Soheil Zarei

PHD candidate in Cognitive Neuroscience (Artificial Intelligent major)

Master of Technology in Software Engineering

Member of Addiction Recovery Path (ARP) project

Ongoing project:

- Resting state fMRI data analysis
- Resting state MRI in addiction: systematic review
- Addicted people classification based on biomarkers derived from resting functional magnetic resonance imaging and developing treatment prediction

Skills:

Software programming, Shell scripting

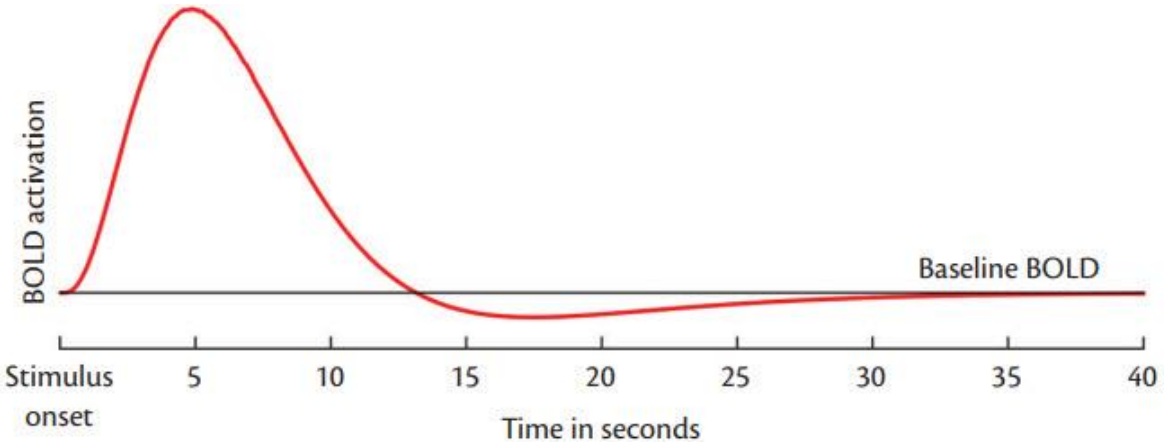
Work by neuroimaging tools and software like AFNI, FSL, CONN, SPM, FreeSurfer and etc.

Data analysis

Description:

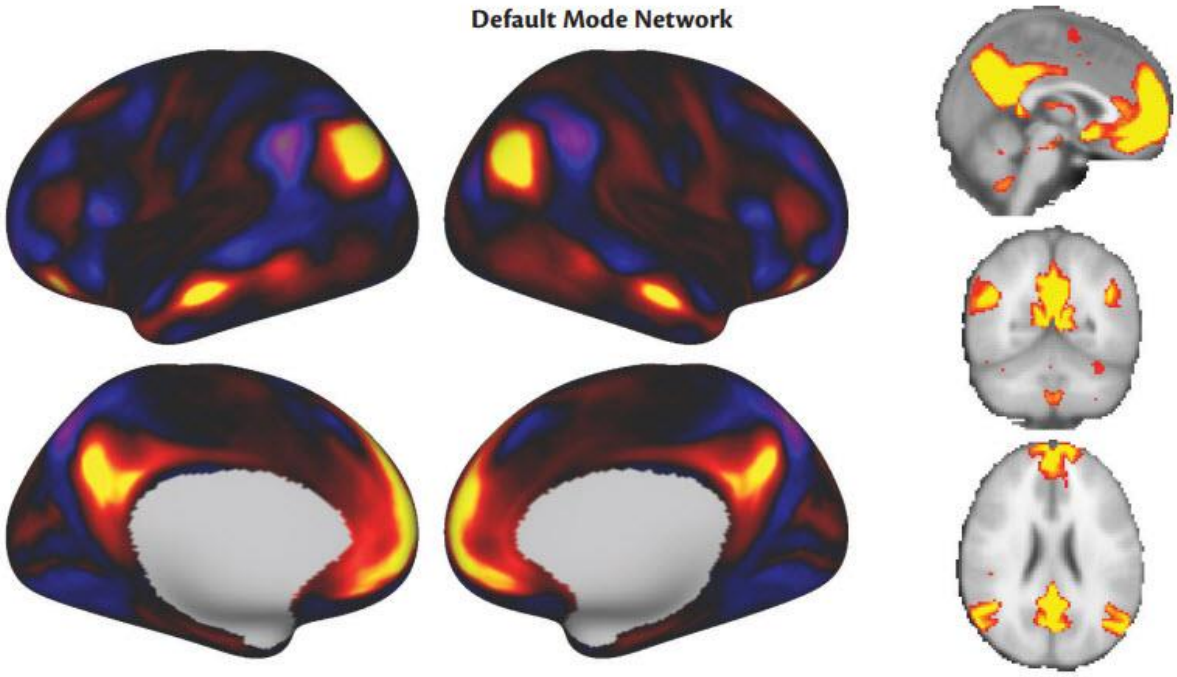
Resting State Functional Magnetic Resonance Imaging

