

Tools for Neuroimaging

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Tools

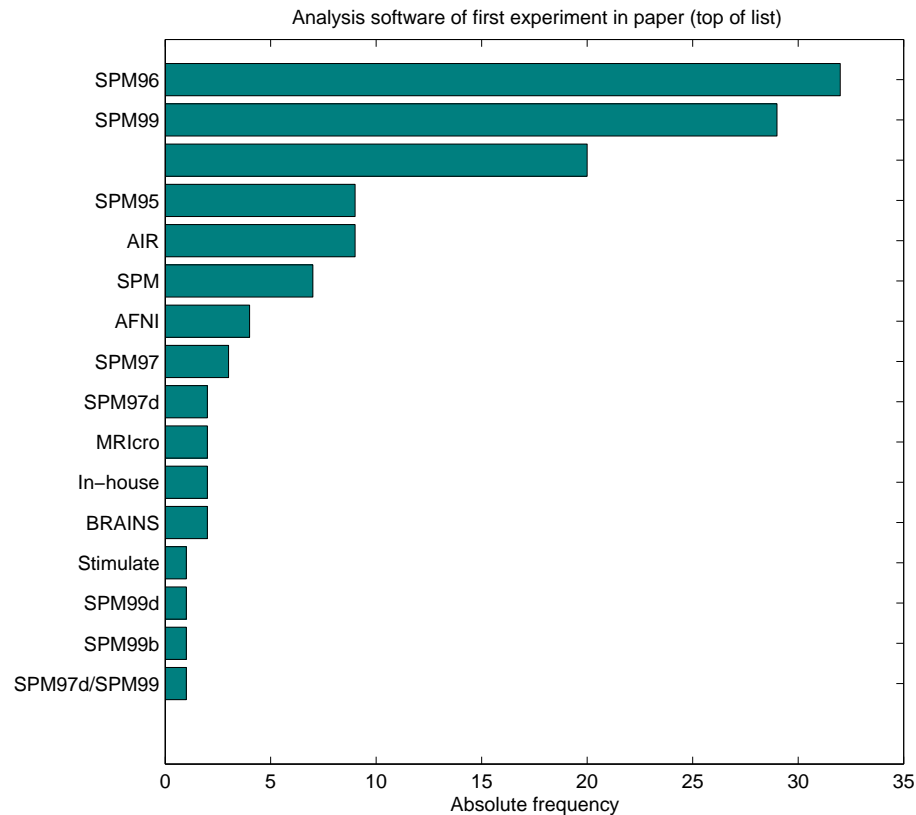


Figure 1: Histogram of used analysis software as recorded in the Brede Database, see original at http://hendrix.imm.dtu.dk/services/jerne/-brede/index_bib_stat.html

Bibliographies in functional neuroimaging. Link:

<http://www.imm.dtu.dk/~fn/bib/-Nielsen2001Bib/>

Neuroinformatics with links to programs for processing, analysis and visualization, databases, terminology.

SPM is very dominating in functional neuroimaging. AIR, AFNI and MRICRO somewhat used.

