Kaiying Hou

(978) 809-1268 — khou@college.harvard.edu — kaiying.neocities.org— Cambridge, MA

EDUCATION

Harvard University, Cambridge, MA — December 2023
Bachelor of Arts, Mathematics (Highest Honors) — GPA: 3.98/4.00
Relevant Coursework: Topological Modular Forms, Kodaira Dimension, Quantum Field Theory, Algebraic Geometry, General Relativity, Algebraic Topology, Commutative Algebra, Neural Computation, Statistical Mechanics, Measure Theory and Functional Analysis, Theory of Computation, Set Theory.

SELECTED RESEARCH

Symmetry-Informed Dataset Distance, Harvard University — December 2023 - Present

- Under the guidance of Professor David Alvarez-Melis and Professor Melanie Weber, aim to develop a notion of distance between datasets that takes symmetries into account.
- Test how such notion can be used to better understand pretraining efficacy in equivariant neural networks.

Length Generalization in Transformers, Harvard University — January 2024 - Present

- Study length generalization in transformers for arithmetic operations with Dr. Eran Malach.
- Explore how different chain of thoughts and attention masks affect length generalization.

Vector Bundles on Projective Spaces, Harvard University — September 2022 - December 2023

- Under the guidance of Professor Mihnea Popa, explored applications of the Bernstein-Gel'fand-Gel'fand correspondence to the study of vector bundles on projective spaces.
- Constructed simple vector bundles on $\mathbb{P}^n$ with arbitrary homological dimension and arbitrary rank larger than or equal to n, generalizing the rank-n result by Marcos Jardim and Daniela Prata. Preprint is currently under review for Proceedings of the AMS.

The Einstein Institute REU, the Hebrew University of Jerusalem — May 2022 - August 2022

- Under Professor Karim Adiprasito and along with three other undergrads, proved p-anisotropy in finite characteristics for homology manifolds on the moment curve, which was conjectured by Adiprasito, Papadakis, and Petrotou.
- Applications of our result include an alternative proof for the combinatorial hard Lefschetz theorem and for the g-conjecture.

Symmetries of Quantum States, Harvard University — September 2021 – May 2022

- Joined a research group under Professor Susanne Yelin aiming to develop algorithms for finding the symmetries of quantum states.
- Found a way to incorporate supervised learning into our existing algorithm so that we could efficiently avoid finding symmetries that were already known. Preprint is currently under review for Physical Review Research.

PUBLICATIONS & PREPRINTS

Kaiying Hou. Large rank simple bundles of all homological dimensions, 2023. preprint arXiv:2310.09788.

Karim Adiprasito, Kaiying Hou, Daishi Kiyohara, Daniel Koizumi, and Monroe Stephenson. p-anisotropy on the moment curve for homology manifolds and cycles.

Jonathan Z. Lu, Rodrigo A. Bravo, Kaiying Hou, Gebremedhin A. Dagnew, Susanne F. Yelin, and Khadijeh Najafi. Learning quantum symmetries with interactive quantum-classical variational algorithms, 2022. preprint arXiv:2206.11970.

Kaiying Hou and Jayson Lynch. The computational complexity of finding hamiltonian cycles in grid graphs of semiregular tessellations. In Stephane Durocher and Shahin Kamali, editors, *Proceedings of the 30th Canadian Conference on Computational Geometry, CCCG 2018, August 8-10, 2018, University of Manitoba, Winnipeg, Manitoba, Canada*, pages 114–128, 2018.

PROJECTS

Generating Metal Guitar Tracks with Transformer December 2023 – Present

- Scraped for the Guitar Pro files of over 70k songs and created a 2-billion-tokens dataset of guitar tracks with individual riffs annotated.
- Trained a model that generates convincing metal guitar using cloud GPUs.
- See https://kaiying.neocities.org/metal_gen for more information.

Deep Reinforcement Learning Project on Slitherin' June 2021 – September 2021

- Used deep RL to tackle Slitherin', i.e., the multiplayer snake game (one of the seven unsolved problems in OpenAI's Requests for Research 2.0) with another student.
- Programmed a deep Q-learning algorithm that can beat beginner human players.
- See https://kaiying.neocities.org/slitherl for more information.

GRANTS, HONORS & AWARDS

John Harvard Scholar (2019-2020) October 2020
Harvard College Research Program Grant Recipient May 2021
John Harvard Scholar (2021-2022) October 2022
John Harvard Scholar (2022-2023) November 2023

TEACHING & LEADERSHIP

Harvard Undergraduate Gender Inclusivity in Mathematics Cambridge, MA
Math Night Coordinator September 2023 - Present

- Organized Math Night where students collaborate and get help on their homework.
- Fostered open discussions on inclusivity in the Harvard math department.

Math 123: Algebra II Cambridge, MA
Teaching Assistant January 2023 - May 2023

- Ran problem sessions and review sessions, graded homework, and answered questions.

Phillips Brooks House Association's Chinatown ESL Program Cambridge, MA
Teacher September 2019 - December 2019

- Organized a class to teach Chinese immigrants English along with two other students.
- Created lesson plans, organized fun learning activities, and designed tests.

SKILLS

- **Technical:** Python, Java, Mathematica, Macaulay2.
- **Languages:** Chinese (native), English (fluent).
- **Interests:** Guitar, Piano, Clarinet.