Predicting thermal inertia of HVAC installations

Project in the field of IoT for building energy systems in cooperation with Indoorclima

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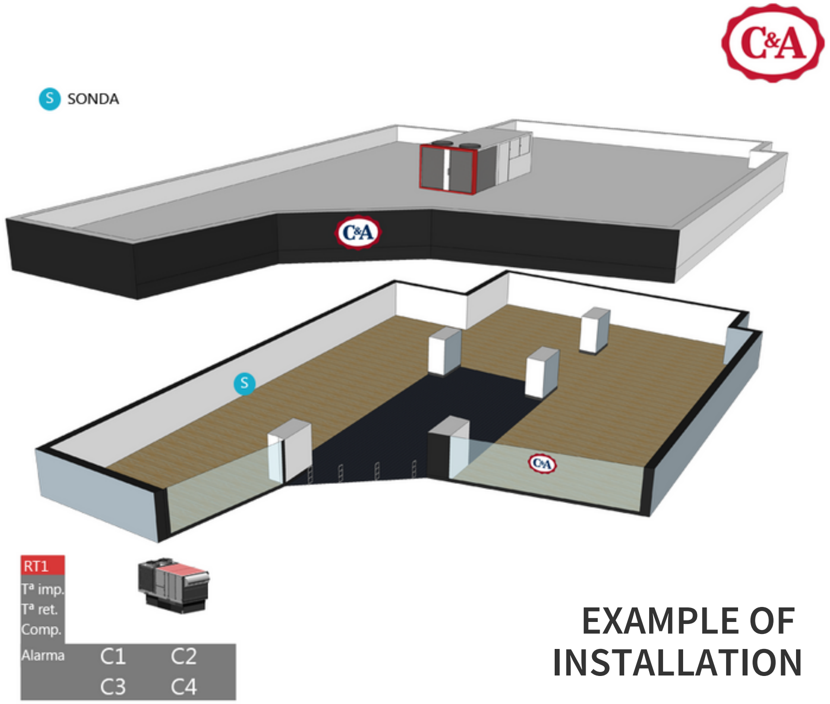
Outline

Predicting thermal inertia of HVAC installations

Motivation

Predicting thermal inertia of HVAC installations



EXAMPLE OF INSTALLATION

The smart management of HVAC installations leads to energy savings of 5% to 20%

A thermal inertia algorithm should indicate when to power on/off the HVAC system to reach desired temperature at the desired time

Inertia model developed in the past running with limitations: not considered external temperature and can't be trained on more than 2-3 months of data

Thermal inertia: the degree of slowness with which the temperature of a body approaches that of its surroundings and which is dependent upon its absorptivity, its specific heat, its thermal conductivity, its dimensions, and other factors.

Objectives and goal

Predicting thermal inertia of HVAC installations

Objectives

- Create a model for the prediction of thermal inertia during power on and power off
- Improve error metrics by means of feature selection/engineering as compared with the model currently used
- Create a model which can be trained on 1 year data without negative impacting error metrics

Goal

- To now when to power on / power off
- Do as much as possible in 4 weeks time

Executive summary

Predicting thermal inertia of HVAC installations

Achievements:

- 30min change in room temperature predicted with an accuracy of 0.3°C
- Training in 1 whole year
- Development of a pipeline for the prediction of change in temperature from 5 to 60min during power on/off.
- With the predicted DTs the perfect time to power on/off can be easily calculated

Further steps:

- Scale-up to all locations and integrate into production
- Use forecasts of outer temperature to further improve the model
- Use dummy variables to consider the occupation level of buildings (big stores)

Data extraction, transformation and loading (ETL)

