

Statistical Techniques for Monitoring Industrial Processes

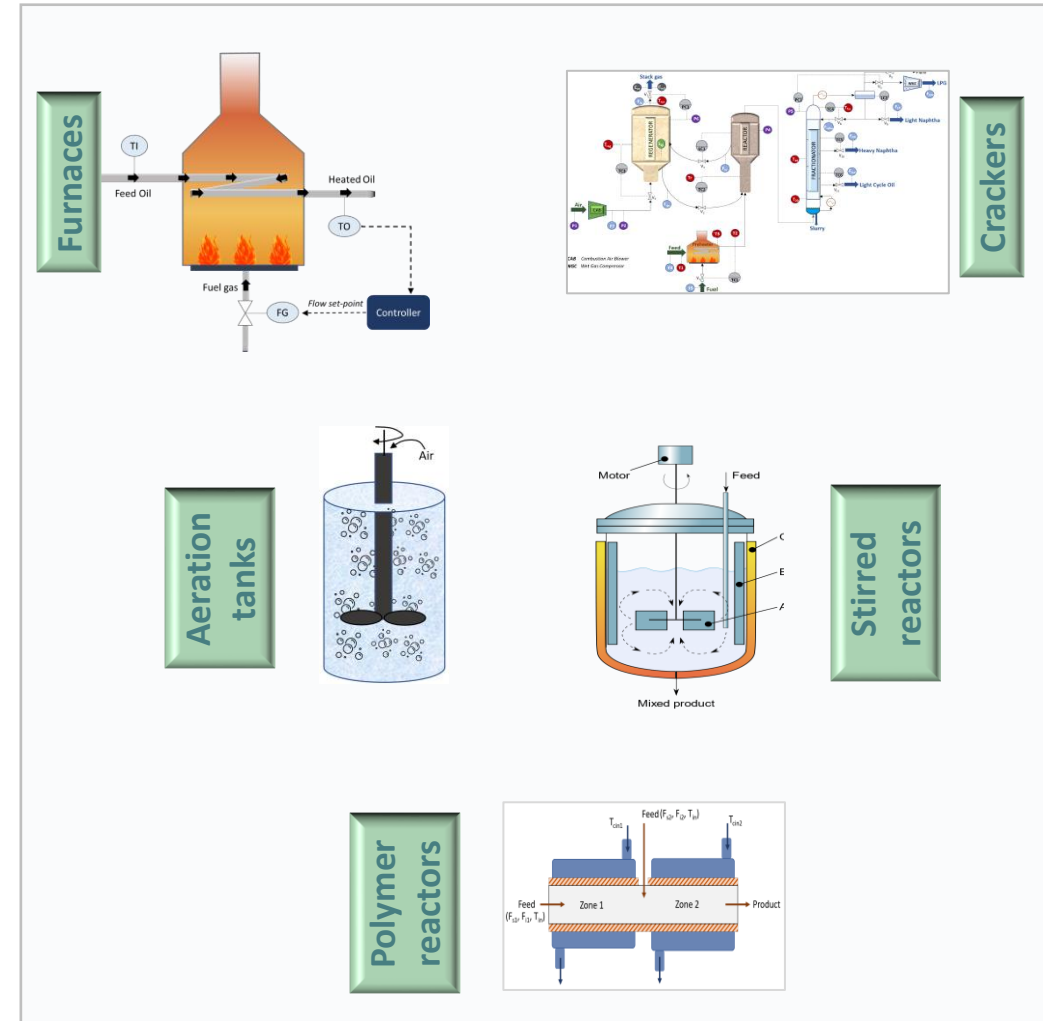


Concluding Remarks

Topics Covered

- ❑ Introduction to Statistical Process Monitoring (SPM)
- ❑ Python Installation and basics (optional)
- ❑ Univariate SPM
 - Shewhart Charts
 - CUSUM Charts
 - EWMA Charts
- ❑ Multivariate SPM
 - Fault detection using **Principal Component Analysis (PCA)**
 - Fault detection using **Partial Least Squares (PLS)** regression
 - Fault diagnosis using PCA/PLS contribution charts
 - Strategies for handling nonlinear, dynamic, multimode systems
- ❑ Deploying SPM solutions

