

Integrating the Brain Imaging Data Structure with RT-Cloud, a Cloud Platform for Real-Time fMRI Analysis

Stephen Polcyn '21 | COS (BSE)

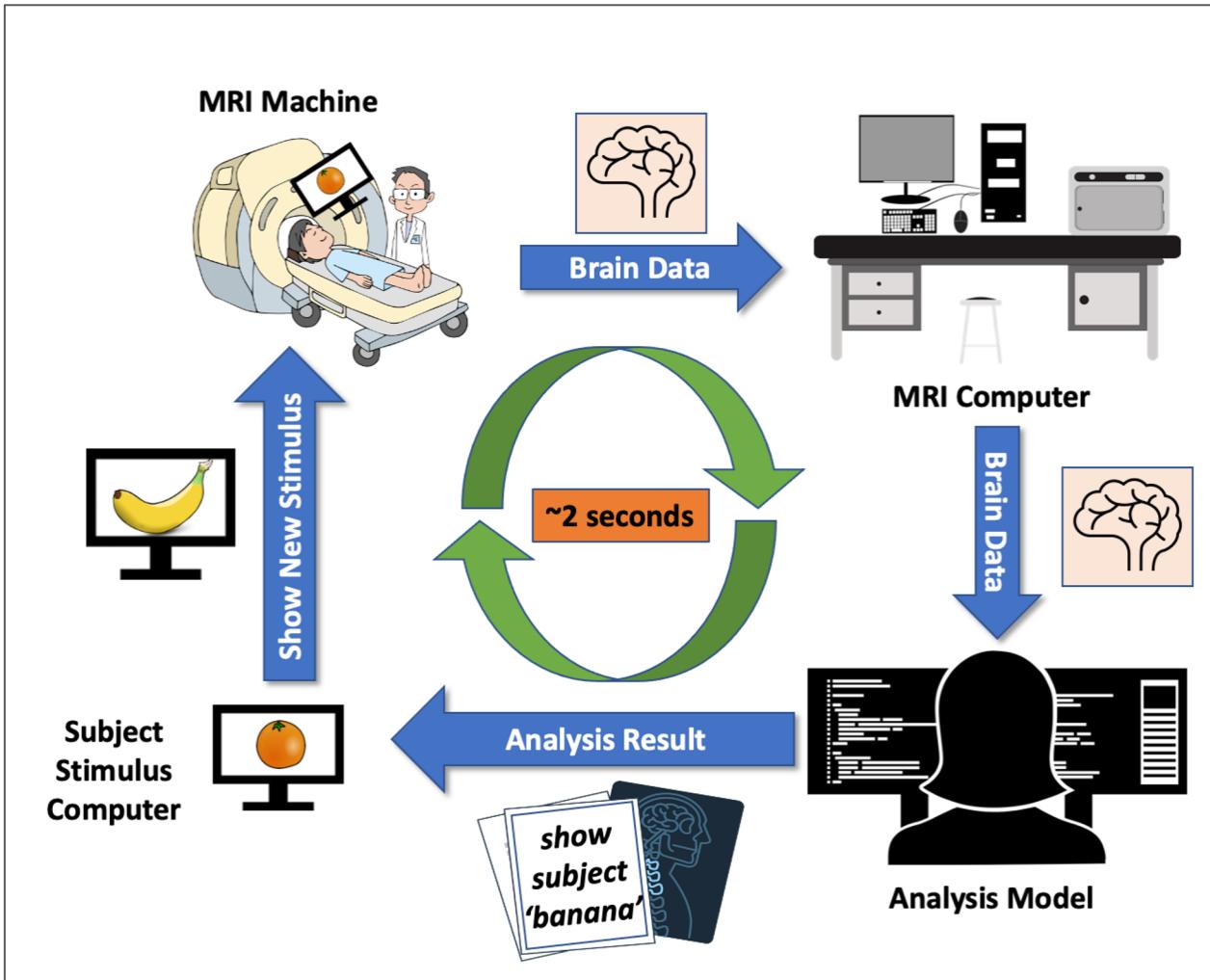
Advisors:

Professor Ken Norman, PNI/PSY (Primary Advisor)

Professor Kai Li, COS (Second Reader)

Grant Wallace, COS (Project Mentor)

Real-Time fMRI (RT-fMRI) Overview



Real-Time fMRI (RT-fMRI) Overview



Compatibility Advantage:

Both Users and Software Understand the

Format

Users can...

- a. Understand system input and output
- b. Link system with standards-compatible software
- c. Easily share data with external collaborators

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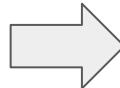
Developers can...

- a. Quickly develop new features
- b. Maintain system for long-term

Brain Imaging Data Structure (BIDS):

A standardized, hierarchical format for storing brain imaging data and metadata.

Sample BIDS Dataset
from OpenNeuro



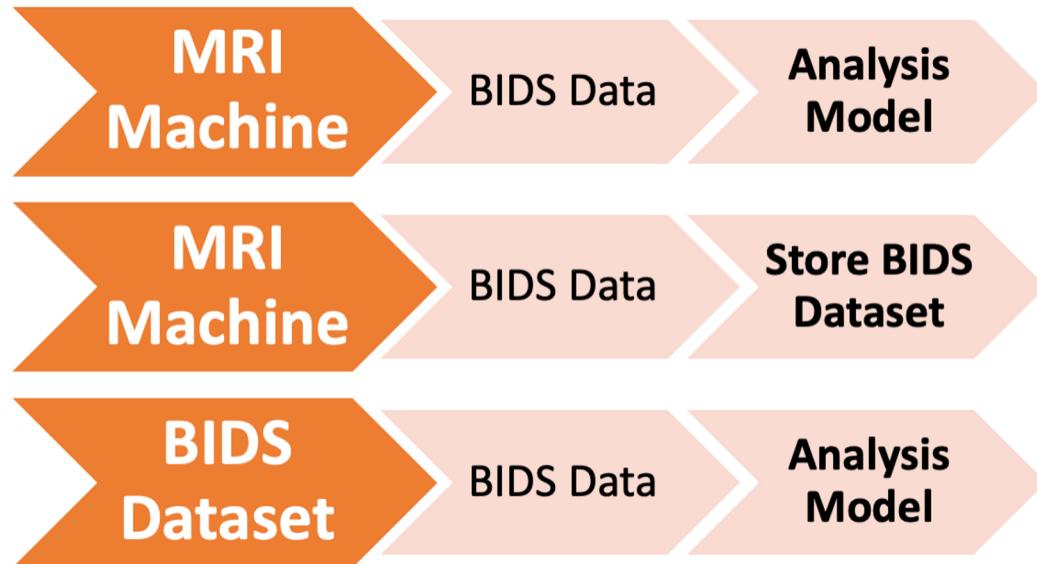
周五夜灯_研究2
- CHANGES
 DOWNLOAD VIEW
- dataset_description.json
 DOWNLOAD VIEW
- participants.tsv
 DOWNLOAD VIEW
- README
 DOWNLOAD VIEW
- task-movie_bold.json
 DOWNLOAD VIEW
- sub-sid000216
- sub-sid000216_scans.tsv
 DOWNLOAD VIEW
- anat
- func
- sub-sid000216_task-movie_run-01_bold.json
 DOWNLOAD VIEW
- sub-sid000216_task-movie_run-01_bold.nii.gz
 DOWNLOAD VIEW
- sub-sid000216_task-movie_run-01_events.tsv
 DOWNLOAD VIEW
- sub-sid000217
- sub-sid000375

