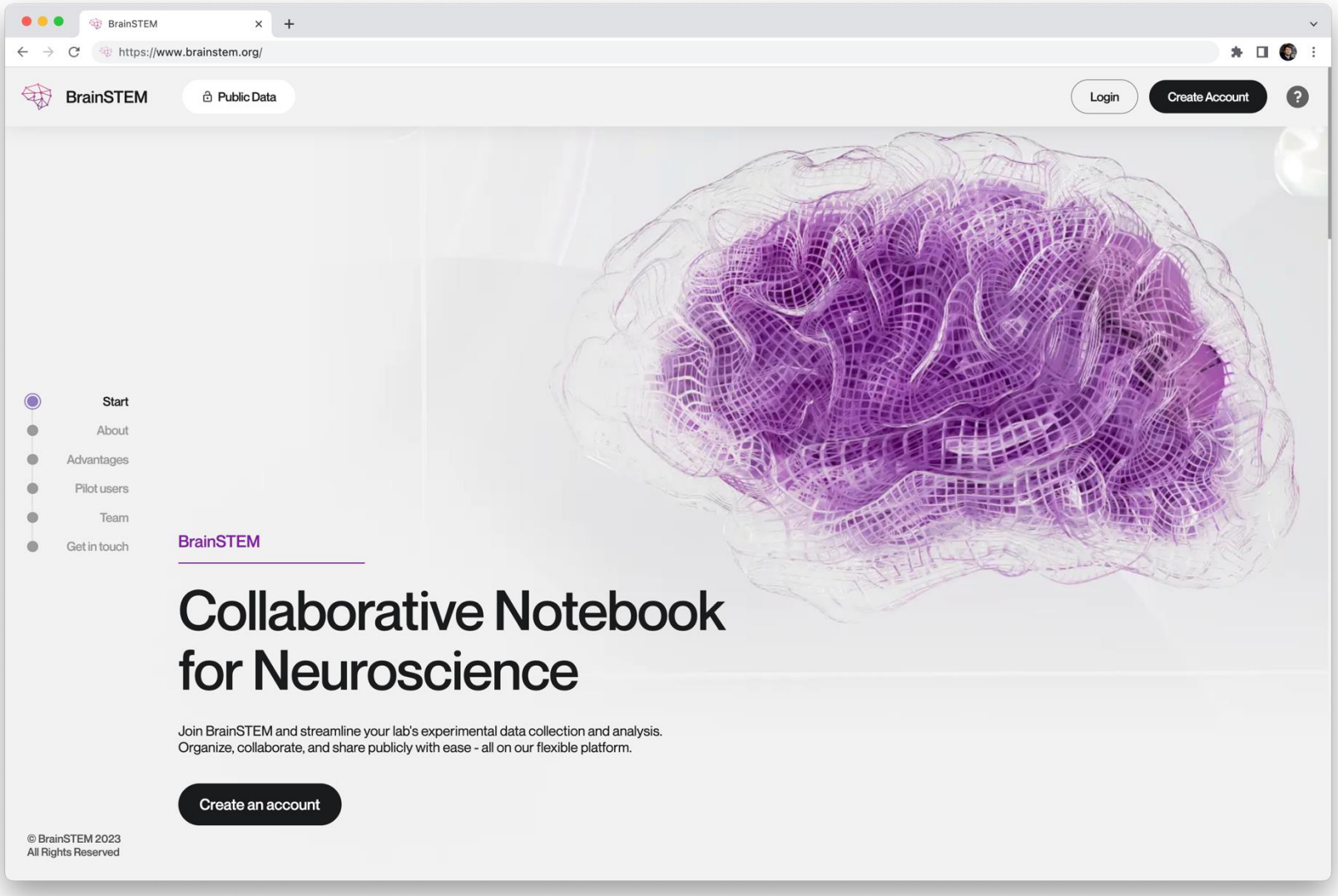
BrainSTEM: An Open Platform for Structured, FAIR Neuroscience Data

NYU NEUROSCIENCE

BrainSTEM

UNIVERSITY OF COPENHAGEN



Peter C. Petersen, Associate Professor
Department of Neuroscience, UCPH

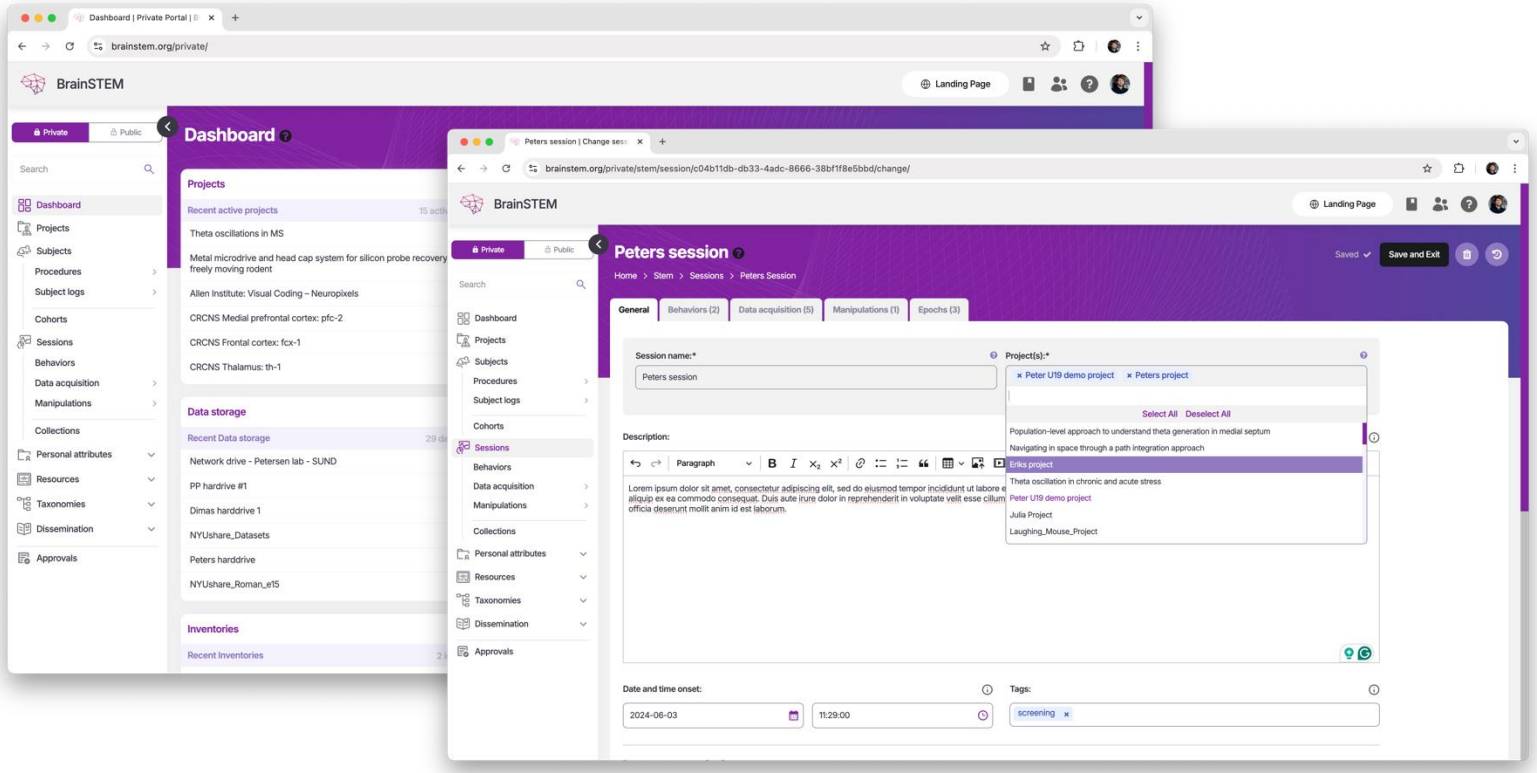
BrainSTEM.org

MIT, June 11, 2025

Why BrainSTEM?
The Problem with Today's Neuroscience Data

1. **Metadata is fragmented**
   - Lab notebooks
   - Spreadsheets
   - Embedded with the data
   - Programming scripts
2. **Lack of standardization and insufficient documentation for reuse**
   - Personal language
   - Lab conventions
   - Implied experimental conditions
3. **Data sharing has a high entry barrier and is often of limited effectiveness**
   - Sharing your data is very time-consuming
   - Public repositories have limited discovery functionality
   - Sharing has limited impact

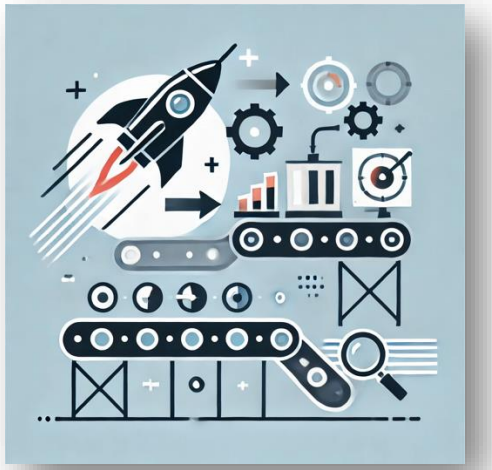
What is BrainSTEM?



