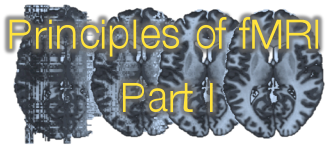
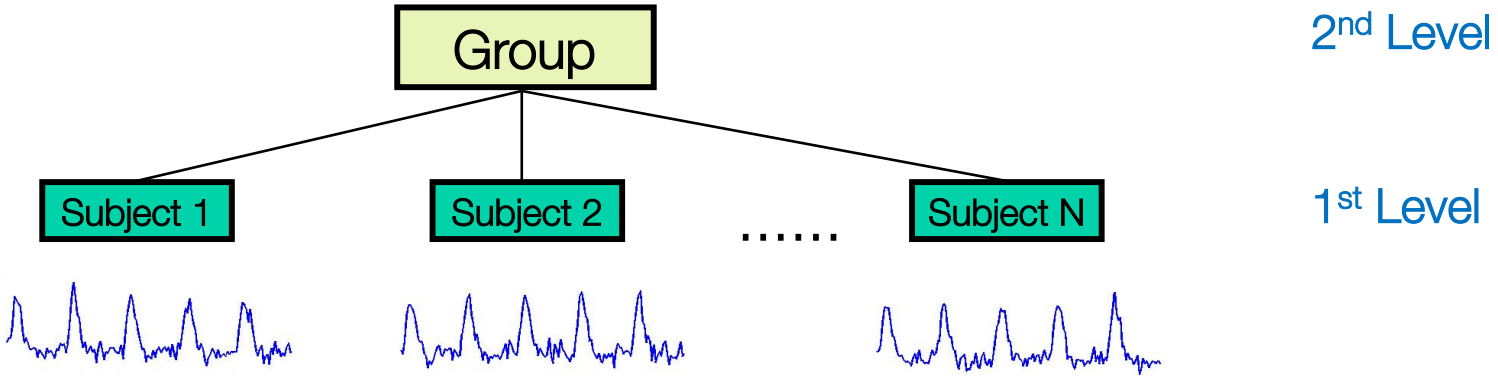
Group-level Analysis II

Fixed and random effects

Multi-level Model

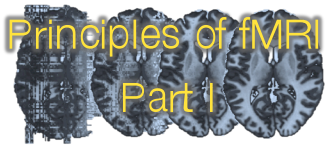


- When performing group analysis we often use multi-level models. Often performed in two levels:
  - The first level deals with individual subjects.
  - The second level deals with groups of subjects.



- All inference typically performed in the 'massive univariate' setting.

Multi-level Models

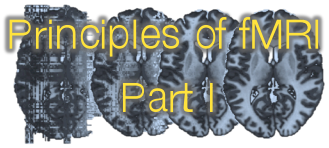


- Multi-level models have been specifically developed for analyzing hierarchically structured data.

- They allow different variance components to be introduced at each level (e.g. within-subject and between-subject variance).

- They provide a framework for performing mixed-effects analysis.

Mixed effects models

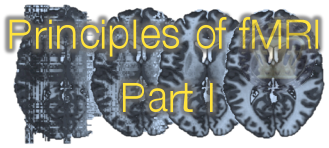


- Mixed Effects Models
- Hierarchical Models
- “Random Effects (RFX)” Models in neuroimaging.

All the same idea:

- Model multiple sources of variation (“Variance Components”)
- In contrast to “fixed effects models”, with only one variance component

Mixed-effects analysis



Assume the signal strength varies across sessions and subjects.

There are two sources of variation:

