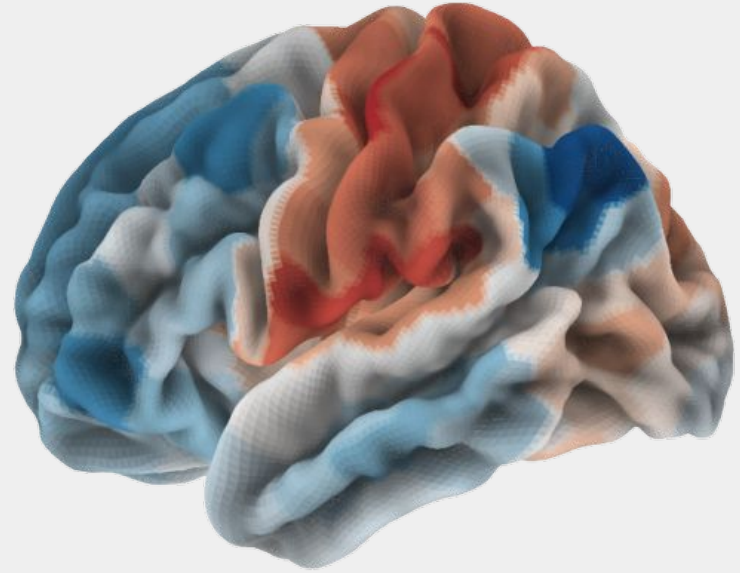


Advanced fMRI data analysis

Karolina Finc

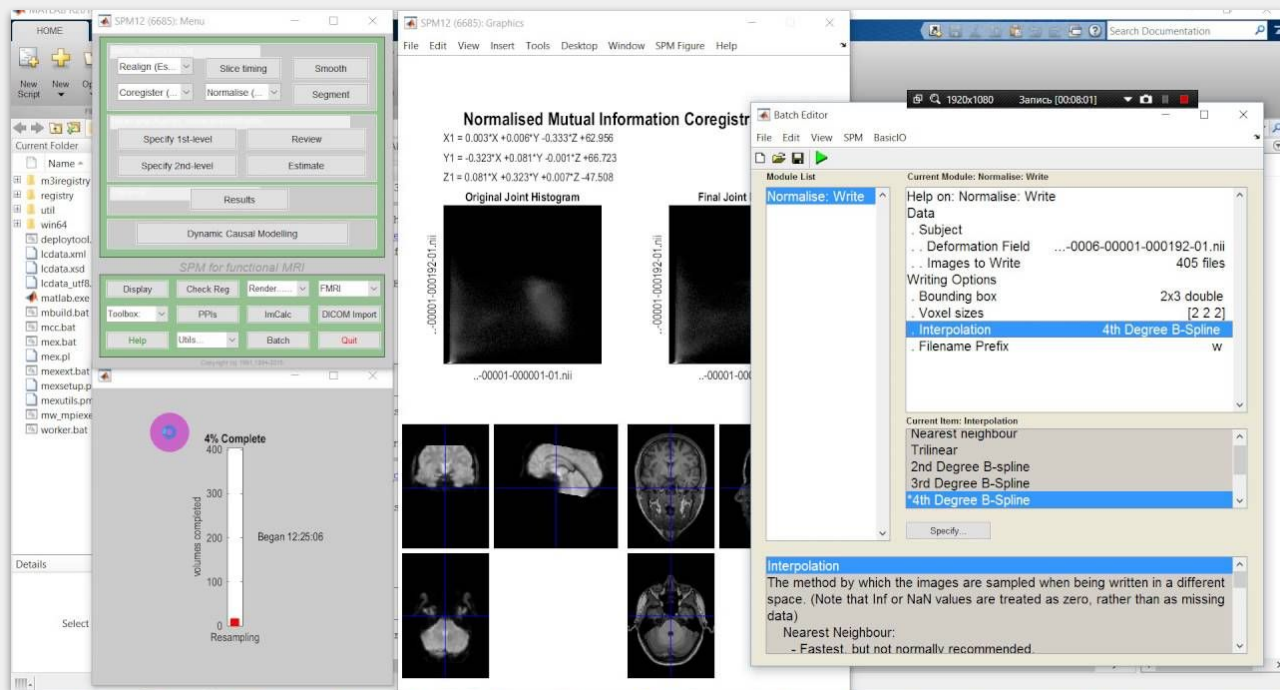
Centre for Modern Interdisciplinary Technologies

