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Reproducible neuroimaging: a review on past and emerging questions

Camille Maumet

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*Reproducible neuroimaging: a review
on past and emerging questions*

—
**Reproductibilité en neuroimagerie
état des lieux**

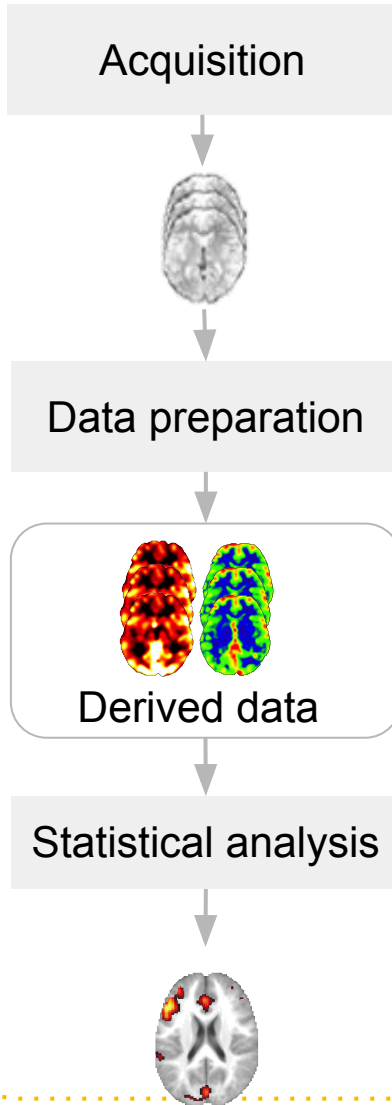
March 8, 2023

Camille Maumet

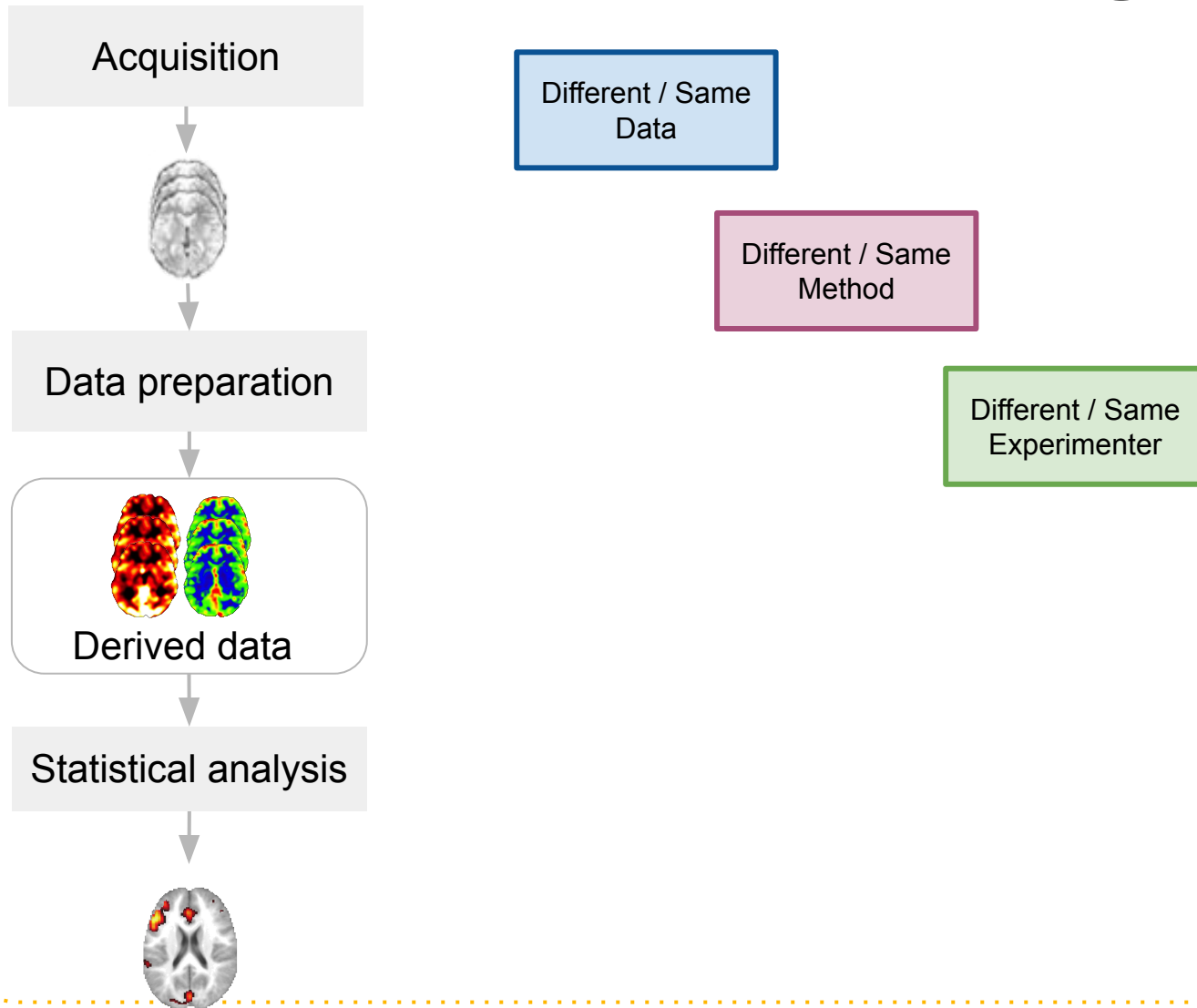
Univ Rennes, Inria, CNRS, Inserm

ILLUSTRATION DE MOTS CLÉS EN FRANÇAIS :
MÉDECINE • NEUROSCIENCE • ÉCONOMIE • PHILOSOPHIE
HISTOIRE • DROIT • ASTRONOMIE • GÉNÉTIQUE
ANTHROPOLOGIE • PSYCHOLOGIE • CHIMIE
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PHYSIQUE • HISTOIRE • DROIT • ÉCONOMIE • CHIMIE
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Reproducible brain imaging



