Behavior of Graph Laplacians on Manifolds with Boundary

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In manifold learning, algorithms based on graph Laplacians constructed from data have received considerable attention both in practical applications and theoretical analysis. In particular, the convergence of graph Laplacians obtained from sampled data to certain continuous operators has become an active research topic recently. Most of the existing work has been done under the assumption that the data is sampled from a manifold without boundary or that the functions of interests are evaluated at a point away from the boundary. However, the question of boundary behavior is of considerable practical and theoretical interest. In this paper we provide an analysis of the behavior of graph Laplacians at a point near or on the boundary, discuss their convergence rates and their implications and provide some numerical results. It turns out that while points near the boundary occupy only a small part of the total volume of a manifold, the behavior of graph Laplacian there has different scaling properties from its behavior elsewhere on the manifold, with global effects on the whole manifold, an observation with potentially important implications for the general problem of learning on manifolds.

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