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Efficient Multiscale Methods for Modeling of Liver Tumor Growth
Effiziente Multiskalen-Methoden zur Modellierung des Wachstums von Lebertumoren

Metastatic liver cancer constitutes the fourth-leading cause of cancer-related death. A critical challenge is the fine-tuning of therapeutic options such as tumor resection, such that the risk of tumor recurrence and the risk of liver failure are well balanced. Patient-specific models of the liver-tumor system [1] can help surgeons make optimal treatment decisions and improve the success of cancer treatment.

To simulate the growth of the tumor in the specific environment of the liver, a multiscale system, spanning two scales, is used. A modeling approach can only be considered multiscale if it is able to resolve certain quantities of interest with a significantly lower cost than solving the corresponding fine-scale system. In the current tumor growth model, a generalized FE^2 approach is used, which describes both scales but is inefficient.

The aim of this thesis is to find a more efficient multiscale approach, suitable for describing liver tumor growth. For this, a review of practical multiscale methods [2] as well as summarizing the theoretical background of tumor growth processes needs to be done. A suitable and efficient multiscale approach for modeling liver tumor growth should be implemented using either Matlab or FEniCS. In the last step, the efficiency of the approach should be compared to the generalized FE^2 approach.

Required knowledge:

- Solid understanding of Finite Element Methods
- Basic programming skills (Matlab or Python)
- Motivated to familiarize with biomedical problems

Literature:

[1] CRISTINI, VITTORIO, & LOWENGRUB, JOHN (2010): Multiscale modeling of cancer: an integrated experimental and mathematical modeling approach. Cambridge University Press.

[2] FISH, JACOB (2013): Practical Multiscaling. John Wiley & Sons.