Preface

Neuroscience is nowadays one of the most appealing research fields for interdisciplinary research. The rich dynamics and complexity of living neuronal networks, and the brain in particular, has long fascinated biologists, physicists and mathematicians alike. In the last decade, however, and thanks to the giant development in computational tools and scientific interconnectivity through Internet, neuroscience has experienced a new drive that seems unstoppable and more interdisciplinary than ever.

Machine learning is one of the most innovative modern computational tools. In the context of neuroscience, it has already procured extraordinary results in brain activity data analysis, artificial intelligence, and human–machine interfacing. Machine learning tools have the capacity to predict the behavior or response of a complex system given sufficient data and training. This capacity is precisely what motivated us to launch the Connectomics Challenge. The task in mind was to solve an interesting yet highly complex inverse problem: given the time series of neuronal spontaneous activity, which is the underlying connectivity between the neurons in the network?

The present volume illustrates the efforts of the scientific community to use machine learning concepts to tackle this problem and to develop tools for the advancement of neuroscience. The volume is specially oriented to the mathematical, physical and computer science community that carries out research in neuroscience problems. It may also be of great interest for the machine learning community since it exemplifies how to approach the same problem from different perspectives. Finally, a broader readership may find interesting the description and development of the Connectomics Challenge itself and get a glimpse of major open problems in current neuroscience.

The contributions in this volume are organized as follows. Orlandi et al. will first provide an overview of the Connectomics Challenge, describing its goals, the procured data and challenge development, to finally compare the strategies and outcome among participants. The next five articles will describe in detail different approaches used by the participants to tackle the problem. They include partial correlation analysis by Sutera et al.; a connectivity feature engineering pipeline by

Magrans et al.; a convolutional approach by L. Romaszko; the use of Csisz's Transfer Entropy and regularization by Tao et al.; and a random forest classification algorithm by Czarnecki et al. The next two contributions close the volume by illustrating the potential of machine learning approaches to support neuroscience research. Ma et al. will describe a Poisson Model to infer spikes trains from in vivo recordings in the rat brain; and Laptev et al. will introduce a neuroimage tool to enhance information retrieval from image sequences and apply it to improve neuronal structure segmentation.

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