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Title

Statistical Parametric Mapping, There and Back Again.

Authors

Christophe Phillips, c.phillips@uliege.be GIGA *in silico* medicine & CRC *in vivo* imaging, GIGA Institute, University of Liège, Belgium. Department of Electrical Engineering & Computer Science, University of Liège, Belgium.

Guillaume Flandin, g.flandin@ucl.ac.uk Welcome Centre for Human Neuroimaging, University College London, London, UK.

Abstract (1000 ch)

In 1988 the first brain activation studies, relying Positron Emission Tomography (PET) and the availability short half-life radio tracers, were reported. Back then regional differences between brain images were simply characterised over hand-drawn region of interests. The idea of producing a "statistical parametric map" (SPM), i.e. providing valid inferences about brain signals over all the voxels, was formally introduced in 1990 by Friston et al. for PET images. The SPM framework (Fig. 1) was further extended over the years to handle functional and structural MRI, along with EEG and MEG data [1]. Since its first instance in 1991, the SPM software is openly and freely available to the neuroimaging community, to promote collaboration and a common analysis scheme across laboratories.

Nowadays SPM remains the most used software for the analysis of neuroimaging data [2,3]. Its openness lead to the development of a whole ecosystem where extensions (more than 60!) were developed to address other problems. Some of these constitutes toolboxes on their own, e.g. the application of machine learning techniques in neuromaging [4] or the processing of quantitative MRI [5].

other researchers could develop their own tool by using SPM's building blocks. Currently more than 60 extensions are available. Some of these constitutes toolboxes on their own, for example on the application on machine learning techniques in neuromagin (PRoNTo [4]) or the processing of quantitative MRI (hMRI [5]).

References (5):

[1] K.J. Friston. A short history of statistical parametric mapping in functional neuroimaging. Technical report, Wellcome Department of Imaging Neuroscience, ION, UCL, 2002. https://www.fil.ion.ucl.ac.uk/spm/doc/history.html

[2] J. Carp, The secret lives of experiments: Methods reporting in the fMRI literature. NeuroImage. 2012 63:289-300. https://doi.org/10.1016/j.neuroimage.2012.07.004

