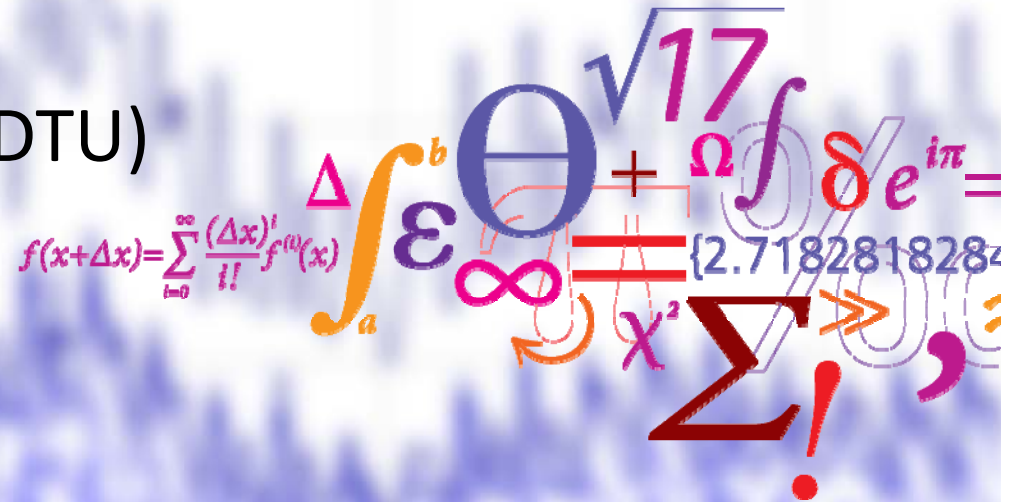


Classification of District Heat Heat Exchange Stations Using Smart Meter Data

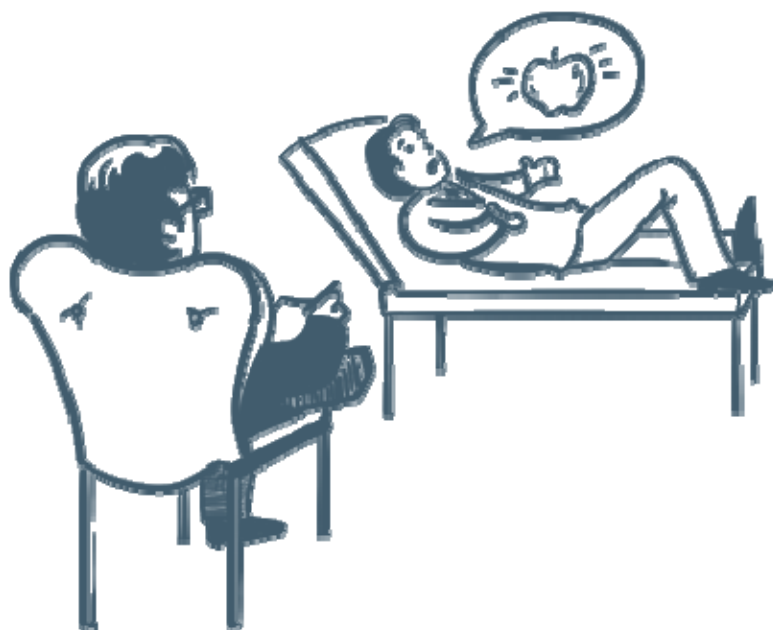
A. Tureczek, P. S. Nielsen (DTU)

H. Madsen (DTU)

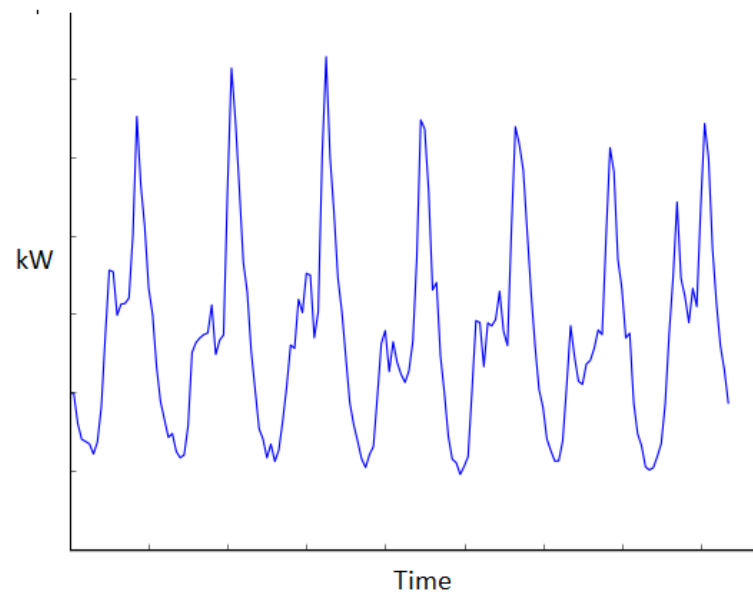
A. Bruun (AVA)



