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Different analysis pipelines, different results... How to deal with analytical variability?

Camille Maumet

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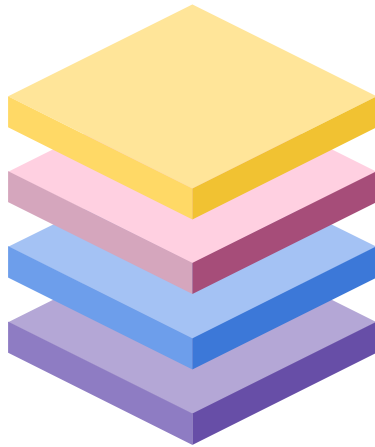
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Special session 10 years of reproducibility in biomedical research: how can we achieve generalizability and fairness?



Different analysis pipelines, different results...

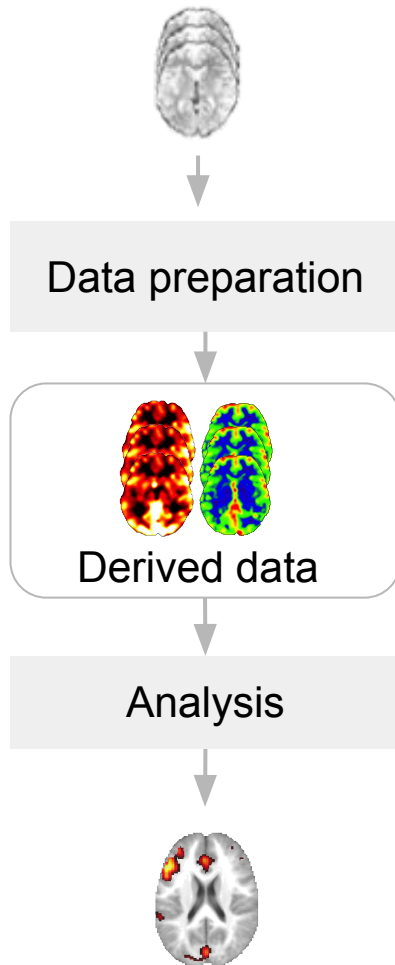
How to deal with analytical variability?

