Learning-based feeding strategy for fed-batch bioreactor

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Fed-batch fermentation is a primary technology in producing antibiotics. The yield of the antibiotics highly depends on the substrate feed trajectory. Since feeding strategy is mostly depending on empirical rules, the productivity of the fed-batch bioreactor is undermined.
Fed-batch bioreactor has stochastic dynamics by biological behaviors. This makes the application of the model-based feeding strategy difficult. However, due to the development of hardware technology, gathering and processing data has become more feasible. Therefore, the data-driven strategy is introduced to surmount model-based strategy.
This paper applies data-based reinforcement learning for determining the optimum substrate feed trajectory. The substrate feed trajectory is set as the manipulated input. The state, input, and reward data were collected from simulating the digital twin of the bioreactor. The action value function is approximated by a neural network and trained from the data set. The simulation results show that the expectation of yield and summation of the reward using the feeding trajectory obtained from the RL exceeds the expectations obtained from the empirical feeding trajectory.