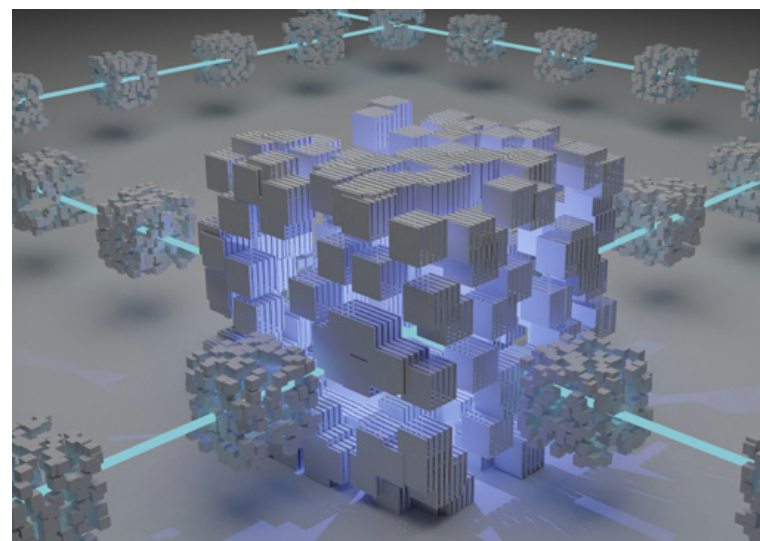
Artificial neural networks imitate the human brain.

Real or not? This screenshot is from a video generated using OpenAI's Sora AI model.

Generative **AI** on digital platforms

"Integrating artificial intelligence into digital platforms is a growing trend that has the potential to transform our daily lives," says Johannes Gölz, research assistant at TUM Campus Heilbronn, who is investigating the use of generative AI to better understand its mechanisms and impact.

A woman in trendy clothes strolls elegantly across the rain-slick pavement. The camera follows her slowly through a pedestrian area of a bustling Asian city. Bright neon signs contrast with the night sky. Then, the camera zooms in on the woman's face to show moles on her skin and reflections on her dark glasses.

The Sora AI model, presented by Open AI, created the video. It is an impressive demonstration of the potential of generative AI, the digital technology that makes it possible to turn brief descriptions into realistic videos that previously existed only in people's imagination, thus opening new creative paths.

Increasingly better integration

For Gölz, Sora is like an outlook to the future of generative AI: The model can make boundaries among diverse types of data disappear. "We assume multimodal models that can process various types of data such as text, images, and video are becoming increasingly integrated," explains research assistant Gölz at TUM Campus Heilbronn who is investigating the impact of generative AI on platforms.

Gölz has noticed another general trend: Large language models (LLMs) increasingly are integrated directly into platforms. He uses Copilot, Microsoft's AI-based assistant, to illustrate: "So far, we have seen LLMs implemented separately on dedicated platforms without seamless integration being achieved. We are currently observing a trend towards direct integration into the platforms themselves," he explains. These developments facilitate the use of LLMs and help expand the data foundation in daily life.

Popular through personalization

According to Gölz, numerous other changes can be expected over the next few years including LLMs that recognize and react to emotions. Also, it may become possible to translate audio and video sequences and text in real time. The content is likely to become increasingly personalized in the process. In addition, Gölz remarks, LLMs may be used for effective data anonymization and, thus, to enhance user privacy.

Reflecting on the implications these advancements will have on content creators, Gölz assumes their work may become easier. He identifies potential benefits at several levels. "By increasingly personalizing interactions with users, LLMs facilitate customized recommendations adapted to the respective context. This may enhance the quality of content and increase its popularity, which in turn increases the creators' prospect of success."

Train, test, improve

While Gölz is familiar with the opportunities generative AI can provide, he also calls for a conscientious approach to handling its risks. "Bias and hallucinations, for example, are challenges that could be manipulated with targeted input; however, we need sustainable strategies to ensure the integrity of the models." In his opinion, dealing proactively with the risk and improper use of misinformation is important, but we must not lose sight of the transformative opportunities presented by generative AI.

Johannes Gölz investigates the use of generative AI.

