Connectomics Multimodal Atlas Project

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Idea

Building a **scalable, accessible** tool that enables visualization, retrieval, and **comparative analysis** of petabyte-scale neuroscience data and annotations

Objectives

- Facilitate research in **connectomics** (mapping neural connectivity) to accelerate advancements in **health and computation**
- Establish a **novel, open tool** for use in neuroscience research
- **Democratize access** to publicly-available neuroimaging data

Opportunity & Challenge

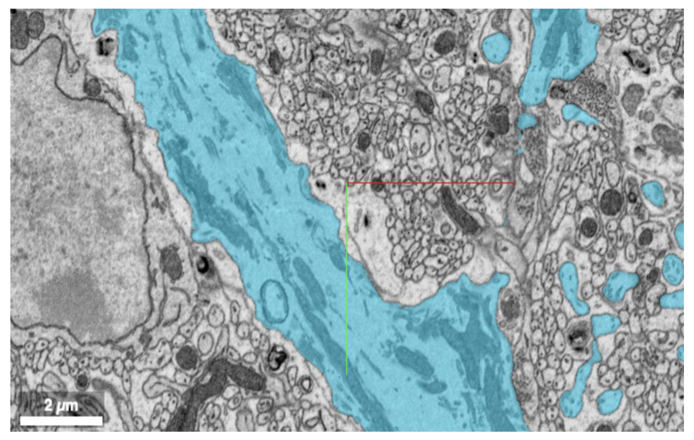
- There exists a **demand** to provide the community with an atlas illustrating datasets available across the brain by species
- Current datasets exist in **isolation** with little information about relative spatial location, which makes comparison difficult
- The issue is significant with available data **growing in scale** [1]

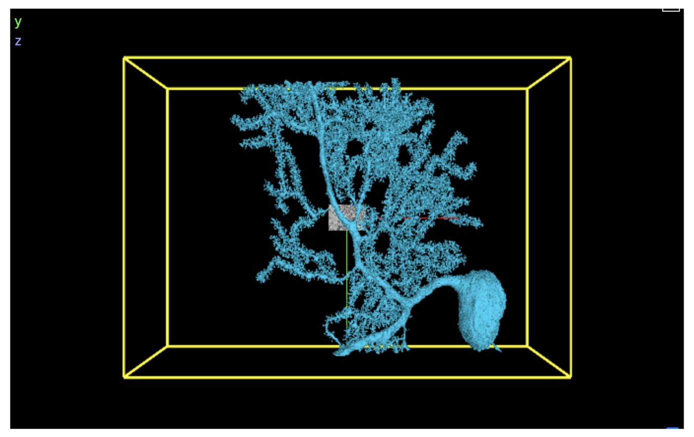
Impact & Future Directions

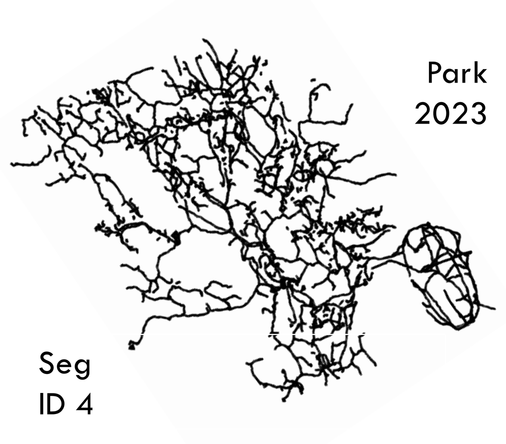
- With burgeoning information, it is imperative that scientists have **integrated access points** for comparative connectomics
- As algorithms are developed to "snap" imaging volumes onto reference models, a visual atlas will allow for **co-registration**
- **Secondary analysis** of overlapping studies will help quantify the extent of individual variation in brain connectivity, reveal patterns that underly cognition, behavior, and disease, and inform neural networks

