

Mindshift

Impulses for change – TUM Campus Heilbronn

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Dear Readers,

In late 2024, it was time for me to bid farewell to TUM Campus Heilbronn after six fulfilling years.

Since beginning in the winter semester 2018/19 with just 46 students, our TUM Campus Heilbronn has become a dynamic institution and home to more than 1,000 students. Today we offer a range of degree programs including Management and Technology, Management and Digital Technologies, and Information Engineering, as well as the master's programs in Management and Data Science, and Information Engineering.

In 2019, we succeeded in bringing Dr. Gudrun Kiesmüller on board as the first professor for our young campus. That same year, it was decided to extend the courses offered at the School of Management and the School of Computation, Information and Technology; today, economics and information engineering continue to shape TUM Campus Heilbronn's academic profile.

Simultaneously, we started building international partnerships with renowned universities, including Stanford University, HEC Paris, the Oxford Internet Institute, the Hebrew University of Jerusalem, ETH Zurich, and the National University of Singapore. These alliances strengthen the global network and visibility of Bildungscampus Heilbronn. In 2024, TUM's Institute for Advanced Study awarded two Dieter Schwarz Fellowships for the first time, along with the first Dieter Schwarz Courageous Research Grant. The recipients were researchers from Oxford, Melbourne, and MIT who will address fascinating topics together with their colleagues at TUM.

My thanks go to the Dieter Schwarz Foundation for making this project possible and to all the staff and supporters in Heilbronn and Munich. Together we have made TUM Campus Heilbronn a pioneer in the fields of management, digital technologies, and partnerships with family enterprises.

I have found a worthy successor in business information scientist Prof. Dr. Ali Sunyaev. He will continue walking proven paths and engender fresh momentum. To have supported the development of TUM Campus Heilbronn – for the digital age – to this point fills me with pride. “Every goodbye is the birth of a memory” – with this thought, I look back on these past years with gratitude. I wish TUM Campus Heilbronn, its staff, and in particular my successor, much success, drive, and foresight.

Prof. Dr. Dr. h. c. Helmut Krcmar

Managing Director

Die TUM Campus Heilbronn gGmbH, founding dean (2018–2020) and long-time representative of the president for TUM Campus Heilbronn



Riding the data stream towards innovation

Be it in communications, healthcare, or business processes, data permeates our daily lives. It shapes how we interact, work, and make decisions. As the driver of the modern economy and the key to innovation and efficiency, data is the center of this issue of Mindshift, which outlines how data strategies pave the way to a digitized, sustainable future.

“Data is the backbone of the digital world. Without data, there would be no artificial intelligence (AI), no automated processes, and no smart systems that can revolutionize the way we live and work,” says Prof. Dr. Helmut Krcmar, founding dean and long-time representative of the president for TUM Campus Heilbronn. “Data pervades all areas of our lives; it is the invisible nervous system that develops connections and initiates processes. Data drives digital transformation and creates new opportunities over and over again.”

This issue of Mindshift revolves around the transformative potential of data. Similar to nutrients flowing through a tree’s roots, data unfolds its impact by driving innovations in diverse areas of life and benefiting people – if

used purposefully. The resulting progress underlines that data is fully effective only when utilized responsibly and developed continuously. Only then can it serve society.

Data-driven research and practice

At TUM Campus Heilbronn, the Center for Digital Transformation (CDT) has largely contributed to raising awareness of the importance of data-driven strategies. Looking back on the CDT’s five years of existence, it becomes clear that under the direction of Prof. Dr. Gudrun Kiesmüller and Prof. Dr. Sebastian Müller it has advanced a broad spectrum of research and practice-related projects that illustrate how companies can utilize data effectively for long-time success. Prof. Dr. Krcmar summarizes: “The CDT strives to merge the

latest findings from research and the field to help businesses design their digital transformation successfully.” This approach will continue to point the way for years to come.

One example of how academic expertise can be transferred to entrepreneurial action is the Deeplify start-up. With the support of TUM Professor Dr. Maribel Acosta, students developed an AI-based quality management software.

Data as a strategic factor for success

The Catena-X initiative strikingly demonstrates how secure and controlled data exchange among companies in the automotive industry can lead to new synergies. Alexander Buresch, CIO of the BMW Group, and Dr. Jürgen Sturm, CIO of ZF, two member companies of Catena-X, share insights into their strategic work.

These developments are not limited to the automotive industry. Consumer goods producer Procter & Gamble utilizes data to personalize customer journeys and develop relevant marketing strategies. Even smaller companies such as Eskon in Neckarsulm rely on targeted data analysis to optimize their corporate management and respond better to customers’ needs. Martin Buchwitz, Managing Director of Packaging Valley Germany e.V., also highlights the essential role data plays in digitization and is developing an exchange platform for companies.

Collecting data is one thing, analyzing and utilizing it purposefully is another. According to Prof. Dr. Greg Taylor of the University of Oxford, “quality over quantity” makes all the difference. In his opinion, to create actual benefit the increasing flood of data must be filtered and evaluated in terms of its usefulness. “An effective data strategy extends beyond collecting data; it must include the extraction of relevant information from this data,” Prof. Dr. Krcmar sums up.

In this context, Dr. Edeltraud Leibrock, Global Managing Director at Roland Berger, advocates for liberating data from the silos and integrating it efficiently. According to



Prof. Dr. Helmut Krcmar

her, AI is the key to leveraging the potential of data, and sustainable data storage remains indispensable.

Data and daily life: focus on people

Data has the potential to improve not only business processes, but also people’s everyday lives. Prof. Dr. Chunyang Chen of TUM Campus Heilbronn develops tools such as “HintDroid” that make mobile apps more accessible to people with disabilities by optimizing assistance texts using AI. How data can help prepare climate models or simulate the functions of the human heart and thus prevent cardiac diseases, explains Prof. Dr. Hartwig Anzt of TUM Campus Heilbronn.

In addition to technology and physical health, people’s mental wellbeing is important. In ever faster-paced environments, employees can feel overwhelmed and fall ill. At TUM Campus Heilbronn, Dr. Simon Senner holds seminars on mental health at the workplace to explain

how executives can counteract this trend and create a positive sustainable work culture. Another example of the close ties between data, technology, and wellbeing.

Data protection as a foundation for trust

Fostering cooperation among people and raising awareness of common values also is the goal of Europe Week organized at TUM Campus Heilbronn. Against the background of an increasingly globalized economy and the growing importance of data streams, committing to upholding common values and ethical standards is imperative.

Protecting personal data in particular is essential. While the European Union’s General Data Protection Regulation stipulates clear benchmarks for the handling of sensitive data, data protection encompasses much more than adhering to laws. “Data protection is a central factor for success,” says Prof. Dr. Krcmar. “Companies committed to protecting their customers’ data can strengthen trust in their services and at the same time stand out from their competitors.”

Dr. Alena Buyx, Professor of Ethics in Medicine and Healthcare Technology at TUM, explains that increasing users’ faith in digital technologies is conditional upon implementing minimum global ethical standards, in particular for health-related data.

Data and shaping a sustainable future

Observing data protection and principles of sustainability while processing data may contribute to a responsible and sustainable future. “Sustainability is mandatory in every phase of data processing, from storage to processing and utilization,” says Prof. Dr. Krcmar. The team at the Supercomputing Centre (LRZ) headed by TUM Professor Dr. Martin Schulz has demonstrated that simulations on supercomputers and climate protection are not mutually exclusive, and how sustainable data management works with the employment of resource-saving technologies. Since 2018, the LRZ has been operating a high-performance computer that helps with resource conservation thanks to innovative cooling techniques and intelligent scheduling.



TUM Campus Heilbronn, a competence center for data-driven innovations

In addition, edge computing and other technologies facilitating decentralized data processing show great potential for energy-efficient development. Prof. Dr. Carsten Trinitis of TUM Campus Heilbronn sees enormous opportunities for reducing energy consumption in this field.

Overall, it becomes clear that the full potential of data as a driver of digital transformation can be tapped only when purposeful strategies are in place that combine innovation, efficiency, and ethical responsibility. Prof. Dr. Krcmar firmly believes that this can be brought to fruition: “Our systems are becoming increasingly powerful, and we will be taking additional steps towards increasing sustainability. I believe we always will opt for the good at the end of the day. We only need to determine what we utilize data for and how we can design the process responsibly.”