> **We can teach users about the capabilities and limits of current AI in an understandable manner.**
>
> Johannes Gölz, research assistant at the Center for Digital Transformation

Gölz lists a number of ways to achieve this goal: "Going forward, we could label AI-generated content even if it is the result of collaboration among people and AI." He also places great value on the context of further education and ethics: "We can teach users about the capabilities and limits of current AI in an understandable manner. Also, we can drive the uniformization of standards and incorporate feedback when developing new generations of models."

A matter
of skills

The perfect employee is young, experienced, flexible, never out sick, and never makes mistakes – a machine of sorts. Is this machine, specifically artificial intelligence, the perfect worker bee? In a time of skills shortage and digitization, this question is justified. Dr. Fabian Stephany, Assistant Professor of AI & Work at the Oxford Internet Institute, is searching for answers.

The labor market is transforming from an employer to an employee market, a trend also reflected in the results of Dr. Stephany's research. He analyzed professions requiring AI skills. He says: "Talent is spread so thin that companies no longer can afford to hire only candidates who bring a formal education to the table."

Dr. Fabian Stephany of the Oxford Internet Institute strongly believes that the labor market needs AI skills.

The expert refers to this new recruiting method as skills-based hiring. In his opinion, today's market resembles the situation of the medical sector during the coronavirus pandemic. "Back then, people with medical knowledge were coveted, regardless of whether or not they had a university degree in medicine – it was the skills the employers were after."

AI pays off for everybody

Being able to use AI has become a key competence for numerous professions. "We evaluated one million entries in online job portals in Great Britain and found that the demand for employees who know how to handle AI has increased significantly more than demand in the average market," says Dr. Stephany. Growing demand goes hand in hand with a boost in income. "If you have AI skills, you will be offered a salary that is usually reserved for graduates with doctoral degrees." Dr. Stephany adds that this should not be seen as the end of formal education, but rather as additional opportunity for career changers who acquire AI skills through self-tuition.

Labor market expert Dr. Stephany does not expect employment to decline, nor does he share people's fear of being replaced. "Studies show that machines can do routine tasks well or even better than humans. When it comes to complex assignments, it is important that we work with the machines to increase productivity." During the Industrial Revolution people had similar concerns, but today people do not work less, they work as much or

even more. According to Dr. Stephany, only sectors that basically have been treating people like machines are replacing employees. Take, for example, production line workers who are limited to one task and do not have a network to fall back on. For Dr. Stephany, "skills" are key.

Tap your potential

"All hiring entails costs. Ideally, a new employee brings formal education AND skills," explains Dr. Stephany. That is why, he says, investing in further educating their core workforce is an opportunity for companies, because "there are no basic AI skills one can learn in an adult education center." He continues by saying that promoting talent within your company in a targeted manner is easier and more cost-efficient, and lists a number of advantages: "The employees already have been integrated into the team, and they are familiar with the workplace and internal workflows and hierarchies."

If a company decides to hire and uses AI for filtering, the decision must be scrutinized diligently. "A sticking point in this screening process that is being used exhaus-

tively is the question of how AI selects." According to Dr. Stephany, AI typically draws on historical data, and that has its disadvantages. "The past will not deliver any data concerning the future, and that is exactly where we want to be when it comes to gender equality in the labor market," he comments and adds his personal conclusion: "At the end of the day, the decision should be left to people."

Time for development

The expert views the much-discussed issue of four-day work weeks critically: "Work also gives us a purpose and helps shape our identity. To me, finding out how flexibly work can be designed is much more interesting." Google is a good example, says Dr. Stephany. The platform giant has introduced 20 percent learning time to some of its units. This means, four days of regular work and one for personal development. Dr. Stephany deems this win-win situation to make sense economically: "It means investing in the most important things we have – our education, our power of innovation, and our minds." ●

Continuing education as a
natural process

New technologies such as artificial intelligence (AI) can assume human tasks and replace people as workers. Continuing education can counteract these developments. However, a study conducted by Professor of Economics Philipp Lergetporer of TUM Campus Heilbronn shows that many employees underestimate the risk of automation affecting their jobs. In the interview, he talks about the motivation to embrace continuing education and how the upskilling system has to change.

