Dynamic connectivity

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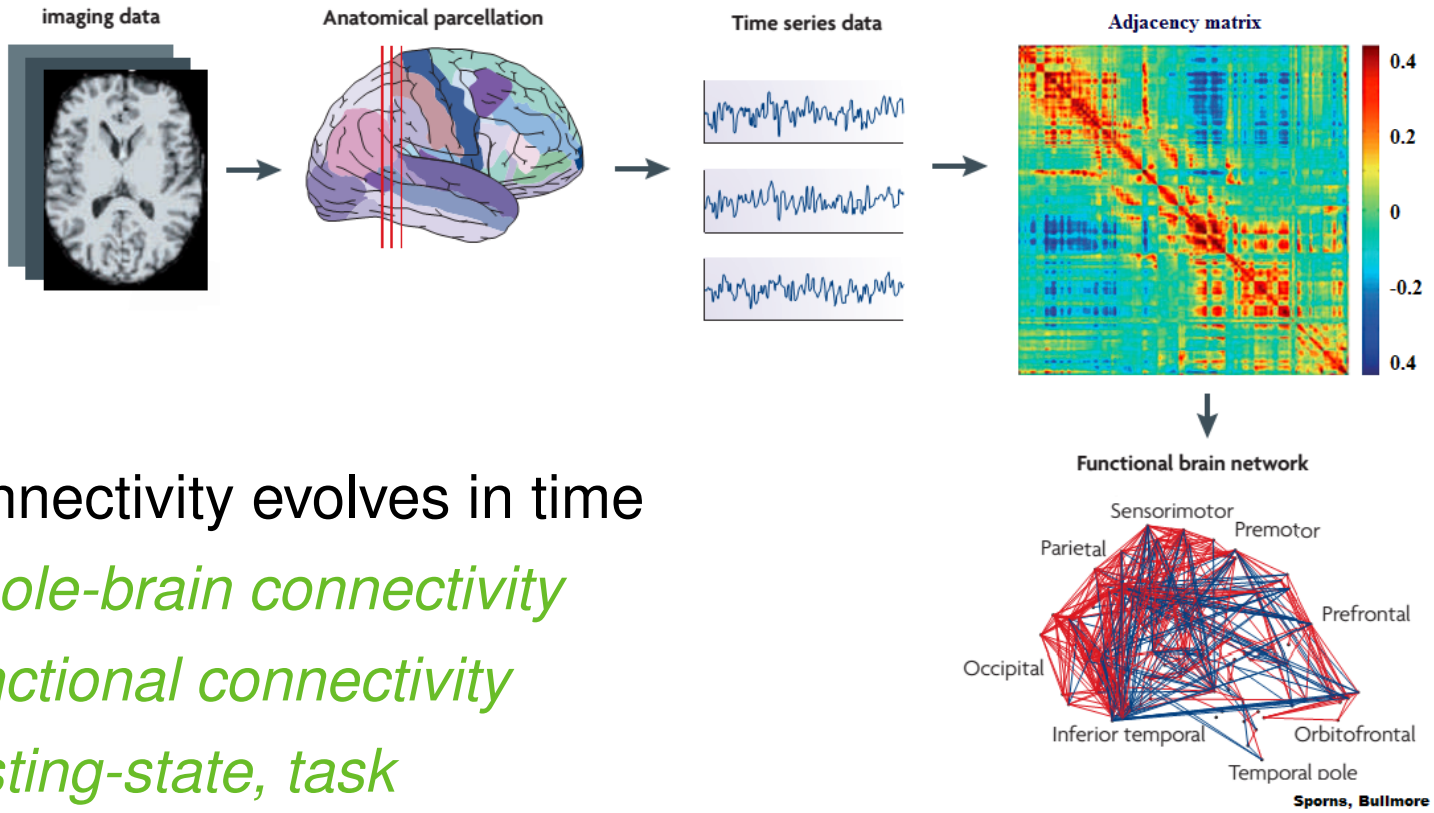
Introduction

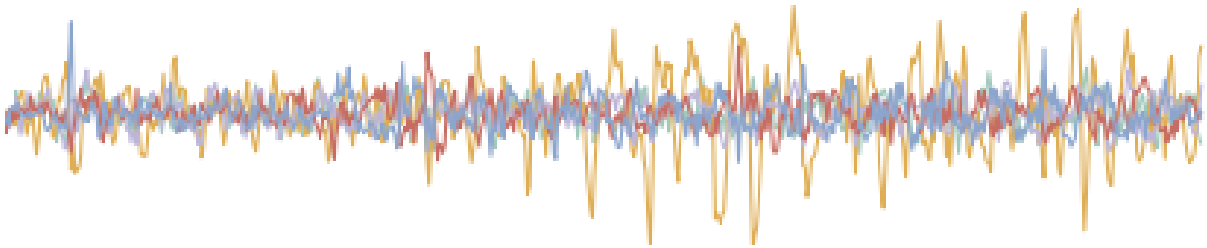
Why?

