Adjoint method for a tumor invasion PDE-constrained optimization problem

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Abstract In this talk we present a method for estimating unknown parameter that appear in a two dimensional non-linear reaction-diffusion model of cancer invasion. The model considers that tumor-induced alteration of micro-enviromental pH provides a mechanism for cancer invasion. A coupled system reaction-diffusion describing this model is given by three partial differential equations for the 2D non-dimensional spatial distribution and temporal evolution of the density of normal tissue, the neoplastic tissue growth and the excess concentration of H + ions. Each of the model parameters has a corresponding biological interpretation, for instance, the growth rate of neoplastic tissue, the diffusion coefficient, the reabsorption rate and the destructive influence of H + ions in the healthy tissue.

After solving the direct problem, we propose a model for the estimation of parameters by fitting the numerical solution with real data, obtained via in vitro experiments and fluorescence ratio imaging microscopy. We define an appropriate functional to compare both the real data and the numerical solution using the adjoint method for the minimization of this functional.

We apply a splitting strategy joint with Adaptive Finite Element Method (AFEM) to solve the direct problem and the adjoint problem. The minimization problem (the inverse problem) is solved by using a trust-region-reflective method including the computation of the derivative of the functional.