UNIVERSITY OF SOUTH FLORIDA

Defense of a Doctoral Dissertation

Efficient Algorithms and Applications in Topological Data Analysis

by

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For the Ph.D. degree in Computer Science and Engineering

Topological Data Analysis (TDA) is a new and fast growing research field developed in last two decades. TDA finds lots of applications in computer vision, computer graphics, scientific visualization, molecular biology, and material science, to name a few. In this dissertation, we make algorithmic and application contributions to three data structures in TDA: contour trees, Reeb graphs, and Mapper. From the algorithmic perspective, we design a parallel algorithm for contour tree construction and implement it in OpenCL. We also design and implement persistence pairing algorithms to compute persistence diagrams directly from contour trees, Reeb graphs, and Mapper. In terms of application, we apply TDA in the design and implementation of an image enhancement application using contour trees. Lastly, we introduce an application of Mapper in model quality assessment for 3D printing.

<u>Examining Committee</u>
Alon Friedman, Ph.D., Chairperson
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Publications

1. **Junyi Tu**, Paul Rosen, Topologically-Guided Color Image Enhancement, International Symposium on Visual Computing (ISVC), Lake Tahoe, Nevada USA, October 7-9, 2019
2. **Junyi Tu**, Mustafa Hajij, Paul Rosen, Propagate and Pair: A Single-Pass Approach to Critical Point Pairing in Reeb Graphs, International Symposium on Visual Computing (ISVC), Lake Tahoe, Nevada USA, October 7-9, 2019
3. Paul Rosen, Mustafa Hajij, **Junyi Tu**, Tanvirul Arafin and Les A. Piegl, Inferring Quality in Point Cloud-based 3D Printed Objects using Topological Data Analysis, Computer-Aided Design and Applications, 16(3), 2019,519-527
4. Paul Rosen, **Junyi Tu**, Les A. Piegl, A hybrid solution to parallel calculation of augmented join trees of scalar fields in any dimension, Computer-Aided Design and Applications, 0, 2018, 1-9

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