Preface

Machine Learning, Multivariate Methods and Interpretation: New Avenues in Neuroimaging

Modern multivariate statistical methods developed in the rapidly growing field of machine learning are being increasingly applied to various problems in neuroimaging, from cognitive state detection ("mind reading") to clinical diagnosis and prognosis. Multivariate pattern analysis methods are designed to examine complex relationships between high-dimensional signals, such as brain images, and outcomes of interest, such as the category of a stimulus, a type of a mental state of a subject, or a specific mental disorder. Such approaches are in contrast with the traditional mass-univariate approaches that dominated neuroimaging in the past and treated each individual imaging measurement in isolation.

We believe that machine learning has a prominent role in shaping how questions in neuroscience are framed, and that the machine-learning mindset is now entering modern psychology and behavioral studies. It is also equally important that practical applications in these fields motivate a rapidly evolving line or research in the machine learning community. In parallel, there is an intense interest and several ongoing efforts focused on learning more about brain function in the context of rich naturalistic environments, beyond highly specific paradigms that pinpoint a single function. In this context, many controversies and open questions exist.

This volume is a collection of contributions from the 4th Workshop on Machine Learning and Interpretation in Neuroimaging (MLINI) at the Neural Information Processing Systems (NIPS 2014) conference; moreover, it also includes three papers that received the best paper award at the Third MLINI Workshop in 2013. The first workshop in these series was organized in December 2011. The MLINI workshop series focuses on machine learning approaches in neuroscience, neuroimaging, with a specific extension to behavioral experiments and psychology, and provides a forum that facilitates cross-fertilization across those fields.

The key objective is to pinpoint the most pressing issues and common challenges, and to sketch future directions and open questions in the light of novel methodology. Besides interpretation, and the shift of paradigms, many open questions remain at the intersection of machine learning, neuroimaging, and psychology. These questions include, but are not limited to the following. Can we characterize situations when multivariate predictive analysis (MVPA) and inference methods are better suited for brain imaging analysis than more traditional techniques? How well can functional networks and dynamical models capture the brain activity, and when using network and dynamics information is superior to standard task-based brain activations? How can we move toward more naturalistic stimuli, tasks, and paradigms in neuroimaging and neurosignal analysis? What kind of mental states can be inferred from cheaper and easier to collect data sources (as an alternative to fMRI scanners) such as text, speech,

audio, video, EEG, and wearable devices? What type of features should be extracted from such naturalistic input to detect specific mental states and/or mental disorders?

Exploring these and many other related questions remains the source of inspiration for the MLINI workshop series.

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