Three BIDS Workflows to Support:

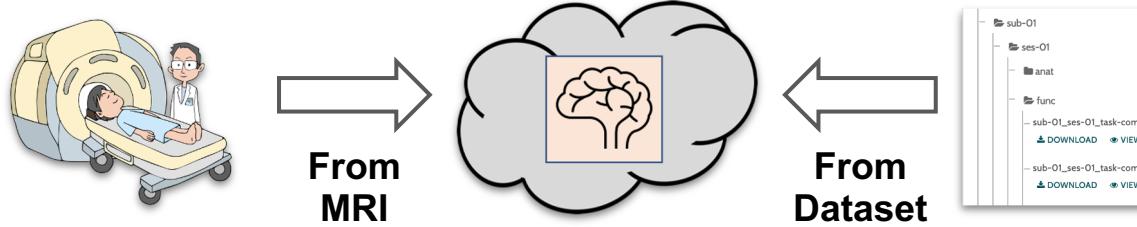
Live fMRI



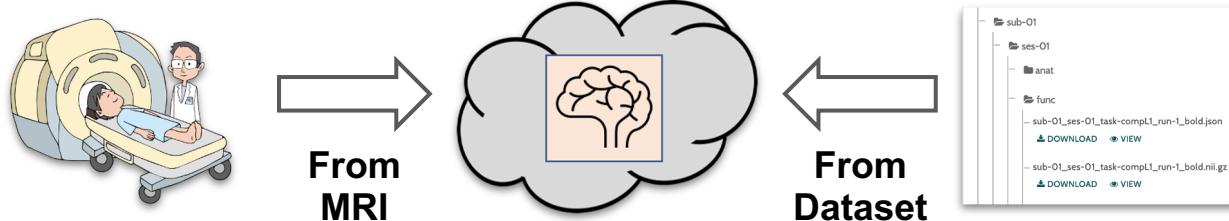
Testing



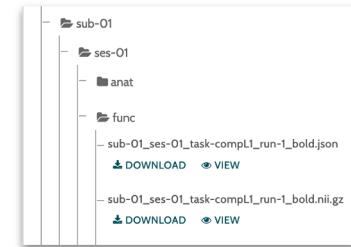
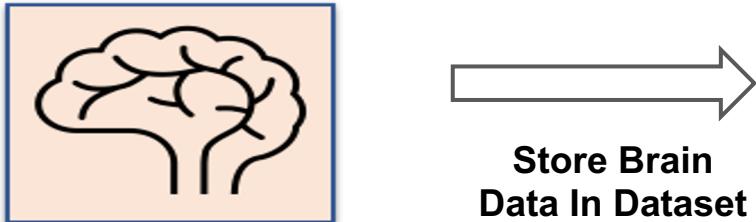
Stream Data



