Fostering Dynamic Interdisciplinary Creation of Research Software—Case Study

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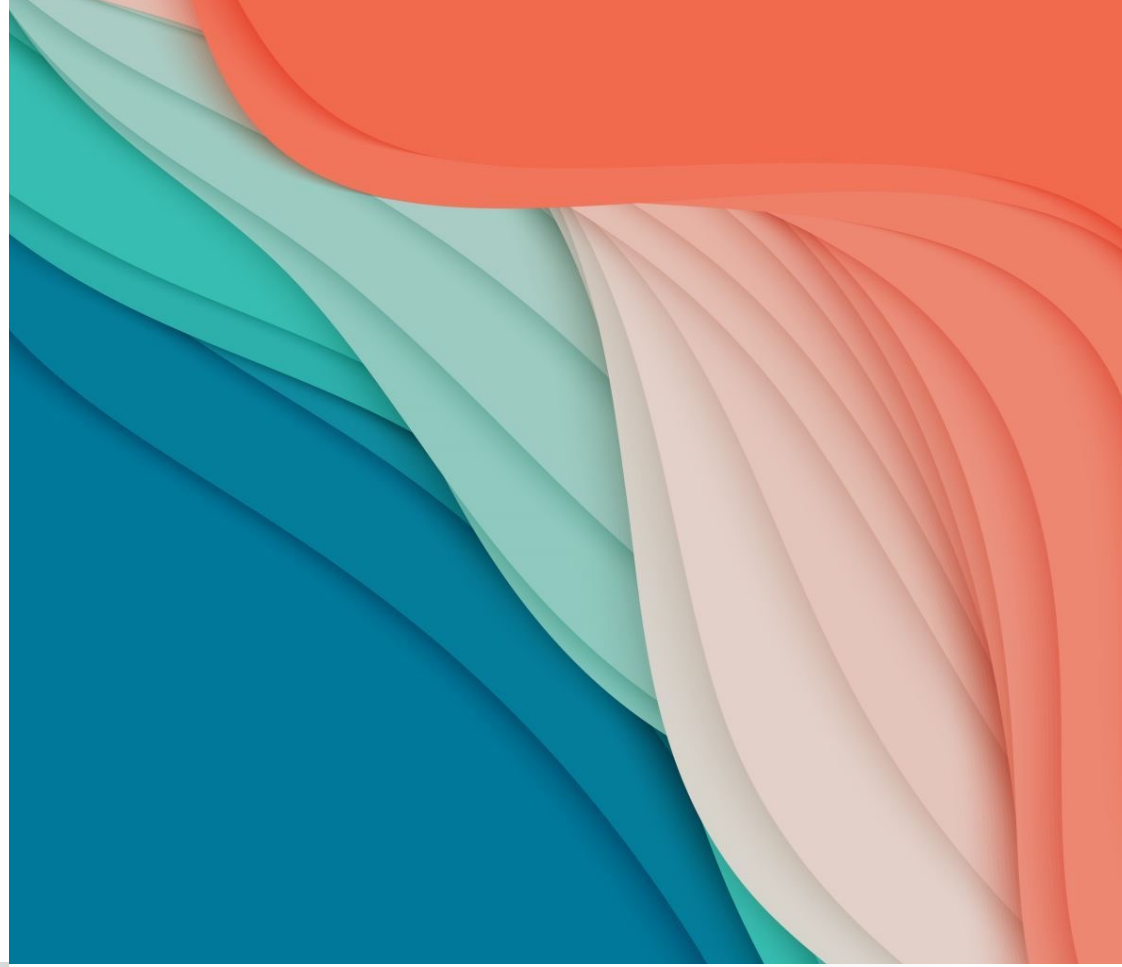
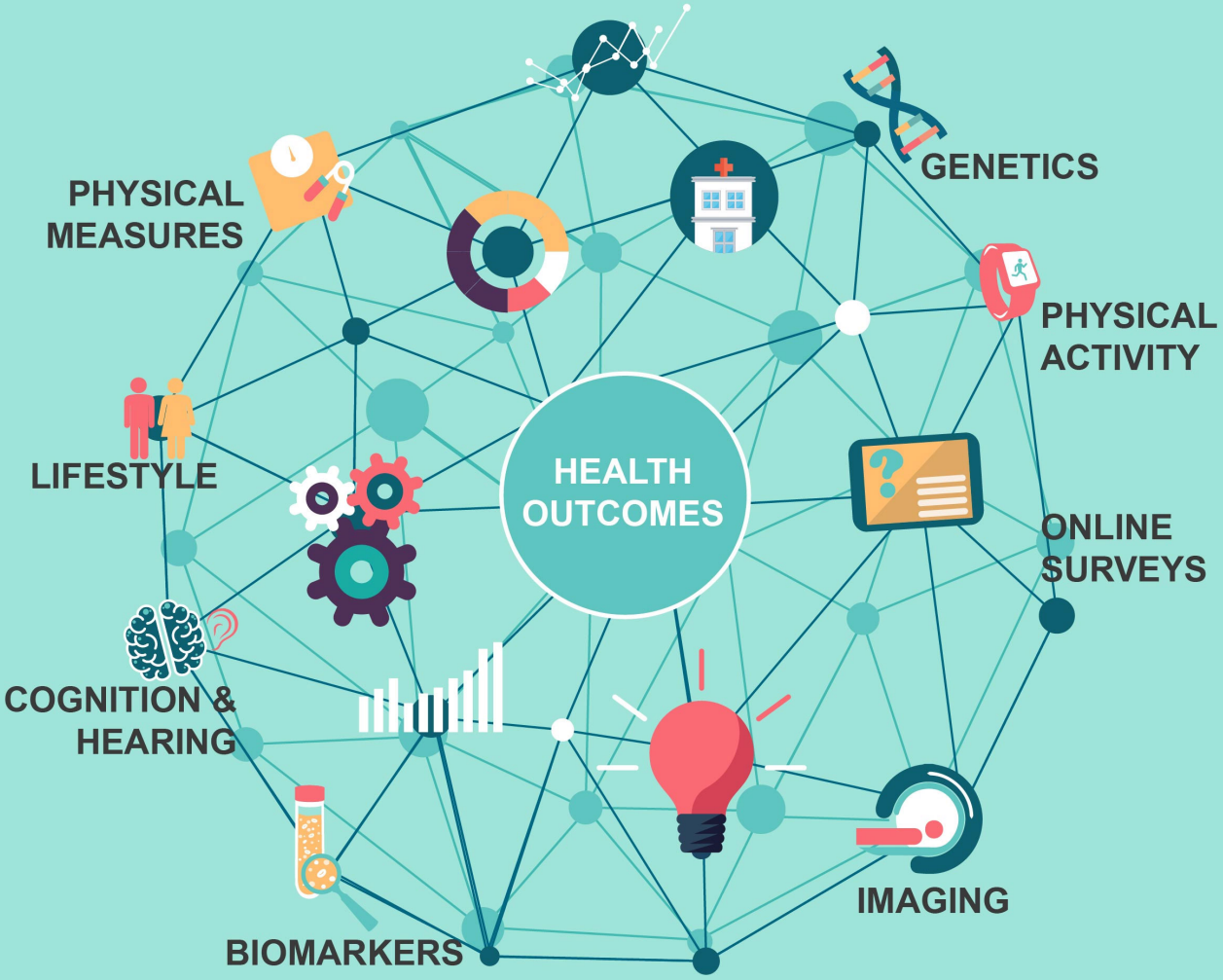


