

William Chuang

Curriculum Vitae

Department of Mathematics
University of Arizona
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Tucson, AZ 85721

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<https://williamchuang.github.io>

EDUCATION

University of Arizona

Ph.D. Student in Mathematics

Fall 2022 – Present

San Francisco State University

M.A. in Mathematics

Spring 2022

Thesis: *The Hausdorff Dimension of Limit Sets of Well-Distributed Schottky Groups*

Link: <https://scholarworks.calstate.edu/downloads/xd07h079g>

Advisor: Dr. Chun-Kit Lai

University of San Francisco

B.S. in Mathematics, Minor in Computer Science

Fall 2018

Major GPA: 3.88/4.00

Graduated with Honors

RESEARCH INTERESTS

I am broadly interested in the interplay between mathematical physics, geometry, and the topology of data. My recent work focuses on:

- Analyzing the intrinsic factors and topological structures underlying self-attention architectures, aiming to understand how geometry and topology inform algorithmic design.
- Developing theoretical frameworks in geometric data analysis, notably through an abstract definition of curvature for novel data representations.
- Applying hyperbolic geometry and Kleinian groups to enhance neural network performance and security—specifically:
 - (1) Introducing global symmetries into networks (especially autoencoders and transformers),
 - (2) Strengthening data encryption and decryption,
 - (3) Devising new approaches for deriving neural networks that can be composed or edited mathematically based on previously trained models,
 - (4) Dynamically modifying energy landscapes on a global scale to reduce computational costs during training by sequentially mapping model parameters to configurations that systematically decrease the loss function's output.
- Investigating linear combinations, cyclic groups, and orbifolds of feedforward neural networks with restricted codomains, leveraging autoencoders composed of feedforward networks and their inverses to achieve deeper model interpretability.

- Constructing a rigorous interaction theory by integrating:
 - (1) The Callan–Symanzik equation and stochastically motivated measures,
 - (2) Motives and Hopf algebras within a renormalization group (RG) framework,
 to advance the mathematical understanding of deep neural networks.
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OTHER INDEPENDENT PROJECTS

University of Arizona

- **Independent Study: Real and Complex Analysis, and Applications of Hyperbolic Geometry**

With Prof. David Glickenstein, Fall 2023

University of Arizona

- **RTG Project: Scaling Factors of Self-Attention Weights in Transformers**

With Prof. Ning Hao, Fall 2023

San Francisco State University

- **Computation of the Hausdorff Dimension of Limit Sets of Schottky Groups**

With Dr. Chun-Kit Lai, June 2021 – May 2022

San Francisco State University

- **Independent Study: Prime Geodesic Theorem and Limit Sets of Schottky Groups**

January 2021 – May 2021

Wrote a summary of the modern proof with an emphasis on growth rates based on the Hausdorff dimension of the associated limit set.

Advisor: Dr. Chun-Kit Lai

San Francisco State University

- **Topology Project: A Study on Fundamental Groups**

September 2020 – December 2020

Advisor: Dr. Emily Clader

San Francisco State University

- **Independent Study: Hom-Polytopes**

September 2019 – December 2019

- **Combinatorics Project: Simplicial Complexes**

January 2019 – May 2019

Advisor: Dr. Joseph Gubeladze

University of San Francisco

- **Independent Study: Prime Number Theorem**

January 2018 – May 2018

Advisor: Dr. Paul Zeitz

Pennsylvania State University–University Park

- **Functional Analysis Project: Hardy's Proof of Uniform Distribution**
January 2018 – May 2018
- **Independent Study: Reading "Lecture Notes on Functional Analysis: With Applications to Linear Partial Differential Equations"**
January 2018 – May 2018
Advisors: Dr. Sergei Tabachnikov and Dr. Moisey Guysinsky

Pennsylvania State University–University Park

- **Topology Project: Solving the (9, 8, 4, 3, 7)-Linkage Problem**
January 2018 – May 2018
- **Topology Final Project: Conway's Basic Theorem**
September 2017 – December 2017
Advisor: Dr. Sergei Tabachnikov

