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Estimating brain connectivity from fMRI data

fMRI (functional magnetic resonance imaging) is a modern technique for creating 3-dimensional images of brain activity. The method measures the oxygen level of the brain over time, which is represented as a sequence of images. These images can be used to say something about the functional behavior of the brain, since brain activity in a certain part of the brain will have effect on the oxygen level in the same region. The fMRI data is usually quite noisy and therefore require powerful statistical in order to correctly infer the brain activity. For an introduction see (The Statistical Analysis of fMRI Data, Lindquist, 2008).

An important application of fMRI data is to infer connections between different brain regions, to produce maps of the brain's intrinsic networks. The proposal for this project is to investigate how these connections can be measured using correlation, a task that contains several challenges. The huge amount of data is maybe the greatest one, which makes sophisticated methods time consuming unless the dimensionality of the data is reduced in some way. This can be done by locating spatial ICA (independent component analysis) networks or by parcellating the brain into smaller regions, which also has the benefit of making the results more interpretable. Also, since the time series for each voxel typically displays autocorrelation, this could be modeled in order to reduce the variance of the correlation estimate. Two possible extensions for the project could be to also model the correlations as time-varying[1] and to compare the correlation to other measures of connectivity, for example spectral coherence or mutual information.

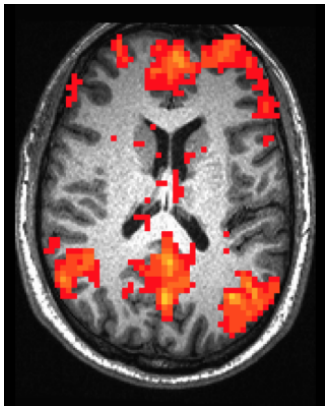

Figure 1: Brain correlation map.

[1] See movie at http://www.nil.wustl.edu/labs/raichle/images/Restless_Brain/correlation_matrix.html