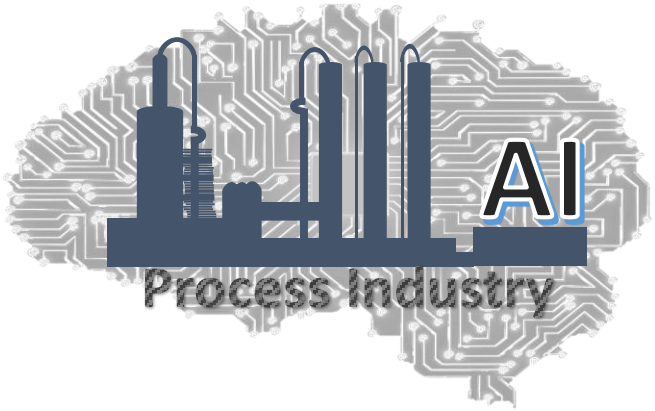
Statistical Techniques for Monitoring Industrial Processes



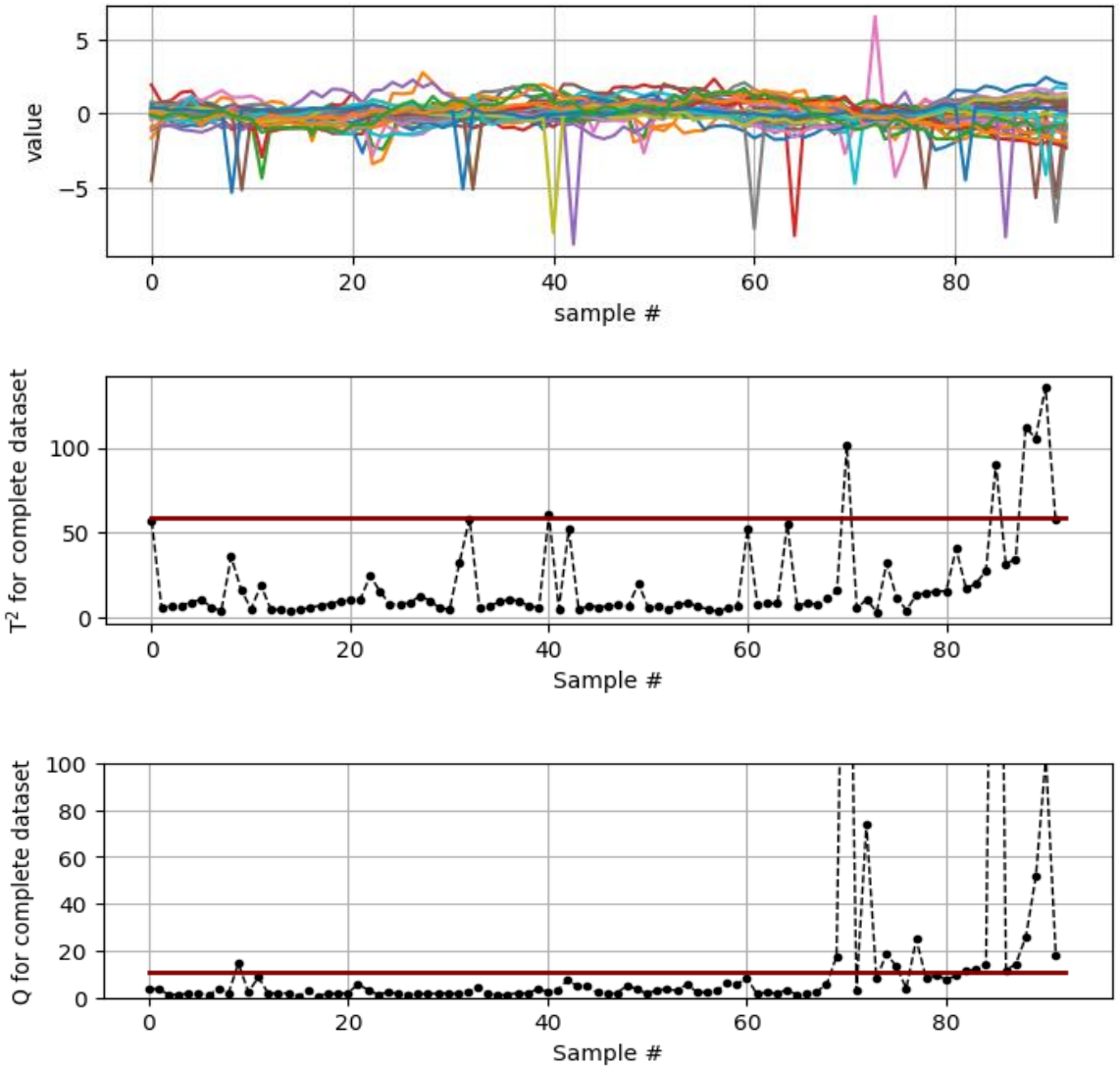
Lecture : PCA – Fault Diagnosis

Module : PCA-based MSPM

Course TOC

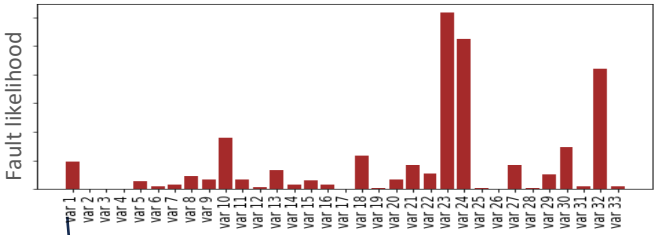
- ❑ Introduction to Statistical Process Monitoring (SPM)
- ❑ Python Installation and basics (optional)
- ❑ Univariate SPM & Control Charts
  - ➢ Shewhart Charts
  - ➢ CUSUM Charts
  - ➢ EWMA Charts
- ❑ Multivariate SPM
  - ➢ Principal Component Analysis (PCA)-based MSPM
    - ➢ Dimensionality reduction
    - ➢ 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

