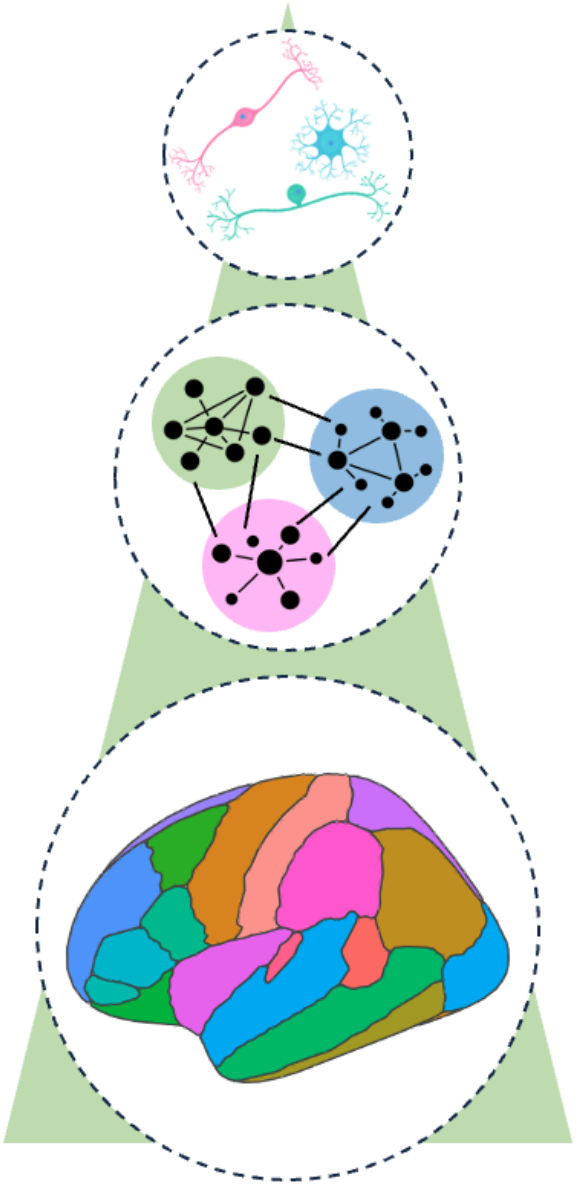
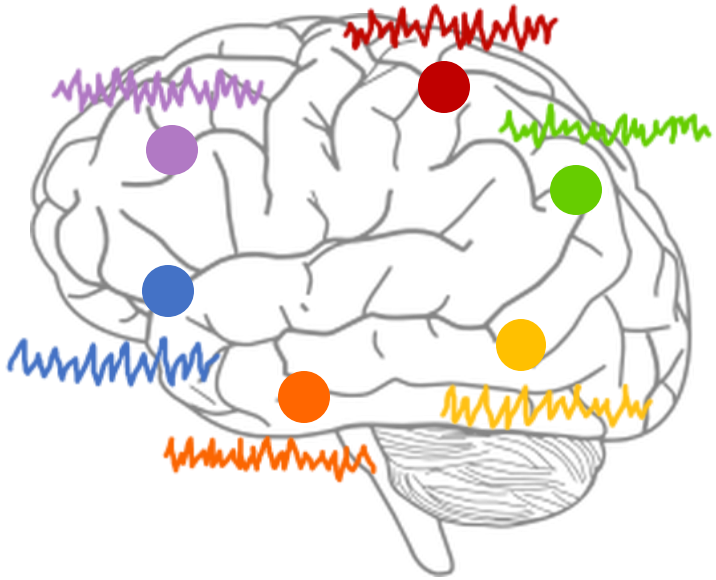
The highly comparative approach: Interpretable insights for structural and functional neuroimaging

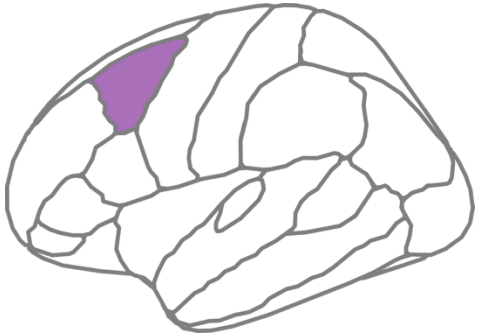
ANNIE G. BRYANT

THE UNIVERSITY OF SYDNEY

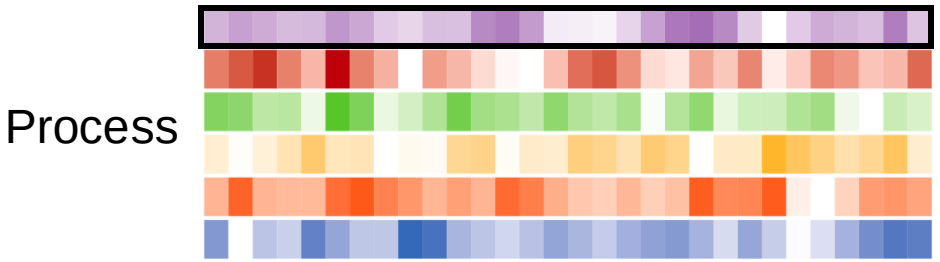
Brain dynamics can be quantified at **multiple scales**







Multivariate time series (**MTS**)



