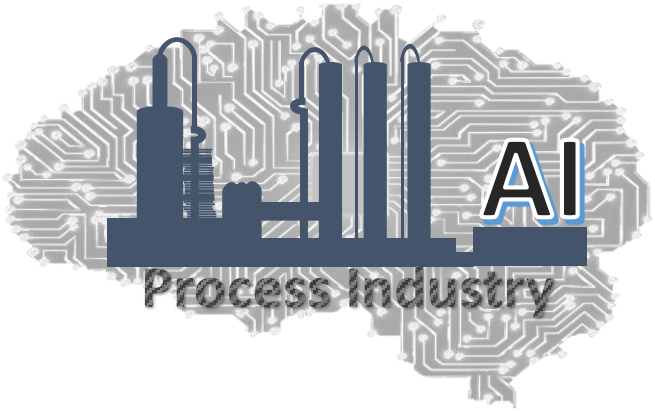
Statistical Techniques for Monitoring Industrial Processes



Lecture : Judging Performance of Control Charts

Module : Univariate SPM

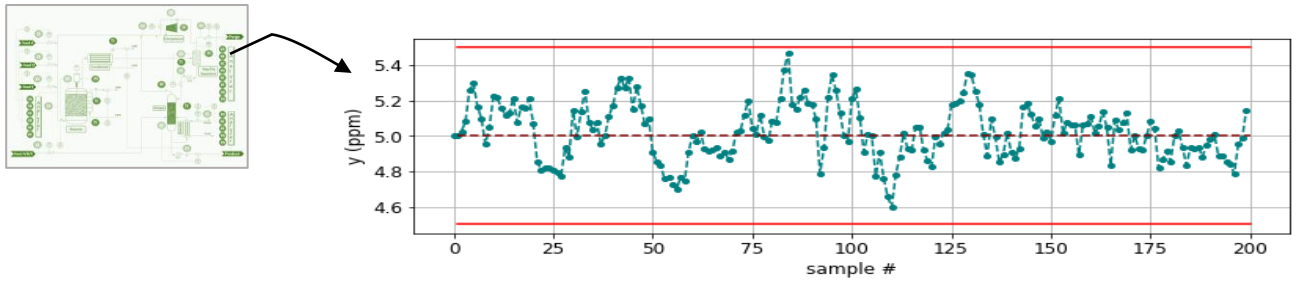
Course TOC

- ❑ Introduction to Statistical Process Monitoring (SPM)
- ❑ Python Installation and basics (optional)
- ❑ Univariate SPM & Control Charts
  - ➢ Shewhart Charts
  - ➢ CUSUM Charts
    - Application: Aeration tank monitoring
  - ➢ Assessing Performance of Control 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
- ❑ Deployment of SPM Solutions

Typer of Errors by a Control Chart

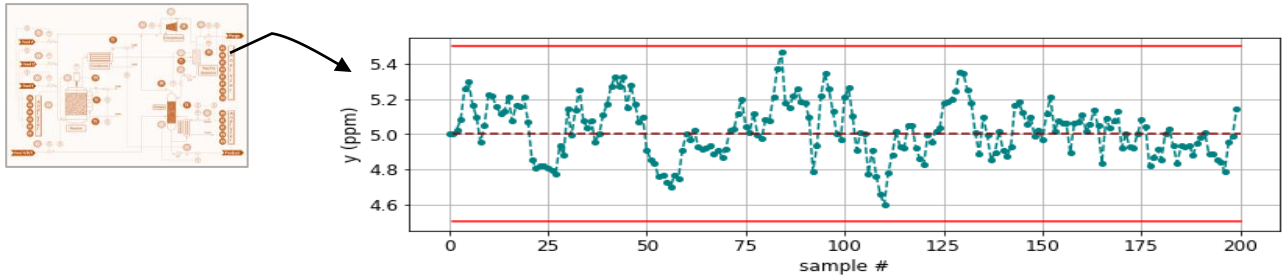
❑ Type I error:

- ➢ process is operating without any issues
- ➢ but control chart statistic violates the control limits



❑ Type II error:

