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First level fMRI data analysis

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Outline

- We learned the general linear model (GLM), preprocessing, and experimental design

- What is next:

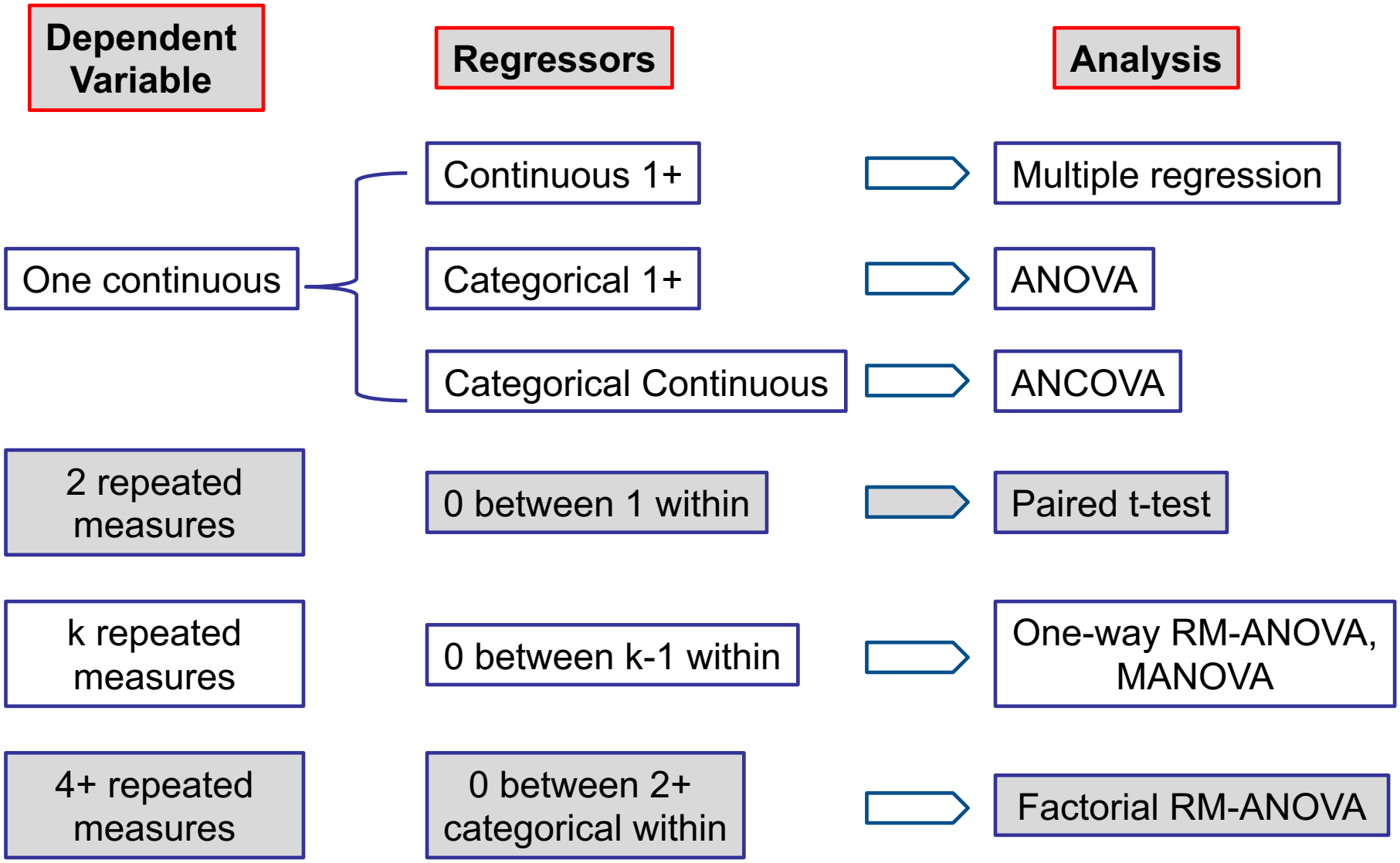
  Apply the GLMs to the preprocessed data

  Note: 1st level analysis = within subject analysis

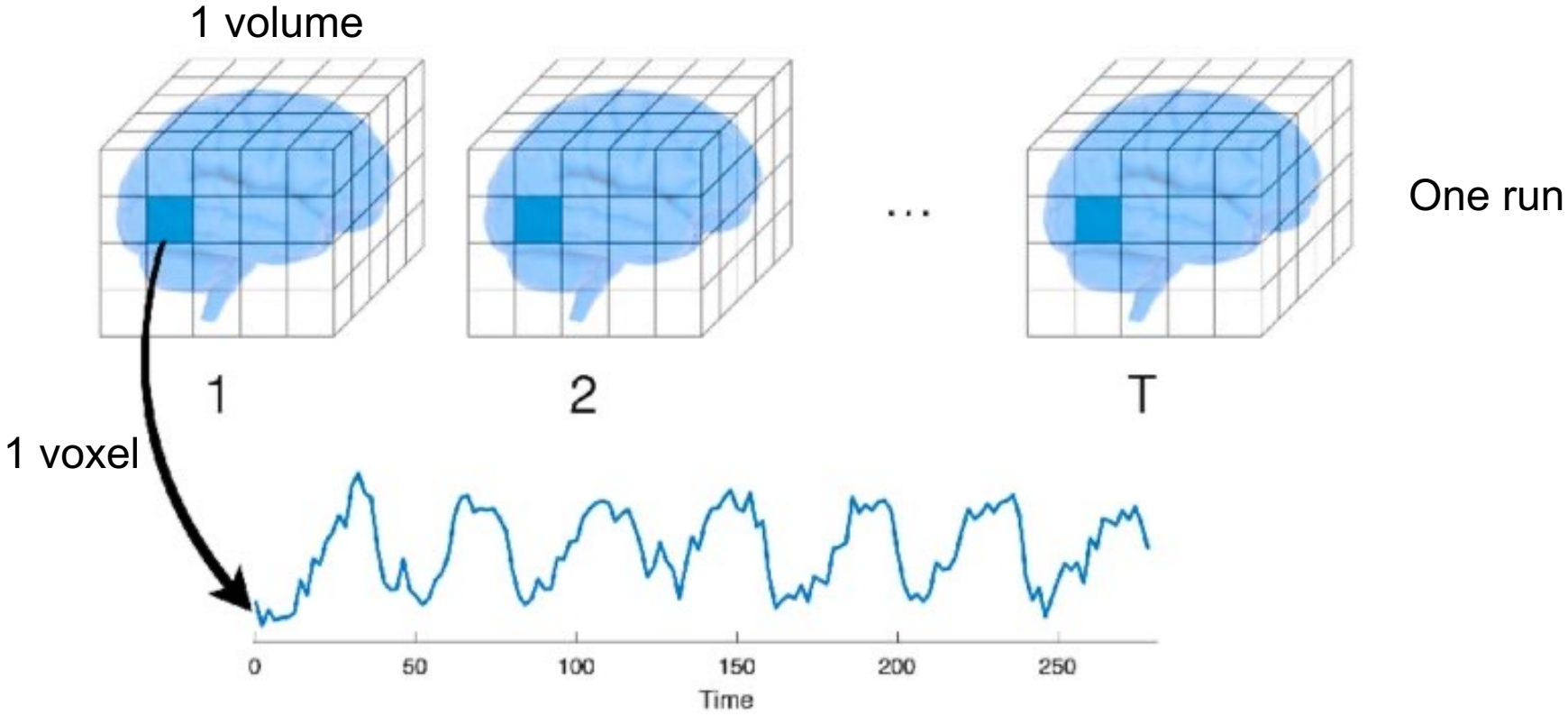
Outline

- Statistical models according to experiment design
- Contrasts
- Operation in SPM12
  - To set the parameters
  - To make contrasts: T contrasts