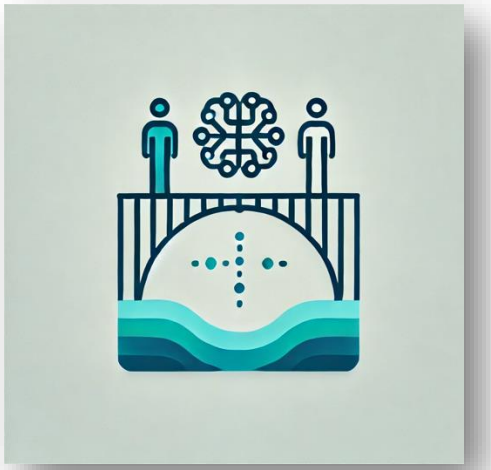
- A user-friendly web-based notebook for describing day-to-day experiments, collaborations, and data sharing
- Focused on experimental neuroscience: from behavior to neurophysiology
- A central resource streamlining data analysis and a portal for reuse of experimental data

Why are we building BrainSTEM?

Capture the Incredible Volume of Rich and Diverse Data

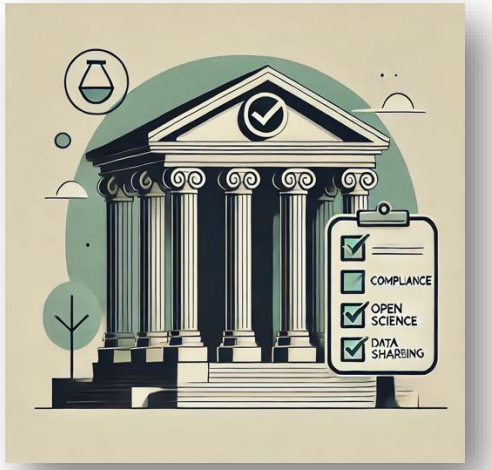


Accelerate and Streamline Discovery



Lower Barriers in Collaborations

Enhance Reproducibility and Discoverability



Align with Priorities of Funding Agencies

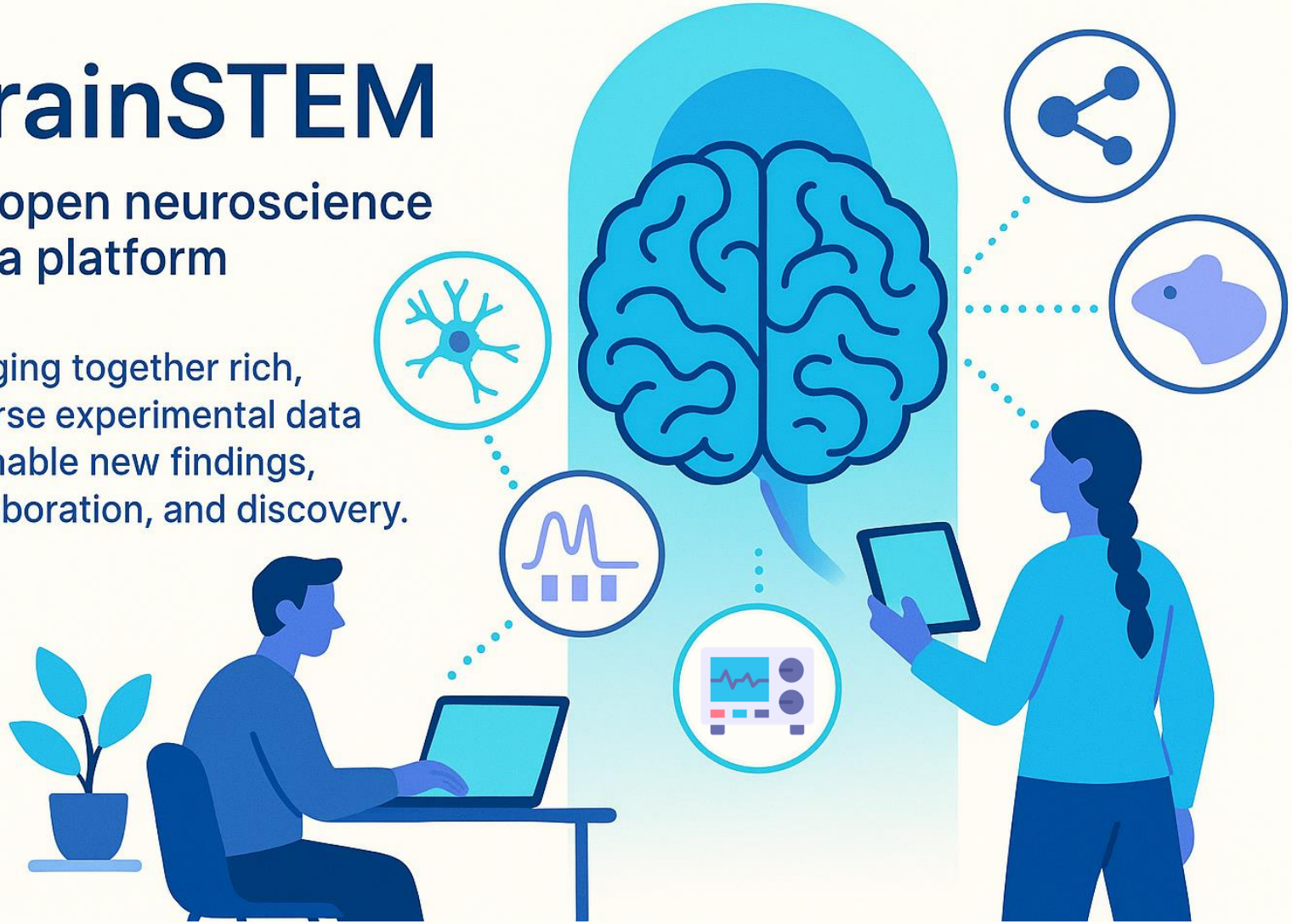
Make data FAIR

The Bigger Picture

BrainSTEM

An open neuroscience data platform

Bringing together rich, diverse experimental data to enable new findings, collaboration, and discovery.



The team and funding behind BrainSTEM

The team behind BrainSTEM

BrainSTEM is developed and funded by the Oxytocin U19 Brain Initiative Grant 5U19NS107616, led by György Buzsáki, Moses V. Chao, Robert C. Froemke, Dayu Lin, Adam Mar, Alisa R. Surkis, Richard Tsien.

BRAIN INITIATIVE
BRAIN INITIATIVE ALLIANCE

Peter Petersen | PhD
Project leader

Assistant Professor at University of Copenhagen.

Alisa Surkis | PhD
Director of the Data Core

Deputy Director at NYU Health Sciences Library.

Rodrigo Amaducci | PhD
Lead developer (2021-2023)

Now: Software Developer, Majorel, Spain.

Mingze Dou
Documentation

Master's student at University of Copenhagen

QUOIN

Lorena Carballo
Front-End & Graphics Designer

Eli Taft
Senior Software Engineer

Jack Miszencin
Project Leader

Main features of BrainSTEM

Advantages

Discover what BrainSTEM can do for your lab

BrainSTEM can accelerate your science, promote collaboration, extend the lifetime of your data, and make FAIR data sharing easy.