University of San Francisco

- **Capstone Project: Graph Theory for an Inverted-Index-Based Search Engine**
January 2018 – May 2018
Advisor: Dr. Chris Bryan

University of San Francisco

- **Capstone Project: Applying the Method of Steepest Descent and Cauchy Contour Integrals to the Fisher Exact Test**
January 2018 – May 2018
Advisor: Dr. Xuemei Chen

University of San Francisco

- **Research Assistant**
August 2016 – May 2017
Assisted with lecture notes for MSAN 504 (Review of Probability and Statistics).
Advisor: Dr. Jeff Hamrick

University of San Francisco

- **Capstone Project: Implementing Dijkstra's Algorithm Applications**
Spring 2016
 - **Summer Research Project: Therapeutic Video Games for Patients with Disabilities**
June 2016 – September 2016
 - **Interpreting Deep Neural Networks**
Fall 2016
Explored causal structures within deep networks to map them onto symbolic graphs, and investigated methods to initialize models from human-written code.
Read causal inference research by Prof. David Galles and Judea Pearl.
Advisor: Dr. David Galles
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PRE-BACCALAUREATE INDEPENDENT PROJECTS

National Taiwan University

- **Research Student at LeCosPA**

September 2011 – May 2013

Old Profile: Tao-Mao Chuang

LeCosPA People (Archived)

Presented various topics in weekly meetings and seminars, including:

- Bremsstrahlung and Cherenkov radiation
- Topological quantum field theory and 2+1D quantum gravity via Chern-Simons terms
- Cosmological constant, vacuum structure, and vacuum energy
- Radiation from moving mirrors and black holes (Schwinger mechanism, Casimir effect, Hawking/Unruh effects)
- Potential carbon-free energy sources via low-energy nuclear reactions
- Metamaterials and analog models of gravity
- Instability of Anti-de Sitter space
- Induced gravity, Coleman-Weinberg–Witten theorem on Lorentz violation, AdS/CFT correspondence
- Quantum information, holographic turbulence, AdS/CMT, sonoluminescence
- Holographic renormalization group flow and Ricci flow
- Background-independent spin foam models and Regge calculus

Advisor: Dr. Pisin Chen

National Taiwan University

- **Kontsevich–Soibelman Wall-Crossing Formula for Mathematical QFT**

January 2012 – May 2012

- **Conformal Bootstrap Methods for the 3D Ising Model**

2011

Advisor: Dr. Heng-Yu Chen

National Taiwan University

- **A Study on the Lee–Yang Theorem and Riemann Zeta Function in Statistical Mechanics**

January 2012 – May 2012

Advisor: Dr. Ning-Ning Pang

National Taiwan University

- **Dark Energy Problem via Modified Gravity**

September 2010 – May 2011

Focused on the equivalence of Einstein frames and conformal mappings in scalar-tensor theory.

Advisor: Dr. Je-An Gu

WORK EXPERIENCE (TEACHING & RESEARCH)

University of Arizona

- Graduate Teaching Assistant, MATH 112 (College Algebra), Section 33 – Fall 2022
- Graduate Teaching Assistant, MATH 112 (College Algebra), Sections 12 & 18 – Spring 2023
- Graduate Teaching Assistant, MATH 112 (College Algebra), Section 13 – Fall 2023
- Grader, MATH 112 (College Algebra), Sections 9, 13 & 20 – Fall 2023
- Tutor, MATH 129 (Calculus II) – Fall 2023
- Grader, MATH 129 (Calculus II) Final Exam – Fall 2023
- Grader, MATH 122B/125 (Calculus I) Common Final Exam – Fall 2023
- Graduate Teaching Assistant, MATH 112 (College Algebra), Sections 101, 102, 201, 202, 401 & 402 – Spring 2024
- Graduate Teaching Assistant, MATH 125 (Calculus I), Section 001 – Fall 2024
- Graduate Teaching Assistant, MATH 112 (College Algebra), Sections 103 & 203 – Spring 2025
- **Teaching Mentors & Advisors:** Mitchell Wilson, Tina Deemer, Catherine Yslas, Ousama Ben Said, Tynan Lazarus, and Prof. David Glickenstein

