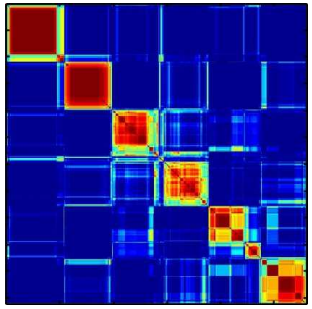
Bootstrap analysis of stable clusters in resting-state fMRI



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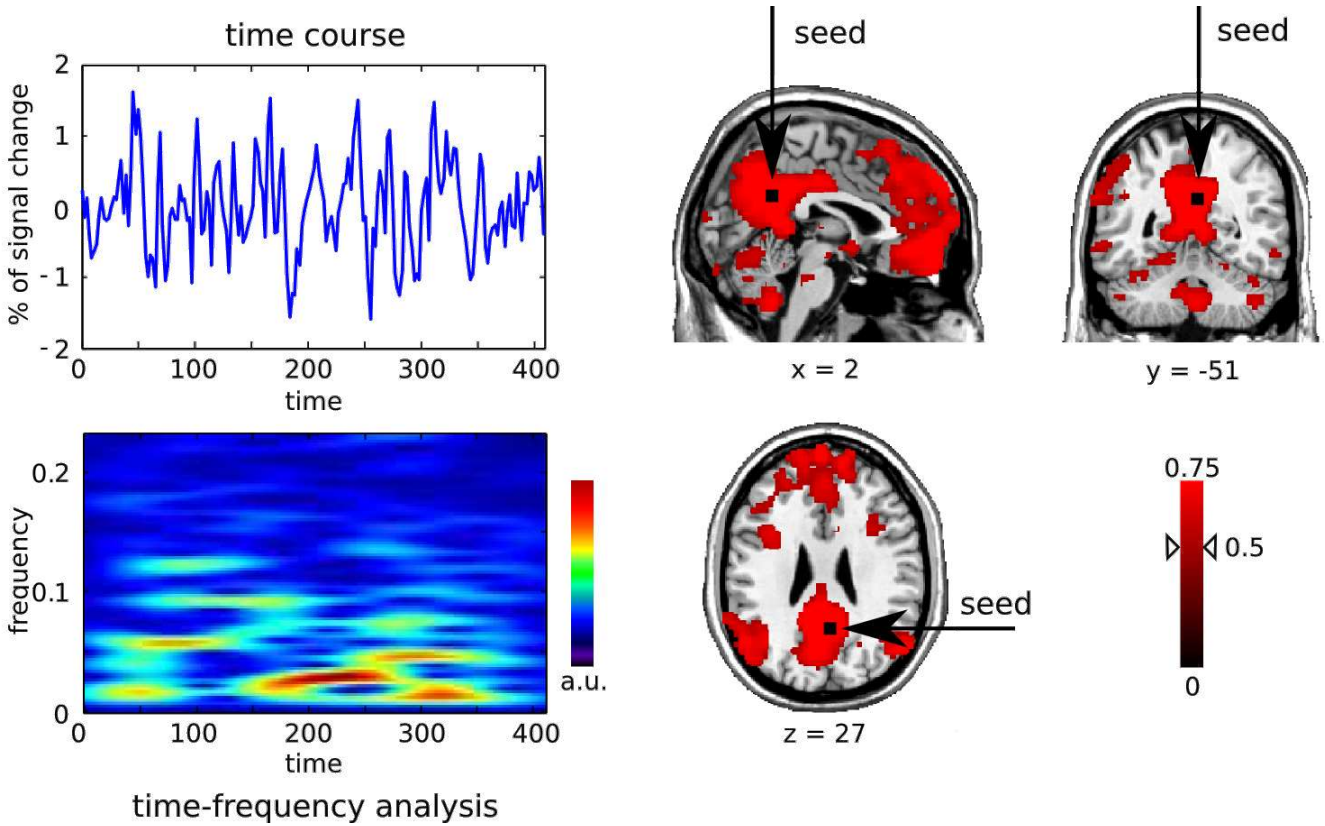
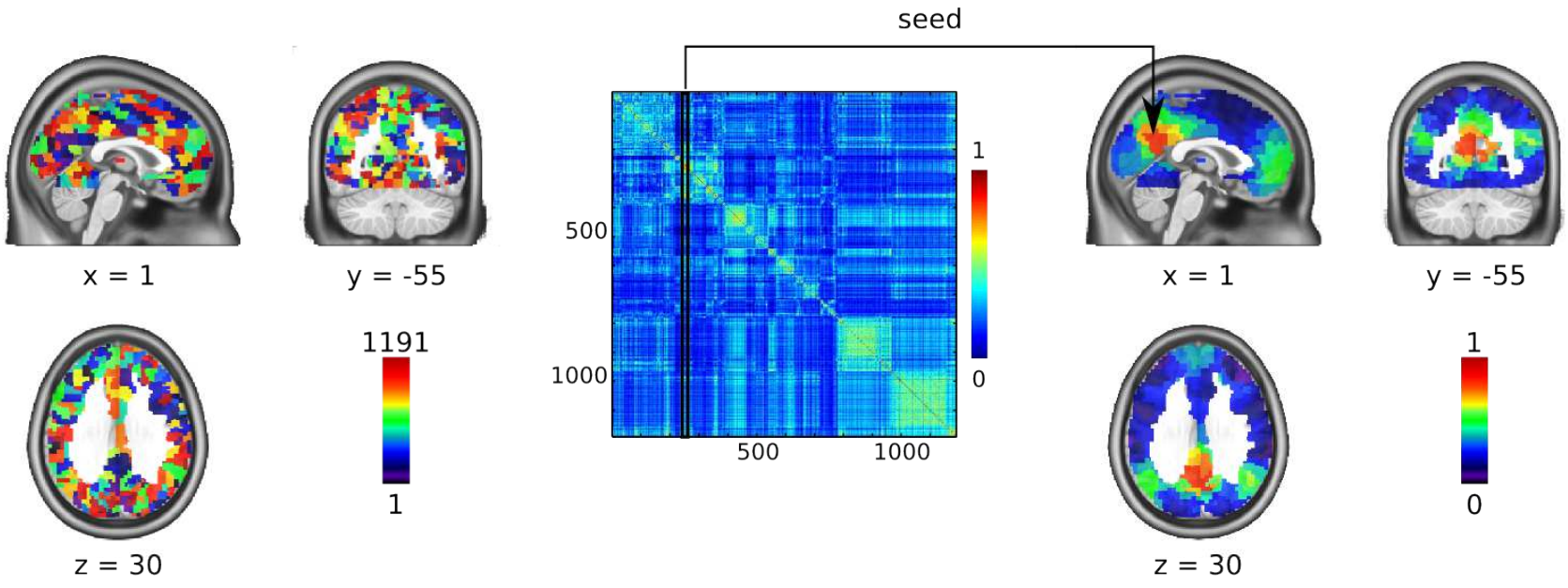
UNF Unité de neuroimagerie fonctionnelle

