

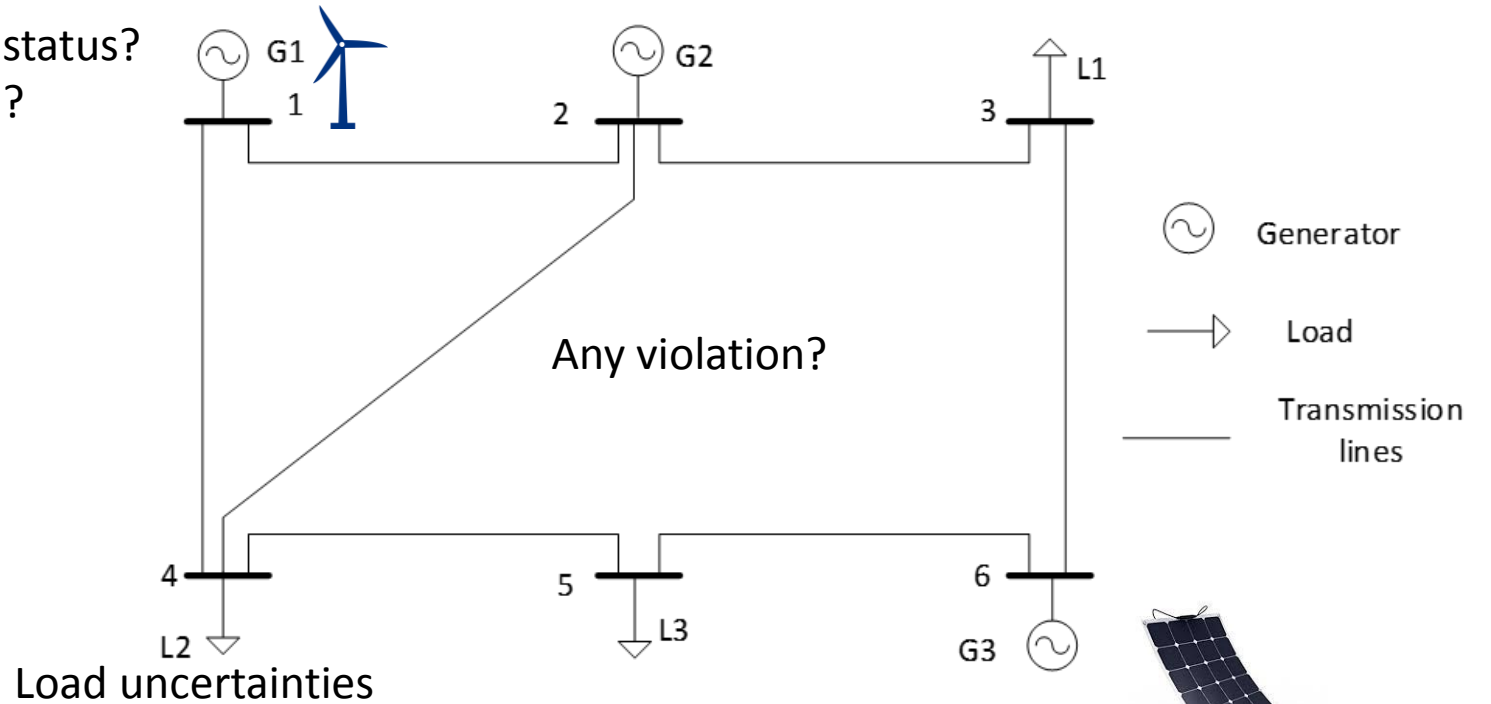
Load Sampling for Enhancing the Robustness of SCUC Based on Principal Component Analysis and Kernel Density Estimation

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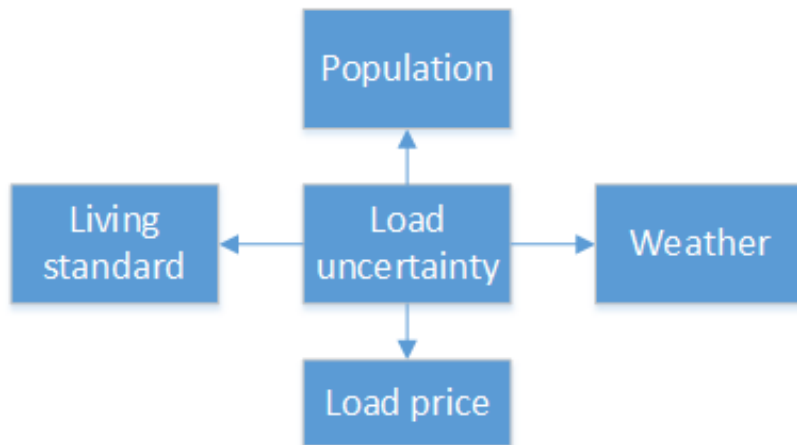
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Security Constrained Unit Commitment (SCUC)

ON/OFF status?
Dispatch?



