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**Cluster priors in the Bayesian modelling of fMRI data.**

Bericht. Universität Jyväskylä, Institut für Mathematik und Statistik. 82. Jyväskylä: Univ. of Jyväskylä, Department of Mathematics, 105 p. (2001).

The goal of this paper is to introduce new statistical ideas applied to FNI (functional neuroimaging) and fMRI (functional magnetic resonance imaging) in the context of Bayesian estimation methods. The fMRI technique allows for the application of different tests to a single patient without riskiness for his/her health. Data coming from the fMRI technique can be considered as spatial time series. The signal is contaminated with noise coming from the scanner and physiological factors which cannot be kept under control. Data coming from fMRI techniques are usually used to locate neural responses to given stimuli in the brain as well as the magnitude of such responses. Therefore, the goal of the paper is to propose a prior distribution to model activations in the brain. Voxels are modelled as a union of clusters, where cluster means a local area in the cortex. The knowledgeability of the experts can be included in the prior in terms of location and size of the clusters. In Section 2, the author describes how fMRI data are measured and discusses the main characteristics of the procedure under consideration. The thesis focusses on the spatial aspects of the procedures. Section 3 reviews statistical methods used frequently in the analysis of fMRI data. The methods mostly refer to either the estimation of hemodynamical processes or the location of neural activation. In Section 4, neural activations are described through a model specially tailored to the problem. Some assumptions on neural activations are made. In Section 5, a probabilistic model is proposed for data conditioned to neural activations. In Section 6, a detailed explanation is given on sampling techniques of the posterior distribution for neural activations. The technique is based on the generation of Markov chains for limiting distributions with variable dimension. It is necessary to include the possibility of variable dimension since configurations of different profiles of activations have variable size. Section 7 (entitled Analysis of the sound-stimulus data) shows how to apply the proposed techniques to estimate specific points related to real data. In Section 8, a simulation study is included. The consequences for not using the proper prior likelihood functions are analyzed. Section 9 includes alternative proposals to apply in prior modelling of neural activations, noise processes and posterior distribution sampling. Section 10 discusses critically the advantages and disadvantages of Bayesian techniques in fMRI data analysis. The Bayesian paradigm seems to provide a natural context to model the neural activation process in neuroimaging problems. However, the author warns that “if a profile can be estimated from the data with high precision, the application of sophisticated Bayesian techniques becomes more or less inappropriate since the posterior will not be sensitive to the prior.” Anyway, a rich variety of interactions between statistics and FNI can be expected. The thesis ends up with an appendix devoted to mathematical aspects, and an exhaustive list of bibliographical references. Undoubtedly, this thesis is a very useful device for statisticians interested in FNI.

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