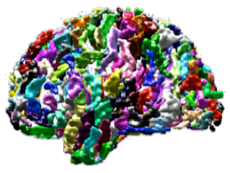
Open labels: online feedback for a public resource of manually labeled brain images



Arno Klein, Tito Dal Canton — New York State Psychiatric Institute, Columbia University, New York, NY

Satrajit S. Ghosh — Research Laboratory of Electronics, MIT, MA

Bennett Landman — Vanderbilt University, Nashville, TN

Joel Lee — VA Medical Center, Minneapolis, MN

Andrew Worth — Neuromorphometrics, Inc., Somerville, MA

Goal

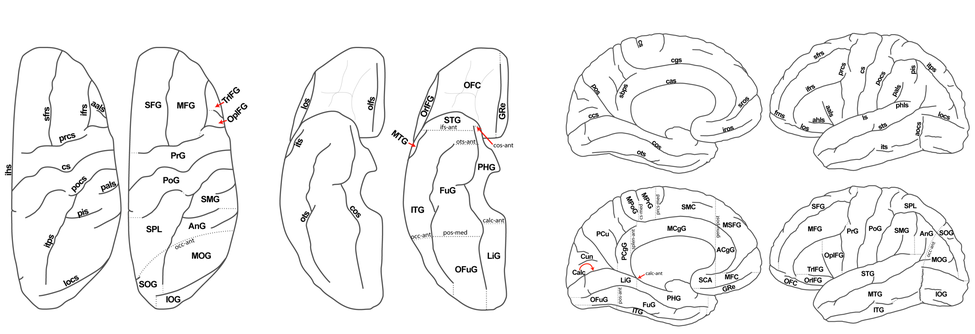
Create a web application to interactively view manually labeled brain images and submit comments to the labelers and developers of the labeling protocol.

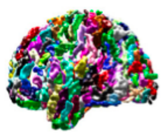
Background

Neuromorphometrics has developed a brain labeling protocol that will be used by trained personnel to manually label the anatomy in an initial set of at least 800 to 1,000 T1-weighted MRI volumes.
The labeled brain images will be made publicly available online as a free, downloadable resource. In order to ensure that these anatomical labels are meaningful and useful to the neuroscientific community, we gathered feedback about the protocol using online surveys.

Problem

The schematics used in the survey were not sufficient for users to evaluate the protocol, and we needed to provide a way for users to view the labeled image data to provide feedback. We considered using two different Java applications, WebMILL (https://brassie.ece.jhu.edu) and the Internet Image Viewer (http://james.psych.umn.edu/iiV), but determined that they would require significant modifications to achieve our goal: iiV had difficulty scaling up to larger images; WebMill has advanced image labeling capabilities, but it does not have the capability of cross-referencing slices or providing text-based user feedback. We therefore decided to design a new online brain image viewer in JavaScript.





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Proposed Cortical Parcellation Protocol: SURVEY 1 SURVEY 2

Frontal Lobe (FL): Lateral Surface

Precentral Gyrus (PrG)

Anterior: precentral sulcus --- Posterior: central sulcus --- Superior: superior margin of the interhemispheric fissure --- Inferior: lateral margin of the dorsal bank of the lateral fissure

Superior Frontal Gyrus (SFG)

Anterior: frontomarginal sulcus --- Posterior: precentral sulcus / plane prcs-med --- Medial: superior margin of interhemispheric fissure --- Inferior: anteriorly: lateral orbital sulcus; posteriorly: middle frontal sulcus

Middle Frontal Gyrus (MFG)

Posterior: precentral sulcus --- Superior: superior frontal sulcus --- Inferior: anteriorly: lateral orbital sulcus; posteriorly: inferior frontal sulcus

Inferior Frontal Gyrus (IFG)

Posterior: precentral sulcus --- Superior/anterior: anteriorly: lateral orbital sulcus; posteriorly: inferior frontal sulcus --- Inferior: anteriorly: lateral orbital sulcus; posteriorly: lateral orbital sulcus / posterior projection from the posterior limit of the lateral orbital sulcus to the lateral sulcus

Regions of interest included in the protocol

ACgG	anterior cingulate gyrus
AIns*	anterior insula
AnG	angular gyrus
Calc*	calcarine cortex
CgG	cingulate gyrus
CO	central operculum
Cun	cuneus
Ent	entorhinal area
FO	frontal operculum
FuG	fusiform gyrus
GRe	gyrus rectus
IFG	inferior frontal gyrus
IOG	inferior occipital gyrus
ITG	inferior temporal gyrus
LiG	lingual gyrus
MCgG*	middle cingulate gyrus
MFC*	medial frontal cortex
MFG	middle frontal gyrus
MOG*	middle occipital gyrus
MPoG	postcentral gyrus, medial segment
MPrG	precentral gyrus, medial segment
MSFG	superior frontal gyrus, medial segment
MTG	middle temporal gyrus
OFC*	orbitofrontal cortex
OFuG*	occipital fusiform gyrus
OpIFG	opercular part of the inferior frontal gyrus
OrIFG	orbital part of the inferior frontal gyrus
PCgG	posterior cingulate gyrus
PCu	precuneus
PHG	parahippocampal gyrus
PIns*	posterior insula
PO	parietal operculum
PoG	postcentral gyrus
PP*	planum polare
PrG	precentral gyrus
PT*	planum temporale
SCA	subcallosal area
SFG	supereior frontal gyrus
SMC*	supplementary motor cortex
SMG	supramarginal gyrus
SOG	superior occipital gyrus
SPL	superior parietal lobule
STG	superior temporal gyrus
TriFG	triangular part of the inferior frontal gyrus
TTG	transverse temporal gyrus