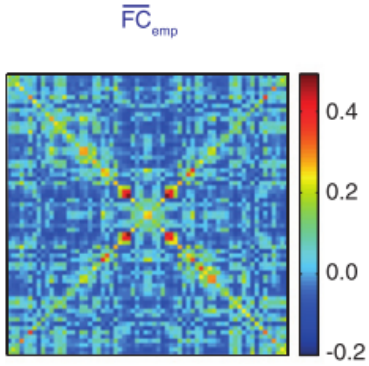
Classical approach to functional connectivity: relations between time-series, one connectivity matrix over whole measurement $\rightarrow$ static description of the dynamic system



- connectivity evolves in time
- *whole-brain connectivity*
- *functional connectivity*
- *resting-state, task*

What to do to capture the dynamics?



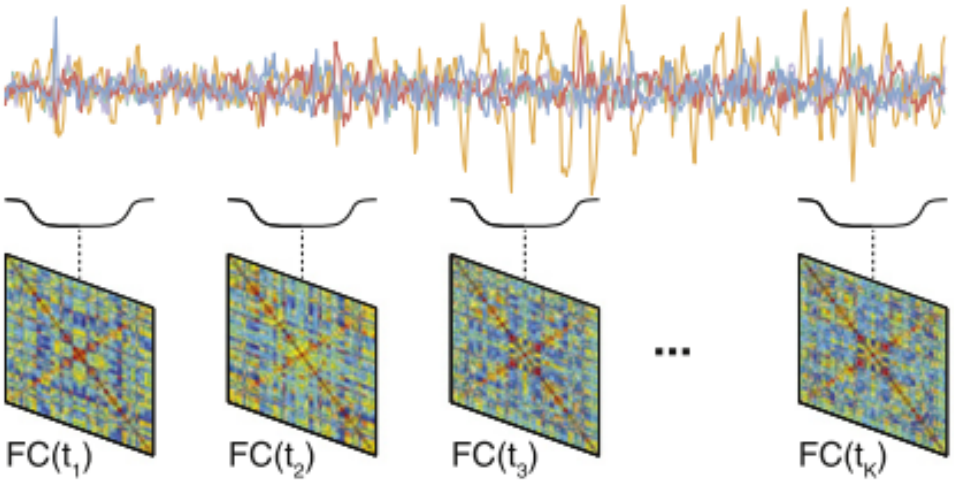


- evolution of static metric in time
- detection of brain states changing in time
- temporal extension of static metrics
- detection of change-points

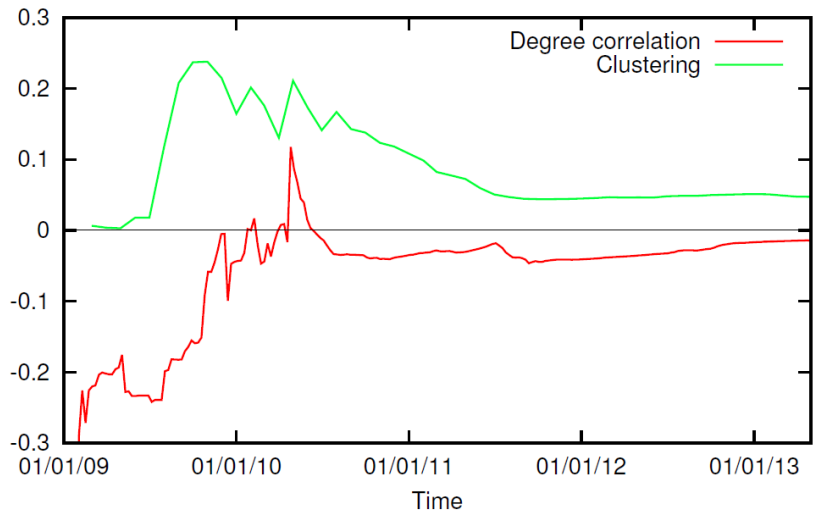
Evolution of static property/metric in time

sliding window approach

- the easiest
- global metrics (temporal evolution of one value for the whole brain)
- local metrics (temporal evolution for each ROI)



