Topological Data Analysis

and its Application in Vascular Research

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Cardiovascular disease is the leading cause of death world-wide. About 17.3 million people die every year and the number of deaths is expected to exceed 23.6 million by 2030. Better understanding and classifying of the types of vasculature can help save more lives. Diagnosis is based on the anatomical approach using the angiography and/or direct measurement of the fractional flow reserve with catheter or computational fluid dynamics. Numerical indices obtained by these methods, however, do not necessarily provide clear interpretation of the vasculature unless the case is extreme and the intervention is inevitable. In this talk, we present a new additional approach using the topological data analysis for the stenotic vascular flows. The key element of the topological data analysis for vascular disease presented in this talk is to project the physical data unto the n-dimensional unit sphere and then find the number of generators of the homology group at each dimension. For the vascular data, we use the spectral element method and solve the incompressible Navier-Stokes equations. By generating more refined numerical indicators, the proposed method could provide more definite interpretation in the ambiguous range of the numerical indices and more accurate diagnosis of the disease.