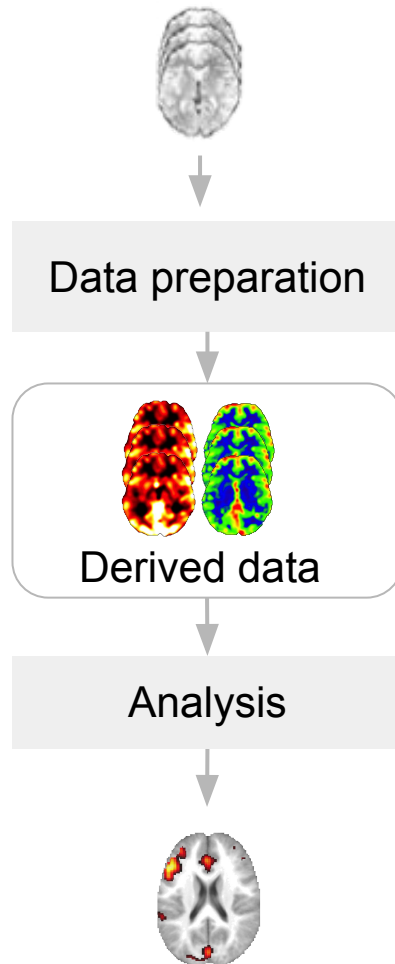
Reproducible brain imaging



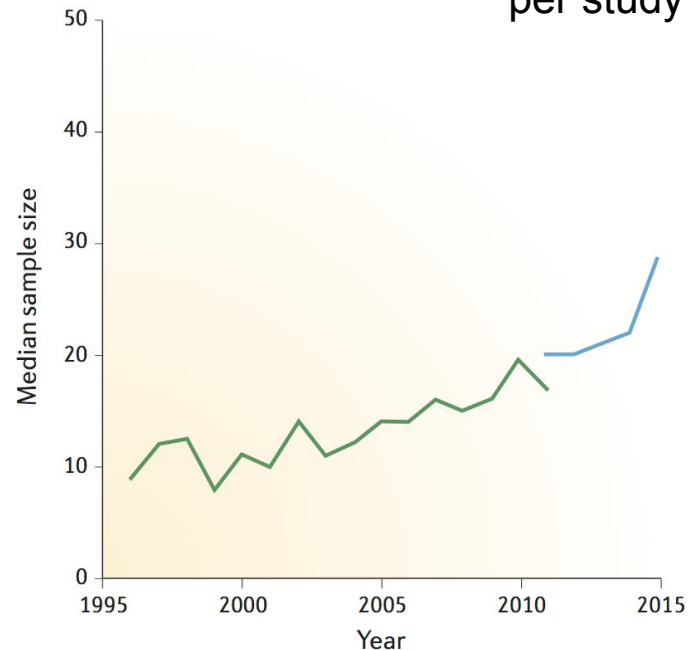
Towards **reproducible** neuroimaging

Irreproducible with...

Different Data



about 30 participants
per study



[Poldrack et. al, Nature Neuroscience 2017]

Towards **reproducible** neuroimaging

Irreproducible with...

Different Data

Towards **reproducible** neuroimaging

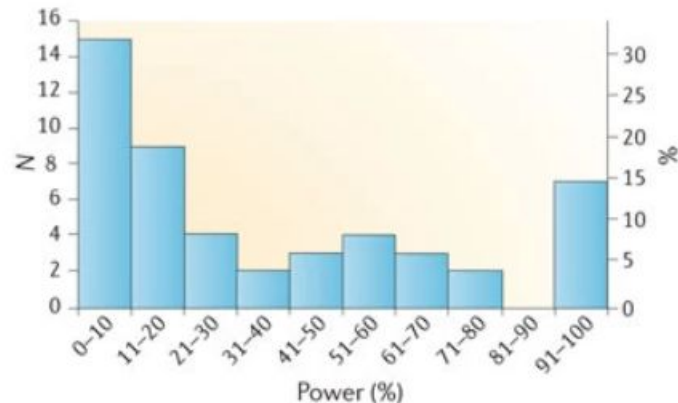
Irreproducible with...

Different Data

Lack of power

Power of neuroscience studies

Power = Prob. to correctly find a significant effect when a the alternative hypothesis is true.



[Button et. al, Nat Rev Neurosci 2013]

We need bigger datasets

Towards **reproducible** neuroimaging

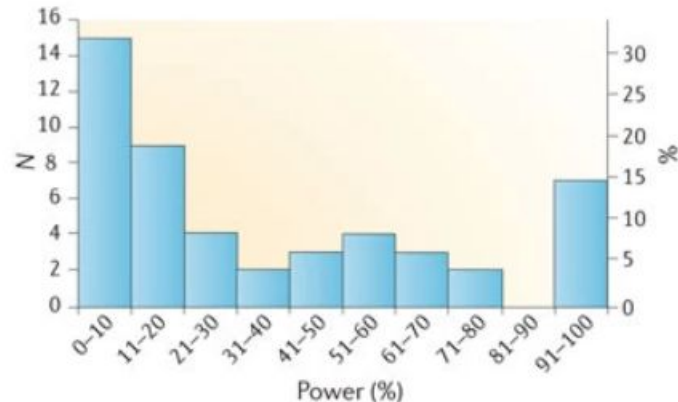
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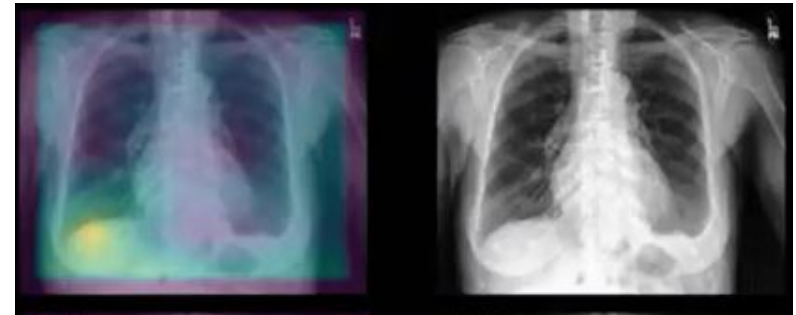


[Button et. al, Nat Rev Neurosci 2013]

Generalizability and fairness

X-ray: Lung opacity detection

Model trained on male images, tested on female images



[Larrazabal et. al, PNAS 2020]

We need bigger datasets

We need representative and diverse datasets



Open data

Unique study
30 participants



OpenNEURO

studyforrest.org



NEUROVAULT

L I E L N L F T Q K T Q R V
S M Y C O N N E C T O M E Q
G S P K K W A R R G K E H R

NITRC

OSF

- + Images
- + Homogenous
- Datasets



Open data

Unique study
30 participants



OpenNEURO

studyforrest.org

Consortium
1000 participants



ABIDE

Autism Brain Imaging
Data Exchange

1000 Functional
Connectomes Project



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Autism Brain Imaging
Data Exchange

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NITRC

OSF

CORR
CONSORTIUM FOR
RELIABILITY AND
REPRODUCIBILITY



Cohort
100 000 participants



HUMAN
Connectome
PROJECT

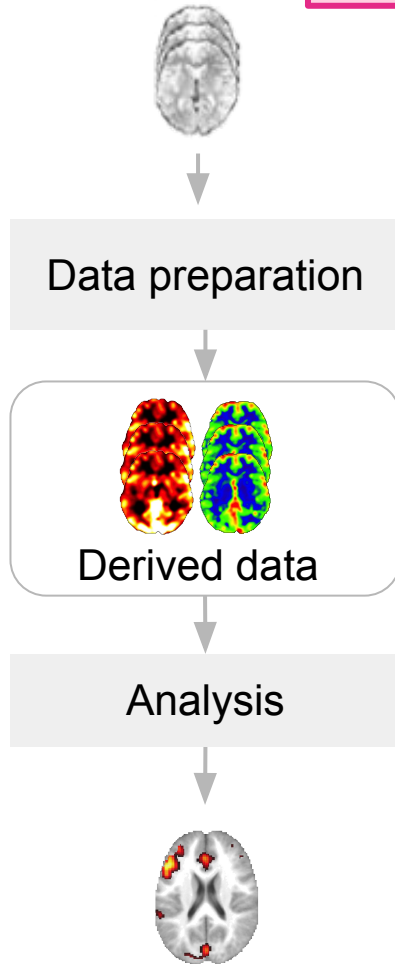
biobank^{uk}
Improving the health of future generations

- + Images
- + Homogenous
- Datasets

On our way **to fix irreproducibility**

Irreproducible with...

