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## Reproductibilité en neuroimagerie: état des lieux

Camille Maumet

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*French network on reproducible research – Réseau de la recherche reproductible*  
Journées Recherche reproductible: état des lieux

*Reproducibility in neuroimaging*  
*State of the art*

—  
Reproductibilité en neuroimagerie  
état des lieux

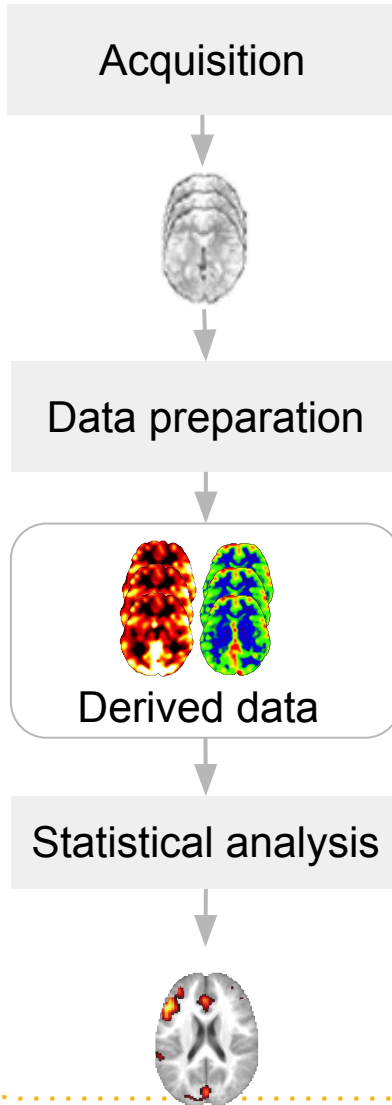
March 8, 2023

Camille Maumet

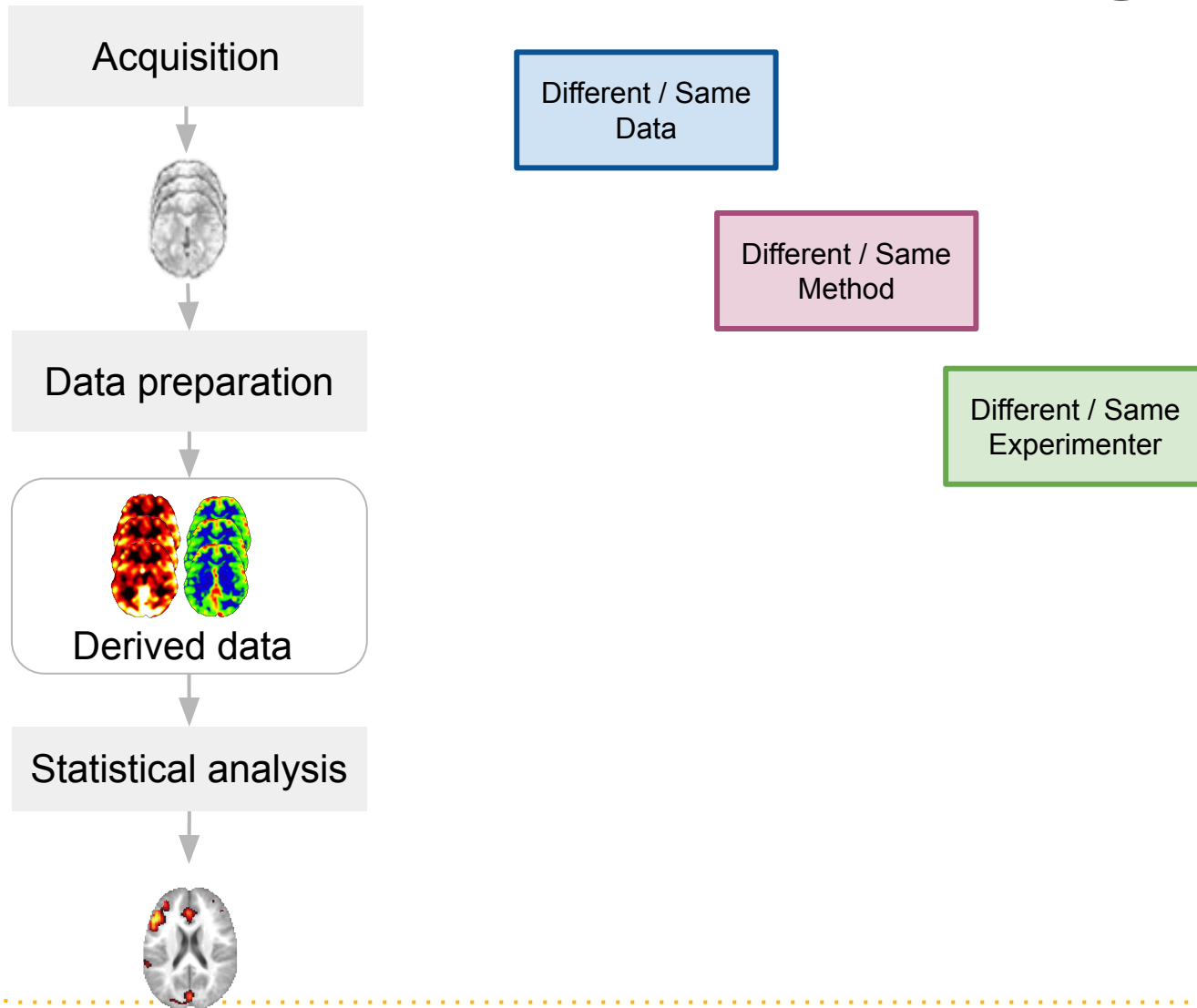
Univ Rennes, Inria, CNRS, Inserm

IL  
ECINE • NEUROSCIENCE • MATHEMATIQUES  
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HEMATIQUES • MECANIQUE • GENETIQUE • A  
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**8 & 9 MARS 2023**  
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GENERALISABLE • ANALYSE