One-line diagram of the 6-bus system

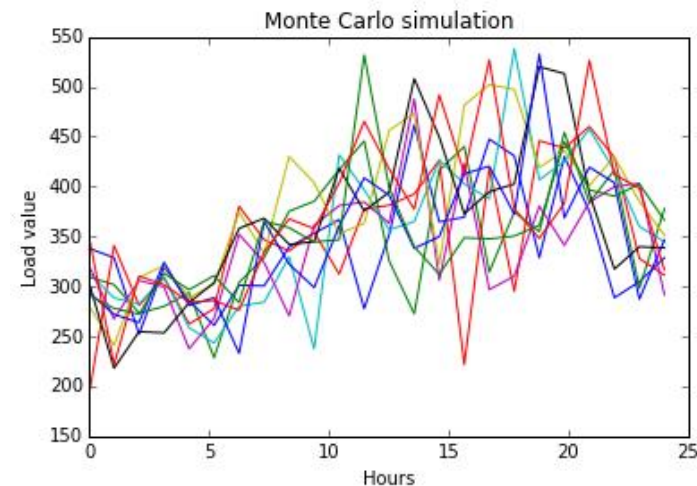
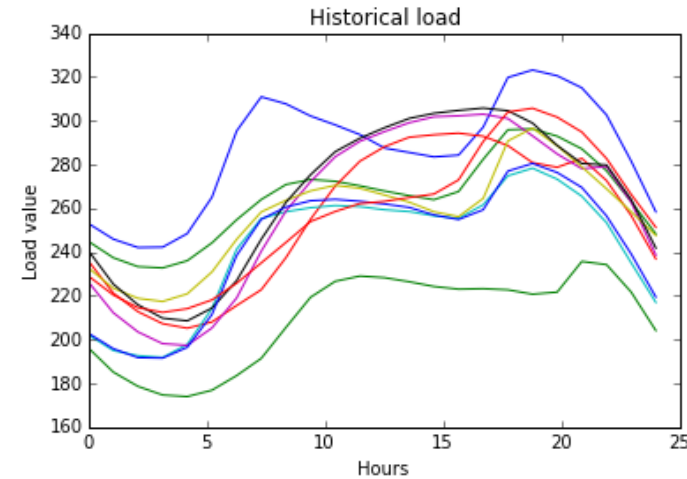
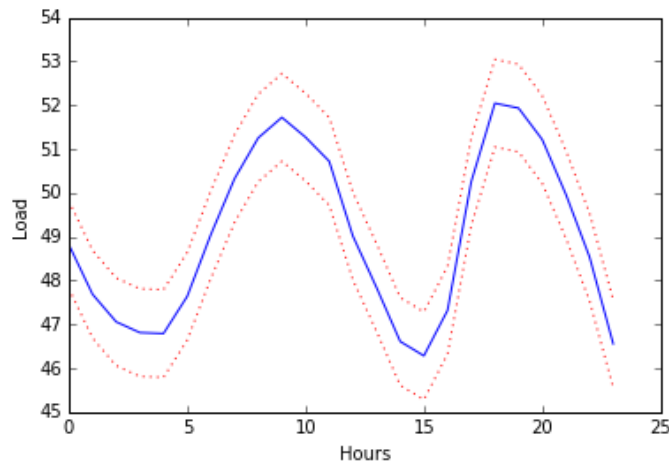


Target:
How to immunize load uncertainties of SCUC



Previous work on SCUC with load uncertainty

- Monte Carlo (MC) simulation
 - Unrealistic load curve
 - No time relevance
 - No location relevance
- Robust optimization
 - Conservative: the worst case

