SPM: Introduction

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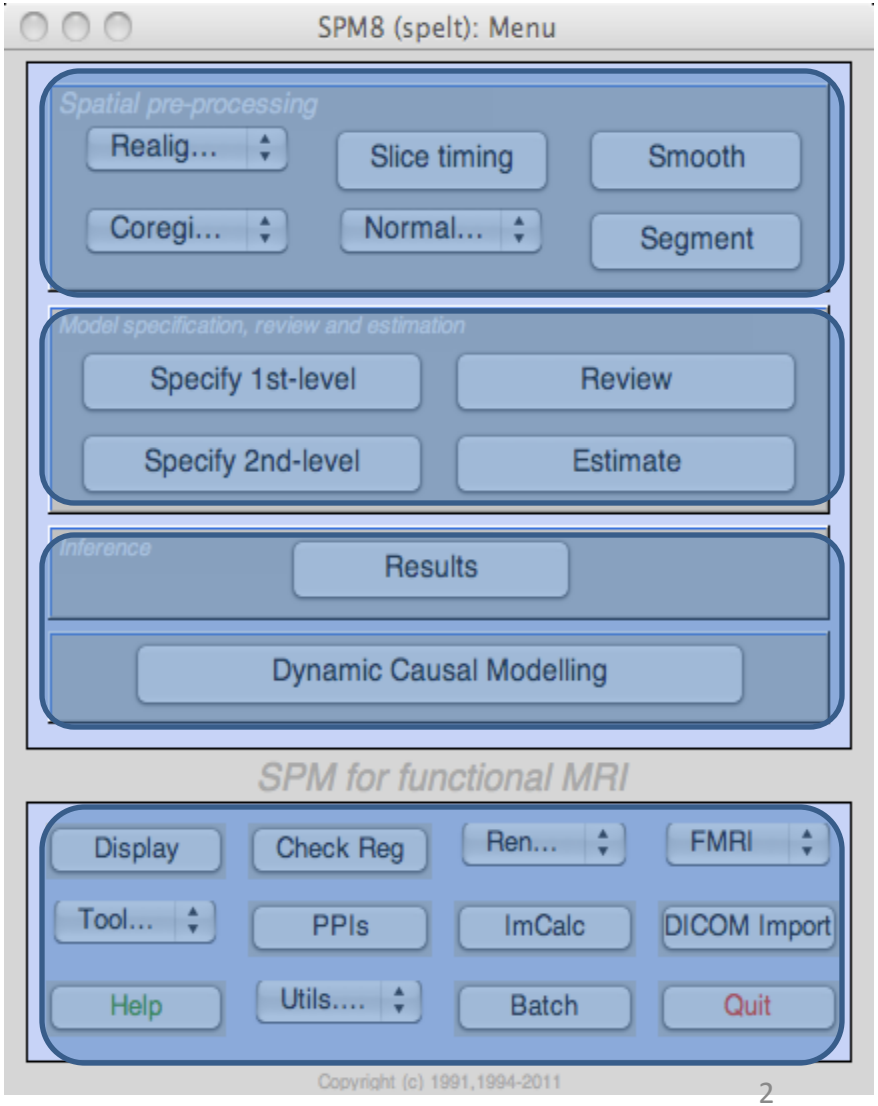
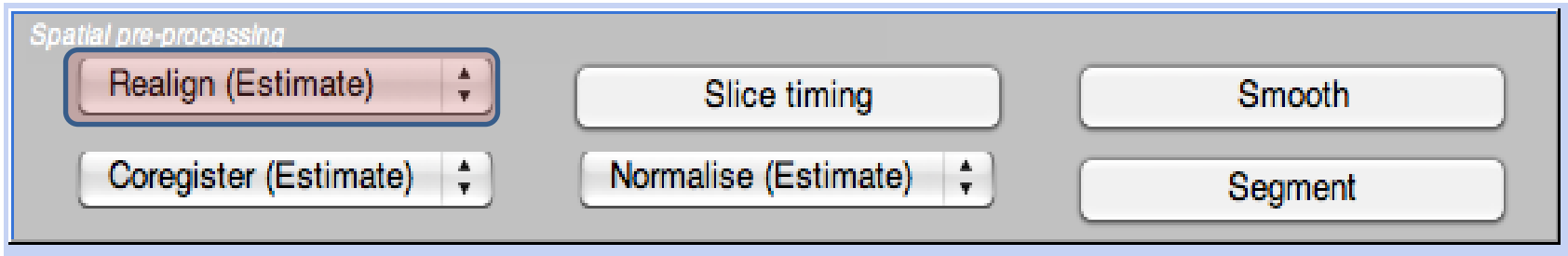
SPM: Overview

- C language and MATLAB
- Friendly GUI
- Main Functions
  - 1- Spatial pre-processing
  - 2- Model specification, review and estimation
  - 3- Inference
  - 4- Other fMRI tools



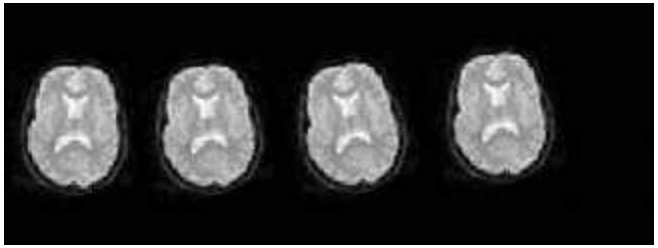
Preprocessing: Realignment

- Realignment
  - Intra-subject registration
  - Align all functional images
  - Positioning of the brain in each image is the same

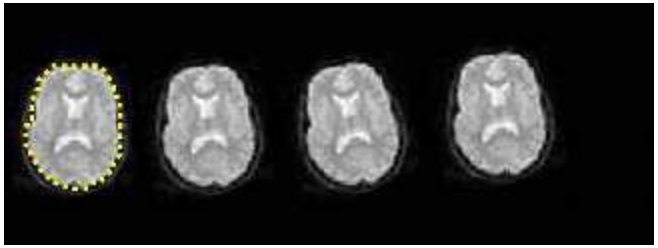


Preprocessing: Realignment

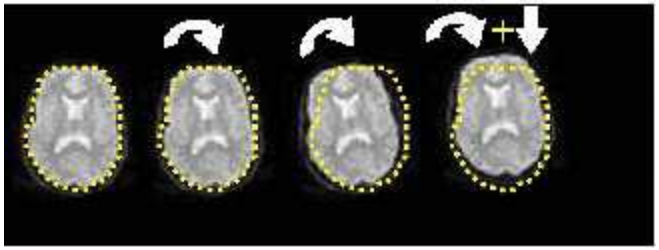
Step 1



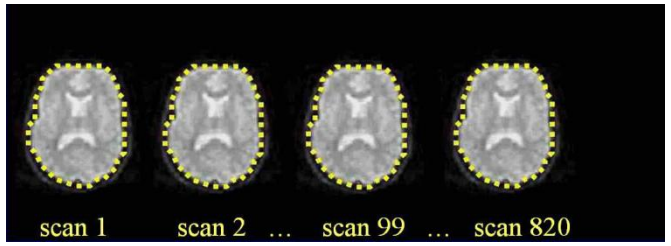
Step 2

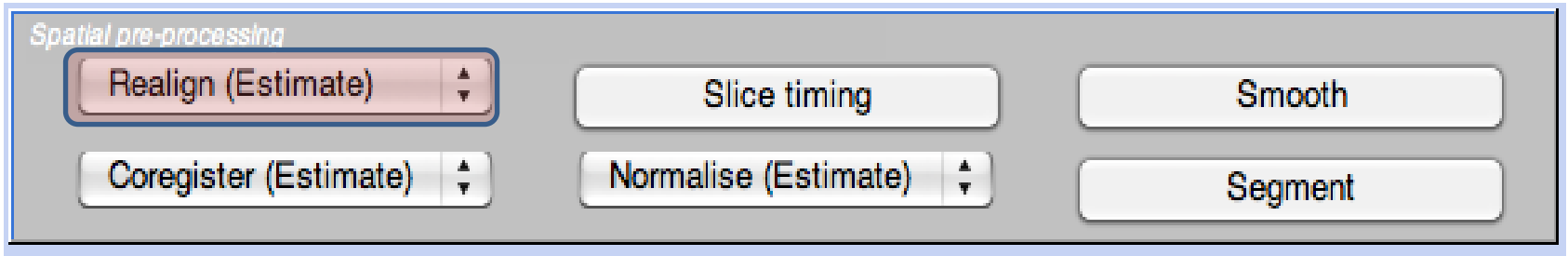


Step 3



Step 4





Preprocessing: Realignment

Image realignment

1 F:\Iraqi_Universities\Data\Preprocessing\fM00223\fM00223_004.img
2 F:\Iraqi_Universities\Data\Preprocessing\fM00223\fM00223_005.img
3 F:\Iraqi_Universities\Data\Preprocessing\fM00223\fM00223_006.img
4 F:\Iraqi_Universities\Data\Preprocessing\fM00223\fM00223_007.img
5 F:\Iraqi_Universities\Data\Preprocessing\fM00223\fM00223_008.img
6 F:\Iraqi_Universities\Data\Preprocessing\fM00223\fM00223_009.img
7 F:\Iraqi_Universities\Data\Preprocessing\fM00223\fM00223_010.img
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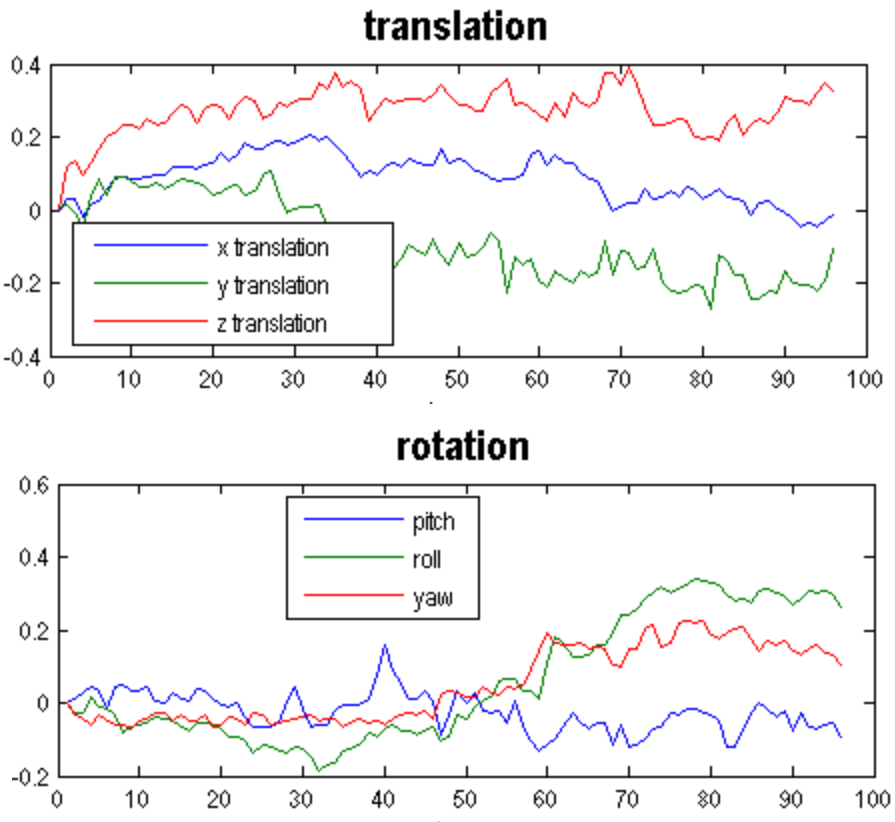
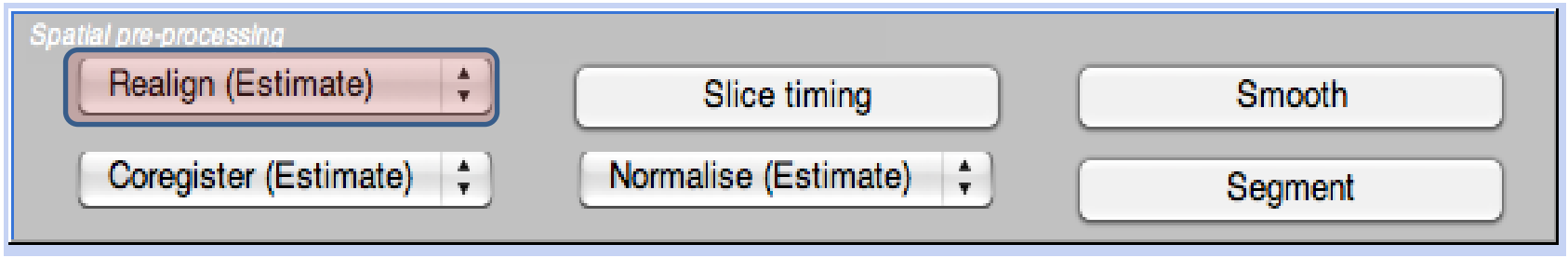
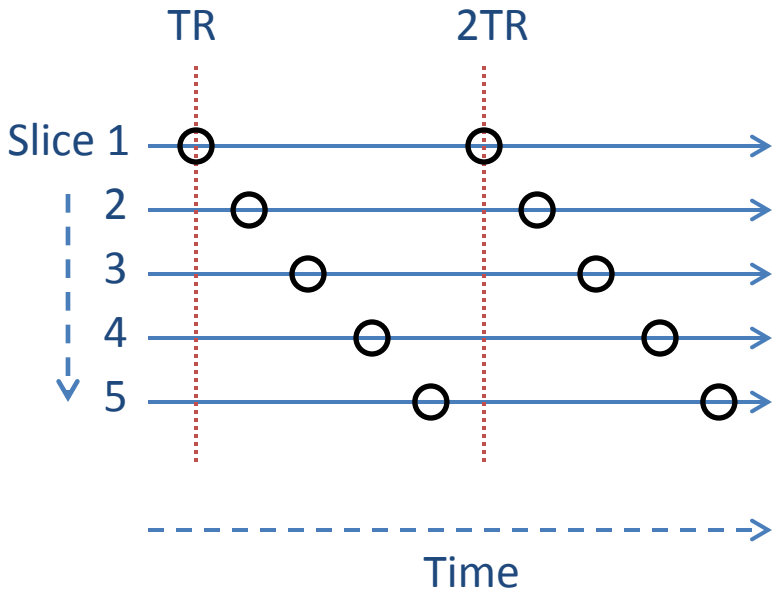
10 F:\Iraqi_Universities\Data\Preprocessing\fM00223\fM00223_013.img
11 F:\Iraqi_Universities\Data\Preprocessing\fM00223\fM00223_014.img
12 F:\Iraqi_Universities\Data\Preprocessing\fM00223\fM00223_015.img
..... etc