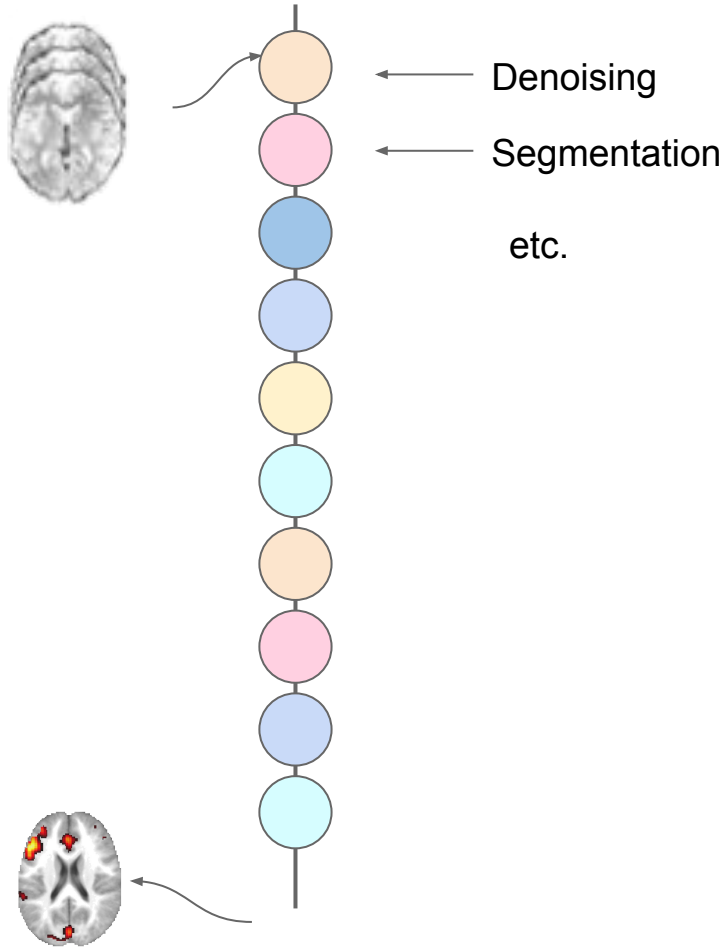
Different Post-processing Methods



On our way **to fix irreproducibility**

Irreproducible with...

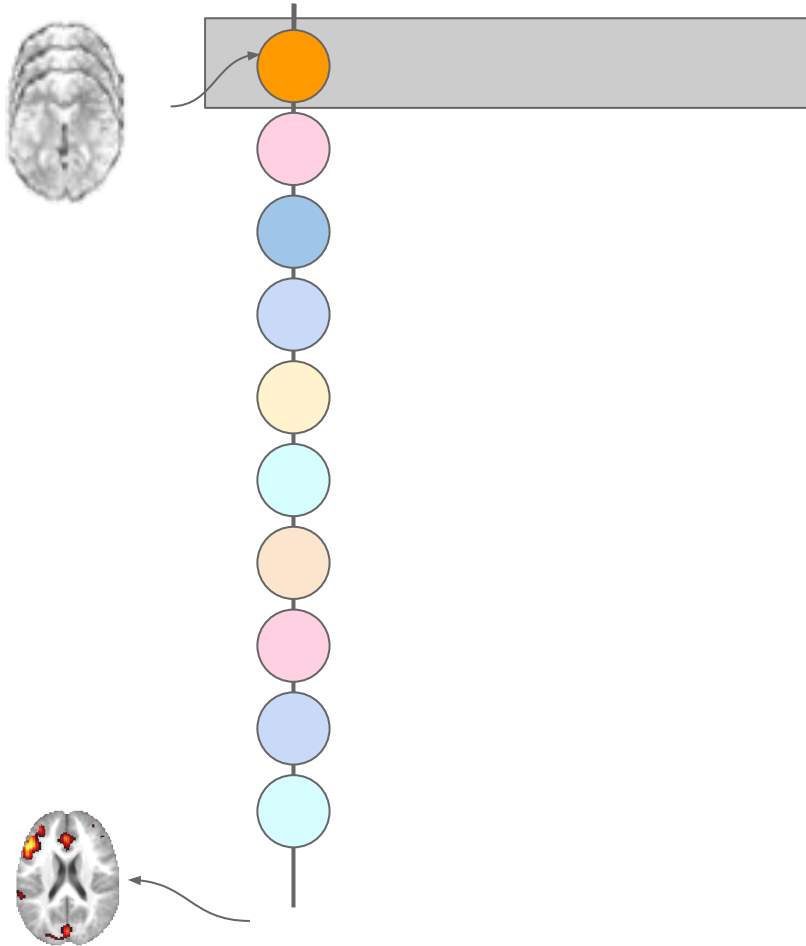
Different Post-processing Methods



On our way **to fix irreproducibility**

Irreproducible with...

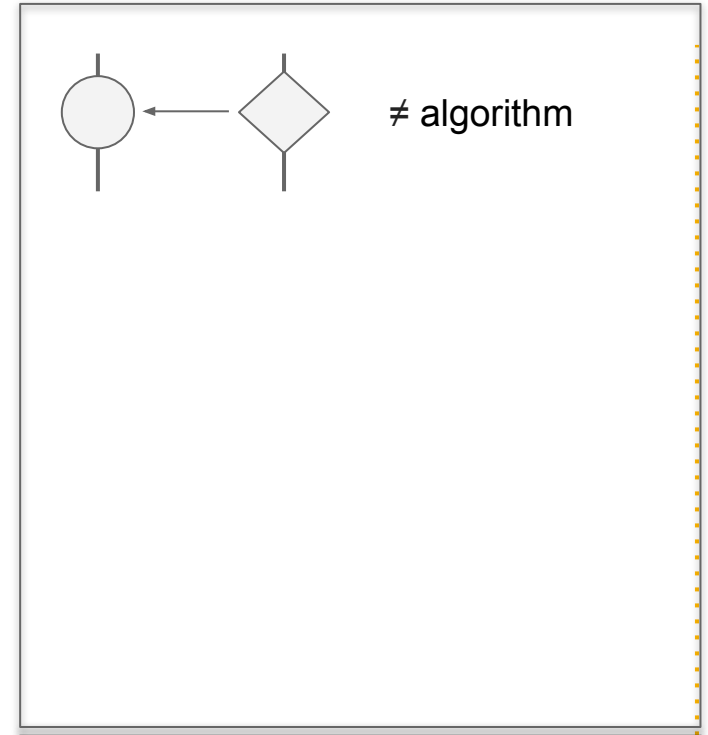
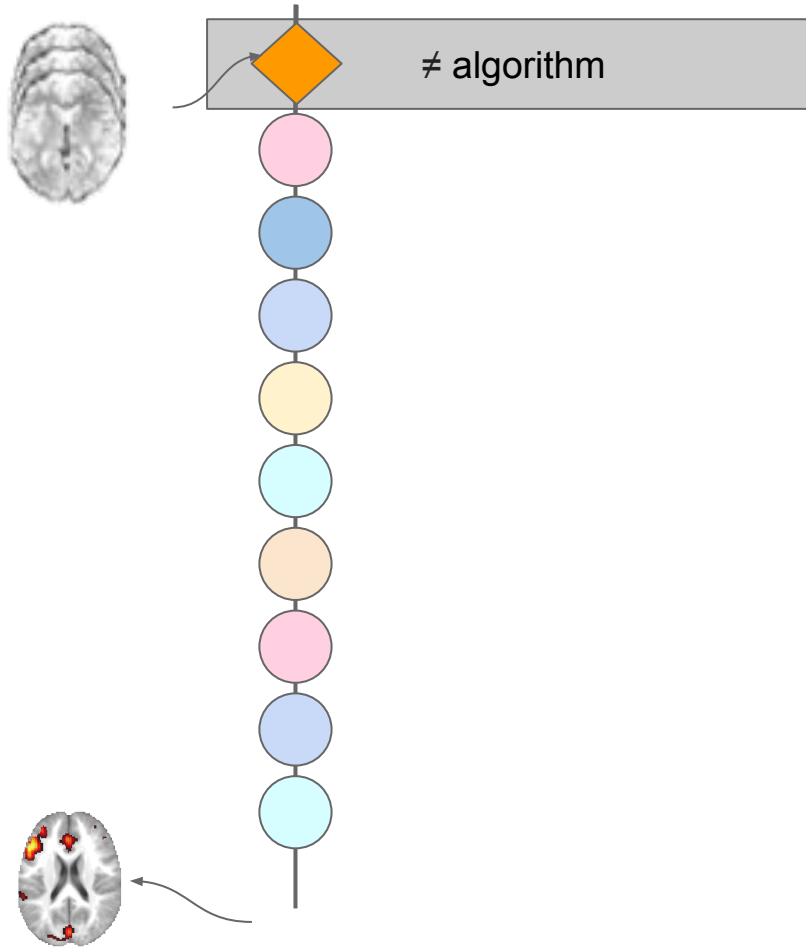
Different Post-processing Methods



On our way **to fix irreproducibility**

Irreproducible with...