The Concept



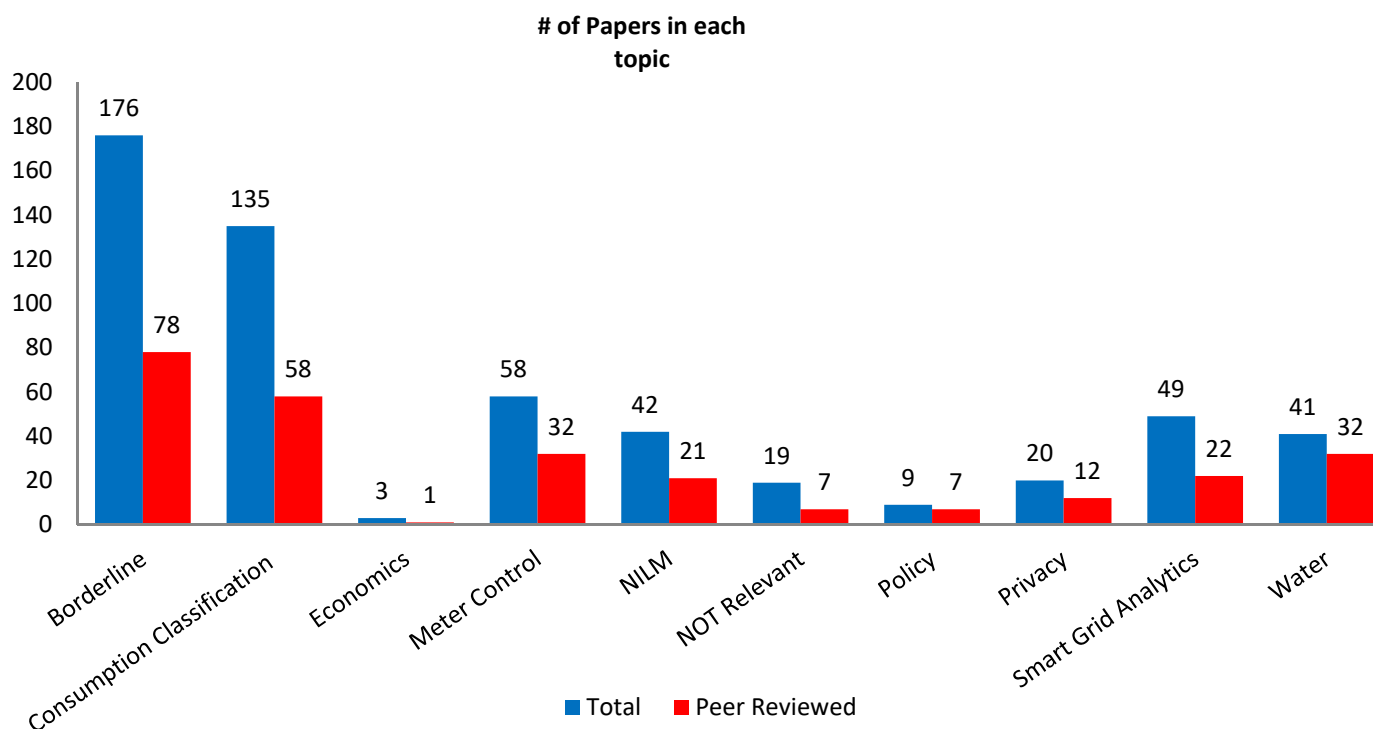
Smart Meters



- Recording frequency down to seconds, usually 15 min – 60 min interval



Smart Meter Data Application

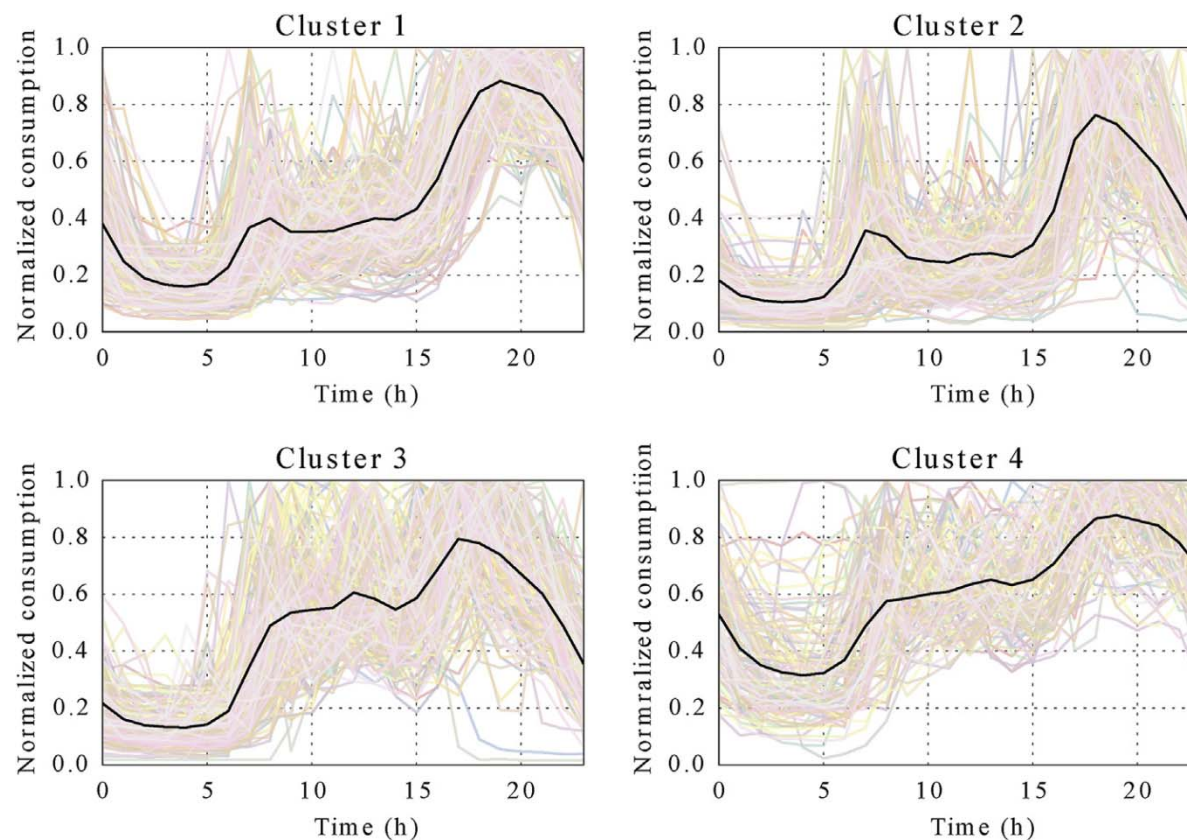


Limited research on DH smart meters analytics!

Source: Tureczek. Alexander M, Nielsen. Per S. Structured Literature Review of Electricity Consumption Classification Using Smart Meter Data. Energies 2017;10:584. doi:10.3390/en10050584.



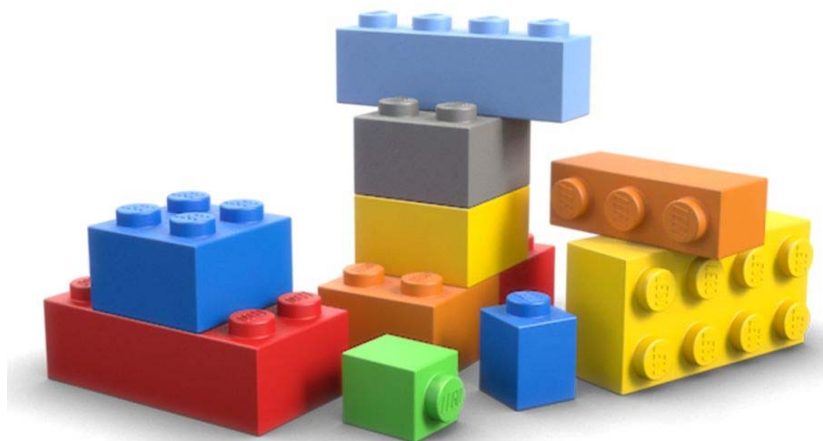
Electricity Smart Meters Clustering



Source: Viegas JL, Vieira SM, Melício R, Mendes VMF, Sousa JMC. Classification of new electricity customers based on surveys and smart metering data Commission for Energy Regulation. Energy 2016;107:804–17. doi:10.1016/j.energy.2016.04.065.