Nicolaus Copernicus University in Toruń



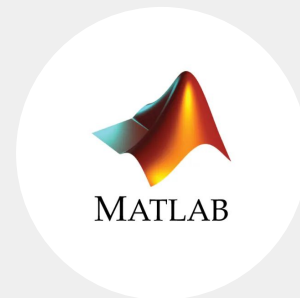
COURSE #2: **Reproducible neuroimaging** | 6th March 2020

My story



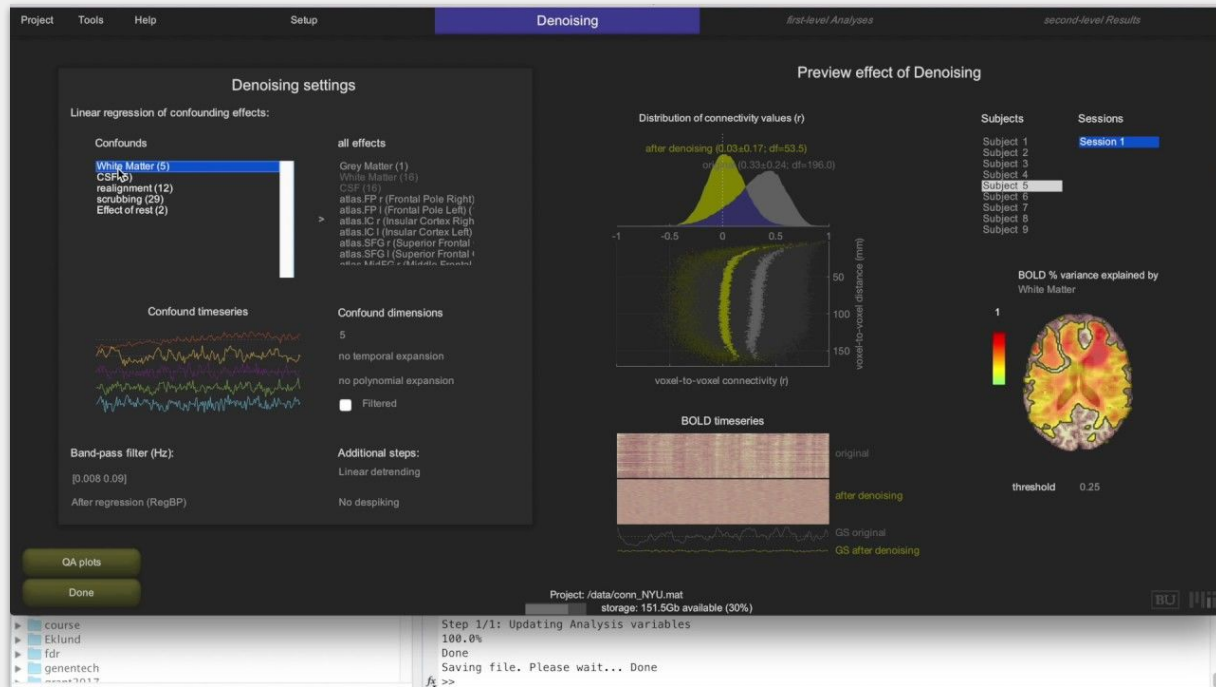
2014

Learning brain activity analysis in SPM.



Statistical Parametric Mapping: <https://www.fil.ion.ucl.ac.uk/spm/>

My story



2014

Learning functional connectivity & graph theory analysis in CONN & BCT.



