Issue No. 10

CAMPUS HEILBRONN

Mindshift

Impulses for change – TUM Campus Heilbronn

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TUM Campus Heilbronn of the Technical University of Munich

Content

Issue No. 10

Dear Readers,

As Vice President of TUM Campus Heilbronn and new editor of Mindshift I'm delighted to welcome you to this issue of Mindshift. TUM Campus Heilbronn represents the dynamic interplay of research, teaching, and practical application and stands for openness, exchange, and collaborative learning. Education is not formed only in seminar rooms or lecture halls; it grows through communicating, questioning, and the courage to think for oneself.

Our campus is a place where people from around the world come together, share their perspectives, inspire and learn from each other, and create something new. We take on social responsibility and develop the future – with scientific depth as well as creativity, determination, and a spirit of innovation. Offering various perspectives on AI between automation and creativity, this Mindshift issue shows how it can be done. What does it entail when machines seemingly become creative? What remains "typically human"? How can artificial intelligence be embedded in social, ecological, and ethical contexts in ways that make sense?

In this issue, Prof. Yair Weiss of Hebrew University of Jerusalem explains why AI relies on the creative vision of humans. Also, you can read about developments in business and technology: Two TUM professors discuss generative AI in software development, and two companies based in the Heilbronn-Franken region are implementing their own AI strategies. Additionally, we highlight the significant potential of promising technologies such as real-time image processing and 3D reconstruction.

Other articles explore the connection between sustainability and digitalization, for example, when using AI to preserve endangered languages or in GovTech initiatives designed to develop citizen-oriented solutions. Another article deals with the high consumption of resources by intelligent systems. The "Digital Transformation for Sustainability" seminar conveys strategic input for a sustainable future.

Learn about the modern technologies that are shaping work environments, from hybrid work models to the changing status of professions or the interaction between humans and machines in decision-making. Examples include hybrid intelligence or practice-based courses such as the seminar "AI as a Colleague".

From international engagement, the SME sector's pioneering spirit, or the perspectives of our students, guest lecturers, and executives – Mindshift reflects the variety and dynamics of TUM as an Entrepreneurial University.

I warmly invite you to discover more about this variety on-site at Bildungscampus Heilbronn and in this edition. Stay curious – be inspired, surprised, and encouraged to reflect.

Prof. Ali Sunyaev
Vice President of Technical University of Munich
TUM Campus Heilbronn

Clever ideas instead of blind data collection

Yair Weiss, Professor of Computer Science at the Hebrew University of Jerusalem, conducts experiments with neural networks for image recognition to illustrate how often AI makes mistakes. He is convinced that machine learning has its limits – it cannot work without human creativity and empathy.

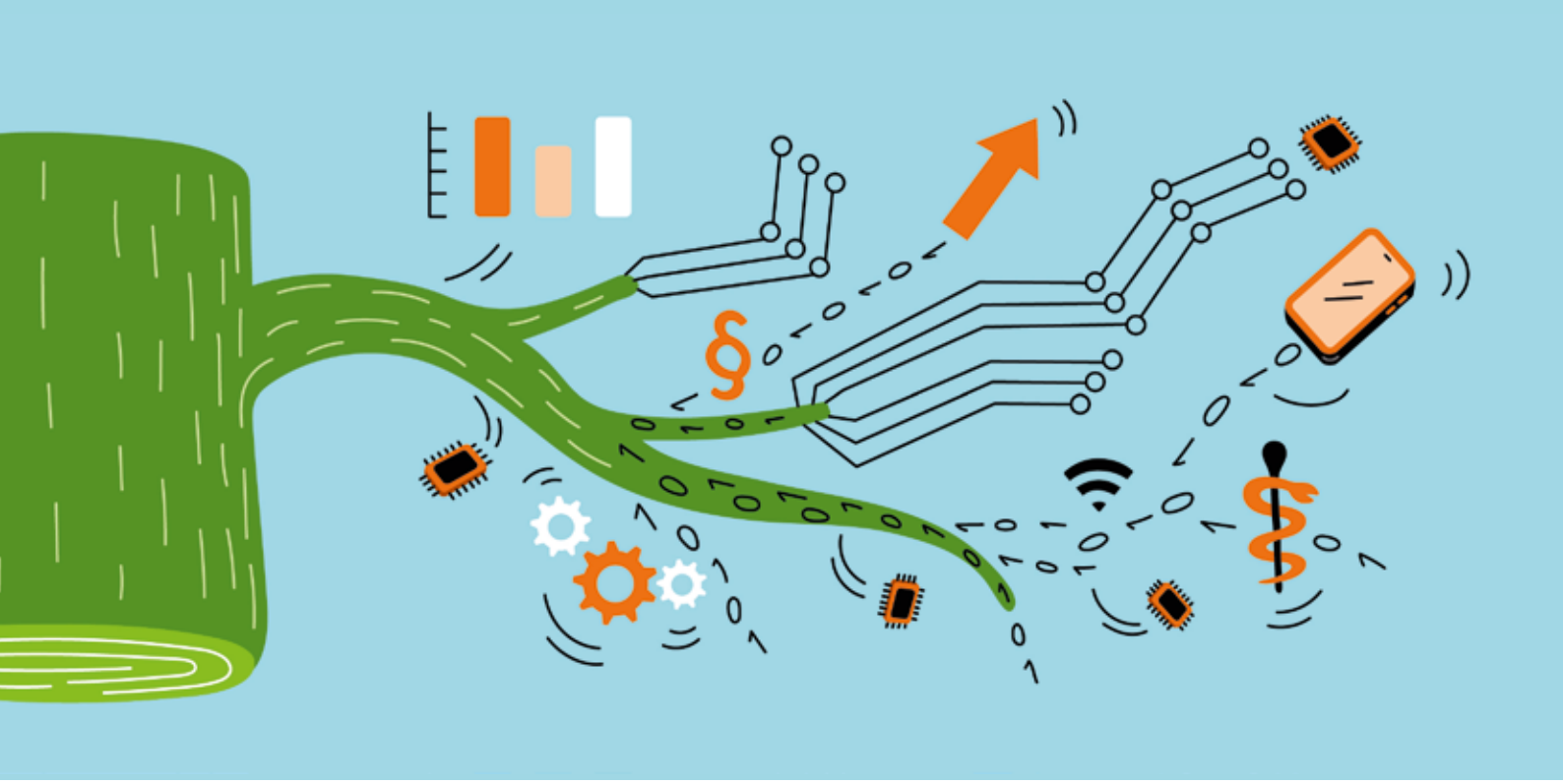
Even the smallest changes can have a big impact: My experiments showed that shifting just one pixel led to a significantly different interpretation in almost 40 percent of test images. The consequences can be grave, for example, in cancer detection and other sensitive areas.

The previous strategy of training models with increasingly larger datasets or modifying the network architecture did not lead to solutions. A simple, effective approach did: Instead of using the entire image, we used a smaller, sliding window that stabilized recognition. This indicates that logical technical principles are often more effective than blind data collection.

Why we need skilled engineers

What general conclusions can be drawn from our findings about machine learning? Sam Altman, Founder and CEO of OpenAI, wrote in his manifesto “The Intelligence Age” that deep learning can solve all of humanity’s problems. I don’t share his blind faith in technological progress. Algorithms minimize errors statistically, but human logic and engineering skills remain indispensable. The future of AI lies in combining both approaches.

Are there still enough people with solid engineering skills out there? Or, to put it more generally: Has AI become so embedded in daily life that we’re starting to forget



basic human skills? In Israel, many people struggled when the GPS went down, and they had to read maps again. Students rely too heavily on AI tools and forget how to understand complex texts. Two lawyers blindly trusted ChatGPT and referred to cases that never existed. However, examples like these also give me hope because they show that critical thinking is still essential.

We are only moved by human art

Automation has been with us since industrialization. Today, AI can write texts, compose music, and paint pictures, but its products will never move us like a work of art created by humans – not because human art is better per se, but because we feel emotionally connected to it. We want to understand what the artist was trying to express. We benefit from our creativity and empathy in the technical field as well. AI can write code, but good programming requires more: You have to maintain flexibility, good design and customers' needs.

Another strength is our adaptability. Given how rapidly AI tools evolve, the focus of education should not be on current tools alone. It is important to adapt and develop continuously – as humans have always done.

Different but equal

Instead of wondering whether AI will be superior to us one day, let's view the diversity of life as a branching tree: Every creature occupies one branch with its special strengths – birds can fly, bees can navigate in the dark; we can't. Many organisms are better at some tasks than humans, but none have ever threatened our existence. AI, too, is superior to us in some areas and inferior in others. It expands our opportunities and has its place on the tree of life – but it will never change what it means to be human.

Why even smart algorithms cannot replace human logic – Prof. Weiss is looking for answers.

Programming support with strengths and weaknesses

Artificial intelligence is a versatile tool that helps software developers debug code and manage large data sets, and it saves human resources. Chunyang Chen and Stefan Wagner, Professors of Software Engineering at the TUM School of Computation, Information and Technology at Campus Heilbronn, have similar assessments of the opportunities and risks of AI.

Code plays a vital role in software development. Can you explain its functions and how it is built?

Prof. Wagner: Source code is structured text that follows formal grammar and explains to machines what they need to do. What you can and cannot write is defined clearly. In addition, code is used for communicating with other software developers. Code is read far more often than it is written – clarity is essential.

Prof. Wagner warns against trusting AI blindly.

Prof. Chen: Software developers spend between 9 and 61 percent of their time writing source code. The hardest part is understanding the requirements because at the end of the day, software is not developed for machines, but for people – and people tend to change their perceptions over and over. For example, today they are asking for a specific color, tomorrow they want a new function or a different page layout. The challenge in programming is capturing the requirements precisely and translating them into technical specifications.

What is the difference between source code and machine code?

