

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

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INM-6, IAS-6, INM-3

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Project overview

What?

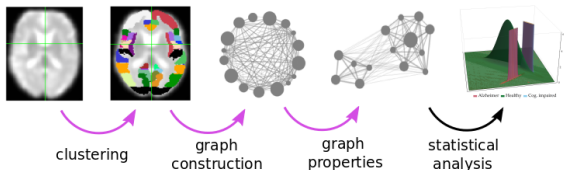
Distinguishing Alzheimer (A), mild cognitive impaired (MCI) and control (C) individuals based on resting state fMRI-data

Why?

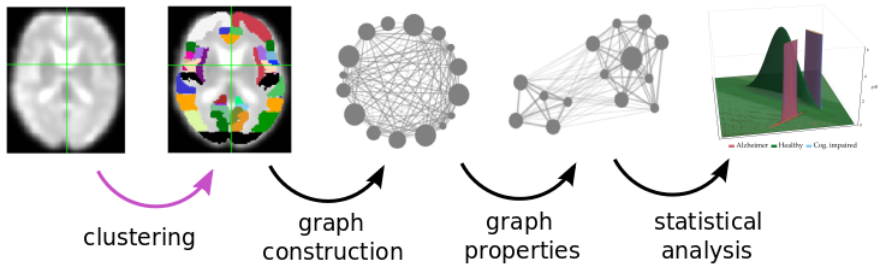
Expanding repertoire of AD diagnosis tools

How?

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

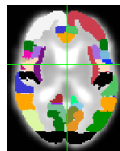


Clustering



Clustering

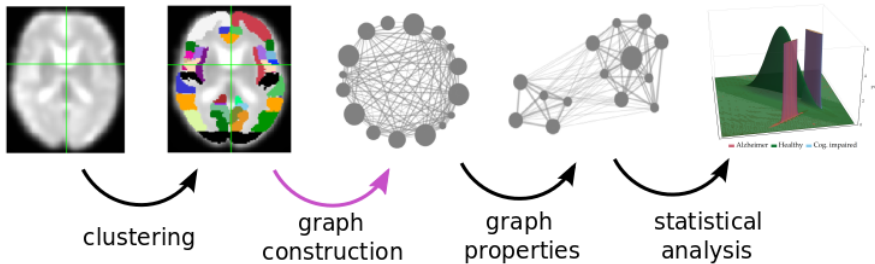
- based on a structural **atlas** (Harvard-Oxford Atlas)
 - mapping of individual brains to standard brain
 - same number of nodes for all individuals
 - inhomogeneous signal across voxels in a cluster



- **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)

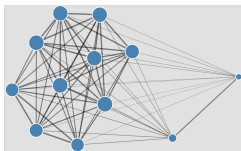
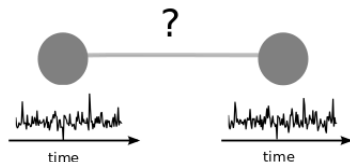


Graph construction

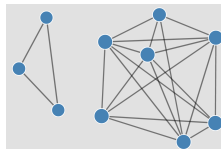


Graph construction

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

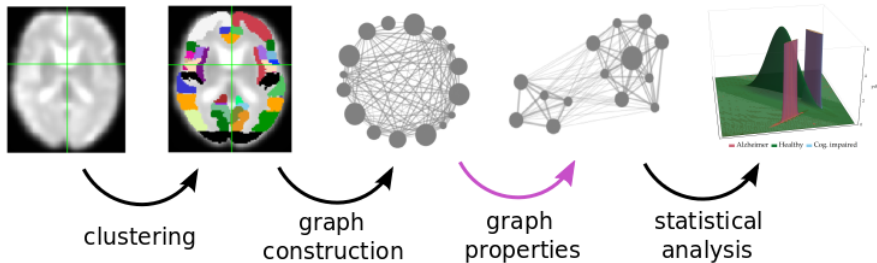


full graph



thresholded graph

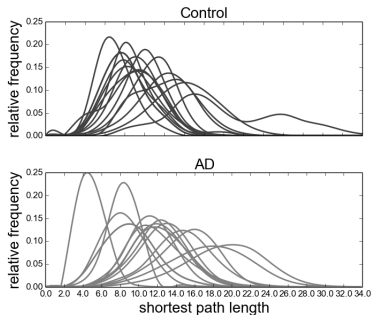
Graph properties



Graph properties

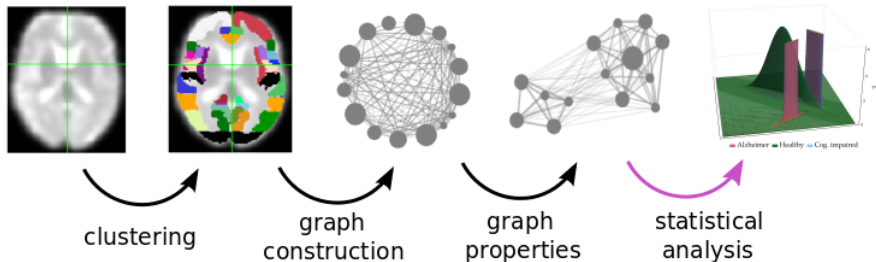
- various graph properties:
e.g weighted degree, shortest path, clustering coefficient, modularity

- huge diversity in distributions of graph properties across individuals



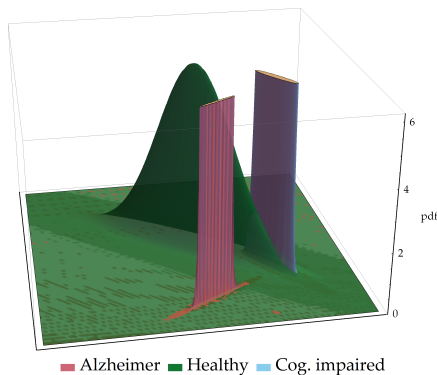
- first four moments used for statistical analysis
(mean, variance, skewness, kurtosis)

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

References

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- ② Lu Y, Jiang T, Zang Y.: Region growing method for the analysis of functional MRI data. *Neuroimage*. 2003, 20(1): 455-65.
- ③ Ward JH. Hierarchical Grouping to Optimize an Objective Function, *Journal of the American Statistical Association*, (1963), 58, 236–244.
- ④ Marrelec G, Fransson P.: Assessing the influence of different ROI selection strategies on functional connectivity analyses of fMRI data acquired during steady-state conditions. *PLoS One* 2011, 6(4): e14788.
- 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.
- ⑥ J.-M. Bernardo, A. F. Smith: *Bayesian Theory*. Wiley 2000.

Thank you

Thank you for your attention and feedback!

Different ways of accessing function connectivity

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

(Wang et al. 2014)

Probability plot