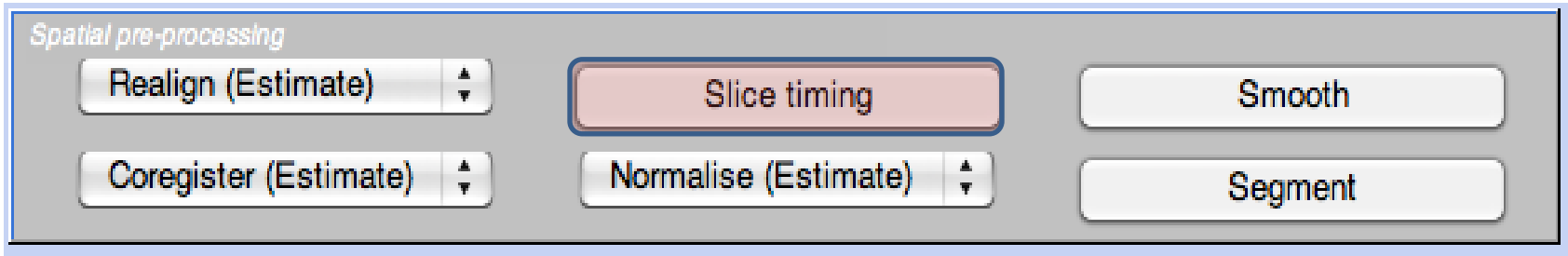




Preprocessing: Slice Timing

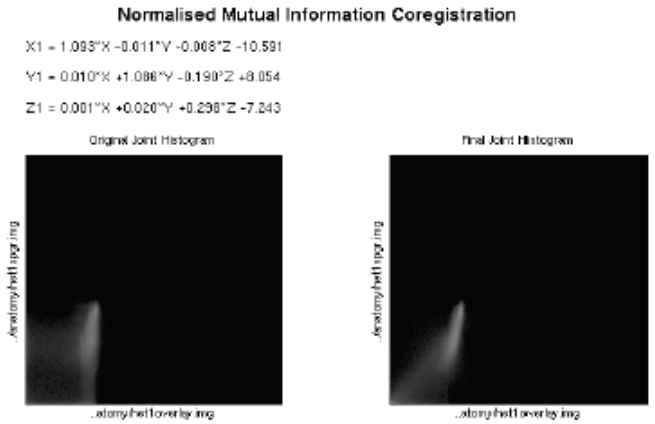
- Slice timing
  - Correcting the time of image acquisition

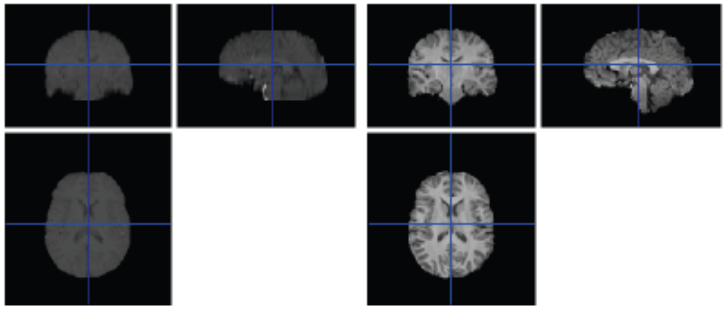


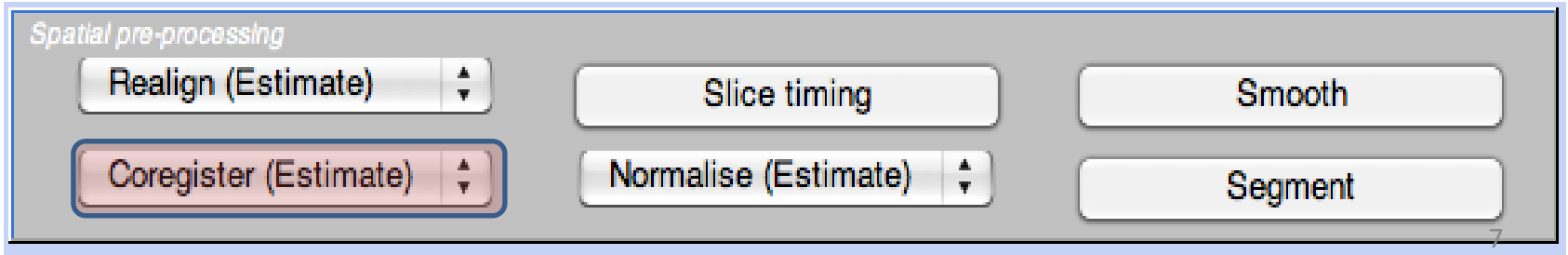


Preprocessing: Coregistration

- Coregistration
  - Intra-subject
  - Differences in signal intensity between the images, e.g., EPI and T1
  - Methods
    - Segmentation
    - Mutual information