Prof. Wagner: Source code defines how computers should operate. In most cases, source code is translated into machine code with the use of what is referred to as a compiler. Machine code is what the processor in the computer truly can understand as a prompt – zeros and ones, essentially.

Prof. Chen: While source code can be read by humans, machine code is binary. Some codebases are huge, such as those for the Google Chrome browser or operating

systems. This code is highly complex and very long. So far, AI is not able to model it very well because it has difficulty processing such a large codebase.

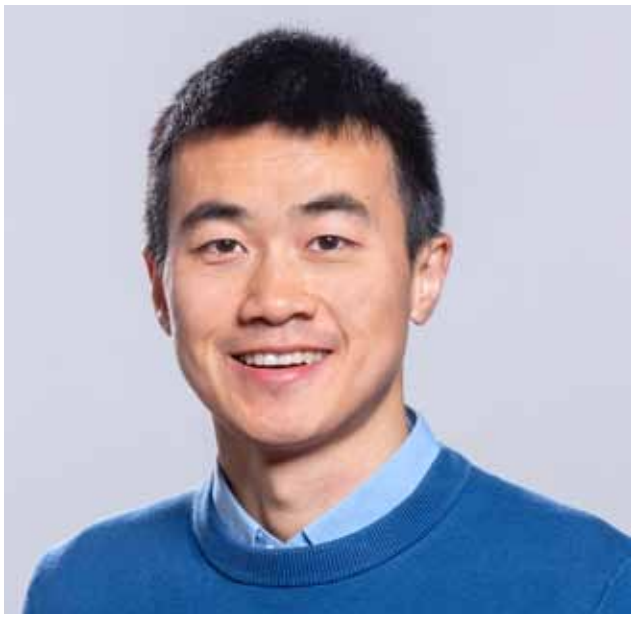
Can generative AI become a go-to tool that makes it easier for humans to write and test code?

Prof. Wagner: The term "go-to tool" sums it up pretty well. If you want to work with source code, Large Language Models (LLMs) are your tools of choice because they can handle language perfectly. Source code is no different from language. Thanks to open source, we have access to an incredible amount of source code. You can use it to train the models. They are good at completing simple tasks. The only drawback is that you still have to check the results and understand everything because LLMs do not always achieve perfection.

Prof. Chen: Not yet, but AI is continuously developing. Tasks that cannot be solved today may be learned as early as tomorrow. AI is very dynamic. We see breakthroughs every day. In the end, I believe AI is already very powerful, will become even better, and can be used in every field going forward.

What other tasks can generative AI assume?

Prof. Chen: I develop software for users with visual impairment. I have to find users that fall into this category as test persons, so I know whether or not they can handle the program. This takes time. Building learning model agents is easier. These agents can imitate the behavior or preferences of specific groups of people, like a virtual audience. They save us a lot of time and work because we can forgo user studies.



Prof. Chen conducts research on AI for practical applications.

If we rely on AI too heavily, we will lose important abilities – a process we refer to as skill depletion. That definitely is a potential threat when using AI, not only in programming and software development but in all areas of life. We cannot lose control over computers.

Prof. Chunyang Chen

Prof. Wagner: AI can explain how code fragments work, and it can help us understand error messages and find a solution. There is also testing: AI can generate tests that allow us to see whether the code we wrote is working.

So, AI is like a colleague that gives you initial feedback. Do you truly understand what generative AI did after a job is done?

Prof. Wagner: I can and have to understand it. If I rely on AI completely, without understanding what it generates and how, I run the risk of errors occurring in some sections or the results not being usable. For the foreseeable future, humans always will be at the center. We call it human in the loop – we can ask the tool for help but always have to comprehend what it is doing. LLMs work with statistical probabilities. Of course, hallucinations can occur in the process when a model tries to >

access an interface that does not exist, simply because similar interfaces exist in other frameworks.

Prof. Chen: If we rely on AI too heavily, we will lose important abilities – a process we refer to as skill depletion. This is definitely a potential threat when using AI, not only in programming and software development but also in all areas of life. We cannot lose control over computers.

Is it a fundamental weakness of LLMs that they sometimes appear to know it all even though they don't? Is this where their limitations lie?

Prof. Chen: Using AI, I can generate code in three seconds, but finding and solving an error takes me three hours. While I may realize something is not right, I still don't know which data is the culprit. It is really difficult for LLMs because the content is very complex. If I write the entire code myself, I am aware of the entire logic. AI basically is good, but we still have a long road ahead of us before we can fully apply it in the real world. When AI faces a problem it cannot solve, it should say so rather than try to please the user at all costs.

Prof. Wagner: Absolutely, it even has its dedicated field of research. When it comes to interfaces, it would be very easy to add a layer between the developer and the LLM and then have it run through a compiler after it is generated to determine whether the interface exists, similar to an iteration. This could help filter out hallucinations, which are a fundamental problem that until now we have not been able to eradicate. In my opinion, the sheer volume of generated code is another risk. Nobody can handle these volumes.

If you were to juxtapose humans and machines: What are the strengths of humans and of LLMs?

Prof. Wagner: LLMs have so much knowledge and are much quicker in retrieving it than humans. In turn, LLMs have problems with making the right choice. Their way of operating is more random. However, if you are an expert in writing Java programs, you know exactly which interfaces exist and which do not. You will have a fundamental understanding of what it is you are building. LLMs don't have this understanding. Proving programs is a dedicated area of computer science and involves a lot of math – LLMs are not made for that.

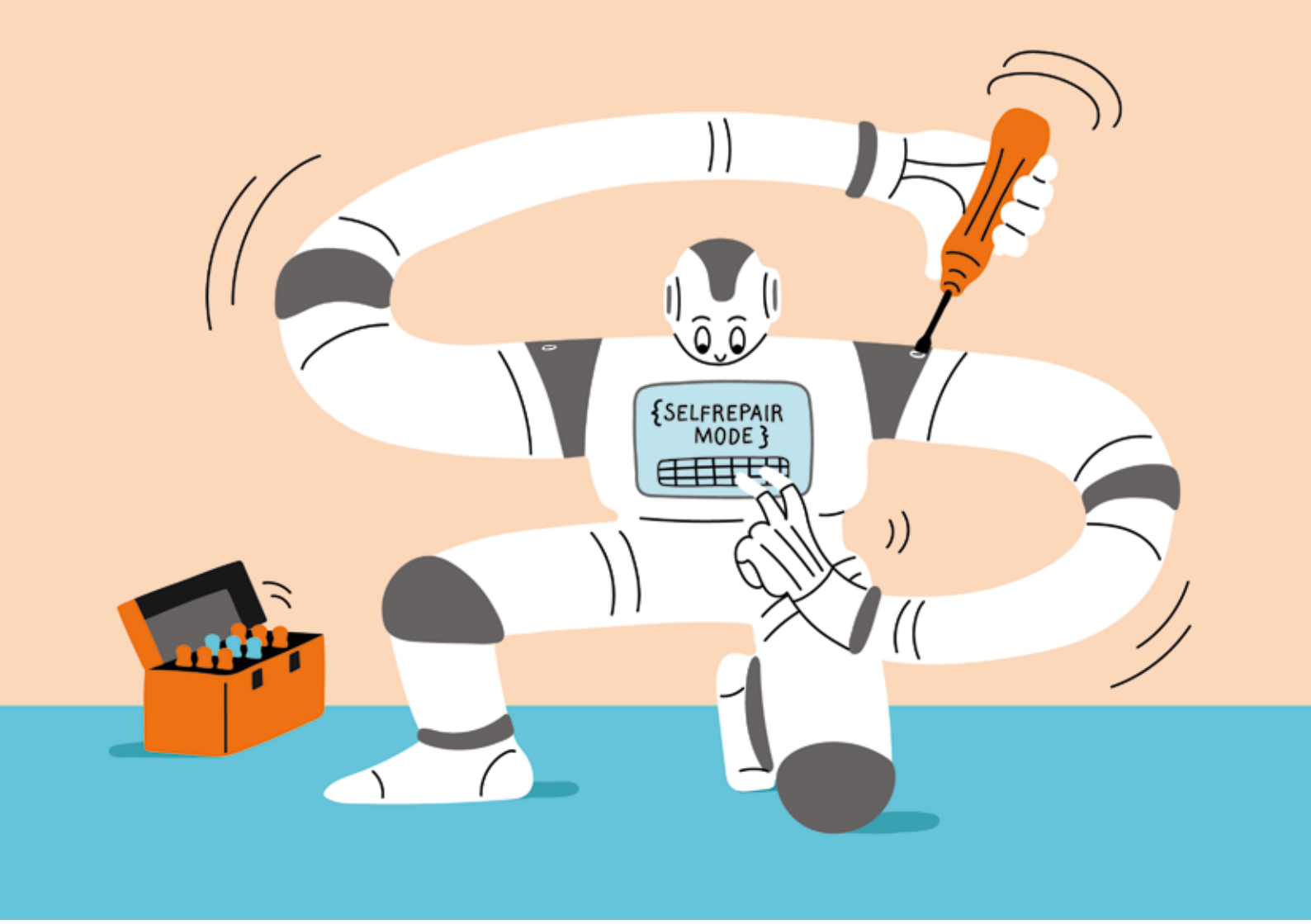
> **If I rely on AI completely, without understanding what it generates and how, I run the risk of errors occurring in some sections or the results not being usable. For the foreseeable future, humans always will be at the center. We call it human in the loop.**
>
> Prof. Stefan Wagner

Prof. Chen: If you want to develop general AI agents, you have to take more parameters into consideration. The algorithm must be more robust and more universal. That means a lot more work for humans. While solutions proposed by LLMs cannot be used at face value, they can at least give hints and make suggestions. We must show users the limits to AI.

How can humans assist generative AI?

