SIMULATION OF AIR CONDITIONING IN BUILDINGS

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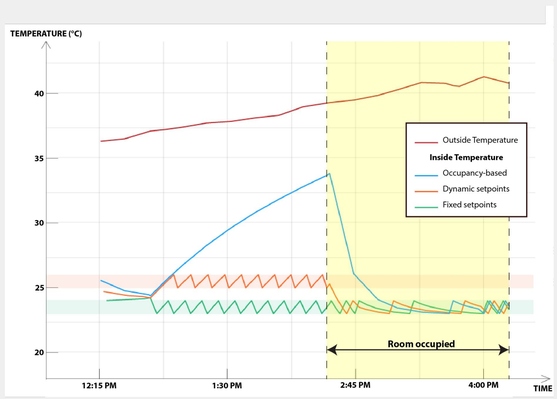
AIM

To make use of past data of a room to predict the rate of heating and cooling of AC given a certain set of parameters.

MOTIVATION

- Heating and cooling of a building contributes significantly to energy costs
- Strong desire for efficient HVAC systems
- Need for optimisation: trade-off between efficiency and occupant comfort
- To optimise such a system, we must first understand how the system works
- Investigating the possibility of an efficient occupancy-based setpoint



Methods of temperature control

CONCLUSION AND PLANS FOR FURTHER WORK

- Predictions made by the model for all 3 algorithms were fairly accurate
- Model was built based on one specific room in the building
  - applying this same method to different rooms in the building still resulted in accurate predictions
- However, the model was only tested for the cooler months of the year
  - Different algorithm would be needed for the summer months
- In the future - look at different variables and features (room properties, occupancy of rooms, etc.)

Example of AC unit at Monash

REFERENCES

- Z. Afroz, G. Shafiullah, T. Urmee and G. Higgins, "Prediction of Indoor Temperature in an Institutional Building", Energy Procedia, vol. 142, pp. 1860-1866, 2017.
- N. Attoue, I. Shahrour and R. Younes, "Smart Building: Use of the Artificial Neural Network Approach for Indoor Temperature Forecasting", Energies, vol. 11, no. 2, p. 395, 2018.
- U.S. Department of Energy, Office of Scientific and Technical Information, "The impact of demand-controlled and economizer ventilation strategies on energy use in buildings", 1999.

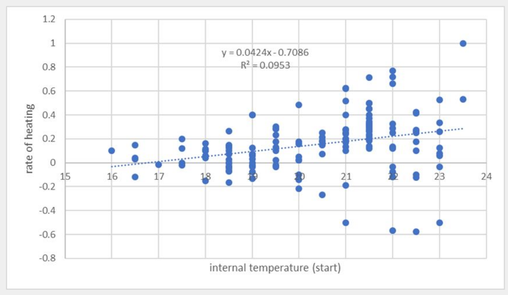
THE DATA

- Heating/cooling: done by OAPU (Outside Air Processing Unit) and AC
- System tries to maintain a certain set point (between 21-24 degrees Celsius)
- Obtained data regarding temperature at 15 minute intervals
- Parameters: room temperature, set point, external temperature, level of CO2

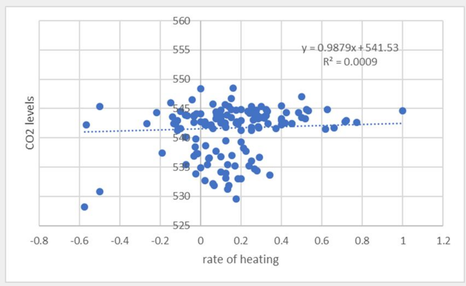
METHODOLOGY

1. EXPLORATORY ANALYSIS

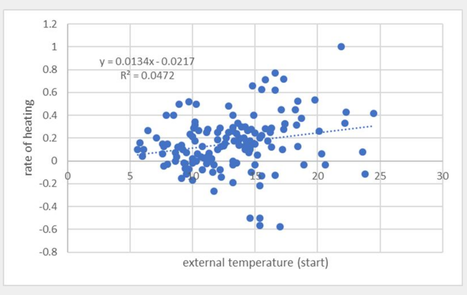
- Initial plotting of data to identify patterns
- Looked at how various parameters related to temperature



