Brain Imaging Data Structure (BIDS) tutorial

StratNeuro Retreat 2024 - Exclusive day for PhD students

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Department of Computer Science, University of Copenhagen

KØBENHAVNS UNIVERSITET

What do you hope to learn from the tutorial?

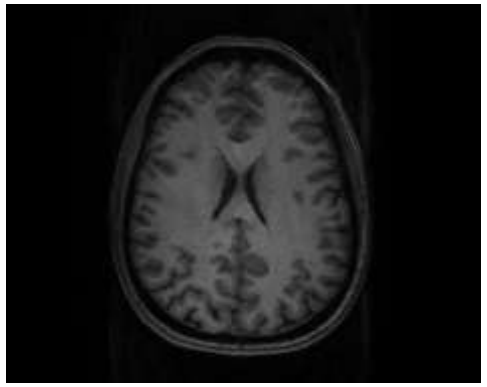
- How to structure MRI data in a good way/ How to improve data structuring / Learn a method to organize data that I can apply in future PostDoc positions (even if different field from mine now) 
- I expect to get started with BIDS since I do not have previous experience and I might need it in the future / To learn how to work with BIDS 
- Apply BIDS for PET with focus on specificity of PET metadata  Learn more on MRI and MEG BIDS 
- "I'm interested in multimodal method, and one of the modality I wish to use in the future is brain imaging. I have interacted with EEG data before but not PET or other imaging data. 
- So I wish to learn the basic of dealing with brain imaging and the analyse techniques." 

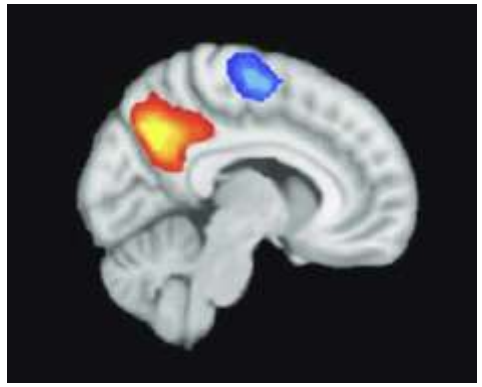
Do you have any specific questions or topics?

- What is the optimal way to structure repeat scans for the same individual(s)?
  - BIDS specification uses sessions (like baseline and followup) or runs (test-retest like re-scans)
  - See definitions here: https://bids-specification.readthedocs.io/en/stable/common-principles.html

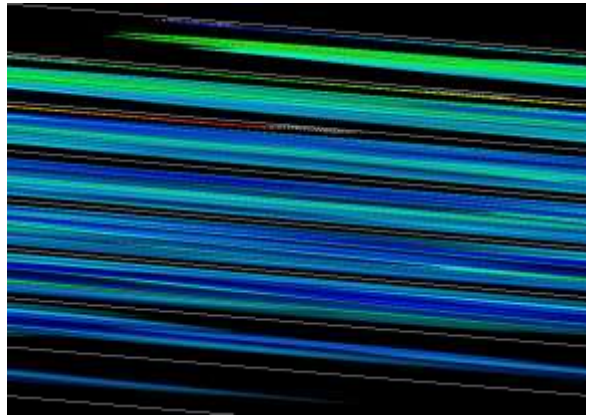
- How BIDS can be useful in machine learning applications if applicable
  - Let's take a little detour…

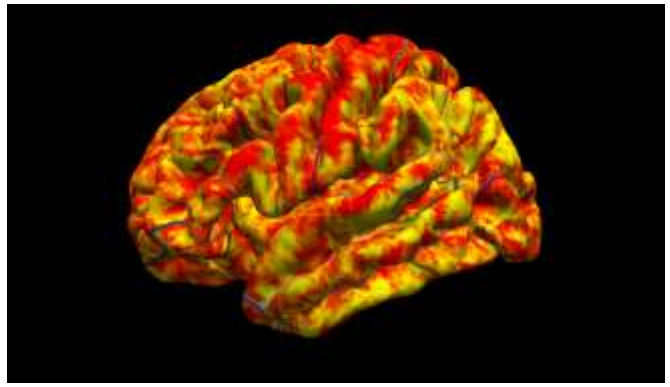
Current neuroimaging in a nutshell





Magnetic resonance imaging (MRI) – both structural and functional (fMRI)





Positron emission tomography (PE

Electroencephalography (EEG)

+ many other MRI based modalities (diffusion, arterial spin labelling, spectroscopy)
+ Magnetoencephalography (MEG)
+ CT (limited)
+…