Prof. Chen: Let me give you an example: We develop attack and defense mechanisms to backdoor attacks which are the worst kind of possible hacker attacks. To do so, we use an obfuscation approach, for instance, meaning we conceal code to ensure AI is protected as well as possible in the end.

Prof. Wagner: A combination of LLMs and what is called symbolic AI would be the interesting solution. It takes us back to what we used to do: describe things and define an ontology. Telling AI what the software is and what the units are in my code. Giving AI reliable knowledge that I then link with the LLM's encyclopedic



knowledge. That could be an approach to preventing hallucinations.

In your opinion, will LLMs be able to develop programs autonomously in a few years without any human intervention?

Prof. Chen: AI does a very good job at developing and testing simple software. I sometimes write a website or a couple of scripts, and AI does almost all the follow-up work. I give only the bare minimum of instructions. So far it has worked quite well with these types of programs, but problems persist with larger programs. AI still makes mistakes very easily.

Prof. Wagner: I also think it is possible. The question is whether the results make sense and whether it is what you want. I can imagine an autonomous bot trying to figure out what type of software is needed. In this scenario, the LLM writes code, sends it to the compiler, generates appropriate test cases, and uploads the results to a server directly. However, how much do I trust what AI does?

What is your personal view on trust? Do you use ChatGPT every day?

Prof. Wagner: I try to run many models locally at my office. I don't use ChatGPT that often even though it is one of the best LLMs. I sometimes generate code with it and use it in my lectures to show what does and what does not work. I mainly work with ChatGPT to write recommendation letters, which used to be a repetitive and time-consuming task because, at the end of the day, all letters tend to look quite similar. However, I have to pay attention to see if the tool produces nonsense, which occurs regularly.

Prof. Chen: I am very open to new technologies and want to try them all out. If I can't understand them or don't use them often enough, I can't see their boundaries or conduct research on the most pressing questions in the respective field. Both my personal life and my job demand that I use them extensively. I am even teaching my son how useful AI can be, for example, I have shown him the best ways to find information through ChatGPT. Building AI skills early on is very important to me.

AI with purpose and impact

How does an IT services provider such as Bechtle manage to turn artificial intelligence into a game changer? Pit Ogermann, Head of AI Research and Strategy, plays a part in it – and has a clear focus: Using AI as a strategic tool for innovating and adding value rather than as an end in itself. His approach entails encouraging smart solutions that focus on human needs.

The kick-off to a sustainable AI strategy was marked by an extensive analysis of stakeholders. Following talks with the staff responsible at system integrator companies and interviews with experts, Bechtle assessed its strengths and challenges. Based on this list, the company developed an AI strategy with four central domains: internal optimization, market-driven development, customer-oriented solutions, and social responsibility. Bechtle uses AI in-house in a targeted manner to increase efficiency. In addition to Microsoft Copilot, the company's own chatbot Bechtle GPT improves internal connectivity, while the company's own AI models optimize customer service using ticket classification.

However, AI goes beyond automation. "It is trained and actively designed by humans. This cooperation is what gives rise to creativity," says Ogermann. This is why Bechtle relies on hands-on, gradual strategy development. Even at the test stage, humans and machines work together to design tailored solutions as part of AI-based customer consulting in e-commerce.

Europe's research potential

As a lecturer at DHBW Heilbronn, Ogermann advocates a differentiated view on AI in Europe. "We tend to focus on regulations and overlook our strengths," he explains. In fact, many groundbreaking AI developments, including the fundamentals for ChatGPT, originate in research conducted in Europe. According to Ogermann, this potential should be utilized more effectively instead of making comparisons with the U.S. or China.

Bechtle takes this idea further in real-world applications. For example, alliances with TUM, as part of the 1000+ project week (details on p. 30), and with DHBW Heilbronn provide fresh ideas for the company and address the challenges of the future today. Planet AI, an AI specialist majority-owned by Bechtle, also works closely with researchers, collaborating with the University of Rostock on topics related to intelligent document recognition. Ogermann is convinced that "the collaboration between academia and industry is key to speeding up innovations."

Shaping the future actively

In addition to AI, quantum computing is another key area for the future. "For the time being, quantum computing does not pay off when used to solve small problems, but that can change," Head of AI Research and Strategy Ogermann believes that the fast-paced development of AI over the past few years has shown how quickly technologies can transform. This is why companies not only need to implement AI but also to develop long-term innovation strategies. For Ogermann, one thing is certain: AI must be actively guided. Instead of waiting for new technologies to become the standard, companies should help drive their development. "If you can't predict the future, you have to shape it." For Bechtle, this is more than just a slogan.

Progress to the rhythm of a waltz

Breaking habits, making bold decisions, and being open to innovation are essential for small and medium-sized companies in Germany to be successful. Dr. Gunther Wobser, President and CEO of LAUDA, made these principles work for himself and his business.

Dr. Gunther Wobser of LAUDA backs an AI-driven strategy.

Wobser was born into a family-run company and took over full leadership of LAUDA in 2010. The company headquartered in Lauda-Königshofen specializes in constant-temperature equipment and plants. “Especially in a family business that has been around for almost 70 years you constantly balance tradition and innovation,” says the CEO. Curiosity, tenacity, and endurance have motivated him in his professional career. Another characteristic could be added to this triad: willingness to take risks.

It was his curiosity that made Wobser move to the U.S. technology hub – Silicon Valley – for one year in 2017. The stint helped him grow both personally and as a leader, and understand why the region is considered the world’s leading hub of innovation.

AI is picking up speed

The experience was an eye-opener. “It became clear to me how crucial innovation is to a company’s survival. Only a few decades ago, oranges were grown in Silicon Valley; today, a giant network of business and science revolving around Stanford University connects the most brilliant minds.” Wobser compares AI-induced acceleration to a Viennese waltz: “You move forward in circles quickly, and only now and then you add a rocking step.” If you snooze, you lose.

Hence, it comes as no surprise that LAUDA is all about progress. Wobser explains: “LAUDA.GPT is a vital element of our digital strategy.” The multi-faceted platform created by the company bundles the various AI functions to support the staff in their daily work, including code writing in software development. “We want to use the customer interface to create a knowledge base that provides answers to recurring questions,” says the businessman with a doctorate.

The company’s constant-temperature equipment comes with integrated technology as well. “Customers are still a bit reluctant, but our products are AI-ready. LAUDA.LIVE is our platform that facilitates intelligent connectivity and remote diagnosis.” In the future, customers will benefit from automated maintenance and cloud-based error diagnoses. Even the company’s recruiting process focuses on AI skills: “We want to read the joy of innovation from the CVs.”

Keeping pace

The CEO leads by example: “I am not afraid of science – TUM Campus Heilbronn has the know-how; we have the data and the use cases.” At AI House during the World Economic Forum in Davos, Wobser was part of the TUM Campus delegation that discussed the future of the midmarket and also initiated joint projects. “TUM Campus Heilbronn is now an official sponsor of Futurelabs gGmbH, which I founded and where we develop ideas for SMEs and young talents to keep pace with the rhythm of the waltz.”

Seeing through the machine's eye

From detecting tumors to interacting with three-dimensional environments – Daniel Cremers, Professor of Computer Vision and Artificial Intelligence at the TUM School of Computation, Information and Technology, explains how artificial intelligence is revolutionizing visual perception.

AI that understands images: Prof. Daniel Cremers works at the interface of image processing, pattern recognition, and machine learning.

Prof. Cremers, how would you define artificial intelligence?

Prof. Cremers: Broadly speaking, the term refers to the reproduction of human skills by machines. In particular, the goals are to capture and understand the world via the senses, respond intelligently to the environment, and take action. One of the most important human senses is seeing, which relates directly to my primary field of research, visual data analysis. We equip machines with cameras and try to understand the world even better with them.

In your opinion, do machine learning and artificial intelligence necessarily form a unit?

Prof. Cremers: In my opinion, machine learning is a vital part of AI. Take autonomous driving, for example: You create a model of the world with all types of obstacles that could approach the vehicle from various directions. Because these models always contain uncertainties, you have to use reasoning, for example, by modeling probability distributions. This leads to the field of statistical pattern recognition, which is the background of machine learning processes. Deep neural networks are essential components.

What were some of the milestones in two of your specialist areas, image recognition and 3D reconstruction?

Prof. Cremers: In the field of image recognition, Alex Krzyzewski and Geoffrey Hinton demonstrated in 2012

that deep neural networks can help detect structures in images much better than conventional methods. In 3D reconstruction, an important breakthrough was a process developed by my doctoral student Jakob Engel in 2014. We named it LSD Slam, an acronym for "large-scale direct simultaneous localization and mapping". It was the first in the world to calculate reconstructions based on images from one single, freely moving camera.

What are some of the practical applications for these technologies?

Prof. Cremers: Image recognition is used in face and fingerprint recognition, and there are several applications in medicine as well, for example, tumor detection. To do so, patients are screened, and the images are then analyzed by machines. The method is very reliable when it comes to detecting whether an image shows a tumor. These preliminary steps help physicians work more efficiently because they only need to re-examine the results if the machine is unclear.

In addition to autonomous driving, 3D reconstruction can be applied in augmented reality, where computers project virtual objects into the real world. It becomes relevant in surgery, for example: Before an operation, the computer can show the location of the lungs, the kidneys, or the heart virtually. This improves orientation because the surgeons are able to see structures that are normally invisible, directly superimposed on the body. Another huge field of application is robotics.

As part of one of your current research projects, you have developed a method to track what are called event cameras with unprecedented precision to date.

Prof. Cremers: Exactly. Event cameras are special light sensors that react to changes in brightness – even by one pixel. They allow you to make much more efficient use of the bandwidth of information and essentially enable an extremely high frame rate. This is used for supporting robotics applications that require great speeds. We developed the first autonomous drones that use these cameras for orientation to navigate around obstacles autonomously. Event cameras are very useful at high speeds because they can capture the environment incredibly quickly with near-zero latency.