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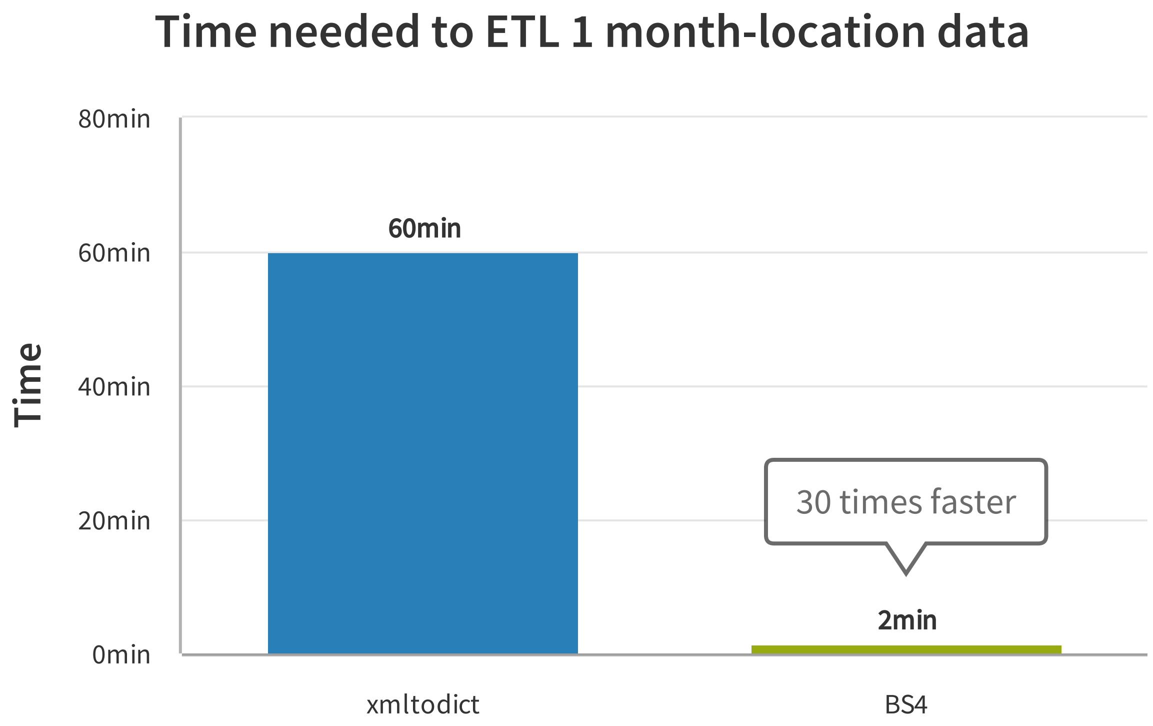
- Access to data through Indoorclima's API
- Data in xml format
- Parsing of xml:
  1. Parsing into ordered dictionaries
  2. Parsing with Beautiful Soup



Since the origin of the data is a SQL database, the xml's are well structured. Therefore the faster method was chosen for being also reliable (thanks god!)

Data extraction, transformation and loading (ETL)

