Q:

In the box below explain how your undergraduate study has prepared you to do the coursework for your chosen Pathway. You may describe the courses you have taken as an undergraduate and how you believe they will support your studies at Brown. A later question will ask about any research experience you have had, so don't include that in your answer here.

A:   
As a Computer Science undergraduate with a fervent interest in Artificial Intelligence and Machine Learning, I have excelled in all core advanced math courses, computer science courses, and specialized AI/ML courses, attaining A/A+ grades throughout.

In the realm of mathematics, my achievements include an A+ in Linear Algebra and Mathematical Analysis, as well as an A in Probability and Statistics. Linear Algebra, dealing with data representation and transformations, complements Mathematical Analysis, which supports optimization and enhances function comprehension. Probability and Statistics, on the other hand, contribute to managing uncertainty, aiding inference, and evaluating models. This comprehensive background forms the bedrock for machine learning, facilitating the development, analysis, and decision-making processes of effective algorithms.

In the domain of computer science, my accomplishments include A+ grades in Operating Systems, Computer Organization, and Algorithm and Complexity, with an A in Computer System Architecture. Operating Systems play a pivotal role in AI/ML by managing resources and optimizing task scheduling. Proficiency in Computer Organization and System Architecture is indispensable for designing hardware tailored for efficient AI computations. Additionally, a deep understanding of Algorithms and Complexity is fundamental in crafting optimized AI/ML algorithms, ensuring computational efficiency. Mastery in these areas enables seamless integration and efficient execution of AI/ML tasks across diverse computing environments.

Within the AI/ML courses, I have secured A+ grades in Artificial Intelligence, Machine Learning and Data Science, and an A in Digital Graphics Processing. These courses have offered a profound exploration, covering a diverse range of knowledge and skills crucial for the contemporary tech landscape. Starting with foundational AI concepts, such as replicating human-like intelligence in machines, the journey involved understanding problem-solving, decision-making, and learning mechanisms inherent in intelligent systems. Topics like natural language processing, computer vision, and robotics showcased AI's transformative potential across various industries. As I delved deeper into Machine Learning, the journey encompassed supervised and unsupervised learning, reinforcement learning, and deep learning. Practical application of ML algorithms deepened my understanding of regression, classification, clustering, and neural networks. Real-world applications, from image recognition to recommendation systems, underscored the versatility and impact of ML across domains. Notably, a course project allowed me to apply machine learning by combining Graph Neural Networks with MCTS to predict chemical compounds in a retro-synthetic manner. This practical application deepened my understanding of ML's real-world efficacy. The synergy of graph-based neural networks and Monte Carlo Tree Search enhanced predictive accuracy, showcasing the potential of AI in designing novel chemical syntheses. This project exemplifies my ability to apply advanced ML techniques to complex problems, demonstrating their practical utility in cutting-edge scientific endeavors. The exploration extended into the realm of Data Science, emphasizing the pivotal role of data in driving informed decision-making. Proficiency in data wrangling, exploration, and visualization, alongside the utilization of libraries like PyTorch and TensorFlow, became paramount. Statistical techniques, hypothesis testing, and robust model creation further highlighted the importance of data in the AI/ML landscape. A visually stimulating turn occurred in Digital Graphics Processing, where the fusion of creativity and technology became evident. Understanding image processing, computer graphics, and visualization techniques became integral, incorporating techniques like morphology method and deep learning to craft visually compelling digital content. In our course project, my group developed a diabetic diagnosis AI assistant using UNet for image segmentation. We curated a diverse medical image dataset, meticulously annotated it, and trained the UNet model for precision. The AI assistant accurately identifies and highlights diabetic abnormalities. This hands-on experience honed my skills in data pre-processing, model training, and interdisciplinary collaboration, emphasizing the practical application of AI in healthcare.

This interdisciplinary journey has equipped me with the skills to address real-world challenges and drive innovation. The impact of informed decision-making, intelligent automation, and visually compelling digital content is profound. As the technological landscape continues to evolve, I believe the experience and skills acquired in mu undergraduate study serve as a robust foundation for continual exploration in the renowned Brown CS master's degree program.

Q:

Undergraduate programs may offer students a chance to engage in research alongside a faculty member during their study. Opportunities to have one or more professional internships are ways to gain exposure to work in industry as an undergraduate. If you participated in a research project or had an internship, please briefly describe your experience and how it has prepared you for further study.

