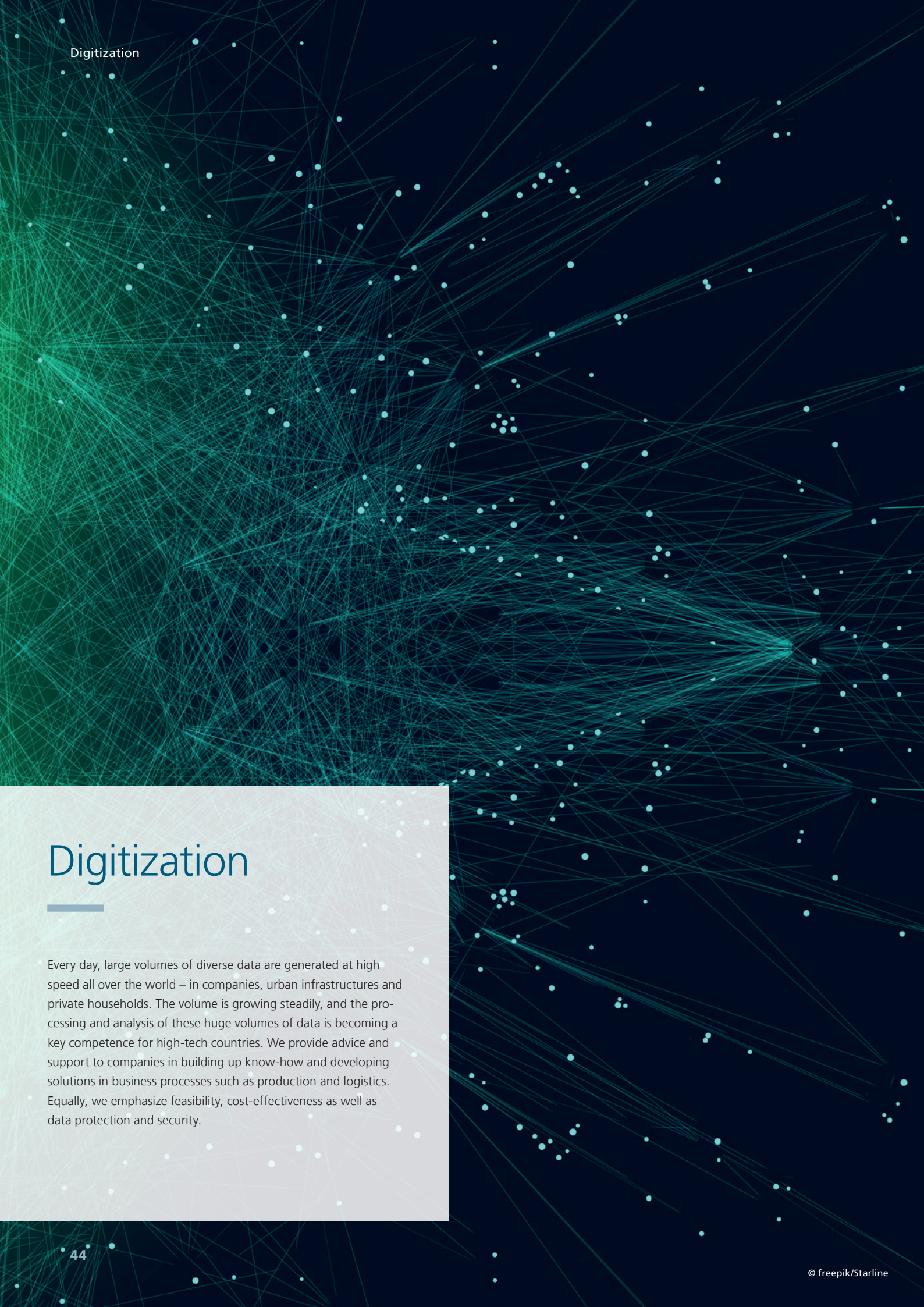

Digitization

Every day, large volumes of diverse data are generated at high speed all over the world – in companies, urban infrastructures and private households. The volume is growing steadily, and the processing and analysis of these huge volumes of data is becoming a key competence for high-tech countries. We provide advice and support to companies in building up know-how and developing solutions in business processes such as production and logistics. Equally, we emphasize feasibility, cost-effectiveness as well as data protection and security.