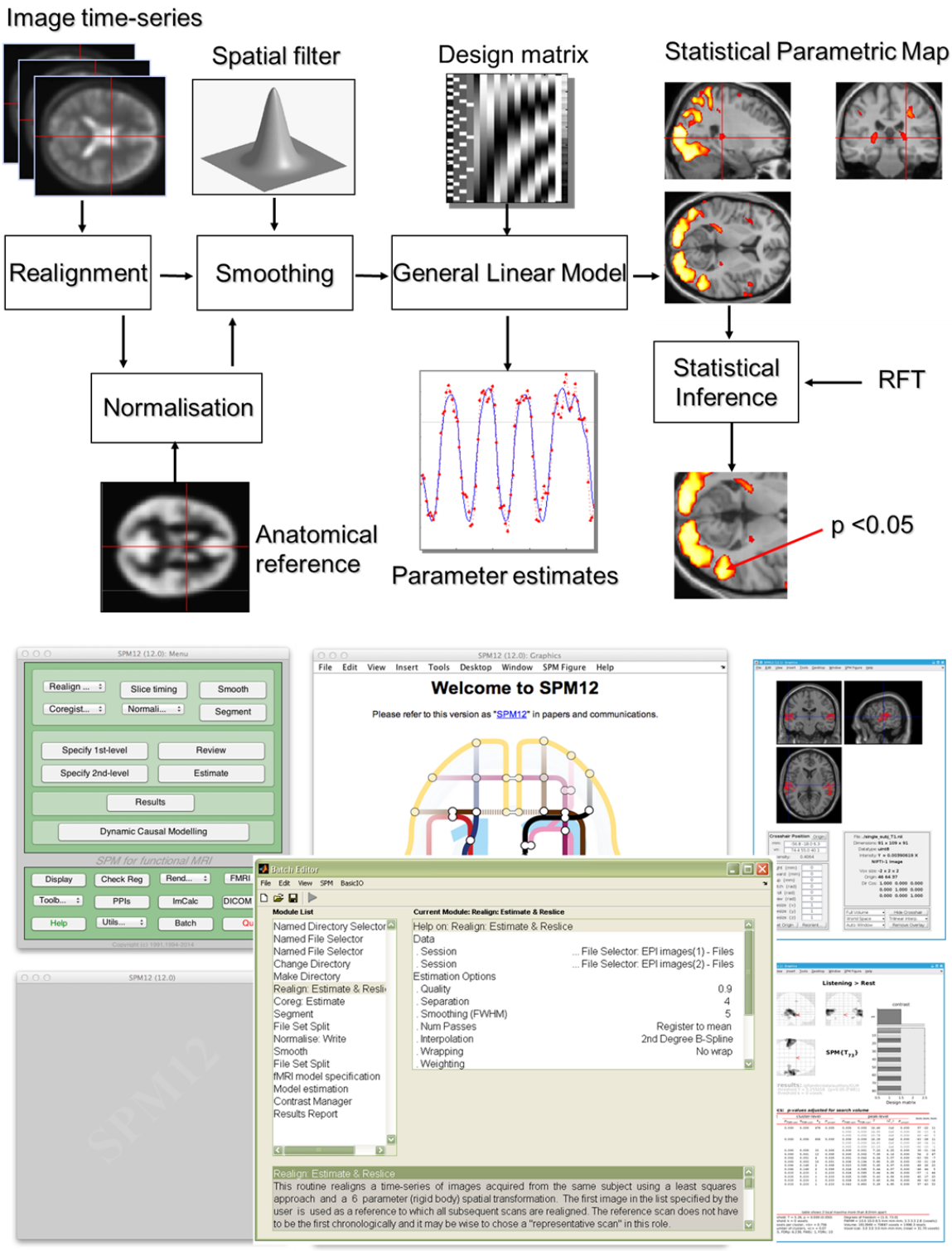
[3] R. A. Poldrack, et al., Computational and Informatic Advances for Reproducible Data Analysis in Neuroimaging, Annu. Rev. Biomed. Data Sci. 2019. 2:119–38. https://doi.org/10.1146/annurev-biodatasci-072018-021237

[4] J. Schrouff, et al., PRoNTo: Pattern Recognition for Neuroimaging Toolbox. Neuroinformatics. 2013. 11: 319. https://doi.org/10.1007/s12021-013-9178-1 and http://www.mlnl.cs.ucl.ac.uk/pronto/

[5] K. Tabelow, et al., hMRI – A toolbox for quantitative MRI in neuroscience and clinical research. Neuroimage. 2019. 194:191-210. https://doi.org/10.1016/j.neuroimage.2019.01.029 and http://hmri.info