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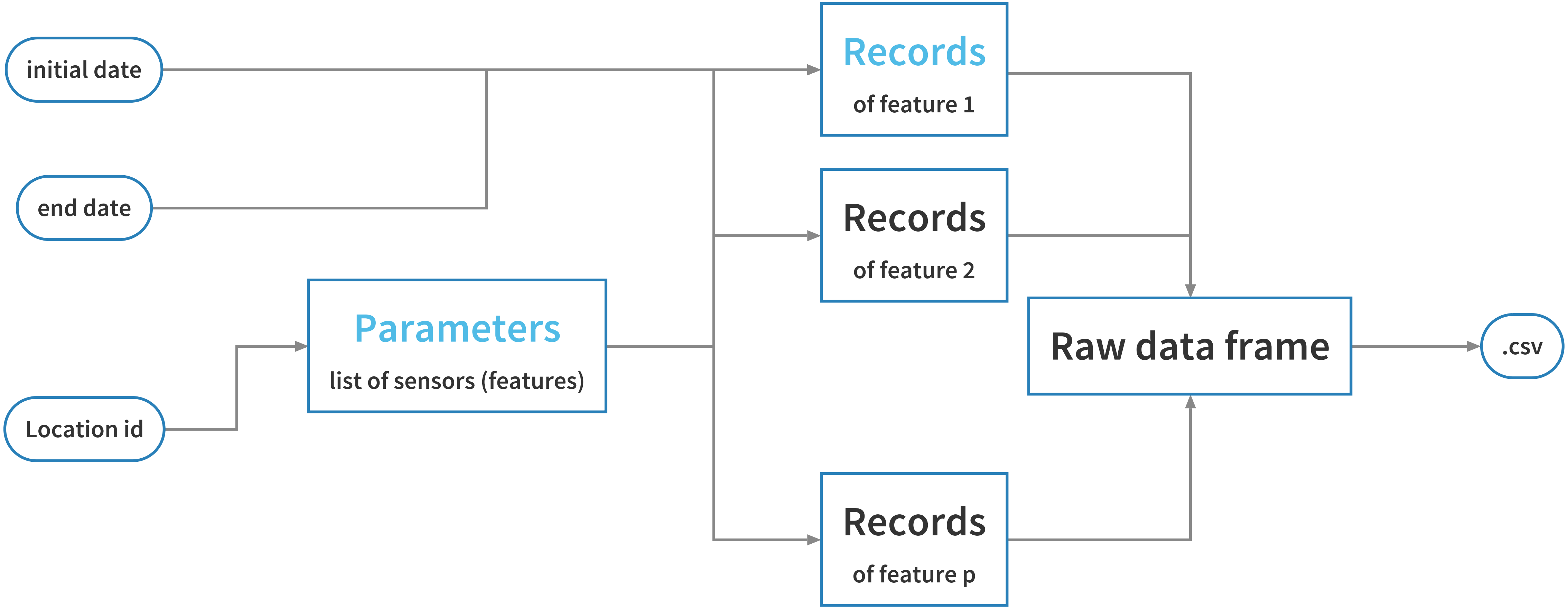

Defining the machine learning problem

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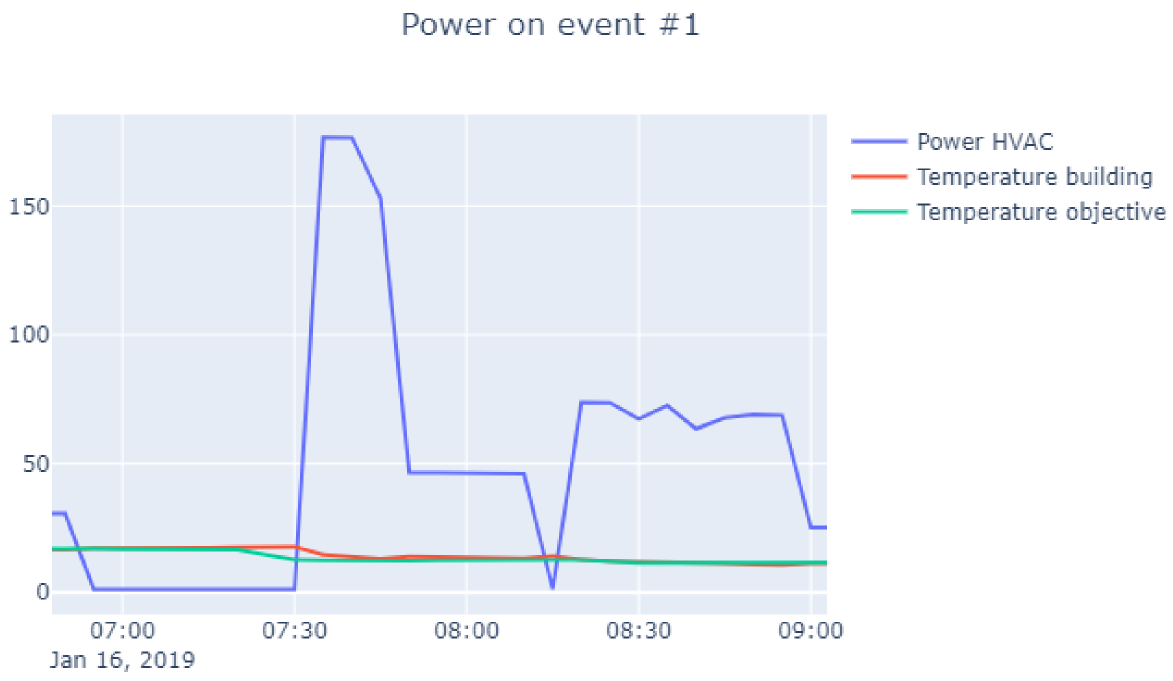
- **The goal is to predict when to power on/ power off the HVAC system in order to reach the obejtive temperature at opening / closing time.**
- **Subsetting dataframe for power on/off events**
- **Creating dependent variables: 12 DT variables (from 5 to 60min)**