The general linear model (GLM) family

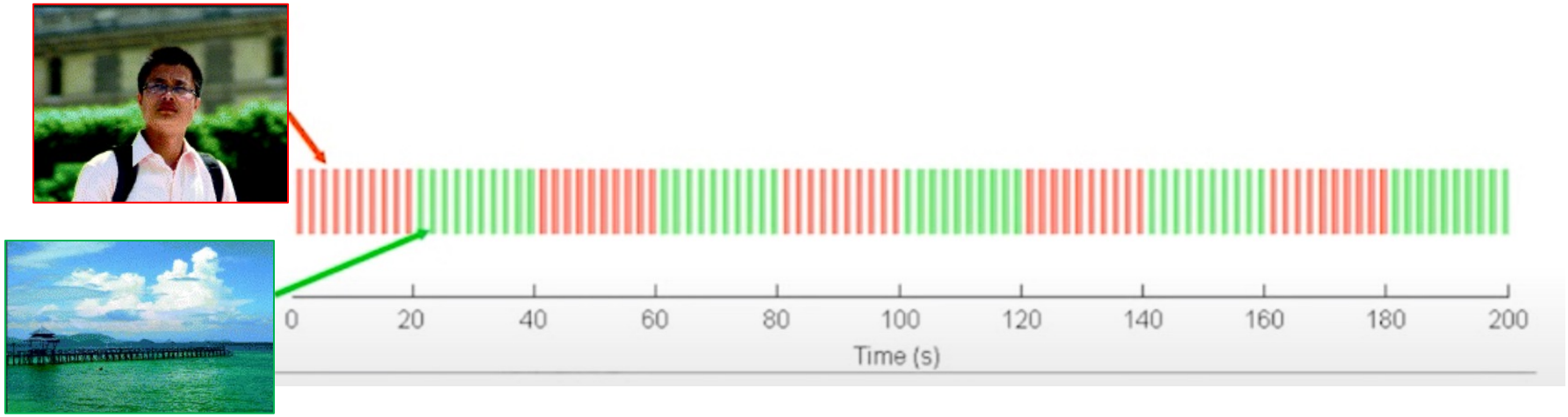


Mass univariate approach

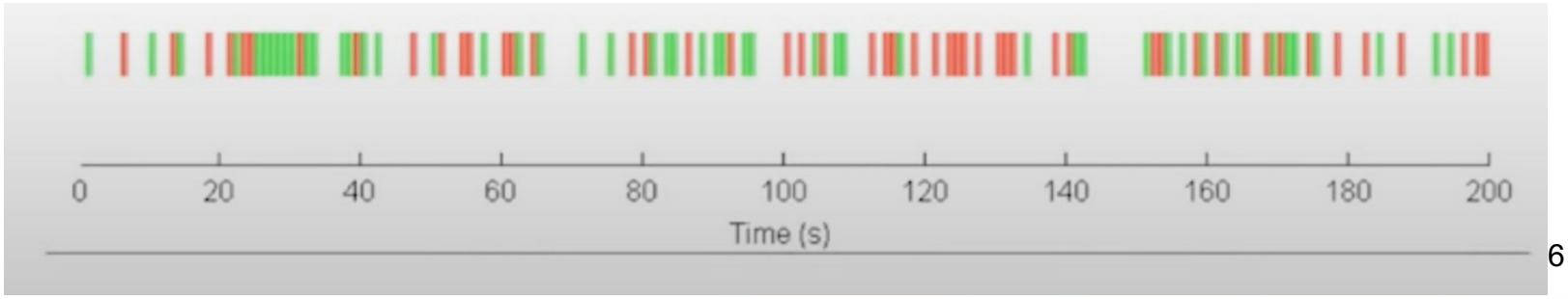


1st level GLM: single-voxel, signal subject

1. Block design



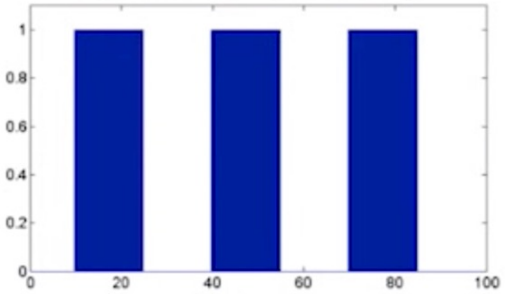
2. Event-related design



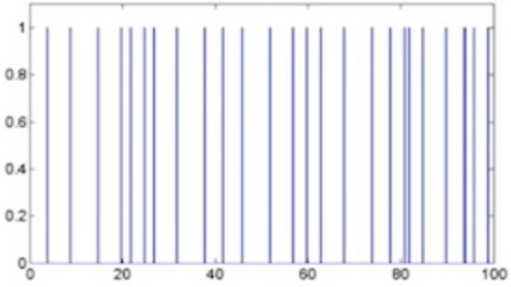
How to build a regressor?

- BOLD responses are delayed: **peak at 4-6 s** and **baseline 20-30 s**.
- Convolved with the hemodynamic response function (**HRF**)
- The linear time-invariant (**LTI)** system

