# Derek Wu

#### **RESEARCH INTERESTS**

My research interests lie in the intersection of differential geometry and partial differential equations. I am interested in topics such as pluripotential theory and complex geometry, geometric analysis, and gauge theory.

#### **EDUCATION**

# **Bachelor of Mathematics**

University of Waterloo, Honours, Computer Science and Pure Mathematics Major, Co-op

### **Masters of Science**

University of Toronto, working under Professor Ilia Binder on partial differential equations and potential theory.

#### RESEARCH

# Masters Project | University of Toronto

• The harmoinc measure of an elliptic PDE can also be viewed as the hitting measure of certain special continuous Markov process (Feller processes). For Brownian motion, the harmonic measure has support on a "small" subset of certain fractals, naively unbiased random processes will get caught on corners of fractals and induce a hitting measures with dimension 0. My master project is to explore harmonic measure for other elliptic PDEs that are large in the Hausdorff dimension sense.

#### AWARDS

# Math Undergraduate Research Award | Award \$10,000

- · Research award with professor Rahim Moosa, where I worked on complex geometry and logic
- Provided a proof that a compact complex variety was essentially saturated if and only if its Barlet Spaces had compact connected components. An essentially saturated variety was one with "enough analytic subsets" such that are all constructible sets (in the analytic Zariski topology) can be described using countable many specially chosen analytic subsets.

#### Undergraduate Research Award | Award \$1000

- 4 month part time research award given to do a part time position with professor Christopher Batty to work on a numerical PDE solver using the closest point method
- Implemented a least square interpolater made to test the closest point method for non-uniform grid sizes

# Math Undergraduate Research Award | Award \$10,000

• Awarded again (same amount) for the fall term to work with professor Chen Xuemiao. Worked on gauge theory and on the completion of moduli spaces of connections. Focused on reading Donaldson's paper Compactification and Completion of Yang-Mills Moduli Spaces and Geometry of Four Manifolds.

# INDUSTRY EXPERIENCE

#### **3D Software Developer** | *SideFx*

 Implemented a shape matcher between triangulated meshes. The idea is to compare the space of functions of the two surfaces by using the basis found by diagonalizing the Laplace-Beltrami operator. Then an energy function is computed and minimized to get the bijection matrix between the two function spaces. The bijection matrix is then converted into a correspondence between the two meshes using tools from high dimensional data analysis.

# Compiler Researcher | Huawei

- Implemented a pass to convert MLIR loop code into high level abstracted loop code for simplification
- Worked on loop optimization using polyhedra tiling

# Software Developer | Cynorix

• Worked on a file encryption system two safely transfer files on a P2P service

# Waterloo Online Learning Assistant | University of Waterloo

· Worked in Maple to create randomly generated differential equation questions with auto generated solutions

# Sep 2019 - Apr 2024 CMA: 92/100 Expected: Aug 2025

Jan 2023

May 2023

Fall 2023

2024-2025

#### Apr 2022 - Aug 2022

Sep 2021 - Dec 2021

Jan 2021 - Apr 2021

Apr 2020 - Aug 2020

# ACADEMIC EXPERIENCE

# Mathematics Classes | Waterloo

- Real Analysis, Complex Analysis, Measure Theory and Fourier Analysis, Functional Analysis, Harmonic Analysis
- Differential Geometry, Smooth Manifolds, Algebraic Geometry, Riemannian Geometry
- Groups and Rings, Fields and Galois, Mathematics of Quantum Information

# Graduate Topics Courses | Waterloo

• Differentially Closed Fields, Gauge Theory on Riemann Surfaces, Almost Complex Manifolds

# Computer Science Classes | Waterloo

 Algorithm Analysis, Type Theory and Formal Verification, Operating Systems, Numerical Computation, Theory of Computation, Computer Graphics, Quantum Information Processing, Computational Linear Algebra, Machine Learning

# Graduate Courses | Toronto

 Real Analysis I, Real Analysis II, Partial Differential Equations I, Partial Differential Equations II (Elliptic PDEs). Complex Analysis, Symplectic Geometry, Ergodic Theory

# Presentations | Waterloo & Toronto

- Riemann Surfaces By Donaldson presented the proof of the solvability of  $\Delta \rho = f$  when  $\int_X f = 0$  where X is a compact Riemann surface
- Differential Forms in Algebraic Topology by Bott and Tu presented chapters on vector bundles, Thom classes, Euler forms, and double complexes.
- Gauge Theory end of term presentation a high level overview the ADHM construction, which is describing the moduli space of ASD connections using algebraic data
- Almost Complex Manifold end of term presentation Gromov's *h*-Principle and Almost Complex Structure, explained *h*-principle and then used it to extend in-class assignment results on existence of almost complex structure to genuine complex structures
- Harmonic Analysis end of term presentation Proof that the orbit of two elements of *SO*(3) acting on *S*<sup>2</sup> is uniformly distributed if and only if it is dense using harmonic polynomials.
- Presentation on Donaldson's new proof of Narasimhan and Seshadri
- Presentation on plurisubharmonic functions and applications complex geometry (such as Lelong numbers and multiplier sheaves)

# Teaching | Toronto

- TA for Calculus I for Engineers, Linear Algebra I for Engineers, and Complex Variables
- Directed Reading Program (A one-to-one mentorship with an undergraduate student) to explore relations between plurisubharmonic functions and several complex variables.