Mining the BrainMap™ database: Detection of outliers

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OUTLIER DETECTION

Find outliers in the BrainMap Database by modelling the relationship between coordinates and their associated label.

$$\mathbf{X} = (38, 24, 8) \longleftrightarrow \text{“Right orbitofrontal cortex”} \tag{1}$$

Model $p(\mathbf{x}|w)$ with a non-parametric probability density estimator.

$$E(\sigma^2, w) = -\sum_{n=1}^{N_w} \log p_{-n}(\mathbf{x}_n|\sigma^2, w), \tag{2}$$

where $\mathbf{x}_n$ is the three-dimensional Talairach coordinate of the n'th location with label w, N_w is the number of locations labeled w, and the density based on all examples except the n'th is given by

$$p_{-n}(\mathbf{x}|\sigma^2, w) = \frac{1}{N_w - 1} \sum_{n' \neq n}^{N_w} \left(2\pi\sigma^2\right)^{-3/2} \exp\left(-\frac{1}{2\sigma^2}(\mathbf{x} - \mathbf{x}_{n'})^2\right). \tag{3}$$

PROBABILITY DENSITY VOLUME

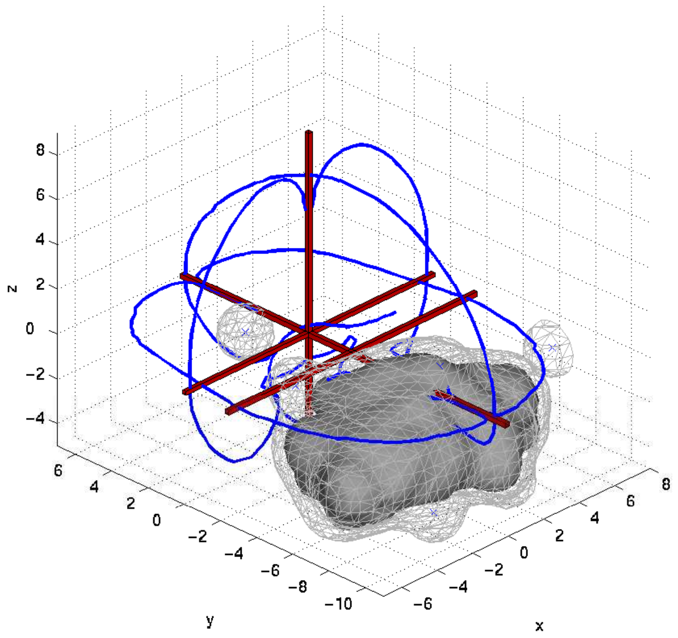


Figure 1: “Cerebellum”. Modelled from BrainMap.