# Reproducible brain imaging



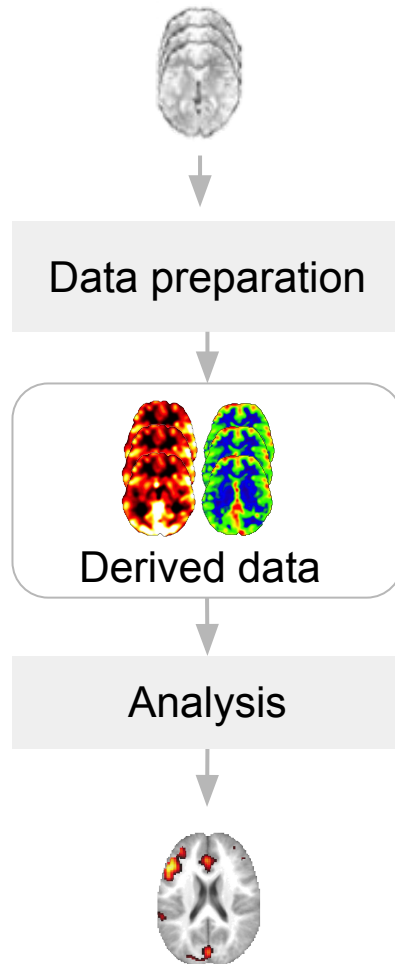
# Reproducible brain imaging



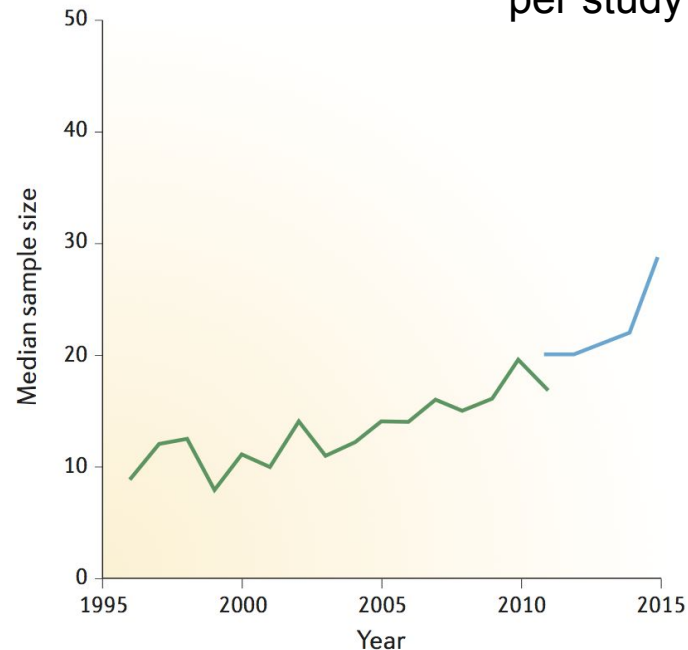
# Towards **reproducible** neuroimaging

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

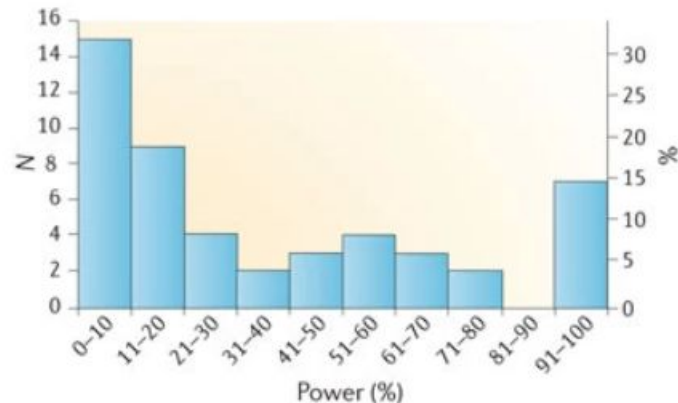
Irreproducible with...

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

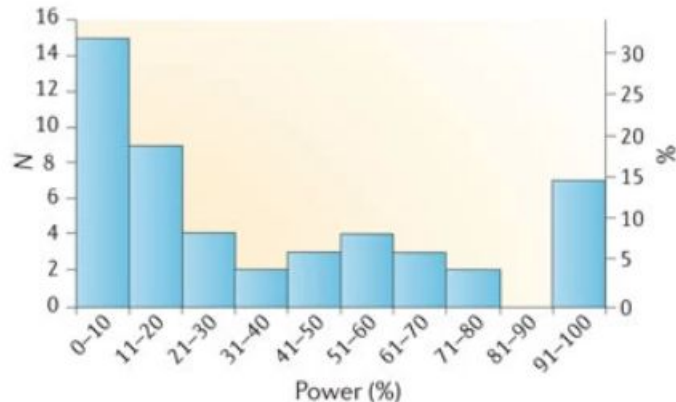
Irreproducible with...

Different Data

## Lack of power

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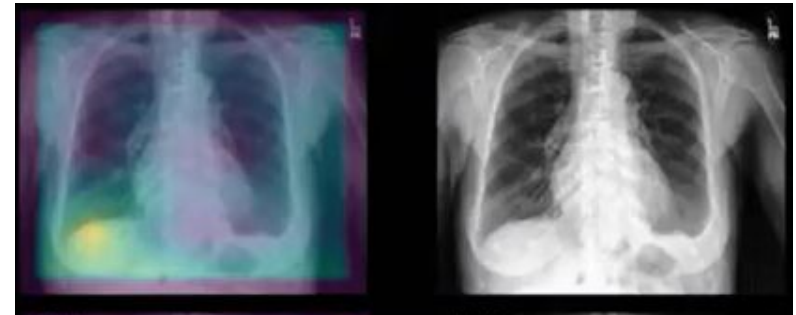


[Button et. al, Nat Rev Neurosci 2013]

## 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

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

CORR  
CONSORTIUM FOR  
RELIABILITY AND  
REPRODUCIBILITY



- + 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



Cohort  
100 000 participants



HUMAN  
Connectome  
PROJECT

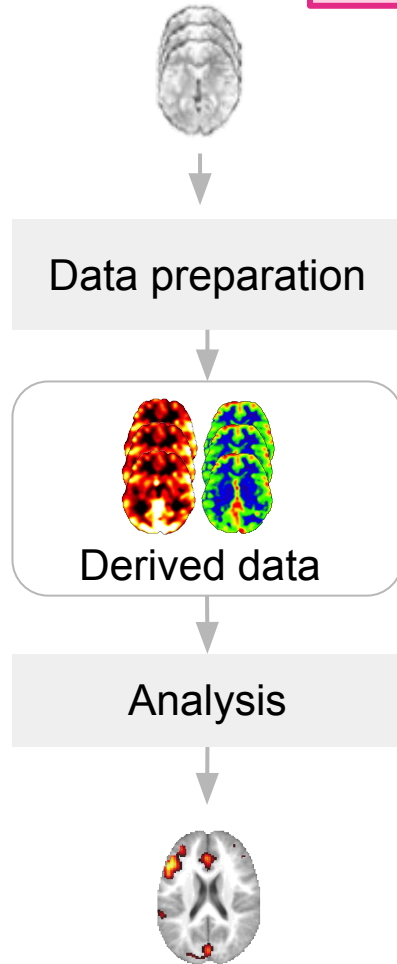


- + Images
- + Homogenous
- Datasets

# On our way **to fix irreproducibility**

Irreproducible with...