BREADTH AND DEPTH

A summary of all the information gathered and available for research can be found in the UK Biobank Data Showcase.

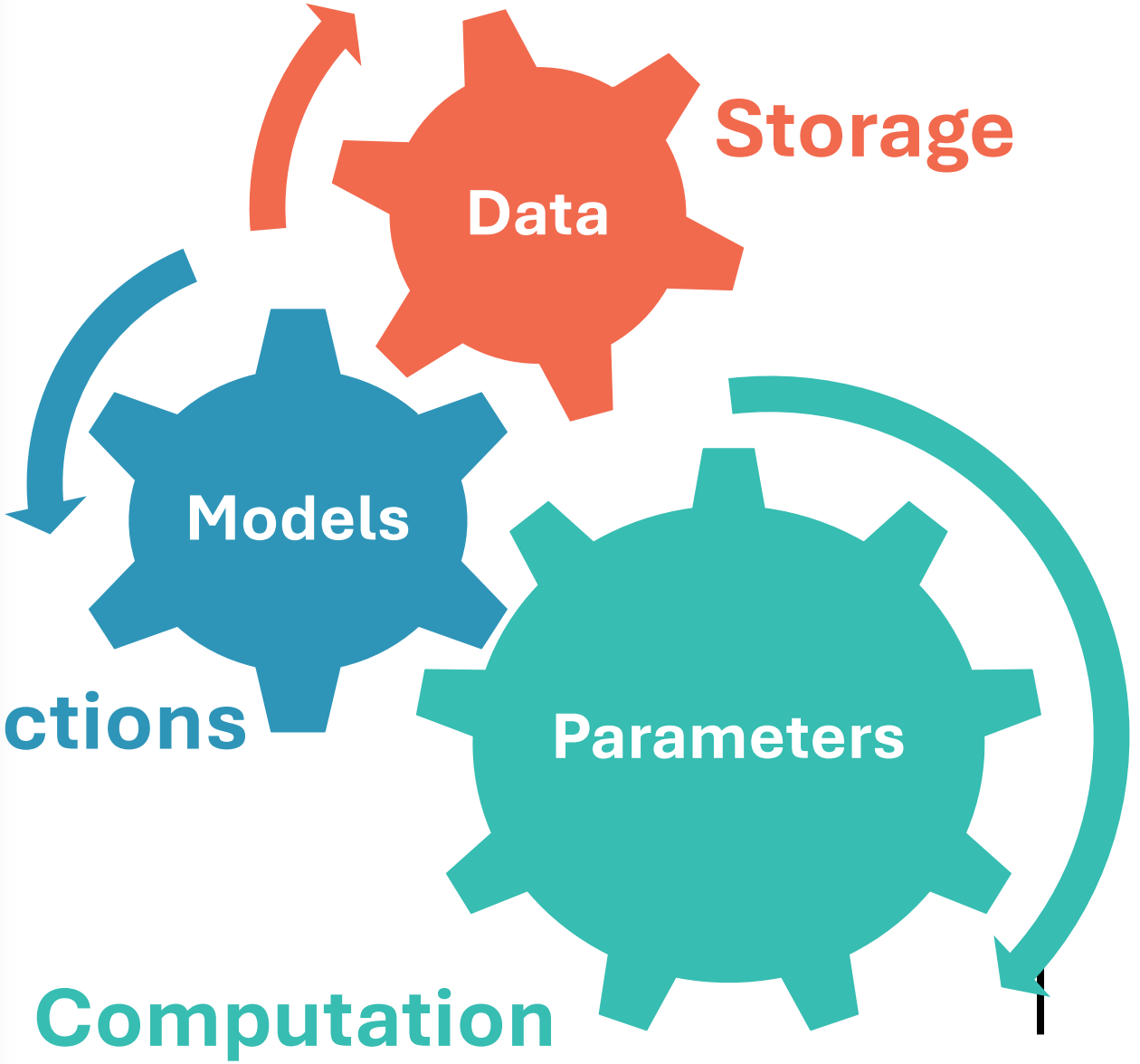


Holistic Approach to Health Science

We need data-driven, ‘holistic’ and participatory research ecosystems that allow for inter-disciplinary inquiries into possible causes of illness

Research Software Requirements

Integrative
Reproducible
Robust



CANARIE RS3-031

Our Objective