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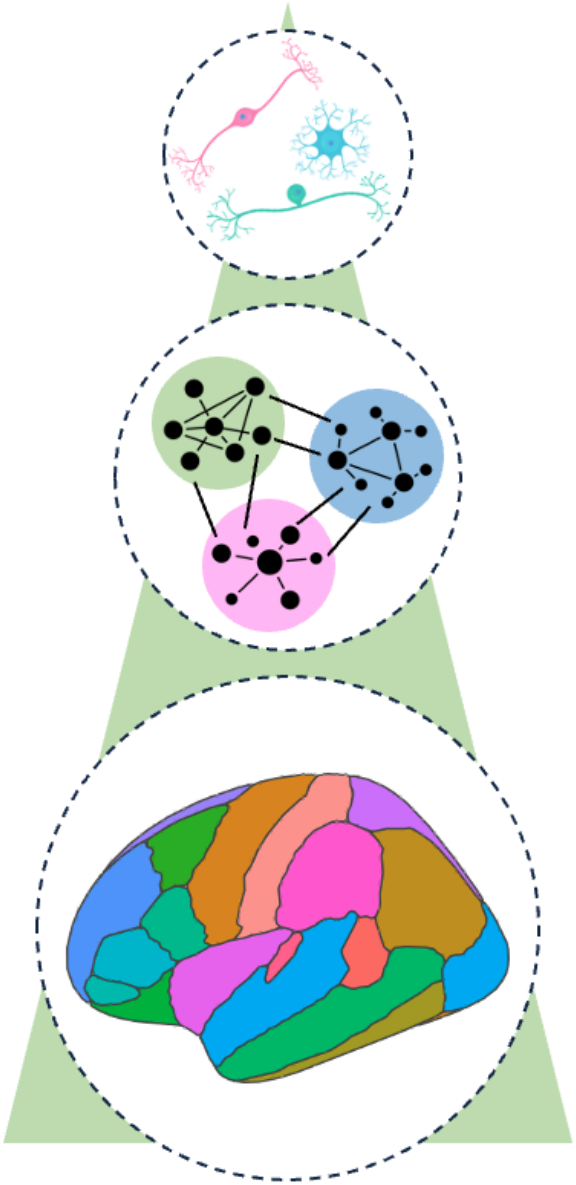

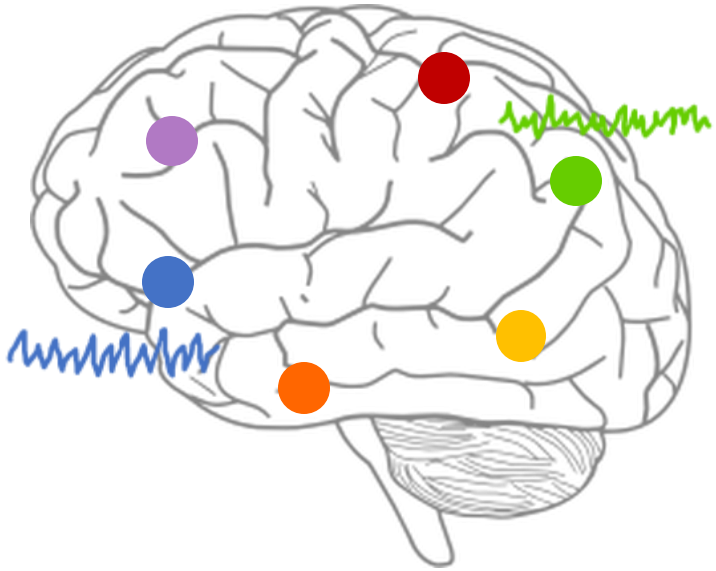

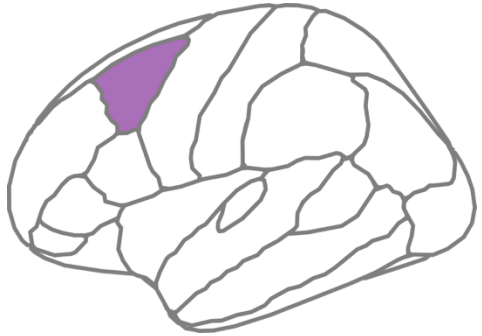

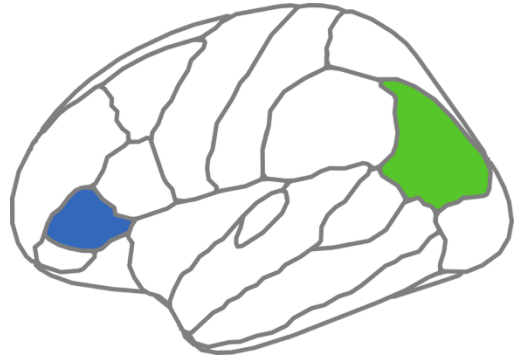

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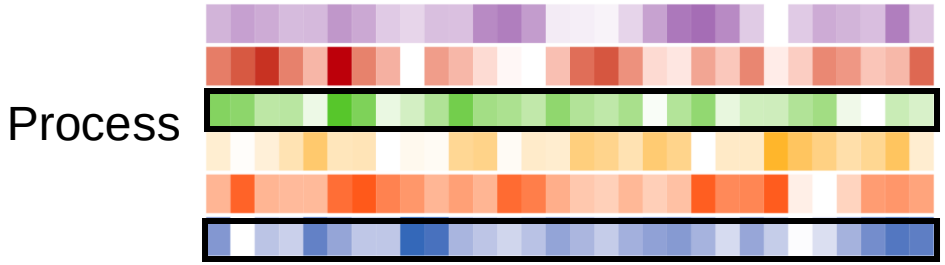

