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TEACHING STATEMENT

My teaching philosophy and methodology have been shaped by the great instructors that I have had the fortune to learn from and work with throughout my academic career, as well as through additional training that I have pursued through Carnegie Mellon University's Eberly Center for Teaching Excellence and Educational Innovation. Below, I outline my teaching experience, philosophy, and courses I would be comfortable teaching from day one.

Teaching experience

I have served as a teaching assistant (TA) for: *Mathematical Foundations of Computer Science*, a B.S. in Computer Science (CS) core course introducing undergraduate CS students to discrete mathematics and proofs; *Modern Convex Optimization*, a Ph.D. in Operations Research (OR) and Ph.D. in Algorithms, Combinatorics, and Optimization (ACO) core course on conic optimization, duality, semidefinite programming, and first-order methods; *Advanced Algorithms*, a Ph.D. in CS elective course surveying a wide array of algorithmic ideas; and *Optimization*, a 130+ student MBA core course introducing optimization and its practical applications.

I have also completed The Eberly Center's Future Faculty Program—a certificate program through which graduate students at CMU may develop and practice effective teaching techniques. As part of this program, I have participated in seminars including: Centering DEI in Course Design; Creating a Welcoming and Supportive Climate from Day One; Grading and Delivering Feedback on Quantitative Assignments; and Teaching Problem Solving in Recitation.

Teaching philosophy

As an instructor, my goals are for my students to be able to: (1) comfortably apply and explain technical course concepts, (2) recognize course topics and its connections in adjacent application areas, and (3) demonstrate proficiency in the tools they may need in their professional careers and/or research fields. In order to help my students achieve these goals, I strive to incorporate effective teaching practices such as balancing instructor-led and student-led learning, emphasizing connections between course content and adjacent topics, and creating a welcoming environment for students to comfortably explore course topics.

Towards applying and explaining technical course concepts. As an instructor, one of my foremost goals for my students is to be able to apply and explain technical course concepts. This goal is especially important for core or sequence courses where students may be expected to develop specific skills to bring to their future coursework. To help my students achieve this goal, I intend to strike a balance between passive instructor-led learning and *active* student-led learning in all aspects of my teaching. This part of my teaching philosophy is informed by my own experience, as both a student and a researcher, that most mathematical concepts cannot be solidly grasped without active and open-ended engagement.

A natural place where student-led learning occurs is in solving homework problems. I plan to carefully design problem sets with a healthy mix of difficulties and scaffolding. As an example, such a problem set in a graduate course emphasizing research ability could be composed of: one-line exercises designed to get students comfortable recalling new definitions and results from lecture; a bulk of more difficult but well-structured problems that students should be able to complete with moderate effort using only tools from lecture; and a few open-ended challenge problems that explore ideas beyond what is covered in lecture. These challenge problems, graded only for completion, would ask students to demonstrate effort in thinking about a given question using their own unique perspectives (e.g., by solving a special case, constructing examples or counterexamples, or posing and offering evidence for a conjecture related to the problem). Following each problem set, I will post a number of responses to the challenge problems highlighting the diversity in ways that different students may have chosen to approach the same problem.

I further emphasize active learning by holding student-led problem-solving sessions, providing actionable feedback on assessments and creating a positive classroom environment where students are comfortable participating. In this direction, I plan to experiment with classroom assessment techniques such as "muddiest point," where students are given a few minutes during class to write down and explain questions or confusions they may have. Beyond allowing students to reflect on their own grasp of course materials, this will also allow me to adapt my teaching to their specific sticking points. Such active learning strategies will allow both the students and I to assess and gauge their progress towards learning objectives both formally and informally.

