Continuous Process Analytics

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Multiway PCA has significantly enhanced process monitoring of batch processes.

Continuous processes lack of an equivalent technology because of their flexible operations and undefined time duration.

An example is the continuous CO₂ capture process.
The definition of state variables allows to define modes of operation.

State variables can represent physical measurements or empirical indexes.

For the CO$_2$ capture process, one state variable is used to capture data variation.
States of operation represent the modes at which the process operates.

Clustering techniques can be used to define such modes.

The CO₂ capture process shows three modes, with most likely points of operation at \( \tau_1 \), \( \tau_2 \) and \( \tau_3 \), respectively.
States of operation allow to adjust data normalization for process monitoring.

Confidence regions, data mean and variance are made state dependent.

A compact confidence region for CO$_2$ capture data reduces the number of false alarms (blue).
Multistate PLS: Dynamic Data Filtering

- Multistate PLS is similar to Multistate PCA but it accounts for process inputs and outputs.
- Process dynamics are filtered to defined steady state modes of operation.
- Dynamic PLS is here used to filter process dynamics.
The scores \((\bar{t}_1, \bar{t}_2)\) from Dynamic PLS are used as state variables.

Modes of operation are determined by data clustering, with centroids \(\tau_1\) and \(\tau_2\).

Interpolation paths between cluster centroids are defined for process monitoring.