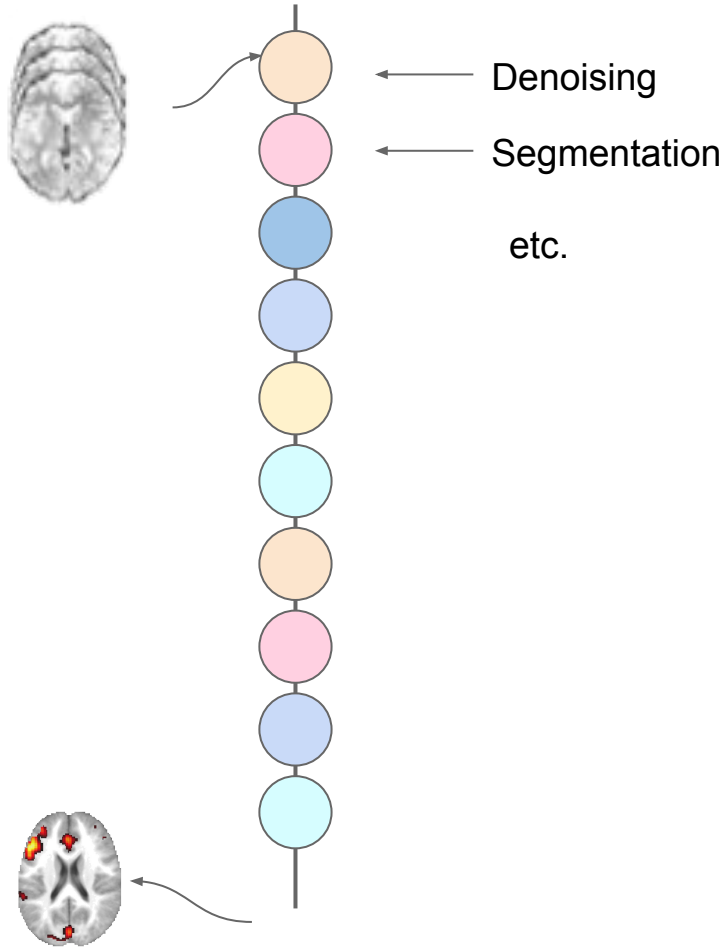
Different Post-processing Methods



# On our way **to fix irreproducibility**

Irreproducible with...

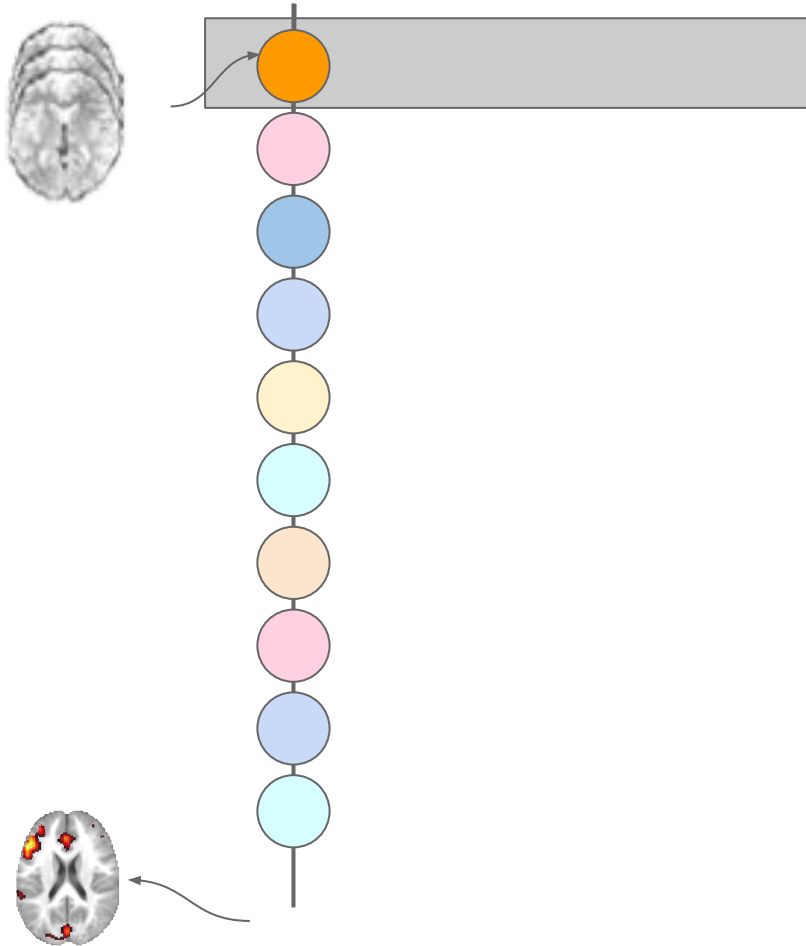
Different Post-processing Methods



# On our way **to fix irreproducibility**

Irreproducible with...

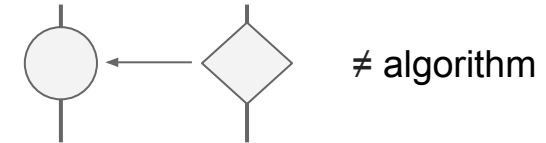
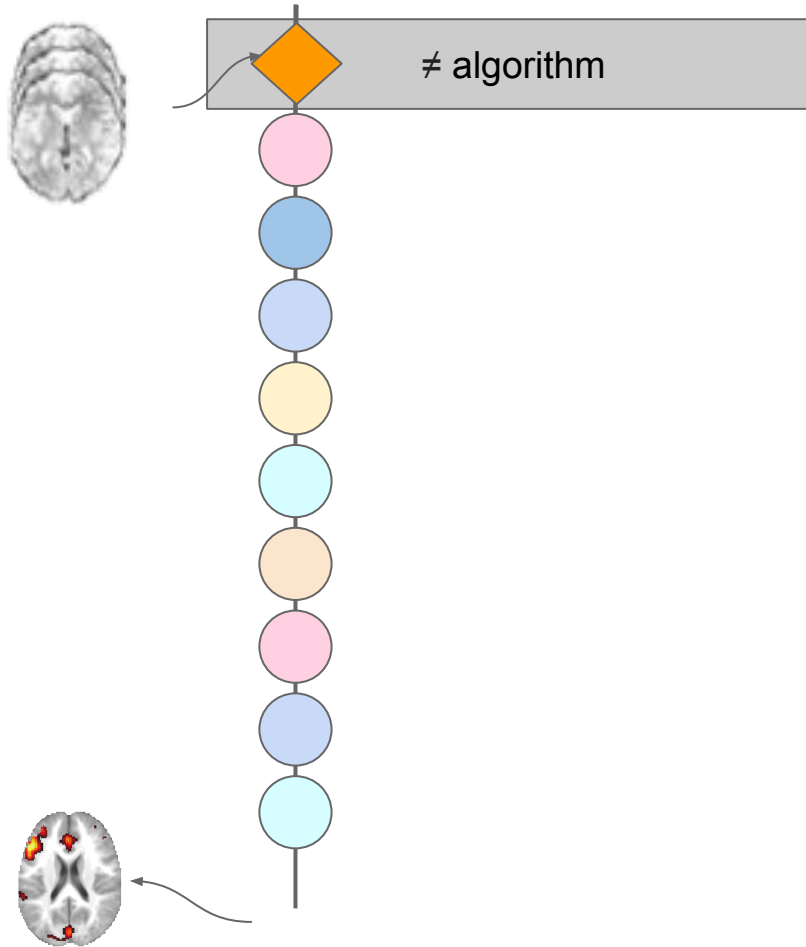
Different Post-processing Methods



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Irreproducible with...