Graph of internal temp vs rate



Graph of CO2 vs rate



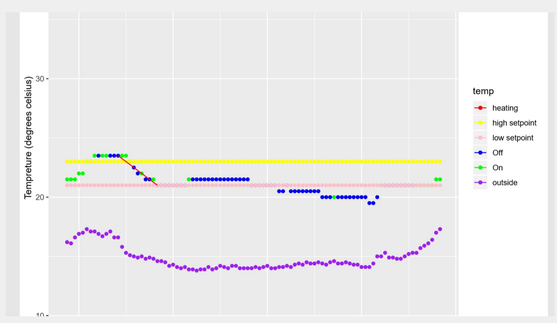
Graph of external temp vs rate

2. DATA PREPARATION

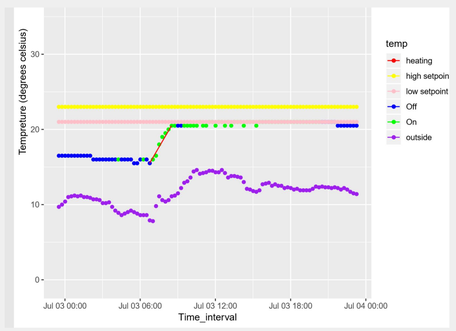
- Involved cleaning up the data set by removing empty sets, and combining data from various sources to form one complete data-frame

3. HEATING/COOLING DETECTION ALGORITHM

- The OAPU functions at different rates according to the start temperature



Example of a cooling period



Example of a heating period

4. MACHINE LEARNING ALGORITHMS

- Linear model
- Random forest
- SVM

Using different parameters in the building of the model can yield different results. The parameters included in the building of the final model were:

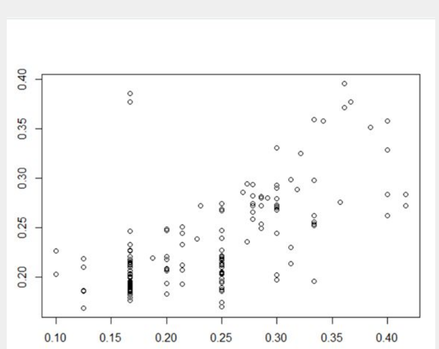
- Internal starting temperature
- External starting temperature
- Average CO2 level of the room

5. 7-FOLD CROSS VALIDATION OF THE MODELS

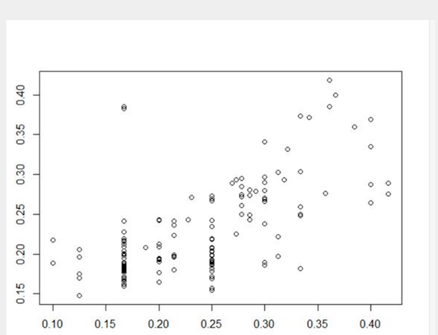
RESULTS

- Calculated root mean square error of the model for different rooms on the ground floor
- Obtained average root mean square error across the rooms

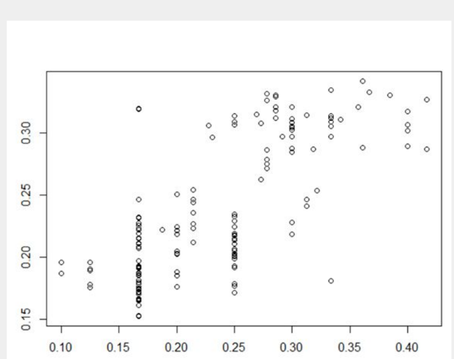
	Average Root Mean Square Error
Linear Model	0.0588
SVM	0.0576
Random Forest	0.0544



Example of results of linear model



Example of results of SVM



Example of results of random forest