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Data driven root-cause analysis - optimization of processes with the help of machine learning

Supervisor: Daniel Einsiedel

Ensuring food quality and safety is one of the most important issues in the food industry, affecting both producers and consumers. The quality of food is determined by a large number of parameters and we can have a major influence on this during processing. In short, if something goes wrong during processing, this can have an impact on the final quality of the product. The processes should therefore run as smoothly as possible. One option to ensure this and to further optimize processes is to analyze the data that is generated during the processes. Various methods (including machine learning and image recognition) can be used to determine correlations in the data in order to find out what, for example, leads to faulty products particularly frequently. Ideally, corrective measures can be taken in good time before errors even occur.

Variable selection in the context of smart health-based applications

Supervisor: Falk Gogolla

Diet-related diseases and physical inactivity are one of the biggest drivers of climate change and healthcare costs. Smart health technologies such as fitness trackers generate comprehensive data sets from a wide variety of sources, such as food diaries, exercise metrics or physiological data. However, this data is often also used in or supplemented by population-based epidemiological studies. The sheer volume of data alone leads to analysis problems that require challenging artificial intelligence approaches in the selection of variables. Is heart rate (variable 1) more important than calorie intake (variable 2) or exercise in the first half of the day (variable 3) for developing metabolic syndrome (target variable)? Surely you have an idea because you might be a future nutritionist or biotechnologist. But the machine selects according to purely statistical characteristics. So far, however, it is unclear how expert-based knowledge such as that of physicians, nutritionists and sports scientists, in contrast to technical selection of variables, influences the results at both individual and population level. Project-related, exciting questions for a review can be realized according to personal prior knowledge and interests.

Approaches for determining the shelf life of food in real time

Supervisor: Elia Henrichs

Packaged food must be labeled with a best-before date. In the case of perishable foods, a use-by date must be given instead of the best-before date, as these can be harmful to health due to microbiological spoilage. However, the best-before date only indicates until when the unopened food retains its specific properties. The best-before dates are often oversized and many foods are disposed of as a precaution because they have passed their best-before date, even though they are often still edible. Intelligent packaging can monitor food during transportation and display the current state of food quality. Current developments also make it possible to predict the remaining shelf life.

Digital Food Twins - process mapping through machine learning

Supervisor: Dana Jox

Digitalization in the food industry enables trends such as flexible contract manufacturing and individualized food, but requires real-time analysis of production lines. The complexity of food production and the monitoring of changes in raw materials and process parameters pose challenges. A digital twin could map and analyze processes, requiring data from the entire value chain and theoretical knowledge. This linking of data and models is currently inadequate. In our project, machine learning methods will be used to identify and predict critical process and quality patterns in companies, with the predictions being validated experimentally.

Process optimization using optimization algorithms

Supervisor: Pia Schweizer

The optimization of processes is of central importance both in the laboratory and in food production. These challenges are often complex, as numerous parameters have an influence. For example, laboratory tests usually depend not only on temperature and pressure, but also on the starting materials and their concentrations, among other factors. Optimization algorithms aim to find optimal or at least quasi-optimal solutions for such problems without actively testing all parameters - this saves both time and money. However, as the spectrum of existing optimization methods is very broad, various types of optimization algorithms will first be researched and implemented as part of this project. These algorithms will then be compared with each other in terms of their strengths and weaknesses.

Determining food freshness using sensor technology and AI

Supervisor: Julia Senge

Consumers are often faced with the uncertainty of whether food is still edible and tend to dispose of it as a precautionary measure instead of reusing it. The resulting increase in food waste by consumers, especially with fresh produce such as fruit and vegetables, poses a major challenge. In my research, I am working on the development of non-destructive sensor technologies, e.g. electronic nose, combined with artificial intelligence (AI) to predict food freshness. I focus on real-life conditions. The aim is to use precise prediction models to determine food freshness or residual shelf life in order to reduce food waste.