Camille Maumet

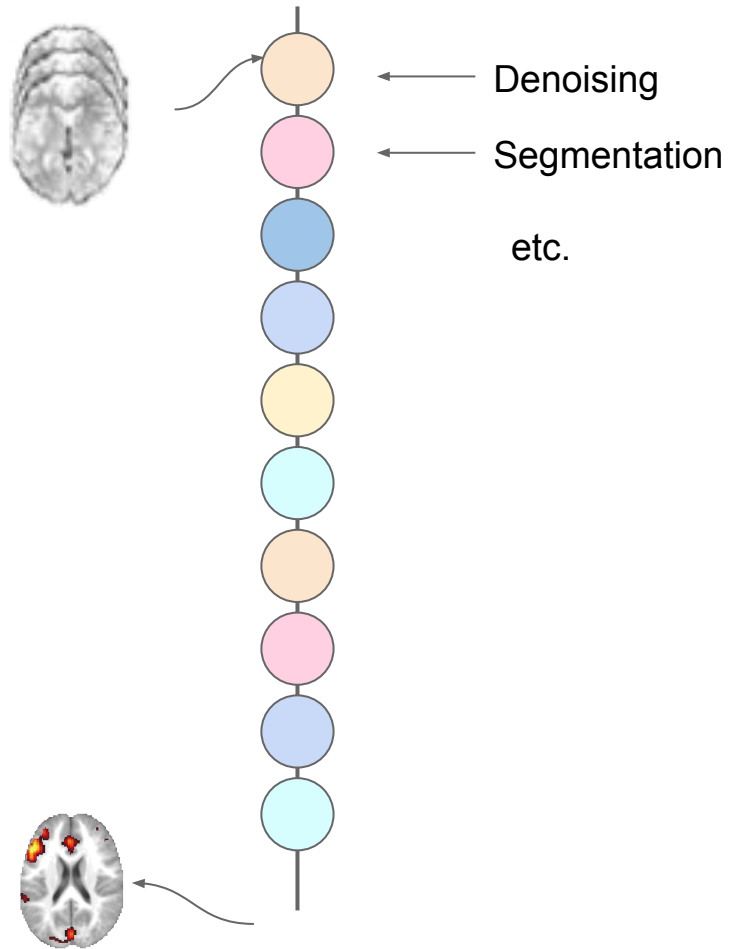
Inria, Univ Rennes, Inserm, CNRS, IRISA



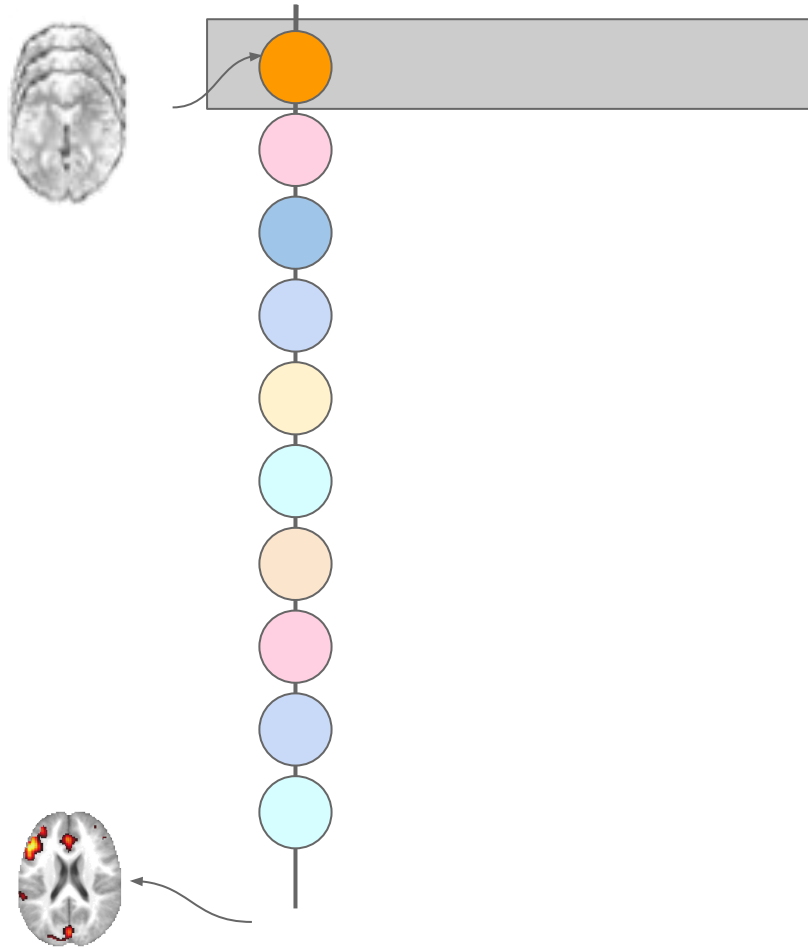
Analytical pipelines



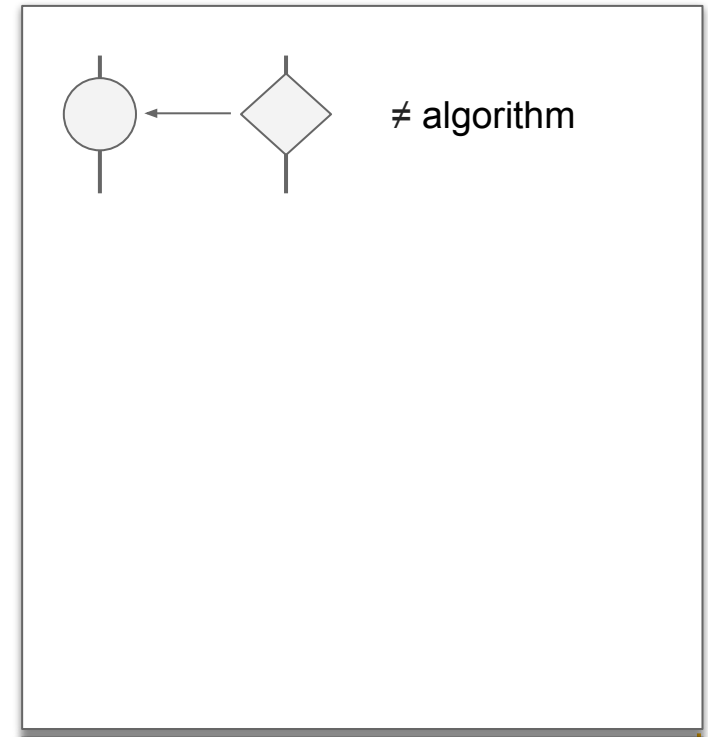
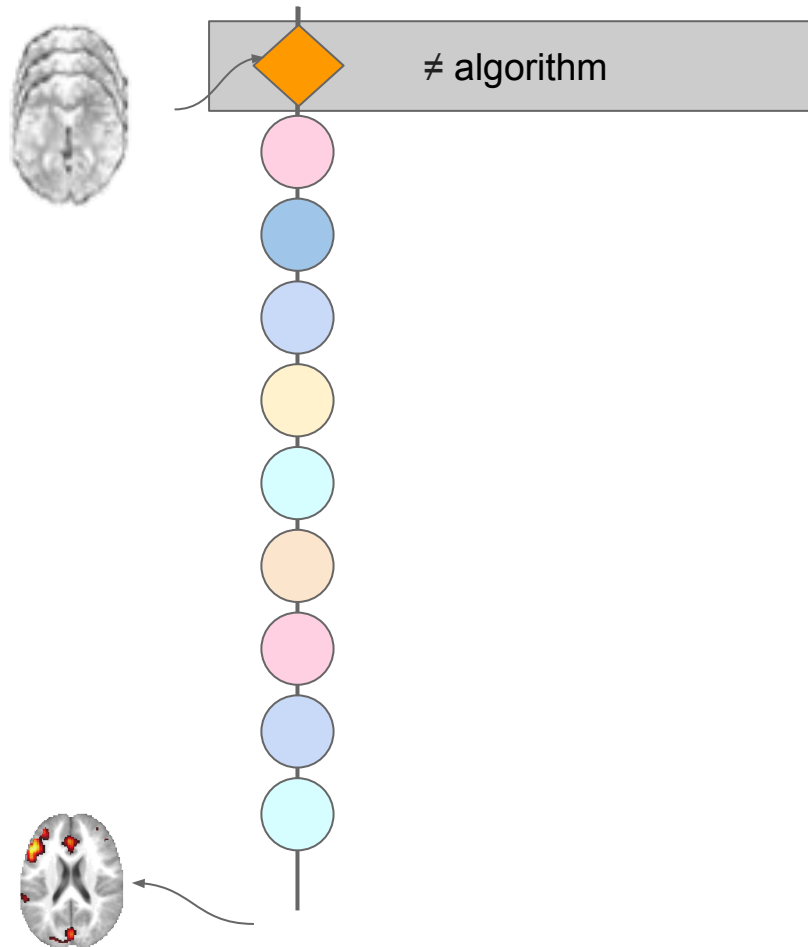
Analytical pipelines



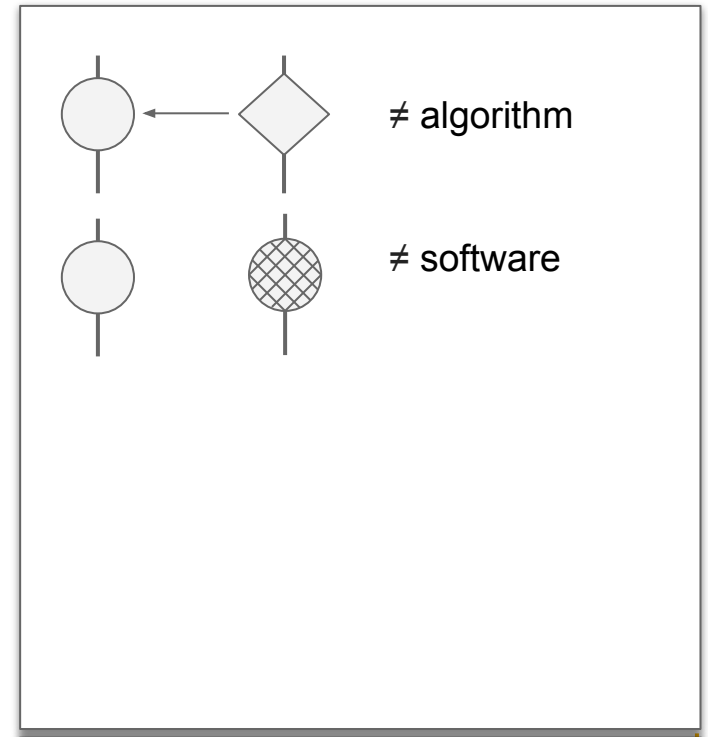
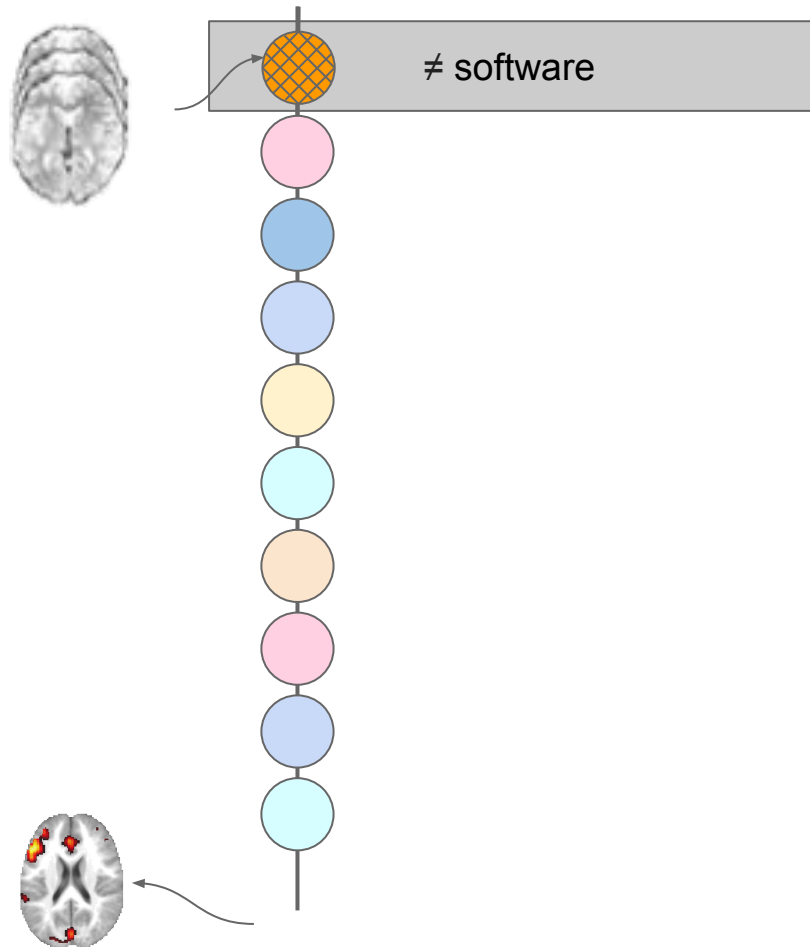
Analytical pipelines