Functional connectivity analyses are used to explore the intrinsic organization of the brain in individuals typically at rest. To measure functional connectivity, similarities in the temporal fluctuations of blood oxygenation level dependent (BOLD) fMRI data are quantified. The simplest way to investigate similarity between two signals is by looking at their timeseries correlation using Pearson's correlation coefficient. Correlation ranges from –1 (perfect negative correlation) to +1 (perfect positive correlation), where 0 indicates no relationship on average between two signals.



What is resting state network?

Resting state network is simply a set of brain regions that show similarities in their BOLD timeseries obtained during rest. Perhaps the best-known resting state network of all is the Default Mode Network (DMN). The DMN contains regions in the brain that consistently show decreases in activity when the brain is performing any type of task compared with rest (deactivations). Key regions of the DMN are the posterior cingulate cortex, precuneus, medial prefrontal cortex, inferior parietal lobule, and lateral temporal cortex.



What can be gained from rsfMRI?

First, resting state fMRI can be used to inform us about the inherent organization and functioning of the brain. Second, gaining a better understanding of the brain in its basal resting state may be helpful in order to better understand how the brain activates in response to task demands. In addition to the improved understanding of the basic neuroscience of the brain, resting state fMRI also has great potential to serve as a biomarker for mental disorders

International projects

The Human Connectome Project (HCP; http://www.humanconnectome. org) provides MRI data (including resting state and task fMRI, diffusion imaging, and structural scans), as well as extensive behavioral and epidemiological data from 1200 subjects, obtained from family groups.

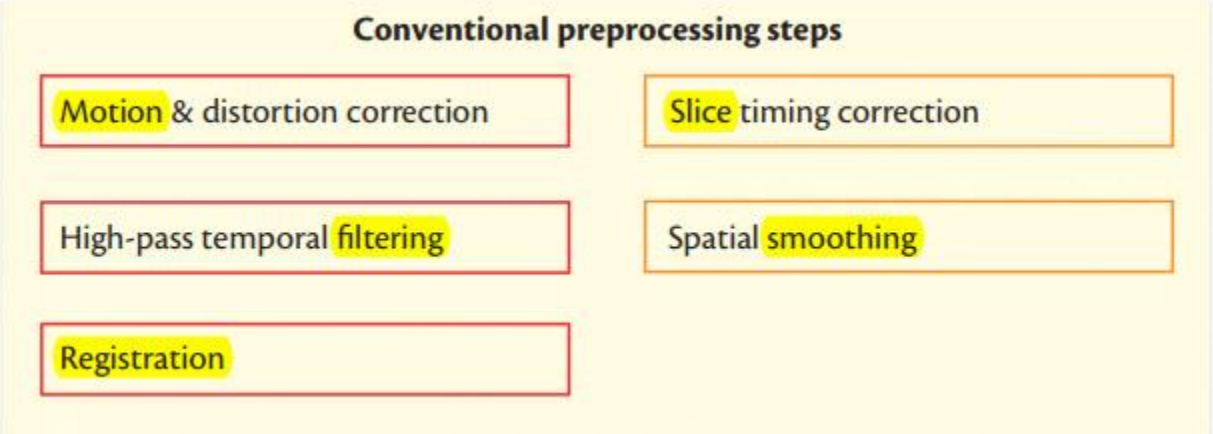
UK Biobank Imaging study, which is currently the biggest of all, as it will obtain data on lifestyle, environment, genetics, and multiple multimodal imaging measures, including resting state, from 100,000 subjects

