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# Increasing computational reproducibility or how-to share *\*your\** research code

Camille Maumet

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Camille Maumet. Increasing computational reproducibility or how-to share *\*your\** research code. MRI Together 2024 - Global workshop on open, reproducible, and inclusive MR, Dec 2024, Online, Australia. hal-04814565v2

**HAL Id: hal-04814565**

**<https://inria.hal.science/hal-04814565v2>**

Submitted on 2 Dec 2024

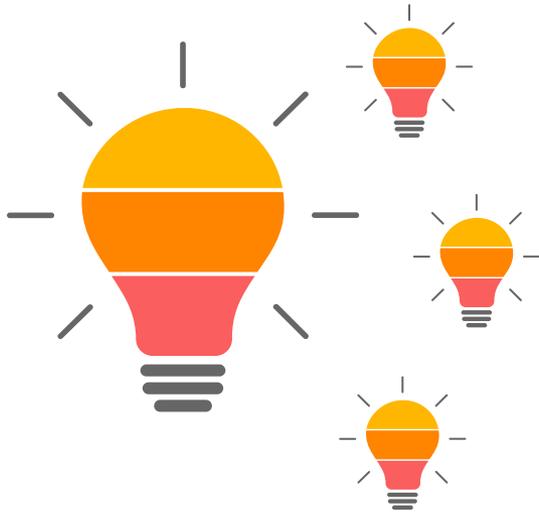
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**MRI Together**  
December 5, 2024



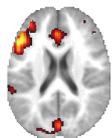
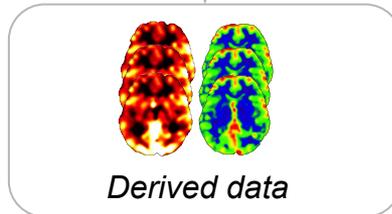
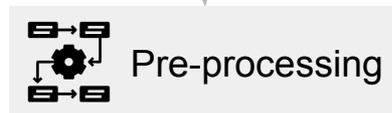
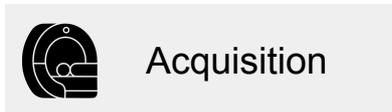
# **Increasing computational reproducibility or how-to share \*your\* research code**

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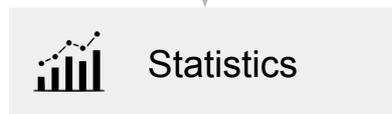
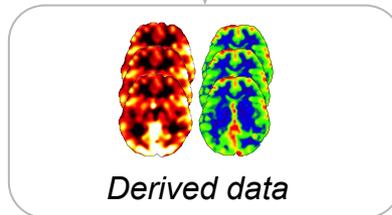
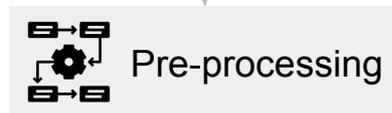
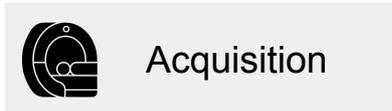
Inria, Univ Rennes, Inserm, CNRS, IRISA



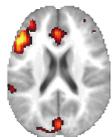
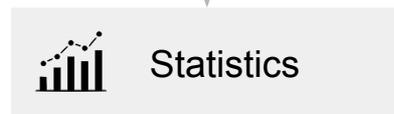
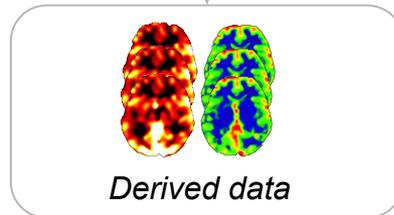
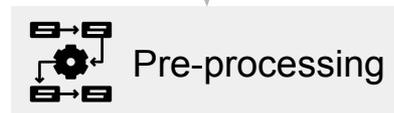
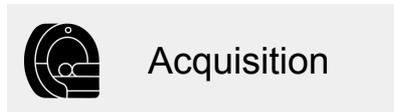
# An **MRI** study



