Identifying Alzheimer patients based on the analysis of graphs constructed from resting state fMRI data

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Project overview

What?

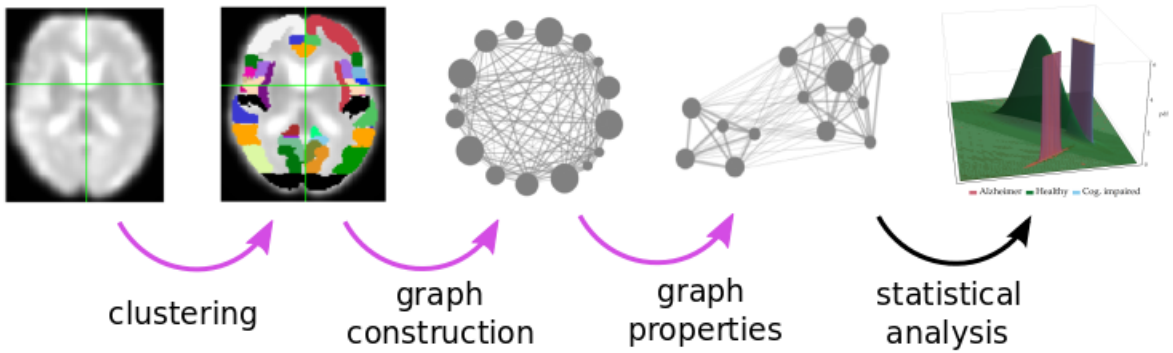
Distinguishing Alzheimer (A), mild cognitive impaired (MCI) and control (C) individuals based on resting state fMRI-data

Why?

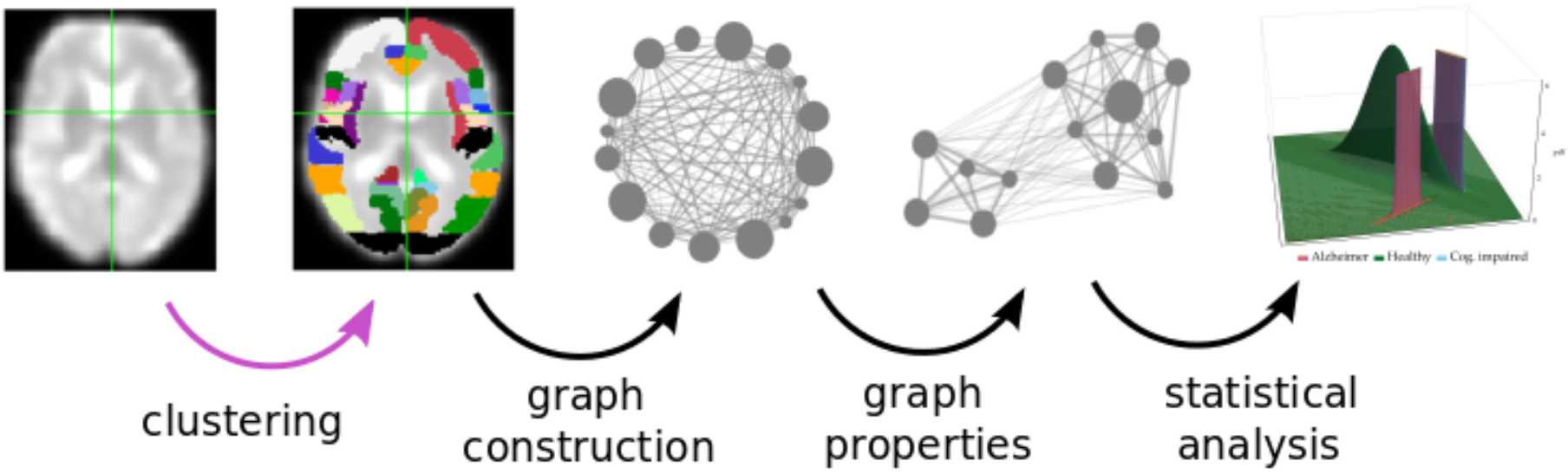
Expanding reportoire of AD diagnosis tools

How?