User-friendly

Designed for ease of adoption and use. No technical know-how is needed.

Standardized

A standardized yet, flexible, and extendable data model.

Customizable

The interface can be customized to suit your needs.

Collaborative

Granular access control enables collaboration within or across labs.

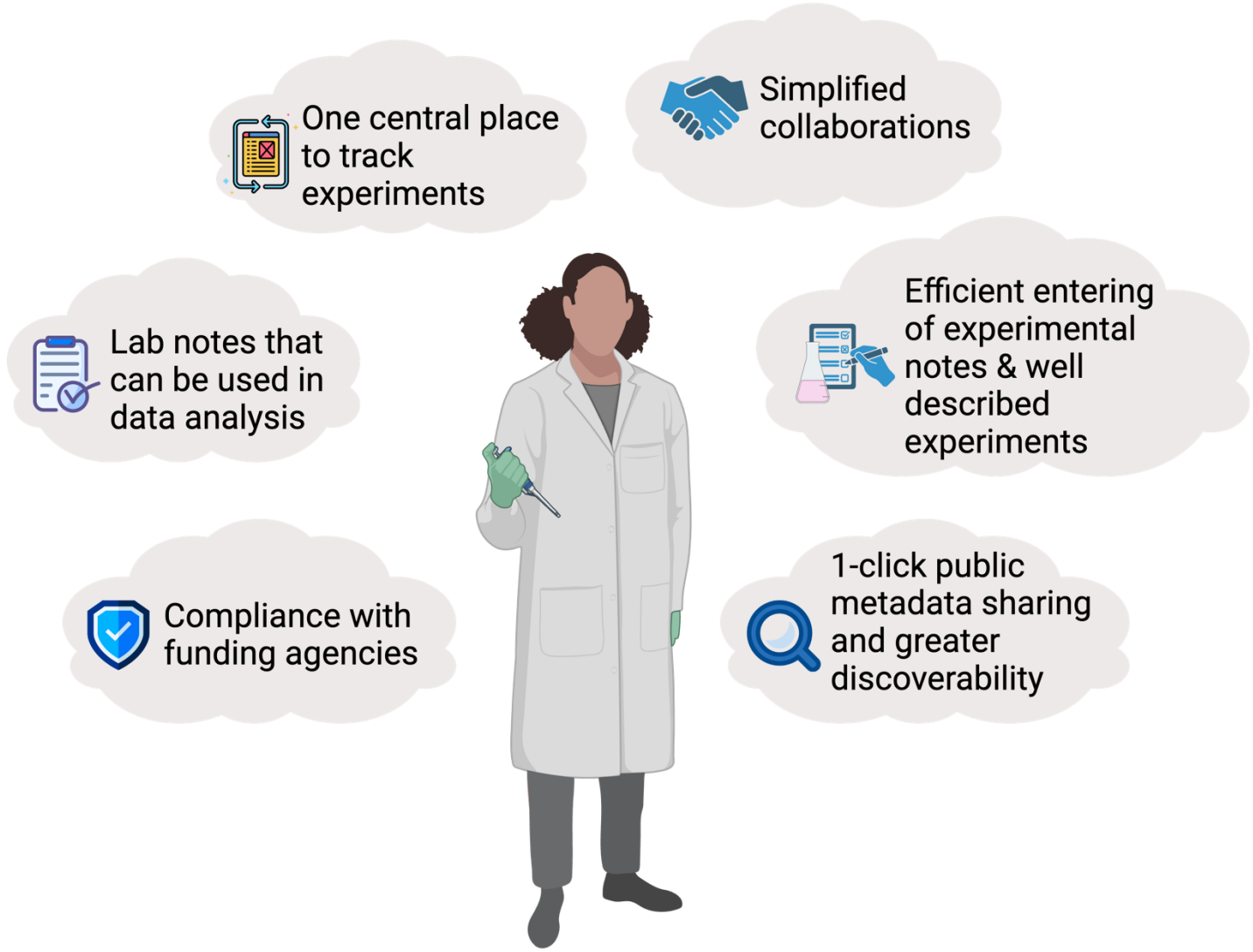
Programmable access

An API provides coordination with Python, Matlab, and other analysis tools.

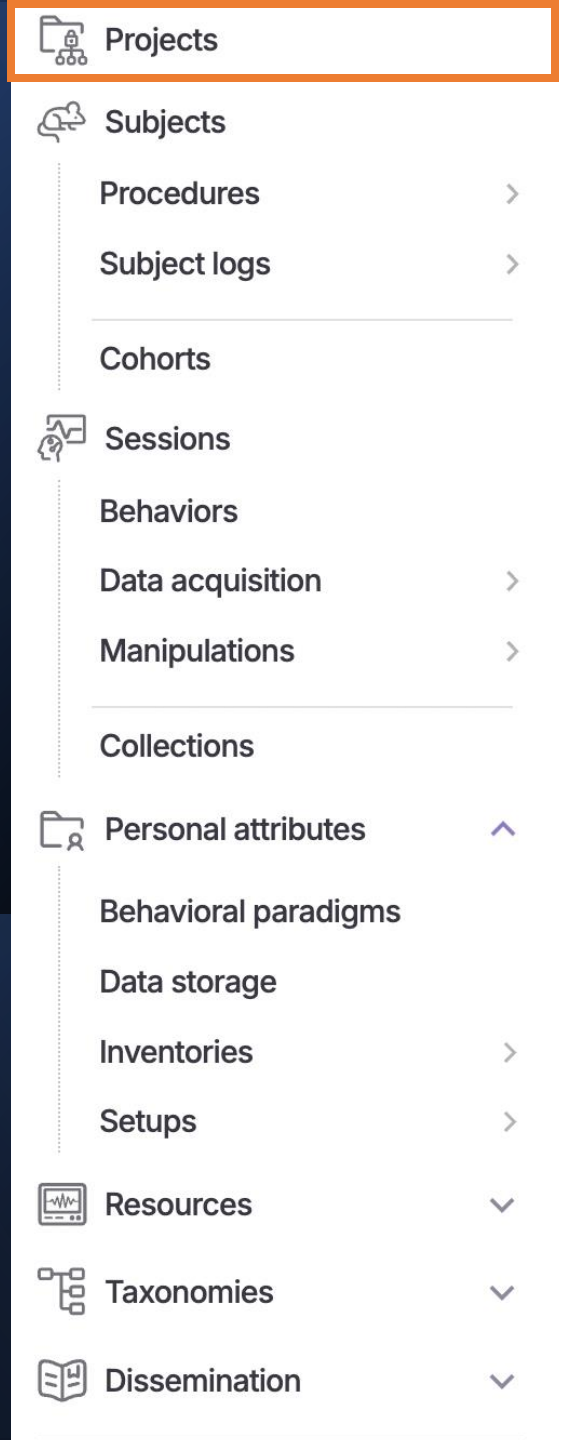
Relational

Organized data model for accuracy and easy access.

Benefits to researchers

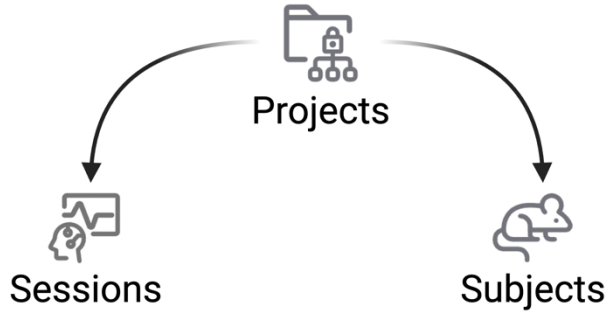


Basic elements of BrainSTEM



Projects

Organizational units representing research initiatives encompassing related subjects and sessions.

