BAYESIAN MODEL SELECTION AND AVERAGING

STEFAN FRÄSSLE

TRANSLATIONAL NEUROMODELING UNIT (TNU)
UNIVERSITY OF ZURICH & ETH ZURICH

Methods and Models for fMRI Analysis (HS 2018)

Practical Session

Zurich, November 27, 2018

Today's Tutorial

Bayesian model selection and averaging:

- Brief teaser into Dynamic Causal Models (DCMs), representing the class of models we aim to compare and average today

- Fixed- and random-effects Bayesian model selection (BMS)

- Bayesian model averaging (BMA)

Translational Neuromodeling Unit

University of Zurich UZH

ETH
Eidgenössische Technische Hochschule Zürich
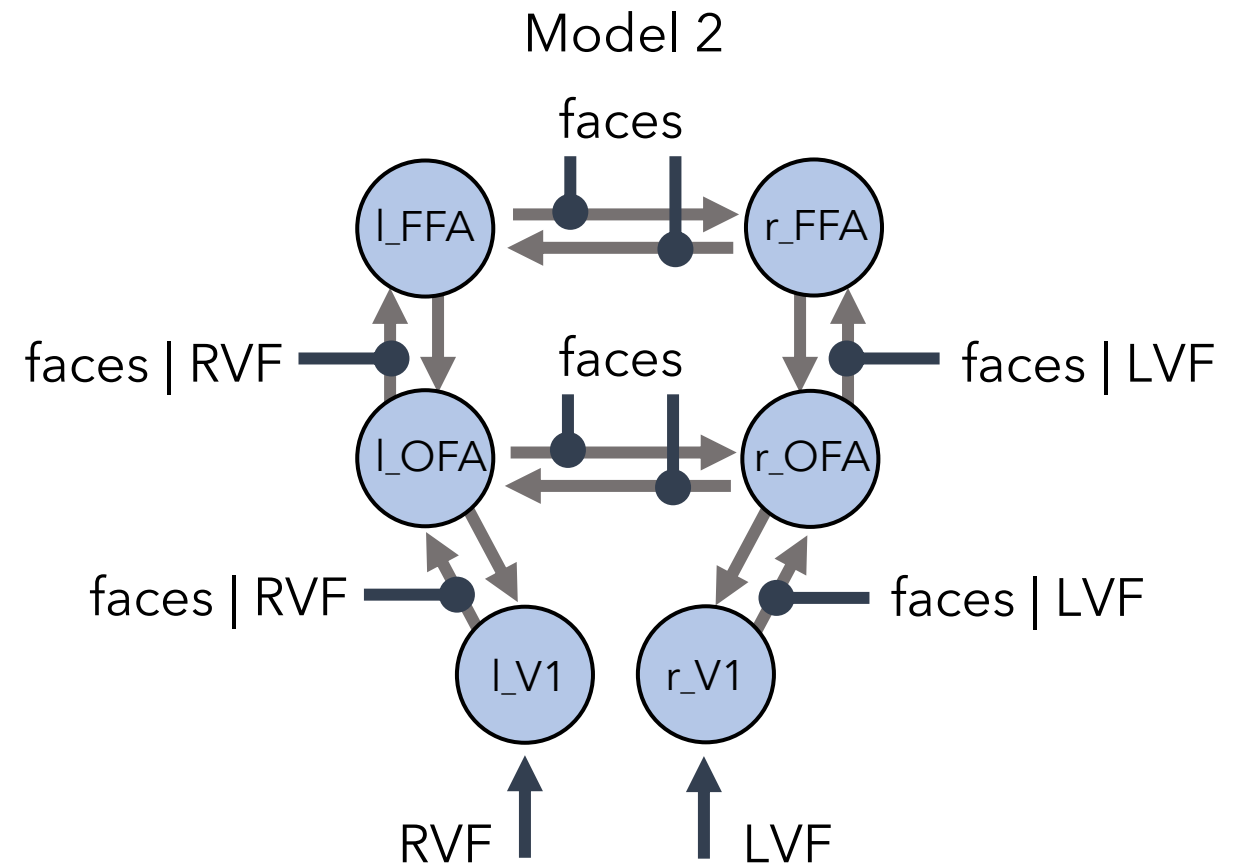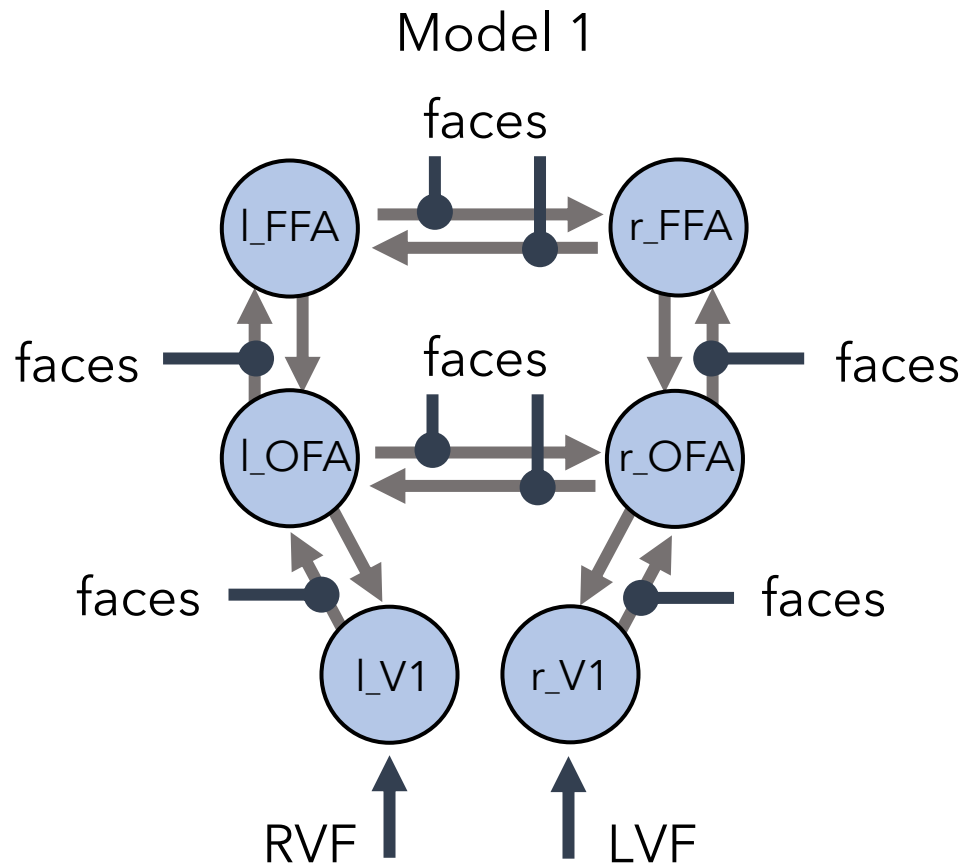Swiss Federal Institute of Technology Zurich