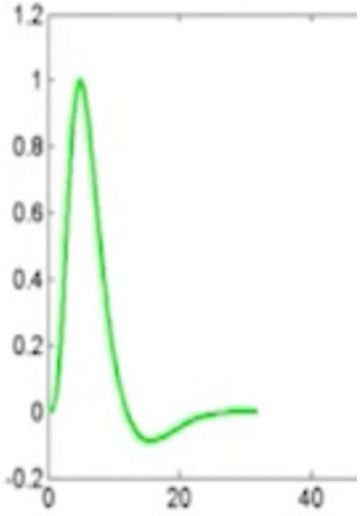
Block design

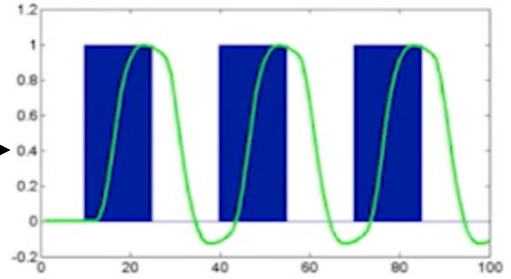


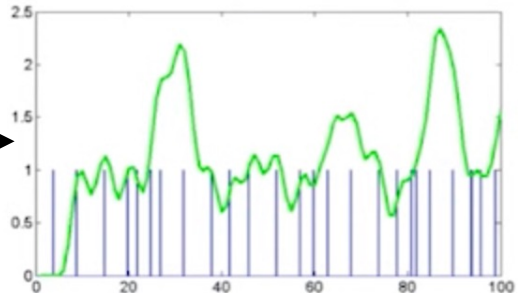
Event-related design



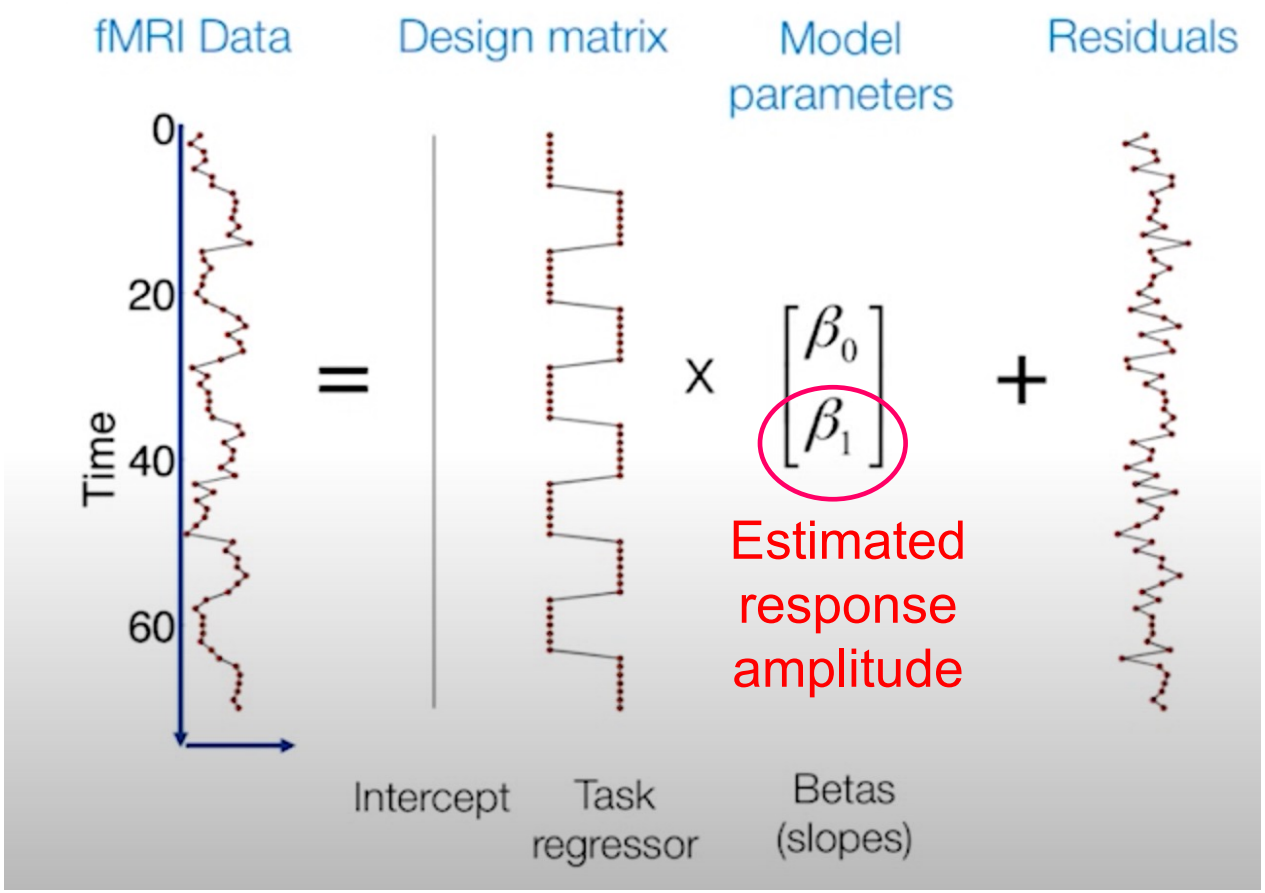
Hemodynamic delay



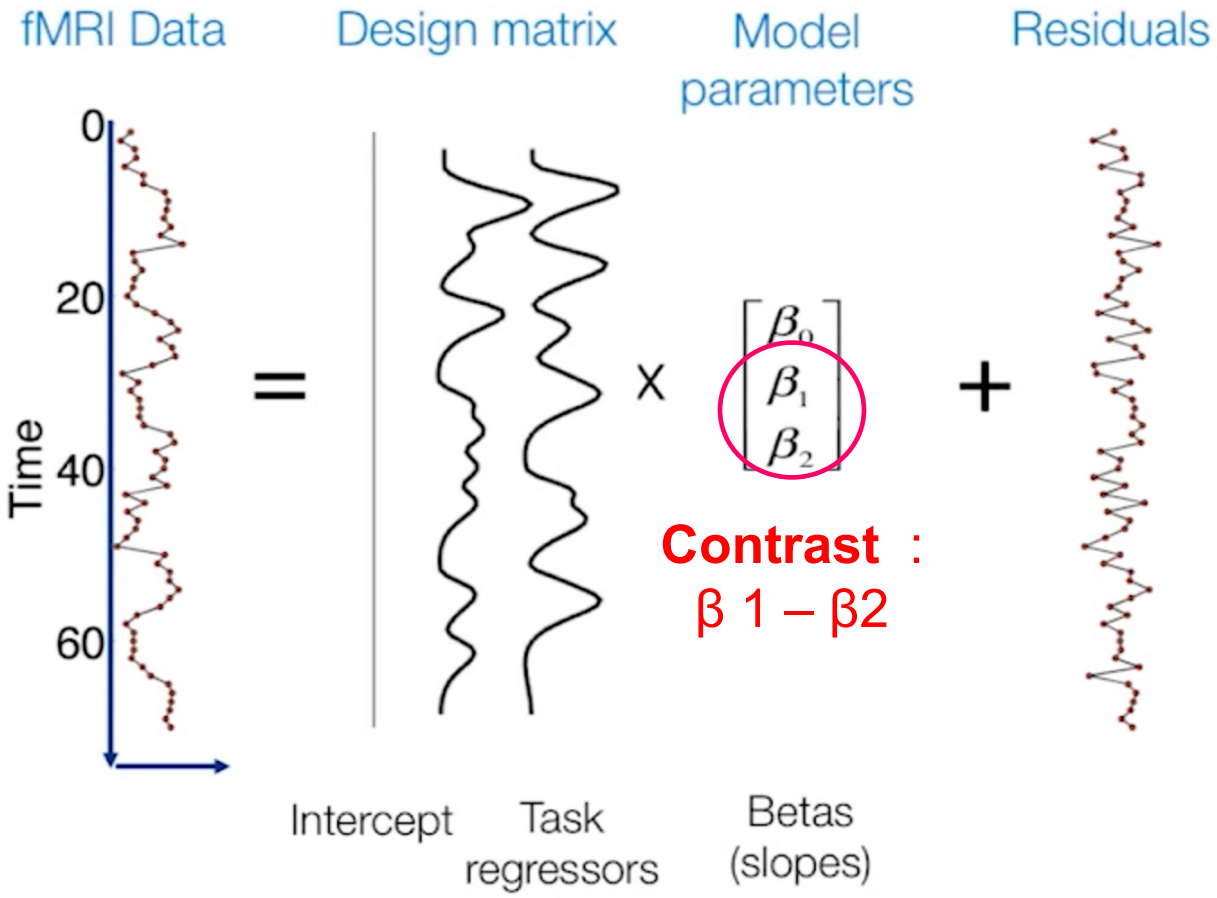




Block design: one regressor of interest (e.g. people vs. landscape)



