Istituto di Analisi dei Sistemi ed Informatica "Antonio Ruberti"
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colloquia@iasi

*"La mente è come un paracadute.
Funziona solo se si apre"
A. Einstein*

Stochastic Modelling of Tumour-induced Angiogenesis

Prof. **Vincenzo Capasso**
Dipartimento di Matematica "Federigo Enriques", Università di Milano, Milano

Abstract

A major source of complexity in the mathematical modelling of an angiogenic process derives from the strong coupling of the kinetic parameters of the relevant stochastic branching-and-growth of the capillary network via a family of interacting underlying fields.

Methods for reducing complexity include homogenization at larger scales, e.g. by (locally) averaging the stochastic cell, or vessel densities in the evolution equations of the underlying fields, while keeping stochasticity at lower scales, possibly at the level of individual cells or vessels. In this way only the simple stochasticity of the geometric processes of birth (branching) and growth is kept This kind of models are known as hybrid models.

Here, as a matter of example, a simplified stochastic geometric model is presented, for a spatially distributed angiogenic process, strongly coupled with a set of relevant underlying fields. The branching mechanism of blood vessels is modelled as a stochastic marked counting process describing the branching of new tips, while the network of vessels is modelled as the union of the trajectories developed by tips; capillary extensions are modelled by a system of a random number of Langevin type stochastic differential equations, coupled with the random PDE's describing the evolution of the underlying fields involved in the process. We perform a heuristic law of large numbers as the number of tips increases, showing that, when the number of tips, and then of trajectories, is large enough, the stochastic branching and growth of vessels can be described, at the macroscale, by the relevant mean densities, coupled with the, now deterministic, PDE's describing the evolution of the underlying fields involved in the process.

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