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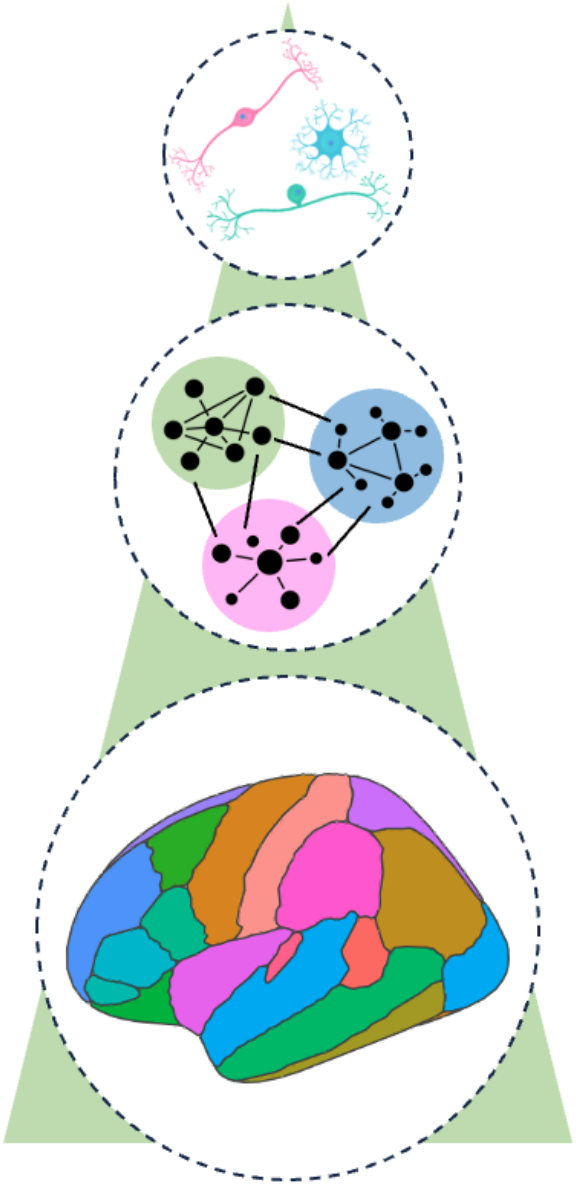

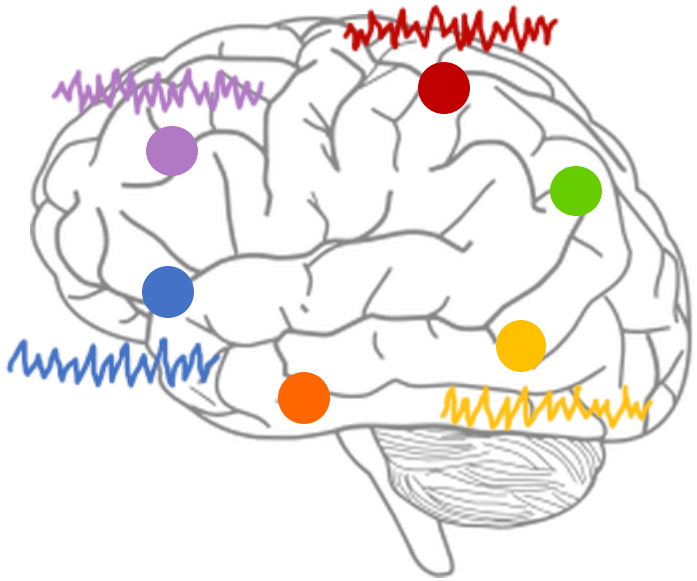

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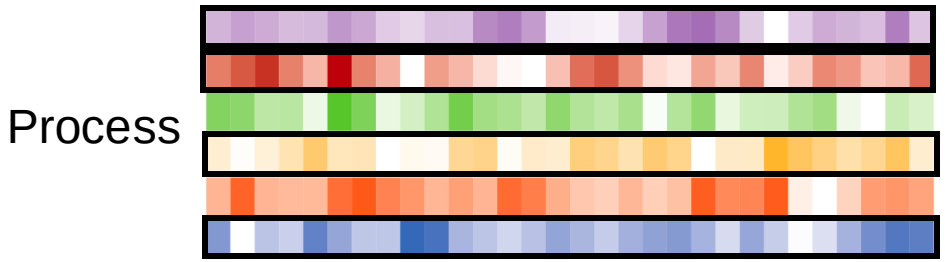
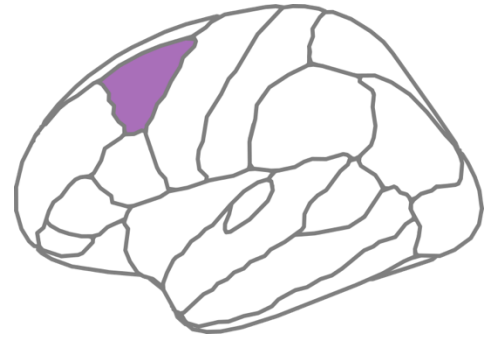
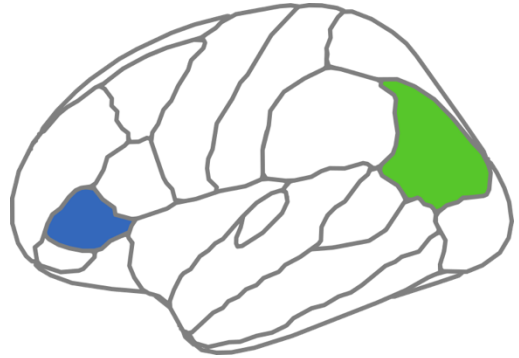
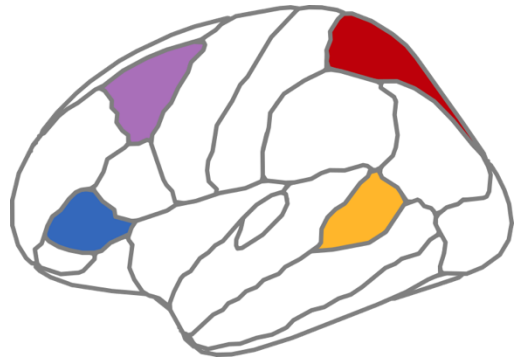