Interview with Prof. Philipp Lergetporer

Prof. Lergetporer, what skills has digital transformation made obsolete?

Prof. Lergetporer: Some aspects of digital transformation are reminiscent of radical changes in the past. Just like at the time of robotization, we currently are seeing less demand for jobs involving a high percentage of routine tasks. In the 1990s, conveyor belt workers no longer were needed because robots suddenly were able to insert screws. Today's AI applications allow us to automate other chores as well. Transformation is pushing out functions that can be assumed by new machines and technologies, and at the same time it is causing increased demand for new skills that complement these new technologies.

Isn't generative AI replacing a lot of creative work as well?

Prof. Lergetporer: For sure. At the same time, new tasks are emerging. Copywriters presumably will not write complete texts anymore, but they should be able to write prompts that bring out the best in AI applications. We are expecting a shift towards an increase in supervision activities.

What professions are particularly affected and what skills will become important?

Prof. Lergetporer: In the past, mostly people with limited qualifications were affected. The digital transformation will likely reinforce that. While I cannot name any specific occupations, we know that many skills that complement the new technologies now are appreciated to a larger extent, including prompt engineering, specific IT skills, and fields such as social interactions for which machines are not suited. The biggest challenge will be to adjust one's own skillset to the requirements of the labor market.

The results of your study indicate that especially people with limited qualifications underestimate the risk of automation eliminating their jobs.

Prof. Lergetporer: We have a hypothesis that these workers simply are misinformed about the risk that comes with automation. For our study, we interviewed 3,000 employees about the jobs they currently are doing and about the percentage of their main tasks they believe

could be automated. Mainly respondents exposed to a high risk of automation underestimated the percentage considerably. We proceeded to inform a randomly selected group of these respondents about the probability of automation in their individual cases. This piece of information alone significantly increased their awareness of the problem, which led them to state greater probability of enrolling in an upskilling or retraining program in the future.

Who could convey this type of information?

Prof. Lergetporer: The main question is: How can we promote upskilling effectively. How can we succeed in anchoring upskilling measures within society in a way that regular participation in upskilling programs becomes a natural process? It will be a group effort involving lots of players.

At the macro level, the government is a crucial creator. People often claim that Germany has no consistent upskilling system. According to the German National Academy of Sciences Leopoldina, introducing a dual system in the style of Germany's education system could solve the problem.

At the other end of the spectrum, we have the large number of workers who do not want or are unable to upskill. When asked by the Institute for Employment Research about the reasons for their non-participation, mostly people with limited qualifications responded that they no longer were able to learn at their age or that upskilling would not pay off for them. However, this is not true: First, it is a known fact that upskilling is crucial for careers; second, cognition psychologists have found that people can learn at any age. These barriers must be addressed at the individual level.

There are other relevant players including companies and educational institutions between the two ends of the spectrum. While companies deem upskilling to be a key strategy to counter skills shortages, they often are reluctant to enroll employees in upskilling programs if they are needed on the job urgently.

Will automation pick up speed?

Prof. Lergetporer: The potential of automation will continue to increase. The data for our study originates from a time before AI tools such as ChatGPT were introduced to the market. Since then, we have seen that text writing, graph designing, and other activities can be completed with a few prompts. The type of tasks that also can be automated going forward will surprise us. ●