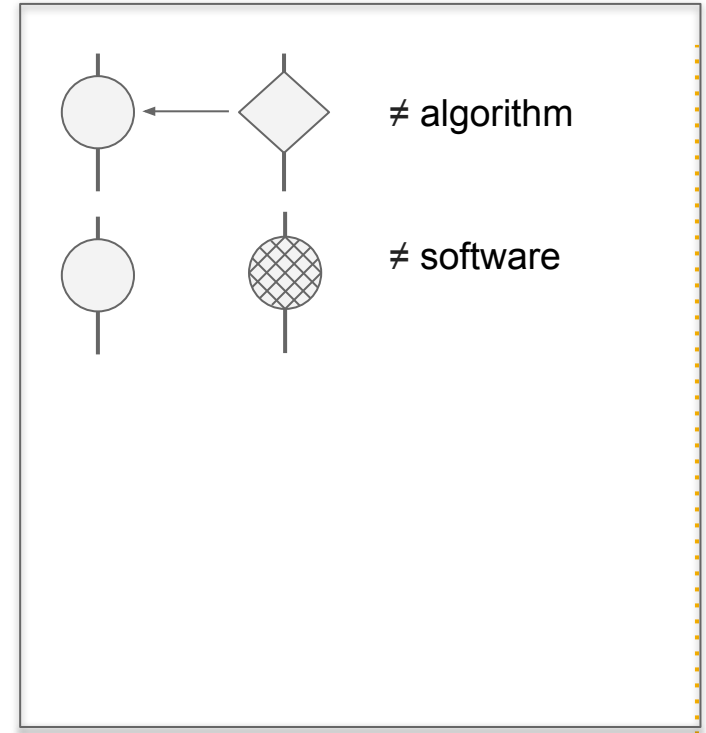
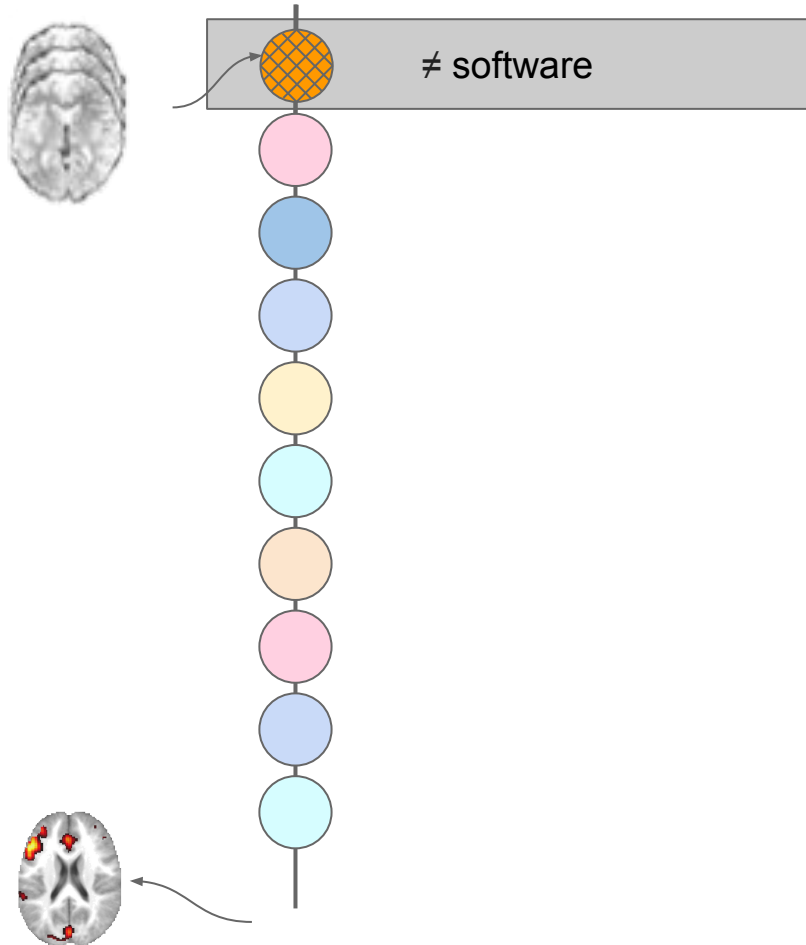
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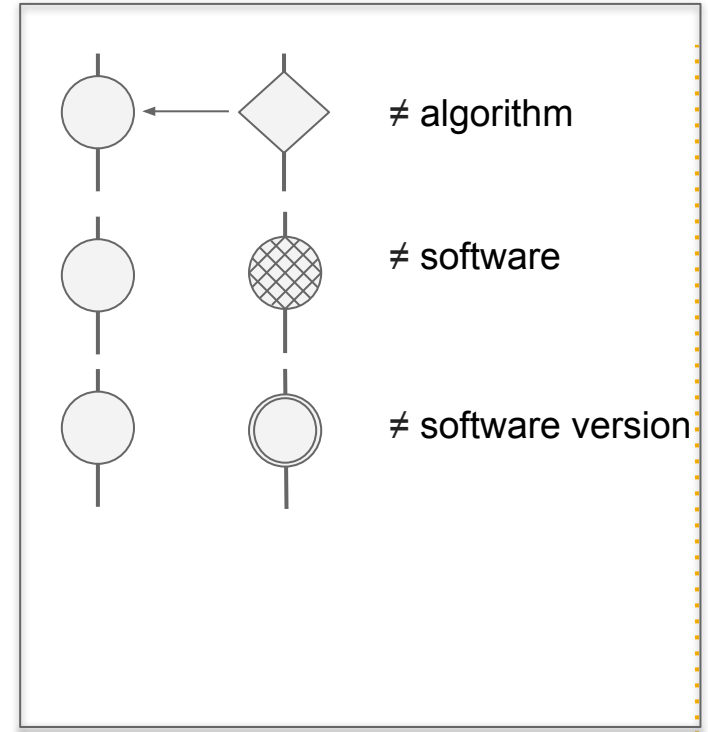
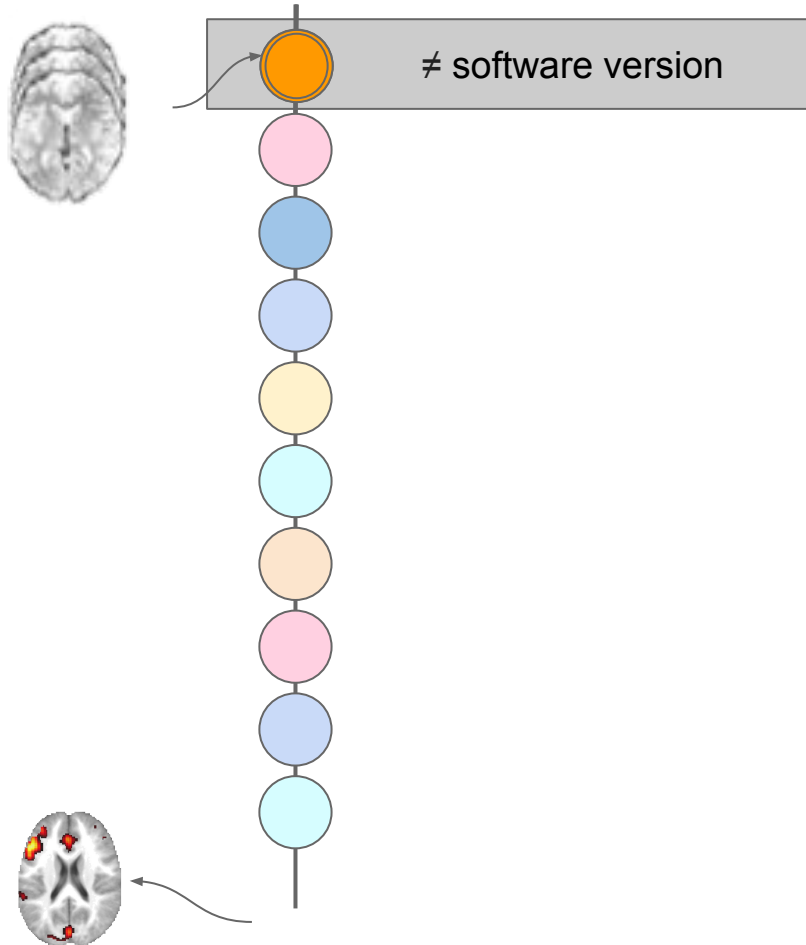
Different Post-processing Methods