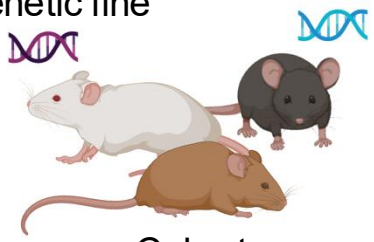


Basic elements of BrainSTEM

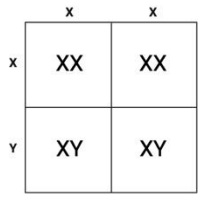
- Projects
- Subjects
  - Procedures
  - Subject logs
  - Cohorts
- Sessions
  - Behaviors
  - Data acquisition
  - Manipulations
  - Collections
- Personal attributes
  - Behavioral paradigms
  - Data storage
  - Inventories
  - Setups
- Resources
- Taxonomies
- Dissemination

Subjects

Genetic line

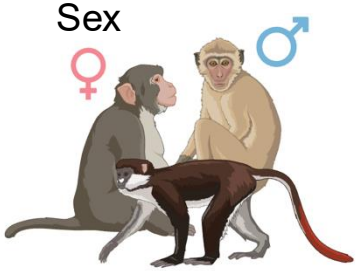


Cohorts



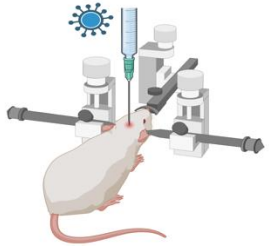
Breeding

Sex

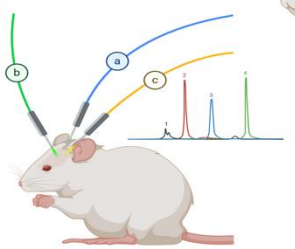


Species & Strains

Procedures

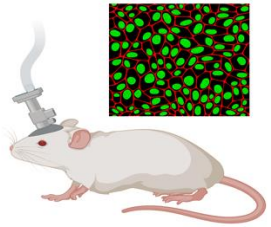


Virus injections



Optic fibers

Probe implantations



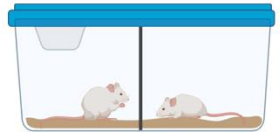
Cranial windows

Surgical procedures

Subject logs

Weighing

Food & Water



Housing

Basic elements of BrainSTEM

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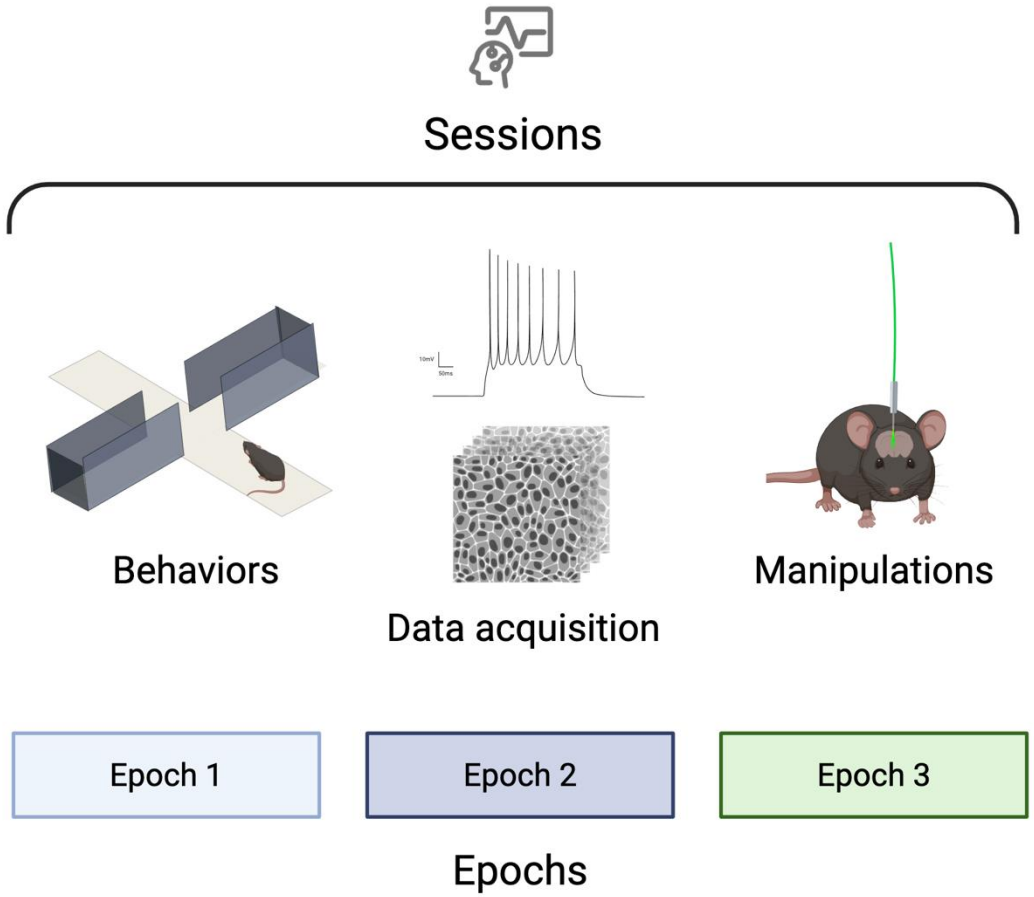

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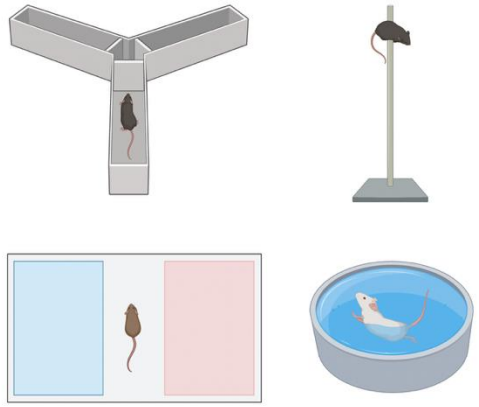
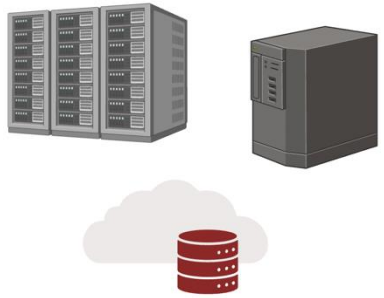
Behavioral paradigms



Data storage

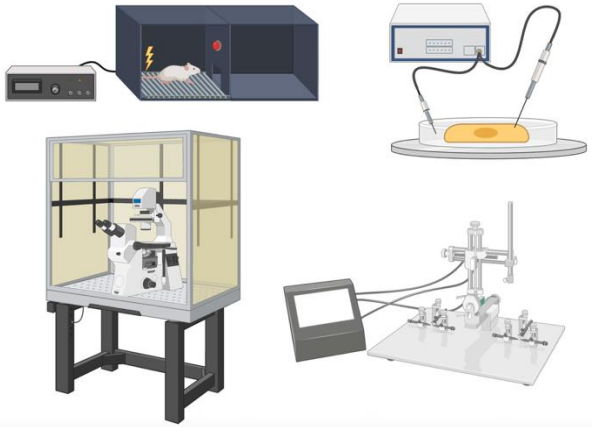


Inventories

+ Consumable stocks

Setups

+ Equipment



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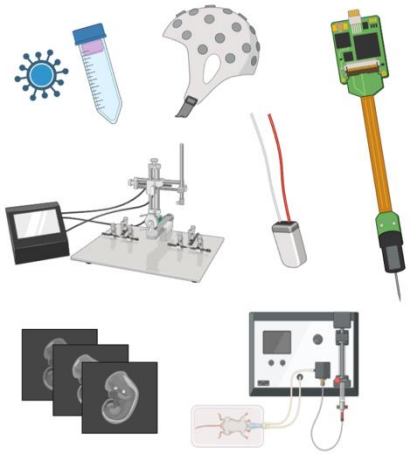
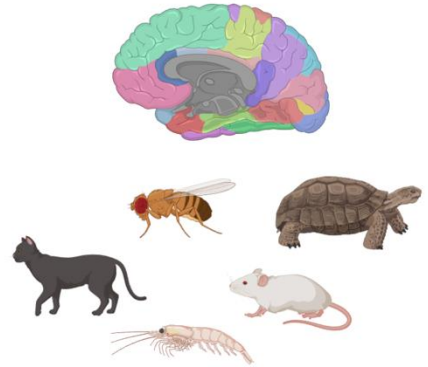
Resources



