THESIS PROJECT APPLIED MATHEMATICS – DIEDE ROOM

In prior master theses, Nathalie Oudhof, Eva Slingerland, and Rutger Engelberts developed a model to predict the tumour response of HER2+ breast cancer patients. The model, based on a dataset of MRI scans from Erasmus MC (EMC), implemented the Mechanically Coupled Reaction Diffusion model (MCRD) and its extension, Drug-Included MCRD (DI-MRCD). The dataset consists of three scans—initial, mid-treatment, and post-treatment. Parameters for proliferation, tumour movement, and chemotherapy efficacy are derived from the initial two scans. The calibrated DI-MRCD model then forecasts the outcome of the third scan. Currently there are only scans of three patients available. This is since obtaining patients' scans with all three sessions is limited, as the last scan often shows no visible tumours due to complete chemotherapy response (pCR). Therefore, the EMC is likely not able to deliver more patient scans including all three sessions.

This thesis aims to enhance the model's predictive capability. Firstly, the timing of the three scans will be investigated, as discussed in the literature[1]. Refining the timing might ensure more precise predictions through patient-specific parameter calibration.

Secondly, to address the issue of unrealistic parameter values resulting from previous theses' tuning, a verification process is initiated. Additional scans of patients, comprising only the first two scans, are used for assessment, as there are more scans available from the EMC only consisting of the first two-time sessions. If the issue of unrealistic parameters persists, the suitability of the DI-MRCD model will be reassessed. This involves parameter fitting using all three scans, accompanied by a thorough revisit to the tuning process.

Moreover, in the final phase, alternative methods for modelling HER2+ tumour response are considered. Level-set methods, known for their effectiveness with binary data, implicitly model the tumour boundary instead of individual cells, providing a potential better fit for the dataset.

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[1] Julie C DiCarlo, Angela M Jarrett, Anum S Kazerouni, John Virostko, Anna Sorace, Kalina P Slavkova, Stefanie Woodard, Sarah Avery, Debra Patt, Boone Goodgame, et al. Analysis of simplicial complexes to determine when to sample for quantitative dce mri of the breast. *Magnetic Resonance inMedicine*, 89(3):1134–1150, 2023.