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1. Researchers have observed "states" of the human brain. These appear as configurations of brain regions that often occur together when we are resting. Little is known about how we transition from one brain state to another, or what the significance of these temporal transitions might be in terms of our experience or behaviour. To learn more, this project will involve modelling of brain state transitions and an initial probe into their significance. Phase one involves modelling the brain states themselves; Phase 2 involves modelling the transition structure; and Phase 3 will scale up the algorithm to a "big data" project involving thousands of brain scans. We will calibrate the scope of the project to one or all of these phases based on available time. Analysis will be performed on the HPCVL supercomputer cluster using Matlab.
2. The brain of a human adult looks like a pile of spaghetti. What is the meaning of the "folds" on its surface? One theory is that these folds emerge because of mechanical tension formed by connections between neurons on opposite side of each fold. This theory predicts that neurons sitting on opposite sides of the folds should be more connected than those in other areas. We can test this proposal by performing a "big data" analysis of neural connections on thousands of brains from a neuroimaging database. We will identify the best model for representing functional integration (cross-fold vs. along-fold covariance). Analysis will be performed on the HPCVL supercomputer cluster using Matlab.