Taxonomies



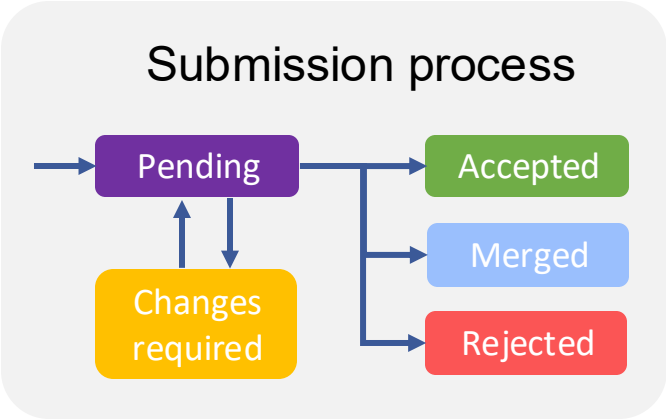
Dissemination

Shared standards and controlled vocabulary

Resources
- Consumables
- Hardware devices
- Suppliers

Taxonomies
- Species and strains
- Setup types

Dissemination
- Journals
- Publications



1. New entries and changes are submitted through forms.
2. *Submitting authors can use entries right away.*
3. Submissions must be approved by us (admin team).
4. Pending approvals can be monitored on the approval pages.
5. An email alert is sent on status changes.
6. Once approved, entries will appear for everyone.

How about extension of the data model?

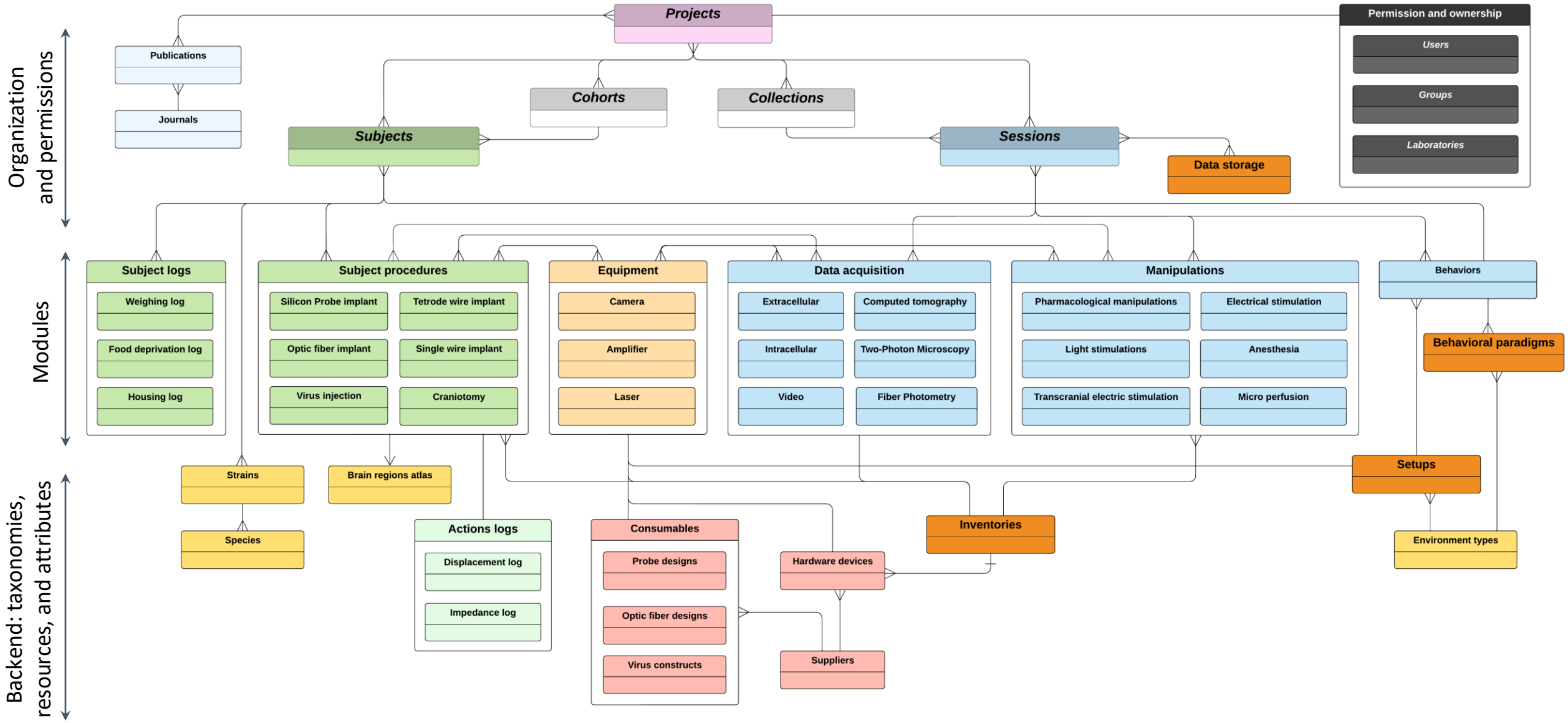
We implement changes to the actual database and codebase

1. General changes to fields and options available in forms.
2. New types of modules or changes to existing ones:
   - Procedures
   - Data acquisition
   - Manipulations
   - Equipment
   - Subject logs
   - Procedure logs

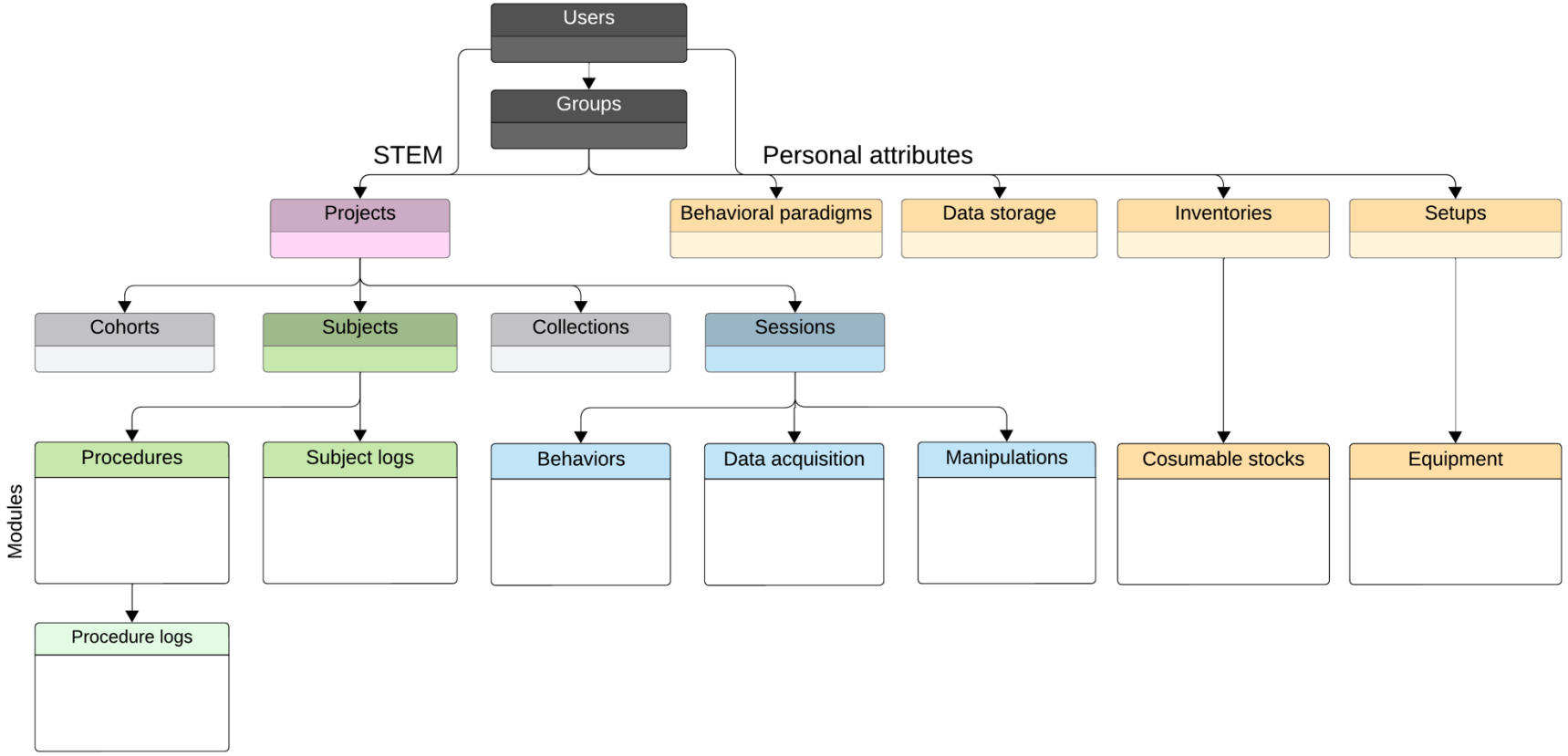
   Also, new types of consumables, brain region atlases, and coordinate systems.

