Identification of Recurrent Patterns in the Activation of Brain Networks

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Motivation

- Mapping the neural correlates of recurring patterns in mental activity – i.e. brain states - is equivalent to finding recurring spatial patterns in the activations of brain networks

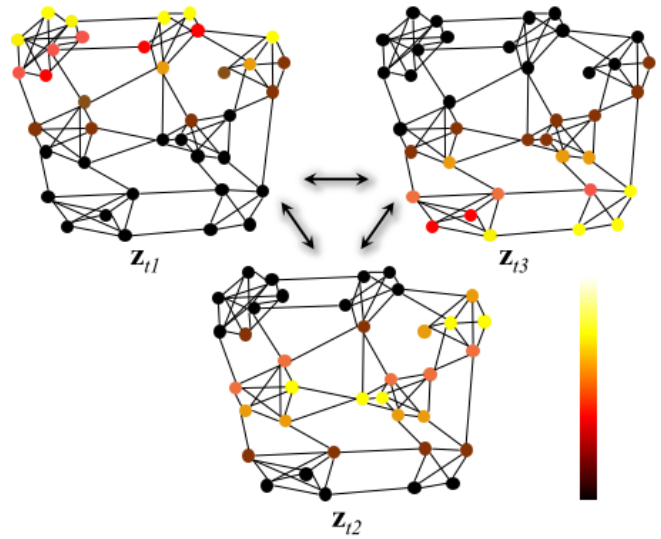
- Challenges:
  - Notion of similarity, across time, between measurements of a signal on nodes of a network
  - p >> n
  - Strong noise-induced correlations between adjacent time-points

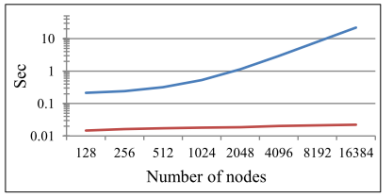
- Contribution: Definition of a network-aware distance metric
  - Low dimensional linear feature-space representation
  - Robust to structured fMRI noise and head motion

Concept

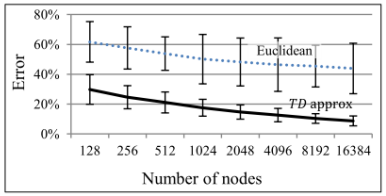
- Transportation distance
  - encodes network structure
  - robust to random noise
  - allows partial matches

- Network aware metric: linear feature space approximation
  - Spherical relaxation of the TD dual
  - Approximation error decreases with number of nodes
  - Very easy computation
    - Obtained from the graph Laplacian of the network

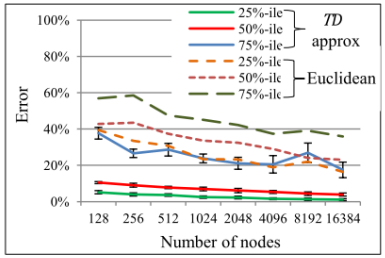




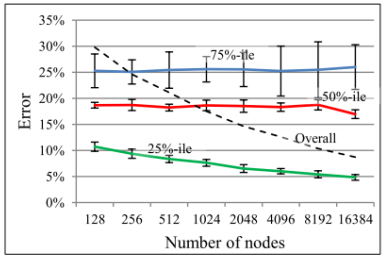
(a) Running time



(b) Approximation error

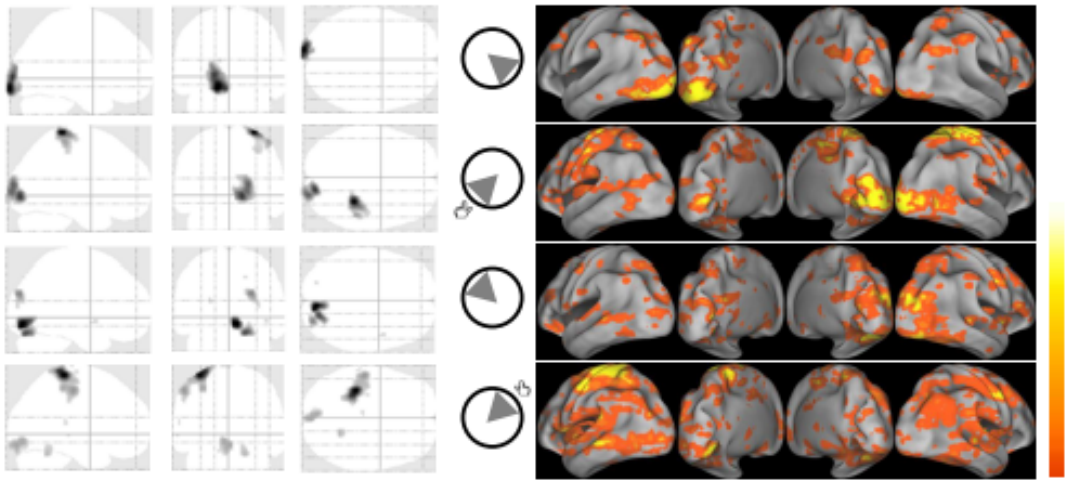


(c) Ordering error



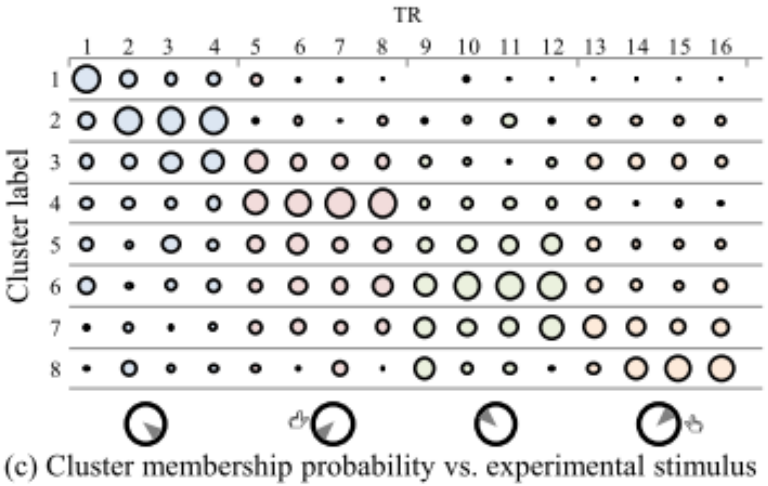
(d) Neighborhood error

Results



(a) GLM regression

(b) SSM based clustering



(c) Cluster membership probability vs. experimental stimulus