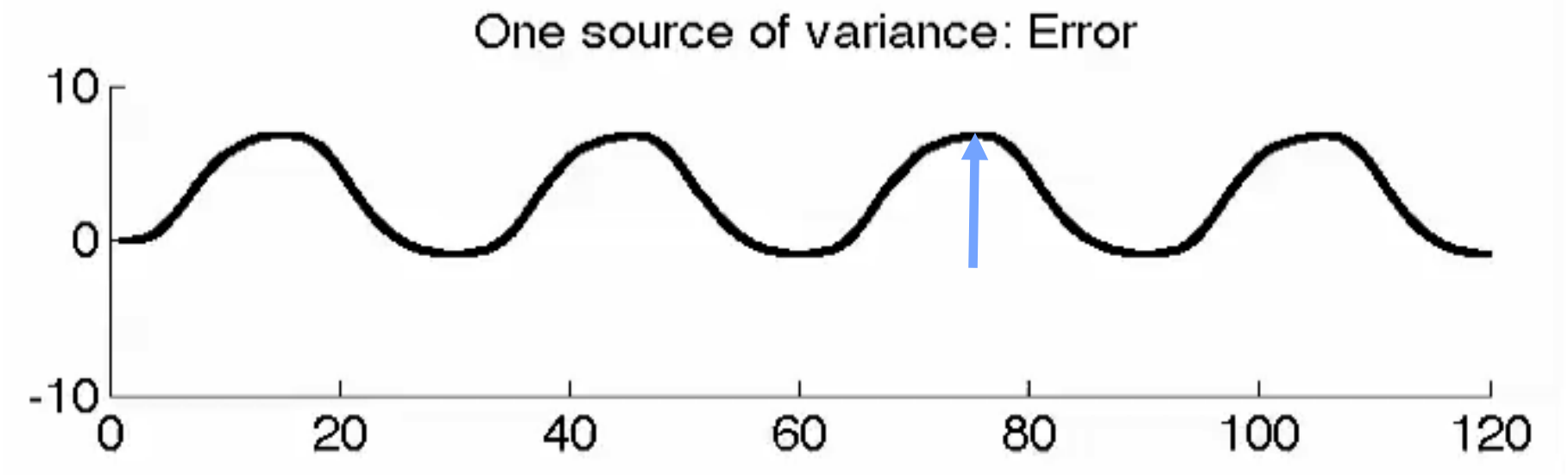
(i) Measurement error

(ii) Response magnitude - Each subject/ session has a random magnitude.

The population mean is fixed.

Data with one source of error

Animation over replications of one subject's experiment



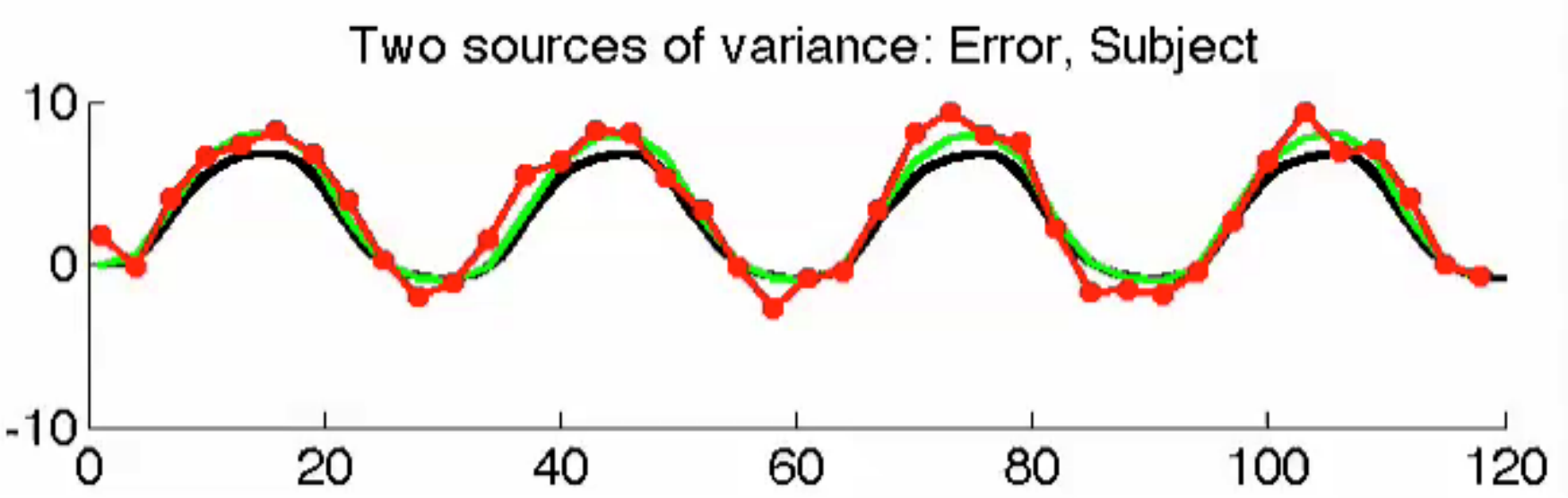
Only variation is measurement error

True response magnitude is *fixed*

- Significance based on estimated response relative to measurement error variance

Data with two sources of error

Animation over different subjects

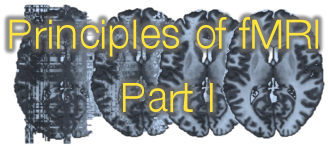


Two sources of variation

- Measurement error (scan-to-scan var.)
- Individual differences (subj.-to-subj. var.)

- Only by including both sources of variation in my error term can I generalize to unobserved subjects

Fixed and random effects



In a mixed effects model, we choose whether to model each effect as "fixed" or "random" in a mixed-effects model

Fixed effect

Always the same, from experiment to experiment; levels are not draws from a random variable

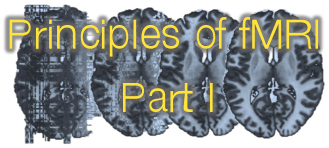
- *Sex (M/F)*
- *Drug type (Prozac)*

Random effect

Levels are randomly sampled from a population

- *Subject*
- *Word, in experiments with verbal materials*

Fixed and random effects



Variance across the levels of each random effect is included as a source of error in the model

