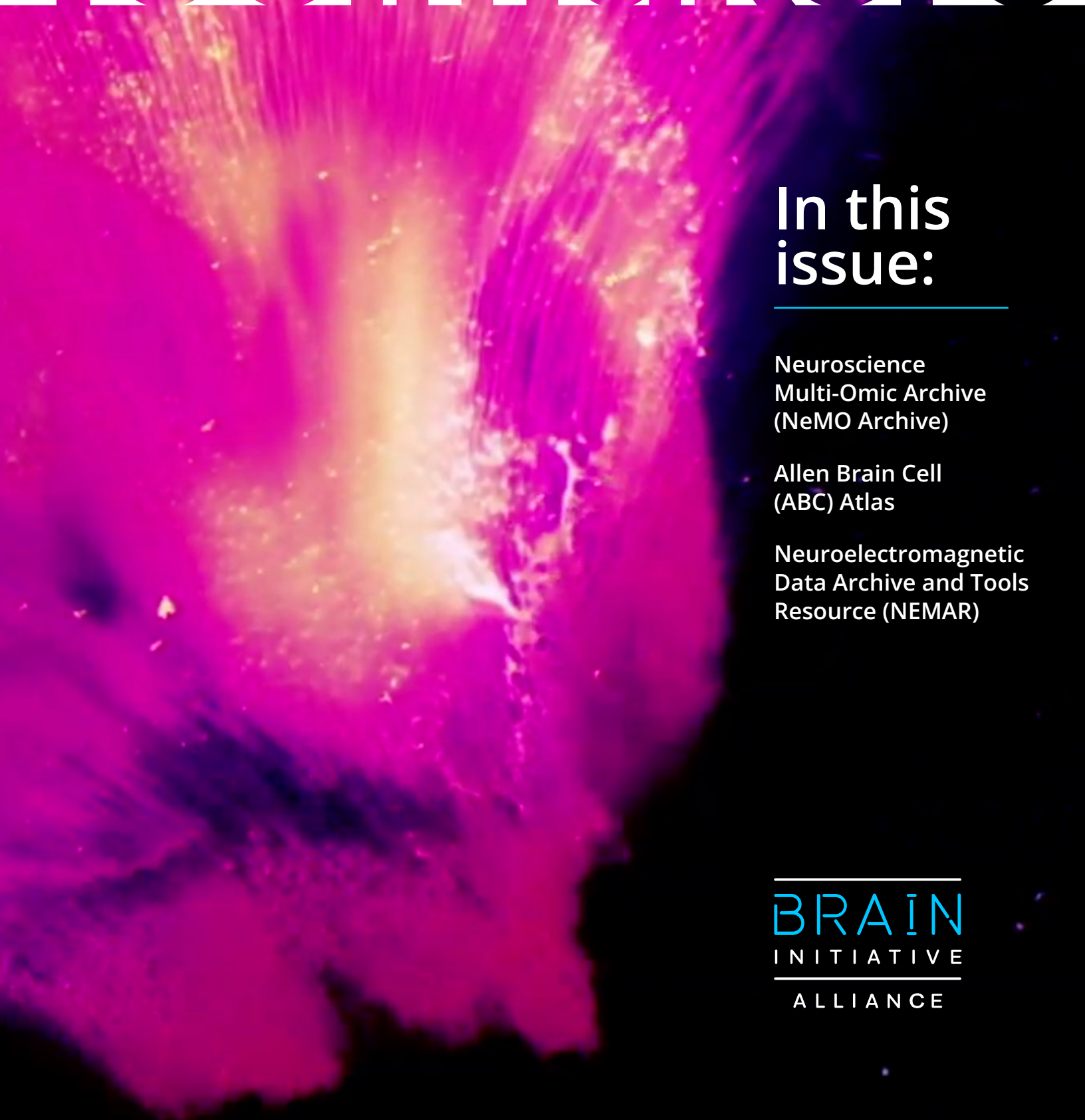
Fall 2024

Issue Fourteen

BRAINInitiative .org

Toolmakers



In this issue:

BRAIN INITIATIVE ALLIANCE

Welcome

Image: An image from the ABC Atlas. Credit: ABC Atlas, 2024.

