EKATERINA IVSHINA

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EDUCATION

Harvard University Dec 25
M.S. in Applied Mathematics

Princeton University May 23
Bachelor of Arts in Mathematics with honors

PUBLICATIONS

Kelly Maggs, **Ivshina ES**, et al. *Volumetric representation learning on point clouds.* submitted to NeurIPS.
Ivshina ES, et al. *Drug safety in the age of AI agents.* in prep.
Wang E, **Ivshina ES**, et al. *Sentence Processing is Surprisingly Robust to Verbatim Repetition.* 39th Annual Conference on Human Sentence Processing (2026).
Roggeveen JV et al. *HARDMath2: A Benchmark for Applied Mathematics.* NeurIPS 2025.
Ivshina ES, Anikeeva G, Zhou L. *Doughnut or Mickey Mouse? Detecting Toroidal Structure in Data through Persistent Cup-Length.* ArXiv preprint (2025).
Ivshina ES *Patterns in Knot Floer Homology.* ArXiv preprint (2023).
Ivshina ES *On Slice Knots and Patterns in Knot Floer Homology.* Senior thesis (2023).
Ivshina ES, Winn JN. *TESS Transit Timing of Hundreds of Hot Jupiters.* Astrophysical Journal Supplement Series (2022).
Etzel R, Mekkaoui C, **Ivshina ES**, et al. *Optimized 64-channel array configurations for accelerated simultaneous multislice acquisitions in 3T cardiac MRI.* Magnetic Resonance in Medicine (2021).

RESEARCH & TEACHING EXPERIENCE

`Researcher, advised by Kelly Maggs, Harvard University` Jul 25 - present
Motivated by oversmoothing in graph neural networks, I develop a framework for using learnable finite differential forms for point-cloud representation learning. This approach can enable deeper, more expressive networks.

`Researcher, advised by Ling Zhou, Harvard University` Jun 24 - present
I implemented and provided theoretical proof for persistent cup-length algorithm, a cohomology-based method that extends persistent homology to capture interactions between topological features in data. This work demonstrated toroidal structure in grid cell population activity—providing robust evidence for continuous attractor network (CAN) models underlying spatial navigation.

`Researcher, advised by Eghbal Hosseini, MIT` Jul 24 - Feb 25
I investigated representational alignment by analyzing the internal representations of language and vision models using curvature as a geometric metric. Findings revealed consistent straightening in the language model with limited evidence in the vision model, highlighting the critical role of metric selection in alignment studies.

`Teaching Assistant, Harvard University` Jun 24 - Dec 24
I helped design am210: Mathematical Modeling course. I lead small-scale sections to reinforce concepts from lectures, hosted office hours and graded problem sets & research projects. In addition, I proposed a new structure for the final projects to encourage collaboration between graduate and undergraduate students, mirroring peer review process in tech.

`Seminar Instructor, Yale Young Global Scholars` Jun 23 - Jul 23
I designed and taught four seminars in knot theory, topological data analysis, ethics & machine learning, and astrophysics to high school students from around the world. I led group discussions, mentored capstone projects, and facilitated bonding activities among the students.

`Senior Thesis Researcher, advised by Zoltan Szabo, Princeton Math Department` Sept 22 - May 23
I conducted computational experiments and established three new conjectures relating the hyperbolic volume of knot's complement, the knot determinant, and the total rank of knot Floer homology.

`ML Intern, Advanced Computation Group, Camera & Photos, Apple Inc.` Jun 22 - Aug 22

I was responsible for writing a research proposal of a new music source separation model. I have experience in designing system architectures and implementing ML models with sliced score matching and Langevin dynamics. I am also skilled in collaborating with team members on evaluating state-of-the-art source separation models on internal datasets. I presented my work to Apple's VP of Camera & Photos.

`Researcher, advised by Herman Verlinde & Zoltan Szabo, Princeton Physics Dept` Jan 22 - May 22

I implemented ML models for predicting solar wind min B_z value from in situ observations of coronal mass ejections. My contribution was creating a new dataset by extracting statistical features from solar wind time-series, training the models and improving on the state-of-the-art performance. This work is a step towards forecasting intense geoeffective events on Earth.

`Researcher, advised by Ev Fedorenko. MIT Dept of Brain and Cognitive Sciences` Jul 21 - Feb 22

I designed a self-paced reading study to test the effects of repeated sentence presentation on language processing. I collected & processed the data, and performed a statistical correlation analysis of the survey results. This work has implications both for theories of language comprehension and for experimental methodology.

`Researcher, advised by Joshua Winn, Princeton Astrophysics Department` Feb 20 - Jan 22

I searched for evidence of orbital period changes in 382 planets. My contribution was developing a parallelized code to fit transit models to TESS light curves and scrape timing data from ArXiv, which helped us discover transit timing variations and detect a new planet, NGTS-11c. The project's website is transit-timing.github.io

LEADERSHIP

`Content Creator` June 21 - present

My blog's mission is to inspire and empower young individuals, particularly international students, immigrants, and underrepresented minorities in the world of higher education, with the dream of making research and education accessible to all. I currently have 100,000+ followers and 30+ million views across social media platforms.

`Co-founder & President, "02.24.2022" Student Organization, Princeton` Feb 22 - Feb 23

In response to the war in Ukraine, I lead a team of ten students to write a letter of solidarity with Ukraine signed by 550+ Princeton affiliates; co-organize a series of talks with prominent anti-war public figures; co-organize four charitable concerts to raise funds for Ukrainian refugees. I led a 5-week "Momentum 4 Ukraine" educational program pairing 50 Ukrainian war refugee students with mentors from Princeton/Harvard/MIT.

ACCOMPLISHMENTS

- Gave a poster presentation at the London Summer School on Geometric Machine Learning (Imperial College London, 2025).
- Gave a research talk at the Young Topologists Meeting (Stockholm, 2025).
- Invited to give a research talk at the Computational Geometry Week, the premier international forum for advances in computational geometry (Japan, 2025).
- Analytic Connectionism Summer School participant (Flatiron Institute, 2024).
- NSF Graduate Research Fellowship; Harvard Graduate School of Arts and Sciences Prize fellowship (2023).
- Inducted into Sigma Xi honor society by Princeton's Mathematics Department (2023).
- Machine Learning and Math program participant (Institute for Advanced Study, Princeton, 2022).
- Alberto Santos-Dumont Prize for Innovation (Princeton Office of the Dean of Undergraduate Students, 2022).
- Manfred Pyka Memorial Prize in Physics (Princeton Department of Physics, 2021). The award is given to "outstanding physics undergraduates who have shown excellence in course work and promise in independent research."
- All-Russian National Astronomy Olympiad (ranked top 3 in state, top 50 nationally, 2018, 2019).
- "PhysTech" All-Russian National Physics Olympiad bronze medalist (2019).

OUTREACH

- Keynote speaker, Girls in Engineering and Robotics Symposium, Andover Robotics Club (March 2025).

- Invited speaker at Imperial College London (July 2025), Northeastern Graduate Women in Science and Engineering workshop (February 2024), BB&N High School HacKnight (June 2024), "Alternative pathways in Mathematics", ENYGMMa (Empowering New York Gender Minority Mathematicians), CUNY (May 2024).