Make a niche functional neuroimaging software available to larger community of (clinical) researchers.

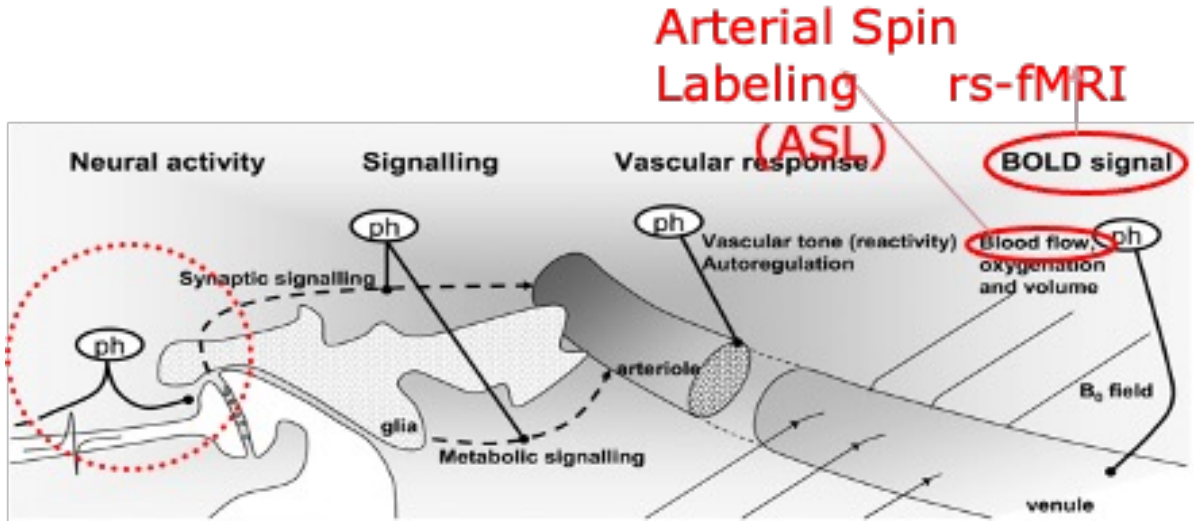
Aims

fMRI => CBRAIN

Functional Magnetic Resonance Imaging measures brain activation in response to stimuli or drugs.

Canadian Brain Research and Imaging Network is a CANARIE-funded web-based data processing system for analyzing large-scale research data.

Motion Artifacts
Physiological Signals
Cerebral Blood Flow
+ fMRI

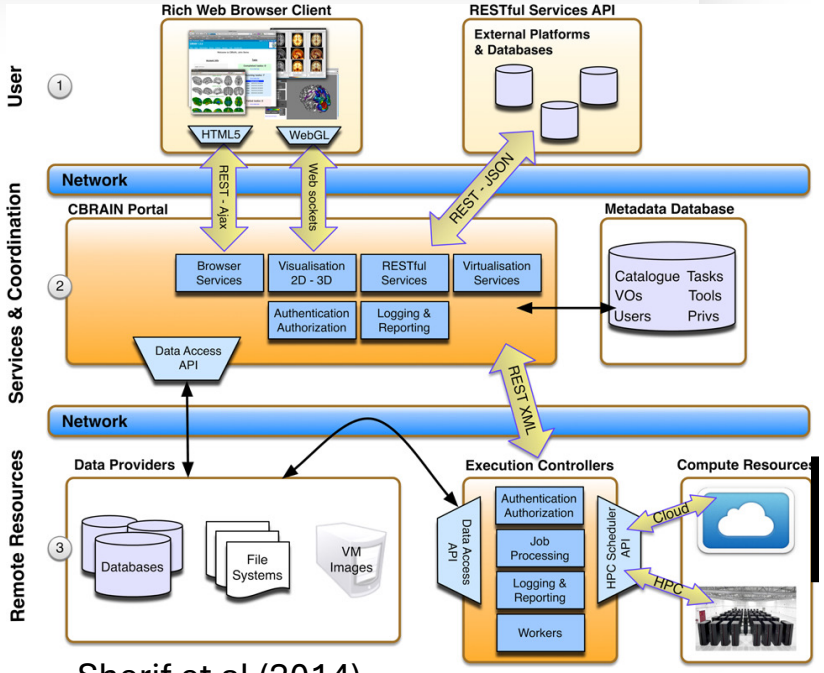


Tracy, Wise (2014)

