

# CNS2022

**pyspi**: python toolkit for statistical analysis  
of pairwise interactions

Package author: Oliver Cliff

Workshop presenter: Annie G. Bryant

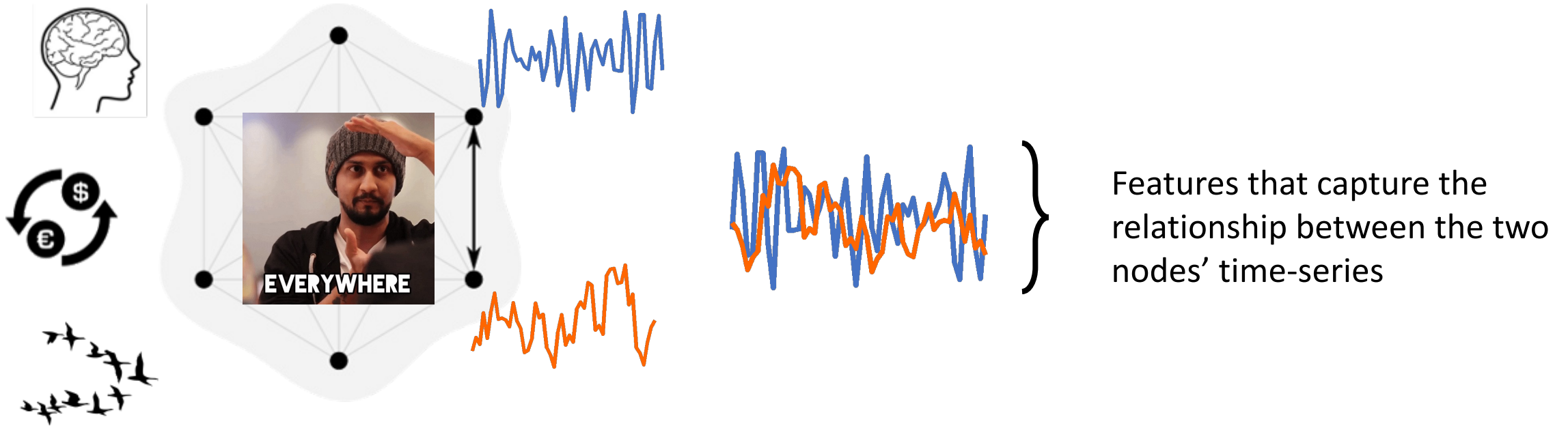
16 July 2022

**Dynamics and Neural Systems Lab**

The University of Sydney

<https://github.com/olivercliff/pyspi/>

# What are pairwise interactions?



**Pairwise interactions are studied across disciplines**

Neuroscience: Connectivity measures

Econometrics: Interactions between assets

Biology: Leader/follower in collective motion



# What else is out there?

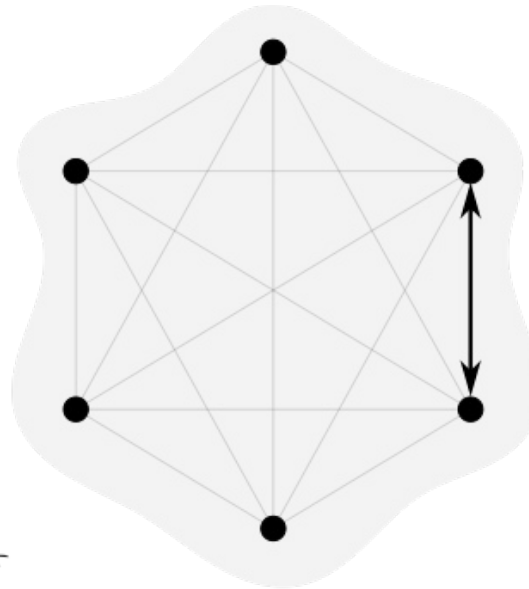
Pearson correlation



Cointegration



Transfer entropy



**pyspi**

*Basic (23 SPIs)*

Covariance  
Kendall's tau  
Cross-correlation  
...



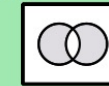
*Distance similarity (35 SPIs)*

Distance correlation  
Heller-Heller-Gorfine test  
Dynamic time warping  
...