How might we begin to **quantify** brain dynamics?

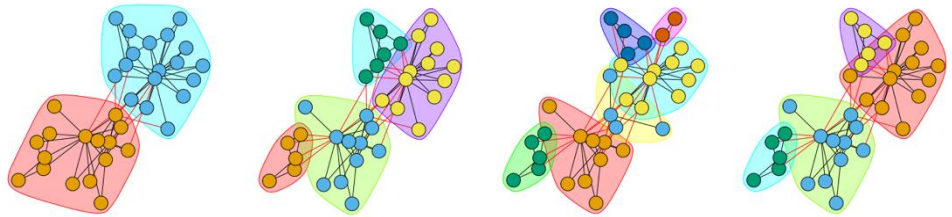
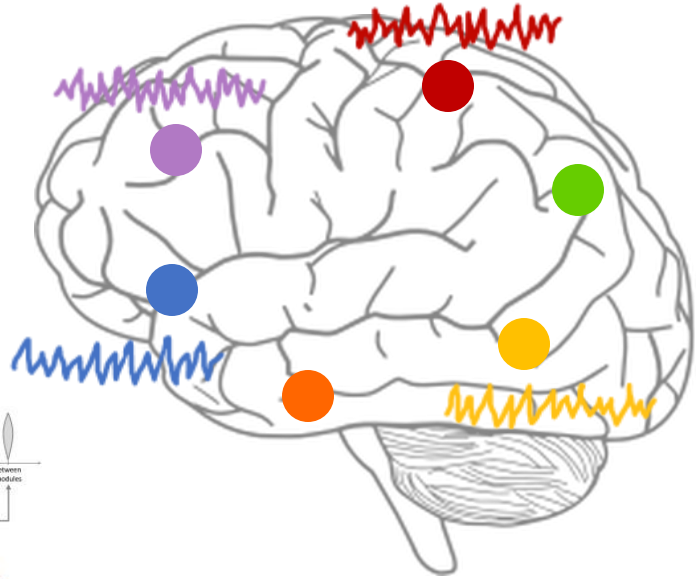


Image Source: Leão 2019

Examining **modularity** of **connectome-based networks**



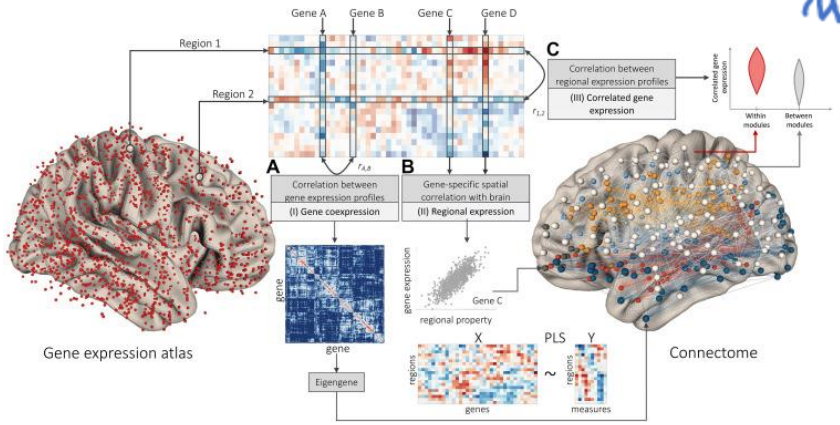
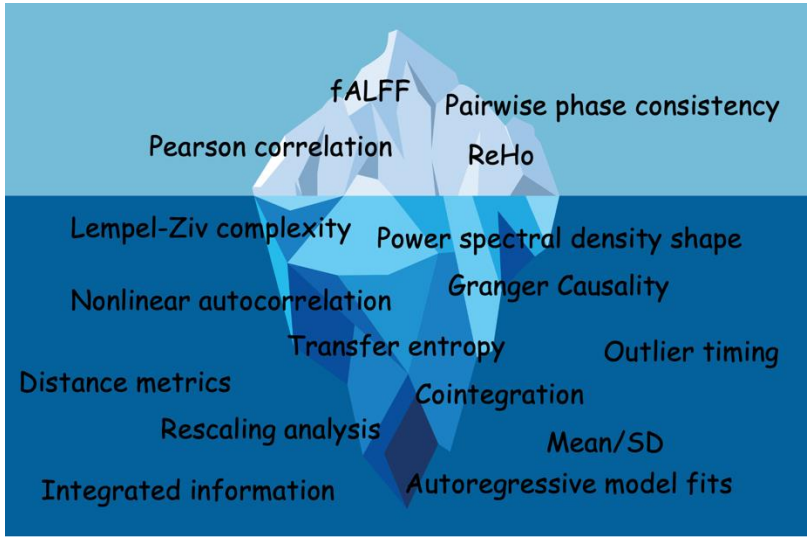