* not included in the NeuroNames database

Sulci included in the protocol and their abbreviations

aals	anterior ascending ramus of the lateral sulcus
ahls	anterior horizontal ramus of the lateral sulcus
aocs	anterior occipital sulcus
cas	callosal sulcus
ccs	calcarine sulcus
cgs	cingulate sulcus
cis	central insular sulcus
cos	collateral sulcus
crs	circular insular sulcus
cs	central sulcus
fms*	frontomarginal sulcus
ftts*	first transverse temporal sulcus
hs*	Heschl's sulcus
ifrs	inferior frontal sulcus
ihs*	interhemispheric sulcus
itts*	intermediate transverse temporal sulcus
iros	inferior rostral sulcus
ips	intraparietal sulcus
its	inferior temporal sulcus
locs	lateral occipital sulcus
los	lateral orbital sulcus
ls	lateral sulcus
olfs	olfactory sulcus
ots	occipitotemporal sulcus
pals	posterior ascending ramus of the lateral sulcus
phls	posterior horizontal ramus of the lateral sulcus
pis*	primary intermediate sulcus
pocs	postcentral sulcus
pos	parietooccipital sulcus
prcs*	precentral sulcus
sbps	subparietal sulcus
sfrs	superior frontal sulcus
sros	superior rostral sulcus
sts	superior temporal sulcus

* not included in the NeuroNames database

Dividing planes included in the protocol and their abbreviations

The following dividing planes are used in the protocol.
Planes are coronal unless specified otherwise:

calc-ant	anterior limit of the calcarine sulcus
cos-ant	anterior limit of the collateral sulcus
cs-med	dorsomedial limit of the central sulcus;
genu-post	marked by the posterior limit of the genu of the corpus callosum
ifs-ant	anterior limit of the inferior temporal sulcus
occ-ant	oblique medial-lateral plane given by a line drawn through points at (i) ventrolateral limit of the anterior occipital sulcus, (ii) jnct of the lateral occipital sulcus and the anterior occipital sulcus, and (iii) the dorsomedial limit of the parietooccipital sulcus
ots-ant	anterior limit of the occipitotemporal sulcus
prcs-med	dorsomedial limit of the precentral sulcus
prcs-lat	ventrolateral limit of the precentral sulcus
pocs-lat	ventrolateral limit of the postcentral sulcus
pos-ant	anterior limit of the ventral bank of the parietooccipital sulcus
tf-jnct	junction of the temporal and frontal lobes
splen-ant	anterior limit of the splenium of the corpus callosum

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The Roy G. BIV Image Viewer

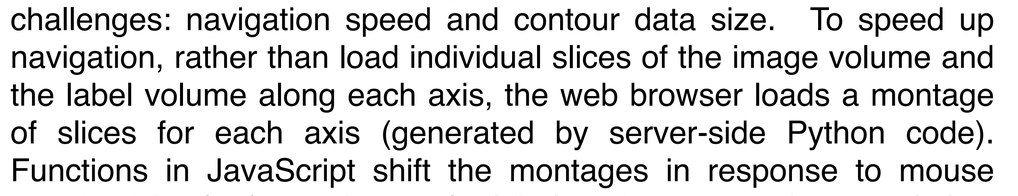
To open the labeling process to easier and more detailed feedback as part of the *Collaborative Open Labeling Online Resource* (www.brainCOLOR.org), we have created Roy G. BIV, an online brain image viewer with label overlays. A user can change the opacity of the labels, can click on cross-referenced coronal, sagittal, and horizontal slices to move through the images, and can mouse over coronal slices to see label highlights and titles.

We are developing the viewer using the jQuery JavaScript library (jquery.com) with the Map Hilight and Draw plugins. We faced two challenges: navigation speed and contour data size. To speed up navigation, rather than load individual slices of the image volume and the label volume along each axis, the web browser loads a montage of slices for each axis (generated by server-side Python code). Functions in JavaScript shift the montages in response to mouse events. The (x,y) coordinates for label contours in each coronal slice also exist, but would require a user to upload 15MB of XML data for a single brain. Instead, the viewer remotely loads a few kilobytes at a time of HTML image map data using jQuery AJAX functions.

Next, we will add a navigation panel in the empty quadrant, integrate feedback forms and PHP/SQL database call options for loading image data. We will release the code as open source under the MIT license and extend its functionality as per user requests.

Please visit:

http://www.braincolor.org/openlabels/roygbiv



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