Why Fault Diagnosis?



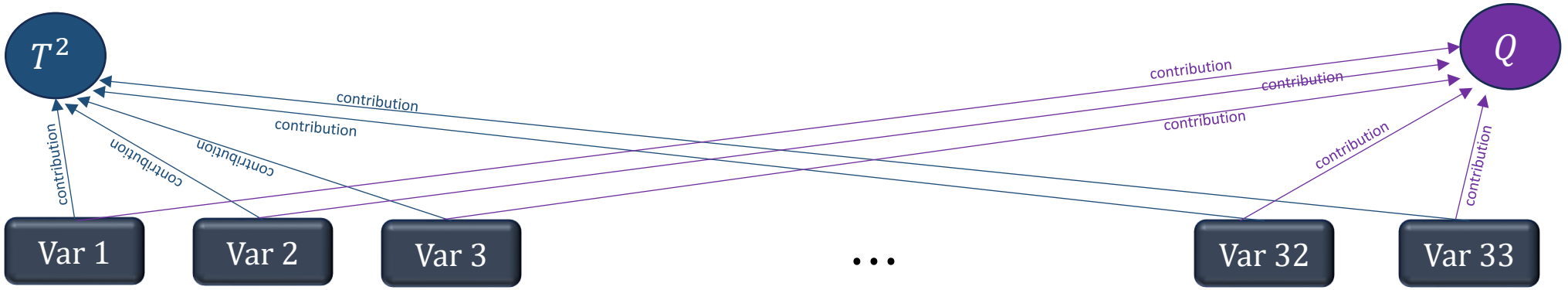
- Operator knows that there is an issue that needs attention
- Out of so many variables, which ones to look at?

- Fault isolation exercise provides the following information



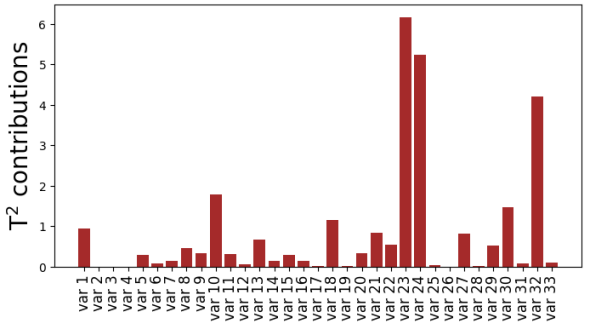
indicates which variables are most likely impacted by the fault

Fault Diagnosis via Contribution Analysis

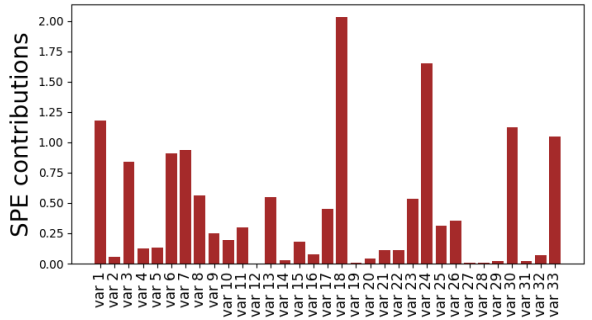


$$T^2 = \sum_{variable} Contribution_{T^2,variable}$$

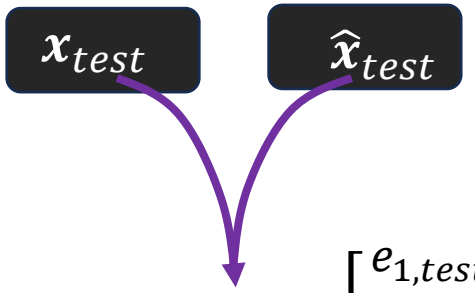
$$Q = \sum_{variable} Contribution_{Q,variable}$$