San Francisco State University

- Graduate Teaching Assistant, Calculus – Spring 2022
- Grader, MATH 227 [05] (Calculus II)
- Instructor, MATH 226 [38] (Calculus I) – Fourth-hour component of MATH 226 [37]
- Instructor, MATH 227 [06] (Calculus II) – Fourth-hour component of MATH 227 [05]
- Instructor, MATH 227 [36] (Calculus II) – Fourth-hour component of MATH 227 [35]
- **Advisors:** Prof. Kim Seashore, Prof. Shandy Hauk, and Prof. Eric Hsu

OTHER ACADEMIC EXPERIENCE

San Francisco State University

- Graduate Teaching Assistant, Pre-Calculus – Fall 2019
- Advisor: Prof. Kim Seashore

University of San Francisco

- San Francisco Math Circle – Fall 2016
- Advisor: Prof. Paul Zeitz

National Dong Hwa University

- Undergraduate Research Assistant – Spring 2010 Hired and advised by Prof. Cheng-Pang Liu
 - Tutor of Calculus and General Physics – August 2008 to December 2009 Hired by the NDHU Department of Physics
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AWARDS AND HONORS

- **Nominated for MSRI Summer Graduate School on Metric Geometry and Geometric Analysis**
University of Oxford (UK), Fall 2021
 - **Dean's Honor Roll**
University of San Francisco, Spring 2018
 - **Mathematics Advanced Study Scholarship and Internal Scholarship (MASS Program)**
The Pennsylvania State University–University Park, Fall 2017
(Covered tuition and fees)
 - **Dean's Honor Roll**
University of San Francisco, Spring 2015, Fall 2016, and Spring 2017
 - **Pi Mu Epsilon Honor Society**
University of San Francisco
 - **Admitted to the Summer School on Symmetry in Mathematics and Physics**
National Taiwan University, Summer 2012
 - **Admitted to Prof. Anthony Zee's Quantum Field Theory Course**
Institute of Physics, Academia Sinica, February 2012
 - **Admitted to the 1st LeCosPA Symposium: Towards Ultimate Understanding of the Universe**
National Taiwan University, February 2012
[\[Link\]](#)
 - **Admitted to the 2nd International Workshop on Dark Matter, Dark Energy, and Matter-Antimatter Asymmetry**
National Tsing Hua University, Winter 2010
[\[Link\]](#)
 - **Admitted to the Summer School for Theoretical Physics**
National Tsing Hua University, Summer 2009
 - **President's List**
National Dong Hwa University, March 2008, November 2008, March 2009, March 2010
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CERTIFICATES

- **Safety Preparedness Training**
The University of Arizona, Employee Development, Growth, and Engagement
December 8, 2023
- **Information Security Awareness Certification**
The University of Arizona, Employee Development, Growth, and Engagement
August 27, 2023
- **MASS Program Completion**
Completed all requirements for the 2017 Mathematics Advanced Study Semesters program at The Pennsylvania State University

- **Recognition of Service Award**

ACM Special Interest Group on Management of Data (SIGMOD) – 2016

- **Tackling the Challenges of Big Data**

Online program developed by the faculty of the MIT Computer Science and Artificial Intelligence Laboratory

February 3 – March 17, 2015

SKILLS

- **Problem Solving and Adaptability:** Demonstrated ability to learn new skills quickly.
- **Programming Languages:** C/C++, Python, R, Java, Lisp, Shell Script, Sed, Awk, \LaTeX , Mathematica
- **Libraries and Packages:** PyTorch, Lightning, NumPy, Pandas, scikit-learn, Matplotlib, Ogre3D
- Designing algorithms to generate examples for theoretical research in mathematics, physics, statistics, and computer science