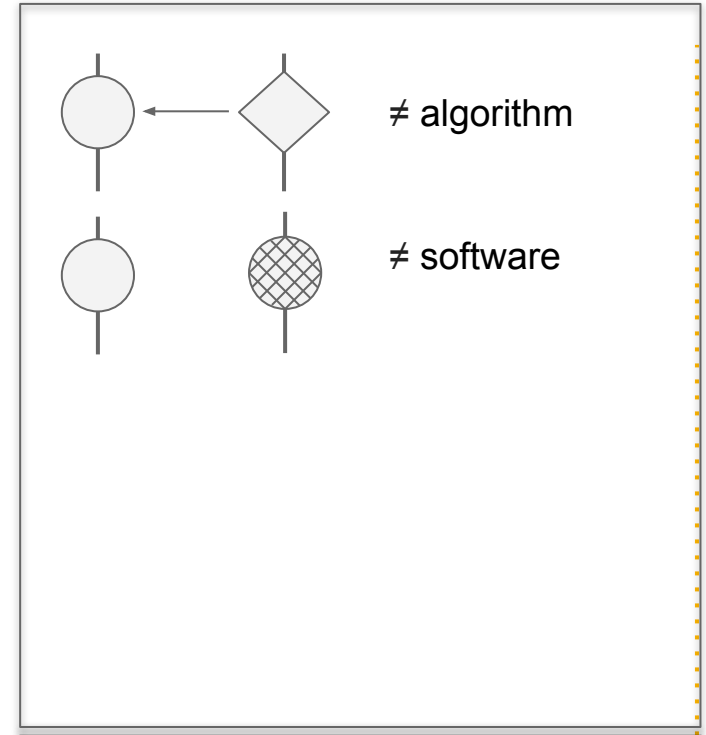
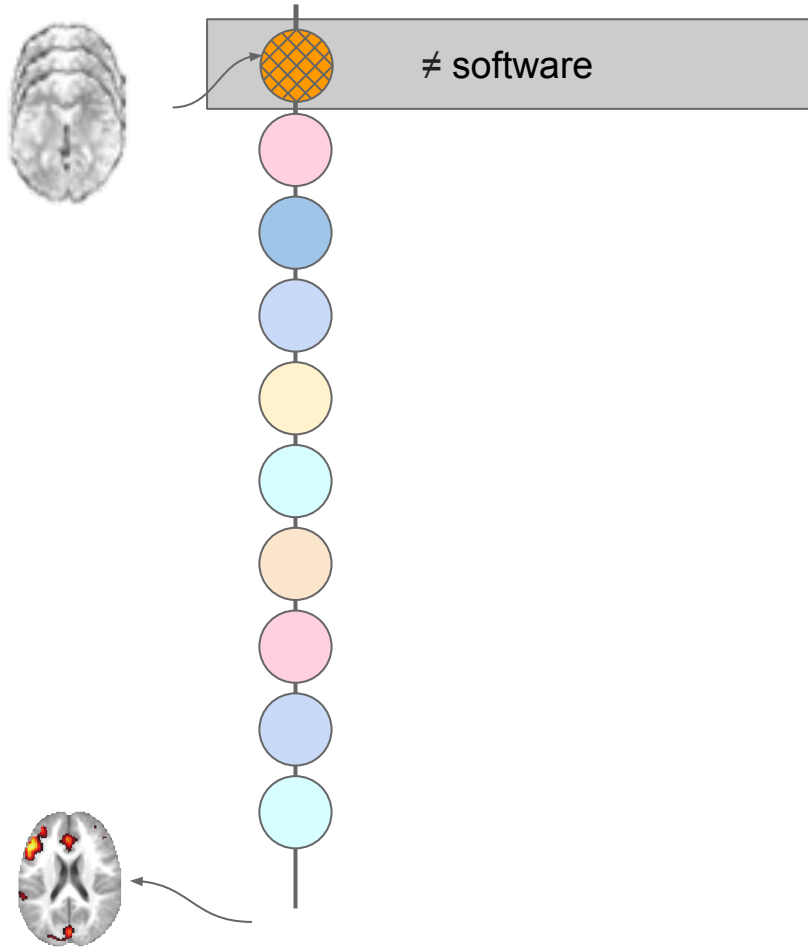
Different Post-processing Methods



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Irreproducible with...

Different Post-processing Methods

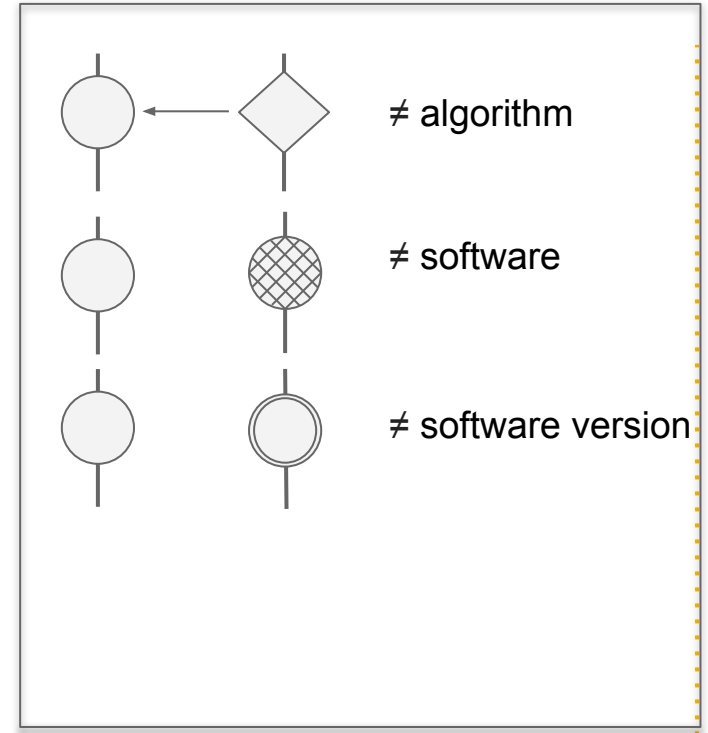
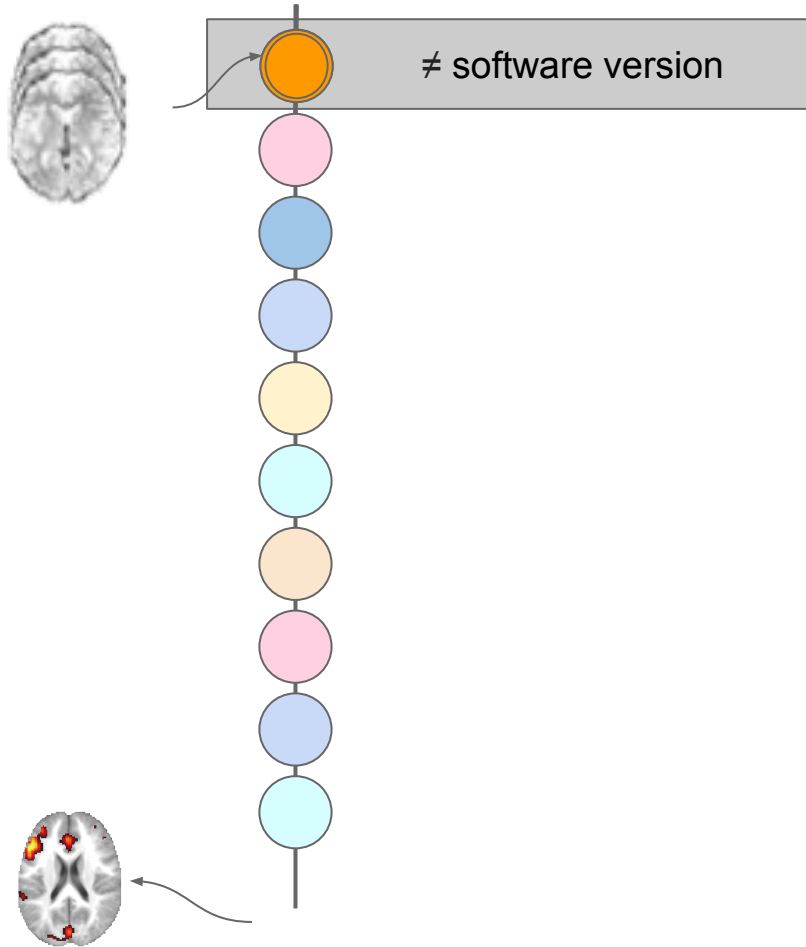




# On our way **to fix irreproducibility**

Irreproducible with...