Sources of Heterogeneity

Experiment	Single dose, dose controlled, oral, intravenous
Data	3T, 1.5 T, **RSfMRI** (# frames, TE/TR), **ASL** (pulse/continuous)
Objectives	Localization, Dose-response, Validation, Calibration, Clinical
Analyses	**Preprocessing and noise removal**, phenotypes (static/dynamic connectivity, hubness, BOLD response, etc.), Modeling

Khalili-Mahani et al (2017)



Sherif et al (2014)

Typical fMRI dataset (Raw 0.2 GB ->Derivative 4.0 GB)

Subject {1… N}

Session {1 … M}

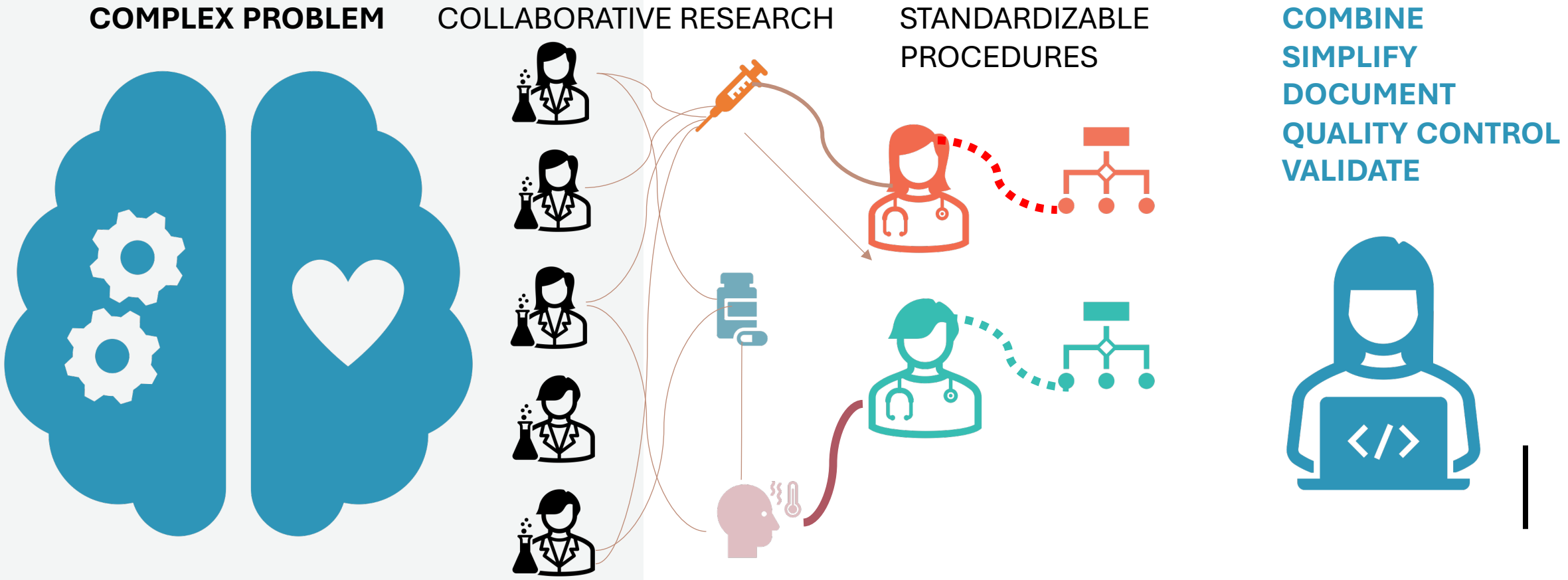
Anatomical MRIs =>Pipeline A =>Standardize to an Atlas

T2* Weighted fMRI =>Pipeline B + Pipeline A =>Compute Metrics

Physiological Data => Pipeline C + Pipeline B => Noise-Correct

Arterial Spin Labeling =>Pipeline D + Pipeline A => Compute Metrics

Challenge: Integration of Heterogenous Methods into Standardized & User-Friendly Software



In this presentation

- **Approach**
- **Methodology**
- **Outcomes**

Pragmatic Approach

Stretching the Penny

- Ensure that the additions support and fall in line with previous or ongoing work.

Identifying the Lowest Hanging Fruit

- Create intrinsic reward by energizing the team from succeeding in delivering MVPs.

Fitting In

- Respect existing standard operating procedures and software development culture.

Communication

- Translate between different disciplines and their practical cultures (e.g., neuroscientist, physicist, software engineer, designer.)