SPM — Statistical parametric mapping

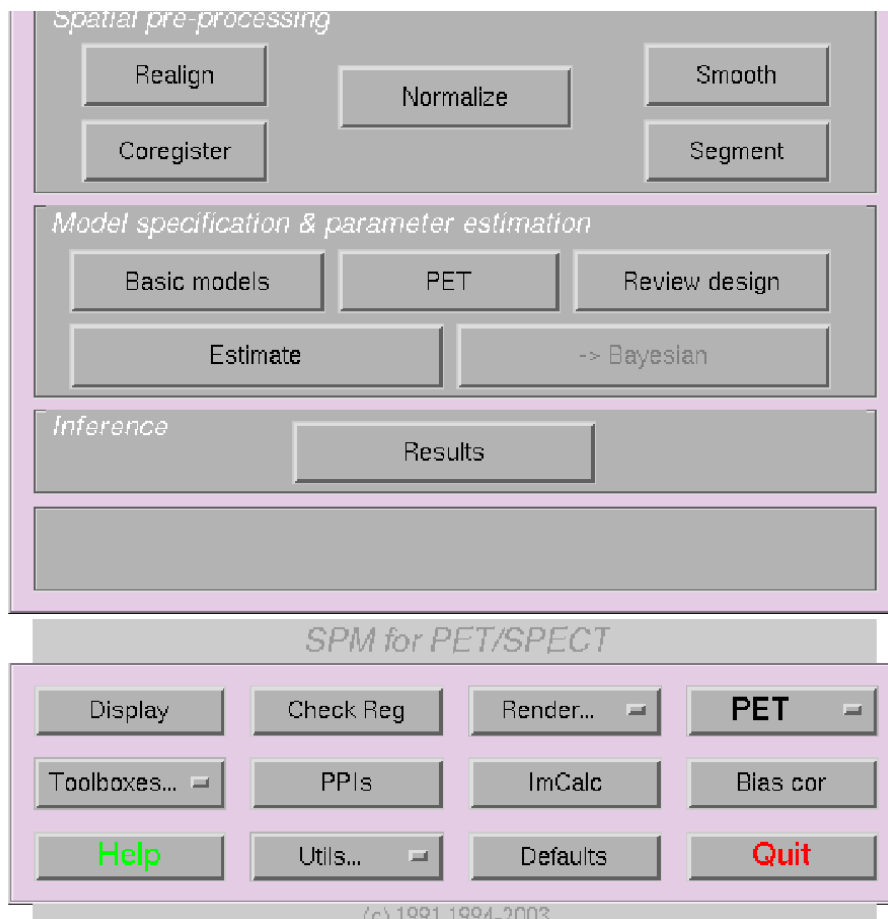


Figure 2: Main window of SPM.

Matlab and C functions programmed by John Ashburner (55), Karl Friston (46), Andrew Holmes (45), Jesper Andersson (11), Thomas Nichols (6), ...

Image registration, segmentation, smoothing, algebraic operations

Analysis with general linear model, random field theory, dynamic causal modeling

Visualization

Email list with ~ 2000 subscribers

SPM plugins — third party software

Batch processing. Programs to construct batch jobs.

INRIAlign. Robust motion alignment.

Diffusion. Functions for DWI MRI

Region of interest modeling (MarsBar, WFUPickAtlas),

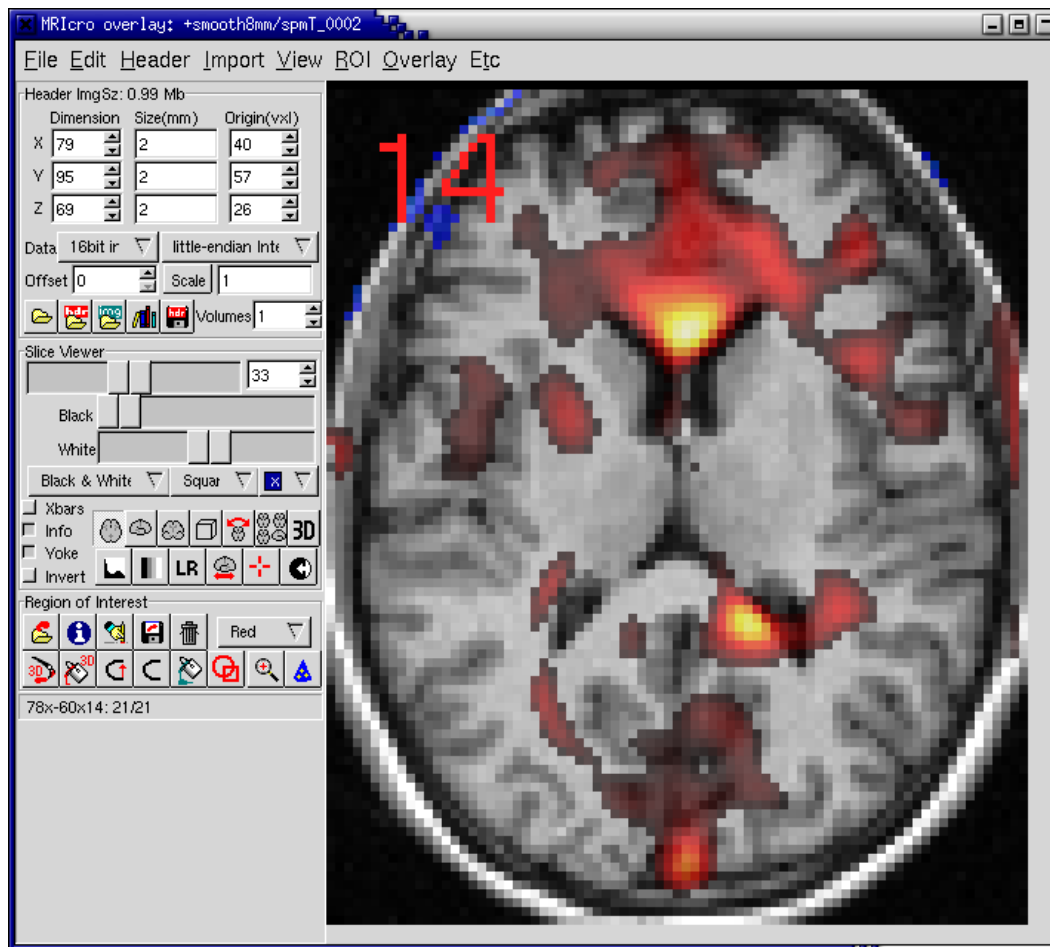
Multivariate analysis (MM Toolbox),

“Statistical Parametric Mapping Diagnosis”

Non-parametric permutation test (SnPM) (Holmes et al., 1996; Nichols and Holmes, 2001)

...

