Shang-Tse Chen
Georgia Tech

Teaching Statement

I believe teaching is not only about imparting knowledge to students, but also about sparking students' interest in the subject and helping them develop independent thinking skills, so that they can continue their study and research outside of the classroom. Teaching is an exciting mutual learning process, and it has provided me one of the most rewarding experiences during my Ph.D. years at Georgia Tech.

Teaching Experience

I have taught a wide spectrum of topics, from introductory programming concept and data analytics skills to advanced machine learning (ML) theories. As a teaching assistant of the *Computing for Data Analytics* course (CSE-6040, Fall 2015) taught by Prof. Richard Vuduc, I delivered four interactive hands-on lectures on various data analytics topics, including data visualization and popular machine learning algorithms like *k-means* clustering, to around 30 non-CS Masters students with diverse backgrounds (e.g., management, finance, and sciences). To bring these topics to life and to create a forum for interactive learning, I used *Jupyter notebook* where I demonstrated the core concepts live using real data. Students can immediately try the examples that I provided as well as their own implementations.

For example, when teaching *k-means* clustering, I guided the students to first focus on the correctness of their code and implement the algorithm in any ways that they wanted. I proceeded to teach the importance of algorithmic efficency, and challenged the students to come up with ideas for speeding up their implementations without sacrificing accuracies. To encourage critical thinking and cultivate the culture of knowledge sharing, I invited students to share their more advanced implementations (e.g., using vectorization) and explain to the class why their approaches were faster. After that, I showed my implementation and ran it on benchmark datasets, to compare the run time differences among different implementation strategies. To help students visualize the clustering results produced by k-means, I provided them with some small and interesting datasets, to let them better understand what problems they can solve with the code they just implemented. It is an extremely rewarding experience to see the students' improvement over the semester: from little-to-no programming experience to comfortably using data analytics techniques to solve complex problems in their final course projects.

Being a teaching assistant of *Machine Learning Theory* (CS-7545, Spring 2015) taught by Prof. Santosh Vempala was a different challenge. It was an advanced course primarily taken by ML and math PhD students. Some Masters students with less experience with theoretical analysis also enrolled in the course; I observed that they had a harder time keeping up with the lectures. I held extended TA office hours and taught them some fundamental math concepts and tools essential to understanding the course material. Through this experience, I learned how to explain difficult and abstract math concepts in ways that are easier for students to understand.

Big Data Bootcamp. I co-led the design and development of an intensive two-day *Big Data Bootcamp*[1], that is now offered yearly to students in the *Master of Science in Analytics* program ($\sim$ 50 students each year). The bootcamp introduces students to essential big data tools in the Hadoop and Spark ecosystems. It was one of the most interesting teaching experiences I ever had; I had to succeed across multiple important aspects. I tailored my messages, so they were easy to understand by the students with diverse backgrounds, and designed hands-on exercises that were suitable for the students to quickly complete. Through this experience, I learned how to design concise teaching materials tailored to the audience. The bootcamp was a huge success. Besides being repeatedly offered at Georgia Tech, it is now also publicly available on the web, to broaden general public's access to the materials.

[1] `http://www.sunlab.org/teaching/cse8803/fall2016/lab`

Teaching Methodology

To help students understand why they should care about the subject, I will motivate them by connecting the knowledge that they learn in class to real-world problems. For example, students in an undergraduate linear algebra course may not yet know why it is important or useful in solving many problems in our daily lives. If I teach linear algebra, instead of introducing definitions, equations, and theorems in the beginning, I will first show them a real-world problem (e.g., a machine learning problem), ask them to think about possible solutions, and then gradually introduce the techniques in linear algebra that more generally and systematically derive the solutions.

To encourage independent thinking, instead of showing them algorithms and techniques directly, I emphasize the intuition behind them and how such intuition inspires the development of the technical approaches. For example, when teaching machine learning, I will give a toy example problem, ask the students to think about how human thinks, and how to concretely write down the problem-solving steps as executable procedures. Then I will challenge their solutions by extending the problems to the more complicated settings, and interactively guide their algorithm designs.

An effective way to reinforce students' learning is by engaging them in fun projects and competitions. In my undergraduate artificial intelligence (AI) course, one of the projects was to participate in an AI poker tournament. It was an exciting experience to collaborate and compete with other students, and I learned many AI techniques not covered in textbooks. When I teach, I will carefully design projects and class competitions that promote solid understanding of course materials and independent research ability to learn beyond what is taught.

Advising

At Georgia Tech, I have the great pleasure to have advised several bright students, from undergraduate to Masters and junior PhD level. Mr. Paras Jain was a computer science undergraduate student who worked with me on the fraud detection research. He joined the project as a freshman, with little experience in data mining. However, he had strong programming skills. Therefore, I helped him get started with research by asking him to implement some of my fraud detection ideas, and then we would study the results together. He gradually gained more research experience. In the end, he came up with good experiment designs and obtained deep insights from the dataset, and published a poster paper as the first author at *IEEE Security and Privacy* 2015, a top security conference. Paras is now a CS PhD student at UC Berkeley.

I also advised first year PhD student Mr. Nilaksh Das and first year Masters student Ms. Madhuri Shanbhogue, on an adversarial machine learning project funded by Intel; I served as an intellectual lead in writing the grant's proposal. When Nilaksh and Madhuri joined the project, I described in detail its goals and scope, as well as my ideas and preliminary results. Together, we published a full paper at KDD 2018, a top data mining conference. Madhuri is now a software engineer at Facebook working on adversarial ML.

Future Teaching Plan

My research and education in both theoretical and application sides of machine learning (ML) and artificial intelligence (AI) have prepared me to teach and advise students in a wide range of computer science areas. I will be delighted to teach any introductory computer science courses, and graduate-level courses on theory and application of AI/ML.

I would like to create a new course on security in machine learning, with emphasis on how to design robust ML algorithms in the adversarial settings and under various threat models. I will design class competitions to help students learn the attack and defense side of adversarial ML.

AI talent shortage is an urgent, national issue that can only be solved with education. I look forward to becoming a professor, and teaching and learning from the best young talents of our next generation.