Preface

Machine learning stands as an important research area that aims at developing computational methods capable of improving their performances with previously acquired experiences. Although a large amount of machine learning techniques has been proposed and successfully applied in real systems, there are still many challenging issues that need to be addressed. In the last years, an increasing interest in techniques based on complex networks (large-scale graphs with nontrivial connection patterns) has been verified. This emergence is explained by the inherent advantages that the data representation as networks provides. They allow for capturing spatial, topological, and functional relations of the data. This book presents the features and possible advantages offered by complex networks in the machine learning domain. In the first part, we give an introduction to the machine learning and complex networks areas, supplying necessary background materials. Then, we present a comprehensive description on network-based machine learning. In the second part, we describe some specific techniques based on complex networks for supervised, unsupervised, and semi-supervised learning as case studies with the purpose of showing detailed know-how on network-based machine learning. Particularly, we explore a particle competition technique for both unsupervised and semi-supervised learning using a stochastic nonlinear dynamical system. We also walk through analytical aspects of the competitive system, enabling us to predict the behavior of the technique. Additionally, we deal with the problem of imperfect learning, exploring data reliability issues in semi-supervised learning and adapting the competitive system to withstand flawed training sets. Identifying and preventing error propagation have practical importance and are found to be of little investigation in the literature. Still in the second part of this book, we present a hybrid supervised classification technique that combines both low and high orders of learning. The low-level term is implemented by traditional classification techniques, while the high-level term is realized by extracting features of the underlying network constructed from the input data. The general idea of the model is that the low-level term classifies test instances by their physical features, while the high-level term

measures the compliance of test instances with the pattern formation of the data. We show that the high-level technique can realize classification according to the semantic meaning of the data.

This book intends to bridge two widely studied research areas: machine learning and complex networks. Therefore, we hope it will generate broad interests to the scientific community. This book is intended to be employed by researchers and students who are interested in machine learning and complex networks. To accomplish that, not only have we included classic knowledge but also recent research results. This book is aimed to be self-contained and to give interested readers insights on modeling, analysis, and applications of network-based machine learning techniques. We also provide pointers to the literature for further reading on each explored topic. Moreover, numerous illustrative figures and step-by-step examples help readers to understand the main ideas and implementation details.

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