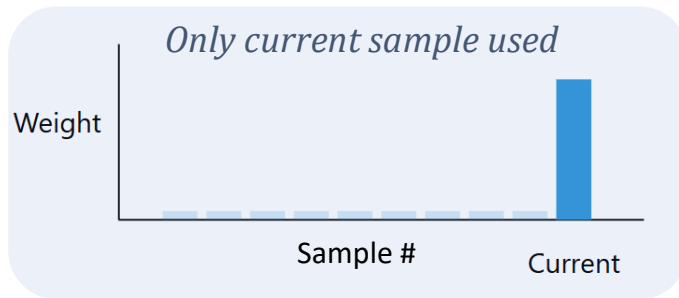
Process Industry-relevant case Studies



* Stirred reactor diagram: created by Daniele Pugliesi under [Creative Commons Attribution-Share Alike 3.0](https://commons.wikimedia.org/wiki/File:Agitated_vessel.svg), https://commons.wikimedia.org/wiki/File:Agitated_vessel.svg
 Chemical plant diagram: adapted from the original flowsheet by Gilberto Xavier (<https://github.com/gmxavier/TEP-meets-LSTM>) provided under [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by-sa/4.0/)

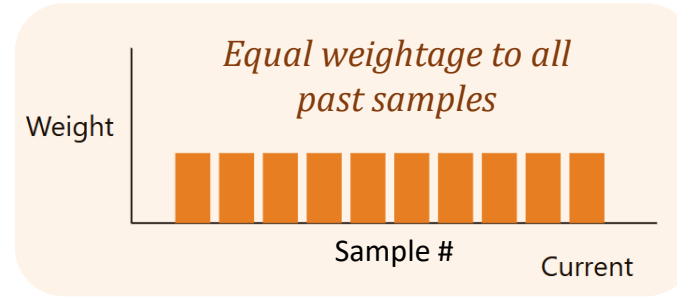
Univariate Process Monitoring: Shewhart, CUSUM, and EWMA

Shewhart



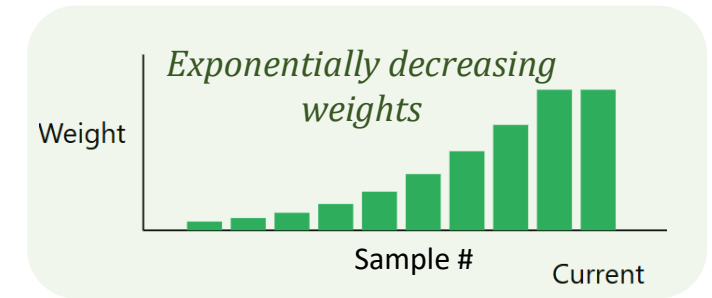
- Simple to construct and interpret
- Effective for detecting large shifts
- Widely used and understood

CUSUM



- Excellent for small persistent shifts
- Uses memory of previous data points
- More sensitive than Shewhart charts