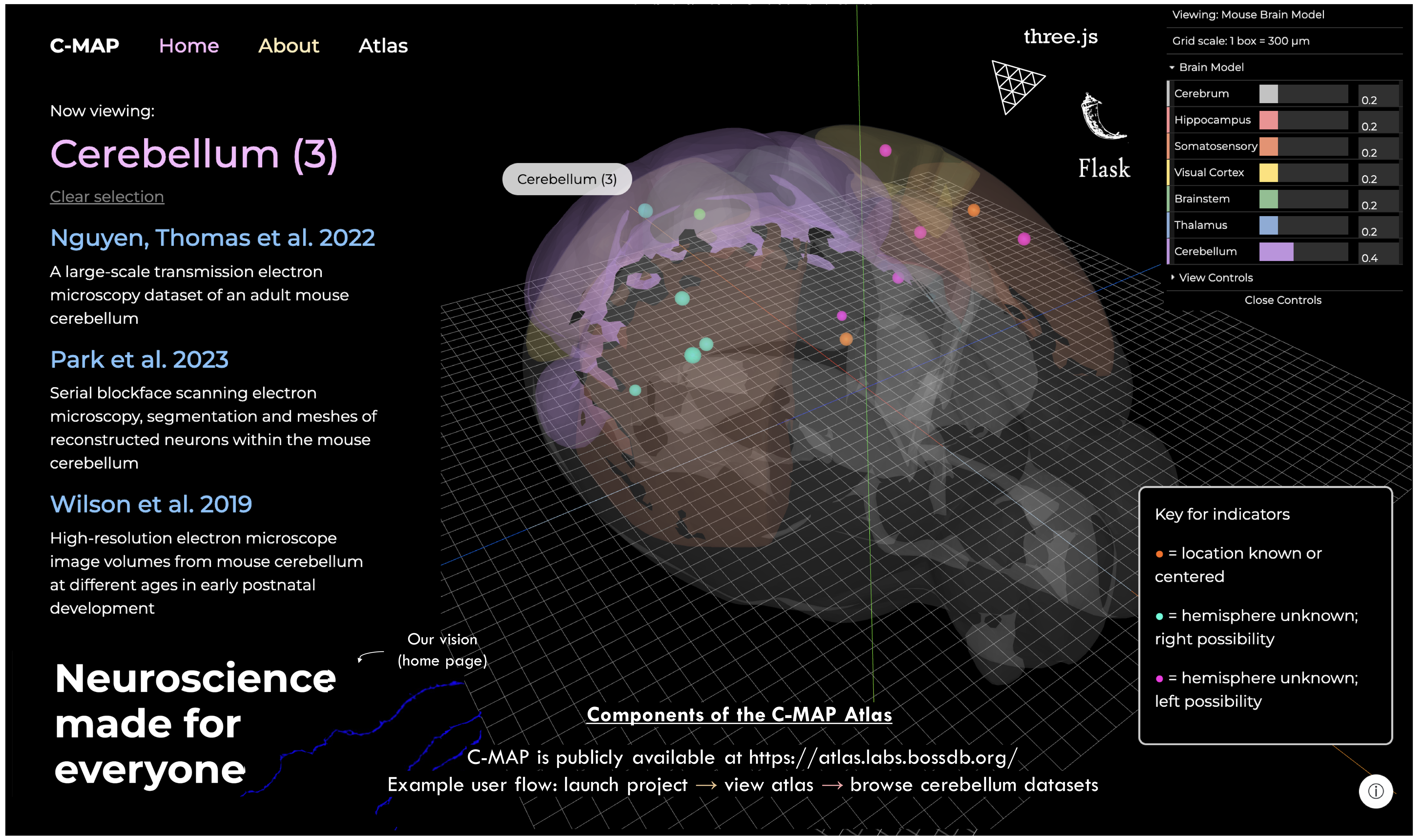
Case Study

- C-MAP enabled the identification of three datasets from the mouse cerebellum; we propose a case study on neuron development through an analysis of Purkinje Cells in this region
- Pipeline: Segmentation → Neuron meshes → Skeletons → Statistics