Wanted: hardware experts

Europe's heyday of high-performance chip production is long gone. There are not enough plants – or experts. What does it require to turn the tide? Professor Carsten Trinitis has a plan.
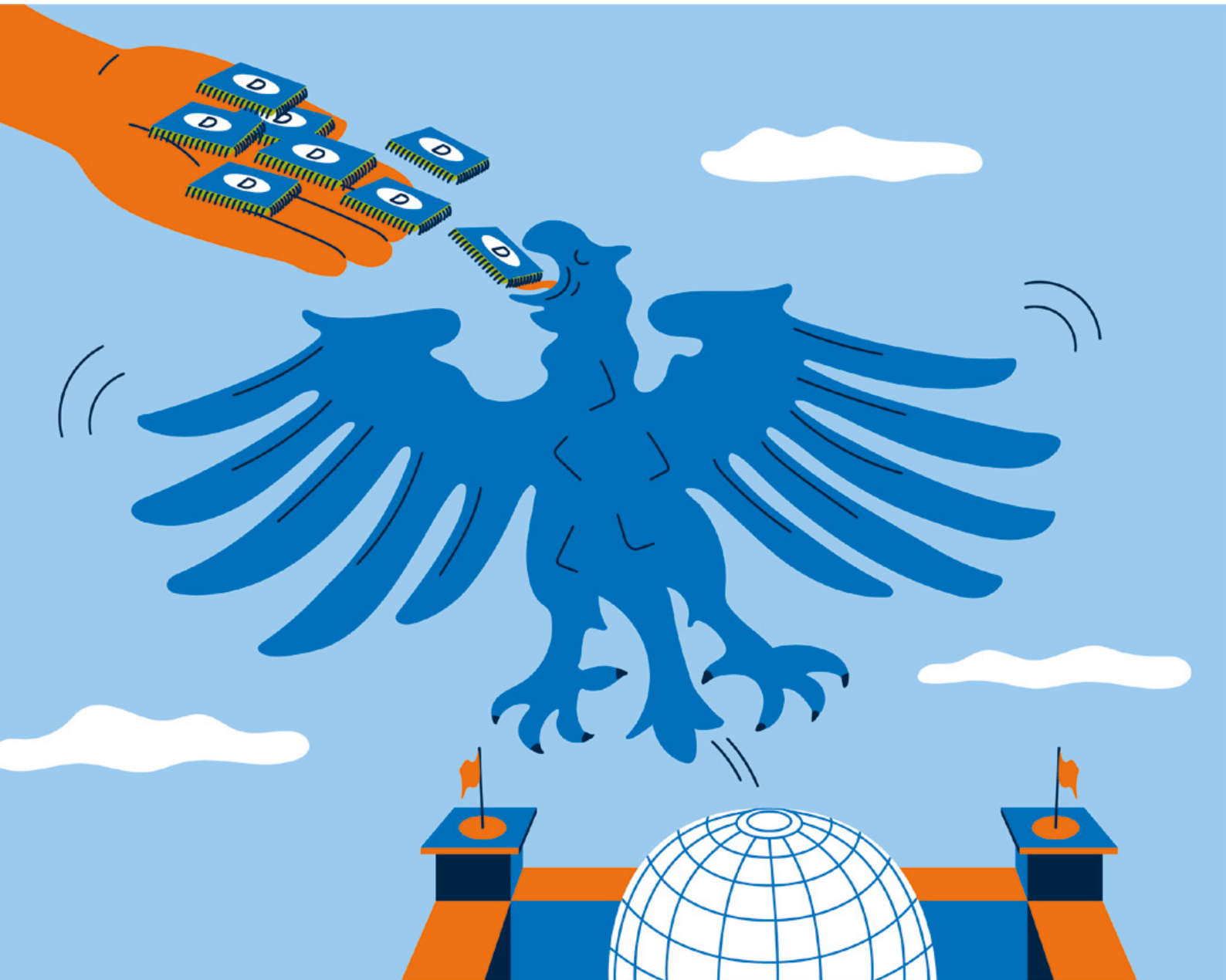
All everyone wants to do is program, but who has the skills to produce the chips for the fastest, state-of-the-art computers, chips that can process AI algorithms? "Truly powerful processors in desktop computers, laptops, supercomputers, phones, and tablets are not developed in Europe – at least not yet," says Carsten Trinitis, Professor of Computer Architecture and Operating Systems at the TUM School of Computation, Information and Technology (CIT) at TUM Campus Heilbronn. This was not always the case: "In the past, we had more computer development in Europe, for example, at Nixdorf or Siemens. The fact that it was neglected over time is likely due to policy-makers' failure to recognize the importance of it."

