Katya Ivshina's statement of purpose

I am proud to be a first-generation Russian immigrant in the US, a woman mathematician, and an active researcher focused on ethical Artificial Intelligence (AI). My dream is to build a future where Artificial Intelligence empowers humanity, making research and innovation accessible to all. With a degree in Applied Mathematics from the Harvard John A. Paulson School of Engineering and Applied Sciences, I aspire to become an interdisciplinary researcher and a social entrepreneur.

Mathematics is a language for formulating and solving scientific problems, and I strive to use this language to address important research questions in different fields. As an undergraduate student, I co-authored two research papers. Throughout these works, I came to appreciate the power and generality of mathematics in solving a wide range of real-world problems - in particular, I detected a new planet by fitting astrophysical data using optimization and modeled the diffusion MRI by applying tensors.

Having spent high school years pursuing astrophysics research in Russia, I developed an interest in the planetary sciences and approached Professor Joshua Winn about working on hot Jupiter research my freshman spring of college. Transiting hot Jupiters are the most intensively studied category of exoplanets — planets orbiting stars other than the Sun. Photometric and spectroscopic observations of transits provide information about the planet's size, mass, orbit, and atmosphere. However, since many of the follow-up observations are time-critical, observers need the ability to predict future transit times reliably and precisely. The easiest way to improve our ability to predict future transits is to measure new transit times, a process known as "refreshing the ephemerides." In this work, I developed a database of transit times and updated ephemerides for hundreds of planets. We then used our database to search for long-term transit timing variations, determining several planetary systems that may exhibit interesting physical effects, such as tidal orbital decay. We published our paper in the *Astrophysical Journal Supplement Series* in 2022, where we also reported the detection of a new planet, NGTS-11c. In addition, I presented this work at the American Astronomical Society's Topical Conference Series 9: Exoplanets IV conference in Las Vegas in May 2022.

In my junior spring, I worked with Professor Herman Verlinde and Zoltan Szabo on improving space weather forecasting tools. Such tools provide critical information for many populations, from airline pilots to astronauts to tourists hoping to observe the northern lights. Yet current models lack accuracy in predicting the magnitude of geoeffective events on Earth. The capacity of Coronal Mass Ejections to produce extreme geomagnetic storms depends on their internal plasma structure and B_z magnetic field. In this work, I implemented Random Forests and Gradient Boosting Regressors for predicting solar wind $\min(B_z)$ value from in situ solar wind measurements at the Sun-Earth L_1 point. 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.

During the summer of 2020, I attended a Topological Data Analysis reading course at Princeton's Mathematics Department, where I developed a new music identification model using persistent

homology techniques. Given this research experience and six years of professional musical training, I was offered to join Apple's Advanced Computation Group as a Machine Learning Intern in the summer of 2022. I was responsible for writing a research proposal for a new model for music source separation, the task of separating a song into individual stems (e.g. bass, drums, and vocals). I have experience designing system architectures and implementing machine learning models with sliced score matching and Langevin dynamics. I am also skilled in collaborating with team members on evaluating state-of-the-art models. I presented my work to Apple's VP of Camera & Photos.

While research gives me fulfillment, serving others gives me purpose. Creating ever more powerful AI requires a firm commitment to ethics, community, accessibility, and inclusion. As a low-income student myself, I am committed to addressing social inequalities throughout my career and supporting underrepresented students in STEM. From May 2020 to May 2021, I was a Service Fellow at Princeton's Pace Center for Civic Engagement. I recruited and mentored talented high school girls from disadvantaged backgrounds to conduct summer research with Princeton and Yale faculty. I was also a Racial Justice Fellow in the summer of 2020, helping Princeton's Prison Teaching Initiative develop a computer science curriculum taught in NJ prisons. Furthermore, when Russia invaded Ukraine on February 24, 2022, I co-founded and led the "02.24.2022" student organization to support Ukrainian refugees: our team ideated creative ways of fundraising on campus and established a mentorship program for Ukrainian refugee students. This work convinced me of the importance of incorporating teaching and public service in my career: I aim to collaborate across fields, working with scientists and policymakers internationally to build a prosperous and peaceful future.

My long-term career goal is to advance general interpretable AI systems to empower humanity in addressing many global challenges ethically and responsibly. During my graduate studies, I want to fuse Topological Data Analysis with machine learning to develop more robust, efficient, and interpretable AI models. I hope to work with Professor [redacted] on developing geometric methods for machine learning and/or Professor [redacted] on infusing machine learning with topology, which are the research directions we discussed during our brief Zoom conversations. With the breadth of the Applied Math research at Harvard and the many machine learning initiatives available on campus (such as the Center for Research on Computation and Society), I believe that my interdisciplinary background and goals would make for a good fit with many other research groups.