Paul Scotti, Xiaoli Zhang, Jiageng Chen, & Julie Golomb (in-prep)
paulscotti.com/flowchart.pdf

Complexity

Flowchart of fMRI analysis techniques

What is your goal?

*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 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

Compare similarity structure across modalities / regions

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

PCA
ICA
LDA

Representational similarity analysis
#rsa

Pairwise correlations of conditions

Representational connectivity / Informational connectivity / Second-level RSA
#rsa2

Correlate representational similarity analyses 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?

Multivariate (or multivoxel) pattern analysis
#mvpa

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)

Correlation-based analysis
#mvpa_correlation

Split data in half, correlate one half to other half for both same- and different-conditions

Multivariate pattern classification
#mvpc

Train linear classifier to predict the experimental conditions of held-out test data

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?

Hidden Markov Model
#hmm

Statistical model describes observations based on latent conditional probabilities

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

Encoding & decoding model
#encoding_decoding

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

Neural networks
#nn

Predictive modeling using networks of artificial neurons

CNN
#cnn

RNN
#rnn

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

Mixed effects modeling / Hierarchical modeling / Multilevel modeling
#mixed_model

Model participants as random effects to generalize inferences to population

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)

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

Graph theory / Network neuroscience
#graph_theory

Modeling connectivity as a network of nodes and edges

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

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

Effective connectivity / Dynamic causal modeling
#dcm

Modeling correlations as causal relations