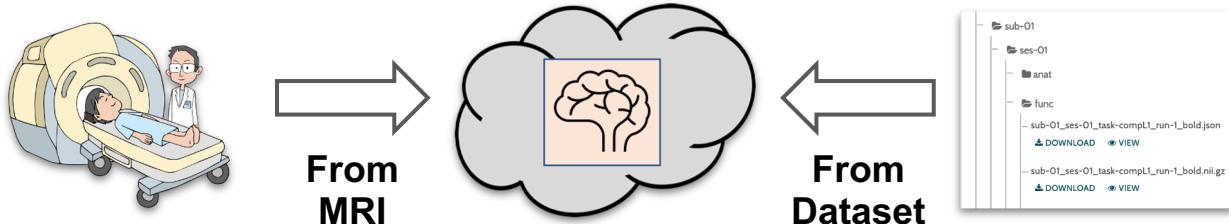
Stream Data



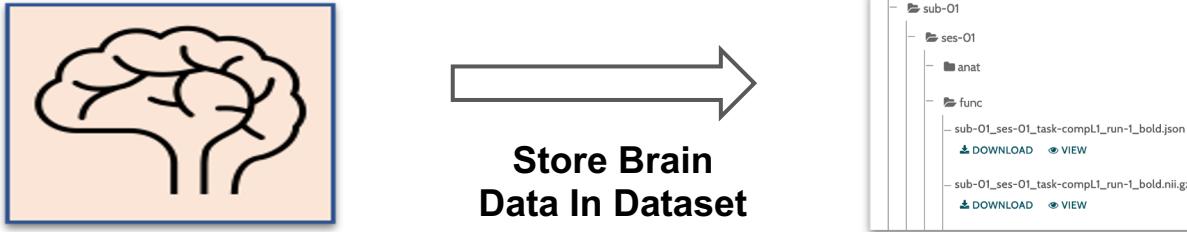
Append Data



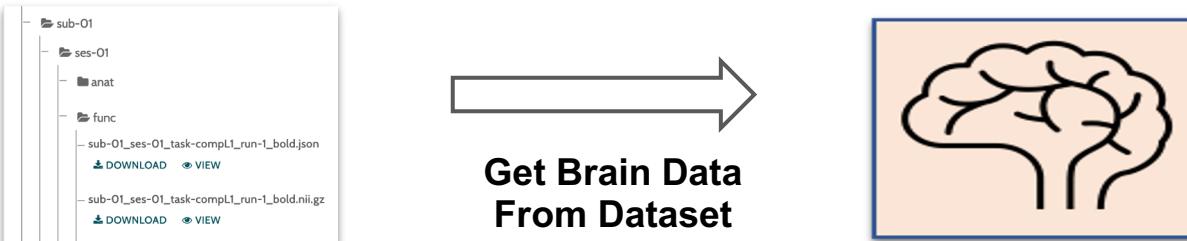
Stream Data



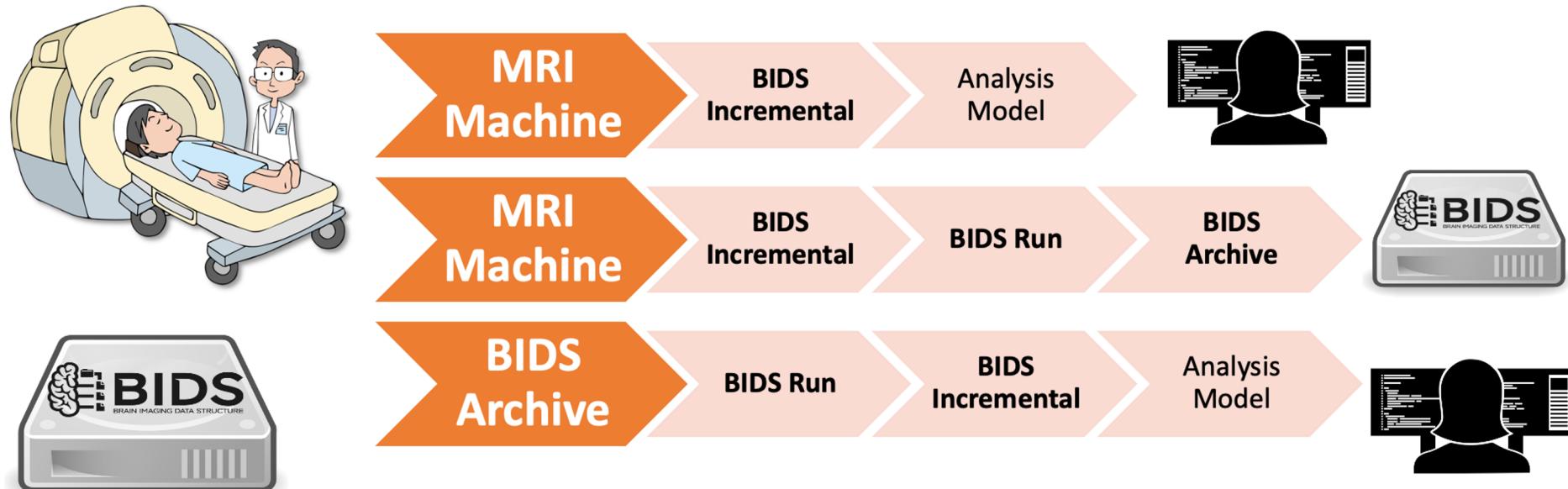
Append Data



Query Data

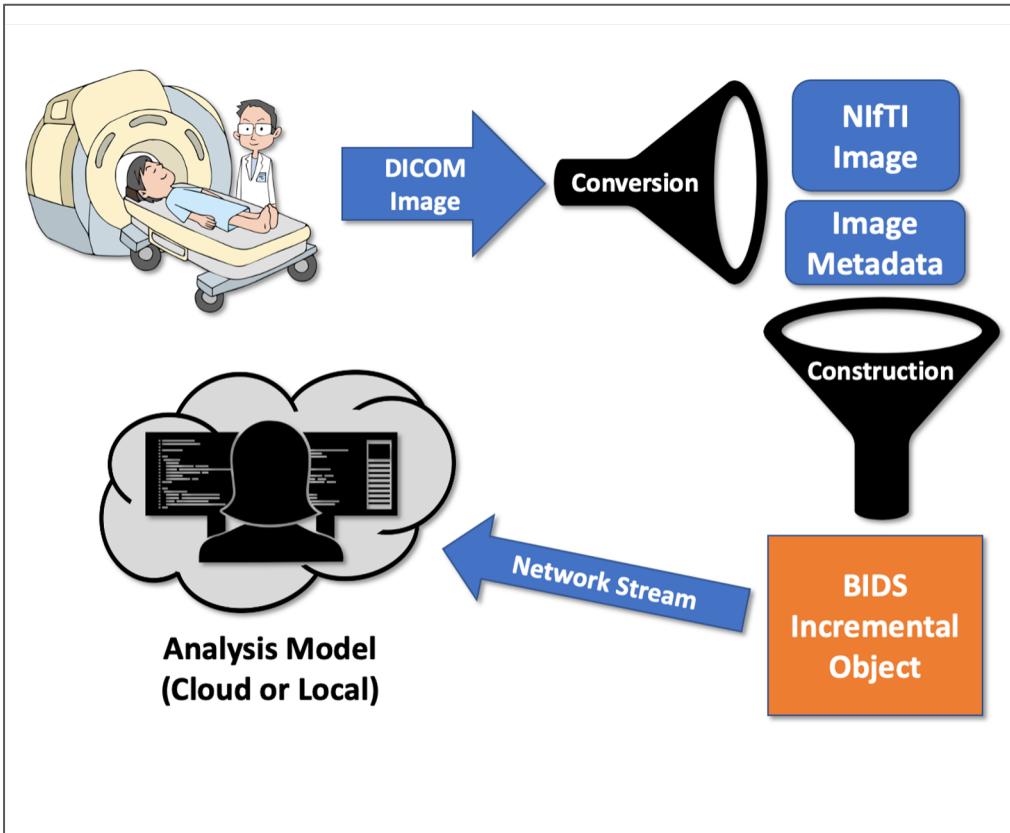


Three BIDS Workflows, With Classes



Incremental Streaming: **BIDS Incremental**

BIDS Incremental: Streaming BIDS Data



Key Properties

1. In-memory
2. Hold image, metadata
3. Write to disk
4. Serialize



MRI
Machine

MRI
Machine

BIDS
Archive

In
ital

In
ital

BIDS Run

Analysis
Model

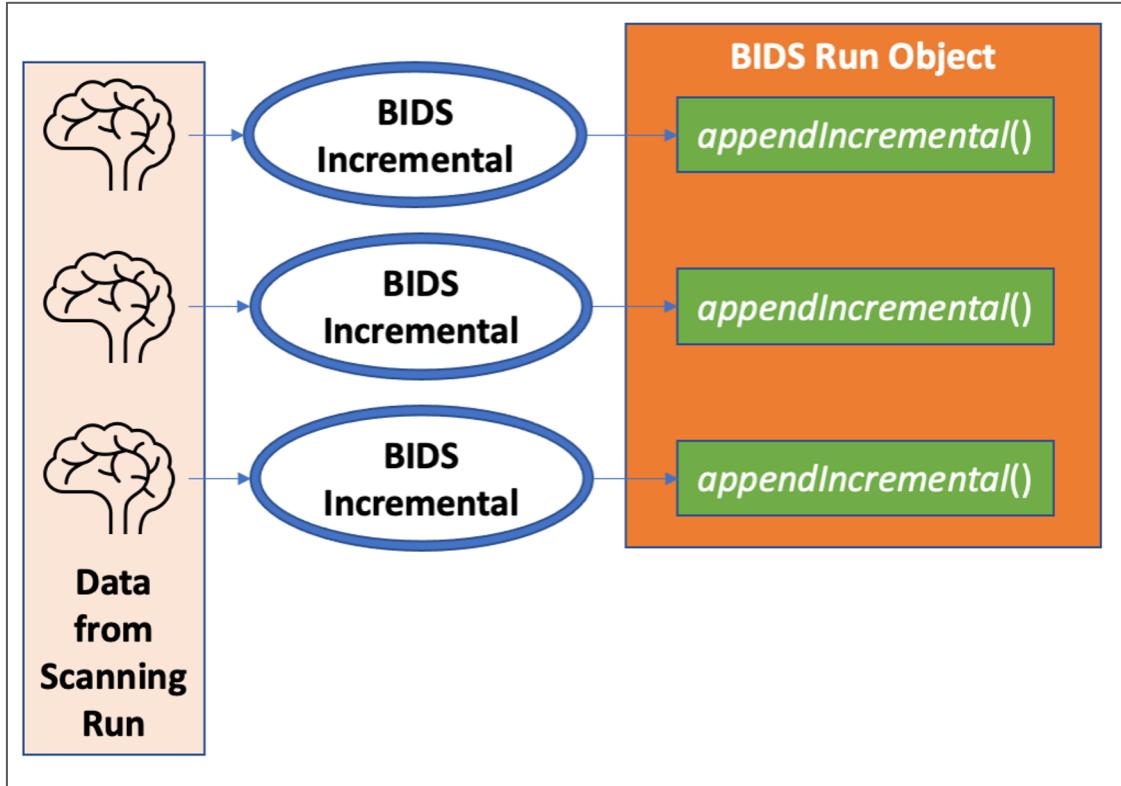
BIDS
Archive

In
ital



Run Streaming: **BIDS Run**

BIDS Run: Streaming Full Run of BIDS Data



Key Properties

1. In-memory
2. Many images
3. Deduplicated
4. Get, append
Incrementals



MRI
Machine

Input
Digital



Analysis
Model



MRI
Machine

Input
Digital



BIDS
Archive



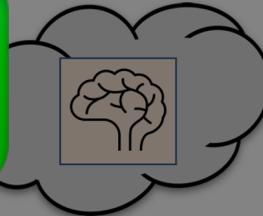
BIDS
Archive



