The Analysis Group workshop 2025

Program

10:30. Introduction. Diego Vidaurre

11:00. The Hidden Markov model. Laura Masaracchia

12:00. Lunch

12.30. Out-of-sample prediction of non-imaging traits.

Christine Ahrends

13.30. Statistical inference on brain dynamics. Nick Larsen

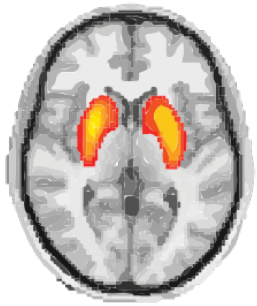
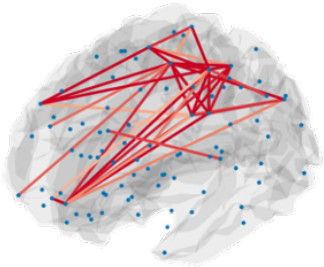
14.30. Coffee break.

15.00. Normative modelling of functional connectivity.

Janus Rønn Lind Kobbersmed

Brain networks and their dynamics

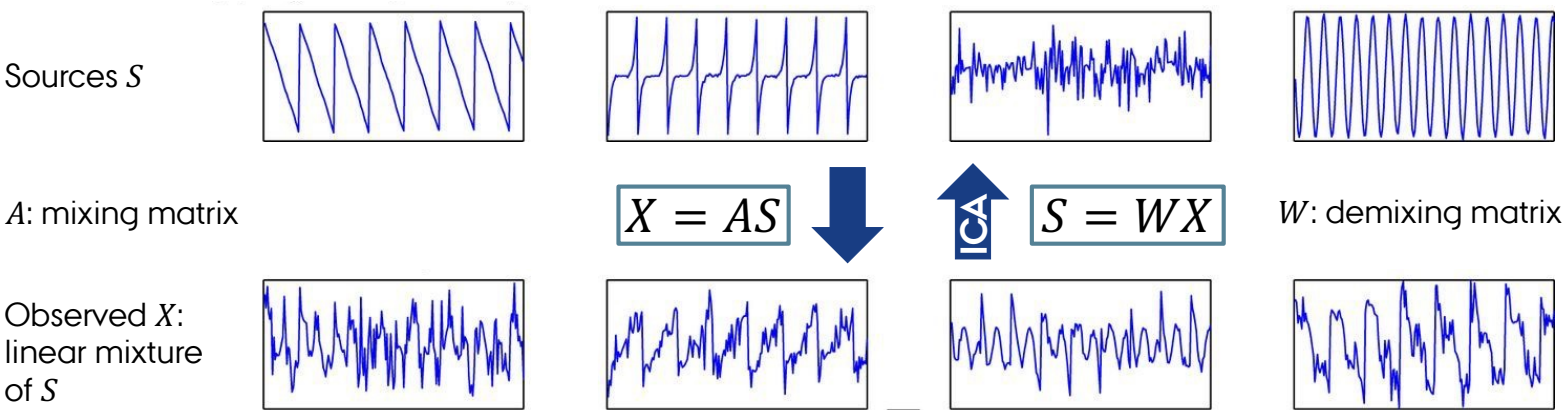
Brain networks and their dynamics

	Level of description:	
Independent Component Analysis	First order moments (e.g., amplitude)	
Hidden Markov Model	Second/higher order moments (e.g., functional connectivity)	

Vidaurre et al. (2022). Imaging Neuroscience

Independent component analysis

- Problem of blind source separation (Hérault and Jutten,1984-1991)
- Express a set of random variables as linear combinations of statistically independent component variables
- Leans on non-Gaussianity



