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 constantly and processing and analyzing these huge volumes of data is becoming a key competence for high-tech countries. We provide companies with advice and support in building up know-how and developing solutions for business processes such as production and logistics. Equally, we emphasize feasibility, cost-effectiveness as well as data protection and security.

Europe-Wide Congress: Trust in AI

Can We Trust Artificial Intelligence (AI)?

This was the question posed by participants at the Europe-wide digital congress "Trust in AI. Responsible AI for Science and Society" on November 26, 2020. Broadcast from the Fraunhofer Center in Kaiserslautern, the German Research Center for Artificial Intelligence (DFKI) together with the two Fraunhofer Institutes ITWM and IESE were able to reach more than 650 interested parties and present current examples from research practice. The Rhineland-Palatinate Initiative for the Future (ZIRP) also invited participants to the conference in the context of the German EU Council Presidency, which was attended, among others, by Minister President Malu Dreyer: In her welcome address, Dreyer highlighted the contribution of Rhineland-Palatinate researchers and companies to responsible AI. Katarina Barley, Vice President of the European Parliament, also had her say, as did the then Rhineland-Palatinate Science Minister Prof. Dr. Konrad Wolf. Institute Director Prof. Dr. Anita Schöbel emphasized the application aspect of AI, especially in the areas of mobility, health and production. AI, especially in the areas of mobility, health and production.

Discussion with Prof. Dr.- Ing. Martin Ruskowski (SmartFactoryKL, DFKI), Prof. Dr. Anita Schöbel (Fraunhofer ITWM) and Prof. Dr. Peter Liggesmeyer (Fraunhofer IESE)

Information on the congress at www.itwm.fraunhofer.de/trustinai_en

Anita Schöbel Becomes AI Pilot

A highlight of 2020: On November 16, former Science Minister Konrad Wolf appointed our Institute Director Anita Schöbel as the first AI Pilot of Rhineland-Palatinate. "She is an internationally renowned expert in the field of Artificial Intelligence and mobility and can already point to a large number of innovative projects. Ms. Schöbel will give a further boost to the application of artificial intelligence in Rhineland-Palatinate," the science minister said at the appointment. As part of the AI agenda of the state of Rhineland-Palatinate, the AI pilots are intended to act as a link between science and industry in order to leverage the potential of AI for companies and businesses. Anita Schöbel herself focuses her activity as an AI pilot primarily in the area of consulting and is available as a contact person for experts and users. In order to enable the use of AI where it can offer added value, lectures on the topic of artificial intelligence are also held at the institute.

The press release is available at www.itwm.fraunhofer.de/ki-lotsin-en

Researchers in Financial Mathematics Calculate Smart Solvency Capital

Insurance companies must regularly present the so-called solvency ratio to the public. This is intended to provide indications of how crisis-proof the providers are. The calculation is very complex and specific, and many companies only perform it once a year. Financial mathematicians are helping to calculate the solvency ratio using artificial intelligence (AI). What this means is explained in an interview with Dr. Stefan Mai, business unit developer "Retirement Provision" in the "Financial Mathematics" department:

Solvency ratio: greater transparency, but also increased complexity. AI provides a remedy.

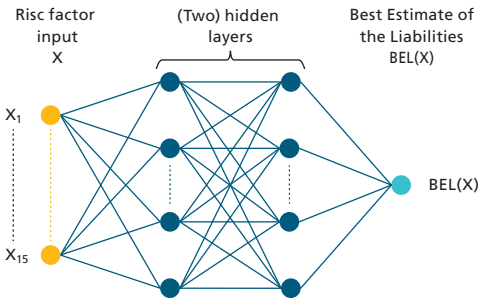
First of all, we should clarify the current meaning of the solvency ratio for insurance companies and how it is dealt with.

The new European supervisory regime Solvency II has been in force since January 2016 – with the aim of avoiding insolvency of insurance companies or ensuring that companies can fulfill their commitments even under extreme circumstances such as crises. Solvency capital is calculated in different ways, with the calculating company having to take into account all risk scenarios relevant to it in each case. Examples of major crises can be natural catastrophes, stock crashes or a strong demand for health insurance services due to epidemics/pandemics. The solvency ratio is a point of reference for the precautions taken by the insurance company.