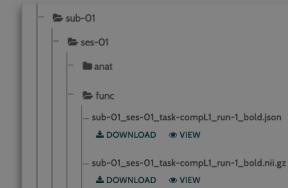
Analysis
Model



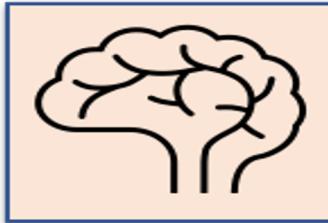
Stream Data



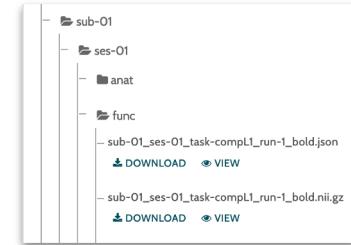
From Dataset



Append Data



Store Brain Data In Dataset



Query Data



Get Brain Data From Dataset

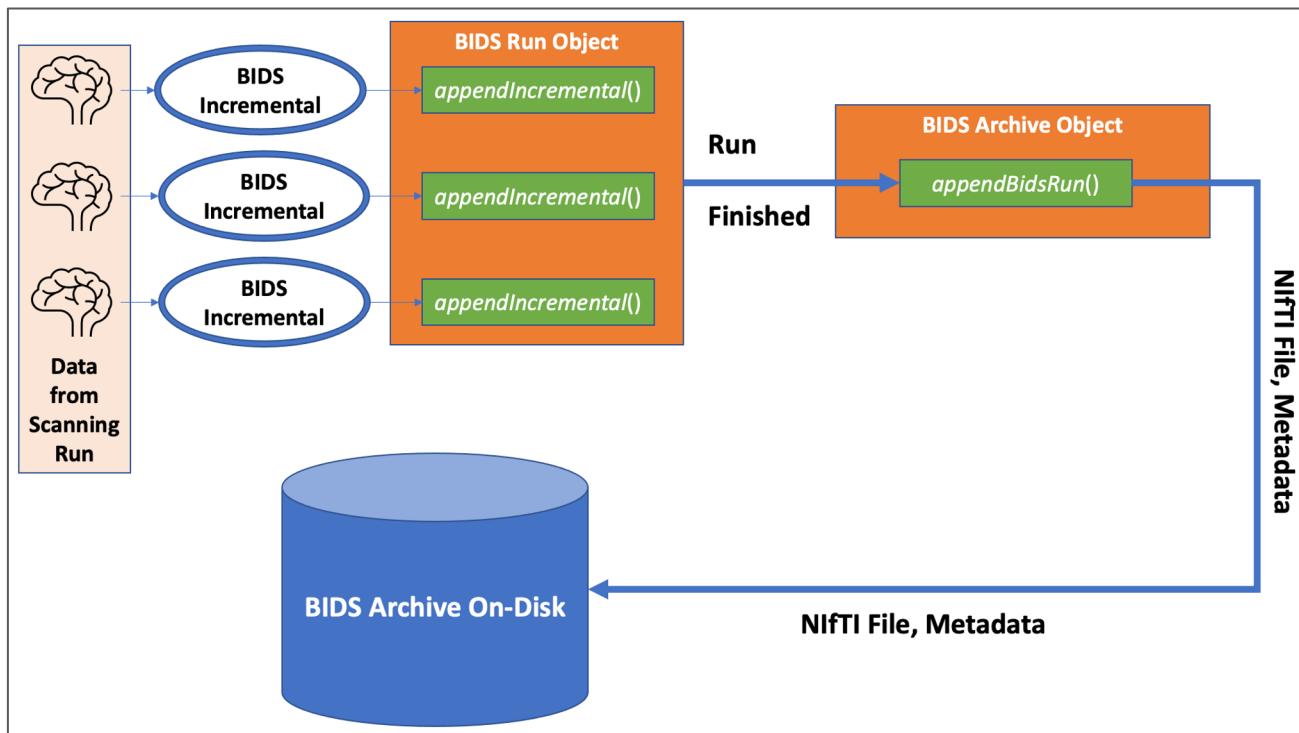


Querying and Appending: **BIDS Archive**

BIDS Archive: Querying and Appending to BIDS Datasets

Key Properties

1. Add BIDS Run
2. Get BIDS Run
3. Get images, metadata, etc.





MRI
Machine

In
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In
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In
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Analysis
Model

In
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In
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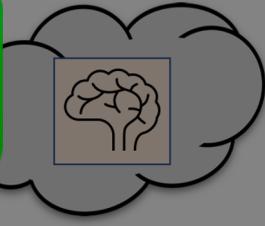
In
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In
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Analysis
Model