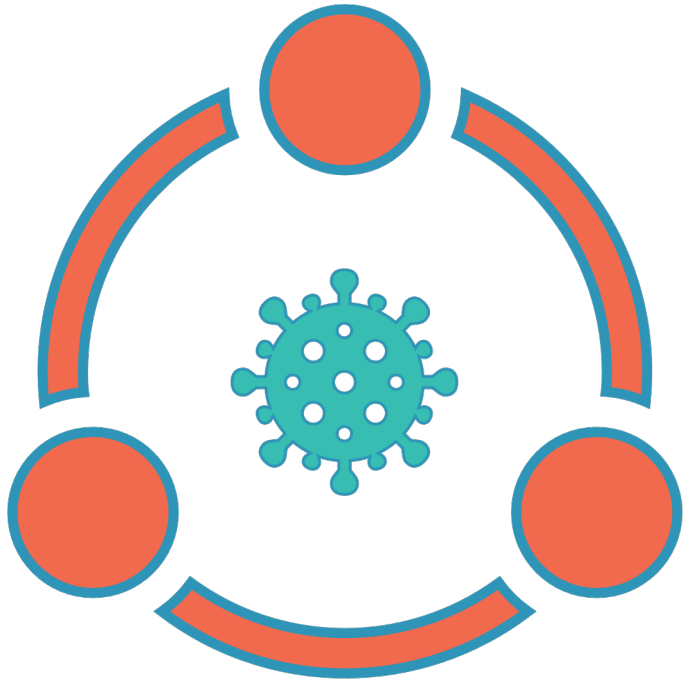
Participatory Approach

Identify scientific stakeholders

- Have they developed any computationally intensive software?
- Do they work with large-scale datasets?
- Do you have a history of collaboration?

Invite them to no-cost partnership

- Include ***their*** students in software integration efforts
- Pre-plan for ***co-publishing*** at the end of the project.



Methodology

Quasi-Agile

Simulation-Assisted

Pair Programming

Quasi-Agile: **Constraints**

Existing Code	• PhysIO • OxfordASL • fMRIPrep
Existing Framework	• NIFTI file format • CBRAIN • Boutique
HQPs	• Students who needed training • Coders who needed time • Scientists who had time & data
Funding	• No revenues can be expected • Under-appreciation of software development costs

Quasi-Agile “Sprints” are not 2-weeks!