PCA - cumulative explained variance

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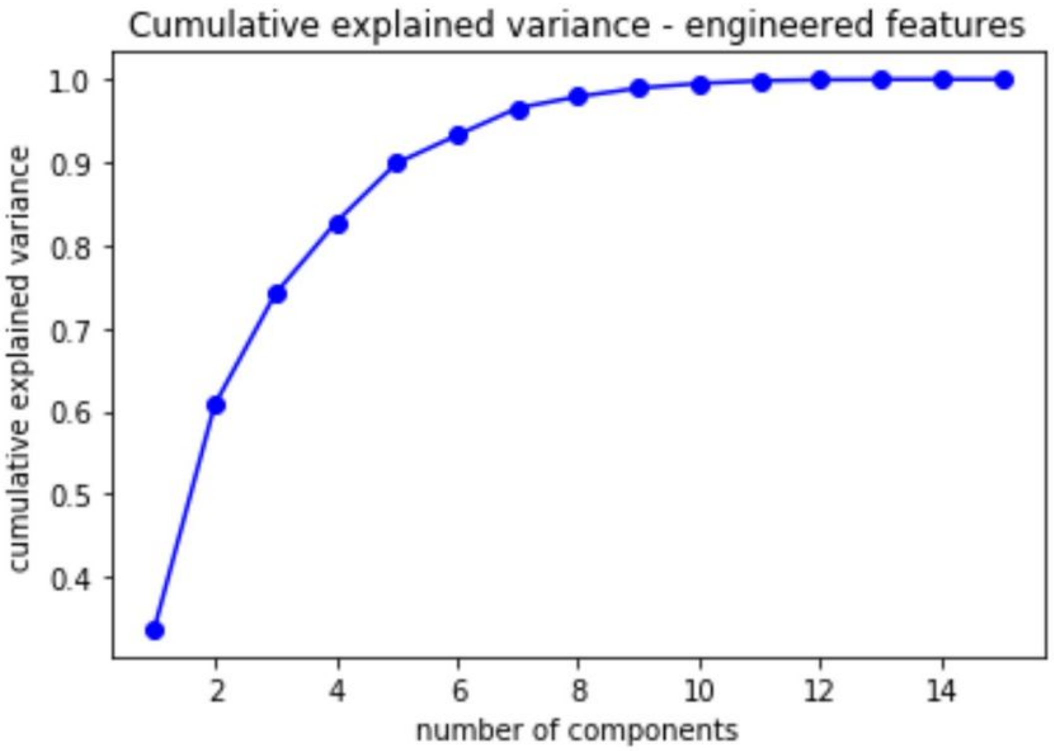

