Computational Psychiatry Course – Zürich 2015

Behavioural DCM *in practice*

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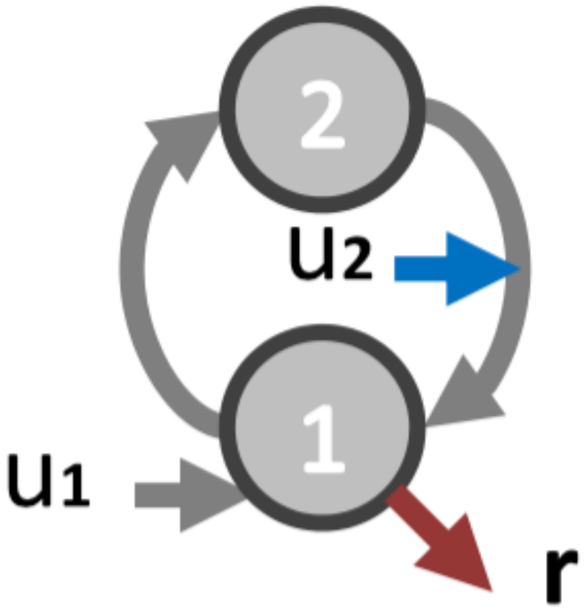
Outline

- Preparing the data
  - Extracting ROI time series
  - Behavioural responses and resampling
  - Defining the inputs
- Specifying the model
  - DCM connectivity
  - Behavioural mapping
  - Behavioural response transformation
- Model simulation & inversion
  - Sources and hyperpriors
  - Wrapping up
- Model Simulation and analysis
  - Artificial lesions
  - Susceptibility analysis



Preparing the data

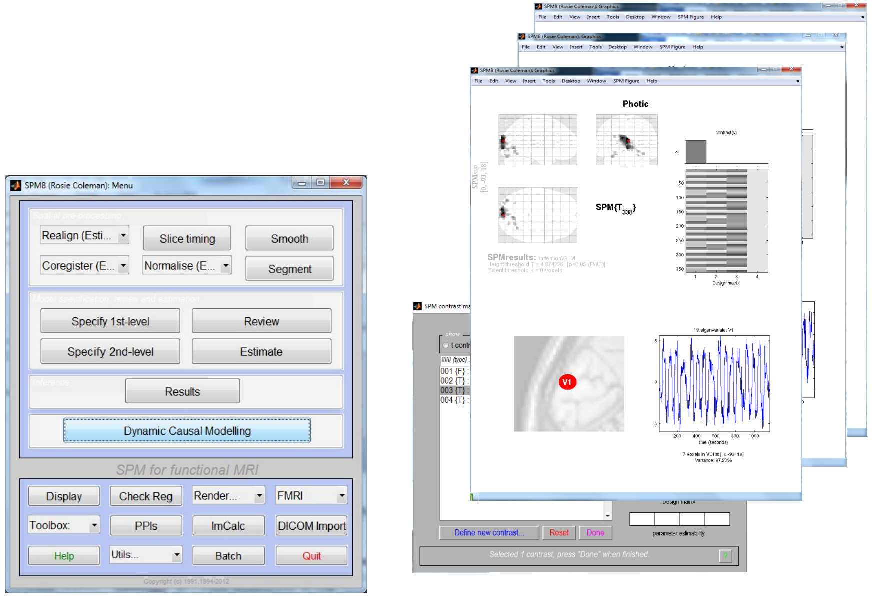
Extracting timeseries

From a DCM specified in SPM:

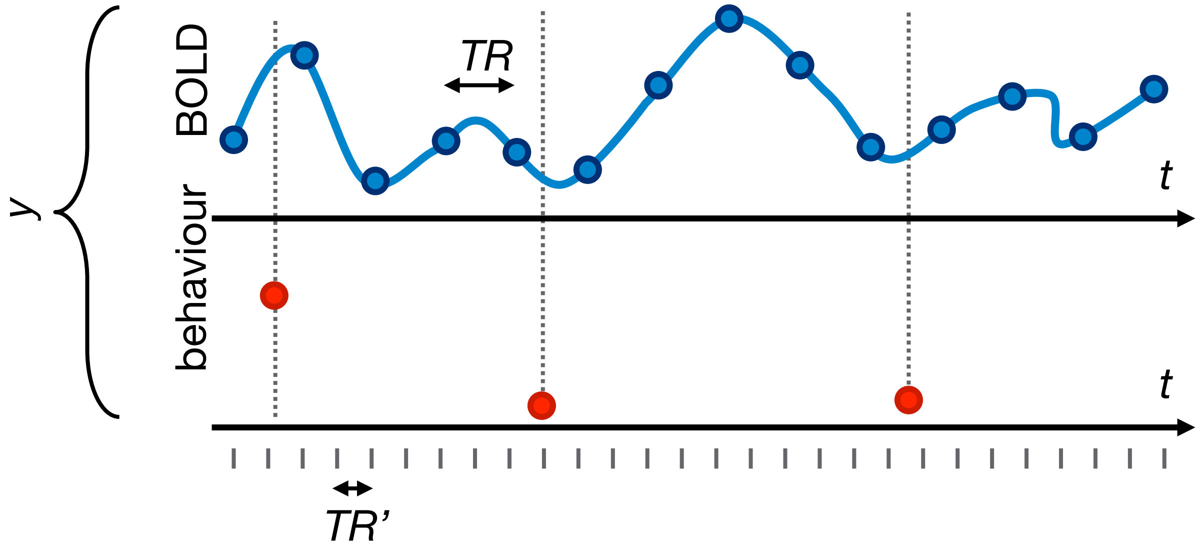
- DCM.y’

Using SPM:

- Define your ROI
- Extract 1st eigenvariate
- Adjust for effect of interest
- Save



Preparing the data



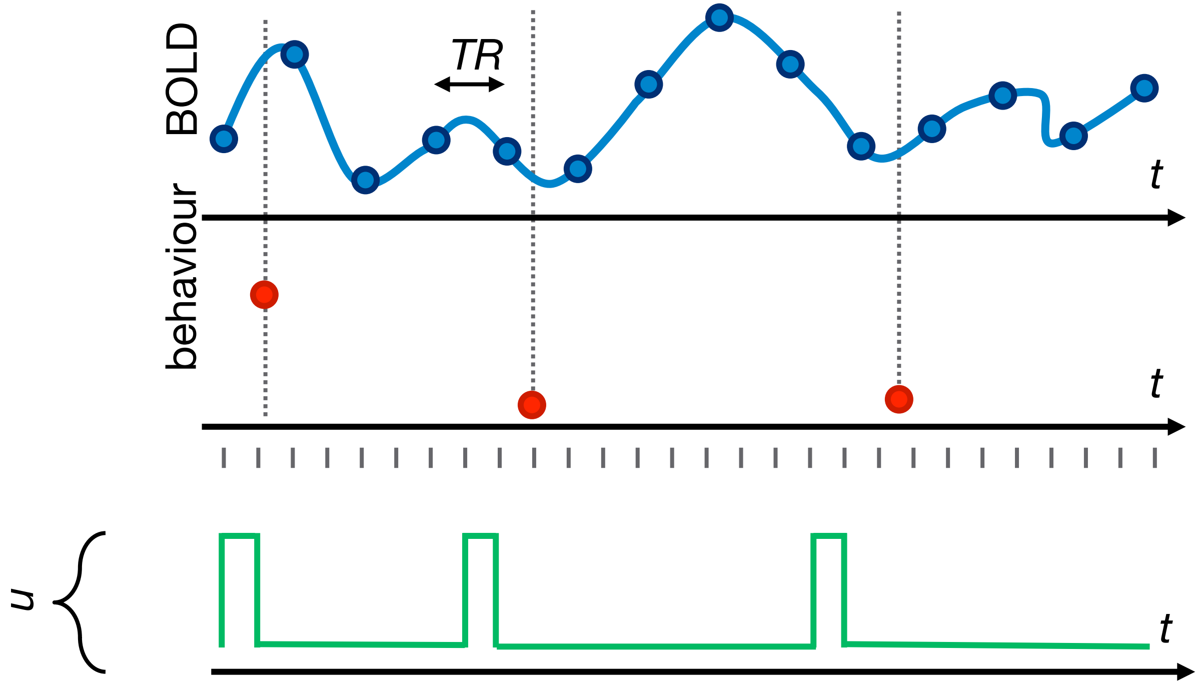
In practice

- Resample BOLD and behaviour at the same frequency (eg. TR/4 or TR/20)
- Fill in missing value with NaNs
- Store in one matrix $y = [y\_bold \; ; \; y\_resp]$

Tips

- Increasing the frequency will slow down the inversion
- Response predictor is smoothed by a kernel: round to the next timestep

