84 King Street # 5 **Stefan C. Schonsheck** (315).317.5098

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**Education**

**Rensselaer Polytechnic Institute (RPI)** --Troy, NY Fall 2014-May 2020

PhD Candidate in Applied Mathematics: Adviser: Dr. Rongjie Lai

**Thesis:** Analysis of Deformable Manifolds: Geometry, Differential Equations and Deep Learning

**Research Interests/Skills:** Computational differential geometry and shape processing, especially numerical methods for PDEs, non-convex optimization, inverse problems, computer vision and machine learning on curved domains in 3(+)D represented as meshes, point clouds and/or graphs.

**Skidmore College**--Saratoga, NY Fall 2009-May 2013

Bachelor of Arts, Double Major: Mathematics, *with honors in* Music, Cum Laude

**Capstone**: *A Hero's Tale* for Orchestra, and *The Mathematician's Sketchbook* for chamber ensemble

**Research Projects**

**Parallel Transport Convolution-**https://arxiv.org/abs/1805.07857

I proposed new generalization of convolution which applies to manifolds represented as triangle meshes or point clouds. This allows for the generalization of wavelet-like operations and convolutional neural networks in ways which are less sensitive to deformation of the underlying surface. I implemented the method in both MatLab and TensorFlow and show results in signal processing on curved domains and shape matching. Presentations at IPAM 2018 Geometry and Learning.

**Laplace-Beltrami Basis Pursuit for Deformable Shape Correspondence**-https://arxiv.org/abs/1809.07399

I developed and implemented a new model for computing dense shape correspondences between highly non-isomorphic shapes by linking the Laplace-Beltrami eigensystem of a shape to a conformal deformation. We proved local convergence and established a re-initialization scheme to overcome some local minima in the non-convex objective as well as a subsampling scheme to improve computational performance. Presentations at SIAM Imaging 2018 and RPI Applied Math Day 2018.

**Patch Based Auto-Regressive Model**s-<https://openreview.net/pdf?id=rJeBJJBYDB>

I proposed and implemented a new class of auto-encoder like with a latent space structed as an atlas to parameterize manifold structured data. We impose a set of connectivity and regularity conditions to develop models with latent spaces which are much smaller than traditional methods. Current work involves using insights gained in this local analysis to prove universal generation theorems. Our first paper is currently in review.

**Conformal Graph Geometry**

In an extension of our previous work on conformal deformations of manifolds, I extended the analysis to apply to graphs. By using spectral information of the graph in concert with traditional data science tools we deform graphs to achieve state-of-the-art results in semi-supervised and unsupervised problems. Ongoing work with a new graduate student and undergraduate mentee involves generalizing these techniques to improve graph convolutional neural networks.

**Recent Work History**

**Rensselaer Polytechnic Institute Math Department--**Troy, NYFall 2014-Current

Research Assistant: PI: Rongjie Lai

Teaching Assistant: Intro to Diff Eq/ Numerical Computing/Health Analytics Data Lab

**Skidmore College Math Department--**Saratoga, NY September 2010-May 2014

Calculus Tutor

**Achievements/Memberships**

**Bill and Nancy Siegmann Applied Mathematical Modeling Prize** May2020

**Rensselaer-IBM Artificial Intelligence Research Collaboration** September 2019-Current

**IPAM Senior Fellow:** Geometry and Learning from Data in 3D and Beyond March-June 2019

**Dr. Richard C. and Maureen DiPrima Graduate Research Award (x2)**   May 2017 & May 2018

**SIAM RPI Chapter Secretary** Fall 2016-Spring 2018

**Pi Mu Epsilon Induction** April 2, 2013

**Presentations/Posters**

SIAM Annual Meeting 2020: Patch Based Auto-Encoding July 2020

IPAM Geometry and Learning from Data in 3D and Beyond Culmination Presentations: Graphs and Data: A review and brief glimpse forward

UTD Workshop on Recent Developments on Mathematical/Statistical Approaches to Data Science (MSDAS): June 1, 2019

IPAM Workshop IV Deep Geometric Learning of Big Data and Application Posters: Convolutional Operators on Deformable Surfaces

IPAM Workshop II Shape Analysis Poster Session: Modeling and Learning Shape Correspondence

SIAM Imaging 2018 Bologna: Nonisometric Surface Registration via Conformal Laplace-Beltrami Basis Pursuit

RPI Applied Math Days 2018: Methods for Nonisometric Surface Registration

**Programing Skills**

**Fluent** in: MATLAB (including parallel toolbox), Python (including open CV), TensorFlow, LaTeX

**Some exposure** to: C++, Fortran, R, Visual Basic