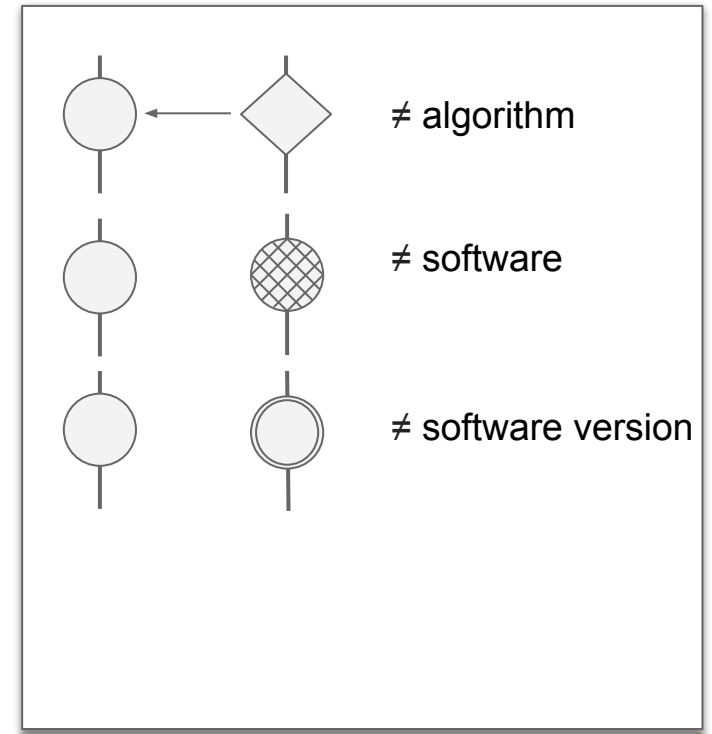
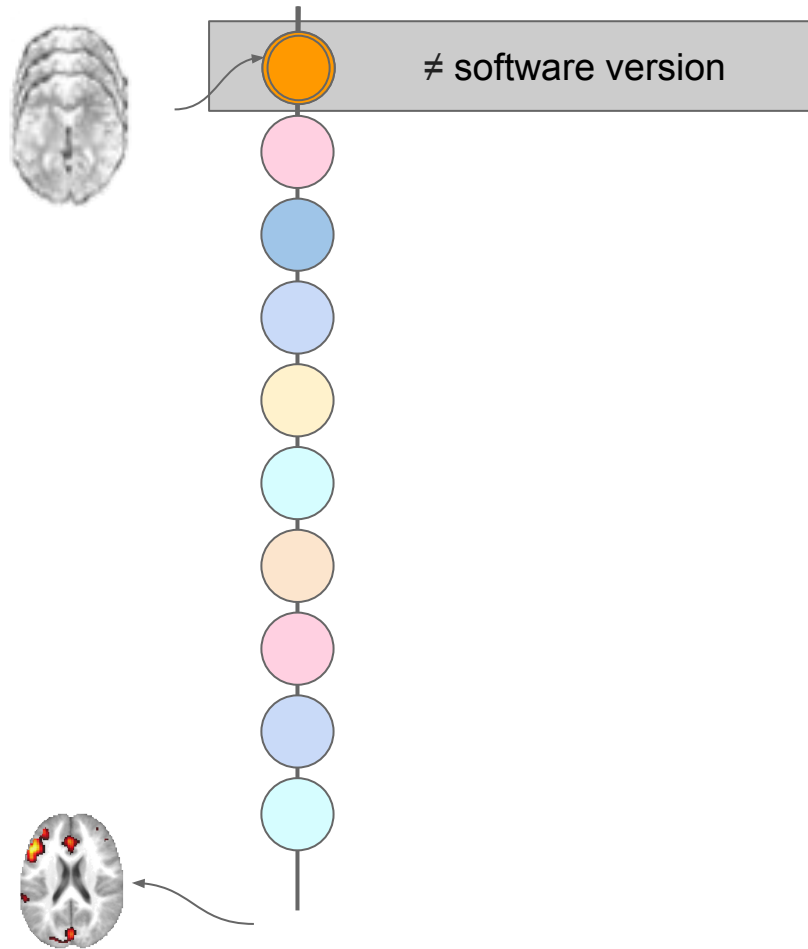
Analytical pipelines



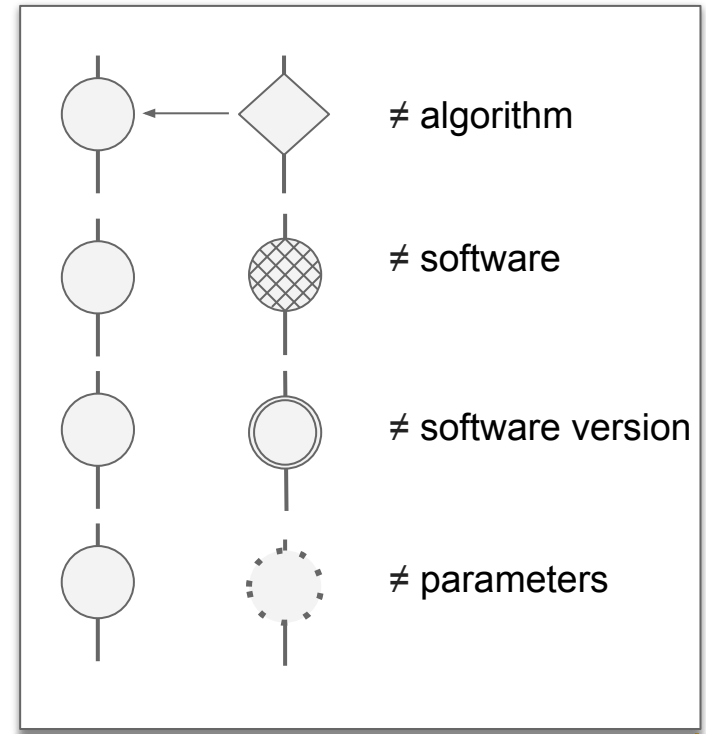
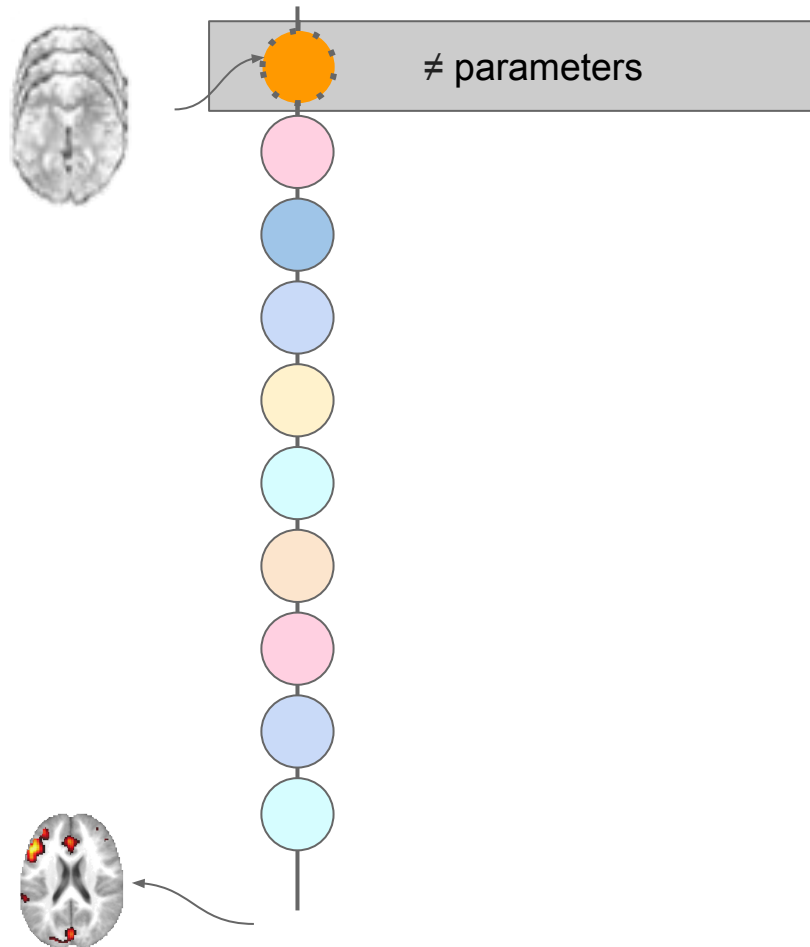
Analytical pipelines