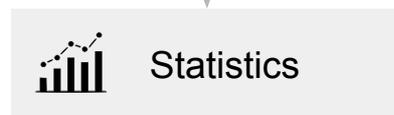
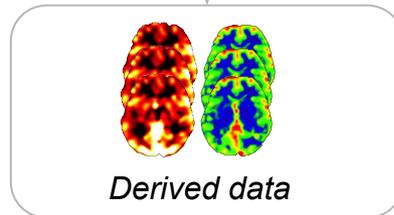
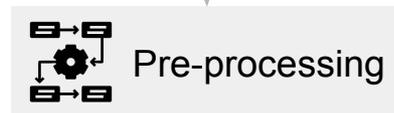
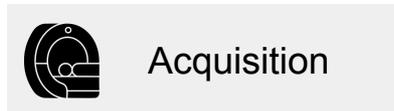
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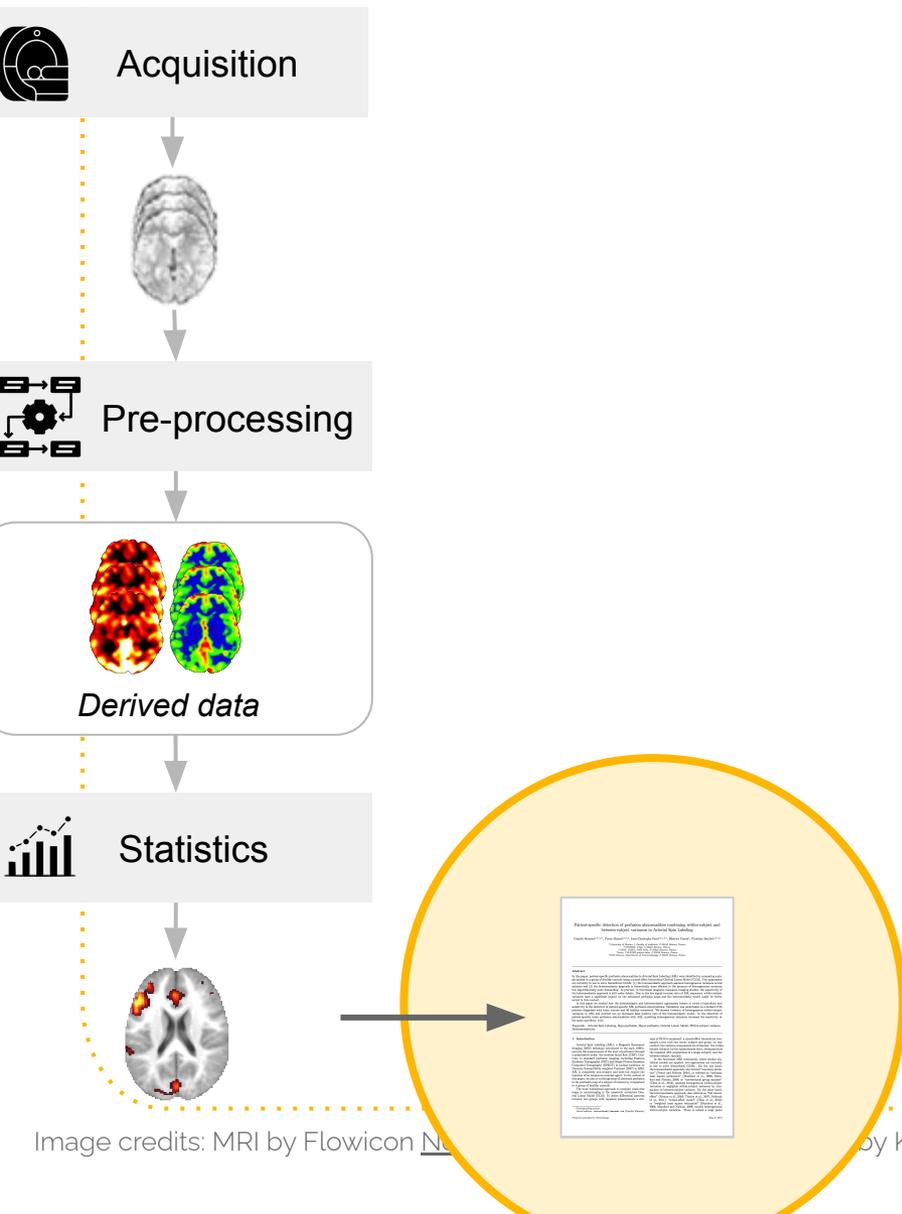
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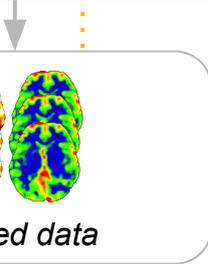


