Teaching Statement — Alex Beutel

For me, one of the most enjoyable challenges of academic life has been working to effectively and simply communicate complex ideas, even when they are at the frontier of research. From teaching to mentoring to collaborating with students and colleagues, the communal exploration of fascinating research concepts has been one of the most rewarding aspects of graduate school. While all of these tasks rest on clarity of thought and communication, each also comes with its own challenges. I discuss below my experience, values, and goals in each area.

Teaching Experience

While at Carnegie Mellon, I have had a variety of opportunities to teach students and professionals. I have been a teaching assistant for both undergraduate and graduate courses, a guest lecturer, and offered tutorials both to colleagues within the data mining field and to broader audiences.

Teaching Assistant

I was a teaching assistant for the undergraduate course "Database Applications" (CMU 15-415), taught by Professor Christos Faloutsos and Professor Andy Pavlo, and for the graduate course "Multimedia Databases and Data Mining" (CMU 15-826), taught by Professor Christos Faloutsos.

As a teaching assistant for undergraduate "Database Applications," I offered recitations, held office hours, designed homework assignments, and helped coordinate grading of assignments with undergraduate teaching assistants. During recitations and office hours, it was insightful to observe which concepts were most difficult for students, and even more rewarding was alleviating their confusion. I was most heavily involved in designing homework assignments, particularly those with programming components, including programming a B+ tree and making a usable online social network. The social network was a new assignment I designed, whereby I created a website "Flitter" (a take on the social network "Twitter") in which people can post messages, follow each other, and view aggregate statistics about the social network. I provided the shell and web-facing components of the website and students were responsible for filling in all database-related code so that the website was entirely operational. The assignment was successful and the website has been adapted and reused for the years since I was a teaching assistant of the class.

As a teaching assistant in graduate "Multimedia Databases and Data Mining," I was responsible for offering office hours, designing homework assignments, and mentoring Masters students for their course projects. In creating homework assignments, I again focused on designing questions that had real-world relevance while supplying the necessary materials so that students could focus on understanding the underlying academic concepts. This included using SQL to analyze patent citation networks and using Hadoop to learn models of Reddit submissions. While mentoring students on their class projects, I guided them in implementing a variety of graph mining algorithms and using those algorithms to find interesting patterns in real-world datasets.

I have enjoyed the focus on ensuring (a) students understand the computer science fundamentals and (b) know how to connect those fundamental concepts to real-world challenges.

Lecturing

In addition to being a teaching assistant, I had the opportunity to lecture in Professor William Cohen's machine learning graduate course "Machine Learning with Large Datasets" (CMU 10-805). During my lecture I taught students about recent research advancements in using stochastic gradient descent (SGD) to learn matrix and tensor factorizations on Hadoop as well as more cutting-edge platforms. The lecture was so positively received that Professor Cohen invited me back to teach it again for a second year.

In teaching this material, I focused on (a) explaining the material in a clear and engaging way so that students understood and remembered the material and (b) offering insight into the strengths and limitations of different approaches, since this is an active area of research and most of the students were pursuing research agendas of their own.

Tutorials

I also have had the opportunity to focus on communicating state-of-the-art research in the form of two tutorials: "Graph-Based User Behavior Modeling: From Prediction to Fraud Detection" at *KDD* 2015 and "Fraud Detection through Graph-Based User Behavior Modeling" at *CCS* 2015. I led the development of both tutorials, including proposing the material, designing the slides, and presenting (1 of 3 hours at *KDD* and for all 3 hours at *CCS*).

In both cases, the tutorials offered an overview of techniques for taking a graph modeling approach to under-

standing user behavior, and how general machine learning techniques for graph modeling have been built upon to capture and understand the unique patterns of user behavioral data. I worked to distill the research to its most basic insights while still explaining why those insights are exciting.

I positioned both tutorials to be accessible and valuable both to practitioners and researchers. However, because much of the research presented in the tutorial came from the data mining and machine learning communities, the focus of each tutorial was slightly different. I aimed the tutorial at *KDD* to encourage conversation between researchers of "normal behavior," e.g. recommendation systems, and researchers of "abnormal behavior," e.g. anomaly and fraud detection. For the tutorial at *CCS*, I instead aimed more to outreach to the security community — to teach security researchers about how graph mining and behavior modeling research can be used for effective fraud detection. Both tutorials were successful, filling their respective rooms.

Research Mentoring

Throughout my work toward the Ph.D., I have worked closely with others, and my role in many of my collaborations has been to mentor younger students. As a senior Ph.D. student, I thus far have mentored two Masters and two younger Ph.D. students. These mentorships have led to high quality research and multiple publications. The Masters students have gone on to both Ph.D. programs and industry jobs, and the Ph.D. students have developed into successful independent researchers.

Mentoring younger students has been an invaluable and fulfilling experience. Because each student has a different background, I worked to structure research problems to match students' strengths and aspirations, while offering a path for student exploration and growth. This structure of open-ended direction for younger students often led to impressive and unexpected research results, coming from the new perspectives they offered. I look forward to continued mentoring and deliberate effort toward improving my mentoring skills.

Future Teaching Goals

I am excited to continue to get exposure and experience with all aspects of communicating, teaching, and mentoring. As a professor, I would enjoy teaching courses for students of all levels. I am qualified and would be happy to teach all courses at the undergraduate level. For graduate students, I would be excited to teach courses on data mining, machine learning, graphical models, optimization, databases and big data systems. For more advanced students, I would like to introduce and design new courses on graph mining and modeling as well as machine learning for massive data. I'd be happy participate in the creation of a data science program, including designing a course or set of courses for holistic data analysis, covering data mining, big data systems, and applications of machine learning. Building on my previous teaching experience, I would take a hands-on approach to students' learning, ensuring they can connect fundamental computer science concepts to real-world challenges, with most courses including a project component and mentoring students of all levels on research projects in which they are interested.