Brain Imaging Data Structure

Submitted for consideration:
Initial Review: July 10, 2018

Basic metadata

Title:
Brain Imaging Data Structure

Description:
A standard for organizing and describing MRI data sets

URL:
http://bids.neuroimaging.io

Steward(s):
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Relevant publication:
Gorgolewski, Krzysztof J., Tibor Auer, Vince D. Calhoun, R. Cameron Craddock, Samir Das, Eugene P. Duff, Guillaume Flandin, et al. 2016. "The Brain Imaging Data Structure, a Format for Organizing and Describing Outputs of Neuroimaging Experiments." *Scientific Data* 3 (June): 160044.
https://www.nature.com/articles/sdata201644

Nomination information:
BIDS was nominated for consideration by two community members on April 15, 2018

Summary of discussion

Overall, the committee felt that BIDS was a strong candidate for INCF endorsement and should be put forward. It is open, has strong documentation, is well conceived and executed, supports FAIR reasonably well, has evidence of community support and use outside of the core group involved in its specification and development. Although it appears to be operating under a shared, community governance model, details about governance (e.g., who makes decisions; how are conflicts resolved) and current and future support are needed.

Recommendation

The committee unanimously recommended that BIDS be put forward for community comment, but requested some additional information from the nominator and steward.

Conflicts of Interest

The reviewers declared no conflicts of interest, but the committee wishes to note that BIDS was developed in part with support from the INCF and is currently hosted on the INCF website.

Open criteria:

1. **Is the SBP covered under an open license so that it is free to implement and reuse by all interested parties (including commercial)?**
   Yes
2. **What license is used?**
   CC BY 4.0
3. **Does the SBP follow open development practices?**
   Yes
4. **Where and how are the code/documents managed?**
   BIDs documentation, tools and examples available through multiple repositories in https://github.com/INCF/. There is a main repository, https://github.com/INCF/BIDS, that is moderately active. The BIDS web site provides links to documents and other materials that are available for community comment.
5. **Any additional comments on the openness of the SBP?**
   BIDS meets the criteria for an open standard

FAIR criteria

Considers the SBP from the point of view of some of the FAIR criteria (Wilkinson et al. 2016). Is the SBP itself FAIR? Does it result in the production of FAIR research objects? Note that many of these may not apply.

1. **SBP uses/permits persistent identifiers where appropriate** (F1)
   Not applicable
2. **SBP allows addition of rich metadata to research objects** (F2)
   Yes. BIDS requires only the minimal set of metadata required for standard analyses, but allows and encourages an extensive set of metadata.
3. **SBP uses/permits addition of appropriate PIDs to metadata** (F3)
   The Dataset description section in the specification document describes how to link to datasets using DOI:s, etc
4. **The protocol allows for an authentication and authorization when required** (A1.2)

Reviewers did not agree on this, but the consensus is that this does not apply to BIDS.

5. **SBP uses or allows the use of vocabularies that follow the FAIR principles** (I2)
   Clear definitions of terms used in TSV and JSON files are provided together with links to DICOM, Cognitive Atlas (Poldrack et al. 2011), and Cognitive Paradigm (Turner and Laird 2012) ontologies.
6. **SBP includes/allows qualified links to other identifiers** (I3)
   The Dataset description section in the specification document describes how to link to datasets using DOI's, and to terms in ontologies
7. **Does the standard interoperate with other relevant standards in the same domain?** (I)
   Yes, e.g., NIFTI and DICOM. Multiple converters exist to translate other formats into BIDS.
8. **Does the SBP provide citation metadata so its use can be documented and tracked? (R1.2)**
   Yes, it provides a citation to be included when using BIDS.
9. **Any additional comments on aspects of FAIR?**
   BIDS will be an important component of a FAIR neuroimaging data ecosystem and does a reasonably good job of ensuring that such data are FAIR by supporting features such as persistent identifiers and rich metadata.

Testing and implementation

1. **Does the SBP have a reference implementation?**
   Yes. BIDS provides reference examples (https://github.com/INCF/BIDS-examples) and a reference converter (https://github.com/INCF/openfmri2bids). A step by step implementation example is available in (Gorgolewski et al. 2016). The BIDS format is also in use by the OpenNeuro database.

2. **What tools are available for the SBP?**
   BIDS lists many converters and implementation tools on their website: http://bids.neuroimaging.io/#software. Many different extensions are also being developed for other techniques and data (eg derived data, PET, EEG, MEG, statistical models, etc).
3. **Are the tools and implementations covered under an open source license?**
   The majority appear to be, although we would certainly expect (and encourage) commercial tools to be developed around BIDS as well.
4. **Assessment of the quality of the code/document**
   The specification and associated documentation are very strong. The ideas and rationale are also detailed in published papers. We did not review the code base, but it has been well tested.
5. **Any additional comments on testing and implementation?**

Governance

1. **Does the SBP have a clear description on who is maintaining the SBP and how it is maintained?**
   The BIDS website contains little explicit information about maintenance and governance. The responsible individuals appear to be Dr. Russ Poldrack and Dr. Chris Gorgolewski, based on personal knowledge and published papers. Dr. Gorgolewski appears to be in charge of

responding to and resolving comments raised in the Google Docs. Issues are raised in discussion forums and often resolved by the community through these discussions.