+demographics
+neurospsychological questionaires

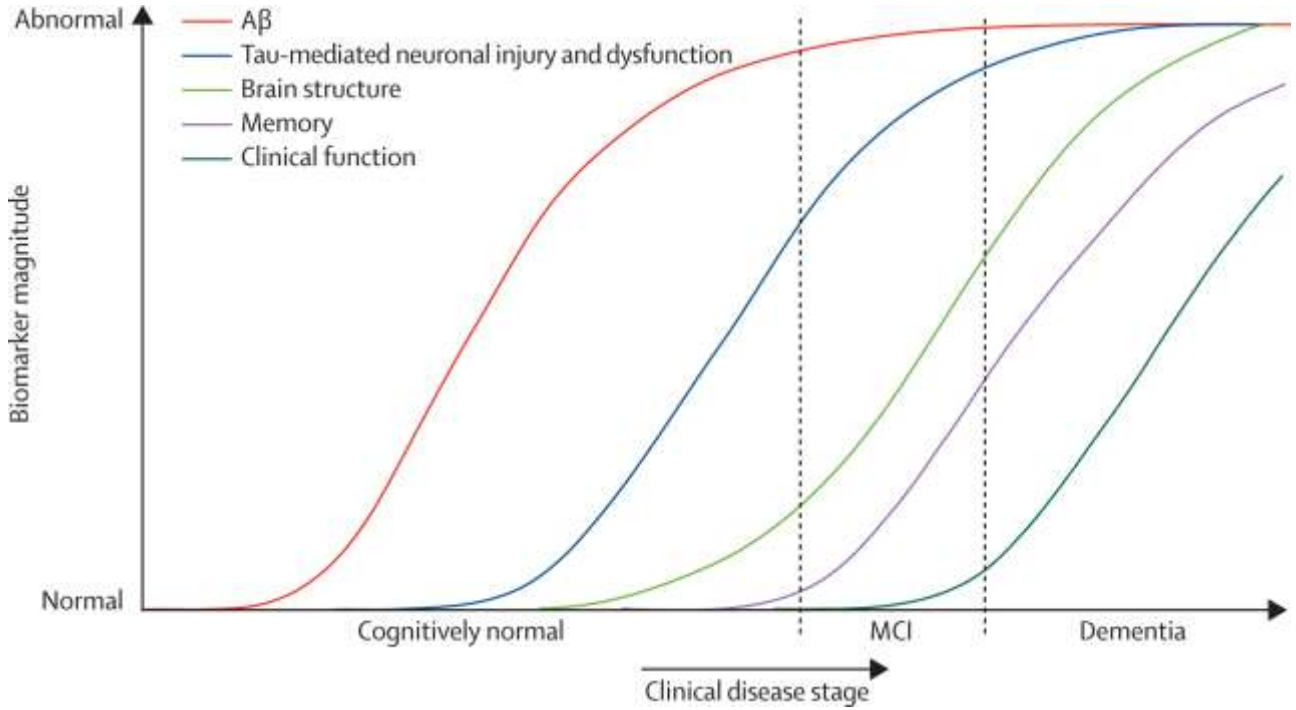
Areas of interest in neuroimaging

Symptoms vs. State	Neuropsychiatry	
	Neurological	Psychiatric
Diseases	e.g. stroke, multiple sclerosis, Parkinson's	e.g. schizophrenia, depression, anxiety disorders
Biological processes	e.g. sleep	e.g. learning

Baker et al. *BMJ* 324.7352 (2002): 1468-1469.

Why neuroimaging?

AD



Jack et al. *The Lancet Neurology* 12.2 (2013): 207-216.

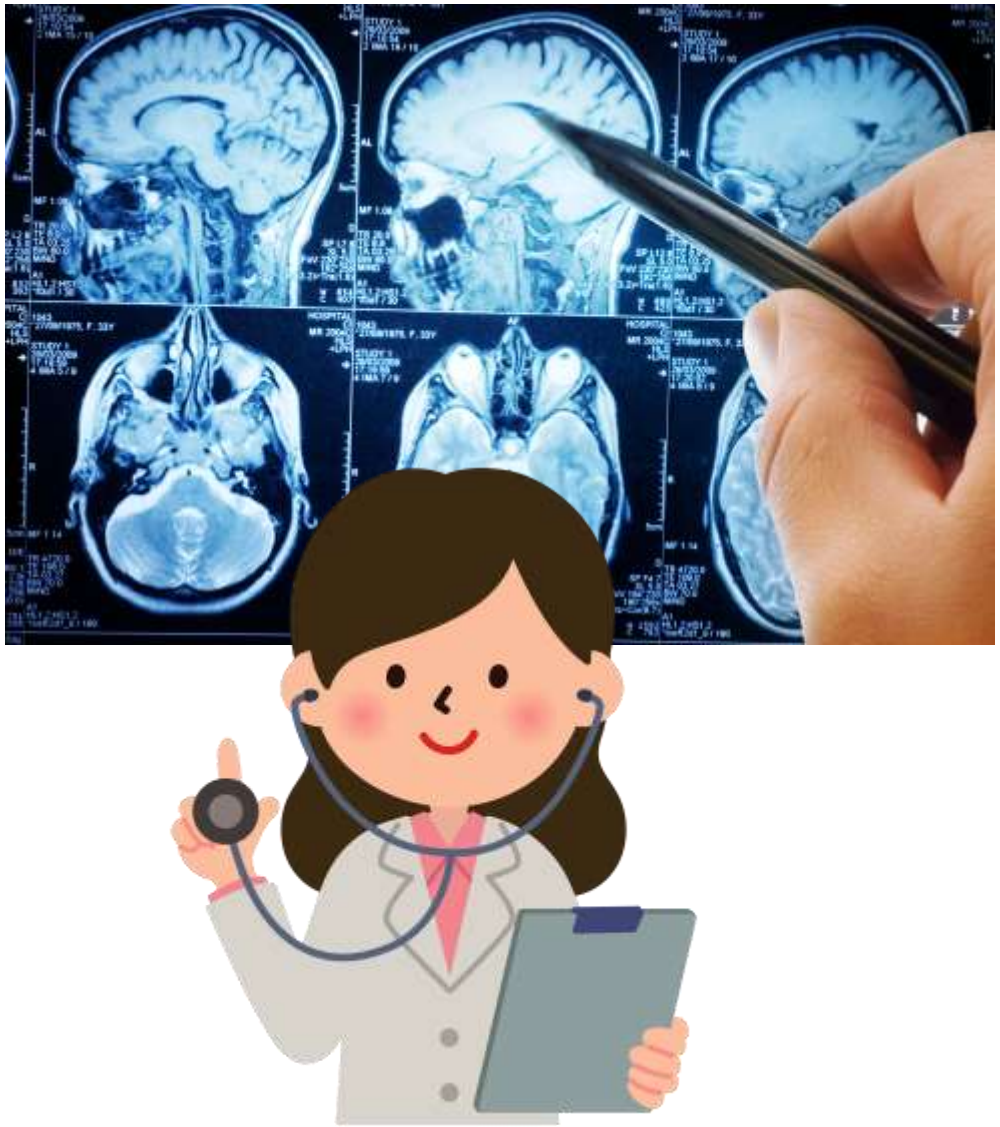
MDD

SSRI:

- **40–60% of patients will respond**
- **30-45% will achieve remission**

Khin et al. J Clin Psychiatry 72 (2011)
Carvalho et al. J Clin Pharm Ther 32 (2007): 415–428.
Thase et al. Br J Psychiatry 178 (2001): 234–241.

