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Group-level Analysis I

From single-voxel GLM to group analysis: An overview

Statistical Analysis

- When applying statistics to real-world problems we need to separate between the **model** used to describe the data, the **method** of parameter estimation and the **algorithm** used to obtain them.
 - The **model** uses probability theory to describe the parameters of the unknown distribution thought to be generating the data.
 - The **method** defines the loss function that is minimized in order to find the unknown model parameters.
 - The **algorithm** defines the manner in which the chosen loss function is minimized.

Multi-level Analysis

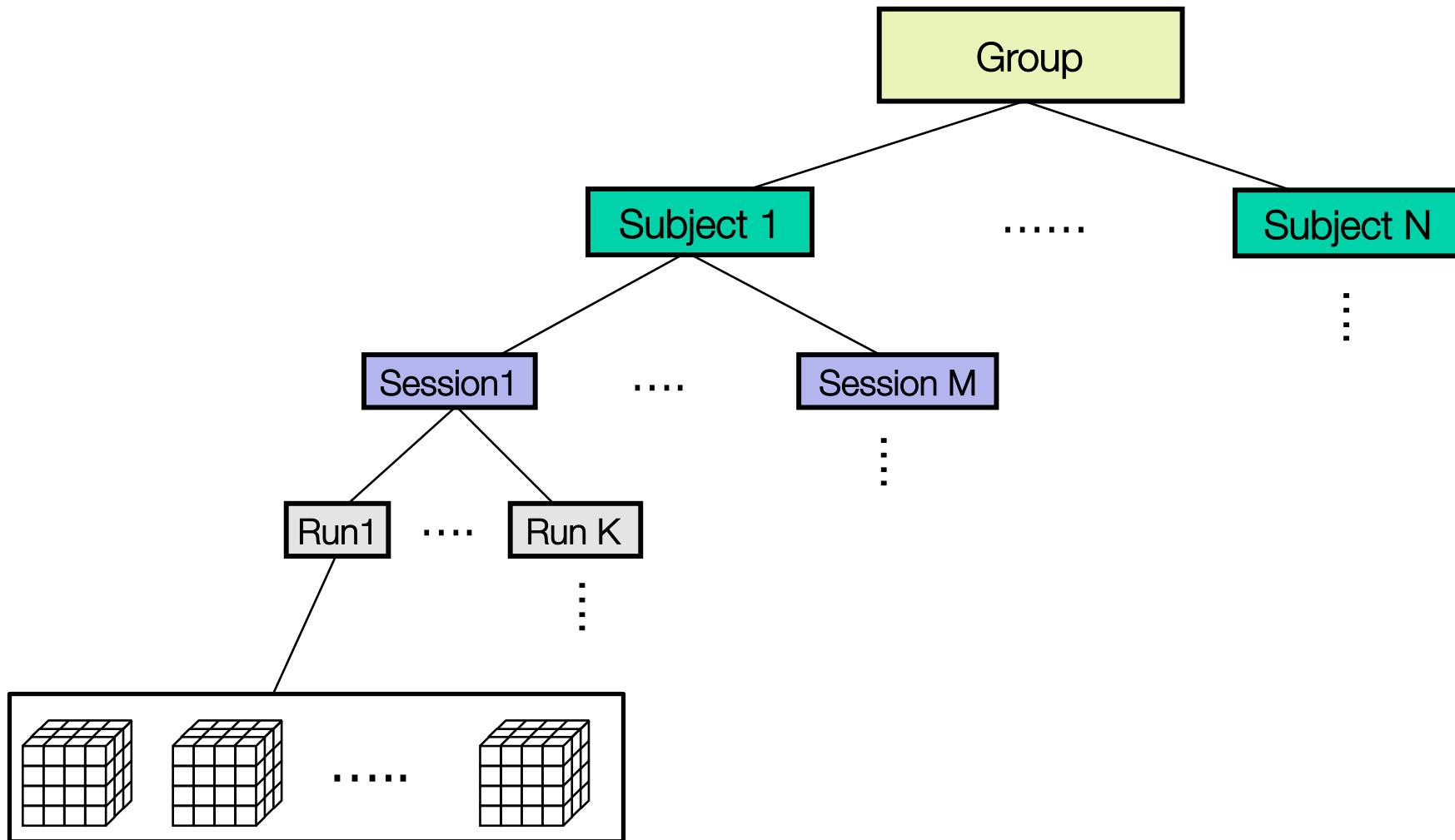
- fMRI experiments are often repeated for:
 - Several **runs** in the same session;
 - Several **sessions** on the same subject;
 - Several **subjects** drawn from a population.