Drivers of digital transformation

Companies using data and artificial intelligence (AI) effectively have a significant competitive edge. Soon, such skills will be crucial to the survival of globally acting companies. Alexander Buresch, CIO of the BMW Group, explains how the company tackles AI-related challenges and the importance of having a comprehensive data strategy.

In 2017, the BMW Group introduced a comprehensive data strategy that follows the motto *data at your fingertips*. In addition to enabling all staff members to access data easily, the goal of the strategy is to increase efficiency, foster innovation, and provide a basis for the widespread utilization of AI use cases. Three factors are essential:

- Strategic use of data: We are expanding our understanding of data by not only analyzing it but also leveraging it actively with the objective of adding value for our customers and our company processes. This is how we recognize data as a strategic company value.

- **Uniform data structures:** From creation to deletion, we ensure our data structures are uniform and consistent to promote cooperation across business units.
- **Data access and quality:** We guarantee optimal access to and high quality of data to facilitate quick and precise decisions. To this end, we deliver the right data at the right time to the right location – for a suitable purpose.

Technology infrastructure and AI platform

Because data is an indispensable part of the development of AI use cases in our company, we employ technologies such as the Cloud Data Hub (CDH). With its streaming and data warehouse functions, this data lake based on Amazon Web Services (AWS) facilitates both analytical and operational use cases by amalgamating relevant data centrally. This makes it possible to prepare data for GenAI and to use it throughout the company via 'Chat Your Data'. Today, CDH delivers more than 11 petabytes of data via various analysis tools and manages over 14,000 S3 buckets and more than 7,000 datasets in a centralized data catalog. Based on AWS Glue, this catalog currently supports more than 1,000 use cases. This makes CDH a secure global infrastructure that allows our staff to use data efficiently and in a compliant manner, thus contributing directly to the BMW Group's power of innovation.

Our company's AI platform offers a high-performing infrastructure for developing, delivering, using, and managing AI models and is connected seamlessly with CDH. With our API First approach, developers can implement and integrate large language models (LLMs) easily. The BMW Group AI Assistant is an accessible self-service and low-code platform every staff member can use to develop AI applications instantly. In addition, the associated Shared App Store grants secure and compliant access to AI applications.

Production and simulation with precision

Our data and platforms enable us to implement a series of applications such as digital twins. These are virtual reproductions of physical objects or processes which help us plan our sites and production processes more

precisely. We also use digital twins in computer simulations of crash tests and to optimize the aerodynamics of our vehicles. Thanks to these simulations, we can make exact forecasts regarding vehicle performance under diverse conditions as early as the planning stage, which reduces the number of real tests and thus development times.

Shaping the future with data and talent

Another key part of the BMW Group's data strategy is Catena-X, a platform that facilitates secure data exchange across the company along the entire supply chain. Catena-X is a standardized solution for efficiently sharing data, integrating it, and using it strategically – with a focus on sustainability, quality management, and supply reliability.

Our customers benefit from this data utilization as well: They experience individualized, highly personalized customer journeys that meet the highest security and data protection requirements.

To advance these data-driven innovations further, we rely on fresh impetus: The BMW Group is always on the lookout for young talent to share new perspectives and embrace change to actively shape the mobility of the future and our company's digital transformation. ●



Alexander Buresch, CIO of the BMW Group

Creativity in collaborative data rooms

Holistic data strategies help companies remain innovative, boost productivity, and make supply chains more resilient.

They also have the ability to transform entire sectors.

The automotive industry has created Catena-X, a collaborative data ecosystem. Dr. Jürgen Sturm, Chief Information Officer (CIO) of founding member ZF, outlines the details.

The automotive industry has a global network. Hundreds of companies, including suppliers, contribute to the production of every single vehicle. To keep the supply chain stable, their processes have to dovetail precisely. This is of particular importance in production, where delivery processes must be *just in time* or *just in sequence*.

As the CIO of global technology company ZF, Sturm recognizes the central role data plays in all this: “The goal is to generate added value from data and make things better, faster, more secure, or more sustainable in real time – not only for our products and solutions in the market but also for the workflows in our company. We use master and movement data to increase the efficiency and effectiveness of business processes along the supply chain.”

Collaborative software development with Catena-X

For three years, ZF has been sharing its experiences with its own data strategy with a network the company itself helped establish: Catena-X, an open, decentralized data ecosystem designed to facilitate secure, controlled data exchange among suppliers, car manufacturers, service partners, and recycling companies. “We decided in favor of a decentralized approach,” says Sturm, “in which each company has access only to data concerning its respective direct partner along the supply chain – one up, one down. This is how misuse is prevented.”

The CIO is particularly enthusiastic about Catena-X’s open-source approach, which allows partners in the network to work on applications based on joint specifications, technologies, and principles of exchange. “That is a novelty,”



Dr. Jürgen Sturm, CIO of ZF

emphasizes Sturm. One example: An application and a pertaining set of rules that help record and reduce CO₂ emissions across the entire vehicle production and supply chain.

Thinking ahead: cross-industry data rooms

Once Catena-X was created, the Manufacturing-X initiative was launched, backed by the corporate, science, and political sectors, with the goal of establishing a digitally connected industrial sector. Other data rooms based on the same technologies are underway. This could allow for data exchange across industries including mechanical and plant engineering, energy, chemical and pharmaceutical, transportation, mobility, or healthcare in the future. Sturm is certain: “Data rooms that today are separate could progressively become connected, and new applications could be developed for overarching benefits.” ●

Of data, toothbrushes, and brand building

Procter & Gamble (P&G) sees data and consumer insights derived from it as fuel for innovation. A targeted data strategy boosts efficiency, strengthens brand building, improves the marketing of toothbrushes, detergents and other products, and increases customer satisfaction – a clear advantage in a data-driven world, as CMO DACH Kristina Bulle knows.

Over the past few years, consumer goods giant P&G has invested large sums in data analysis and utilization. “We work with data on a daily basis,” says Chief Marketing Officer Bulle who has worked for the company for almost 30 years. P&G uses data at diverse levels, from household panel data to modern customer relationship management systems.

The data enables the company to analyze consumer behavior and predict trends as well as optimize marketing campaigns in real time by continuously evaluating their performance, the sales figures, and market developments. “In peak times, we access this data hourly,” Bulle reports. The goal is to prepare targeted and relevant offers, for example, to up-trade from a basic to a premium toothbrush model. “Our predictions regarding the success of products and messages with specific target groups have become much more stable.”

Algorithms, AI, and smart strategies

To fine-tune its data strategy, P&G relies on artificial intelligence (AI) in the form of large language models (LLMs) and on algorithms. Bulle explains: “They help us detect patterns in large data volumes and create synergies the human brain could not capture alone.” For example, algorithms calculate the optimal times and channels for placing TV commercials taking into consideration factors like the weather, holidays and viewer rates. The company examines continuously whether these technologies are more efficient than traditional approaches.



Kristina Bulle, CMO DACH of Procter & Gamble

Moreover, P&G ensures that campaigns are effective and do not entail unnecessary expenses or squander resources. Bulle emphasizes: “Our focus is on eliminating waste from the digital supply chain.”

Data protection and data democracy

Keeping data secure and upholding ethical standards are also priorities. “Trust is a valuable asset, so we do not compromise when it comes to quality, brand safety, and data protection,” says Bulle. For this reason, responsibility for compliance and for data protection is separated clearly from business development. A dedicated department ensures that all activities meet legal requirements.

The company pays special attention to democratizing data so that it is accessible to all staff members. Bulle adds: “For the next generation of P&G employees, the ability to read and interpret data will be a key competence. We invest in these skills continuously. Data collection at P&G is not an end in itself; our aim is to acquire clear insights that are conducive and relevant to people’s needs.” ●

A helpful voice from the smartphone

Using apps can be challenging for people with visual impairments. Dr. Chunyang Chen, Professor at TUM Campus Heilbronn, developed “HintDroid”, a tool that could help.