Event-related design: two continuous regressors (people vs. landscape)



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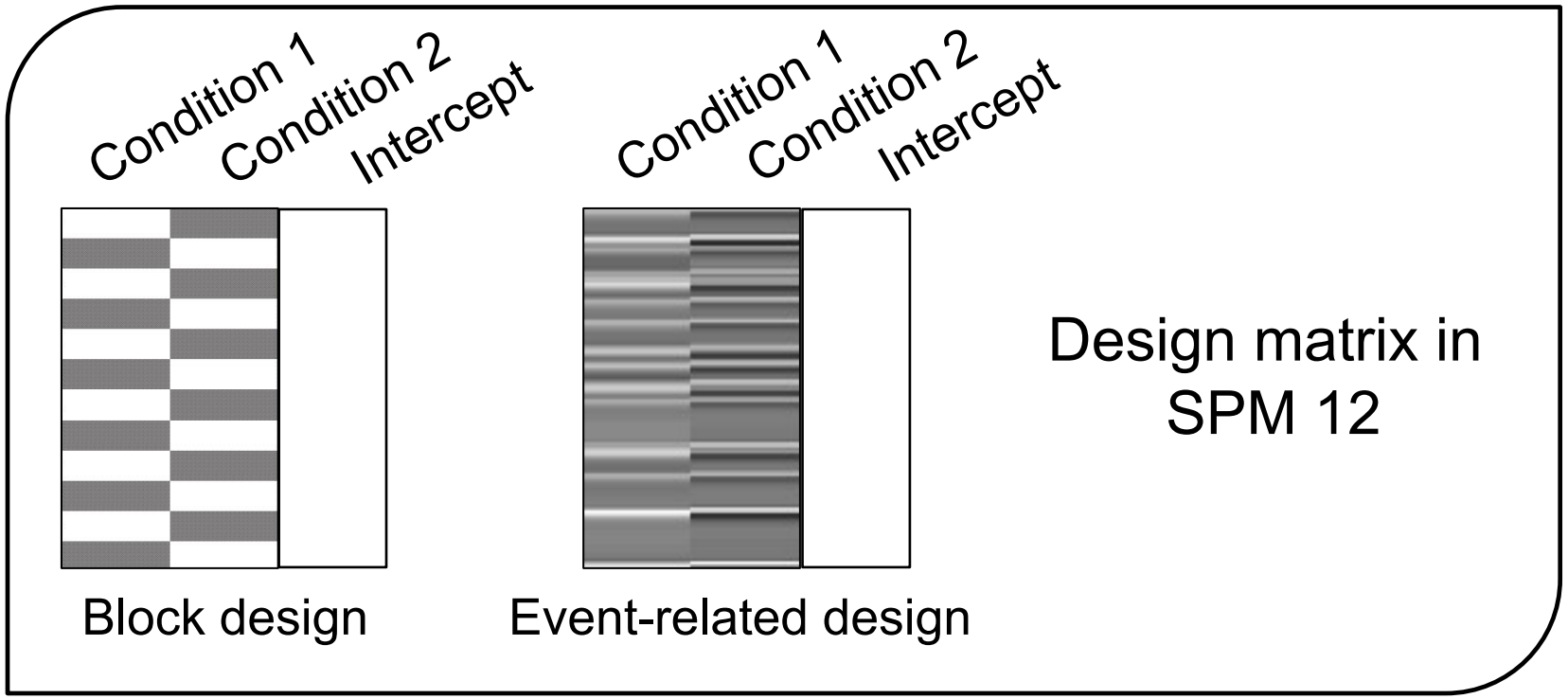
Contrasts

Experimental conditions: people vs. landscape

- Your interest is often the difference between the two conditions, which is "contrast"
- You can calculate the difference, sum or separately each conditions, which are calculated by different linear contrasts.

- We only focus on T contrast in this lecture ! !



Difference between conditions

[1 -1] = “Con1 > Con2”

[-1 1] = “Con1 < Con2”

Separately

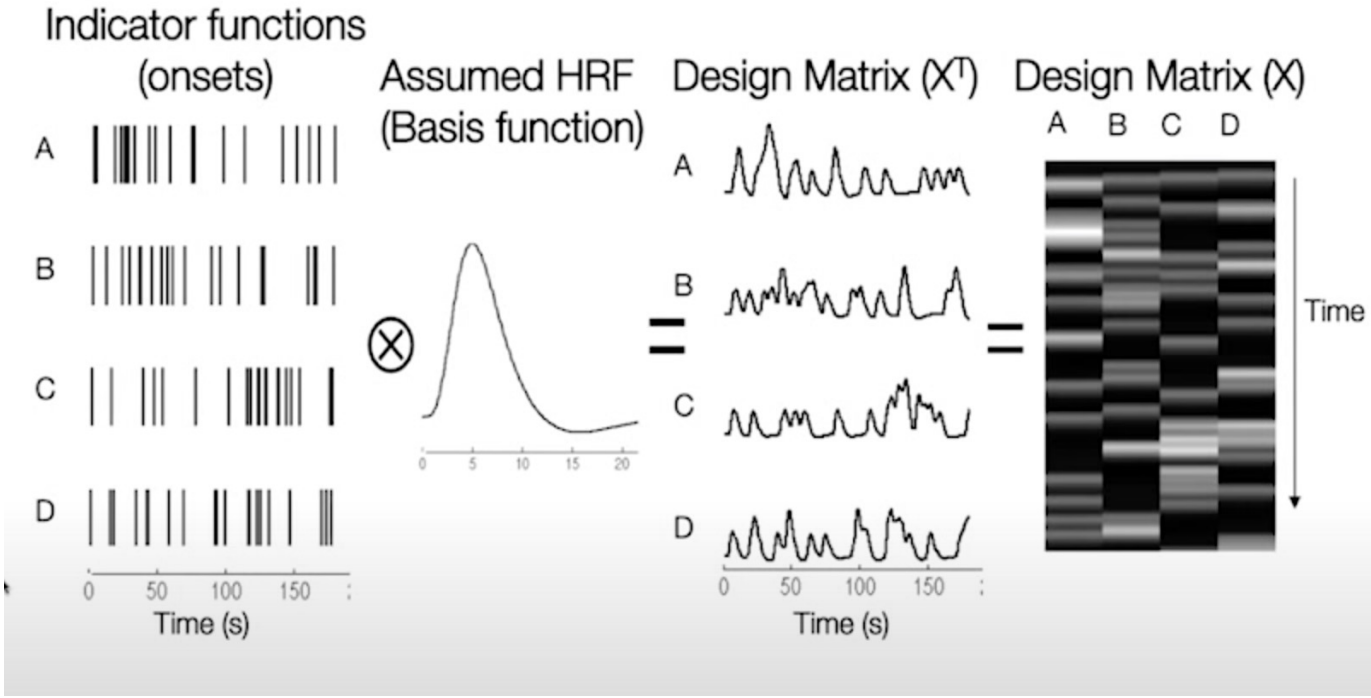
[1 0] or [-1 0] = “main effect Con1”

[0 1] or [0 -1] = “main effect Con2”

Sum

[1 1] or [-1 -1]

More regressors



- [1 1 -1 -1] : (A+B) > (C+D)
- [1 -1 1 -1] : (A+C) > (B+D)
- [1 0 0 0] : main effect of A
- [1 1 0 0] : Sum of (A+B) vs the mean of the signal

  ….