Resting-state fMRI: functional connectivity map

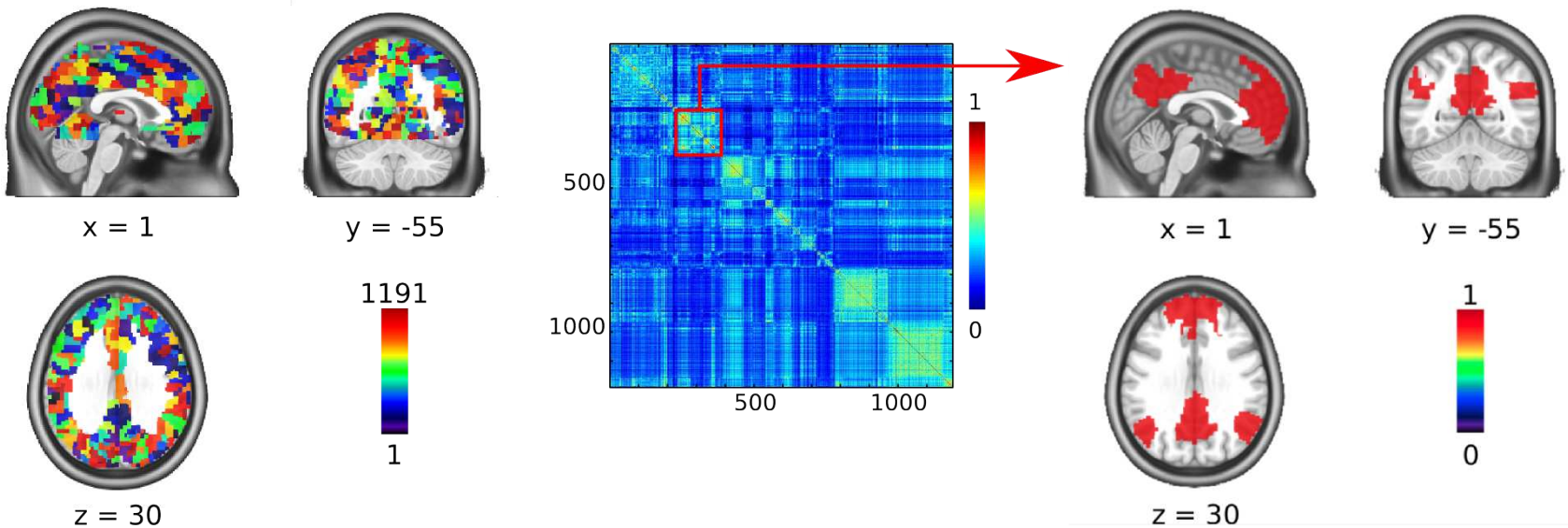


The posterior cingulate cortex is used as a seed to derive an individual resting-state functional connectivity map, identifying the default-mode network.

Resting-state fMRI: functional connectome



Resting-state fMRI: resting-state networks

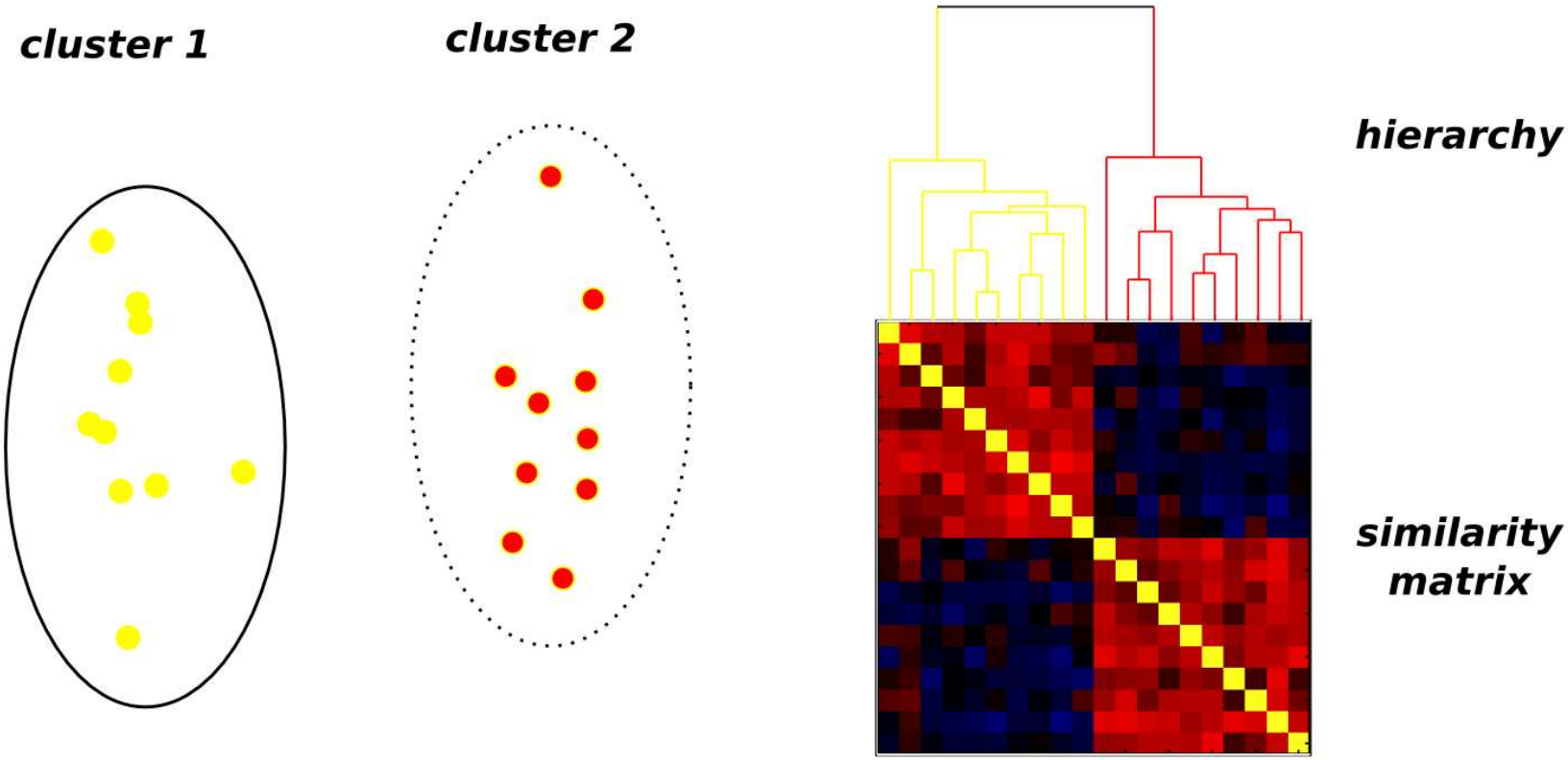


functional parcelation

region-level
functional connectome

resting-state
network

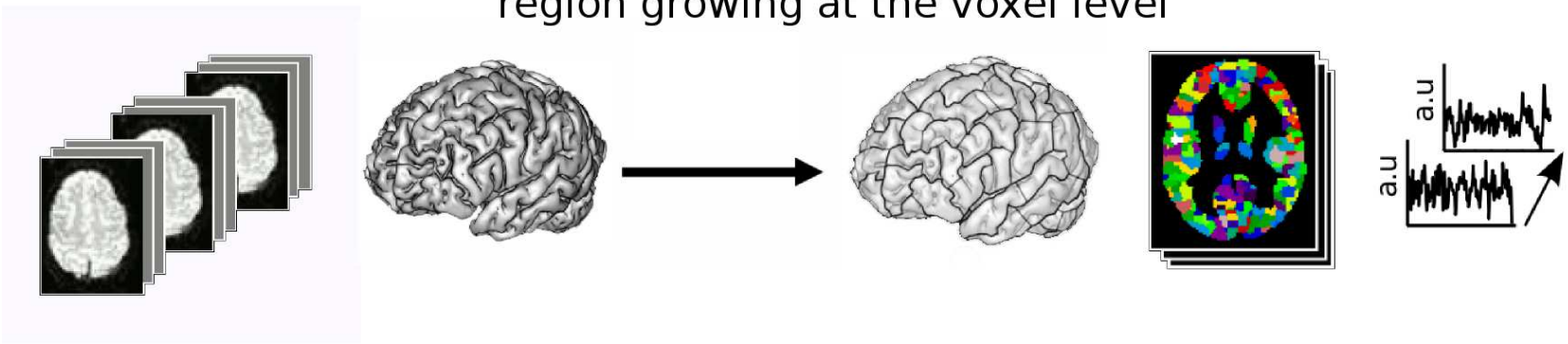
Clustering : unsupervised classification