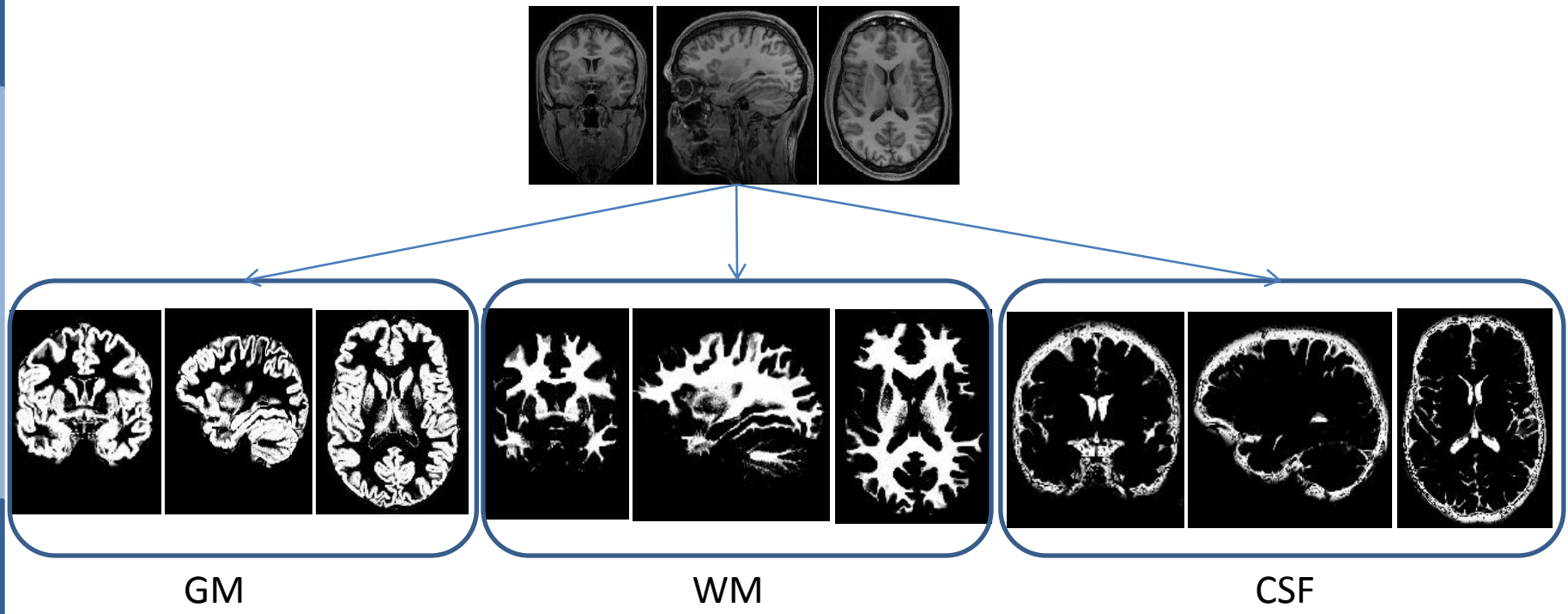


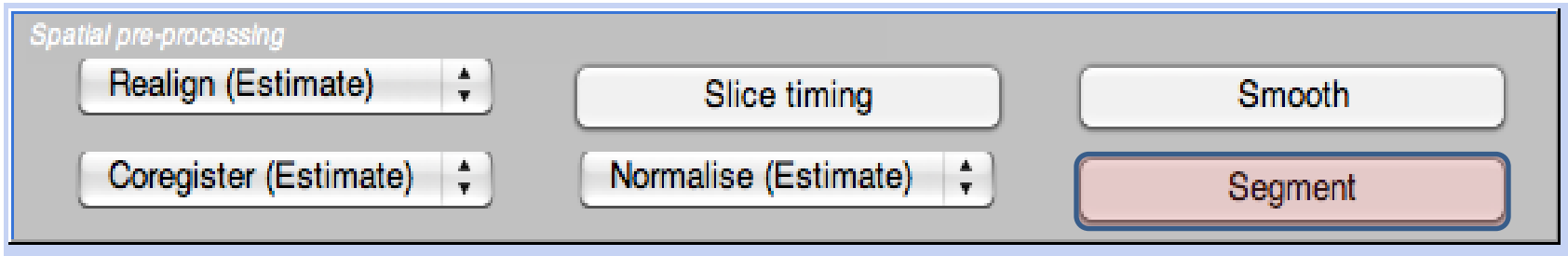




Preprocessing: Segmentation

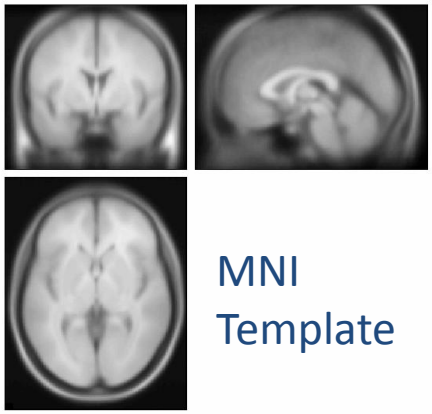
- Segmentation into GM/WM/CSF



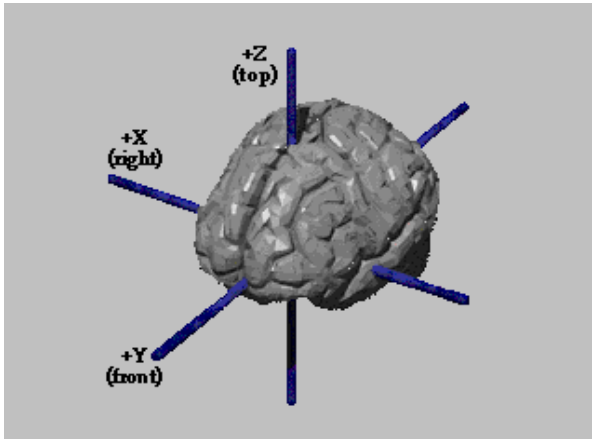


Preprocessing: Normalization

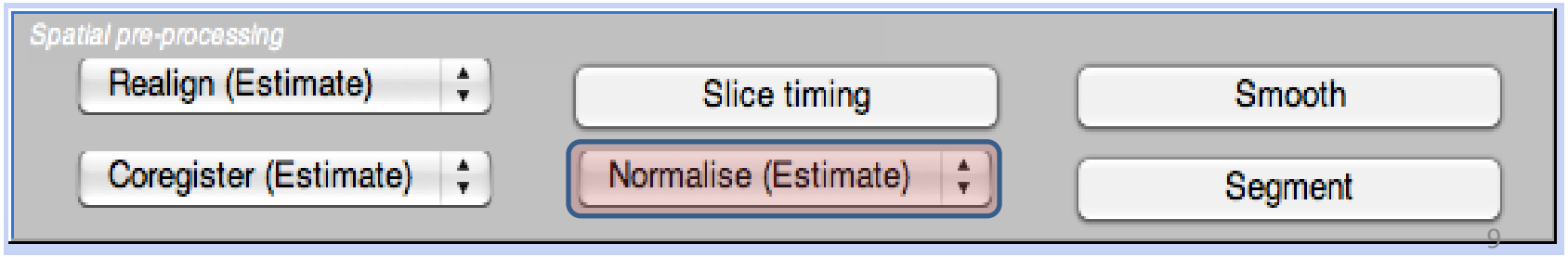
- Spatial Normalization
  - Inter-subject registration
  - Register anatomy images to standard space
    - Montreal Neurological Institution (MNI)
    - Talairach