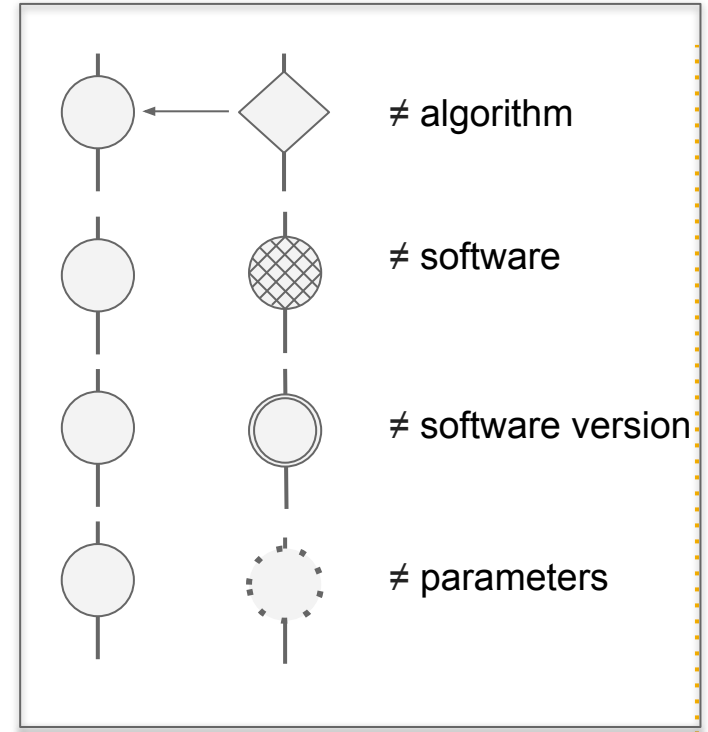
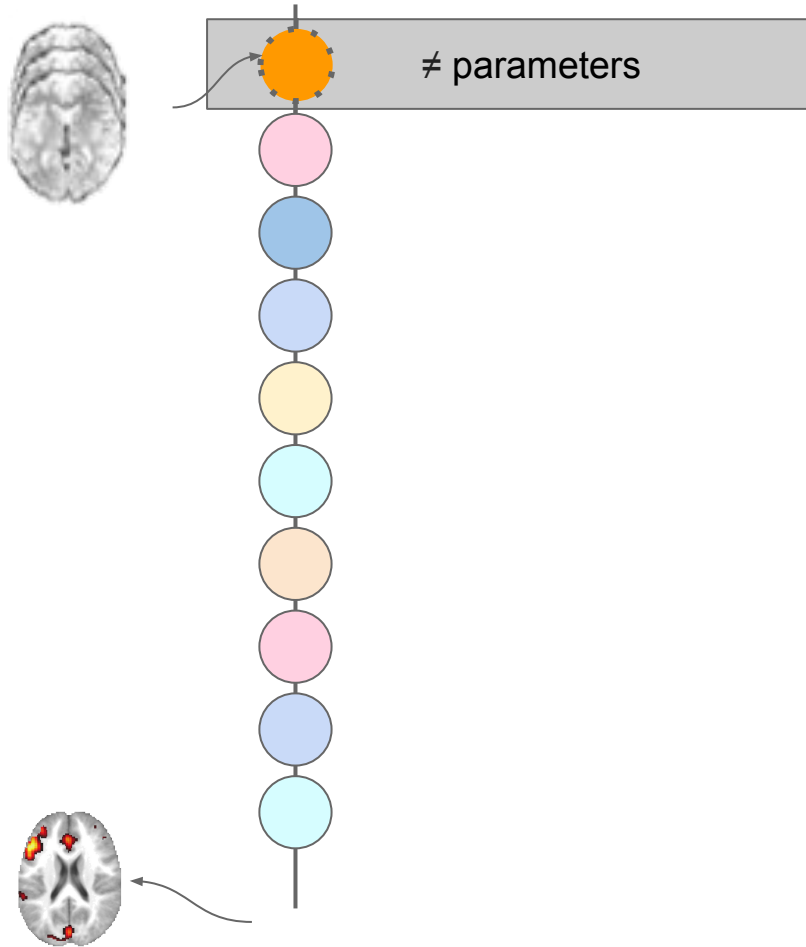
Different Post-processing Methods



# On our way **to fix irreproducibility**

Irreproducible with...