Motivation

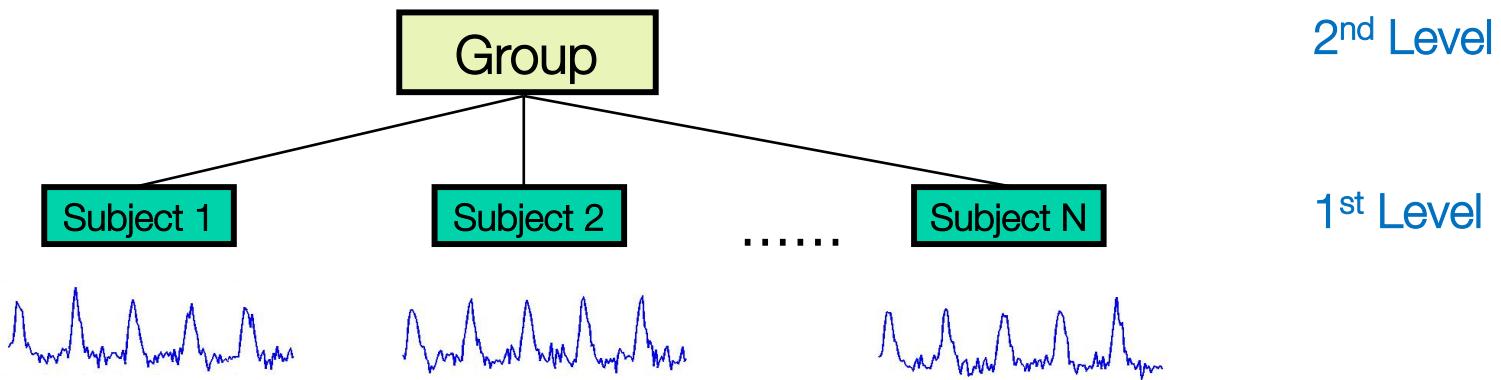
- Multi session/subject experiments may:
 - Increase the **sensitivity** of the overall experiment (more data is available);
 - Allow you to determine whether the observed effects are common and stable **across**, or **between**, groups;
 - Allow for **generalization** of your conclusions to the whole population of subjects.
- This data is hierarchical in nature, with lower-level observations nested within higher levels.