T-KOS: Terahertz Technology for Reliable Communication

Taking part in a virtual meeting while traveling by train – no problem if there are no gaps in the mobile network. Mobile working underscores the importance of stable data connections. This applies equally to industrial production, which is relying more and more on networked components. Our "Materials Characterization and Testing" department is researching how terahertz technology can additionally optimize the integration of assemblies through improved sensor technology.

The requirements for communication networks and sensor solutions in industrial production processes are growing, which is why the German Federal Ministry of Education and Research (BMBF) launched the T-KOS project (Terahertz Technologies for Future-Oriented Innovations in Communication and Sensor Technology) in 2021. In the project, terahertz technology is now being developed synergistically for industry in the fields of "communication" and "sensor technology" for the first time.

Working together to achieve compact system concepts

T-KOS is a joint project of "Forschungsfabrik Mikroelektronik Deutschland "and Fraunhofer ITWM. It bundles the commitment of ten cooperation partners. The researchers are developing demonstrators for wireless communication with high bit rates and industrial measurement technology based on high-frequency electronics and terahertz photonics.

One promising way to increase data capacity at carrier frequencies above 100 GHz is terahertz radio technology. The higher the carrier frequency, the greater the usable bandwidth and thus the data capacity. This means that smaller antenna elements are needed and compact radio systems can be realized with a large number of active antennas. This is an advantage that also benefits industrial terahertz measurement technology, which is used for imaging and testing.

Demonstrators for imaging Terahertz testing

"Electronic and photonic system concepts in the terahertz range are conceptually close to each other," says Dr. Fabian Friederich, coordinator of the T-KOS activities at Fraunhofer ITWM. "Thanks to our expertise and our good laboratory equipment, we can realize demonstrators for both branches of technology in Kaiserslautern for imaging terahertz testing in production processes." While the all-electronic demonstrator aims to provide industrial-grade inline measurement technology with millimeter resolution on the production line, the photonic concept serves as a research platform for future developments towards higher frequencies and improved resolution.

www.itwm.fraunhofer.de/terahertz-testing

T-KOS
Terahertz-Technologien für Kommunikation und Sensorik

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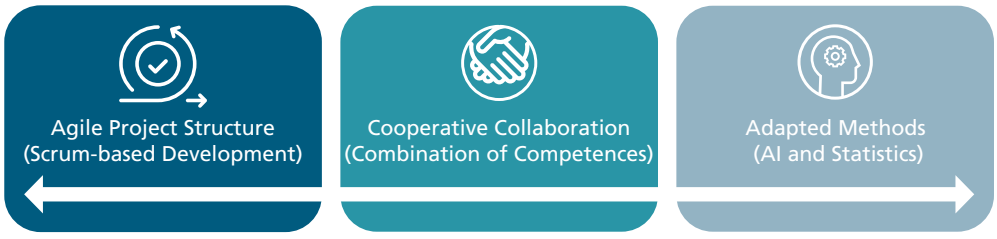
Enterprise Lab: Through Modern Working Methods to Mathematical Success

In the cooperative working method "Fraunhofer Enterprise Lab", several experts from companies and ITWM researchers actively work together in a team on topics and solutions. Our department "Financial Mathematics" thus implements innovations in direct collaboration with an automobile manufacturer.

8
Subprojects in three years

In the focus of the "Enterprise Lab", everything goes hand in hand – from topic identification to market-ready solution. The symbiosis of research and corporate practice enables the implementation of creative ideas that are directly aligned with business processes. "With the Enterprise Lab, we have created an agile method in which companies can live interdisciplinary collaboration with us researchers and work collegially with customers", says Dr. Stefanie Schwaar, business unit developer "Accounting Audit." "They don't just order technologies from us in the classical way and we work off them, but we develop the task, strategy and solutions together.



Our success is based on three components.

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“With the Enterprise Lab, we have created an agile method in which companies can live interdisciplinary collaboration with us researchers and work collegially with customers.”