Stream Data



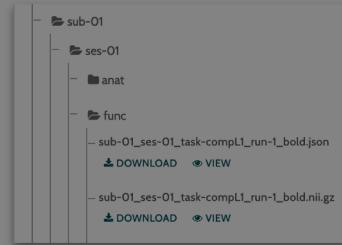
From Dataset



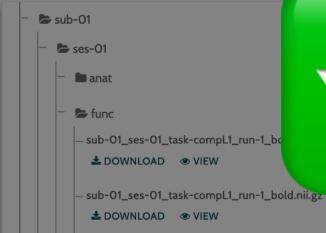
Append Data



Store Brain Data In Dataset



Query Data



Get Brain Data From Dataset

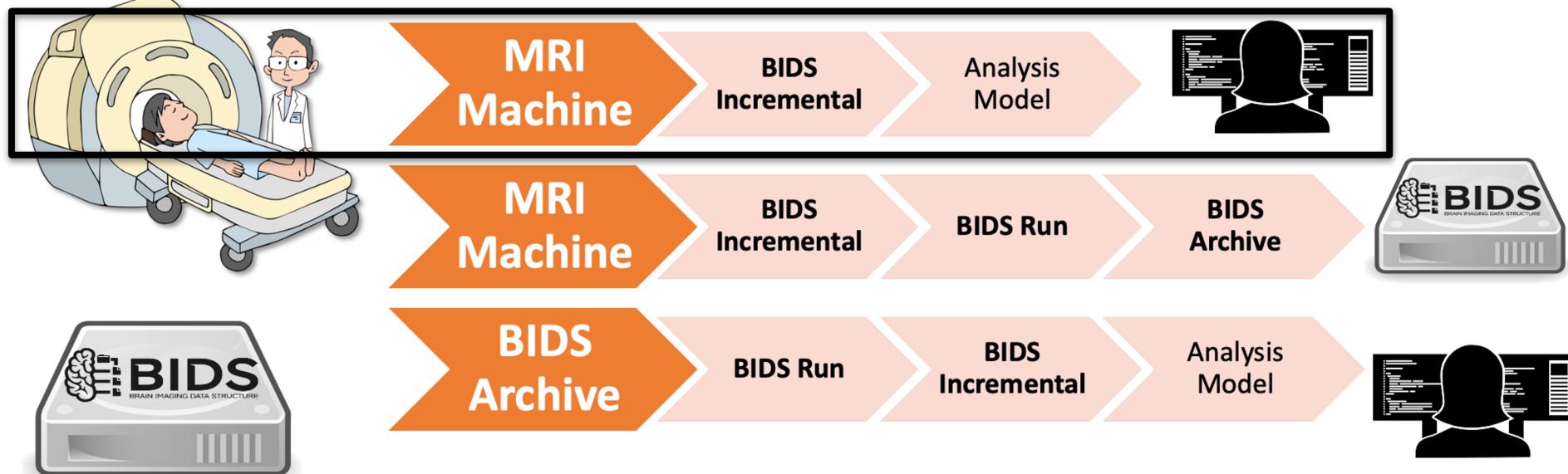


Performance Analysis

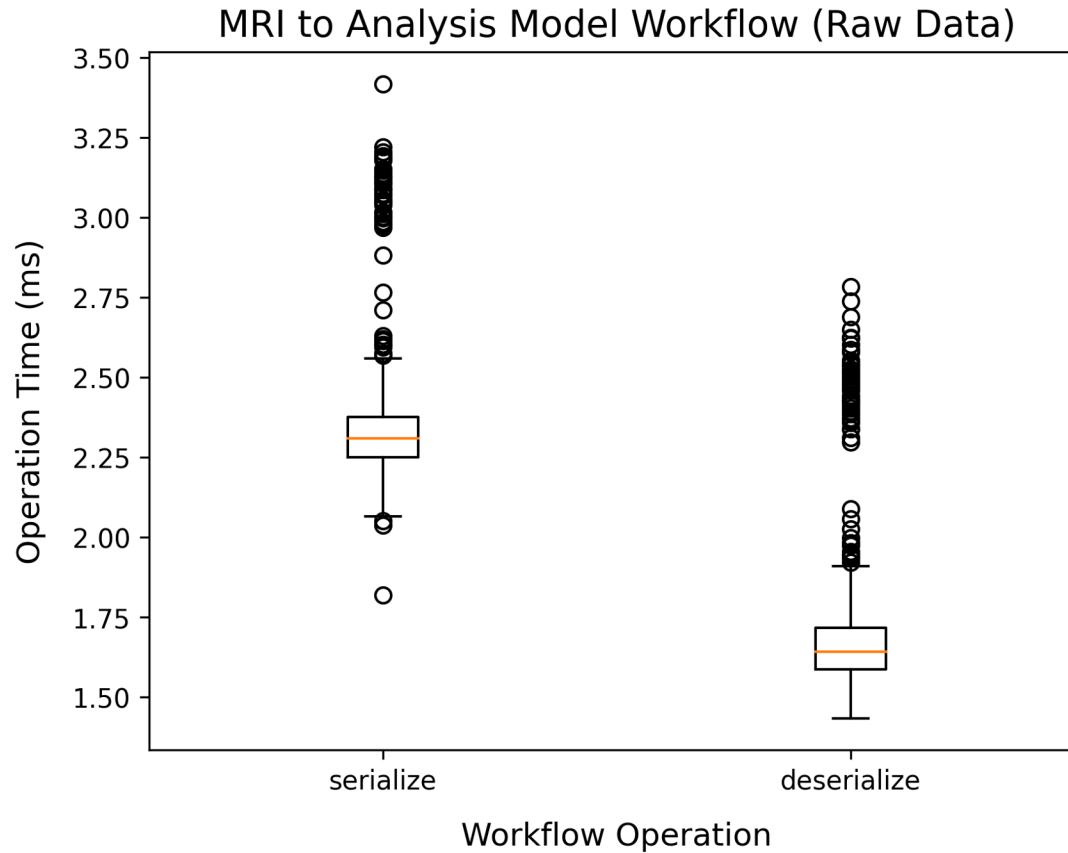
Test Dataset Details:

Subjects	1
Tasks	2
Runs	2
Run Shape (x, y, z, t)	(84, 84, 52, 340)
Run File Size	~500MB
Run Datatype	32-bit Float

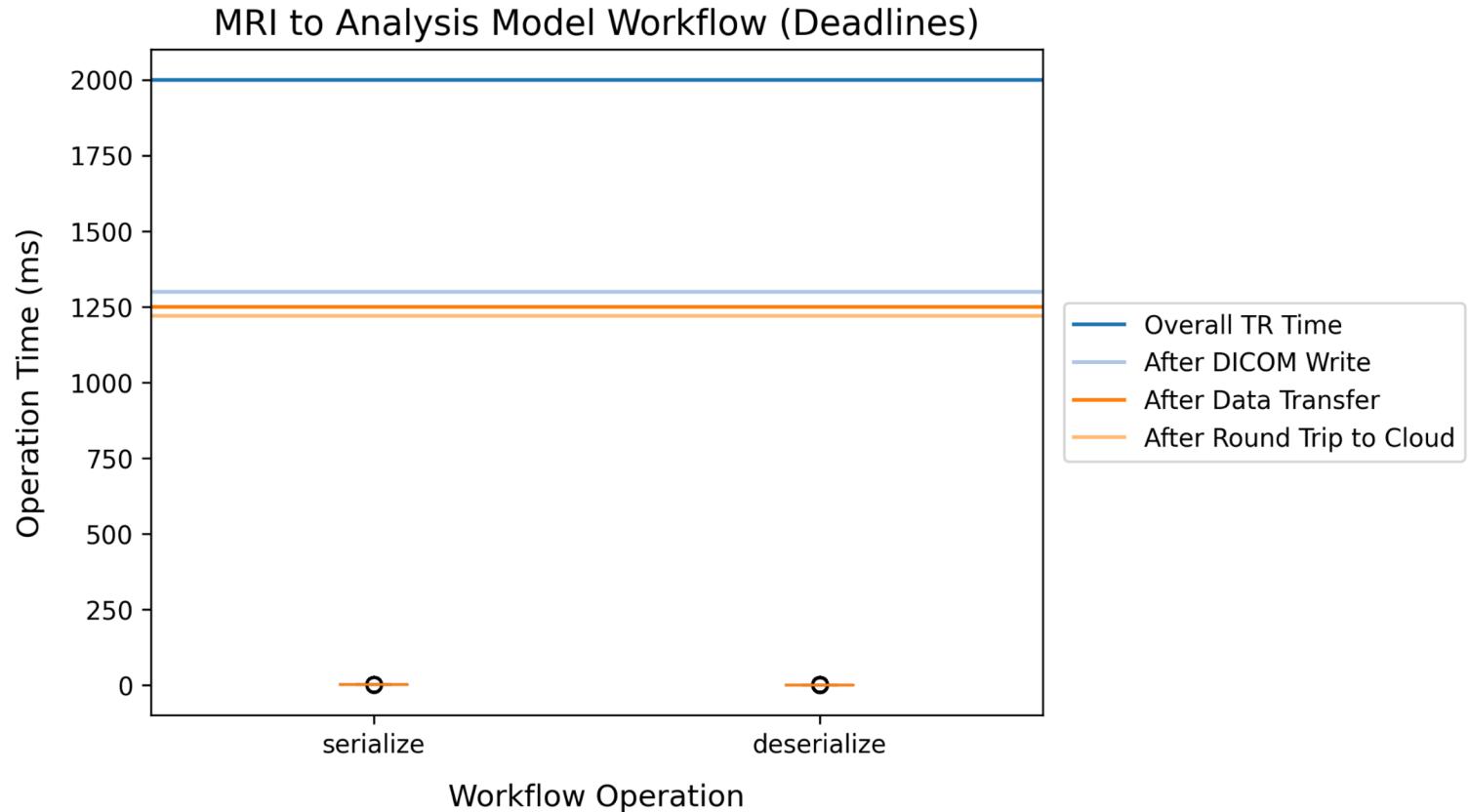
Relevant Workflow: BIDS Incremental Network Transfer