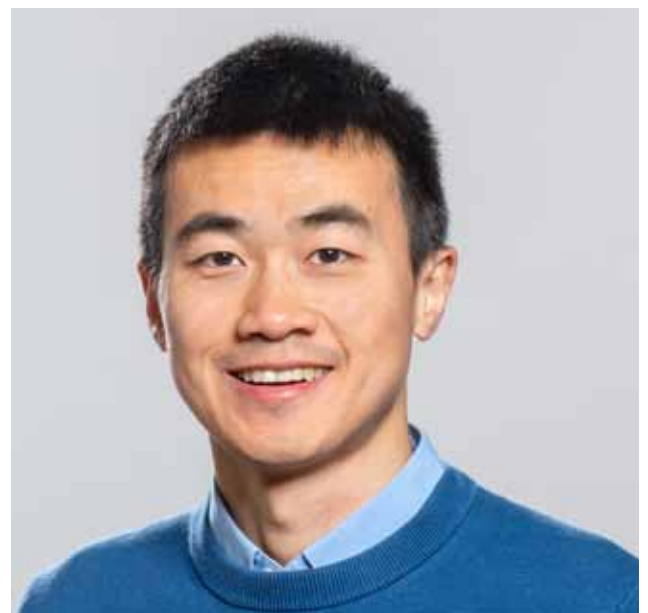
Chen, now Professor of Software Engineering and AI at TUM Campus Heilbronn, began his research on mobile apps nearly six years ago at Monash University in Australia and made an interesting discovery: a comprehensive policy on Google’s website that urges software developers to ensure their apps have a general level of user-friendliness. One group in particular is to benefit from these rules: people with disabilities.

Information scientist Chen extended his research, read numerous blog entries, and watched tutorials on the topic. Then, he simply closed his eyes and tried to use his smartphone as a blind person would. Relying fully on the phone’s hint texts, that is, assistance notes users can have read to them automatically for support with operating their devices, he quickly learned: “It was truly difficult. Every time I tried to scroll or open another page, I made mistakes.” He found that many hint texts failed to meet the needs of the target group for which they were designed.

Challenges for the visually impaired

The consequences can be dire: The simple act of registering for a portal can be stressful for users with visual impairments if there is no hint as to what information to provide in an empty field. “When setting a password, they should be instructed about the minimum length and

whether numbers and special characters are required. Otherwise, they enter a very basic password that makes it easier for their accounts to be hacked,” Chen explains. Without any hints regarding the types of words they can enter, search bars are also challenging for visually impaired users to fill out.



Prof. Dr. Chunyang Chen is conducting research on improving digital inclusion.

Learning to better understand needs

Set out to initiate change, Chen found a group of researchers at Monash University who develop hardware for the visually impaired. After discussing the issue, Chen decided to contribute software. He remembers: “This group had access to a network of people with visual impairments. I got to talk to them and learned to better understand their needs.” Also, Chen’s co-workers contacted visually impaired students at a school for people with disabilities in his home country, China. “We asked them about the challenges they encounter when using specific apps.” Another problem became apparent: “Screen readers are unable to detect symbols in software. Developers should add an attribute, for example, ‘There is a like button; clicking on it is like a thumbs-up’.” Unfortunately, many developers have difficulty putting themselves in the position of users with disabilities. “If they do not have a team that supports people with visual impairments specifically to fall back on, they cannot develop software accessible to them,” says Chen.

The tool created by Chen and his team could provide relief: HintDroid is an AI-supported software for generating hint texts. “We scan new software before launching. Assessments are conducted by an algorithm. Problems we encounter are solved using AI models that predict the best solution. We make a recommendation to the developers, who then update the respective software before it hits the market,” Chen explains.

Huge accolades for years of work

To ensure the hint texts generated fulfill their purpose, they have been tested automatically and by visually impaired people. Chen appreciates the open feedback his team receives from testers. At last year’s ACM CHI Conference on Human Factors in Computing Systems held in Honolulu, the world’s most renowned conference



in the field of human-computer interaction, the professor and his team were rewarded with the Best Paper Honorable Mention Award for their publication on HintDroid.

Chen’s hard work is being recognized and appreciated. But what will it take to get HintDroid to market? According to Chen, there are two options: “We provide the tool to the developer community as an open source and ask them to test it to improve their software. Or we contact Google so our app can be distributed via the Google Play Store.” ●

Google published a policy for developing accessible apps:



Strong together at Packaging Valley

Sustainability and handling sensitive data are just two of the major challenges Germany's packaging industry is facing. Packaging Valley is an organization that is actively helping shape digital transformation. CEO Martin Buchwitz provides insights into current developments.

Located in the Heilbronn-Franken region and the Stuttgart business area, Packaging Valley has brought together manufacturers of packaging machines and providers of associated automation services since 2007 to drive digitization. "Packaging Valley is based on voluntary membership and is not merely a network, but a platform for exchange, innovation, and shaping the future. We want to support companies with their data strategies," says Buchwitz.

As digitization progressed, Packaging Valley took a closer look into data utilization. Its milestones include an EU-financed virtual reality (VR) center that provides member companies with access to VR and digital twins. "It gave members the opportunity to model their machines in a 3D environment, an important step towards data-driven production," he adds.

Data sovereignty – an impediment for innovation?

What remains is the question of data sovereignty. Buchwitz explains: "Many machine manufacturers are justifiably hesitant to share their data because they are concerned about losing their competitive advantages." At the same time, producers demand an increasing amount of data to increase efficiency.

However, there are signs of change: "We have noticed growing awareness of the need for a more comprehensive utilization of the data accruing in machines and plants, especially through artificial intelligence (AI) and Industry 4.0 initiatives." In addition, the increased competition from Asia is transforming mindsets in Germany's (packaging) machine industry.



Driver and networker

Packaging Valley identifies these trends and proposes potential solutions. Focus is not on the organization's own technological developments; the cluster is more about offering workshops, holding network meetings, giving trade fair presentations, and collaborating with universities. Buchwitz reports: "One of our special formats is the Makeathon. The companies further develop the data-driven projects created there subsequently in-house. An example is a digital logbook for packaging machines, which even led to a patent application." Packaging Valley also distributes information about research departments and initiatives such as the Open Industry 4.0 Alliance.

Sustainability is another focal point: Technological innovation and data are pivotal to making machines more sustainable and to processing environmentally friendly materials. The organization's success is reflected in the growing number of members. "The companies' appreciation for the network is our biggest motivation," says Buchwitz. ●

Protective wear meets data power

Work pants, safety footwear, safety vests – and comprehensive data: Eskon of Neckarsulm integrates know-how from intelligent data utilization into its development of functional workwear.

For almost a decade, Eskon has pursued a data strategy that first and foremost is about individual analyses of the company's own database. "In principle, the data is already there," explains CEO Elvis Seretinek, "but we have not always succeeded in capturing it where we need it or in the required form." This realization gave way to targeted data analyses that have become integral parts of corporate management. The goal is to utilize data in a purposeful way to understand better customers' needs and increase the company's efficiency.

A wealth of data

The data collected ranges from product-related information to site data, and it is classified into specific categories. For example, Eskon can determine why some products sell better at one customer's site than at others. This depth of detail makes it possible to curate customized product groups for diverse customer segments. Seretinek gives an example: "If a customer's client base asks for more sustainable clothing, the company's distribution activities must be adapted. If customer group A inquired about a specific item, a similar group of customers is very likely to request the same product as well."

Collected in alignment with established standards, the data is useful for daily business transactions and long-term planning alike. CEO Seretinek adds: "The data we analyze is a treasure trove that helps us to provide our customers with more apposite advice." The system facilitates forecasts, for example, regarding developments in the output of products, or the inventory needed over the following months. These projections enable Eskon to draw up more precise production plans and minimize its financial risk.



The data we analyze is a treasure trove that helps us to provide our customers with more apposite advice.

Elvis Seretinek, CEO of Eskon

Challenges of a digital corporate culture

Introducing and implementing a comprehensive and functional data strategy does not come without its challenges, a major one being adapting all company processes in a way that they lead to digital data and no longer need to be stored in paper form. "You have to determine exactly which data you need and alter the process accordingly," Seretinek emphasizes. The focus is both on efficient data collection and on "data hygiene" by the staff.

