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

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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

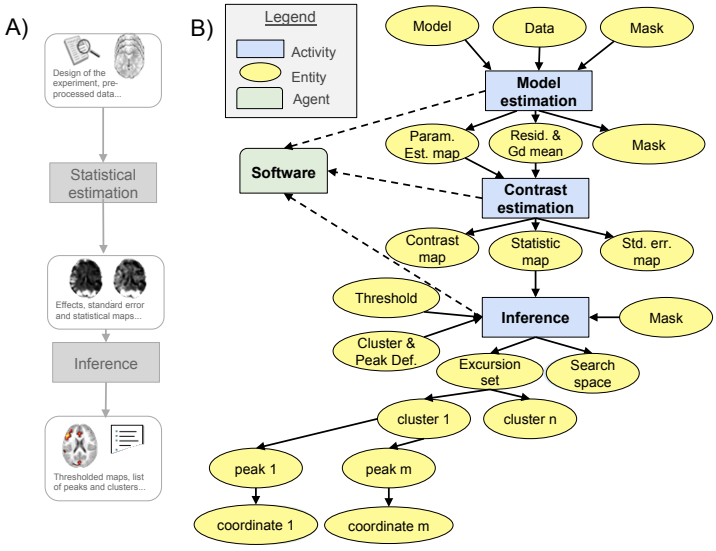
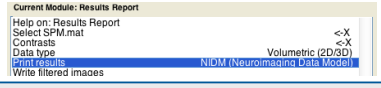


Fig. 1: A) Conceptual overview of the SPM statistical estimation and inference workflow. B) Overview of the proposed model to report "mass univariate" results, including entities (yellow), activities (blue) and agent (green).

Fig. 3: SPM12 support of NIDM found in batch system,
"SPM ➔ Stats ➔ Results report".



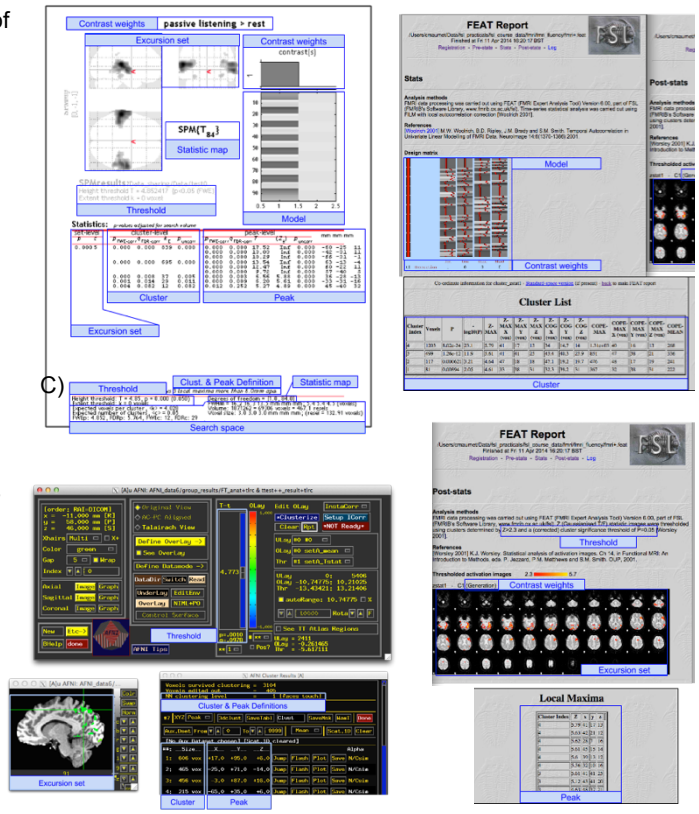


Fig. 2: Mapping between the information displayed as a summary of the results in A) SPM, B) FSL and C) AFNI and the corresponding entities in NIDM.

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.

References

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