A:

My journey in ML research started when I joined the [SJTU-ReThinkLab](https://thinklab.sjtu.edu.cn/) led by Prof. Junchi Yan. I began researching graph matching (GM), which aimed at finding point pairs on the given images. With substantial literature review, I found a gap in works on front-end backbones (e.g. CNNs), as most of the existing works focused on back-end modules while neglected the process of initial image. Inspired by the success of attention mechanism, I decided to design a GM-specific backbone based on ViT. However, the obstacle was that original ViT extracts global information, rather than the local key-point information. To address this limitation, I devoted several days studying the paper and code of ViT, discussing with the professor to understand ViT's capabilities. After reflection, I proposed modifying ViT by introducing patches centered around the key-points and adopting the cross-attention mechanism to leverage the global information as auxiliary for the local information. I also harnessed the attention mechanism to enhance the back-end module's ability to capture the graph's underlying structure. Consequently, my proposed method achieved the state-of-the-art (SOTA) performance on extensively used GM benchmarks and the proposed backbone improved most existing frameworks by over 5%. Our paper was accepted by ICASSP and I was the first author.

Witnessing the success of my method was truly satisfying and I became eager to explore the potential of ML in other combinatorial optimization (CO). I participated in another group in our lab aiming at designing the guided diffusion model for CO problems such as TSP and MIS. One of the most challenging problems is the design of guidance. Injecting guidance to the generation required reformulating the Bayesian probability distribution, demanding a strong grasp of mathematical skills. I spent substantial efforts learning the structure of diffusion models and conducting mathematical derivation meticulously. After contemplation, I proposed approximating the cost of solutions as guidance using Taylor’s First Order Expansion and Energy Function to represent to posterior probability. Nevertheless, I found guided diffusion model showed marginal improvements. I discussed the phenomenon with my group members and proposed to use Bernoulli distribution instead of Gaussian distribution to model the generation process so as to better represent the discrete distribution of 0 and 1, which was more associated with our tasks. This solution addressed the issue of continuous probabilistic modeling and improved the performance by 10%. Eventually, our proposed guided-diffusion model achieved the SOTA performance on TSP and MIS benchmarks compared with learning-based models and reduced the solving time by one order of magnitude compared with exact solvers (e.g. from 1h to 4 min). Our paper was accepted by NeurIPS and I was the second author.

The research in CO honed my programming and mathematical skills and boosted my curiosity to explore ML in more domain-specific problems. Therefore, I joined the [ML-PL](https://github.com/ML-PL/) group led by Prof. [Xujie Si](https://www.cs.mcgill.ca/~xsi/) affiliated to the University of Toronto and [Mila - Quebec AI Institute](https://mila.quebec/). I researched on logical puzzles that can be formulated as SAT expressions, such as Sudoku. My work was built on SATNet, a differentiable MaxSAT solver. Nevertheless, while analyzing the paper of SATNet, I found the learned parameters cannot even represent extremely simple rules such as XOR, contradicting paper’s claim. After discussing with group members, we identified a theoretical error in the interpretation. Armed with mathematical knowledge, I intuitively proposed rewriting the SAT conjunctive normal form directly as a parametric matrix. The main challenge in this project was the unfamiliar programming language CUDA, as all my previous projects were written in PyTorch. To implement my idea, I delved into the NVIDIA CUDA tutorial. Although CUDA is a much more obscure programming language compared with PyTorch, I grasped the basic principle and syntax Within three days, and implemented my idea based on SATNet with group members. The proposed idea substantially reduced the number of trainable parameters while remedying theoretical mistakes in the original design. Notably, once the rules are learned, the model can definitely output correct answers, and this representation made the learned rules entirely interpretable, marking a significant breakthrough in the logic reasoning field. Our paper was accepted by NeurIPS and I was the second author.

The positive impact of my proposed ML method on the specific field and the exhilaration once my paper was accepted strengthened my determination to be a future prominent researcher in the ML field. With a robust quantitative skill-set, extensive experience, and a deep passion for expanding my knowledge of ML, I firmly believe that I am a well-suited candidate for the CS ScM program.

Q: Please describe your longer-term professional and/or academic goals and why you believe the Brown CS master’s program is a good choice for you.

A:

The positive impact of my proposed ML method on the specific field and the exhilaration once my paper was accepted strengthened my determination to be a future prominent researcher in the ML field. My aspirations now extend to designing ML solvers that surpass human experts, well-crafted algorithms, and exact or heuristic solvers for combinatorial optimization problems. I am enthusiastic to witness how ML techniques make contributions to this exciting field. To fulfill my goal, I recognize the need for advanced knowledge and a more extensive research background. I also wish to pursue further study as a PhD and help to actively contribute to the forefront of ML advancements. The distinguished CS ScM program at Brown, with its top-notch faculty and impeccably crafted curriculum, is the perfect incubator for this dream. The specialized concentration in Machine Learning, featuring courses like Advanced Probabilistic Methods in Computer Science, Topics in Advanced Deep Learning and Learning and Sequential Decision Making, will provide me with the knowledge and skills to enhance my understanding of machine learning, especially for the decision making process. I am particularly excited to work with the pioneering ML researcher Prof. Pedro Felipe Felzenszwalb on combinatorial optimization, drawing on my previous research experience to help push the boundaries of this exciting field. The program's meticulously designed courses and the expertise of knowledgeable AI scientists at Brown reinforce my belief that the CS ScM program is the optimal choice for achieving my long-term academic goals. With a robust quantitative skill-set, extensive experience, and a deep passion for expanding my knowledge of ML, I firmly believe that I am a also well-suited candidate for the CS ScM program. I am confident that my journey at Brown will equip me with the expertise demanded to pursue future study as a PhD, make insightful contributions to the ML field and finally contribute back to the community at Brown.

