

Thesis title: A Framework for Automated Real-Time Performance Evaluation of Smart Buildings

Abstract

With the impending climate crisis, it has become vital to take actions to mitigate the negative effects of CO₂ emissions, one of the greenhouse gases responsible for the climate disruption. Limiting CO₂ emissions is achievable through a general reduction of energy consumption, and a movement towards renewable sources of energy. As buildings contribute significantly to the world's energy demand, establishing optimal energy consumption becomes critical. However, there is a documented gap between buildings' intended and operational performance, despite the existence of a commissioning process ensuring their functionality, during handover. The goal of this thesis is to reduce this gap by developing a framework featuring tools and methodologies for continuous evaluation of buildings' performance in real-time, in new and existing buildings regardless of their type and available sensing instrumentation (meters, sensors, etc).

Current building intelligence solutions suffer from poor portability as they are typically tied to specific buildings. To address this shortcoming, the framework in this thesis relies on metadata models of buildings to discover available instrumentation. This metadata enables automatic initialisation and instantiation of the framework regardless of the building's specifics. The building's operational data is then compared to a threshold defining the expected behaviour. The framework identifies the optimal choice for threshold forecasting technique given parameters pertaining to availability of a priori data, and accuracy of forecast.

To increase the framework's maintainability, as well as its ability to integrate with other software, the framework has been implemented as an ensemble of microservices.

The framework has been successfully implemented and deployed on a case study building at the campus of the University of Southern Denmark. The framework has identified numerous faults during its operation, and has helped discover issues with faulty wiring of meters as well as malfunctioning sensors.