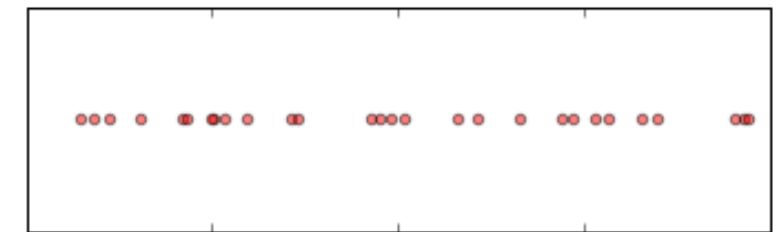
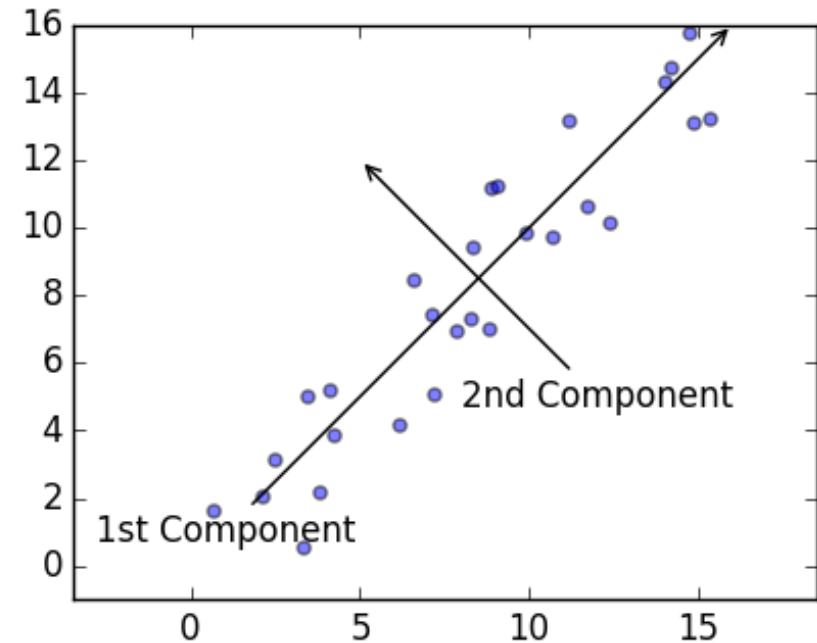


Why Principal component analysis (PCA)?

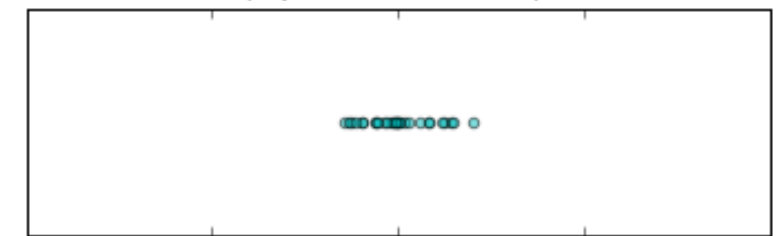
- Reduce dimension
 - Linear
 - Visualization
 - Patterns
 - **Data compression** : less storage and easy retrieval
 - **Noise removal**: positive effect on accuracy

Component t	Variance	Percentage
1 st	30.56	98.4%
2 nd	0.48	1.6%

Illustration of PCA (2 dimensions with high correlation)