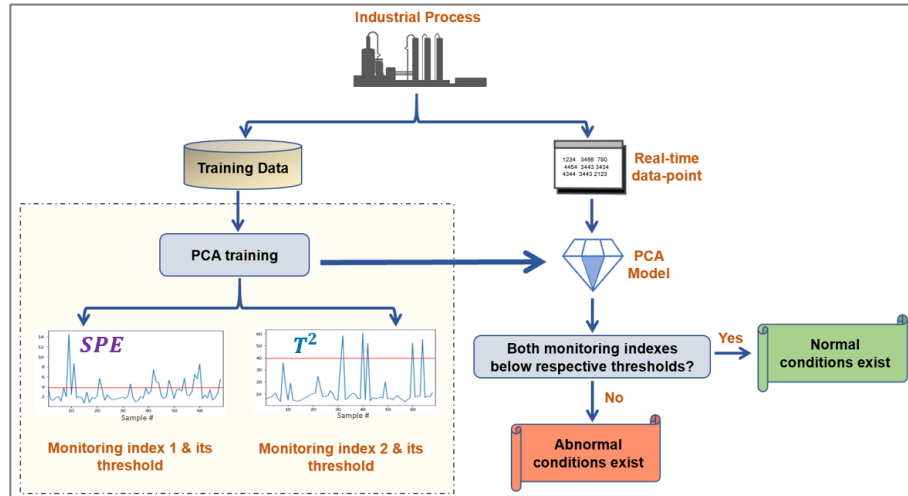
EWMA



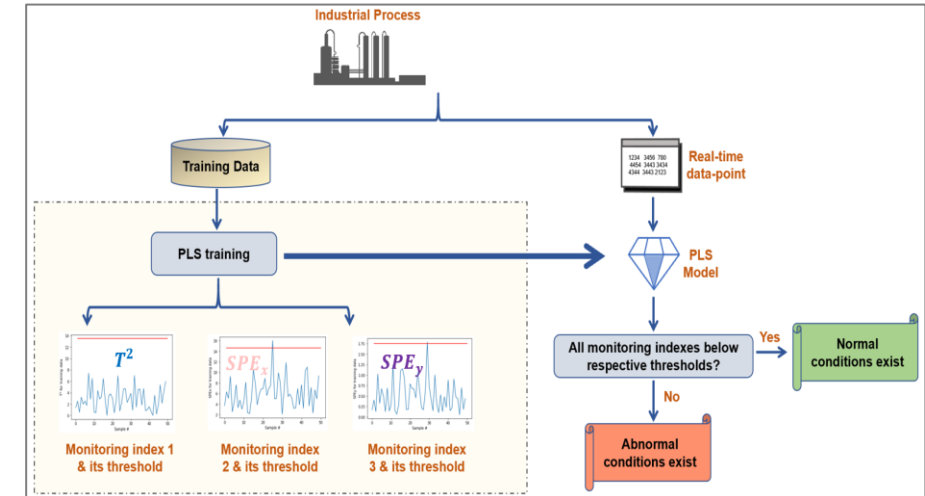
- Good for small-moderate shifts
- Less sensitive to normality assumptions
- Weights recent data more heavily

Multivariate Process Monitoring: PCA and PLS

PCA Workflow

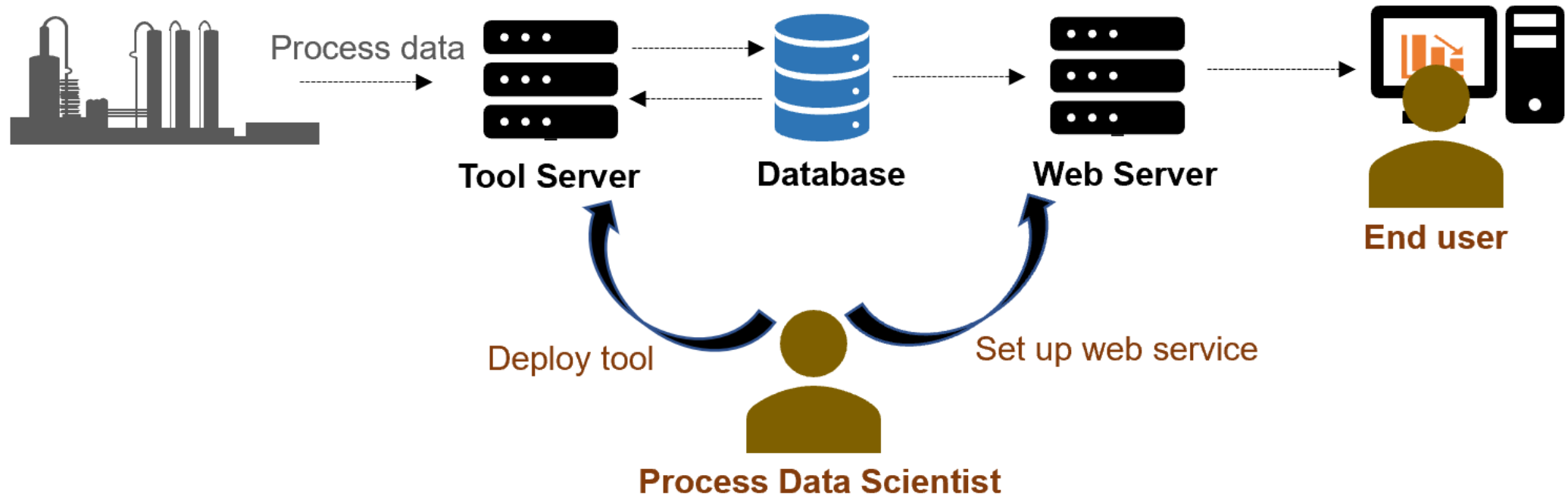


PLS Workflow



- ✓ Hidden process knowledge statistically extracted from process data
- ✓ Very powerful and easy to implement
- ✓ Can handle a large majority of industrial process systems

Monitoring Solution Deployment



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