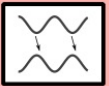
*Information theory (37 SPIs)*

Mutual information  
Transfer entropy  
Integrated information  
...



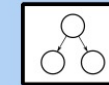
*Spectral (120 SPIs)*

Coherence magnitude  
Directed coherence  
Spectral Granger causality  
...



*Causal indices (10 SPIs)*

Additive noise models  
Convergent cross-mapping  
...



*Miscellaneous (24 SPIs)*

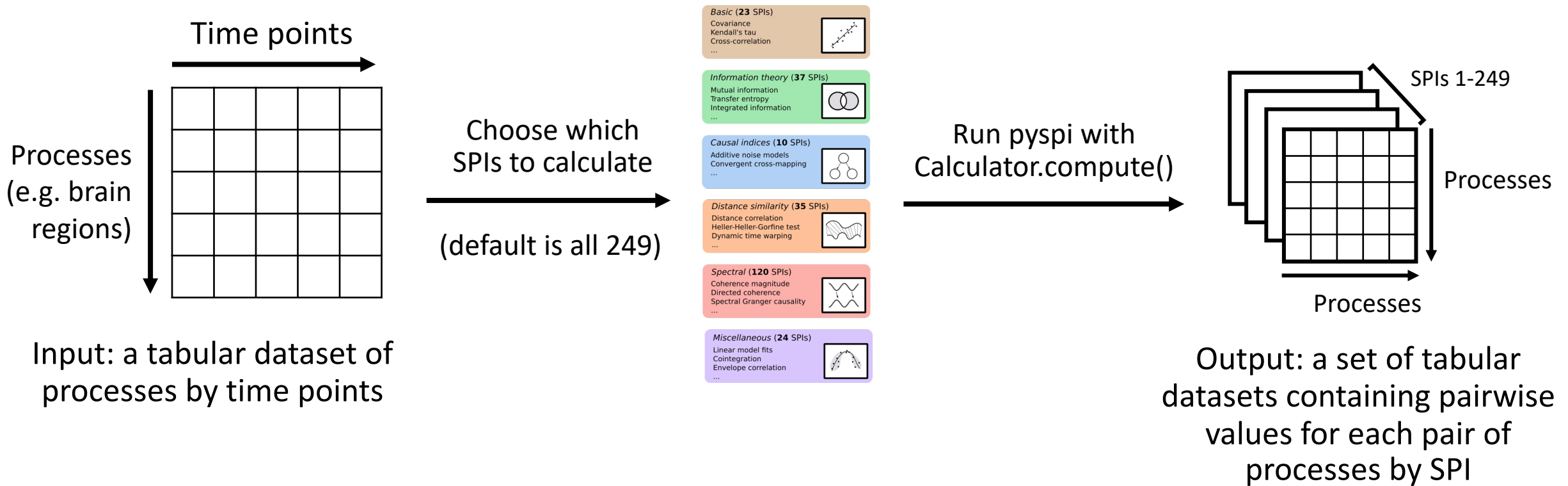
Linear model fits  
Cointegration  
Envelope correlation  
...



