Resting state fMRI and ICA

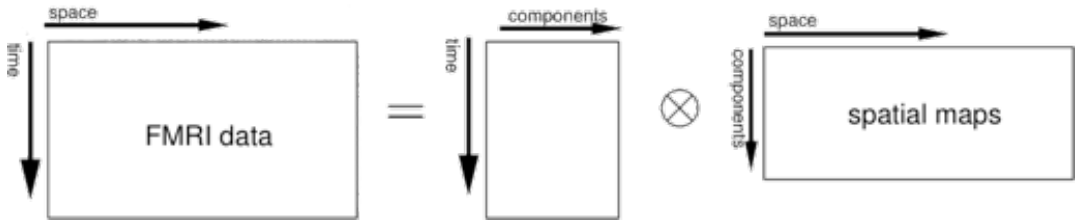
- Introduction to resting state
- Independent Component Analysis
- Single-subject ICA
- Multi-subject ICA
- Dual regression

Different ICA models

Single-Session ICA

each ICA component comprises:

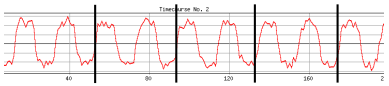
 spatial map & timecourse 

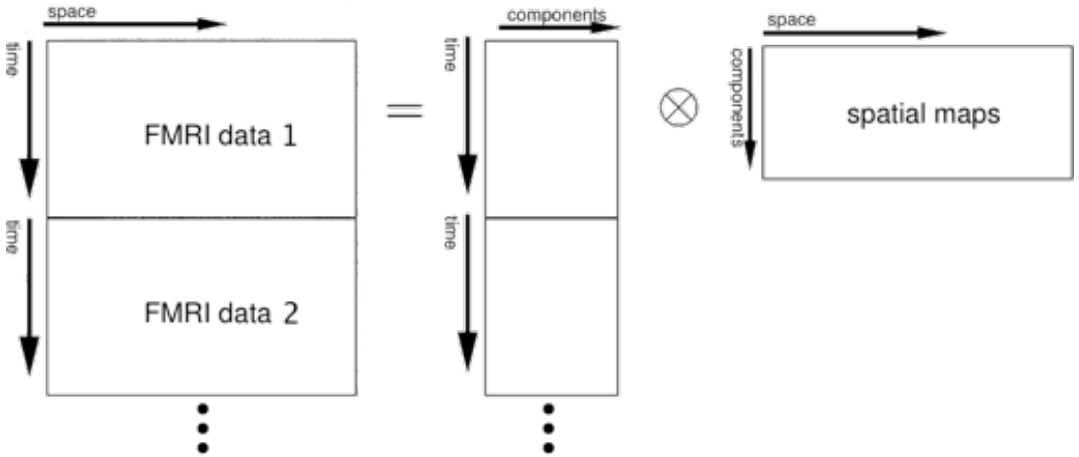


Multi-Session or Multi-Subject ICA: **Concatenation approach**

each ICA component comprises:

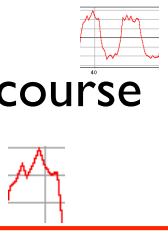
 spatial map & timecourse

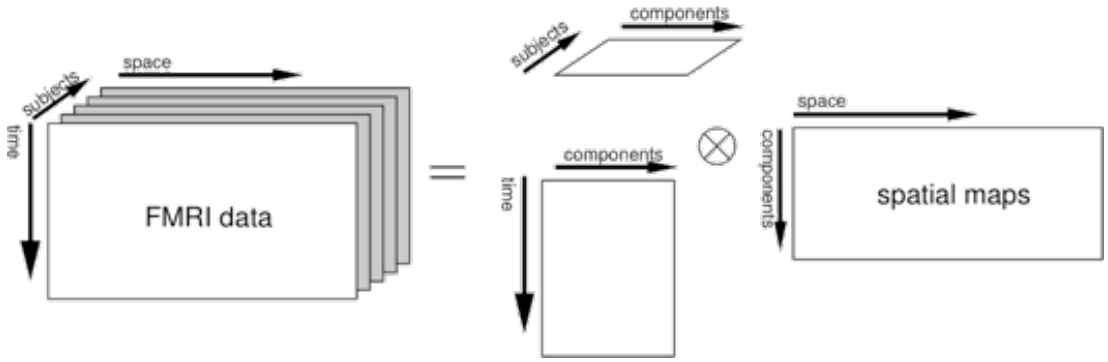
(that can be split up into subject-specific chunks) 



Multi-Session or Multi-Subject ICA: **Tensor-ICA approach**

each ICA component comprises:

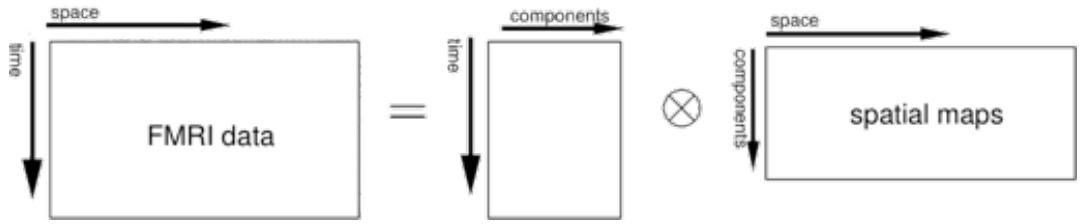
 spatial map, session-long-timecourse & subject-strength plot 