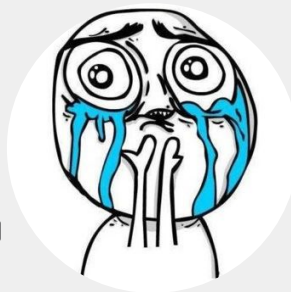
Functional connectivity toolbox: <https://web.conn-toolbox.org/>

Brain Connectivity Toolbox: <https://sites.google.com/site/bctnet/>

Fast way to scientist's depression

Processing step	Reason	Options [suboptions]	Number of plausible option
Motion correction	Correct for head motion during scanning	• 'Interpolation' [linear or sinc] • 'Reference volume' [single or mean]	4
Slice timing correction	Correct for differences in acquisition timing of different slices	'No', 'before motion correction' or 'after motion correction'	3
Field map correction	Correct for distortion owing to magnetic susceptibility	'Yes' or 'no'	2
Spatial smoothing	Increase SNR for larger activations and ensure assumptions of GRF theory	'FWHM' [4 mm, 6 mm or 8 mm]	3
Spatial normalization	Warps an individual brain to match a group template	'Method' [linear or nonlinear]	2
High-pass filter	Remove low-frequency nuisance signals from data	'Frequency cut-off' [100 s or 120 s]	2
Head motion regressors	Remove remaining signals owing to head motion via statistical model	'Yes' or 'no' [if yes: 6/12/24 parameters or single time point 'scrubbing' regressors]	5
Haemodynamic response	Account for delayed nature of haemodynamic response to neuronal activity	• 'Basis function' ['single-gamma' or 'double-gamma'] • 'Derivatives' ['none', 'shift' or 'dispersion']	6
Temporal autocorrelation model	Model for the temporal autocorrelation inherent in fMRI signals	'Yes' or 'no'	2
Multiple-comparison correction	Correct for large number of comparisons across the brain	'Voxel-based GRF', 'cluster-based GRF', 'FDR' or 'non-parametric'	4
Total possible workflows			69,120

- Which software to select?
- Which method to select?
- Which option to select?



Poldrack et al. (2001), *Nat. Rev. Neurosc.*

Fast way to scientist's depression cd.

Many results you've read in papers are **false positives** and are not reproducible.

BAD RESEARCH PRACTICES:

- Not sharing the data
- Not sharing the code
- P-hacking
- HARKing - hypothesis after results are known

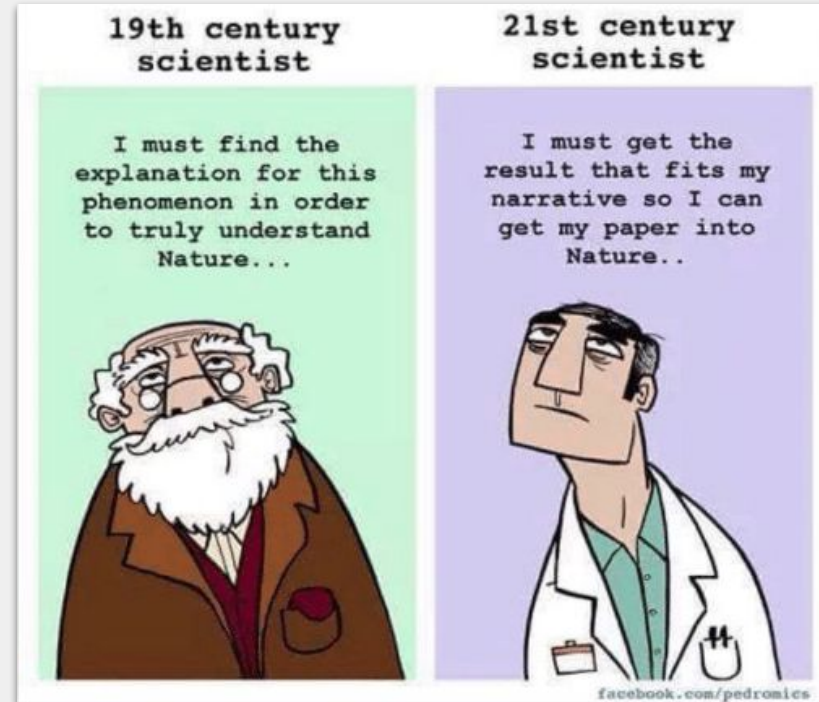


Why?