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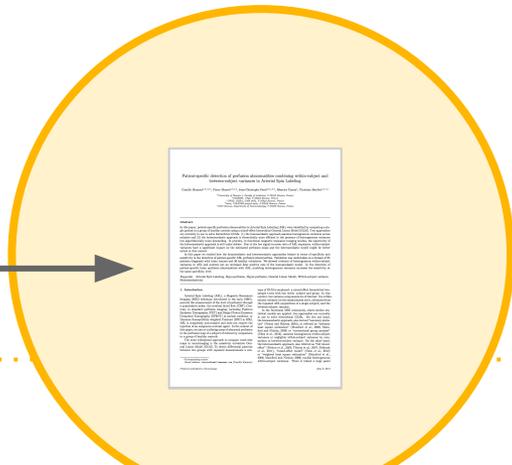
Acquisition



Pre-processing



Statistics



# An **MRI** study



# An **MRI** study



# An **MRI** study



Which version of the SPM software was used?

Which registration algorithm?

How was the brain mask computed?

# An **MRI** study



Which version of the SPM software was used?

Which registration algorithm?

How was the brain mask computed?

Humm... **I can't reproduce** the published results...

Did I understand correctly the method that was used?

... is this due to my (different) data?

... or is this due to my (different) computing resources?

... or even something else?

# An **MRI** study



Humm... **I can't reproduce** the published results...

Which version of the SPM software was used?

Which registration algorithm?