This emphasis on active student-led learning has already informed my prior teaching. As the Head TA for *Optimization*—a course introducing MBA students to optimization and its applications—I prepared and led weekly recitations in which I guided students through practice problem sets. During my first recitation, I sensed that many of the students felt uncomfortable speaking up or offering solutions. In the following recitations, I established up front that I would be asking students to help me with the individual questions, stressing that it was perfectly acceptable not to know the answer as long as they worked with me. Throughout, I practiced using supportive language and highlighting ideas they suggested that made it into the final solution. In an anonymous exit interview, one student said "I really liked the way [Alex] would go down a list of attendees and encourage everyone to try to answer the question. I think this kept everyone alert, thinking ahead and [helped us] actually remember how to approach the question in the future."

Towards recognizing course topics and its connections in adjacent application areas. I believe students engage most deeply with course material when they are able to recognize its motivations and connections with other adjacent fields. To help my students develop this skill, I intend to augment weekly problem sets with questions pointing outside of strict course material. For example, questions on spectral graph theory or polynomial interpolation within a linear algebra course could help motivate eigenvalues or invertibility. Similarly, questions on two-person games or König's Theorem within a course on linear programming could help to motivate LP duality. In advanced undergraduate or graduate courses, these questions could point to cutting-edge applications of course material so that students not only learn the course material but understand how it fits into the current research landscape.

My goal for my students to have a rich appreciation for course content and its context has already informed my prior teaching. As a TA for *Advanced Algorithms*, I routinely participated in classroom discussions and the class message board, offering pointers to other topics related to course material. For example, following a lecture on max-cut, a number of students expressed curiosity in the existence of low-rank solutions to semidefinite programs. In response, I held a follow-up discussion during office hours where we explored proof ideas in Nesterov's $\pi/2$-Theorem and the Barvinok-Pataki bound. Similarly, following a lecture on max-flows and resistance networks, I wrote a message board post with additional exercises regarding graph Laplacians. In an anonymous exit interview, one student said "The professor takes an interest in student learning like no other. TAs are also phenomenal in the same ways. They're so ready to talk to students about math and CS, it honestly made me excited to be taking the course."

Towards tools different students may need. Above all else, I realize that students' needs and goals vary and that an important part of my job is adapting my teaching to help them develop the tools *they* need to take away to their varied careers. As concrete examples, I may choose to emphasize and grade for the ability to *construct and write* clear proofs in advanced undergraduate or graduate theory-focused courses, while emphasizing and grading for the ability to *recall and apply* definitions and course concepts in earlier introductory courses or courses cross-listed for students in other departments. Towards this goal, I will carefully consider how my courses factor into my students' academic journeys and allow this to inform my learning objectives and assessment methodologies.

This part of my teaching philosophy has influenced my approach as a TA for algorithms and optimization courses in diverse classroom settings: from MBA students in *Optimization* learning to recognize concepts and apply tools from optimization to practical problems, undergraduate CS students in *Mathematical Foundations of Computer Science* learning how to construct proofs for the first time, to ACO, CS, and OR Ph.D. students exploring advanced technical concepts and practicing research-related skills. For example, while grading work in *Mathematical Foundations of Computer Science*, I left feedback prioritizing the soundness of different logical arguments. On the other hand, while grading work in *Modern Convex Optimization*, I additionally left feedback related to clarity and style in written proofs (e.g., "Do you see a more direct way of proving this subclaim using duality?" or "These highlighted sections follow the same idea, consider pulling out as a separate lemma.").

Conclusion

My teaching philosophy emphasizes student-centered and inclusive teaching practices in order to help my students develop technical skills within course content and an understanding of motivations for course material and the broader picture, while practicing specific skills they might need in their own careers. Teaching is a skill that I have only just begun to build but is one that I strive to continuously hone. I hope to continue this process of constantly reexamining my current teaching and incorporating additional effective teaching practices into my future teaching.

Within the department, I would be excited to aid in teaching a range of undergraduate and graduate courses, including courses related to linear algebra, linear programming, convex optimization, and algorithms. I additionally look forward to designing and offering special topics courses on topics within semidefinite programming and convex optimization.