2. **Is the governing model document for maintenance and updates compatible with the INCF project governing model document and the open standards/infrastructure principles (Bilder et al., 2015)?**
   BIDS has a code of conduct posted and appears to have a community governance model but as indicated above, no formal documentation of it appears to exist. Who makes the decisions? How are conflicts resolved? Is there an advisory board?
3. **Is the SBP actively supported by the community? If so, what is the evidence?**
   Yes. Numerous people are active in the discussion list on NeuroStars: https://neurostars.org/tags/bids. Many extensions are being developed by various groups according to the website. Many publications by groups other than the primary students.
4. **Does the SBP provide tools for community feedback and support?**
   Yes. Community feedback is solicited through mailing lists, a discussion forum in NeuroStars, a GitHub repository and commenting on Google Docs.
5. **Any additional comments on governance?**
   Although BIDS clearly has an active community and appears to operate via a community governance model, it is not clear exactly how governance works. Who is responsible for the maintenance? Who makes decisions and how are disputes, if any, handled.

Adoption and Use

1. **Is there evidence of community use beyond the group that developed the SBP?**
   Yes. Thirty six publications from multiple groups have cited the Gorgolewski article. Several databases have adopted BIDS.
2. **Please provide some concrete examples of use**
   Sengupta, Ayan, Falko R. Kaule, J. Swaroop Guntupalli, Michael B. Hoffmann, Christian Häusler, Jörg Stadler, and Michael Hanke. 2016. “A Studyforrest Extension, Retinotopic Mapping and Localization of Higher Visual Areas.” *Scientific Data* 3 (October): 160093.
   Goren, Nir, James Avery, Thomas Dowrick, Eleanor Mackle, Anna Witkowska-Wrobel, David Werring, and David Holder. 2018. “Multi-Frequency Electrical Impedance Tomography and Neuroimaging Data in Stroke Patients.” *Scientific Data* 5 (July): 180112.
3. **Is there evidence of international use?**
   Yes, North America, Europe and Asia.
4. **Any additional comments on use?**
   Many of the papers citing BIDS were technical papers describing BIDs or tools rather than what might be called use of BIDS during the course of a scientific study, but there are examples of the latter.

Stability and Support

1. **Who is responsible for maintaining the SBP?**
   The website does not give an indication of who is responsible for maintaining SBP, although one may assume that the authors of the Gorgolewski et al (2016) paper have a major role.
2. **How is it currently supported?**
   The website acknowledges support from the INCF, but current sources of support are not indicated.

3. **What is the plan for long term support?**
   No plan for ongoing maintenance and support.
4. **Are training and other supporting materials available?**
   Yes
5. **Any additional comments on sustainability and support**
   More information on support and plans for sustainability are needed.

Comparison

1. **Are there other similar SBP's available?**
   Yes, e.g., OpenfMRI schema, NIDM-Experiment, EEG Study Schema, XCEDE are similar.
2. **If yes, how do they compare on key INCF criteria?**
   See below
3. **Any additional comments on comparison with other SBP's?**
   BIDS appears to have gained some traction as an open standard for neuroimaging file structures, although as listed above, there have been others developed over the years. Some, like OpenfMRI schema, are no longer active and for others, converters are being developed, e.g., BIDS2NIDM

References

Bilder G, Lin J, Neylon C (2015) Principles for Open Scholarly Infrastructure-v1, retrieved [date], http://dx.doi.org/10.6084/m9.figshare.1314859

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Poldrack, Russell A., Aniket Kittur, Donald Kalar, Eric Miller, Christian Seppa, Yolanda Gil, D. Stott Parker, Fred W. Sabb, and Robert M. Bilder. 2011. “The Cognitive Atlas: Toward a Knowledge Foundation for Cognitive Neuroscience.” *Frontiers in Neuroinformatics* 5 (September): 17.

Sengupta, Ayan, Falko R. Kaule, J. Swaroop Guntupalli, Michael B. Hoffmann, Christian Häusler, Jörg Stadler, and Michael Hanke. 2016. “A Studyforrest Extension, Retinotopic Mapping and Localization of Higher Visual Areas.” *Scientific Data* 3 (October): 160093.

Turner, Jessica A., and Angela R. Laird. 2012. “The Cognitive Paradigm Ontology: Design and Application.” *Neuroinformatics* 10 (1): 57–66.

Wilkinson, Mark D., Michel Dumontier, I. Jsbrand Jan Aalbersberg, Gabrielle Appleton, Myles Axton, Arie Baak, Niklas Blomberg, et al. 2016. “The FAIR Guiding Principles for Scientific Data Management and Stewardship.” *Scientific Data* 3 (March): 160018.