Artificial intelligence (AI) can help: The first version of AI-based order registration at Eskon is waiting in the wings. It is designed to analyze orders automatically and make recommendations in the system. Seretinek maintains a realistic view: "It is an investment that can fail if the yield doesn't justify the expense." He adds that the results of initial tests have been promising – it will be interesting to see what the future holds. ●

Computing power for heart and climate

TUM Campus Heilbronn Professor Dr. Hartwig Anzt develops methods for solving equations. What may sound abstract actually is field-oriented: Computing models are used in medical simulations and climate forecasts, among other things.



Our goal is to detect arrhythmias early on and develop effective treatments.

Hartwig Anzt,
Professor at the TUM School of Computation,
Information and Technology

Developing numerical methods for high-performance computing on supercomputers is the focus of the research conducted by Anzt, Professor of Computational Mathematics at the TUM School of Computation, Information and Technology (CIT). Because making these algorithms available to the research community is important to him, Anzt contributed to the development of GINKGO. He explains: “GINKGO is a software package that delivers diverse numerical methods for solving equation systems. It basically works like a toolbox the community can dig into to solve equations.”

Today, GINKGO is used by a wide array of organizations for simulations in a number of application settings. “In most cases, we do not find it relevant what exactly is to be calculated. For every request to solve an equation system of a specific size with specific characteristics we can point to the respective tool that can be employed,” says Anzt. For example: “The Princeton Plasma Physics Laboratory uses GINKGO to simulate fusion reactors, and the Lawrence Livermore National Laboratory resorts to our library for its rocket propulsion simulations.”

Understanding the human heart better

Another example of GINKGO applications is MICROCARD, a project created by the European High-Performance Computing Joint Undertaking (EuroHPC JU). “The undertaking is about simulating the human heart, more precisely, the electrochemical processes in it,” the computer scientist explains. “We know individual heart cells communicate with each other using electrochemical processes so that they beat in a synchronized manner. What we don’t understand yet is the exact processes, how it works, and why arrhythmias or heart attacks occur.”

The reason simulations of the human heart at the cell level have failed so far is that the human heart contains billions of cells, and the computing power has been insufficient

for such an elaborate model. Therefore, understanding the processes at the cell level requires new numerical methods and a scalable software architecture for supercomputers. Anzt says: “Our goal is to detect arrhythmias early on and develop effective treatments by identifying and potentially removing problematic cells.”

More accurate weather forecasts and climate predictions

Anzt and his team also offer their expertise for an entirely different type of application: They are working to accelerate the ICON climate code by means of efficient software and numerical methods and to optimize its implementation in diverse systems. Developed by Germany’s National Meteorological Service, Max Planck Institute, the Karlsruhe Institute of Technology (KIT), and other institutions, ICON is used, among others, by the German Climate Computing Center and for daily weather forecasts presented in the Tagesschau news program.

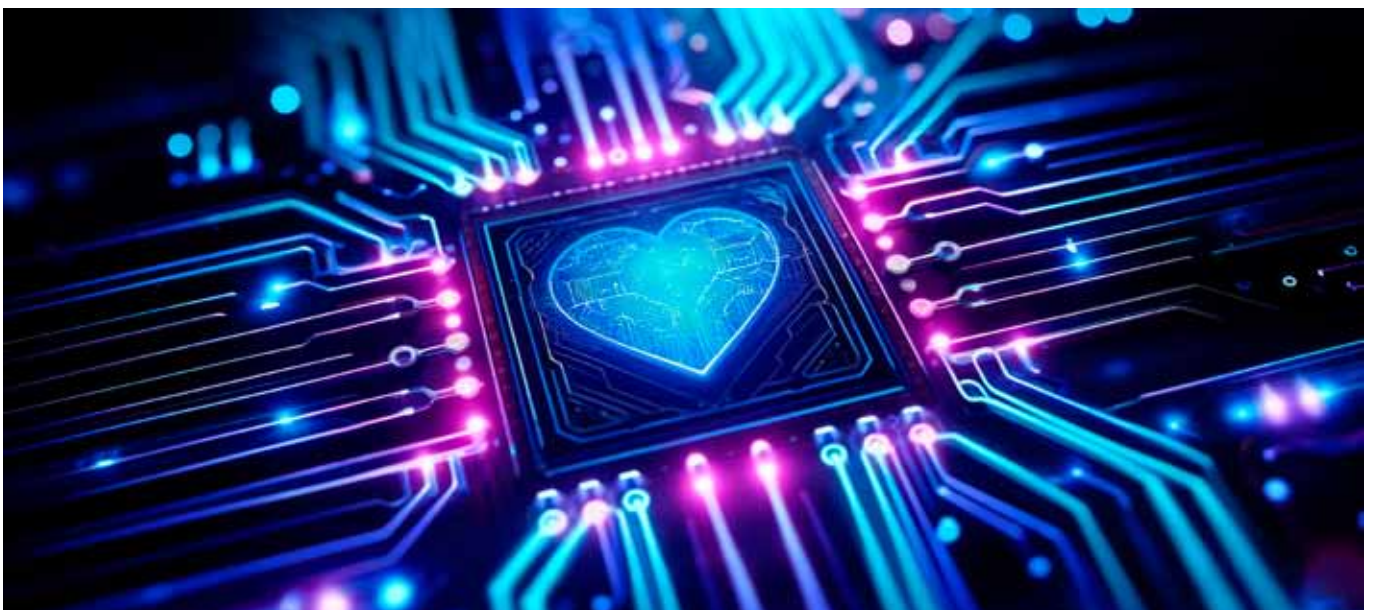
ICON uses a grid that maps the Earth to facilitate weather forecasts for areas that are as narrowly defined as possible. The finer the grid, the more accurate the simulation and the more complex the computing. Creating such detailed grids currently is very time-consuming. For this reason, Anzt and his team focus on speeding up the simulations. Another goal is to make ensemble simulations easier in

order to reduce uncertainties in weather forecasts and climate predictions. The researchers conduct a series of simulations, each one with some slightly altered values, to observe the impact on the probability of rain, for example. “For the ensembles we need to either boost computing power or make the individual simulations more efficient. That is what we are working on,” Anzt adds.

Relevant to a number of stakeholders

A variety of stakeholders could benefit from accurate weather forecasts and climate predictions. According to Anzt, financial interests come first. He gives an example: “If I know whether the sun will shine three days from now, I can buy or sell electricity on the stock market accordingly.” He continues by saying that naturally climate models also have political relevance because they provide information on how specific regions will develop over the next several decades, if they are more likely to experience extreme weather events, and if they will remain habitable in the future – key factors for long-term measures and planning.

History has shown the relevance of precise weather forecasts even to the military: After a brief period of good weather was announced for June 6, 1944, the allies in World War II decided to land their troops in Normandy on this exact day. The weather held, the operation was successful, and the day went down in history as D-Day. ●



Finger on the pulse: Innovative software solutions pave the way for progress in medicine and climate forecasts.

Endless data

From a digital side street to the data highway – without a speed limit to boot. The technological advancements of the past 20 years have a lasting impact on society. How exactly is data generated and what strategies exist to utilize it profitably? Dr. Greg Taylor, Professor of Economics at the Oxford Internet Institute, stays on top of things in a data-driven world.



Prof. Dr. Greg Taylor: a visionary in a data-driven world

From an early age, Taylor knew he wanted to pursue an academic career in economics. However, his first talk with a job counselor was sobering. “He laughed and said, ‘You will be a student forever.’ The funny thing is he was right. After all these years, I still consider myself a student of economics, learning something new every day.”

A job in finance or business consulting would have been the obvious choice, but London’s glittering world of finance was not for Taylor. “I met with several employers and had a strong feeling that the culture wasn’t a good fit for my personality.” Instead, Oxford became his professional and private home. He has been conducting research on digital markets there for more than 15 years.

Taylor studies the impact of data on markets using game theory. “Everyone in a market is making decisions based on their respective goals, the information available, and how they expect others to react,” he explains. “Game theory is a method for anticipating the results of these strategic interactions. For competing companies, this may mean they attempt to outsmart their rival, similar to a game of chess. In other situations, for example, when switching to a new technological standard, interactions

tend to be more cooperative, and – similar to soccer players – the question arises as to whether people are able to coordinate their actions successfully.”