What support can our expertise provide?

The Solvency II calculations in the area of life insurance are not only required by law, but are also extremely time-consuming, as every single contract is calculated in at least 10,000 future capital market scenarios until expiry. Because of the effort involved - many insurance companies manage millions of contracts in their portfolios - calculations are usually performed only once a year.

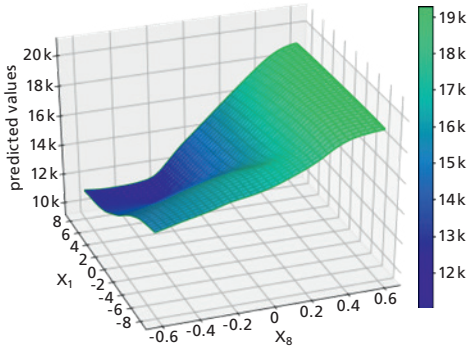
From our discussions with insurance companies, we know that the decision-makers would like to use a neural network that enables a sensitivity analysis of the solvency capital in "real time". Our research concept: The neural network is trained on existing data and the company's internal model. Here, the award-winning ITWM software tool NASE can also be used to determine the optimal architecture of the network. With my colleague Dr. Roman Horsky, I am constantly in discussion about the contribution that quantum computing could make in the context of such a research project, but this is a dream of the future. In any case, as a result, decision-makers should receive information not just once a year, but in "real time" for more precise control - for example, to optimize the return on investment for customers.



Schematic neural network for calculating the available capital (© https://doi.org/10.3390/risks8040116)

What does that mean in practical collaboration? How can I imagine this?

The starting point are discussions in the form of an intensive workshop to understand the parameters, models and variables on the asset and liability side of the insurance. Subsequently, the data basis is jointly reviewed and the processing effort of the preparation is estimated. Only then do we move on to the actual development and evaluation. Here, we are supported in particular by Dr. Stefanie Grimm as an expert in data science. Finally, the software is jointly integrated into the company system. In all process steps, we proceed according to the principles of agile collaboration. This means that we work flexibly with customers to address changed or additional issues. Collaboration can take place in a joint innovation lab. Here, employees of our department cooperate with employees of the company in a team. Regular consultations ensure a direct flow of information and thus lead to the best possible project result.



Behavior of a neural network with Variation of the risk factors X1 and X8. (© https://doi.org/10.3390/risks8040116)

In such an industrial project, we can leverage our unique selling proposition in the market, an exclusive combination of domain knowledge in financial and actuarial mathematics, combined with methodological expertise in data science and quantum computing.

More information is available on our website
www.itwm.fraunhofer.de/retirement

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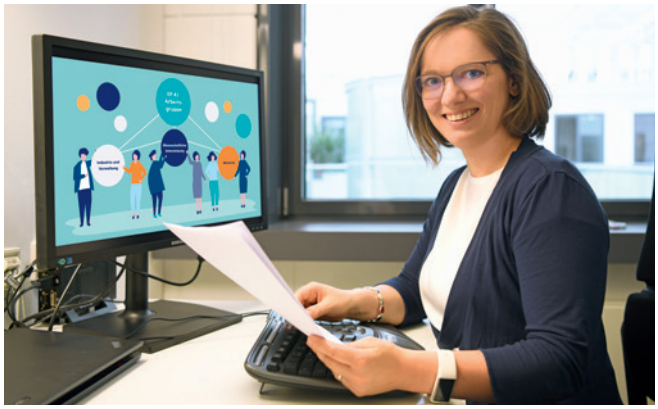
Tracking Down Fraud with Algorithms and AI



Over the past few years, the "Billing Audit and Conspicuity Detection" business area has developed a level of expertise that is probably difficult or impossible to find elsewhere. Two scientists play a special role in this: Dr. Stefanie Schwaar, Business Unit Developer "Billing Verification" and Dr. Elisabeth Leoff, Deputy Head of the "Financial Mathematics" department. Their work focuses on traditional methods and modern AI or machine learning for detecting anomalies.

