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

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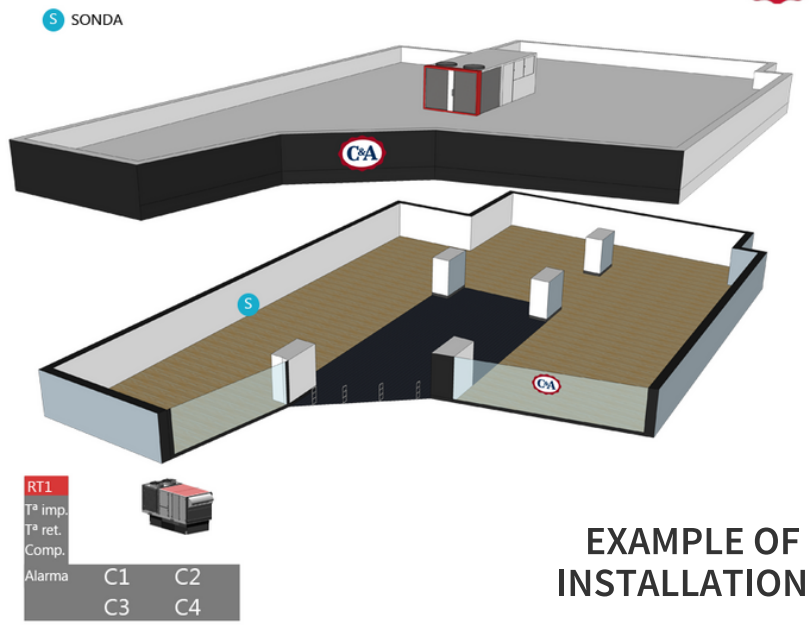
Motivation

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

- For Indoorclima: to now when to power on / power off
- Personal: to face the challenges of a machine learning application in the industry, from data extraction, transformation, definition of the machine learning problem, modeling, testing and implementation.

Data extraction, transformation and loading (ETL)

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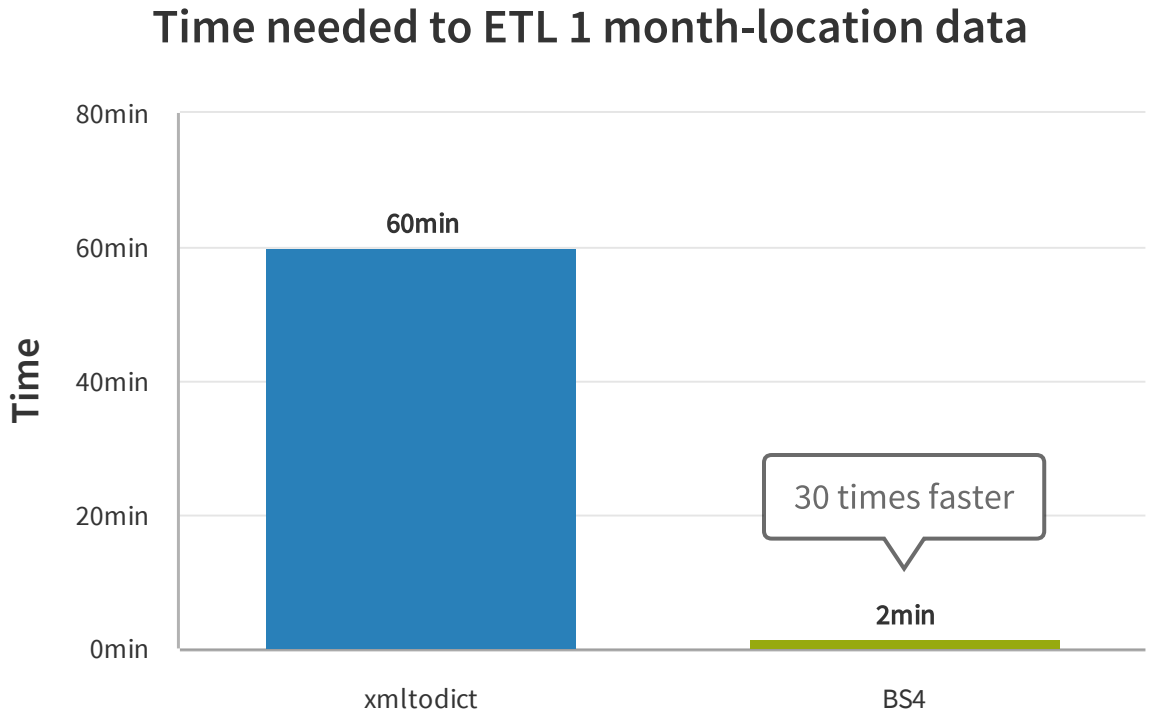
- Access to data through Indoorclima's API
- Data in xml format
- Parsing of xml:
  1. Parsing into ordered dictionaries
  2. Parsing with Beautiful Soup



