Shape Matching and Map Space Exploration via Functional Maps

PhD dissertation by Jing Ren | Thesis: http://hdl.handle.net/10754/670353

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PhD Thesis Abstract

Computing correspondences or maps between shapes is one of the oldest problems in Computer Graphics and Geometry Processing with a wide range of applications from deformation transfer, statistical shape analysis, to co-segmentation and exploration among a myriad others. A good map is supposed to be continuous, as-bijective-as-possible, accurate if there are ground-truth corresponding landmarks given, and low distortion w.r.t. different measures, for example as-conformal-as-possible to preserve the angles. This thesis contributes to the area of non-rigid shape matching and map space exploration in Geometry Processing. Specifically, we consider the discrete setting, where the shapes are discretized as a mesh structure consisting of vertices, edges, and polygonal faces. In the simplest case, we only consider the graph structure with vertices and edges only.

In this thesis, we design algorithms to compute soft correspondences between discrete shapes. Specifically, (1) we propose different regularizers, including orientation-preserving operator and the Resolvent Laplacian Commutativity operator, to promote the shape correspondences in the functional map framework. (2) We propose two refinement methods, namely BCICP and ZoomOut, to improve the accuracy, continuity, bijectivity and the coverage of given point-wise maps. (3) We propose a tree structure and an enumeration algorithm to explore the map space between a pair of shapes that can update multiple high-quality dense correspondences.