

Kaiying Hou

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EDUCATION

Harvard University, Cambridge, MA

December 2023

Bachelor of Arts, Mathematics (Highest Honors)

GPA: 3.98/4.00

Mumford Prize 2024

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.

SELECTED RESEARCH

Leveraging LLMs for Emotional TTS, Hume AI

May 2024 - Present

- Exploring ways to use pretrained LLMs to build text-to-speech (TTS) models with an aim to generate speech with high expressiveness.
- Made progress on using text prompt to control the prosody of generated speech.
- Trained models on multiple H100 nodes, became familiar with WebDataset and distributed training strategies such as FSDP.

Length Generalization in Transformers, Harvard University

January 2024 - June 2024

- Analyzed the impact of chain-of-thought (CoT) techniques and positional embeddings on length generalization in Prof. Sham Kakade's lab.
- Developed an innovative CoT technique that emulates Turing machines, marking the first instance in literature to achieve significant length generalization for multiplication and stochastic gradient descent.
- Preprint is currently under review for NeurIPS 2024.

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, David Brandfonbrener, Sham Kakade, Samy Jelassi, and Eran Malach. Universal Length Generalization with Turing Programs.

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. Dagneu, 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.

GRANTS, HONORS & AWARDS

The Mumford Prize (<i>‘the most promising senior concentrator in mathematics’</i>)	2024
John Harvard Scholar	2020, 2022, 2023
Harvard College Research Program Grant Recipient	2021

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.

Directed Reading on Moduli of Curves, Harvard University September 2023 – December 2023

- Under the guidance of Professor Joe Harris, learned geometric invariant theory and how to construct the moduli space of stable curves.
- Learned about relevant concepts such as relative dualizing sheaves, stable reduction, and the tautological ring.

Directed Reading on Mirror Symmetry, Harvard University January 2023 – May 2023

- Read some of Mirror Symmetry (Clay Mathematics Monographs, V. 1) with graduate student mentor Leon Liu.
- Learned about the formulation of mirror symmetry in physics using supersymmetric sigma models and related concepts such as T-duality, topological twisting, and supersymmetric quantum mechanics.

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*Teaching Assistant*

Cambridge, MA

January 2023 - May 2023

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

Phillips Brooks House Association's Chinatown ESL Program*Teacher*

Cambridge, MA

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.