Data generation is nothing new

Even 200 years ago, craftsmen produced a large amount of data. “They needed to know the amount of raw material used per hour, the most efficient manner of production, or the days of the week with the highest demand. Every business activity is a data-producing activity,” the economist points out and continues: “However, this data was seldom recorded or utilized in the way modern technology made possible. As early as 1854, John Snow demonstrated data’s transformative potential by charting cholera outbreaks in London to investigate the cause.” Many people have come to acknowledge the value of data.

In a world of large data volumes and, most notably, thanks to artificial intelligence and machine learning, companies have new opportunities to evaluate data. Taylor clarifies: “Models are still made, but as black boxes. These approaches put more emphasis on reliable prediction than on understanding the world.” Moreover, developments are speeding up. “Combining large



amounts of data, faster computers, and optimized algorithms has allowed the approach based on forecasting to improve much faster over the past few years than the traditional explanatory approach. So, it is only natural that the first approach I mentioned caught the attention of the industrial sector.”

Where is the journey heading?

According to Taylor, selecting relevant data is key; this selection must be made with the company’s objectives in mind. “Companies need to transform their business goals into research questions and then identify which available data can be used to answer those questions. At times, it will be necessary to collect new data, for example, by conducting experiments, installing sensors on production machines, or surveying customers, but the reward can be a massive increase in efficiency.”

The fact that internal data and external data are of equal value became clear to Taylor during a visit to the Audi plant in Neckarsulm. “What impressed me was the invisible parts: Robots communicate with each other, and the data produced as part of this communication serves to detect bottlenecks in the production line, for example.” He adds that the use of communicating robots has completely transformed production processes. Even bigger changes occur when companies merge.

Mergers provide opportunities

Companies are not the only things that merge, their data fuse as well. The acquisition of the California-based company Keyhole by the world’s largest search platform, Google, in 2004 resulted in an application everyone knows and most have used: Google Maps. “In a way, that is true data fusion, especially if you look at some of the products that came out of it: At least half of all cars in Europe navigate with an Android-based GPS system that combines Keyhole’s card data and Android GPS data, another product in the Google ecosystem. These are the synergies a data merger can create,” says Taylor.

**Models are still made,
but as black boxes.
These approaches
put more
emphasis on
reliable prediction
than on understanding
the world.**

Greg Taylor, Professor at the
Oxford Internet Institute

Where there is light, there is shadow

Some data-driven mergers have a less positive impact. They may give a market-dominating company a data advantage that may keep competitors from entering that market. In other cases, data-driven mergers may allow enterprises to combine data in a way that harms consumers with compromised privacy or new types of exploitative behavior. Thus, Taylor argues that political decision-makers should consider data-related damage when evaluating digital mergers and other matters concerning competition.

“In a way, data available through the many search platforms is not a result of the providers’ investments. It simply was obtained by these companies because of their market power,” Taylor reveals. For this reason, the Digital Markets Act is aimed at lowering barriers to market entries by obligating search engines to share some of their data with competitors. Taylor advocates the plan: “The algorithm Google developed is one thing; it is the product of the hard work the company’s engineers put in. The other part of the input is the data. Competitors need it to develop a viable search algorithm but have no opportunity to obtain it if more than 90 percent of users search through Google.” ●

What a movie has to do with sensor monitoring

When it comes to food, an increasing number of consumers try to avoid unnecessary transportation. What about data? TUM Campus Heilbronn Professor Dr. Carsten Trinitis has researched why applying the same principle to processing sensor data from critical infrastructures could be advantageous and what the technical implementation could look like.

To explain the principle of real-time sensor monitoring, Trinitis, Professor of Computer Architecture and Operating Systems at the TUM School of Computation, Information and Technology (CIT) in Heilbronn, likes to reference Johann, the batty senior machine operator in the 1981 German box-office hit “Das Boot”, who constantly monitors the submarine’s diesel engines with an ear trumpet to detect unusual noises and potential damage early on.

Real-time sensor monitoring used in diverse critical infrastructures works in a similar way: Sensors listen to power plants, IT infrastructures, or steel production plants by monitoring a number of measuring data continuously. In this way, they ensure no damage or other irregularities occur and operations run reliably.

Advantages of processing data directly

During the process, the sensors generate a vast amount of data that, for now, is intended to be processed in clouds. The problem is that only a portion of the data reaches the clouds because, depending on the infrastructure, such transfers can be very laborious.

Trinitis uses power plants as an example: “While they operate all over the world, fast grid connection is not available in some regions. Thus, it makes more sense to transfer less data, but the relevant kind.” The solution is to filter the mass of unremarkable data at the data source, referred to as the edge, and to send only critical mavericks to the cloud. Edge computing – processing data at the source – requires less energy and is more sustainable.

Combining edge and cloud computing and processing sensor data for artificial intelligence (AI) applications were the focal points of the SensE (Sensors on the Edge) project conducted by TUM in cooperation with Ingenieurbüro für Thermoakustik GmbH (IFTA; engineering office for thermoacoustics) in Puchheim in Upper Bavaria. The project, with a volume of approximately one million euros, ran from 2021 through the summer of 2024. Half of the project was financed by the Bavarian Research Foundation. Trinitis headed SensE jointly with Dr. Martin Schulz, Professor of Computer Architecture and Parallel Systems at TUM in Garching, and Dr. Roman Karlstetter, Technical Lead Software at IFTA.



Dr. Roman Karlstetter, Technical Lead Software at IFTA



Prof. Dr. Carsten Trinitis of CIT at TUM Campus Heilbronn

Each problem causes unique vibrations

The project addressed one type of application of real-time sensor monitoring: a two-turbine gas power plant located in Germany. The sensors at the plant monitor the turbines’ acoustic vibrations in real time to ensure smooth operations – just like machine operator Johann did.

Trinitis reports on an incident detected in the recorded sensor data: “Once, a combustion chamber in the gas turbine broke down. This caused the characteristic vibrations in the entire device that point to this type of incident precisely. A tear in the shaft, for example, would trigger different vibrations.”

Combining edge and cloud computing also benefitted the training of an AI model for detecting anomalies: The time-consuming training was conducted in the cloud that was fed data from diverse edge sources. Thereafter, the model was returned to, and applied on, the edge.

Win-win for all

Trinitis summarizes the main project milestones: “We inspected different computer architectures for the edge to identify the ones that are best suited for data processing. In doing so, we analyzed a number of processor models and machine learning algorithms including the ‘Transformer’ everyone is talking about. Our doctoral student Dai Liu has dedicated a large portion of her work to applying these modern machine learning algorithms specifically to the processing of time-series data on the edge.”



We inspected different computer architectures for the edge to identify the ones that are best suited for data processing.

Carsten Trinitis, Professor at the TUM School of Computation, Information and Technology

Karlstetter of IFTA GmbH adds: “With SensE, we conducted research on issues with processing sensor data, particularly for use in AI scenarios, that had been unsolvable up to that point.” In his opinion, the most important outcome has been the creation of a demonstrator that continuously analyzes sensor data from high-performance gas turbines and is able to detect slowly developing damage several days in advance. “The demonstrator uses large amounts of historical sensor data to train an AI-based method,” he explains. “This allowed us to demonstrate that the methods developed as part of the research project are useful for solving actual problems in the industrial sector. Without the results gained from the project, implementing a comparable development technically would be difficult.” ●

The future of data

Dr. Edeltraud Leibrock's career in IT started with her first summer job in programming at the age of 16. She studied physics and biology, and today she is Global Managing Director Innovation and Senior Partner Digital at global management consultancy Roland Berger. As such, she is responsible for artificial intelligence (AI) in the firm. Leibrock discusses with Mindshift the challenges facing companies when it comes to storing and processing data and how it can be done efficiently and sustainably. She also has ideas on how to shape tomorrow's world today.

"We need to take the data out of the silos," says Leibrock. Before introducing professional IT management processes and standard software, many companies worked on the Hey Joe principle. There was no overarching coordination or prioritization: applications basically were developed upon demand from the business units. While these times are long gone, some of the silo architectures created back then have survived to this day. The same applies to data retention. "We must find a way to take the data from their silos without losing the context and, at the same time, integrate it in a way that it can be accessed for overarching processes." This holds true for generative AI applications in particular. Companies need to pay extra attention to prevent new silos from developing and, instead, to ensure the data integration potential of this technology actually is leveraged."

