Dissertation Defense

Reliable direct and inverse methods in computational hemodynamics

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Abstract: In the last 25 years, the use of mathematics to study the behavior of the human cardiovascular system significantly increased, not just as a descriptive qualitative tool, but also for quantitative analysis of patients conditions and even treatment design. The robustness of this tool depends on the reliability of the results. Data Assimilation (DA) is a set of techniques that can help to improve the specificity of the models, by incorporating available data (e.g., measurements), making the results of the simulations patient specific. On the other hand, the numerical methods used in the simulations must be accurate enough to guarantee that the computed solution accurately describes the real behavior of the system.

This work is divided into two parts. In the first, we focus on the problem of the estimation of the compliance of a vessel using DA techniques. In particular, we use measurements of the displacement of the vessel wall to estimate its Young's modulus, and we focus on the issue of the computational costs associated with the solution of the inverse problem. The second part of this work concerns the accurate simulation of flows at moderately large Reynolds numbers. In particular, we focus on a particular discretization of the Leray system, proposing a new interpretation of the method as an operator-splitting scheme for a perturbed version of the Navier-Stokes equations, and we use heuristic arguments to calibrate one of the main parameters of the model.

For both these parts we will perform numerical experiments, on 3D geometries, to validate the approaches. In particular, for the first part, we will use synthetic measures to validate our approach, while for the second part, we will test the method on a benchmark proposed by the Food and Drug Administration, comparing out results with experimental data.

Monday, December 15, 2014, 11:00 am
Mathematics and Science Center: E408

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