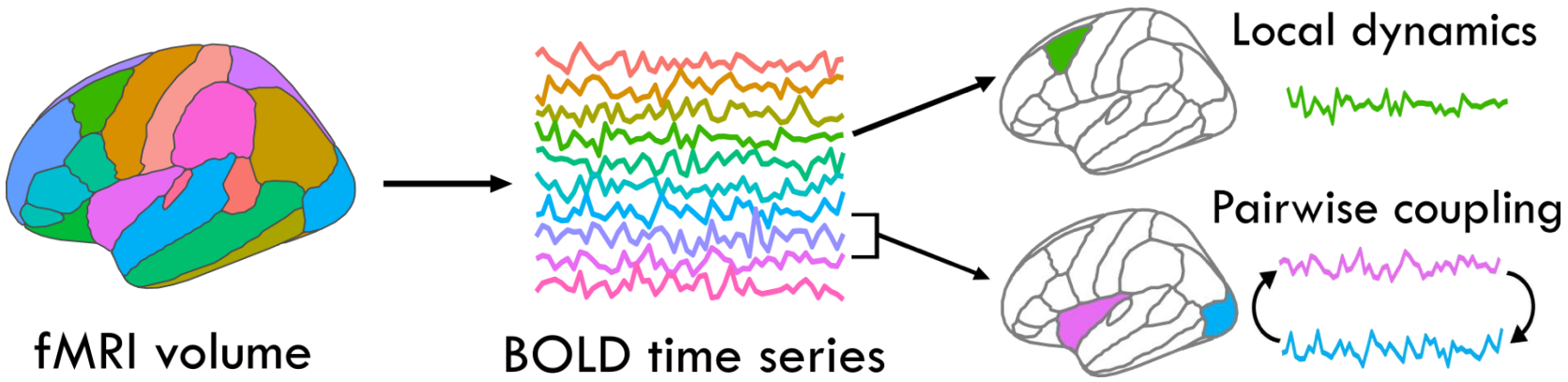
Image Source: Arnatkeviciute et al. 2023

Systematically comparing the brain's **transcriptome** with **neuroimaging properties**

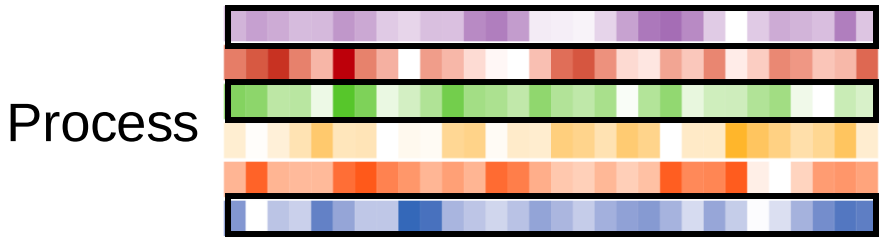


Quantifying **functional activity** and **inter-areal connectivity**

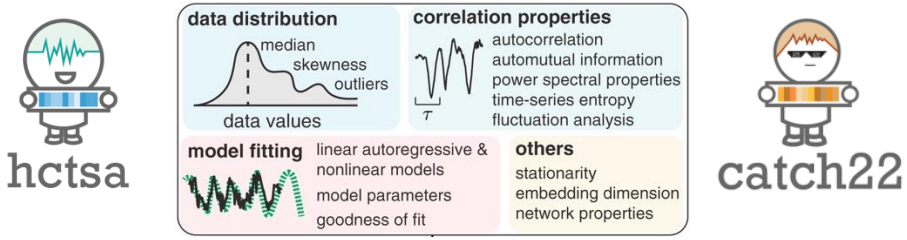
Measuring **local dynamics + pairwise coupling** in the brain



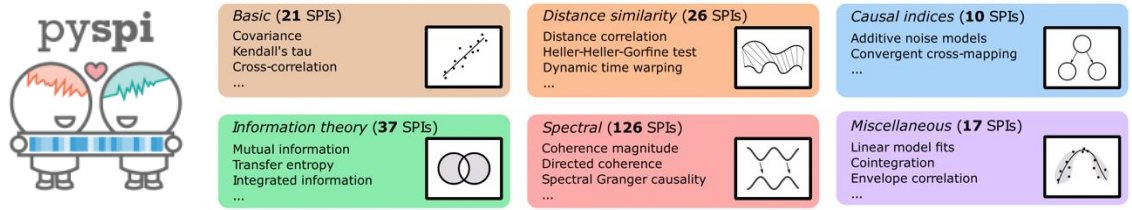
Multivariate time series (**MTS**)



Localized dynamics of one process



Statistical dependencies process pairs



hctsa:
Fulcher et al. *J R Soc* (2013), *Cell Systems* (2017)
catch22:
Lubba et al. *Data Mining and Knowledge Discovery* (2019)
pyspi:
Cliff et al. *Nat Comp Sci* (2023)

Neuropsychiatric disorder classification highlights changes to **region-specific localized dynamics**

