Hybrid methods and coarse-graining in multi-scale modelling of tumour growth

The efficient treatment of cancer is one of the major unsolved problems in modern Biomedicine. Novel therapeutic approaches are often based in *personalised* or *precision* medicine approaches, whereby patient-specific data is used to inform tailor-made therapies. The complexity of such task is a consequence of the fact that the behaviour of biological tissues, both in health and disease, is an emergent property of the collective behaviour of interacting agents (cells) which exhibit complex dynamics themselves in response to their mutual interactions as well as changes in their environment. Understanding such systems requires the formulation of mechanistic, multi-scale models that take into account how individual cell behaviour (determined by networks of (epi)genetic regulation, signalling pathways, etc.) is coupled via cell-to-cell interaction mechanisms (e.g. competition between cancer and normal cells) to generate the global properties of the tumour.

In order to apply multi-scale modelling to situations of practical interest new methods for both efficient numerical simulation and up-scaling of the models into continuous descriptions (PDEs, etc.) need to be developed. We are particularly interested in hybrid numerical methods where mesoscopic stochastic simulations are coupled to coarse-grained, mean-field descriptions of the corresponding mesoscopic dynamics. These methods improve both the overall computational efficiency of the stochastic simulations and the accuracy of the mean-field description.

The work of intern student will consist of (i) familiarizing with the relevant literature (see below), and (ii) applying the methodology to a simple case study.

For this particular project, it is possible to join from 4th June onwards, as the group is organizing the following conference at CRM http://www.crm.cat/en/Activities/Curs_2017-2018/Pages/IRP-Biology.aspx, and the intern will be invited to participate.

Bibliography

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3. H. Perfahl, B.D. Hugues, T. Alarcon, P.K. Maini, M.C. Lloyd, M. Reuss, H.M. Byrne. J. Theor. Biol. 414, 254-268 (2017)
4. R. de la Cruz, P. Guerrero, J. Calvo, T. Alarcon. J. Comp. Phys. 350, 974-991 (2017)