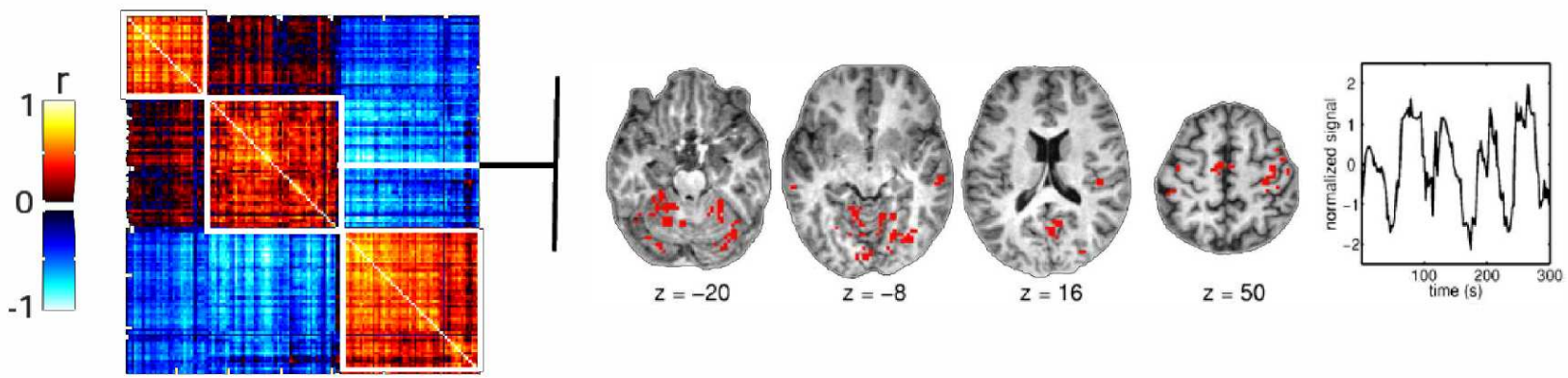
On the left, coordinates of individuals define their similarities; on the right, HC proceeds by iterative mergings. Many clustering algorithms exist, e.g. k-means, fuzzy k-means, spectral clustering, SOM, neural gas. See Jain, Pattern Recognition Letters, 2009, for a review.

Clustering : bi-scale approach in fMRI functional connectivity

region growing at the voxel level

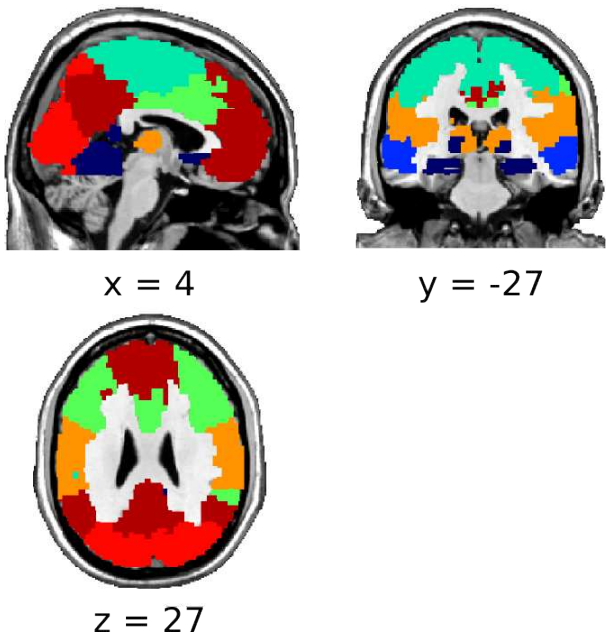


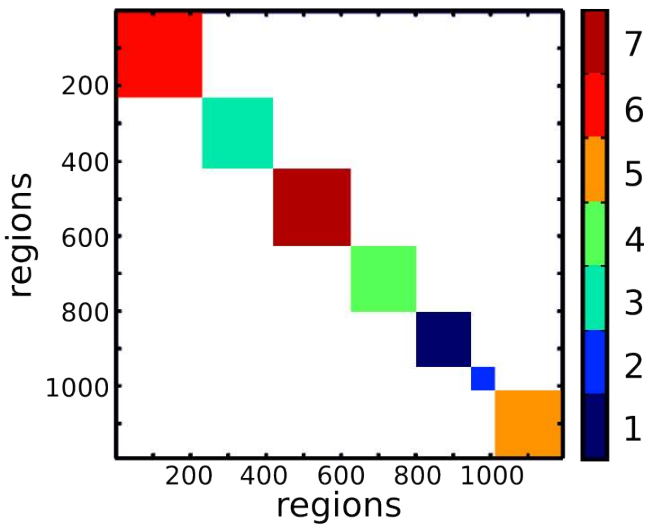
clustering at the region level



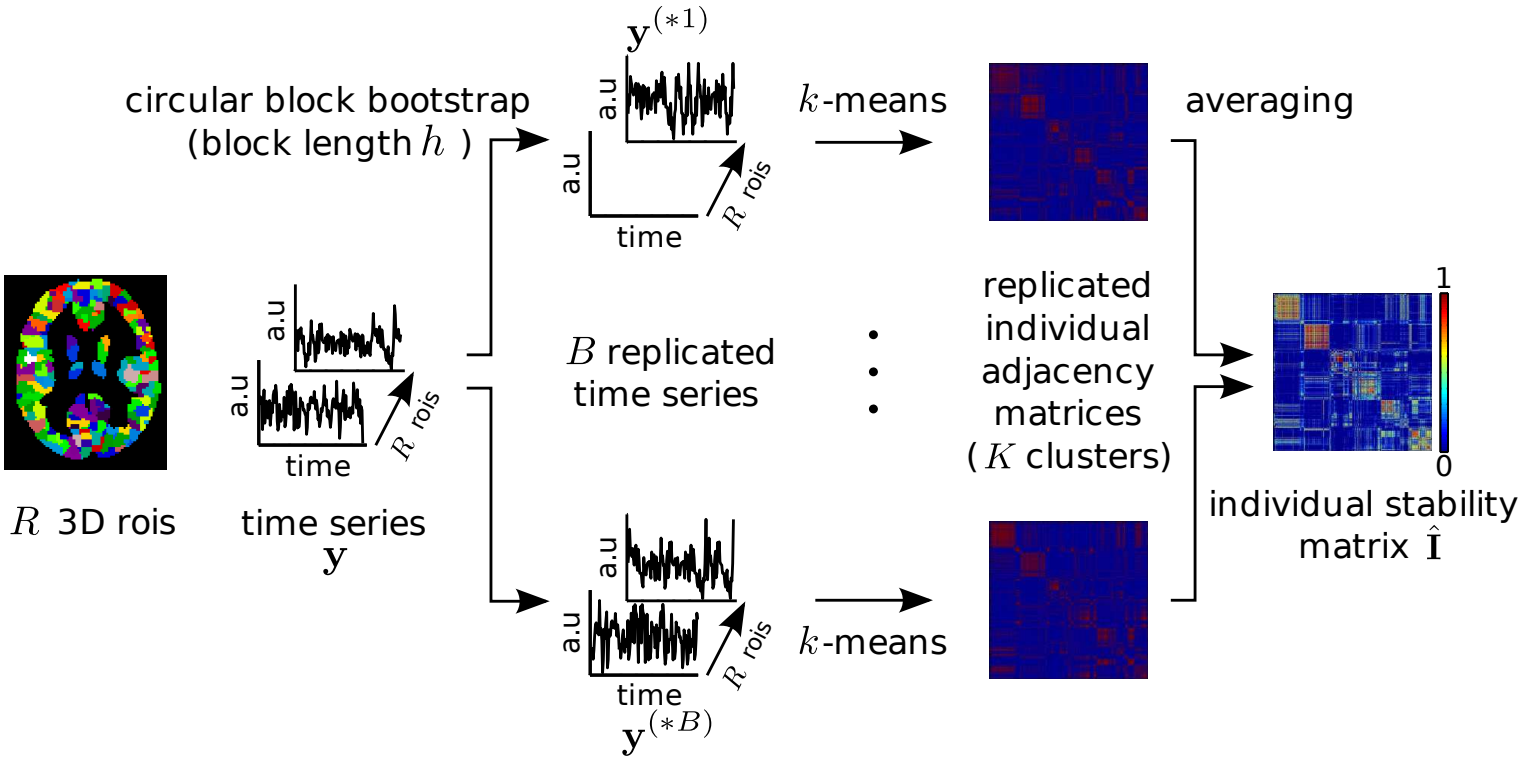
LSNI algorithm, see Bellec et al., 2006, Neuroimage, 29: 1231– 1243.