Welcome to the Fall 2024 issue of the *Brain Research Through Advancing Innovative Neurotechnologies*® (BRAIN) Initiative Alliance Toolmakers Newsletter.

In this issue, we share all the details on three resources that are making it easy to share, store, visualize, and analyze neuroscience data: The NeMO Archive by Dr. Owen White; the ABC Atlas by Dr. Elysha Fiabane; and the NEMAR resource by Dr. Scott Makeig. Let's find out how these tools are revolutionizing brain research and learn more from their talented research teams.

CONTENTS

Excited by the potential of the tools in this issue?

Stay tuned for our next issue and explore more products of BRAIN Initiative discoveries in our **Toolmakers' Resources page**.

"This year marks a decade of advances made by BRAIN Initiative research. As we look toward the future, development and dissemination of innovative tools and technologies remain key to advancing scientific discovery and our understanding of the brain."

— DRS. JOHN NGAI AND ALYSSA PICCHINI SCHAFFER, BRAIN Initiative Alliance Co-Chairs

Neuroscience Multi-Omic Archive (NeMO Archive)

Dr. Owen White

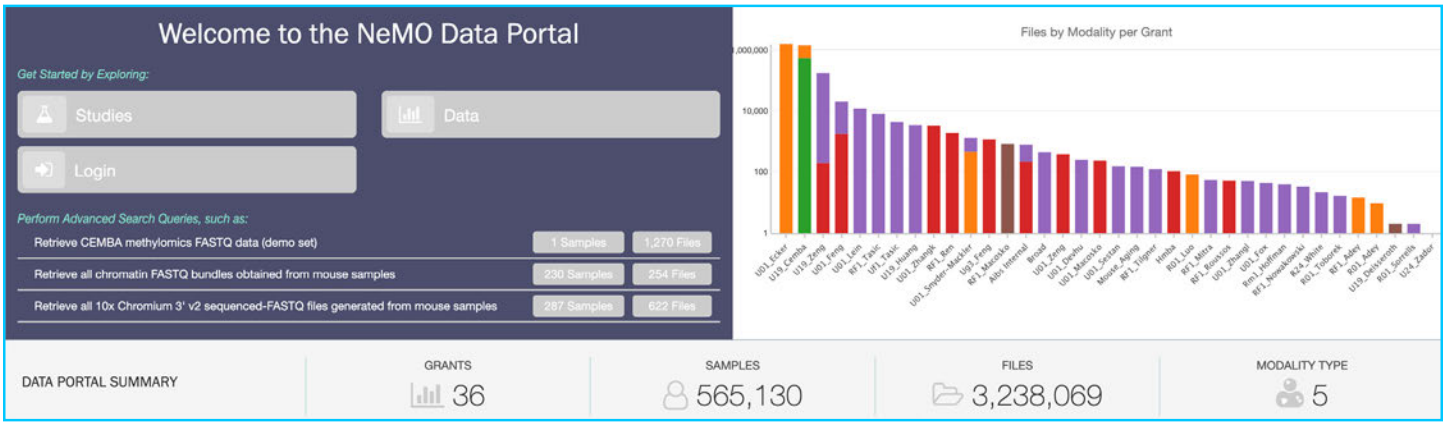


Image: The NeMO Archive Data Portal landing page. Credit: NeMO Archive, 2024.

The NeMO Archive is a large data repository that hosts and provides access to over 1 petabyte of -omics brain research data. It is the primary repository for data generated from the BRAIN Initiative and related brain research projects aiming to map the cell types in the mammalian brain. The NeMO Archive is composed of single-cell transcriptomic and epigenomic data, including: transcription factor-binding sites and other regulatory elements; histone modification profiles and chromatin accessibility; levels of cytosine modification; and genomic regions associated with brain abnormalities and disease. This resource allows users to answer diverse questions of relevance to brain research, such as identifying diagnostic candidates, predicting prognosis, selecting treatments, and testing hypotheses.

