THESIS PROJECT COSSE - RUTGER ENGELBERTS

In previous master theses of Nathalie Oudhof and Eva Slingerland a model was implemented to predict patient-specific tumour response of HER2+ breast cancer patients, with a data-set of MRI scans of patients of Erasmus MC. Specifically, this is the *Mechanically Coupled Reaction Diffusion model* (MCRD), with an extension called the *Drug-Included MCRD* (DI-MRCD). This thesis will continue this research, now focusing on an numerically efficient and accurate implementation. Efficiency is key here, as the models present can take over a day to get to their final prediction with 2D data. Most of the time is needed to tune the patient-specific parameters of the model. For usage in hospitals, this needs to be brought down to a couple of hours for 3D data. Hence an analysis on the bottlenecks of this simulation is crucial to realising a tool which can assist doctors in making a good treatment schedule.

The improvements on the implementation will be done by taking the DI-MCRD model apart, and identifying what steps are done with which numerical methods. Aside from the inverse problem of tuning the model to each patient, there is a sub-problem in the form of a linear-elastic equation. Furthermore, the model needs to be evaluated over time, for which either a system needs to be solved or large-scale multiplications must be done. With state-of-the-art methods and clever programming, the goal of substantially reducing the time needed to run this model should be attainable, as well as improving the accuracy of the predictions afterwards. Research for this can both be done by investigating medical literature, but also literature in mechanical engineering, where they solve similar problems. With this in mind, we state that the goal of this project is to answer the following general research question:

How can the (DI-)MCRD model be implemented more efficiently, in order to be able to tune the model and predict tumour response in 3D for HER2+ breast cancer patients?