1. Request for changes must be done in a dialog with us.
2. Use our GitHub Discussions to suggest features, and our GitHub Issues to report issues and bugs.
3. This feedback is critical!

The relational data model of BrainSTEM



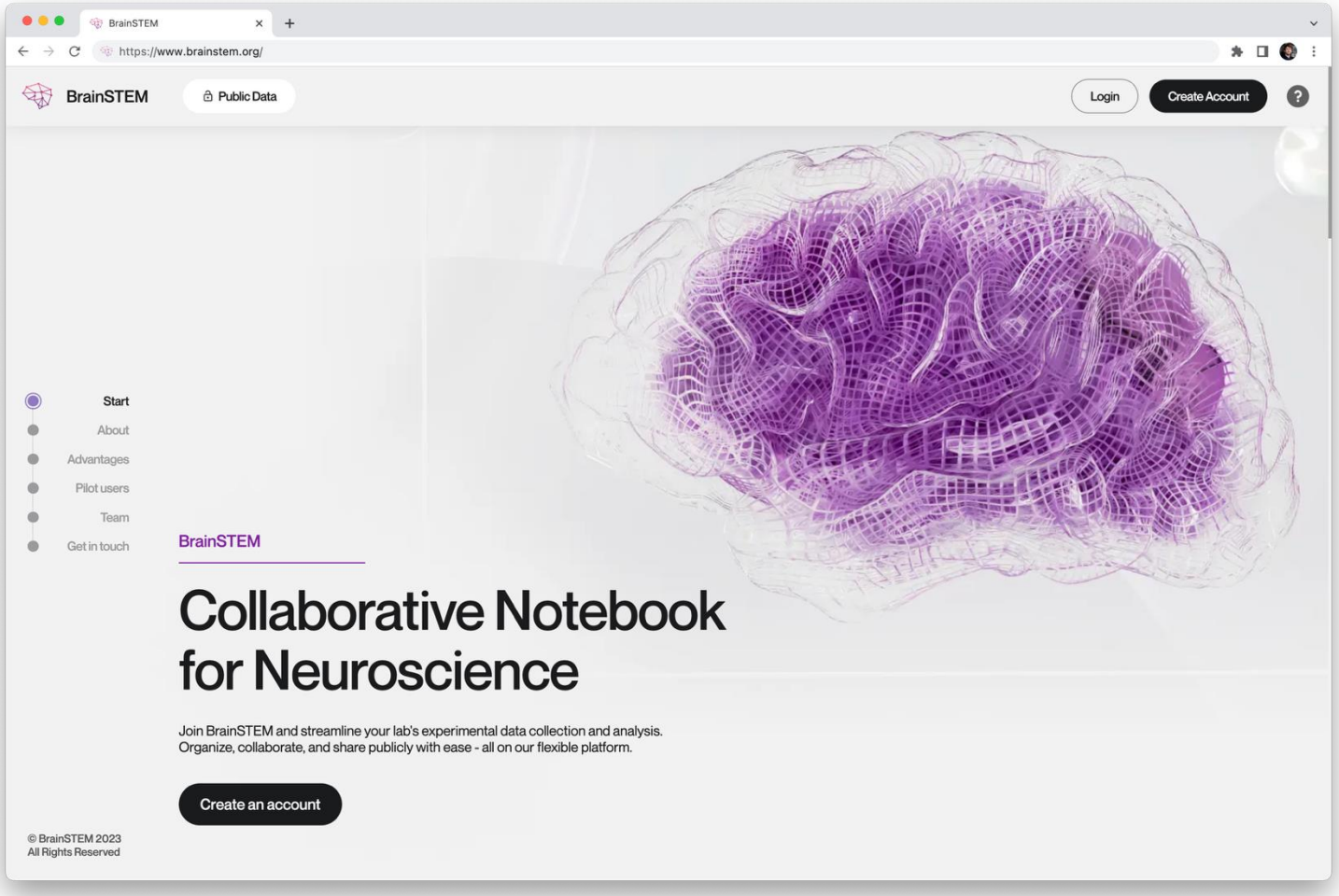
Object-level permissions



Object-level permissions with inheritance from users and groups through projects and personal attributes.

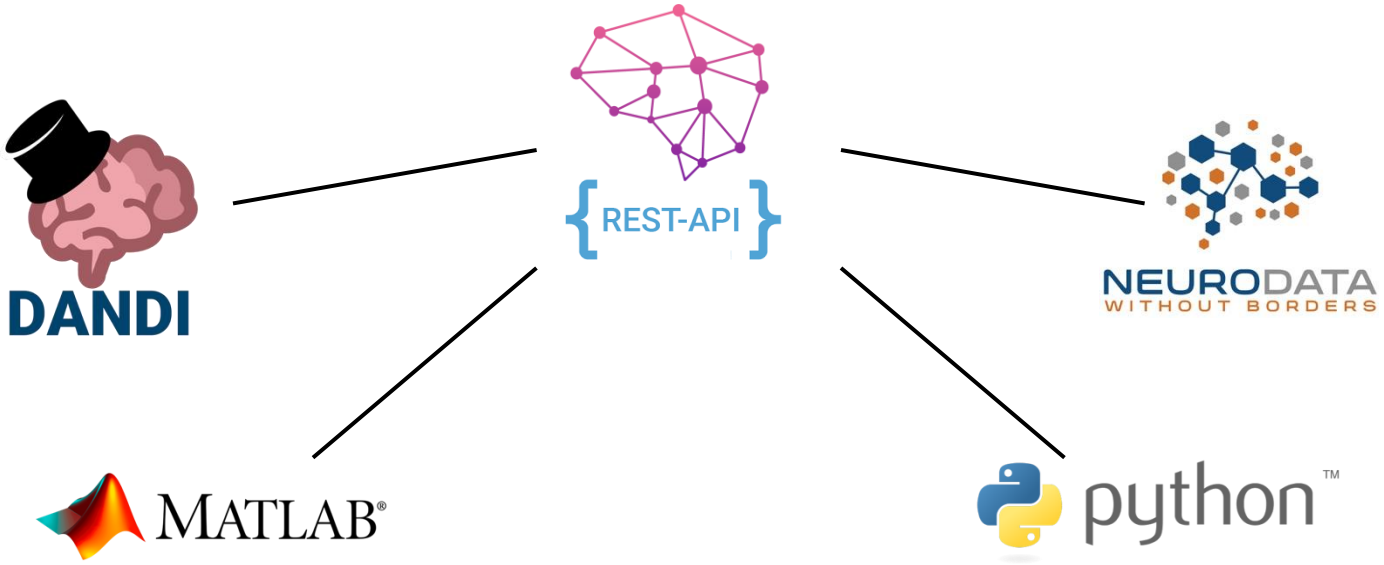
Permission levels	**Groups** *3 levels | users*	**Projects** *4 levels | groups and users*	**Personal Attributes** *4 levels | groups and users*
Members	Inherit project-permissions assigned to the group	Read access to project-related subjects, sessions, collections, and modules	Read access to personal attributes, equipment and consumable stocks
Contributors	-	Create, edit, and delete related models	Create, edit, and delete related models
Managers	Add and remove members	Add and remove members and groups	Add and remove members and groups
Owners	Manage group details and add and remove managers	Edit project details and add and remove managers	Edit personal attribute details and add and remove managers