Developing Human Connectome Project (dHCP), which includes imaging, clinical, behavioral, and genetic data from babies obtained in utero during pregnancy, and in early life (up to 44 weeks post-conception)

International NeuroImaging Data-sharing Initiative (INDI), which includes the Autism Brain Imaging Data Exchange (ABIDE)

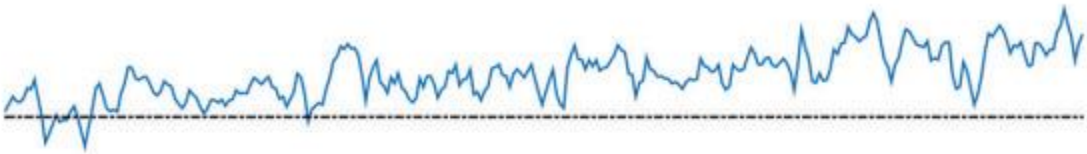
Preprocessing Data

The main aim of preprocessing is to prepare the resting state data for subsequent functional connectivity analysis by reducing the influence of artifacts and other types of structured noise



BOLD Signal Filtering

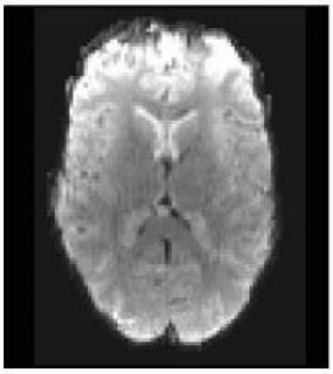
Original BOLD data



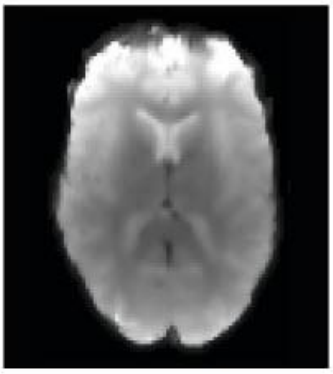
High-pass filtered data (>0.01 Hz)

Band-pass filtered data (0.01–0.1 Hz)