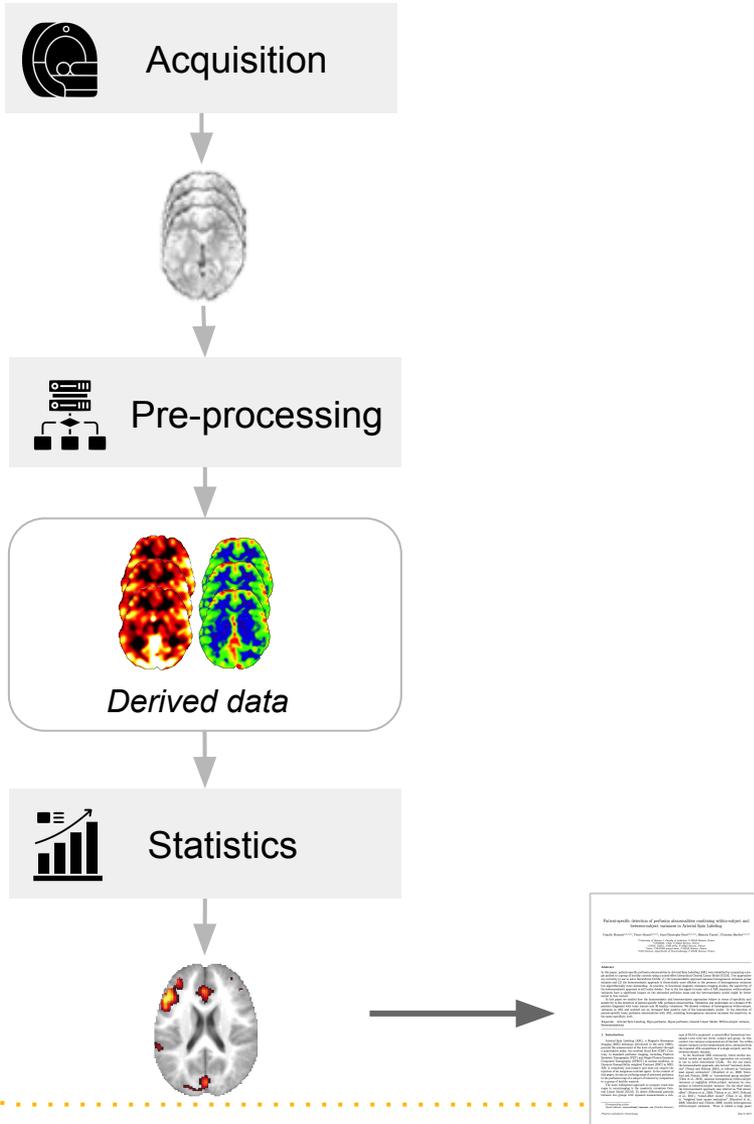
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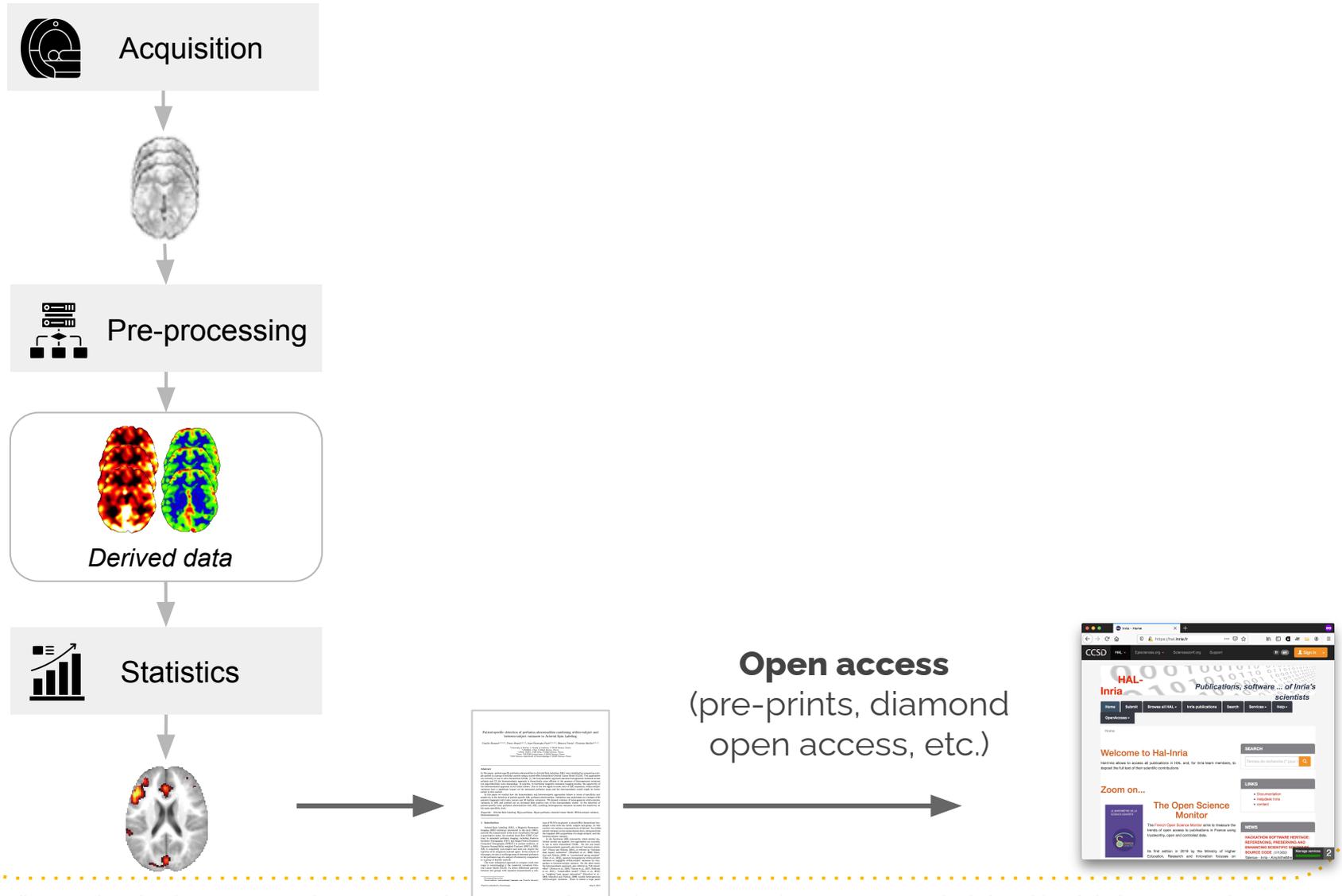
