

My research interests are algorithms, cryptography, graph and probability theory. I would like to apply for Harvard with a focus on theoretical computer science and the intention of going into academia after graduation. My motivation is based on research experience gained during two internships both at ÉPFL and IST Austria, four-year teaching activity and my long-lasting interest in math and computer science.

During high school, I persistently prepared for various mathematics and programming competitions. It resulted in winning the bronze medal on European Girls' Mathematical Olympiad and second place on Ukrainian National Olympiad. Five years of participation in mathematics contests has improved my skills in solving complicated problems, teamwork, dealing with challenges and competitions. It also made me choose math as a direction for further studies.

I have always tried to expand my knowledge on top of the university courses, by taking and successfully passing online courses on algorithms and cryptography from various universities. Additionally, during my second year of studies, I joined the Institute of Mathematics of National Academy of Sciences of Ukraine for the advanced probability theory tutorials. It also enabled me to investigate some research problems with the lecturer of the course Prof. G.M. Shevchenko. I solved a range of questions using the techniques acquired from those tutorials, which were helpful in the research, conducted by the lecturer, about characteristics that randomly occur in the polymers. This activity introduced me to research in general and made me excited to tackle the real-world problems with the aid of math.

My dream about serious research became a reality when I interned at the Institute of Science and Technology of Austria under the supervision of Prof. Krzysztof Pietrzak. The project of the internship was mainly dedicated to developing a more sustainable alternative to Bitcoin, known as Chia network (www.chia.net), aimed to make a cryptocurrency less wasteful and more decentralized. My initial goal was to investigate if the new blockchain is resistant to the known adversarial attacks. Later, we showed that it is actually more vulnerable to "selfish mining" than the Bitcoin blockchain. To solve this issue, we suggested to change protocol and to have miners extend more than just the best branch. I did a simulation of the process showing that this change has a positive effect on the security against selfish mining. Chia is adopting this change and will follow the three best chains. Continuing the project after the internship as a coursework at my university, I proved that some of the assumptions made during the internship are correct and thus we managed to make progress towards formally proving lower bounds on the chain quality of the Chia network design.

Work on this project was the crucial point in understanding that theoretical computer science is the best direction for my future studies and research. It also made me more interested in complexity theory, in particular, I took part at "Parametrized Complexity Summer School" in Vienna.

Being interested in interdisciplinary research, last summer I interned at the Processor Architecture Laboratory (LAP) at EPFL under the supervision of Prof. Paolo Ienne. I was involved in the project that aimed to improve Field Programmable Gate Array (FPGA), by 1) optimization of clustering algorithm; and 2) changing structure of FPGA architecture. The collaboration between LAP and Prof. Michael Kapralov from Theoretical Computer Science group on the first question opened for me new areas of interest such as approximate algorithms and showed how scientists from remote fields cooperate. Most of the internship, I spent working on the second question, which was a captivating problem on the graph theory and algorithms. As the great majority of FPGA chip area goes into the programmable interconnect structure, finding a way to reduce it would be beneficial. In particular, we were interested to investigate the feasibility of FPGA architectures without any dedicated interconnect structures. Finally, I managed to formally describe a wide class of such architectures and construct complete

placement and routing algorithms, capable of mapping any circuit design onto those architectures. All of the results were collected and converted into paper, which was accepted to the FPGA'19.

I am happy that this internship not only enhanced my research abilities but allowed me also to use my theoretical knowledge and formal mathematical approach to make a contribution in an unfamiliar field.

Finally, I am interested in sharing my knowledge. During four years I was teaching topics in advanced mathematics for middle and high-school students all across Ukraine and gave lectures for students who prepare to International Mathematical Olympiads. To make the material easier for students I wrote new problems and tried to make my explanations interesting by additional examples. One of these discussions led to the "Cards shuffling and Markov Chains" article in the scientific-popular journal "In the world of mathematics" (Ukrainian) for high-school students and freshmen. Meanwhile, I have been organizing and improving Math Olympiad Movement in Ukraine. I have also become a member of a jury of competitions on the regional and National level. Currently, I am helping in the organization of European Girls' Mathematical Olympiad, which will happen in Ukraine this April, and I am also honored to be invited as a jury member there. Eventually, teaching and organizational experience significantly improved my soft skills and inspired me to pursue an academic career.

During my experiences, I realized that I wish to deepen in the wide area of my interests, further to choose one direction and become an expert in it. Ph.D. program in "Theory of computation" group at Harvard is an ideal opportunity to accomplish my desires. I appreciate the highly interdisciplinary and collaborative approach of the group, as I wish to make a contribution to the real-life problems. Although I am open to a variety of research, there are several professors at Harvard whose projects are especially appealing to me. I am particularly interested in research of Prof. Michael Mitzenmacher because it combines both algorithms, complexity and probability theory. My interests also go along with the work of Prof. Yaron Singer and Salil Vadhan. Studying some of these professors' papers made me sure that Harvard is a great match for me.