The Data

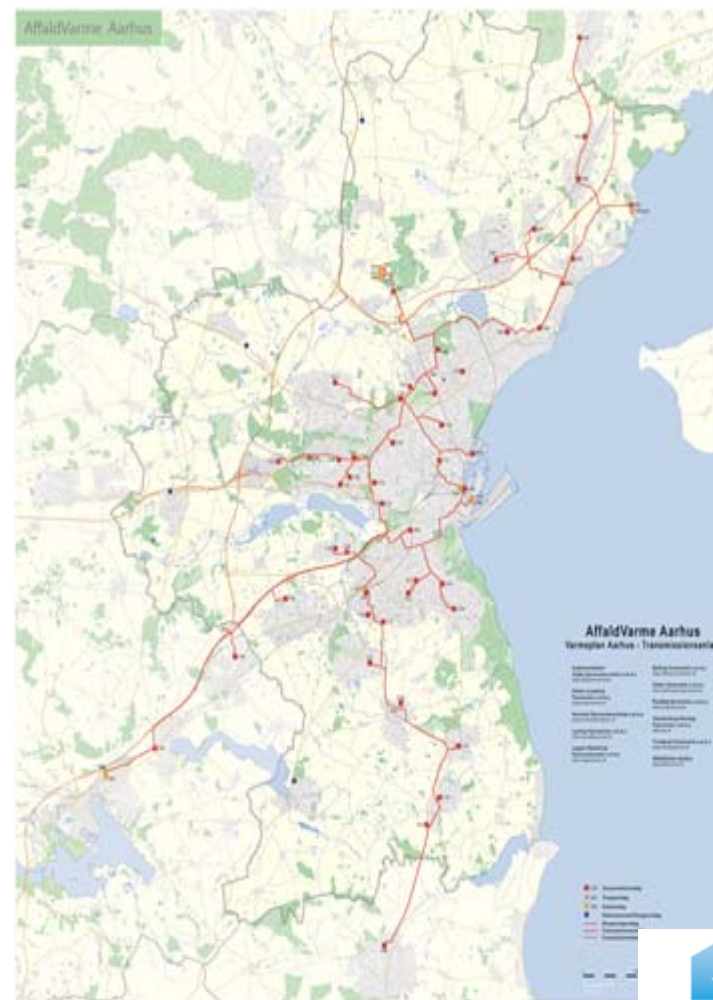
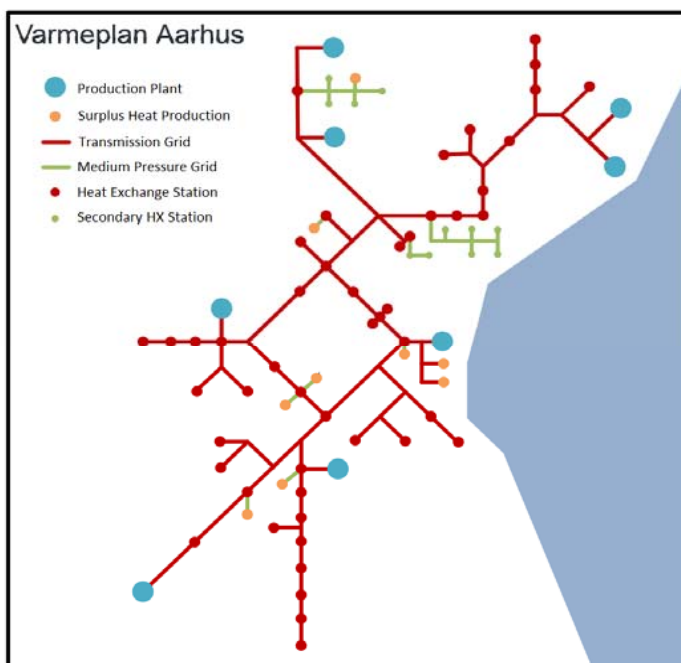


