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 Context: PhD research
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PCA based modelling for monitoring, diagnosis and control of fouling in membrane bioreactors (MBR)

Objectives

- Development of a data-driven model to capture MBR filtration behaviour and deduce the membrane state
- Investigation on its use for real-time system diagnosis
- Development of a model-driven control strategy
- Implementation and validation on pilot and/or full scale
- Optimizing membrane bioreactor operation and energy use

Background

- ▶ MBR technology has many advantages over conventional wastewater treatment systems, which can serve goals on water quality, water management and sustainability. However, MBRs are hampered by high operational costs, partly due to the process of membrane fouling.
- ▶ Since the complex and interrelated nature of the fouling process, the mechanistic knowledge is still limited and even contradictory results are found. As a consequence, fouling remediation schemes (backwash, relaxation, cleaning, ...) are conservative and suboptimal.

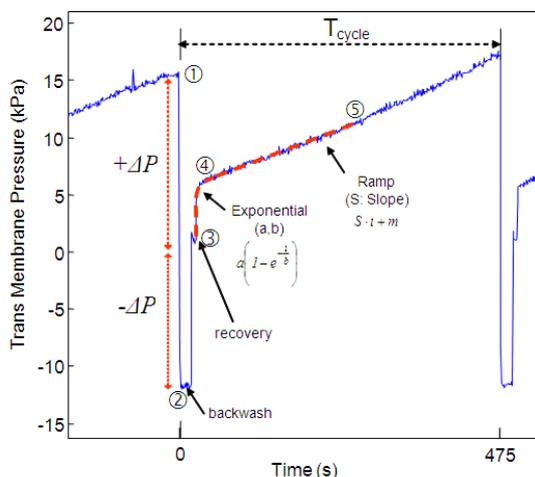


Figure 1: Data functionalisation for maximum information extraction

Methodology

- ▶ To build a model, transmembrane pressure (TMP) data are segmented to turn each filtration cycle into a single multivariate observation. To facilitate information extraction, data are functionalized (Figure 1), before data reduction is performed with PCA. Based on the transformed observations (principal scores), clustering of the results (Figure 2) and reconstruction of the data, an assessment of the membrane state can be made.
- ▶ Based on this model, future cycles can be evaluated. Different disturbances are invoked to the system to test diagnosis possibilities. Doing so, the model can be trained in the recognition of certain faults.
- ▶ After model training, a control system will be constructed to reduce energetic efforts while optimizing operational conditions based on the model's monitoring properties. Model based predictive control seems promising to account for limitations and costs.
- ▶ In a final stage, the PCA monitoring, diagnosis and control system will be implemented on pilot or full scale for validation of the technique.

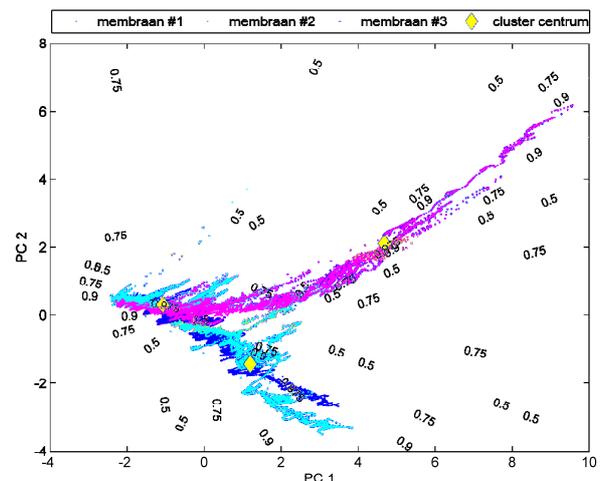


Figure 2: Plot of the principal scores. Each cycle can be evaluated by its position in the reduced PC-space and membership to the fuzzy clusters.