Different ICA models

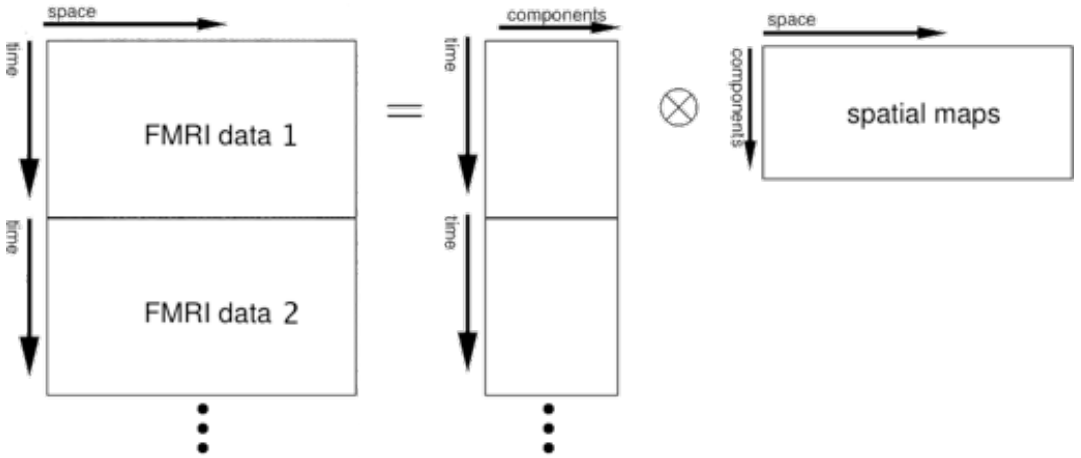
Single-Session ICA

each ICA component comprises:
spatial map & timecourse



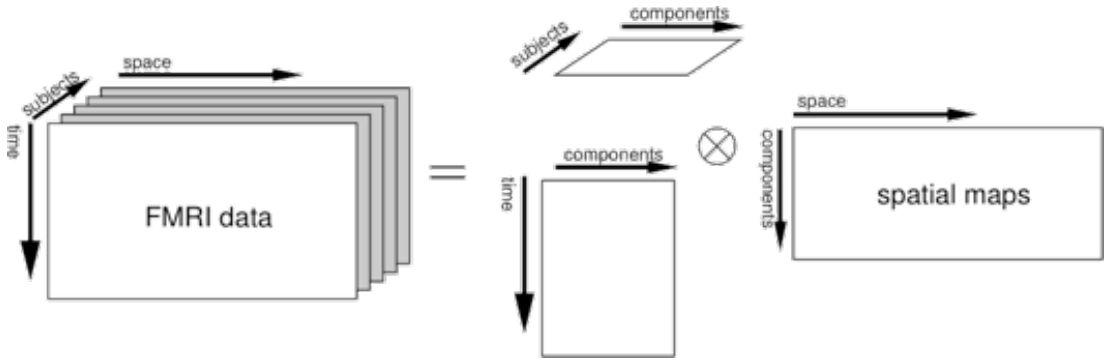
Multi-Session or Multi-Subject ICA:
Concatenation approach

good when:
each subject has DIFFERENT timeseries
e.g. resting-state FMRI



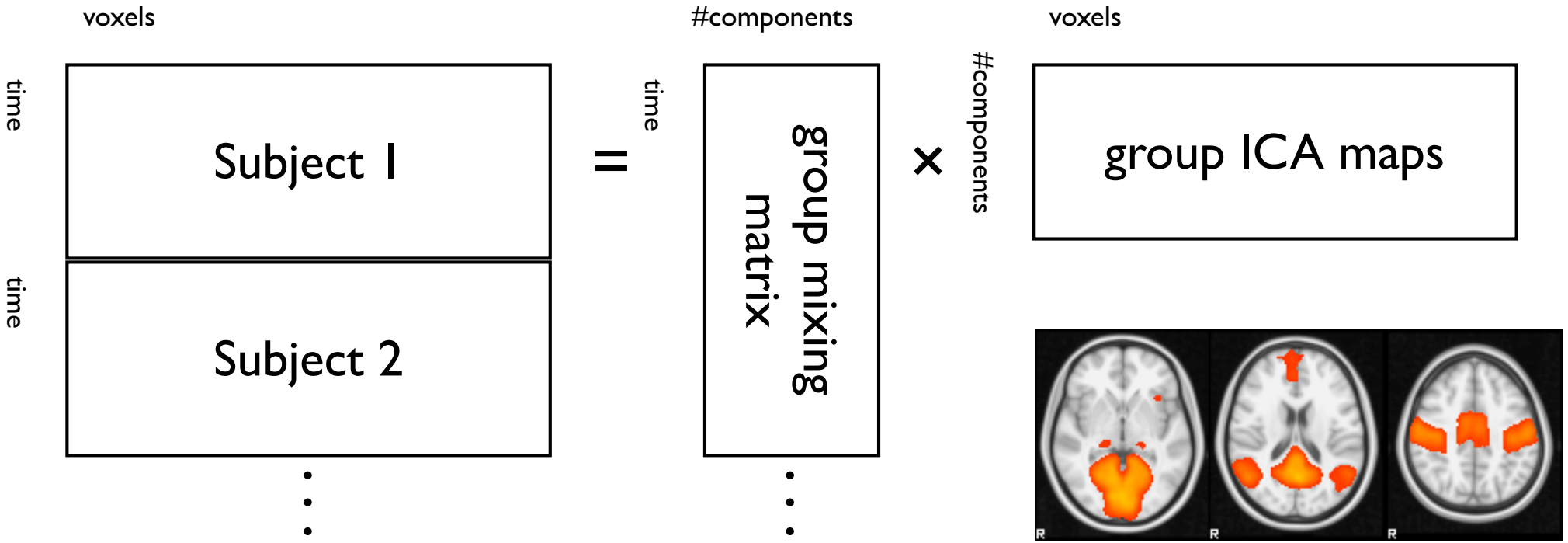
Multi-Session or Multi-Subject ICA:
Tensor-ICA approach

good when:
each subject has SAME timeseries
e.g. activation FMRI



Concatenated ICA

- Concatenate all subjects' data temporally
- Then run ICA
- More appropriate than tensor ICA (for RSNs)