Hyvärinen (2013), Philos. Trans. Royal Soc. A

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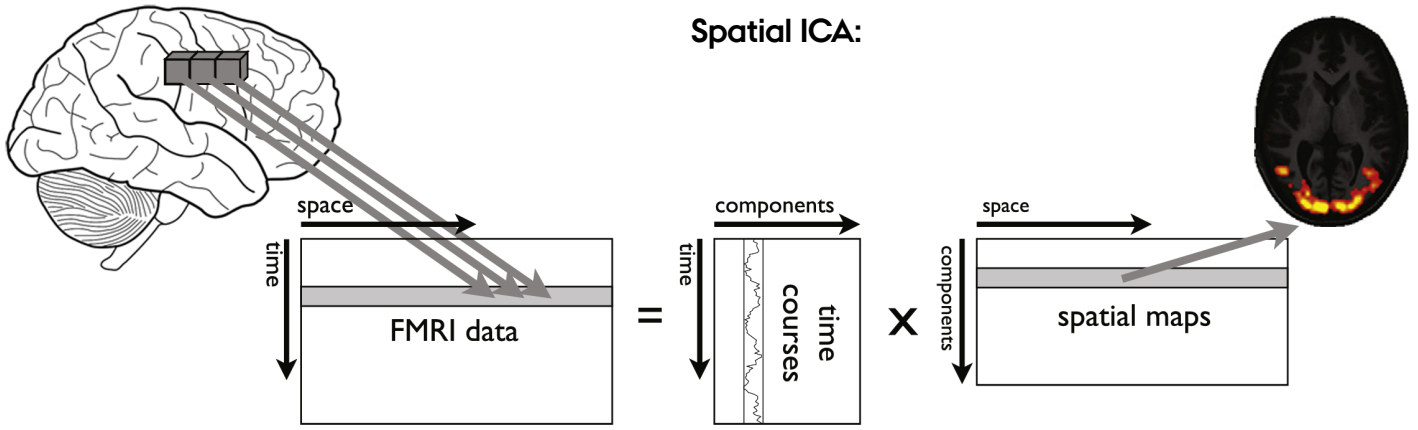
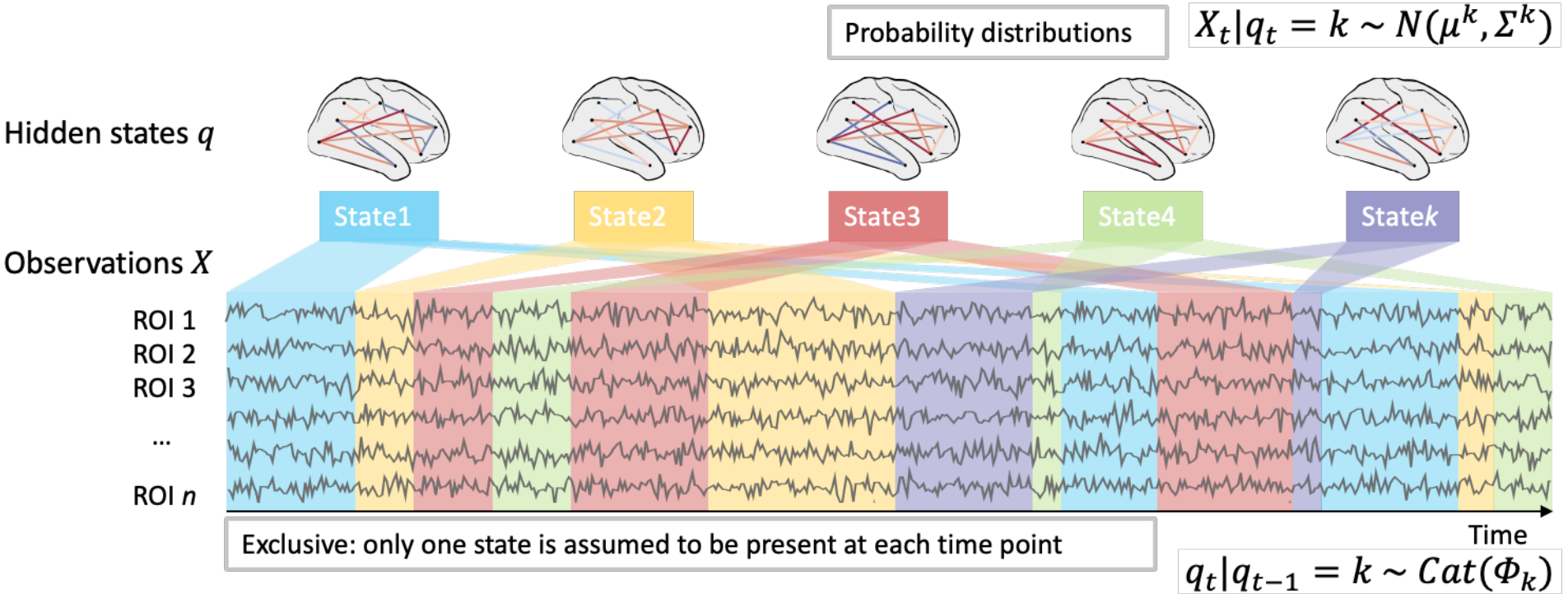