Teaser: DCM for FMRI

FYI: a more detailed introduction to the generative model of DCM will follow in two weeks
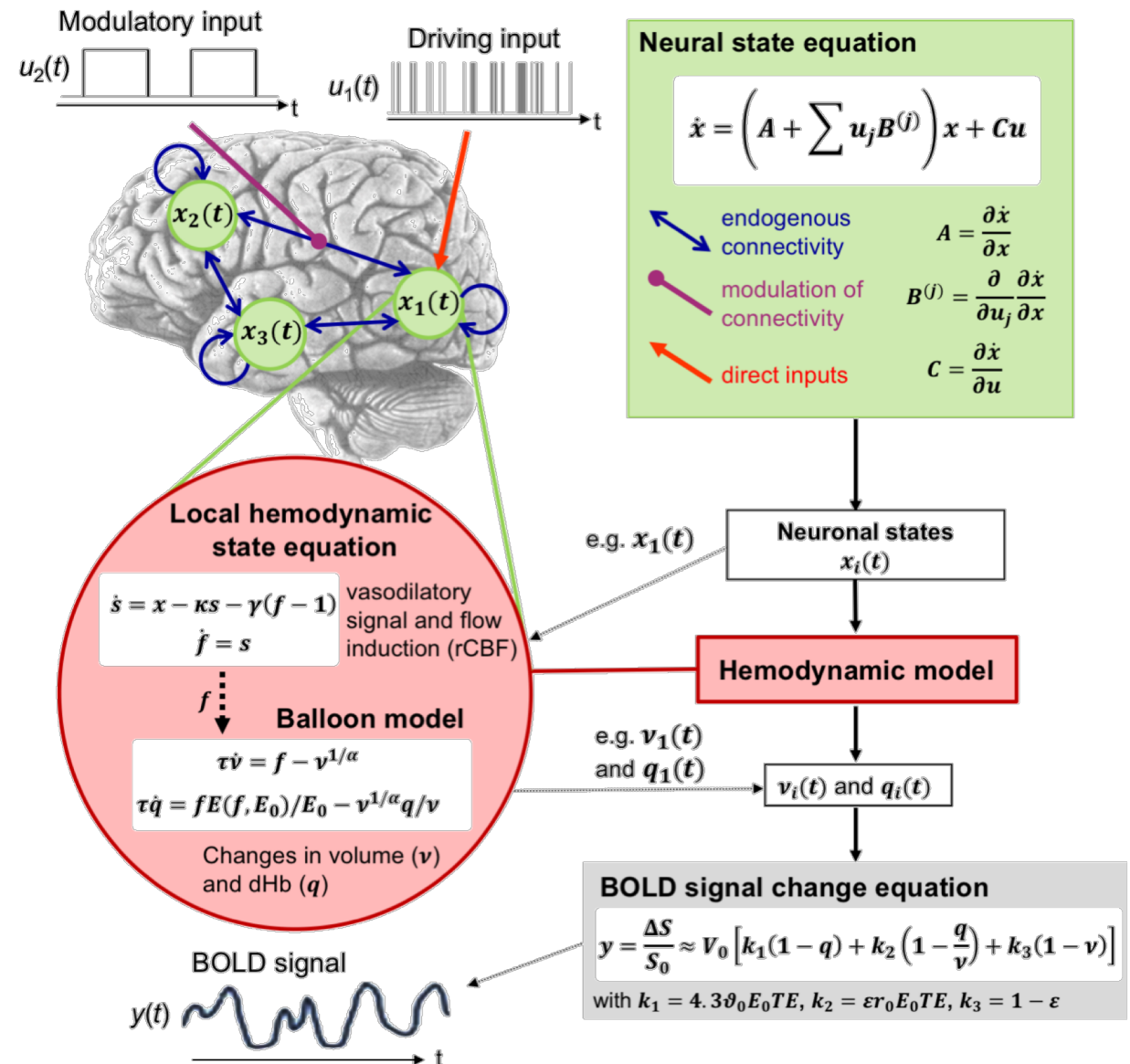
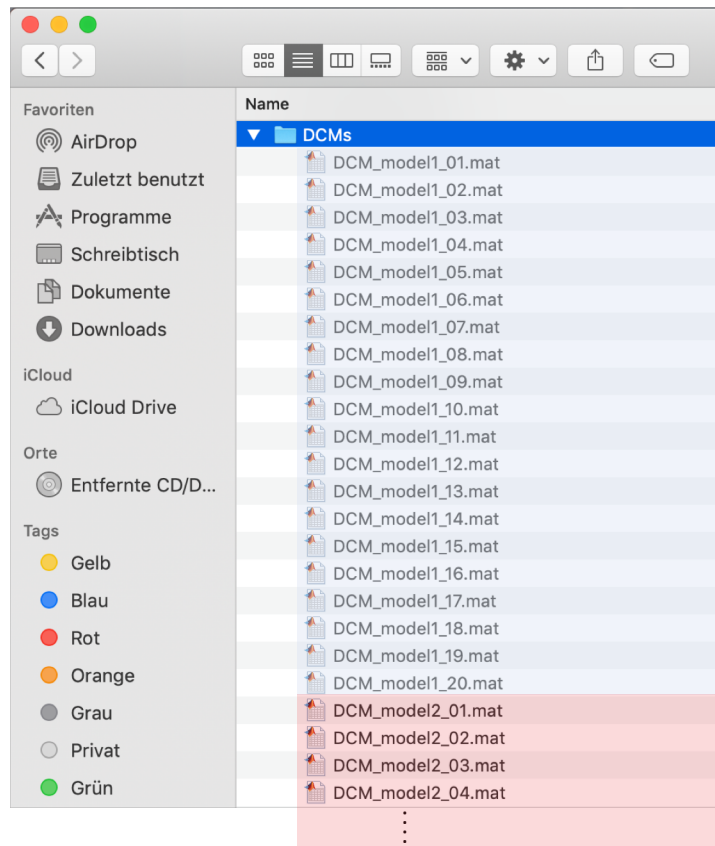Friston et al., 2003, *NeuroImage*; Stephan et al., 2015, *Neuron*

Dynamic Causal Modeling

Different mechanisms in the face perception network:

