3D Brain Atlas Reconstructor and Common Atlas Format, the infrastructure for constructing three dimensional brain atlases

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Anatomical brain atlases are essential part of neuroscientific toolbox. There is a growing demand for extending typical two dimentional atlas frameworks into the three-dimensional space. In response to such demands we propose a Python package for automated reconstruction of 3D models of brain structures basing on their 2D delineations of varying formats, sophistication and quality.

The 3d Brain Atlas Reconstructor (3dBAR, http://www.3dbar.org) contains a set of generic Python parsers for converting source atlases into Common Atlas Format (CAF), Python API for manipulating CAF datasets, and Python reconstruction module for generating 3D models. All segments of software were prepared in object-oriented manner to simplify code maintenance and extensibility. 3dBAR relies fully on open file formats (XML, SVG, VRML, NIfTi) and open source packages and will also be open. 3D graphics processing is performed using Visualization ToolKit (http://www.vtk.org/). SVG rasterization and image manipulation is handled by python-rsvg library (http://cairographics.org/pyrsvg/), Python Image Library (http://www.pythonware.com/products/pil/) and SciPy. Graphical User Interface was prepared using wxPython (http://www.wxpython.org/). NifTi export is based on PyNIfTI (http://niftilib.sourceforge.net/pynifti/).

Reconstruction process leading to a three dimensional model proceeds in two steps. First the source atlas is parsed into a Common Atlas Format dataset. Every CAF dataset consists of SVG graphics files and an XML index file. SVG files contain 2D representations of brain slices divided into separate structures represented by closed paths and an information about the brain's spatial coordinate system. Structures' hierarchy and additional informations (e.g. structures full names, external references to databases) are stored in the index file. The second stage involves processing CAF dataset and results in a 3d reconstruction in the form of a volumetric data or polygonal mesh and it is realized with an user friendly GUI written in Python.

The 3dBAR uses automatic, customizable and reproducible workflow which allows tracking and reviewing of the whole reconstruction process as well as locating and eliminating reconstruction errors or data inconsistencies. Thank to it's open format policy it supports interoperability with other neuroinformatics tools and exchange of content at any stage of processing.

We have used this infrastructure to process several widely used brain atlases, including published atlases with PDF datasets (“The Rat Brain in Stereotaxic Coordinates” by Paxinos and Watson and “The Mouse Brain in Stereotaxic Coordinates” by Paxinos and Franklin) or prepared from volumetric data (The Waxholm Space Atlas; Johnson et al, 2010). Five other datasets were derived from the Scalable Brain Atlas (SBA, http://scalablebrainatlas.incf.org).

Apart from standalone package we provide a web service (http://www.3dbar.org) that allows a variety of operations on available CAF datasets, e.g. customizable reconstructions, downloads in various formats, viewing thumbnails of structures, customized viewing of slides from provided CAF datasets and access to structure hierarchy. Live view of 3D structures is also possible in WebGL enabled browsers where one can manipulate (rotate, zoom, etc.) lightweight versions of the reconstructions.