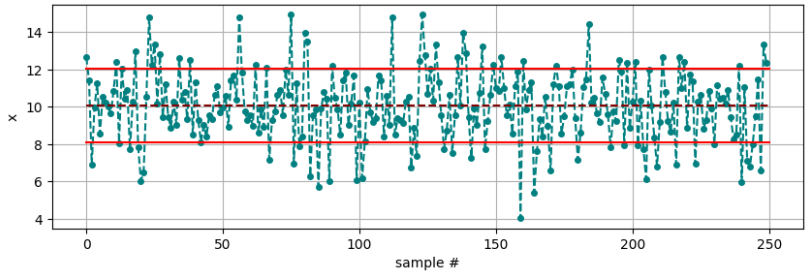
- ➢ process is abnormal
- ➢ but control chart statistic falls within the control limits



Quantifying the Errors

- **Type I error**: False alarm rate (FAR)

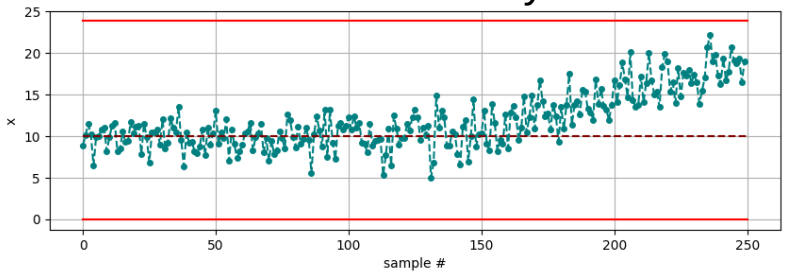
Control limits set very close to mean



$$FAR = 100 * \frac{\text{Number of observations violating control limits when process is in-control}}{\text{Total number of in-control observations}}$$

- **Type II error**: Missed detection rate (MDR)

Control limits set far away from mean

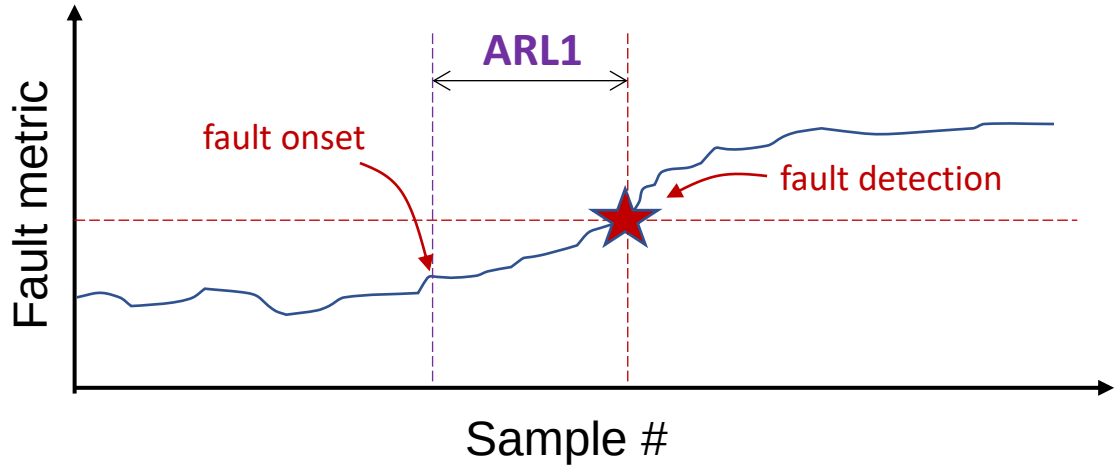


$$MDR = 100 * \frac{\text{Number of undetected out-of-control observations}}{\text{Total number of out-of-control observations}}$$

Difficult to have both FAR and MDR very low!

Average Run Length (ARL)

ARL1 refers to the number of samples (on an average) after the onset of fault that an alert is generated



- *a measure of fault detection speed*
- *small ARL values desirable*
- *ARL value table**

Mean shift (δ) (in multiples of $\hat{\sigma}$)	CUSUM ($k=0.5\hat{\sigma}$, $H=4\hat{\sigma}$)	CUSUM ($k=0.5\hat{\sigma}$, $H=5\hat{\sigma}$)	Shewhart
0.00	336	930	371.00
0.25	74.2	140	281.14
1.00	8.38	10.4	44.0
3.00	2.19	2.57	2.00
4.00	1.71	2.01	1.19

ARL0 refers to the number of samples (on an average) between false alerts!

- *large ARL0 desirable*

**https://www.itl.nist.gov/div898/handbook/pmc/section3/pmc3231.htm*

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Next Lecture : EWMA Control Charts

Module : Univariate SPM