Teaching Statement

I believe that teaching is one of the most rewarding aspects of academia because it can consistently and positively improve the lives of others. Below, I describe my experiences as a teacher and mentor as well as my future plans for teaching.

Teaching Experience

During graduate school, I was a co-instructor for a new course, *Modern Mobile Systems,* that was designed to expose students to the broad variety of applications possible with commodity mobile devices, e.g., diagnosing diseases on smartphones and developing new interaction systems for virtual and augmented reality. The course covered both CS and EE topics, including signal processing, wireless sensing, machine learning for new interaction systems, fabrication, and localization.

Since no prior UW courses matched our course goals, we developed the syllabus from scratch and outlined topics, papers, and guest lectures for the entire term. Since most of the students were from the CS department, I tailored the teaching of EE-related concepts like signals to improve their appeal and understandability; I easily empathized with their situation given that my undergraduate degree was also in CS, and I taught myself signal processing concepts from conversations with grad students in my lab. By leveraging my personal experience, I could foresee their potential misconceptions or knowledge gaps and explain the topics clearly and coherently. Although challenging to balance with my research obligations, I remained committed to assembling cohesive and engaging lectures for the students. By term's end, we received positive teaching evaluations from students, who commended the lectures, projects, and readings for being interesting, fun and useful for their learning. It was rewarding to see such positive feedback, especially given the many late-night efforts I had placed into developing the course throughout the term.

I also served as teaching assistant for a graduate-level course, *Mobile Systems & Applications*, which focused on teaching core concepts used in many mobile systems, including acoustic and radio wave propagation, signal processing, ranging, localization, angle of arrival algorithms, and IMU systems. Given my significant experience programming mobile devices as part of my research, I redesigned several course assignments so students could gain experience deploying these techniques on smartphones. However, I also recognized that not all students would be familiar with smartphone programming or even have a smartphone available for development purposes.

I therefore developed tutorials and code samples that taught students how to access data from the IMU and speaker and microphone simultaneously. Further, my code helped students plot the sensor data they were receiving on the screen in real time so they could debug their assignments interactively; this interactive style of debugging was particularly important for two class assignments, one on how to fuse data from the accelerometer and gyroscope to calculate tilt and another on recognizing in-air hand gestures by measuring the Doppler effect when students pushed/pulled their hand towards their phone. Mid-way through the class, I observed that several students using iPhones were encountering more problems than those using Android phones. I realized that this was due to the much clearer Android ecosystem documentation. Therefore, instead of spending unnecessary time debugging their iPhone code, I loaned Android devices from our lab to several students in the class, which accelerated their progress.

Towards the end of this class, I developed an open-ended assignment that encouraged students to develop machine learning models that they could deploy on smartphones to solve a problem in their domain of interest. Because some students were not computer science majors, I also developed a lecture that aimed to bootstrap students with machine learning tools and concepts they could use for their assignments. It was encouraging to see that the most interesting final projects actually came from students without a computer science background: a student from the medical school ended up developing a heart murmur classifier to distinguish between heart sounds from a digital stethoscope; another student with a background in biology developed a real-time model to classify different bird sounds and tested it in the wild on birds while going on a hike, reporting accurate results.

Further, I personally completed all assignments in the class myself and attended every lecture, even though it was not required of me. As a result, I could help students by providing both high-level intuitions and concrete details about their assignments. During office hours, I examined details of each student's code to uncover potential misconceptions instead of just addressing their questions at a high-level. By understanding their questions in detail, I could prompt them with hints about how to proceed, which helped them arrive at the correct solution on their own. Outside of office hours, I held one-on-one tutoring sessions that were useful for students that did not have a strong computer science background. I found that these students were able to easily complete the assignments after filling in gaps in their knowledge.

I was also a teaching assistant for an undergraduate course, *Introduction to Computer Communication Networks,* three times. The course taught networking concepts, starting from signals and bits at the physical layer all the way to the application layer. For each new course iteration, I made an effort to incorporate student feedback I had received during my previous time teaching it. My first time teaching the recitation section (my first year in grad school), I had difficulty designing sufficient material to fill up an entire hour and was often met with blank stares when I asked students if there were any questions. I quickly realized that I had become too focused on content instead of ensuring the material was taught in an interesting, effective way.

During the next two course iterations, I made a deliberate effort to put myself in the shoes of the student as I prepared the section materials, and I even practiced hour-long lectures end to end to ensure that what I prepared was worthy of the students' attention. During the lectures, I set a tone that encouraged intellectual curiosity while also being relaxed and welcoming. Initially, only the most vocal students in the front row of the class contributed, but very soon after the quieter students in the back started to regularly respond to my questions, which I took as a positive sign that I had managed to create an engaging and friendly classroom where students felt comfortable contributing. After section and office hours, I started to find many quieter students approaching me individually to have longer discussions about the course material. These extended discussions always ended on a positive note and were an indicator that I had made significant strides in my teaching skills. Such experiences continue to motivate me, and I look forward to continually upgrading my teaching skills as I embark on my career as a professor.

Mentoring Experience

I have been fortunate to mentor 3 junior PhD students, 3 undergraduates, and 1 high school student in our lab. Below, I describe my experiences with several of them.

