# Standardizing neuroimaging atlases formats

## Introduction

Researchers using neuroimaging techniques rely on some brain template space, such as the MNI 305 space, and one or several atlases providing anatomical or functional information for a given location in this space. Most atlases are constituted of either hard labels (zero, one, or several labels for a given position), or probabilistic information indicating the likelihood of a label. Atlases exist for both 3D and surface geometry and can represent various types of information (e.g. cytoarchitectonic or anatomical macroscopic sulco-gyral information, functional information, etc).

The use of atlases is ubiquitous and many have been proposed in the past. For anatomical structures only, Harvard-Oxford (HO), Automatic Anatomical Labelling (AAL), Freesurfer labels, JuBrain, or Talairach are amongst the most used ones. More recently, a number of functional parcellations have been proposed, and atlases of functional networks are also emerging.

There is, however, no standard way of describing the information contained in an atlas. Even for very similar types of atlases such as the HO and AAL, similar information is encoded differently. This constrains developers and researchers to write specific code for each atlas format, leading to maintenance and error tracking issues. More broadly, the lack of a common format makes the comparison or the combined use of atlases more difficult, therefore preventing easy experimentation and eventually formalization of this field. In other words, it is more difficult to address atlasing issues without a well-designed and easy to use computational framework.

## Methods

The definition of a new format raises both technical and sociological issues. Under the umbrella of the International Neuroinformatics Coordinating Facility neuroimaging data sharing and atlasing programs, we gathered a group of researchers with competences and experience in human brain atlases.

To constitute the working group, we reached out to the main neuroimaging software developers and to large projects such as the Allen brain Institute and the Human Connectome Project, as well as to neuroanatomists to obtain a good representation of both the developers of tools and the neuroscience community.

We used in person meeting (the first meeting took place at the MNI in Montreal) to first establish the specifications and use cases of this format, and work on a first proposal based on commonly used atlases examples. We use collaborative development tools such as Google documents and GitHub to further discuss and improve these specifications and develop a first implementation of the format.

## Results

We decided to separate the high level information (what are the structures described, the labels, etc) from the low level information, and keep the images containing the atlases information with the same format. We converged on using json to encode this high level information, which will contain the description of the files (nifti or other). We use labels and tags that provide a more general framework than hierarchical structures. We also chose not to impose specific ontologies at this stage, although a recommended set of terms / ontologies may be proposed in the future. We have encoded four examples of atlases with these principles, including HO, AAL, FreeSurfer, and a developmental atlas (GitHub / INCF /Hawg), and we will consolidate the format specifications and propose a reference implementation during our next meeting in February in Boston, before openning up the discussion to the whole community for feedback.

## Conclusion

The specification of a new format faces social and technical challenges. The International Neuroinformatics Coordinating Facility allows to create and fund working groups and help organize these standardization projects, which should foster a more efficient research in neuroimaging.

[McGill Centre for Integrative Neuroscience, FreeSurfer project, Human Connectome Project, Allen Brain Institute, Harvard neuroanatomists, UCL SPM, Oxford FSL, and a few others]