Digital Test System (DTS) And Energy Monitoring for Buildings

Degree programme: BSc in Computer Science | Specialisation: Data Engineering
Thesis advisor: Prof. Dr. Erik Graf, Prof. Dr. Mascha Kurpicz-Briki
Industrial partner: Amstein+Walthert AG, Bern

Amstein + Walthert developed a system to automatically test and find construction errors in HVAC (Heating, ventilation and air conditioning) mechanisms inside of newly constructed buildings. For these tests, the system automatically collects and stores a huge amount of sensor data from these buildings. The goal of this thesis is to find new ways to use this available data to further increase the business value of the current system.

Initial situation

The digitalization in the construction industry is moving forward. Currently, Amstein + Walthert AG, an engineering company uses smart systems to collect and analyze essential data from newly constructed buildings. Sensors inside the building collect data, which is then sent to the cloud for storage, analyzation, and later to create valuable visualizations from this data. Through the use of state-of-the-art technology (IoT devices, cloud infrastructure), A+W ensures that the HVAC (heating, ventilation and air conditioning) systems are working correctly. This thesis focuses on the further development of this system to increase the efficiency and quality of the HVAC units. This should be achieved with optimization algorithms and or machine learning.

Goals

The main goal of this thesis was to find new ways to optimize the HVAC systems inside the buildings with the available sensor data. Additionally, other external data sources, like weather data could be used. To make sure that the optimization is done on a properly functioning system, functionality checks as well as data visualizations were made. To optimize the system behavior, I explored different approaches like a Proportional Integrate Derivative (PID) controller, Model Predictive Control (MPC) as well as alternative approaches.

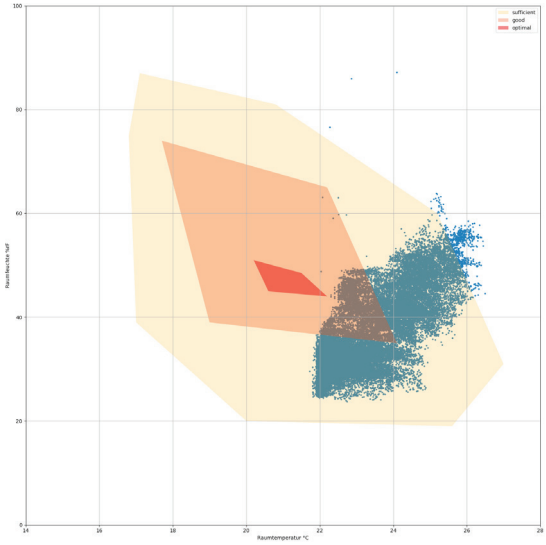
Results

With this thesis, I provided valuable functionality checks and visualizations for Amstein + Walthert to use in production for their customers. In terms of prediction, it became clear that typical machine learning was the wrong approach for this project. Moreover, it became clear that a PID controller in the cloud is not the optimal solution. Also, other approaches were followed like Model Predictive Control (MPC) and using weather data to create predictions. During this thesis, the developed models were not validated in a real-life-system. This will be a future project at Amstein + Walthert. Overall there were a lot of useful insights gained for the further development of optimization algorithms for HVAC systems.

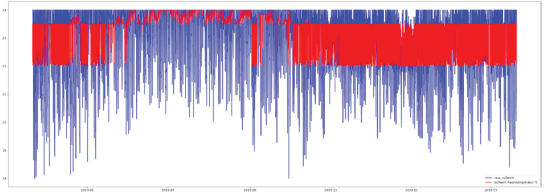
Outlook

It became clear that there is a lot of potential in the optimization of the HVAC system inside a building. Improved efficiency leads not only to reduced costs but also decreases the emitted greenhouse gases.

Silas Stulz
078 623 31 04
silas.stulz@gmail.com



Balance between humidity and room temperature. Occurences inside »dark red» are optimal, «orange» is good and «yellow»



New temperature prediction values using external weather data