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paulscotti.com/flowchart.pdf

Complexity

Flowchart of fMRI analysis techniques

I'm interested in exploring where the brain is responsive to a task

Searchlight maps / T-maps / F-maps
#searchlight

Repeated analyses across the brain

I want voxelwise receptive fields

I'm interested in mapping the different visual areas of the brain

Phase-encoded mapping / Traveling wave
#retinotopy

Show rings/wedges across visual field to map retinotopy

Population receptive field mapping
#prf

Encoding model estimates voxel preferences to presented stimuli

Explore **where** brain responds to different things (brain mapping)

Visualize higher-level structure

Dimensionality reduction
#dimensionality_reduction

Reduce data into components that explain the most data variability/independence

I'm interested in the *representation* of a brain region

A *representation* can be loosely defined as the system or format by which the brain region codes information

Calculate similarity of activity across conditions

Correlation-based multivariate pattern analysis
#mvpa

Representational similarity analysis
#rsa

Pairwise correlations of conditions displayed in a matrix

Compare similarity structure across modalities / regions

Correlate representational similarity matrices to each other

Understand **specific brain region** functioning

Can also be more exploratory where numerous brain regions are separately analyzed and compared to each other

I'm interested in brain region functioning in response to *a task*

Univariate analysis
#univariate

Contrast average activation between your ROI and a control region

Need more sensitive test?

Test if same-conditions have higher correlation than different-conditions

Representational connectivity / Informational connectivity / Second-level RSA
#rsa

Correlate representational similarity matrices to each other

What is your goal?

paulscotti.com/navigateFMRI
add #method_name to end of this URL to learn more about a specific technique, along with practical implementation of the technique in simulated data (using Python)

*Note: these are all fMRI **post-processing** methods, meaning that they would be performed after standard data pre-processing (e.g., motion correction) and processing (e.g., general linear model estimation) steps!*

Glossary
fMRI: functional magnetic resonance imaging
resting state: fMRI data obtained while participant does nothing
ROI: brain region of interest
voxel: a 3D pixel of the brain

I'm interested in how one brain region interacts with another brain region

Repetition suppression / FMRI adaptation
#rs

Contrast average activation between repeated stimuli and new stimuli (i.e., measuring priming)

Multivariate pattern classification / Support vector machine
#mvpc

Machine learning to find optimal boundary between conditions/classes

Hidden Markov Model
#hmm

Statistical model describes observations based on latent conditional probabilities

I'm interested in brain region functioning *at rest*

I want a model that can predict one of several experimental conditions

Are your classes temporally segmented?

Predict experimental stimulus or condition from brain activity

A more specific means to understanding brain region(s) functions, demonstrating above-chance prediction can also serve distinct interpretational benefits

I want a model that can predict *any* stimulus in my stimulus space

CNN   RNN

Neural networks
#nn

Predictive modeling using networks of artificial neurons

I'm interested in comparing groups based on the functioning of a specific brain region in response to a task

Encoding & decoding model
#encoding_decoding

An encoder models how the brain represents stimuli, a decoder predicts stimuli given brain activity

Examine **subpopulations** (clinical, demographic, etc.) **or groups of participants**

Group fMRI analyses are notoriously underpowered, be aware that you'll likely need over 100 subjects (Poldrack et al., 2017)

Mixed effects modeling / Hierarchical modeling / Multilevel modeling
#mixed_model

Model participants as random effects to generalize inferences to population

I'm interested in comparing groups based on differences in brain connectivity

Understand **connectivity** between brain regions

The same methods can be applied to resting state connectivity and task-based connectivity studies

Functional connectivity
#fc

Correlate time series across brain regions

I'm interested in how the brain can be represented as a specialized network

Graph theory / Network neuroscience
#graph_theory

Modeling connectivity as a network of nodes and edges

I'm interested in *causal relationships* for how brain regions interact

Effective connectivity / Dynamic causal modeling
#dcm

Modeling correlations as causal relations