MAE Seminar Series

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Zoom Information

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Dr. Ernesto Augusto Bueno da Fonseca Lima

Research Associate

Oden Institute for Computational Engineering and Sciences

The University of Texas at Austin

Development and Calibration of a Hybrid Agent-Based Model of Tumor Growth

ABSTRACT

Cancer results from a complex interaction of different biological, chemical, and physical phenomena that span a wide range of time and space scales. Computational modeling can help to unfold the role of multiple factors that exist and interact in the tumor microenvironment. Understanding these complex interactions at multiple scales is a crucial step in predicting cancer growth and developing effective therapies. In this work, we integrate different modeling approaches into a hybrid, multiscale, avascular tumor growth model, covering tissue and cellular scales. At the tissue level, we consider the dispersion of nutrients in the microenvironment, modeled by a reaction-diffusion equation. At the cellular level, we use an agent-based model to describe the dynamics of cancer cells differentiated into quiescent, proliferative, and dead (apoptotic and necrotic) states. Cellular motion is driven by the balance of a variety of forces according to Newton's second law, including those related to growth-induced tensions. Phenotypic transitions are defined by specific rules of behavior that depend on stimuli from the microenvironment. The bridge between the cellular and tissue scales is made through the source terms of the reaction-diffusion equation. Our hybrid model is built in a modular way, allowing the investigation of the role of different mechanisms at various scales in tumor progression. The global sensitivity analysis identifies the relative importance of the model parameters in the confluence of living and dead cells. Guided by the parameter's importance, Bayesian calibration is performed to infer the values of the most important parameters using experimental data. The results of the calibrated model indicated that the model can accurately simulate the cellular responses observed in experiments in different microenvironments and initial conditions.

BIO SKETCH

Dr. Lima is a Research Associate in the Center for Computational Oncology at the Oden Institute for Computational Engineering and Sciences at the University of Texas at Austin (UT Austin). He is also a member of the Life Sciences Computing Group at the Texas Advanced Computing Center at UT Austin. He received his Bachelor in Medical Physics (2008) and Master in Biometrics (2010) from the São Paulo State University (UNESP), Brazil, and his Doctor degree in Computational Modeling (2014) from the National Laboratory for Scientific Computing (LNCC), Brazil. He was a Postdoctoral Fellow at the Oden Institute for Computational Engineering and Sciences at Ut Austin from 2014-2017. A common feature in his research is the coupling of relevant biological problems (e.g., population dynamics, pest control, tumor growth) with computer models. Currently, he has been working with the development, calibration, and selection of predictive computational models of tumor initiation, growth, and decline.