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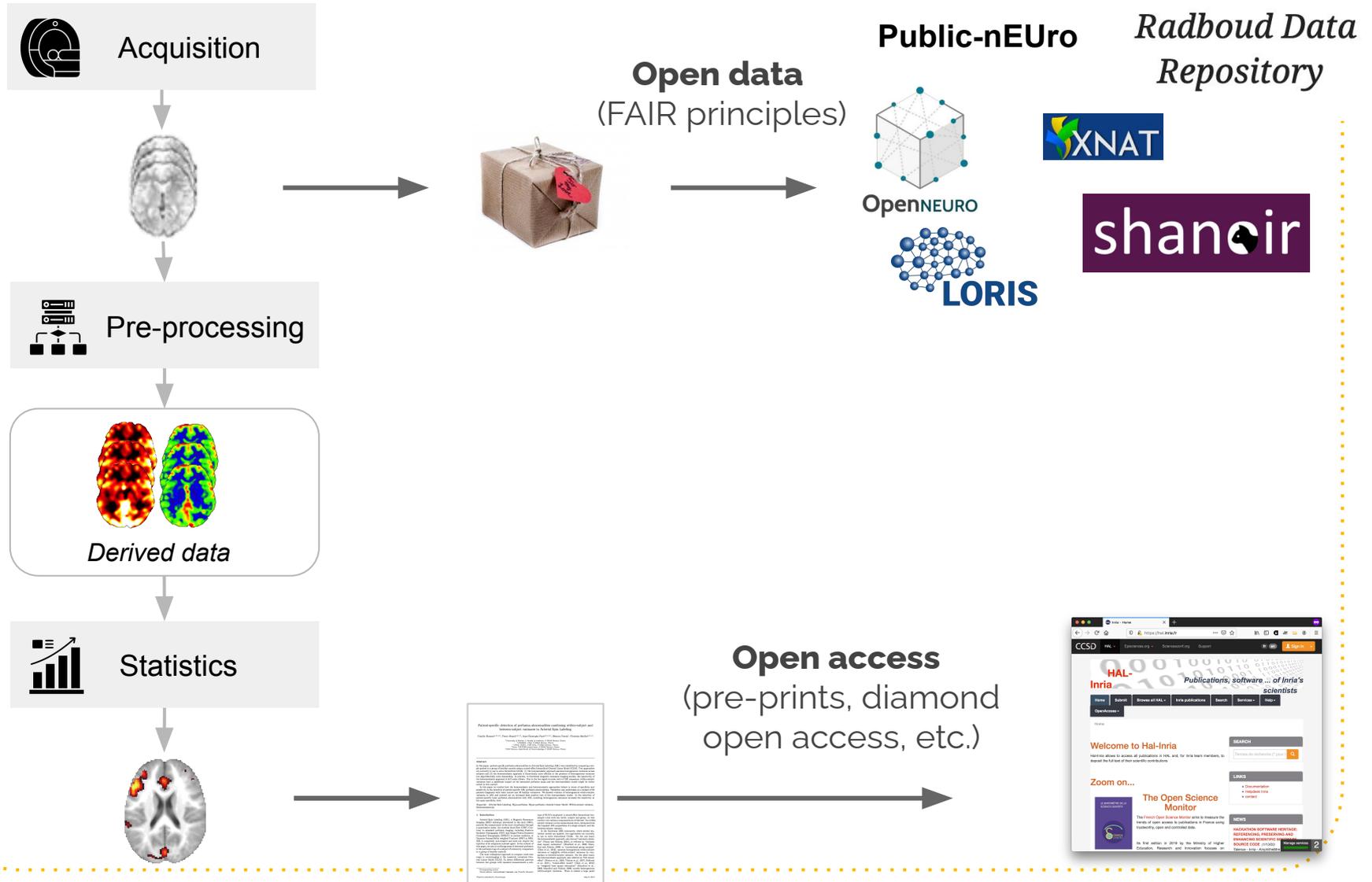
# Towards **reproducible research**



