Teaching Statement

John P. Dickerson

Throughout my academic career, I have benefited from the guidance of many teachers and mentors. Indeed, a teacher's lasting effect on a student goes far beyond whether or not a course's material is learned. The right level of challenge mixed with support can alter a student's perception of an industry, academic field, or career path. With this in mind—and with a natural enjoyment of teaching—I do not see my duty as an educator as a burden, but rather as a serious opportunity to help students grow both intellectually and as citizens, and as a vector for my own personal growth as a scholar.

Teaching Experience & Philosophy

My academic teaching experience has centered around artificial intelligence, optimization, negotiation, and market design—initially as a teaching assistant, and currently as a co-lecturer of a graduate course. Roughly speaking, the following tenets motivate my teaching.

1. **Keep students engaged**—in the lecture, the course, and the subject matter in general. Hand-in-hand with engagement is my belief that students should **learn by doing**. Learning is fundamentally *developmental*: students must *develop* the ability to ask questions, formulate concrete problems from abstract ideas, and solve those problems. One of my favorite methods of maintaining engagement during class is through impromptu question-answer sessions. For example, after describing something analytically, I will present the students with a minimal example of a system or set of equations and ask them to solve it—by themselves—on paper, then discuss their thinking with a neighbor and finally with the class. These frequent semi-voluntary interactions with students during class allow me to pick out those students who are struggling, at which point I can approach them privately to discuss problems in more depth.
2. It is critical to **challenge and support students**. This point ties in with the above. Learning by doing is inherently challenging, and can discourage students if done at the wrong level. That said, I firmly believe that learning a topic *requires* being challenged. Without a challenge, students disengage. To effectively balance "challenge" with "support" for individual students, it is important to **be in tune with students' abilities and backgrounds**—especially in STEM, where students often have vastly different histories with technology. One of my favorite methods for choosing the right level of challenge is through course projects, where students propose a project idea and, as the semester progresses, the course leadership can push the student harder or support the student depending on individual capability.

My teaching philosophy has solidified over my undergraduate and graduate teaching career. During this time, I have served as teaching assistant for eight courses—four B.Sc.-, two M.Sc.-, and two Ph.D.-level. This semester, **I am a lecturer** with my advisor, Tuomas Sandholm (CMU), for a Ph.D.-level graduate course, "Foundations of Electronic Marketplaces" (CMU 15-892). The course is about the theory and practice of market design and is thus inherently multidisciplinary, attracting Ph.D. students from public policy to theoretical computer science. Responsibilities include the creation and presentation of new lectures, as well as mentoring students through a semester-long project of their own design.

At CMU, I have also served as teaching assistant twice for "Graduate Artificial Intelligence" (CMU 15-780), where I created from scratch many of the homework assignments and parts of the exams, and led recitations. Also at CMU, I have twice assisted with the M.Sc. course "Negotiation," part of the eBusiness Technology program; here, I mentored students (primarily with weak technical backgrounds) in course-long projects in the design of a sourcing auction. Earlier, at the University of Maryland, I was **Undergraduate Teaching Assistant of the Year** in the Department of Computer Science for my work on CMSC311, a junior-level computer architecture course—one of four courses for which I was teaching assistant.

Mentoring & Community Involvement

At CMU, I am mentoring computer science student Benjamin Plaut on his undergraduate thesis (with my advisor Tuomas Sandholm). We are working on improving CMU's branch-and-price-based barter exchange clearing engine, a version of which is deployed live at the United Network for Organ Sharing (UNOS) kidney exchange. Ben's project has produced one paper recently accepted to AAAI, a major conference [2]. Figure 1 shows the substantial runtime improvements of his solver from that work (BNP-POLY) on real UNOS data relative to two prior leading solvers (BNP-DFS and CG-TSP). We anticipate another paper by the time he graduates in May 2016. It is exciting to help Ben prepare to apply to top computer science Ph.D. programs, and I look forward to maintaining a role in his career as a scholar.

Recently, I have started informally advising Anson Kahng, an undergraduate at Harvard working on his undergraduate thesis with David Parkes (Harvard). Anson is extending my FUTUREMATCH framework to include new features related to the waiting time of an agent in the market (in this case, patient-donor pairs and altruistic donors in a kidney exchange pool). Anson is also applying to top computer science Ph.D. programs this year.

In the greater community, with Tuomas Sandholm, I will be giving a half-day tutorial [1] on organ exchange at AAAI—a top conference in artificial intelligence—in February 2016. I also serve or have served on the program committee of various AI conferences (e.g., AAAI, ICML, IJCAI), as reviewer for many conferences and journals (e.g., AAAI, AAMAS, EC, IJCAI, Operations Research), and as organizer and chair of invited sessions at the INFORMS annual meeting.

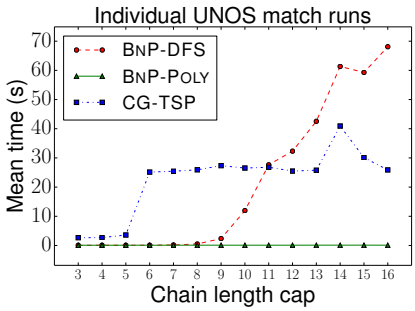

Figure 1: Our method, BNP-POLY, solves all UNOS match runs to optimality in under one second.

Example Future Courses

With a Ph.D. in computer science and a focus on practical applications of optimization and mathematical programming techniques to market design, I would be excited and prepared to teach courses related to algorithms, artificial intelligence, e-commerce, economics and computation, game theory, information systems, information technology strategy, applied machine learning, optimization, operations strategy, and simulation—as well as any of the standard lower-level undergraduate courses.

At the Ph.D. level, I would happily design and teach a new course on various research topics in market design. Along with covering the basics of market design, I would focus on recent advances in artificial intelligence and operations research techniques applied to the design and fielding of markets. Depending on composition, this course could stay seminar-based, or project-based, where students design and execute semester-long projects relating to the course material.

At the undergraduate or graduate level, I would like to create a course that focuses on the design and implementation of currently-fielded Internet-based auctions. Specifically, it would cover the *theoretical basis for each auction* and then compare that against the actual auction *as it is implemented*. Many tech firms—e.g., Adobe, Facebook, Google, Microsoft—have large research teams with expertise in auction theory, and the advertising auctions they run are an interesting mix of principled design with real-world implementation tweaks. This course would also cover systems such as prediction markets, where participants trade based on their belief in the probability of a future event occurring. Here, groups of undergraduates could create their own prediction markets (with, e.g., custom pricing rules and business constraints) and strategic automated trading bots that would participate in their classmates' markets. Tying into my teaching philosophy, this sort of competition is *challenging*, but will keep students *engaged* as they *learn by doing*—in this case, by implementing a real market.

References

[1] John P. Dickerson and Tuomas Sandholm. Organ exchange: A success story of AI in healthcare, February 2016. Half-day tutorial at the AAAI Conference on Artificial Intelligence (AAAI).

[2] Benjamin Plaut, John P. Dickerson, and Tuomas Sandholm. Fast optimal clearing of capped-chain barter exchanges. In *AAAI Conference on Artificial Intelligence (AAAI)*, 2016.