Personal Statement

My name is Tong Wu, a Chinese student. I am currently studying mathematics and applied mathematics at Sun Yat-sen University and expected to graduate in 2022.6. I have a strong interest in information science and computational mathematics, especially in digital signal and image processing, and their applications in medicine and brain science. I hope to study for a Ph.D. in this field and make meaningful contributions both in theory and application.

I choose this field because it is what I am good at and what I love. I learned to implement data structures and algorithms in C++ from the first grade of junior high school. I participated in the National Youth Computer Competition on behalf of our senior middle school and won the first prize of the National Olympiad in Informatics in Provinces(NOIP). I got a solid computing foundation through six years of training in programming and algorithm. However, I was not satisfied with the engineering-oriented training provided by the Department of Computer Science. I hoped that I could study algorithms and theories more deeply and chose the Department of Mathematics.

Mathematics has indeed given me a lot of surprises. I am obsessed with the abstraction and simplicity of mathematical language. Three years of mathematics training in the university gives me the ability to see the essence through phenomena and to see problems in a unified way. I have achieved excellent results in main courses - core GPA 4.5/5.0, ranking 2/137. As for extracurricular exploration, numerical optimization and signal processing are two main aspects. In my freshman year, I took the public elective course of Operational Research in the School of Management. I found that many complex real-world problems are just simple optimization problems under constraints in mathematics. The duality theory is particularly interesting. The method of Lagrange Multipliers in Mathematical Analysis is extended to the more general KKT condition, which is simple and beautiful. In my sophomore year, I participated in an after-school seminar on Fourier Analysis and gave a lecture on the Fast Fourier transform(FFT) algorithm. When preparing the lecture, I read about the application of FFT in signal processing and firstly contacted time-frequency analysis. Through Fourier transform, wavelet transform, and other similar tools, the original data is mapped to a new space, and the potential information is mined. This view of feature transformation is very attractive to me. The theory of Randon transform and its application in CT are also included in this seminar. In my junior year, I participated in another after-school seminar on Sparse Optimization, learning from the classic sampling theorem in signal processing to a newer compressed sensing theory. Through these extracurricular explorations and thoughts, I deeply feel the power of mathematical theories in practical applications and strengthened my determination to work in mathematics rather than engineering.

Computing fills my spare time as an interest. In addition to C++, I mastered Python and Matlab in university. In the Contemporary Undergraduate Mathematical Contest in Modeling, our team chose the discrete optimization problem B, and the work "The Problem of Crossing the Desert Based on Markov Decision and Game Theory" won the national second prize. Crossing the desert is a game similar to a monopoly, we need to give a game strategy through modeling and computing. I built a linear programming model and used the Cplex optimizer in Python to solve it. "How can computers learn to play games by themselves?" After the competition, I continued to think about this question. I taught myself the Berkeley Open Computer Course CS188: Introduction to AI, and completed the course projects (writing an AI to play Pac-Man game in Python). In this interesting

course, I known reinforcement learning, where the DQN (Deep Q-Learning) algorithm prompted me to learn deep learning and PyTorch. In the Matlab course, I successfully implemented the Shazam algorithm to recognize music through pieces of songs, the ADMM algorithm to solve the linear inverse problem, the PDE-based algorithm for image inpainting, and other term projects. My teacher speaks highly of me, and my final score was 99. /100.

As for why I am interested in medicine and brain science, my interest comes from pain. My family was hit hard by the diseases. I lost my father in junior high school, and my mother-in-law was admitted to the hospital because of schizophrenia in 2020. I think that brain waves, CT, and MRI images, which are often referenced in medical research and diagnosis, are one-dimensional and two-dimensional signals. I strongly hope that I can make a contribution to solving the mechanism of mental illness using the tools from computational mathematics.

Recently, I participate in an image processing group in cooperation with Sun Yat-sen University Cancer Center. We need to do registration and 3D reconstruction of mouse liver tissue sections. I searched and read related literature and books, and summarized the classic framework of image registration. Under this framework, I converted the registration problem into an optimization problem of searching optimal transformation parameters, which could be solved by the Powell algorithm. I achieve good primal results and continue to promote this project.

In my opinion on academics, theory and application are two directions of research, and their final goal is the same —— problem-solving. Applied research needs theoretical guidance, and the problems encountered in application inspire us to develop new mathematical theories. I am good at modeling and computing, and I am also keen to study mathematical theories. They are all indispensable knowledge to overcome difficulties. My current future plan is to study for a doctorate, then further post-doctorate, and strive to stay as a professor in a research university.

Finally, thank you again for reading my personal statement in your busy schedule!