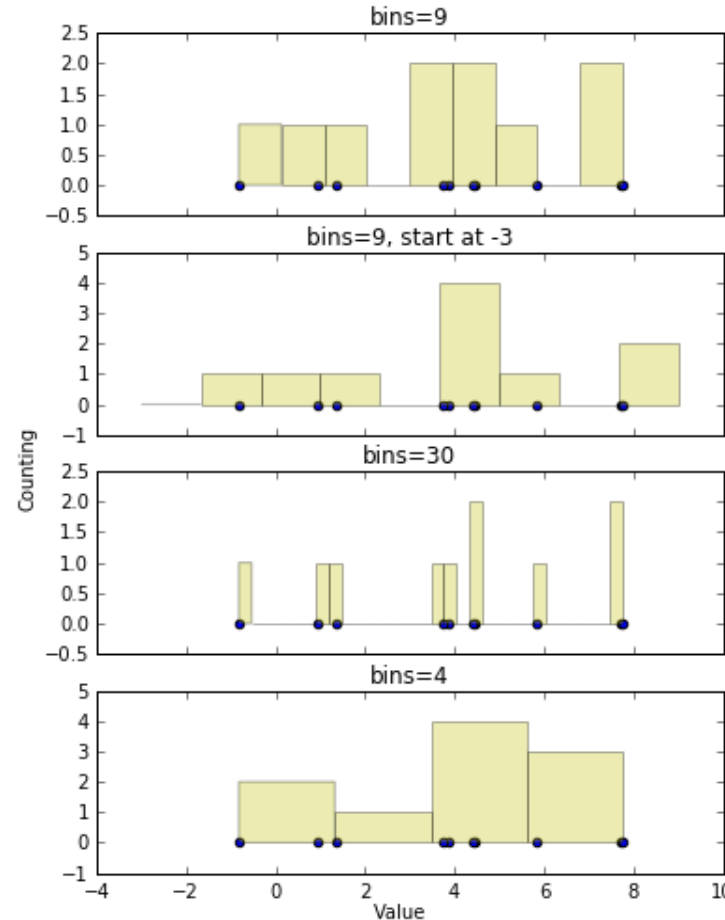
Data projection on the 1st Component



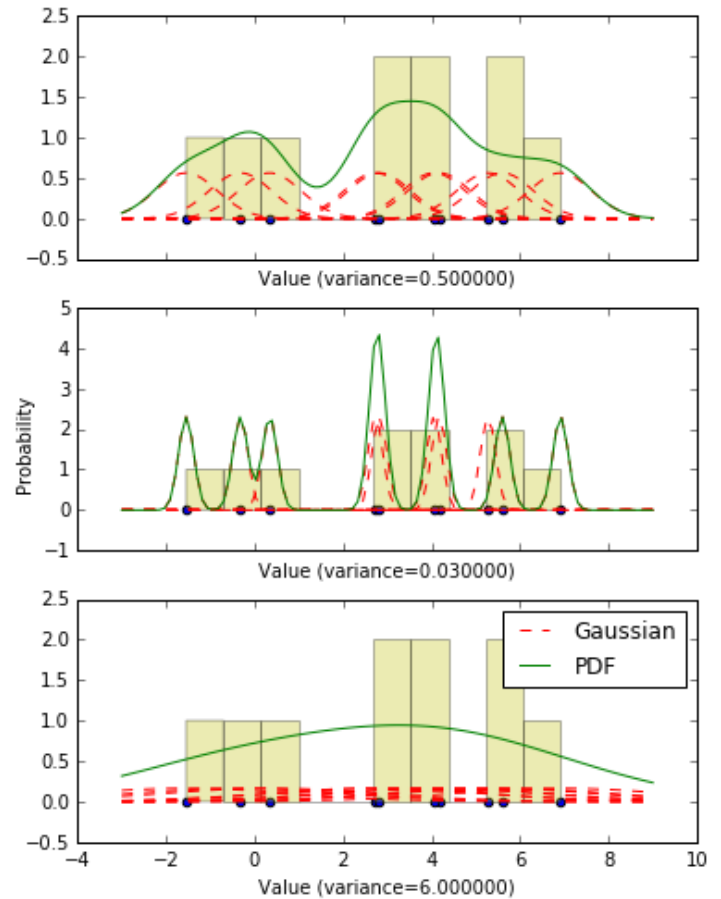
Data projection on the 2nd Component

Kernel density estimation (KDE)