To date, the NeMO Archive contains over 3 million unique files with over 3.9 petabytes' worth of downloads. Data exploration is made easy with the help of the NeMO Portal, a searchable web application that can filter data. Upon completing their search, users can download data and access several tools that help process (implemented on Terra; terra.bio), visualize, and analyze large-scale data. NeMO Analytics is a complementary web-based tool implemented as an instance of Gene Expression Analysis Resource (gEAR), a community-driven, multi-omic data exploration portal. This portal makes data visualization easy by displaying multiple multi-omic datasets at once on one webpage. Its data analysis tools allow users to compare data and annotate cell types even if they have little informatics experience. In the future, the NeMO Analytics portal will expand to include more analytical tools with data from additional brain regions.

> We are excited to support the integration of BRAIN Initiative resources with efforts in the broader research community to further annotate cell types and reveal their dynamic changes across conditions.
>
> **— NEMO ARCHIVE TEAM**

There are three types of data in the NeMO Archive, all of which follow FAIR (findable, accessible, interoperable, and reusable) principles: (1) Public, or open and free data for immediate use; (2) Embargo, or data that will be open and free after a specific date; and (3) Restricted, or controlled data that needs approval for use. For more information about downloading public data on the NeMO Archive, visit its website.

Allen Brain Cell (ABC) Atlas

Dr. Elysha Fiabane

Last year, the Allen Institute for Brain Science published the ABC Atlas, a data visualization platform for multimodal single cell and spatial transcriptomics data. The ABC Atlas is an open science tool that is part of the Brain Knowledge Platform. It benefits the neuroscience community by providing whole-brain datasets that are accessible from a web browser.

The ABC Atlas has many use cases to enable brain research. With the ABC Atlas's help, researchers can identify cell types, examine spatial locations of those cell types, and explore genetic expression across the brain. The platform is helpful for experimental design as users can search for different genes that may relate to their research or find lineages that help label cells for their experiments.

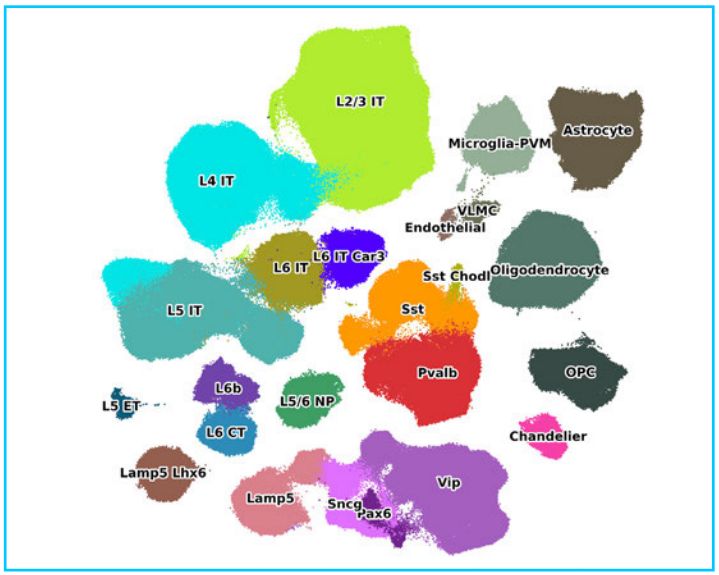


Image: The Seattle Alzheimer's Disease Brain Cell Atlas Whole Taxonomy. Credit: Brain Knowlege Platform, 2024.

Image: The Allen Brain Cell (ABC) Atlas Brain Knowledge Platform. Credit: ABC Atlas, 2024.