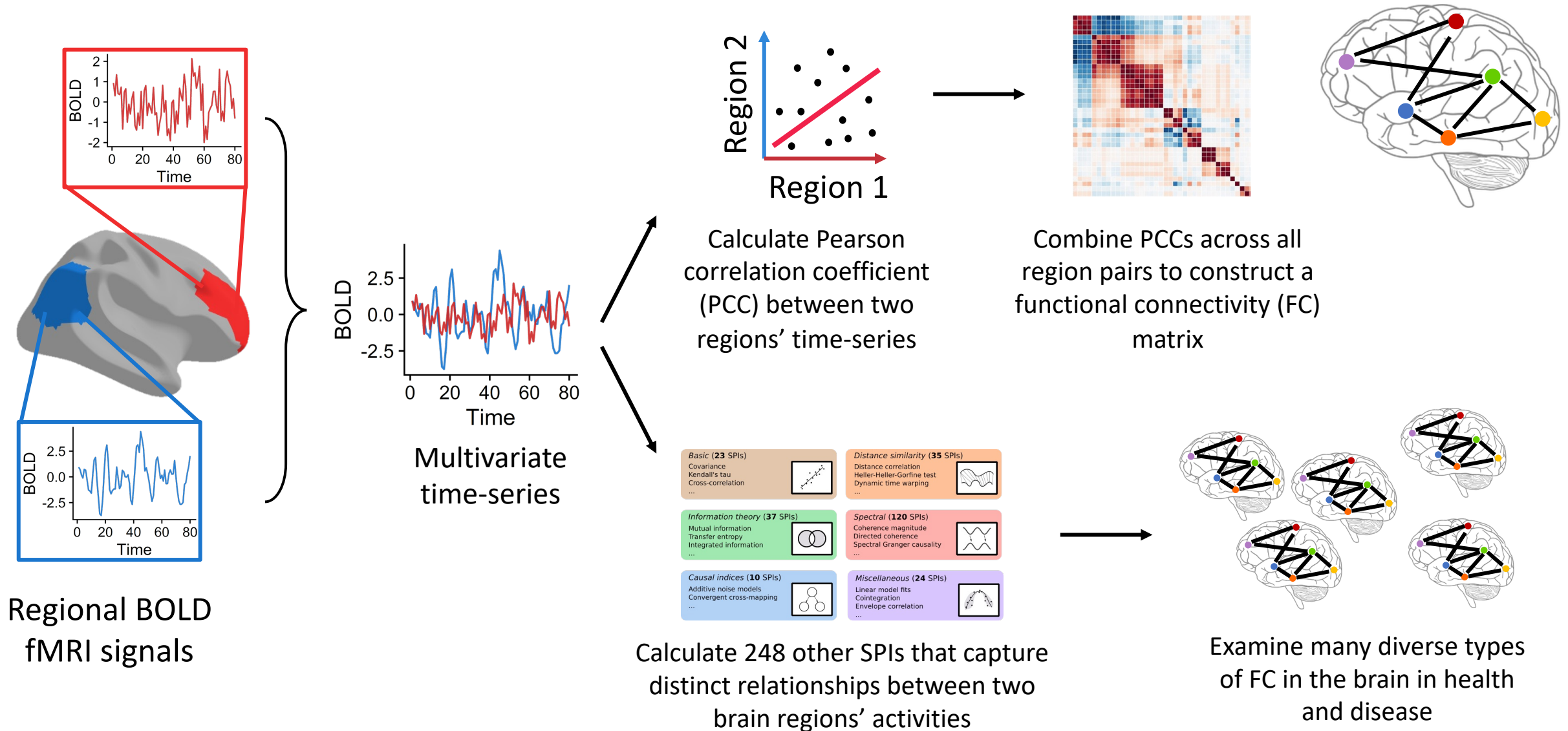
Comprehensive library of 249 statistical pairwise interactions derived from multiple disciplines of research

# I pyspi with my little eye-spi...

... an open-source python package for highly comparative multivariate time-series analysis!



