Classification of District Heat Heat Exchange Stations Using Smart Meter Data

A. Tureczek, P. S. Nielsen (DTU)
H. Madsen (DTU)
A. Bruun (AVA)
The Concept
Smart Meters

- Recording frequency down to seconds, usually 15 min – 60 min interval
Limited research on DH smart meters analytics!

Electricity Smart Meters Clustering

The Data
District Heat Data From AVA

District Heat data from Aarhus

49 Heat Exchange stations (HX)

January 2017 (744) hourly observations per HX

Source: AffaldVarme Aarhus Varmeplan
Ploting of the HX Smart Meter Data

Original Recorded Data

Large differences in consumption volume
The Preprocessing and cleaning of data
Data Preprocessing of the AVA Data – Dealing with Missing Data

Recordings with errors

Recordings with error mean correction
Normalizing Data to Remove Volume Influence on Clustering

\[ \frac{x - x_{\text{min}}}{x_{\text{max}} - x_{\text{min}}} \]
The Clustering of the Original Data Using K-Means
Selecting Optimum Number of Clusters

(4) for K-Means

Normalized Data

Index Value

# of Clusters

4 clusters selected
Cluster Means (4) on Normalized Data

Normalized Class., Random seed: 12345

4 clusters selected
Cluster Members (49) Superimposed onto Cluster Means

Classification Fit. Random Seed: 12345

4 clusters selected
The Preprocessing Revisited: Feature extraction
Autocorrelation as Feature for Clustering

Autocorrelation function for HX station 145 (Kolt)

Coefficient

ACF Lag

ACF coefficients
Confidence bands 0.05%
The Clustering Revisited: Features as Input to K-Means
Selecting Optimum Number of Clusters (7) for K-Means on New Feature Data

ACF Classification, Random Seed: 12345

7 Clusters selected
Cluster Means (7) on Feature Input

ACF Classification, Random seed: 12345

Only 6 clusters are shown as last cluster only had 1 member.
Cluster Members (49) Superimposed onto Cluster Means

Classification Fit. Random Seed: 12345

Only 6 clusters are shown as last cluster only had 1 member.
The Findings
Clustering Comparison

Normalized Data, 4 Clusters

Feature ACF Data, 7 Clusters

For Feature ACF Only 6 clusters are shown as last cluster only had 1 member.
• Classification of Heat Exchangers using Smart Metering data and K-Means can be achieved.

• Preprocessing data for K-Means can improve Clustering performance.

• Classification indicates same underlying model for most Heat Exchangers.

• Outlook
  – Cluster stability Analysis
  – Including jump probabilities
  – Weather / Temperature
Thank you for your Attention...