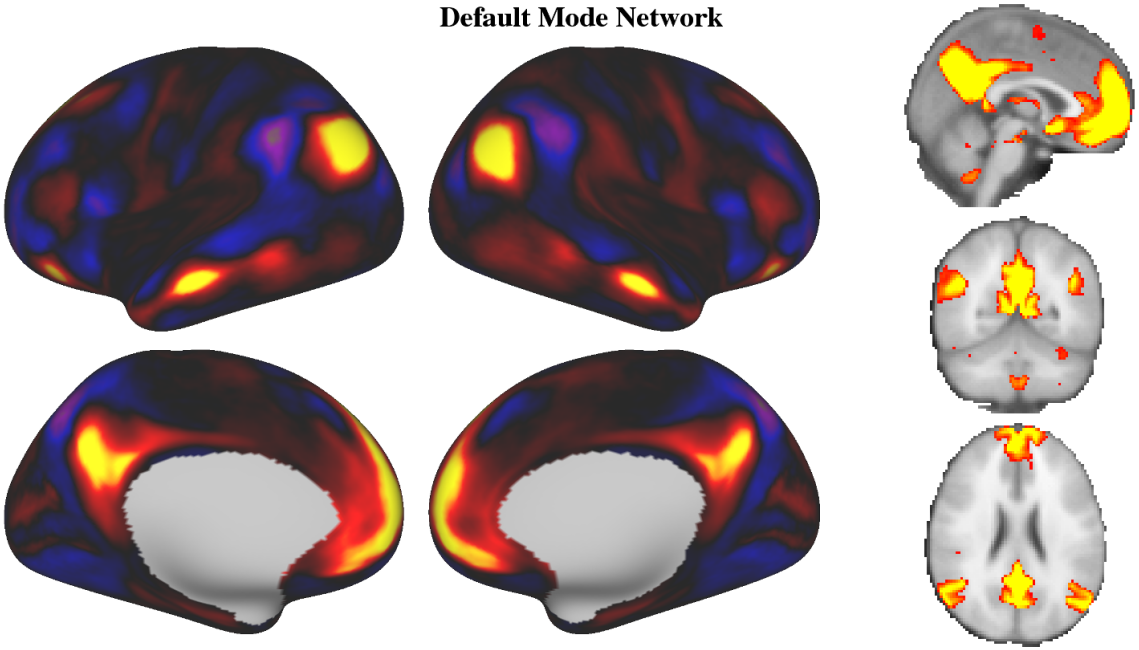


Resting state multi-subject ICA

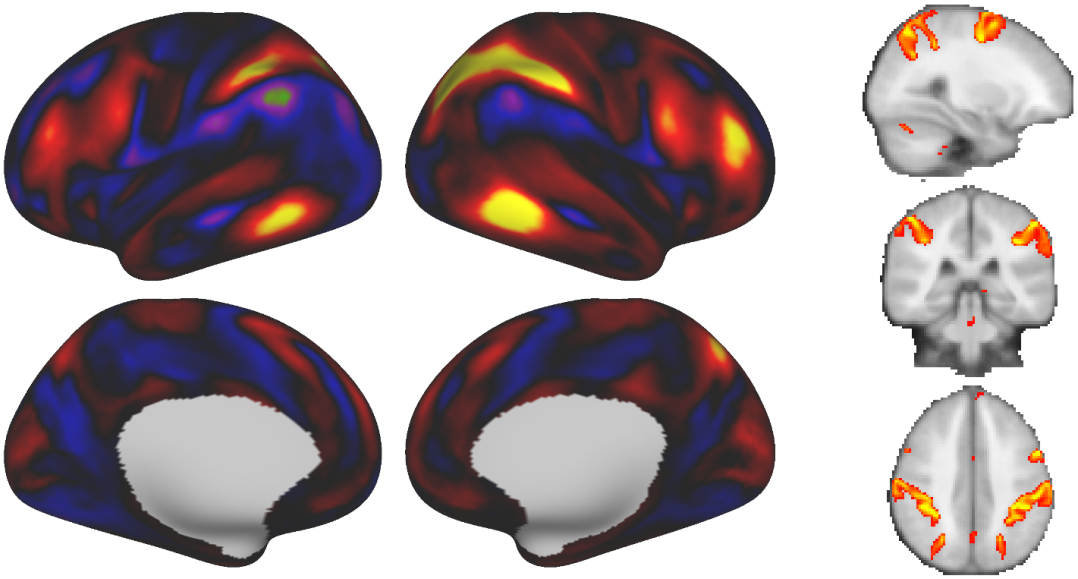
- Why not just run ICA on each subject separately?
  - Correspondence problem (eg RSNs across subjects)
  - Different splittings sometimes caused by small changes in the data (naughty ICA!)
- Instead - start with a “group-average” ICA
  - But then need to relate group maps back to the individual subjects