On our way **to fix irreproducibility**

Irreproducible with...

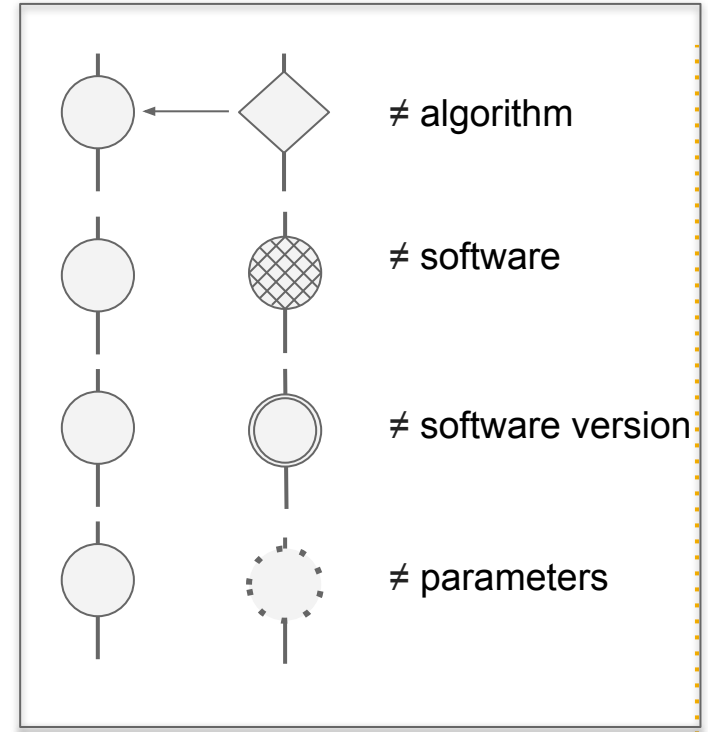
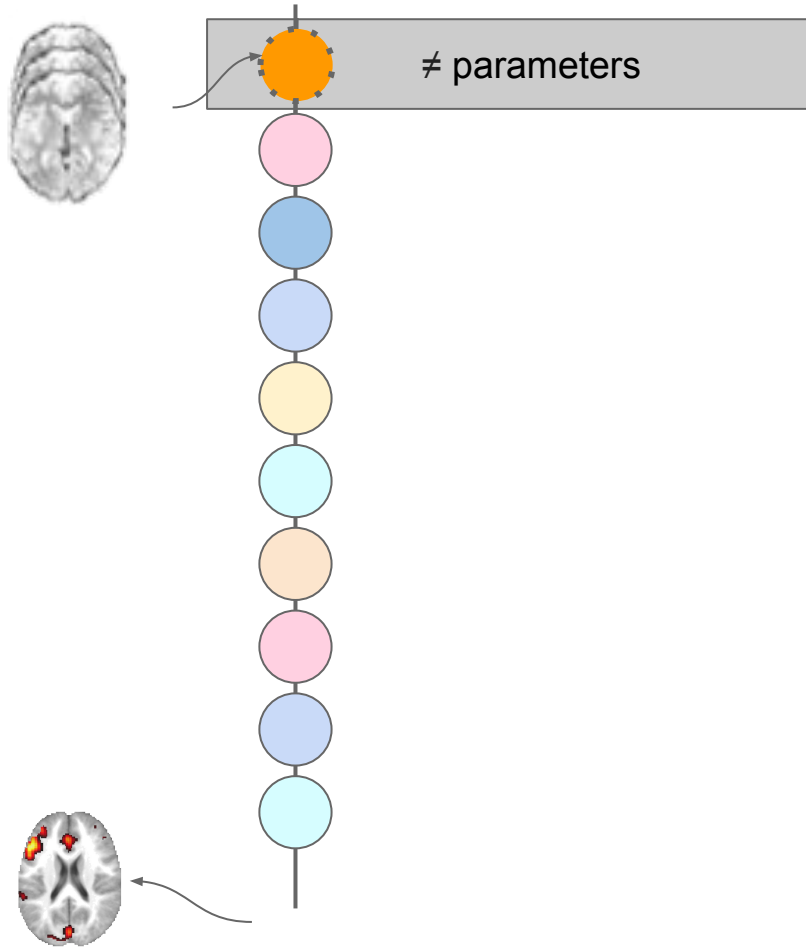
Different Post-processing Methods



On our way **to fix irreproducibility**

Irreproducible with...