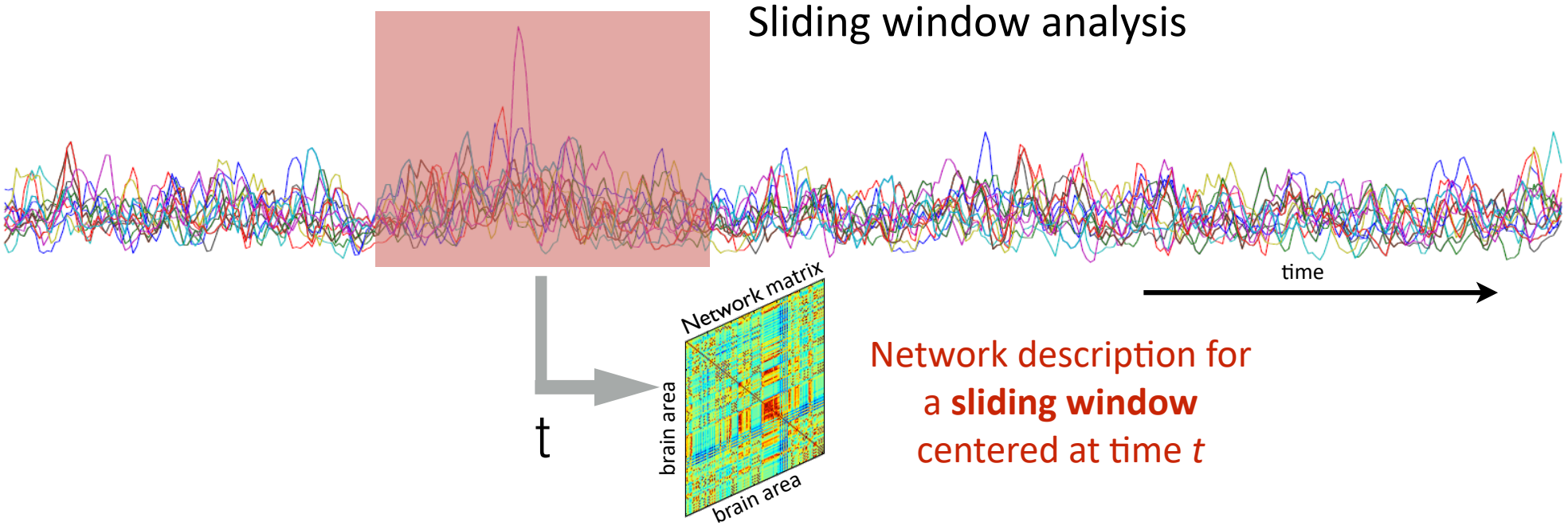
Beckmann (2012), NeuroImage

Hidden Markov Modelling



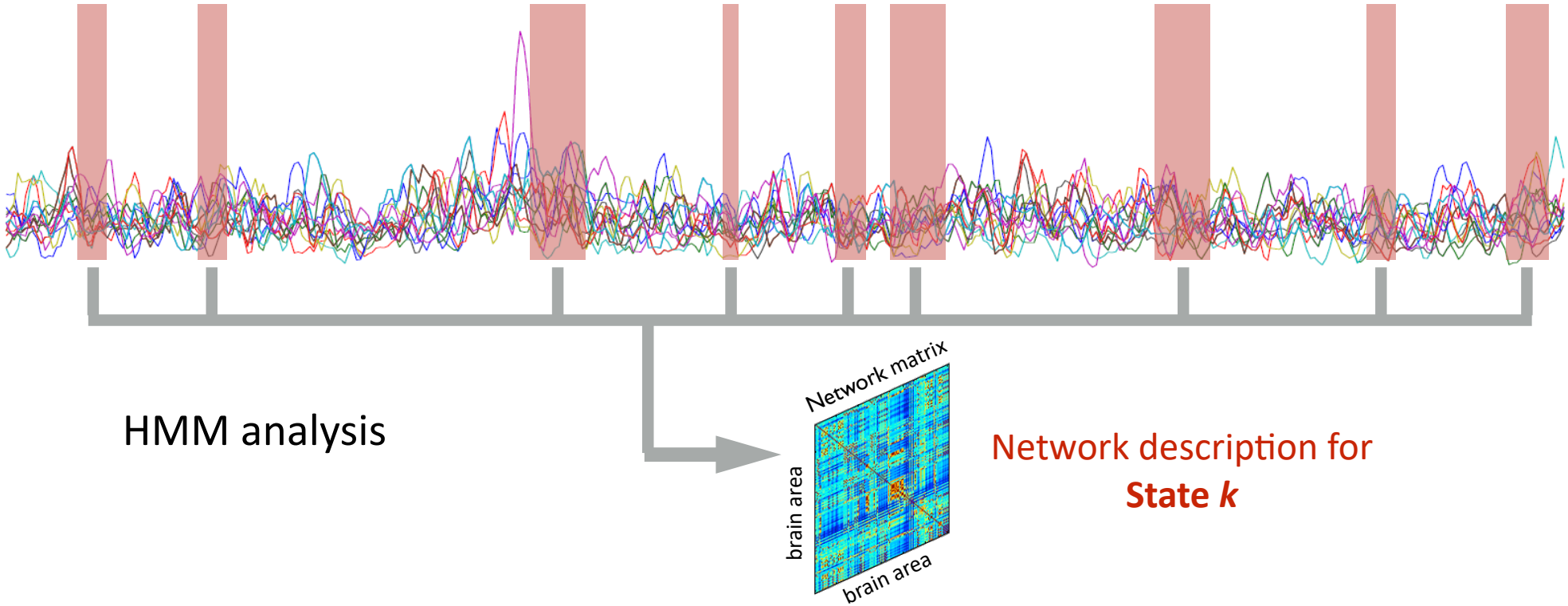
Vidaurre et al. (2017). PNAS
Vidaurre et al. (2018). Nature Communications
Ahrends & Vidaurre (2023). ArXiv

HMM vs. sliding window analyses



