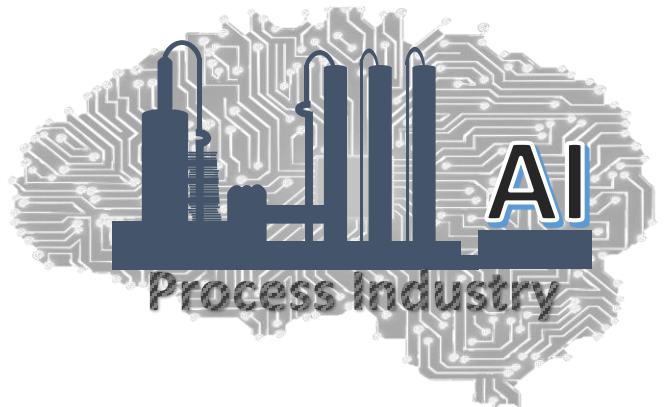


# Statistical Techniques for Monitoring Industrial Processes

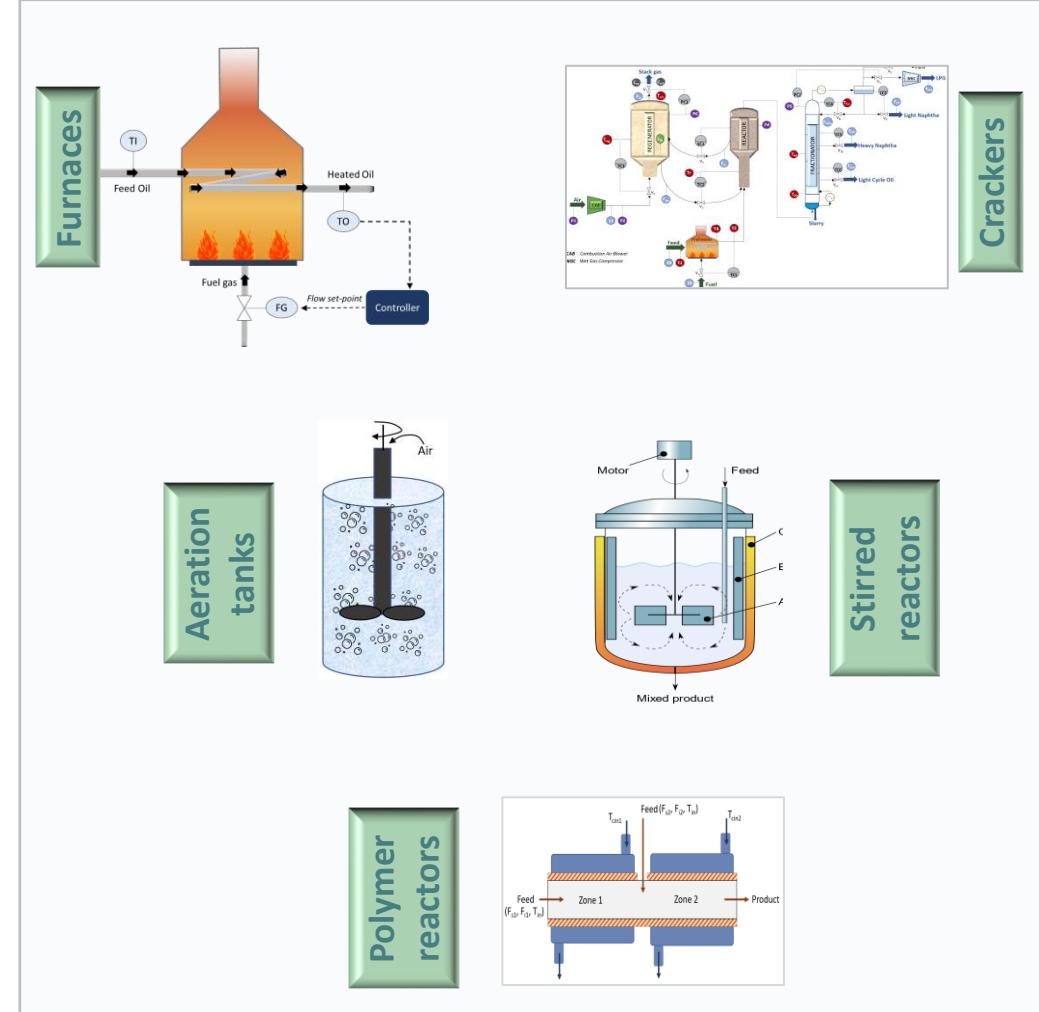


## *Concluding Remarks*

# 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*

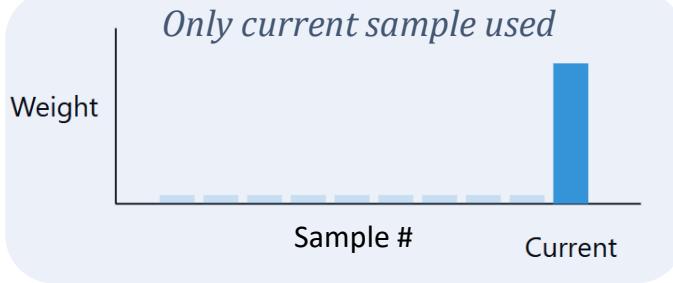


\* Stirred reactor diagram: created by Daniele Pugliesi under Creative Commons Attribution-Share Alike 3.0, [https://commons.wikimedia.org/wiki/File:Agitated\\_vessel.svg](https://commons.wikimedia.org/wiki/File:Agitated_vessel.svg)