> **We equip machines with cameras and try to understand the world even better with them.**
>
> Prof. Daniel Cremers

However, many scientists mistakenly apply traditional algorithms to these cameras. They aggregate the events and combine them into one image. This means losing the main advantage of the cameras, namely the fact that they can react to change immediately, rather than at pre-set intervals.

This is where our Deep Event Visual Odometry (DEVO) method becomes applicable. It allows you to track the movement of the event camera using deep neural networks that detect specific groups of events, and it can reconstruct the 3D structure and camera movements from them.

What technological advancements do you foresee for the next few years?

Prof. Cremers: I expect image recognition and 3D reconstruction to become usable for everybody. Combinations of 3D computer vision and Large Language Models are also on the rise. Two years ago, we founded the start-up SE3 Labs in this field. Our goal is to enable city planners, for example, to interact with 3D reconstructions, let's say Munich, querying information regarding the city. We want our system, which we call SpatialGPT, to provide answers within seconds. In my opinion, that is a highly promising direction for research and application.

From files to algorithms

Taking a number, submitting large amounts of paperwork, waiting weeks for a reply – many citizens associate public administration with time-consuming bureaucratic hurdles and high costs. Digital technologies provide opportunities to make administrative processes in the public sector more efficient and user-friendly. As a consultant to ministries and providers of IT services, TUM alumna Jaimee Lau helped promote digital transformation in the public sector. As an AI strategist at the appliedAI Institute for Europe, she focuses on developing and implementing trustworthy AI solutions.

TUM alumna Jaimee Lau focuses on AI solutions for the common good.

The public sector is facing major challenges. “Modernizing and digitalizing the administration is paramount, and there is growing urgency for action,” says Jaimee Lau. Financial resources are scarce, and demographic change is intensifying labor shortages. At the same time, given the speed at which digital technologies such as AI, blockchain, or cloud computing are developing, administrative processes must be adapted continuously. This is a complex task, particularly in a federal system and in a sector that lacks digital skills.

Administration under transformation

Digital and AI-based solutions have the potential to reduce the administrative workload significantly. By automating application reviews and other routine tasks, resources can be used elsewhere. Jaimee Lau adds another key point: “We can boost the quality and availability of administrative services through digitalization.” Hence, digital technologies contribute to more citizen-centered administration. “People and companies expect both uncomplicated access to administrative services and enhanced administrative processes.” Another major opportunity would be that more efficient and user-friendly communication with public authorities in the long term could strengthen trust in democratic institutions and in Germany as a business location.

Since technologies deployed in the public sector often have a direct impact on the lives of many people, trust is key to success. According to Jaimee Lau, meeting standards of fairness and transparency and the development of AI skills must be kept in mind when implementing AI applications, for example. “These sustainability criteria are arguably even more important in the public sector than in any other area where AI is used primarily to improve efficiency,” she explains.

Technology meets sustainability

When she speaks about sustainability, Jaimee Lau refers to more than climate action. According to the Triple Bottom Line approach, sustainability includes environmental, economic, and social aspects. Jaimee Lau

points out that the ecological footprint of AI systems, including high energy consumption and the need for limited resources for hardware, is just one aspect of the issue. She says: “Social aspects such as training-data quality and digital inclusion also play a key role when assessing sustainability. The critical factor is how representative the data is and whether unequal access to specific technologies is an issue.”

Sustainability was also the focus of Jaimee Lau’s studies of Politics & Technology at TUM. Her master’s thesis dealt with ways to measure and assess sustainability in climate tech start-ups as part of public sponsorship programs.

Jaimee Lau’s research was dedicated to turning scientific research into usable products and devices. “We need tech start-ups spun off from universities to address the challenges of our time such as climate change.” Against this background, the infrastructure built by TUM, which comprises incubators and accelerators, offers founders the support they need to translate scientific findings into marketable products and services.

45 under 45

Last year, Jaimee Lau was invited to join a leadership program hosted by Lucerne Dialogue, a conference that takes place in Switzerland. Each year, 45 individuals under the age of 45 from all over Europe with diverse professional backgrounds are selected for the event. In a three-day Social Hackathon, participants addressed one question: How can companies foster participation and strengthen democracy? “As a TUM alumna, it was a great joy to learn that our project partner was TUM Campus Heilbronn,” she says.

Jaimee Lau and her team developed and pitched a project called “Tech Ties”. “The program connects master's students specializing in data science and artificial intelligence with SMEs for technical consulting projects,” she explains. The idea behind the concept: to link TUM students and companies and create connections between the aspiring technology hub in Heilbronn and the backbone of the regional economy, the mid-market.

In her role as AI strategist at the appliedAI Institute for Europe, Jaimee Lau will work both in Munich and in Heilbronn. It is important to her to build trust in AI as a technology and create positive experiences with it. “My goal is to make use of the benefits of AI in a responsible manner that also keeps the common good in mind, to increase its acceptance within society.”

Towards a sustainable digital future together

Last year, some regions in Bavaria and Brandenburg experienced a drinking water shortage. At the same time, artificial intelligence uses 465 million cubic meters of water per year, an amount that could supply 10.5 million people in Germany annually. How can digitalization become sustainable? Answers are provided by Dr. Dina Barbian, Managing Director of eco2050 Institute for Sustainability.

"Something new has come up – sustainability or sustainable development!" With these words, Barbian's mentor sent her off to write a doctoral thesis in 1994. "At that time, I learned that in addition to environmental protection, the environmental economy also has a social component," she remembers. The idea stayed with her and led to the founding of her own start-up. "Despite the lack of role models, my female colleagues and I established the Institute for Sustainability in 2012." The objective was, and still is, to design sustainable digital solutions and technologies. The sustainability economist with a doctorate refers to the process as twin transformation.

It did not take long before the first customers reached out. "We started by calculating carbon footprints for their products and processes," Barbian explains. The next milestone was a sustainability report for the city of Erlangen. Just like with sustainability, she and her team were also among the first to explore artificial intelligence. "In those days, sustainable AI was a completely new idea, so our publications were among the first of their kind." The study titled "The Ambivalence of Artificial Intelligence and Sustainability" is an example. The preliminary work the institute did back then pays off in one of its current projects: developing sustainable servers.

Instant results, heavy impact

The quick and efficient way AI provides answers to (almost) any question has significant environmental costs. Barbian clarifies: "Power consumption increases exponentially. I need 454 million kilowatt hours per year for prompts alone." Water consumption is extremely high as well: AI requires a total of 465 million cubic meters of water, mainly for data center cooling, equal to the annual water consumption of 10.5 million people in Germany. If you think water scarcity is not a problem in this country, you're wrong. In the summer of 2024, many cities had to be supplied with drinking water.

So, AI needs a lot of electricity and water. A never-ending issue? "Switching from water to air cooling for data centers or developing an alternative solution with technologies not yet available would be important because the water primarily is used for cooling data centers," says Barbian. One of these new technologies comes from the

Companies gain financial added value if they assess which departments can save electricity and water or which parts of their supply chain generate the most CO_2 emissions.

Dr. Dina Barbian

hardware side: As part of a research project sponsored by the Federal Ministry for Economic Affairs and Climate Action that involves six partners, Technical University of Dresden is developing NPUs, neuromorphic chips that work like the neural network in the brain. “Compared to conventional CPU and GPU processors, these chips are much more efficient, saving up to 50 percent of power during training and up to 80 percent during inference of AI models – that is huge,” says Barbian.

Recycling, not smoldering fires

A success story from the past shows how innovation can be achieved: Jointly with a large electronics company, Barbian and her team developed a chip to track the raw materials, for example, gold and silver, that are used in smartphones. The scientist illustrates the background: “We aim to develop digital products designed for reuse, not disposal or incineration, so that the raw materials they contain can be recovered and used again.”

Before the chips existed, most electronic waste was shipped to Ghana. A source of income for local residents, but at a high price. “Average life expectancy of the workers is 42 years. Burning the waste at low temperatures produces furans, which are toxic and carcinogenic.”

The Ecodesign Regulation that requires producers to be mindful of the post-use stage of products shows alternatives, for example, repair and recycling businesses in Germany. This is a successful twin transformation with digital product passports that will be required for all products traded in Europe, starting in 2027.

Implementing this transformation in the corporate sector is the focus of the eco2050 Institute’s consulting services. “Companies gain financial added value if they assess which departments can save electricity and water or which parts of their supply chain generate the most CO_2 emissions,“ says Barbian. Drawing up a balance sheet helps highlight the adjustments businesses can make. In addition, they become attractive to young university graduates who are highly aware of sustainability issues.

Conscious consumption and travel

Barbian has three tips for those who want to reduce their personal carbon footprint: “Look at the amount of electricity you use. Reducing your heating by one degree leads to a drop in CO_2 emissions of approximately 10 percent per year. Use public transportation instead of your car; mobility has an enormous CO_2 footprint. Watch what you buy: eat less meat and purchase regional, seasonal, and package-free foods.”

In her opinion, the joint effort pays off for companies, society, and politics. “Once we manage our resources more consciously and embrace technological innovations, we can use the benefits of AI and other digital tools in a sustainable manner.” She adds that these technological innovations will be expensive at first, but still cheaper than what climate change would cost in the long run. Barbian is convinced that “the time to make strategic decisions is now.”

Preserving endangered languages with chatbots

There are growing concerns that Large Language Models such as ChatGPT endanger linguistic diversity. Alexander Fraser, Professor of Data Analytics & Statistics at the TUM School of Computation, Information and Technology at Campus Heilbronn, is convinced of the opposite: He uses machine translation to help preserve endangered languages.

Prof. Fraser, how does machine translation work?

