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Approximate Bayesian computation for generating 3D structured trees to model the pulmonary arterial network

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"Approximate Bayesian computation for generating 3D structured trees to model the pulmonary arterial network"

The pulmonary arteries form a rapidly branching network that serves to perfuse the lungs and oxygenate blood. Pressure and flow in the main pulmonary artery can be determined by solving a multiscale 1D fluid dynamics model, where large arteries' dimensions are explicitly defined and small vessels are represented by self-similar structured trees. These trees are generated from parameters such as minimum vessel radius, radius scaling factors, vessel length-to-radius ratio, and branching angles. In this study, we aim to optimize the formation of the structured trees so that they closely resemble pulmonary arterial networks in CT scans. This is accomplished via approximate Bayesian computation, whereby the structured trees' parameters are extracted from distributions of observed parameter values, and summary statistics of the generated trees are compared to those from the data. Optimizing the creation of these trees would allow us to predict perfusion in lungs of patients with and without pulmonary hypertension, which has long been associated with changes in the arterial morphology. Additionally, these methods could be extended to characterize other physiological networks and inform fluid dynamics models in other organs.