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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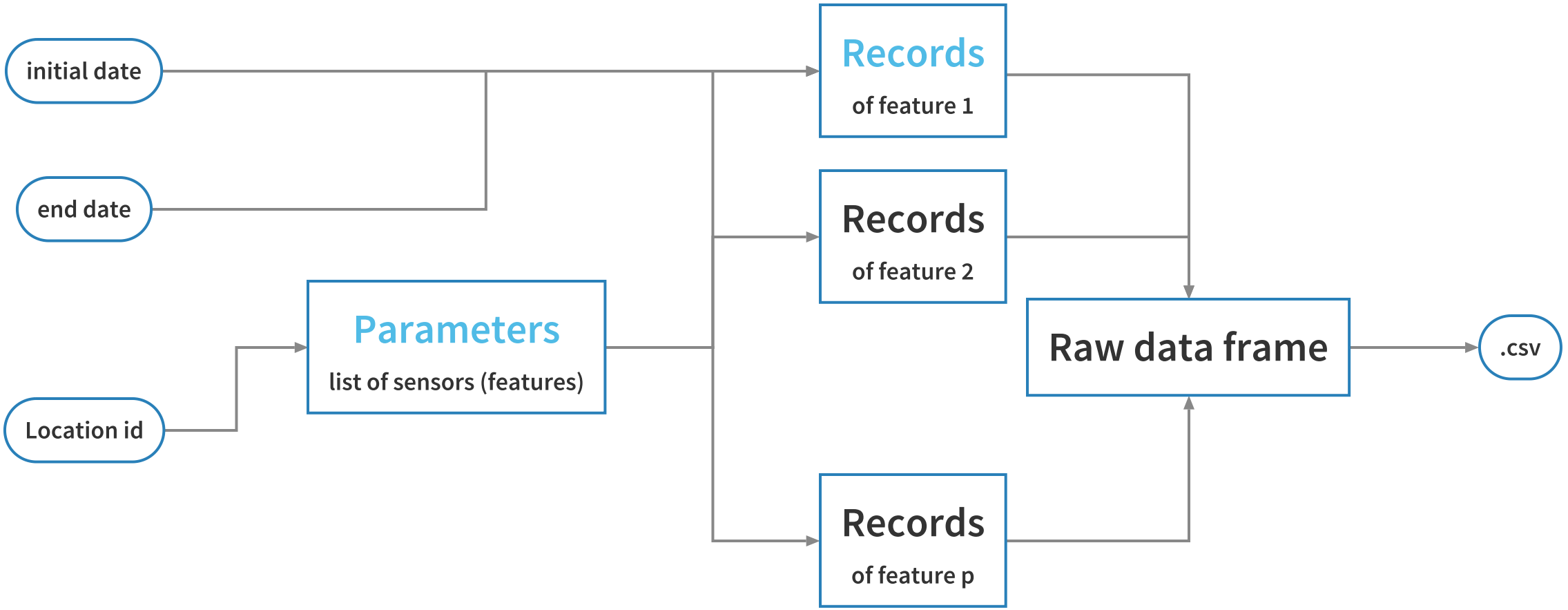

Pre-processing

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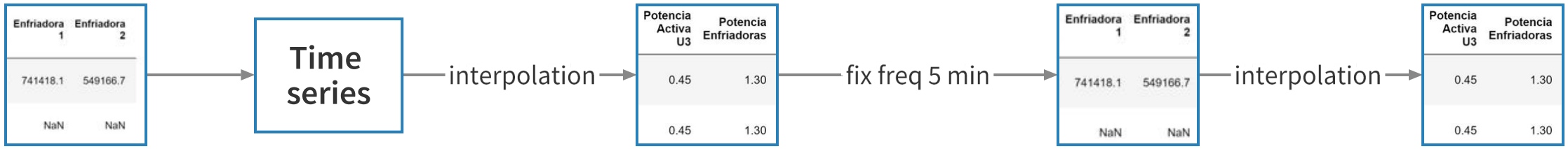