Comparing properties of graphs derived from resting state fMRI data
Investigating different methods for each step of graph construction

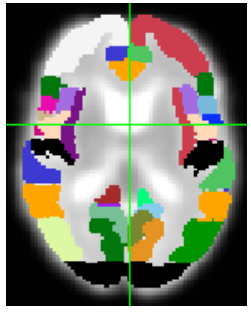


Clustering


clustering
graph construction
graph properties
statistical analysis

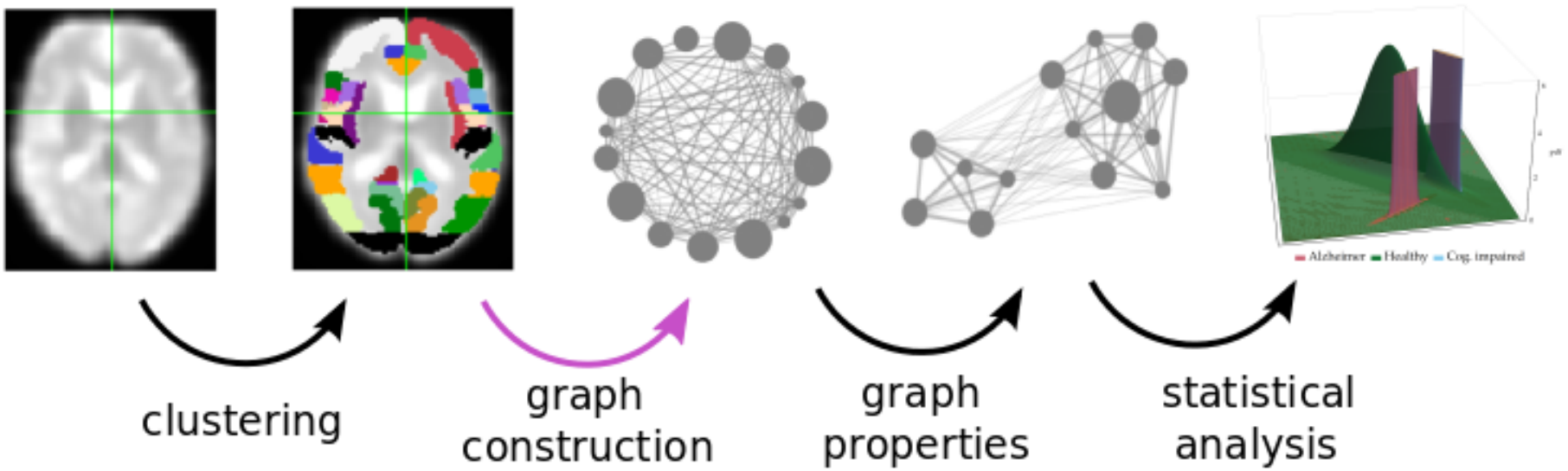
Clustering

- based on a structural **atlas** (Harvard-Oxford Atlas)
  - mapping of individual brains to standard brain
  - same number of nodes for all individuals
  - inhomogeneous signal across voxels in a cluster



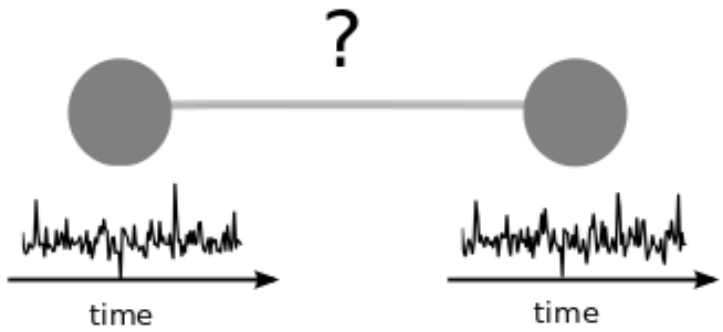
- **activity-driven**
  - Region growing and selection (Lu et al. 2003) and Ward clustering (Ward 1963)
  - different number of nodes for individual graphs
  - homogeneous signal across voxels in a cluster (Marrelec et al. 2011)