Adjacency matrix representation of a clustering

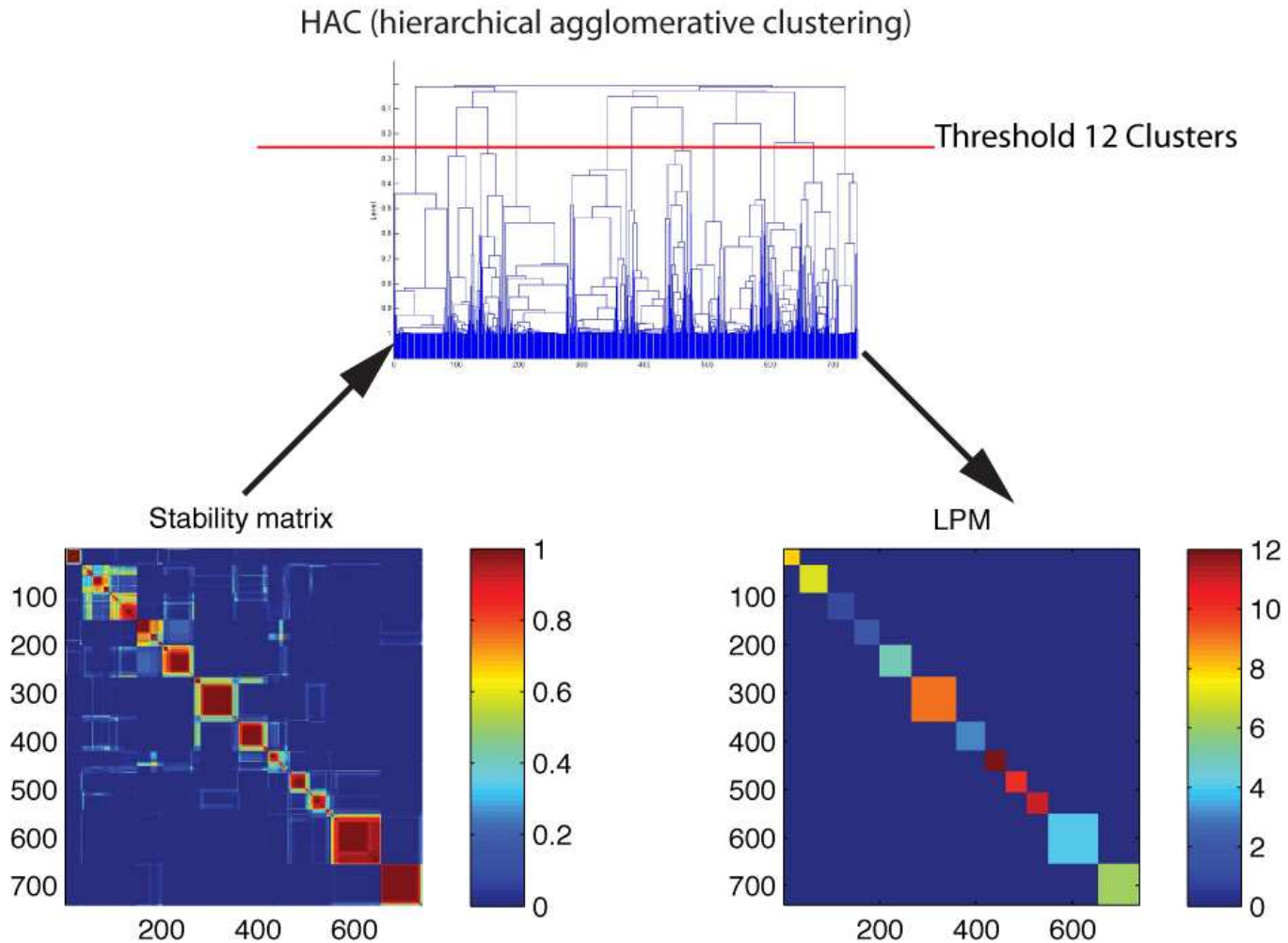




Individual-level bootstrap stability analysis

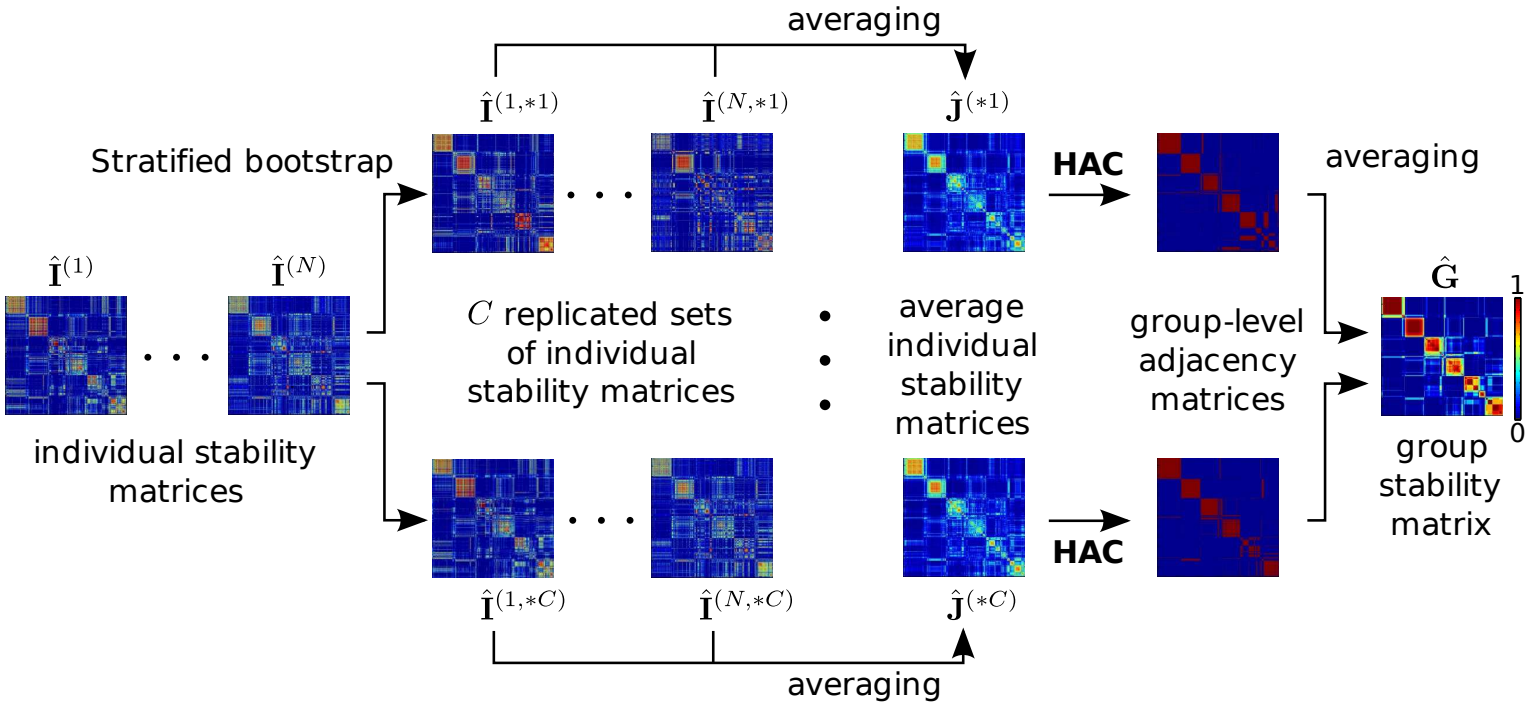


Consensus clustering



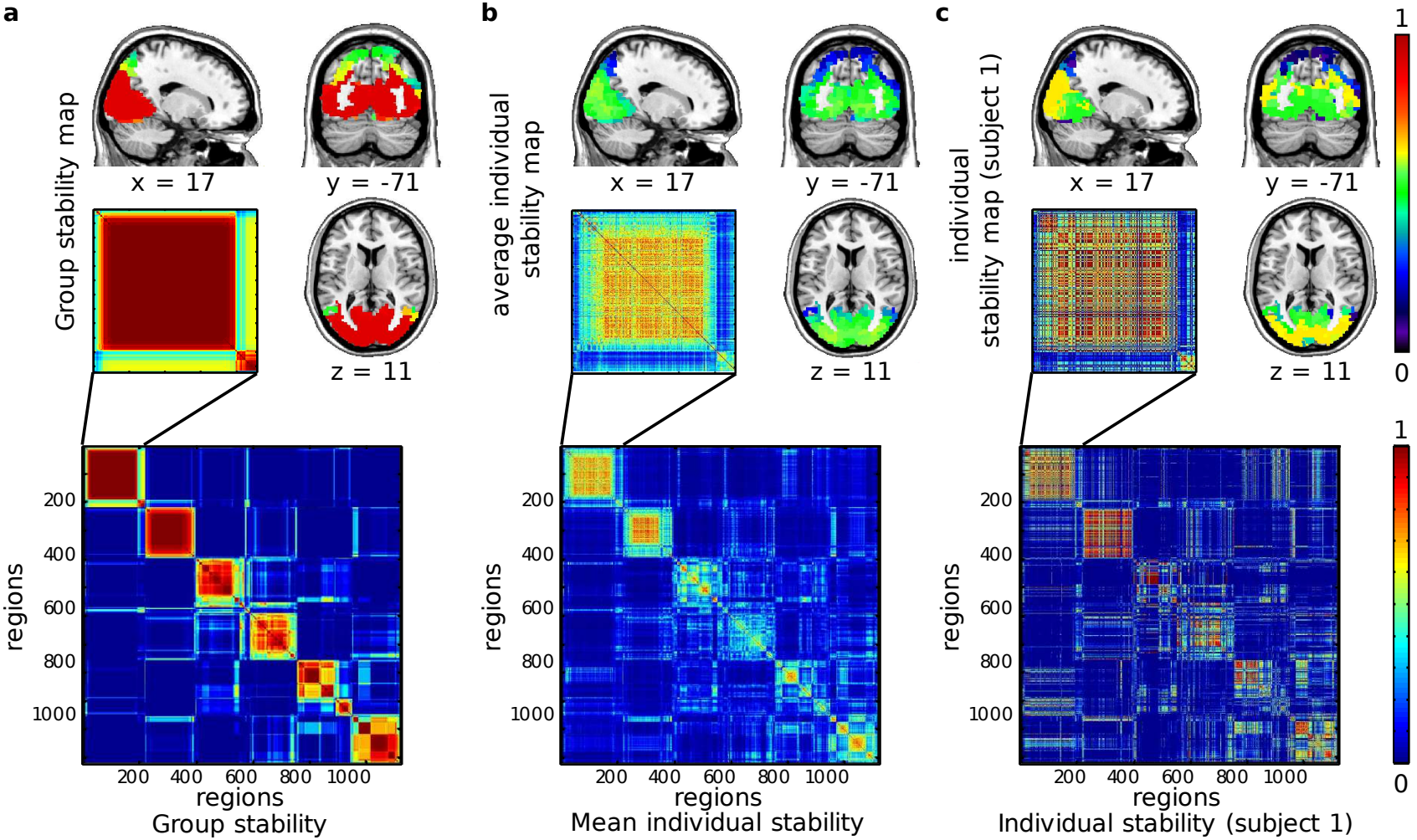
From Dansereau et al., Front. Neurosci. 8:419. doi: 10.3389/fnins.2014.00419

Group-level stability analysis

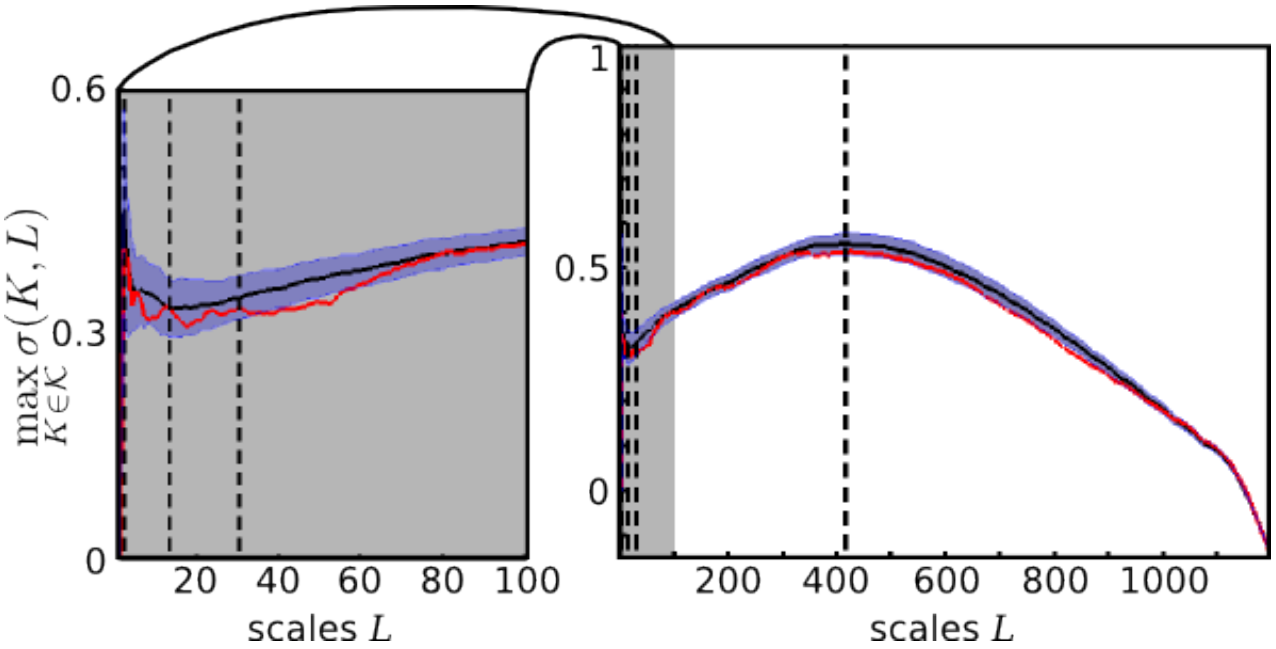


From Bellec et al., Neuroimage 2010.

