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paulscotti.com/flowchart.pdf

Complexity →

Flowchart of fMRI analysis techniques

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

Explore where brain responds to different things (brain mapping)

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

I want voxelwise receptive fields

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

Visualize higher-level structure

Dimensionality reduction
#dimensionality_reduction
Reduce data into components that explain the most data variability/independence

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 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
Correlate the correlations of conditions

Compare similarity structure across modalities / regions

Representational connectivity / Informational connectivity / Second-level RSA
#rsa2
Correlate representational similarity analyses 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?

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

Encoding & decoding model
#encoding_decoding
An encoder models how the brain represents stimuli, a decoder predicts stimuli given brain activity

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

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

Mixed effects modeling / Hierarchical modeling / Multilevel modeling
#mixed_model
Model participants as random effects to generalize inferences to population

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
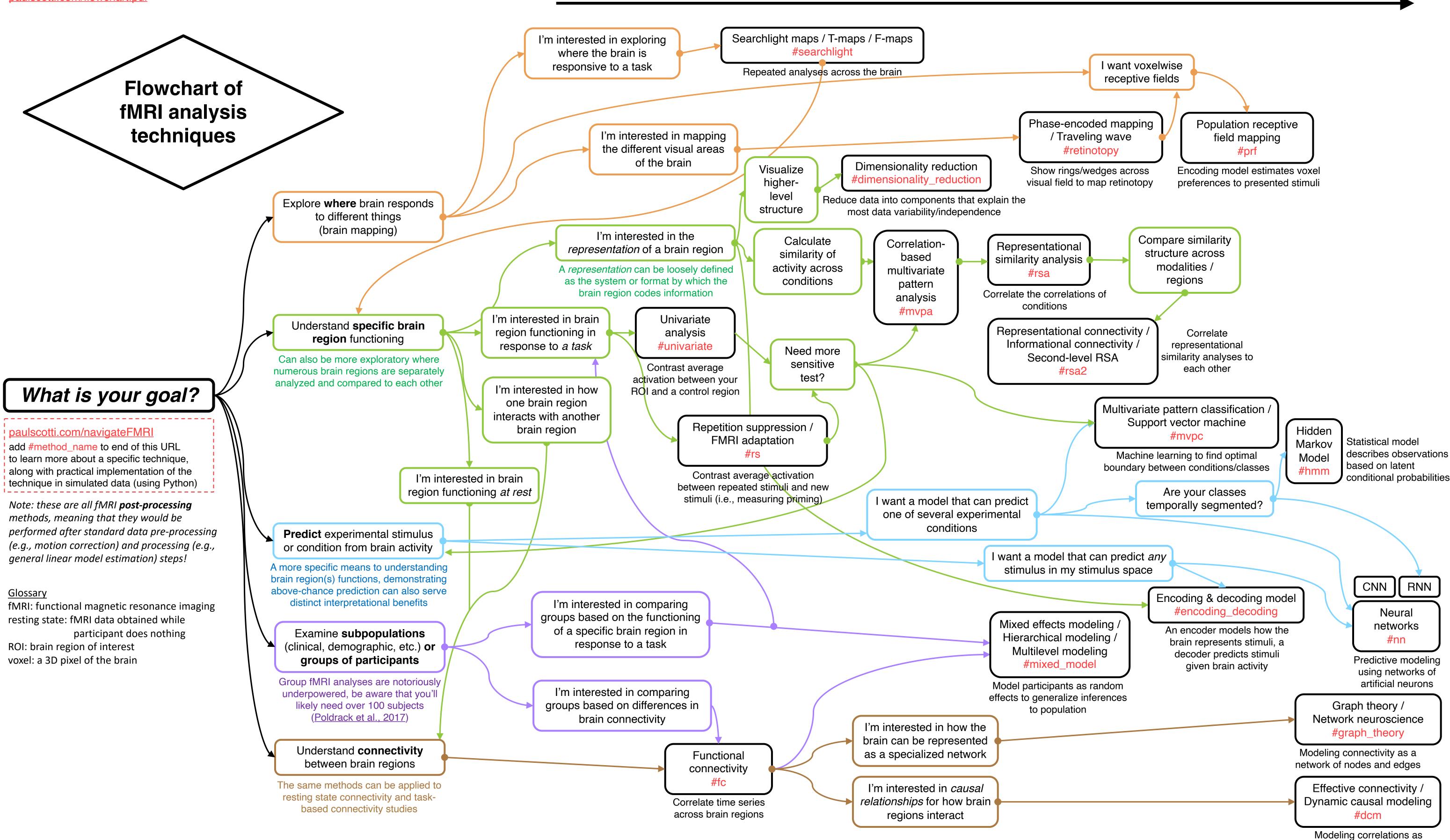
Effective connectivity / Dynamic causal modeling
#dcm
Modeling correlations as causal relations

T-test (A , B)

T-test (A , chance)

What is your goal?

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to learn more about a specific technique

Explore where brain responds to different things (brain mapping)

Searchlight analysis #searchlight
Repeated analyses across spheres of voxels all over the brain

Phase-encoded mapping / Travelling wave #retinotopy

Functional connectivity #fc

Population receptive field mapping #prf

Understand specific brain region(s) functioning

Repetition suppression / Adaptation #repetition_suppression

Multivariate pattern classification #mvpa

Population receptive field mapping #prf

Univariate analysis #univariate

Dimensionality reduction #dimensionality_reduction

Representational similarity analysis #rsa

Correlation-based analysis #mvpa_correlation

Encoding & decoding model #encoding_decoding

Inverted encoding #iem

Predict experimental stimulus or condition from brain activity

Multivariate pattern classification #mvpa

Neural network #neural_network

Convolutional #cnn

Encoding & decoding model #encoding_decoding

Reinforcement #rnn

Inverted encoding #iem

Examine subpopulations (clinical, demographic, etc.)

Effective connectivity / Dynamic causal modeling #dcm

Shared response modeling #srm

Connectome fingerprinting #fingerprinting

Psychophysiological interaction #ppi

Complexity

Graph theory / Network neuroscience #graph_theory