MRicro



MRicro programmed by Chris Rorden.

Slice view and volume rendering view. Overlay of functional images on structural

Drawing of regions.

Extraction of the brain

Includes a labeled volume (Tzourio-Mazoyer et al., 2002)

Lyngby Toolbox

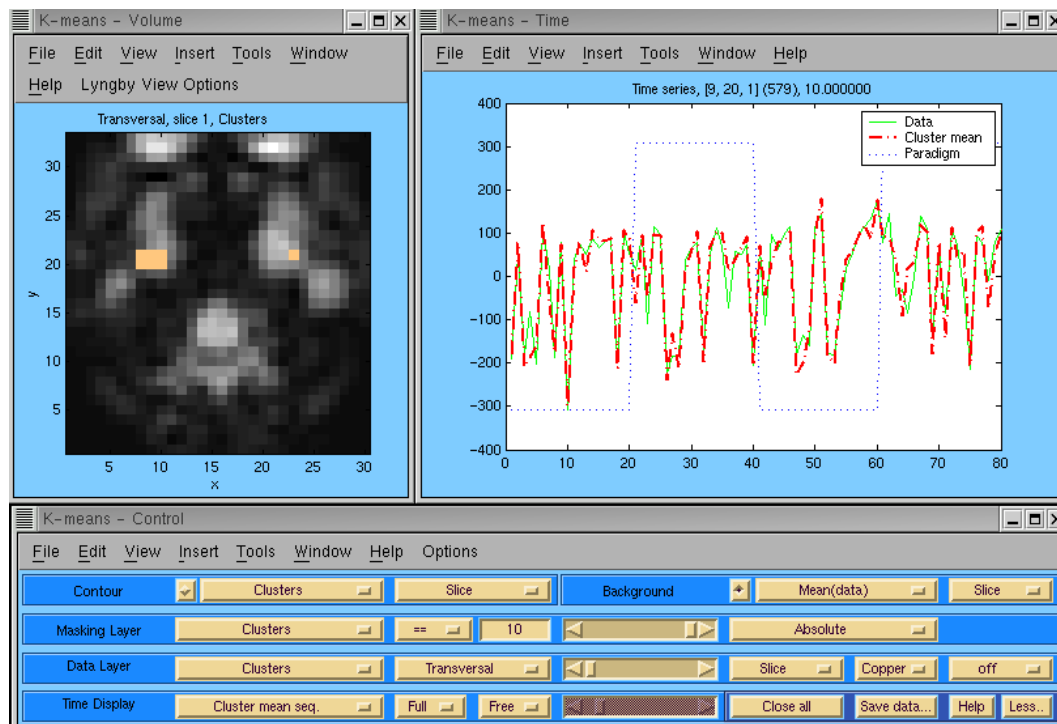


Figure 3: One of the windows in the Lyngby toolbox

Programmed by Matthew Lip-trot, Lars Kai Hansen, Finn Årup Nielsen, ... (Hansen et al., 1999)

Multivariate analyses: Cluster analysis, canonical correlation, independent component analysis

Databases

BrainMap — Two databases with stereotaxic Talairach coordinates and annotation. Contains data from over 500 articles.

fMRIDC — fMRI data center. Contains raw fMRI data sets primarily published in the *Journal of Cognitive Neuroscience*. Presently only simple search interface. Data set is set by ordinary mail. 71 studies.

CoCoMac — Connections in the monkey brain. Established from anatomical tracing studies in 391 articles.

BrainInfo (NeuroNames) — Brain structures linked in an ontology with images.

Spatial normalization

Spatial normalization: Deform subject brain scans to a template.

Determine warp parameters by matching a subjects anatomical MRI (“Source image”) to a template (“Determine parameters”)

```
params = spm_normalise(Vtemplate, Vmri, matname, '', '', ...  
defaults.normalise.estimate);
```

Apply (“Write normalised”) the warp parameter to warp the functional image (“Images to write”)

```
spm_write_sn(Vpet, params, defaults.normalise.write, msk);
```

By default SPM is normalizing to so-called “MNI-space” which is slightly different from the original “Talairach atlas”.

Spatial normalization

```
defaults.normalise.estimate.smosrc = 8;
defaults.normalise.estimate.smoref = 0;
defaults.normalise.estimate.regtype = 'mni';
defaults.normalise.estimate.weight = '';
defaults.normalise.estimate.cutoff = 25;
defaults.normalise.estimate.nits = 16;
defaults.normalise.estimate.reg = 1;
defaults.normalise.estimate.wtsrc = 0;
defaults.normalise.write.preserve = 0;
defaults.normalise.write.bb = [[-78 -112 -50]; [78 76 85]];
defaults.normalise.write.vox = [2 2 2];
defaults.normalise.write.interp = 1;
defaults.normalise.write.wrap = [0 0 0];
```

`reg` (regularization) and `cutoff` (cutoff of the discrete cosine basis functions) determine the smoothness of the warp.