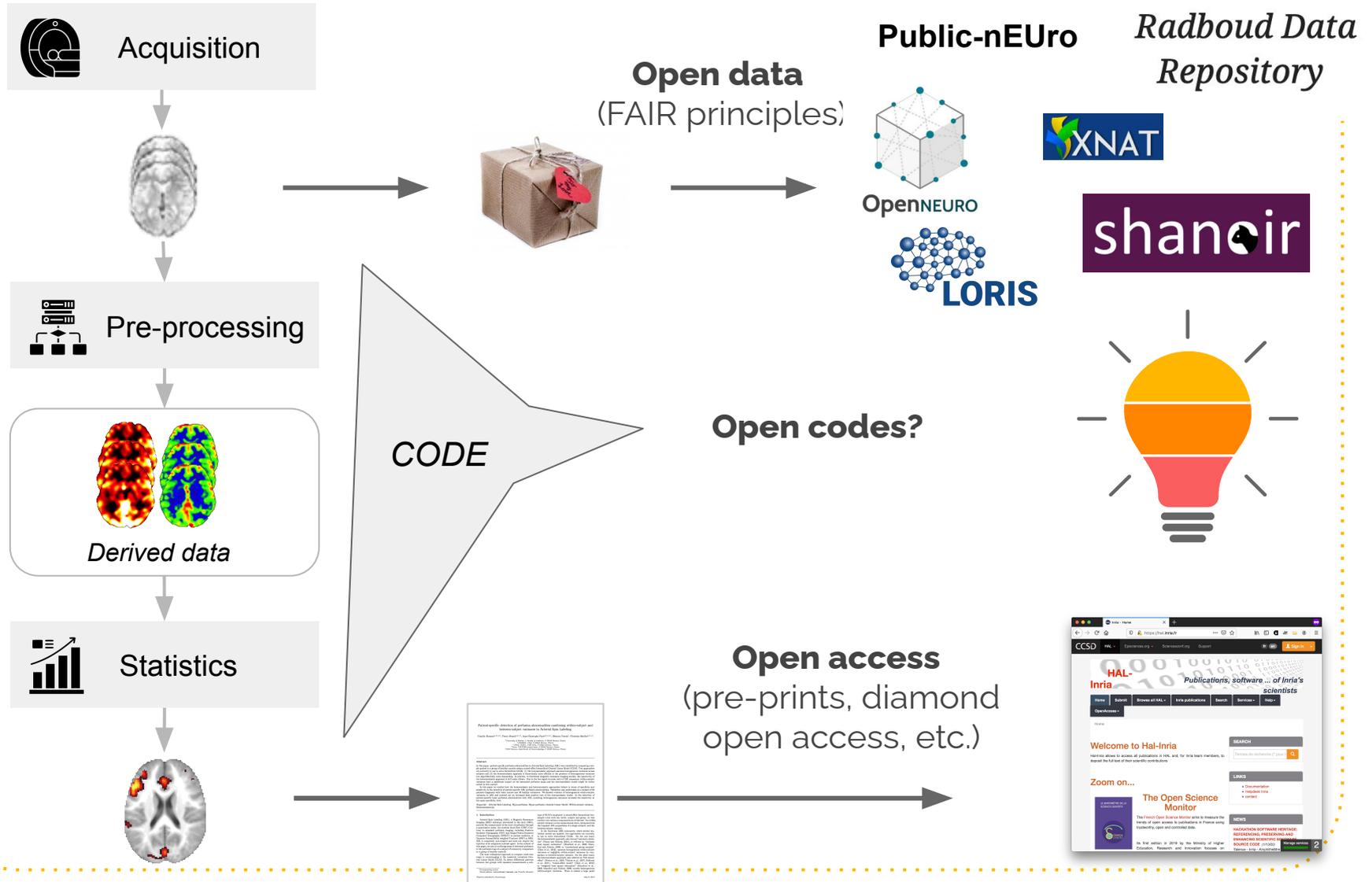
# Towards **reproducible research**



# Towards reproducible research



# Towards reproducible research



# Towards **reproducible research**

## **Computational reproducibility**

Ability to reproduce **exactly the same results** using the **same data** and **same code**.

## **Replicability**

Ability to reach the **same scientific findings** using **similar data** and a **similar method**.

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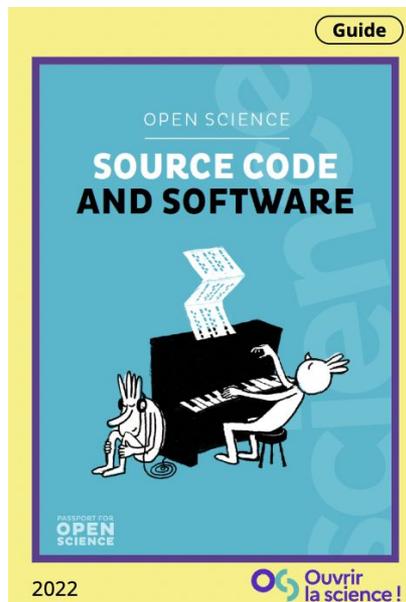