Dr. Stefanie Schwaar
Business Unit Developer “Accounting Audit”

Example Data Science in the Automotive Industry

One example of the successful implementation of the concept is the collaboration with a premium car manufacturer. “Here, we have already been working on a wide variety of topics since 2018. The team keeps changing, depending on the expertise required,” says Schwaar. In the lab, companies have direct access to the know-how of the scientists. Everything revolves around challenging data sets in the area of testing and forecasting.

Thus, completely new possibilities for explorative data analysis have emerged in the Lab, such as a specific anomaly detection: The Fraunhofer ITWM solution supports the merging of complex data from different sources, aggregates them automatically to an efficiently usable data set, and visualizes them interactively. Statistical and machine learning (ML) methods are used to automatically search for anomalies in the data. In this way, potential incorrect entries or presumably underbilled repairs can be investigated in a targeted manner and major sources of error can be identified at an early stage.

Interdepartmental Project Planning in the Lab

The flexible working model enables strategic cooperation – even across departments. In the lab’s latest project a team from the “Mathematics in Vehicle Development” and the “Financial Mathematics” department is working together on the digital processing of complex vehicle analysis protocols. That means Big Data on a grand scale. The range of topics for using the data is extensive and constantly changing. When a new car goes on the market, there are various questions to be answered such as: What is the predicted damage rate? What are the frequent repairs? What costs can be expected? For these and related questions, we provide data-driven support.

The development of an ML-supported interactive analysis tool is also the focus here. Experts from both departments work closely with the teams from the customers’ teams, and a steering committee ensures the conceptual orientation and goal setting. A real formula for success in modern project work.

www.itwm.fraunhofer.de /datascience-car

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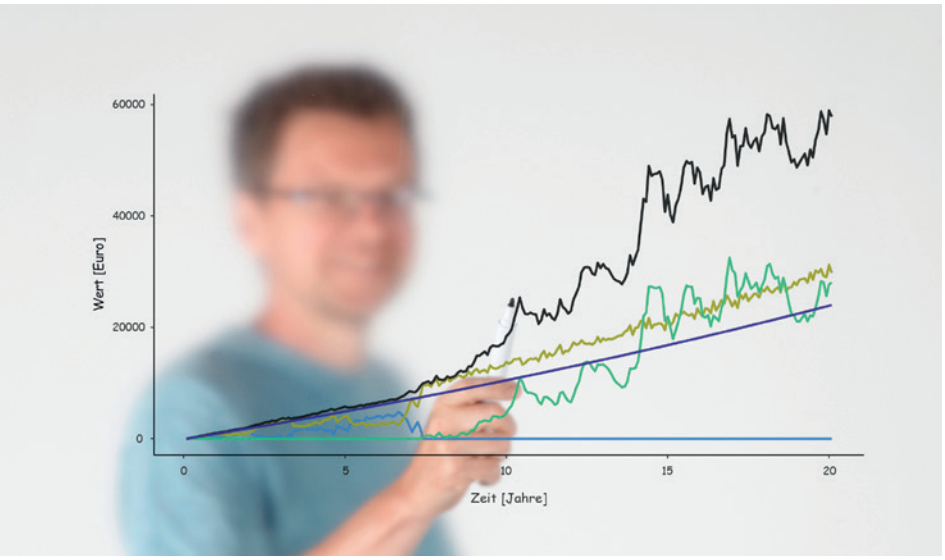
Mathematics Creates Transparency – Making Secure Provision for Old Age



Since 2016, a team from the "Financial Mathematics" department has been carrying out classification for state-subsidized pension products on behalf of "Produktinformationsstelle Altersvorsorge gGmbH (PIA)." A model that has set standards and has now been adapted to make company pension plan contracts objectively comparable.

Old-age provision in Germany is based on three pillars: mandatory systems under public law (including statutory pension insurance), occupational pension schemes and private pension contracts. The latter include products that are subsidized by the state, for example through the so-called Riester pension. In the meantime, the range of products is very complex and it is difficult for consumers to keep an overview. To alleviate uncertainty and create more transparency, the Ministry of Finance introduced a classification for state-subsidized contracts, including, for example, the Riester products. In order to be subsidized, they must comply with legal requirements and be classified.

