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► To cite this version:

Camille Maumet, Nolan B. Nichols, Guillaume Flandin, Karl Helmer, Tibor Auer, et al.. Standardized reporting of neuroimaging results with NIDM in SPM, FSL and AFNI. 21st Annual Meeting of the Organization for Human Brain Mapping (OHBM 2015), Jun 2015, Honolulu, United States. inserm-01149484

HAL Id: inserm-01149484

<https://inserm.hal.science/inserm-01149484v1>

Submitted on 24 Aug 2015

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Standardized reporting of neuroimaging results with NIDM in SPM, FSL and AFNI

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Acknowledgments: We would like to acknowledge the work of all the INCF task force members as well as of many other colleagues who have helped the task force. We are particularly indebted to Mathew Abrams, Linda Lanyon, Roman Valls Guimera and Sean Hill for their support at the INCF. Further we acknowledge the long-standing support of Derived Data Working Group activities by the BIRN coordinating center (NIH 1 U24 RR025736-01), and the Wellcome Trust for support of CM & TEN.

Introduction

The growing awareness of underpowered and irreproducible research [1] has highlighted the necessity for data sharing in neuroimaging. Encouragingly, in the past ten years, the number of publicly available datasets has greatly increased [3,4,5,10].

But while there is an increasing interest in sharing raw or pre-processed data, statistical images supporting neuroimaging publications are rarely made available. Furthermore, despite the availability of guidelines [7], ambiguous or incomplete methodological reporting is still commonplace [2] making image-based meta-analysis and reproducibility studies particularly challenging.

In [6], we introduced the Neuroimaging Data Model (NIDM), a domain-specific extension of the recently-approved W3C recommendation, PROV-DM [9]. Here, we introduce **NIDM-Results**, a standardised representation of “mass univariate” neuroimaging results for the three major software analysis packages: **SPM, FSL, and AFNI**.

Methods

Since August 2013, we have organised weekly conference calls and 5 focused workshops with a core group of experts representing more than 10 labs involved in various facets of neuroimaging. Separate meetings were organised with the development teams of SPM, FSL and AFNI.

We selected the pieces of information to be included in the model based on two inclusive criteria:

1. piece of information present in the results display of SPM, FSL or AFNI (e.g. peak location),
2. piece of information considered as essential to support image-based meta-analysis by our panel of experts (e.g. standard error of a contrast).

For each piece of information, we checked if an appropriate term was available in publicly available ontologies (in particular: OBI, STATO, Dublin Core). And, if not, we created a new term and carefully crafted a definition.

Results

A total of 98 classes and 93 relations were created. An overview of the proposed model is provided in fig. 1.

Specification:

<http://nidm.nidash.org/specs/nidm-results.html>

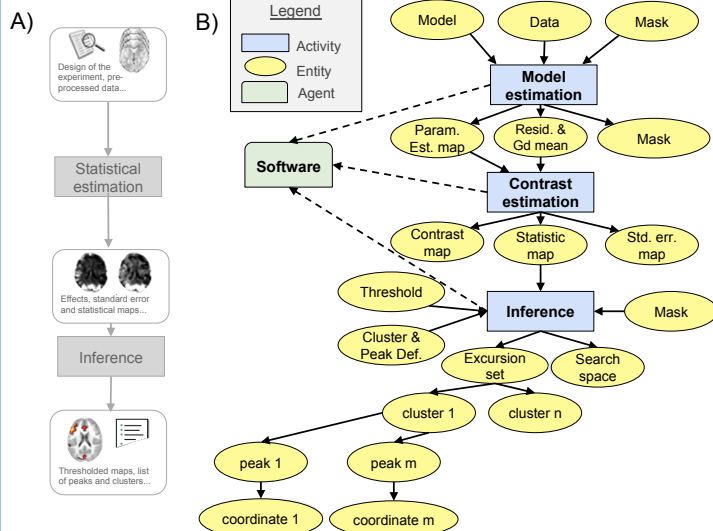


Fig. 1: A) Conceptual overview of the SPM statistical estimation and inference workflow. B) Overview of the proposed model to report “mass univariate” results, including entities (yellow), activities (blue) and agent (green).



Conclusion

We have presented a standardized representation for “mass univariate” neuroimaging results. In future work, we will provide a native export for FSL and AFNI and for previous releases of these neuroimaging software (e.g. SPM8). A viewer (HTML5, Javascript) is also under development.

Figure 2 shows three panels (A, B, C) illustrating the mapping between software outputs and NIDM entities. Panel A shows SPM output including Contrast weights, Excursion set, SPM(T_{max}) Statistic map, Threshold, Cluster, and Peak. Panel B shows FSL output including FEAT Report, Stats, Contrast weights, Cluster List, and Local Maxima. Panel C shows AFNI output including Threshold, Cluster & Peak Definition, Statistic map, Search space, Excursion set, and Cluster/Peak. Arrows indicate the mapping from these software outputs to the corresponding entities in the NIDM model.

Fig. 2: Mapping between the information displayed as a summary of the results in A) SPM, B) FSL and C) AFNI and the corresponding entities in NIDM.

References

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