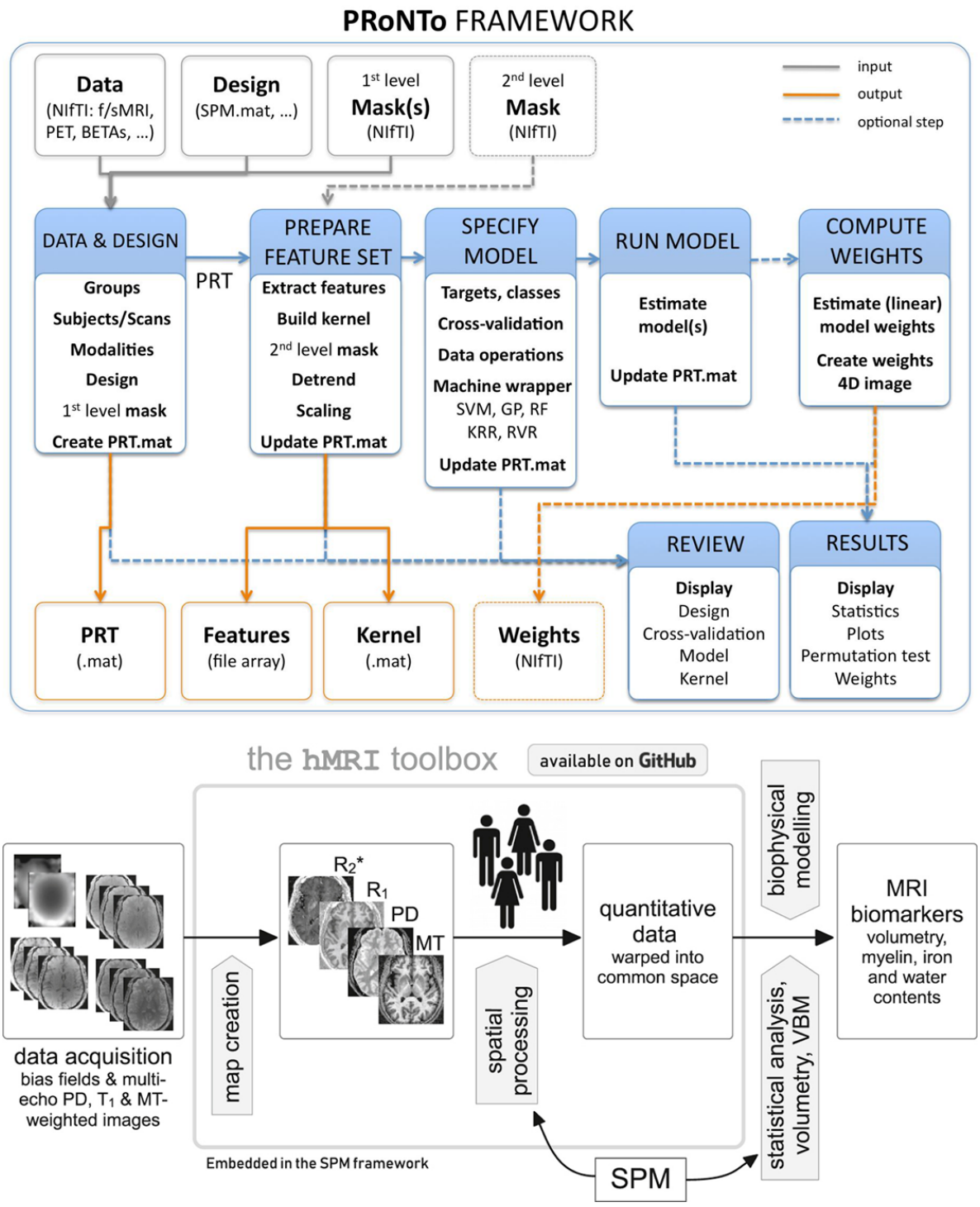
Figures

Figure 1



Top: Standard SPM processing pipeline for functional MRI data (left) from the raw fMRI data to the map voxels showing a statistically significant activation, displayed over a structural MRI for anatomical reference (right). **Bottom:** Graphical user interface of SPM12 (left), with batching system (centre) and results visualization (right).

Figure 2



Top: Pattern Recognition for Neuroimaging Toolbox (PRoNTo) framework, providing a multivariate machine learning tool. Only low-level SPM functions (data I/O, batching facility, etc.) are used in the 5 main modules. **Bottom:** hMRI toolbox framework, extending SPM's functionality to the creation of quantitative MR images and processing at the group level. Spatial processing and statistical analysis rely heavily on SPM machinery.

Short biography (500 ch)

Christophe Phillips has a Master in Electrical Engineering and a PhD in Applies Sciences, both from the University of Liège. He has been working for more than 20 years in the field of neuroimaging, specifically developing open source data processing tools like SPM, PRoNTo and the hMRI toolbox. He is now a FRS-FNRS Senior Research Associate at the GIGA Institute and

Associate Professor at the Department of Electrical Engineering & Computer Science, University of Liège, Belgium.