The EU has initiated a countermeasure, the European Processor Initiative (EPI), to establish a European processor architecture. In addition, the European Commission adopted the European Chips Act with the objective to drive production of semiconductors as material for chips in Europe, increase the resilience of supply chains, and reduce dependence on other countries. At the national level, until last year the Federal Ministry for Economic Affairs supported 18 companies in Germany with approximately one billion euros as part of the EU's IPCEI Microelectronics promotional program. Promising developments also can be found locally: Taiwanese semiconductor manufacturer TSMC is planning to erect a new chip factory in Dresden starting in mid-2024, and US-based giant Intel has announced its intention to make chips in Magdeburg.

Prof. Trinitis explains the challenge: "None of these companies are based in Europe. While the chips are produced in Europe, the development itself is not European." In his opinion, Europe is becoming dependent on producers in the United States, Taiwan, Israel, and elsewhere – and the numerous global crises could cause supply chains to break down quickly.

Involvement of four TUM professors

To remedy the situation, three years ago Prof. Trinitis together with CIT professors Martin Schulz and Daniel Cremers, and Prof. Martin Werner of the TUM School of Engineering and Design developed a project jointly with the University of Potsdam to create a hybrid educational program. The goal of the project titled Brandenburg and Bayern Action for AI Hardware – or BB-KI Chips – is to bundle theoretical foundations, design, and use cases for hardware specifically for AI applications and engage students across disciplines by offering a practice-oriented educational program. BB-KI Chips

is sponsored by the Federal Ministry of Education and Research with about four million euros.

TUM course program

Ethics for Nerds (Prof. Carsten Trinitis, Prof. Michael Stich, Prof. Ulrike Lucke), TUM Campus Heilbronn/Neudietendorf (Thuringia)

Hardware Development (Prof. Carsten Trinitis, Kun Qin, Sameh Nour), TUM Campus Heilbronn

Lab Course – Mobile Computer Vision (Prof. Martin Werner), TUM School of Engineering and Design Ottobrunn

Selected Topics in Big Geospatial Data (Prof. Martin Werner), TUM School of Engineering and Design Ottobrunn

Hardware Description Languages and Hardware Design (Prof. Martin Schulz, Dirk Stober), TUM Campus Garching

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From student to chip developer

The project is coordinated by Prof. Miloš Krstić who teaches at the University of Potsdam and is Head of the Department System Architectures at IHP – Leibniz Institute for High Performance Microelectronics in Frankfurt/Oder. Thanks to the alliance with IHP, the chips developed by students can be produced at the institute's in-house clean room. The project team also is exploring potential chip production at other fabs in Germany.

According to Prof. Krstić, the crises of recent years have underlined the strategic meaning of the semiconductor industry and of chip design. He adds that the optimized hardware AI processors have made the extensive developments in the field of AI possible: "BB-KI Chips centers around these important topics, focusing on the development of teaching programs, new courses, and innovative learning methods that will make it easier to discuss AI hardware as part of the university's curriculum in a more effective manner."

Even if these advancements do not make Europe a competitor in chip production, at least one goal should be achieved in the medium term: The number of hardware specialists finally will increase. Prof. Krstić says: "We indeed hope to train many new AI hardware experts at both universities through the project who will contribute to making Europe more competitive with regard to the respective products and innovative AI solutions." Prof. Trinitis also is convinced: "We have a few very good students, and if their number grows at the same rate as that of new applicants for our universities, we will succeed." ●

When bots spread misinformation

Michaela Lindenmayr: exposing fake news

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The risk of social bots spreading false information is real because they are not human and do not ask themselves: What is this news I am about to share?

The manipulated photo of Pope Francis wearing a white down coat might make us smile. What is less funny, however, is the allegation that coronavirus vaccinations contain strong magnetic microchips, or the deliberate misinformation that Russian war crimes committed in Bucha, Ukraine were staged by Ukrainians.

The three examples show that false information is widespread and intensifies particularly in heated times, for example, during wars, pandemics, or election campaigns. According to Michaela Lindenmayr, research assistant at the Center for Digital Transformation at TUM Campus Heilbronn, another factor caters to the dissemination of misinformation: "Many users who feel strongly about a topic they believe is particularly pressing and important do not take the time to verify the facts because they want to forward the information right away. That is dangerous."

