

A title

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Read "not so short introduction to latex" ("<http://www.ctan.org/tex-archive/info/lshort/english/lshort.pdf>").

1 A section

1.1 A sub section

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1.2 A sub section

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2 A section

Conclusion

Note that the title above has no numbering. It is because of the 'star' at the end of section.

Large-scale functional-connectivity graphical models for individual subjects using population prior



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Network inference

Gaussian Graphical models

- Generative model of the signal
- Interaction between regions estimated by partial correlation
- Amounts to covariance estimation
- An estimation problem**
- Many brain regions, short time series
- **Inter-subject variability** prevents data accumulation

ℓ_{21} penalization for inverse covariance

$$\hat{\mathbf{K}}_{\ell_{21}}^{(s)} = \underset{\mathbf{K}^{(s)} \succ 0}{\operatorname{argmin}} \sum_{s=1}^S \left(\operatorname{tr}(\mathbf{K}^{(s)} \Sigma_{\text{sample}}^{(s)}) - \log \det \mathbf{K}^{(s)} \right) + \lambda \sum_{i \neq j} \|\mathbf{K}_{ij}^{(s)}\|_2$$

- **Joint sparsity:** pattern shared in population (similar to group-lasso)
- Convex optimization with cyclical coordinate descent on Choleski decompositions of the precision matrices [A. Rothman, 2008]

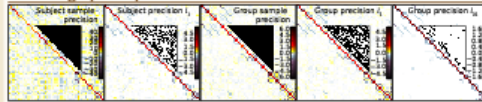
Subject-level edge values



Group-level edge selection

Experimental validation

- Use a full-brain atlas to extract time-series
- Probabilistic atlas of anatomical structures (poster 335)
- 137 cortical and sub-cortical regions
- Resulting sparse precision matrices



Cross validation results

Comparison with other covariance estimation method:

■ LW = Ledoit-Wolf: non-sparse shrinkage

■ ℓ_1 = Normal sparse inverse covariance

	Using subject data				Uniform group model				ℓ_{21}
	MLE	LW	ℓ_2	ℓ_1	MLE	LW	ℓ_2	ℓ_1	
Generalization score	-57.1	33.1	38.8	43.0	40.6	41.5	41.6	41.8	45.6
Filling factor	100%	100%	100%	45%	100%	100%	100%	60%	8%
Communities	6	5	5	9	9	8	7	9	16
Modularity	.07	.07	.12	.25	.23	.23	.18	.32	.60

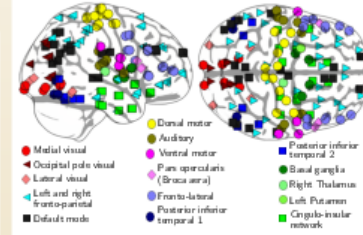
Reference:

G. Varoquaux *et al.*, Brain covariance selection: better individual functional connectivity models using population prior, Adv. NIPS 2010

<http://books.nips.cc/nips23.html>

Segregation into functional networks

Segregation: graph communities [Bullmore, 2009]



■ **Modularity:** partitioning the graph in functional communities to maximize the ratio of connections inside/across clusters

■ Graph cut algorithm similar to normalized cuts

■ Communities of sparse (ℓ_{21}) graphs separate functional networks

Integration: mutual information [Tononi 1994]

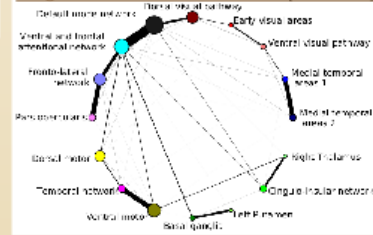


Figure 1: A caption