Defining the machine learning problem

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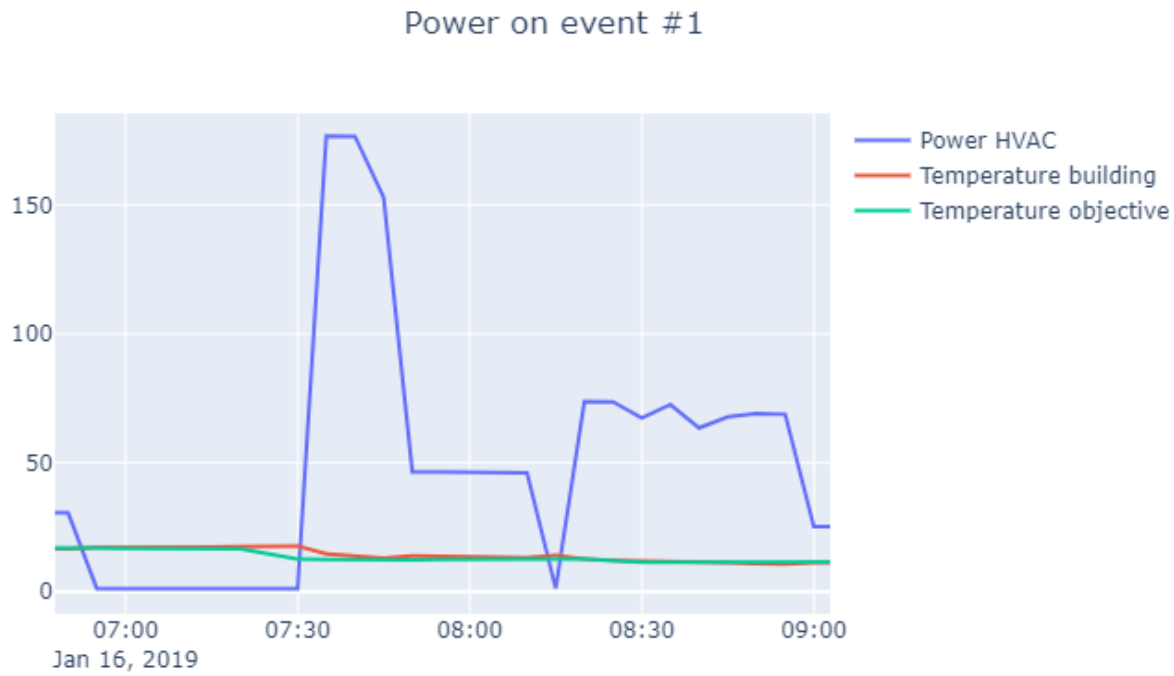
- The goal is to predict when to power on/ power off the HVAC system in order to reach the obejtive temperature at opening / closing time.
- Subsetting dataframe
- Creating dependent variables