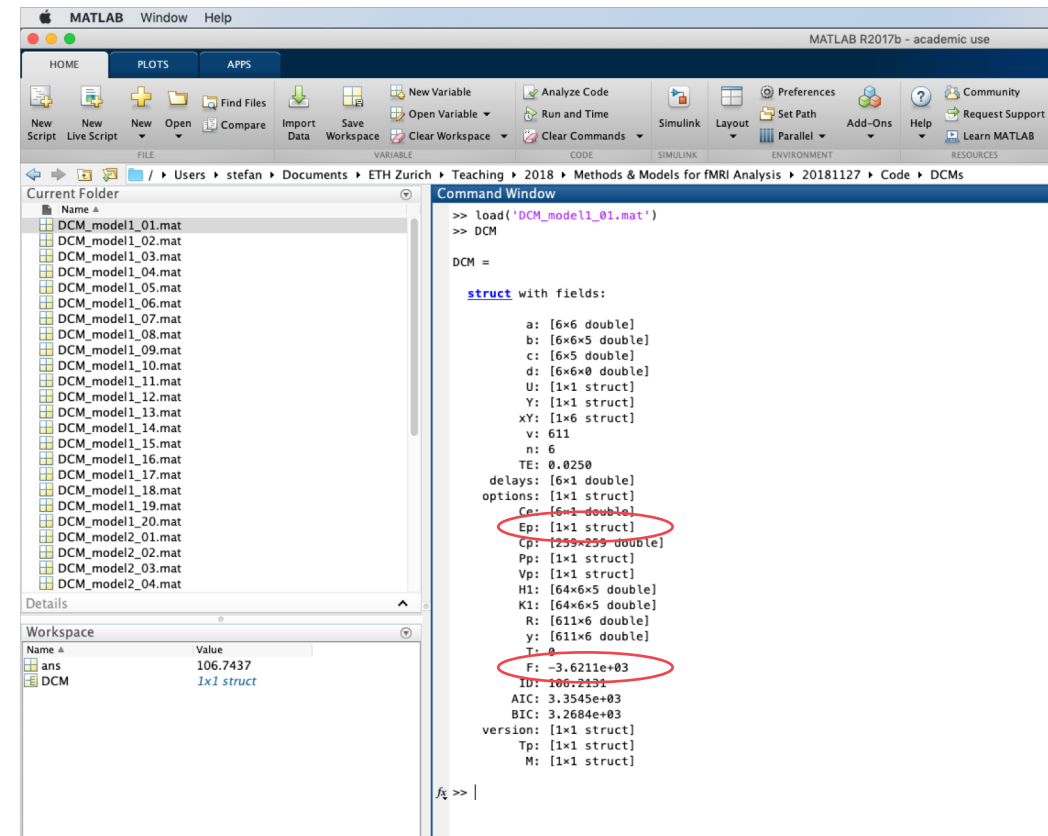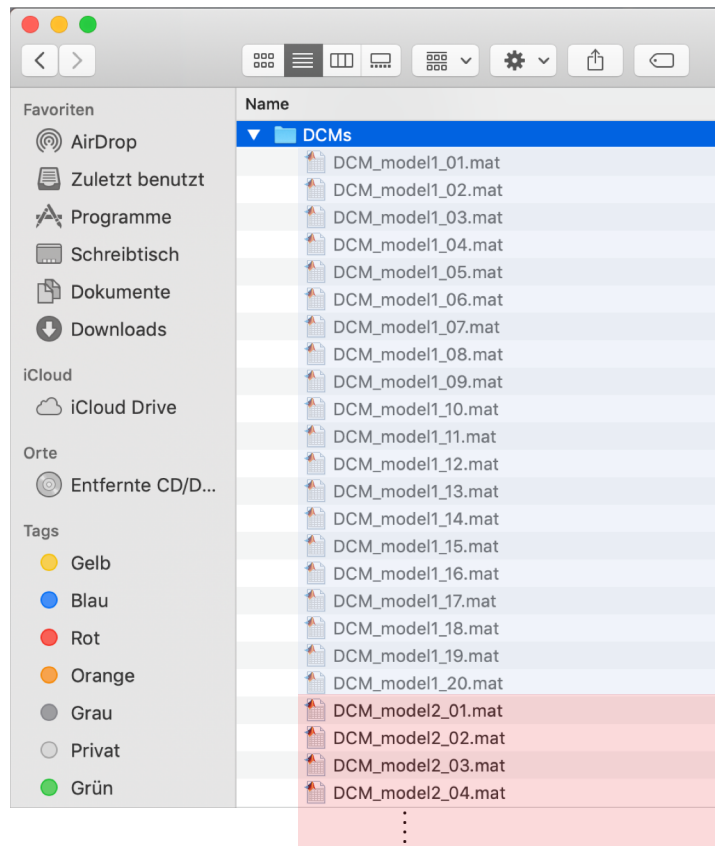# ORGANIZATION OF DATA

Data is stored in "**DCM_model*.mat**" files:

ORGANIZATION OF DATA

Data is stored in "**DCM_model*.mat**" files:

TRY TO SET UP A FIXED-EFFECTS BMS ANALYSIS

Implement the following two analyses:

(1) Compute the individual log Bayes factors and plot the results. You should write your own MATLAB code for this. The negative free energies serve as our metric of model goodness and are stored in the "**DCM.F**" field.