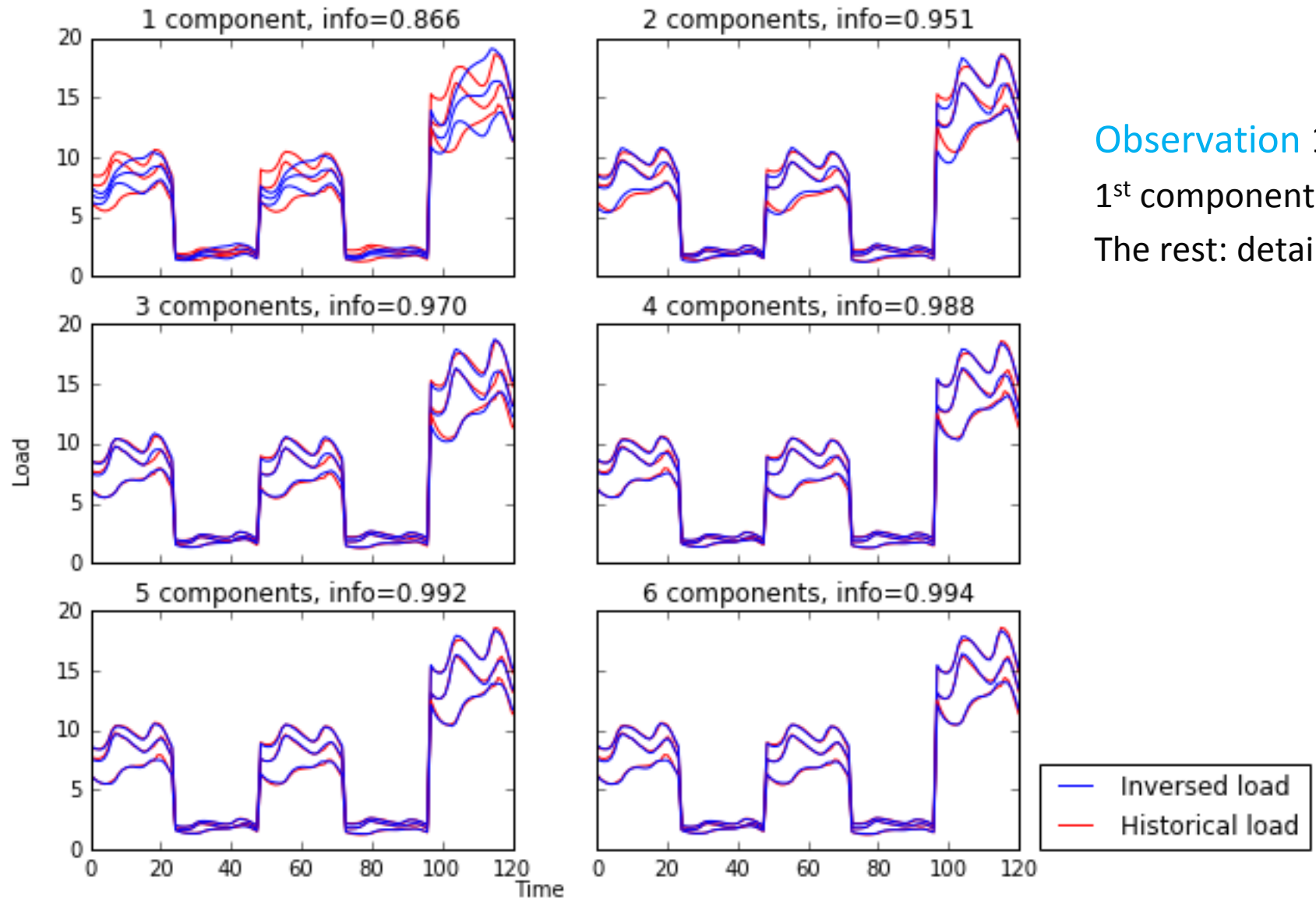
To get the density of the reduced load profile to provide the guidelines for sampling load for SCUC problems more realistically and efficiently.



