A validation framework for neuroimaging software: the case of population receptive fields

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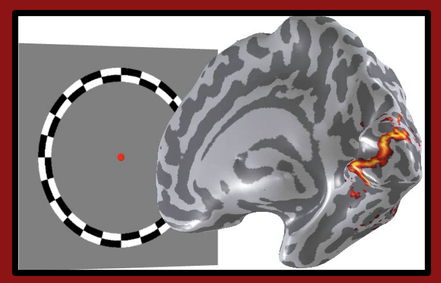
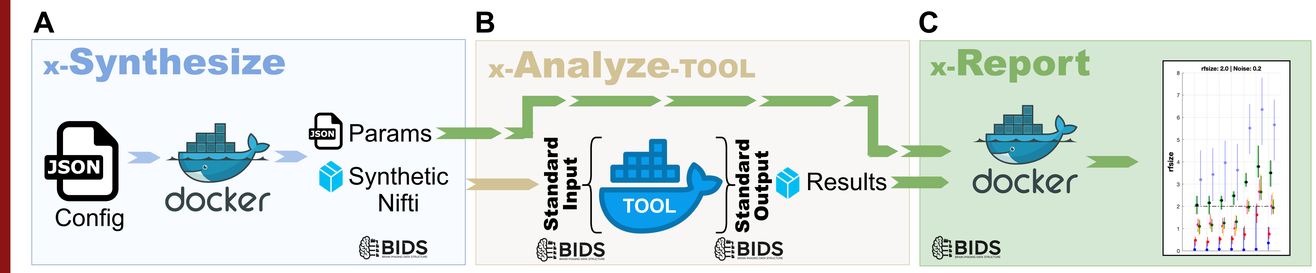
BASQUE CENTER ON COGNITION, BRAIN AND LANGUAGE



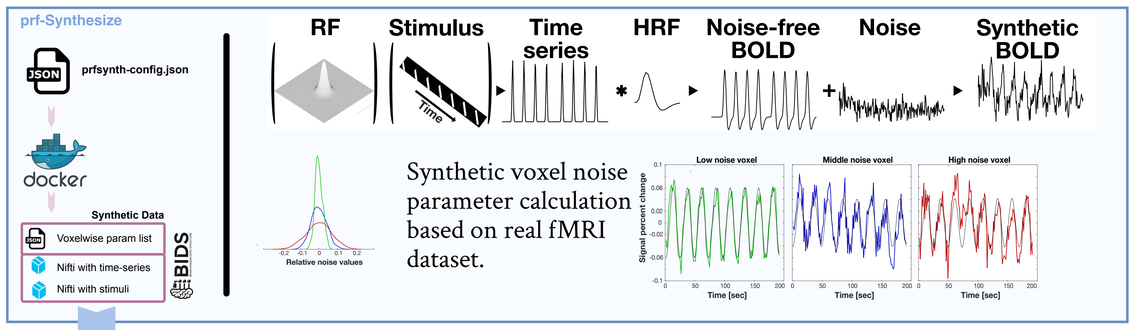
Framework for validating and sharing neuroimaging software implementations



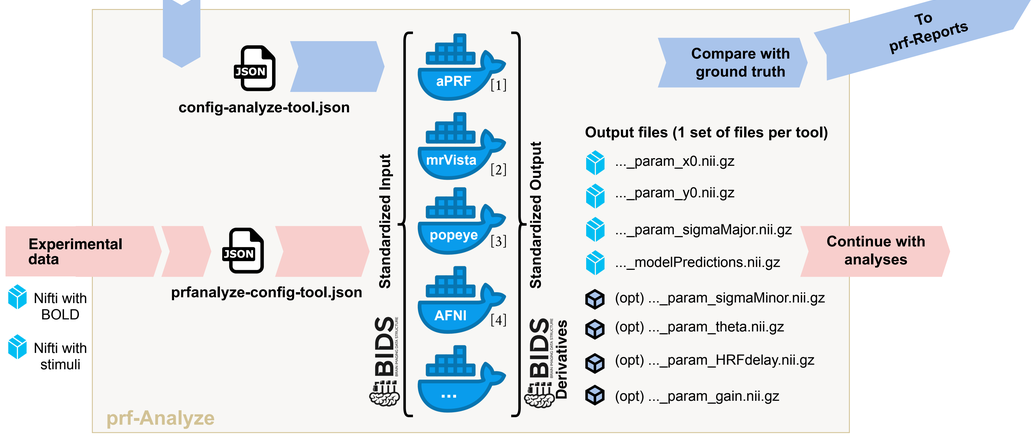
INTRODUCTION

- Neuroimaging software methods are complex, making it a near certainty that some implementations will contain errors.
- Modern computational techniques (i.e. public code and data repositories, continuous integration, containerization) enable the reproducibility of the analyses and reduce coding errors, but cannot guarantee the scientific validity of the results.
- The framework is designed to check the validity of the tools.
- Use case: framework for population receptive field (pRF) validation.
- In addition to identifying limitations in four existing tools, the framework helped us develop better experimental mitigation methods.

A- SYNTHESIZE *Synthetic BOLD generation: ground truth*

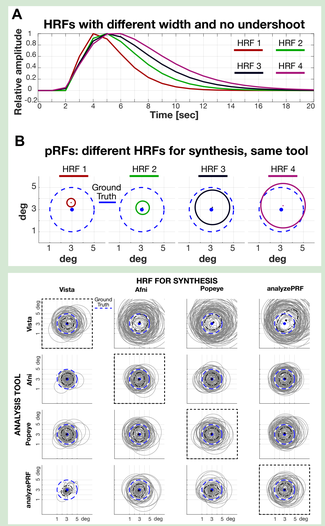


B-ANALYZE *Reproducible analyses with standardized input/output*



C- REPORTS

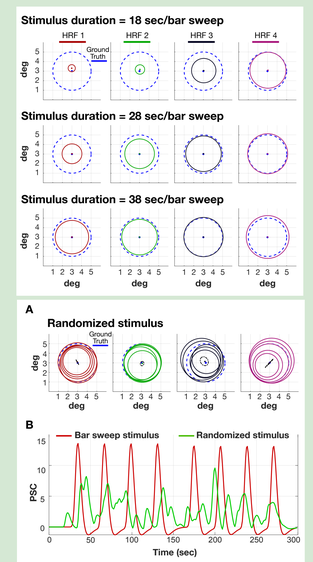
ISSUE: All tools recover the synthesized parameters in the noisefree case, when same HRF used to synthesize and to solve. There is an HRF dependence on size, for all tools, when a different HRF is used for synthesis and solving.



The interaction between synthesis and analyze HRF affects size of RF

pRF size is affected by the HRF used in the synthesis and HRF assumed by tool

MITIGATION: Changes in the experimental design to improve the pRF size recovery.



Slowing the bar sweeps improves the pRF size estimation

Randomizing the stimulus sequence improves pRF size estimation, at the cost of lower SNR

SUMMARY

- The computational validity framework supports scientific rigor and creativity, as opposed to the oft-repeated suggestion that investigators rely upon a few agreed upon packages.
- Having validation frameworks help:
  - (a) Developers to build new software
  - (b) Research scientists to verify the software's accuracy
  - (c) Reviewers to evaluate the methods used in publications and grants.
- pRF size dependency on HRF, for all examined tools
- There is the need to look at the sizes reported in the literature depending on the tool used.
- We proposed mitigation strategies that can be used when designing pRF experiments.

References

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Paper: https://www.biorxiv.org/content/10.1101/2020.01.07.897991v2

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