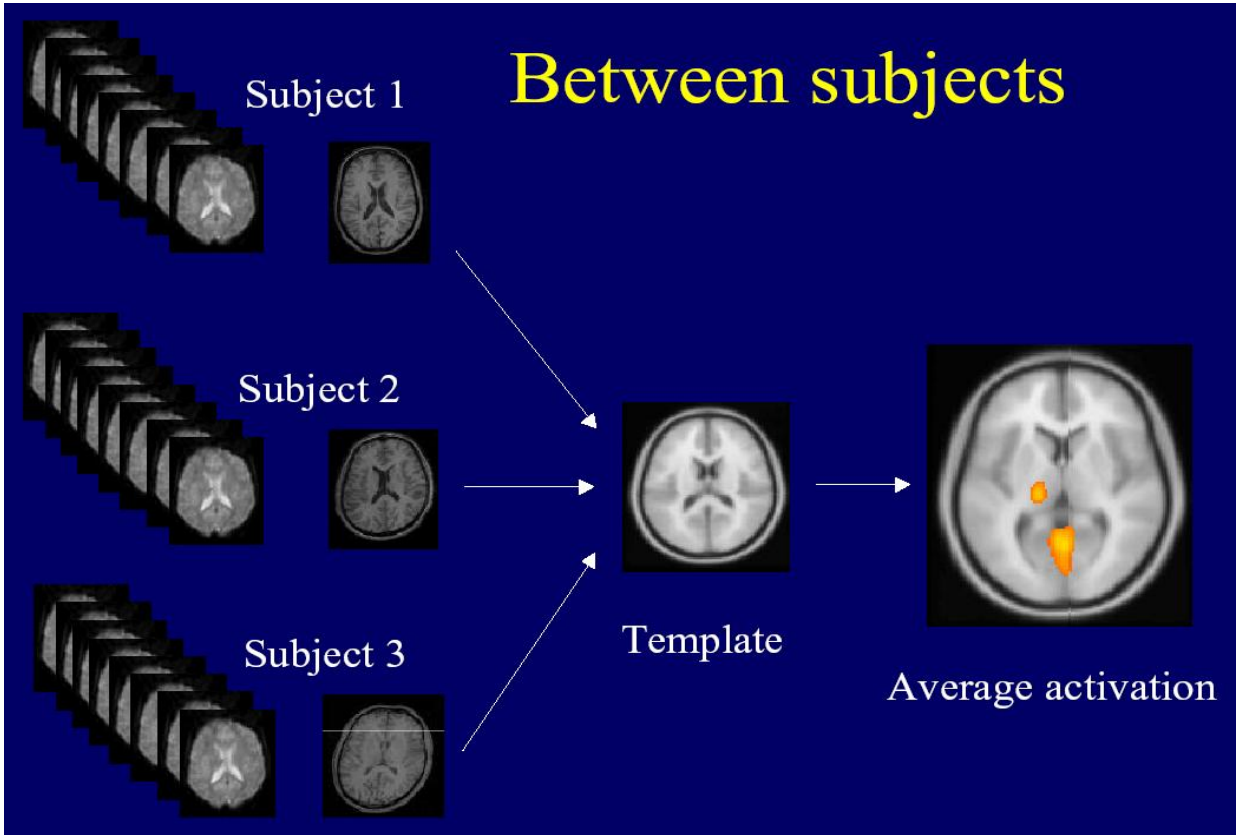
MNI Template

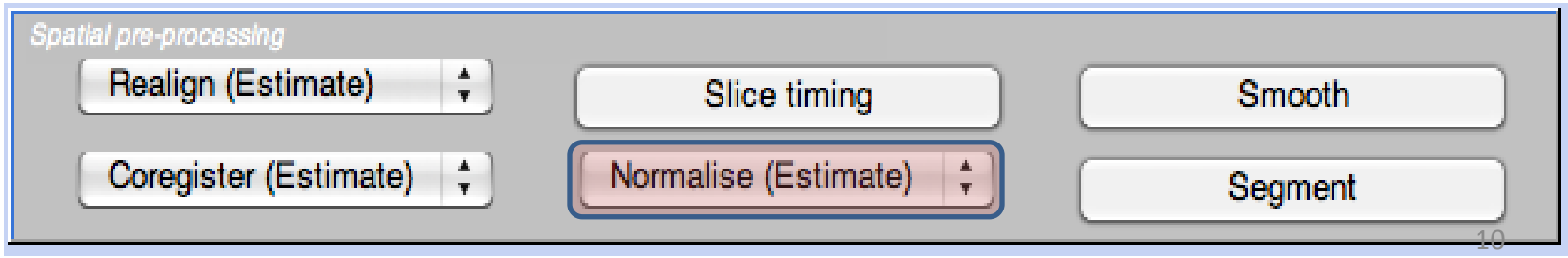


Talairach Template

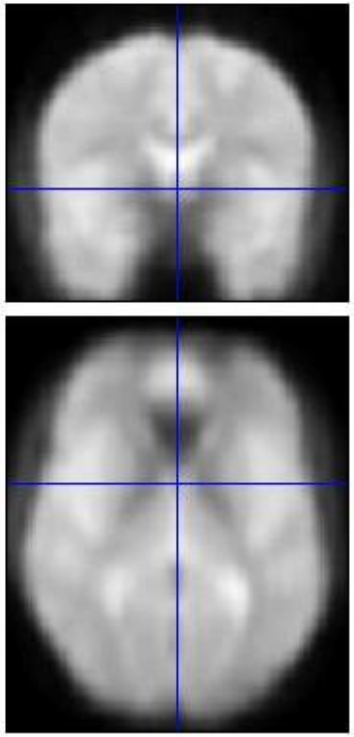


Preprocessing: Normalization

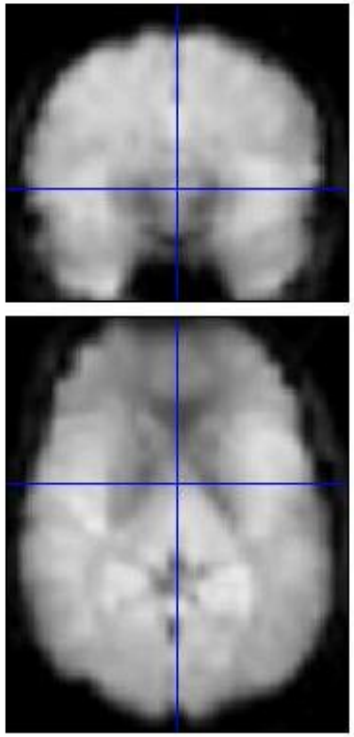




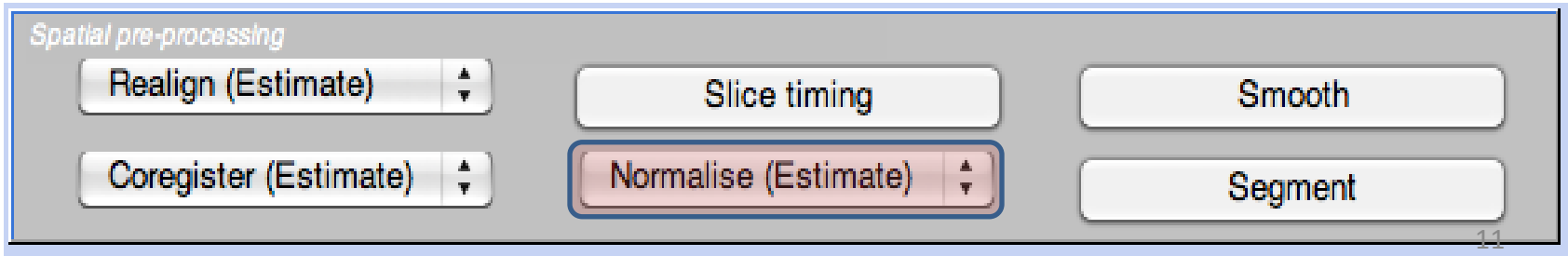
Preprocessing: Normalization



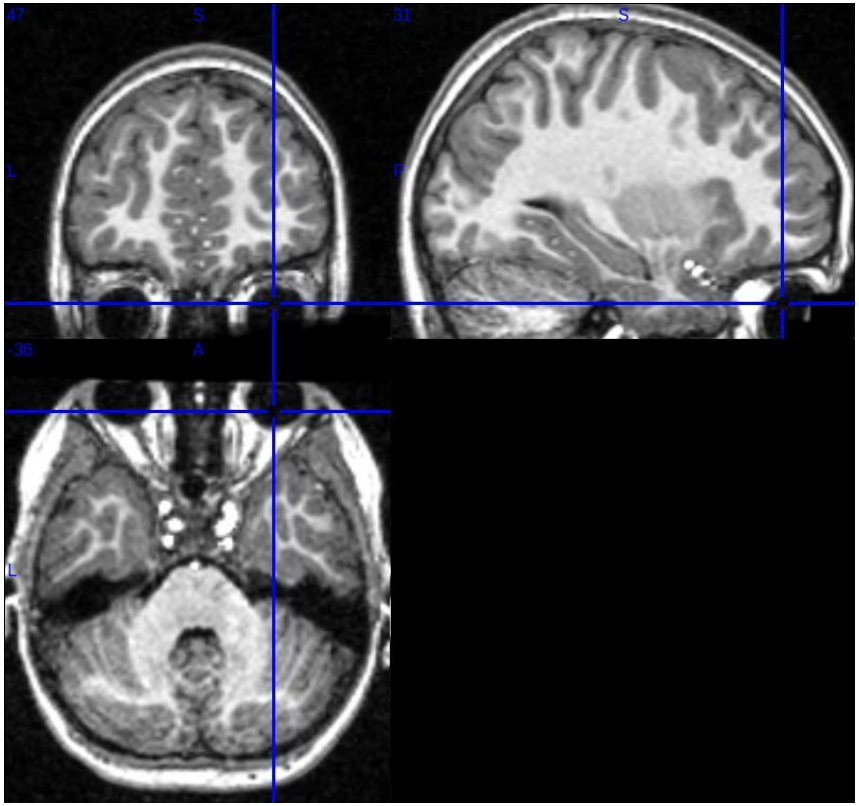
MNI Template

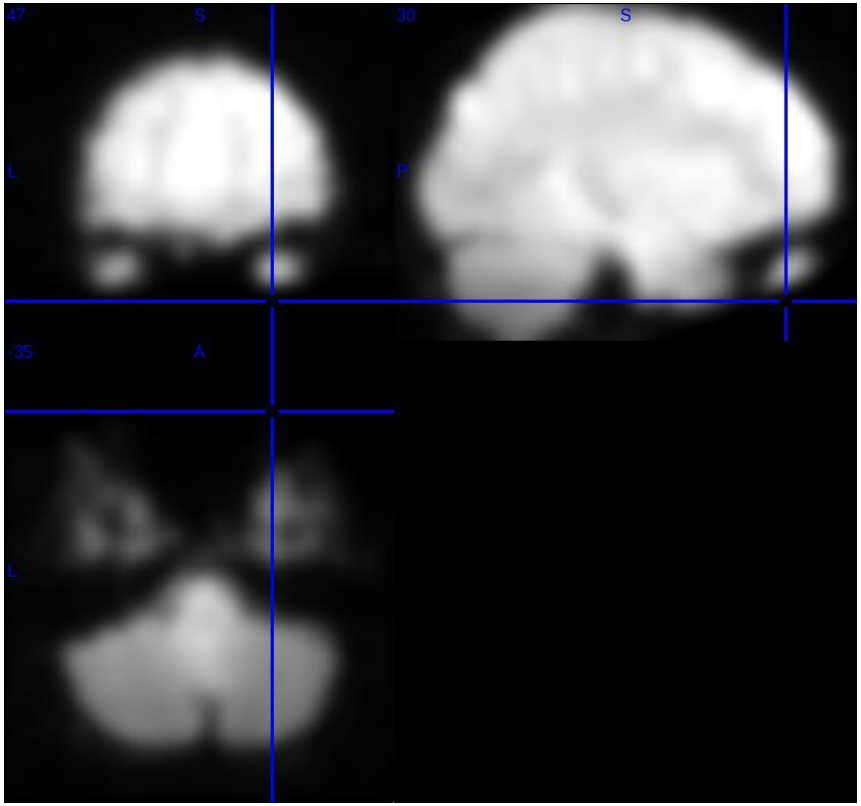


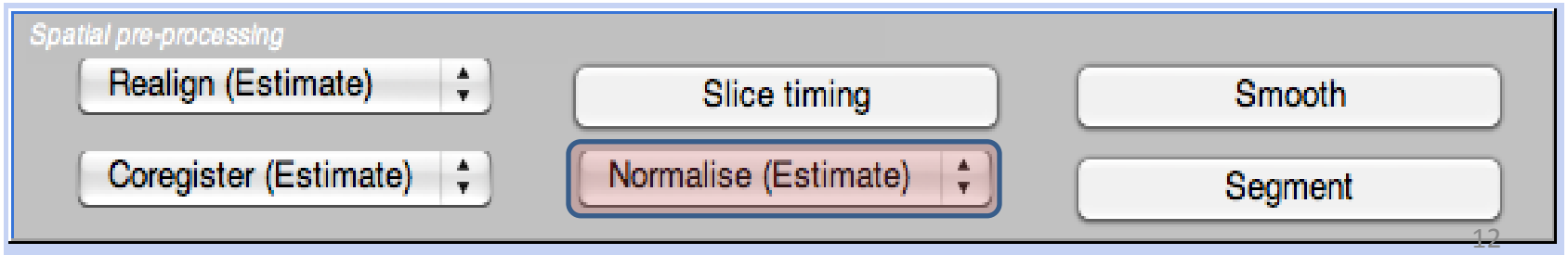
Normalized Image



Preprocessing: Normalization

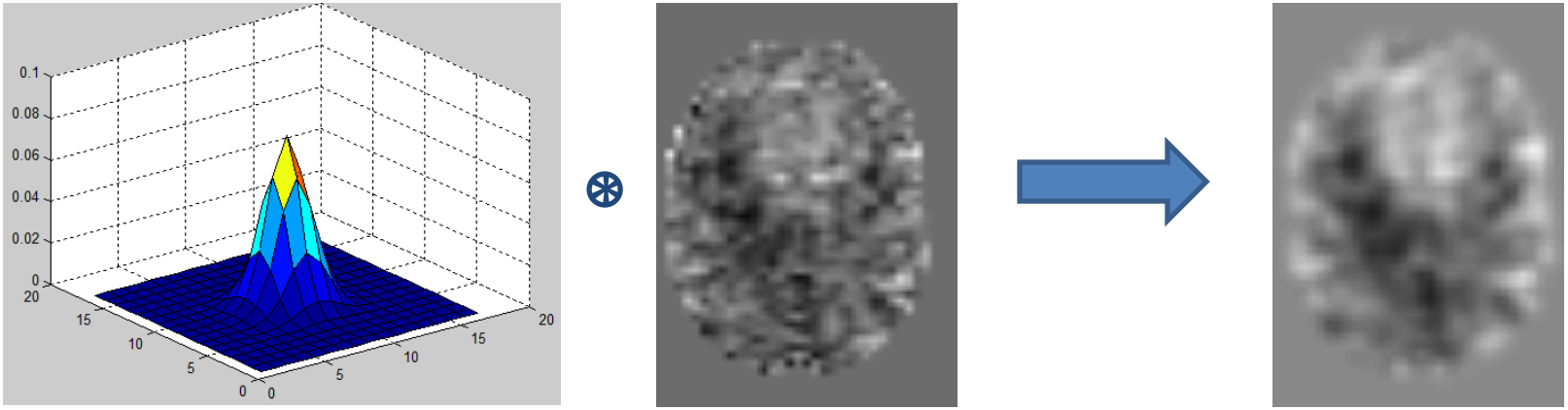


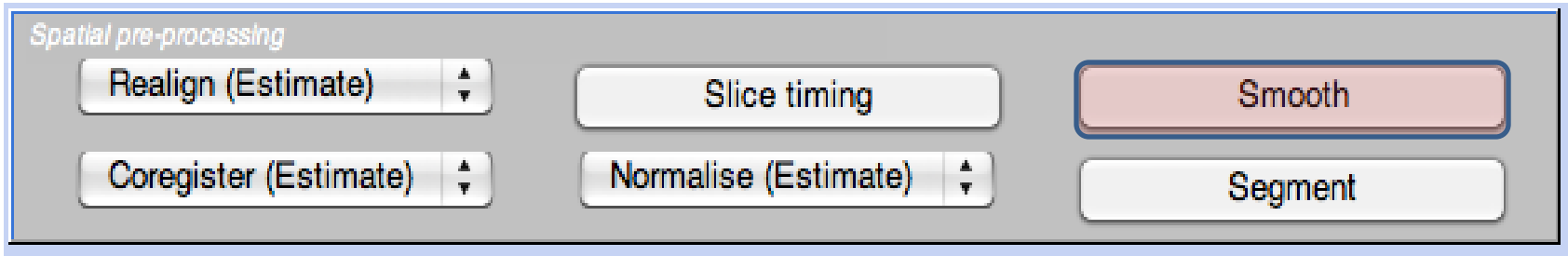




Preprocessing: Spatial Smoothing

- Spatial Smoothing
  - Inter-subject analyses
  - Bluer fMRI data

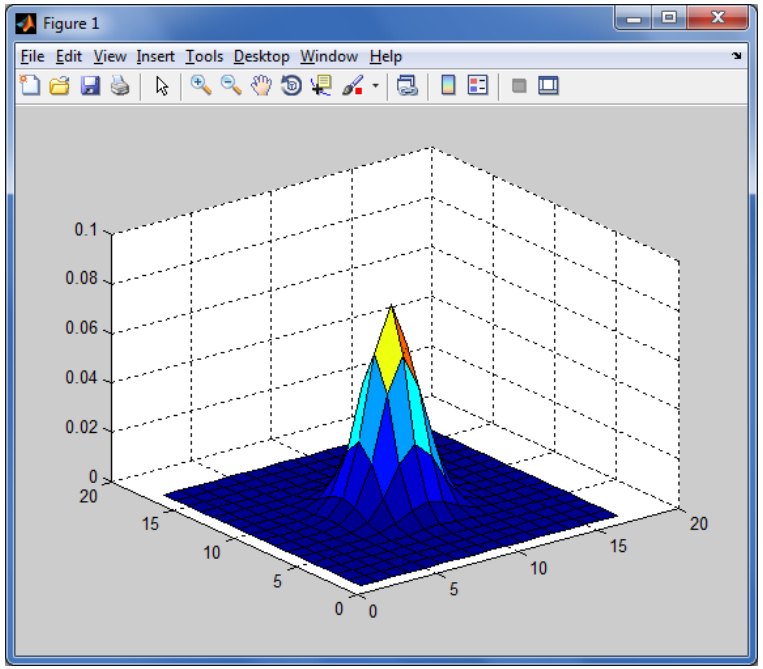