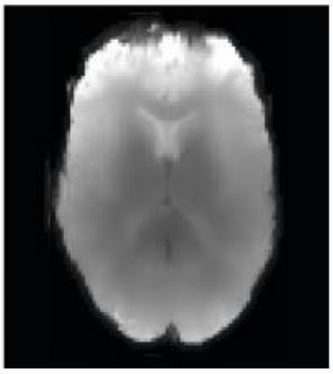
Smoothing



No smoothing

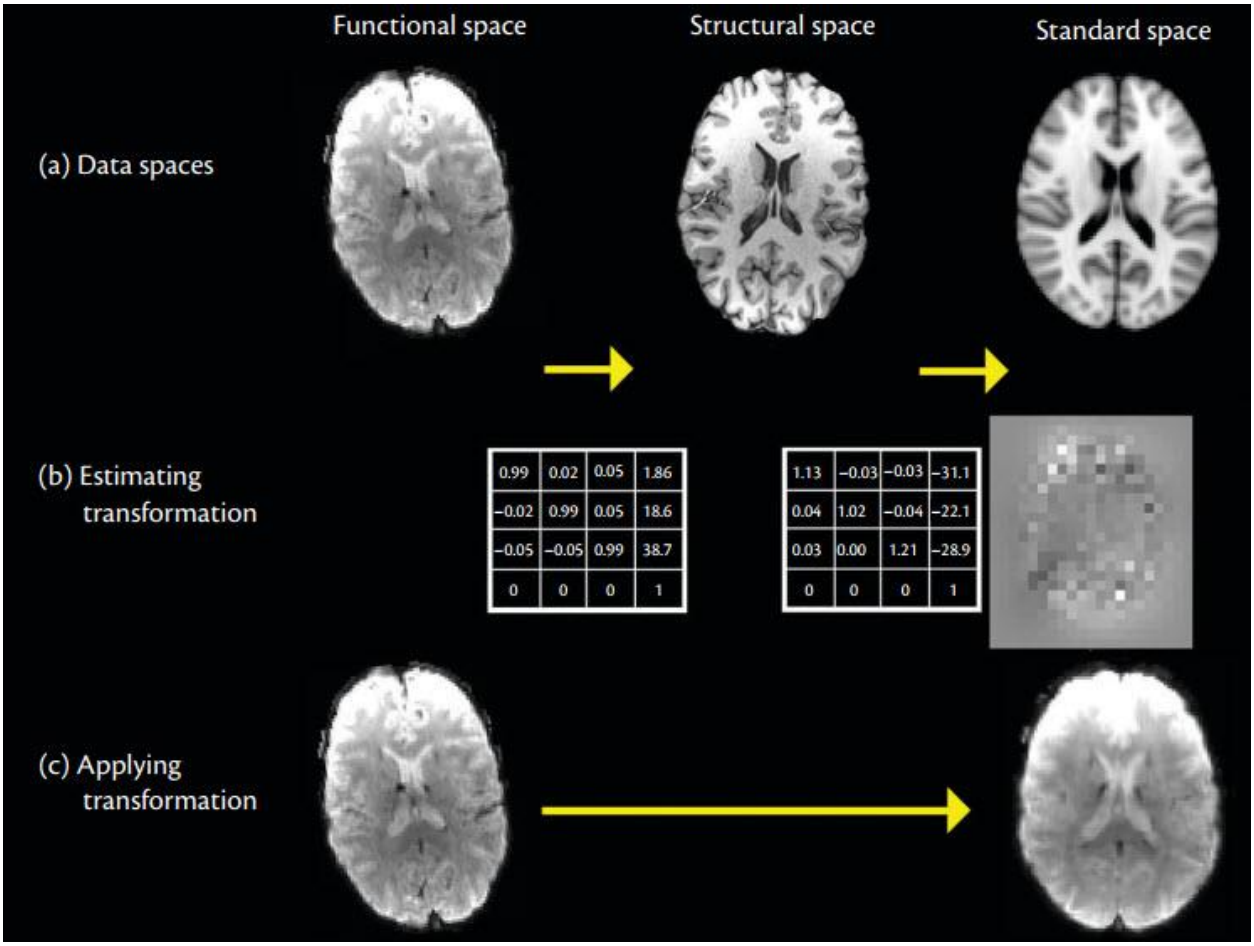


5 mm smoothing



10 mm smoothing

Registration



RsfMRI data analysis

Seed-based Analysis:

In seed-based correlation analysis (SCA), one region of interest is chosen that will drive the resulting functional connectivity map. This region of interest (ROI; also called the seed region) can be a single voxel, or more commonly a functional region made up of a group of voxels. Several commonly adopted voxel-based functional connectivity analyses including seed-based correlation analysis (SCA), independent component analysis (ICA), fractional amplitude of low-frequency fluctuations (fALFF), and regional homogeneity (ReHo).

Whole Brain Analysis:

Whole Brain analyses are a form of graph-based connectivity modeling. A graph is a convenient way to represent nodes and edges in a diagram. A graph can be used to represent connections between regions in a simple graphical format. The brain regions are called nodes, and the connections between regions are called edges.

Connectivity matrix (also called a network matrix or adjacency matrix) offers a compact description of the pairwise connectivity between all nodes of a network. For example, if the node-based analysis contains 100 regions (nodes), you can build a 100 by 100 matrix that describes all possible pair-wise connections (edges).