Incentives

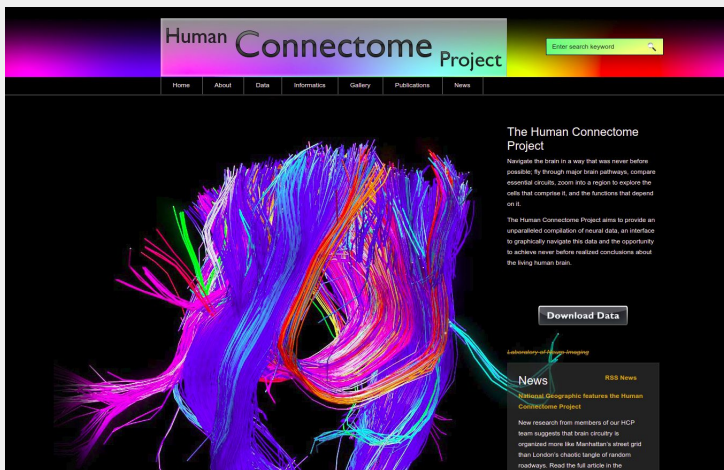
- Significant results are easier to publish
- Journals are not very open to publish replications (what's new in this?)
- fMRI studies are expensive and time consuming (small sample sizes)
- Learning programming takes time and much effort
- Designing a good experiment and stating a good hypothesis takes time
- etc.



Open science



Open data



The Human Connectome Project

Explore the brain in a way that was never before possible. Fly through major brain pathways, compare essential circuits, zoom into a region to explore the cells that comprise it, and the functions that depend on it.

The Human Connectome Project aims to provide an unparalleled correlation of neural data, an interface to geographically integrate the data and the opportunity to achieve never before realized conclusions about the living human brain.

Download Data

Latest News

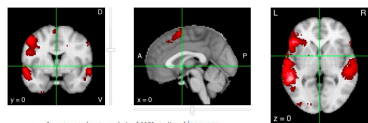
Neuroscientist, Geographic features the Human Connectome Project

New research from members of our HCP team suggests that brain connectivity is organized more like Manhattan's street grid than London's chaotic tangle of random roadways. Read the full article in the

neurosynth.org

Neurosynth is a platform for large-scale, automated synthesis of functional magnetic resonance imaging (fMRI) data.

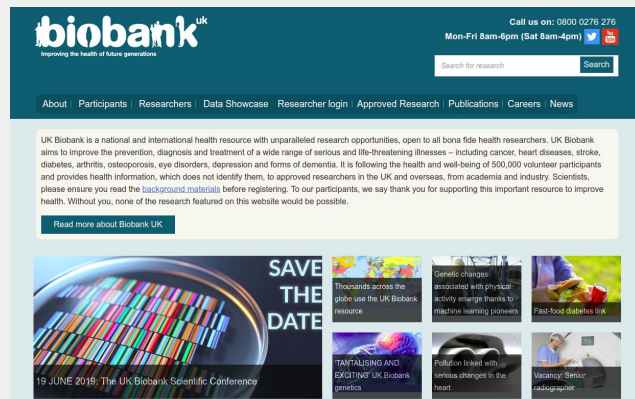
It takes thousands of published articles reporting the results of fMRI studies, chews on them for a bit, and then spits out images that look like this:



An automated meta-analysis of 1101 studies of language

Database Status

50786 activations reported in 14371 studies



UK Biobank

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UK Biobank is a national and international health resource with unparalleled research opportunities, open to all bona fide health researchers. UK Biobank aims to improve the prevention, diagnosis and treatment of a wide range of serious and life-threatening illnesses – including cancer, heart diseases, stroke, diabetes, arthritis, osteoporosis, eye disorders, depression and forms of dementia. It is following the health and well-being of 500,000 volunteer participants and provides health information, which does not identify them, to approved researchers in the UK and overseas, from academia and industry. Scientists, please ensure you read the [background materials](#) before registering. To our participants, we say thank you for supporting this important resource to improve health. Without you, none of the research featured on this website would be possible.

Read more about Biobank UK

SAVE THE DATE
19 JUNE 2018: The UK Biobank Scientific Conference

Thousands across the globe use the UK Biobank resource

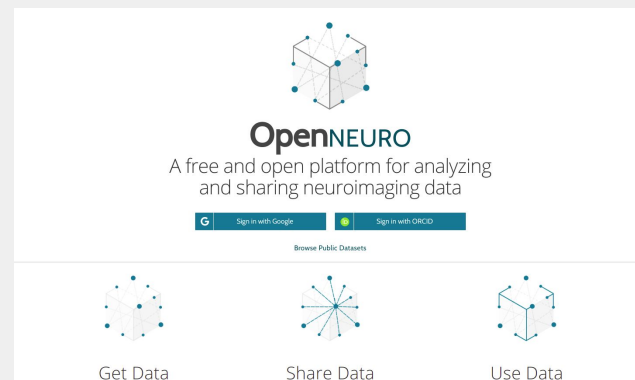
Genetic changes associated with physical activity emerge thanks to machine learning pioneers

Fast-food diabetes link

TANTALISING AND EXCITING! UK Biobank genetics

Pollution linked with serious changes in the heart

Vacancy: Senior radiographer



OpenNEURO

A free and open platform for analyzing and sharing neuroimaging data

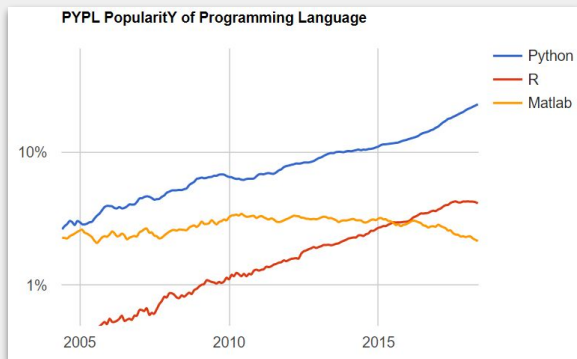
Sign in with Google | Sign in with ORCID