The young team is working on sophisticated methods and software tools for auditing accounts and has already established itself in sectors such as the automotive industry, care and health, and public administration.

Research project: an AI tracking dog for billing in the care sector

Billing fraud and corruption in the healthcare sector cause major damage to social insurance schemes. This results in enormous costs of several billion euros per year for the taxpayer. Up to now, it has been very time-consuming to accurately check the accounts of care services and contract physicians, and detecting fraud has involved a great deal of complex, manual paperwork. At the same time, due to the particular situation in care (dementia patients, many "small" services), it is difficult to prove a complaint for individual services. In the joint project "PflegeForensik – Effektive Strafverfolgung bei Pflegebetrug durch automatisierte Bildverarbeitung" (Care Forensics – Effective Prosecution of Care Fraud by Automated Image Processing), which is funded by the BMBF within the framework of the "Forschung für die zivile Sicherheit" program, ITWM researchers from two departments support prosecution with modern algorithms of artificial intelligence (AI) in the field of image as well as text recognition. It is carried out in cooperation with the Leipzig Police Department and the General Prosecutor's Office in Dresden.

The core objective of the project is to develop algorithms for the automatic scanning and intelligent evaluation of mountains of paper. This is because every nursing service has its own paper documents, they are structured differently and often not everything is available digitally. Some of them are handwritten, some are tables, some are not. So automated checking is a real challenge. "So far, the various documents have been manually transferred to tables and checked. Image processing can automate a lot of this. Intelligent algorithms can capture both the document

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structure and the content. For example, signatures can be found in documents and assigned to the correct employees," explains Dr. Henrike Stephani, deputy head of the "Image Processing" department at Fraunhofer ITWM.

Machine learning method supports smart fraud detection

The accounting documents are an interplay of performance records, tour and duty schedules and other documents. These have to be combined during the inspection in order to detect fraud. "A conspicuous feature can be, for example, that many of the nurse's services were billed at the same time in the service record, but the duty roster only lists a short assignment. We need to find such peculiarities in an automated way," Leoff said.

Machine learning (ML) methods are used in the research project – more precisely, deep learning methods. With the help of so-called "supervised learning", the algorithm learns from a mixture of real and artificially generated data to first recognize crucial information and then detect anomalies. To train these AI algorithms, the ITWM team designs a database and fills it with data. This means that several thousand documents must have been created by humans and marked with properties in order to make the algorithm intelligent at all. The algorithms are programmed and tested again and again with data from real investigation procedures. The evaluation is then based on the analysis of the documents and conspicuous features are automatically searched for.

But the work is not done with algorithms only: "In the end, we want to provide investigators with a software tool that helps to systematically uncover fraud cases more quickly. It must be easy for the public prosecutor's office and the police to use and deliver results that are as reliable as possible. In addition, the computing time must not take too long, as the police should be able to retrain the software independently for unknown formats. Which can often still be difficult with deep learning methods today," Leoff emphasizes.

AI competencies are constantly being expanded

The business area is complemented by the six-member EP-KI team (EP-KI: AI decision support for business processes) around Stefanie Schwaar. This team also takes care of the development of smart AI processes for applications, but with a different target group. Many decisions in companies and administrations today are still based on manually evaluated data sets. The knowledge of many employees in companies remains with them and is rarely taken into account for future decisions. At the same time, public administrations, in particular, are facing a major technological upheaval which is leading to the digitization of numerous other processes. In this context, the AI junior research group supports companies and administrations.

The group, which is funded by the German Federal Ministry of Education and Research, focuses its research on future-oriented issues and their solution through application-friendly processes.

The fields of application are not limited to billing verification and fraud detection. Here, methods of explainability (Why is a bill conspicuous?) and prognosis (How is the development to be expected?) are also considered. They share more about their work and activities on the team's website and blog.