Histograms of the same data with different starting points and bin widths

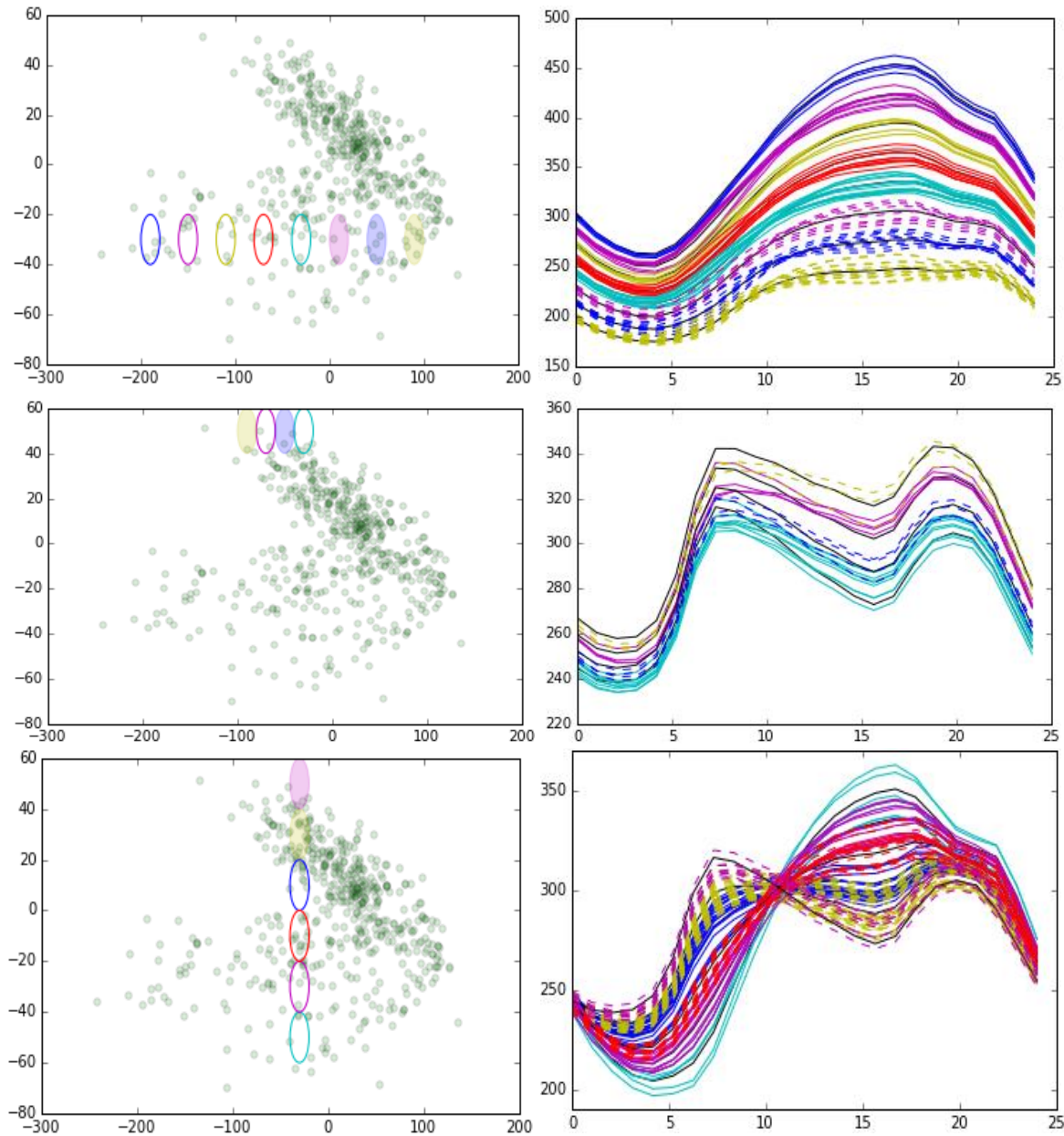


KDE using Gaussian kernel with different variance

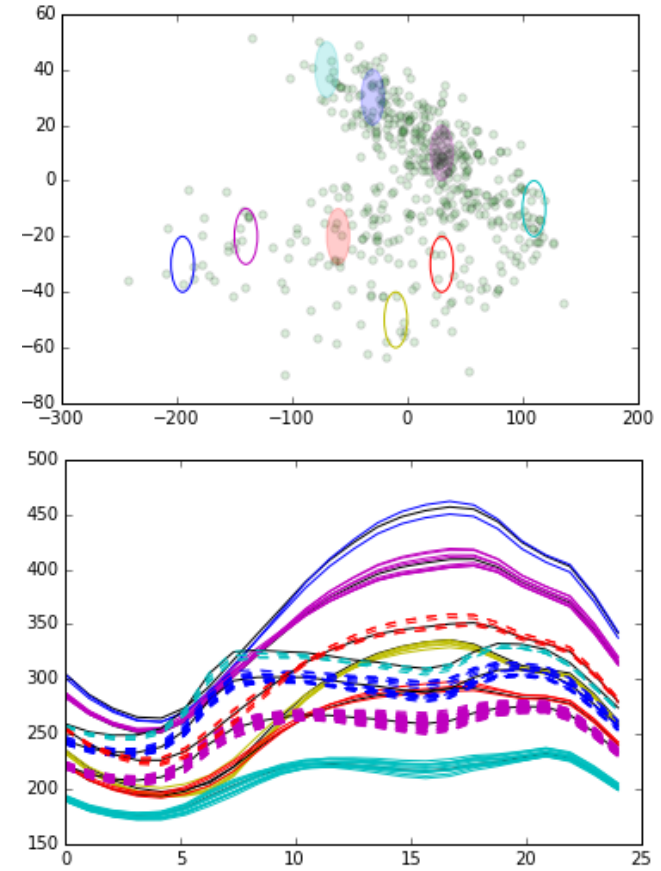


Observation 1:
 1st component: shape
 The rest: details

