

# FRANCIS WILLIAMS

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## SUMMARY

I am a PhD student in the [Math and Data](#) and [Geometric Computing Lab](#) at New York University. I am interested in problems at the intersection of machine learning and geometry. In particular, my research aims at designing, developing, and understanding algorithms to process and understand geometric data acquired from scans of the real world. In addition to research, I have a strong background in software engineering and systems programming backed by several years of industry experience, and open source projects.

## EDUCATION

**PhD in Computer Science (In Progress, Year 3)** - GPA: 3.98/4.00  
New York University, New York, NY  
Advisor: [Joan Bruna](#)

**Bachelor of Software Engineering - Honors Co-operative program** - GPA: 81% (A)  
University of Waterloo, ON, Canada  
Graduated with Distinction  
October 1<sup>st</sup> 2015

## PUBLICATIONS

**[VoronoiNet: General Functional Approximators with Local Support](#)** - *arXiv preprint*  
**Francis Williams**, Daniele Panozzo, Kwang Moo Yi, Andrea Tagliasacchi

**[Gradient Dynamics of Shallow Univariate ReLU Networks](#)** - *NeurIPS 2019*  
**Francis Williams**, Matthew Trager, Claudio Silva, Daniele Panozzo, Denis Zorin, Joan Bruna

**[Deep Geometric Prior for Surface Reconstruction](#)** - *CVPR 2019*  
**Francis Williams**, Teseo Schneider, Claudio Silva, Denis Zorin, Joan Bruna, Daniele Panozzo

**[ABC: A Big CAD Model Dataset For Geometric Deep Learning](#)** - *CVPR 2019*  
Sebastian Koch, Albert Matveev, Zhongshi Jiang, **Francis Williams**, Alexey Artemov, Evgeny Burnaev, Marc Alexa, Denis Zorin, Daniele Panozzo

**[Unwind: Interactive Fish Straightening](#)** - *CHI 2020*  
**Francis Williams**, Alexander Bock, Harish Doraiswamy, Cassandra Donatelli, Adam Summers, Daniele Panozzo, Claudio Silva

## OPEN SOURCE

***Point Cloud Utils***

<https://github.com/fwilliams/point-cloud-utils>

- A Python utility library exposing common algorithms on 3D point clouds and meshes:
  - Random point sampling of meshes with Poisson Disk Sampling and Lloyd-Relaxation
  - Fast pairwise nearest neighbor
  - Point set distances including Chamfer, Sinkhorn, and Hausdorff

### ***NumpyEigen***

<https://github.com/fwilliams/numpyeigen>

- A library for fast zero-overhead bindings between Numpy and Eigen:
  - Makes it easy to transparently convert NumPy dense and sparse arrays into Eigen types while taking full advantage of expression template optimizations in Eigen
  - Features near-zero performance overhead and supports function overloading
  - Used by LibIGL, a major open source project, for Python bindings

### ***FML - Francis' Machine-Learnin' Library***

<https://github.com/fwilliams/fml>

- A collection of Pytorch utilities for machine learning tasks:
  - Includes a numerically stable implementation of the Sinkhorn algorithm to compute optimal transport of point sets in any dimension
  - Also includes a vectorized implementation of the Chamfer-Distance between point sets in any dimension

### ***Unwind***

<https://github.com/fwilliams/unwind>

- A software tool for segmenting and unwarping volumetric CT scans of fishes:
  - Currently deployed in 2 Labs (at Tufts and the University of Washington) with plans for expansion
  - [Paper](#) in submission to IEEE TVCG 2019

### ***LibIGL***

<https://github.com/fwilliams/libigl>

- Actively contribute to LibIGL, an open source geometry processing library:
  - Designed, wrote, and maintained new Python bindings (release planned for July)
  - Implemented techniques for meshing
  - Implemented volume rendering in the viewer

## WORK EXPERIENCE

### ***Software Engineer***

MemSQL

Jan 2016. - Jan. 2017

San Francisco, CA

- Developed [Role-Based Access Control](#) into the MemSQL database engine
- As part of a team of two, designed and implemented [Pipelines](#) a high throughput distributed data ingest and transformation engine
- Designed and implemented a subprocess management system in the database engine allowing MemSQL to execute external code in a secure manner without leaking resources
- Designed and implemented a general database backup system which allowed users to specify a backup target (e.g. Amazon S3) and automatically write backups and snapshots to this location

### ***Research Intern***

HP Labs, Systems Software Group

Sept. - Dec. 2014

Palo Alto, CA

- Researched designed and implemented distributed file system to run on a simulated memristor computer with ~10 TiB of DRAM and hundreds of CPUs with the goal of evaluating performance of file workloads in persistent memory computing environment
- Designed and implemented directories, file descriptor management, and journaling
- Delivered functional prototype with demo which compiled source code of the file system stored in the file system

**Research Assistant**  
Oregon State University

Jan. 2014 - Apr. 2014  
Corvallis, OR

- In collaboration with Dr. Eugene Zhang, researched and developed a correct and efficient algorithm to compute photorealistic lighting in 3D scenes containing multiple interacting mirror surfaces
- Formulated theory to model lighting conditions due to mirrors by understanding how mirrors change the topology of the underlying path space of a scene
- Generated results demonstrating the quality of our method compared to existing techniques
- Designed and developed algorithm as a modification of *POV-Ray*, an existing open source ray tracer
- Independently learned about many new subjects to conduct research, including group theory, topology, and photorealistic rendering

**Graphics Software Engineering Intern**  
Amazon (A9.com)

May - Aug. 2013  
Palo Alto, CA

- Independently developed cross platform graphics framework for rendering 3D scans of products
- The framework supported model and image based rendering techniques with the ability to easily add new rendering modes
- The framework could be deployed to Linux, Windows, Android, iOS and any WebGL compatible browser from a single C++ code-base using *emscripten*

**Augmented Reality Intern**  
NVIDIA

Sept. - Dec. 2012  
Durham, NC

- Designed, improved and debugged real time vision based orientation tracking algorithms
- Developed Android multimedia framework to decode and playback synchronized video data into Augmented Reality engine
- Developed Unity3D plugin to stream video data to a texture on Android
- Built series of Unity3D plug-ins to develop Augmented Reality applications in Unity