fMRIPrep

Commonly demanded

Incorporated by senior programmer

Used as a show-case to recruit Partner 1

OxfordASL

Partner 1 offered student A

Similar tools were already implemented and used to train student A & B

Student A & Senior developer implemented the tool

PhysIO

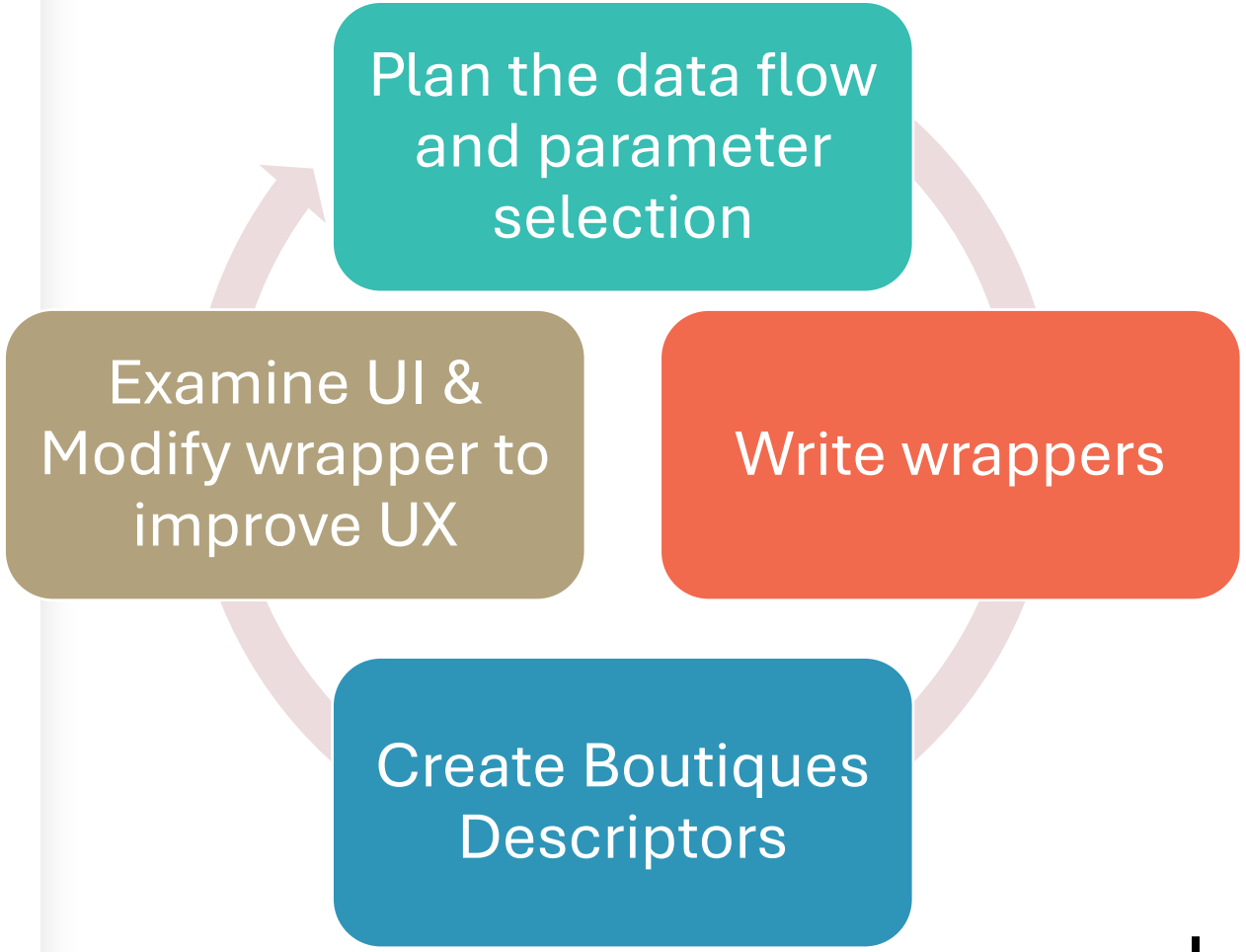
New tool assigned to

Student B and New developer C

Implement in CBRAIN

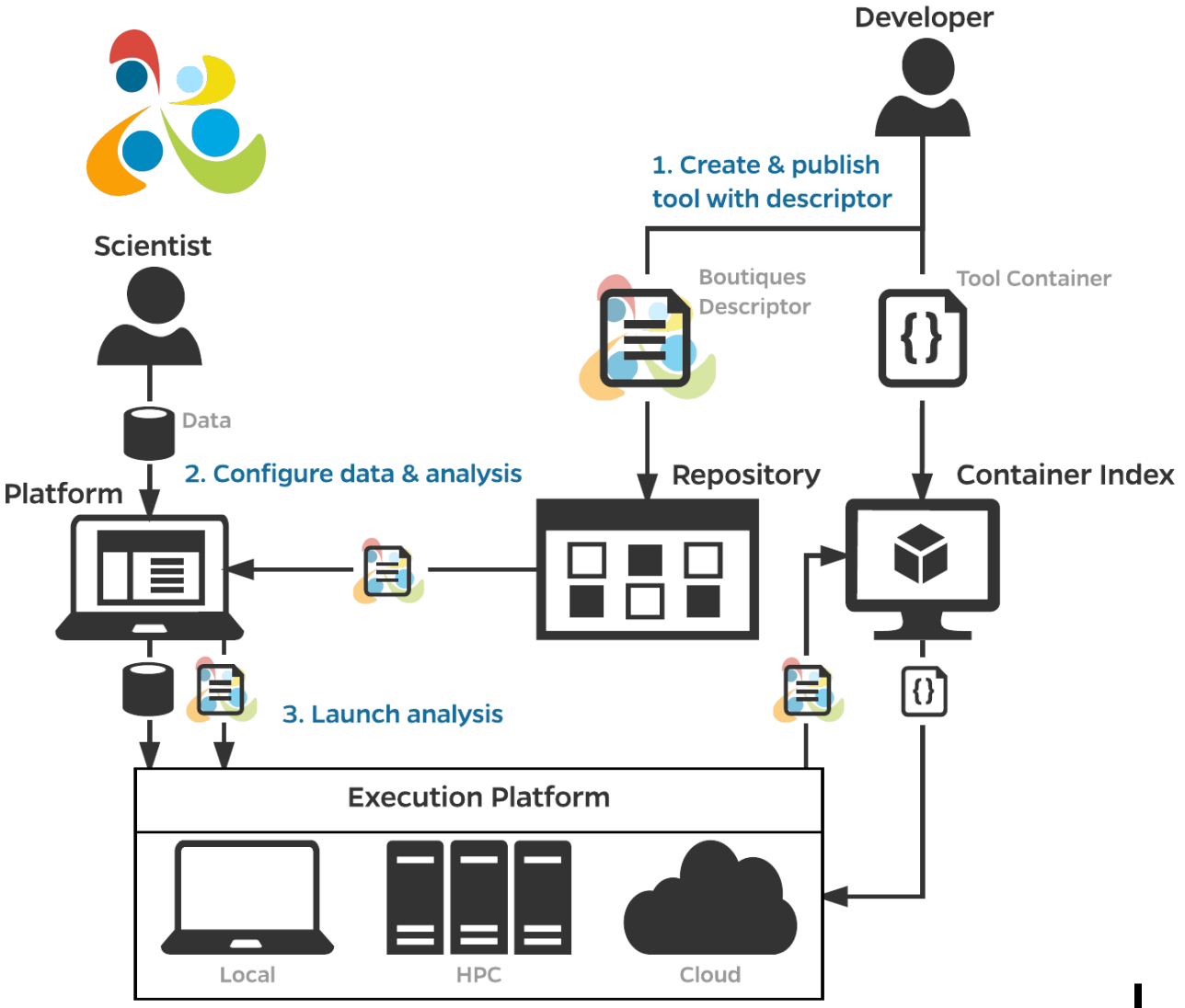
Tool Preparation For Each Sprint

This task was done by **students** (Neuroscience and Brain Imaging) who were found through scientific **research partners**