Resting state networks

Default Mode Network

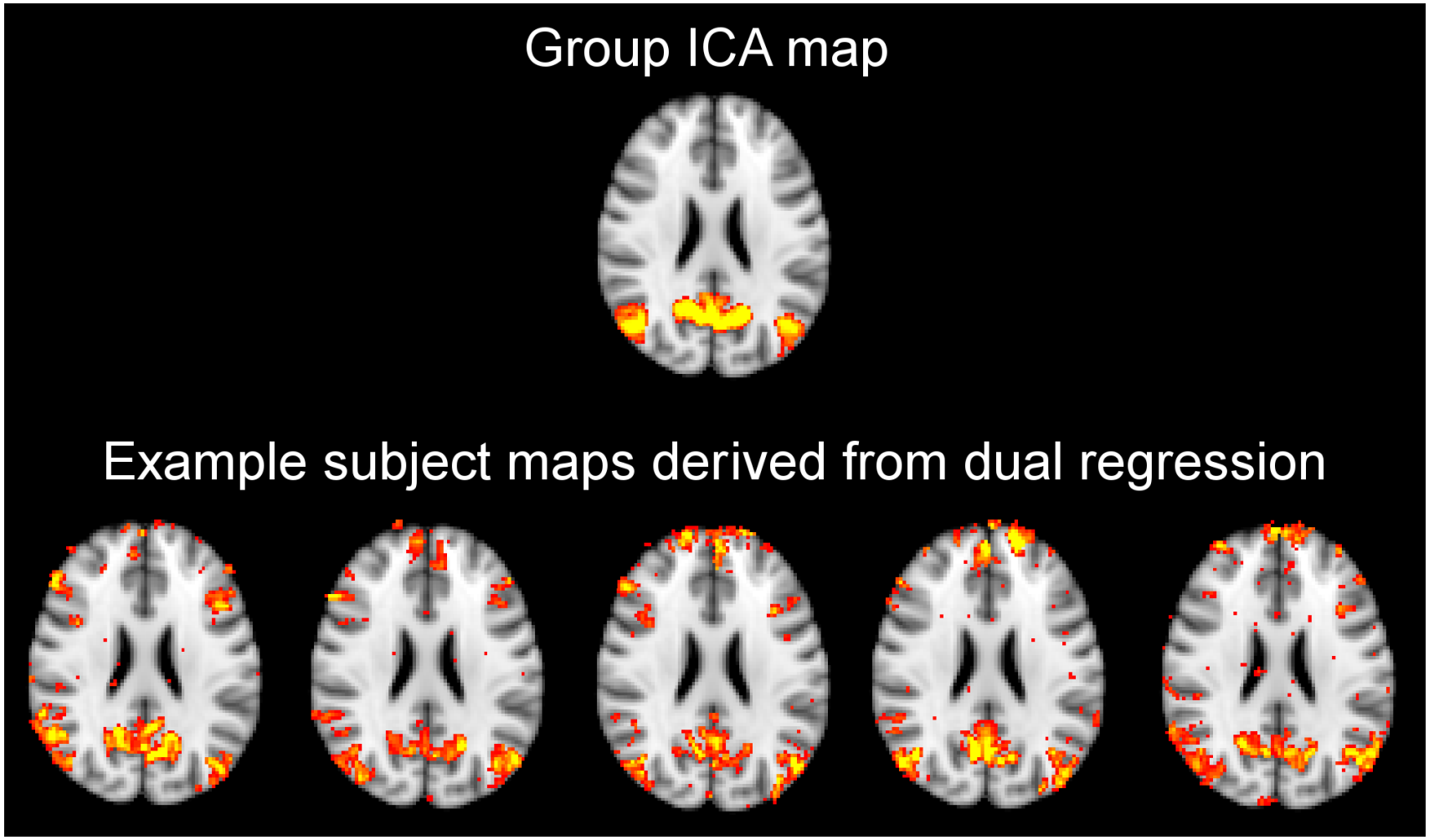


Dorsal Attention Network



Dual regression

Resting state multi-subject ICA

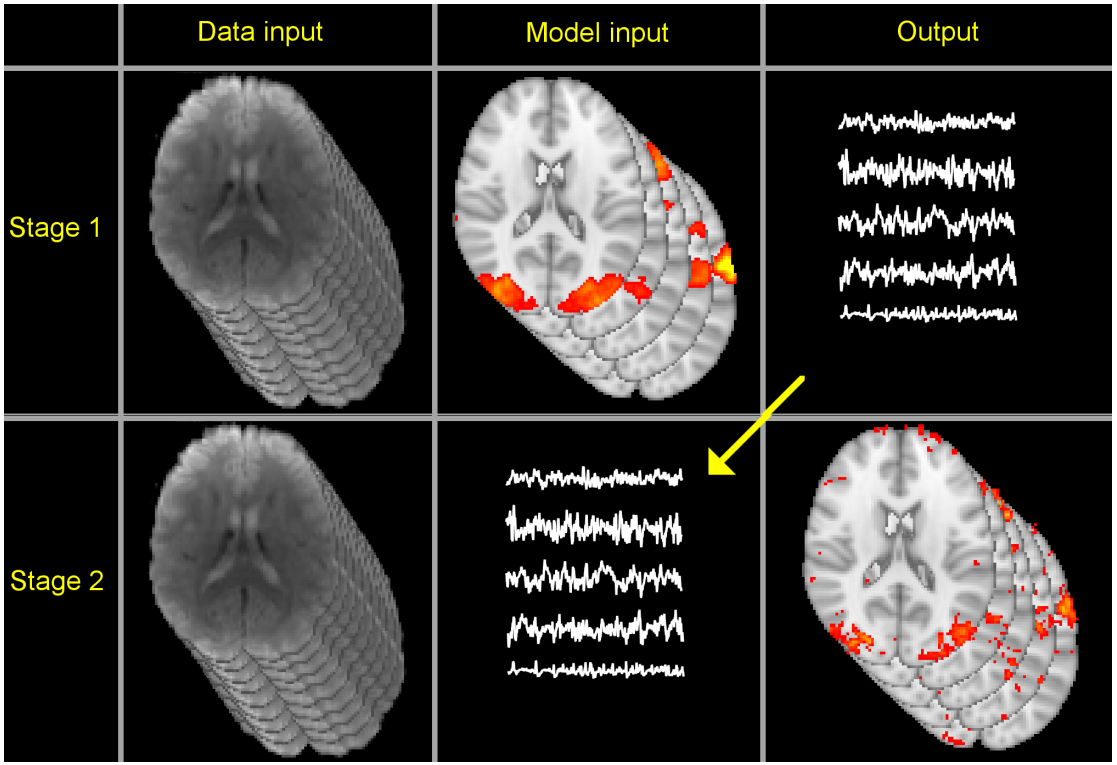


Dual Regression

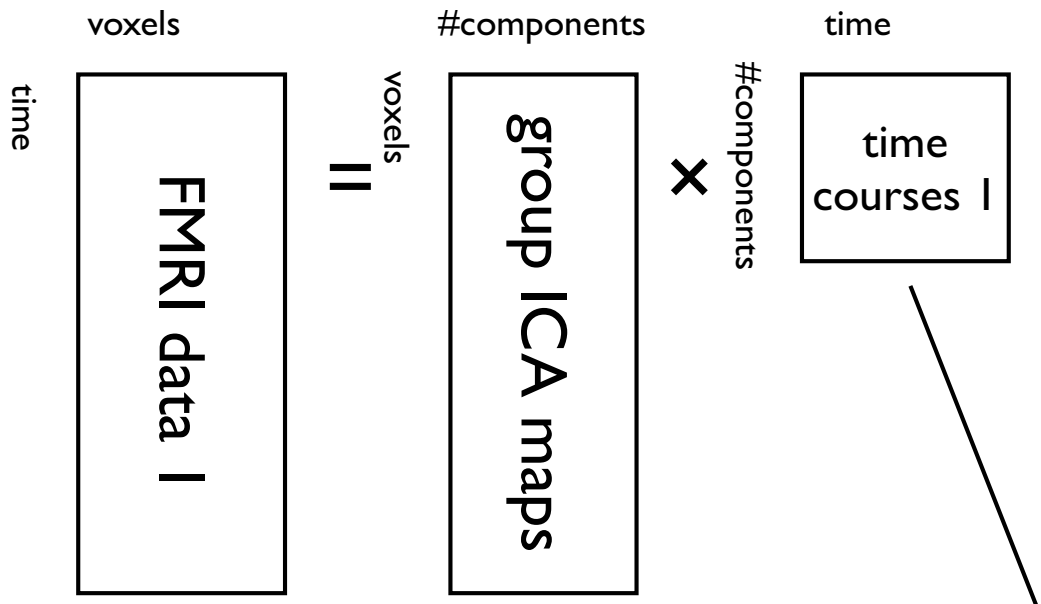
Two steps that both involve multiple regression:

1. Extract subject timeseries

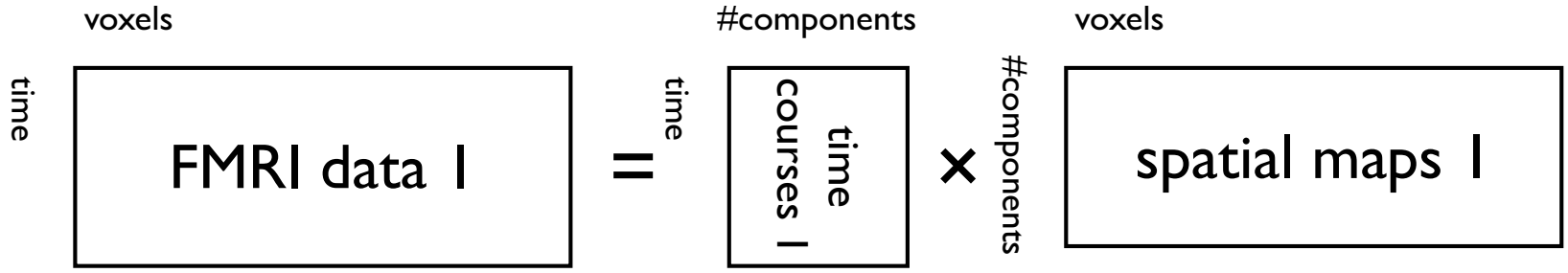
2. Extract subject maps



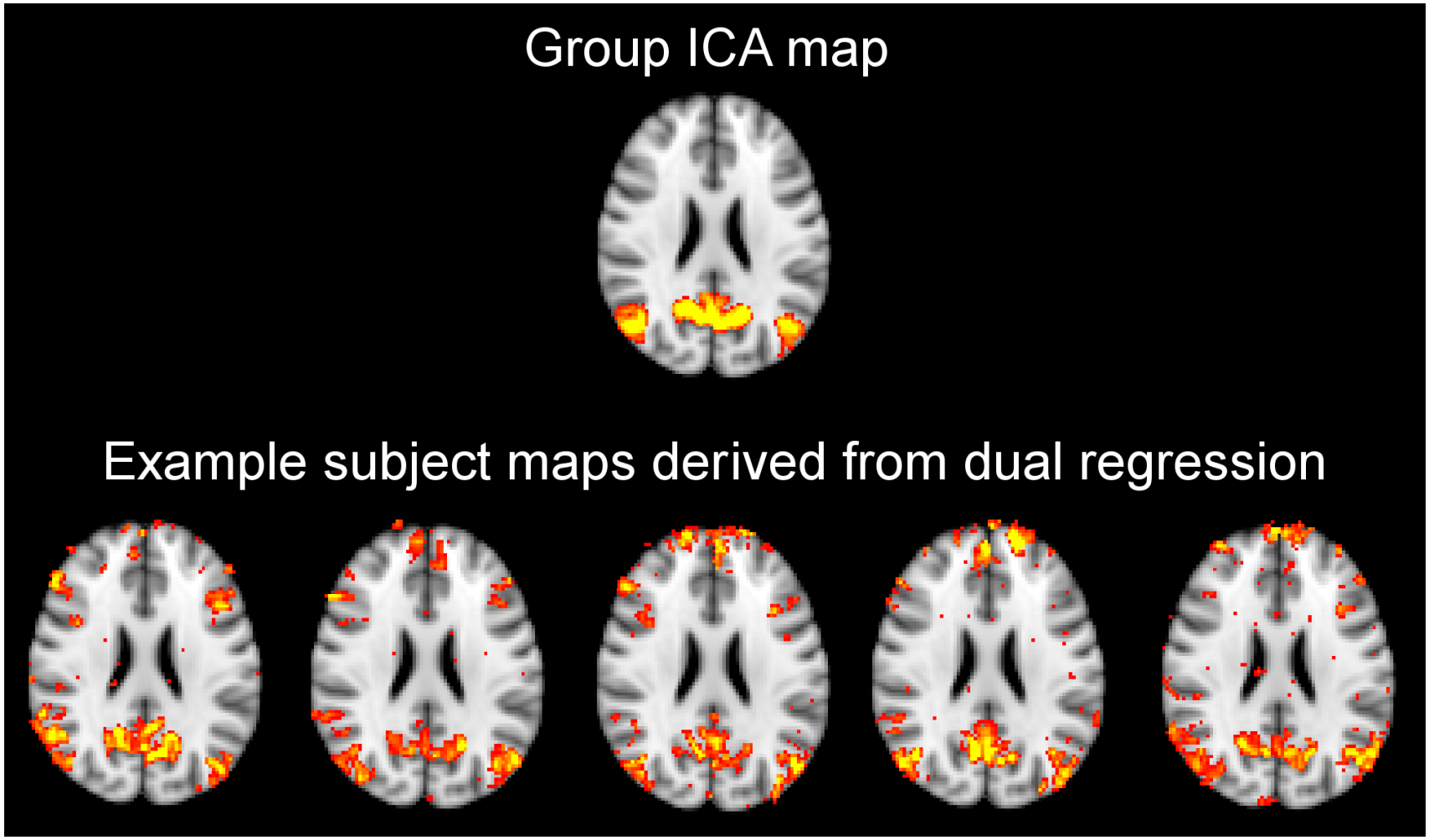
Dual Regression



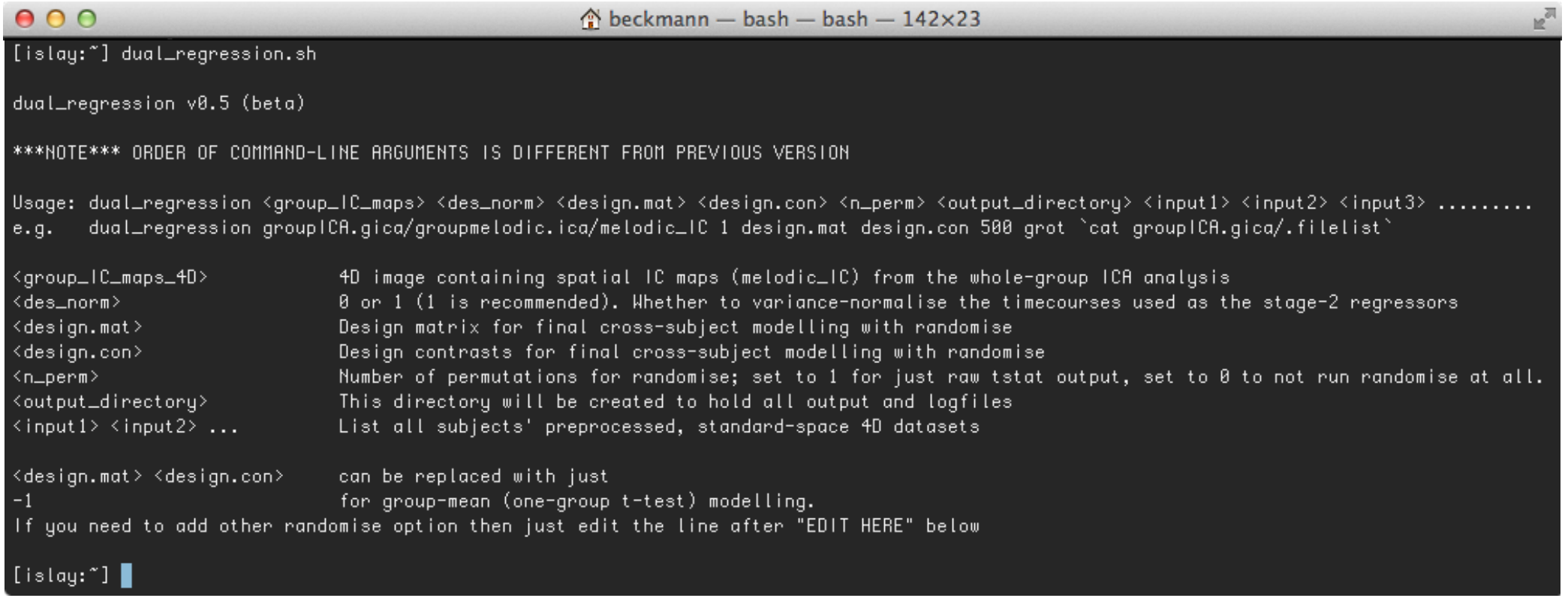
1. Regress group maps into each subject's 4D data to find subject-specific timecourses
2. Regress these timecourses back into the 4D data to find subject-specific spatial maps