Prof. Fraser: Machine translation is a two-step process. First, the model analyzes the source sentence, then it generates the translation. The part of the neural network responsible for analysis is called the encoder. The encoder creates a vector representation of the sentence and should produce the same representation for sentences like "I saw the dog" and "Ich sah den Hund". These representations can then be translated into any language. If the system doesn't work properly, an Upper Sorbian and a German sentence with the same meaning, for example, will result in very different representations. In this case, the output cannot be correct. You can test this by asking the model to translate a German sentence into Sorbian. We then use automated tools to compare the system's output to a correct reference translation.

Prof. Fraser uses AI to preserve endangered languages.

Upper Sorbian, a minority language spoken in the Lusatia region of eastern Germany, is the focus of your research project EPICAL. Your aim is to preserve low-resource languages. What fascinates you about analyzing languages and texts?

Prof. Fraser: In the previous projects – "Domain Adaptation for Statistical Machine Translation", and "Health in my Language" – we worked with medical texts

for consumers. The system we employed was trained exclusively on this type of text and therefore worked well in this area only. At the time, I wasn't yet focused on rare languages, but I quickly realized that whether a model works doesn't depend on the subject matter – it depends on the language you're translating into or from. Especially for languages with few resources, there are often insufficient parallel texts to train powerful machine translation systems.

How many languages in the world are currently under threat?

Prof. Fraser: There are around 7,000 languages worldwide, but one becomes extinct every two weeks. Around 40 percent are considered endangered. According to the Summer Institute for Linguistics, a Christian organization that has translated the Bible into diverse languages, around 1,500 languages could disappear in the near future. Of course, it would be unrealistic to assume that machine translation for all 7,000 languages could prevent this. The decisive factors are the prestige of the language and whether it is actively used – especially by children.

How can EPICAL help?

Prof. Fraser: We want to support language advocates in using chatbots to write texts in their language. The more texts that are created, the better we can train the bots, and the better they are, the easier it is to write new texts. In other words, we are trying to improve the language models for these languages so that people use them more often. For example, dedicated people could create Wikipedia entries with AI support and then edit them by hand. In this way, language models are incrementally trained, resulting in better encoding and, ultimately, faster work. Our technologies alone won't preserve these languages, but they can help ensure languages are perceived as modern and enable speakers to use the language more confidently.

What languages other than Upper Sorbian are you working with?

Prof. Fraser: We are looking specifically for languages that are actively used by a community of language advocates. We work with text data only, and we need texts that are already available. We are particularly interested in a wide range of linguistic diversity. Therefore, we also want to work with people in Africa, South America, and Asia.

Can the findings from EPICAL also be applied to other areas of machine learning?

Prof. Fraser: Yes, our research could improve the English version of ChatGPT, especially for specific technology-related topics that are not yet adequately represented. In addition, language models such as the transformer model, which stems from natural language processing, influence many other areas of machine learning. If we manage to train better transformers with less data, it could have broad impact on all areas of machine learning. For instance, in the field of medical image processing: Systems for automatic tumor detection currently require numerous training images. If we succeed in training high-performing models with a significantly smaller amount of data, we could improve early detection significantly.

Digital pioneers for a green future

The two major drivers of transformation are sustainability and digitalization. How can they be linked strategically? The "Digital Transformation for Sustainability" seminar at TUM Campus Heilbronn is a unique opportunity for companies to prepare for the twin transformation.

Whether it's the Green Deal, the Circular Economy Action Plan, the Act on Corporate Due Diligence Obligations in Supply Chains, or the Ecodesign for Sustainable Products Regulation, regulatory requirements are placing increasing pressure on companies. At the same time, customers and stakeholders expect sustainable business practices. "Twin transformation links digitalization and sustainability in one systematic approach," explains Dr. Dina Barbian, Managing Director of eco2050 Institute for Sustainability and lecturer of the seminar (read the article about her on p. 16/17).

In addition to the fundamentals of the law, concepts such as circularity and carbon accounting are covered in the intensive course. Further, participants learn to apply digital tools for sustainable business models.

Hands on and interdisciplinary

The seminar is aimed at professionals and executives in IT management and environmental management and anyone interested in driving digital transformation and strategically integrating sustainability in their companies. Besides theoretical basics and keynote speeches presented by industry experts, essential elements of the seminar include practical assignments which can be completed directly at the company. "Corporate decision-makers need to be familiar with laws, respect ethical parameters, and be able to assess decision-making situations soundly," says Michael Stich, Professor of Accounting at the TUM School of Management, who manages one of the modules.

Dr. Will Ritzrau, who has established sustainability in the core business of all the business units at SAP, adds: "Sustainability's key factor is trust – and trust is achieved through transparency based on credible, updated, and relevant data." Accordingly, seminar participants learn to integrate social, environmental, and financial data to manage their sustainable strategies transparently and efficiently.

Barbian says: "Companies are under growing pressure to think strategically when it comes to environmental management. Over the course of the seminar, we show how digital technologies can help implement sustainability measures efficiently."

Continuing Education at TUM Campus – promoting green transformation

For updated information on the seminar please write to *weiterbildung@tumheilbronn-ggmbh.de* or visit the website:

Content of the seminar

- Digital transformation and sustainability: fundamentals and interrelations
- Digital business models
- Legal framework
- Environmental management and circularity
- Sustainable strategy development and implementation
- Digital tools and innovative technologies
- Data-driven decision-making
- Incentives, responsibility, and accountability

AI is coming, humans are staying

When planning to introduce AI systems, company owners and executives have increased efficiency and their businesses' competitive edge in mind. The "AI as a Colleague" seminar held at TUM Campus Heilbronn shows them ways to address potential resistance from their staff and focus on the human perspective during implementation.

From recommendations for streaming series to smart-home applications, we often use AI in our everyday lives without realizing it. What we deem to be natural in our personal lives can lead to insecurity in the workplace. "Introducing AI systems entails a number of emotional reactions," explains Eleni Georganta, Professor at the University of Amsterdam, who gives lectures as part of the "AI as a Colleague" seminar. "In class, we look into adjustments needed for staff, executives, and top management," adds lecturer Dr. Anna-Sophie Ulfert-Blank of Eindhoven University of Technology.

To be able to use the changes brought about by AI as an opportunity in the company, acceptance and understanding must be ensured among all those involved. To guarantee AI is not seen as just a tool but rather as a supportive team member, the focus must remain on humans.

Developing approaches to AI changes for the company

In the concise, one-day course for business executives, owners, and others offered at TUM Campus Heilbronn, participants can learn to reduce uncertainties when dealing with AI in the company. Practical examples provide insight into AI applications at the workplace and address expectations and boundaries. Working in small groups and with guided reflection, attendees primarily learn about approaches to implementing changes, using AI implementation as an example, and to develop strategies for their companies.

High-fiving AI: rethinking collaboration

Moritz Marbach, management trainee at Karl Marbach and Marbach Werkzeugbau in Heilbronn, reflects on the experience: "Working collaboratively allows us to identify sample applications together and obtain new findings. The fact that we come from various industries makes this a truly enriching experience. I am confronted with new perspectives and learn to think creatively. For me, this seminar is an important initial spark." In his opinion, the options to build networks at a regional level are an added value of the event.

Other participants share his view. Gernot Feiel, Chief Operating Officer at producer of sealing solutions KACO in Kirchardt, plans to engage more with Bildungscampus. He says: "Of course, AI is a big issue for local businesses like KACO. The fact that it is actively promoted so extensively here on campus is perfect for us."

The next "AI as a Colleague" seminar will take place on September 22, 2025. More and updated information is available on the TUM Campus Heilbronn website:

Not just temporary

The breakthrough for working from home (WFH) came with the Covid-19 pandemic; AI tools and other modern technologies may help establish it permanently. Dr. Christina Langer of Stanford University conducts research on WFH and is convinced that the future belongs primarily to hybrid work models.

Mobile work is rapidly growing – or at least did during the pandemic. This is the result of an ongoing study co-authored by Langer, postdoctoral fellow at the Stanford Digital Economy Lab, Jean-Victor Alipour, and Layla O'Kane. So far, the team has evaluated 67 million job vacancy postings of German companies to

see if they included a WFH option. One main finding is that the percentage of postings having such an option increased from 4 to almost 20 percent between 2019 and mid-2024.

This aligns with data indicating that during the first peak of the pandemic in spring 2020, more than a third of Germany's employees worked mainly or entirely from home, three times as many as before the crisis. It appears they enjoyed it: According to the results of a study conducted in Germany, respondents accepted a 7.7 percent salary cut for working exclusively from home and a 5.4 percent deduction for WFH two days per week on average. According to VoxEU, four out of ten employees in the U.S. even planned to switch jobs if their employer asked them to return to the office full-time.

Skills shortage drives negotiating power

The pandemic officially ended more than two years ago, and other crises, such as the recession and the rise in unemployment, are now dominating the news. Many leading entrepreneurs often call strongly for a return to the office. Has the situation changed significantly in the work world, pushing employees back to the corporate office? Can they afford to insist on WFH in a time of economic uncertainty?

Langer differentiates her answer: "As part of our study, we also looked into the impact of WFH on skill requirements." Her hypothesis: The higher an employer's negotiating power, the higher the number of skill requirements listed in job postings. If employees are in a stronger position, the opposite happens. While preliminary results showed that companies seem to have more negotiating power, Langer believes specialists in certain fields are still in high demand and oftentimes leave future employers no choice but to take their wishes into account.

Room for improvement

According to Langer, combining office work and WFH brings together the best of both worlds: "Because at home you can concentrate on your tasks and still stay in contact with your team, a lot of companies choose this combination." She expects the trend towards more remote work to continue: "The data we have collected since the pandemic shows that in mid-2024 around 20 percent of job postings included a WFH option."

The potential has not even been fully tapped yet: The results of a study conducted by Langer's co-author Alipour

Dr. Christina Langer's research deals with changes in mobile work since the pandemic – and why hybrid models will change the world of work in the future.

show that 56 percent of professions in Germany could theoretically be practiced from home, but only one-fourth of employees work entirely or partly remotely, according to the latest figures published by ifo-Institut. Langer sees room for increasing the number of days on which employees are allowed to not come into the office: "According to an ifo study, employees would like to WFH 1.8 days a week on average but often are only allowed to do so for one day."