Ability to reach the **same scientific findings** using **similar data** and a **similar method**.

# Open code



Open source  
*Transparency*

- With an open **source licence** and **publicly accessible**.



<https://www.ouvrirlascience.fr/source-code-and-software/>

# Open code

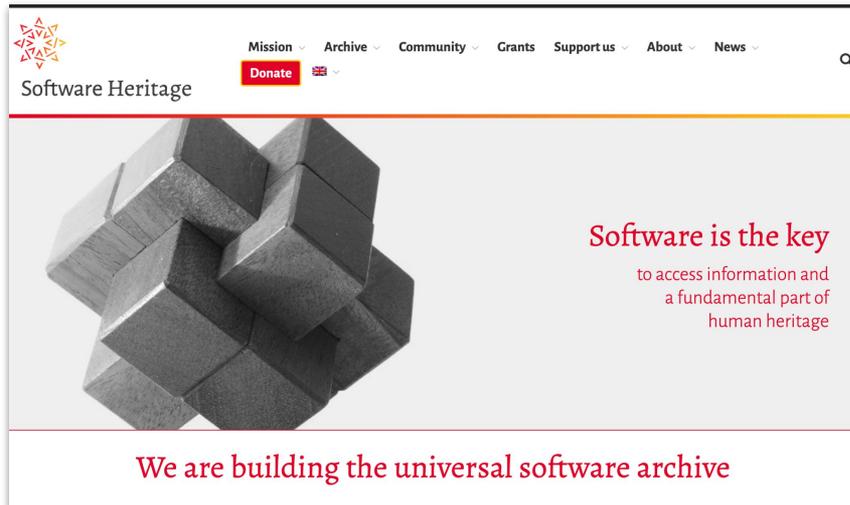


**Archived**  
*Sustainability*

- **Archived** for **long-term preservation** (e.g. using Software Heritage, Zenodo)