PCA - cumulative explained variance

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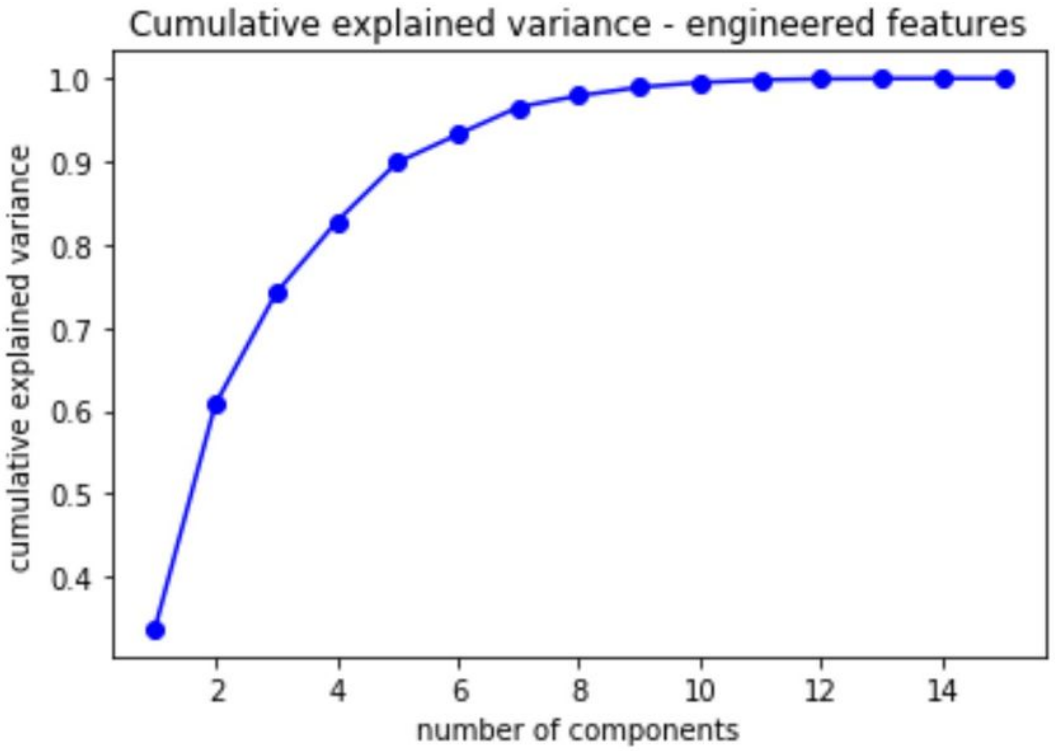
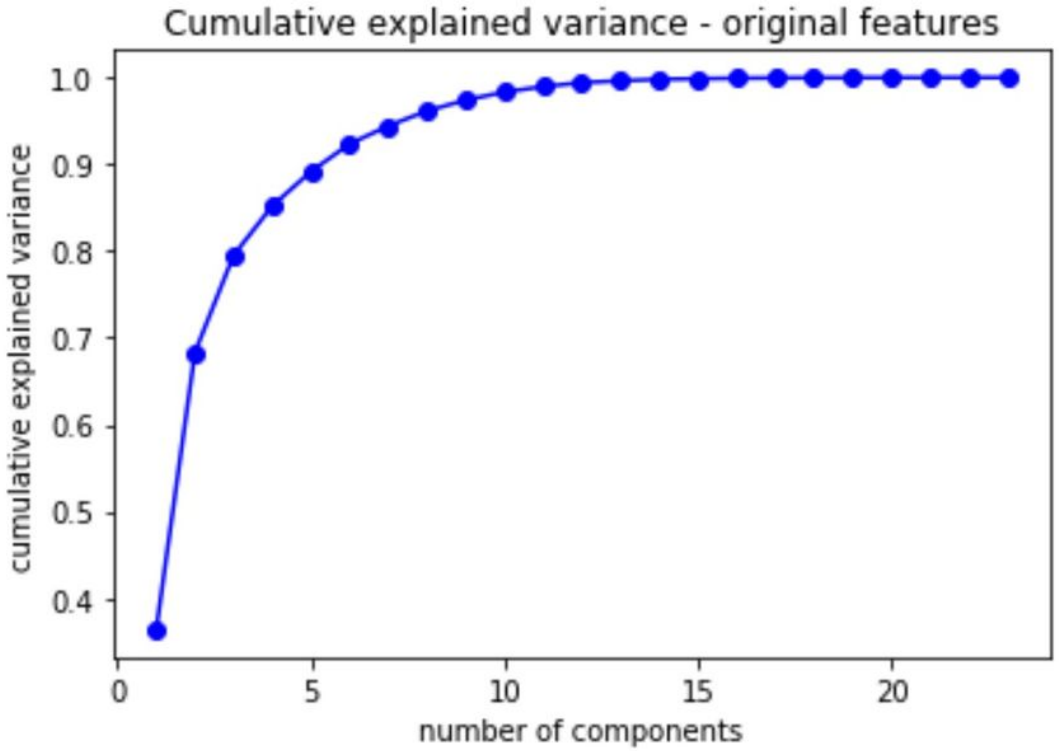
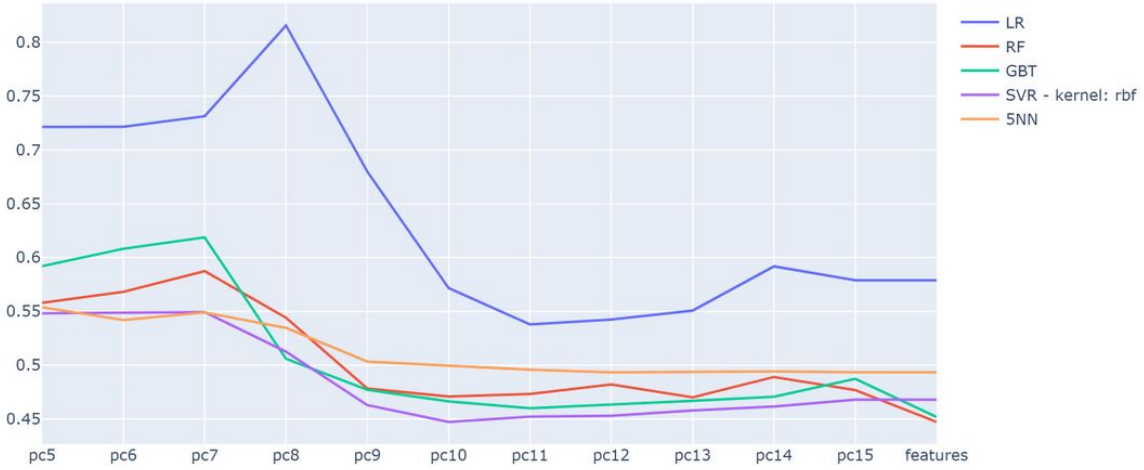
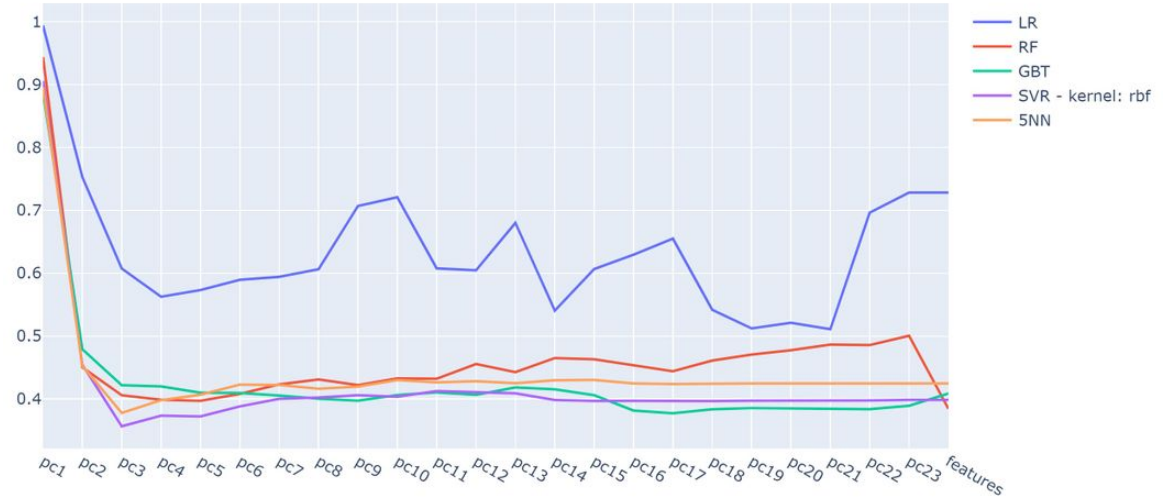