Hansen 2015

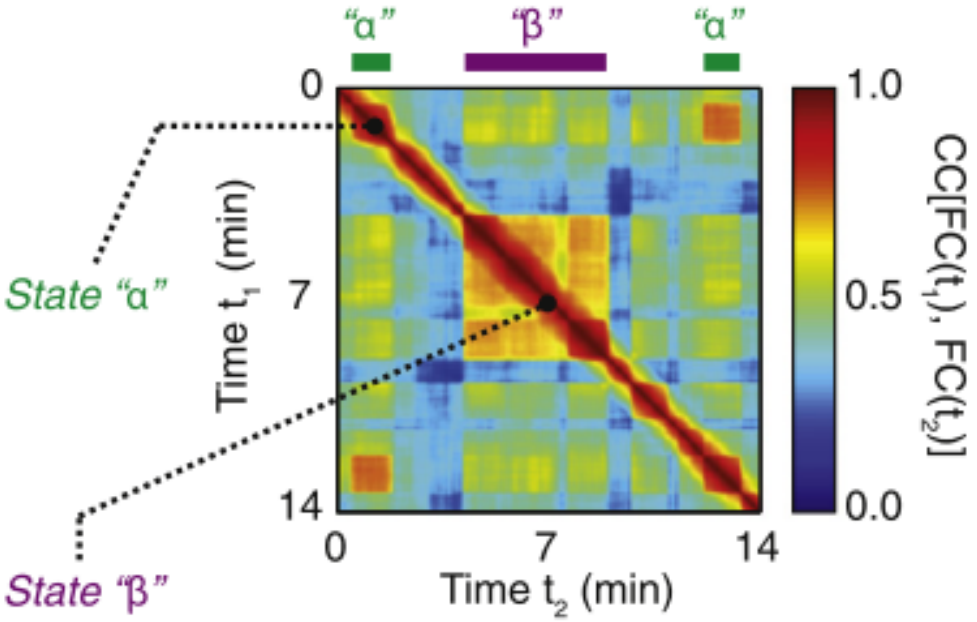


Kondor, 2014

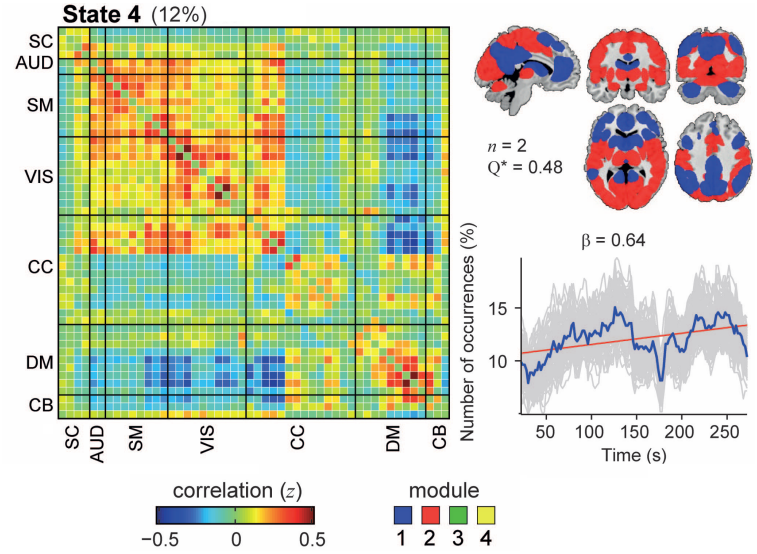
! *window length*

! *windows overlap*

Identification of recurring states of FC



Hansen 2015



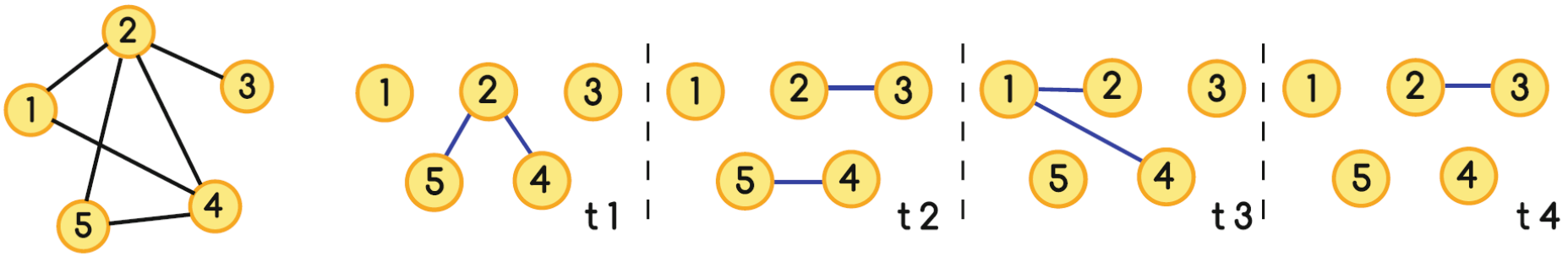
Allen, 2012

Inter-correlations of correlation matrices in time windows resulting in time-time correlations. Follow-up application of a clustering algorithm (e.g. k-means) identifies brain states.

Temporal networks

timestamp matters

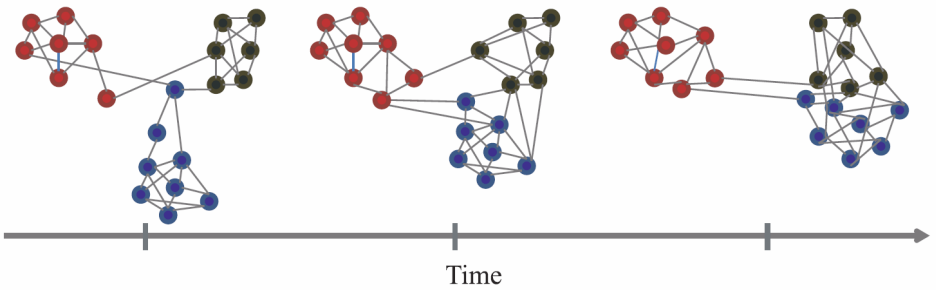
- network topology influences information spreading
- extensions of static network measures
  - path length (time-dependent paths / walks)
  - clustering coefficient (friend of my friend doesn't have to be my friend)
  - centrality measures (broadcast and receive centrality)
  - spatiotemporal patterns of connectivity



