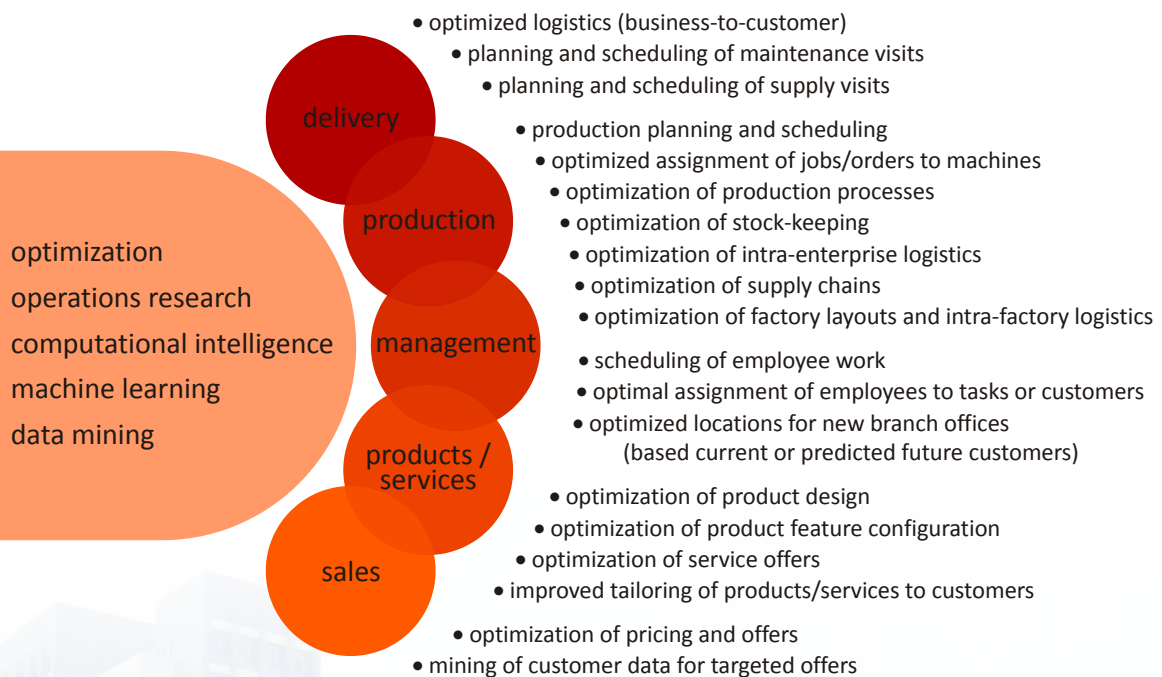


Institute of Applied Optimization (IAO)

The rise of vast computing power and data storage capacity together with the ubiquitous availability of the internet has brought us to the dawn of a new era, which leaves no aspect of industry, business, services, logistics, or even basic infrastructure unchanged. An enterprise must seek to take advantage of these new resources in order to stay ahead of the market, to become more efficient, to reduce its costs, and to increase its speed. Computational Intelligence conquers tasks which were previously pure human domains, ranging from driving vehicles, playing Go, to the automated planning of intermodal logistics tasks involving hundreds of trucks, trains, and ships and to the scheduling of the production of complete multi-production line factories.

The **Institute of Applied Optimization (IAO)** of the Hefei University (合肥学院) provides applied research services in the fields of mathematical and combinatorial optimization, operations research, machine learning, statistics, metaheuristics, data mining, and computational intelligence. With more than twelve years of research experience, we help industry partners to discover where Computational Intelligence technologies can increase their efficiency and speed, can reduce their costs, resource consumption, and work efforts; how it can improve their products and services by making them cheaper, better, and more reliable – all while additionally making them more environmentally friendly. Five groups of business and operational aspects can be supported by Computational Intelligence:



Optimization can, for instance, make **logistics** more efficient, both on the large scale of intermodal cargo transport down to the logistics on the factory floor. It can help to make **optimal management decisions**, such as finding the best assignment of staff to tasks or discovering ideal locations to open branch offices. It can also **improve production processes** by automatically splitting incoming orders in production tasks and assigning these tasks to time slots on suitable machines in order to minimize the time-to-delivery and costs.

Optimization can be combined with machine learning and data mining technologies to optimize business processes based on predicted future market developments. It is a key ingredient for production which is both highly automated and green, as prescribed by **Industry 4.0** and **Made in China 2025 [中国制造 2025]**. More examples will be given on the next page.

Example Application Areas of Computational Intelligence

The areas of application of Computational Intelligence in the industry are extremely diverse. Every application is unique and needs to be designed for the particular needs and situation of a partner. In the following, we present a small selection of the possible application areas for which we can implement optimization and machine learning based software solutions using state-of-the-art and tailored algorithms.