Q: We will be awarding a small number of full-tuition scholarships to applicants who come from disadvantaged socioeconomic backgrounds, but who have accomplishments showing that they can overcome the negative effects of their backgrounds. If you are interested in such a scholarship, please briefly explain the nature of your socioeconomic disadvantages and the accomplishments you've achieved in spite of them. Scholarships are awarded regardless of an applicant's race, color, national origin, or gender.

A:

I am writing to express my sincere interest in applying for the full-tuition scholarship aimed at supporting individuals from disadvantaged socioeconomic backgrounds who have demonstrated resilience and achieved significant accomplishments despite their challenging circumstances.

Growing up in a relatively financially constrained environment has been a defining aspect of my life. Despite this challenge, I am proud to share my journey of overcoming adversity through determination, hard work, and a commitment to education.

I managed to maintain a stellar academic record throughout my academic career. I consistently ranked at the top of my class, demonstrating my dedication to learning and my ability to excel academically. I had four publications in the machine learning field during my third year at SJTU. My academic contribution was recognized by experts in the school and industry. As a result, I was awarded SenseTime Scholarship (awarded to 30 undergraduates nationwide), National Scholarship twice, Shanghai Scholarship, Zhiyuan Scholarship, etc.

Furthermore, my commitment to extracurricular activities and community involvement showcases my resilience and determination to make a positive impact. In SJTU, I got opportunities to participate in various activities, where I honed my leadership skills and create inclusive environments. In the second year’s SJTU summer camp, I led a social practice group, with over 100 members, to investigate tourist cities and identified opportunities for technological applications to enhance tourism. As a result of our hard work and achievement, our team was awarded Third Prize of "Knowledge and Practice Cup" in Shanghai College Students' Social Practice Competition (Top 0.1% in Shanghai) and I was awarded Advanced Individual in the Social Practice Group and the National Scholarship.

In conclusion, I am applying for this scholarship with the belief that education is the key to breaking the cycle of poverty. Despite the obstacles posed by my socioeconomic background, I have demonstrated the ability to excel academically and engage in community service. I am confident that, with your support, I can continue to overcome challenges and make a meaningful contribution to society through my education.Thank you for considering my application. I am excited about the opportunity to contribute to the Brown community and make the most of the resources provided by this scholarship.

Q:   
Brown University values having students from a variety of backgrounds and experiences to be members of our intellectual community. Please describe an aspect of your background and how it has shaped your life experiences thus far. How do you feel it will contribute to your academic program and to the wider Brown community?

A:   
As a computer science undergraduate, my fascination with AI, particularly Machine Learning (ML), has been a driving force in my academic journey. During my research in ML, I was always captivated by its seemingly “magical” capabilities. This curiosity led to three publications in top ML conferences, garnering approval from experts and earning me prestigious accolades such as the SenseTime Fellowship (awarded to 30 undergraduates nationwide), National Scholarship (twice), and Shanghai Scholarship.

My initial exposure to ML, where I delved into research at SJTU-ReThinklab under the guidance of Prof. Junchi Yan, paved the way for deeper exploration. Through dedicated efforts to enhance my programming skills and grasp the intricacies of ML, I took charge of my research projects, specifically focusing on combinatorial optimization. This endeavor resulted in publications, including one as the first author at ICASSP and another as the second author at NeurIPS.

Recognizing my outstanding performance, my professor's recommendation opened doors to the University of Toronto's summer research program. Collaborating with Prof. Xujie Si, we focused on ML for reasoning tasks, a captivating field that applies ML to conduct logical reasoning akin to humans. We proposed innovative methods to empower ML models in robustly learning logical rules, ensuring the inference process completely interpretable, marking a great breakthrough in this exciting field. Our paper was accepted by NeurIPS and I was the second author.

Aspiring to become a distinguished ML researcher, I sought to further my knowledge at Brown. I am confident that my robust quantitative skillset and extensive research experience will be valuable to the academic program. These experiences will not only contribute to the ML field but also allow me to make insightful contributions and give back to the community at Brown.