(2) Perform fixed-effects Bayesian model selection by computing the Group Bayes factor and/or the posterior model probabilities. You can either use the SPM GUI or write your own code. What do you notice when comparing the results from (1) and (2)?

TRY TO SET UP A FIXED-EFFECTS BMS ANALYSIS

Reminder: **Bayes factors** and **Group Bayes Factors**:

$$BF_{ij} = \frac{p(y|m_i)}{p(y|m_j)} \longrightarrow \log(BF_{ij}) = \log(p(y|m_i)) - \log\left(p(y|m_j)\right)$$

$$GBF_{ij} = \prod_k BF_{ij}^{(k)} = \prod_k \frac{p(y_k|m_i)}{p(y_k|m_j)} \longrightarrow \log(GBF_{ij}) = \sum_k \log\left(BF_{ij}^{(k)}\right)$$

Kass & Raftery, 1995, *J. Am. Stat. Assoc.*

Translational Neuromodeling Unit

University of ZurichUZH

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

TRY TO SET UP A FIXED-EFFECTS BMS ANALYSIS

(1) Implementation of individual log Group Bayes factor:

(2) Implement fixed-effects Bayesian model selection:

Implement the following analysis:

(1) Perform random-effects Bayesian model selection by computing the protected exceedance probability. You can either use the SPM GUI or write your own code (*Hint: when writing your own code, use to function "spm_BMS.m"*). What do you notice when comparing the results with the FFX-BMS results from before?
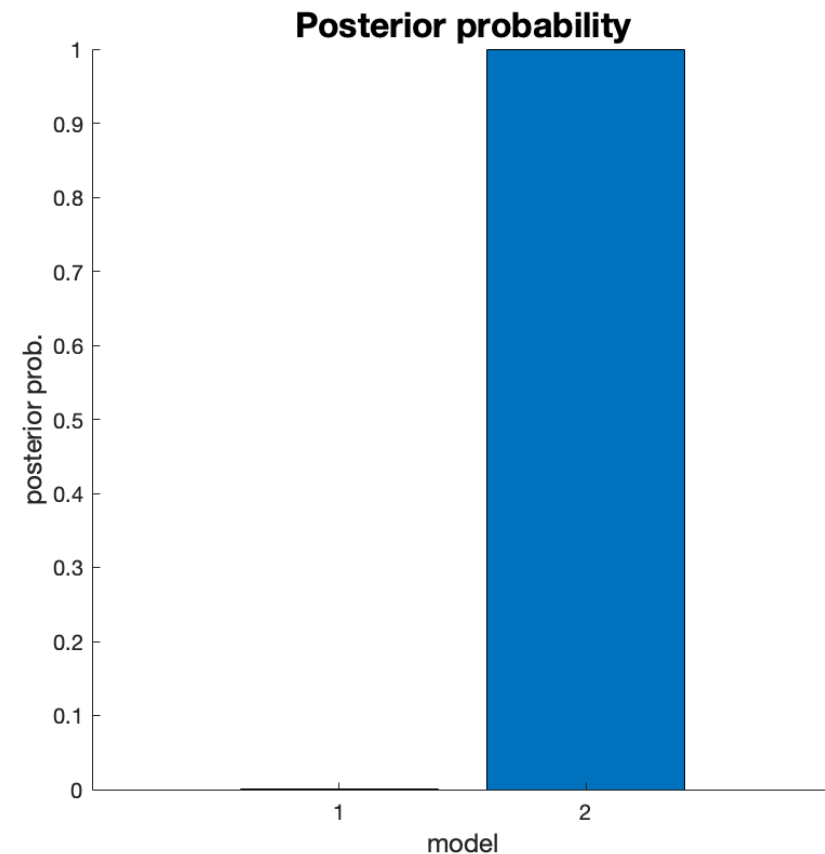
TRY TO SET UP A RANDOM-EFFECTS BMS ANALYSIS