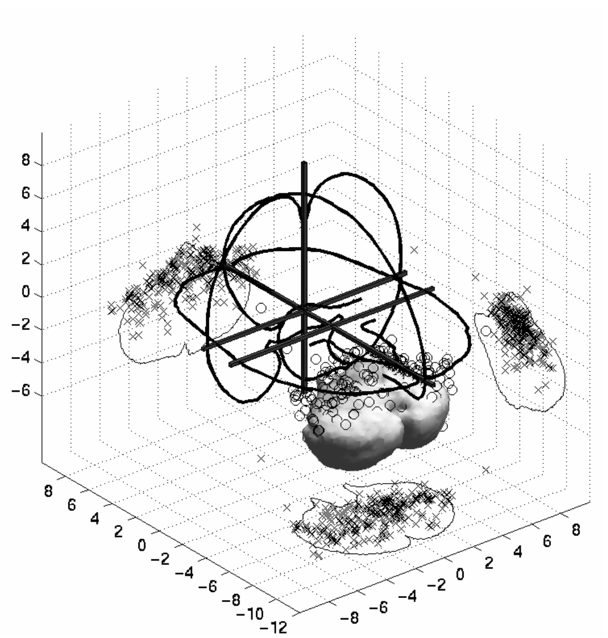
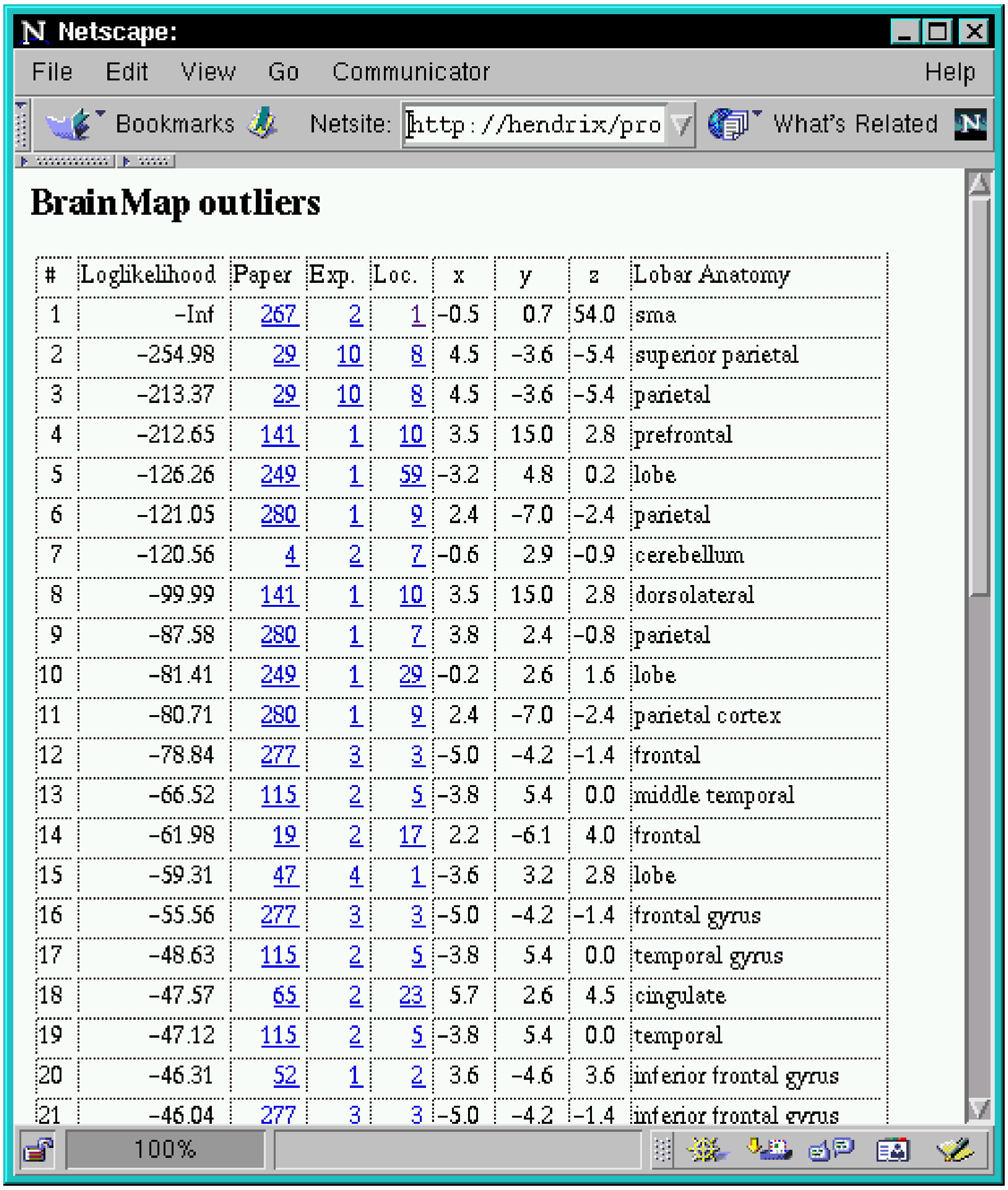