Preparing the data



In practice

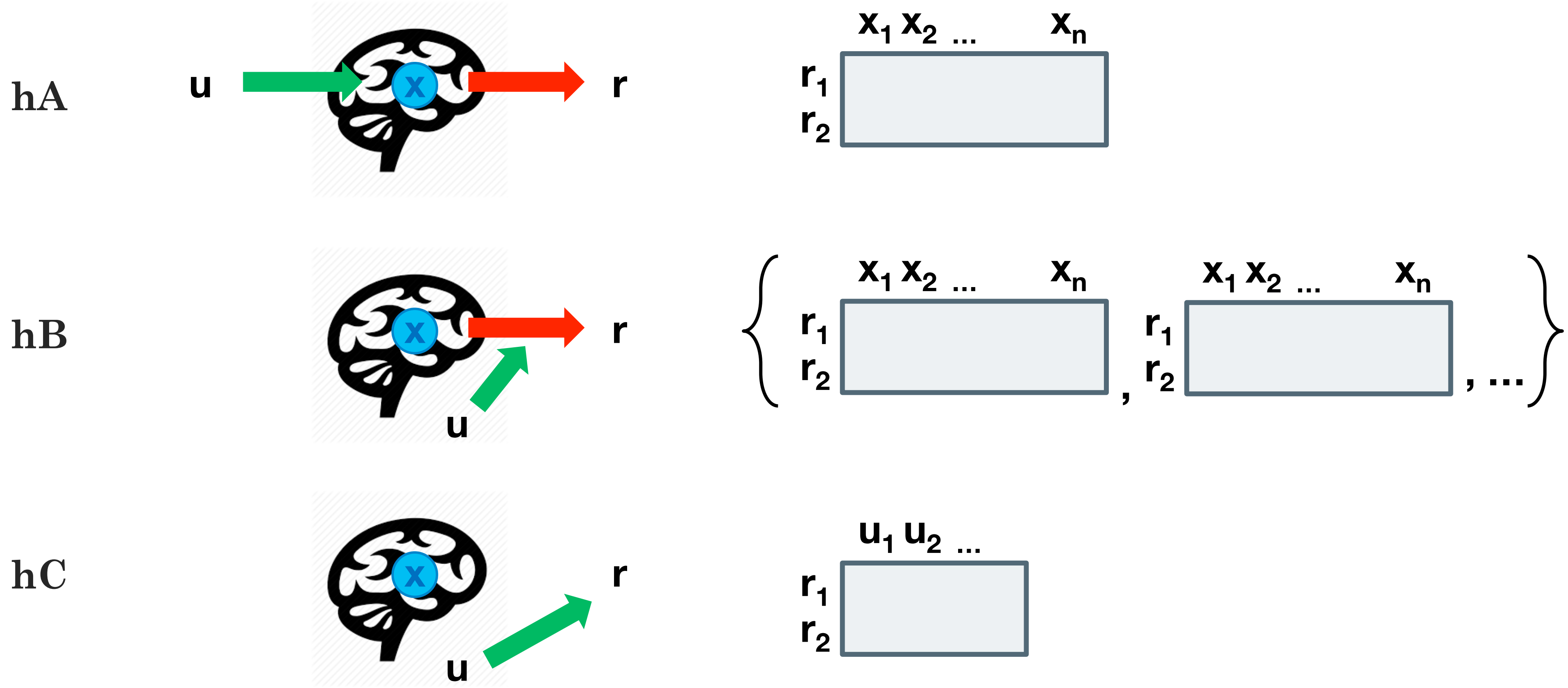
- You can use DCM.U.u'
- Resample the inputs:
  - at the same frequency as y
  - at the microtime resolution DCM.U.dt

Specifying the model

Define the brain connectivity model

A = DCM.a	intrinsic connectivity
B = DCM.b	modulatory influences
C = DCM.c	inputs
D = DCM.d	quadratic effects

Specifying the model



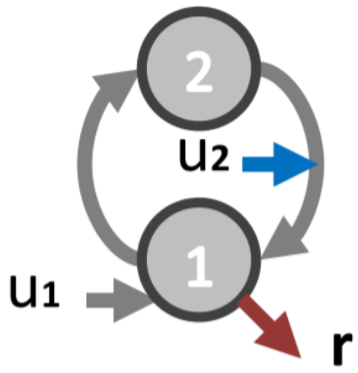
Specifying the model

Define the brain connectivity model

A = DCM.a	intrinsic connectivity
B = DCM.b	modulatory influences
C = DCM.c	inputs
D = DCM.d	quadratic effects