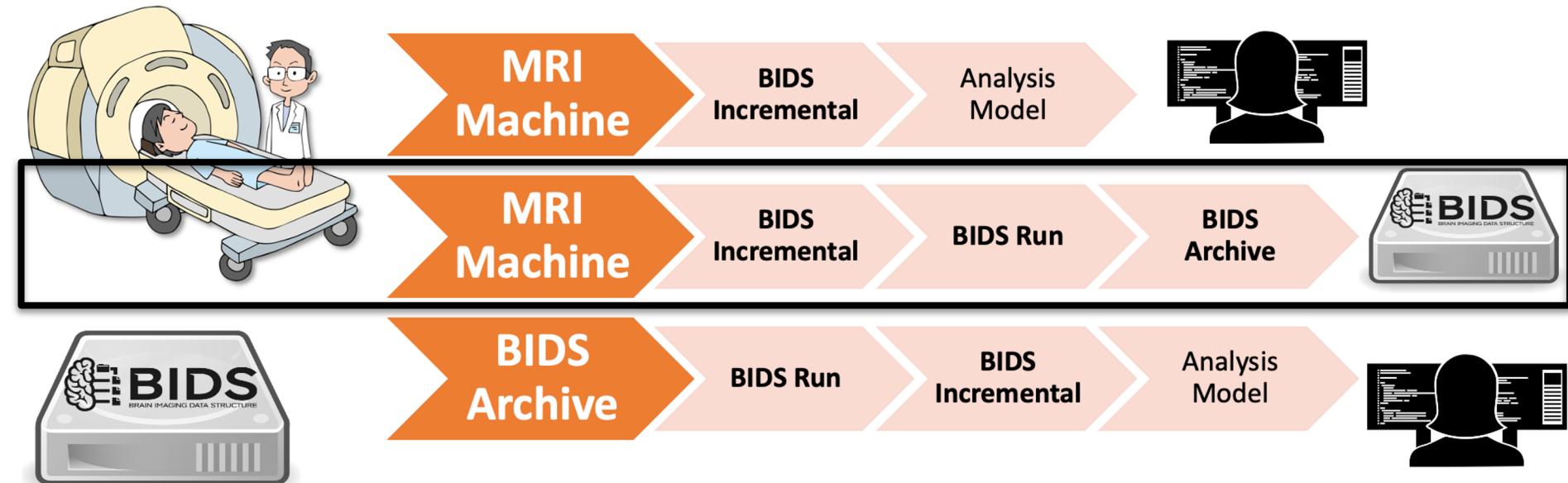
Workflow 1: BIDS Incremental Network Transfer