The basis for this is provided by mathematics from the Fraunhofer ITWM. Since 2017, the PIA has been assigning each state-subsidized pension product a risk-reward classification for the standardized information sheet. Their standard comprises five classes - from one as strongly safety-oriented to five as yield-oriented. As a rule, a rising risk level is linked to increasing opportunities for returns. Interested parties are thus provided with a standardized assessment framework for products, which captures the key characteristics of the policies and allows them to compare rates.

PIA Provides Insight with the Help of Mathematics

For this purpose, the PIA was founded as a non-profit organization. An ITWM team from the department "Financial Mathematics" has been working for the PIA for more than six years and evaluates the insurance tariffs. Both are entrepreneurially separated. The contract simulations for the classification into chance-risk classes are carried out at Fraunhofer ITWM.

"We have already evaluated several thousand contracts and PIA has classified them. The PIA basic model was developed by our institute and is now considered the industry standard," says Dr. Roman Horsky. "In this way, we ensure greater transparency for policyholders. Of course, we cannot predict long-term economic developments, but models simulate different development scenarios based on the current economic situation. This is always changing, which is why the parameters of our simulation model are also readjusted annually," emphasizes the financial mathematician. PIA communicates the risk classification alone and does not provide specific tips or advice on the selection of a product.

"We have already come to appreciate the close cooperation with Fraunhofer ITWM during the establishment of the Pension Improvement Act. With the consortium 'Das Rentenwerk', we have also entered completely new territory."

Dr. Normann Pankratz
Member of the Board of Management Debeka Versicherungen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Setting Industry Standards Also for Company Pension Plans

This basic model has become established in recent years. At the European level, a market model that is recognized in the industry is needed. The German Actuarial Association (DAV) recommends the use of the PIA basic model, and other countries have already adopted this proposal in an adapted form.

An adapted model for comparing rates could also support insured persons in the area of "company pension plans". This pillar of old-age provision includes further different tariffs and the offers include different model calculations as well as performance indicators. It is difficult for interested parties to evaluate the products. Therefore the ITWM team is now working together with Debeka on a project for more transparency. The insurance company has developed a new pension product for the company pension plan to be offered in 2023.

Similar to other pension products the key product figures important for sales are to be determined on the basis of a mathematical model. The goal also here: To create an evaluation framework for tariffs that to create a fair comparison of offers enables. Ideally, a cross-pillar standard should emerge that makes it easier for the insured persons to assess their pension provision their pension provision in a holistic manner.

To read the full interview with Dr. Normann Pankratz, go to:
www.itwm.fraunhofer.de/interview-debeka

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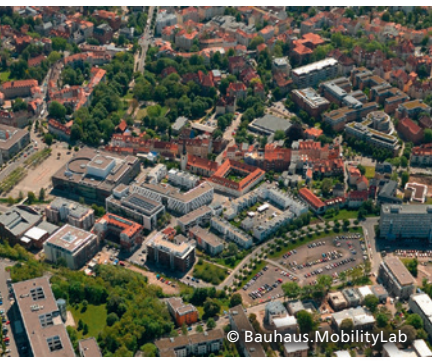
Bauhaus.MobilityLab – AI in the Big City Experiment


© Bauhaus.MobilityLab

With the help of AI, innovative solutions are being developed in the areas of mobility, logistics and energy are being developed and tested under real conditions in the Brühl urban district in Erfurt.

In Erfurt, interdisciplinary innovation becomes reality in the Bauhaus.MobilityLab: A digital laboratory platform and experiments in the living lab contribute to the development of AI-based solutions. Mobility, logistics and energy are being rethought for urban planning. Our institute supports with expertise and AI methods.

The project "Bauhaus.MobilityLab – Innovation by Experiment" develops and realizes sustainable and intelligent solutions in the living lab in Erfurt, more precisely in the Brühl urban district. The experimental ideas workshop is in the spirit of the open Weimar Bauhaus tradition, hence the name. The consortium is made up of a cross-domain association of research institutes, large, small and medium-sized companies as well as universities and the state capital Erfurt.