District Heat Data From AVA

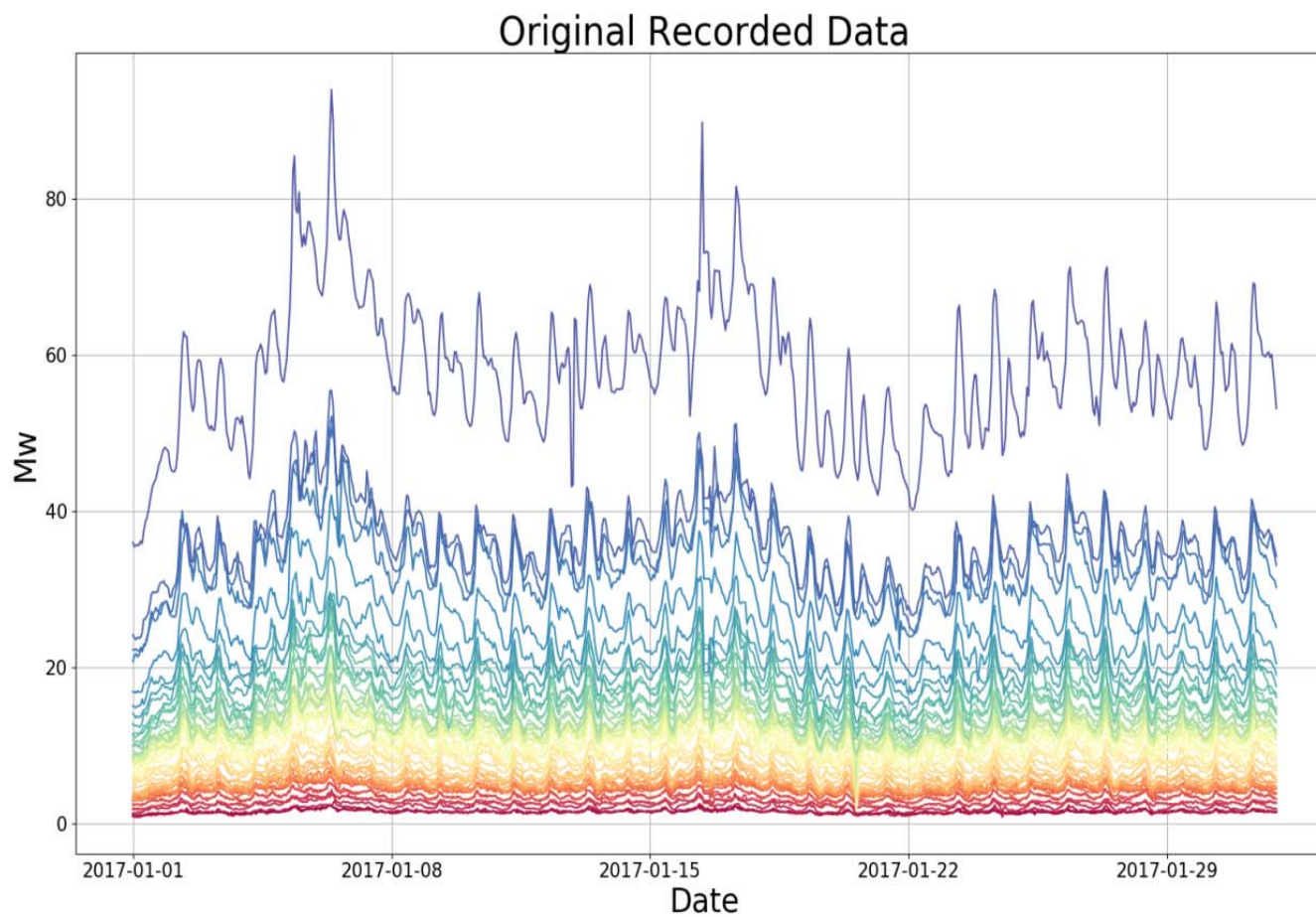
District Heat data from Aarhus

49 Heat Exchange stations (HX)

January 2017 (744) hourly observations per HX



Plotting of the HX Smart Meter Data



Large differences in consumption volume

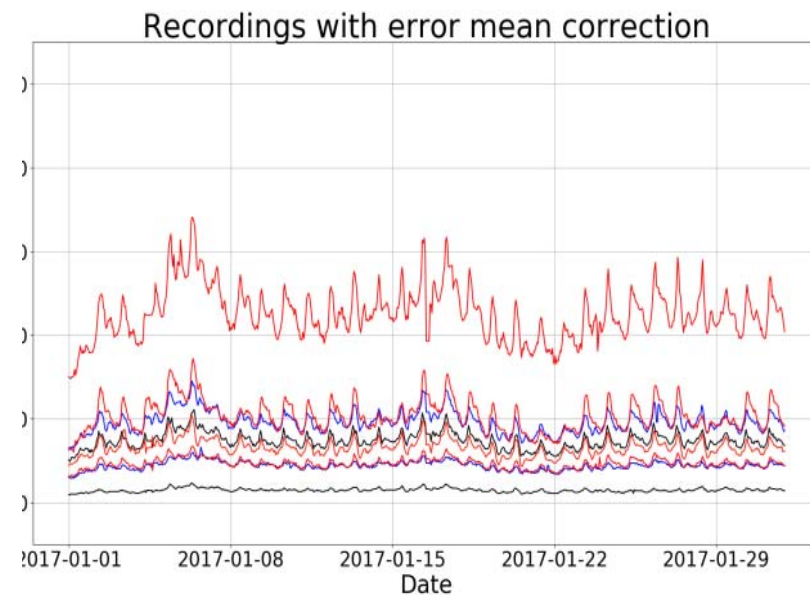
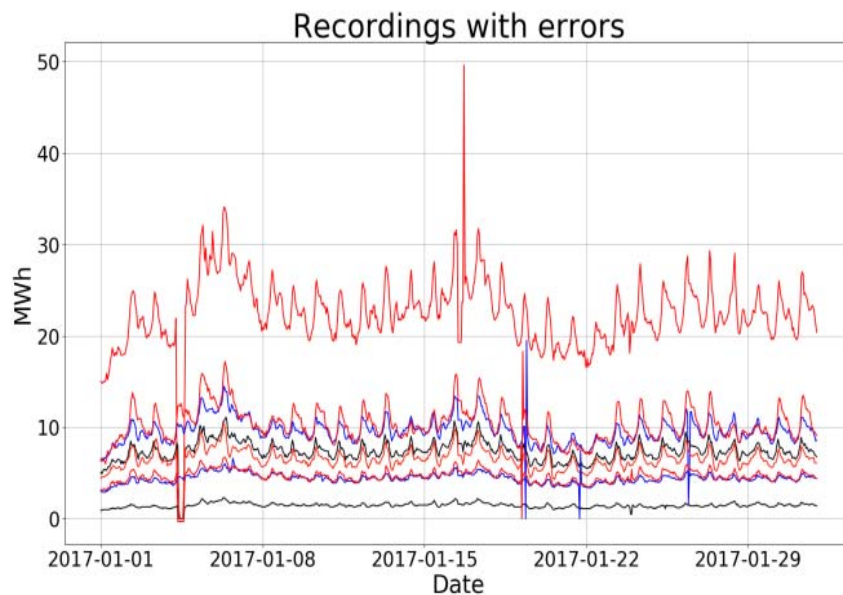


