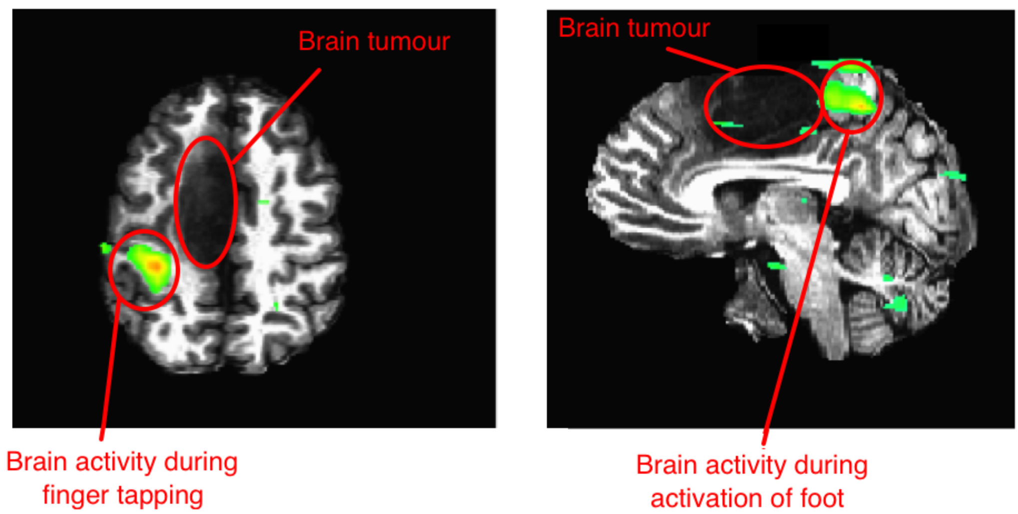
MASTER THESIS PROPOSAL SPRING 2018

PER SIDÉN

ESTIMATING BRAIN ACTIVITY NEARBY BRAIN TUMOURS USING FMRI AND BAYESIAN SPATIAL MODELS

fMRI (functional magnetic resonance imaging) is a modern technique for creating 3-dimensional images of brain activity. The method measures the oxygen level of the brain over time, which is represented as a sequence of images. These images can be used to say something about the functional behavior of the brain, since brain activity in a certain part of the brain will have effect on the oxygen level in the same region. The fMRI data is usually quite noisy and therefore require powerful statistical in order to correctly infer the brain activity. For an introduction, see Lindquist (2008).

An interesting application area for fMRI is that of planning brain tumour surgery (Gallen et al., 1994; Pillai, 2010). Using fMRI one can locate the patient's areas of brain activation associated with different tasks (e.g. movement, vision, etc.), in order to avoid removing these areas during surgery. However, the use of such methods in day to day clinical practice is rather small, due to limited accuracy (Pernet et al., 2016).



In previous work (Sidén et al., 2017), we developed Bayesian, computationally efficient methods for spatially modeling the brain activity in single subject fMRI data, using Gaussian Markov random fields. In this project, the goal will be to apply these methods to data from brain tumour patients, in order to estimate the active brain regions of different tasks and to visualize these relative to the tumour. The resulting posterior will also be used to compute the joint posterior probability of activity within or nearby the brain tumour, using the excursion sets defined in Bolin and Lindgren (2015). Our methods are likely to be successful in this task, since the spatial priors work as regularization and provide a Bayesian approach to multiple hypothesis correction.

The model estimation will be carried out in Matlab using the package BFAST3D (https://github.com/psiden/BFAST3D), but post-processing, posterior computations and visualization can be carried out in any language. A well written master thesis might result in that the method becomes further analyzed in an upcoming research collaboration together with Elekta, a company who develops a gamma knife as an alternative to traditional brain surgery.

References

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