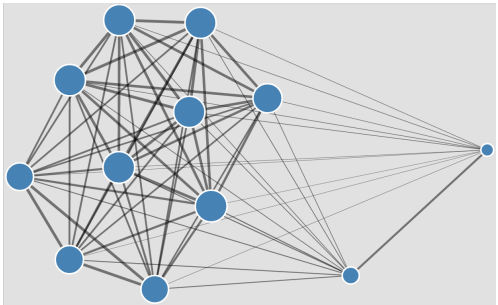
Graph construction



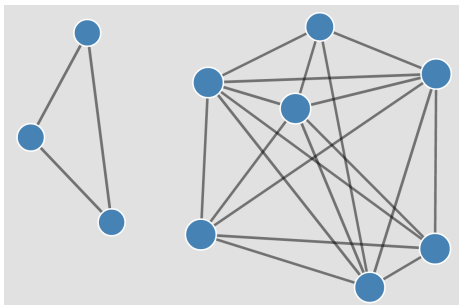
Graph construction

- how to measure functional connectivity?
- different connectivity analysis methods:
  - time/frequency based
  - model-based/model-free
    (Wang et al. 2014)
- thresholding graph weights on different levels





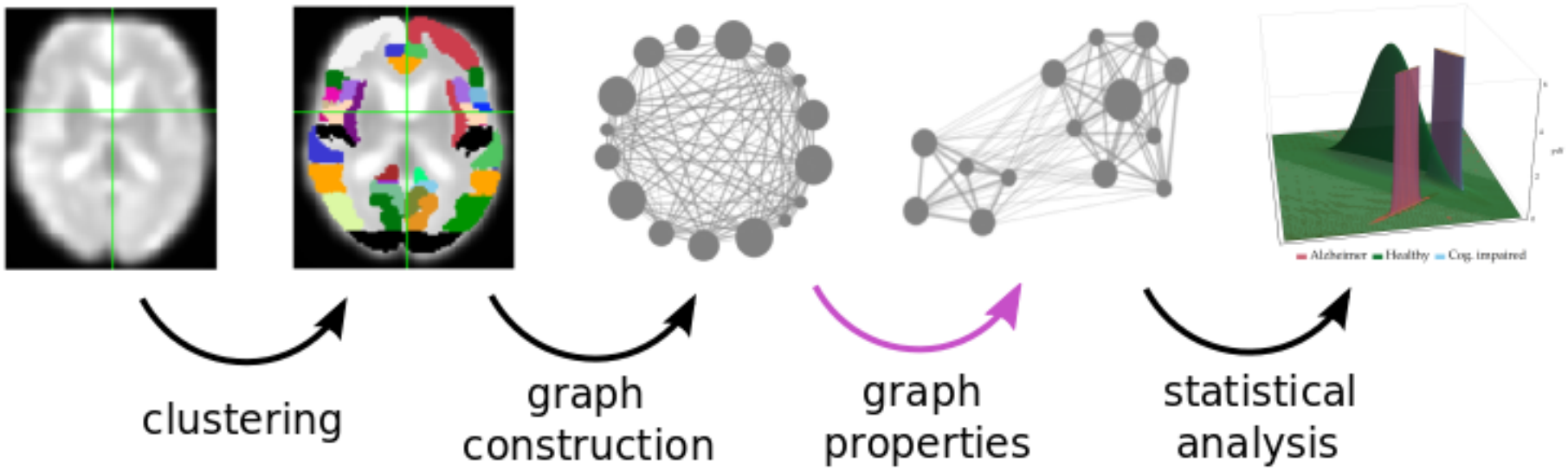
full graph



thresholded graph

(images by Fahad Khalid, JSC)