A typical neuroimaging study



Hypothesis

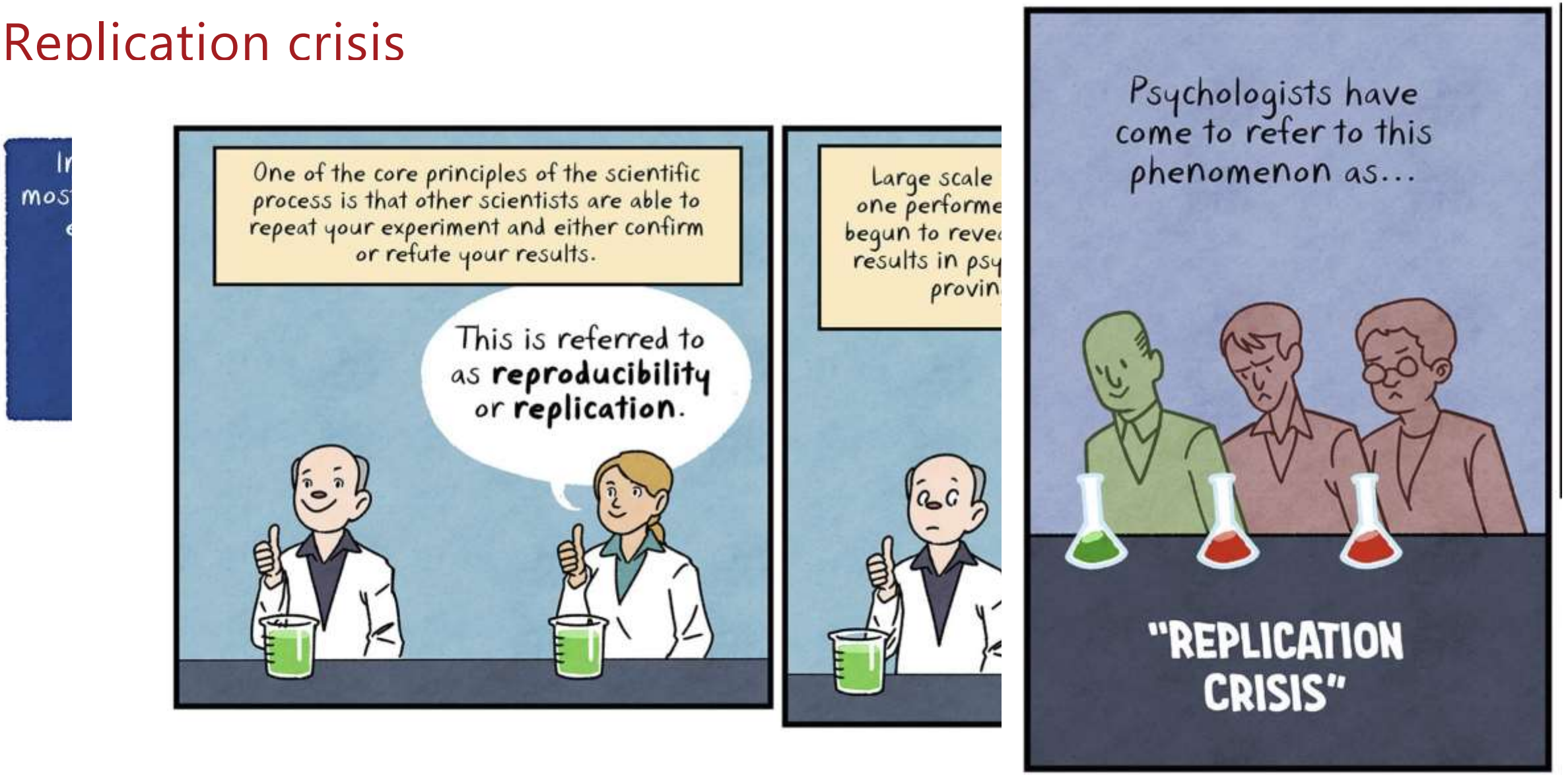
Data Acquisition

Preprocessing

Analysis

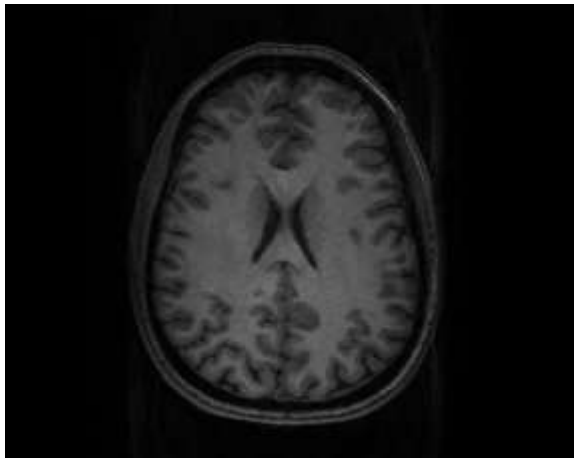
Biomarker

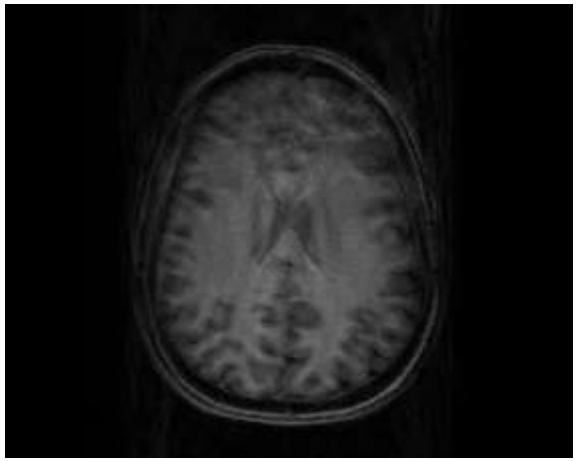
Replication crisis

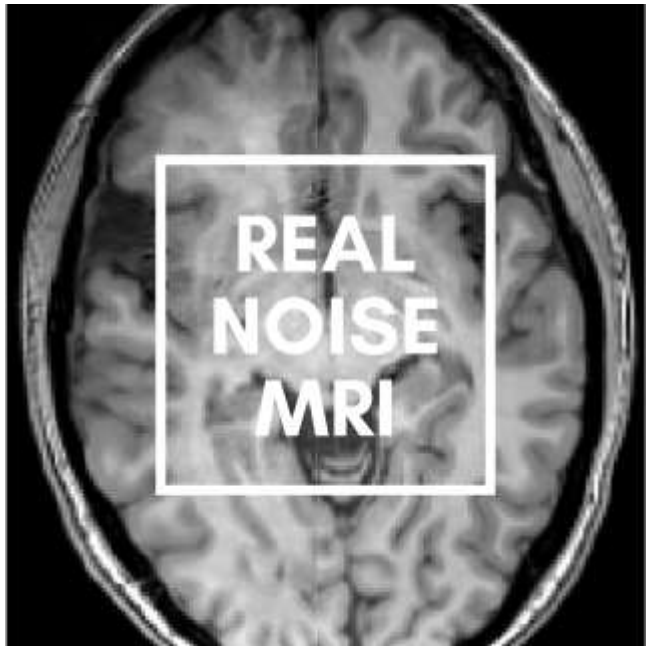


https://thenib.com/repeat-after-me/

Acquisition







ELSEVIER

NeuroImage

Volume 107, 15 February 2015, Pages 107-115

Head motion during MRI acquisition reduces gray matter volume and thickness estimates

