Bayesian spatial regularization in nonlinear regression

Presenter: Sommer Julia, Ludwig-Maximilians-Universität München, Deutschland, julia.sommer@stat.uni-muenchen.de
Co-authors: Schmid Volker

Abstract
Dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) assesses the perfusion in tissue in vivo. After injection of a contrast agent, a series of images shows its uptake into the tissue over time. Quantitative analysis of this uptake plays a decisive role in the diagnosis and classification of cancer. The shape of the concentration time curves is modeled with compartment models, which describe the exchange of contrast medium between well-mixed compartments. As the standard model with one tissue compartment proposed by Tofts and Kermode (1991) does not capture heterogeneity within voxels, more complex models are needed. A two tissue compartment model for DCE-MRI at a voxel level, however, suffers from parameter redundancy. As a solution to redundancy issues we propose to use the spatial information intrinsic in an image. We incorporate spatial smoothness of the kinetic parameters imposing Gaussian Markov random field priors on them. We analyze to what extent this spatial regularization helps to avoid parameter redundancy and to obtain stable parameter estimates. Choosing a full Bayesian approach, we obtain posteriors and point estimates running Markov Chain Monte Carlo simulations. The proposed approach is evaluated for simulated concentration time curves as well as for in vivo data from a breast cancer study.