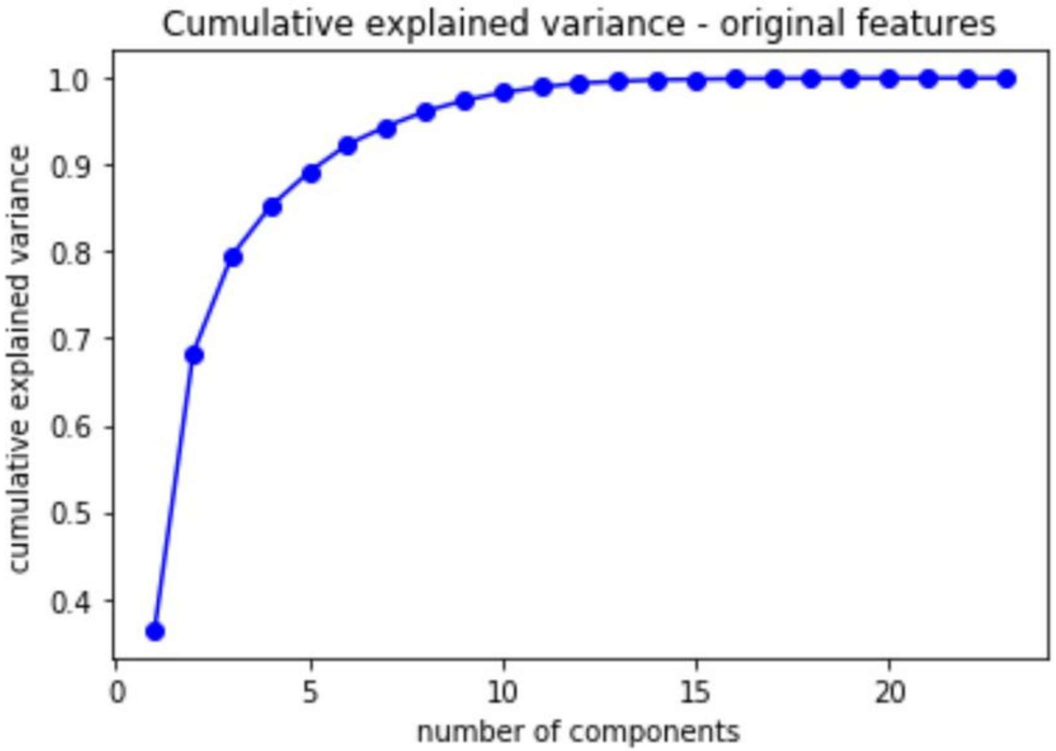

PCA - cross validating different models

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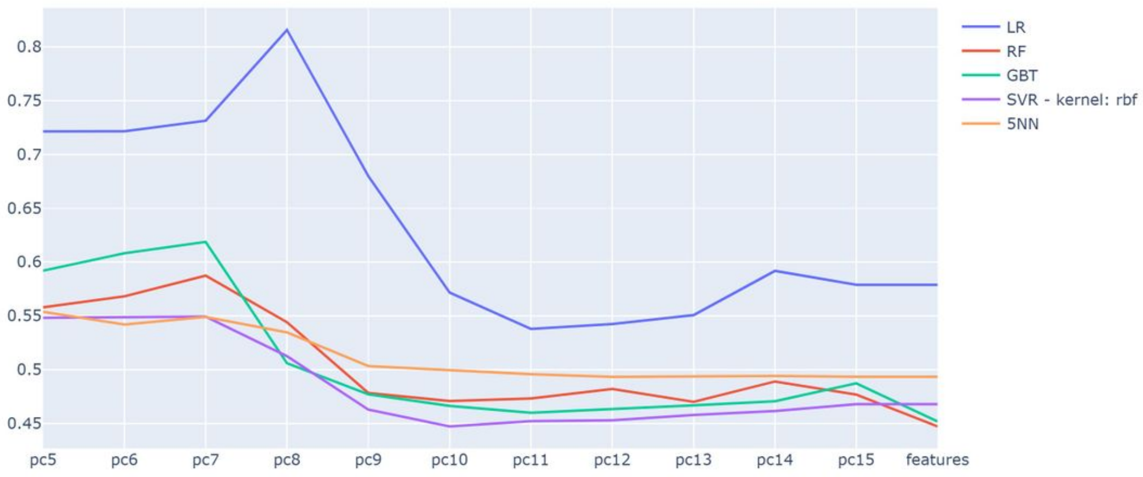