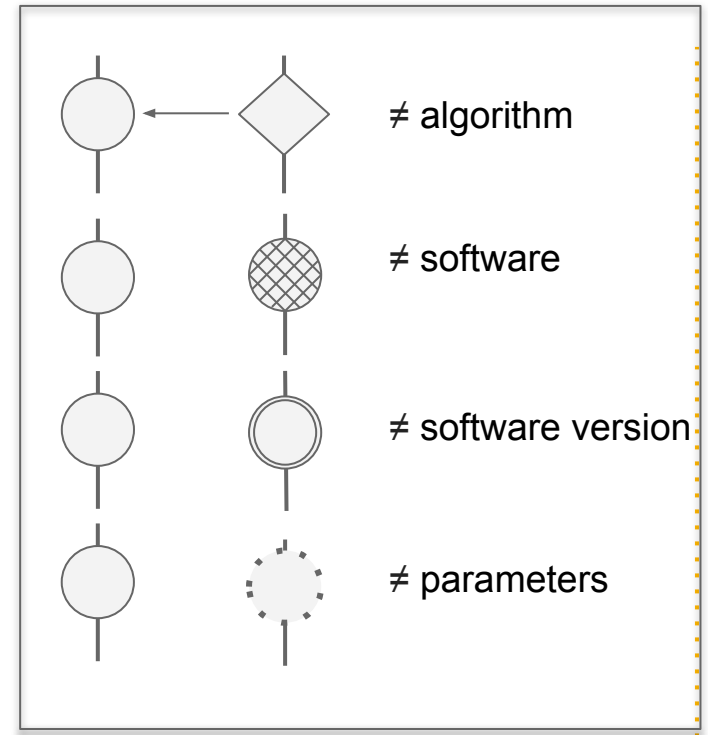
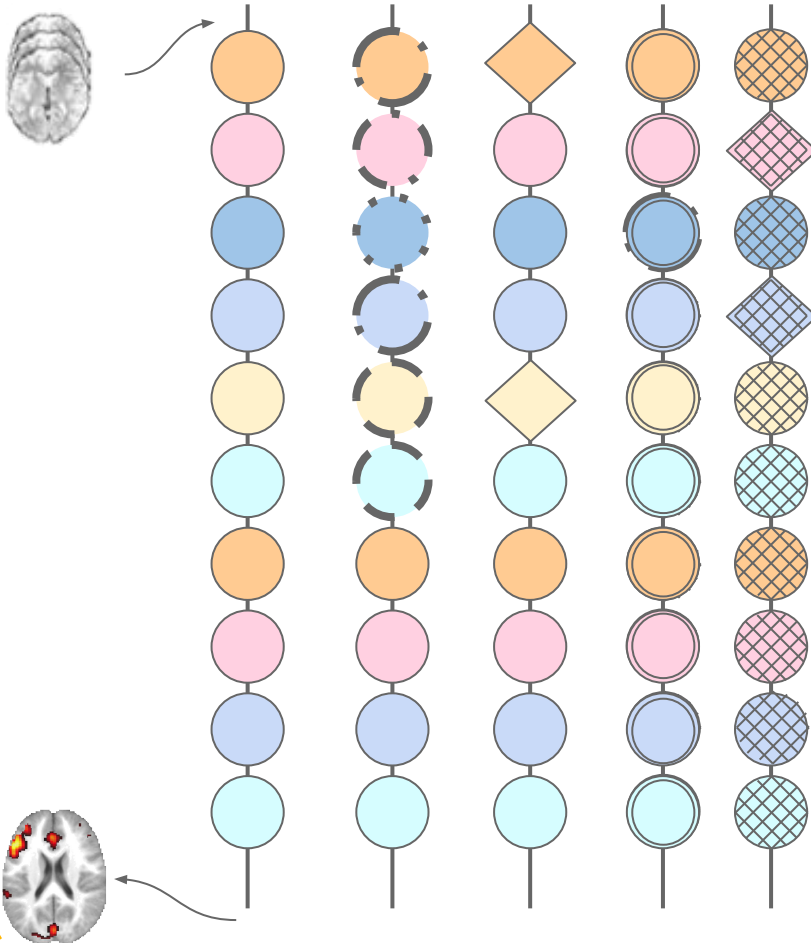
Different Post-processing Methods



# On our way to fix irreproducibility

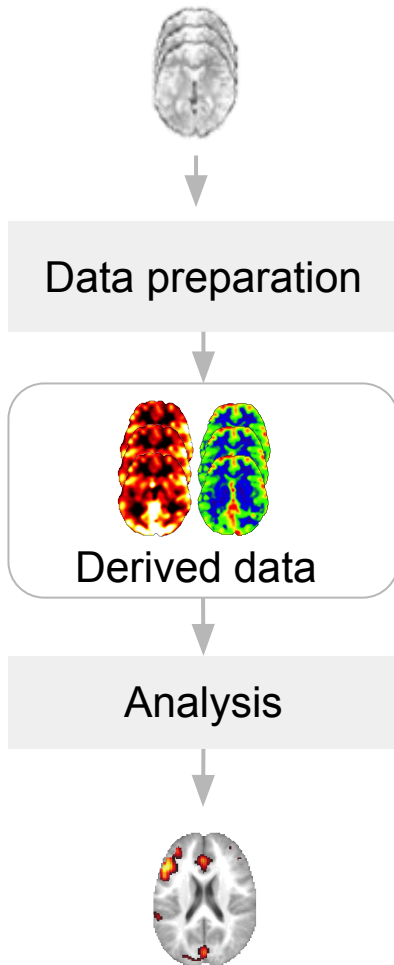
Irreproducible with...