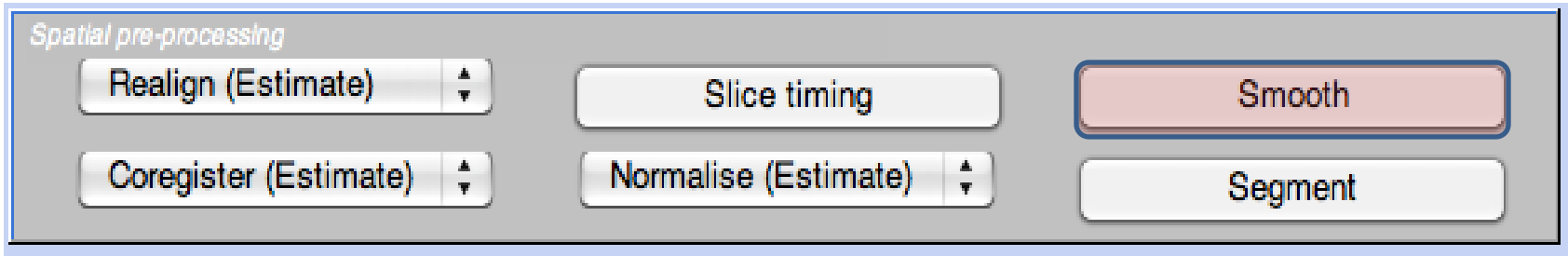


Preprocessing: Spatial Smoothing

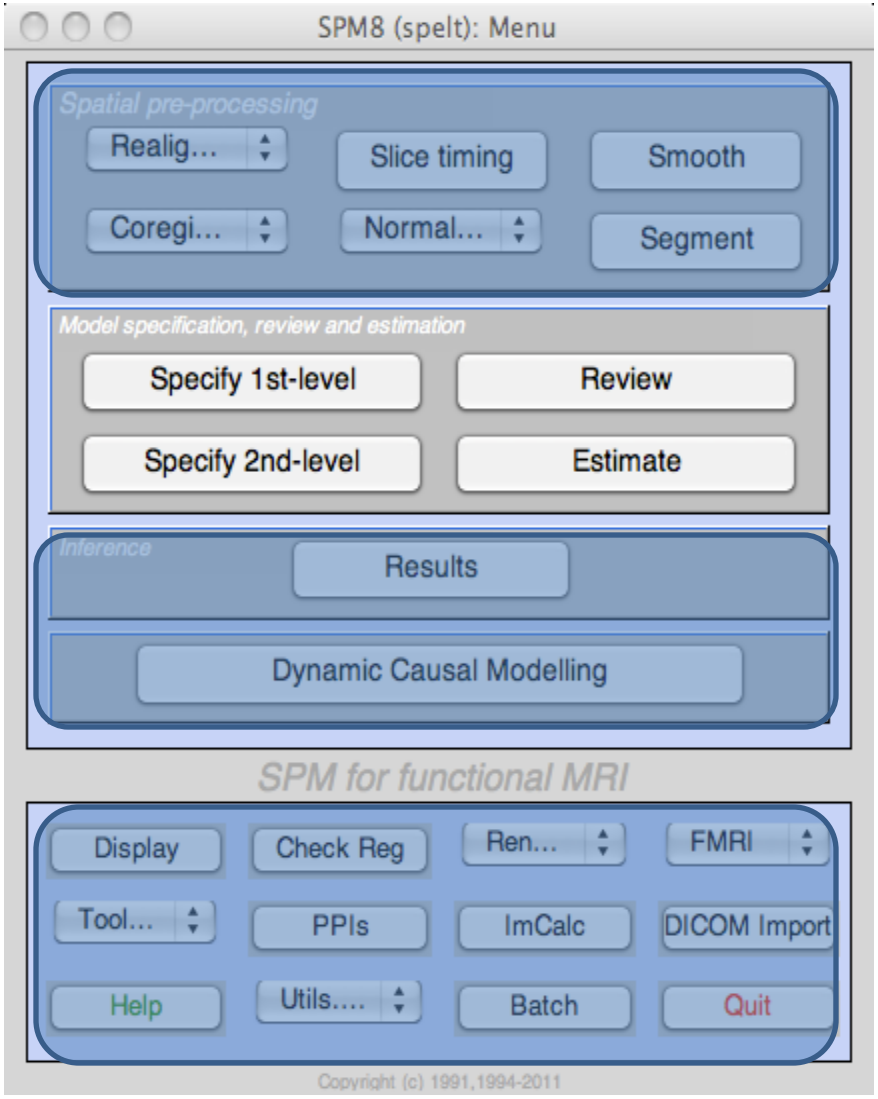
```
%  Gaussian Filter for smoothing image data
%  Shamil Hadi
%  Oakland University
%  September 12, 2012
% $Id: Gaussian_Filter Shamil $

clear all;
clc;
[X, Y] = meshgrid(-8:8, -8:8); % specifying the range
sigma = 1;
Gaussian = 1/(2*pi*sigma^2)*exp(-(X.^2 + Y.^2)/(2*sigma^2));
Gaussian = Gaussian./sum(Gaussian(:)); % normalizing the filter
figure, surfc(Gaussian);
```



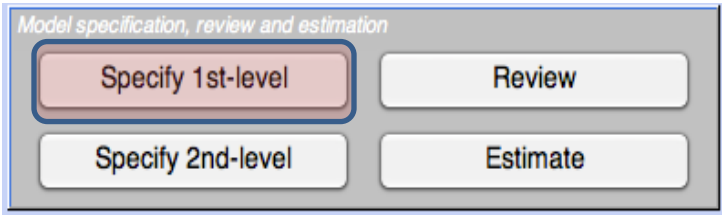


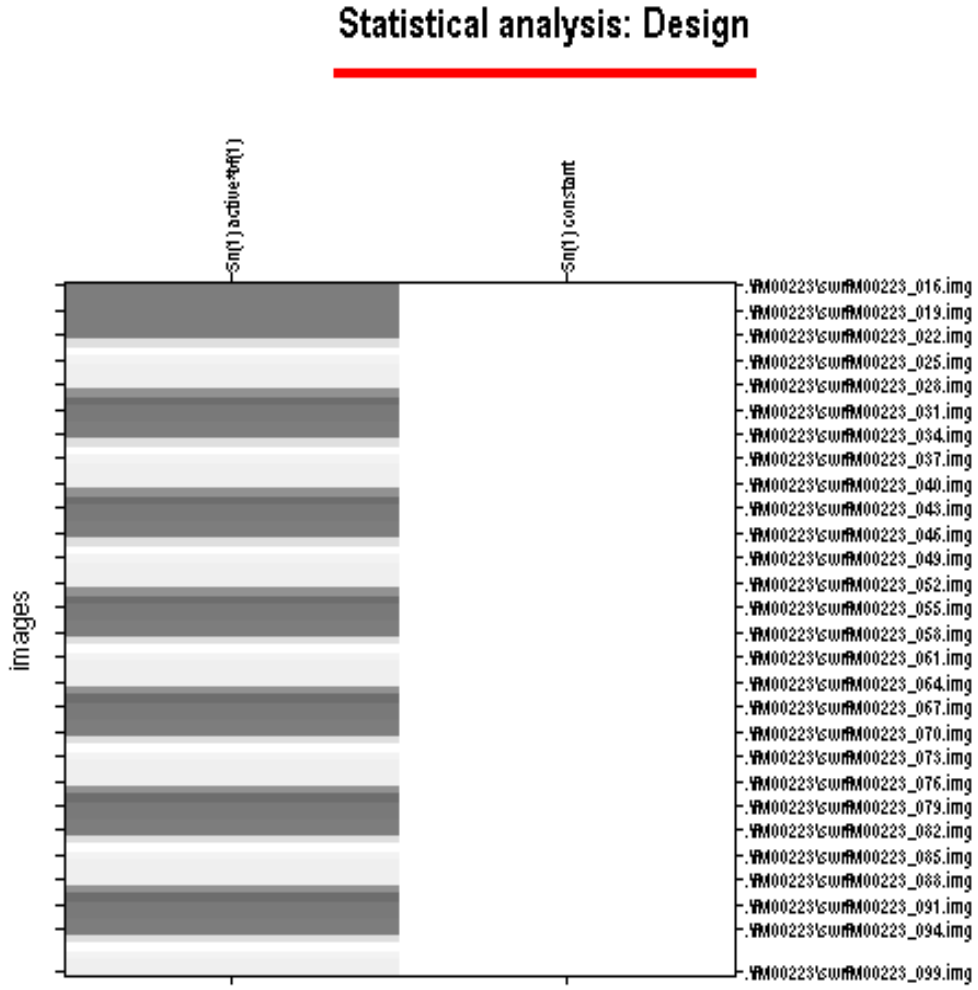
Model Specification



Model Specification

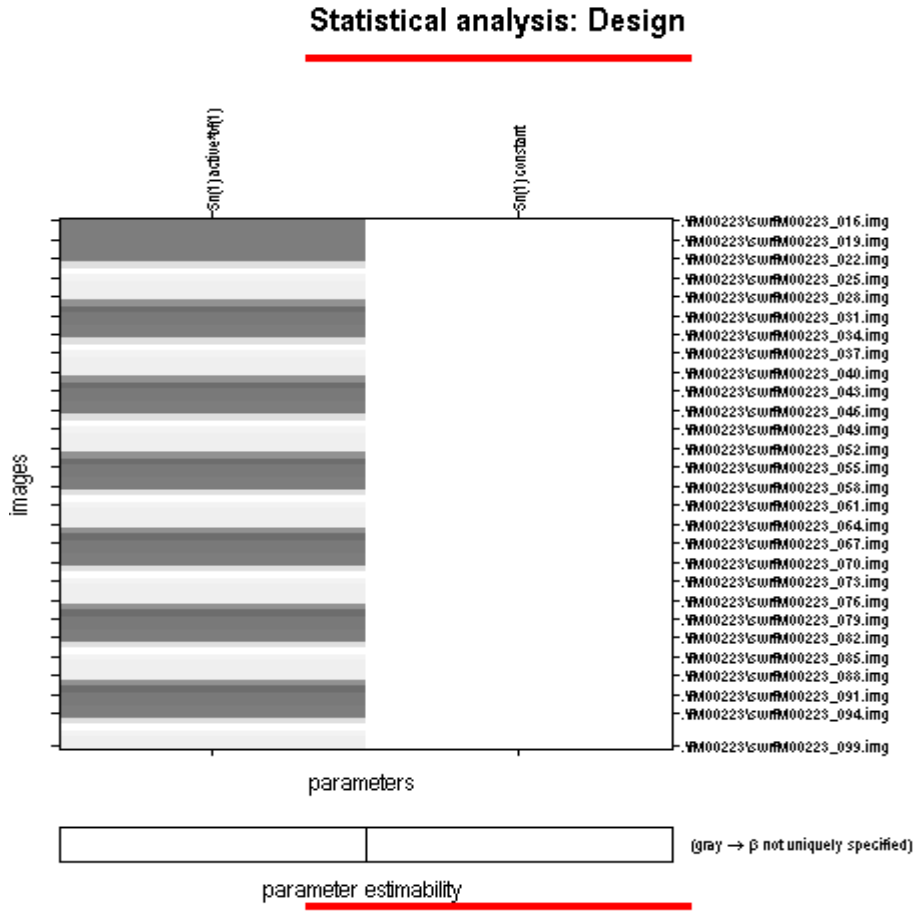
- Specify 1st-level
  - Specify GLM design matrix, and data file