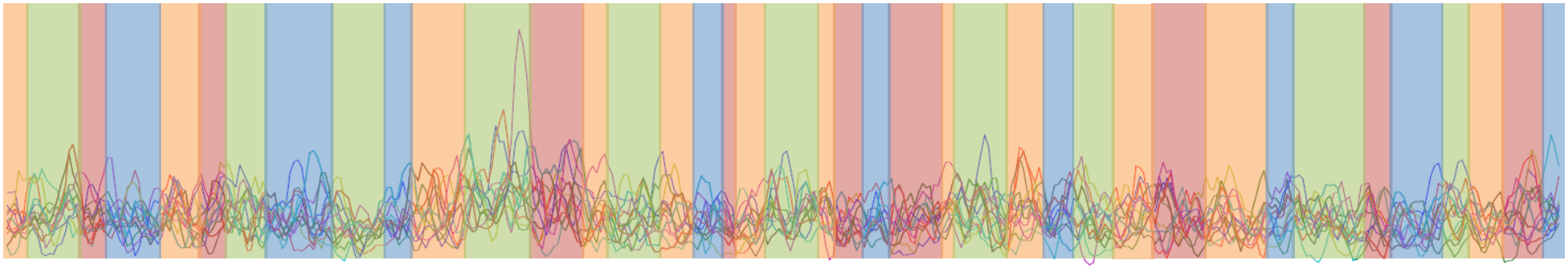
Network description for
a **sliding window**
centered at time *t*

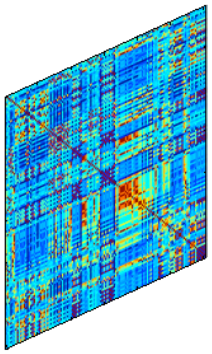
From windows to state visits



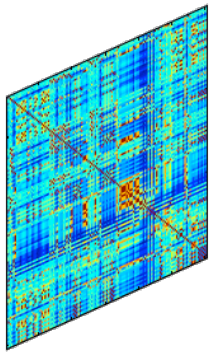
From windows to state visits

Pooling data over disjoint time periods:

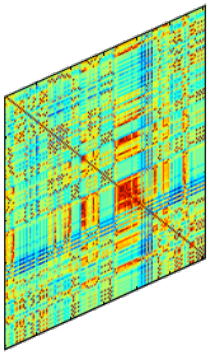




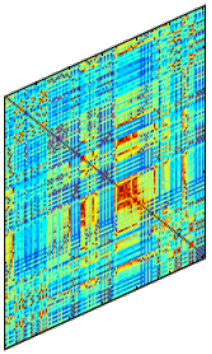
State 1



State 2



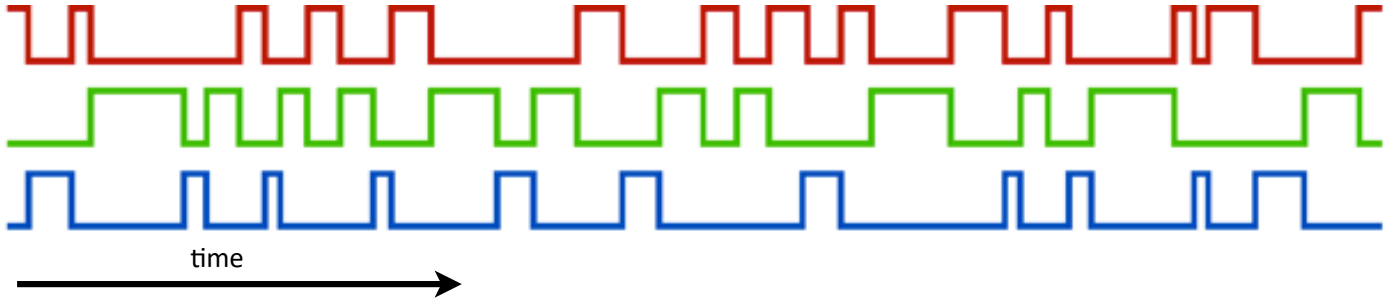
State 3



State 4

The elements of the HMM

State time courses:
When



State probability distribution
(one for each state):
What

Mean activation

Functional connectivity

Spectral properties

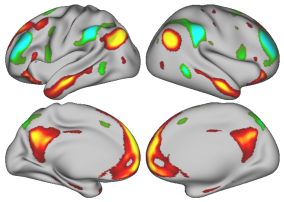
Transition probability matrix

The elements of the HMM

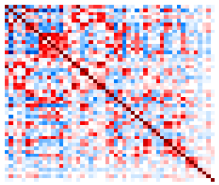
State time courses:
When

State probability distribution
(one for each state):
What

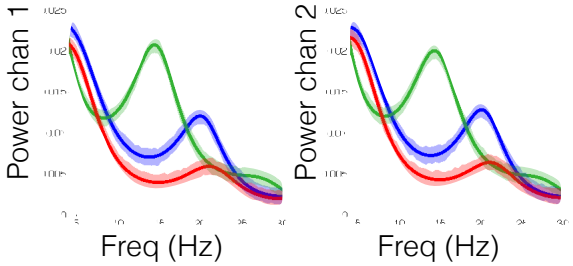
Mean activation



Functional connectivity



Spectral properties



Transition probability matrix

The elements of the HMM

State time courses:
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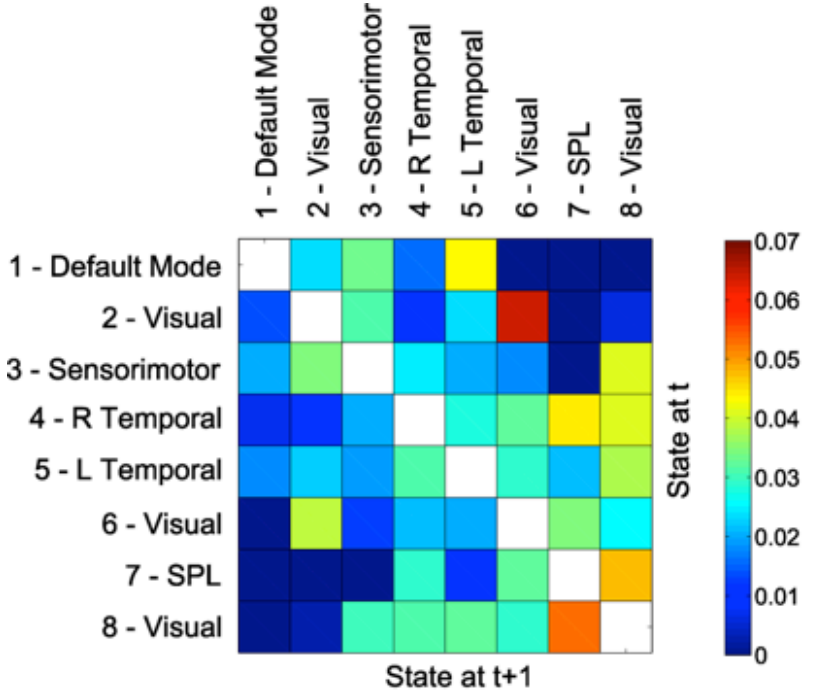
