# Teaching Statement

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I love teaching. I have been engaged in teaching at an informal level since I was in high school. In my second year of graduate school at Stanford University, I got the opportunity to design and teach a new graduate course in artificial intelligence to my peers. I was hooked! I discovered that teaching a subject was the best way to learn it, and that the role of a teacher was not simply to convey facts, but to inculcate joy and interest in learning. My students nominated me for the George Forsythe Award for excellence in teaching, which I won as a student.

At Cornell University where I began my teaching career, and subsequently at Rice University, I have refined my pedagogical skills, inspired by the many excellent teachers among my colleagues. In a field such as mine which undergoes frequent upheavals in its theoretical and experimental base, I have kept my courses[1] current and relevant by distilling cutting-edge research, and filling in the needed mathematical background. I have discovered that explaining the latest developments in my field to a group of bright students is the best way to get at unarticulated assumptions in research and even generate ideas for new directions. For example, a casually assigned laboratory experiment in my graduate class to recreate the work in a just-published paper led to the surprising discovery of a brand new family of reinforcement learning algorithms, a great collaboration with a departmental colleague, and a PhD thesis for our joint graduate student. My attempt to illustrate classical AI planning techniques in the context of engineering design, rather than standard examples of stacking children's blocks, made me realize that the algorithms were inadequate for the task. This led me to exciting new research, a grant from the NSF, and a fruitful industrial collaboration with Xerox.

I enjoy involving undergraduate students in my research projects. Some of my projects (e.g., my outdoor robot tour guide project and my project on engineering design) involve undergraduates exclusively. I have been fortunate in being able to work with some of the top undergraduates at Cornell and Rice who signed up to work with me after taking my undergraduate AI course. Two of my students who were at the top of their graduating class at Cornell named me the most influential teacher in their lives. Their nominations earned me the Merrill Presidential Teaching Award in 1991 and 1993. I am very proud of the fact that all of my undergraduate research assistants at Cornell went on to pursue graduate careers at Stanford, MIT, CMU, University of Rochester, University of Washington and University of Pennsylvania. At Rice, I served as a CRA mentor from 1996-1999 for four outstanding CS undergraduate women. Many of my undergraduate research students (both men and women) at Rice have gone on to graduate school at Cambridge University, University of Washington, and Cornell. I was honored to receive the student-nominated Julia Miles Chance Teaching Prize in 2000.

Overall, my teaching objective is to instill in my students a sense for how to aesthetically formulate problems and engineer elegant solutions. A very big challenge is to teach students how to cope with partially specified problems for which there is no single correct answer. A pedagogical approach I have evolved through the years has culminated in annual PacWar competitions in my senior artificial intelligence class. PacWar is a challenging computational problem involving the selection of the "best" species from a space of $4^{50}$. Teams of undergraduates compete to improve on the current best record. They work on this problem for the entire semester. They determine on their own which of the various algorithms covered in class are relevant to their problem. To produce a winning entry for the competition, students have to understand the problem, formulate a strategy, and devise algorithms for that strategy. After performing a series of directed

[1] The syllabi, lectures, readings, homework and laboratory assignments for my courses can be found at `http://www.owlnet.rice.edu/~comp440` and `http://www.owlnet.rice.edu/~comp540`.

computational experiments, they learn how to interpret their results and rework their algorithms and overall strategy. They maintain logs describing their problem-solving attempts and finally synthesize them into a report. The report highlights their approach to the problem and explains how and why they selected their entry for the final round-robin competition. In the last three years, with the assistance of Professor Linda Driskill of the Cain Project, I have been able to give feedback on early drafts of these reports to students. The act of recording and reflecting on their design decisions and having them be critiqued early (and often), has led to a dramatic jump in the quality of the entries in the competition. From the feedback I get from my students, I know that I have given most of them the confidence to attack unstructured problems, to critically evaluate different approaches to solving them, and to use their technical skills to implement algorithmic solutions.

I believe in learning by doing. My homeworks and projects require students to implement the theories I describe in the classroom. For instance, I help them understand the limits of backpropagation learning by having them build feedforward neural networks to recognize their classmates' faces. The most important part of this assignment is the analysis of the performance of their networks. With a little help from me, students generate hypotheses as to why such a network easily solves the binary classification problem of discriminating their face from their classmates faces; yet does so poorly on the multi-class problem of distinguishing each individual's face. They test their hypotheses and report their conclusions. I am proud to say that the quality of the top quarter of my students' reports rivals the research papers for the top neural network conferences that I review for.

I set high standards of performance for my students, and design exercises to challenge and motivate the top 10% of students in the class. The undergraduates at Rice have been a delight and a great source of inspiration; they have always risen to my challenges. However, my approach is by no means purely elitist — I provide a lot of support and encouragement both inside and outside the classroom to all students. My goal is to provide an environment that enables each student to perform at their personal best. It is heartening to know from student evaluations and comments that my efforts and teaching initiatives are well appreciated and liked.

I consider it a privilege to be in a position to excite young people and introduce them to the joys of science and engineering. I routinely volunteer to talk about my research to high school and middle schools students who visit Rice. I regularly participate in Professor Tapia's summer training program for AGEP undergraduate interns. I also give lectures and interact with middle and high school teachers in HISD. I appreciate these extra-mural teaching opportunities very much, because they give me the opportunity to reflect on my work and its relevance to the world at large. While I was at Cornell, I took an active part in the national Expanding Your Horizons program for middle school girls.

Teaching has brought me great joy in my career. My students' questions have provoked me to look at familiar material in new ways, which has led me in new directions in research. My students keep my interest and passion for science and engineering alive. I will continue my pursuit of innovation in teaching and work hard to inspire the next generation of scientists and engineers.