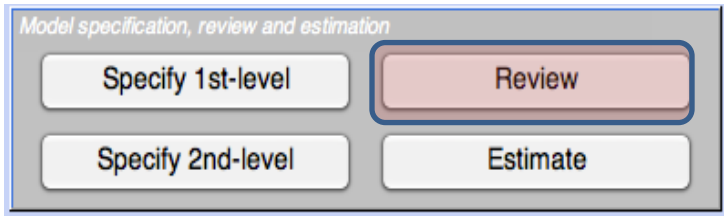




Model Specification

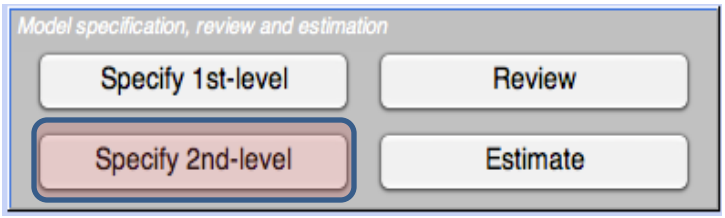
- Review
  - Check the work

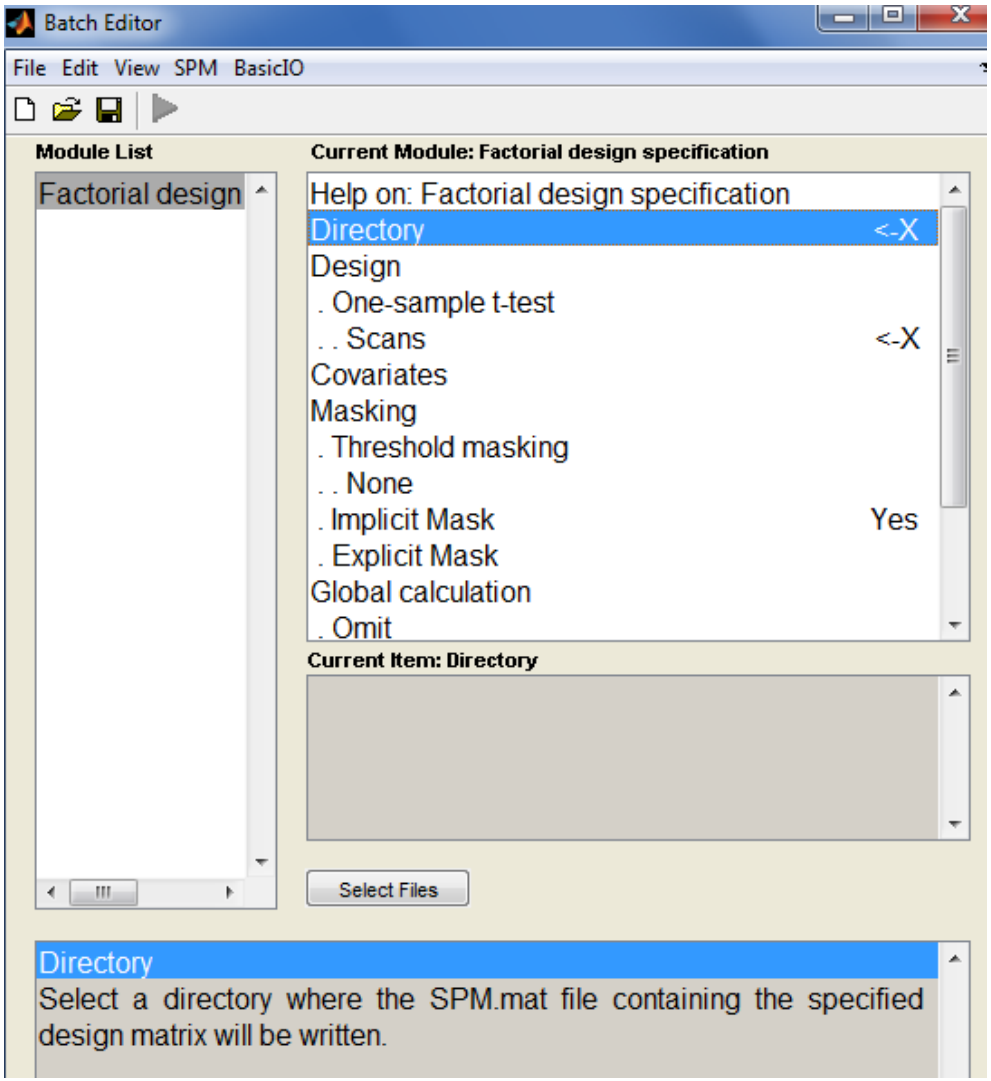




Model Specification

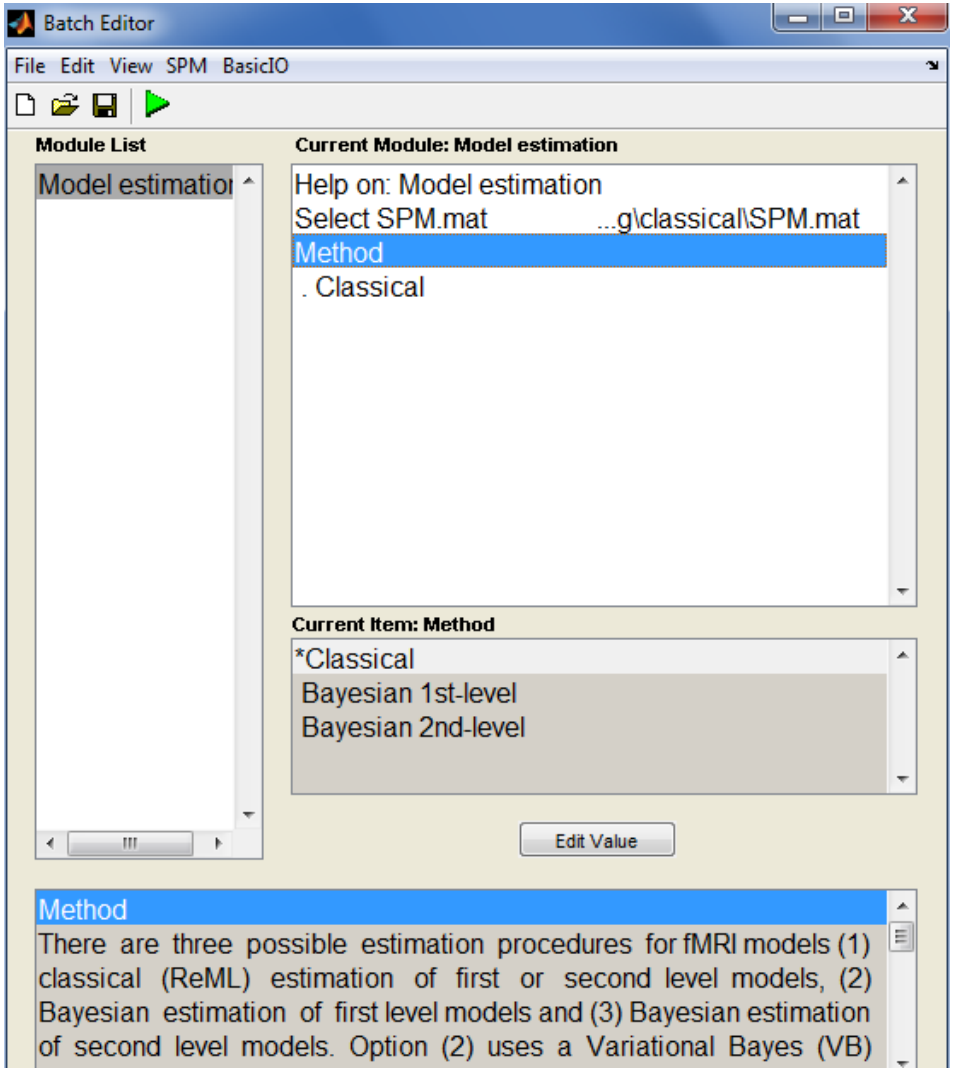
- Specify 2nd-level
  - Statistical test, e.g., one sample *t*-test