Clustering : stability maps

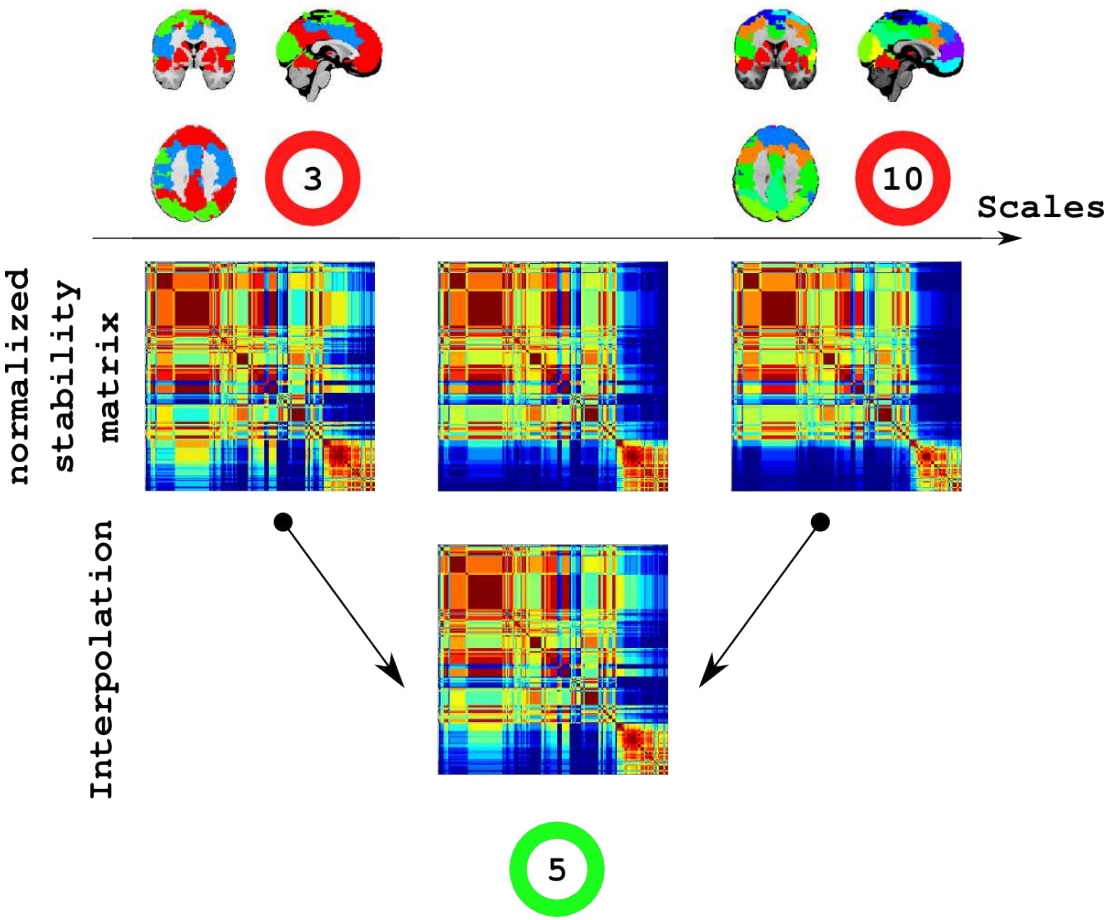


Local maxima of stability

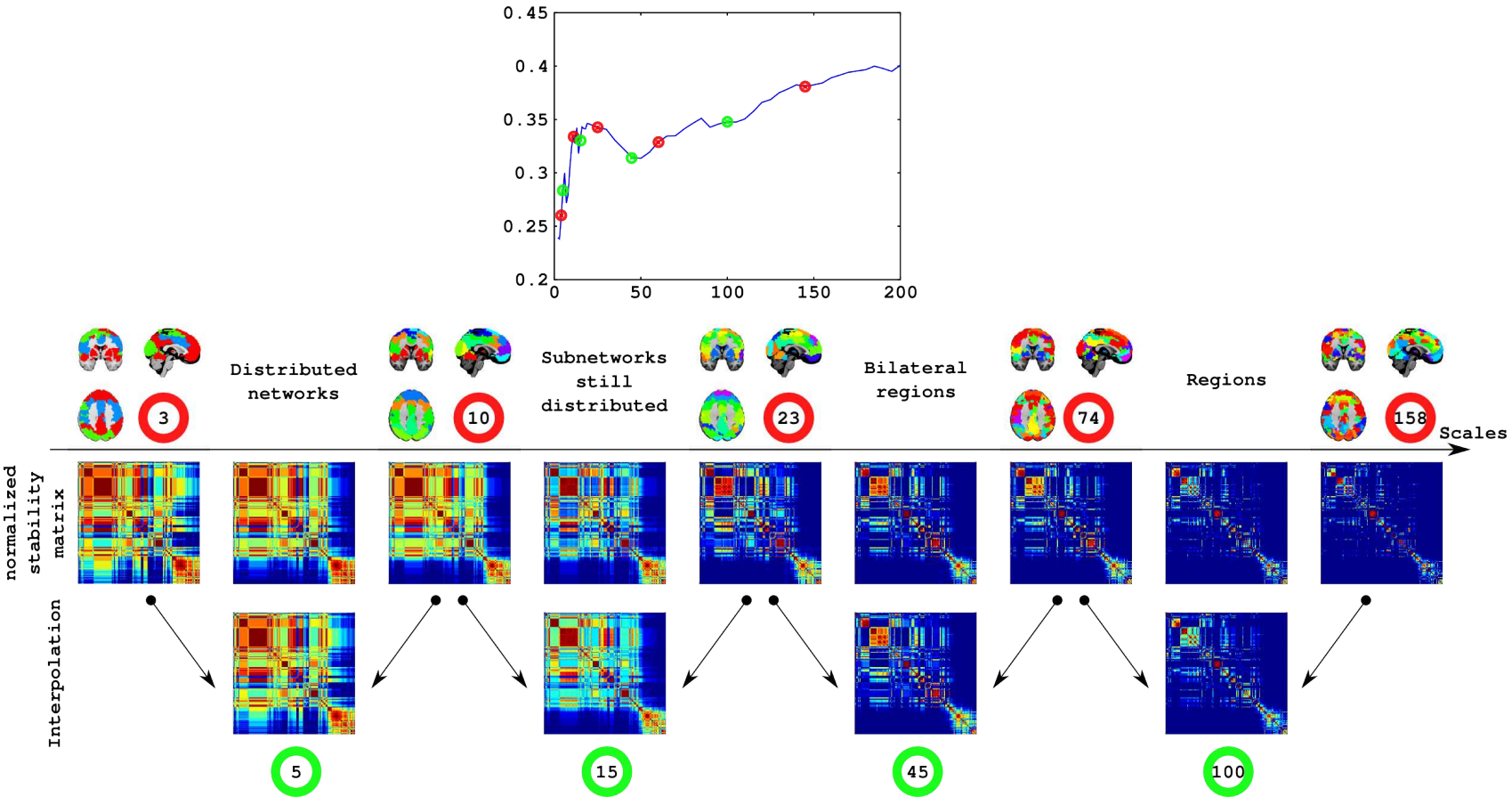


Individual stability contrasts for 43 subjects.

Interpolation of stability matrices I



Interpolation of stability matrices II



Bellec, Proceedings of the 2013 International Workshop on Pattern Recognition in Neuroimaging (PRNI), IEEE, 2013, pp. 54-57.

Multiresolution stepwise selection (MSTEPS) I

Forward MSTEPS procedure

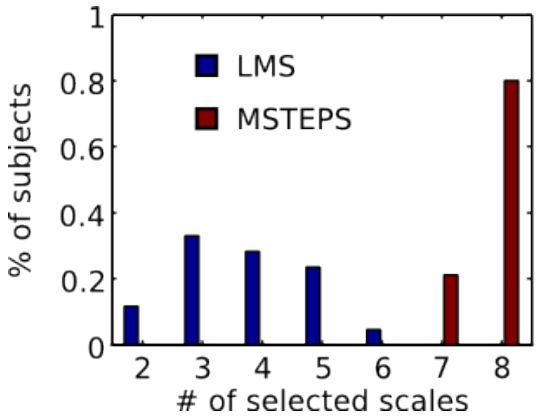
1. Initialization: no resolution is selected.
2. Select a resolution that has not yet been selected, with probability proportional to the residual sum of squares at this resolution.
3. Iterate (2-3) until a predefined percentage of residual sum of squares across all resolutions is reached.
4. Iterate the model selection B times, and keep the model with smallest residual sum of squares.