PCA - cross validating different models



PCA - engineered features



PCA - original features

PCA - first results

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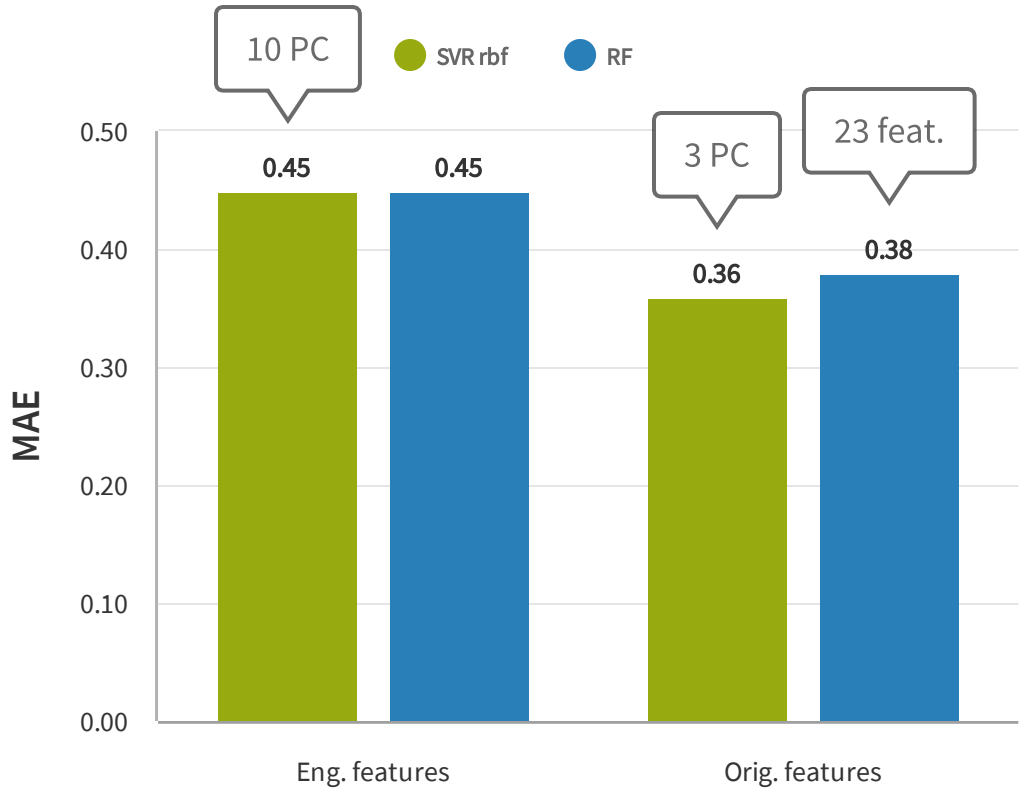
RF performs better with all the original features