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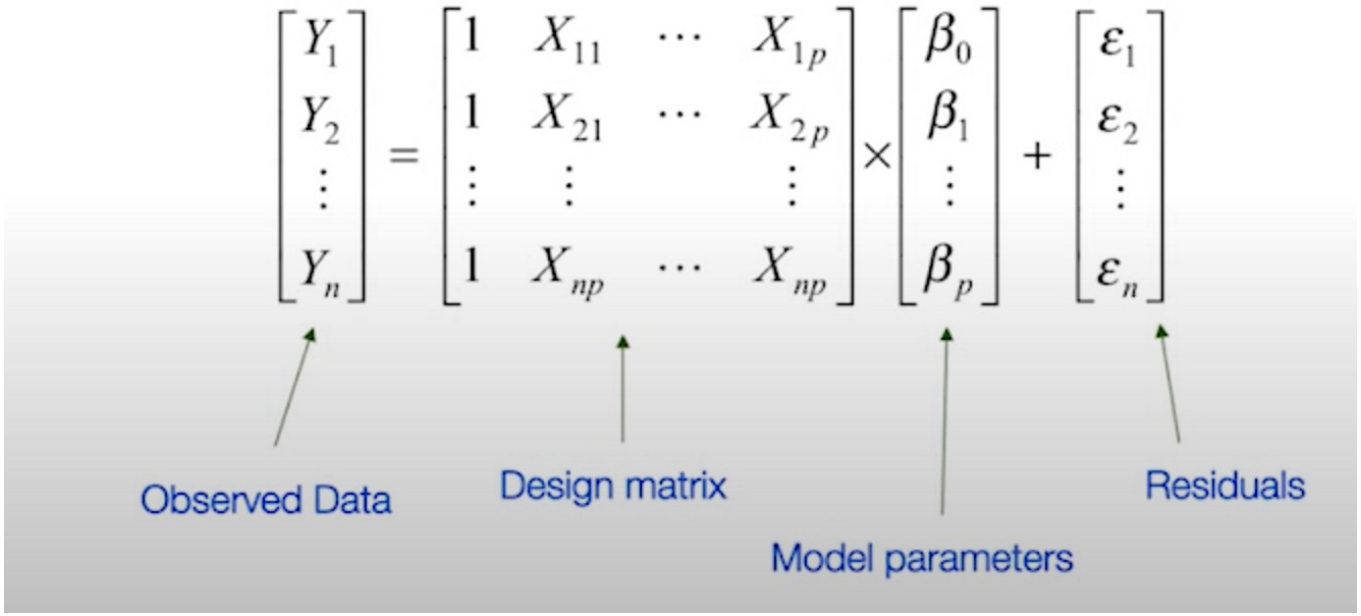
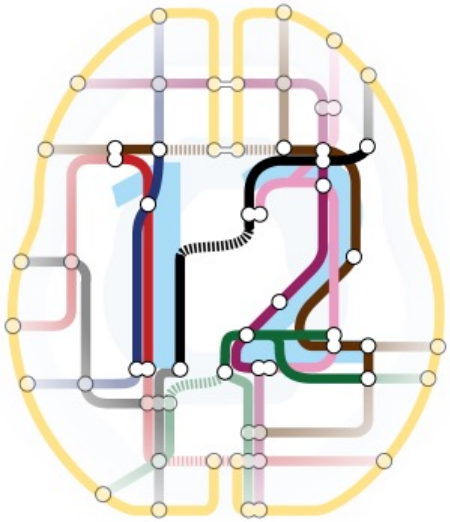
Simple or multiple regression, t-tests, ANOVA, ANCOVA