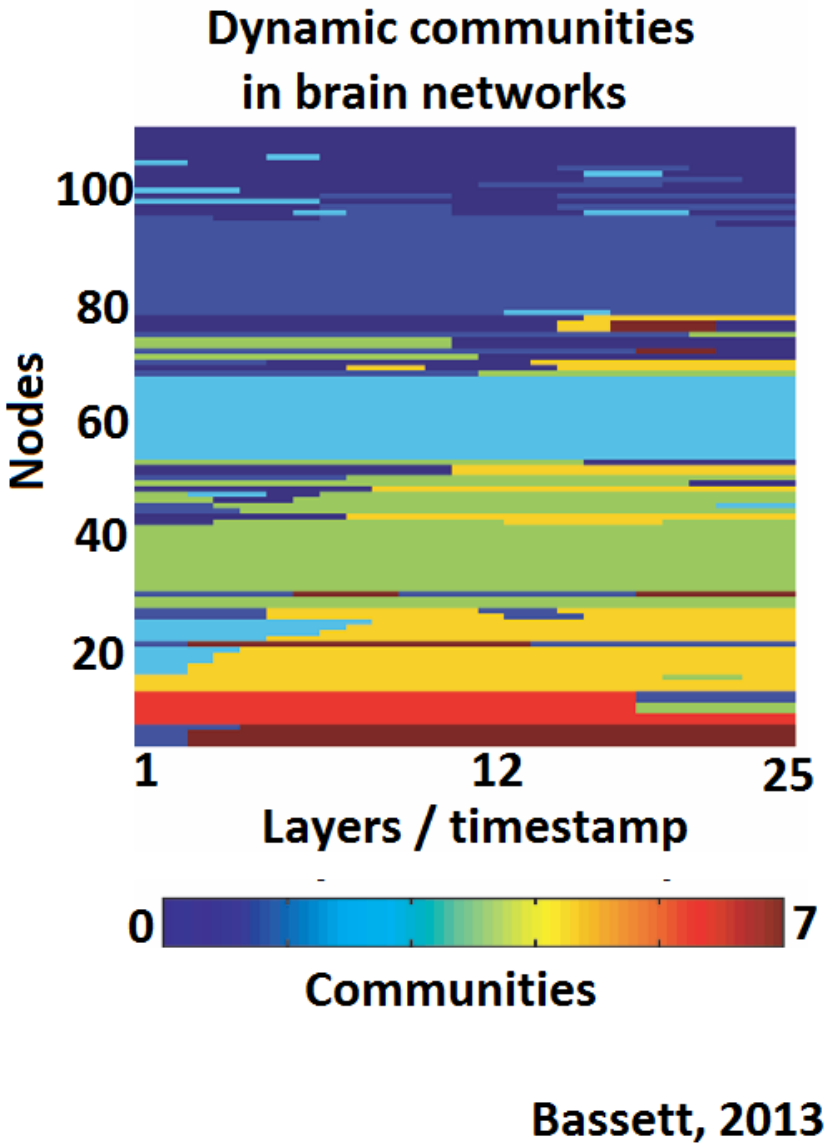
Nicosia 2013

Detour: multilayer networks

- generalization of temporal networks
- better established, possible to force time order
- layers dependent on each other but without any order
- e.g. diverse means of communication (e-mails, social networks, intranet, family, entertainment groups, . . .)



Bassett, 2013



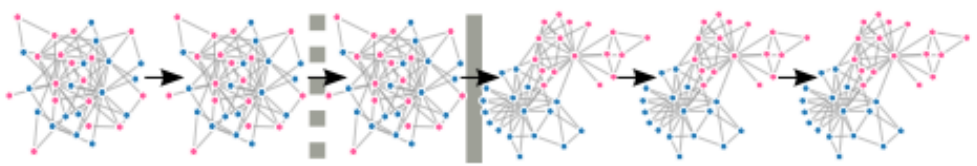
Bassett, 2013

Change-point detection

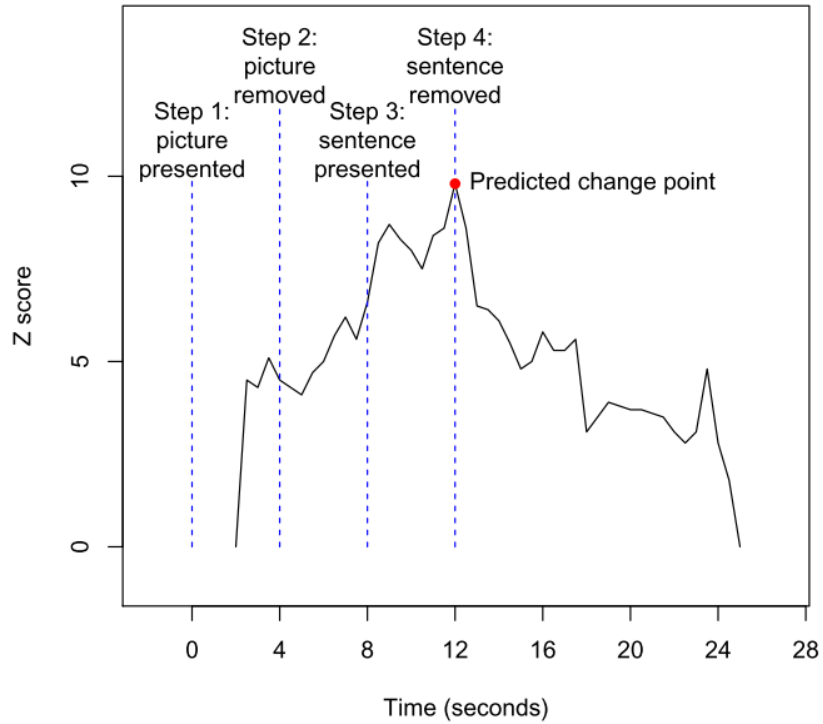
detection of critical moments when network topology changes

identification of important moments

- similarity between two snapshots
  - task-based experiments
  - interictal – ictal phases



Peel, 2014



Barnett, 2014

Issues

- time window length
- overlap of time windows
- correlation character of brain functional connectivity

Studying dynamics is important! But be extra careful.

Thank you for the attention.