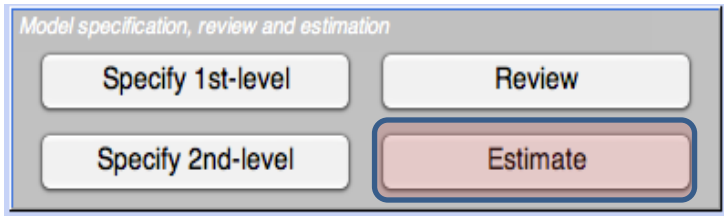




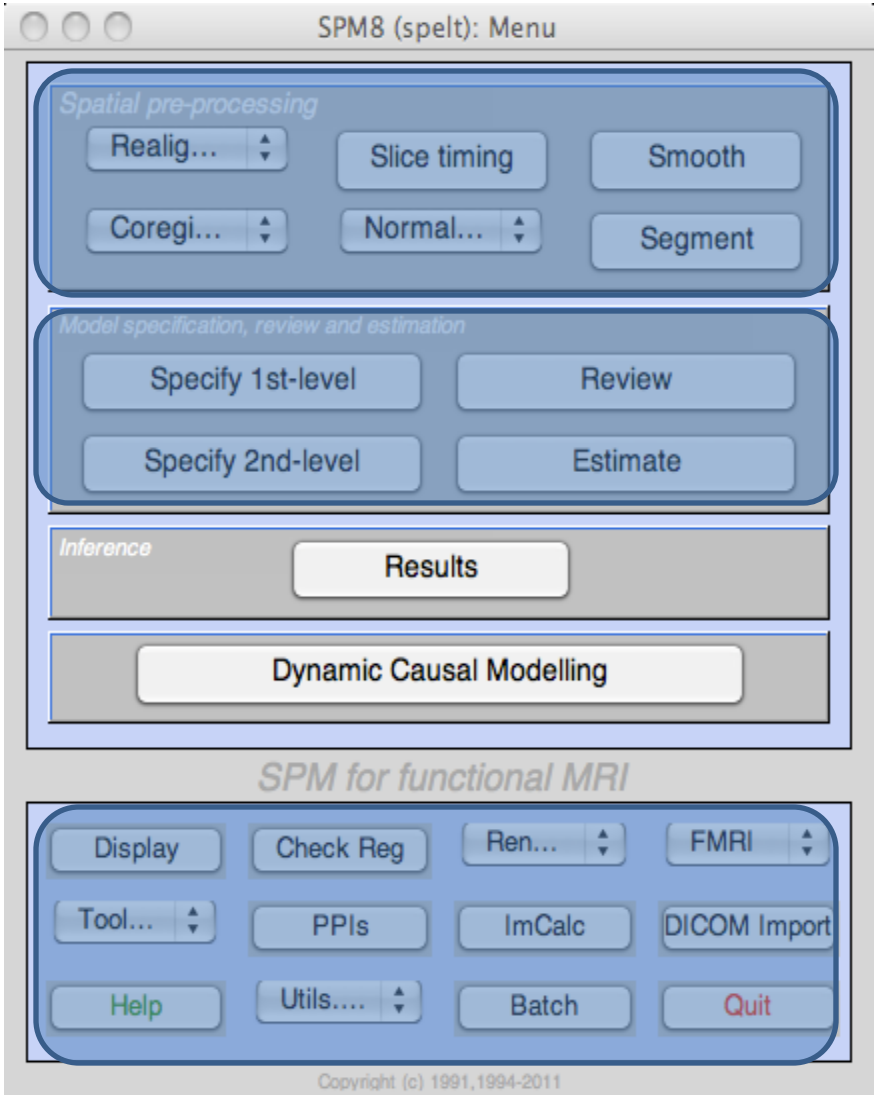
Model Specification

- Estimate
  - Estimation of GLM parameters



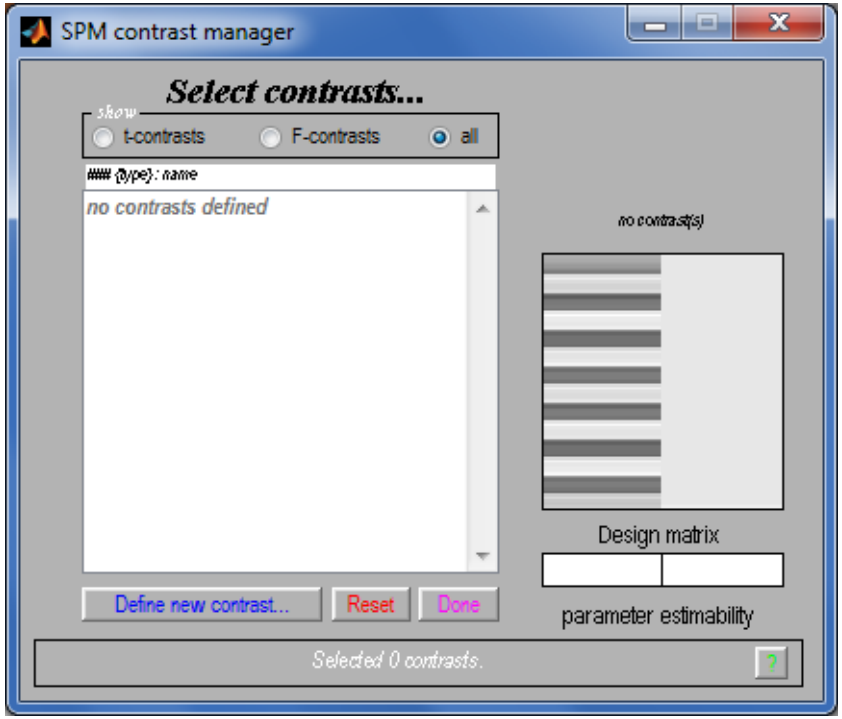


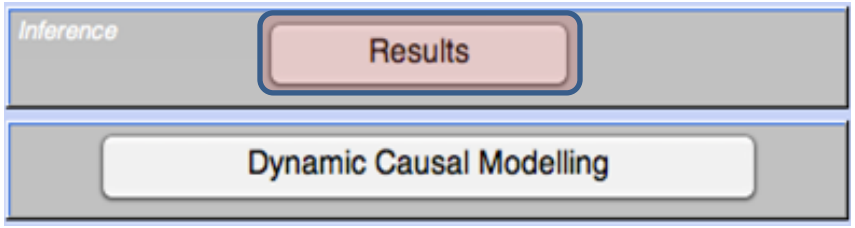
Inference

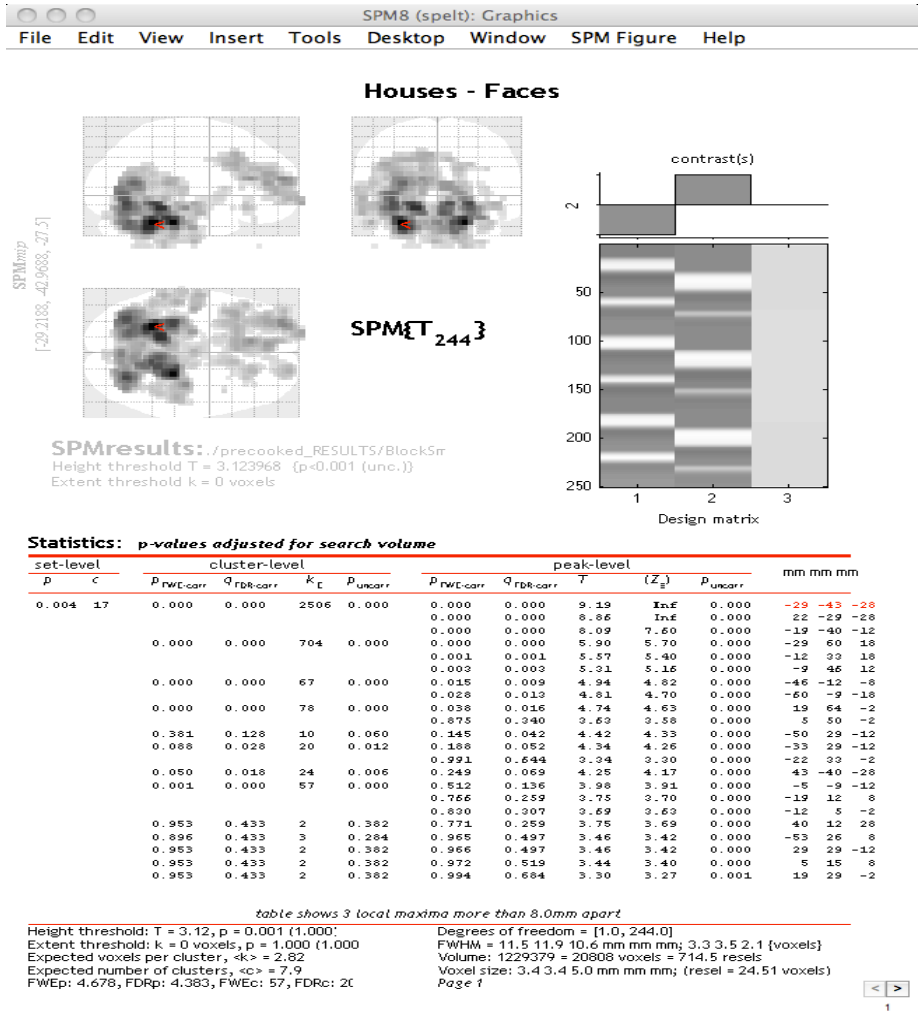

SPM8 (spelt): Menu
Spatial pre-processing
Realig...
Slice timing
Smooth
Coregi...
Normal...
Segment
Model specification, review and estimation
Specify 1st-level
Review
Specify 2nd-level
Estimate
Inference
Results
Dynamic Causal Modelling
SPM for functional MRI
Display
Check Reg
Ren...
FMRI
Tool...
PPIs
ImCalc
DICOM Import
Help
Utils....
Batch
Quit
Copyright (c) 1991,1994-2011

Inference

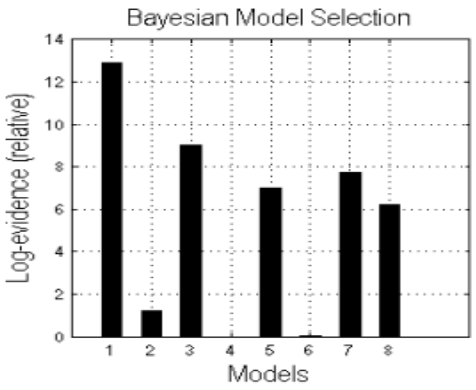
- Results button
  - Contrast Manager

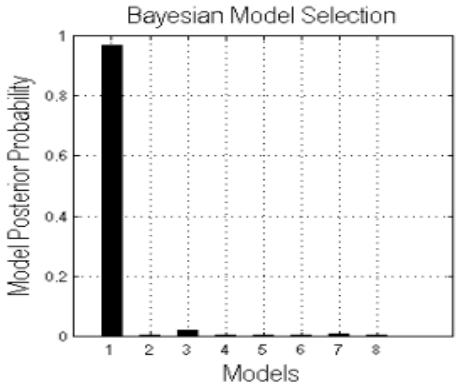


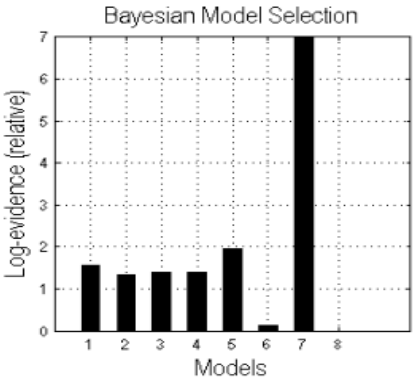


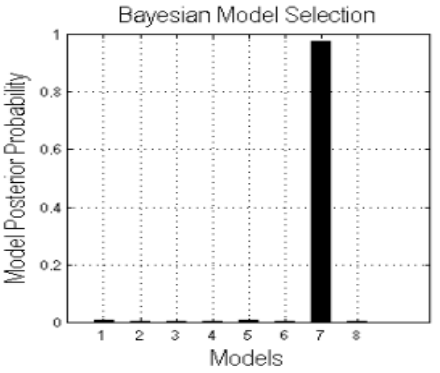


Inference


Bayesian Model Selection
Log-evidence (relative)
Models


Bayesian Model Selection
Model Posterior Probability
Models


Bayesian Model Selection
Log-evidence (relative)
Models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Model Posterior Probability
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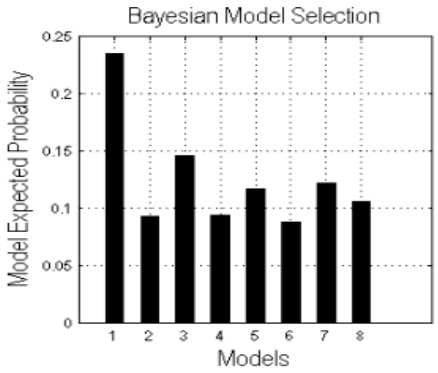
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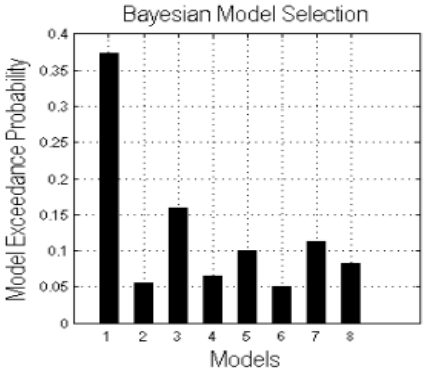
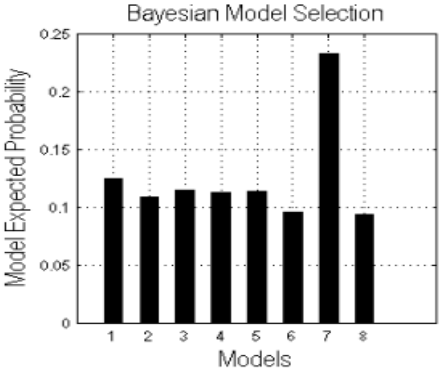
Model Expected Probability
Models


Bayesian Model Selection
Model Exceedance Probability
Models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Model Expected Probability
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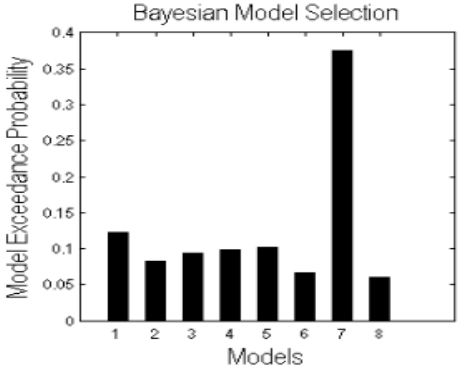
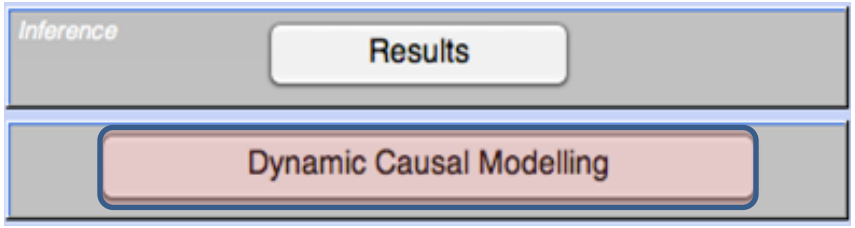
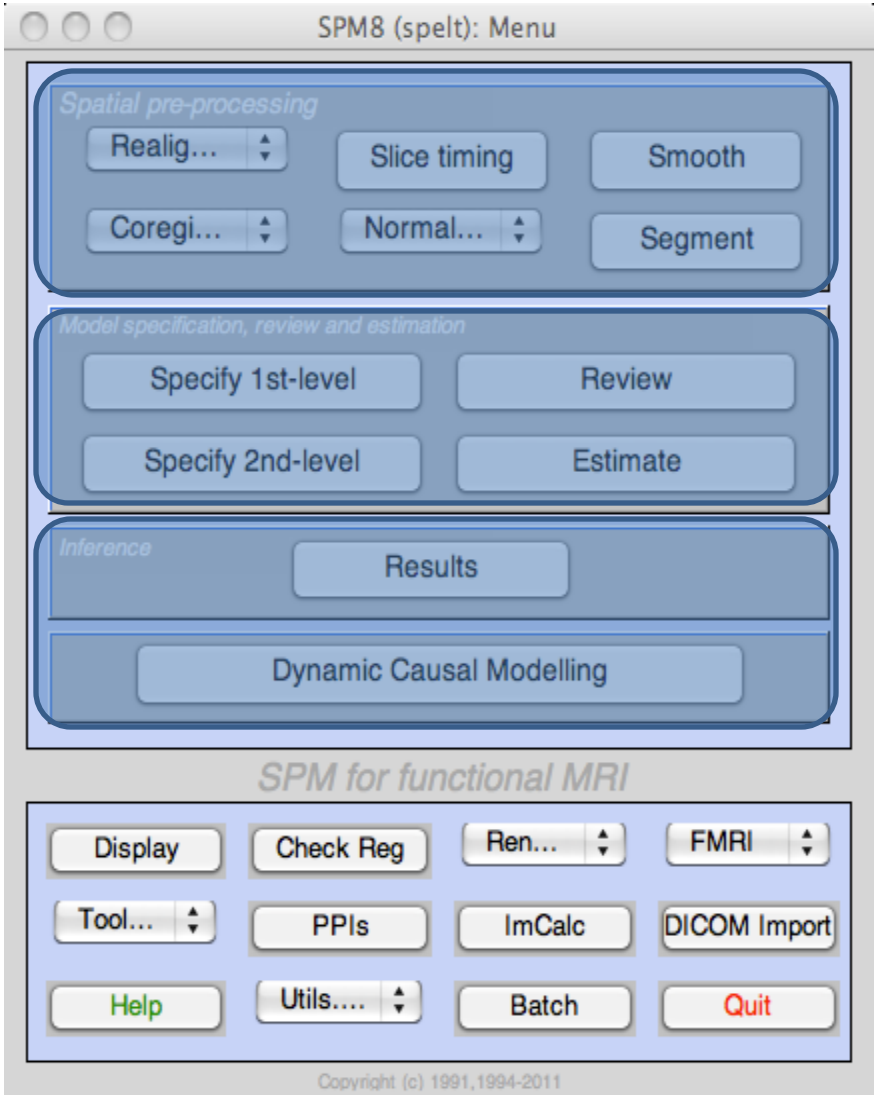