Martin Reuter [a, b, c, d] [1] ✉, M. Dylan Tisdall [b, d, 1], Abid Qureshi [a, d], Randy L. Buckner [b, d], André J.W. van der Kouwe [b, d], Bruce Fischl [b, c, d]

[WIP]

Preprocessing I

ORIGINAL RESEARCH article

Front. Neuroinform., 24 April 2015 | https://doi.org/10.3389/fninf.2015.00012

Reproducibility of neuroimaging analyses across operating systems

Tristan Glatard[1,2], Lindsay B. Lewis[1], Rafael Ferreira da Silva[3], Reza Adalat[1], Natacha Beck[1], Claude Lepage[1], Pierre Ric Sherif[1], Ewa Deelman[3], Najmeh Khalili-Ma

[1]McConnell Brain Imaging Centre, Montreal Neurological In
[2]Centre National de la Recherche Scientifique, University of
[3]Information Sciences Institute, University of Southern Calif

PUBLISH ABOUT BROWSE

PLOS ONE

OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

The Effects of FreeSurfer Version, Workstation Type, and Macintosh Operating System Version on Anatomical Volume and Cortical Thickness Measurements

Ed H. B. M. Gronenschild, Petra Habets, Heidi I. L. Jacobs, Ron Mengelers, Nico Rozendaal, Jim van Os, Machteld Marcelis

Published: June 1, 2012 • https://doi.org/10.1371/journal.pone.0038234

Preprocessing II

ICBEM

Review Article

Cerebr
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PET ce

Martin Nør
Masanori I
Ramin V P
Mark Slifst
Peter S Tal
and Gitte M

Article

Variabi
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NEWS AND VIEWS · 20 MAY 2020

Neuroimaging results altered by varying analysis pipelines

Seventy laboratories that analysed the same neuroimaging data each produced different results. This finding highlights the potential consequences of a lack of standardized pipelines for processing complex data.

Martin Lindquist

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NARPS - https://www.narps.info

Different preprocessing strategies lead to different conclusions: A [^{11}C]DASB-PET reproducibility study

Martin Nørgaard,[1,2] Melanie Ganz,[1,3] Claus Svarer,[1] Vibe G Frokjaer,[1] Douglas N Greve,[4] Stephen C Strother,[5] and Gitte M Knudsen[1,2]

[WIP]

Statistical Analysis

PNAS
Proceedings of the National Academy of Sciences of the United States of America

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RESEARCH ARTICLE

Cluster failure: Why fMRI inferences for spatial extent have inflated false-positive rates

Anders

NeuroImage
Volume 171, 1 May 2018, Pages 6-14

ELSEVIER

A
o **False positive rates in surface-based anatomical analysis**

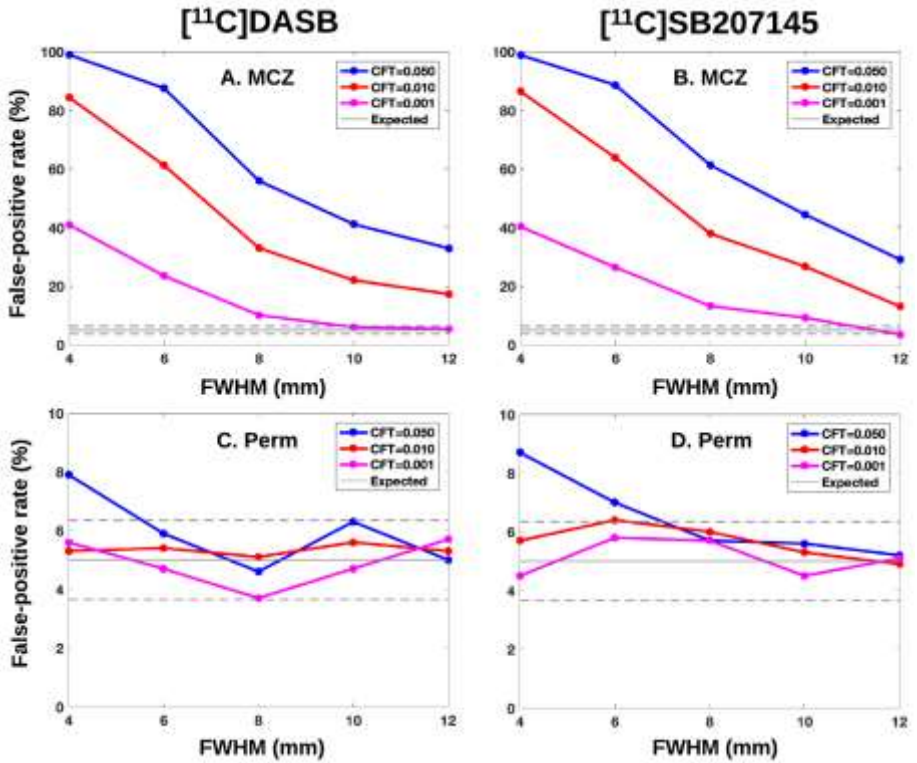
Douglas N. Greve [a, b], Bruce Fischl [a, b]

JCBFM Journal of Cerebral Blood Flow & Metabolism

J Cereb Blood Flow Metab. 2021 Jul; 41(7): 1647–1657.
Published online 2020 Nov 26. doi: 10.1177/0271678X20974961
PMCID: PMC8221774
PMID: 33241770

False positive rates in positron emission tomography (PET) voxelwise analyses

Melanie Ganz,[1,2,*] Martin Nørgaard,[1,3,*] Vincent Beliveau,[4] Claus Svarer,[1] Gitte M Knudsen,[1,3] and Douglas N Greve[5]