The Preprocessing and cleaning of data

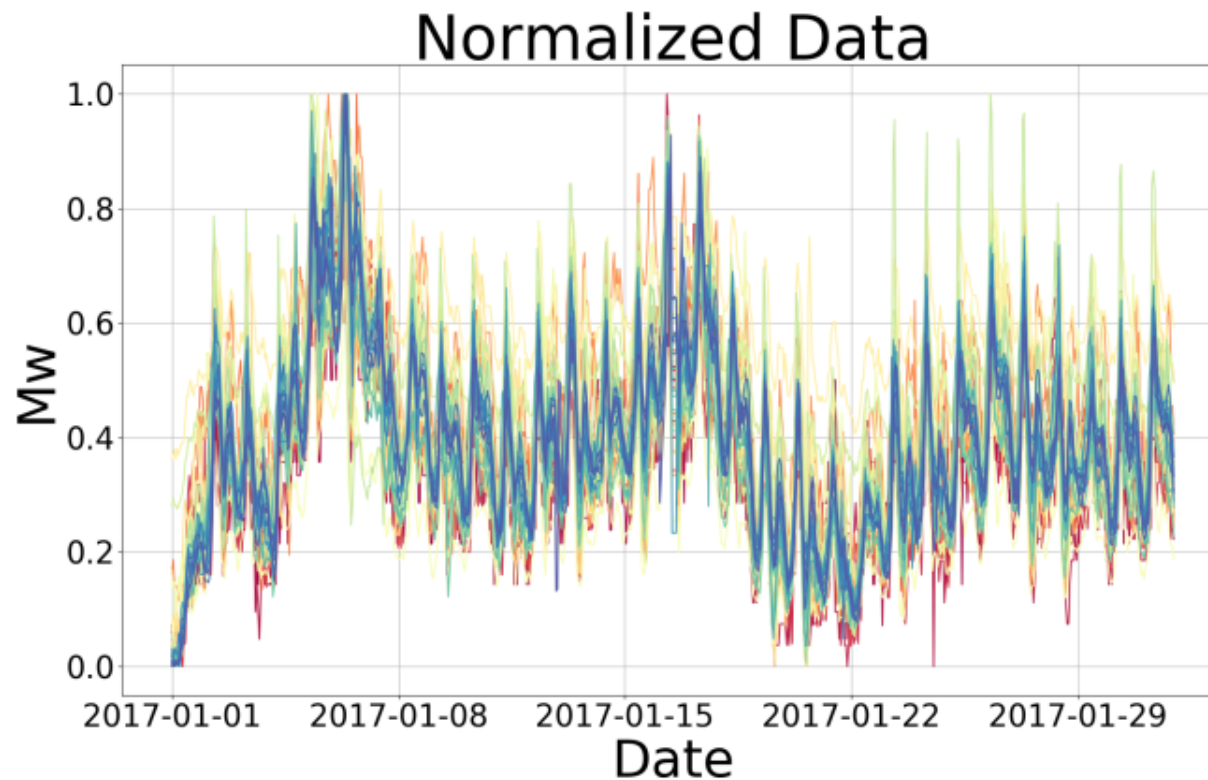


Data Preprocessing of the AVA Data

Dealing with Missing Data



Normalizing Data to Remove Volume Influence on Clustering



$$\frac{x - x_{min}}{x_{max} + x_{min}}$$



The Clustering of the Original Data Using K-Means



Selecting Optimum Number of Clusters

(4) for K-Means