This problem also affects social media providers. "They cannot check all the content for accuracy because so much of it is created at a high speed. A piece of misinformation may have reached millions of people before it is even detected," explains Lindenmayr, who is writing her doctoral thesis about diverse types of deception on digital platforms.

Many covert beneficiaries

Very often, the creators of misinformation remain undetected. According to Lindenmayr, the reason for this is the high number of potential beneficiaries. Politicians may benefit from misinformation in support of their party. Some companies are engaged in astroturfing, that is, they orchestrate campaigns to push their agendas under the cover of alleged activism. Public organizations

also can benefit from misinformation, for example, coal industry associations affected adversely by the fight against climate change. "Misinformation potentially can benefit a lot of people. The creators can spread news themselves or ask someone to do it. Also, in many cases, people forward fake news unknowingly," Lindenmayr adds.

In this age of AI, another group has joined the ranks: social bots, that is, computer programs or artificial intelligence that create, share, like and/or comment on content automatically. How do these bots work? Doctoral student Lindenmayr explains: "In principle, social bots react to specific triggers and respond accordingly." For example, they can be sparked by certain hashtags to generate news or share content. In doing so, they also might support or disseminate misinformation unintentionally. "The risk of social bots spreading false information is real because they are not human and do not ask themselves: What is this news I am about to share?"

Many bots remain undetected

According to Lindenmayr, there are no reliable figures regarding inaccurate content on the internet created by social bots – the estimated number of unknown cases is too high. She says, bots are difficult to detect, which is why she prefers a different approach: "Rather than going on a bot detection mission, we have to dive in at the user level and think about how we can help people challenge information to a greater extent."

To this end, she says, people and their belief in conspiracy theories must be taken seriously and approached with convincing facts. "The key is to ask them to think about where this news came from. Is there mention of a reliable source? Is the same information available elsewhere? Take a moment to consider who could benefit from this information."

Raising awareness

Lindenmayr places great importance on prevention and calls upon diverse stakeholders to become active: "Platforms should publish targeted warnings about specific topics to raise user awareness. They could introduce quality assurance mechanisms to ensure that only trustworthy content is shared, maybe through platforms' ranking systems or fact checking organizations."

Schools and other educational institutions also can contribute and inform. Doctors could place warnings or

Today, misinformation is spread much more subtly – not on the streets, but on the internet.

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Platforms cannot check all the content for accuracy because so much of it is created at a high speed. A piece of misinformation may have reached millions of people before it is even detected.

Michaela Lindenmayr, research assistant at the Center for Digital Transformation

informative banners on their websites and put out brochures in their waiting rooms to encourage patients to think critically. Lindenmayr summarizes: "Raising awareness is the main goal. We want to increase media literacy." ●

Five-minute skills check

Are company owners' skills and the success of their companies connected? Very much so, as demonstrated in a study conducted by Prof. Miriam Bird and Jannis von Nitzsch of TUM Campus Heilbronn. Their next step will involve developing an online tool everybody can use to determine whether one has what it takes to own a company.

"A tool that could tell company owners whether or not they have necessary skills would be exciting," says the Professor for Entrepreneurship and Family Enterprise at TUM Campus Heilbronn. More precisely, the goal is to assess a person's matching skills – or, simply put, entrepreneurial spirit – and governance skills, meaning the strength to build a company structure that brings together the interests of the company owners, other stakeholders, and employees. "Within five minutes you could find out whether you have distinct matching or governance skills," Prof. Bird explains.

Suggestions could complement the tool

Based on a questionnaire that they have developed over the past four years, she and her doctoral student want to offer all interested parties a target/actual performance comparison. "Owners could use the questionnaire to

Prof. Miriam Bird

> **Within five minutes you could find out whether you have distinct matching or governance skills.**
>
> Prof. Miriam Bird,
> TUM School of Management

gauge the current situation, that is, how pronounced their individual skills are. The results certainly could be used to deduce a target situation," von Nitzsch clarifies. Recommendations on that can be done to achieve this target could complement the tool and increase its use in the field.

These developments were preceded by years of research that culminated in an article titled The Strategic Role of Owners in Firm Growth: Contextualizing Ownership Competence in Private Firms published in early 2024 in the prestigious Strategic Entrepreneurship Journal. Prof. Bird and von Nitzsch wondered why some companies are more successful than others and what the owners' skills have to do with it.