$$\mathbf{Y} = \mathbf{X}\beta + \varepsilon$$

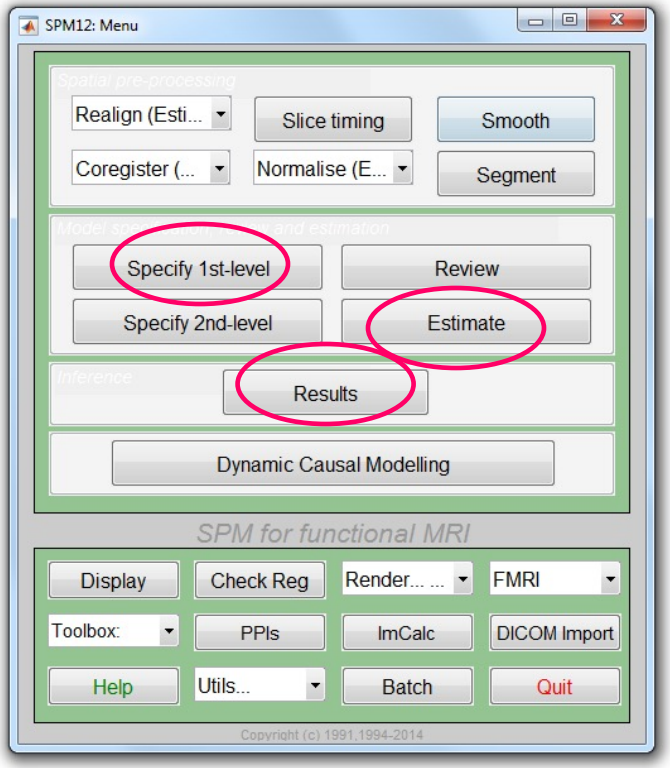


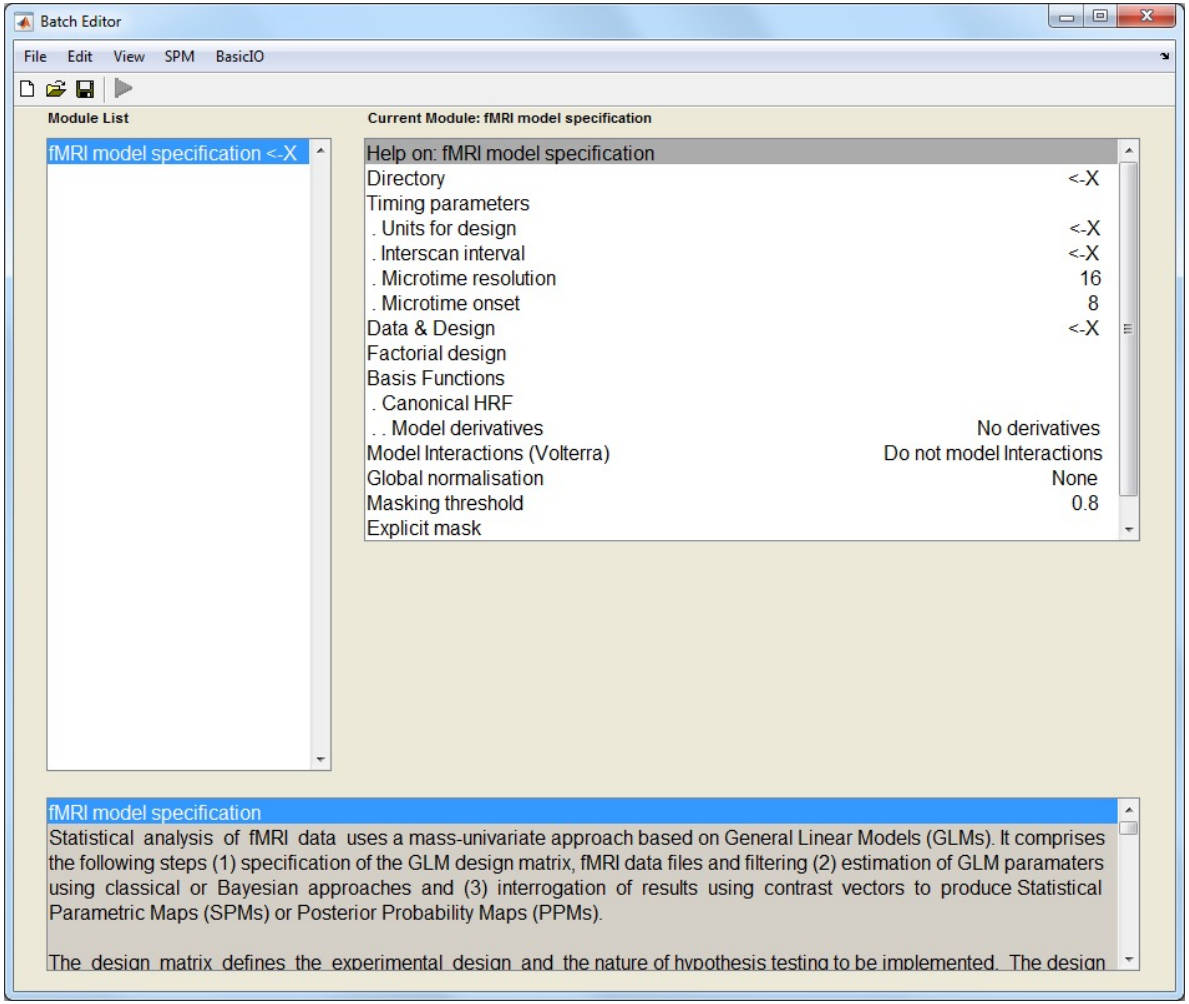
SPM12

- SPM - theoretical concepts of Statistical Parametric Mapping in a complete analysis package.
- Run in matlab
- See more information: https://www.fil.ion.ucl.ac.uk/spm/software/spm12/