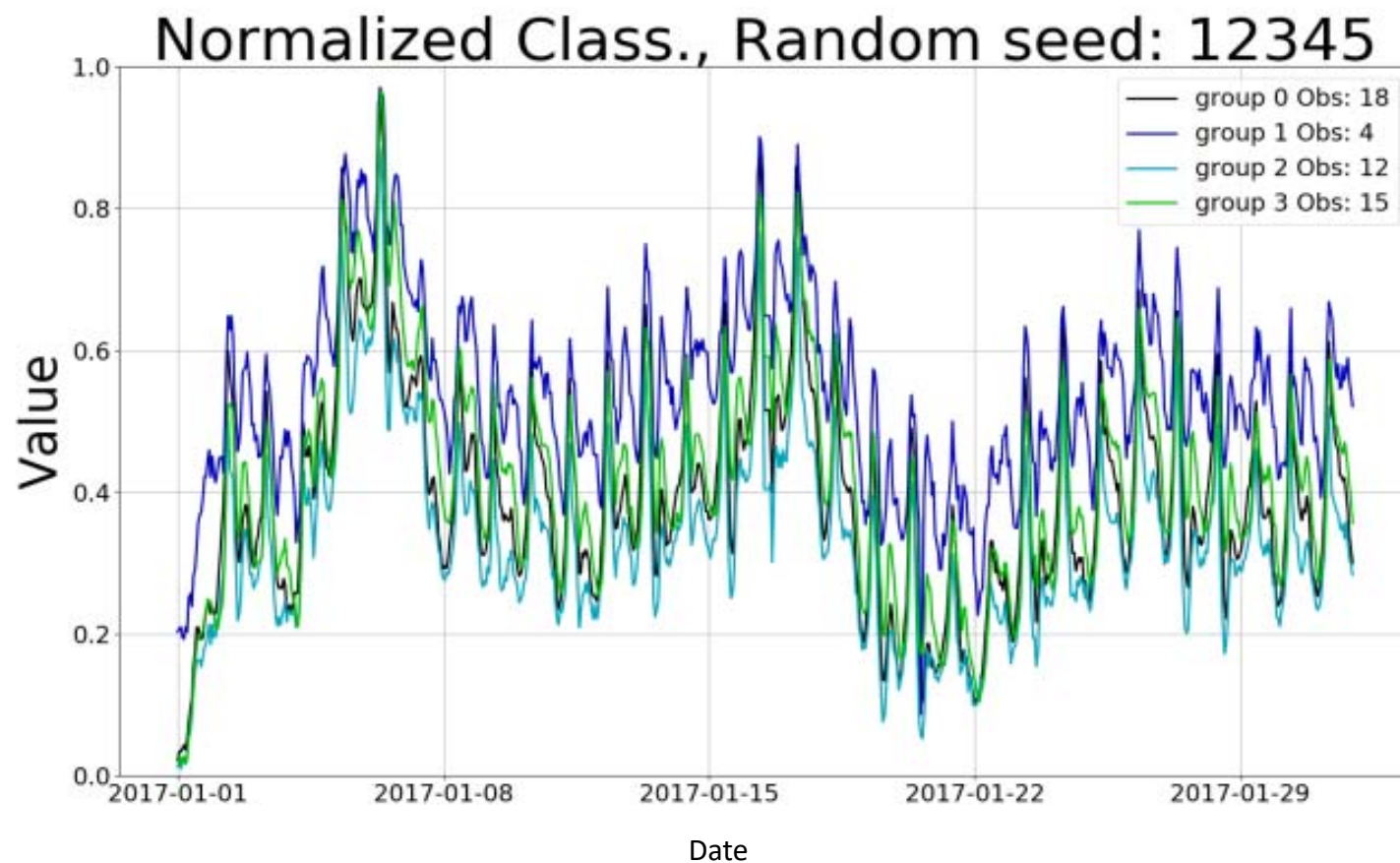
Normalized Data



4 clusters selected



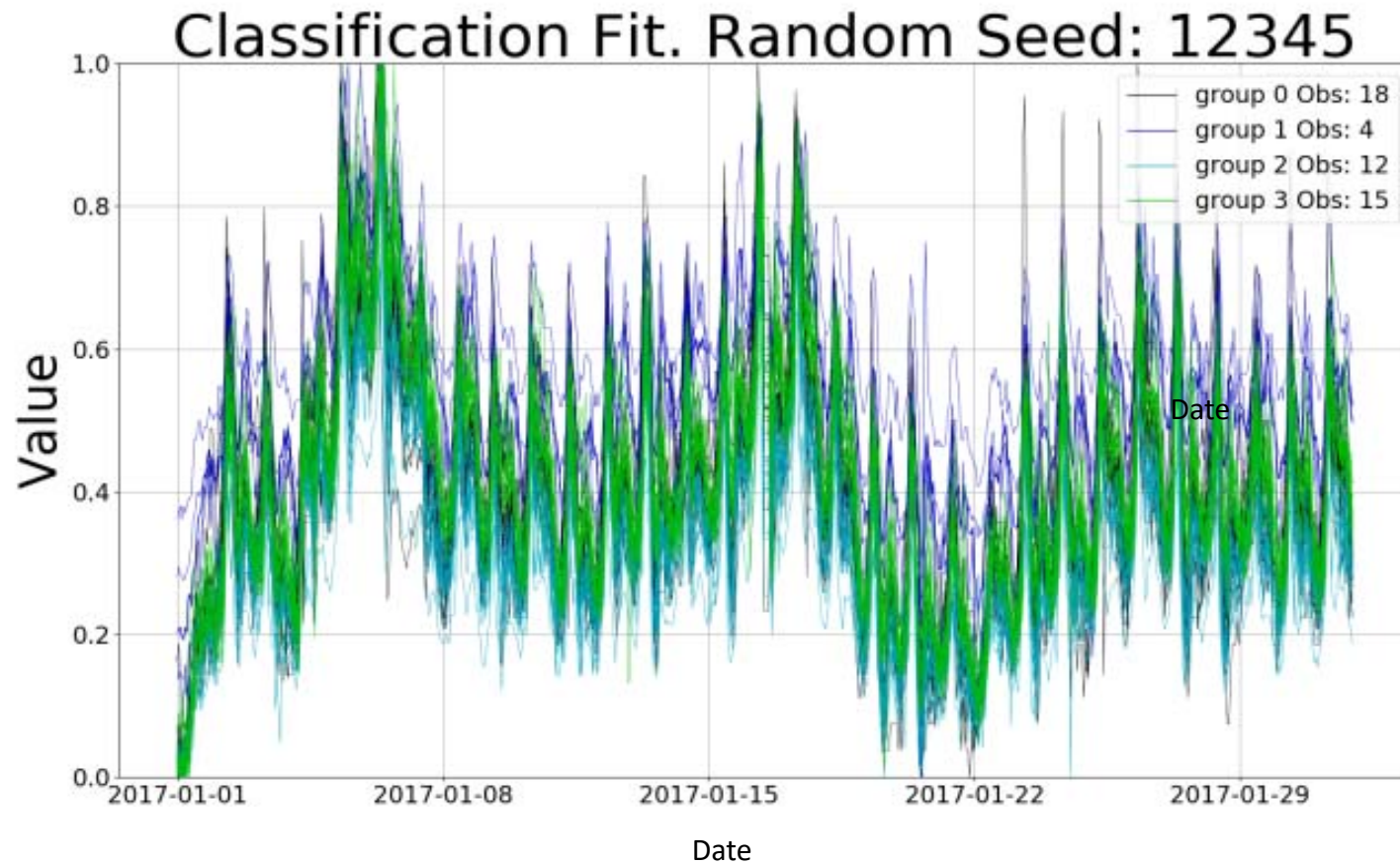
Cluster Means (4) on Normalized Data



4 clusters selected



Cluster Members (49) Superimposed onto Cluster Means



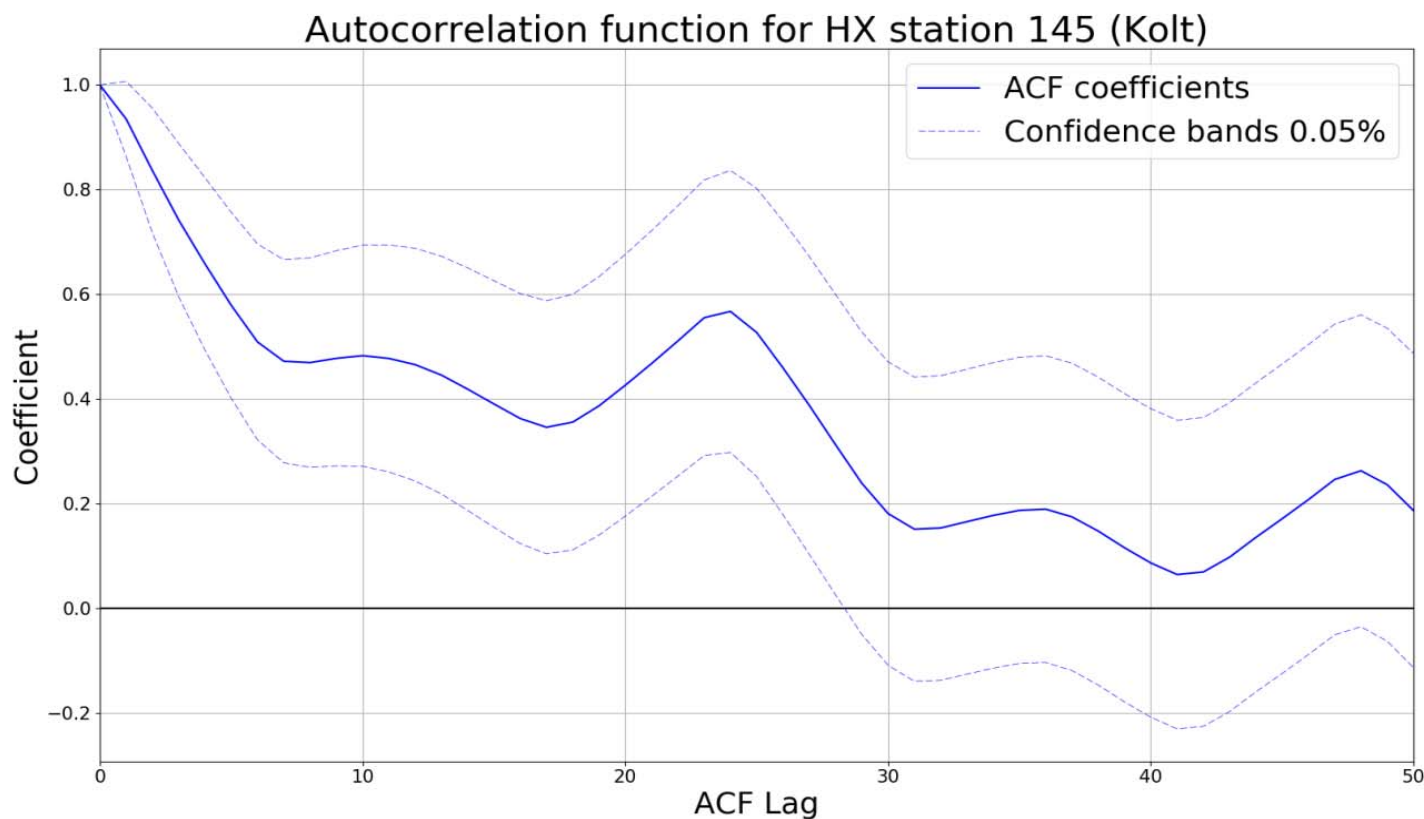
4 clusters selected



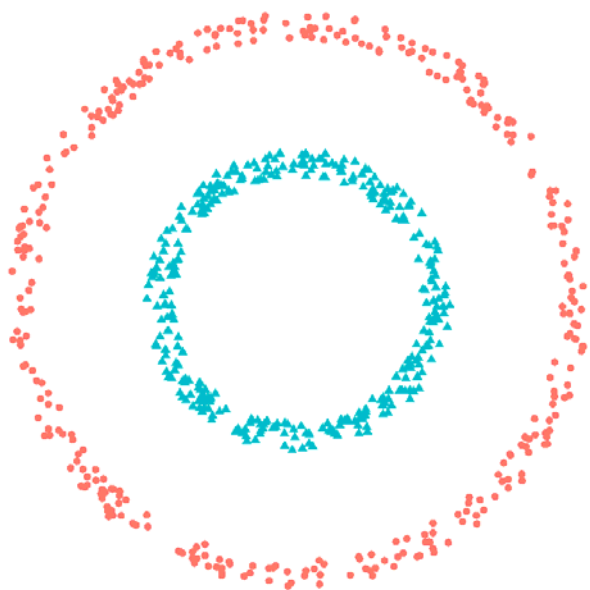
The Preprocessing Revisited: Feature extraction



