AI & bioprocess modeling in multi-product plant

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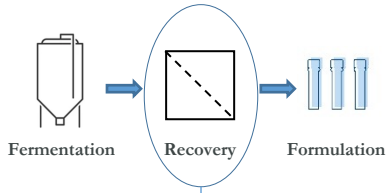
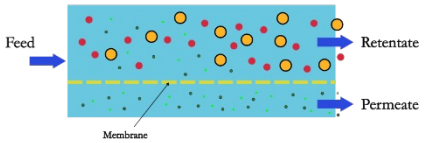
Helix Lab

Introduction

Enzyme production



ULTRAFILTRATION



PROCESS PARAMETERS

Temperature	Concentration
Pressure	pH
Power consumption	...

Project goals

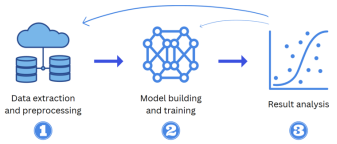
- Build model of ultrafiltration for one product type
- Maximize efficiency

$$\max\left(\frac{\text{permeat flow}}{\text{power consumption}}\right)$$

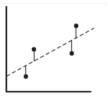
- Generalize model to other products

Methodology

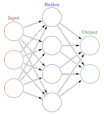
Modelling



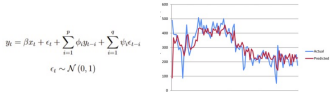
MODELS



Partial Least Squares



Neural networks



ARIMAX

ACCURACY

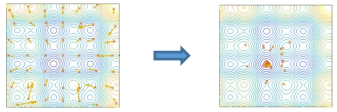
$$MSE = \frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y}_i)^2 \qquad R^2 = \frac{SSR}{SST} = \frac{\sum(\hat{y}_i - \bar{y})^2}{\sum(y_i - \bar{y})^2}$$

where: y_i - true value; $\hat{y}_i$ - estimated value; $\bar{y}$ - mean

Optimization

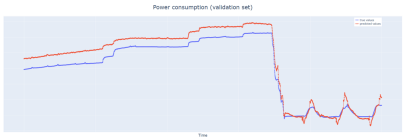
Brute force search - straightforward method that exhaustively explores all possible solutions within a given search space to find the optimal solution

Particle Swarm Optimization - population-based metaheuristic algorithm that simulates the collective behavior of particles to iteratively search for optimal solutions in a problem space.



Results (in progress)

MSE = 0.69 R^2 = 0.99



MSE = 76.14 R^2 = 0.86

Perspectives

Future projects

- Optimization of other enzyme production stages (fermentation, drying, etc.)
- Use of more precise and advanced optimization methods
- Development of one huge model for whole plant with all process parameters

Being a Helix Lab Fellow

- Access to high-tech equipment and industrial knowledge
- Daily access to production site, Helix Lab and corporate office
- Challenge of skills in real life problem solving
- Project management
- Networking opportunity
- Living with fellow students
- Weekly site visits and other activities
- Increasing employment prospects