Reconstructed hourly load profiles of nodal load based on PCA

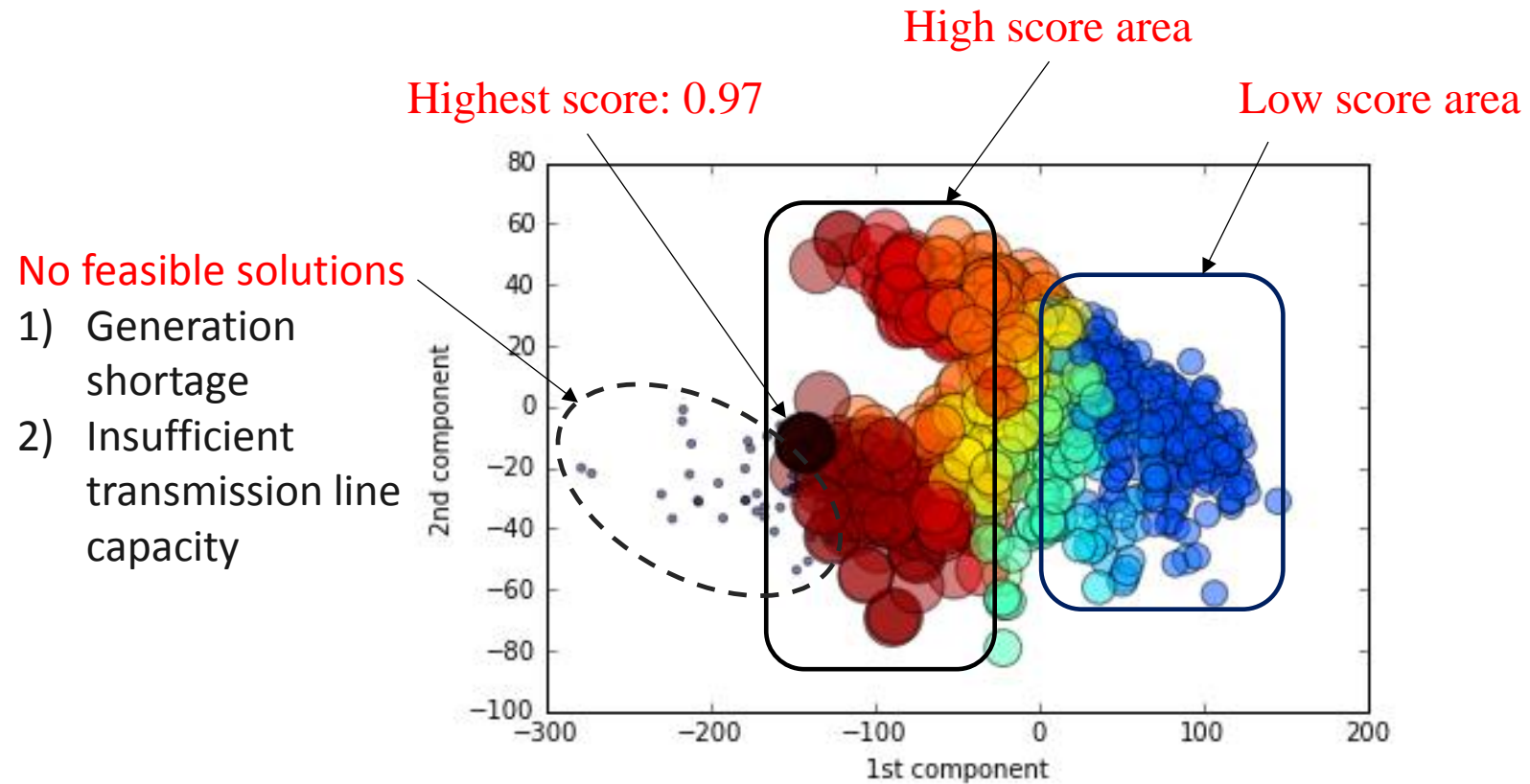


■ Observation 2:
Clear patterns.



Patterns of the inversed load

Load Sampling Case Study



Scores of the UC solutions corresponding to sampled load profiles in the first two dimensions for the 30-bus system