(1) Implement random-effects Bayesian model selection:
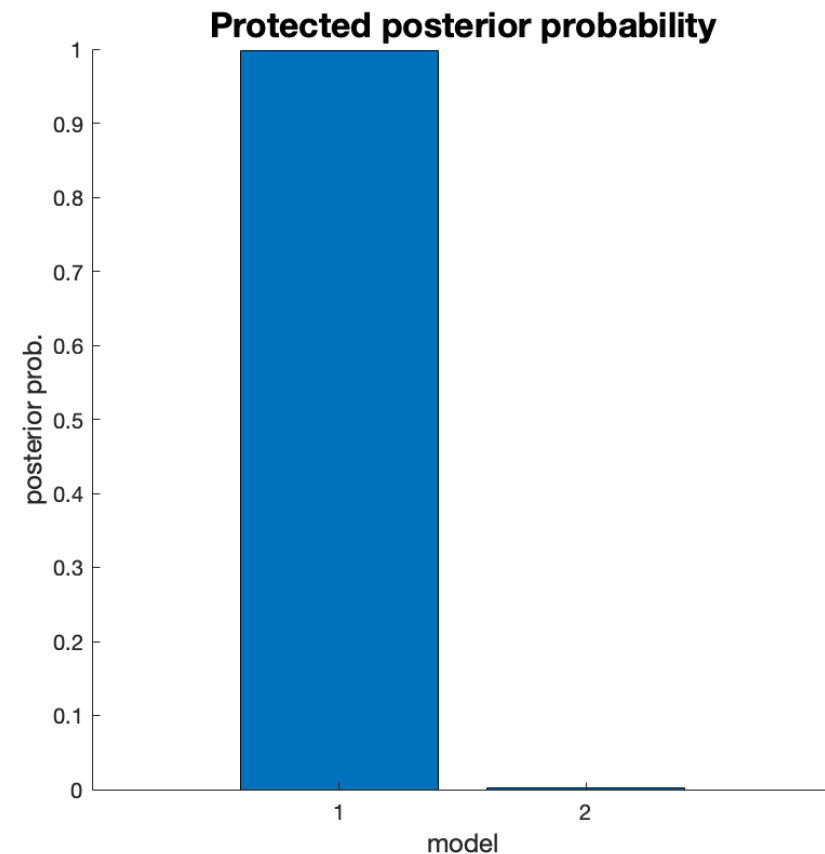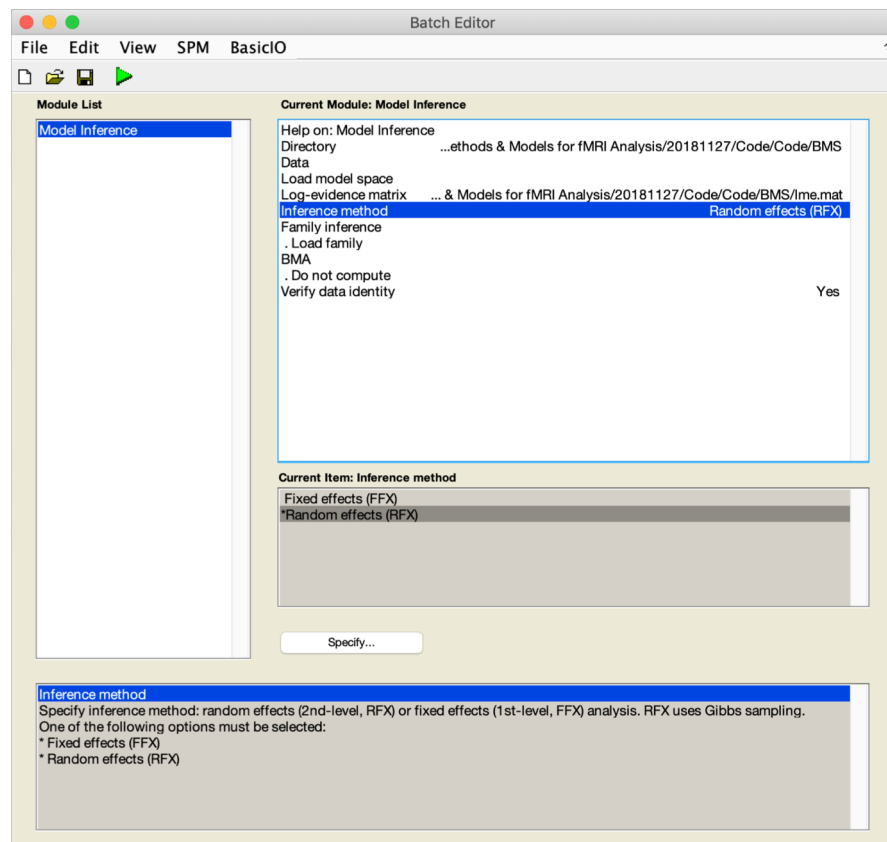
FOLLOWING SLIDES WERE NOT COVERED
IN PRACTICAL SESSION