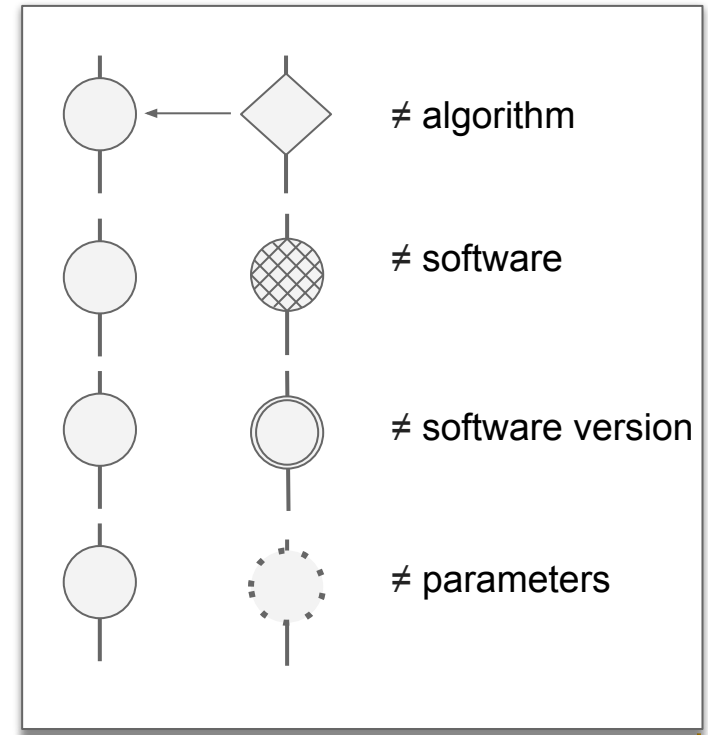
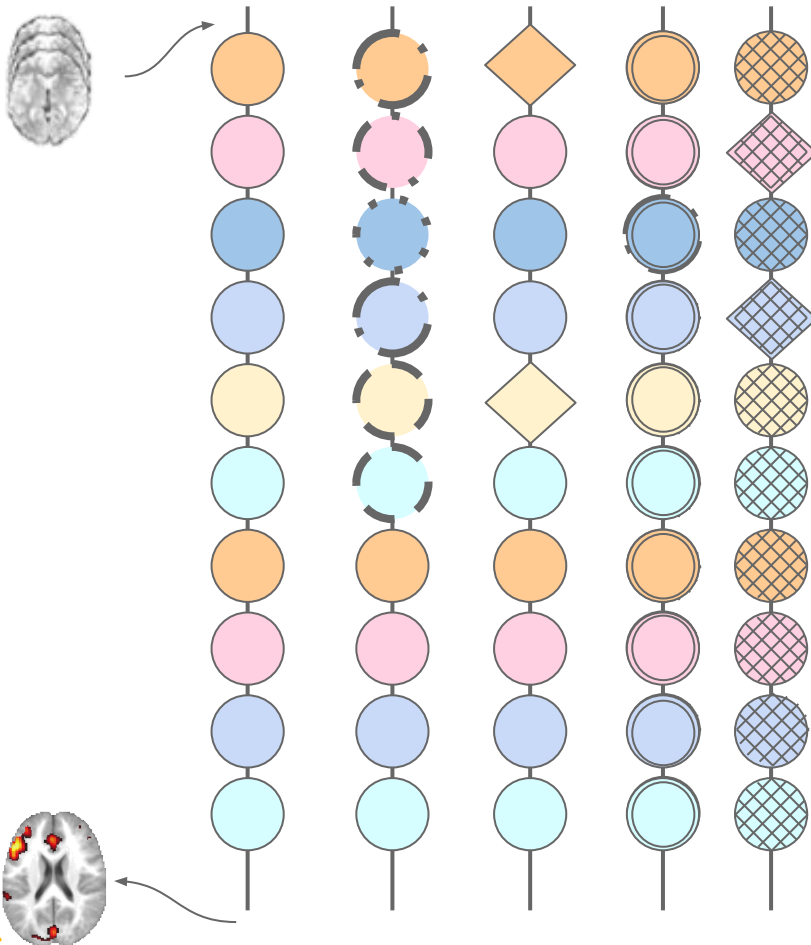
Analytical pipelines



Analytical pipelines

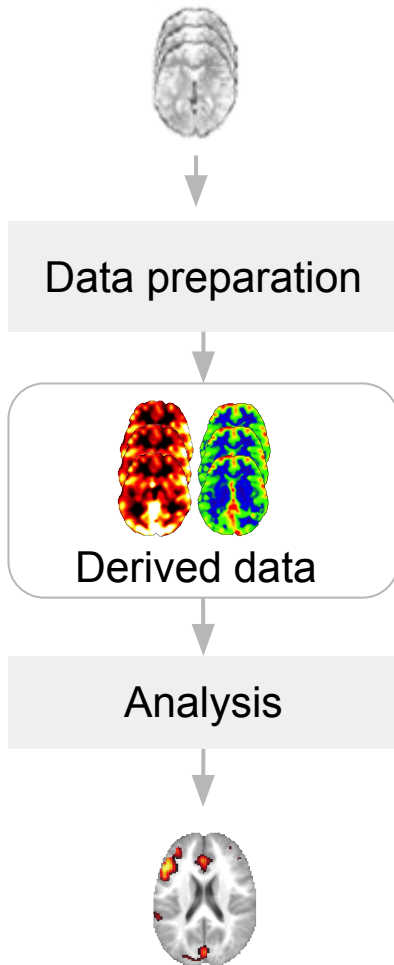


Analytical pipelines

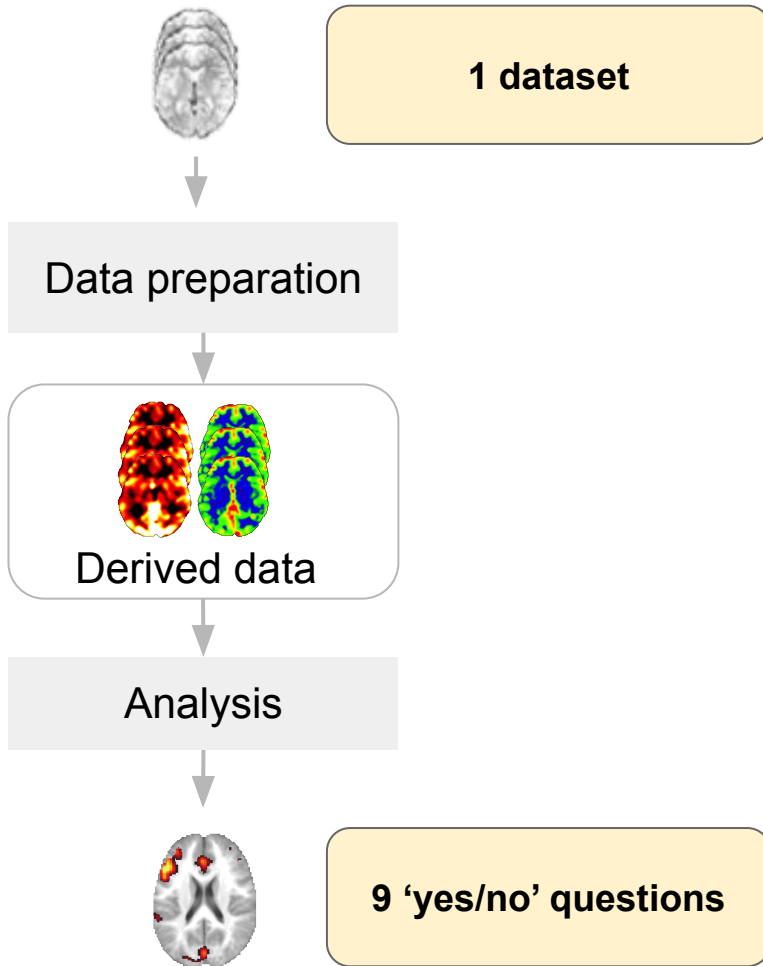


A family of "acceptable" pipelines
over 10^{30} combinations...