Technology for the home

Another crucial factor for the future of WFH is technological advancement. According to Langer, developments in this field support WFH fans: "The number of patent applications concerning remote work has more than doubled between January and September 2020." In Langer's opinion, video conference platforms such as Teams and Zoom or AI tools that can translate discussions into minutes fall into this category. Also, developments in IT security and cloud services could have a positive impact on the establishment of mobile work.

"It is highly likely that many German companies will continue offering WFH," Langer offers a final prediction. "Hybrid models allow them to increase both productivity and the level of their staff's satisfaction."

Losing control in virtual space?

> There is no doubt that group dynamics and discussion culture differ among virtual, hybrid, and physical meetings.
>
> Lino Ballof

Haven't we all become used to participating in meetings via Teams or Zoom rather than at the office? If we haven't had time to dress and are still at the breakfast table in pajamas, the camera simply stays off. A new reality of work?

Lino Ballof, research assistant at the Department of Accounting headed by Prof. Michael Stich at TUM Campus Heilbronn, also enjoys the advantages of working remotely, from the increased convenience and the time saved to the smaller carbon footprint. "Even before restrictions were introduced during the pandemic, I was a big fan of virtual meetings because they allow more flexibility in my academic and my personal life. Today, I am much more skeptical about whether these presumed convenient formats actually lead to optimal results for me and for others. After many meetings, I think that physical meetings would have been the better option," says the junior researcher at the TUM School of Management.

The main reason for Ballof's shift in perspective is that now he has scientific proof of his initial doubts because he has conducted extensive research into the motives for and consequences of diverse communication and meeting formats – virtual, hybrid, and in person.

Research on supervisory board meeting formats

As part of his current research project, Ballof investigates the influence of technology-based forms of communi-

cation and meetings of supervisory boards of companies in Germany on the effectiveness of these powerful control committees. He focuses on the deliberate manipulation by CEOs of business figures, such as sales and annual net profit – or, in Ballof's words "accounting policy measures that do not necessarily constitute illegal or ethically reprehensible practices."

In addition to parameters defined in a targeted manner for the accounting department such as a deliberately overstated useful life of a machine, measures include project design and business relationships, for example, deliberately delaying promising research projects. The question is whether supervisory boards holding virtual or hybrid meetings can counter this type of manipulation as effectively as when meeting in person.

Through meticulous and detailed work, Ballof has collected large quantities of data from non-standardized corporate documents which provide an in-depth view of the composition and workstyles of supervisory boards that meet in person. Because Germany is a leader in supervisory board transparency in Western countries, an ostensibly unique data treasure trove has been compiled at TUM Campus Heilbronn over the past few years. The data stems from information published by companies according to the German Corporate Governance Code (GCGC) regarding the format of their supervisory board meetings.

Balance between flexibility and effectiveness

Ballof's main finding is that several empirical clues indicate a connection between the formats of supervisory board meetings and the extent of accounting manipulations of balance sheets. Supervisory boards meeting in virtual rooms tend to be able to counter this manipulation less effectively than those that meet on-site. "There is no doubt that group dynamics and discussion culture differ among virtual, hybrid, and physical meetings. We all have been in situations where we prepare differently for interactive presentations than for monologs followed by Q&A sessions in virtual rooms. Also, we have found significant differences between the challenges of leading meetings productively and the meaning of non-verbal communication," Ballof explains.

Another noteworthy finding is that meeting exclusively in person is not optimal for any supervisory board as well. The empirical data suggests that strategically combining physical and virtual meetings and allowing individuals to participate remotely in justified exceptions is the most effective way to curb earnings management practices.

For this reason, Ballof advocates for a flexible approach between flexibility and effectiveness: "Direct personal dialog is paramount to effective supervision. Even though members of supervisory boards tend to be busy people working in an international arena, it is plausible that you can get and motivate the best talent if you don't complicate participation in meetings unnecessarily."

Only strategic combinations promise long-term success

"My primary goal was to use the results of my research to spark an open discussion about strategic work formats for the future," says Ballof. So how do his findings affect the ongoing discussion about working remotely? Should working from home be banned immediately as many company owners demand? "Of course not," says Ballof, "trying to revert to outdated practices and taking a binary approach surely will not bring about the desired results. Instead, companies need to take an honest and unbiased look at their processes and use the strengths of both approaches and use them purposefully."

Between hype and shame

Work is more than just a way to earn a living. It can fill people with pride and boost their self-confidence, or it can embarrass them and be a source of shame. Dr. Gemma Newlands, an expert in AI & Work at the Oxford Internet Institute, investigates the influence of digitalization on the prestige of professions. How are modern technologies changing the world of work and how is this affecting people's self-image?

The question of the value of work initially affected Newlands at a personal level: "I had some really bad jobs and started to take an interest in the topic of work," the scientist recalls. There are objective, functional reasons for working, because most people earn a living this way, she says. If they did not work, society would collapse. Why is work important from an individual, subjective point of view? "It is a crucial factor for self-esteem, and in our modern society, many people's social status is tied to their professional rank."

When people mention their occupation, we inevitably categorize them and assign them a social status: "We agree that a cardiologist has a higher social standing than a pizza delivery worker," says Newlands. However, this says nothing about the dignity of the work, only about the social status and prestige of a profession. Newlands adds that prestige does not automatically mean high social value: "In our research, we found the greatest discrepancy in the profession of a soccer player – it is considered extremely prestigious, but when the apocalypse comes, we can do without soccer players." The pandemic has shown that there are many occupations, particularly in healthcare and social services, that are underpaid and low-prestige, but have high social value. Therefore, despite being strongly correlated, prestige and social value should not be equated.

The stretch and tension of digitalization

Newlands examined the prestige of 76 occupations in the digital economy. Each occupation was compared to an analog counterpart, for example, on-demand Uber drivers and regular taxi drivers. The results were quite surprising: "Almost every job that was related to digital technology or involved an AI technology component was considered less prestigious than the analog alternative," she says, and adds: "In the world of work, many of these new technologies have a very narrow scope of use."

In her research, Newlands investigated how people actively use technologies, including basic models such as artificial neural networks, LLMs, and AI products, in their work environment. She found that there is a stark contrast between the hype and its trivial real-world use, and is convinced that this gap will make the prestige and value of human-created physical, analog, tangible craftsmanship more significant.

> **I see students who are afraid of taking written exams because they are not used to writing without AI support.**
>
> Dr. Gemma Newlands

"AI products are not exclusive, which reduces their value, and this in turn is based on exclusivity," says Newlands. AI mass-produces art, but not everyone can paint an oil painting. In contrast, when Newlands thinks of the new business images companies are designing, she sees a disconnection from reality: "They talk about transforming the organization or the business model for the language model to develop its full creative potential. I would like to challenge this: When have you ever considered redesigning your business model, your organizational purpose, or your workflows to fully harness your employees' creativity?"

If it were up to Newlands, AI would be employed for routine tasks so that human creativity could be fully unlocked, not the other way around. "Humans have this technological dream of human intelligence being used to fully exploit AI and its creative potential." When it comes to recruiting, filtering CVs using AI to pick out keywords is helpful, she says, but if it results in digital employees, the labor market will lose its soul and the diversity of human thinking. "I am not anti-AI. I am just pro-human," Newlands emphasizes.

AI as part of the self

Preserving this diversity is bound to be problematic for the next generation: "I am increasingly fascinated by this sense of shame that young people in particular feel when they recognize the discrepancy between their abilities and the misrepresentation of their abilities," says Newlands. This discrepancy is growing. She is concerned about job applications and CVs created using language models. In her opinion, people are becoming dependent on integrating these systems into work processes, and AI becomes part of the person: "Either they are open about using AI and say, 'This is my digitally enhanced version of myself', or they use it secretly in the workplace, even though it's not officially allowed."

Newlands believes this will have organizational and social implications. She already has spotted the first warning signs: "I see students who are afraid of taking written exams because they are not used to writing without AI support." Therefore, stopping the decline in independent thinking skills is important, she says. "Ultimately, young people still need to be able to write e-mails or birthday cards themselves."

Preserving human decision-making authority

At the Chair of Information Infrastructures at TUM Campus Heilbronn, research assistant Florian Leiser conducts research on hybrid intelligence, the process of collaboration between humans and machines. The focus is on decision-making and decision-making authority, who should make the final decision, and trust.

Leiser recalls one of his first ChatGPT prompts; he wanted to show his grandparents just how much this technology can do: Explain the rules of the traditional German card game Binokel in the form of a poem. Everyone was enthusiastic when the language model responded. However, over time Leiser realized the more precise his prompts and the more specific background knowledge they required, the more often the answers received were inaccurate or partly incorrect. The chatbot made up these answers. This process is referred to as hallucinating. “Generative AI is very similar to humans in this regard. It is reluctant to admit it doesn’t know something,” says Leiser with a laugh.

> **Decisions about what is right and wrong must remain with humans. AI can only assist.**
>
> Florian Leiser

From a user’s perspective, formulating ChatGPT prompts purposefully remains a compromise. How accurate does a prompt have to be for results to be good? How vague does it need to be to allow the language model enough flexibility to generate creatively? “If I am deeply involved in the topic, it is easier for me to assess if answers are plausible. If incorrect information continues to accumulate, I start to doubt the model,” adds Leiser. He likes ChatGPT as an engine for brainstorming. “In this case, small inaccuracies can be overlooked. However, once

I make decisions based on the information provided to me, blindly trusting AI, things can become critical quickly, for example, in politics or medicine."

