

Preface

Most industrial biotechnological processes are operated empirically. One of the major difficulties of applying advanced control theories is the highly nonlinear nature of the processes. This book examines approaches based on artificial intelligence methods, in particular, genetic algorithms and neural networks, for monitoring, modelling and optimization of fed-batch fermentation processes. The main aim of a process control is to maximize the final product with minimum development and production costs.

This book is interdisciplinary in nature, combining topics from biotechnology, artificial intelligence, system identification, process monitoring, process modelling and optimal control. Both simulation and experimental validation are performed in this study to demonstrate the suitability and feasibility of proposed methodologies. An online biomass sensor is constructed using a recurrent neural network for predicting the biomass concentration online with only three measurements (dissolved oxygen, volume and feed rate). Results show that the proposed sensor is comparable or even superior to other sensors proposed in the literature that use more than three measurements. Biotechnological processes are modelled by cascading two recurrent neural networks. It is found that neural models are able to describe the processes with high accuracy. Optimization of the final product is achieved using modified genetic algorithms to determine optimal feed rate profiles. Experimental results of the corresponding production yields demonstrate that genetic algorithms are powerful tools for optimization of highly nonlinear systems. Moreover, a combination of recurrent neural networks and genetic algorithms provides a useful and cost-effective methodology for optimizing biotechnological processes.

The approach proposed in this book can be readily adopted for different processes and control schemes. It can partly eliminate the difficulties of having to specify completely the structures and parameters of the complex models. It

VI Preface

is especially promising when it is costly or even infeasible to gain *a priori* knowledge or detailed kinetic models of the processes.

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