The ABC Atlas can also help researchers gain a deeper scientific knowledge of their own data and the brain regions they study or other regions across the brain. Users can compare their data with other cell types to find co-expression patterns or search genes to see expressions in the whole brain and learn about other gene expressions. This kind of whole-brain exploration paves the way for new or unexpected discoveries guided by open science.

One example of data made available through the ABC Atlas is the Seattle Alzheimer's Disease Brain Cell Atlas. This consortium investigates early indicators of Alzheimer's disease and published the largest human cell-resolution spatial transcriptomics data set, available on the ABC Atlas.

In the future, the team at the Allen Institute for Brain Science hopes to continue growing the ABC Atlas to add new modalities, species, and insights that enable new collaboration and data exploration.

> Understanding the conservation and divergence of cell types between human and model organisms will have profound implications for the study of human brain function and diseases.
>
> **— Excerpt from *Nature* (2023) on the ABC Atlas titled, "A high-resolution transcriptomic and spatial atlas of cell types in the whole mouse brain."**

Neuroelectromagnetic Data Archive and Tools Resource (NEMAR)

Dr. Scott Makeig

Storing and sharing data from neuroelectromagnetic (NEM) human brain imaging research is made easier by NEMAR, a large open access data portal. NEMAR directly interfaces with the OpenNeuro neuroimaging data archive. When a human NEM data set is uploaded to OpenNeuro, it is also copied to NEMAR and stored at the San Diego Supercomputer Center.

University of California, San Diego researchers developed NEMAR to provide extra magnetoencephalography (MEG) and electroencephalography (EEG) data processing tools for NEM data mining. NEMAR uses the Brain Imaging Data Structure (BIDS) format so that its datasets are standardized, organized, and easy to sort through. While NEMAR and OpenNeuro work together to make more data available, NEMAR also works with The Neuroscience Gateway (NSG) to facilitate data transfer and processing. The NSG has high-performing computing resources that prevent users from having to download and upload NEMAR data, because it has direct access to NEMAR's NEM datasets in a web browser. With NSG, users can submit scripts and analyze their data from NEMAR in a variety of computing environments.

For example, one study involved a categorization task and a recognition task, whereby human participants were shown a series of images and used button pressing for target images, such as responding whenever there was an animal in the picture. Reaction times and EEG data were recorded and uploaded to OpenNeuro. Through NEMAR, interested researchers can use that dataset to learn more by downloading or reprocessing it using the NSG.

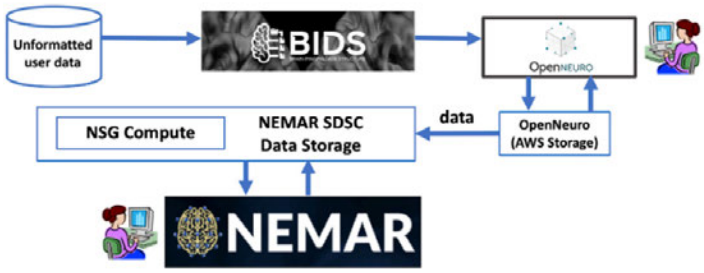


Image: The NEMAR framework. Credit: Abstract submission for the Organization for Human Brain Mapping Annual Meeting, 2024.

The first paper highlighting NEMAR was published in *arXiv* in 2022, outlining the need for a large portal for mining NEM data from OpenNeuro. Today, NEMAR has grown to host 29.5 terabytes of NEM data from 308 human studies. The team behind NEMAR also recently presented a poster abstract submission on NEMAR at the Organization for Human Brain Mapping Annual Meeting in Seoul, Korea in June 2024. Future developments for NEMAR include web applications that help with data visualization, quality assessment, and simplification of data processing.

> Our overall goal is to support the creation, maintenance, analysis, and cross-study mining of human NEM data by seeding and growing a 'minable' archive of NEM data deposited in the OpenNeuro resource.
>
> **— Excerpt from the abstract submission for the Organization for Human Brain Mapping Annual Meeting titled, "The NEMAR gateway to neuroelectromagnetic (NEM) brain imaging data."**