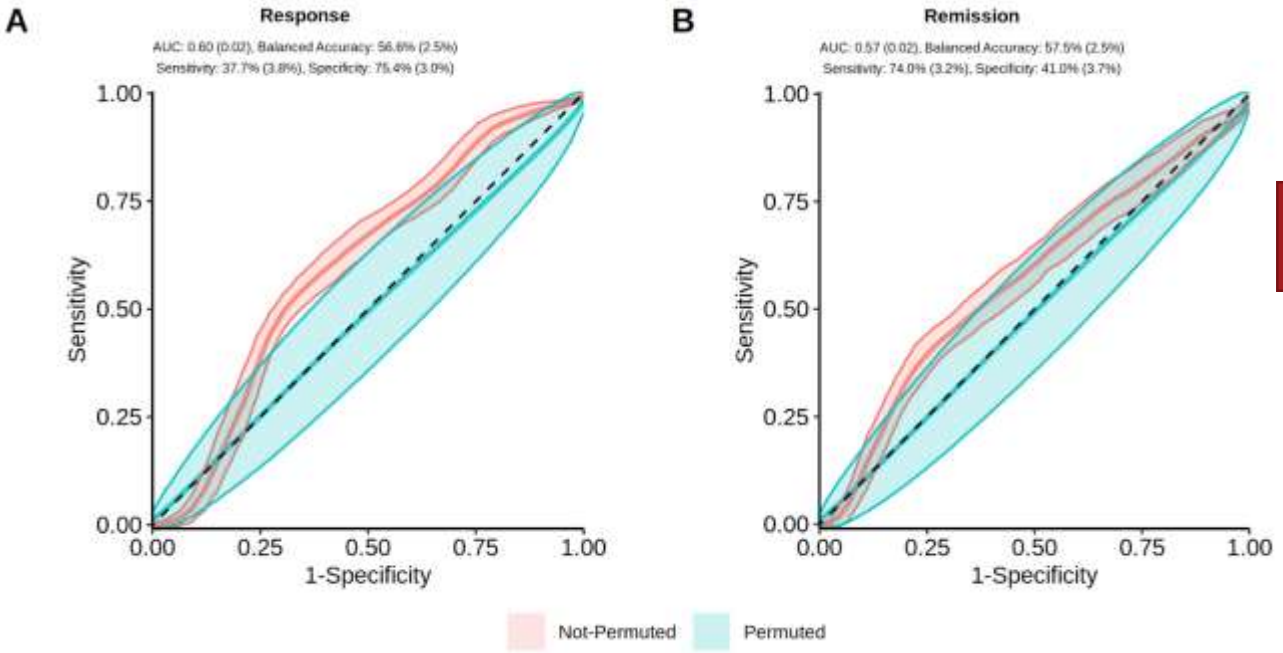
Deployment of biomarker

NeuroImage: Clinical
Volume 36, 2022, 103224

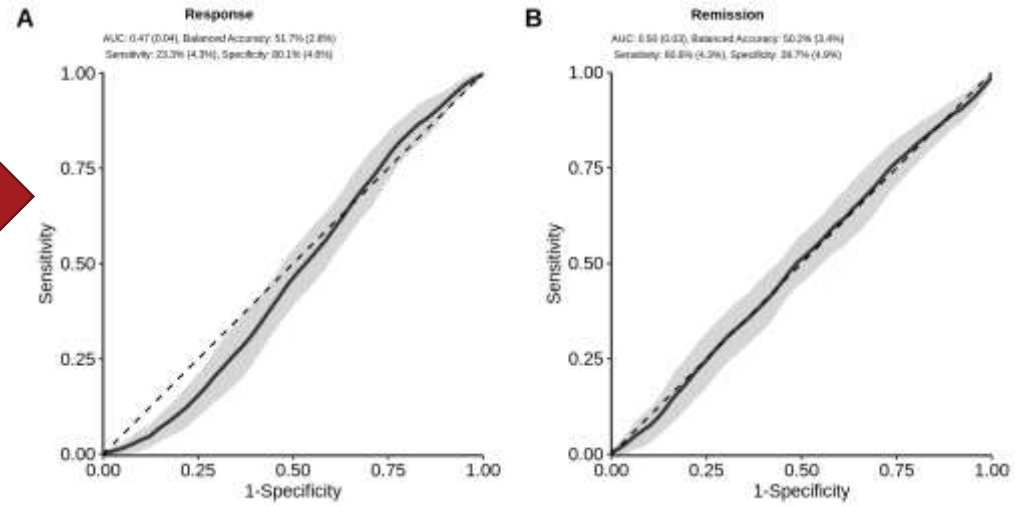
Generalizability of treatment outcome prediction in major depressive disorder using structural MRI: A NeuroPharm study

Vincent Beliveau [a b], Ella Hedeboe [a], Patrick M. Fisher [a], Vibeke H. Dam [a], Martin B. Jørgensen [a c d], Vibe G. Frokjaer [a c d], Gitte M. Knudsen [a c], Melanie Ganz [a *]