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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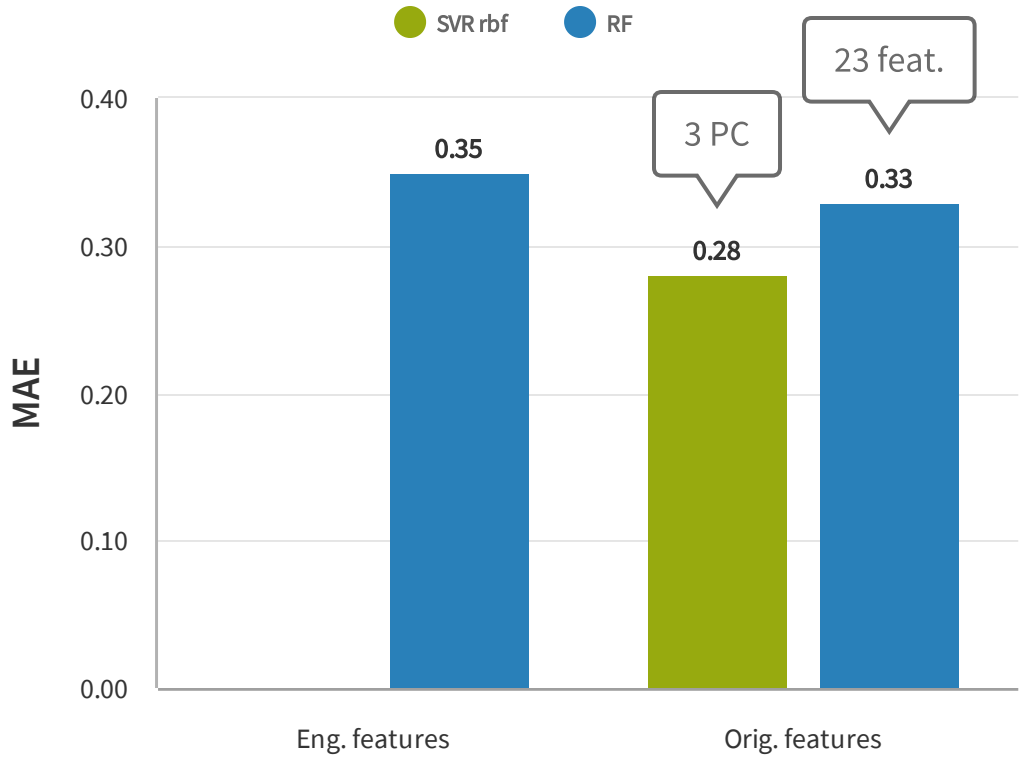
Indoorclima reports an average error of 0.8ºC

First results show and improvement reducing the error to 0.3ºC



Next-steps

Predicting thermal inertia of HVAC installations

1. **Feature engineering is not easy. Evaluate the feature engineering further to improve prediction**
2. **Generalize the process to all locations**
3. **Use public weather forecasts to include outer temperature forecast in the model**
4. **Use dummy variables to consider the occupation level of buildings (big stores)**

Questions?