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

# Univariate Process Monitoring: Shewhart, CUSUM, and EWMA

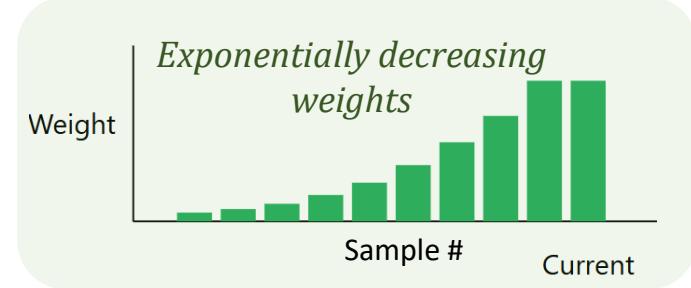
## Shewhart



## CUSUM



## EWMA

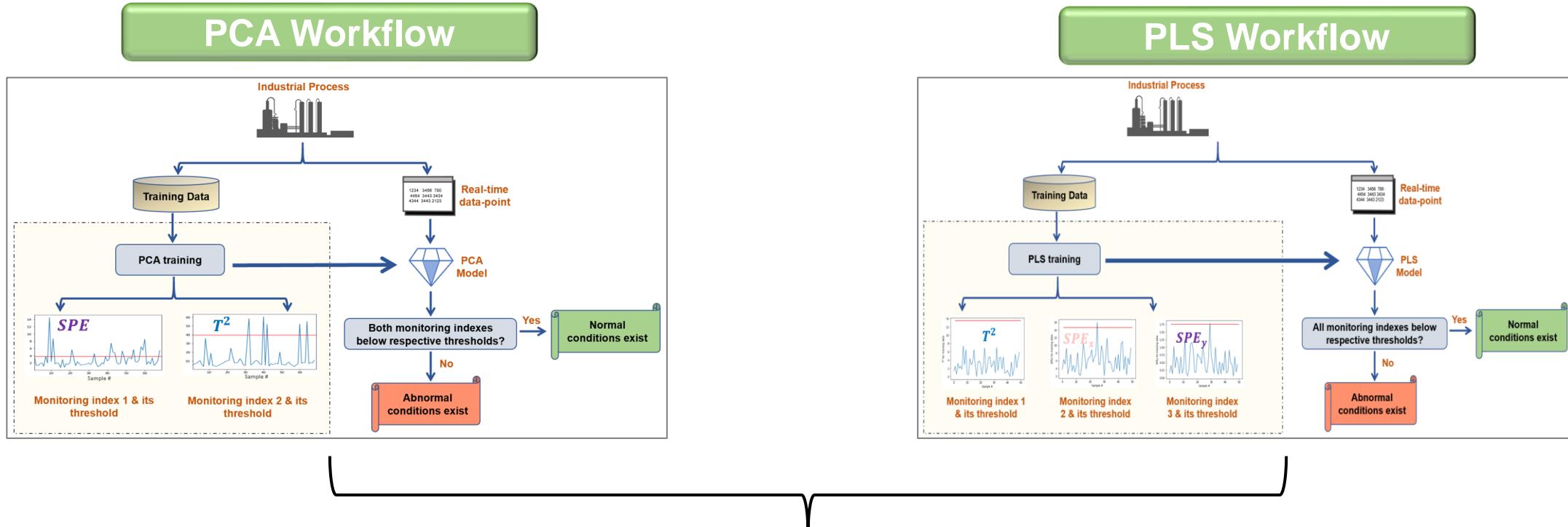


- Simple to construct and interpret
- Effective for detecting large shifts
- Widely used and understood