Neuropharm study



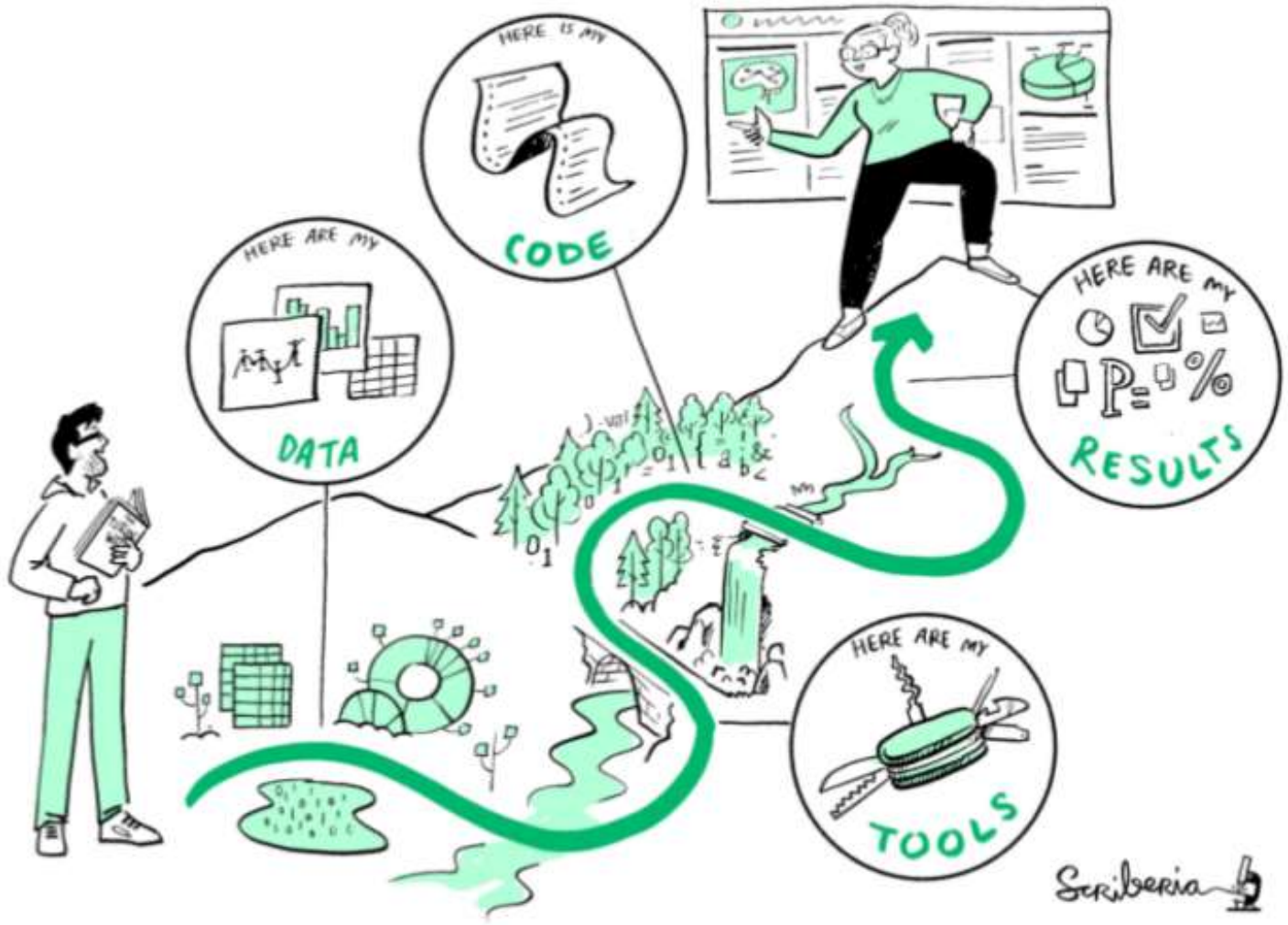
EMBARC study



In sample

Out of sample

Solutions?



Reproducible Research. Image adapted from The Turing Way handbook
DOI: 10.5281/zenodo.3332807 https://the-turing-way.netlify.app/welcome.html

Solutions I

Review Article

JCBFM

Journal of Cerebral Blood Flow & Metabolism
0(0) 1–10
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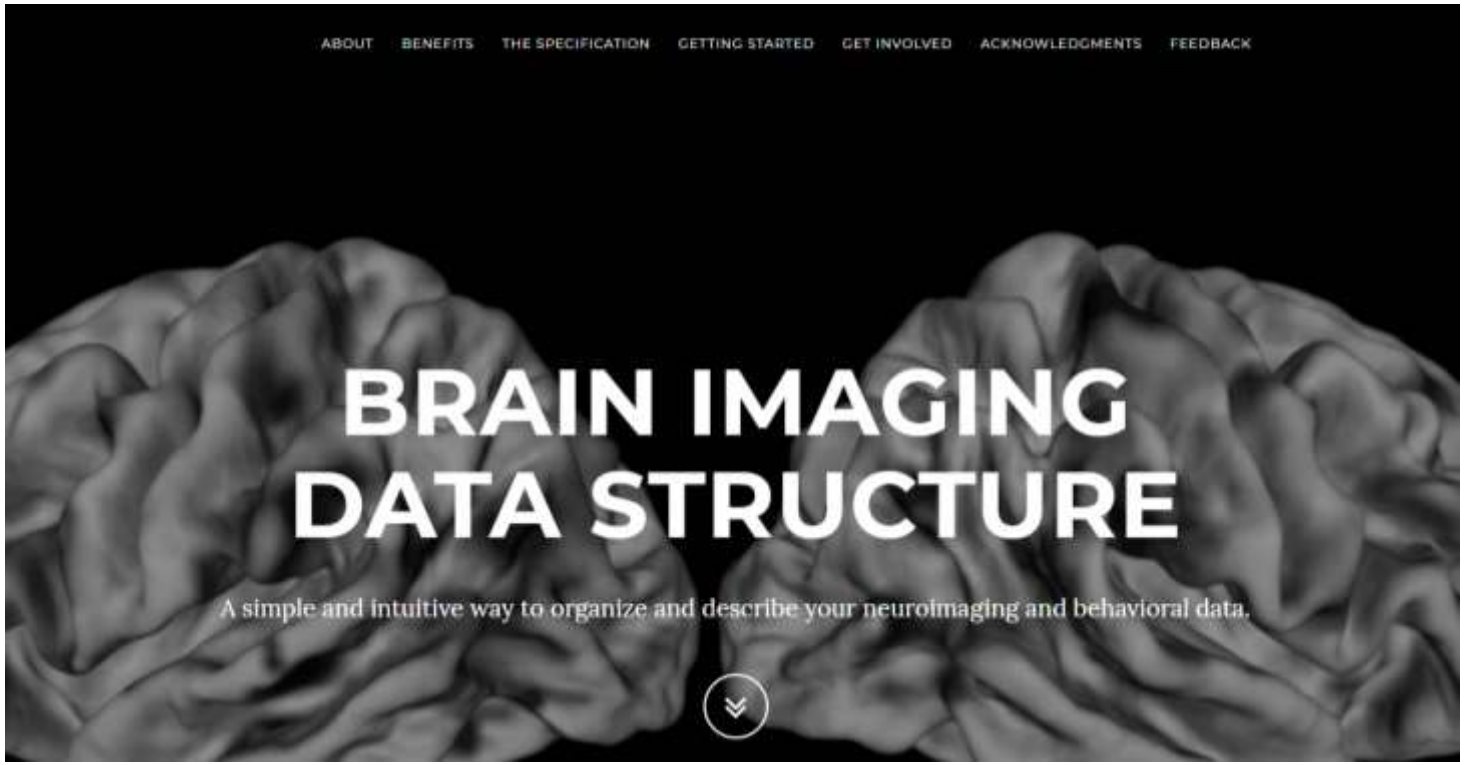
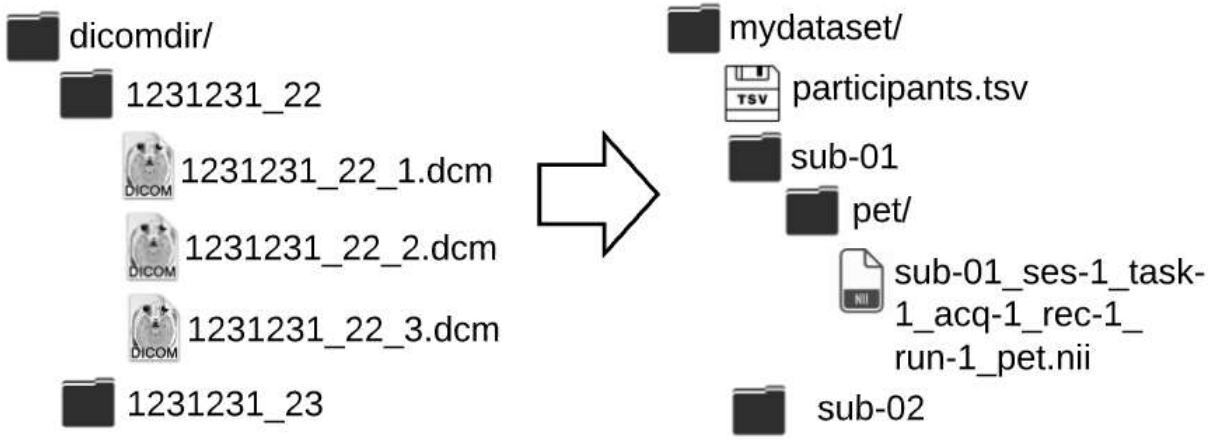
sagepub.com/journals-permissions
DOI: 10.1177/0271678X20905433
journals.sagepub.com/home/jcbfm
SAGE