More information on the "Accounting Audit" business unit www.itwm.fraunhofer.de/accounting-audit

To the EP-KI team blog www.itwm.fraunhofer.de/epki-blog_en

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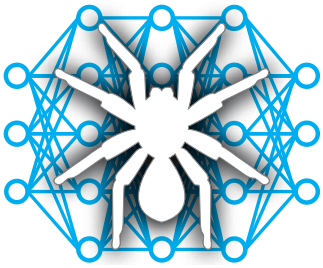
Tarantella Spins Fast Networks – Computing Power for Deep Learning



The development of tools that facilitate Deep Learning users' entry into High Performance Computing was the goal of a BMBF project; the share of the "High Performance Computing" department is explained by project manager Dr. Peter Labus.

Your team has developed the Tarantella framework – an unusual name for a piece of software. How did it come about? And how dangerous is Tarantella?

Tarantella enables artificial neural networks to be trained on high-performance computers. This makes the time-consuming process faster because more data can be processed at once. The artificial neurons are activated more frequently – so they start dancing, so to speak. Tarantella expresses this very well because it is a boisterous Sicilian dance that is danced in large groups. So a spider metaphorically spins the neural web, which is why it's in our logo. And of course completely harmless!

What can Tarantella do?

Besides the already mentioned feature that neural networks can be trained faster with more computers, we also support the training of arbitrarily large neural networks. This was previously not possible due to the limited memory of a graphic card. Now, even deeper neural networks can be trained, which can learn more complex mathematical functions and thus solve more difficult problems. We were supported on the one hand by the German Research Center for Artificial Intelligence (DFKI), which dealt with the issue of partitioning the neural network among the various computers of the supercomputer. Support for the performance evaluation of our software came from the Center for Information Services and High Performance Computing (ZiH) in Dresden. And finally, the University of Heidelberg: The team dealt with application scenarios of particularly large neural networks, for whose training Tarantella is needed.

So the framework is ready to use. What application areas have emerged?

Neural network training is becoming increasingly relevant as the computing time invested in AI grows exponentially. This has enabled many breakthroughs in speech and image processing, which we are already using in social media, online shopping, but also in the smart home. Science also benefits from the use of large neural networks, e.g. cosmology, climate research, particle physics. Our goal was to make supercomputers usable by Deep Learning users without assuming knowledge of these systems (or of parallel programming), thus democratizing the development of new AI solutions. Tarantella makes this possible by building on one of the most widely used Deep Learning frameworks – TensorFlow – and its interface. Existing AI applications can be ported to run on a high-performance computer with minimal changes due to Tarantella.

Further information www.itwm.fraunhofer.de/HP-DLF_en

Tutorials on our website www.tarantella.org

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Customized Digital Planning Processes

The digitization of planning processes is intended to help manufacturing companies get the optimum out of their processes. A team from the "Optimization" department provides support with the development of customized software.

Questioning existing planning processes is often the task of researchers in the field of "optimization" in their industrial projects. In many cases, commissioning companies are convinced that they know the bottleneck in their own process. The experience of the researchers shows: A different picture often emerges through process simulation.

Mathematically imitating the way experienced workers think

A team led by Dr. Heiner Ackermann and Dr. Elisabeth Finhold is helping companies get started with digital production planning. "In any production, there are many tasks that need to be highly coordinated. In such a case, we look closely at the setting and questions: How are individual processes coordinated? What is happening on which machine? How well are they utilized?" is how Finhold describes the first phase of such a project. "Then it gets mathematical: We develop algorithms that are specifically tailored to the complex rules of the company."

The goal is to customize planning processes. With customized algorithms, the project team replicates to a certain extent what experienced production planners do in their everyday work. "Those who plan production know the working environment very well and have a lot of know-how. We are trying to imitate how these employees structure their tasks," explains Ackermann and emphasizes: "This is also about knowledge management and the digitization of knowledge. We can help automate a high proportion of routine tasks." This would relieve specialists and at the same time create resources for special tasks.

Increase of production efficiency

The software, which has been specifically developed to meet a company's needs, can then be used to explore which variants are possible in the process. Potential for improvement comes to light and there are suggestions as to how production as a whole can run more effectively.

Further information at www.itwm.fraunhofer.de/en/opt

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