Hierarchal Structure



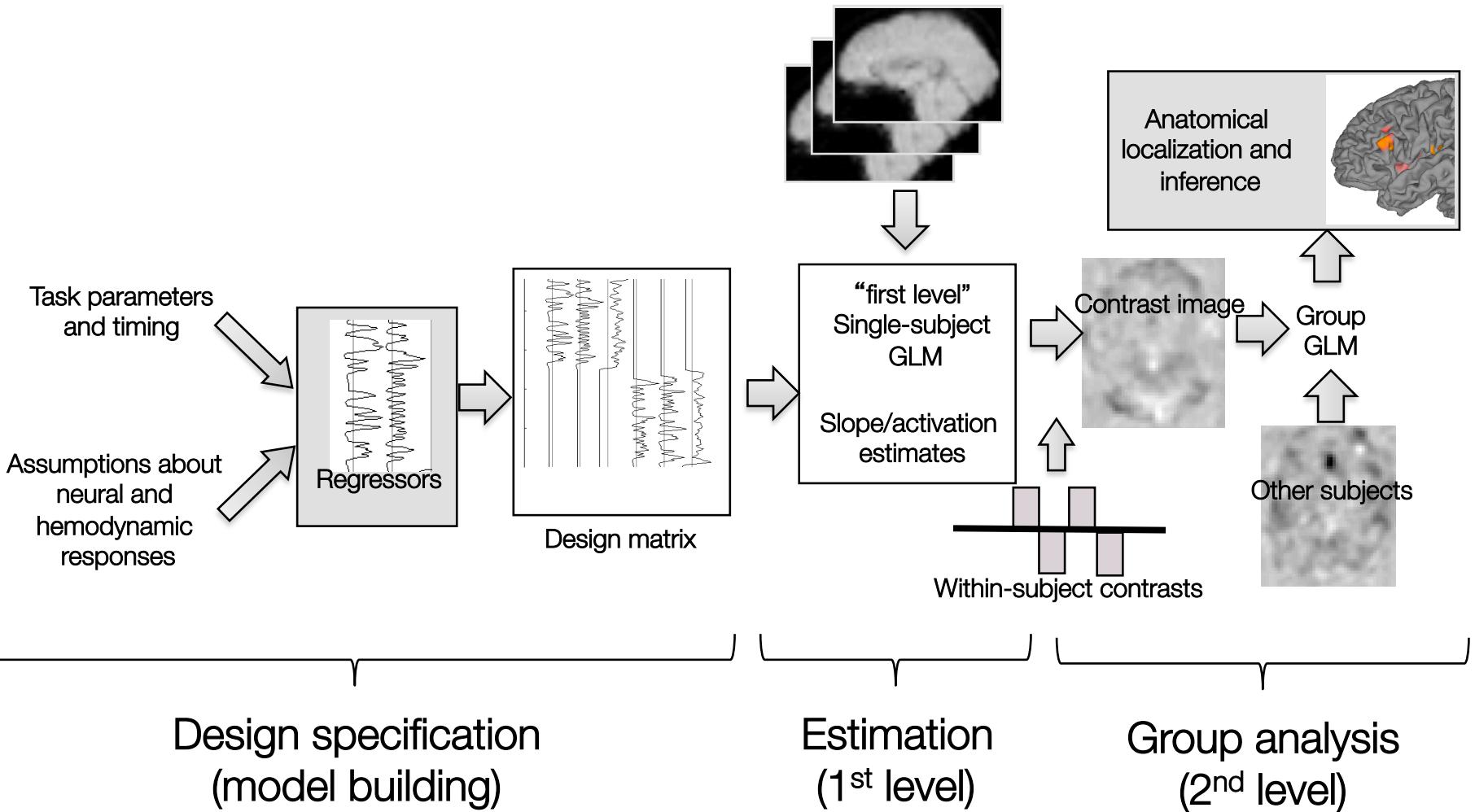
Multi-level Model

- 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.

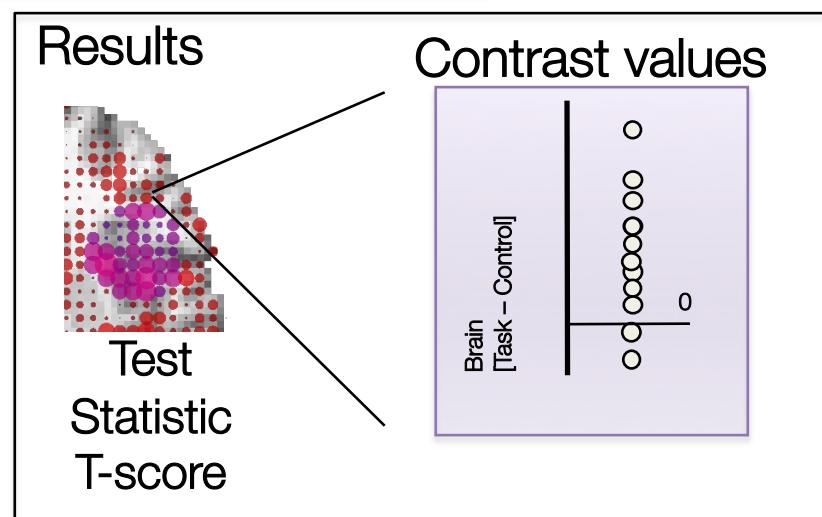
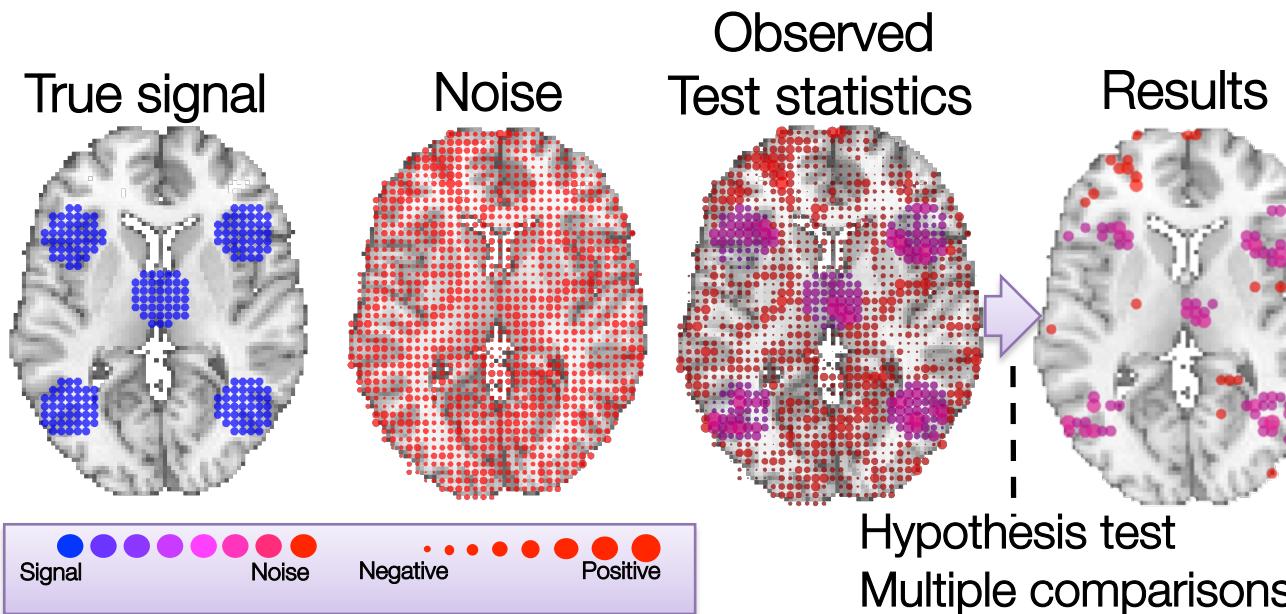


- All inference typically performed in the 'massive univariate' setting.