- Allows generalization to unobserved levels

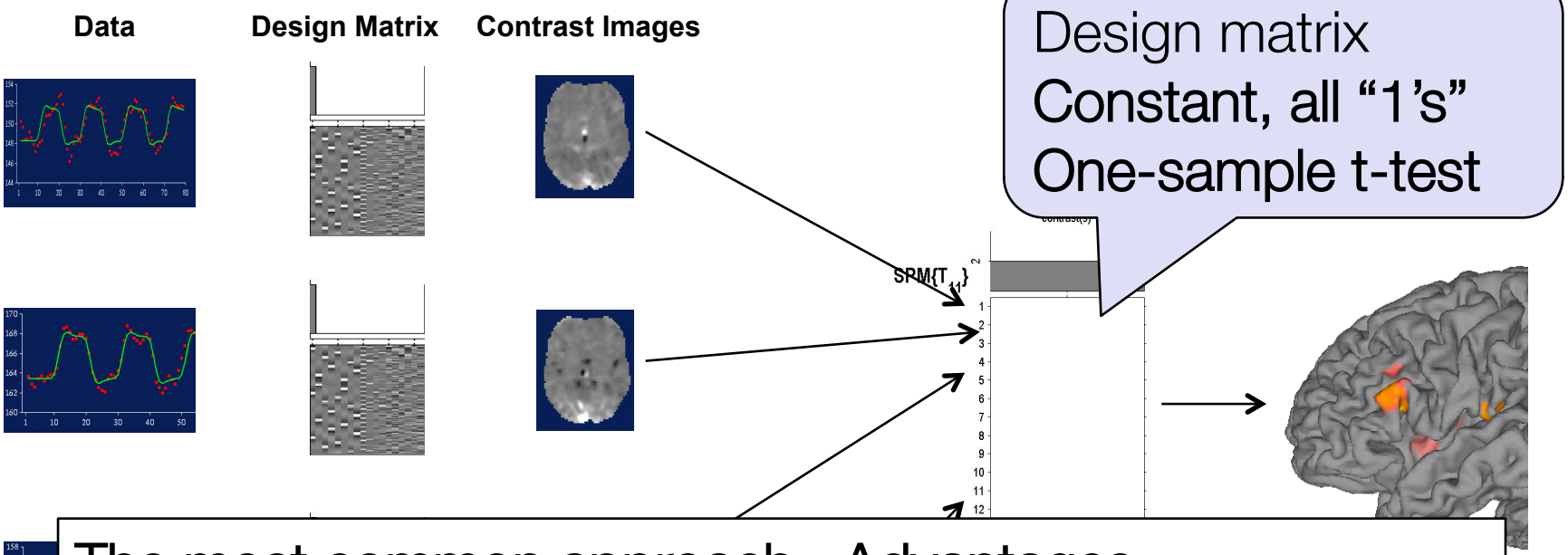
If effect is treated as fixed, error terms in model do not include variability across levels

- - Cannot generalize to unobserved levels
- - e.g., if subject is fixed, cannot generalize to new subjects

Group analysis using summary statistics: A simple kind of 'random effects' model

First level

Second level



The most common approach. Advantages:

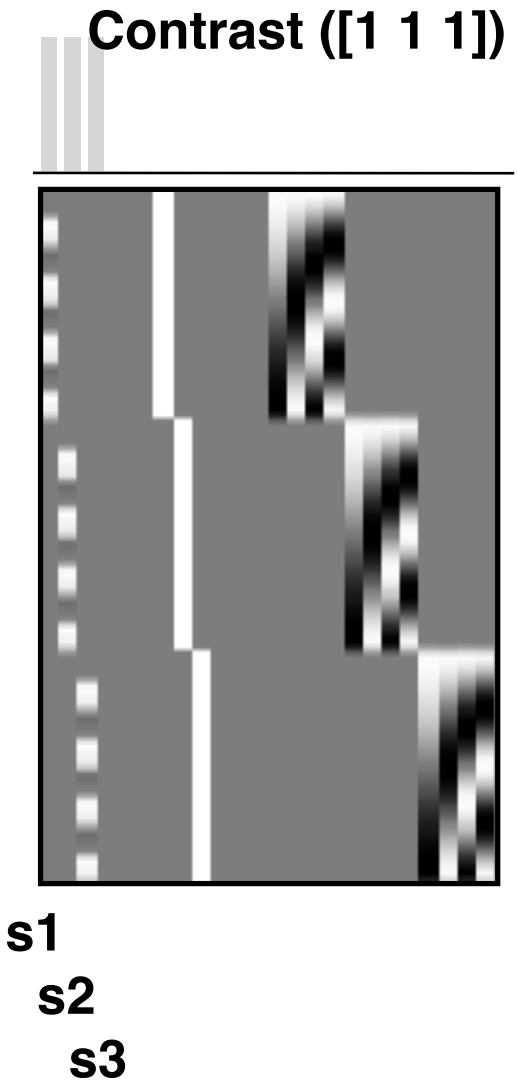
- Easy to do
- Optimal if within-person precisions are equal
- Fairly robust to violations in terms of false positives

A“Fixed effects” analysis (wrong)

“Grand GLM” approach

GLM on data concatenated across subjects

- Assumes the only source of error is within-scanner noise
- Tests the mean effect against within-subjects error
- Does not account for between-subjects error



End of Module

@fMRIstats