“[...] if your normalized images appear distorted, then it may be an idea to increase the amount of regularization” (`spm_normalise_ui.m`)

Spatial smoothing

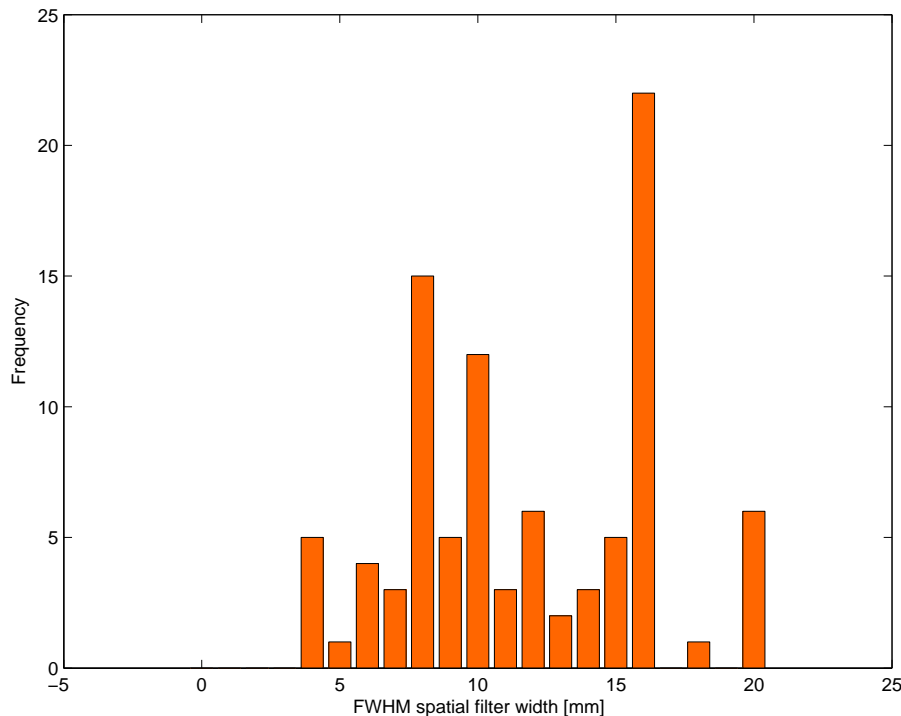


Figure 4: Histogram of smoothing width in the Brede database, see original at http://hendrix.imm.dtu.dk/services/jerne/-brede/index_bib_stat.html

Accounts for anatomical variability.

Usually performed with with an Gaussian kernel.

SPM command line

```
spm_smooth(filenameIn, filenameOut, 16);
```

Here 16 is the full width half maximum

$$\text{FWHM} = \sqrt{8 \ln 2} \sigma \approx 2.35\sigma.$$

An “s” is prefixed on the filename.

References

Hansen, L. K., Nielsen, F. Å., Toft, P., Liptrot, M. G., Goutte, C., Strother, S. C., Lange, N., Gade, A., Rottenberg, D. A., and Paulson, O. B. (1999). “lyngby” — a modeler’s Matlab toolbox for spatio-temporal analysis of functional neuroimages. In Rosen, B. R., Seitz, R. J., and Volkman, J., editors, *Fifth International Conference on Functional Mapping of the Human Brain, NeuroImage*, volume 9, page S241. Academic Press. <http://isp.imm.dtu.dk/publications/1999/hansen.hbm99.ps.gz>. ISSN 1053–8119.

Holmes, A. P., Blair, R. C., Watson, J. D. G., and Ford, I. (1996). Non-parametric analysis of statistic images from functional mapping experiments. *Journal of Cerebral Blood Flow and Metabolism*, 16(1):7–22. PMID: 8530558.

Nichols, T. E. and Holmes, A. P. (2001). Nonparametric permutation tests for PET functional neuroimaging experiments: A primer with examples. *Human Brain Mapping*, 15(1):1–25. PMID: 11747097. <http://www3.interscience.wiley.com/cgi-bin/abstract/86010644/>. ISSN 1065-9471.

Tzourio-Mazoyer, N., Landeau, B., Papathanassiou, D., Crivello, F., Etard, O., Delcroix, N., Mazoyer, B., and Joliot, M. (2002). Automated anatomical labeling of activations in SPM using a macroscopic anatomical parcellation of the MNI MRI single-subject brain. *NeuroImage*, 15(1):273–289. <http://www.idealibrary.com/links/doi/10.1006/nimg.2001.0978>.