Teaching Statement

Haoyue Tang

As a teacher and mentor in the field of communication networks and information theory, my teaching philosophy is to help students **explore their talents and achieve the best as they can**. My past research, teaching and mentoring activities in chasing the boundary of networking systems help me formulate my own way of working with students from diverse background.

1 Teaching Experience

I have been a TA for course "Communication Signal Processing", a guest lecturer for course "Networks and Communications" in Tsinghua University. I was fortunate to mentor 6 senior undergraduates and 2 junior PhD students on their first research project about network optimization, from proposing the research topic, leading the research discussions, to exemplifying academic writing and presentation. I have been a senior undergraduate student mentor for two years. I highlight below some important aspects during those experiences:

- **Clear Motivation** I believe to explore students' talents, it is important to show them the motivation behind each piece of theorem and algorithm to enlighten their learning interest. While delivering guest lecture on data freshness optimization, I talked about the bottleneck of the current networking protocols I observed during my industry internships, and showed them how theoretic developments in data freshness optimization guide the communication protocol refinement in real-time applications. At the end of the lecture, I showed them the unfairness phenomena when a mice flow co-exists with an elephant flow. I addressed the importance of fairness and then invited students to work on the problems themselves. The lecture attracted many students' interests in the ongoing research projects in our lab. Four of them finished their undergraduate project in our lab with conference and journal publications (See CV [11, 16, 18-20]).

- **Step-by-Step Guidance and Closed Loop Feedback** During the TA sessions and guest lectures, I introduced theoretic results by letting students re-discover the theorems themselves through step-by-step hints. While mentoring students' research project, I helped students develop new algorithms with step-by-step guidance. One such classical theorem is the capacity of the Multiple-Input-Multiple-Output (MIMO) system. Instead of letting students compute the numerical capacity in various situations using the theorem directly, I guided them re-prove the channel capacity theorem through homework. I read the original paper, figured out the challenging steps during the proof, then divided the whole proof into small sub-problems and provide enough hint for each of them. The other session does not use the same home work programme, and my students does better in the final exam. When mentoring undergraduate research projects, I am always ready to discussions of every problem solving intuition, simulation trial and early draft feedback. The first four undergraduate students I have worked with: Wenhao Zhan (now EE PhD student at Princeton), Qining Zhang (now ECE PhD student at Umich), Chenghao Deng (now ECE PhD student at University of Maryland) and Yuchao Chen (now EE PhD student at Tsinghua) have continue to pursue research careers that build upon the researcher ground that we built. I have won the Zijing Scholar award from Tsinghua University for being an excellent undergraduate mentor.

- **Outstanding Research Communication** I believe students should be equipped with outstanding communication skills for problem solving and discussions through lectures and research projects. I cultivated the communication abilities of students through group discussions and observations. I encourage students to raise questions and discuss their eureka ideas at any time. To build their confidence during the process, I talked to students about their background knowledge, and then paired them with papers/projects that are compatible with their knowledge level. Before they meet as a group, I met with them one-on-one and give detailed suggestions for their paper/project presentation. Two of my mentored undergraduate students received the "Advanced Undergraduate Research Project Award" from Tsinghua University in the annul undergraduate research forum.

2 Teaching Interests

Undergraduate and Graduate Curricula I am prepared to teach a variety of courses related to Information and decision systems, applied probability and stochastic analysis in the EE department of Notre Dame as follows:

- Junior Undergraduate Level: EE 30344 – Signals and Systems; EE 30363 – Random Phenomena in Electrical Engineering; EE 40453 – Communication Systems; EE 40471 – Digital Signal Processing
- Senior Undergraduate and Graduate Level: EE 60551 – Mathematical Programming; EE 60553 – Advanced Digital Communication; EE 60554 – Communication Networks; EE 60563 – Probability and Random Processes; EE 60573 – Detection and Estimation; EE 60671 – Advanced Digital Signal Processing; EE 80653 – Information Theory

I can also teach introductory courses in a wider EE areas such as: CIS 1100 Introduction to Computer Programming, ESE 2150 Electrical Circuits and Systems and ESE 5000 Linear Systems Theory. Based on my research background, I will use specific examples during my research and industry experiences to illustrate how these introductory course can be used in students' future career. I will also post research projects opportunities in the introductory courses.

Proposals for Graduate Seminars Based on my prior research experience, I propose two special seminar courses for exceptional undergraduate students and graduates:

"Stochastic Approximation: From Learning Queues to Q-Learning" This course introduces recent progress in reinforcement learning and the queueing networks. We will first use queueing network as a background application to teach the fundamental mathematic tools in stochastic approximations. We will then move on to discuss how those mathematics tools are used in bandit and reinforcement learning algorithm design. The goal is to help students understand how the insights from classical theory and mathematics affect system design and the current research trend.

"Content and Task Oriented Communications" The upcoming 6G communication systems has to fulfill critical sensing, computing and decision tasks in emerging applications such as the AR/VR, mobile computing. The goal is to expose students new problems and research trends in future communication systems, and help them gain confidence in problem solving through interactive teaching and discussing.

3 Teaching Philosophy

I believe higher education should help students discover their own strengths and interests by sharing them the most beautiful aspects of a wide range of areas, and then equip students with confidence, creativity and critical thinking when exposed to new problems. The critical aspects I will address in the future are as follows:

- **Critical Thinking** When working with complex communication systems, a satisfactory solution to all the optimization goals (e.g., achieving both high throughput and low delay) is impossible. Therefore, I will always encourage students to discover of the drawbacks and bottlenecks of each algorithms, figuring out the application domain and potential refinement strategies when applied to other applications.
- **System Level Thinking** As a theoretic researcher in Electrical Engineering, I will cultivate my students' system level thinking ability through hands-on projects on communication systems. Together with my TAs, we will design step-by-step lab assignments on communication testbeds to reveal the trade-off relationships (e.g., delay and throughput) we discovered during theoretic courses. I will share my own industrial experiences on multi-objective optimization, and let students figure out their own way multi factor balancing and trade-off design to achieve specific goals in complex systems. As a starting point, I have been developing a new lab course on O-RAN systems during my postdoctoral research together with Prof. Leandros Tassiulas.