Teaching Statement

Yuhao Zhang, University of Wisconsin–Madison
https://pages.cs.wisc.edu/~yuhaoz/

Imagine a classroom where students are explorers who adventure across the vast sea of knowledge, their curiosity serving as their compass. Obstacles, such as complex theoretical concepts, are transformed into accessible ports of call, enabling every student to sail their course freely. Moreover, each student is empowered to use their unique background and strengths in navigating the uncharted frontier of knowledge. These are not mere daydreams but the guiding principles of my teaching and mentoring approach. I am committed to fostering an environment that is engaging and inclusive to all students and where they can shine with their diverse backgrounds.

I have gained a wealth of experience in various roles that have further sharpened my skills and reinforced my teaching philosophy. As a **teaching assistant** for Algorithm Design and Analysis at Peking University, I scored assignments, addressed assignment problems in weekly seminars with a group of twenty undergraduates, and designed course projects and extra resources that extended the learning beyond the classroom. I delivered two **guest lectures** on neural program synthesis in a graduate-level course (CS 703 Program Synthesis) at UW-Madison, covering topics such as transformers, pre-training, few-shot learning, and neural-symbolic program synthesis. I gave a **tutorial** on the "Large Language Models for Code" reading group where attendees are graduate students and professors from different research fields, including Programming Languages, Systems, Architecture, and Human-computer Interaction. I **led discussions** at an online "Model Checking" reading group where attendees are graduate students and postdocs from various universities across North American. As a **mentor**, I have organized and hosted events, mentored undergraduate and graduate students, and tailored projects to their unique backgrounds and specialties.

1 Teaching Philosophy

Strategic Questions for Active Learning. I believe that one way to promote active learning among students is through well-crafted questions that stimulate their interest in the material, thus encouraging them to delve deeper into the topic and create an engaging in-class atmosphere. To cater to students with varying levels of familiarity with the topic, I design pre-course questions that range in complexity. Some questions are accessible to anyone with a basic understanding of the topic, while others require more in-depth reading and thinking of the handout materials. This approach ensures that every student, regardless of background, feels motivated to engage with the new topic. During the course, I aim to foster an inclusive in-class atmosphere by posing questions that all students can engage with. Drawing from my experiences as a student, I understand that challenging in-class questions can inadvertently turn the learning atmosphere into a game among the top students, leaving others feeling passive and even discouraged.

Experiential Learning through Hands-On Projects. I believe that the learning process is incomplete until students can apply their knowledge in practical settings. This belief is particularly relevant when teaching cutting-edge topics, where new ideas often emerge from hands-on experimentation. For example, I designed course projects for undergraduate students interested in blockchain technology during my teaching assistantship. I encouraged students to form groups to deploy and experiment with well-maintained Github repositories and write reports about their usage, limitations, and potential improvements. The results exceeded my expectations, with some groups not only presenting innovative ideas in their reports but also demonstrating improved Ethereum blockchain applications. Besides my TA experience, I created a toy repository for the "Large Language Models for Code" reading group. Using this repository, a first-year graduate student with no prior experience with LLMs was able to evaluate and fine-tune these models, presenting preliminary results to his advisor within a few weeks.

Simplifying Complex Concepts through Examples and Intuition. I believe the key to understanding complex theoretical concepts lies in breaking them down into simpler, more intuitive components. This belief is particularly relevant in areas such as Model Checking, where abstract concepts and dense formulations can be daunting for students. I encountered this challenge directly when leading discussions at the Model Checking reading group. Even experienced graduate students and postdocs struggled to grasp certain concepts in fair discrete systems (FDS) and temporal logics. To address this, I adopted the Feynman technique, saving examples and intuitive explanations that I used to understand these concepts myself and reusing these examples to clarify complex ideas to others. For instance, when explaining the definition of states and paths in an FDS, I used a simple one-statement example of `x=x+1` to illustrate the transitions in FDS, and `prime` and `unprime` operations. The positive feedback from attendees, such as *"Ahh... I finally got this"* and *"Thanks for the lovely example. That's really helpful,"* reinforced my belief. Moreover, I found that even examples needed intuitive explanations when it came to Linear Temporal Logic and Computation Tree Logic. Therefore, I provided each formula with a one-sentence description in English, adding more intuitions to these formulas.

Understanding and Supporting Students Beyond Academics. In my experience mentoring new graduate students, I have come to understand that their needs and concerns often extend beyond the academic sphere, encompassing aspects of life, culture, and even politics. I believe that while teaching and research aim to universalize and equalize individuals, the unique humanity of each student shines through when we strive to let race, ethnicity, gender, and other diverse backgrounds of a person particularize oneself in their being. During the Covid-19 pandemic, I experienced the importance of this holistic approach to mentoring. When anti-Asian sentiment was rising, my advisors reached out to me, expressing concern for my well-being and offering practical support. Their empathy and understanding not only provided me with much-needed emotional support during a challenging time but also deepened my understanding of the principles of diversity, equality, and inclusion. As a future educator, I aim to emulate my advisors' approach, striving to understand and support my students in all aspects of their lives and fostering a respectful environment.

2 Research Mentorship

As a mentor, I believe in fostering a supportive research environment that encourages students to explore their interests and develop their skills. To create such an environment, I have helped organize events such as the Programming Languages seminar in our group, providing a platform for students to engage with new research papers and share their ideas. I have also hosted and co-hosted the PL open house events from 2020 to 2023, where graduate students shared experiences with prospective students.

In addition to these group activities, I have mentored undergraduate and graduate students. One of the key lessons I have learned is the importance of understanding the unique educational background and strength of each mentee. For instance, when mentoring my first undergraduate student, I initially overlooked her educational background and strength. This oversight led to some challenges in pushing the project, as it required more Python knowledge than she possessed because she was a double-major student and had not yet taken any programming courses. To rectify this, I provided her with programming materials and assisted her with coding. This approach enabled her to run code from a research project and conduct evaluations of natural language processing models, aligning with her strength in linguistics. This experience has influenced my subsequent mentoring practices. For example, my recent mentorship with a female graduate student resulted in a promising research project, which we plan to submit to an upcoming conference.

Moving forward, I will be always available to help new graduate students with low-level details, such as proofs, derivations, and programming, as I believe that a strong start is crucial for building research momentum. For highly motivated new graduate students, I encourage them to propose their own projects. For those who need more guidance, I will tailor projects to their background and specialty.

Furthermore, I also plan to involve senior graduate students in the projects of new students. This approach not only provides additional support for new students but also helps senior students develop their mentoring and management skills, which are invaluable for their future careers.

Lastly, I believe that mental and physical health is a prerequisite for research success. While everyone has their own way of balancing research and personal wellness, and my approach might not work for everyone, I am committed to supporting my students on their journey to success with excellent mental and physical health.

3 Future Courses

My diverse research interests equip me to teach a wide range of courses, spanning from **programming languages** and **software engineering** to **deep learning**.

At the undergraduate level, I am prepared to instruct introductory courses, including but not limited to, introduction to **programming languages and compilers** and **neural networks**.

At the graduate level, I am eager to offer traditional advanced courses such as **program analysis**, **model checking**, **software testing**, and **program synthesis**. These courses will incorporate lectures, assignments, and small course projects to ensure a comprehensive understanding of the subject matter. Additionally, I am enthusiastic about leading research-oriented courses that involve paper reading, discussions, and small research projects, particularly under the topics of **verification of neural networks** and **large language models for code**.

As I look forward to the opportunity to teach and mentor at your esteemed institution, I am excited to inspire and be inspired by the next generation of computer scientists.