To answer these questions, they drew on a dataset of more than 2,500 owner-run companies in Germany that contained information regarding financials, ownership, and top management for each year between 2011 and 2018. Second, the two researchers and co-author Prof. Ed Saiedi of the BI Norwegian Business School reviewed the LinkedIn profile of each major shareholder of these companies. Through web scraping, they searched specifically for information about the company owners' work experience and formal education and for words implying pronounced matching or governance skills including experimenting, creative, startup, or entrepreneur for the matching skill.

The human factor

Their research findings indicate that revenue growth is more probable if the owner has above-average governance and matching skills. In young companies, this connection is more pronounced. The logical explanation: When employees already are established in the positions that match their qualifications and efficient structures are in place, the owners have less to do, but they also have less influence.

The team discovered another limitation: Compared to other companies, family-run businesses are less likely to benefit from the owners' governance skills. This can be attributed to the human factor. "Family-run operations tend to prioritize members of the family, who are not necessarily the most skilled employees. These companies

do not open the pool of resources and advertise vacancies; instead, they automatically fill them with sons or daughters," Prof. Bird explains.

What also has been determined is that family-run companies have it in their own hands. Thus, the most important recommendation based on the results of the study is: "To start by setting goals and values, and then think about how each family member's skills, in particular the owners', can contribute," von Nitzsch suggests. He adds that identifying and countering potential resistance within the family is important because only then can measures be implemented to achieve the previously defined goals. Total commitment is important, especially right after the company's inception: "People who found a business should be aware of how crucial the first few years are." ●

> ❝
> ## People who found a business should be aware of how crucial the first few years are.
>
> Jannis von Nitzsch

Jannis von Nitzsch

Neurons play chess

Who doesn't sometimes wish they could look inside the other person's head? But would that really be revealing? At first glance, it's just teeming with neurons and synapses. Professor Israel Nelken from the Hebrew University of Jerusalem (HUJI) is trying to shed light on this supposed chaos: He is researching how rodents make decisions and explains what we can learn about artificial intelligence from this.

For Israel "Eli" Nelken, the path to neuroscience was not predetermined: "Life is a walk full of coincidences. I actually wanted to become a physicist," he says. But his later doctoral supervisor Moshe Abeles convinced him that the brain was more interesting than the formulae of physics. Eli Nelken has now been teaching and researching in the field of brain research for over 30 years: "We have further developed the Israeli neurosciences and promoted interdisciplinarity. This ultimately led to the founding of the Edmond and Lily Safra Centre for Brain Sciences."

Between the sounds

His main area of research is the auditory system, which is responsible for hearing. "I have always made progress in my research when I started from a logical, obvious and ultimately incorrect assumption," says the professor

Prof. Israel "Eli" Nelken wants to find out what happens in the brain between the sounds.

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Even when I was 15, I wanted to find out new things that nobody had discovered yet. That's the main reason why I became a scientist.

Prof. Israel Nelken,
Hebrew University of Jerusalem

with a laugh. For example, he spent many years investigating how the brains of animals react to sounds under passive conditions. In order to learn more about animal behavior in the real world, he expanded his investigations: "I began to study awake animals and it turned out that a lot of things happened in auditory cortex that were not directly related to sounds."

One of his most important findings: "I spent years researching what happens in the brain during sounds, but the activity of the neurons between the sounds is much more exciting," explains Nelken and continues: "To be able to interpret this activity, we wanted to find out what the animal was thinking at each individual

moment." Technical aids for data collection are implemented metal electrodes, which have been continuously developed in recent years so that they can now have hundreds of contacts and record hundreds of neurons simultaneously.

Terabytes of decisions

Nelken and his team aimed to track a specific decision made by the animal from moment to moment. The behavior of the animal is measured ten times per second. "Based on this amount of data, we try to trace back what is going on in the animal's head and ultimately leads to its decision. This can easily result in half a terabyte – or 500 gigabytes – of data per day."