Different Post-processing Methods

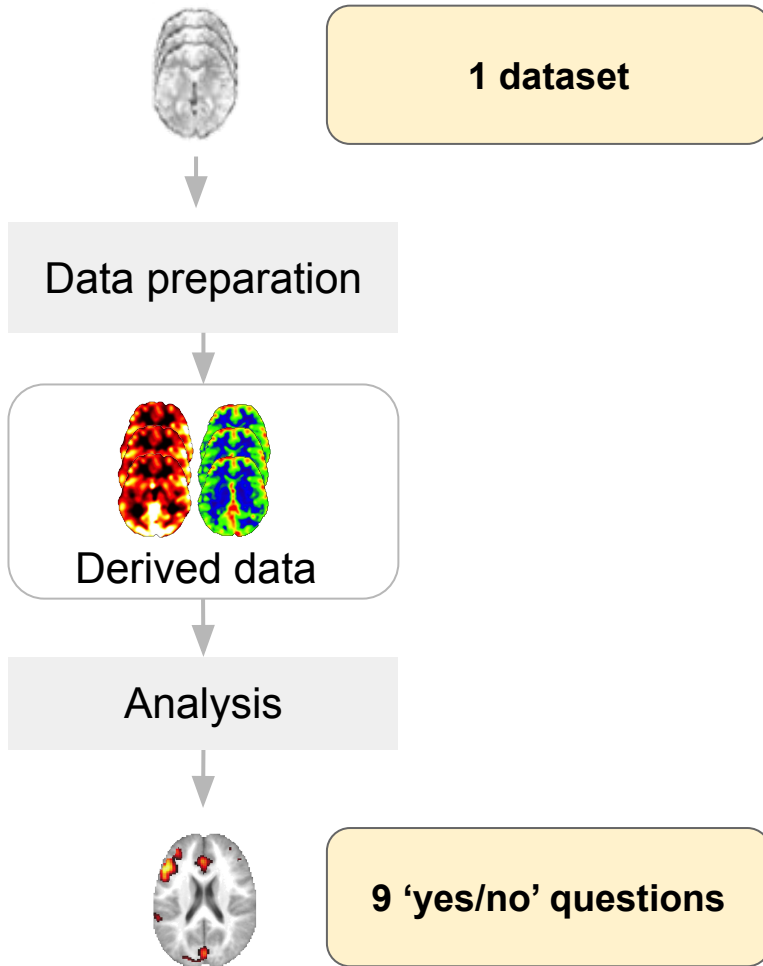


**A family of acceptable pipelines**  
over  $10^{30}$  combinations...

# Many analysts project : NARPS

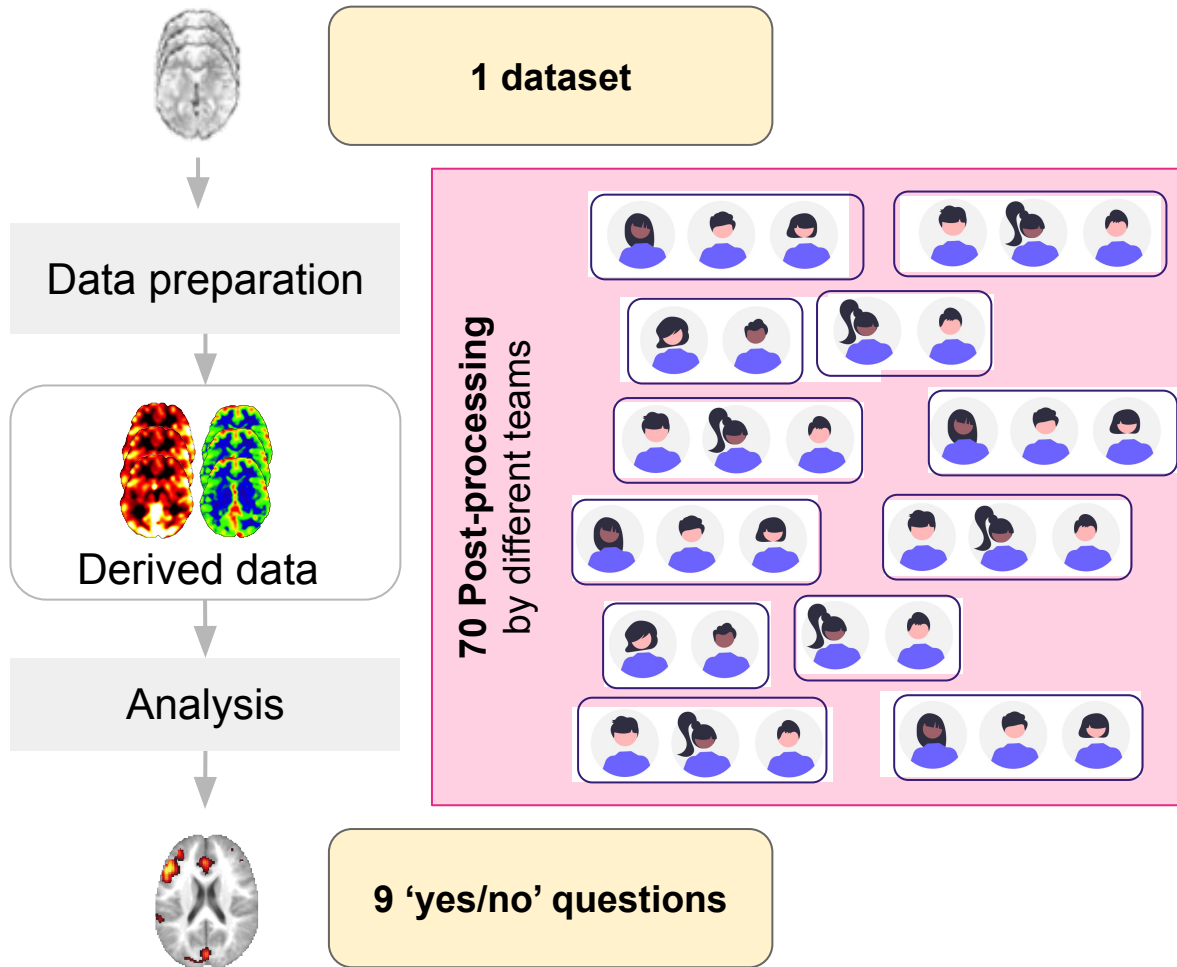


# Many analysts project : NARPS



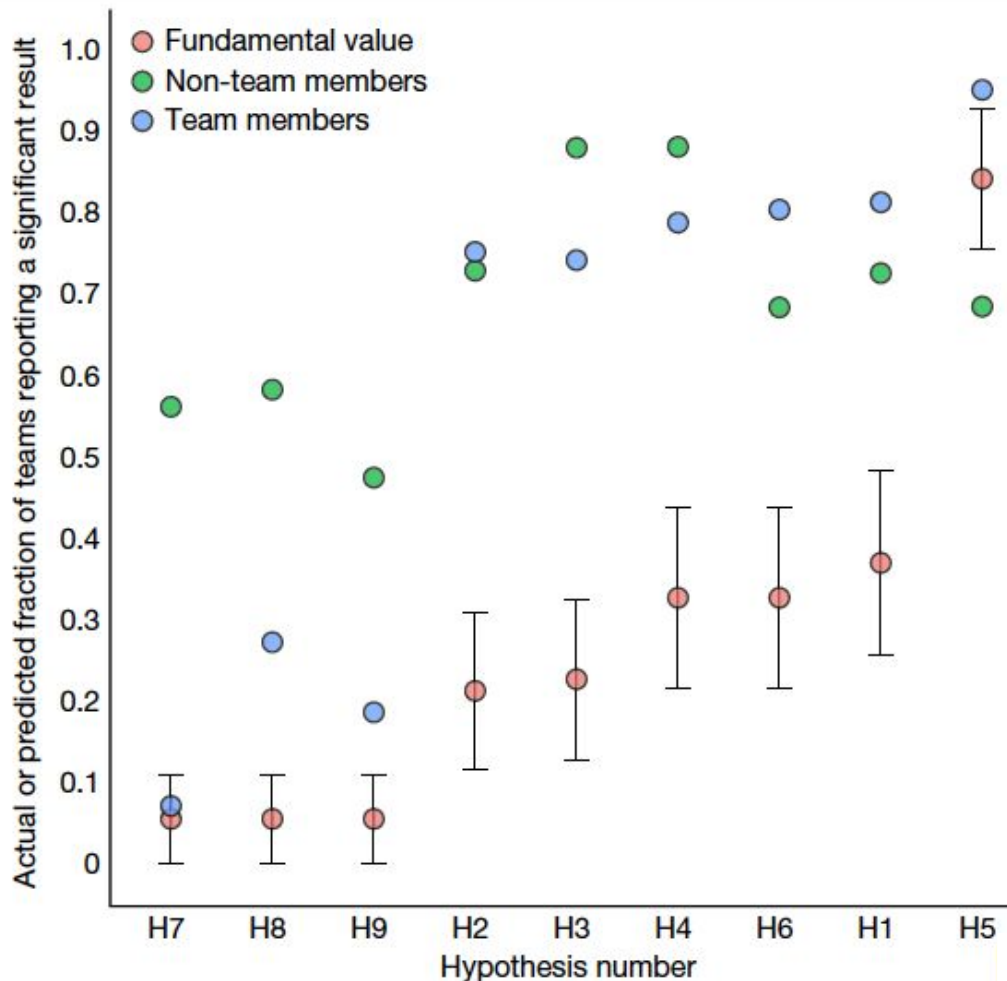
*e.g. Is there a parametric effect of gain:  
Positive effect in ventromedial PFC -  
for the equal indifference group?*

