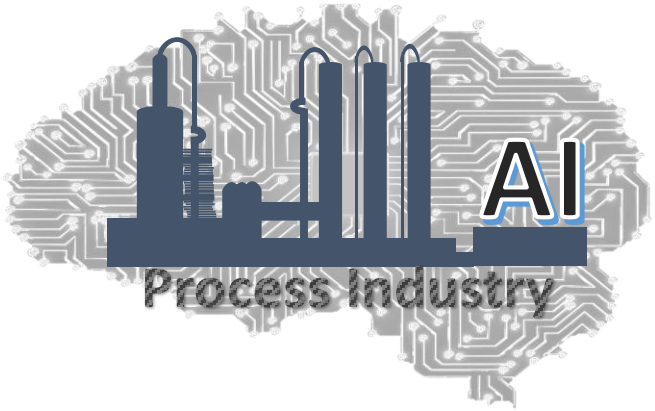
Statistical Techniques for Monitoring Industrial Processes



Lecture : PCA – An Industrial Case Study

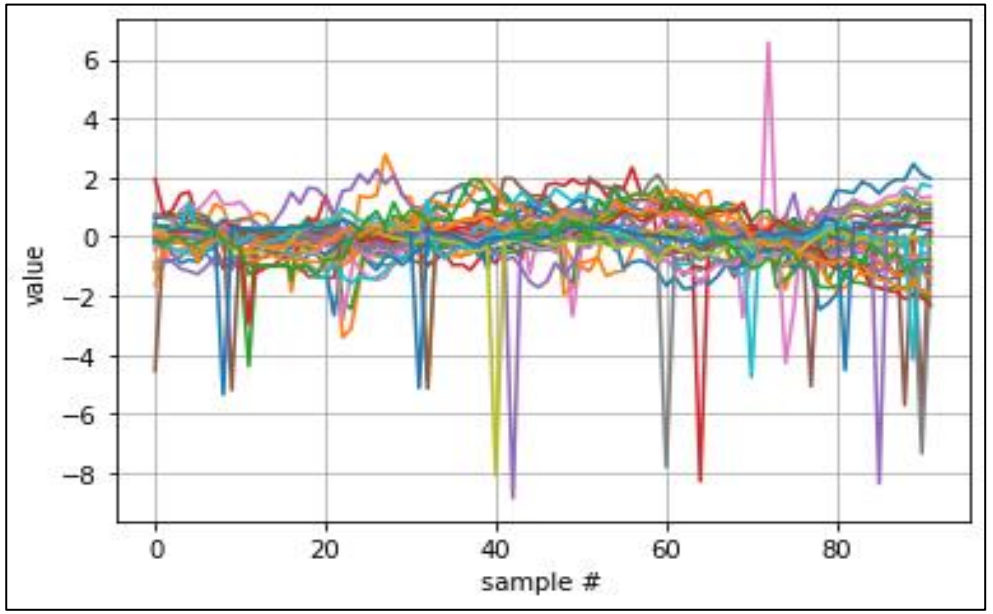
Module : PCA-based MSPM

Course TOC

- ❑ Introduction to Statistical Process Monitoring (SPM)
- ❑ Python Installation and basics (optional)
- ❑ Univariate SPM & Control Charts
  - ➢ Shewhart Charts
  - ➢ CUSUM Charts
  - ➢ EWMA Charts
- ❑ Multivariate SPM
  - ➢ Principal Component Analysis (PCA)-based MSPM
    - ➢ Dimensionality reduction
    - ➢ Fault detection & diagnosis (FDD) using PCA
    - ➢ Application to a Polymer Manufacturing process
  - ➢ Partial Least Squares (PLS) regression-based MSPM
  - ➢ Strategies for handling nonlinear, dynamic, multimode systems
- ❑ Deploying SPM solutions

Polymer Manufacturing Process Dataset

Process data from a polymer manufacturing plant. Each colored curve corresponds to a process variable.*



- 33 variables
- 92 samples (collected hourly)

- It is reported that the process started showing abnormality around sample 70 and eventually had to be shutdown
- We will use samples 1 to 69 for training a PCA model

*Dataset is also referenced at https://www.academia.edu/38630159/Multivariate_data_analysis_wiki. Data file is made available in this course's GitHub repository.

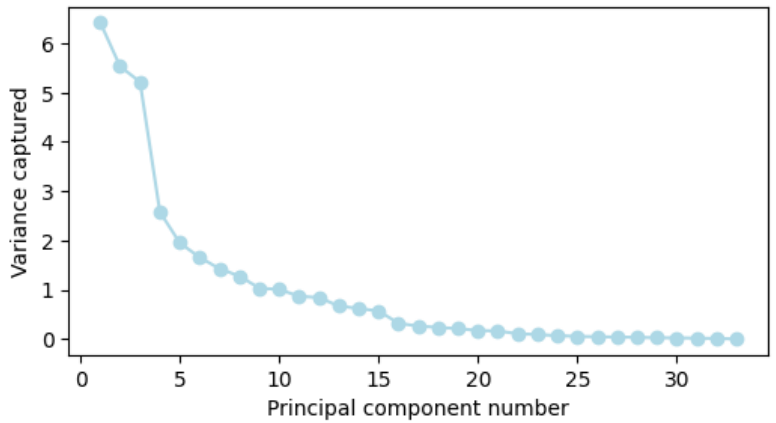
PCA Modeling of Polymer Manufacturing Process

For the polymer manufacturing plant dataset

- Fit a PCA model using the training dataset
- See how PCA helps in removing correlations among process variables
- See the variances explained by the different principal components

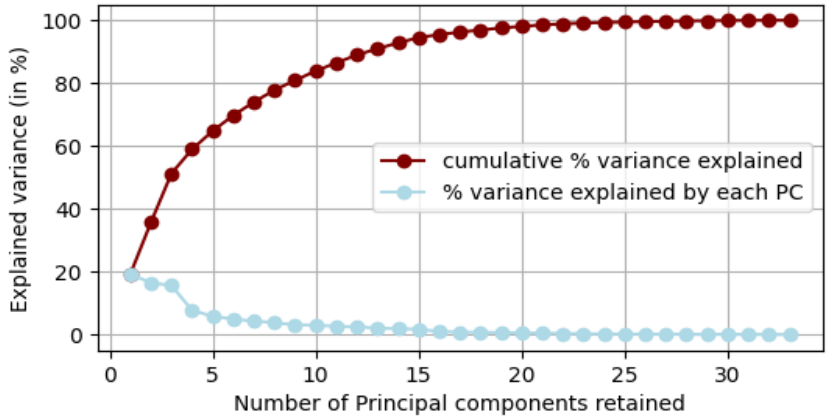
Determining the Number of Principal Components to Retain

Scree plot



- Plot the variance captured vs the principal component number
- Look for a ‘elbow’ in the curve where variance stops decreasing sharply

Cumulative Percent Variance (CPV) plot



- Plot the total variance captured (in %) vs the number of PCs retained
- Number of PCs retained is chosen such that some minimum % of total variance is captured (often 90% or 95%)

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Next Lecture : PCA – Fault Detection

Module : PCA-based MSPM