PhD students

When mentoring junior PhD students, I consider it my responsibility to take a *student-first* approach that sets research goals based on students' individual strengths. I found that this approach ultimately leads to more successful project outcomes and a more fruitful, collegial relationship. I recently mentored a first-year PhD student, *Antonio Glenn*, on a project to bring hearing screening to low-cost wireless earbuds. During prototyping, I learned that Antonio had a background in biomedical engineering and noticed his knack for hardware design and aesthetics. Therefore, I assigned him ownership of the selection and assembly of the printed circuit board that powered the earbuds and the design of the 3D-printed enclosure, while I focused on developing the software algorithms to run on the earbuds. Although we each had our individual responsibilities, frequent and close interactions were essential to sustaining project progress, and I worked side by side with him to transition the hardware from my previous wired prototype to the final wireless earbud design.

Through these interactions, I strived to lead by example by demonstrating how to systematically and efficiently uncover and debug practical system issues as well as how to experimentally evaluate the system to generate interesting research results that others would care about. I deliberately involved Antonio in aspects of the project I was responsible for instead of siloing myself. Specifically, I pair-programmed with him to develop a clinically accurate algorithm and invited him to join me on long recruitment days at pediatric clinics to validate our device. Keeping him updated and on the same page on all aspects of the project helped him feel a greater sense of project ownership and created a productive team dynamic whereby either could pitch in to solve problems and bugs, regardless of which project domain it was in. Our efforts paid off when we submitted a full conference paper to MobiSys in a matter of 1.5 months from project conception, with Antonio and I listed as co-primary authors on the submission.

During the COVID-19 pandemic, I mentored first-year PhD student *Ananditha Raghunath* on a project to use the LiDAR smartphone sensor to test the properties of liquids using the laser speckle phenomena. Ananditha had very different strengths than Antonio; she was a creative, big-picture thinker able to present conceptually interesting, untried directions for the project. To leverage her strengths, I asked her to conduct a comprehensive literature survey of ideas and algorithms in the laser speckle and LiDAR space. She responded positively and identified new project directions week after week that helped us overcome conceptual roadblocks. As with Antonio, I maintained a tight feedback loop with Ananditha in spite of COVID-19 isolation guidelines by reaching out over email and Zoom multiple times a week to keep us on the same page regarding project status. Further, I involved Ananditha in hardware aspects of the project despite her remote-work status. Specifically, I successfully guided her in replicating a portion of our in-lab setup in her home, which gave the team greater confidence that our lab setup was working. Ultimately, Ananditha's many conceptual contributions helped to strengthen the project significantly, and we submitted the project as a full conference paper to IMWUT 2022, where it was also published.

Finally, I worked with first-year PhD student *Tuochao Chen* on two projects related to using the smartphone to perform underwater acoustic communication and ranging. Tuochao had significant prior research experience and could very capably design project algorithms. To complement his skills, I took on the task of building a robust real-time smartphone implementation that we could practically test in the ocean to get research results. Here, too, I maintained a tight communication loop with him to develop a practical system that we were both proud of designing. By identifying each student's strengths early and assigning appropriate tasks, my projects have benefited greatly from synergy. My work with Tuochao produced a joint primary-author publication at SIGCOMM 2022, where it went on to receive a SIGMOBILE research highlights award.

Undergraduates

I also had the opportunity to mentor an EE undergraduate *Jordan Hsu* on a project to detect seizures using active sonar on smart speakers. Based on Jordan's strength in embedded systems, I assigned him to modify the smart speaker code to send custom acoustic signals. He soon reported however that it was challenging for him to understand the code templates that we were working with, and upon deeper inspection, I realized that the code was completely undocumented and difficult to understand. To resolve this, I contacted the previous owner of the code, and worked side by side with Jordan, to resolve many of these low level issues. Upon this resolution, he was able to begin experimenting with signal processing and deep learning approaches to detect motion patterns of seizures from the acoustic data. This project is currently undergoing evaluation at the seizure ward at the University of Washington medical center.

Earlier during my PhD, I worked with a mechanical engineering undergraduate *Ian Culhane* on a project to embed wireless communication abilities into 3D printed objects using backscatter technology. Ian had been very active in running the Makerspace on campus, and had a knack for mechanical and 3D printed designs. Based on this, I worked with him to develop several prototypes for the project including a 3D printed prosthetic hand which we modified to send information about wrist motion. My collaboration with Ian resulted in a paper at UIST 2018 that was highlighted by MIT Tech Review as "6 of the most amazing things that were 3D-printed in 2018", with a specific reference to the 3D printed prosthetic hand.

Future Teaching Plans

Given my research and teaching experience, I am qualified to teach courses in mobile systems, embedded systems, data science, wearable computing, smartphone programming, computer networks, and introductory computer science. I am interested in developing an *interdisciplinary course for mobile systems* that teaches (1) the hardware skills to prototype embedded systems and program mobile CPUs, smartphones, and microcontrollers, (2) signal processing algorithms for sensor data (e.g., acoustic, video, inertial measurement data), and (3) machine learning algorithms for real-time processing of multiple data modalities, including speech, language and videos. I believe these skills will enable students to build mobile systems with valuable applications, including physiological sensing, localization, communications, and interaction.

As an undergraduate student in computer science, the curriculum was largely focused on software courses. As a result, most hardware or signal processing knowledge I used for my research was passed down to me by senior graduate students. Based on these experiences, I am motivated to create a structured mobile systems course that is accessible to students from a variety of backgrounds. Many of the most significant applications in computer science come from combining hardware and software systems, and I look forward to teaching these skills through a mobile systems course that is stimulating, practical, and in-demand by students.