Check variables contributing the most to the metric that violates its control limit



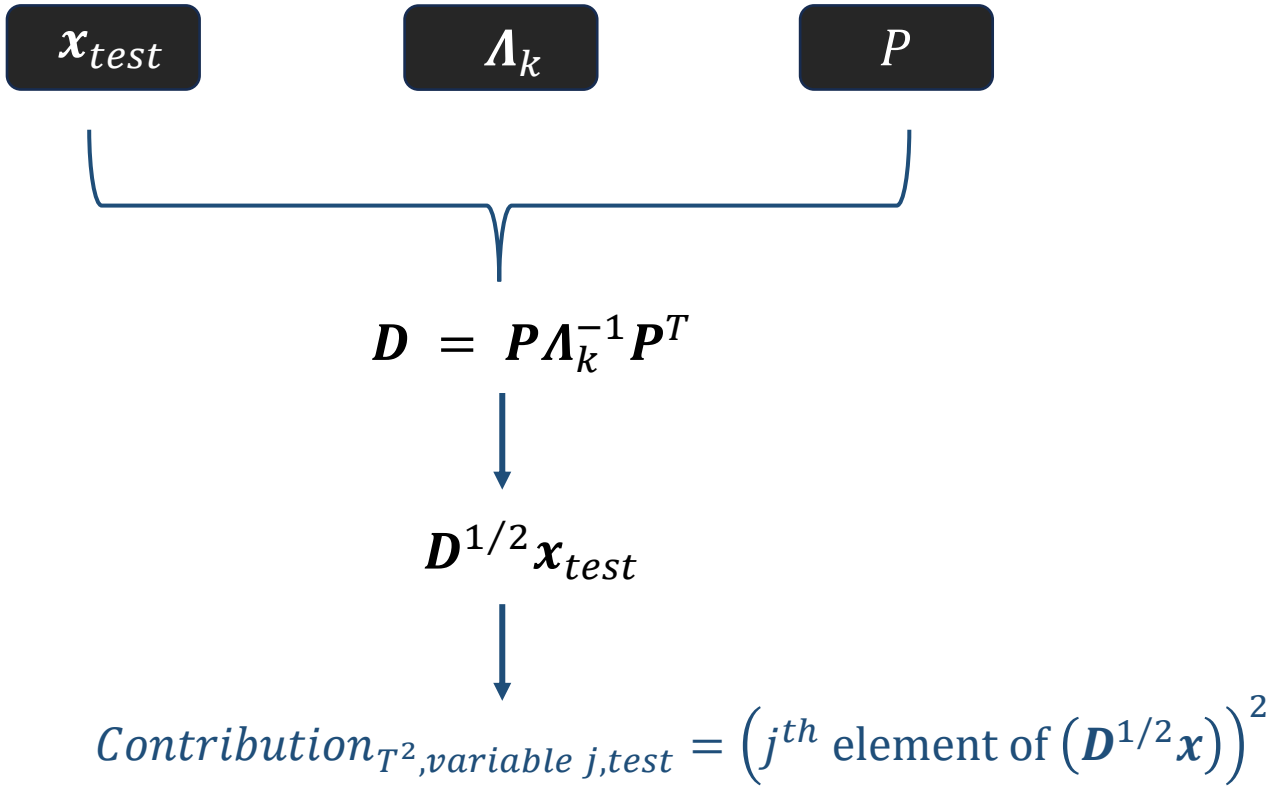
SPE Contributions



$$\boldsymbol{e}_{test} = \begin{bmatrix} e_{1,test} \\ e_{2,test} \\ \vdots \\ e_{m,test} \end{bmatrix}$$

$$Q_{test} = \sum_{var=1}^{m} e_{var,test}^2 = \sum_{var=1}^{m} Contribution_{Q,var,test}$$

T^2 Contributions*



*Wise et al., PLS toolbox User Manual, 2006

Statistical Techniques for Monitoring Industrial Processes

Next Lecture : PCA – Fault Diagnosis Implementation

Module : PCA-based MSPM