Demo



BrainSTEM.org

API



API

Allows for both reading and writing content

API endpoints:

https://www.brainstem.org/api/*portal*/*app*/*model*/*id*/

Session endpoint:

https://www.brainstem.org/api/private/stem/session/

Procedure endpoint:

https://www.brainstem.org/api/private/modules/procedure/

Private and public portals have separate authentication systems:

Public sessions:

https://www.brainstem.org/api/public/stem/session/

Filters:

/?filter{name}=project1

/?filter{description.icontains}=hippo

Sorting:

/?sort[]=-name

/?sort[]=description

Include relationships:

/?include[]=behaviors

/?include[]=dataacquisition

Combine query parameters:

/?filter{name}=project1&sort[]=-name&include[]=behaviors

Documentation of API endpoints: support.brainstem.org/api

API tools for Python and Matlab

```
% 0. Setup credentials:
% Email and password will be requested
get_token

% 1. Loading sessions
output1 = load_model('model', 'session');

% 2. Updating a session
session = output1.sessions(1);
session.description = 'new description';
output2 = save_model('data', session, 'model', 'session');

% 3. Creating a new session
session = {};
session.name = 'New session85';
session.description = 'new session description';
session.projects = {'0c894095-2d16-4bde-ad50-c33b7680417d'};

output3 = save_model('data', session, 'model', session');

% 4. Load public projects
output4 = load_model('model', 'project', 'portal', 'public');
```

```
# 0. Setup credentials:
# Email and password will be requested
settings = StemSettings()

# 1. Loading sessions
output1 = load_model(settings, session')

# 2. Updating a session
session = output1["sessions"][0]
session["description"] = 'new description'
output2 = save_model(settings, "session", data=session)

# 3. Creating a new session
session = {}
session["name"] = 'New session88'
session["description"] = 'new session description'
session["projects"] = ['e7475834-7733-48cf-9e3b-f4f2d2d0305a']

output3 = save_model(settings, "session", data=session)

# 4. Load public projects
output4 = load_model(settings, "project", portal="public")
```

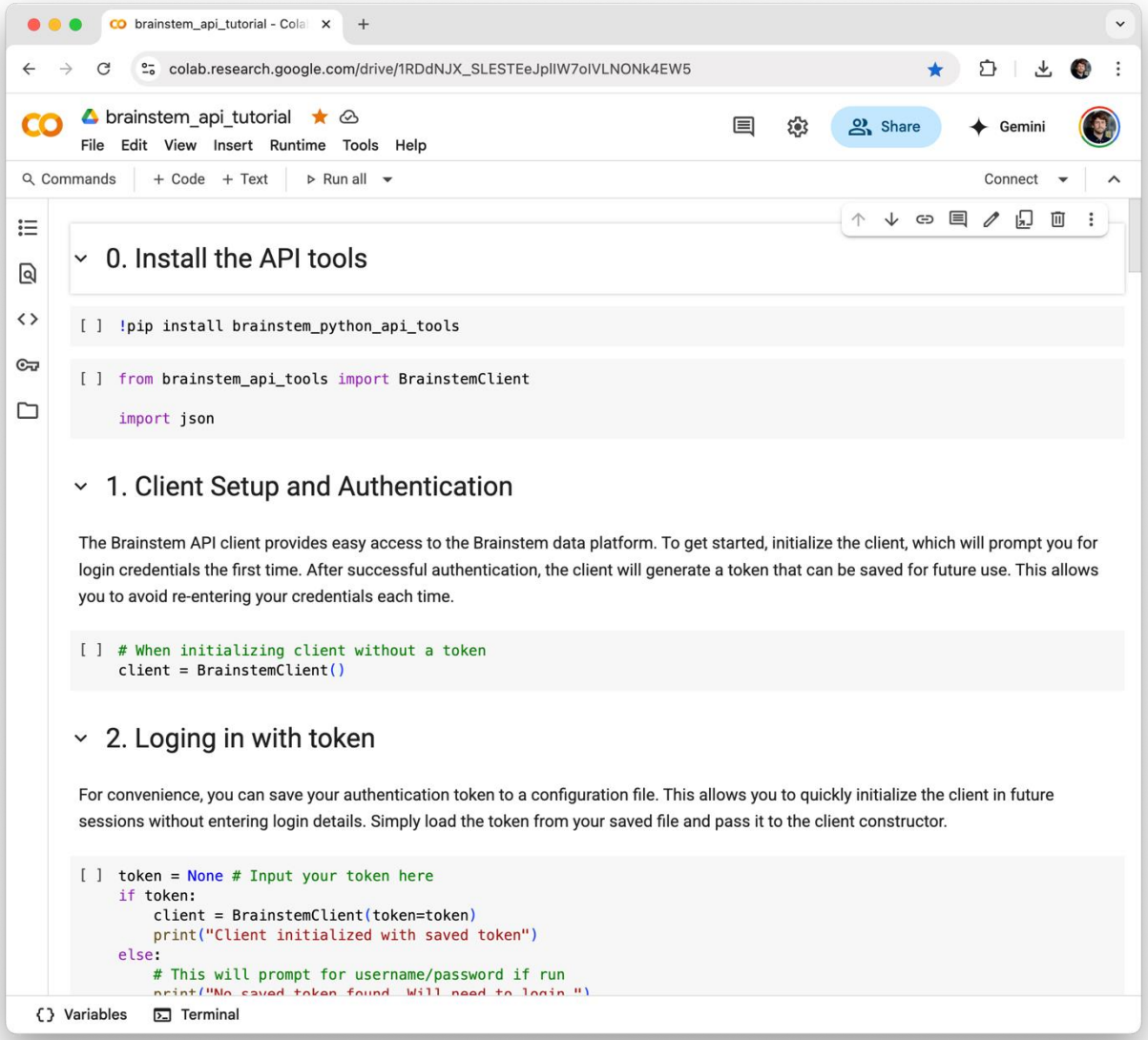
API tools available at GitHub: https://github.com/brainstem-org/