SCZ
N=48
UCLA CNP

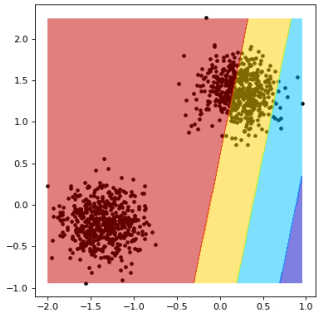
BP
N=49
UCLA CNP

ADHD
N=39
UCLA CNP

ASD
N=513
ABIDE

Controls

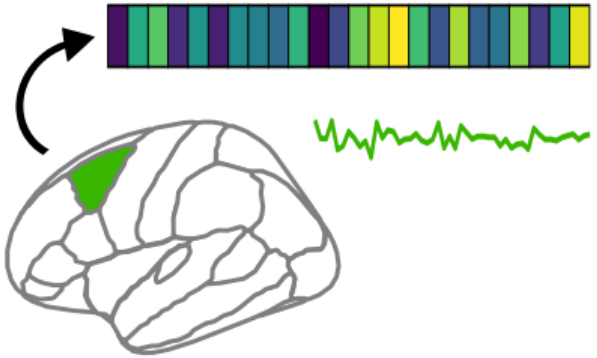
Cases

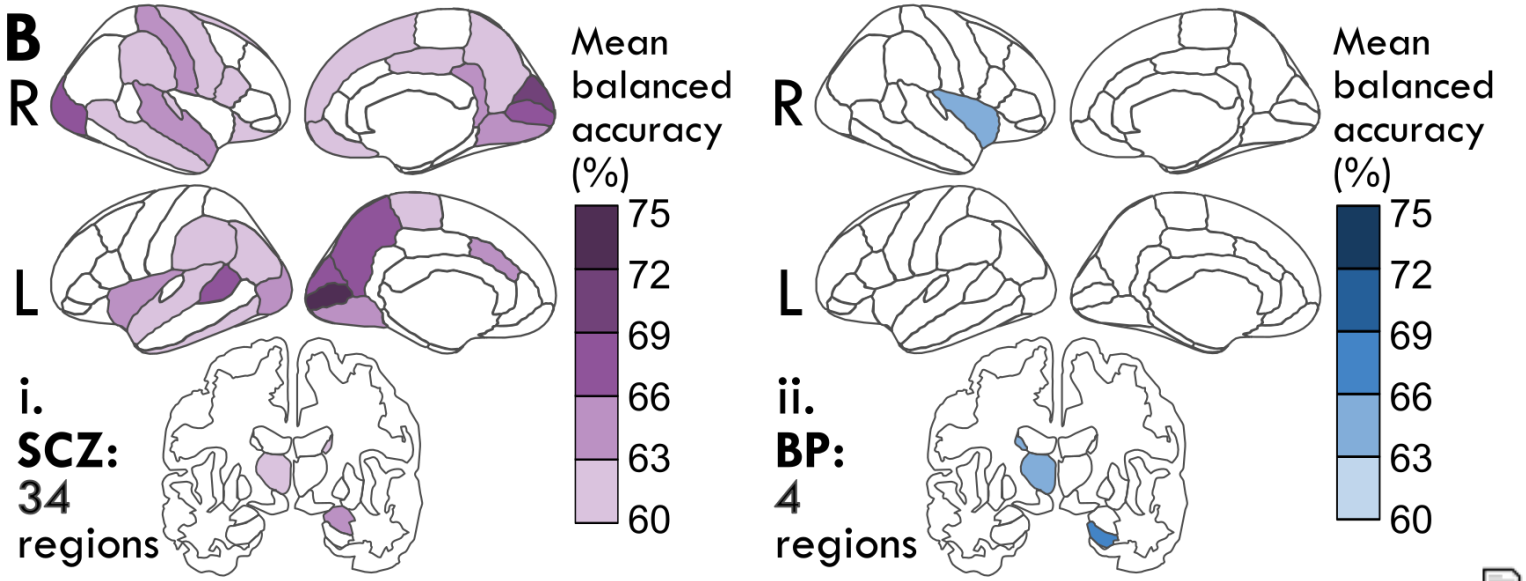


Source: scikit-learn

Linear support vector machine (SVM)