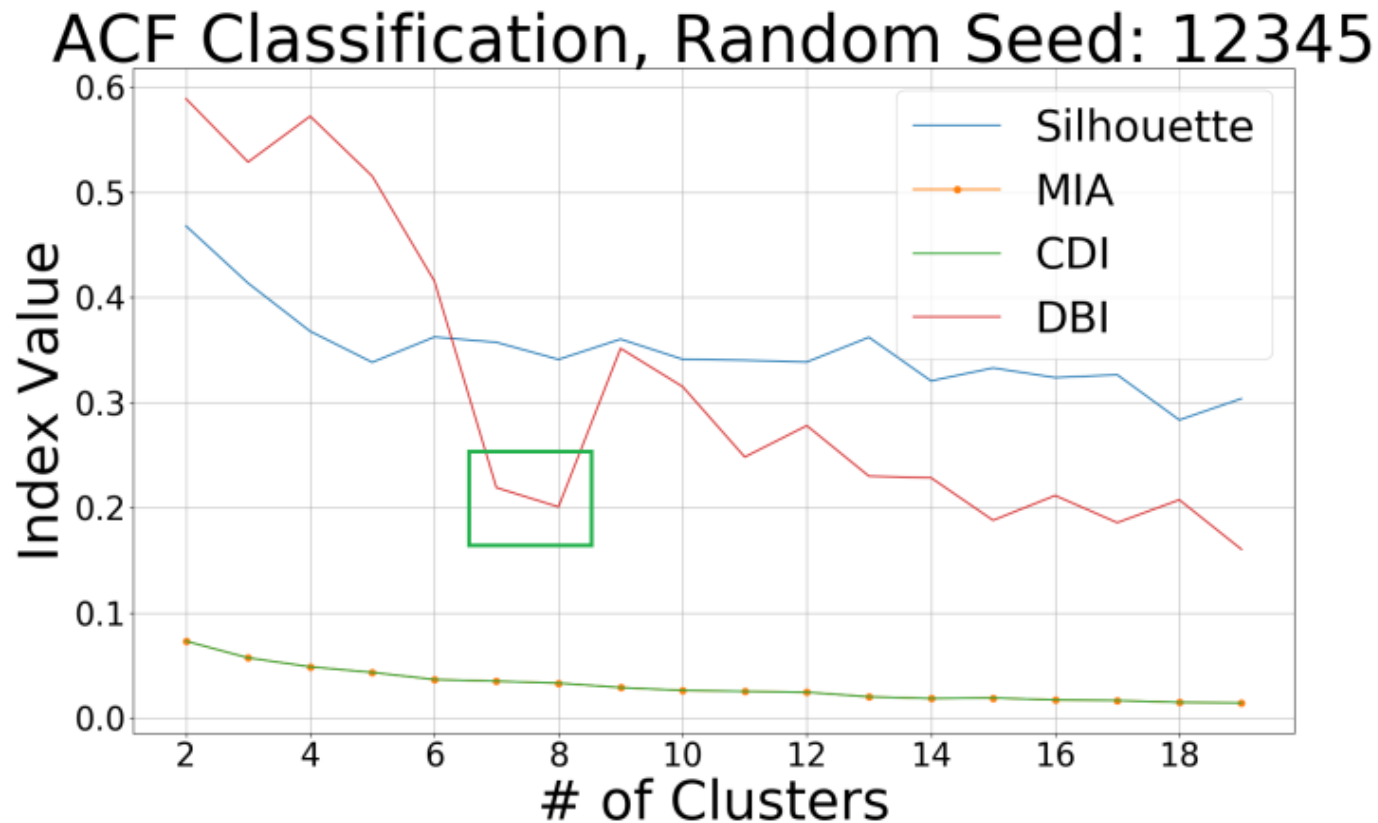
Autocorrelation as Feature for Clustering



The Clustering Revisited: Features as Input to K-Means



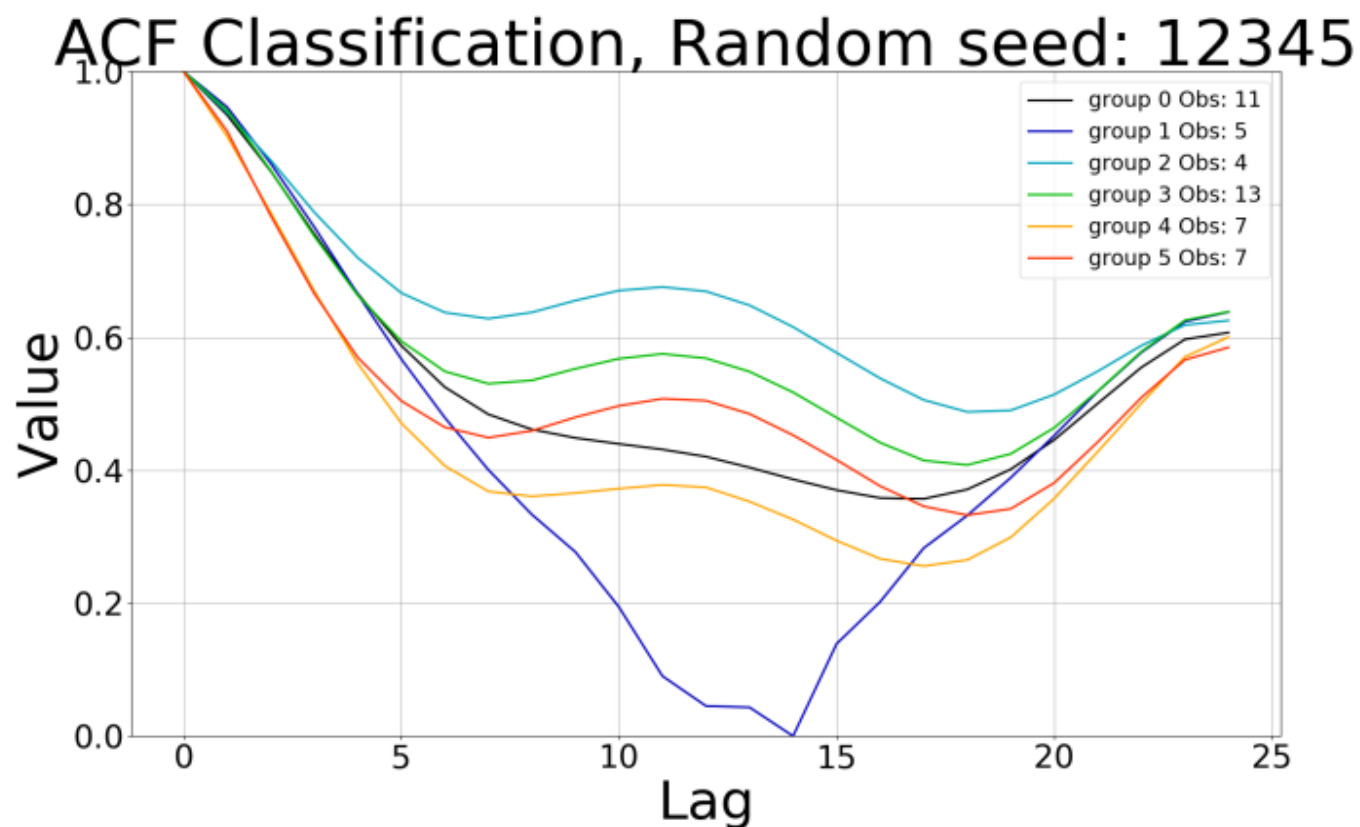
Selecting Optimum Number of Clusters (7) for K-Means on New Feature Data



