PROMICON

A GENERAL DEEP HYBRID MODEL FOR BIOREACTOR SYSTEMS: COMBINING FIRST PRINCIPLES WITH DEEP NEURAL NETWORKS

Key message

These findings hold immense value for bioprocess engineers and researchers invested in optimizing bioreactor systems as the proposed general deep hybrid modeling technic can unlock a deeper understanding and control of biological processes.

Background

Mathematical models, represented by equations, simulate biological reactors and play a crucial role in optimizing processes that utilize microorganisms to produce valuable products. Traditionally, scientists have relied on a combination of fundamental physical laws (First Principles) and basic artificial intelligence (shallow neural networks) to model these systems. However, recent breakthroughs in deep learning (more advanced neural networks) present an exciting opportunity to create more powerful and accurate models.

Objective

This study aimed to enhance bioreactor modeling by seamlessly integrating deep neural networks with First Principles. The result is an improved model performance, including better predictions and enhanced generalization.

Source

Pinto, J., Mestre, M., Ramos, J., Costa, R. S., Striedner, G., & Oliveira, R. (2022). A general deep hybrid model for bioreactor systems: Combining first principles with deep neural networks. *Computers & Chemical Engineering*, 165, 107952. Available from: https://doi.org/10.1016/j.compchemeng.2022.107952

Findings

Deep Hybrid Models: A novel paradigm combining the complexity of deep neural networks with the rigor of First Principles equations was introduced.

Advanced and efficient Training Techniques: Various deep learning methods were compared resulting in 43.4% faster deep hybrid model training compared to traditional shallow models.

Real-World Applications: The methods were put to the test using both synthetic data and a real bioprocess data from a pilot 50L bioreactor.

Accuracy Boost: Deep hybrid models consistently outperformed their shallow counterparts, boasting an impressive 18.4% increase in prediction accuracy.

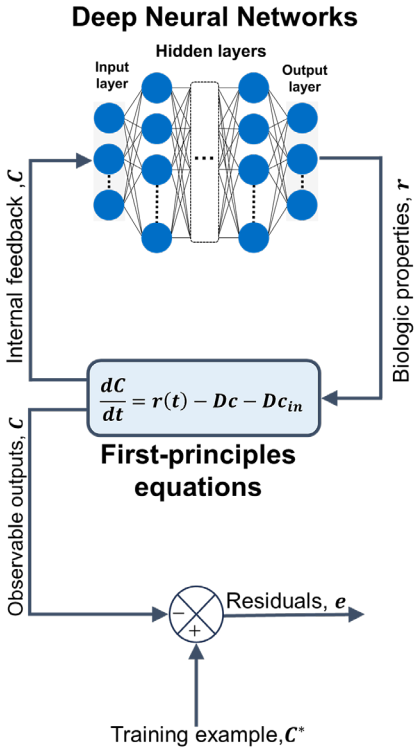

Figure. Deep hybrid model structure for bioreactor systems.

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