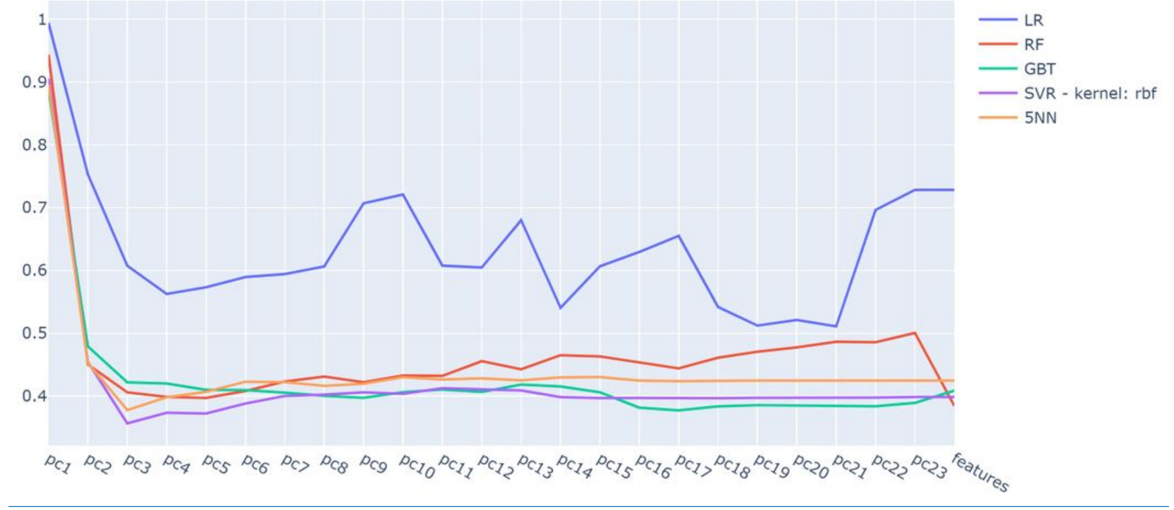

PCA - engineered features

PCA - original features

PCA - cross-validation results

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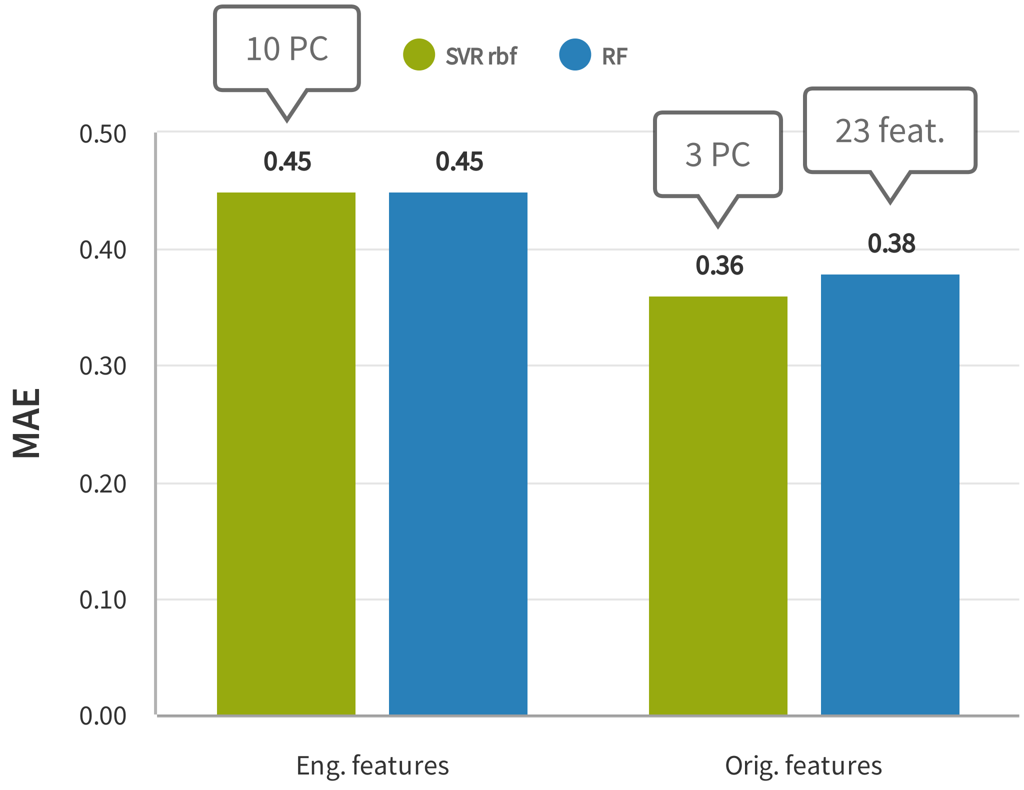
RF performs better with all the original features