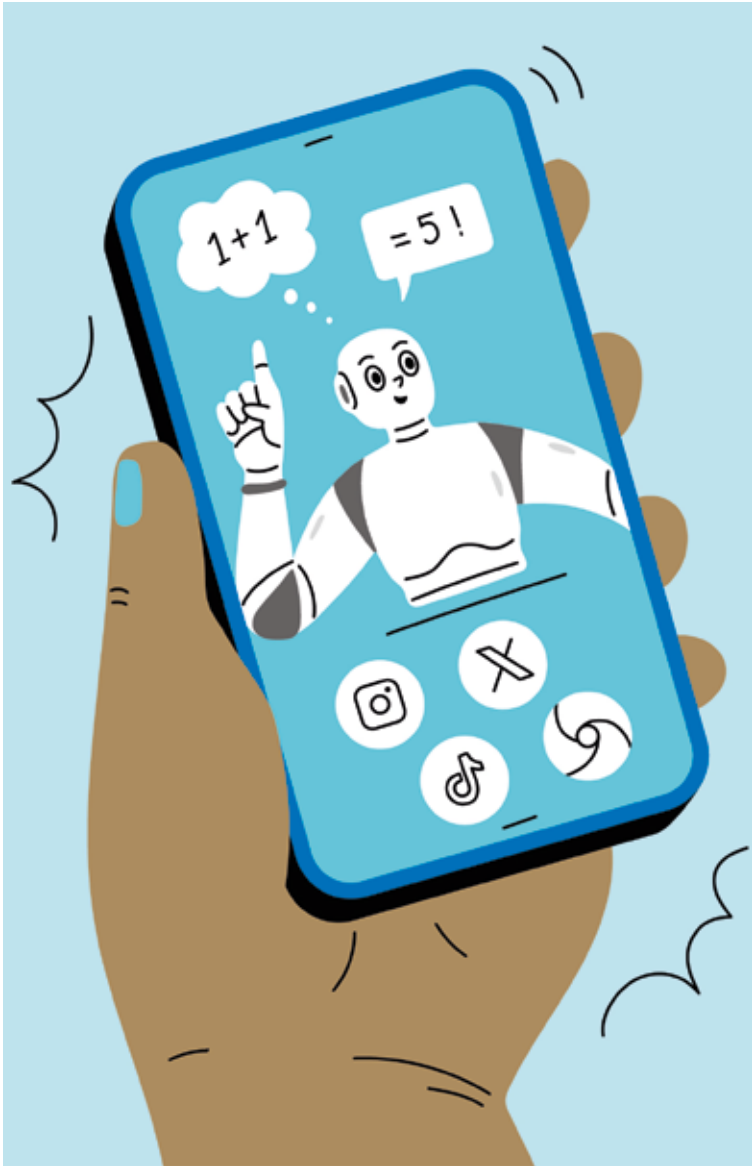
Knowledge-guided machine learning in medicine

As part of the team headed by Prof. Ali Sunyaev, Leiser researches hybrid intelligence, the best possible synergy of human intelligence and artificial intelligence. In line with knowledge-guided machine learning, the goal is to determine the parameters of human decision-making processes and use them in the development of AI. One of the large fields of research is healthcare. Doctors can detect diseases because of their medical expertise, their professional experience and judgment based on experience. They make diagnoses, define treatment plans, and when in doubt, rely on ethical principles. How can machines learn to understand these decisions?

"We intend to train AI so that it delivers better results faster, for example, in cancer detection," Leiser explains. To do this, physicians look at images of tissue. Eye tracking is used to determine where exactly the doctor is looking when he or she decides whether the tissue is cancerous. The knowledge regarding the location is fed into AI. In addition to images, text sources such as doctors' reports and medical guidelines can be used for training purposes. Leiser emphasizes that the aim of his research is not to take decision-making away from medical staff: "Decisions about what is right and wrong must remain with humans. AI can only assist."

Strengthening decision-making authority among youths

Leiser studied Computer Science and Business Information Systems at Karlsruhe Institute of Technology (KIT). As a doctoral student, he became part of the Critical Information Infrastructures research group and followed his group leader Sunyaev to TUM Campus Heilbronn, a home advantage for Heilbronn-born Leiser. "While it is nice to be back in my home town, it is not the only reason I am happy to be here. TUM Campus has an atmosphere of new beginnings; things are happening." Leiser appreciates the collaboration within the team and with companies in the region. For one of his research projects, he is currently in contact with SLK-Kliniken, one of the Heilbronn-Franken region's largest providers of healthcare services.



Beyond healthcare, interest in the area of hybrid intelligence extends to a variety of application fields. The research group considers education as a focal point. The project application has been submitted. Leiser says: "Media literacy is a huge issue in education. If we fail to strengthen the next generations' decision-making authority and allow them to rely entirely on AI for critical thinking, we will have a problem in the long term." He adds: "Humans have thousands of years of knowledge of cultural techniques and problem-solving strategies. We must preserve this knowledge and find ways to develop alongside AI in the future."

Think, Talk, Connect

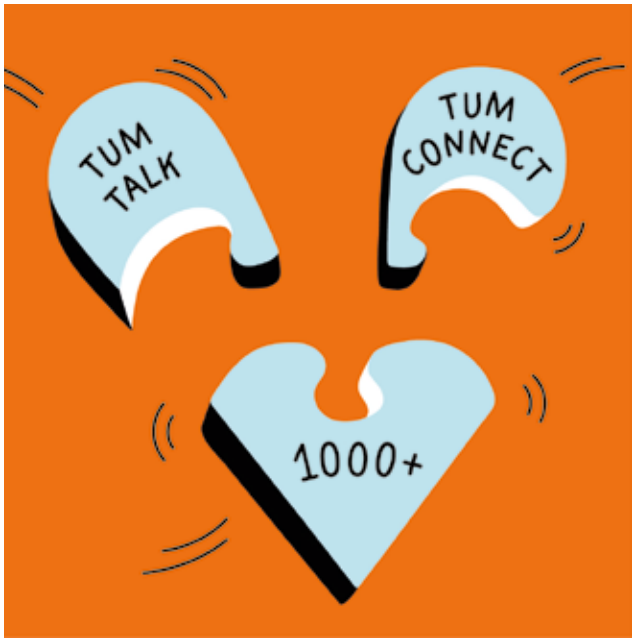
Science and the corporate sector are collaborating more closely in the Heilbronn ecosystem, aligned with TUM's mission as an Entrepreneurial University. Renowned formats such as 1000+, TUM Connect, and TUM Talk help connect stakeholders from both academia and industry, and strengthen the region.

1000+: students solving real business problems

Forty student teams, thirty-five small or medium businesses, five days – these are the conditions for project week 1000+, where students in master's programs in all TUM departments tackle real-life business challenges. The task the team received from Schwarz IT, the IT system company of the Schwarz Group, was to develop a tool that automatically checks the company's project management software for errors. Two students came up with a solution and programmed an application that significantly accelerates tests. Business Consultant Inna Wallbaum was excited: "They provided us with a solid infrastructure that we will now develop further and can actually use."

The team supporting Münzing Chemie was equally successful. Four students developed a tool for appraising innovations and, in addition, suggested the company focus more on biotechnology and biodegradable products. At IT services provider Bechtle, the team dealt with the question of fair payment for consulting services using AI trained by staff members. Pit Ogermann, Head of AI Research and Strategy, praised the concept as "a good starting point for further discussion" (read more on AI at Bechtle on p. 10).

f.l.t.r.: Ines Söhner (Business Consultant Project Management & Risk Management), Jose Alexis Alvarez Olivares, Mohamed Ghayad, Inna Wallbaum (Business Consultant Project Management & Risk Management), and Tim Hirschmann (Team Head BC Sustainability/Project Management) during the final presentation at Schwarz IT



The students also consistently provided positive feedback. The experience has allowed TUM to come one step closer to its long-term goal to place 1,000 talented people at 200 companies. The next project week 1000+ is scheduled for April 2026. Applications are open from July to November 2025.

Find out more about 1000+ at *https://1000plus.cit.tum.de*

TUM Connect: four stages for topical issues

Vice President of TUM Campus Heilbronn Prof. Ali Sunyaev launched the fifth edition of TUM Connect with the words: “The stage is yours.” Inspired by public speaking traditions like Speakers’ Corner in London’s Hyde Park, four podiums were installed to foster dialog between science and companies in the region.

Stefan Wagner, Professor of Software Engineering at the TUM School of Computation, Information and Technology at Campus Heilbronn (read the interview on p. 6–9), sparked a discussion about whether generative AI can replace humans as workers – or whether humans still are needed as sources of oversight and creativity. Dr. Dina Barbian (you can find the article about her on p. 16/17), Managing Director of eco2050 Institute for Sustainability, invited the audience to think about ways to make sustainability part of digital systems and ensure digitalization aligns with sustainable goals. The focus of the area around the podium of strategy consultant Dr. Christoph Geier was exploring future scenarios in the context of digital transformation. Business Coach Dr. Karl Rabes advocated for a paradigm shift in innovation in Germany, from the perspective of customers’ needs.

Find out more about TUM Connect at *https://chn.tum.de/de/events/tum-connect*

Doubling up: Rethink.Mittelstand and TUM Talk

In cooperation with the ZEIT Publishing Group, TUM invited more than 300 representatives of SMEs, start-ups, companies, and the science sector to Bildungscampus Heilbronn on October 30. For the first time, TUM Talk was the final session of the one-day conference titled “Rethink.Mittelstand – Erfolgreich durch Machen (successful through action)”. The focus was on how AI can help make future-proof business models.

Over the course of the congress, participants discussed the impact of digital technologies and AI on generating economic or customer value, ways for SMEs to collaborate with TUM research teams in Heilbronn, and future developments and challenges.

Science meets business: TUM Connect encourages exchange and fresh ideas.