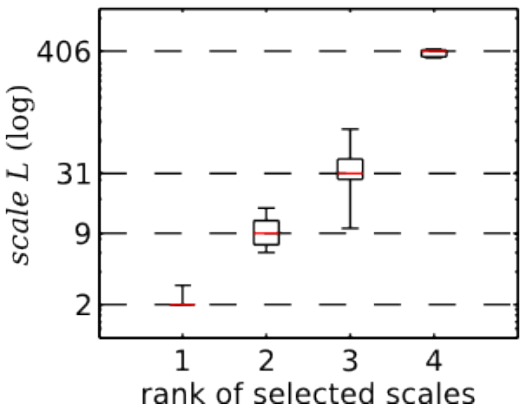
Multiresolution stepwise selection (MSTEPS) II

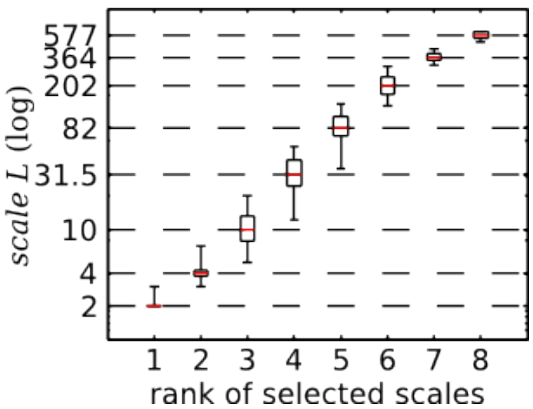
Component-wise MSTEPS procedure

1. Initialization: run a forward MSTEPS.
2. For each resolution of the model, try to replace it by any of the resolutions not currently in the model.
3. Keep the model with the minimal residual sum of squares across all resolutions.
4. Iterate (2-3) until it is not possible anymore to reduce the residual sum of squares.