The feature engineering yields worst results

The best results are with SVR - radial kernel on 3 PC

MAE: 0.36 (+/- 0.27)



Prediction on unseen data - first results

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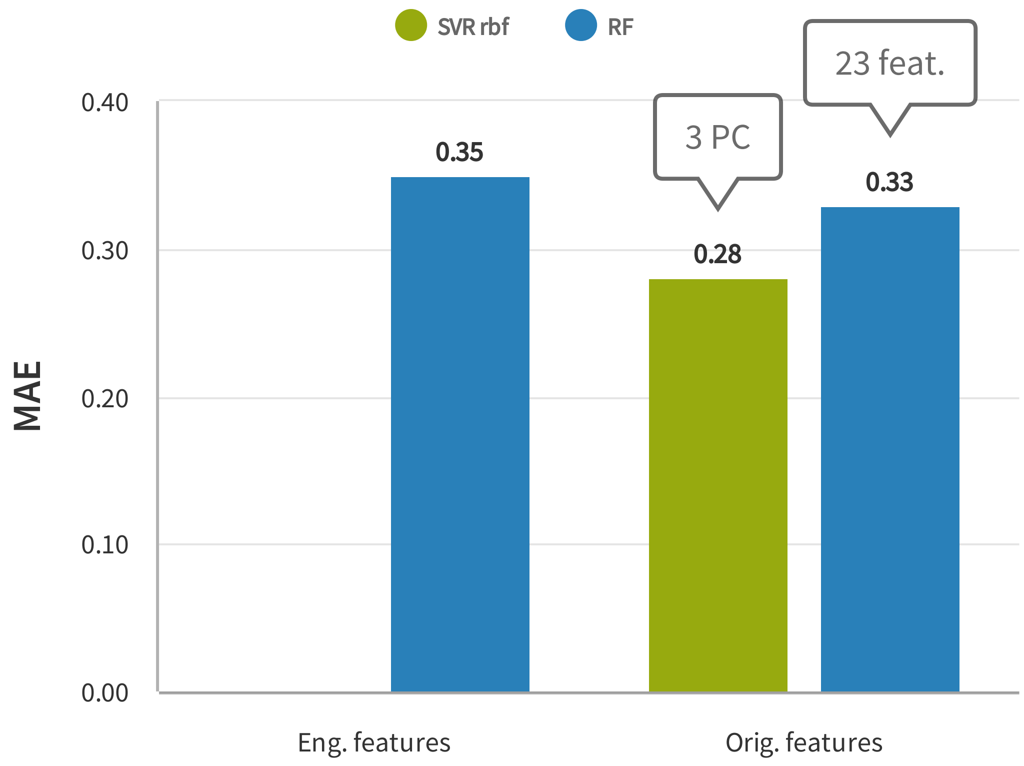
Estimated current average error of 0.8°C

First results show and improvement reducing the error to 0.3°C



Thanks!

Pre-processing

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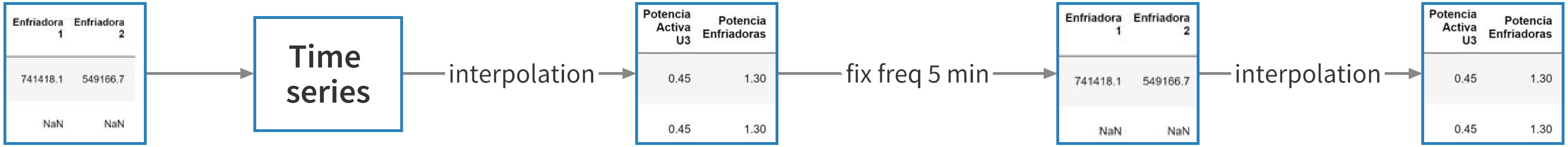

Next-steps

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1. Create scripts in order to generalize the process to all locations
2. Include outer temperature forecast in the model
3. Use dummy variables to consider the occupation level of buildings (big stores)