Many analysts project : NARPS

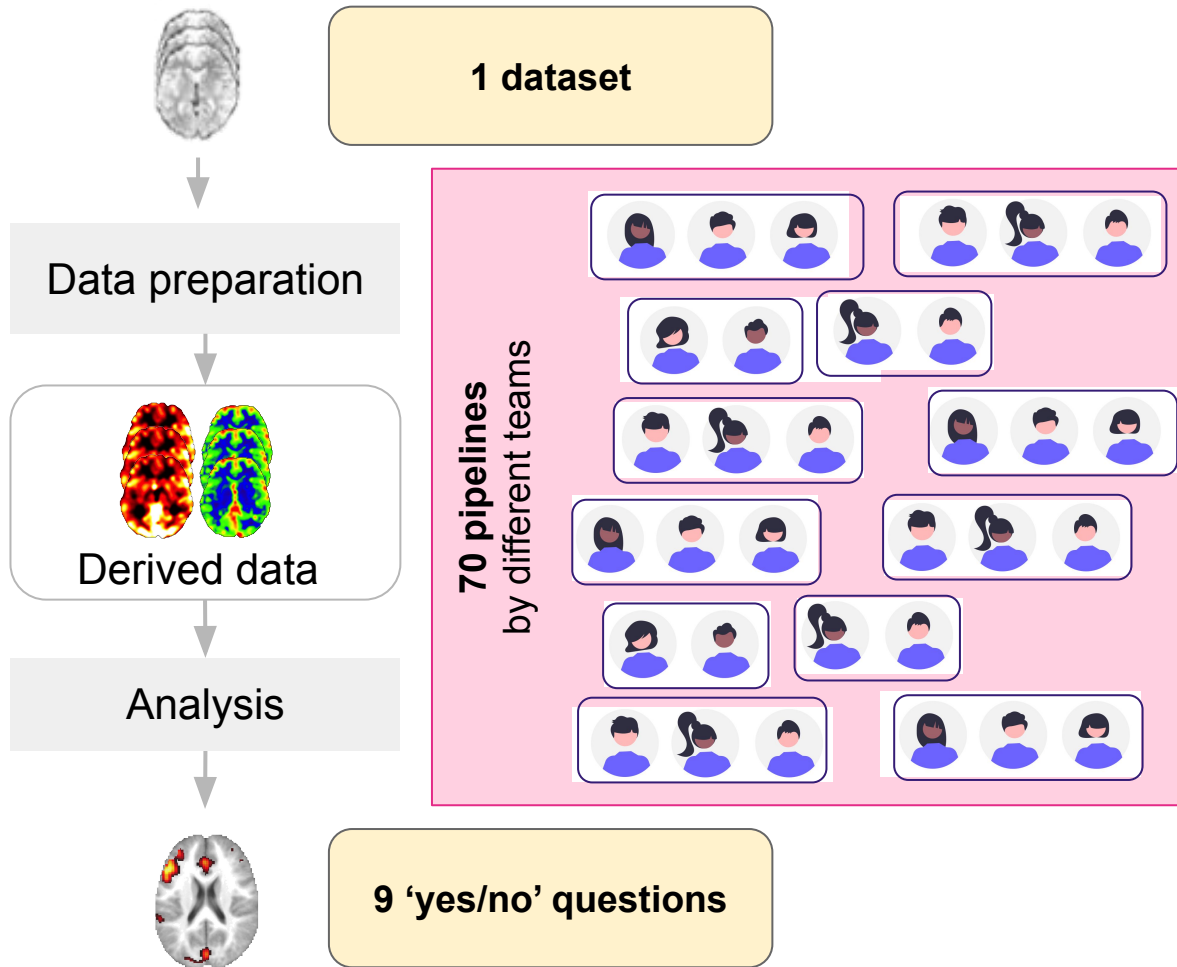


Many analysts project : NARPS



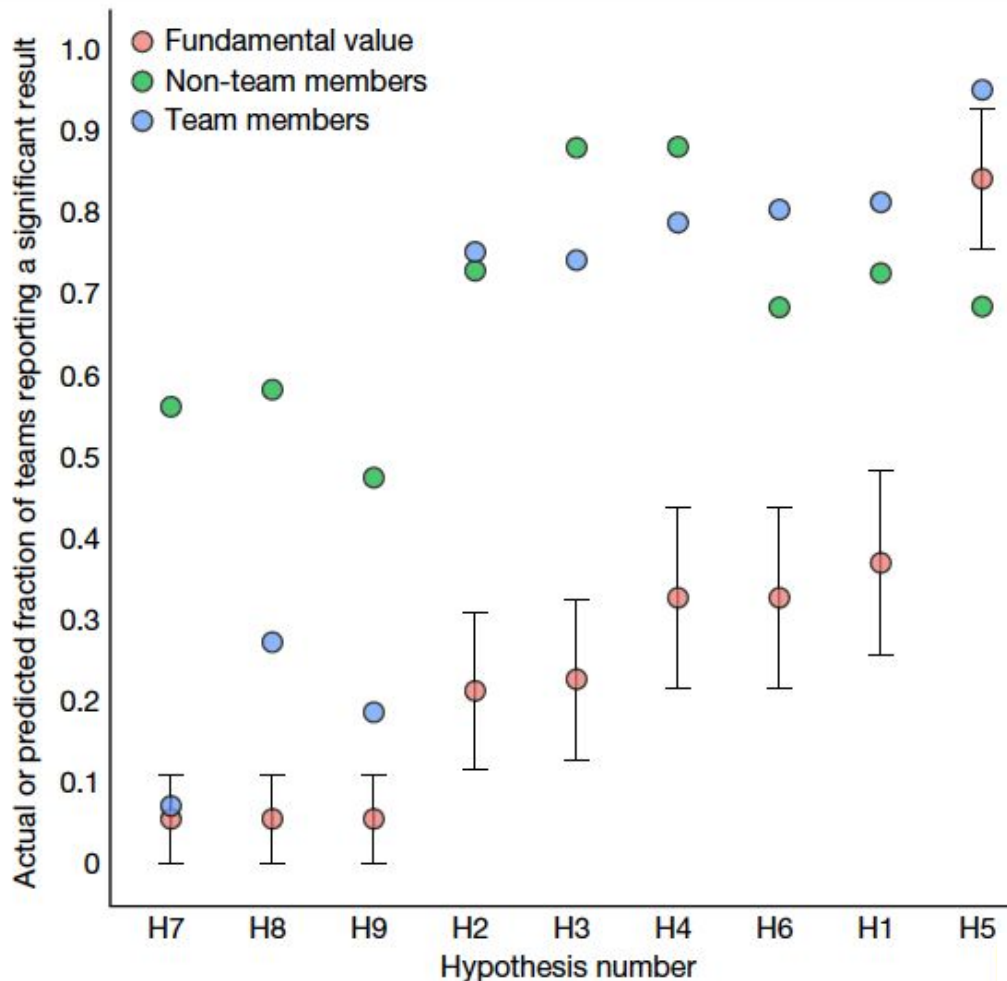
*e.g. Is there a parametric effect of gain:
Positive effect in ventromedial PFC -
for the equal indifference group?*

Many analysts project : NARPS



Many analysts project : NARPS

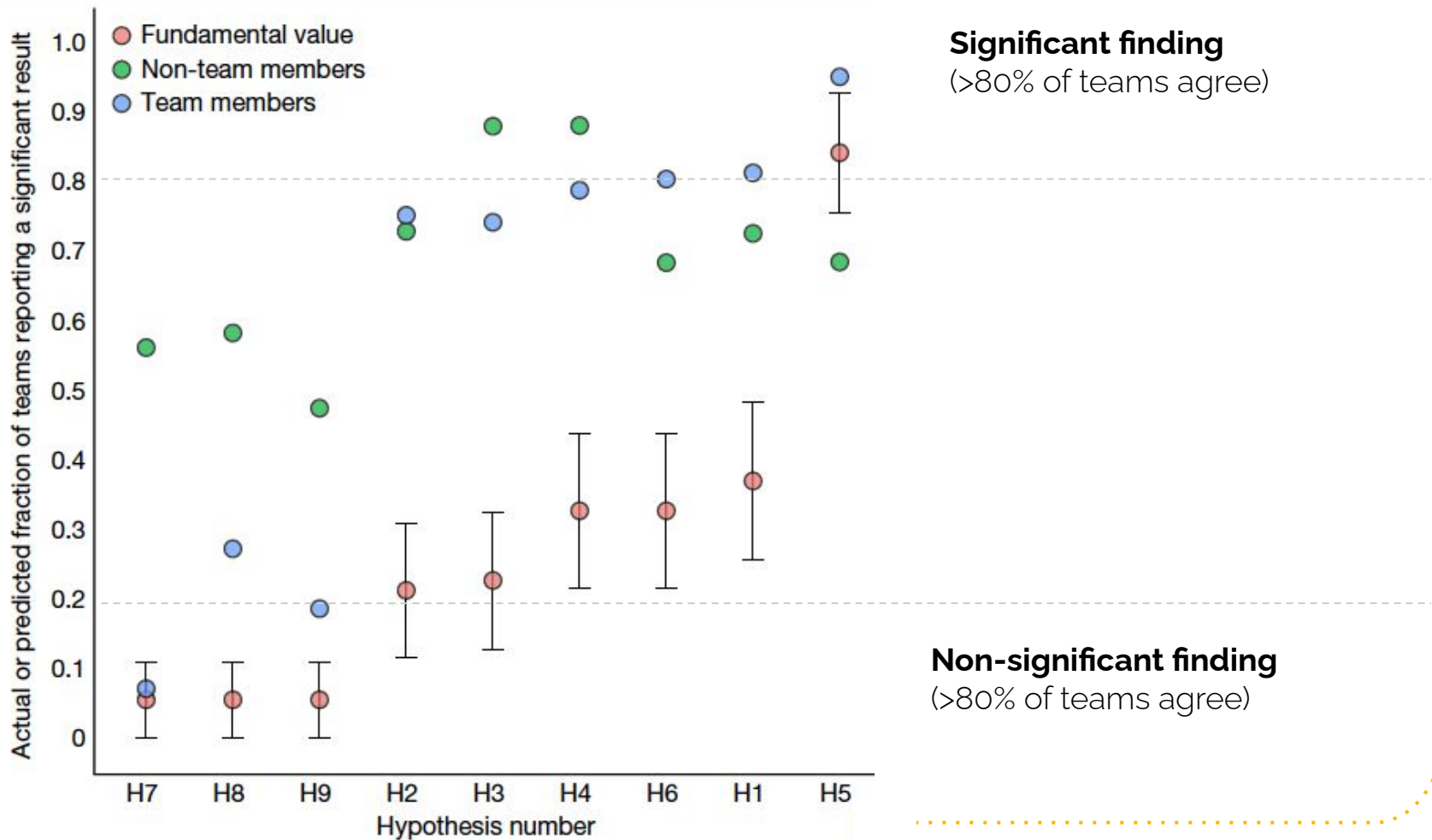
Results over the **70 post-processing pipelines**:



[Botvinik-Nezer et. al, Nature 2020]

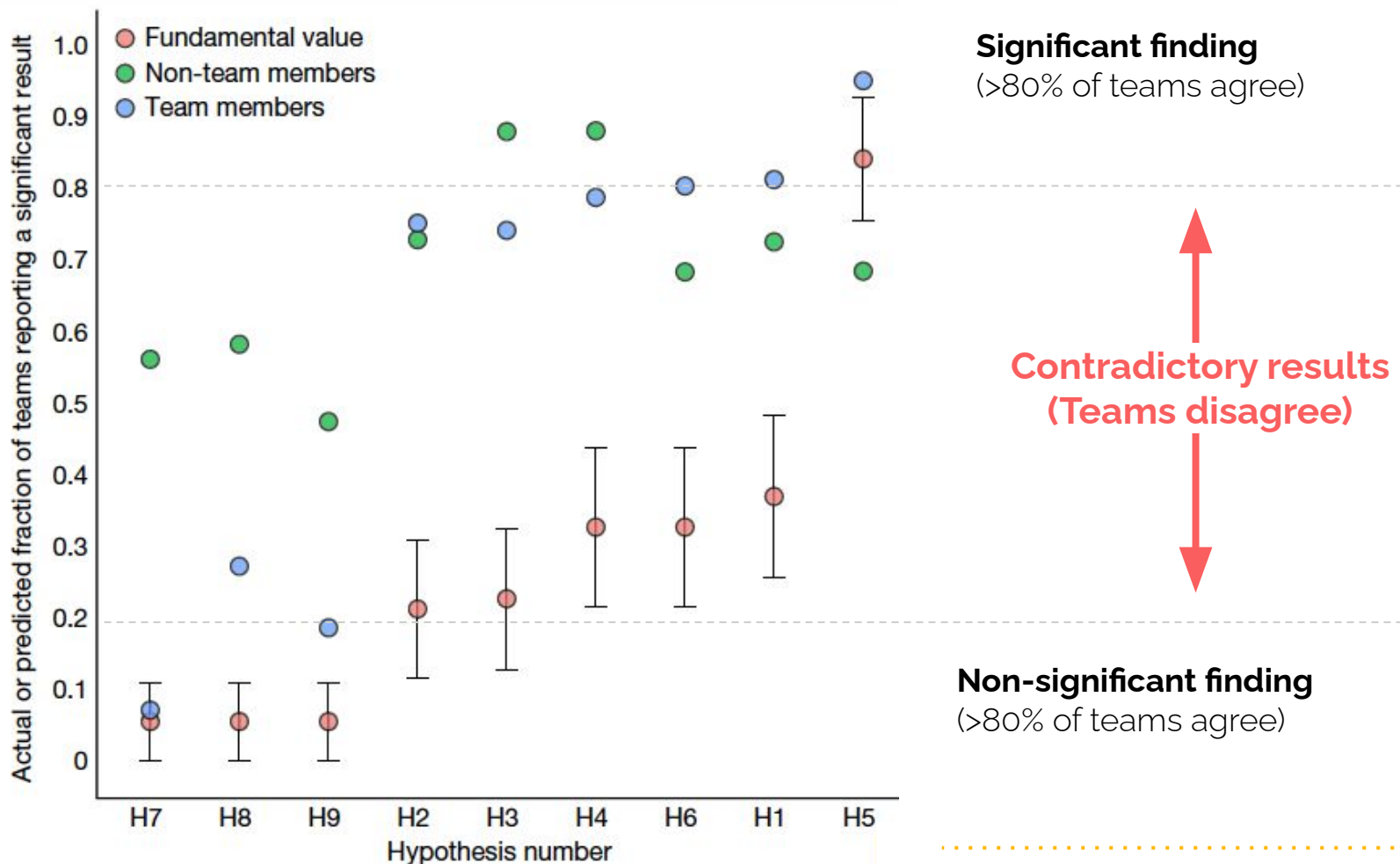
Many analysts project : NARPS

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



Many analysts project : NARPS

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



Different levels of variability in analytical pipelines

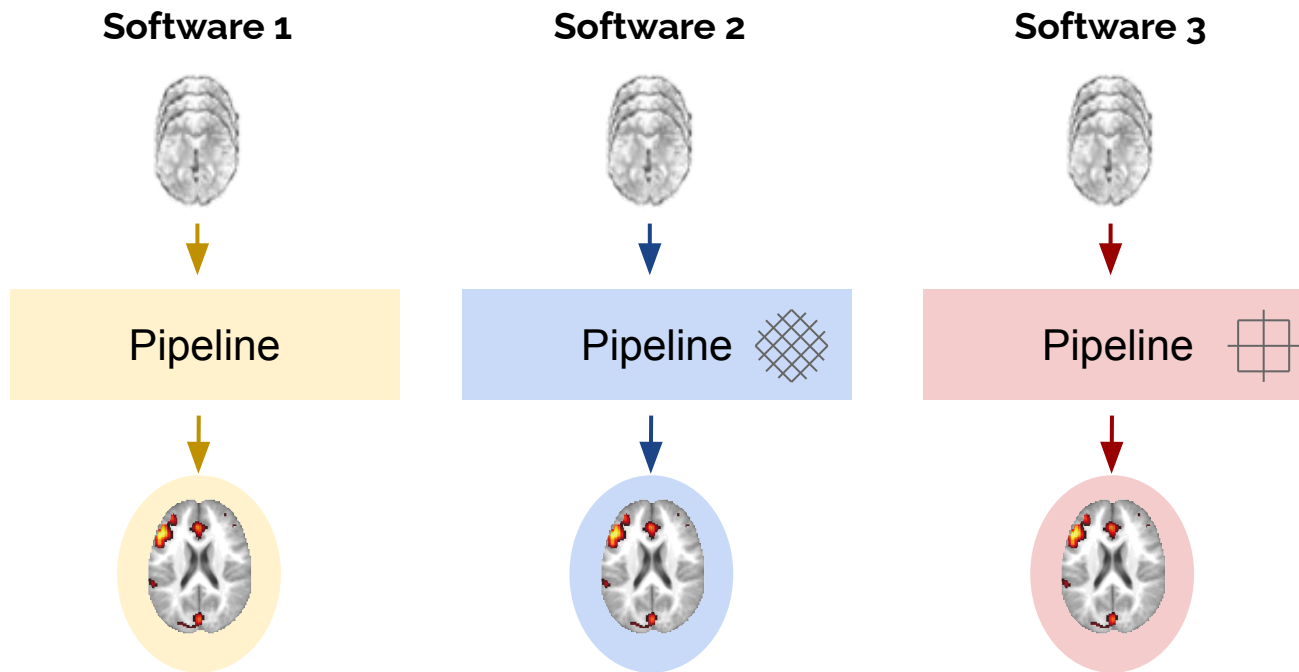
- Different end-to-end pipelines using different algorithms+parameters [[Churchill 2012](#), [Carp 2013](#), [Li 2021](#), [Dafflon 2022](#)]
- Different Software Version [[Gronenschild 2012](#)]
- Different operating system [[Glatard 2015](#), [Kiar 2021](#)]
- Different software packages [[Bowring 2019](#),
- and more...