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

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

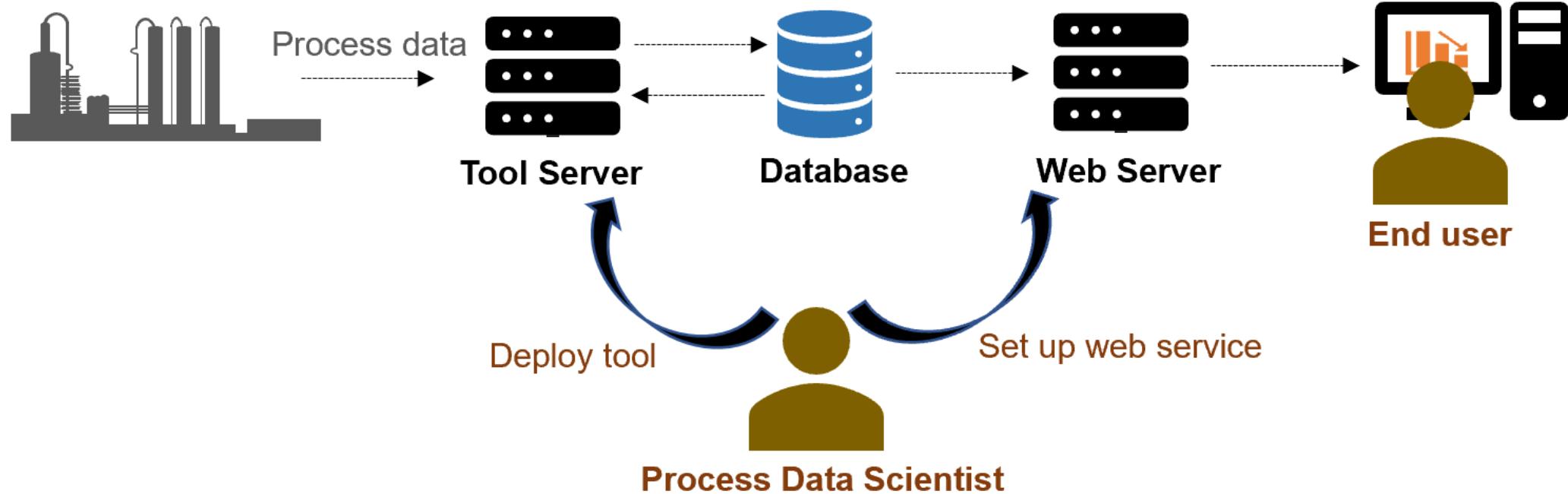
# Multivariate Process Monitoring: PCA and PLS



- ✓ 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



# Statistical Techniques for Monitoring Industrial Processes