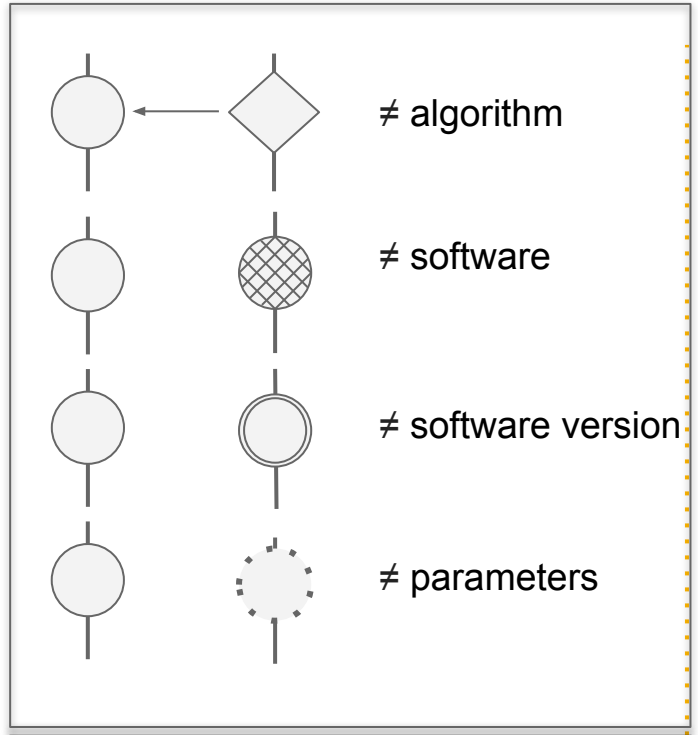
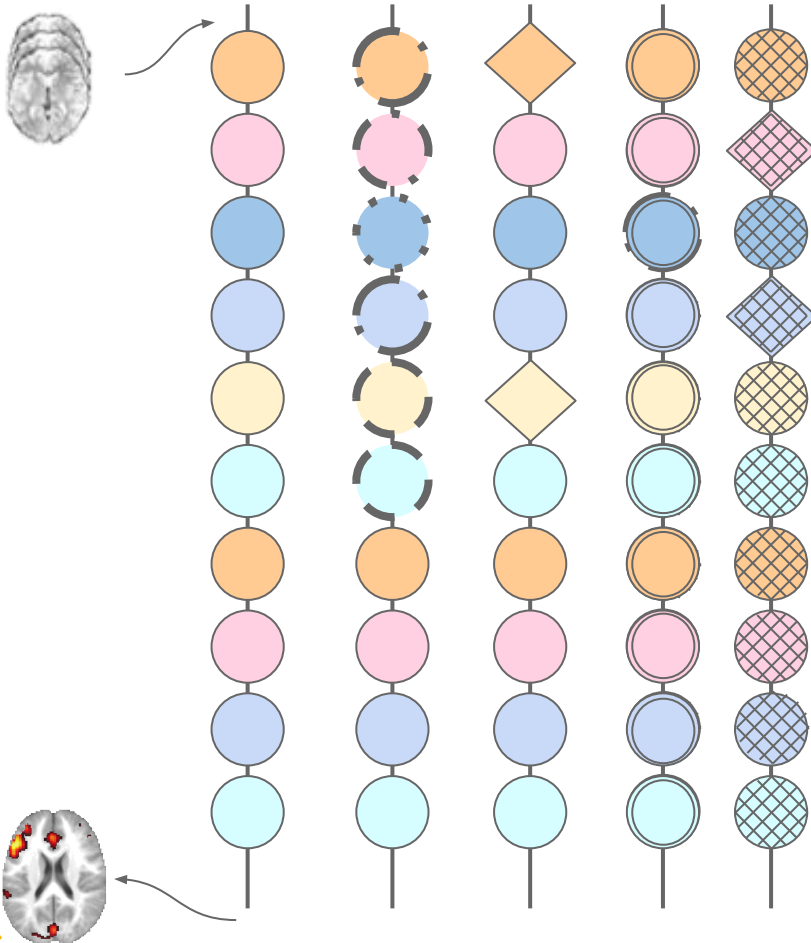
Different Post-processing Methods



On our way **to fix irreproducibility**

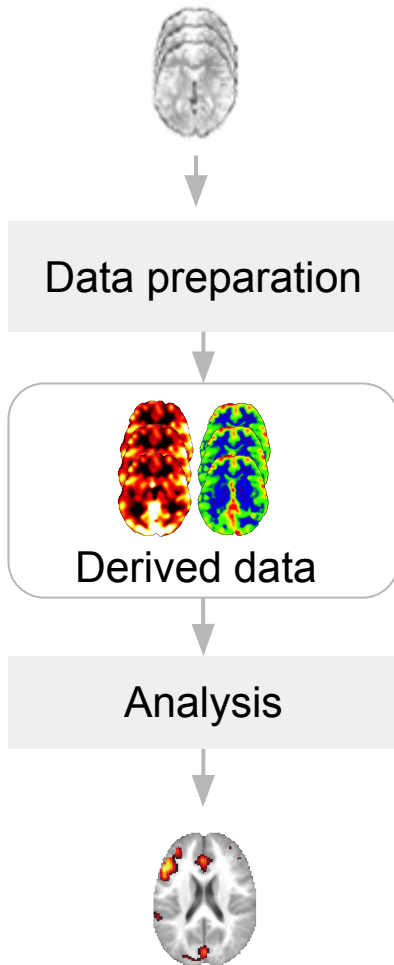
Irreproducible with...

Different Post-processing Methods

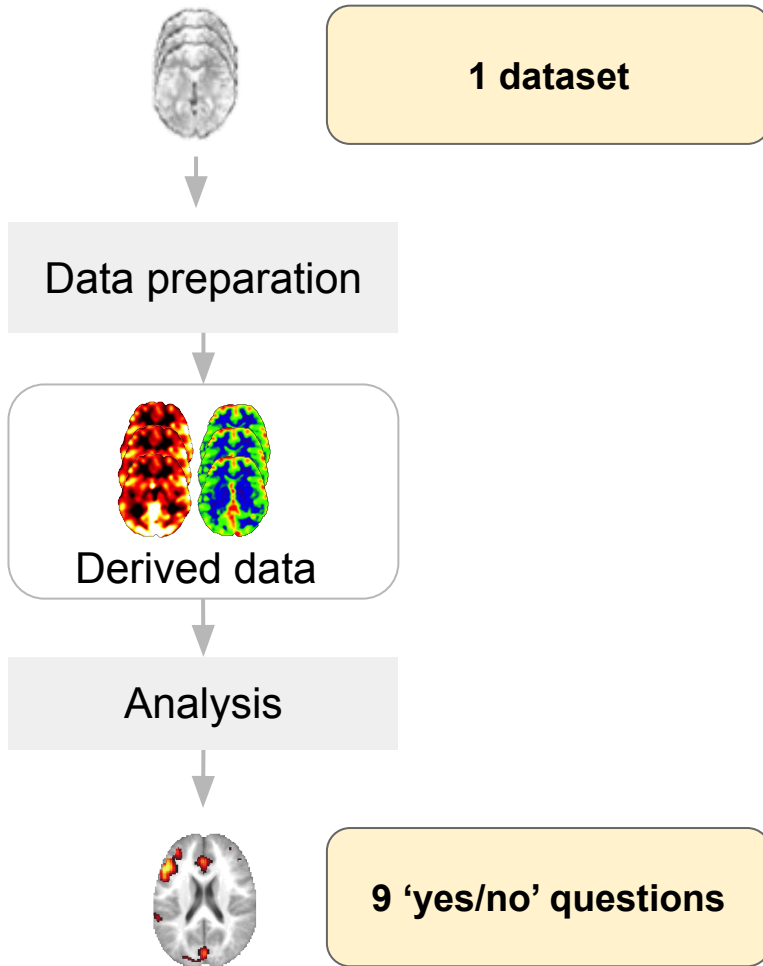


A family of acceptable pipelines
over 10^{30} combinations...

