Automatic anatomical labeling of Talairach coordinates and generation of volumes of interest via the BrainMap database

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Introduction

Automatic translation of Talairach coordinates to anatomical labels is, e.g., implemented in the Talairach Daemon [1] that is based on a digitization of the Talairach Atlas [2] and probabilistic atlases [3]. Here we describe a bootstraped method based on labels in the literature as recorded in the BrainMap database [4], This method allows us to label new Talairach coordinates as well as generate probabilistic based volumes of interest. It also gives us the possibility of partially assessing the validity of association between stereotactic coordinates and anatomical nomenclature [6].

Method

Web-pages from the BrainMap database were downloaded and the 3D Talairach coordinates $\mathbf{x}$ as well as the anatomical label (BrainMap: "Lobar Anatomy") were extracted. Each anatomical label was split into all subsets of phrases, e.g., the string "midline occipital lobe" generated an event in the classes of "midline", "occipital", "lobe", "midline occipital", "occipital lobe" and "midline occipital lobe". Probability density estimates $p(\mathbf{x}|w)$ in Talairach space $\mathbf{x}$ was constructed independently for each word/phrase w. A Parzen window (also called a Specht kernel estimator) with a Gaussian kernel was used as a model. An anatomical label for a given Talairach coordinate $\mathbf{x}$ can now be established by comparing each of the constructed probability estimates, either directly on the densities or on the probabilities (P-values). The P-value is found by constructing a density volume and summing the densities from all voxels below the density value for the present Talairach coordinate $\mathbf{x}$

$$P(\mathbf{x}|w) = \sum_{p(\mathbf{x}'|w)<p(\mathbf{x}|w)} p(\mathbf{x}'|w). \quad (1)$$

Equal weight is given for each label $P(w) = 1$ and the P-values are sorted and presented to the user in a list.
With a model for each label probability density volumes can be constructed by computing the density value for all voxels in the volume. These can be saved as ordinary 3D volumes and used as masks in analysis where volumes of interests are desired. Together the volumes form a probabilistic atlas and since the words and phrases form a tree structure the atlas is hierarchical.

Result

The figure shows a transversal cut in the probability volume for the label "Inferior temporal gyrus". The 604 volumes are presently available from http://hendrix.imm.dtu.dk/services/jerne/ in Corner Cube visualizations. To help navigating among them the most similar volumes for a given volume are displayed in a list. An alphabetic sorted list with all labels and their associated sub- and super-phrases are also constructed.

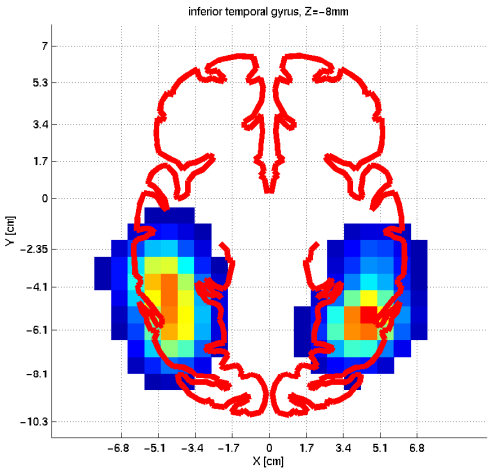

Figure 1: Probability density of "Inferior temporal gyrus".

Conclusion

We have constructed a *hierarchical* and *probabilistic* brain atlas with a large number of brain regions and shown its capability for generation of labels for Talairach coordinates and volumes of interests.

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References

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