Dual Regression



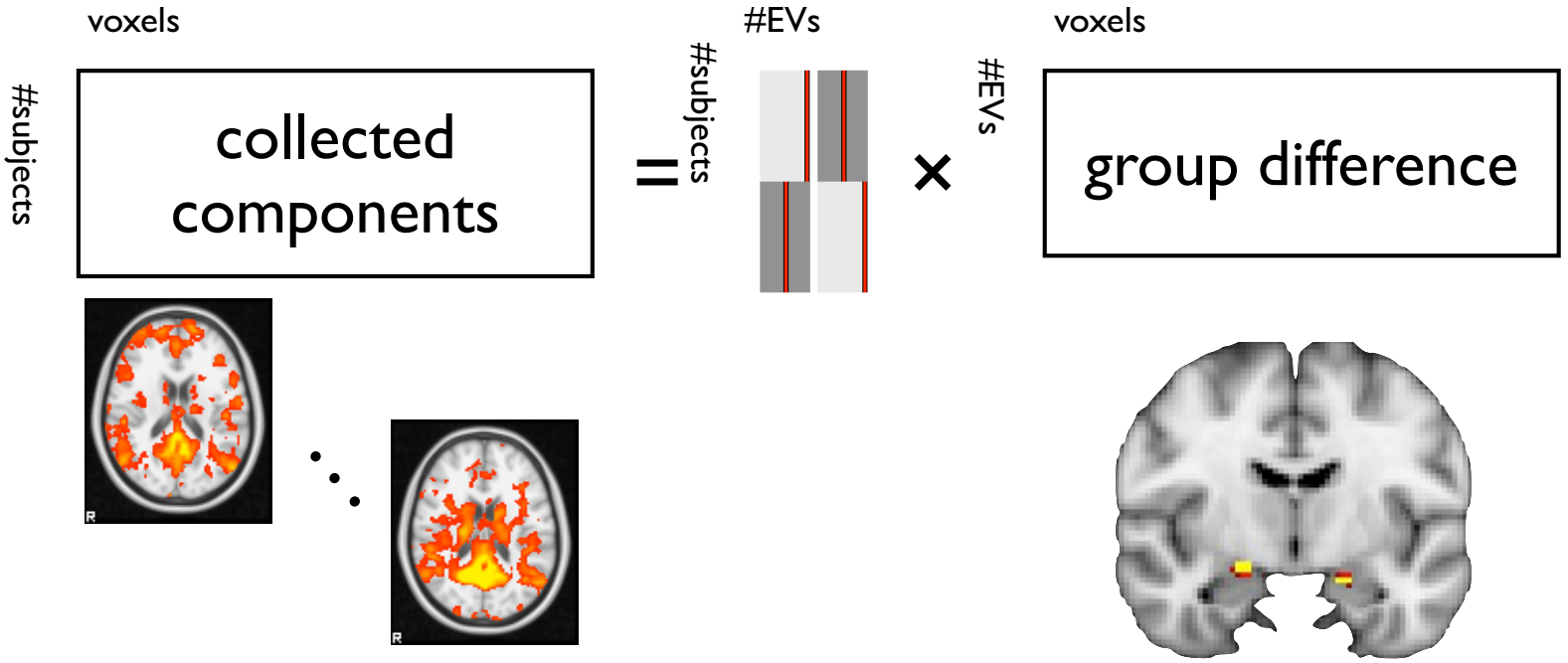
Running dual_regression



- FSL command line tool, combining:
  - DR to create subject-wise estimates (stage 1 + stage 2)
  - Group comparison using randomise (stage 3)

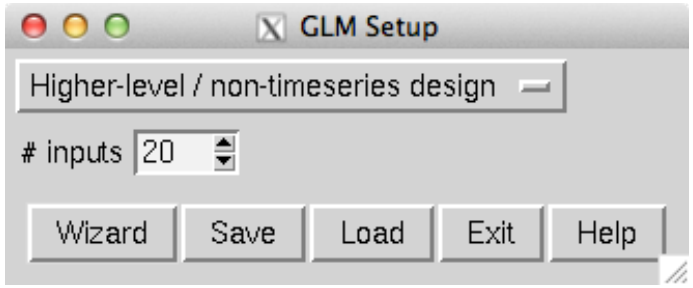
Group comparison

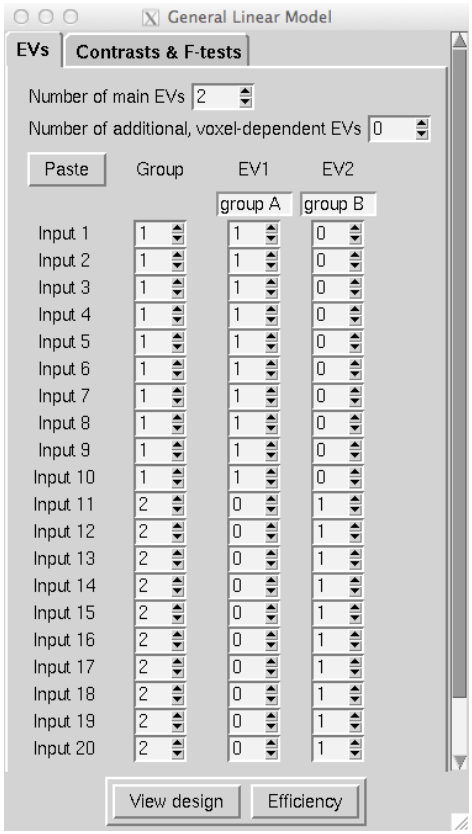
- Collect maps and perform voxel-wise test (e.g. randomisation test on GLM)

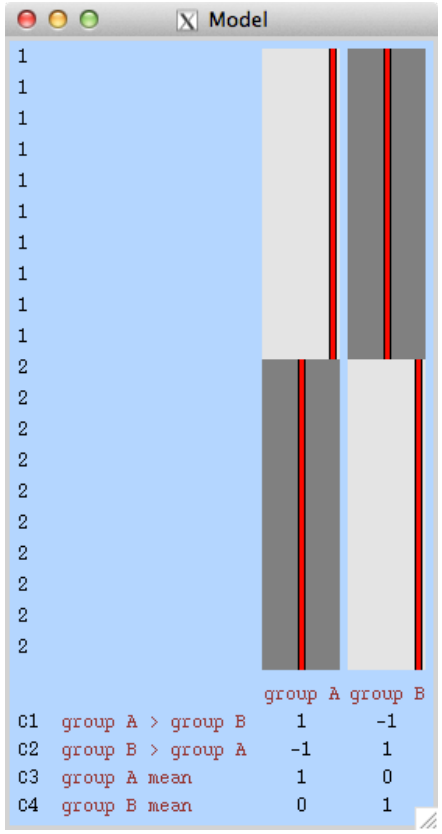


- Can now do voxelwise testing across subjects, separately for each original group ICA map
- Can choose to look at strength-and-shape differences

Group analysis on maps



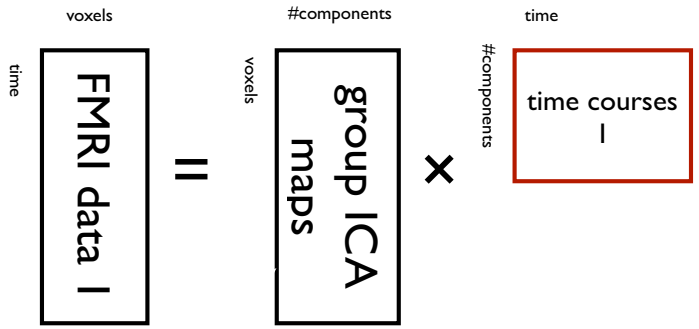




- can use the Glm tool (Glm_gui on mac) to create GLM design and contrast matrices