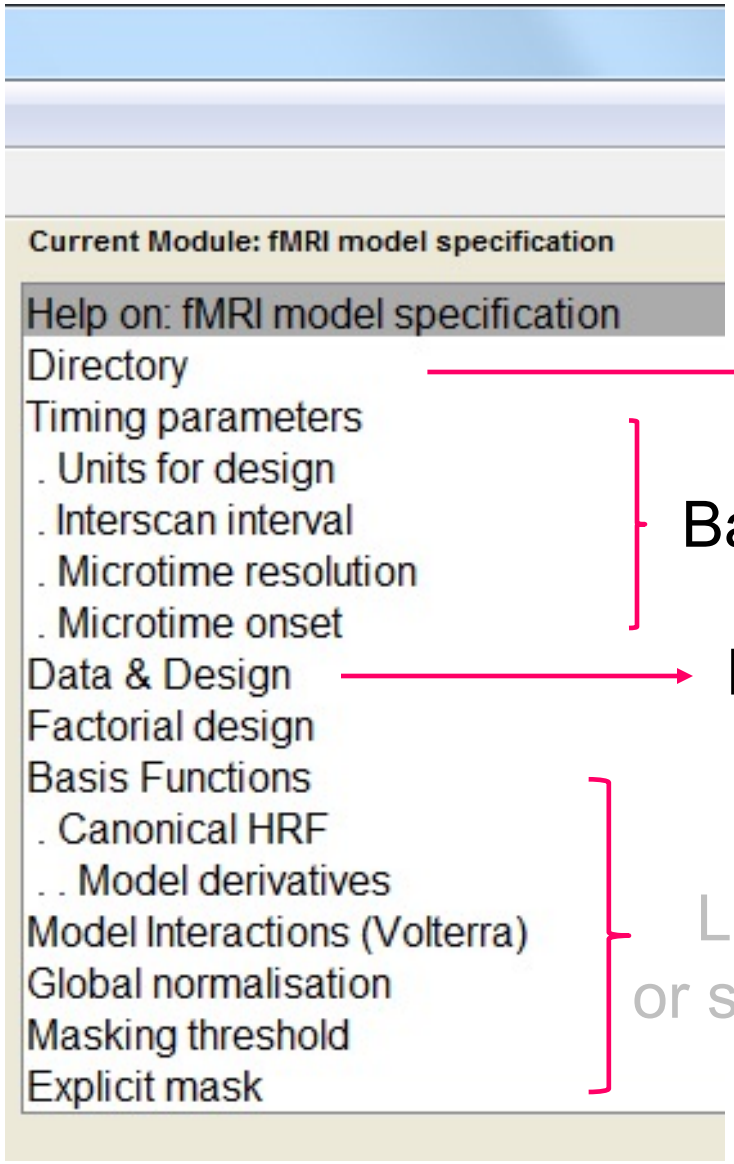


Operation in SPM12





SPM12: parameter setting

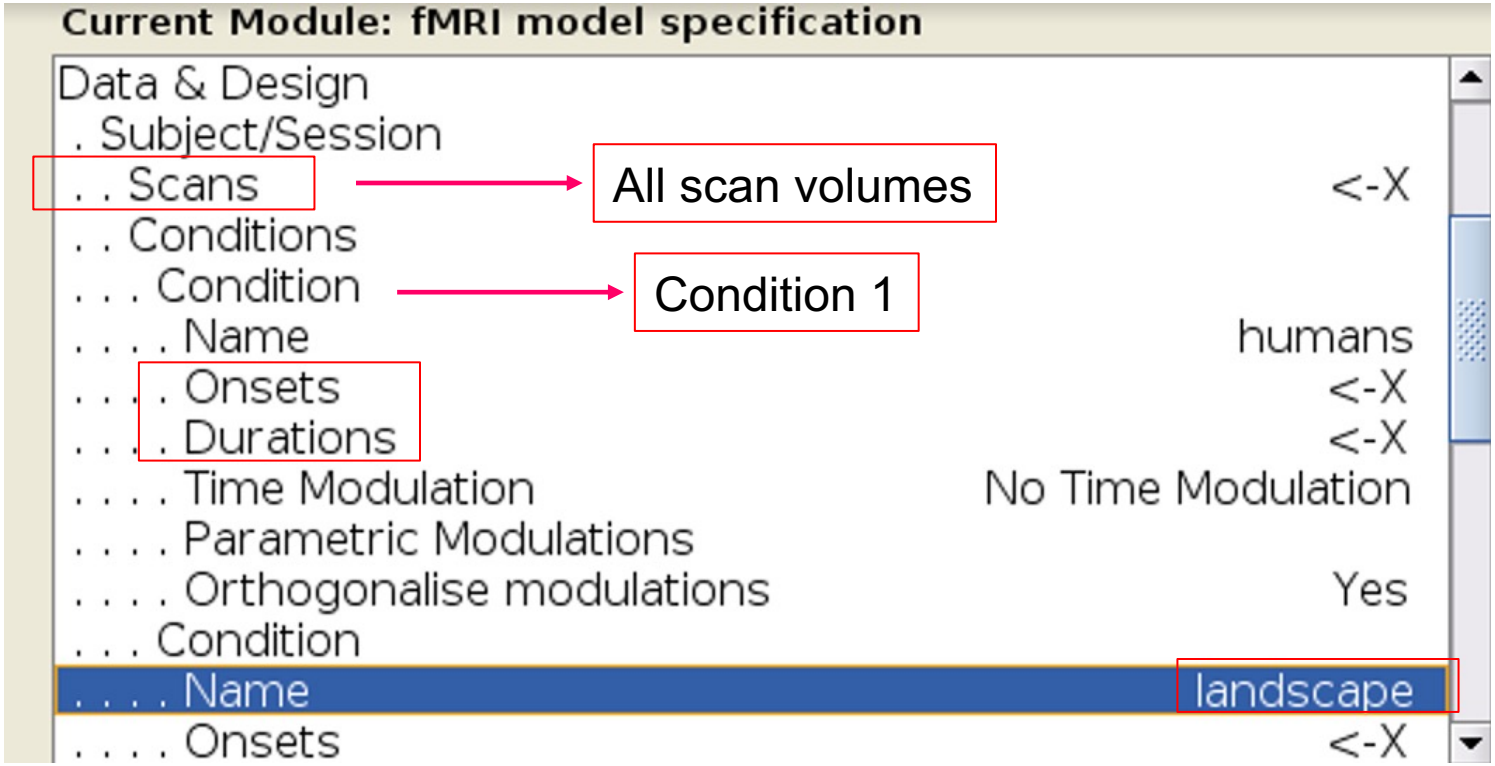


Result folder

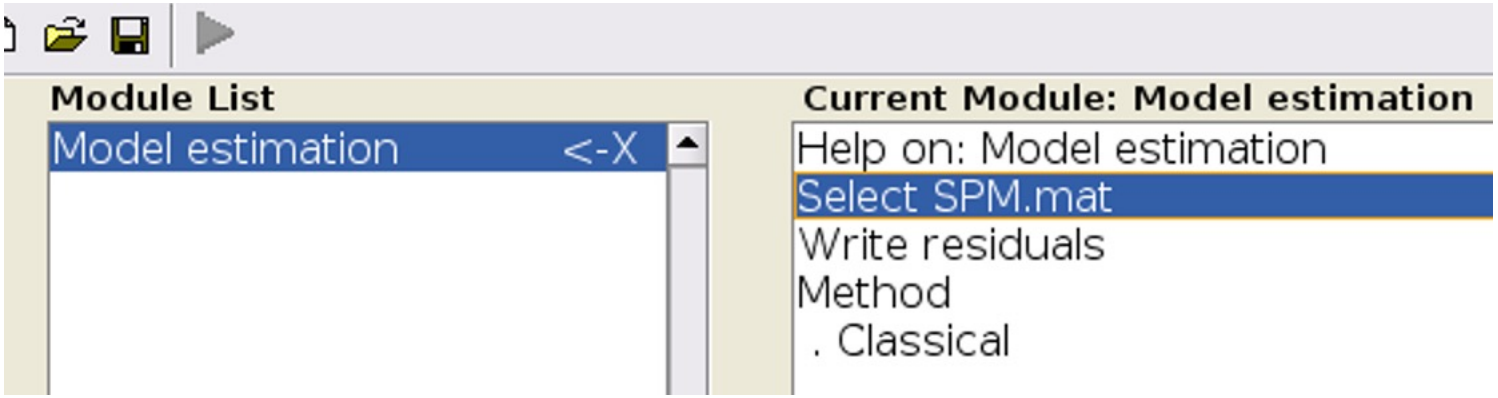
Basic imaging parameters

Design matrix: sessions & conditions

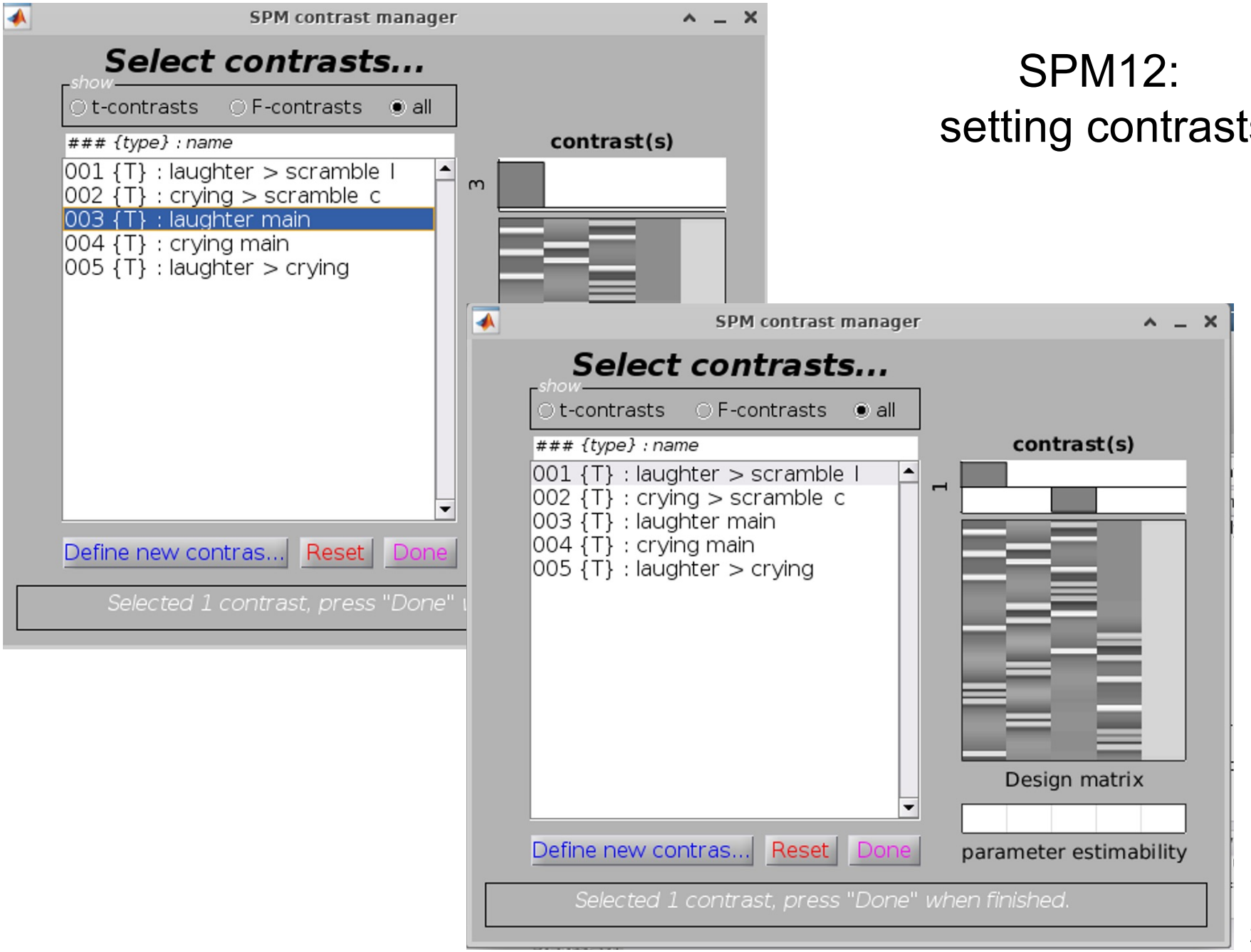
Leave as default,
or specify if necessary