Overview of the GLM analysis process



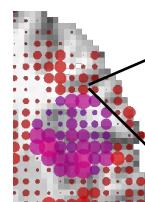
Framework: Working backwards from a group result



The full analysis:

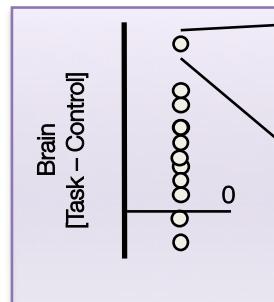
Overview of two-level model, one voxel

Each voxel



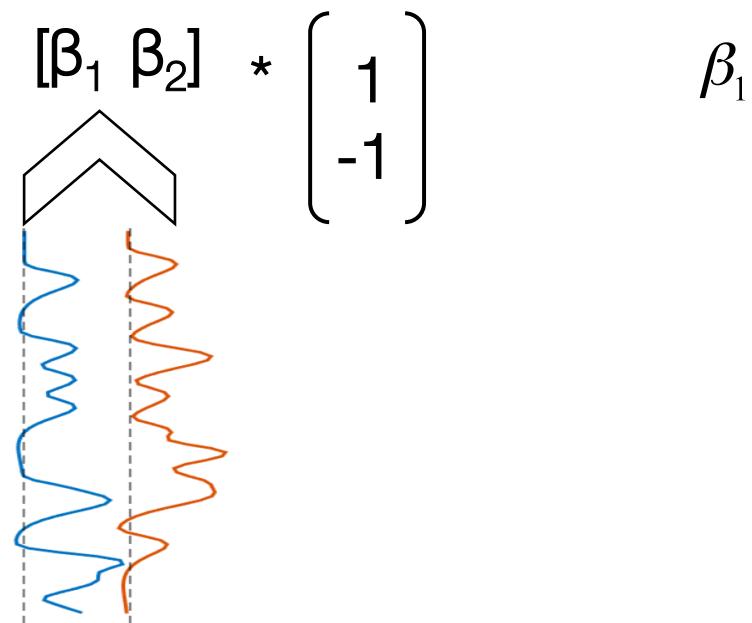
Test
Statistic
T-score

Group analysis



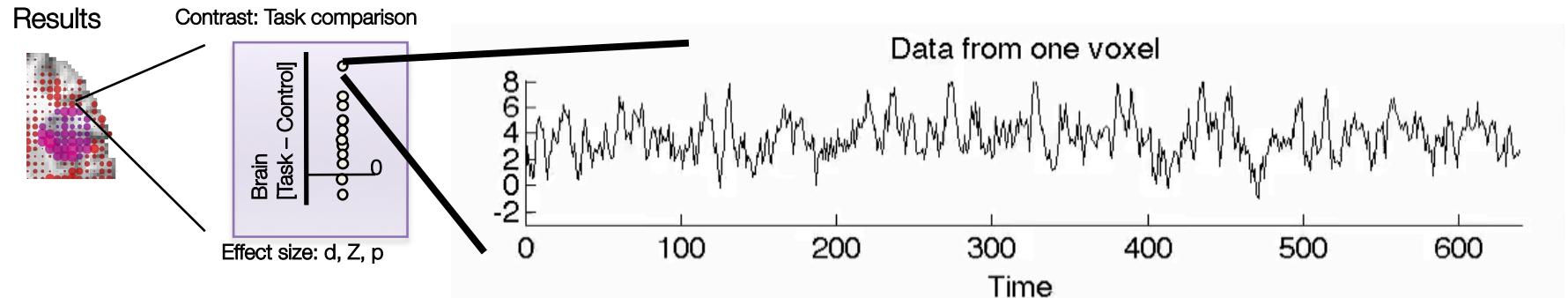
Tests
A group of
subjects

One subject's score



Amplitude Contrast
estimates * weights

The full analysis: Overview of two-level model, one voxel



E=unexplained error

D=design-related inefficiency

I = individual differences

repeated
measures

0 or more between
1+ within

“GLM”

Generalized linear
model:
correlated errors
(timeseries)

End of Module



@fMRIstats