Implement the following analysis:

(1) Perform random-effects Bayesian model averaging and compute the BMA posterior over model parameters. You can either use the SPM GUI or write your own code (*Hint: when writing your own code, use the functions "spm_BMS_gibbs.m" and "spm_dcm_bma.m"*).

(2) Bonus: Test for which of the parameters, the connection strength of an "average" subject differs from zero. For this, use the group-level BMA results (*which are stored in mEp and sEp*) from step (1) to compute, for each connection, the posterior probability that the connection strength differs from zero.

TRY TO SET UP A RANDOM-EFFECTS BMA ANALYSIS

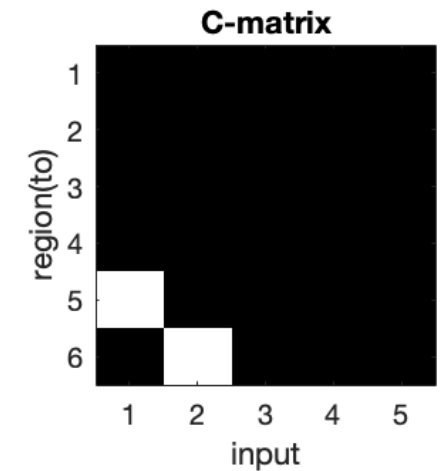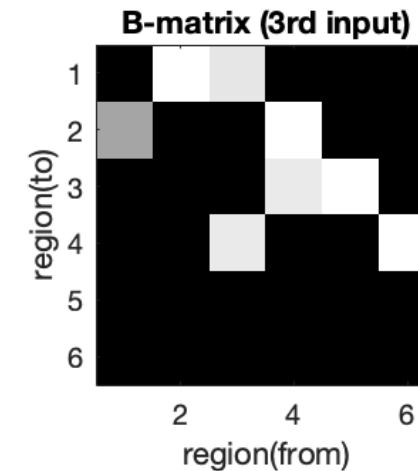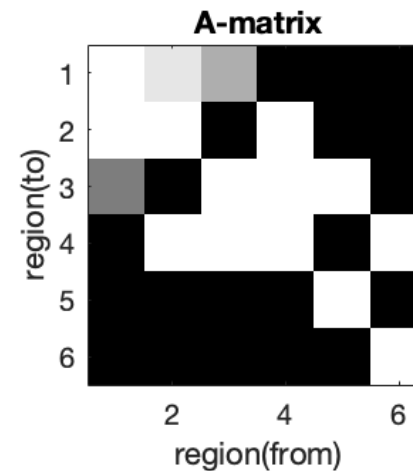(1) Implement random-effects Bayesian model averaging:
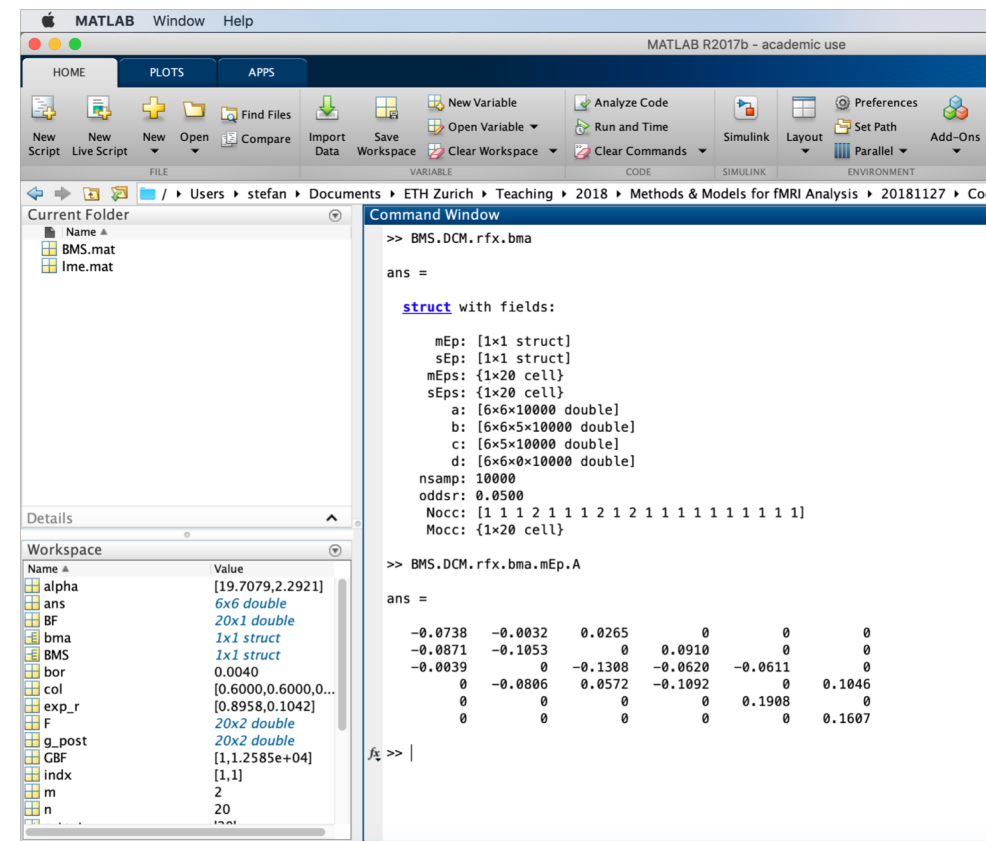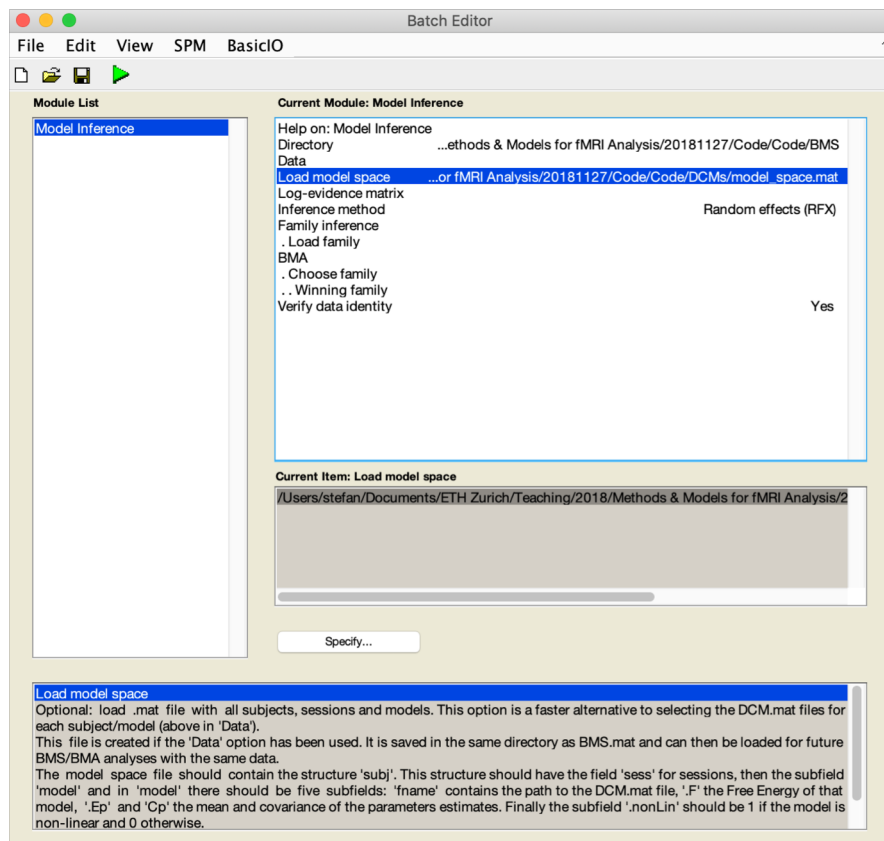
TRY TO SET UP A RANDOM-EFFECTS BMA ANALYSIS

(2) Evaluate the posterior probability of each connection:

QUESTIONS

REGARDING LECTURE OR PRACTICAL SESSION

?

THANK YOU FOR YOUR ATTENTION !

Stefan Frässle, PhD

Translational Neuromodeling Unit (TNU)

University of Zurich & ETH Zurich

Email: stefanf@biomed.ee.ethz.ch

Phone: +41 44 634 91 14

@stefan_fraessle