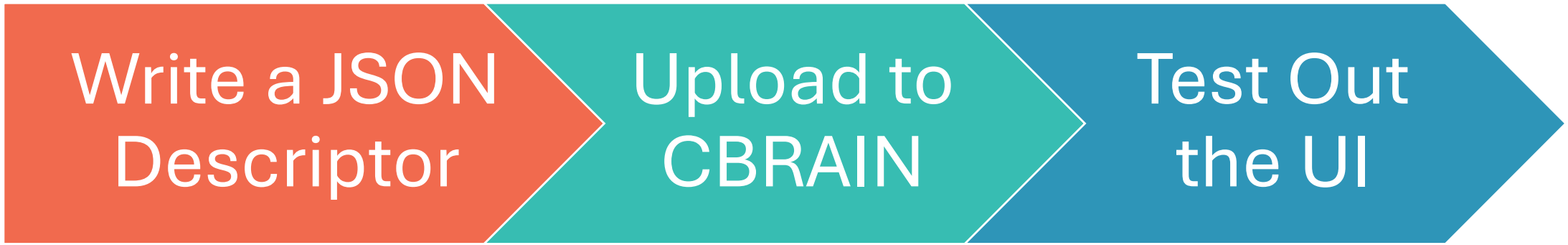
Simulation-Supported *Design* via ***Boutiques***

Boutiques is a tool to automatically publish, integrate, and execute applications across computational platforms. Boutiques applications are summarized in a simple yet rich JSON description, and enable the simulation, validation, evaluation, and application-specific monitoring of command-line tools.



Glatard et al, (2018) Boutiques: a flexible framework to integrate command-line applications in computing platforms. ***Gigasci (7) 5***