The applied Markov Decision Process (MDP) theory has shown that one can maximize the reward in a decision environment by basing the decision only on the current state. For the rats in this experiment, the chosen goal was food. Nelken cites the game of chess as a prime example: "We know that the future of the chess game depends only on the current state of the board and not on how you got to that state."

Motivation is key

The reward principle plays a decisive role here: "To achieve their goal, animals choose a strategy or rule that tells them what action they should perform in a certain state." In chess, a strategy would be a mental map that leads from the current position of the pieces on the board to the best moves. "We can calculate what these optimal strategies should look like. However, our data is not yet sufficient to fully estimate the decisions made by individuals; but we are getting closer," summarizes the researcher.

The methodology is also used in modern technologies: "The MDP framework and the associated learning theory, reinforcement learning, forms the basis for a large part of modern artificial intelligence."

Smart minds are good dancers

How can the results be transferred to humans? Where are the parallels? "A mouse has a spinal cord, a brain stem, a cerebellum and a cerebral cortex just like humans," says Nelken. At the same time, there are obvious differences between the species and other things that cannot be generalized. One thing that stands out is that one ability exclusive to humans is dancing: "When I start tapping, we start moving. It's a natural reaction. Humans are the only species that dances."

Our body reveals a lot about our mind: "The more intelligent a person is, the better they can lock to a rhythmic signal," says Nelken. However, there are still many questions to answer in the field of neuroscience. For Nelken, this is not an obstacle, but an incentive: "Even when I was 15, I wanted to find out new things that nobody had discovered yet. That's the main reason why I became a scientist." •

Indication of intelligence: Humans are the only species that dances.

Fully committed to the pet project

Last fall, Linus Henrik Weber, Management & Technology student at TUM Campus Heilbronn, was selected as a Deutschlandstipendium holder. Perhaps his social engagement tipped the scales, a decisive criterion in the selection process. It may also have been his excellent academic achievements or his wide range of interests.

Deutschlandstipendium holder Linus Henrik Weber

He is a realist but always sees the positive side of things. Weber's biggest dream? "To be able to identify in every situation of my life what makes me happy and pursue it."

What is his impression of Bildungscampus Heilbronn? "What the Dieter Schwarz Foundation has put together here is impressive." Why does Weber volunteer for several organizations? "I have found my purpose because you get a lot in return from community engagement," says the 20-year-old, smiling.

Stuttgart-born Weber likes to deal with the less appealing things in the world. During a trip to South Africa, he was weighed down by many young people's level of poverty and lack of perspective. He founded Eduzade, a pet project he based on this experience. Eduzade is about building educational partnerships between high school students in fifth grade and up in Germany and elementary school students in South Africa. As part of these tandems, the students in South Africa receive support with their homework from their counterparts in weekly Zoom meetings and talk about cultural differences and potential perspectives for the future. Weber has taken on several responsibilities in Eduzade: coordinating partnerships with the schools and preparing a pilot project with them. Going forward, he will be in charge of matching tutors with students and establishing initial contact.

More time for social engagement

The news about being awarded the scholarship was relayed to him – with a six-hour delay due to the time difference – while he spent a semester in Canada. "I was still in bed when I saw the message on my mobile. I jumped up and called two friends who also had applied. It made me so excited to hear the three of us had been selected."

What does he plan to do with the extra money? "I am taking two trips: one to Shanghai with TUM's Department of Strategic Management and one to Mexico when I finish my bachelor degree." However, the money is not the most important thing for Weber: "Because of the scholarship I will have more time to drive Eduzade. It is deliberately granted to students whose social engagement is an added value for society." ●

Deutschlandstipendium

The Deutschlandstipendium is awarded to students who excel academically and at societal and social engagement. TUM Campus Heilbronn joined in the 2022/23 academic year and currently supports 23 students in bachelor or master programs. With this, TUM Campus Heilbronn contributes to TUM's overall record number: For the first time, more than 1,000 scholarships are supported in the current academic year. Recipients are given 300 euros per month paid in equal shares by the Federal Government and private individuals. More information is available at *www.tum.de/studium/studienfinanzierung/stipendien/ stipendien-der-tum/deutschlandstipendium*