Bayesian Model Selection
Model Exceedance Probability
Models


Inference
Results
Dynamic Causal Modelling

Other Tools


SPM8 (spelt): Menu
Spatial pre-processing
Realig...
Slice timing
Smooth
Coregi...
Normal...
Segment
Model specification, review and estimation
Specify 1st-level
Review
Specify 2nd-level
Estimate
Inference
Results
Dynamic Causal Modelling
SPM for functional MRI
Display
Check Reg
Ren...
FMRI
Tool...
PPIs
ImCalc
DICOM Import
Help
Utils....
Batch
Quit
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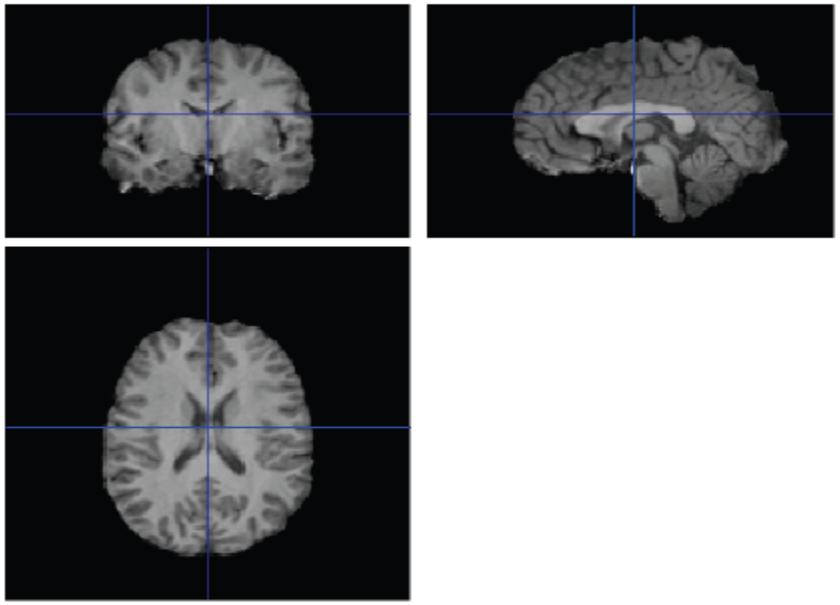
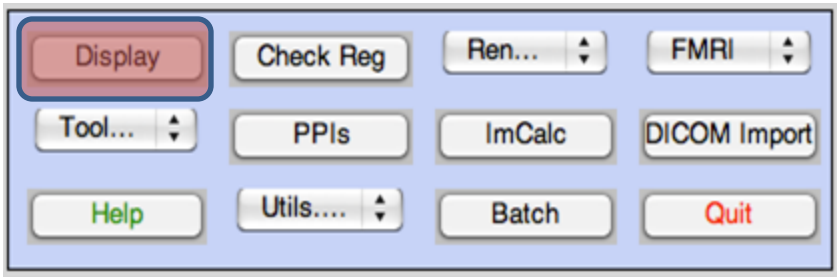
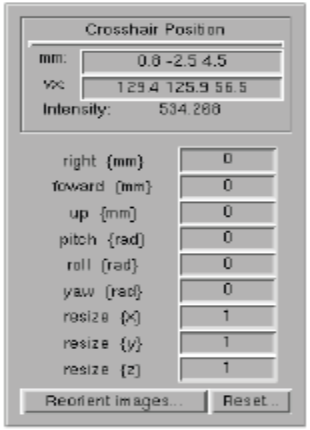
Other Tools

- Display
  - Change world space and/or origin
  - Displays image with orthogonal sections

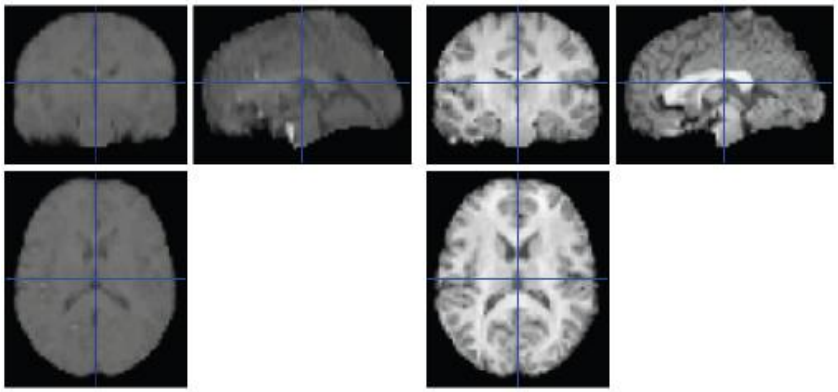


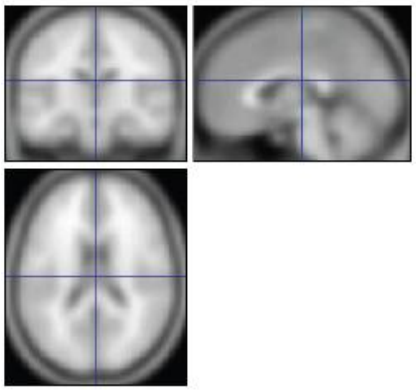


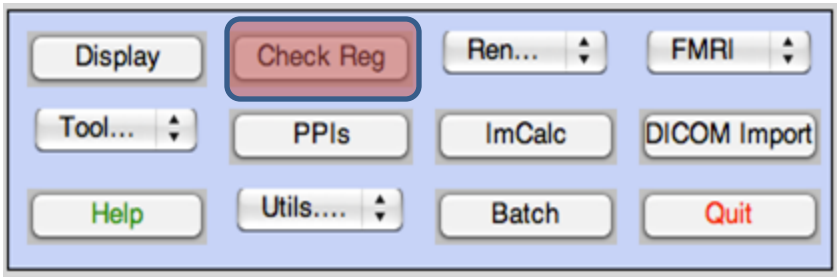


Other Tools

- Check Reg.
  - Displaying more than one image
  - alignment of images
  - All images will be displayed in the space of the first image (MNI)

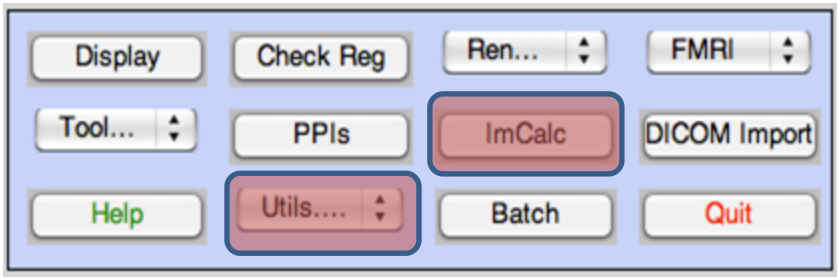




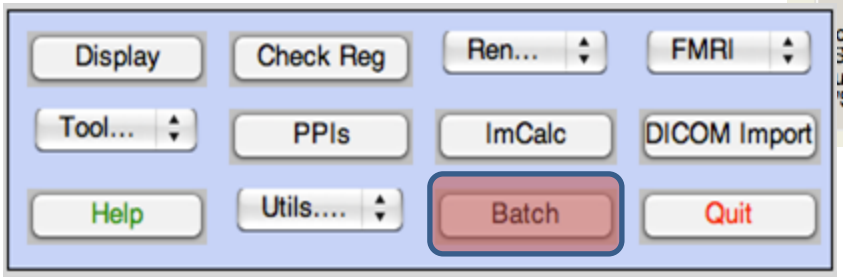


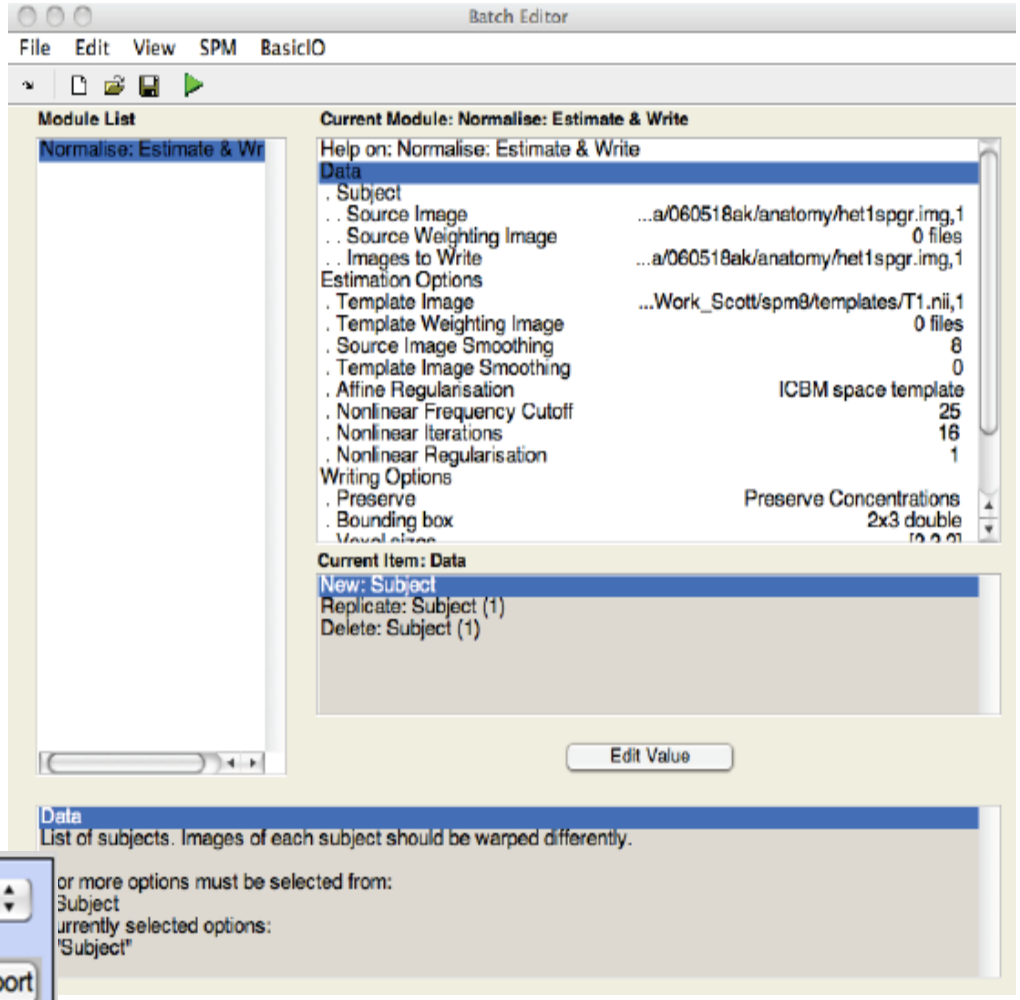
Other Tools

- ImCalc
  - Image calculator
  - Give one or more images, perform MATLAB arithmetic such as mean value
- Utils
  - Delete files
  - Change directory
  - Results are written to current directory



Batch Editor





Resources

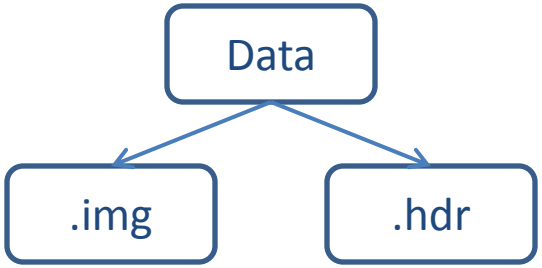
- SPM*web site:* ***http://www.fil.ion.ucl.ac.uk/spm/***
  - SPM: Introduction
  - Free : SPM2, SPM5, SPM8
  - Courses are available around the world
  - Forum list
- MRIcro
  - MRIcro: http://www.cabiatl.com/mricro/
  - Complementary with SPM
  - Easy to learn

Alternative

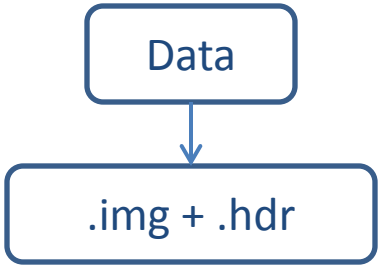
- FSL: http://www.fmrib.ox.ac.uk/fsl
  - Open source, you can change the code for your requirement
  - Can be used for fMRI and DTI
  - Free
- AFNI: http://afni.nimh.nih.gov
  - Open source, you can change the code for your requirement
  - Free
- BrainVoyager: http://www.brainvoyager.com
  - Closed source, you are not able to change the code
  - Great visualization
  - Not free, ~$5k

Image Format

- Data format
  - Analyzing format

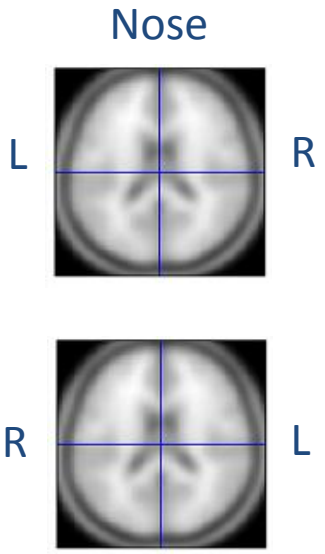


  - NIFTI format
    - Transformation of the world space is coded in NIFTI header



Important Issue

- Is Left Right?
  - Neurological
    - Standing behind a subject
    - Right is right side of the subject
  - Radiological
    - Standing in front of a subject
    - Right is left side of the subject
  - Neurological convention has been always used in SPM



Thank You!

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