Guidelines for the content and format of PET brain data in publications and archives: A consensus paper

Gitte M Knudsen[1], Melanie Ganz[1], Stefan Appelhoff[2], Ronald Boellaard[3], Guy Bormans[4], Richard E Carson[5], Ciprian Catana[6], Doris Doudet[7], Antony D Gee[8], Douglas N Greve[6], Roger N Gunn[9], Christer Halldin[10], Peter Herscovitch[11], Henry Huang[5], Sune H Keller[12], Adriaan A Lammertsma[3], Rupert Lanzenberger[13], Jeih-San Liow[14], Talakad G Lohith[15], Mark Lubberink[16], Chul H Lyoo[17], J John Mann[18], Granville J Matheson[10], Thomas E Nichols[19], Martin Nørgaard[1], Todd Ogden[20], Ramin Parsey[21], Victor W Pike[14], Julie Price[6], Gaia Rizzo[9], Pedro Rosa-Neto[22,23], Martin Schain[20], Peter JH Scott[24], Graham Searle[9], Mark Slifstein[21], Tetsuya Suhara[25], Peter S Talbot[26], Adam Thomas[27], Mattia Veronese[28], Dean F Wong[29], Maqsood Yaqub[3], Francesca Zanderigo[30], Sami Zoghbi[14] and Robert B Innis[14]

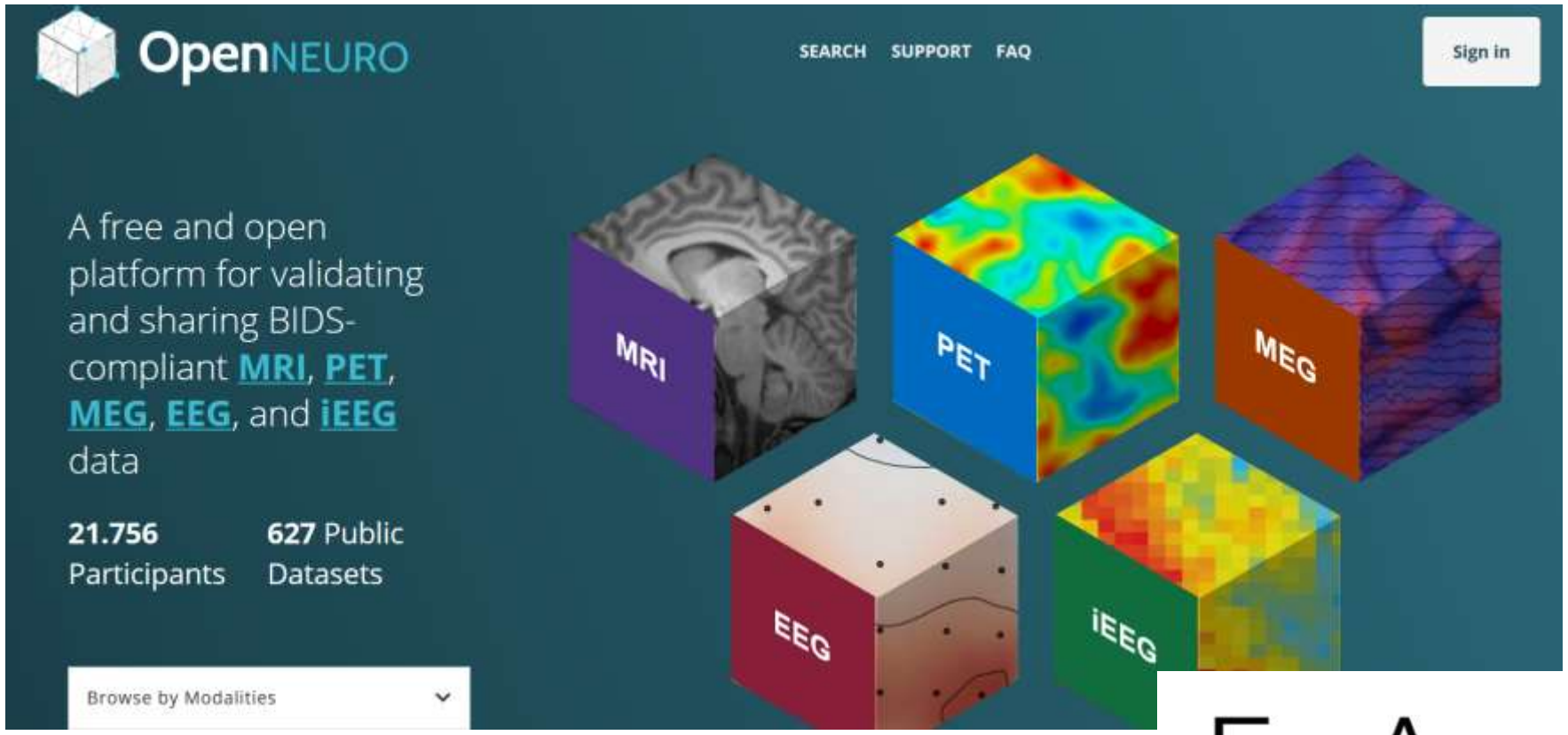


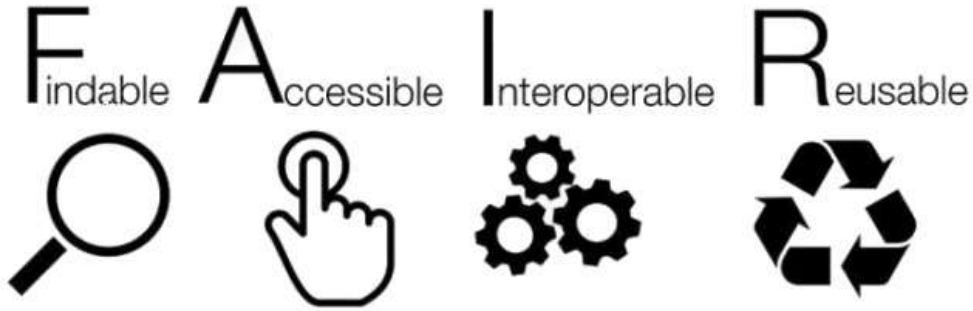
From raw data to BIDS format



[WIP]