AI as a game changer

For Leibrock, AI is a veritable game changer. "Today, data availability, performance of the models, and the foundations including scalable infrastructures, computing power, and storage capacities are at a level where we can finally tap their potential. There is no turning back. The question is no longer if, but how." Because data volumes increase so rapidly, they require storage space that is provided by giant data centers with the respective energy consumption.

Green energy for green AI?

On the path to green AI, increasing efficiency will not suffice, if for no other reason than exponential development. The thermal energy generated in data centers can



Dr. Edeltraud Leibrock



and should, of course, be used regionally, for example to heat buildings in Scandinavia and other cool parts of the world. However, all things considered, only CO₂-free energy sources are climate-neutral. “There is no alternative to renewable energies,” Leibrock explains, and continues by saying that even today photovoltaics is by far the most affordable way to generate power. “These technologies are the future, also and especially for data centers, data storage, and AI.” She believes Germany is on a good path in this regard: At 14.1 gigawatts, the increase in solar power in 2023 was nearly twice the previous year’s amount. The capacity of plants to utilize renewable energies increased by 17 gigawatts in 2023 to a total capacity of close to 170 gigawatts. Also notable: 52 percent of German power production in 2023 originated in renewable energies, with the OECD average being 33 percent. However, since generating renewable energies tends to require a lot of space, some hyperscalers already are considering building their own, decentralized nuclear power plants to supply their cloud data centers reliably with CO₂-neutral power.

Audits for data protection

In addition to ensuring sustainability, data protection plays a key role. How can data be stored securely and, at the same time, be utilized in a way that produces plausible

results? “Companies are responsible for implementing all the applicable regulations and ensuring their security technology is updated to a level adequate for them,” Leibrock explains. “Regular audits are part of it.” In her opinion, the job profiles of chief information security officer and chief data officer are in high demand. In addition, she says, a sound data basis is the prerequisite for plausible results because “every form of intelligence needs context.”

In what world do we want to live tomorrow?

According to Leibrock, the transformation of technologies goes hand in hand with societal changes: “We are at a crossroads, also due to current geopolitical developments. Technology in itself is value-neutral, it is not good or bad per se. It depends on how we use it.” Her approach includes international communication and implementing the respective regulations. “I believe that would be conditional upon a joint global effort.” She also believes all people are entitled to determine their contribution themselves, even if it is small, and she has an idea for a thought experiment: to consider what would happen if US futurist Ray Kurzweil was right and we really could live forever one day? What would a world worthy of eternal life look like? ●



Prof. Dr. Martin Schulz, member of the LRZ board of directors

Good, better, SuperMUC-NG

Supercomputer SuperMUC-NG, SNG for short, located at the Leibniz Supercomputing Centre (LRZ) of the Bavarian Academy of Sciences and Humanities in Garching, raises the bar. It is at the forefront when it comes to computing power for scientific calculations and simulations. It also is a paradigm of energy efficiency and resource conservation.

SuperMUC-NG is able to execute several millions of billions of computing operations per second – a number that greatly exceeds human imagination. This makes this high-performance computer (HPC) a pre-exascale system. It was introduced to the LRZ, the data center operated jointly by TUM and Ludwig-Maximilians-Universität in Munich, back in 2018. With the successor SuperMUC-NG Phase 2, SNG-2 for short, the LRZ is taking the next step. While the computing performance of both phases is at the same level, the new supercomputer takes up only 25 percent of the space, is less costly, more energy-efficient, and better for resource conservation.

Experiment, theory, simulation

“Modern HPC systems are integral parts of scientific work,” says Dr. Martin Schulz, Professor of Computer Architecture

and Parallel Systems at the TUM School of Computation, Information and Technology and member of the LRZ board of directors. “We used to have experiment and theory, now the standard is experiment, theory, and simulation.”

Because SNG was developed for science, the main considerations while planning and designing it were the performance needed by its users. “We used calculations conducted previously and also made forecasts about the demands regarding the system researchers could have in years to come,” says Schulz.

Since the state of Bavaria and the federal government via the Gauss Centre for Supercomputing (GCS) finance the LRZ’s national high-performance computer, it is mainly scientists from Bavaria and Germany who can request

computing time; in cooperation, applicants from the rest of Europe can also apply. Applications are evaluated and selected based on their scientific merit.

3D models of magma flows, machines, and human organs

SNG has conducted calculations for a wide range of scientific disciplines, for example, magma flows in the Earth's mantle were simulated in one of the largest plate tectonic models. In climate impact research, it has become possible to increase image resolution, precision, and speed. Simulations of large machines and plants such as plasma fusion reactors have been conducted successfully as well. In the medical field, digital twins of lungs, other organs, and entire bodies, have helped detect diseases even earlier.

Today, simulations are presented in 3D – “a giant leap” according to Schulz. In his opinion, the use of artificial intelligence (AI) in the HPC also is part of the progress made. “The benefit of AI is that it makes scaling possible; for our forecasts we no longer have to calculate all the points individually but can predetermine some of them with the help of AI.”

Even though results of the research are published and made available to the general public at the end, the LRZ data management team ensures no user accesses data pertaining to other projects without consent. While so far simulation data mostly is collected without any references to people, this practice could change with personalized medicine in mind. “At the moment, calculations are based on anonymized data that does not allow deducing patient information. However, we are investigating how to manage personal data securely,” says Schulz.

Adjusting for sustainability

Efficient scheduling enables the team to determine which calculations SNG conducts, and when, to prevent idle time to the largest degree possible. An algorithm selects the assignments based on specific criteria to ensure an optimal workload for the HPC system as well as fair operations, that is, avoiding excessive time in the pipeline for projects.

Optimizing scheduling is an adaptation technique to make supercomputers more resource-friendly despite their increasing energy consumption. In addition, the LRZ uses green power generated from renewable energies. In the future, computing systems could become even more energy-efficient with software yet to be developed. Schulz

Super and quantum computers go hand in hand

In June 2024, the LRZ saw a world premiere when connecting the SuperMUC-NG and its quantum computer Q-Exa to form one system of superlatives. The hybrid constitutes a future technology enabling even more comprehensive computing operations in less time. Plans also include coupling Q-Exa and SNG-2. Quantum technology at the LRZ is also being driven forward by Munich Quantum Valley (MQV), a network of research community, industrial sector, and research funding in which TUM is a strong partner.

clarifies: “HPC systems could compensate for fluctuations in power grids; to do so, you regulate down when power is scarce. In turn, surplus energy can be used for energy-intensive computing.”

Other levers for boosting energy efficiency and sustainability include the built-in hardware and the infrastructure. Hardware components are becoming increasingly smaller and energy-efficient. In addition, just as many other data centers the LRZ uses warm water cooling. “We developed the principle here at the LRZ together with IBM and were the first to pursue it,” Schulz reveals. Grid losses in the form of waste heat can be used for heating, for example.

Successor system is waiting in the wings

“For sustainability and cost efficiency, systems should not be replaced too often,” says Schulz. “Five years have proven to be a reasonable average.” At the time of purchase, the team verifies that suppliers will take back their components at the end. While some parts can be repurposed, most of the components of these specialized systems are discarded. “Integrated AI technologies alone have developed significantly over this time and are outdated.”

As making a new high-performance computer operational requires significant lead time, the LRZ has begun to prepare for a successor system. “Technology is advancing. Moving forward, we will see even more potent systems and further advancements toward sustainability,” Schulz asserts. ●

Data protection: curse and blessing

As a Professor of ethics in medicine and healthcare technology at TUM, Dr. Alena Buyx addresses questions in her field that go far beyond the operating room. She is also the Director of the TUM Institute of History and Ethics in Medicine. She spoke with Mindshift about current data protection challenges and why she remains optimistic.

Prof. Buyx, should doctors make decisions regarding treatments like artificial intelligence (AI) does – namely, the more data, the better?