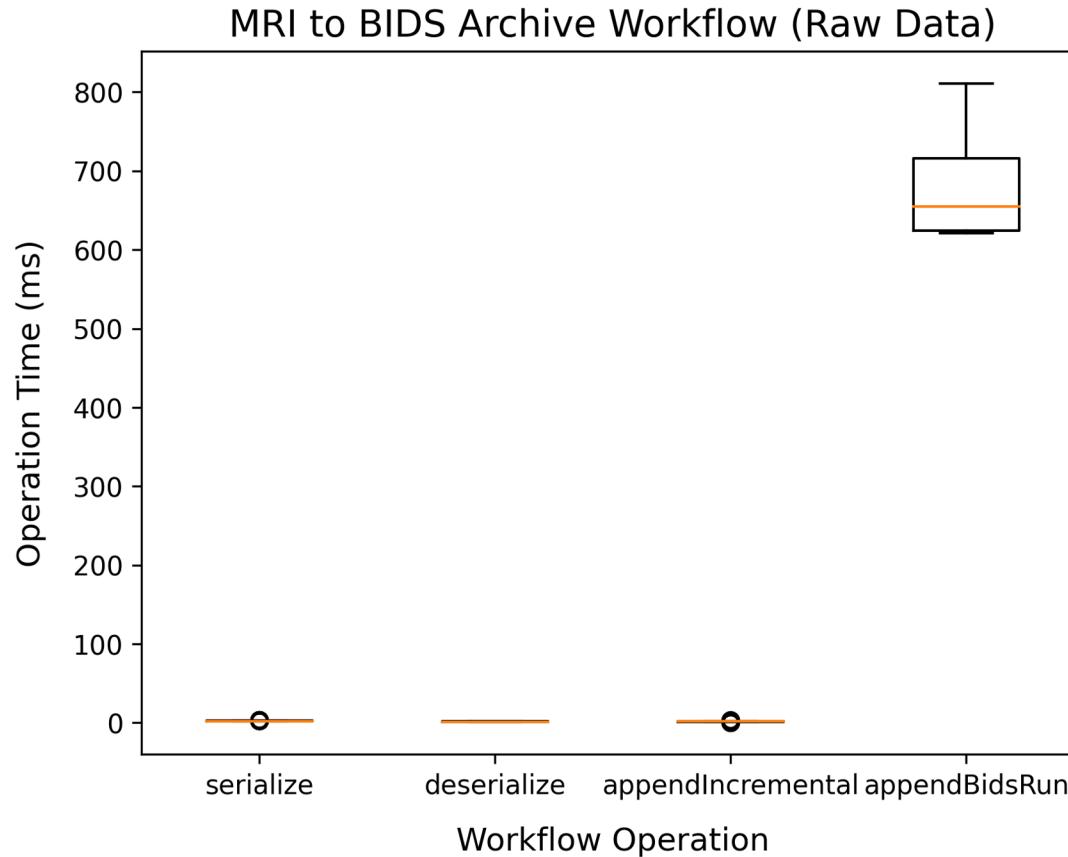
Workflow 1: Deadline Comparison



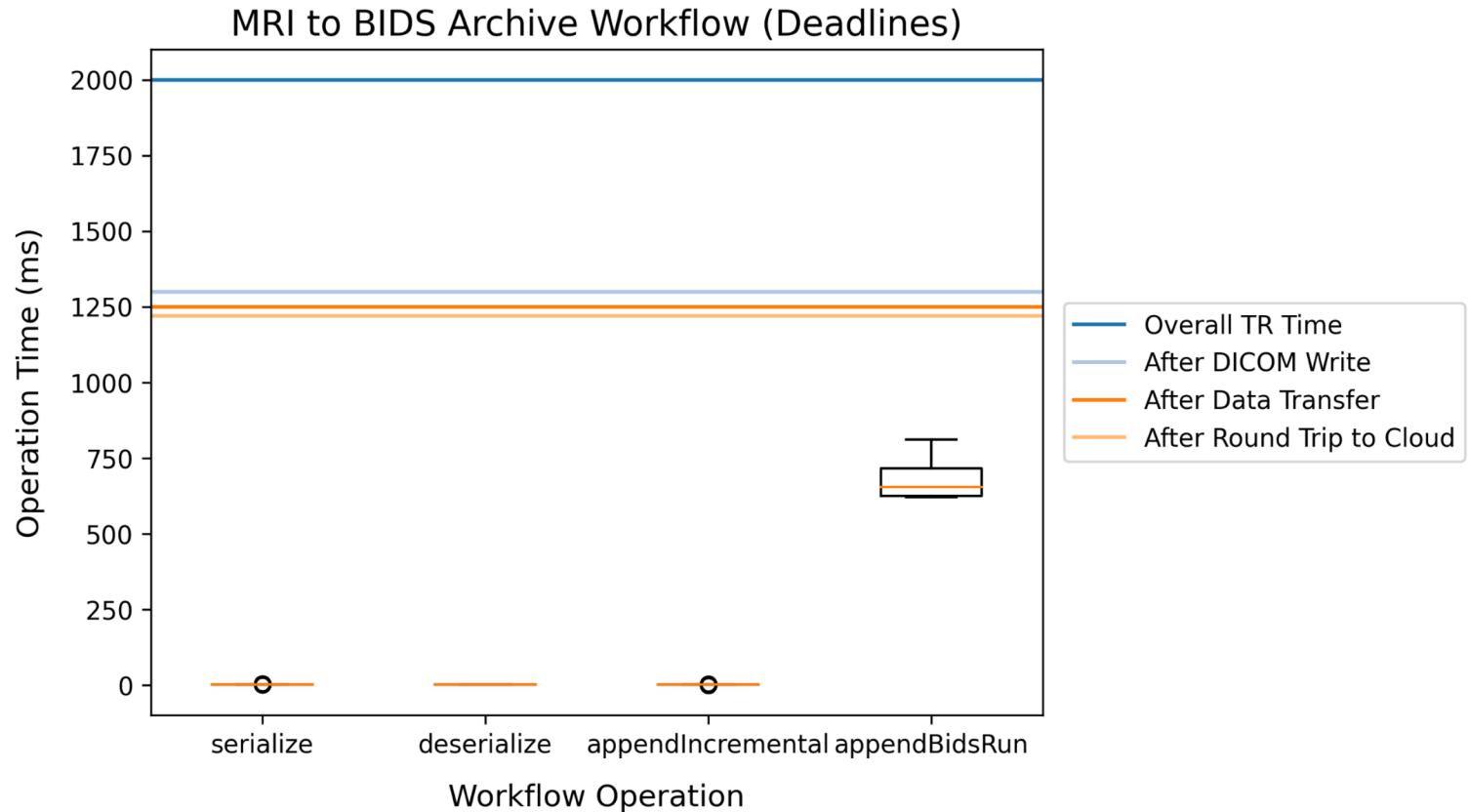
Relevant Workflow: Workflow 1 (Stream) with Store



