Charlie Godfrey

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Skills

• Python (`pytorch, numpy, scipy, pandas`) • Git • Bash • Linux • cluster computing (SLURM)

Education

PhD in Mathematics, The University of Washington-Seattle June 2021

- Extended results on singularities using inductive construction algorithms for semi-simplicial schemes. Built a new Fourier-type transform on differential forms with poles using duality theory. Defined generalizations of ordinary elliptic curves over finite fields and studied their deformations.
- Completed the eScience Institute's Advanced Graduate Data Science Option
  - PhD-level courses in machine learning, data visualization and statistical inference
  - Implemented machine learning methods like LASSO, kernel regression and k-means clustering in raw `numpy` and `scipy`
- Department of Mathematics Graduate Fellowship 2018-2019

Master's of Science in Mathematics, The University of Washington-Seattle June 2018

Bachelor's of Science in Mathematics and Physics, The University of Wisconsin-Madison May 2014

Experience

Postdoctoral Research Associate, Pacific Northwest National Laboratory October 2022 - Present

Research areas:

- robustness and security of machine learning algorithms and pipelines, in the domains of computer vision and multi-modal data
- geometry and statistics of hidden features of deep learning models, with applications to neural network interpretability
- updates to deep learning models requiring limited additional data (model editing and patching)

Student, MSRI Mathematics of Machine Learning Summer Graduate School July 29-August 9 2019

- Attended mini-courses and problem sessions on statistical learning, convex optimization, bandits, deep learning and reinforcement learning
- Presented an expository account of recent work on linear stochastic bandits

Program Associate, Mathematical Sciences Research Institute March-May 2019

Graduate Mentor, Washington Experimental Math Laboratory January 2019-December 2020

- Mentored undergraduate research projects on foundations of quantum mechanics and mathematical epidemiology

Publications

1. Charles Godfrey, Davis Brown (equal contribution), Tegan Emerson and Henry Kvinge. On the Symmetries of Deep Learning Models and their Internal Representations. To appear in *NeurIPS 2022*. Code available at github.com/pnnl/modelsym.
2. Elizabeth Coda, Nico Courts, Colby Wight, Loc Truong, WoongJo Choi, Charles Godfrey, Tegan Emerson, Keerti Kappagantula and Henry Kvinge. Fiber bundle morphisms as a framework for modeling many-to-many maps. In *ICLR 2022 workshop on geometrical and topological representation learning*.
3. Higher Direct Images of Ideal Sheaves, Correspondences in Log Hodge Cohomology and Globally F-Full Varieties. PhD thesis, University of Washington 2021.

Preprints

1. Henry Kvinge, Davis Brown and Charles Godfrey. Exploring the Representation Manifolds of Stable Diffusion Through the Lens of Intrinsic Dimension (2023).
2. Henry Kvinge, Grayson Jorgenson, Davis Brown, Charles Godfrey and Tegan Emerson. Neural frames: A Tool for Studying the Tangent Bundles Underlying Image Datasets and How Deep Learning Models Process Them (2022).
3. Charles Godfrey, Elise Bishoff, Myles Mckay, Davis Brown, Grayson Jorgenson, Henry Kvinge and Eleanor Byler. Convolutional networks inherit frequency sensitivity from image statistics (2022).
4. Takumi Murayama and Charles Godfrey. Pure subrings of du bois singularities are du bois singularities (2022).
5. Higher direct images of ideal sheaves (2022).

Invited Talks

1. February 2023 Boston College Math and Machine Learning Seminar.
2. January 2023 Joint Mathematics Meetings (Boston, MA).
3. November 2022 Purdue Algebraic Geometry Seminar.
4. October 2020 AMS Fall Eastern Sectional Special Session on Algebraic Singularities in Arbitrary Characteristic.
5. October 2020 University of Washington Algebra and Algebraic Geometry Seminar.
6. April 2019 Mathematical Sciences Research Institute Graduate Student Seminar.

Organizing

1. Co-organizer, Pacific Northwest Seminar on Topology, Algebra, and Geometry in Data Science.