Many analysts project : NARPS

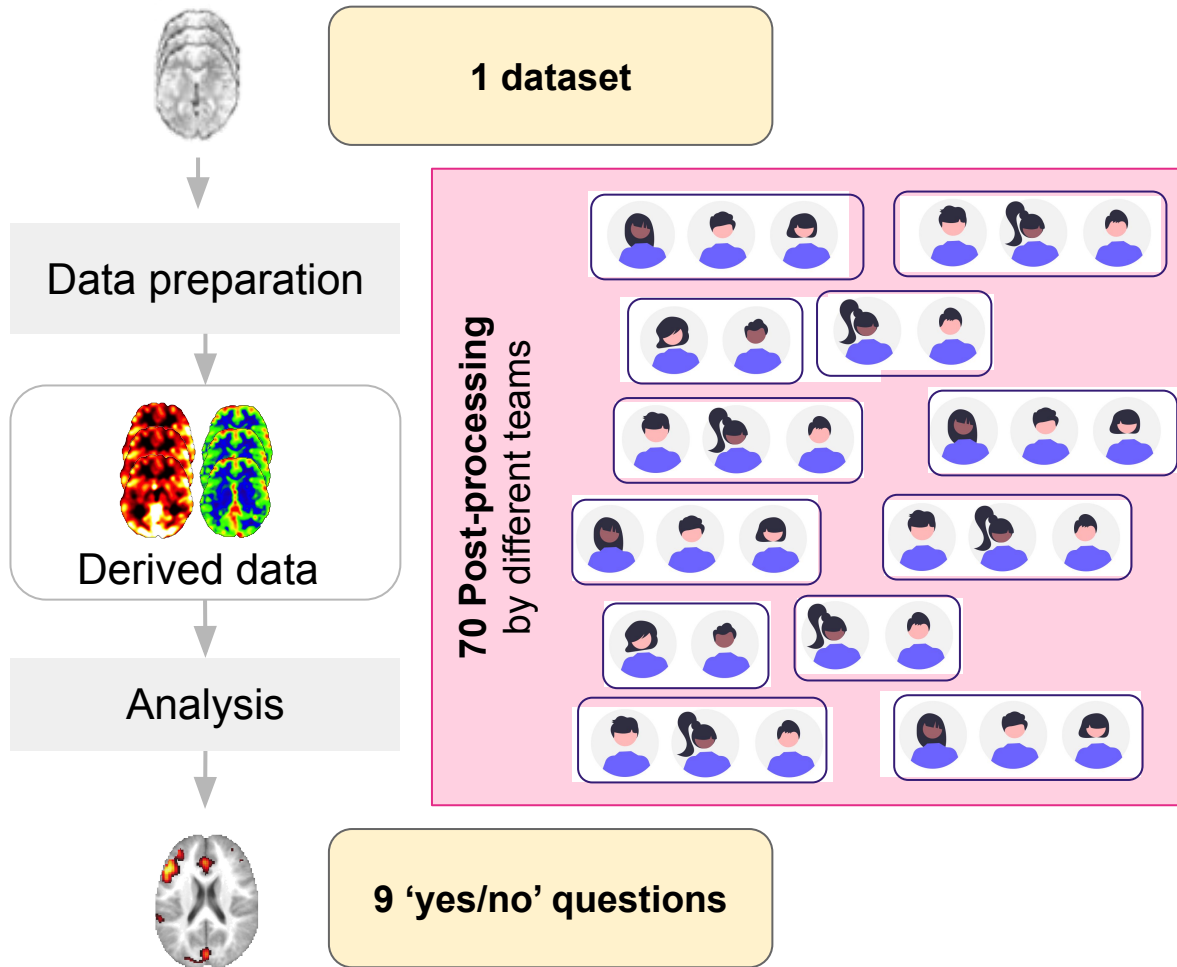


Many analysts project : NARPS



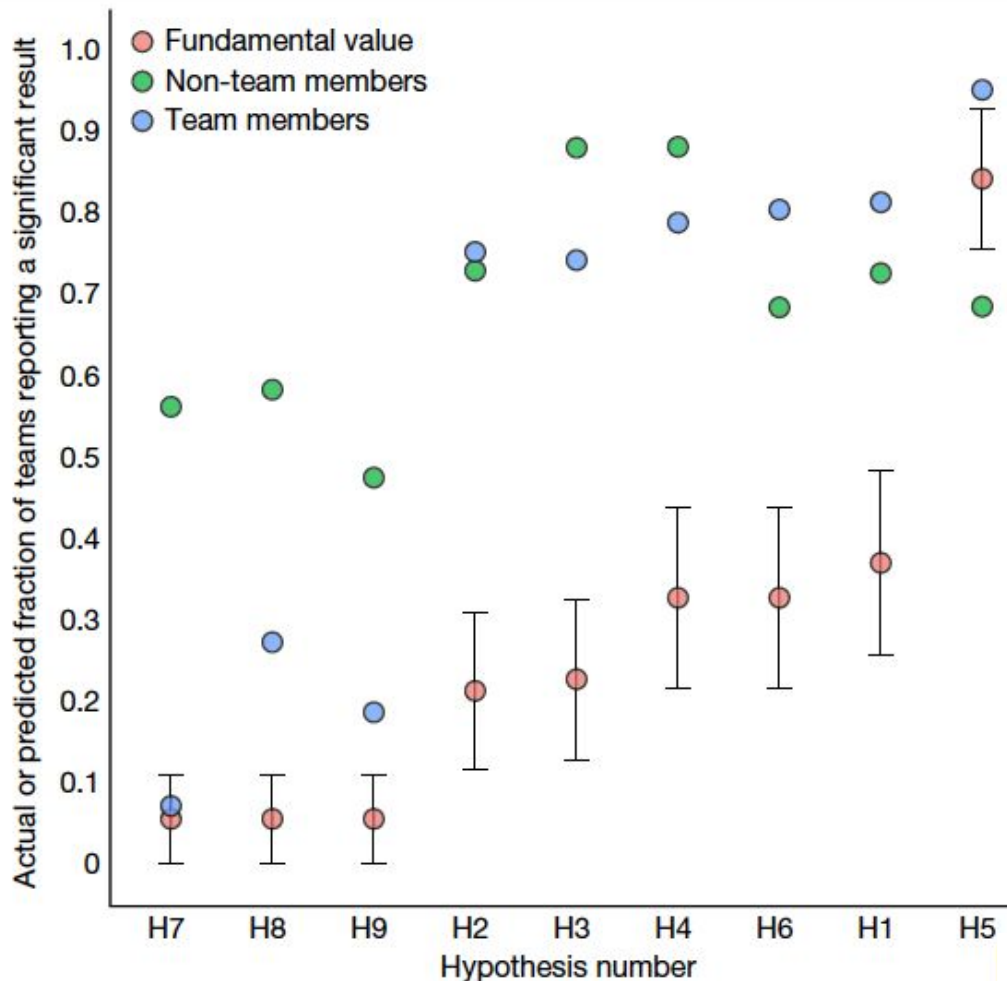
*e.g. Is there a parametric effect of gain:
Positive effect in ventromedial PFC -
for the equal indifference group?*