Prof. Alena Buyx: Yes and no. Learning as much as possible about a patient as quickly as possible is part of medical practice. That is why we have diverse systems in place to document a patient's medical history. We

combine this with the current clinical situation and then decide on treatment. Where AI is concerned, the larger – and especially, more accurate the data – the better the results the algorithm produces. So yes, in a way there are some parallels.

Now to the no: Doctors' decisions are also based on empathy and experience. Hyperbolically you could say it is part of a doctor's art, and 'doctor's art' is an adequate term because not everything is quantifiable science.

What types of patient information are particularly worthy of protection?

Prof. Alena Buyx: Most patients want information regarding their mental health to be protected the most. However, we can no longer hold onto the idea that some data is irrelevant. In data ethics, we have ample discussions about whether genetic data should be treated more sensitively than other types of data because you can deduce a lot from it, about the person and his or her entire family, including children and children's children.

Is there a point where the interests of the greater good exceed the protection of the individual?

Prof. Alena Buyx: That requires ethical consideration between damage prevention and benefit. Data must be secured and protected well. However, in a time of data-driven medicine we need to foster advancements in therapies and drug development. At the end of the day,



Prof. Dr. Alena Buyx

impeding or increasingly complicating data utilization would harm every individual patient and the entire health-care system.

In Germany, significantly fewer clinical studies are conducted because data protection hurdles obstruct the sensible utilization of data. That is not in the best interest of our patients. Being able to predict diseases earlier and diagnose them faster would be to everyone's benefit.

And then there are people who disclose their data recklessly. What is your assessment of this behavior?

Prof. Alena Buyx: I see a huge discrepancy. On the one hand, we have a highly regulated system in research, medicine, and patient care. On the other hand, we have doctors leaving meetings, opening their smartphones, ignoring a 40-page declaration of consent, and disclosing their data for failure of reading the cookie policy.

People tend to divulge information to large data companies without much hesitation; in research, data protection feels suffocating. My research has shown that 90 percent of respondents were willing to share their medical data for a charitable cause. When medical data is collected for commercial purposes, this number decreases rapidly, where people are much more reluctant. What we are currently seeing is the opposite: Data ethics repeatedly suggests that this responsibility should not be delegated to the consumer. The strictest settings should be the standard so that users can decide which portions they are willing to disclose.

In your opinion, should governments dictate regulations through laws and directives?

Prof. Alena Buyx: The European Union's General Data Protection Regulation and Digital Services Act are a start, but in our giant global data society, enforcing them is extremely difficult. We are fighting a hard battle because these major companies base their original business models on maximum data utilization and maximum data collection. After a year of browser tracking, they even know your most private secrets.

Some insurance companies in the United States that sell life insurance no longer conduct one-time health checks. Instead, they continuously collect their clients' fitness tracker data. Policies are recalculated repeatedly until patients become uninsurable. This is why we on the German Ethics Council decided to declare that highly

predictive risk profiles should not be used in solidarity-based healthcare systems such as Germany's.

What is your advice to everyone on how to handle their own personal data?

Prof. Alena Buyx: My advice would be to reflect on your practices and behavior. Take some time to adjust some settings on your smartphone. Unfortunately, it's still a very tedious, complicated, and nerve-racking task, but it is worth the effort.

We should be aware that everybody is ashamed of something that should not become public. Nobody should be concerned about that happening. Although the fact that we all have that in common is slightly liberating.

Despite it all, what makes you hopeful that we can turn all this data into something productive, something that helps people?

Prof. Alena Buyx: For example, one large algorithm can predict acute kidney injury in intensive care units with relative precision 48 hours before it occurs. That is sensational. From a medical perspective, AI has an incredible amount of positive potential. That makes me optimistic. ●



Data utilization: How AI envisions its bright and dark sides.

Everything is physics

Incubator programs, pitching contests, and elaborate simulation games are the most common ways to enter the start-up community. Sometimes, however, roots grow more organically. One example is Deeplify based in Bochum, which uses artificial intelligence (AI) to optimize quality management. Former physics students Jan Löwer and Tim Schwabe turned their project work into the vision of their own start-up.

Physics and AI do not seem to be obvious partners at first glance, but appearances can be deceiving. “The study of physics teaches you a lot about the principles applied in AI – linear algebra, optimization, and statistics,” says Schwabe, doctoral student at TUM Campus Heilbronn. He and his cofounder, Löwer, share a passion for technology. Both studied in Bochum, where they joined forces and extended their horizons. Löwer remembers their beginnings with AI: “The Institute for Neuroinformatics at Ruhr University Bochum offered several in-depth courses on image recognition and neural networks.” The two were filled with enthusiasm and soon took their adventure from theory to practice.

Market research by happenstance

They started out as a small consulting firm. Löwer reports: “In the beginning, we did manageable software develop-



Deeplify founders Jan Löwer (left) and Tim Schwabe



All the data is fed into the test software. Even today, we can reduce the working time of human testers by 90 percent with a high level of precision in many cases.

Jan Löwer,
founder of Deeplify

ment projects for start-ups we were friends with, founded a private company, worked, and sent invoices. That was it.” The large potential for establishing a software-as-a-service start-up became clear to them after they had developed a non-destructive quality control solution for a mid-market test equipment manufacturer. “We realized there was a large market for this application, and many companies were dealing with similar issues.”

Rather than keeping navigating from project to project, Löwer and Schwabe founded Deeplify and developed an AI-based platform. “Customers can adapt the software in many ways to meet their individual testing needs,” Löwer explains. The goal is for companies to integrate their test data into the platform and train the AI program

with their own datasets. The customers at their premises then validate the results. “All data is fed into the test software. Even today, we can reduce the working time of human testers by 90 percent with a high level of precision in many cases.”

In use: discriminative AI. Schwabe explains how it works: “Like generative AI, discriminative AI also works with data but pursues a different goal. The result is not intended to reproduce values or create something new, but to evaluate data sets – in the case of quality testing, as good or bad.” Sounds complicated? Good if you have a real AI expert on board as a consultant. Dr. Maribel Acosta, Professor of Data Engineering at TUM Campus Heilbronn, supports Deeplify as a mentor. Schwabe began his path to a doctoral degree in Acosta’s team in Bochum. When it became clear that the professor would be moving to Heilbronn, Schwabe was faced with the decision: “Do I go with her or stay in Bochum? I went with her.”

Next stop: Heilbronn

Because AI and Heilbronn – they go together. Acosta and her research team have found fertile ground: “With our specialized profile in neuro-symbolic AI, we have the unique opportunity to collaborate with the AI initiatives in Heilbronn and various institutions on campus. As a state-of-the-art facility, the campus offers inspiring working environments that are ideal for the development of cutting-edge technologies.”

The fact that one of her doctoral students has bridged the gap between science and business with Deeplify fills the professor with pride: “Tim is a prime example of how dedication and the right attitude can lead to success in both the academic and entrepreneurial worlds.” In her roles as professor and mentor, she sets different priorities: “As a professor, my main focus is on teaching technical content and creating a research plan with clearly defined goals so that doctoral candidates can success-



Prof. Dr. Maribel Acosta supports Deeplify.



With our specialized profile in neuro-symbolic AI, we have the unique opportunity to collaborate with the AI initiatives in Heilbronn and various institutions on campus.

Maribel Acosta,
Professor at TUM School of Computation,
Information and Technology

fully complete their dissertations. As a mentor, on the other hand, I am strongly committed to the personal and professional development of the doctoral students.”

This is best achieved through personal dialog: “We often discuss challenging situations in which difficult decisions must be made. In this way, I promote their ability to reflect and their self-confidence.” In her dual role, she tries to provide the researchers she supervises with the professional insights they need to maximize their chances of success in their future careers in addition to their specialist expertise. The field seems to be set. “It’s an exciting time to be working in AI research. The field is rapidly evolving, with disruptive technologies emerging at an unprecedented pace,” says Acosta. ●

Thriving transformation

Becoming an adult in five years' time is possible, at least when it comes to research centers such as the Center for Digital Transformation (CDT) at TUM Campus Heilbronn. Dr. Sebastian Müller, Professor of Financing and Director of the CDT, and CDT Manager Dr. Franziska Schmidt recap the development and venture an outlook.