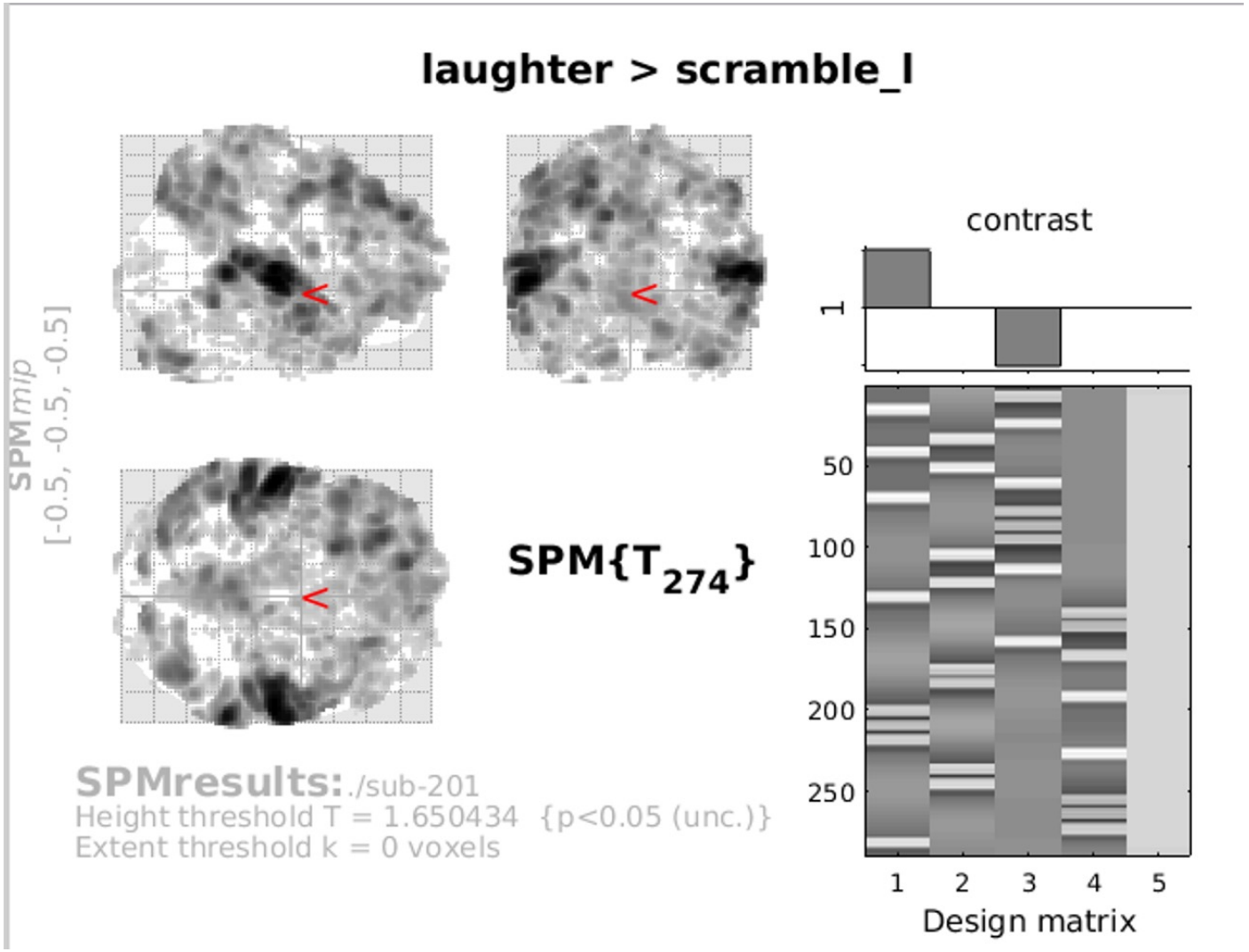
Data estimation



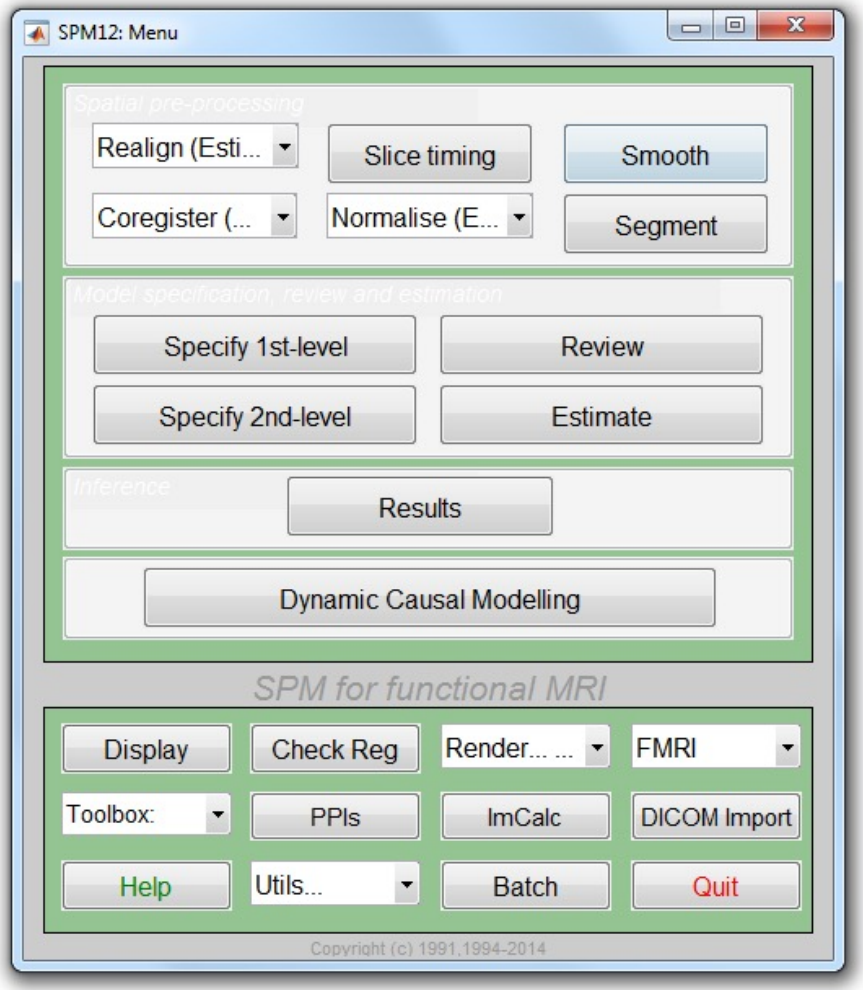
SPM12: setting contrasts



SPM12: result



Ready for 2nd-level analysis



Resources

- Principles of fMRI: https://youtu.be/OyLKMb9FNhg
- Spm12 manual: https://www.fil.ion.ucl.ac.uk/spm/doc/spm12_manual.pdf

- Behav Res (2014) 46:596–610