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From fMRI noise to brain connectivity? Statistical learning to the rescue

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fMRI is a noisy imaging that captures neural activity via it's very indirect impact on local magnetic susceptibility. Fluctuations in fMRI signals observed in the absence of task (the so-called resting state) almost magically reveal complex and structured patterns. How can we trust these patterns to faithfully express brain interactions? From a statistical modeling, we cast this question as a graph-learning problem, in which the edges should represent interaction strength and the graph the independence structure. The simplest model is that of the Gaussian graphical model and leads to covariance estimation. I will discuss estimation and model selection in this framework. Drawing from the literature of statistical learning to refine the data-processing strategies yields richer interaction structures that give more plausible picture of brain function and inform us on the its large scale functional architecture. Pushing the model further, inter-subject comparisons of resting-state interaction structure open the door to prognosis or diagnosis tools, but also raise the question of statistical control.

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