The professors of the CDT

The Heilbronn-Franken region has a long and successful history of being a business hub and is home to many hidden champions. The CDT was established five years ago to keep pace with technological challenges. “The idea was to build a center for researching the opportunities and risks of digital transformation in the corporate sector – from an academic perspective and in dialog with regional companies,” says CDT Director Müller. Over the past few years, the transformation has gained momentum through developments in the field of artificial intelligence (AI).

The first step is always the hardest, and the newly founded research center and all those involved faced significant challenges. “Building the CDT began in 2019 under its then director, Professor of Operations Management Dr. Gudrun Kiesmüller. Times were challenging, particularly due to the pandemic, when meeting cooperation partners in person was impossible. The team can be satisfied with the CDT’s current operations and organization,” says Müller, Kiesmüller’s successor. The first item on the agenda was to inform companies that TUM would

be a presence in Heilbronn from then on. Founding dean Prof. Dr. Helmut Krömer provided endorsement while the network around TUM Campus Heilbronn was being established. “It took a lot of engagement to create the well-functioning ecosystem we have today. Perhaps Heilbronn will become the leading AI hub in Europe,” Müller emphasizes.

The CDT has made a name for itself, not only in the corporate world: It cooperates with researchers from more than 30 top-caliber universities worldwide. Each year HEC Paris students attend TUM Campus Heilbronn’s summer school, which is under the academic direction of CDT Professors Dr. Jingui Xie and Dr. Jens Förderer. “Visiting researchers from around the globe come to work with us for a few months to benefit from the opportunities we offer,” says Schmidt, CDT Manager since 2021. Müller adds: “The workshops we host jointly with other international researchers have created a very productive environment for new research alliances and the next generation of scientists.”

Establishing priorities

Just like TUM Campus Heilbronn, the CDT is also experiencing continuous growth. Six professors in three main research areas – data-driven decision-making, digital



Our team is made up of 40 people, 40 percent of whom have an international background and 50 percent of whom are women. This level of diversity fosters innovative research results.

CDT Manager
Dr. Franziska Schmidt



It took a lot of engagement to create the well-functioning ecosystem we have today. Perhaps Heilbronn will become the leading AI hub in Europe.

Sebastian Müller, Professor at the
TUM School of Management and
director of the CDT

platforms, and the impact of digital technologies on business – now are working under the CDT roof.

According to Müller, “the perspectives for Heilbronn as a city of science are very good, and the priorities have proven to be the right ones.” Third parties back his assessment. Over the past few years, CDT researchers have prepared approximately 60 scientific publications.

The CDT’s success certainly is due in part to the right composition of the team. Diversity is key to the CDT, says Schmidt and adds, “Our team is made up of 40 people, 40 percent of whom have an international background and 50 percent of whom are women. This level of diversity fosters innovative research results. Many researchers train at the CDT up until the beginning of their doctoral thesis or take the next step towards a professorship.” The CDT team keeps close contact with the other partners in the Bildungscampus ecosystem, such as the Fraunhofer Research and Innovation Center for Cognitive Service Systems (KODIS). Their networking is bearing fruit.

This is also reflected in the funds raised by the six professors. “Professor of Innovation and Digitization Jens Förderer, for example, was granted close to 1.5 million euros from the European Research Council for his research on digital platforms. That’s just one example of the CDT’s level of excellence,” Müller notes. Where does he see the CDT’s priorities moving forward? “We will focus on continuing to establish the CDT as an excellent and innovative teaching and research institution.” ●



As part of the multi-day event We are EUrope, one excursion took participants to the European Parliament in Strasbourg.

Big plans after a successful debut

What defines Europe? In what ways it is different from other continents? How will the Europe of the future present itself? These questions were at the center of the “We are EUrope” event that debuted at TUM Campus Heilbronn in summer 2024.

“We want to raise students’ awareness of the European understanding of democracy,” says Dr. Rangel Trifonov, Project Manager at Die TUM Campus Heilbronn gGmbH and initiator of We are EUrope, an event that was organized in cooperation with the Deutsch-Französisches Institut (dfi; German French Institute), the Heilbronn Theater, the Global Ethics Institute, the City of Heilbronn, European University Viadrina, Fraunhofer IAO, and other partners.

The plan was ambitious for a campus where the majority of students come from outside of Europe. Trifonov is aware: “Because Europe is uncharted territory for most students, our main goal is to show how the European Community of today came to be.”

A varied combination of theory and practice

The multi-day event kicked off with three scientific lectures on the past, present, and future of Europe.



Platform for dialog among students and experts about Europe's past, present, and future

On the second day, students developed visions for the continent, which they presented to the public – primarily interested locals – the following day. The event was rounded off with an excursion to the European Parliament in Strasbourg, including a discussion with Rainer Wieland, then Vice President of the Parliament.

Participants agreed that the event was a success. Jie Li, bachelor student of Information Engineering at TUM Campus Heilbronn, says: “I enjoyed We are EUrope very much. Learning everything about Europe – from history and culture to economy and politics – and brainstorming about the future of the European Union is an enriching experience for students. Being democratically elected as the student representative by a live audience during the closing event was a great honor. It allowed me to join the concluding panel discussion and share views and ideas with esteemed guest lecturers about current events and future ventures in Europe.” The lecturers gave equally positive feedback. “Europe Week was a great initiative because it provided students, particularly those from abroad, with solid knowledge of European integration, the foundation of Germany’s political understanding,” says Matthias Schäfer, Head of the International Office of the Konrad Adenauer Foundation in Algiers.

Dr. Lauri Wessel, Professor of Information Management and Digital Transformation at European University Viadrina in Frankfurt (Oder), has high praise for the format: “It brought together stakeholders from society, scientists, and students.”

Commitment from all cooperation partners

“The event was an excellent opportunity to convey the facets, functioning, and added value of Europe to young people,” says Prof. Dr. Marc Ringel, Director of the dfi. Prof. Dr. Frank Baasner, who established contact between TUM Campus Heilbronn and the dfi, adds: “The strong support from the City of Heilbronn for this event is a good sign.”

All the cooperation partners have already committed to participating in the second edition of the event, which is going to take place in May 2025 and which will focus on current transformation processes in Europe. Organizer Trifonov gives an outlook: “Our continent is at a turning point. Putting established concepts to the test and rethinking and rediscovering Europe against the background of lessons learned is of the utmost importance.”

Strengthening mental wellbeing

Psyche is not only a Greek goddess but also a crucial factor for people's wellbeing. It can be both the main reason for sick days – enigmatic and multi-faceted – and the key to a happy future. Dr. Simon Senner, Chief Physician at the Reichenau Centre of Psychiatry, explains how the transformation towards healthy and successful coexistence in companies can succeed.

Abandon his career as a doctor? Senner briefly faced this decision before discovering his passion for the human brain. "The brain is our most complex organ. You can read 100 books about it and still understand only a fraction." His fascination with the unknown began during a temporary assistant position at the psychiatric clinic of Munich's Rechts der Isar Hospital. Today, Senner is chief physician and supports companies and executives in interacting with employees dealing with mental illnesses.

Healthy leadership, healthy mind

Mental health plays an increasingly important role for companies. "Absences due to mental illnesses are at an all-time high but approximately 75 percent of those affected never seek help." For this reason, Senner advocates for prevention and offers training sessions on the topic in companies and at TUM Campus Heilbronn. An often unexpected benefit: "In contrast to depression, the term burnout is widely perceived as more positive.



It implies that before burning out, you – allegedly! – gave your all. People can identify with this view."

That fact can be the gateway to successful therapy. "Ultimately, it is irrelevant whether the professional diagnosis actually is burnout, depression or an anxiety disorder. What matters is that the person accepts help."

Addressing the issue can be delicate for third parties, especially at work. "Executives have to watch their choice of words. It's easy to get it wrong," Senner explains. He advises against offering a diagnosis; rather, the discussion should focus on the staff member's work behavior and on changes in his or her personal life since the situation is highly stressful for employees.

There is a lot to learn about healthy leadership. "Playing out situations and/or adopting other companies' best practices can help react correctly, reduce absences, and make the company successful in the long-term and sustainably."

Acting preventively

Although no easy solutions exist to this complex issue, everyone can take preventive measures. "Being aware of and acting on our body's signals is important," Senner explains. The earlier we act, the faster things will look up again. ●



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