Variability across software

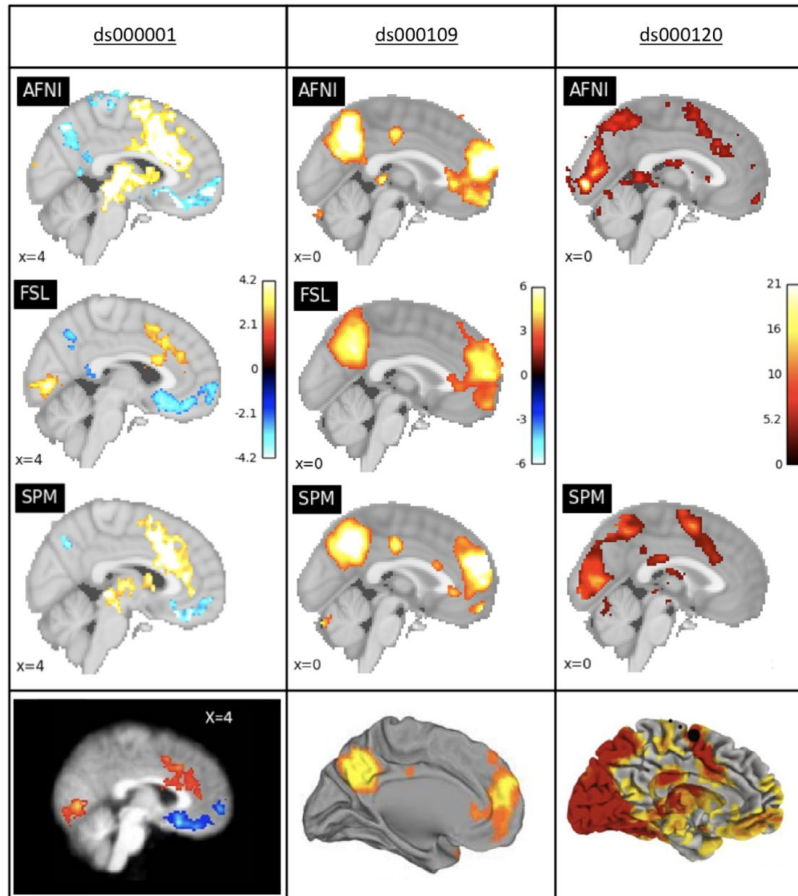
- Reproduced 3 published functional MRI studies
 - ds001, ds109, ds120 (from [Openneuro](#))
- Using 3 different software packages
 - AFNI, FSL, SPM



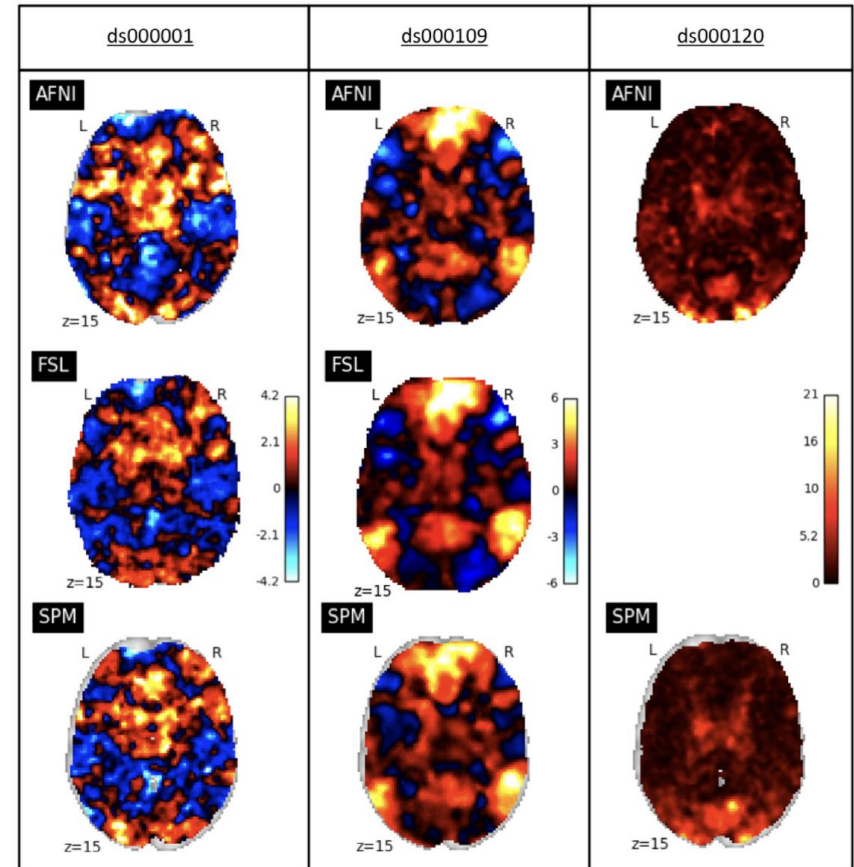
Alex Bowring Tom Nichols



Software Comparison Project



Comparison of the final results

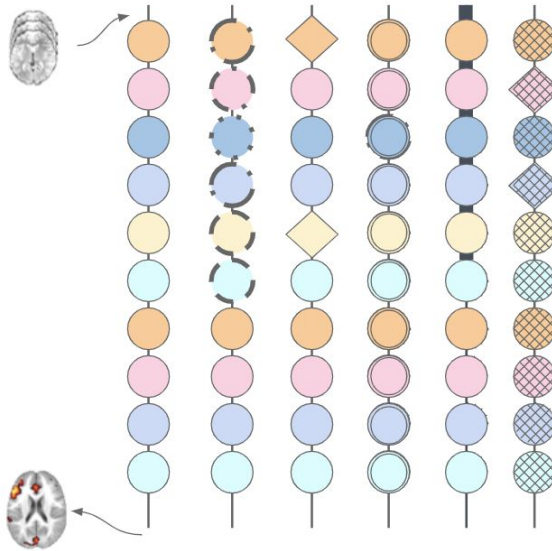


Comparison of the statistical maps

Understanding analytical variability

Explaining analytical variability...

?



Explaining analytical variability...

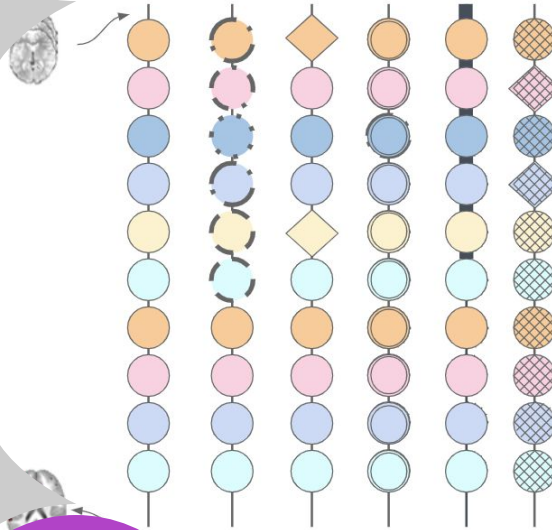
[Glatard 2015,
Kiar 2021]

Numerical
uncertainty
(e.g. \neq OS)