Jupyter notebook & pip Installation

python™

pip Installation

jupyter



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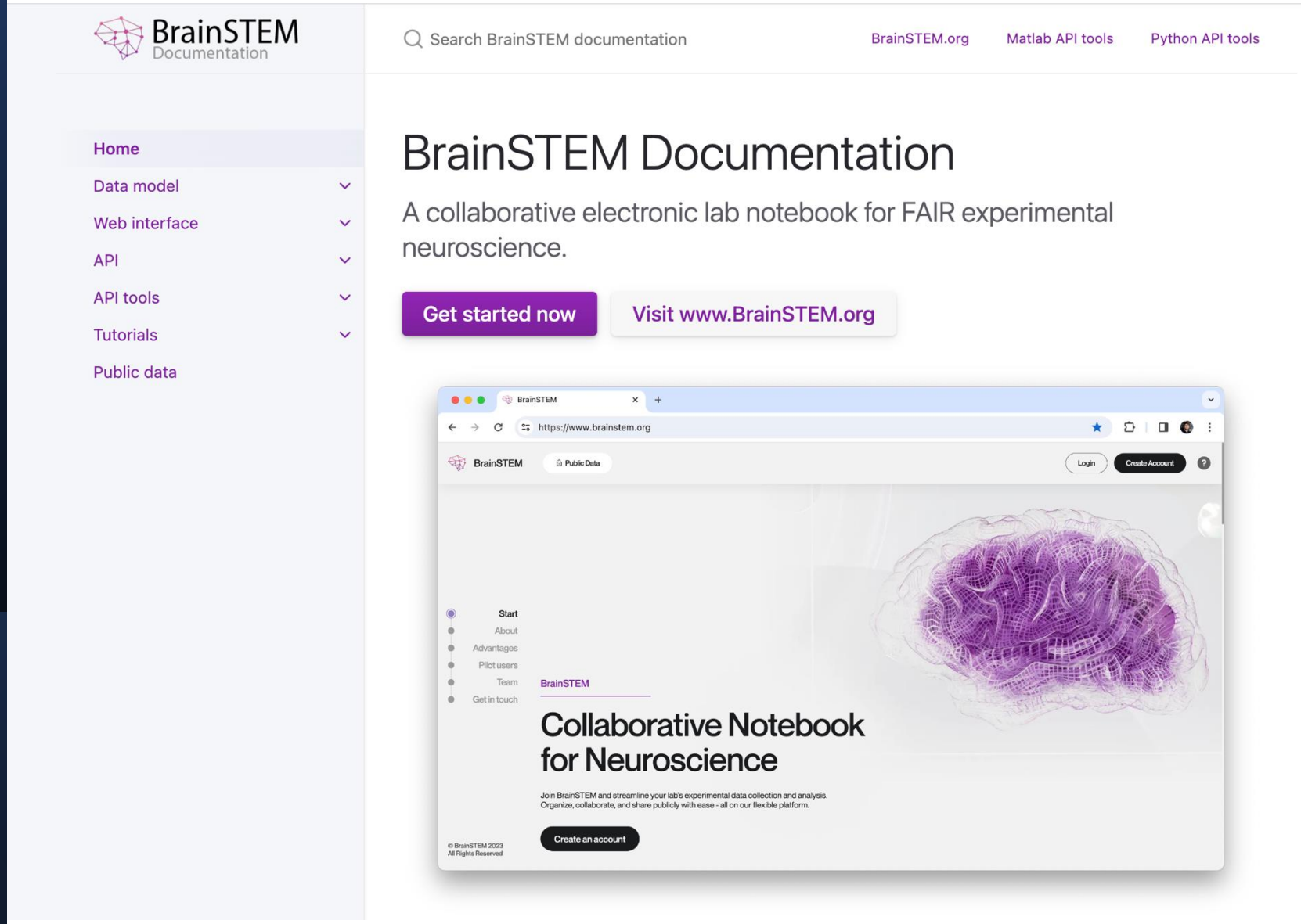
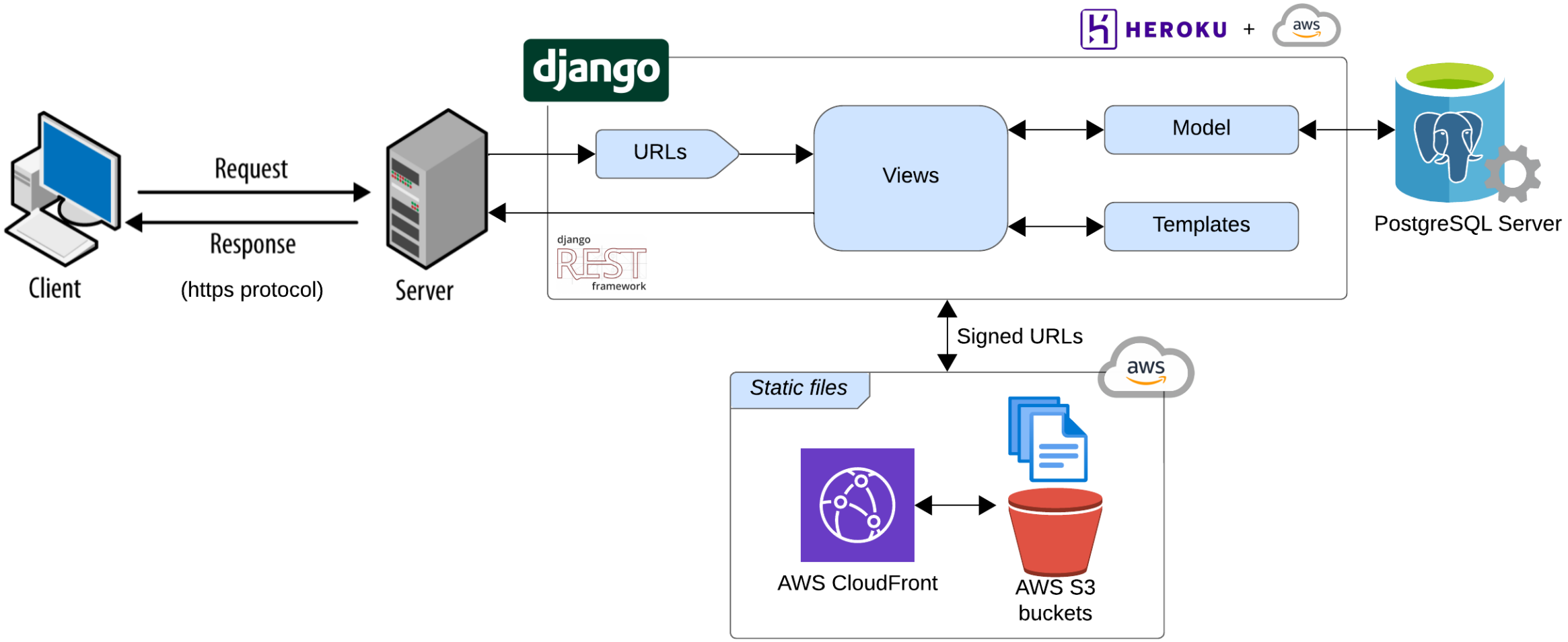
GitHub

Support and documentation



support.brainstem.org

Architecture diagram of BrainSTEM



Global *Active Projects* Filter

Quickly focus on your active projects or collaborations with a single click

Multitab Forms with Autosave

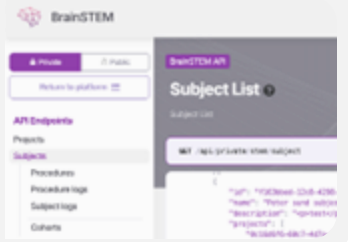
Organize complex metadata in intuitive sections

Redesigned Sidebar & Icons

Navigate your projects, subjects, and sessions with ease

Web API Redesign

Easy Navigation of API Endpoints



Recover Deleted Entries & Tracked Changes

Know exactly who edited what

BrainSTEM

2025: What's New

A major update focused on Adoption Collaborations, Control, and Efficiency.

Shared Consumables

+2600 Viruses, Optic Fibers, and Silicon probes

Simultaneous Edit Warning

2FA + Email Confirmation

Inventories + Consumable Stocks

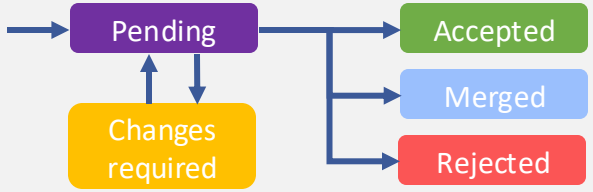
Subject Cohorts

University Admin Groups

Intuitive Naming of Models

Submission Approval System

Shared resources submitted by users go through a transparent approval process.



Wide selection of types of…

Data Acquisition (23 types)

Equipment (53 types)

Procedures (27 types)

Manipulations (15 types)

Subject Logs (13 types)

Documentation & Support

Data Fields

Relationships & Schemas

Tutorials

API + API Tools

Coordinates

Acknowledgement and funding

- Alisa Surkis - U19 Datacore Director
- György Buzsáki
- Rodrigo Amaducci (Postdoc)
- Mingze Dou (Master's student)
- U19 Group Leaders, students, and postdocs
- Quoin: Eli Taft, Lorena Carballo, and Jack Miszencin
- Andrew Max, full-stack developer

BRAIN INITIATIVE
BRAIN INITIATIVE ALLIANCE

Supported by the Oxytocin U19 BRAIN Initiative Grant: 5U19NS107616

What’s Next?

- BioRxiv manuscript
- Templates for modules
- Semantic search
  - ”Find thalamic recordings from a sleeping animal with a Neuropixels probe.”
  - ”Show subjects with an inhibitory-acting virus injections in the Visual cortex"
- Continue enriching shared resources and schemas
- Continue outreach activities
- Incorporation of feedback from users

🚀 Help us with feedback, contribute schemas, or suggest features!

Q&A