Browse Public Datasets

Get Data | Share Data | Use Data

Open source

Open programming languages



Open source packages

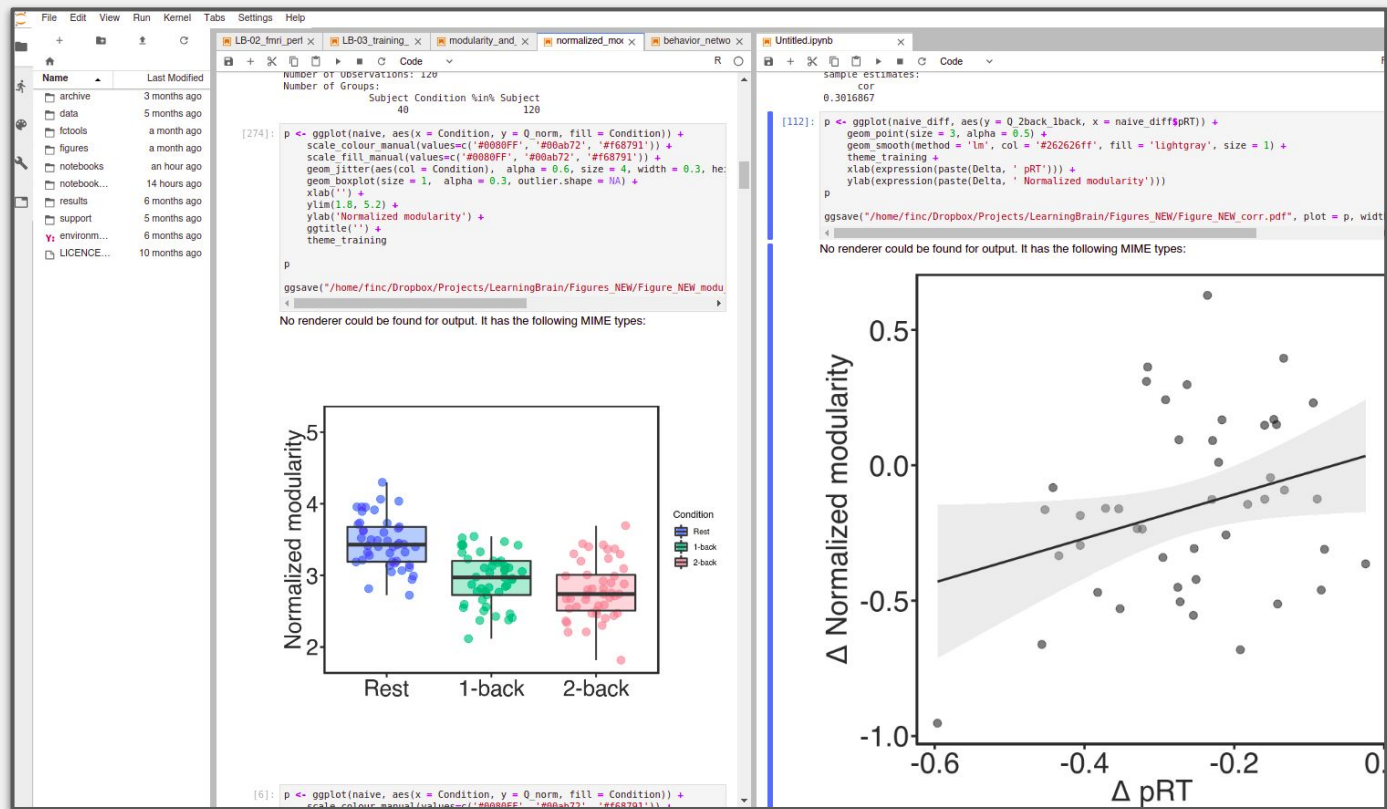


Code sharing platforms



GitHub

Jupyter notebook



Getting started with Jupyter notebooks

Jupyter = **Ju**(lia) + **pyt**(hon) + e**R**



Goal of **Project Jupyter** is to "develop open-source software, open-standards, and services for interactive computing across dozens of programming languages".

More: https://en.wikipedia.org/wiki/Project_Jupyter

1. Open terminal
2. Type "jupyter lab"
3. If you don't have it installed, go to website: <https://jupyter.org/try>

Getting started with Git/GitHub

Git - version control system that stores multiple versions of your files over time

GitHub - provides hosting for software development version control using Git

Example:

<https://github.com/kfinc>

1. Create an account using academic email! (for PRO access)
2. Install Git on your computer (or check if it's already installed)



GitHub

What to install?

1. Git
2. Anaconda 3 (Python distribution)
3. FSL (optional)
4. MATLAB (optional)



Homework

1. GitHub Classroom

fMRI Q&A in Markdown

Deadline: 20-03-2020

2. Data Camp Classroom

<https://www.datacamp.com/enterprise/advanced-fmri-data-analysis/assignments>

Introduction to Python

Deadline: 13-03-2020

Intermediate Python

Deadline: 20-03-2020



Next



**fMRI data manipulation
and plotting in Python**