Figure 2: Montreal cerebellum

OUTLIERS



BrainMap outliers

#	Loglikelihood	Paper	Exp.	Loc.	x	y	z	Lobar Anatomy
1	-Inf	267	2	1	-0.5	0.7	54.0	sma
2	-254.98	29	10	8	4.5	-3.6	-5.4	superior parietal
3	-213.37	29	10	8	4.5	-3.6	-5.4	parietal
4	-212.65	141	1	10	3.5	15.0	2.8	prefrontal
5	-126.26	249	1	59	-3.2	4.8	0.2	lobe
6	-121.05	280	1	9	2.4	-7.0	-2.4	parietal
7	-120.56	4	2	7	-0.6	2.9	-0.9	cerebellum
8	-99.99	141	1	10	3.5	15.0	2.8	dorsolateral
9	-87.58	280	1	7	3.8	2.4	-0.8	parietal
10	-81.41	249	1	29	-0.2	2.6	1.6	lobe
11	-80.71	280	1	9	2.4	-7.0	-2.4	parietal cortex
12	-78.84	277	3	3	-5.0	-4.2	-1.4	frontal
13	-66.52	115	2	5	-3.8	5.4	0.0	middle temporal
14	-61.98	19	2	17	2.2	-6.1	4.0	frontal
15	-59.31	47	4	1	-3.6	3.2	2.8	lobe
16	-55.56	277	3	3	-5.0	-4.2	-1.4	frontal gyrus
17	-48.63	115	2	5	-3.8	5.4	0.0	temporal gyrus
18	-47.57	65	2	23	5.7	2.6	4.5	cingulate
19	-47.12	115	2	5	-3.8	5.4	0.0	temporal
20	-46.31	52	1	2	3.6	-4.6	3.6	inferior frontal gyrus
21	-46.04	277	3	3	-5.0	-4.2	-1.4	inferior frontal gyrus

Figure 3: List of those locations estimated to have the highest novelty. "Paper", "Exp." and "Loc." correspond to the identifiers used in the BrainMap database. X, y, z and "Lobar anatomy" are the associated fields in the database with the coordinates in centimeter and the "loglikelihood" is our novelty measure.

“MANUAL” INVESTIGATION OF OUTLIERS

BrainMap	x	y	z	BrainMap label	Comment	Reference
267, 2, 1	-5	7	540	SMA	Millimeter and centimeter for z-coordinate confused during BrainMap entry	(Buckner et al., 1996, table 4)
29, 10, 8	-48	-23	-51	Lateral superior parietal	Emailed Corbetta.	(Corbetta et al., 1993, table 5)
141, 1, 10	35	150	28	Dorsolateral prefrontal	Millimeter and centimeter for y-coordinate confused during BrainMap entry	(Kosslyn et al., 1994, tabel 2)
249, 1, 59	-31.8	48.1	2.2	Subgyral frontal lobe	Probably correct	S. K. Brannan, 1997, Unpublished
280, 1, 9	24	-70	-24	Dorsal parietal cortex	Is labeled “Right cerebellum” in the article	(Schlösser et al., 1998, table 1)
4, 2, 7	-6	42	-8	Cerebellum	Not possible to find the foci in the article.	(Petersen et al., 1988)
280, 1, 7	38	24	-8	Dorsolateral parietal	Is labeled “Right orbitofrontal cortex” in the article	(Schlösser et al., 1998, table 1)
277, 3, 3	-50	-42	-14	Inferior frontal gyrus, posterior	Is labeled “inferior temporal gyrus posterior (area 37)” in the article	(Owen et al., 1996, table 2)
115, 2, 5	-38	54	0	Middle temporal	Emailed Shaywitz twice. First email was answered but did not resolve the problem. Second email pending.	(Shaywitz et al., 1995, page 155)
65, 2, 23	57	26	45	Anterior cingulate (gyrus)	Millimeter and centimeter for x-coordinate confused during BrainMap entry.	(O’Sullivan et al., 1994, table 4)
52, 1, 2	36	-46	36	Inferior frontal gyrus	Probably misunderstanding of the text during entry. The foci is around supramarginal gyrus and the denoted “BA40”.	(Becker et al., 1994, page 287)
61, 1, 12	-24	42	4	Temporal/insular	Emailed author, answer pending. The coordinate must be wrong. All z-scores are different between article and BrainMap.	(Tulving et al., 1994, table 1)

Table 1: BrainMap outliers. The entries are ordered according to novelty. The first column indicates the paper, experiment and location identifier. The second to fourth column are x, y and z with the “reported” coordinates from BrainMap, not the corrected “Talairach 1988” coordinates.

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