Dual regression outputs

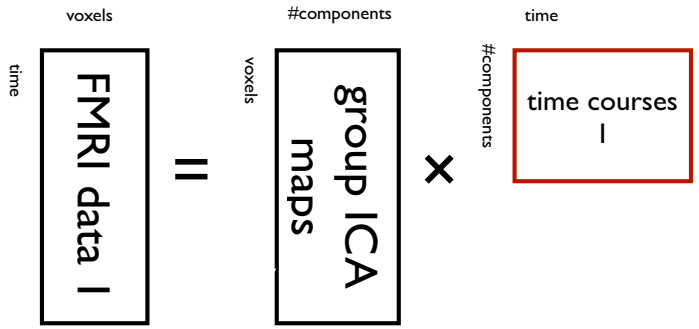
- dr_stage1_subject[#SUB].txt - the timeseries outputs of stage 1 of the dual-regression.

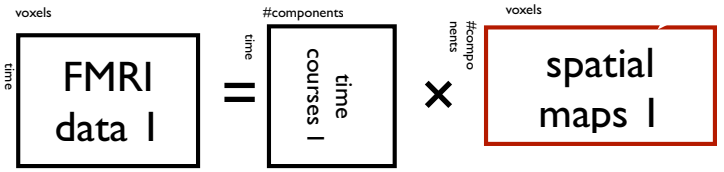


Dual regression outputs

- dr_stage1_subject[#SUB].txt - the timeseries outputs of stage 1 of the dual-regression.

- dr_stage2_subject[#SUB].nii.gz - the spatial maps outputs of stage 2 of the dual-regression.





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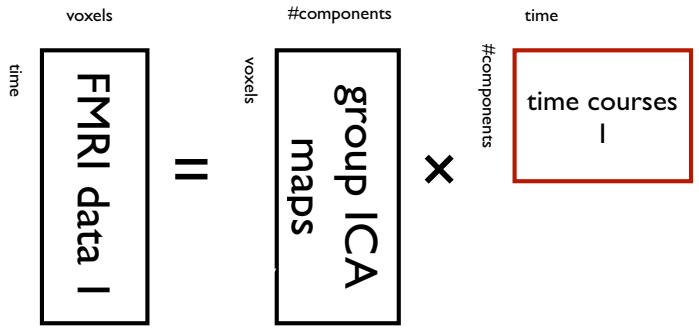
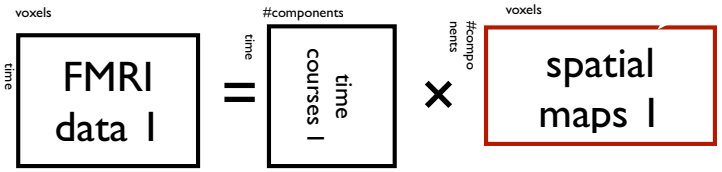
- dr_stage2_ic[#ICA].nii.gz - the re-organised parameter estimate images





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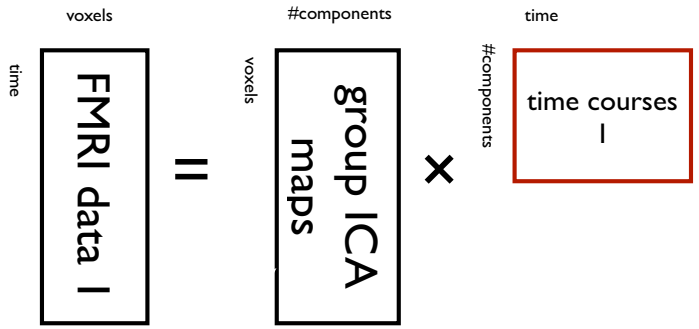
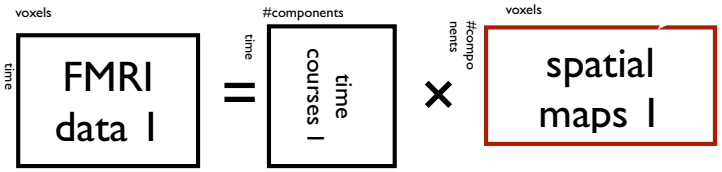
- dr_stage3_ic[#ICA]_tstat[#CON].nii.gz - the output from randomise





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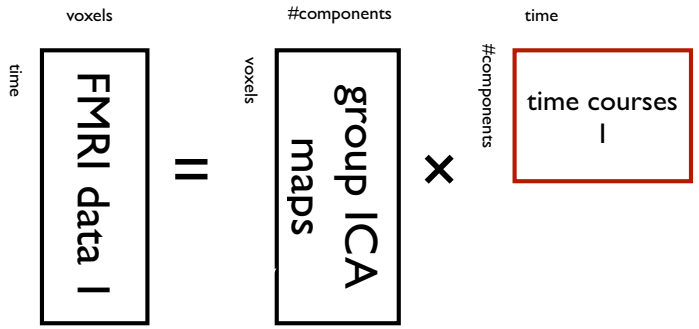
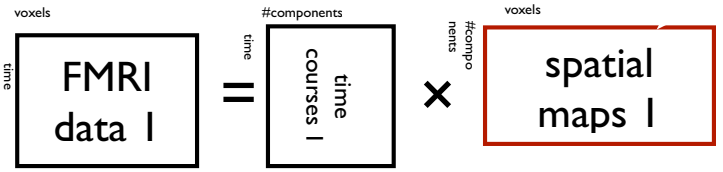
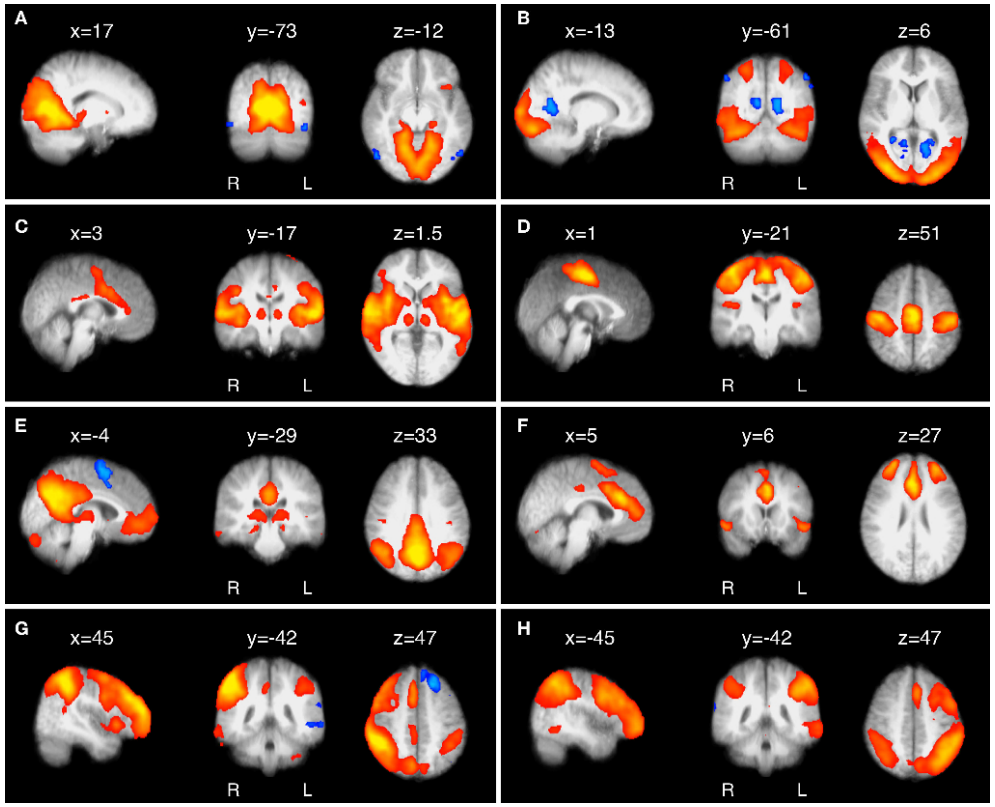