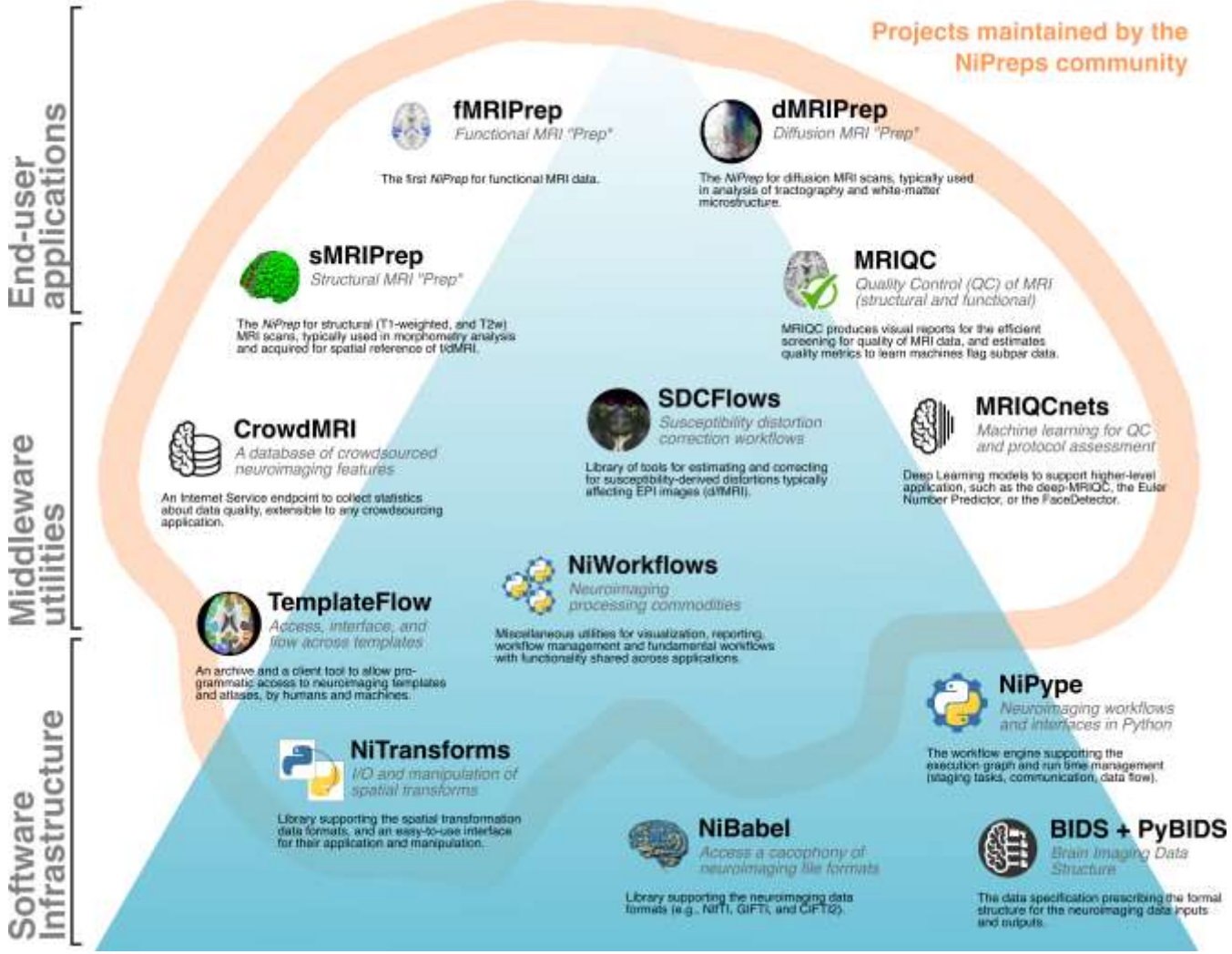
Solutions II





[WIP]

Solutions III



ReproNim

docker

[WIP]

Additional comments

- "I would like to have demo PET data and metadata needed for BIDS conversion. 
- Moreover, both fMRI (resting state and task) and structural MRI(dwi, t1, t2) Arterial Spin labeling and MEG. For me it would very important to have these demo data to convert them as a separate dataset but also to have a tool convert all these modalities into a single multimodal dataset." 
- "I'm currently working on the deep learning methods with eye movement data. It would be very interesting to see the potential multimodal methods between eye tracking data and brain image." 
  - BEP020 https://bids.neuroimaging.io/bep020

Additional comments

- “Since it is for phd students probably approaching new postdoc positions soon, I think it would be great to make the method we learn in the tutorial as transferrable as possible to other environments, working in slightly different fields, so that it is a skill we can bring with us to the next labs.”


Questions?

BIDS resources:

- Website https://bids.neuroimaging.io
- Starter Kit https://bids-standard.github.io/bids-starter-kit/
- YouTube channel https://www.youtube.com/channel/UCxZUcYfd_nvIVWAbzRB1tlw

Data sharing resources:

- Openneuro https://openneuro.org/
- OpenNeuroPET https://openneuropet.github.io/
- PublicNeuro https://publicneuro.eu/
- Serotonin atlas https://xtra.nru.dk/FS5ht-atlas/
- Benzodiazepine atlas https://xtra.nru.dk/BZR-atlas/
- SV2A atlas ...coming online soon!

Thank you!

https://openneuropet.github.io/
https://public-neuro.github.io/




novo nordisk fonden


NIH National Institute of Mental Health



Athinoula A. Martinos Center For Biomedical Imaging

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