The question was picked up in the evening during the fifth TUM Talk that followed the motto “The future does not wait for us!” The experts on the podium explored ways to stay confident despite the polycrisis and establish the right foundation. “Crises have a way of revealing unexpected resilience in individuals and in companies,” said Prof. Dr. Dr. h.c. Helmut Krcmar, long-term Representative of the President for TUM Campus Heilbronn, who moderated the networking event. In his welcome address, TUM President Prof. Thomas F. Hofmann underlined, “The world belongs to those who want to create.”

Find out more about TUM Talk at *https://tum-talk.de*

f.l.t.r.: Prof. Daniel Cremers (Chair of Computer Vision and Artificial Intelligence at TUM), Christine Steger (Managing Director and Owner of Mann + Schröder), Prof. Helmut Krcmar, Prof. Thomas F. Hofmann, Nicole Büttner (investor and cofounder of Merantix Momentum), and Dr. Gerald Karch (CEO of the TII Group)

Empowering the future through knowledge

Lucas Senghaas, a student of Management and Technology at TUM Campus Heilbronn, spent six weeks in Mozambique, where he helped in a bakery that provides food for a whole village. His experiences abroad may have contributed to him being selected for a Deutschlandstipendium in 2024/25 because community involvement is a key selection criterion.

In addition to his hometown of Meerbusch near Düsseldorf, Senghaas' life has been influenced by Heilbronn, Mozambique, and Singapore. In Heilbronn, the 21-year-old is studying for a bachelor's degree in Management and Technology at TUM School of Management. "The university's friendly and familiar setting, the closeness with professors, the opportunities to learn in small groups – all that has a lot of advantages," he says and adds, "the entrepreneurial mindset that already is anchored in TUM's DNA, seems to be particularly pronounced in Heilbronn."

In Mozambique, Senghaas assisted in a bakery for six weeks in 2023. The business is operated by the "Brot gegen Not" foundation and provides an entire village with food. To counter the financial challenges the bakery was facing, Senghaas optimized processes, reduced costs by reducing baking durations, and ensured more efficient energy and water consumption. In addition, he created an additional revenue stream by selling high-quality bread to embassies and hotels.

Strong networks with the corporate sector

The contrast with Singapore, the third location that has had a lasting impression on Senghaas' life, could not be more striking. He spent one semester last year in this cutting-edge city-state in South-East Asia. At the Business School of the National University of Singapore (NUS), which has close ties with TUM Campus Heilbronn,

TUM student Lucas Senghaas showed social engagement in Mozambique.

he found several parallels: "NUS also encourages small study groups of 20 to 30 people." The strong networks with the corporate sector also reminded him of TUM. "Many lecturers are former bankers or have founded their own companies."

While in Singapore, Senghaas was informed he had been selected as a holder of the Deutschlandstipendium – and learned that his scholarship is sponsored by a prominent person: Prof. Dr. Dr. h.c. Helmut Krcmar, Founding Dean and long-term Representative of the President for TUM Campus Heilbronn. "Being sponsored by such a well-respected person means a lot to me. His support gives me confidence and motivation," says Senghaas.

What does he plan to do with the scholarship? Senghaas does not have to think twice: "I want to give the money to the children of Mozambique. Even a small amount of money can make a big difference there – and I would like to return and help again."

The Deutschlandstipendium is awarded to students who excel academically and in societal and social engagement. Recipients are given 300 euros per month paid in equal shares by the Federal Government and private sponsors such as companies and foundations. TUM Campus Heilbronn joined the program in 2022/23 and currently supports 23 students (in total, 906 are sponsored by TUM). Contact at TUM Campus Heilbronn:
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(Manager Forums & Networks)

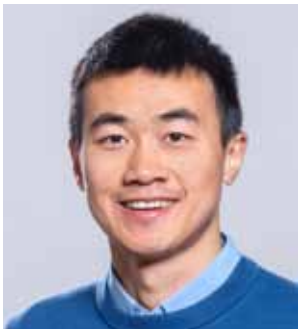
TUM Campus hosting the world

TUM Campus Heilbronn professors value the input offered by guest lecturers to introduce students to practice-oriented approaches and new perspectives. Here, they explain how their guests enhance their lectures.

Luise Pufahl

Professor of Information Systems

"I invite one or two guest lecturers to each of my classes to highlight the importance of the respective topics and offer insight into the research conducted by external researchers in Germany and abroad. Students learn how theoretical methods and concepts are applied in the field – and they ask a lot of questions. My guests included representatives of renowned corporations such as SAP, start-ups and universities around the world, and colleagues of TUM in Garching. I particularly remember a discussion in my Business Process Management lecture with Prof. Jana Rehse of the University of Mannheim about whether LLM-based process modeling should already be used in academia today."



Chunyang Chen

Professor of Software Engineering & AI

"Guest lecturers share their industry experience and offer networking opportunities. They introduce students to the latest developments, practical challenges, and diverse perspectives. My 'AI in Software Engineering at Google' course was attended by Dr. Alexander Frömmgen, an experienced developer of AI-based coding tools. Overall, students show great interest in guest lectures and give very positive feedback."

Jingui Xie

Professor of Business Analytics

"I invite mainly data scientists from the healthcare and retail sectors so they can share with my students their experiences with data infrastructures, forecast models, and data-driven strategic decision-making. Dr. Armin Müller, Global Head of Data & AI at Kaufland International, gave a speech on this topic. In my opinion, guest lecturers provide valuable insight into industry trends and challenges that go beyond academic literature and deepen students' understanding of practical applications. The format is popular among students because it encourages exchange with experts and allows them to ask questions about career paths and the tools used."

Carsten Trinitis

Professor of Computer Architecture & Parallel Systems

"I believe it is important for students to gain insight into actual practices in the industrial sector and expand their perspectives early in their studies. Guest lectures can be good opportunities to establish important contacts for internships or theses in the future. My guest lecturers have included representatives of Advanced Micro Devices (AMD) and NVIDIA. Both companies develop processors and accelerators for computers. Because students found the lectures with AMD and NVIDIA particularly fascinating, I plan to invite staff from these companies again in the future."

Learning from role models

Managing a company and leading it strategically toward future success. Pursuing a career and filling it with passion. During the CEO Leadership Series hosted by Prof. Chengguang Li in the summer term, accomplished executives explained how that can be done.

From fashion to media: The CEO Leadership Series hosted by Prof. Chengguang Li gave top executives from around the world opportunities to talk with students about entrepreneurial mindsets, innovation, and leadership.

Every semester, his Chair of Strategic Management organizes a series that provides students with insights into the careers of international CEOs. In addition to practical knowledge, participants benefit from the executives' valuable experience for their own professional future.

The list of high-profile guests again was long this summer term. From May to July, executives from retail, media, and automotive industries were represented on the podium. A particular focus this year was on the fashion industry.

The event began with a keynote by Antonio De Matteis, CEO of luxury fashion company Kiton headquartered in Naples, Italy. De Matteis has led company growth and expansion into international markets as well as research and innovation in textile development. Kiton suits and coats are made of high-quality textiles including vicuña wool, deemed to be the most luxurious material in the world. Other top-tier managers of the global fashion industry included Paolo Barbieri, CEO of Elite World Group modeling agency.

Meeting successful businesspersons and private individuals

The representatives of the fashion industry were joined by Prof. Kai Gniffke, Director of Südwestrundfunk (Southwest Broadcasting) and former Editor-in-Chief of ARD (Association of Public Broadcasters in Germany), who discussed the challenges journalism is facing in a time of digital transformation. Female expertise was brought to stage by Valerie Bures-Bönström. The current DACH Head and Partner of the European venture capital company XAnge was co-founder and CEO of the fitness chain Mrs. Sporty, which now has more than 200 gyms.

In addition, executives from the consulting, retail, and industrial sectors answered students' questions. Among them were the following:

- Dr. Peter Gassmann, CEO of strategy consulting firm Strategy&
- Erich Harsch, CEO of home improvement store chain Hornbach and former CEO of drugstore chain dm
- Ralph Bast, CEO of Aurora, a manufacturer of heating and air conditioning systems and components for vehicle series
- Prof. Ferdinand Dudenhöffer, founder of the Center Automotive Research (CAR)
- Prof. Siegfried Russwurm, Chairman of Thyssenkrupp and former President of the Federation of German Industries (BDI)

The fact that students have the opportunity to learn about impressive careers and get to know individuals in those careers makes the CEO Leadership Series even more appealing. TUM Campus Heilbronn will continue the series in the next semesters with other notable guests. The next series will take place in the winter term 2025/26.

Imprint: Mindshift is a publication of TUM Campus Heilbronn of the Technical University of Munich
Publisher: TUM Campus Heilbronn, Bildungscampus 9, 74076 Heilbronn
Responsible according to the press law: Prof. Dr. Ali Sunyaev **Conception:** Kerstin Besemer
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Production: Meramo Verlag GmbH, Gutenstetter Str. 2a, 90449 Nürnberg
Design: Viviane Schadde **Printing:** herrmann GmbH, 92289 Ursensollen **Circulation:**: 1,900 copies
Image sources: Illustrations Doro Spiro: cover, back cover, p. 2, 4/5, 9, 10, 15, 19, 22, 29, 30, 35
Photos: p. 3: Terzo Algeri/Atelier M; p. 5: Maxim Dinshtein; p. 6: TUM/Uli Benz; p. 7: TUM/Andreas Heddergott; p. 11: Behrendt & Rausch; p. 12: TUM/Eckert/Heddergott; p. 14, 18, 32: private; p. 17: Giulia Iannicelli; p. 20: AdobeStock/metamorworks; p. 21: Benjamin Widmayer/Dall-E; p. 23: Nadine Stegemann; p. 24: CV Pics Studio; p. 27: Oxford Internet Institute; p. 28: TUM/Benjamin Widmayer; p. 30, 31, 33, 34: TUM Campus Heilbronn
Status: June 2025

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