"Drawing a line: Multi-variate classification"

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This talk should benefit neuroscientists and clinical neuroscientists who are interested in learning about pattern recognition techniques focusing on applications to neuroimaging data analyzes.

Neuroimaging techniques can provide objective measures of brain structure and function. Therefore, numerous studies have used these techniques to investigate basic and clinical neuroscience questions. Until recently, methods used to analyze such data focused mainly on mass-univariate statistical analysis, i.e. treating every voxel in the brain independently and extracting measures of interest from them, such as the average response during a particular experimental condition or for a specific population. Although mass-univariate analyses have proven powerful for making regionally specific inferences on brain function and structure, there are limitations to the type of research questions that they can address.

More recently, mass-univariate analyses have been complemented by the use of multivariate pattern recognition analyses, in particular using machine learning based predictive models (Pereira et al, 2009). These analyses focus on predicting a variable of interest (e.g. cognitive state 1 vs. cognitive state 2, or patients vs. controls) from the pattern of brain activation/anatomy over a set of voxels. Due to their multivariate properties, these methods can achieve relatively greater sensitivity and are therefore able to detect subtle, spatially distributed activations and patterns of brain anatomy. In addition these approaches represent an important paradigm shift in neuroimaging data analysis as they enable predictions at individual level in contrast with standard statistical approaches that describe group or population effects. Applications of multivariate pattern recognition analyses range from decoding mental states from brain activity (e.g. Haynes & Rees 2006) to neuroimaging-based diagnosis (e.g. Klöppel at al, 2012).

In this presentation I will describe the general pattern recognition framework used for multivariate analyses of neuroimaging data and present applications of the framework to investigate a number of research questions including: (i) Can we predict subjective pain intensity from brain scans? (Marquand et al. 2010) (ii) Can we predict the outcome of psychotic episodes based on structural MRI? (Mourao-Miranda et al 2012a) (iii) Can we identify individuals most at risk of anxiety and mood disorders based on function MRI? (Mourao-Miranda et al 2012b).

The attendants will learn the basic principles of pattern recognition analysis of neuroimaging data and the types of research questions that can be addressed with this framework.

References:

Haynes, J. & Rees, G. (2006). Decoding mental states from brain activity in humans. *Nature Reviews Neuroscience*, 7, 523-534.
Klöppel, S., Abdulkadir, A., Jack, C.R. Jr, Koutsouleris, N., Mourao-Miranda, J., & Vemuri, P. (2012). Diagnostic neuroimaging across diseases*. Neuroimage*, 61(2), 457-63.

Marquand, A., Howard, M., Brammer, M., Chu, C., Coen, S., & Mourao-Miranda, J. (2010). Quantitative prediction of subjective pain intensity from whole-brain fMRI data using Gaussian processes. NeuroImage, 49(3), 2178-2189.

Mourao-Miranda J, Oliveira L, Ladouceur CD, Marquand A, Brammer M, et al. (2012b). Pattern Recognition and Functional Neuroimaging Help to Discriminate Healthy Adolescents at Risk for Mood Disorders from Low Risk Adolescents. *PLoS ONE.* 7(2):e29482.

Mourao-Miranda J, Reinders AA, Rocha-Rego V, Lappin J, Rondina J, Morgan C, Morgan KD, Fearon P, Jones PB, Doody GA, Murray RM, Kapur S, Dazzan P. (2012a). Individualized prediction of illness course at the first psychotic episode: a support vector machine MRI study. *Psychol Me*d. 42(5),1037-47.

Pereira, F., Mitchell, T., & Botvinick, M. (2009). Machine learning classifiers and fMRI: a tutorial overview. *Neuroimage*, 45, 199-209.