Department of Applied and Computational Mathematics and Statistics Colloquium

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Assimilation and propagation of clinical data uncertainty in cardiovascular modeling

The increasing adoption of computational tools to complement clinical data collection and inform decisions in treatment demands a thorough characterization of the confidence in the predicted quantities. This confidence is affected by both modeling assumptions and variability in clinical data, anatomy, vessel wall material and response to treatment.

A wide spectrum of pathologies can be investigated using modern computational tools, that are able to account for complex fluid-structure interaction phenomena (e.g., valve dynamics), multiscale coupling between 3D Navier-Stokes solvers and 0D boundary circulation models, growth and remodeling of vascular tissue. Despite significant advances in the numerics, a less debated but equally important problem remains the ability of "learning" the parameters of these models from uncertain patient-specific data. This is key to the ability of simulating large cohorts of patients and to overcome the limitations of the operator-dependent and time consuming "manual" tuning often performed for these models.

Three examples will be discussed with specific focus on the effect of clinical data uncertainty. First, we show an example in the context of Stage I to Stage II single ventricle palliation surgery where distributions of boundary resistances are assimilated from uncertain clinical data and propagated to post-operative results. Second, we use adaptive MCMC to learn the parameters of 0D Norwood circulation models from uncertain blood pressures and flows, following the characterization of structural and practical identifiability metrics and taking advantage of the underlying compartmental layout.
Finally, we conclude by presenting condensation approaches allowing to significantly reduce the computational burden in iterative parameter estimation of full multi-scale models.

Wednesday, November 18, 2015
4:00 PM – 5:00 PM
127 Hayes-Healy Center

Colloquium Tea 3:30 PM to 4:00 PM 154 Hurley Hall