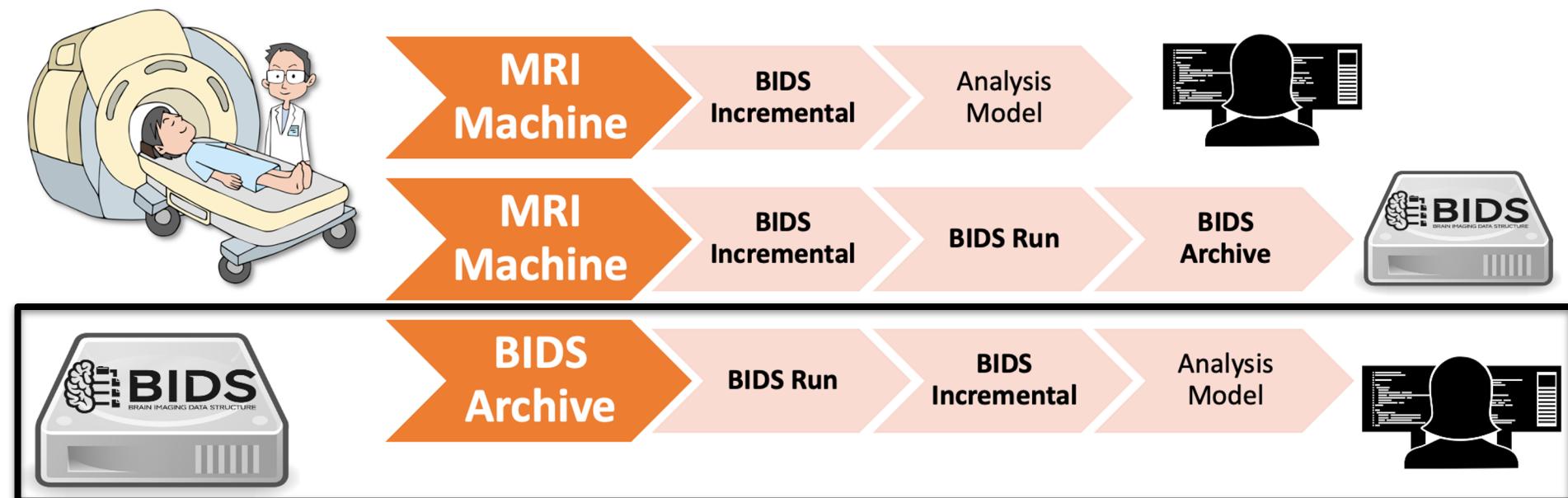
Workflow 2: Stream + Store



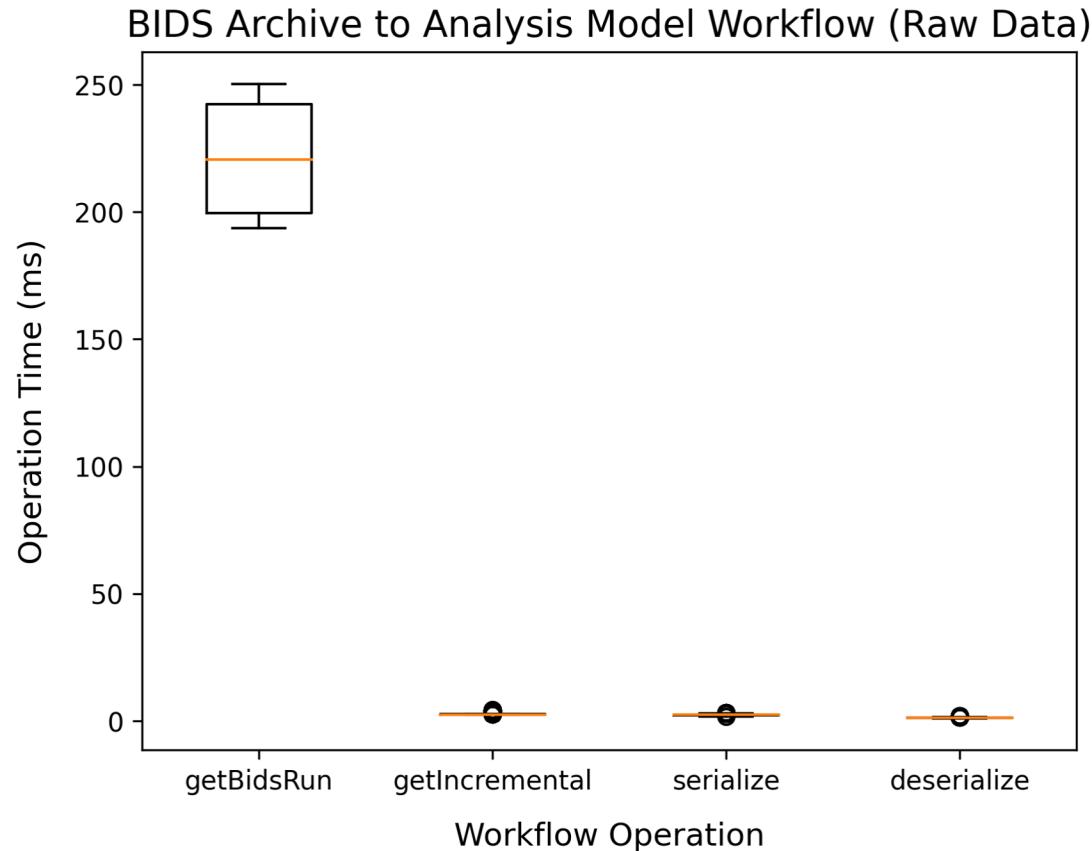
Workflow 2: Deadline Comparison



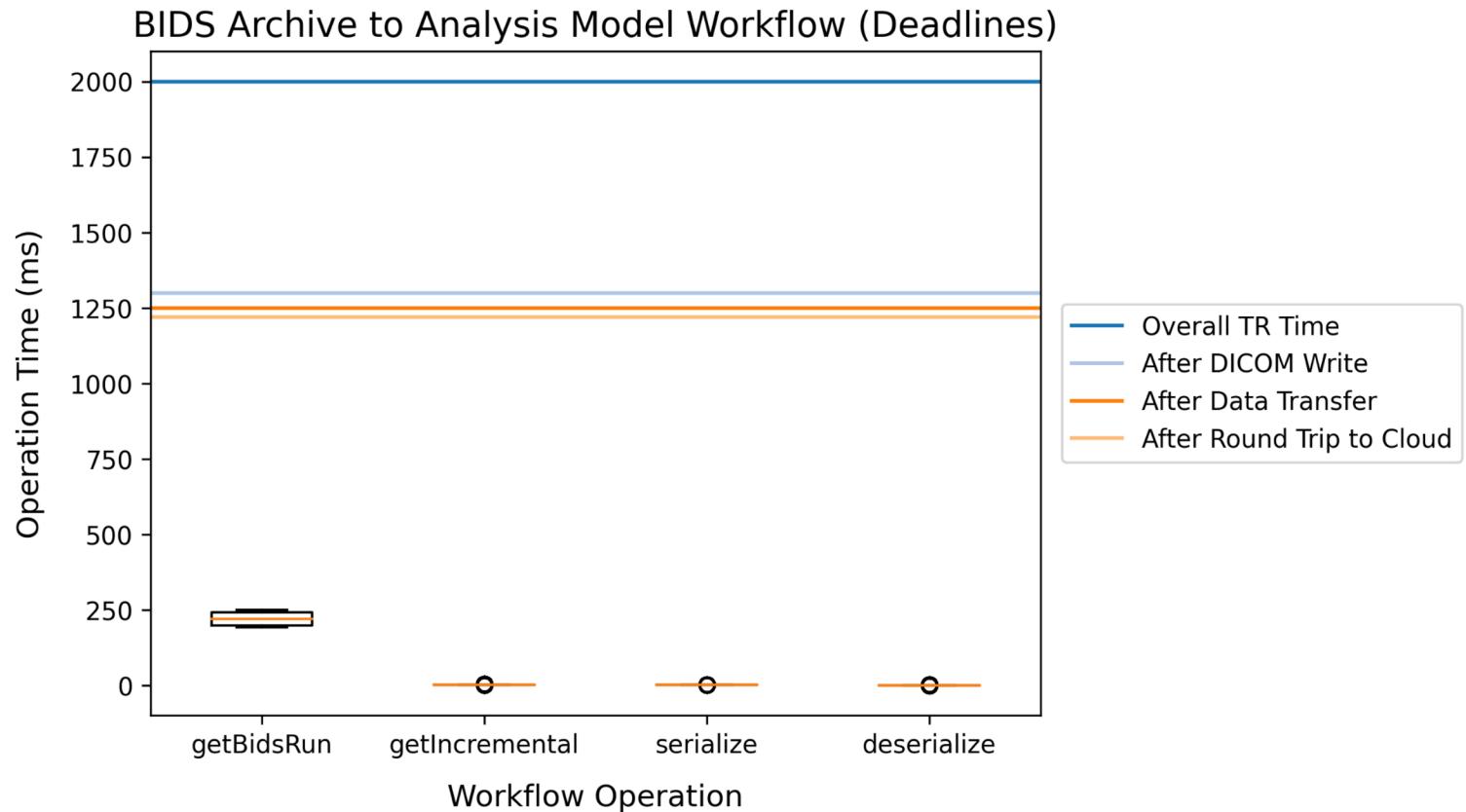
Relevant Workflow: Stream From Archive (Testing)



Workflow 3: Testing



Workflow 3: Deadline Comparison



Workflow BIDS Compatibility

Task	BIDS Validator Error Count
BIDS Incremental <i>writeToDisk</i> output	0
BIDS Archive after <i>appendBidsRun</i>	0

Conclusion

1. **Timing:** Within deadline..... 
2. **Complexity:** Clear classes..... 
3. **Collaboration:** BIDS compliance... 
4. **BIDS compatible RT-Cloud**..... 

Live fMRI



Testing

