Characterizing and decoding distributed brain representations

Organizers

Nikolaus Kriegeskorte (National Institutes of Health)*: kriegeskorten@mail.nih.gov
Dirk B. Walther (University of Illinois at Urbana-Champaign)*: walther@uiuc.edu
Gabriel Kreiman (Children's Hospital Boston, Harvard Medical School): Gabriel.Kreiman@childrens.harvard.edu
Roozbeh Kiani (University of Washington): roozbeh@u.washington.edu
Geoffrey K. Aguirre (University of Pennsylvania): aguirreg@mail.med.upenn.edu
* These two organizers contributed equally.

Abstract

The characterization of neural codes in terms of their representational content and the reading out of that content (decoding) from brain-activity data constitute challenges fundamental to neuroscience. Neural representations are inherently a parallel, multi-unit phenomenon. In order to exploit the increasingly rich spatiotemporal brain-activity data provided by multi-channel electrophysiology and functional imaging, we need to develop analytic methods that handle the multivariate complexity of neural activity patterns and relate them to their representational content.

This workshop will explore two related approaches to analyzing distributed neural representations and their application in electrophysiology and functional imaging. The first approach is that of decoding, where the aim is to read out the content of the representation by means of pattern-classification algorithms. These techniques have allowed the decoding of the orientation of visually presented gratings, the category and identity of visually perceived objects, and even subjects' intended choice of future action.
The second approach is that of representational similarity analysis, which characterizes the neural code by means of a representational similarity matrix. For each pair of experimental conditions (e.g. each pair of stimuli), the representational similarity matrix contains an entry reflecting the similarity of the activity patterns associated with the two conditions. This approach has shown, for example, that inferotemporal response patterns to natural object images form clusters corresponding to conventional object categories.

So far methods for characterization and decoding of distributed neuronal codes have been developed in relative isolation in electrophysiology and functional imaging. In this workshop, we intend to foster interaction and transfer of knowledge between these still largely separate fields. We aim to cover novel neuroscientific insights from these approaches as well as data analytical and algorithmic challenges inherent to the multivariate analysis of multi-channel data.

The workshop will be framed by introductory remarks highlighting common themes and overarching challenges and a concluding discussion. In the concluding discussion, we hope to envision a more integrated systems neuroscience, where different multi-channel measures of neural activity are quantitatively related to each other and to computational theory by means of a common multivariate framework for characterizing and decoding distributed neuronal representations.

Morning session: Decoding Multivariate Signals

Chairs: Dirk B. Walther, Gabriel Kreiman
Time: 8:00-11:00 AM

8:00	**James Haxby**	***Introductory talk*** – Multivoxel pattern analysis of fMRI: What can it reveal about the neural representation of faces and objects
8:30	**Gabriel Kreiman**	What can the brain do with one or a few spikes per neuron?
8:50	**Hans Op de Beeck**	Cracking the code of visual objects in the ventral visual pathway with pattern-based fMRI: The role of perceived shape
9:10	**David Cox**	Untangling transformation-invariant object representations
9:30		**Informal discussion over coffee**
10:00	**Dirk B. Walther**	Predicting perceived natural scene categories from distributed patterns of fMRI activity
10:20	**Sheila Nirenberg**	Population coding in the retina
10:40 -11:00	**Kendrick Kay**	Using voxel receptive field models to identify natural images seen by an observer

Afternoon session: Representational Similarity Analysis

Chairs: Nikolaus Kriegeskorte, Geoffrey Aguirre, Roozbeh Kiani
Time: 4:30-7:30 PM

4:30	**Geoffrey K. Aguirre**	Continuous carry-over fMRI for measurement of focal and distributed neural similarity
4:50	**James McClelland**	Similarity structure in parallel distributed cognitive representations
5:10	**Matthew Botvinick**	Representational similarity structure and the neural basis of decision making
5:30		**Informal discussion over coffee**
6:00	**Rajeev Raizada**	Predicting individual differences in speech perception using pattern-based fMRI analysis of phonemic representations
6:20	**Roozbeh Kiani**	Object category structure in response patterns of neuronal population in monkey inferior temporal cortex
6:40	**Nikolaus Kriegeskorte**	Categorical and continuous IT representations – relating monkey single-cell recordings and human fMRI with representational similarity analysis
7:00 -7:30		***General discussion***