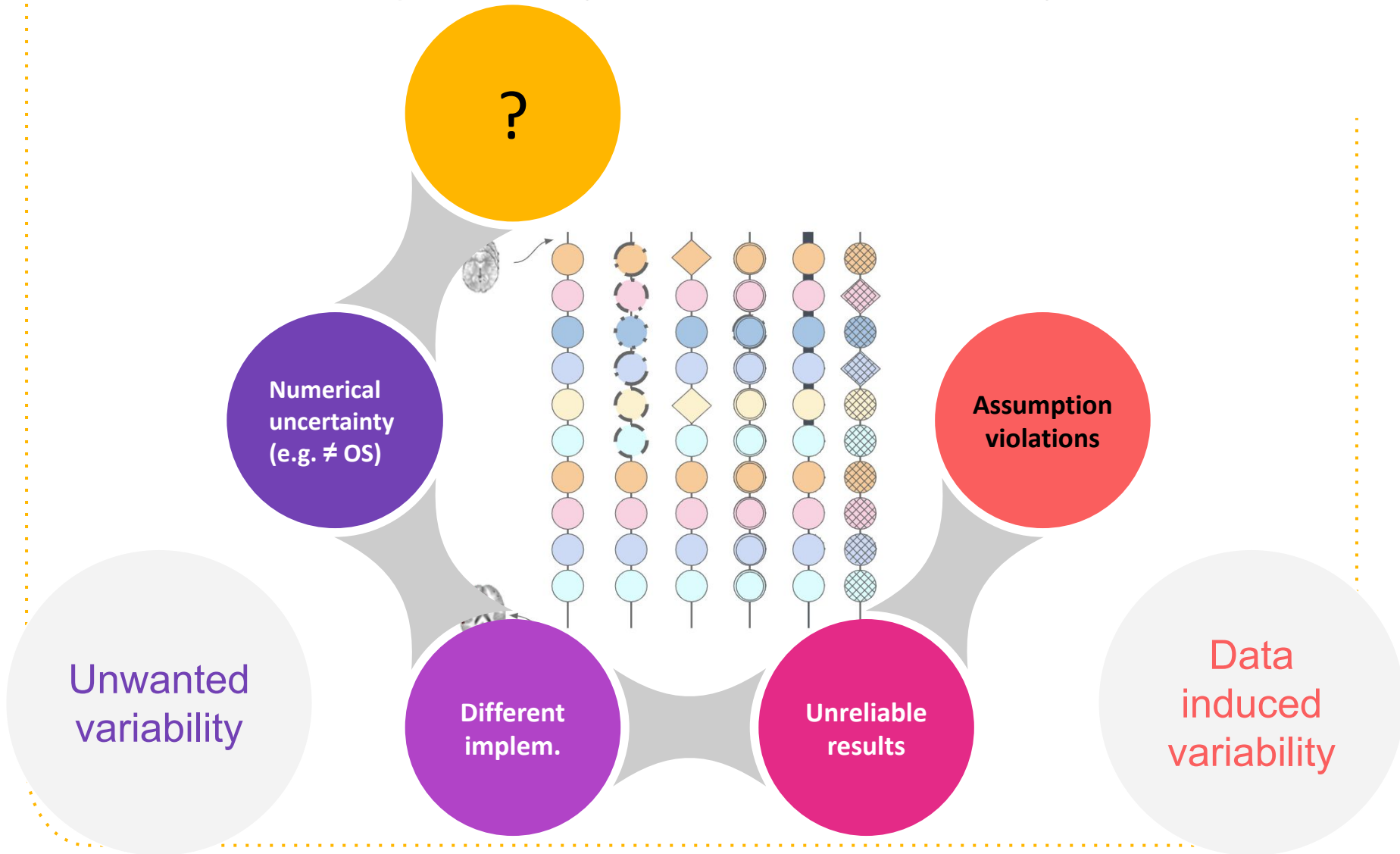
Unwanted
variability

Different
implem.

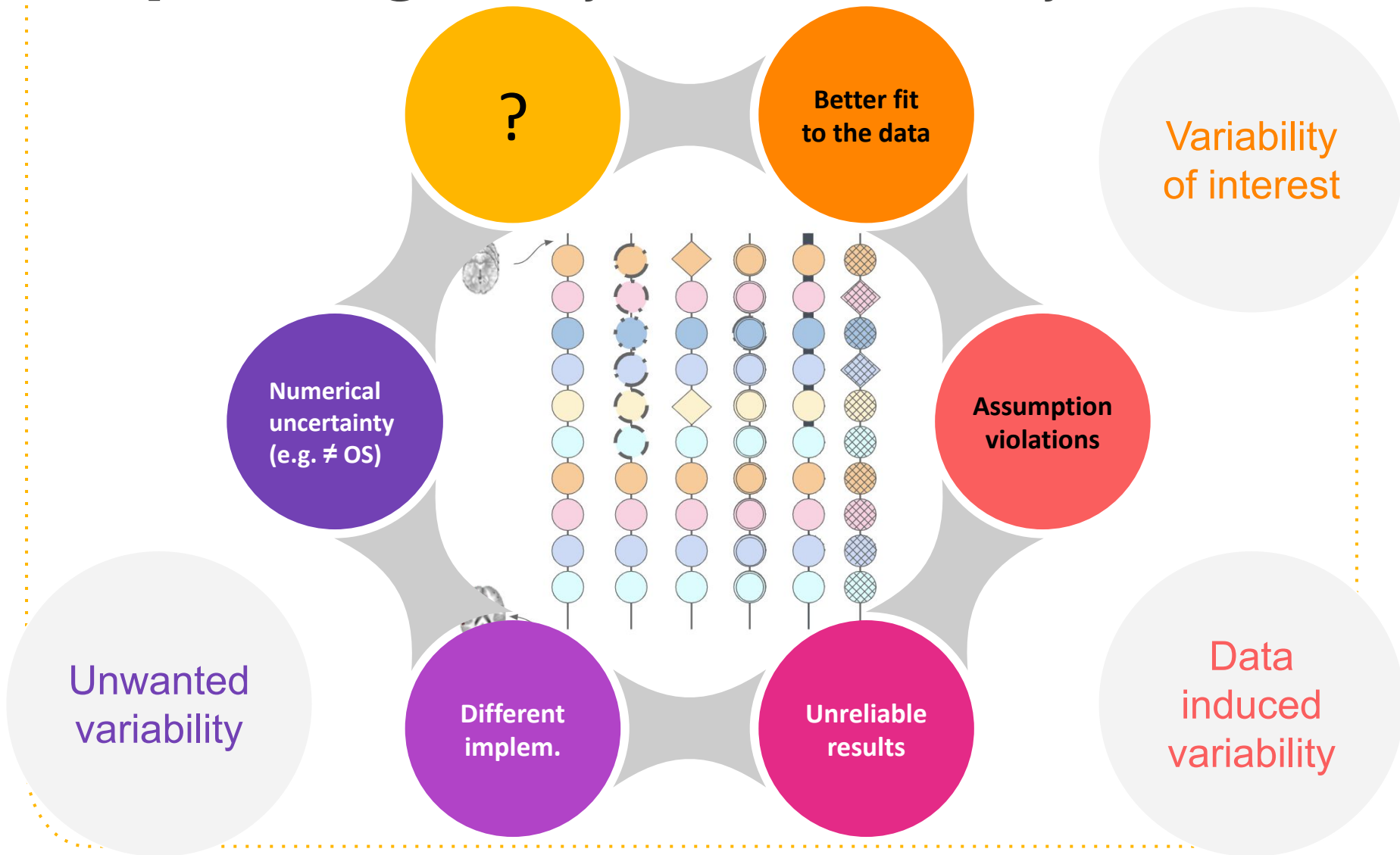
[Gronenschild 2012,
Bowring 2019]



Explaining analytical variability...



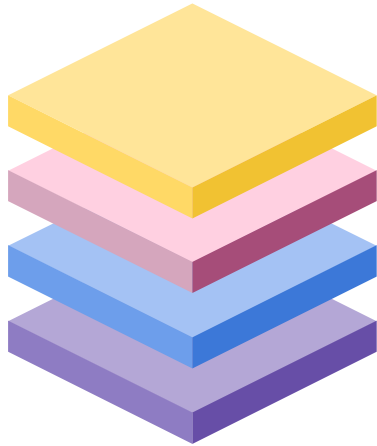
Explaining analytical variability...



On our way...

- Sharing a **variety of research artefacts** and in particular **code** along with paper
- Storing and **sharing provenance** (BIDS-Prov)
- **Benchmarking** different methods

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Thank you!

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