Define the behavioural mapping

hA	neuro-behavioural mapping
hB	neural modulation of inputs
hC	direct input



$$A = \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix}$$

$$B_2 = \begin{pmatrix} 0 & -1 \\ 0 & 0 \end{pmatrix}$$

$$C = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

$$hA = \begin{pmatrix} 1 & 0 \end{pmatrix}$$

Specifying the model

Define the behavioural transformation

- Dynamics of the bDCM is computed by the evolution function *f_DCMwHRFext*

$$\begin{bmatrix} x \\ r \end{bmatrix} = f\left(\begin{bmatrix} x \\ r \end{bmatrix}, u, \theta\right)$$

- Need to map the response predictor(s) *r* onto the response

  - sigmoid for binomial response
  - exponential for RT
  - softmax for multinomial
  - etc.

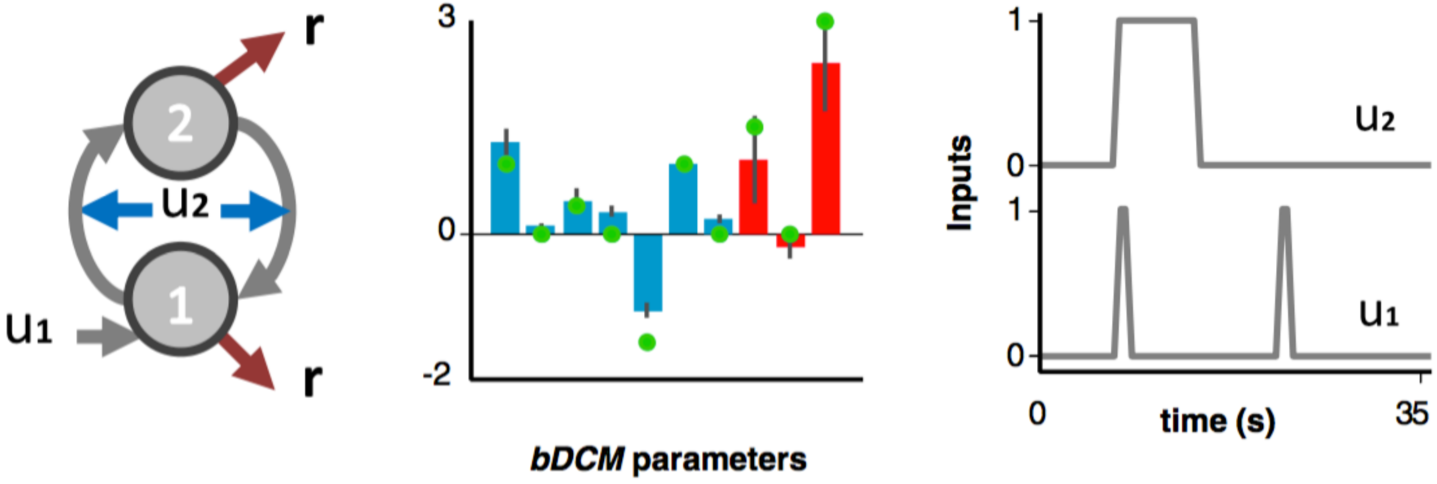
- The HRF and the response transformation must be combined into one observation function, eg. *g_DCMwHRFext*

$$\begin{bmatrix} y_{mri} \\ y_{beh} \end{bmatrix} = g\left(\begin{bmatrix} x \\ r \end{bmatrix}, u, \phi\right)$$

Model simulation

Model simulation

- Set the parameters of the connectivity and the mapping
- *y = simulateNLSS(n_t,f_fname,g_fname,theta,phi,u,alpha,sigma,options);*



Model inversion

Source specification

- Need to use the different data types differently
  - Different distributions
  - Different noise variances

  > *options.sources* to split the observations *y* into separate distributions

Hyperpriors

- All sources are influencing the inversion according to their respective precision
- Hyperpriors define the (prior) precision of Gaussian sources