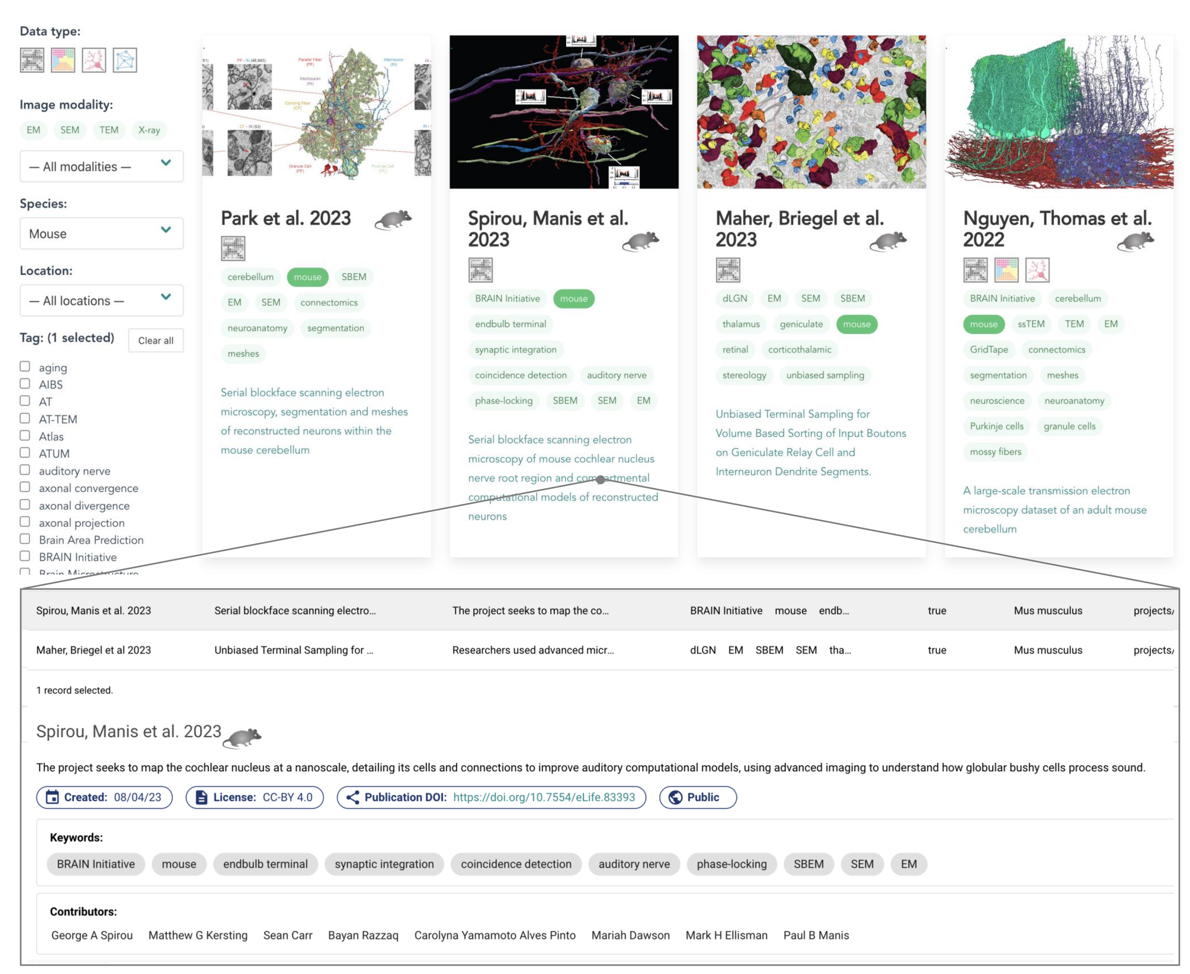






Results

- Built Connectomics Multimodal Atlas Project (C-MAP), a web-based tool for visualizing data using mice as a model organism
- Mapped 25+ studies to brain regions from **standard reference**
- Used Three.JS to create **interactive 3D web-based graphics** as a basis for the atlas
- Developed GUI to **interface with model**, set up improved view, and further accessibility
- Created functions to **retrieve necessary BossDB metadata** to continuously and asynchronously update visual indicators with project descriptors



Snapshot of four recent mouse datasets (bossdb.org) and associated metadata (metadata.bossdb.org) for example project

- **Data sources** include BossDB [1], an APL-developed platform that stores peta-scale information, and the Allen Institute's Brain Atlas [2], a standard neuroanatomical model

References & Acknowledgments

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- [1] R. Hider Jr, D. Kleissas, T. Gion, D. Xenes, J. Matelsky, D. Pryor, ... and B. Wester, "The Brain Observatory Storage Service and Database (BossDB): a cloud-native approach for petascale neuroscience discovery," p. 828787, Feb. 2022, doi: https://doi.org/10.3389/fninf.2022.828787.
- [2] M. Hawrylycz, L. Ng, D. Feng, S. M. Sunkin, A. Szafer, and C. Dang, "The Allen Brain Atlas," pp. 1111–1126, Jan. 2014, doi: doi.org/10.1007/978-3-642-30574-0_62.
- Our work on C-MAP builds on the 2021-2022 CON CIRCUIT cohort: Julie Burroughs, Wendy Chen, Folahan Koleosho, and Toni-Ann Pearson