Many analysts project : NARPS



Many analysts project : NARPS

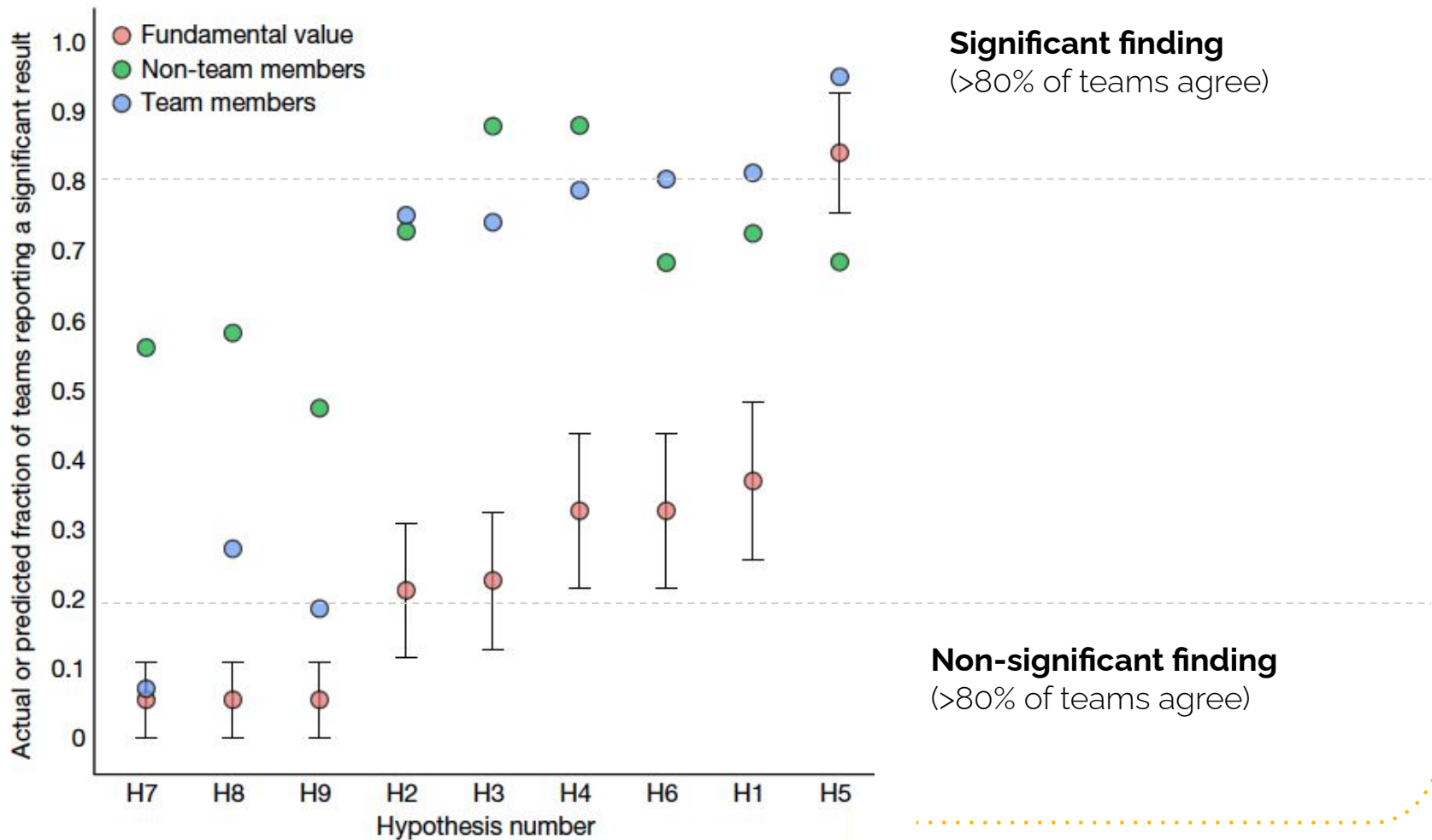
Results over the **70 post-processing pipelines**:



[Botvinik-Nezer et. al, Nature 2020]

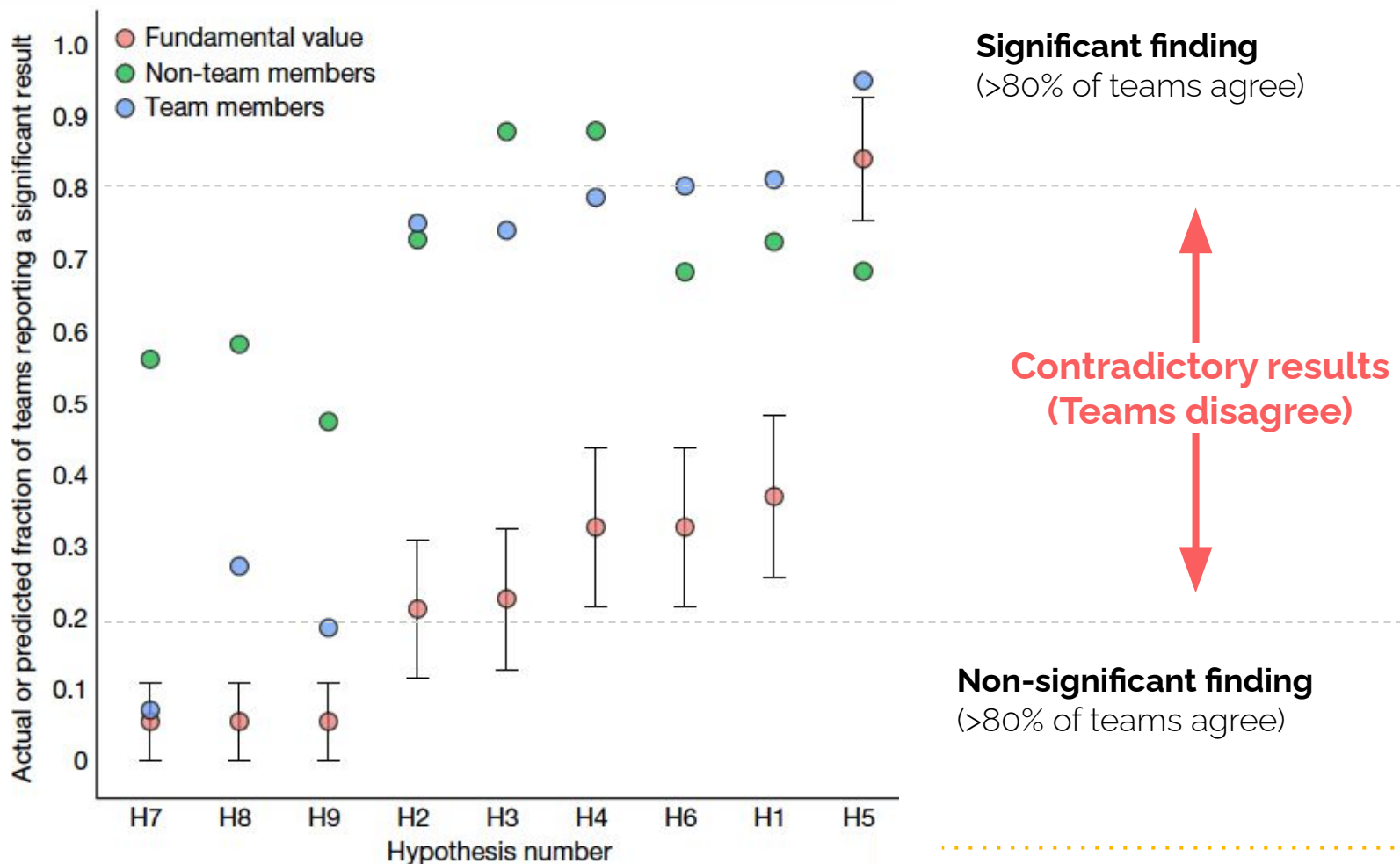
Many analysts project : NARPS

Results over the **70 post-processing pipelines**:



Many analysts project : NARPS

Results over the **70 post-processing pipelines**:



Different levels of variability in post-processing pipelines

- Different end-to-end pipelines [Carp 2013]
- Different Software Version [Gronenschild 2012]
- Different operating system [Glatard 2015]

- Different **post-processing software packages** [Bowring 2019, 2021]

Open questions

Stratégie adoptée par votre communauté

- **sur le plan technique**
 - Partage de code
- **pour les carrières**
 - Data papers
- **en terme d'Animation**
 - Open science community (OHBM open science SIG, Brainhack)
 - Hackathons collaboratifs "Brainhack"

Exemple de problèmes techniques et scientifiques

- Open data in Europe (GDPR, infrastructures)
- Causes of analytical variability (different methods) not well understood

Réseau de la recherche reproductible Journées Recherche
reproductible: état des lieux

March 8, 2023

Reproductibilité computationnelle en **neuroimagerie**:
état des lieux

Camille Maumet

Merci



Credit: Sculpture by Malin Bjornsdotter "Cerebia", [OHBM Brain Art SIG](#); Presentation template by [SlidesCarnival](#), adapted

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