Teaching Statement

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Teaching Philosophy

There have been many teachers throughout my life that I have admired. My own desire to get into research was kindled almost entirely due to excellent artificial intelligence and algorithms teachers that helped me see the joy that can be derived from problem solving. I would love to be able to pay this forward by helping inspire similar feelings in future students.

The two most powerful ideas that I have encountered in terms of engaging students have been problem solving as part of lectures and creation of projects that solve real and fun problems. For problem solving, I have encountered a small number of professors that are able to present material in a way where it feels like the class is working out the solution or right approach together. I believe this style of teaching leads to much better engagement and does a better job teaching students how to approach future problems. The second idea, projects that solve tangible but fun problems, helps students appreciate that the techniques learned in the class can be used to solve real problems, and allows them to get hands-on experience. When done right, I have found that students are sometimes downright excited to do their homework. Representative examples that I have encountered include having students make an AI for a simple game, analyze fun and societally relevant data, or code up an algorithm to compute shortest paths on real traffic networks. As a faculty member, my goal will be to create inspiring and fun classes by incorporating techniques such as these in my teaching.

Teaching Experience and Mentoring

I have extensive teaching experience from my time at CMU as well as the IT University of Copenhagen (ITU). At ITU I was a teaching assistant for a decision making-oriented artificial intelligence course and an algorithms course. At CMU I was a teaching assistant for undergraduate and graduate artificial intelligence. **I was nominated for a teaching excellence award for my teaching in undergraduate artificial intelligence**, which included teaching a lecture, creating theoretical and programmatic homework, conducting office hours, and supervising research projects. For the last three course iterations, I have been the vertical mentor associated with the course “electronic negotiation”, an interdisciplinary course where students create a proposal for an electronic transportation-sourcing solution. This involves supervision of about 15 group projects per course iteration.

For the past year, I have been mentoring first-year Ph.D. student Gabriele Farina as part of a new mentoring system at CMU. In addition to giving advice about graduate-school life, this has turned into a fruitful collaboration. We have been working on several problems, mostly relating to equilibrium computation. So far this relationship has resulted in papers at IJCAI2017 [3], ICML2017 [1], and AAAI2018 [4], and I expect that multiple future papers will follow. I have thoroughly enjoyed this mentoring relationship, and I expect that it will continue in some capacity after I graduate.

Potential Courses

With my background in computer science as well as economics and operations research topics such as game theory, market design, and optimization, I am prepared to teach many courses: algorithms, artificial intelligence, e-commerce and market design, economics and computation, game theory, machine learning, data science, optimization, probability and statistics, and any standard lower-level undergraduate course. I am also well-versed in many modern programming technologies (such as R for data science, Python and Julia for optimization, and Python and modern C++ for general programming), and as such am well-prepared to incorporate useful and motivating project-based components in my courses.

At the Ph.D. level there are several courses that I am excited about teaching. First of all I would be happy to teach a breadth course on artificial intelligence, and I have experience with this from CMU. I would also be very interested in designing and teaching a course on advanced convex optimization methods for large-scale problems, with a focus on methods that pertain to large-scale machine learning, data science and game solving. Finally I would enjoy teaching a course focused on select topics in economics and computation, such as equilibrium computation or market design.

At the undergraduate and graduate level I would be excited about developing new courses pertaining to economics and computation or data science.

For economics and computation, such a course could be grounded in the real-world problem of designing large-scale electronic markets such as those run by Google and Facebook. This topic has a rich set of accessible but interesting theoretical problems to investigate, as well as a practical component. I have experience being the vertical mentor (essentially TA) for a similar project-based course at CMU called "electronic negotiation" focused on designing a truck-load sourcing market.

For data science, I would like to teach a course designed around the pillars of practical data science: data gathering and manipulation best practices, statistical modeling and machine learning, and lots of practical experience. One of the great things about teaching such a course would be the opportunity to design fun practical data science tasks such as analysis of city data (ideally from the university's city if it has an open data policy), economic data, or sports data. This also makes it easy for students to get to work on projects that analyze a topic that interests them.

Diversity

I care deeply about diversity and increasing the accessibility of STEM to underrepresented minorities. I have a small amount of indirect experience with gender bias myself. My wife is a software engineer whom has frequently encountered surprised questions of why a person like her is in an engineering environment. She has likewise recounted how she feels out of place when looking around a lecture room that consist entirely of men. While individual events like these can seem small, their constant presence works to make the field seem unwelcoming. I cannot claim that this indirect experience lets me fully understand all facets of what a minority experience in computer science is like. However, it does make me appreciate the need for change toward a better experience for everyone.

I am fortunate to attend an institution where the tireless work of people such as Carol Frieze (recipient of the 2017 A. Nico Habermann Award, an award given for diversity work) and Lenore Blum have lead to the department achieving near gender-parity in undergraduate computer science enrollment. I would be very happy to build on their experience by trying to implement some of their ideas at whatever institution I myself end up at [2]. One of the things that Frieze and Quesenberry suggest are important is access to role models and peers, which can often be more accessible to the majority group. At CMU one component of solving this issue was the creation of groups such as Women@SCS and SCS4ALL, diversity-focused groups that try to develop a better social environment for people of all backgrounds. I would be interested to help support similar environments at my own future institution.

Selected References

[1] Gabriele Farina, **Christian Kroer**, and Tuomas Sandholm. Regret minimization in behaviorally-constrained zero-sum games. In *International Conference on Machine Learning (ICML)*, 2017.

[2] Carol Frieze and Jeria Quesenberry. *Kicking Butt in Computer Science: Women in Computing at Carnegie Mellon University*. Dog Ear Publishing, 2015.

[3] **Christian Kroer**, Gabriele Farina, and Tuomas Sandholm. Smoothing method for approximate extensive-form perfect equilibrium. In *Proceedings of the International Joint Conference on Artificial Intelligence (IJCAI)*, 2017.

[4] **Christian Kroer**, Gabriele Farina, and Tuomas Sandholm. Robust stackelberg equilibria in extensive-form games and extension to limited lookahead. In *AAAI Conference on Artificial Intelligence (AAAI)*, 2018.