Graph properties

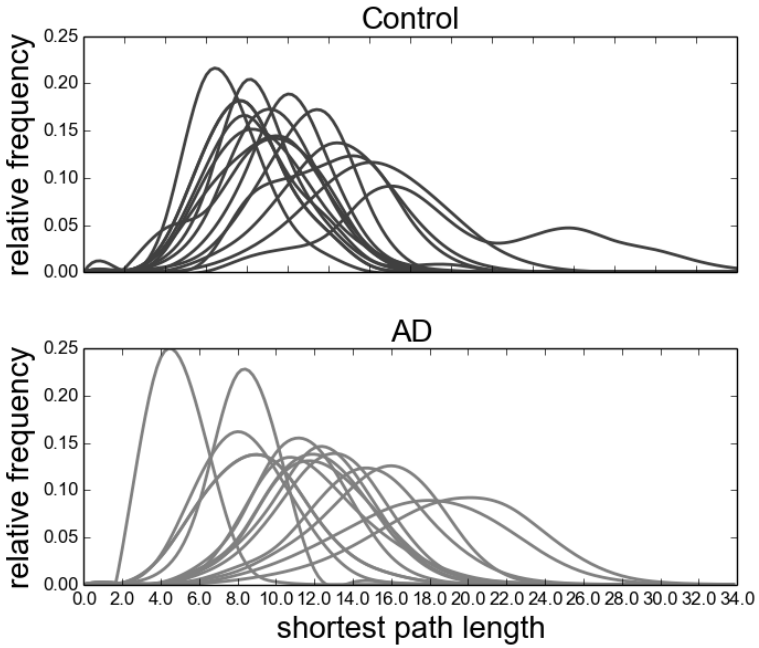


Graph properties

- various graph properties:

  e.g weighted degree, shortest path, clustering coefficient, modularity

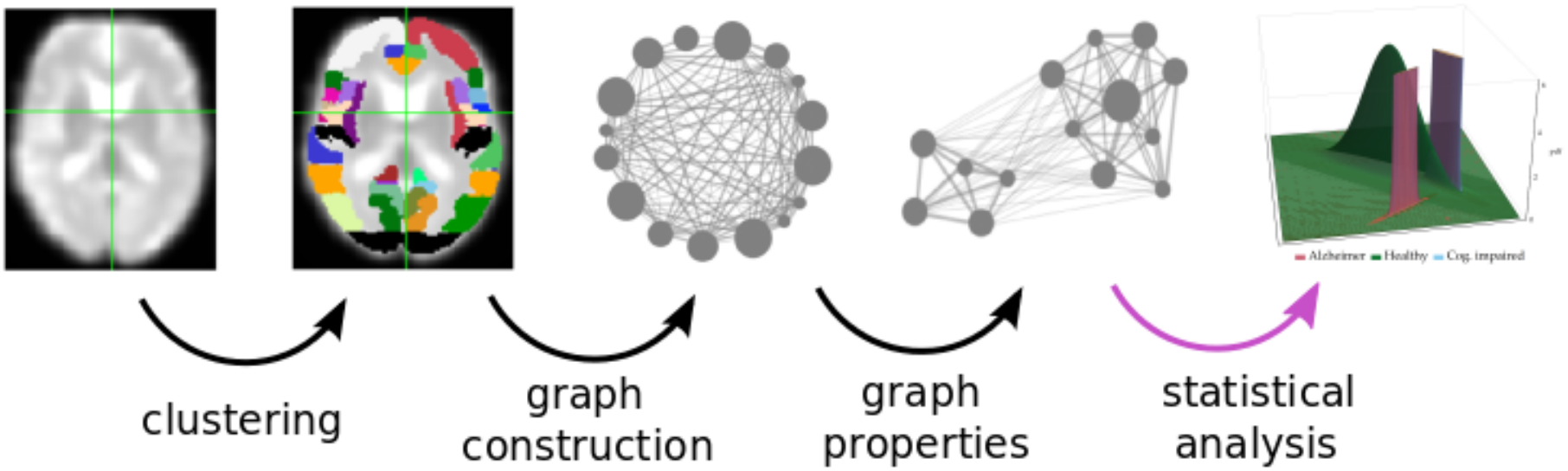
- huge diversity in distributions of graph properties across individuals