- Balanced accuracy
- Inverse probability weighting





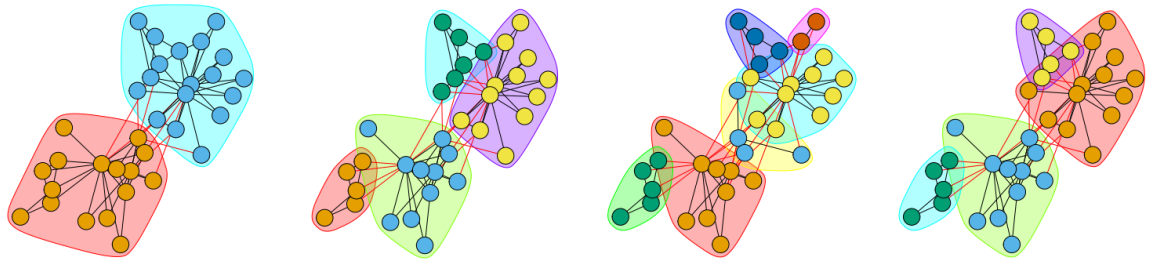
Gene expression

Anatomical changes

Stimulation analysis

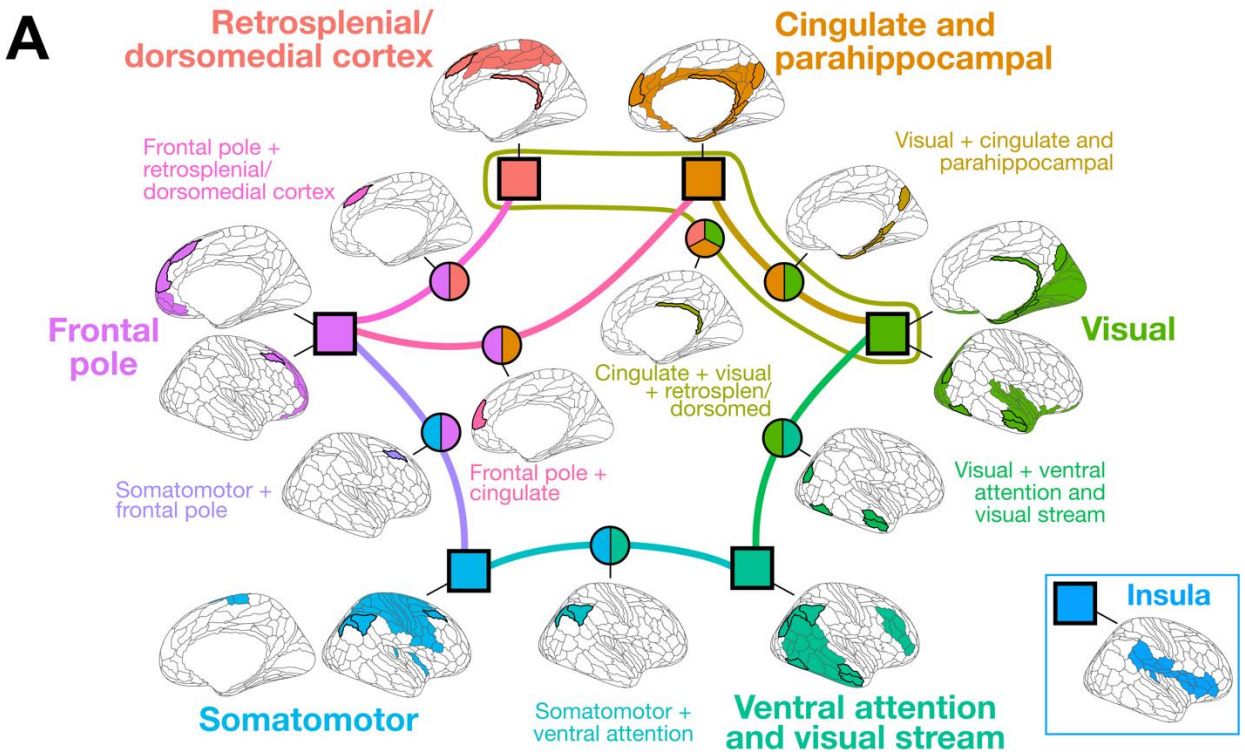
Bryant et al., *PLOS Comp Bio* (2024)

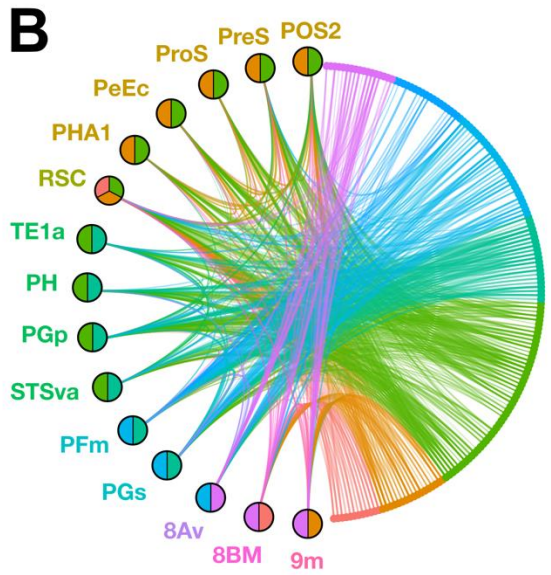
Systematically comparing **overlapping community detection** algorithms for the human brain **structural connectome**

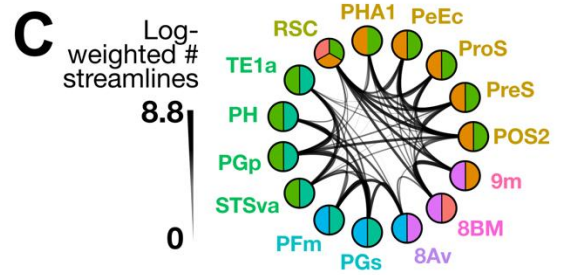


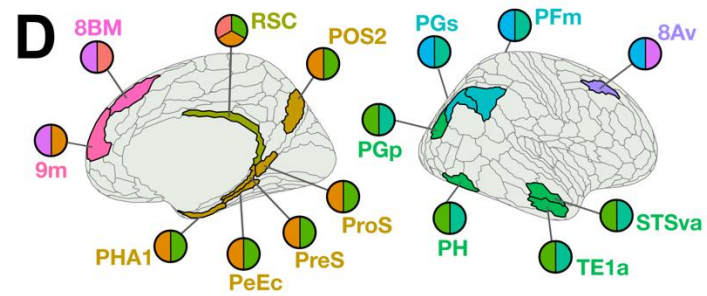
1. **Order statistics local optimization method (Lancichinetti 2011)**
2. Clique Percolation (Shen 2009)
3. Non-negative matrix factorization (Psorakis 2011)
4. Speaker-listener propagation (Xie 2011)
5. Infomap (Rosvall 2008/2009)

Image Source: Leão 2019



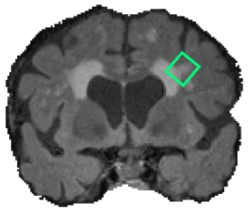






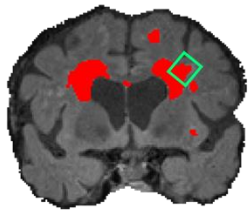
Bryant*, Jha*, et al. *In preparation*.

