Parameter identifiability and estimation in a 1D cardiovascular fluid dynamics model

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One-dimensional (1D) fluid dynamics models can be used to predict network dynamics in a system of branching blood vessels. This is a promising tool for clinical diagnostics, as data cannot be measured in all of the downstream vasculature. Moreover, imaging practices have limited resolution for detecting in-vivo patient geometry, thus limiting the number of vessels captured for subject-specific modeling. To combat this, researchers will employ 0D boundary conditions, such as 3 element Windkessel models, or try to capture the downstream branching properties of the network using fractal surrogates, such as the structured tree model. Determining the parameters that describe distal vascular resistance and small vessel compliance are especially important when modeling the pulmonary circulation and pulmonary disease, as small pulmonary vessels are suspected to play the largest role in disease progression. However, a lack of data distal to the proximal arteries can lead to issues with parameter identifiability, as parameters may not be uniquely informed from the data. This talk will focus on determining parameter identifiability via the use of profile likelihood calculations and posterior parameter distributions obtained from Bayesian inference. In addition, we consider the adjoint PDE system, which provides an analytical gradient for the objective function considered and sheds light onto which parameters may possibly be inferred.