BoutiquesDescriptorMaker

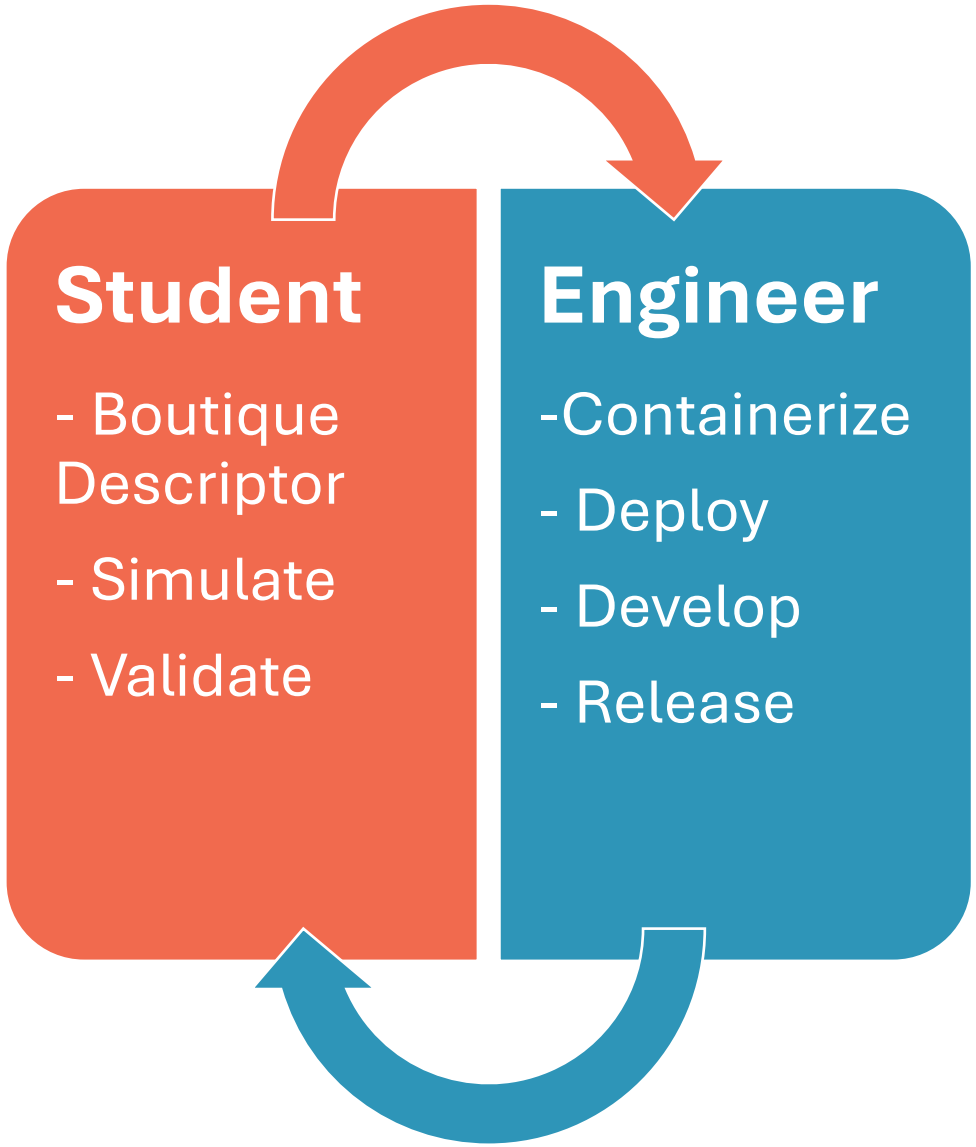


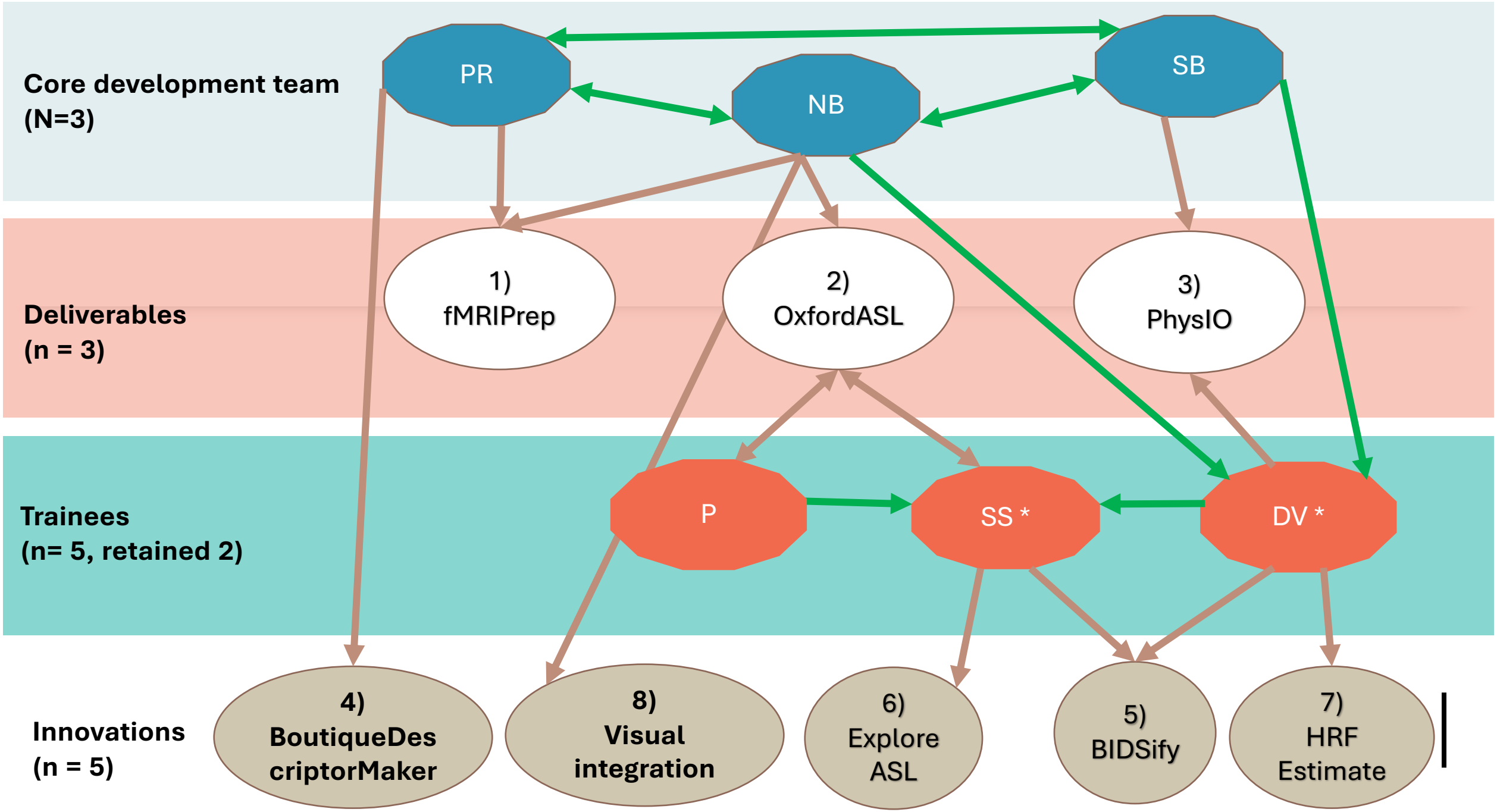
Pair Programming

Facilitated by **Boutiques.**

Allowed ongoing training and communication over UI/UX **simulations.**

Fostered innovations that will further simplify tool integrations procedures.




Core development team
(N=3)
PR
NB
SB
Deliverables
(n = 3)
1)
fMRIPrep
2)
OxfordASL
3)
PhysIO
Trainees
(n= 5, retained 2)
P
SS *
DV *
Innovations
(n = 5)
4)
BoutiqueDes
criptorMaker
8)
Visual
integration
6)
Explore
ASL
5)
BIDSify
7)
HRF
Estimate

Summary

Neuroimaging Software integration is a challenging process due to the complexity of the data and exploratory nature of it.

A **Pragmatic and Participatory Approach** helped us accomplish our aims to integrate specialized fMRI tools into CBRAIN.

A ***Quasi*** Agile Methodology + Simulation-frameworks facilitated student training and software integration.

We were able to complete deliverables and improve tool integration process along the way.

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