- first four moments used for statistical analysis

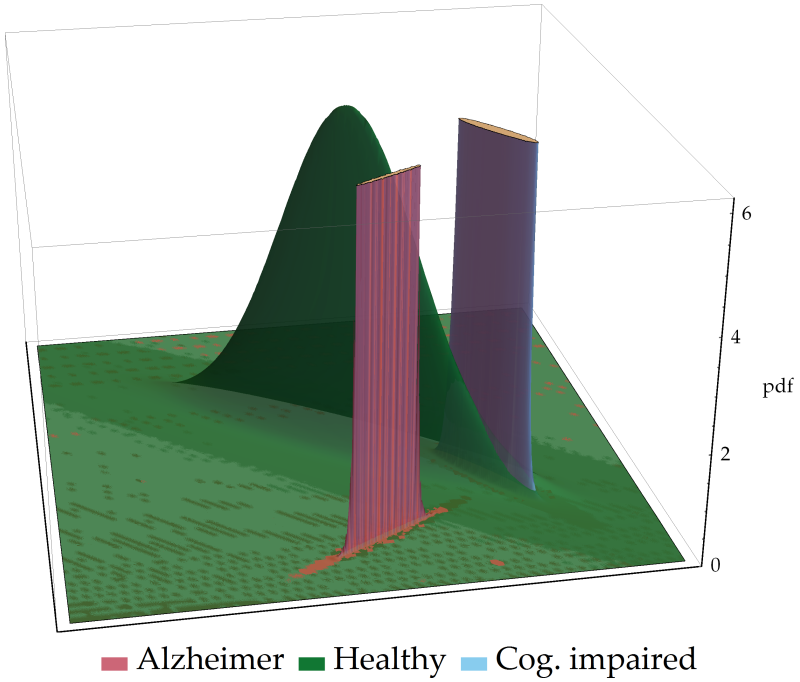
  (mean, variance, skewness, kurtosis)

Statistical analysis



Statistical analysis

statistical analysis based on **Model by sufficiency** (Bernardo and Smith 2000)



sample size: 26 C, 16 MCI, 14 AD

first results so far:

clustering: region growing

graph-weights: transfer entropy

correct predictions:

93% AD, 63% MCI, 96% C

Conclusion:

very good separability of the groups of subjects can be achieved, despite the large overlap in graph properties, if appropriate methods for graph generation are selected.

References

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5. Wang HE, Bénar CG, Quilichini PP, Friston KJ, Jirsa VK, Bernard C. A systematic framework for functional connectivity measures. Frontiers in Neuroscience. 2014;8:405. doi:10.3389/fnins.2014.00405.
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Thank you

Thank you for your attention and feedback!

Different ways of accessing function connectivity

		Model-free		Model-based	
Time	Linear	Correlation		Granger	
		BCorrU	PCorrU	GC	PGC
		BCorrD	PCorrD	CondGC	
	Nonlinear	h^2		Transfer Entropy	
		Bh^2U	Ph^2U	BTEU	PTEU
		Bh^2D	Ph^2D	BTED	PTED
		Mutual Information			
		BMITU	PMITU		
		BMITD1	PMITD1		
		BMITD2	PMITD2		
Frequency	Linear	Coherence		$\bar{\mathcal{A}}\mathcal{H}$	
		BCohF	PCohF	AS	hmvar
		BCohW	PCohW	PDC	DTF
				PDCF	DC
				GPDC	ffDTF
				dDTF	GGC
				PCOH1	COH1
				PCOH2	COH2
				MVAR/Af	Smvar

(Wang et al. 2014)

Probability plot