Linking **white matter hyperintensities** with **transcriptomic changes** in the **Alzheimer's disease** brain



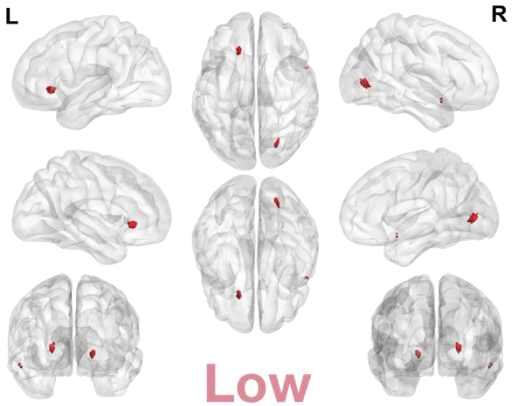
T2-FLAIR MRI

Segment white matter hyperintensity (WMH) volumes

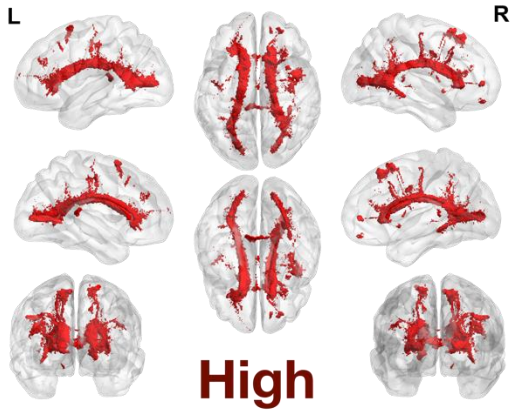


WMH lesions

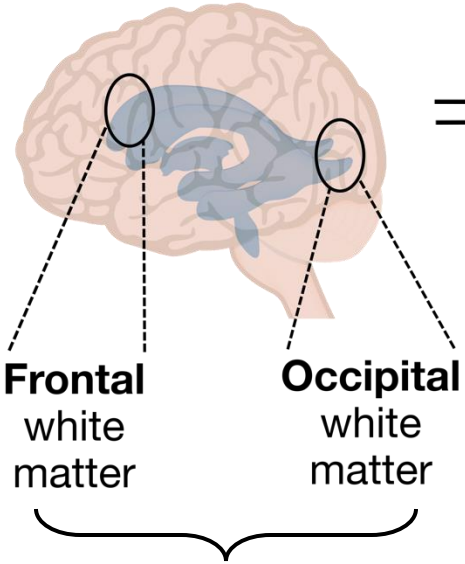
Match T2 MRI slice to frozen brain slab for dissection

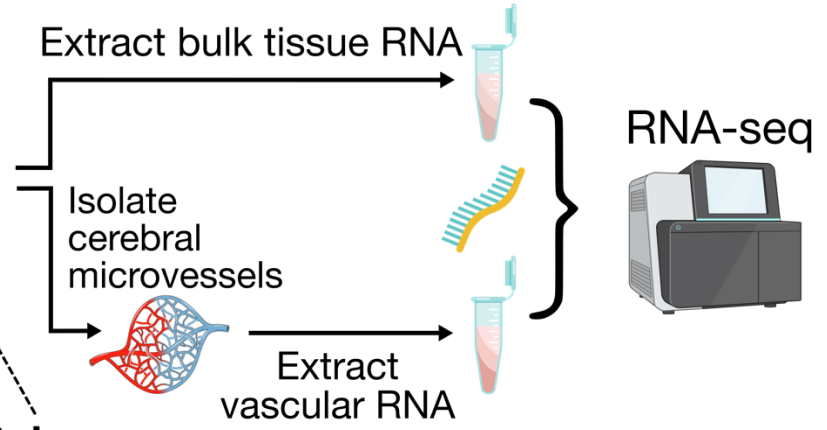


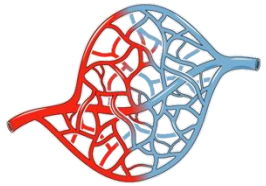
Low WMH burden (**N=5** AD cases)



High WMH burden (**N=4** AD cases)



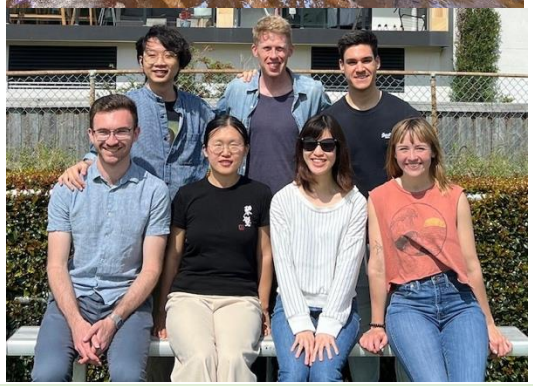




Heat shock proteins

Bryant*, Mala*, et al. *Frontiers in Neurology* (2025)

Thank you to my research groups as always 😊



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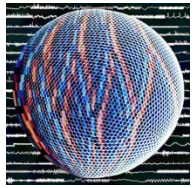

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American Australian Association Graduate Education Fund

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