(corrected for multiple comparisons across voxels but not across #components!!)

Group template maps

- Generate from the data using ICA
  - use all data to get unbiased templates



template RSNs

http://www.fmrib.ox.ac.uk/analysis/research

Group template maps

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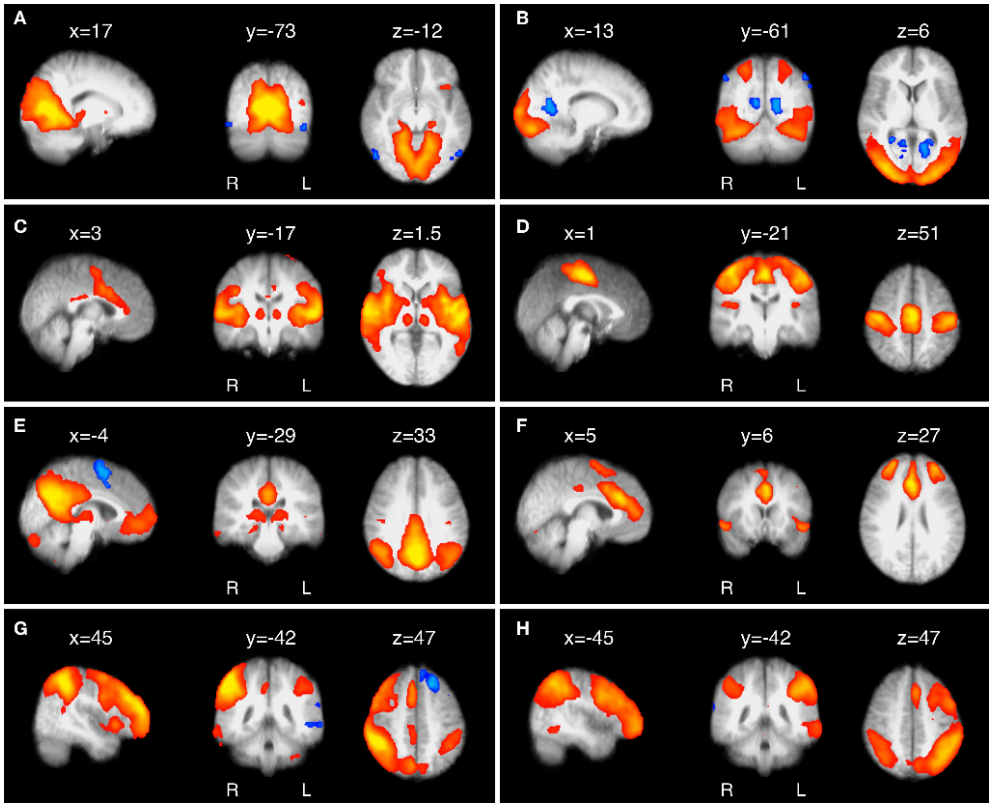
  - use independent control group
  - will model signals and artefacts



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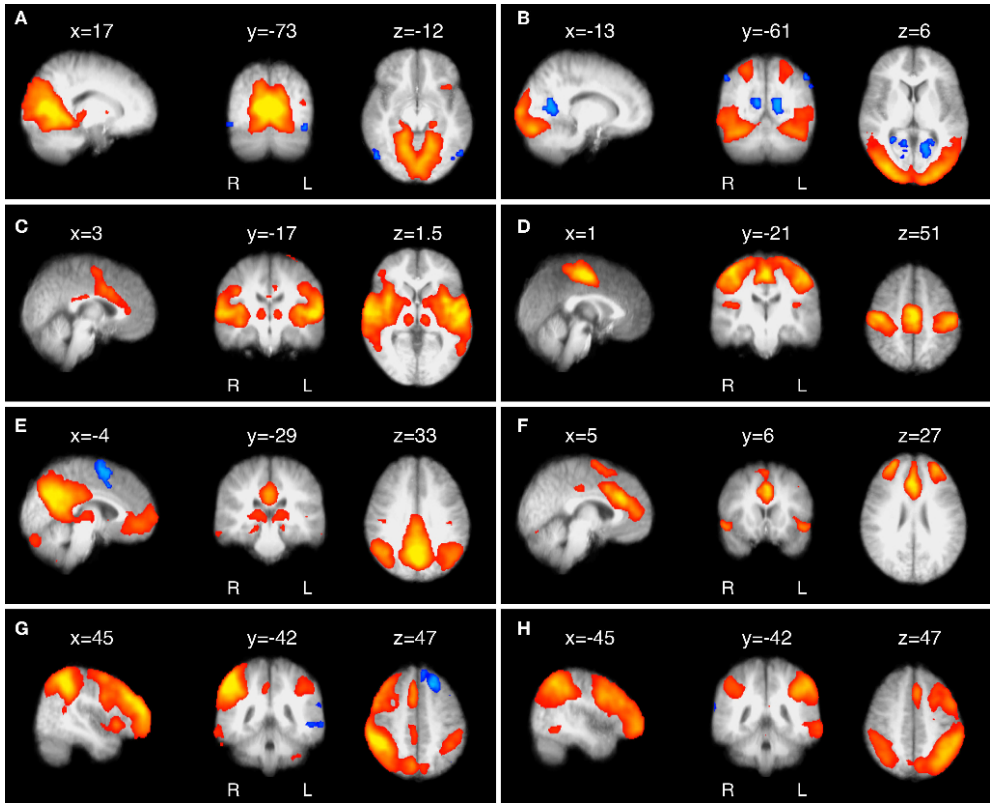

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