CMU-Pitt BRIDGE Center Standardizes on BIDS with Flywheel's Research Platform

The BRIDGE Center and Flywheel are accelerating scientific collaboration and discovery by implementing a neuroimaging platform that standardizes data acquisition, computation, and sharing using the Brain Imaging Data Structure (BIDS).

The past 30 years has been a time of rapid advancement in the use of magnetic resonance imaging (MRI or MR) to measure the structure and function of the living human brain. Neuroscientists and MR physicists have collaboratively worked to develop techniques leading to many discoveries in science and medicine. Over time, this fruitful partnership has led to the generation of vast amounts of complex data requiring intuitive, easy-to-use data handling standards, including how researchers can best manage and analyze their data efficiently and collaboratively.

The Need for Standardization and a Solution - BIDS

The Brain Imaging Data Generation and Education Center (BRIDGE) at Carnegie Mellon University (CMU) and the University of Pittsburgh (Pitt) has been an early adopter of BIDS[1] (Brain Imaging Data Structure). BIDS is an increasingly adopted standard of data organization that allows researchers to more easily share neuroimaging data and software tools across the broad range of research conducted by users scanning at their facilities. The BRIDGE Center leadership sees this technology for standardizing (i.e. organizing, annotating, and describing) data as an important facilitator for replicable analyses and advancing research collaboration to speed discovery.

The BRIDGE Center started in 2018 as a joint MR research center serving Carnegie Mellon University and the University of Pittsburgh. While researchers using the Center were all collecting MRI data, they did not have a standard, easy-to-use means to access, process and share their data. Sharing data across institutions and research groups required multiple cumbersome steps, multiple rigid software tools, and a shared storage space the center had to maintain.

The need for efficient data practices became more evident when the Center decided to purchase another 3-Tesla MRI system in 2019, a decision that would greatly increase the amount of data acquired at the Center. The BRIDGE Center leadership team of Co-Directors Dr. Tim Verstynen (CMU) and Dr. Walt Schneider (CMU), Steering Committee Chair Dr. Julie Fiez (Pitt), and Scientific Operations Director Dr. John Pyles (CMU) decided to investigate BIDS, a neuroimaging standard originally proposed in 2016 by the open science community to organize and share MR imaging and behavioral data. The standard specifies a simple, hierarchical folder structure for organizing neuroimaging data, with key study parameters documented in metadata files. Multiple imaging modalities can be managed using this standard with minimal curation intervention, reducing the likelihood of data handling errors. Another key benefit is the interoperability between BIDS-compatible analysis tools for data analytics.

The BRIDGE Center leadership recognized that the neuroimaging community was gravitating towards this standard for both sharing and processing data, and thus decided that the BRIDGE Center should also become one of the first BIDS compliant research centers in the MRI community.

Addressing the Challenges of Standardization

Incorporating BIDS into the BRIDGE Center was not a trivial task. Dr. Pyles had been exploring the possibility of the Center building their own data management platform to handle the increase in data but was also looking into alternatives that might ease the administrative burden of designing and running such a system. In a discussion of these challenges with colleagues at the University of Pennsylvania, Dr. Pyles heard about the capabilities of the Flywheel data and computational management platform.

After thorough research and discussions with existing Flywheel users, the leadership decided that the Flywheel platform would provide an excellent set of features and user experience for BRIDGE Center researchers, while being cost-efficient and providing professional support and system administration. Moreover, Flywheel had implemented tools that supported BIDS standardization. Specifically, the product included Gears (containerized applications) that enabled users to easily apply any applications that worked with data in the BIDS standard format (BIDS-apps). Additionally, having a cloud-based solution provided a scalable option as data size and storage needs grew over time.

> "We decided that standardizing our users' data into BIDS format as soon as it was transferred off the scanner would greatly facilitate their ability to organize, analyze, and share their data. Flywheel allows this to be done automatically, letting researchers concentrate on analysis instead of data management."
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> — Dr. John Pyles, Scientific Operations Director at the CMU-Pitt BRIDGE Center

Automation of BIDS with Flywheel

Flywheel automates data collection from the BRIDGE Center's Siemens MRI systems. The BRIDGE Center specified a naming convention used by all researchers for their MRI protocols. Once data is acquired, it is immediately and automatically encrypted and securely transferred to a Flywheel cloud instance controlled by the BRIDGE Center. Because of the standard naming convention, the files and associated metadata are automatically curated to the BIDS standard when they arrive in the cloud. Next, quality control and BIDS preprocessing pipelines are automatically scheduled and run. Finally, each data set is checked for completeness and a summary of the project status can be accessed by researchers in Flywheel. With automatic pre-processing and quality assessment, data quality is ensured both within projects and across the different MR protocols run at the Center.

According to Tim Verstynen, the standardization of this workflow is an important advancement for the BRIDGE Center and the greater MRI community.

> "Having user data natively curated into BIDS format opens so many doors for data processing and analysis. Users have access to quality control (MRIQC) and preprocessing (FMRIPrep) routines at the point of data access. These are burdens normally shouldered by individual labs. This greatly reduces errors in the delicate early processing stages, providing greater overall data quality. Also, getting their data in BIDS format at the point of data access automatically allows our users to easily share and collaborate both within our community and to the international research community at large."
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> — Dr. Tim Verstynen, Co-Director of the CMU-Pitt BRIDGE Center

About Flywheel

[1] Gorgolewski, K. J., Auer, T., Calhoun, V. D., Craddock, R. C., Das, S., Duff, E. P., ... & Handwerker, D. A. (2016). The brain imaging data structure, a format for organizing and describing outputs of neuroimaging experiments. Scientific data, 3(1), 1–9.