As part of the project, the researchers are looking at a wide variety of challenges in urban space. In cooperation with the TU Kaiserslautern, the ITWM researchers are modeling problems mathematically and developing new approaches to solutions that make use of both AI and data science. This means new optimization potential in urban life in many places.

Testing New Innovations With AI and Mathematics

"Our team is involved in various work packages in the Lab – of course, mathematics and algorithms are everywhere," says Stefanie Grimm, responsible for the project at the Fraunhofer ITWM. "Our main task: we lead the work package 'AI methods' and thus develop the machine learning core of the platform. In application practice this also means that we provide concrete support with prediction methods. A current use case is the prediction of nitrogen dioxide levels, which say a lot about the city's air quality." Another example is the combined route planning for delivery trucks and cargo bikes in the last mile of parcel delivery. As a result, there mathematical optimization means lower traffic congestion and higher environmental friendliness.

But the prediction of parking space utilization also supports urban planning in the real lab. "Our results contribute to the development of a livable city center. Currently, we are also working in the consortium on a Bauhaus.MobilityLab app, which will facilitate participation in our in our experiment more easily," says Grimm. Another major component of the project is "federated learning", a new type of machine learning method. machine learning method. Here all training data is stored exclusively on local devices or clients, and model training is training is decentralized.

Data Science for the Smart City of the Future

To date, the applications have been developed and deployed on a cloud platform, which brings together data from different areas such as transport, logistics and energy. The project will run for three years and is funded by the German Federal Ministry for Economic Affairs and Climate Protection BMWK.

www.itwm.fraunhofer.de/bauhausmobilitylab_en

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Artificial Intelligence Detects Illegally Imported Wood

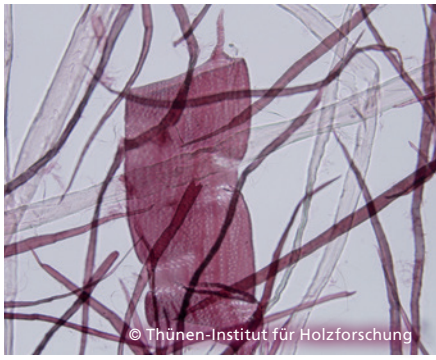
Together with the Thünen Center of Competence for Timber Harvesting in Hamburg, we support customs authorities in detecting illegally imported timber. This is made possible by our AI-based analysis software, which we design and further develop in the "Image Processing" department.

Anyone importing a wood product into the EU must prove with a certificate that the wood does not come from illegal logging. In addition, customs authorities randomly inspect imported furniture and veneers as well as paper and fiberboard. The Thünen Institute for Wood Research in Hamburg often serves as the analysis expert for industry and authorities. „These checks have already led to a number of fine guitars being confiscated prior to an international music fair because their bodies were made of illegally harvested woods," describes project manager Dr. Henrike Stephani the effectiveness of the authorities.

From Mush to Tree

Especially for papers and fiberboards, not whole pieces of wood are examined, but their macerate. This is understood to be a pulp of crushed wood chips from which certain ingredients are dissolved out with water or alcohol. The pulp is treated with various color solutions and applied to glass in a film only a few micrometers thick. This macerate film is so thin that individual vessels can be identified and classified. Up to now, employees of the Thünen Institute have done this by hand and visually. This procedure is time-consuming and sometimes error-prone, which is why the control is to be automated.

"This is where our algorithms come into play," explains Stephani. Using reference specimen that the Thünen Institute produces from its huge wood inventory and makes available as high-resolution microscope images, the researchers train neural networks. Ultimately, the goal is to succeed in uniquely identifying wood. "At the moment, we are only dealing with hardwoods, because here every tree species has unique markers." The goal of the project, however, is a database of all common wood species.



Fiber analysis of a eucalyptus from the Thünen Institute for Wood Research

The Thünen Institute

The Thünen Institute is subordinate to the Federal Ministry of Food and Agriculture (BMEL) and conducts interdisciplinary research aimed at the sustainable development of rural areas, agriculture, forestry and the timber industry, as well as fisheries. It takes socio-economic, ecological and technological aspects into account. As a departmental research institution, the institute develops scientific foundations as a decision-making aid for the federal government's policy. www.thuenen.de

www.itwm.fraunhofer.de/ki-wood-en

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