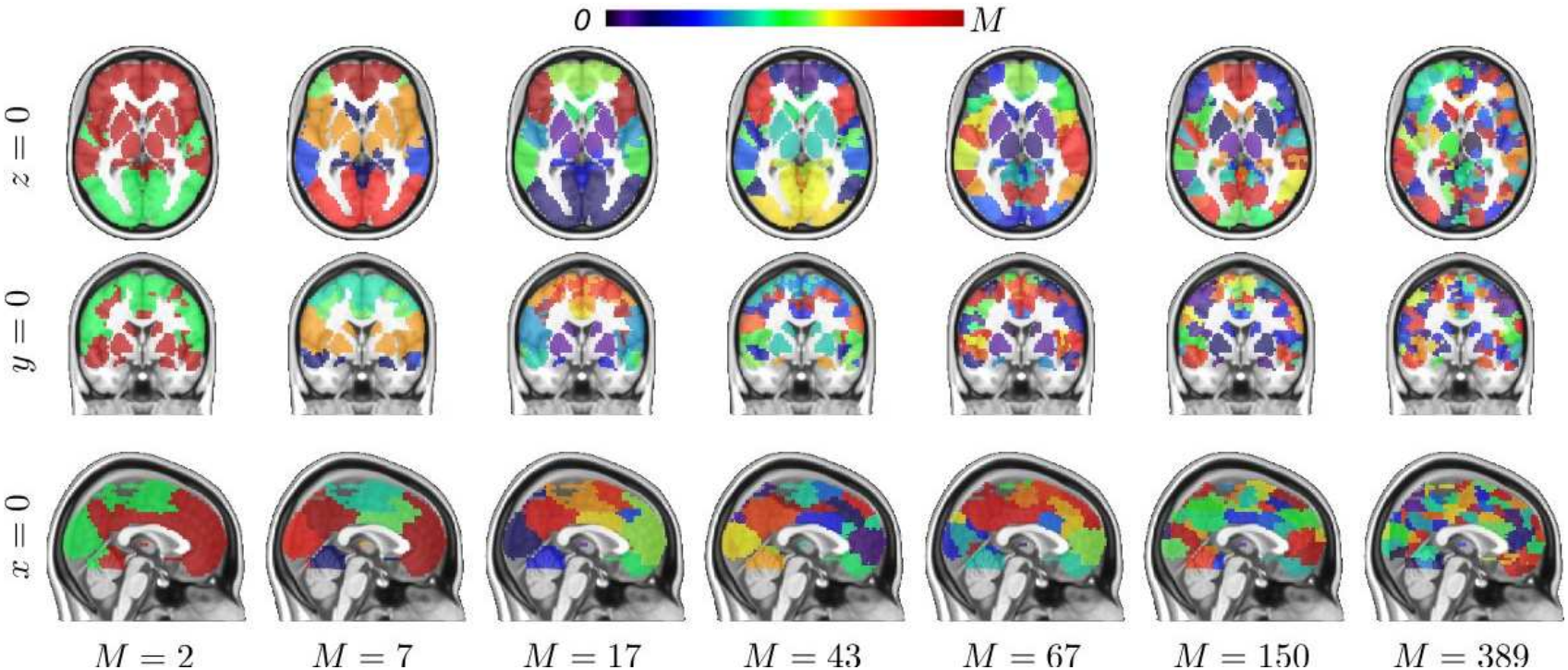
Reproducibility of resolution selection





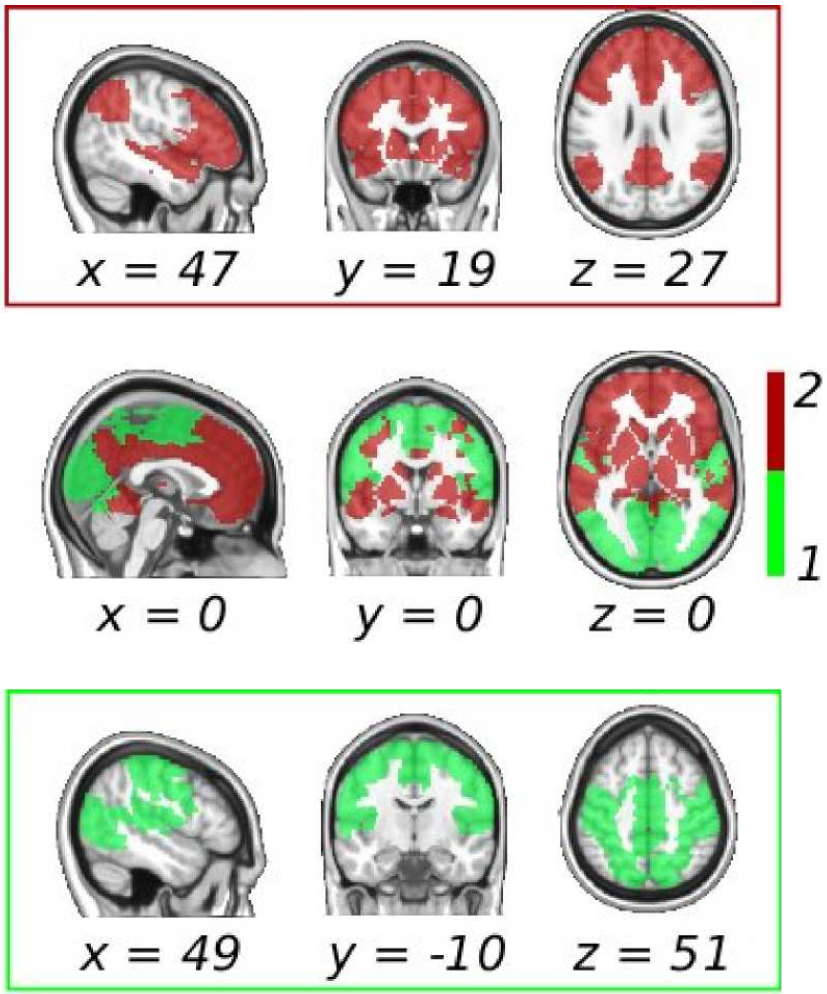


Group consensus clusters as a function of resolution



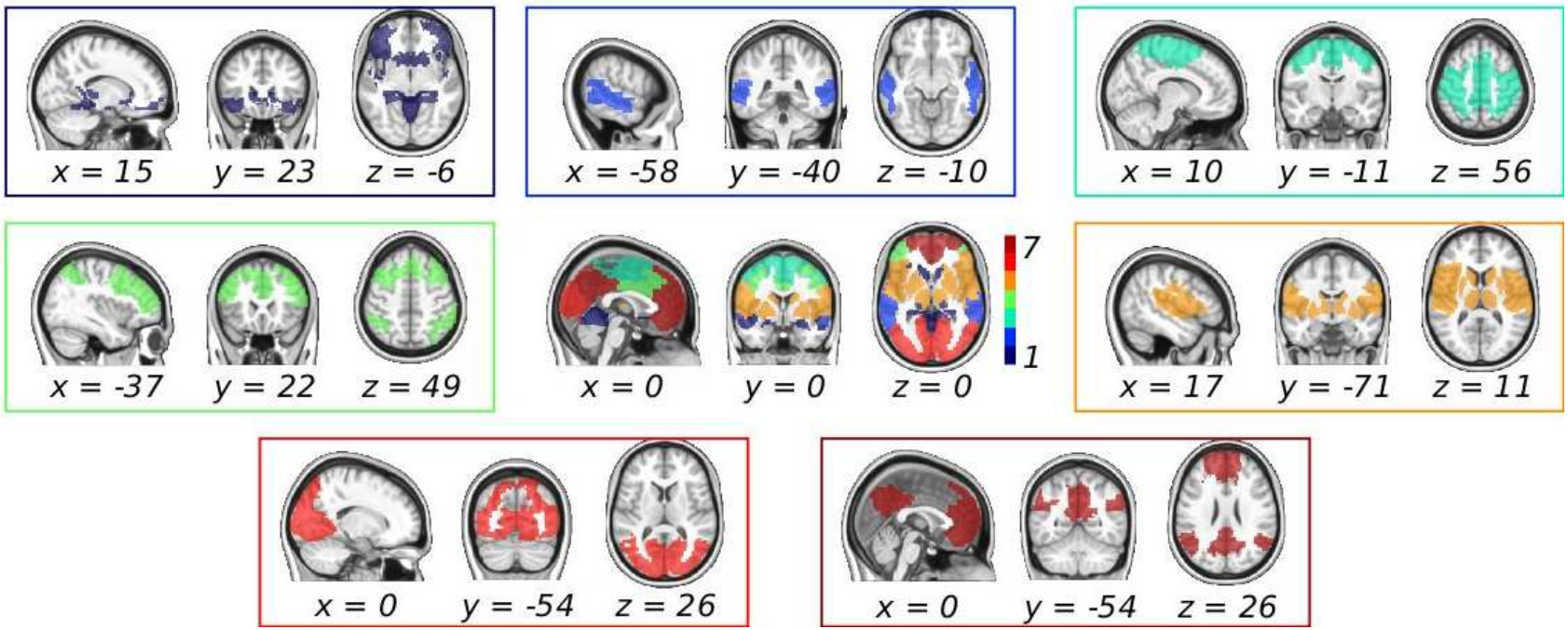
Bellec PRNI 2013.

Group consensus clusters @(resolution 2)



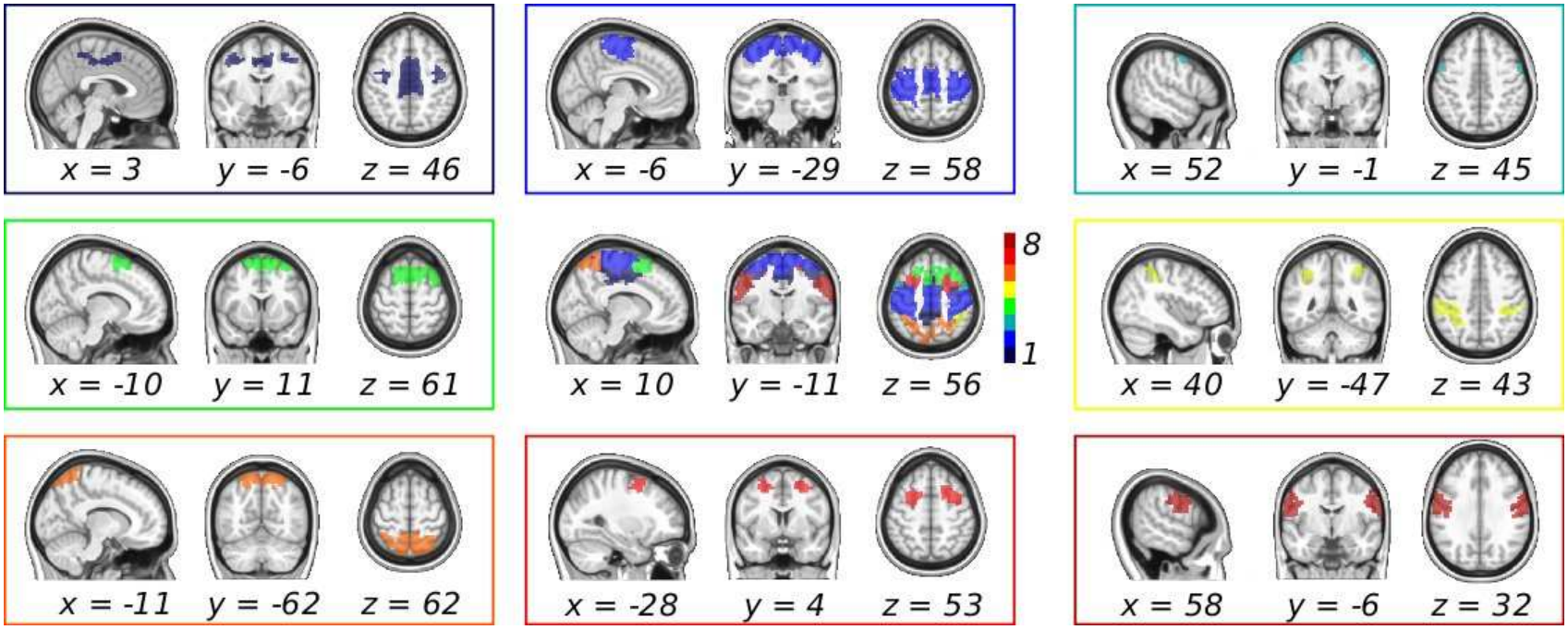
Bellec et al. HBM 2010. See Golland et al, 2008, Neuropsychologia, for more info on this resolution.

Group consensus clusters @(resolution 7)



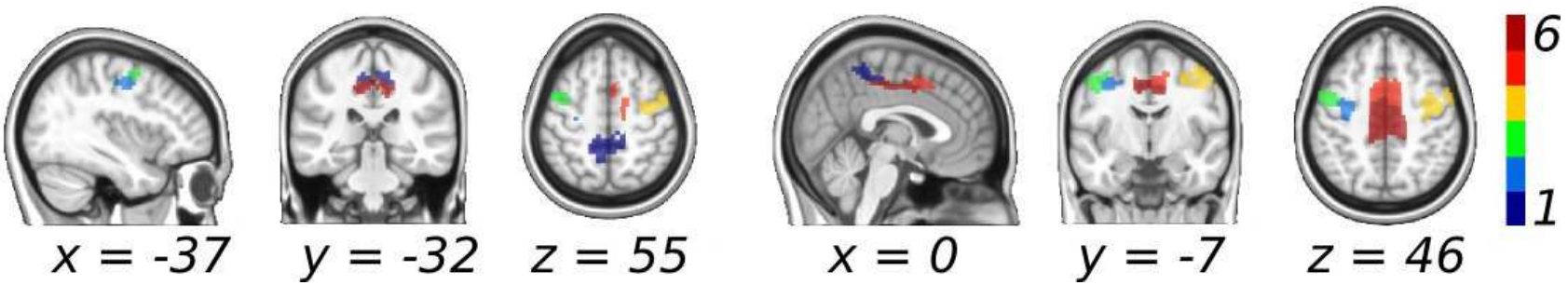
Bellec et al. HBM 2010. See Yeo et al., J Neurophysiol 2011, for more info on this resolution.

Sensorimotor network @(resolution 43)



Bellec et al. HBM 2010.

Sensorimotor network, subnetwork 1 (resolution 43)@(resolution 150)



Bellec et al. HBM 2010.

Summary

- It is possible to identify resting-state networks (RSNs) at different levels and resolutions of analysis, using BASC.
- The estimation of the stability of RSNs is an important validation step.
- Rather than identifying the "correct" resolution (an ill-defined problem in fMRI), MSTEPS seeks representative resolutions, to approximate accurately all stability matrices.

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More infos on **www.simexp-lab.org**