7 Clusters selected



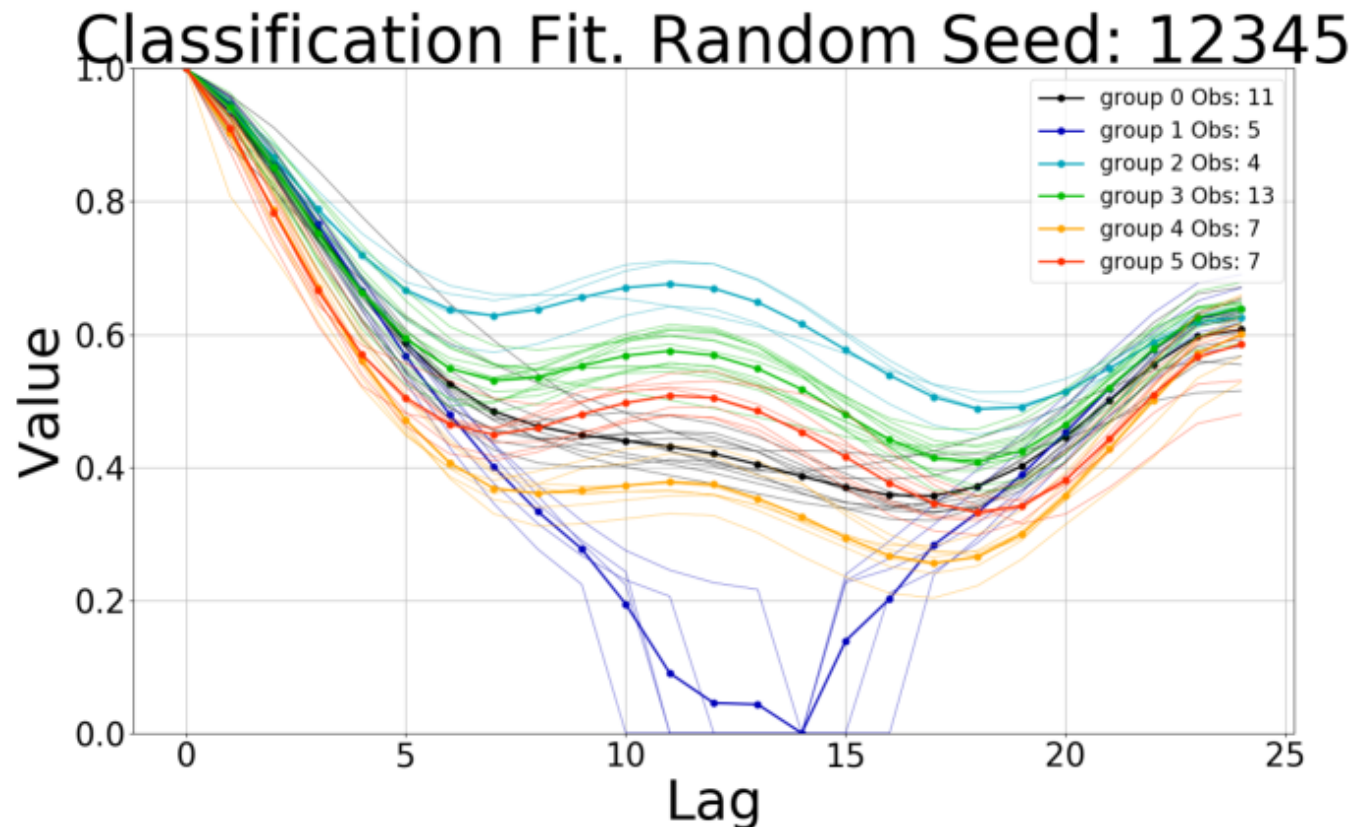
Cluster Means (7) on Feature Input



Only 6 clusters are shown as last cluster only had 1 member.



Cluster Members (49) Superimposed onto Cluster Means



Only 6 clusters are shown as last cluster only had 1 member.

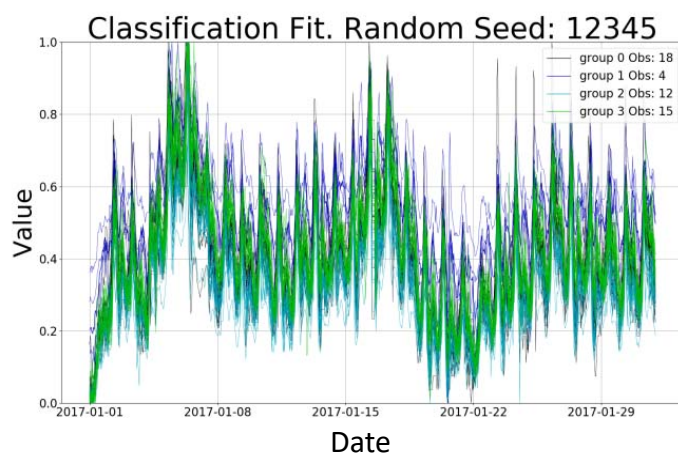


The Findings

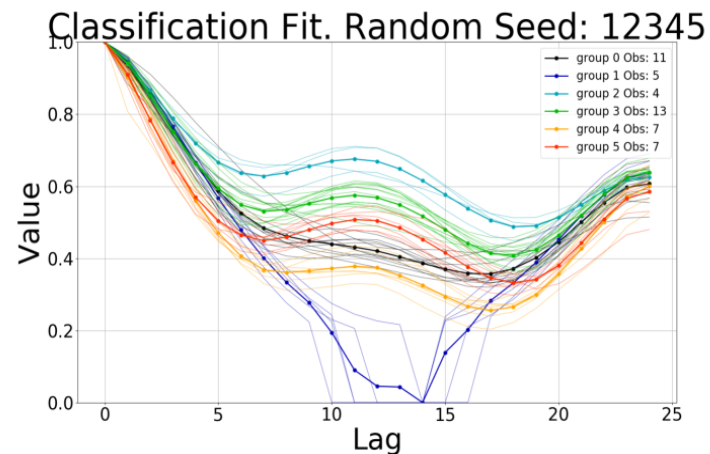


Clustering Comparisson

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...

