Network modeling analysis

- Resting state preprocessing
- Node definition and edge calculation
- Group analysis and challenges
- Comparison of resting state methods
Overview of resting state methods

**Voxel-based**
- Seed-based correlation analysis
- Independent component analysis
- Amplitude of low frequency fluctuations
- Regional homogeneity

**Node-based**
- Network modelling analysis
- Graph theory analysis
- Dynamic causal modelling
- Non-stationary methods
Seed-based correlation

• Easy to interpret
• No correspondence problem
• Seed-selection bias
• Only models seed-effect (ignoring complex structure & noise)

Bijsterbosch et al (2017)
Seed-based correlation results are strongly influenced by small changes in seed location.
ICA

- Multivariate: decompose full dataset
- Test for shape & amplitude
- Can be hard to interpret
- No control over decomposition (may not get breakdown you want)
Graph theory

- Simple summary measures (derived from network matrix)
- Network matrix often binarised
- Difficult to meaningfully interpret (abstract and far removed from data)

Rubinov et al (2010)
Dynamic causal modelling

- Directional interpretation (effective connectivity)
- Biophysical model
- Assumes HRF homogeneity
- Limited model comparisons

Daunizeau et al (2011)
**Overview of node-based methods**

- **Effective Connectivity**
  - More complex, more meaningful
  - Pre-specify (constrain) network model
  - Harder to estimate
  - Can handle fewer nodes

- **Functional Connectivity**
  - Simpler, less meaningful
  - Network “discovery”, better conditioned
  - Can handle more nodes

- **Graph Theory**
  - Clusters / hierarchies, network hubs, network summary statistics (e.g. small-worldness, efficiency)

- **Network Modelling from FMRI Data**
  - Full correlation
  - Partial correlation
  - Regularised partial correlation
  - Bayes nets
  - SEM
  - Non-biological dynamic Bayes nets
  - Biophysical neural-groups to FMRI-signal forward model, fit to data using Bayes (e.g. DCM)

- **Bottom-up Neural Network Simulations**
  - Network of individual neurons simulated
  - Network of groups of neurons simulated (e.g. neural mass model)

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Smith et al (2013)
Node-based versus voxel-based

Bijsterbosch et al (2017)
Node-based versus voxel-based

- Node-based methods
  - Not sensitive to shape changes in connectivity patterns
  - Smaller multiple comparison correction problem

- Voxel-based methods
  - Seed-based correlation additionally tests for spatial (voxelwise shape) changes in connectivity patterns
  - Group ICA can test for shape and amplitude changes
Which method to chose?

- **Interpretation**
  - Relationship to RSNs
    - Dual regression
  - Summary values
    - Graph theory
  - Connections in system
    - Network modelling
  - Biophysical system
    - DCM
  - Connectomics
    - Network modelling
Resources

- FSL mailing list
- Book (Amazon/ OUP)
- All references on the bottom of slides contain ‘clickable’ links