Software Heritage



<https://www.softwareheritage.org/>

zenodo

<https://zenodo.org/>

# Open code



## Using coding best practices

*Reutilisability*

- Following **software development best practices**
  - **Versioning**: using a forge (Github, gitlab, etc.).
  - **Listing dependencies**.
  - **README**, file tree template, etc.

```
.
|-- CITATION
|-- README
|-- LICENSE
|-- requirements.txt
|-- data
|   -- birds_count_table.csv
|-- doc
|   -- notebook.md
|   -- manuscript.md
|   -- changelog.txt
|-- results
|   -- summarized_results.csv
|-- src
|   -- sightings_analysis.py
|   -- runall.py
```

[Wilson et. al, PlosCompBio 2017]

Project/Paper Title

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  - [Fig. 2](#)
- [Reproducing full analysis](#)

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How to cite?

See [CITATION](#).

---

Contents overview

<Summarise what's in this repository>

---

Reproducing figures and tables

<Instructions on how to use summary/derived data in the `results` directory to create figures and tables>

<Specify precise steps, including any datasets that need to be downloaded and path variables that need to be set>

---

Table 1

Fig. 1

Fig. 2

---

Reproducing full analysis

<Instructions on how to (1) obtain raw data; (2) process it to create summary/derived data in the `results`>

<Specify precise steps, including any datasets that need to be downloaded and path variables that need to be set>

Example of [README template](#)

# How-to **open** your **code**



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*Sustainability*

- in an **archive** for **long-term preservation** (e.g. using Software Heritage, Zenodo)

**Using coding best practices**  
*Reutilisability*

- following **software coding best practices**
  - **Versioning** using a forge (Github, GitLab, etc.)
  - **Listing dependencies**
  - **README**, file tree template, etc.

# Are my results (computationally) reproducible now? **Well...**

Beyond source code,  
**environnements** (OS, libraries, etc.)  
can also have an impact...

→ *docker, Guix, Nix*

**Computational** reproducibility **in 10 years** is still an open question...

Perkel, Jeffrey M. "Challenge to scientists: does your ten-year-old code still run?." *Nature* 584.7822 (2020): 656-659.

# Towards **reproducible research**

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Ability to reproduce **exactly the same results** using the **same data** and **same code**.

## **Replicability**

Ability to reach the **same scientific findings** using **similar data** and a **similar method**.

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Ability to reuse some research **artefacts for new purposes**

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# Open software



## Open source

- Choose an **open source license**
- Make **code available for download**
- Use an **archive** for sustainability



# Open software

Who can **access**  
**and use** the  
software?



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Who can **contribute**?



## Open development

- Accept **external contributions** (e.g. Github PR)
- Be transparent in terms of **development choices** (e.g. issues, project board)

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## Open development

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- Be transparent in terms of **development choices** (e.g. issues, project board)

Who can **decide** for **future directions**?



## Open governance

- Transparency in how decision are made
- Possibility to join the **leadership of the project**

# Towards a more **collaborative** science

Beyond technical solutions, open science brings a new culture

- Sharing resources towards the **scientific community**
- **Reusing existing resources** (code, data etc.) generated by others

toward a more collaborative research.



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**Open science awards** for  
open software / open data /  
open PhD thesis

<https://www.ouvrirlascience.fr/category/openscience-prices/>



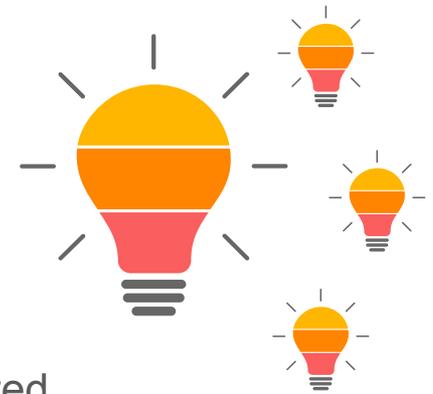
MRI Together  
December 5, 2024



# Increasing computational reproducibility or how-to share \*your\* research code

Thank you

Camille Maumet



**Credit:** Presentation template and icons by SlidesCarnival, adapted



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@cmaumet@fediscience.org