Intelligent Production Planning in Factories

Computational Intelligence can be used to plan production and to make it more efficient. A typical company offers a portfolio of different products and accepts orders from customers for different quantities of these products. Each unit of a product is produced in several steps, possibly involving different machines and workers. Optimization algorithms can distribute the corresponding tasks to the workers and machines in such a way that they will be completed as fast as possible and that every order is fulfilled before its deadline. Such applications are usually implemented as a software which is fed with the current customer orders and the current production plan. It then produces a new production plan as output which can then be edited by the human operator.

Intelligent Logistics for Logistics Providers and for Producing Industries

Optimization methods can also be used to improve the logistics of a company. This can include the planning of routes for the delivery of finished products as well as the flow of material inside a factory or the organization of a warehouse. "Improve" here could, for instance, mean to reduce the overall distance the materials need to be carried or to increase the speed. This reduces costs and increases customer satisfaction. We can also develop software for automating the complete planning of a logistics provider, including the assignment of customers' transportation orders to containers, containers to trains, trucks, or ships, and trucks to routes, in order to pick up and deliver all parcel well within their time windows and to reduce the overall costs.

Data Mining and Machine Learning: Discovering Information, Increasing Efficiency

Often, optimization methods go hand in hand with data mining and machine learning: Data about the production, machine utilization, costs, efficiency, or the customer order situation can be collected and are used for making predictions about the future. These predictions are then used for optimal planning of the production capacity, the acquisition of (the right amount of) raw materials, the employment of staff, or even for deciding when and where to open new dependencies.

Industry 4.0 and Made in China 2025 [中国制造 2025]: Intelligent Automated Production

The concepts of *Industry 4.0* and *Made in China 2025* [中国制造 2025] ask for increasing the automating and customization of production. Here we can apply Computational Intelligence algorithms on two levels: First in the already-mentioned scenario, where sales personnel accepts customer orders and an automatic planning software assigns them optimally to the production units. Second, they can be used inside of an intelligent production, where machines, robots, and systems need to quickly make autonomous, local decisions in order to achieve an optimal operation and to swiftly react to unforeseen events.

Automated Improvement of Product Designs

Optimization can also be used in engineering, to improve design of machines or mechanical components in terms of resource requirements, robustness, and quality: If a work piece is represented as a 3D plan in a computer and the behavior of such a plan can be simulated and its efficiency can be measured, then an algorithm can try to improve the plan in an automatic fashion. This can then result in better work piece designs, e.g., in terms of production costs or robustness.

The Institute of Applied Optimization offers two types of collaboration to industry partners, applied research projects and endowed researcher positions.

Applied Research Projects

Applied research projects aim to improve specific business or operational aspects of an enterprise. Such an aspect can either be named directly by the enterprise or be identified via free consultations. Together with the stakeholders in the enterprise, a project is then defined in terms of goals, volume, a working plan with milestones, and deliverables.

Research projects involving optimization and machine learning technologies differ from traditional software projects in several ways. Additional constraints and objectives for the software are often discovered during an ongoing project. We therefore follow an agile methodology, meaning that we will quickly develop simple prototypes which can be tested by the stakeholders and then are iteratively improved in order to facilitate this dynamic situation.

We offer a wide variety of project sizes. Beginning with a project for developing a software for optimizing an isolated smaller aspect of a partner's operation, we can then build software for more and more complex planning and optimization tasks in subsequent projects. Step-by-step, comprehensive and holistic software solutions like the examples on the previous page can be developed.

Endowed Researcher Positions

An enterprise may endow a researcher position to our institute. This means to fund one PhD for at least one year. This researcher will then carry the title "X Endowed Researcher" (where X is the name of the enterprise) in all official listings, staff directories, communications, and publications. The endowed researcher will fully focus on working with the enterprise to discover where it may benefit from optimization and machine learning and implement corresponding software solutions. The endowed researcher can spend significant time on premise of the enterprise. As a member of our institute, the endowed researcher benefits from our resources and the vast experience and guidance of our other team members. The endowed researcher may also publish scientific articles (advertising the relationship to the enterprise in her/his affiliation), if this is wanted. The enterprise may choose to extend the endowed position on a yearly basis. It may even decide to hire the researcher directly after her/his contract with us ends, at which time the researcher and the enterprise will be highly familiar with each other.

If you are interested in collaborating with us, please directly contact Director Prof. Dr. Thomas Weise at tweise@hfuu.edu.cn (ideally together with a notification SMS to +86 187 551 2284 1) or via WeChat.

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