# How can pyspi revolutionise how we look at functional connectivity in the human brain?





# Let's get pySPI running!

## Key links

<https://github.com/olivercliff/pyspi>

<https://pyspi-toolkit.readthedocs.io/en/latest/>

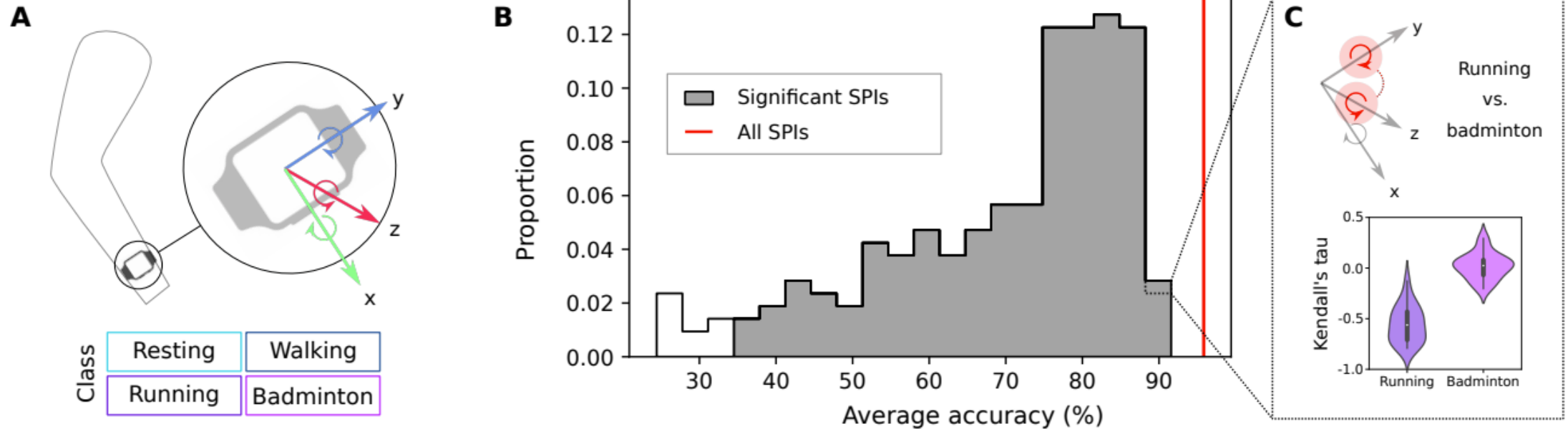
<https://wiki.octave.org/Category:Installation>

<https://www.anaconda.com/products/distribution>

## Quick steps to install

1. [OPTIONAL] install octave on your machine from above link
2. [OPTIONAL] create a specific conda environment for pyspi
  - `conda create -n pyspi python=3.9.0`
  - `conda activate pyspi`
3. Clone the pySPI github repo to your machine
  - e.g. `git clone https://github.com/olivercliff/pyspi.git`
4. Navigate to downloaded repo
  - e.g. `cd ~/pySPI`
5. `python3 -m pip install .`

# Downstream application example: classifying actigraphy data



MTS data from 3-axis accelerometer and 3-axis gyroscope recording

216 SPIs used as basis for linear support vector machine (SVM) classifier, with cross-validated accuracy reported

Zoom in on high-performing SPIs like Kendall's  $\tau$



# Applying pyspi to BOLD fMRI time-series data



**Tutorial data:** one participant from the UCLA Consortium for Neuropsychiatric Phenomics LA5c Study<sup>1</sup>

- Data is split up into 4 sets of 4 brain regions, each of which has 152 time points (fMRI frames)

We will go through:

- Preparing our multivariate time-series data to be in the right format
- Visualizing the raw time-series data
- Running pyspi on our four datasets
- Extracting the resulting SPIs and combining them across the 4 sets
- Visualizing our SPI output



More in-depth tutorial:

<https://github.com/olivercliff/pyspi/blob/main/demos/tutorial.ipynb>

<sup>1</sup>Gorgolewski KJ et al. A Preprocessed consortium for Neuropsychiatric Phenomics dataset. (2017).

# Ways we're improving pyspi accessibility

## pyspi-distribute

<https://github.com/olivercliff/pyspi-distribute>

### Distribute PySPI jobs across a PBS cluster

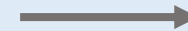
This repository contains scripts for distributing [PySPI](#) jobs across a PBS-type cluster. Each job will contain one calculator object that is associated with one multivariate time series (MTS).

The scripts allow the user to specify a directory containing the MTS files, with each sample's time series stored in a separate binary NumPy (.[npy](#)) file. Within this directory, the user needs to also include a YAML configuration file like [that included in the repo](#) specifying the relative location of each .[npy](#) file (and, optionally, the `name`, `dim_order`, and any relevant `labels`). An R script to automatically populate this configuration file is provided: `create_yaml_for_samples.R`.

## Interfacing with R

**reticulate** package

<https://rstudio.github.io/reticulate/>



# Thank you! Any questions?



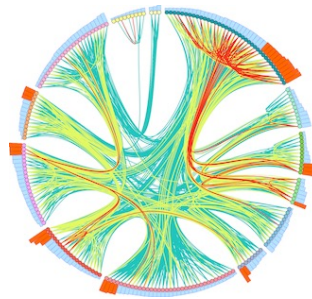
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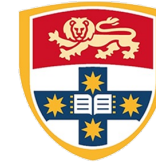


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With support from:



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