# Many analysts project : NARPS



# Many analysts project : NARPS

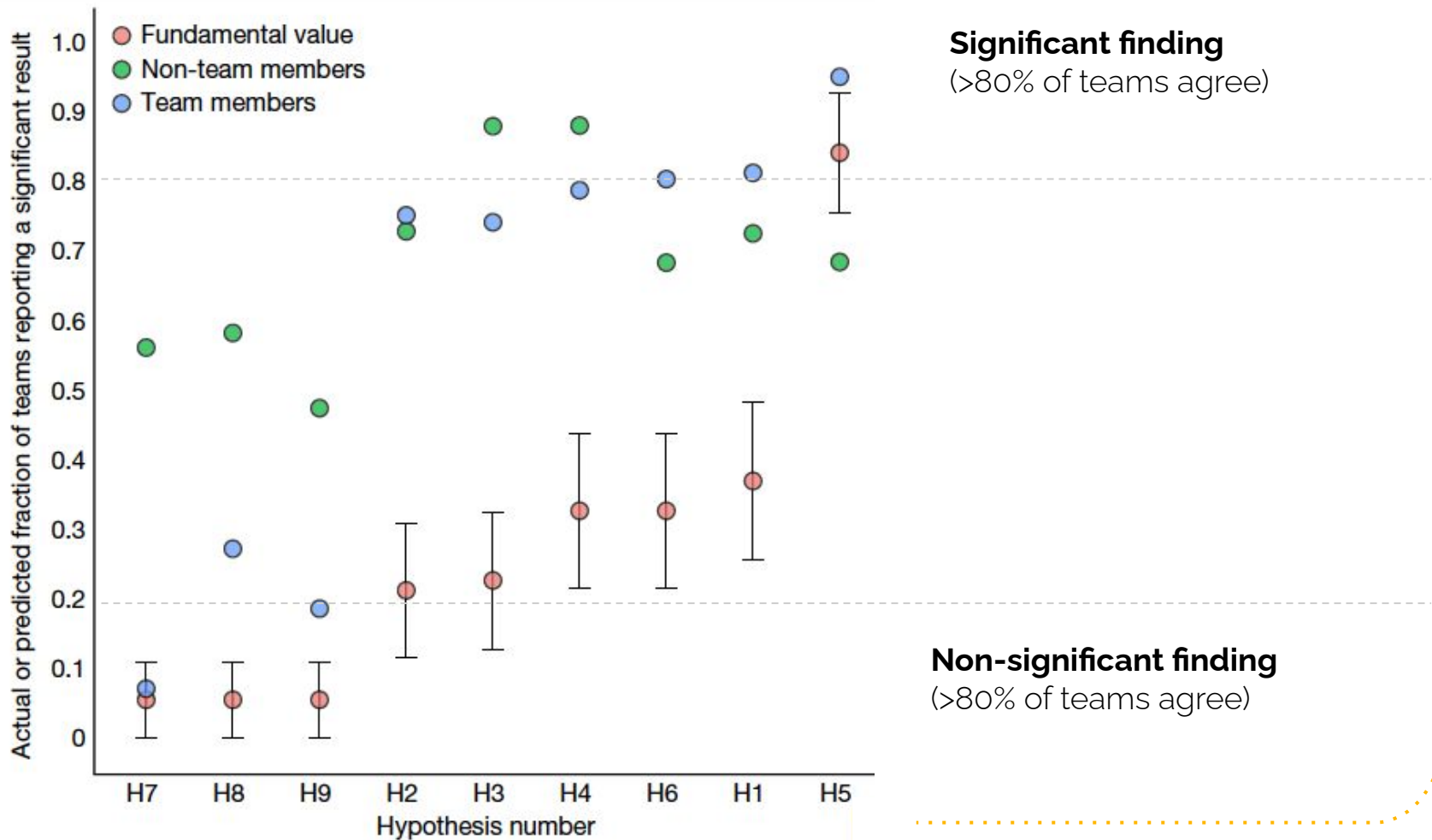
Results over the **70 post-processing pipelines:**



[Botvinik-Nezer et. al, Nature 2020]

# Many analysts project : NARPS

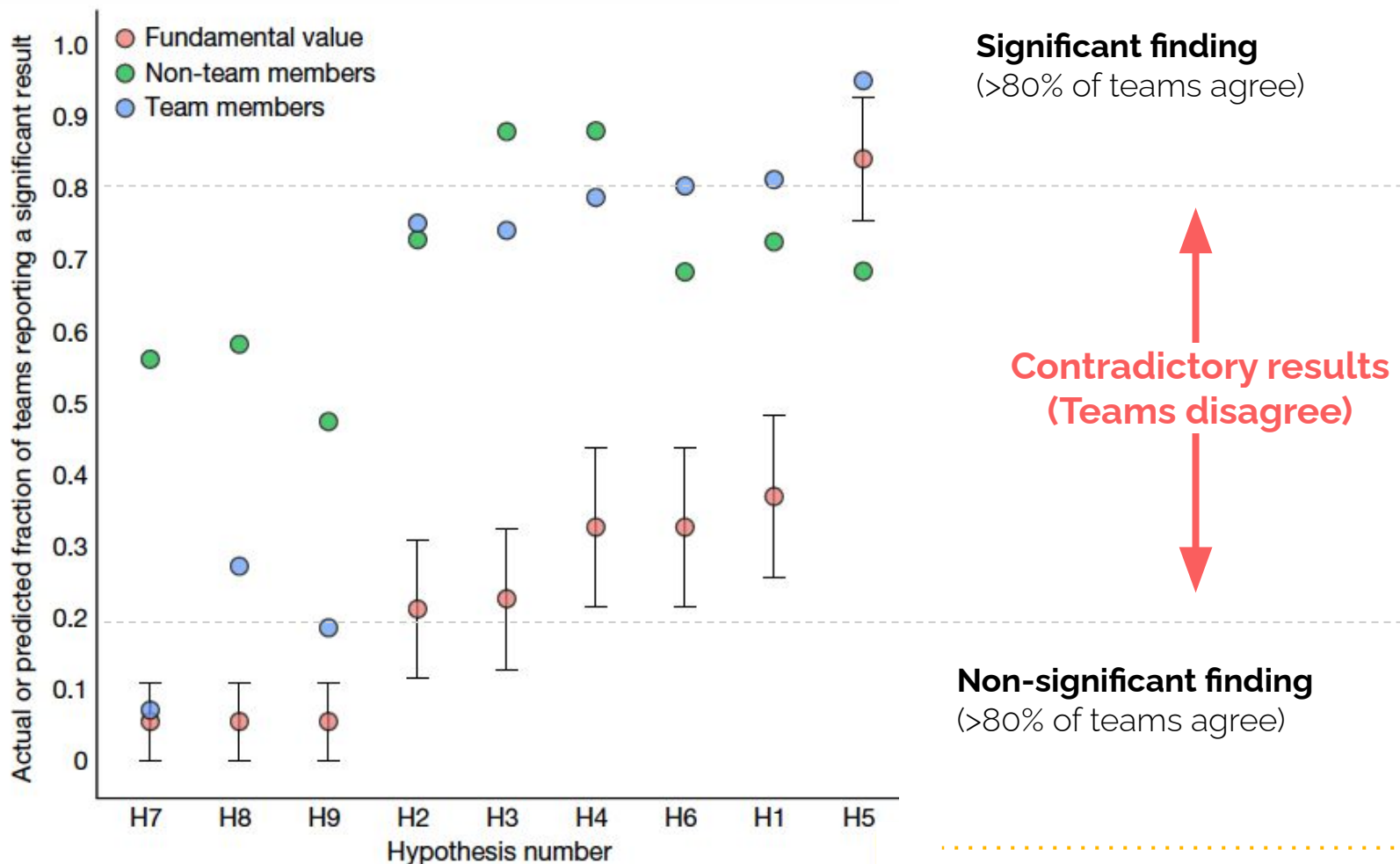
Results over the **70 post-processing pipelines**:





# 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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