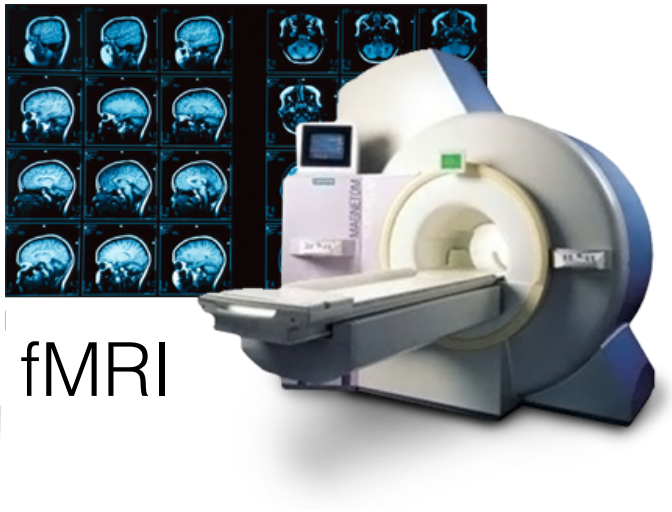


Transition probability matrix

Flexible state models

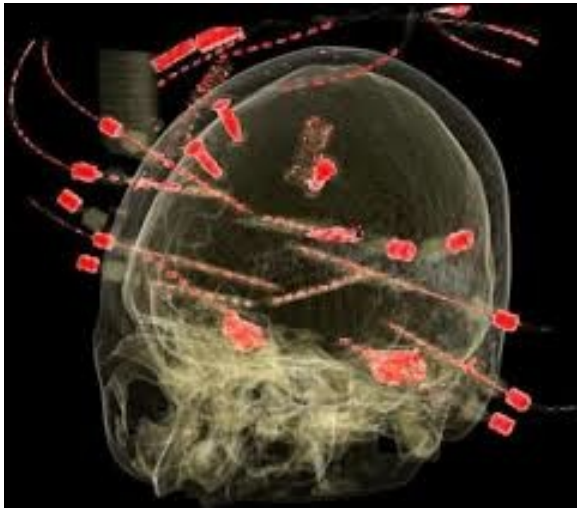
Sensor space M/EEG



fMRI

Source space M/EEG

HMM



Intracranial recordings

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HMM-based, using the GLHMM toolbox

Left-out (but you can ask)

- Advanced decoding analysis:

  What to do when we want to interrogate when and where the brain encodes a stimulus or decision, in a task with variable/unknown latencies —such as recall or imagery? (*Pablo*)

- Generative models of task data, e.g. for hypothesis testing (*Diego*)
- How can we make estimations of dynamics more robust? (*Sonsoles*)
- How to combine multiple models to achieve more powerful out-of-sample predictions of behavioural traits? (*Ben Griffin*)
- How to predict subject traits from EEG spectrograms (*Cecilia Jarne*)

Etc