> *getHyperpriors()* to set priors as a function of expected explained variance

Model inversion

You need

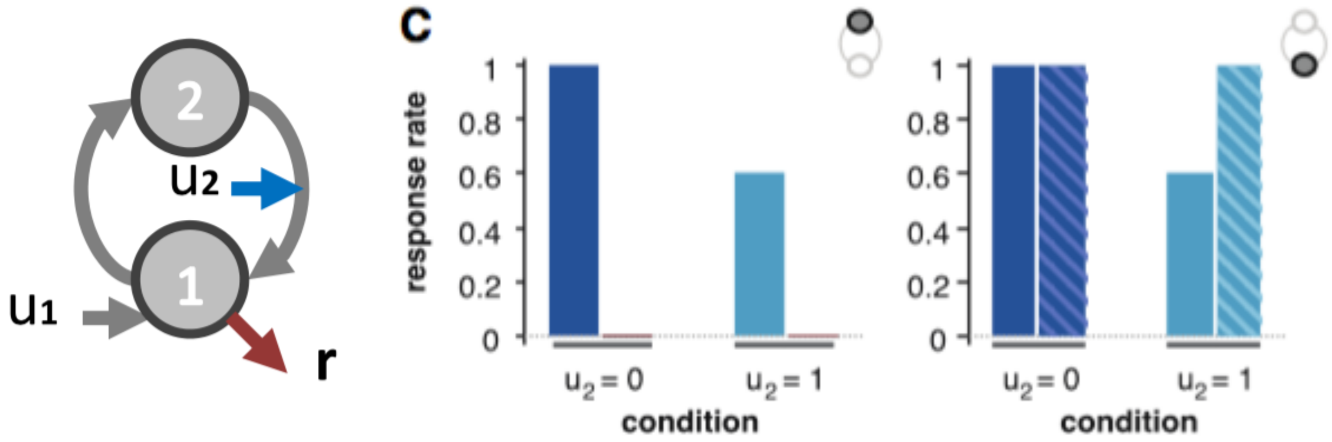
- Combined observations *y* and inputs *u*
- *options* structure containing the model definition: *prepare_fullDCM*
- Combined observation function
- Add priors to the *options*: *getPriors*
- Specify how to split the data: *options.sources*

Then run

```
[posterior,out] = VBA_NLStateSpaceModel(y,u,f_fname,g_fname,dim,options);
```

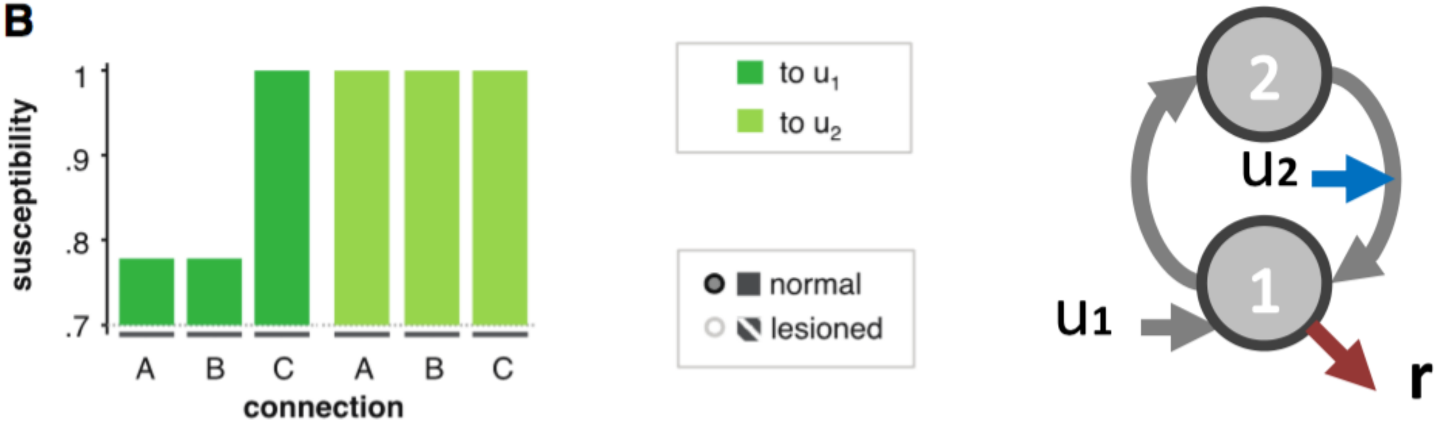
Virtual lesions

- Switch off all the afferences to a ROI and simulate the reduced model
- *res = VBA_bDCM_lesion (posterior,out);*



Susceptibility analysis

- *res = VBA_susceptibility(posterior,out);*
- *res*



Thank you