Statement of Purpose
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We live in an exciting age where Artificial Intelligence (AI) is radically transforming our lives. Today, we can find any information using search engines, have conversations with digital assistants, use translation services to comprehend most languages, and have email clients compose our emails. This promise of AI integrated into our daily lives, automating mundane tasks and empowering us to do much more, is what drew me to Machine Learning (ML) and Natural Language Processing (NLP). It has been exciting to see the recent breakthroughs in NLP, with large language models (LMs) like GPT-3 single-handedly writing code, composing narratives, and summarizing any text. Despite these advances, NLP techniques still struggle with factual correctness, lack common-sense reasoning abilities, often propagate societal biases, are less performant on low-resource languages, and have large carbon footprints. These problems limit the full potential of NLP, and tackling them will require new leaps in thinking. I wish to pursue a Master's in Computer Science (CS) at Berkeley to gain the broad knowledge and in-depth research experience necessary to address these challenges for the even wider adoption of AI. I believe that my expertise in building real-world NLP systems has given me the skill-set to excel in graduate studies and has equipped me with a novel perspective to bring to the incoming class of future technological leaders at Berkeley.

Working as an Applied Scientist at Microsoft for over two years has helped me experience how the challenges faced by real-world applications of NLP limit the adoption of cutting-edge research. This became evident as I worked on the Suggested Replies dialog system, which assists users by providing short reply suggestions to their emails. To keep training and inference times tractable, this system utilized a biLSTM model trained from scratch, and thus could not reap the advantages of transfer learning from large pre-trained models. Motivated to leverage pre-trained models, I experimented with several model compression approaches to bring down their fine-tuning and inference times, and found low-cost techniques to be surprisingly effective at reducing training and inference costs while still bringing in the benefits of transfer learning. This work helped us deploy a fine-tuned pre-trained model, and it was exciting to see the resulting gains in user engagement. Through further experiments, I was then able to show that the size of the dataset affects the efficacy of compression techniques and that the large volumes of data available in the industry can make low-cost approaches very competitive. These findings were published in Microsoft's AI Journal and demonstrated that industrial settings of NLP problems could have optimal solutions that are different from those in academia. I want to take this perspective with me to grad school to bridge the gap between academic and industrial settings and explore robust solutions that can be seamlessly adopted in the industry as well.

Using user information to provide delightful, personalized experiences is crucial for the large-scale adoption of NLP. With strict user data privacy requirements and many active users with varying amounts of personal data, the industry has unique challenges and opportunities in developing novel personalization solutions. To gain exposure to this impactful area, I incorporated personalization into our GPT-2 based dialog system to tailor the reply suggestions to user writing styles. I represented users in the training data with unique user embeddings and then trained these embeddings as a prefix to condition GPT-2's reply generation – similar to the recent work on prefix-tuning. Since this personalized GPT-2 model could only work for the users seen at training time, I added a joint projection network and trained it to project the sparse n-gram features from users' emails to the dense user embedding space. This projection network enabled us to generate user embeddings for new users on the fly using the n-grams extracted from a single one of their emails. Together these approaches helped us suggest personalized replies to all users. However, the large number of users in the industry makes it expensive to

periodically train and update their user embeddings. Motivated by the use of prompts to guide models like GPT-3, I experimented with replacing the trained user embeddings with non-trainable user-specific prompts to induce personalized outputs and found these prompts to show superior performance. This work led to a paper submission at an upcoming NLP conference and taught me how to utilize the distinct constraints of the industry to research novel solutions. Despite these promising results, developing personalized experiences that are robust to adversarial attacks and capable of protecting user privacy remains a challenge. During my Master's, I wish to use my understanding of the industry's needs to study and advance the theoretical underpinnings of privacy-preserving techniques to enable the responsible and secure AI applications of the future. The expertise I've gained through this work in analyzing the weaknesses of cutting-edge techniques and developing innovative solutions will be invaluable in making impactful research contributions during my Master's.

While my current role as an Applied Scientist in a product team offers opportunities to innovate and gain experience with state-of-the-art technologies, the constraint of needing to fulfill an immediate business need through every innovation doesn't provide me the flexibility and environment that I need to grow as a leader in NLP. I strive to develop NLP solutions for users that significantly advance the field and are generalizable across applications. This will involve thinking beyond the immediate needs of a given product. Therefore, my long-term career objective is to be at a research lab in academia or industry, working on such visionary research investments. A Master's program will enable me to gain a broader understanding of the field, conduct in-depth research mentored by outstanding faculty, and be surrounded by brilliant, motivated peers, and is thus the best next step for me to move towards my ambitious goals.

There is a great alignment between my research interests and the research being done by Berkeley's word-class faculty. My broad interests lie in Deep Learning for NLP, with a particular interest in studying and addressing the shortcomings of pre-trained language models (PLMs). Since the current trend of increasing the size of PLMs will be unsustainable, and is unlikely to help them generalize to difficult domains like medicine and law, I aim to explore new pre-training methods, novel model architectures, and compression techniques with Prof. Dan Klein. My experience in compressing PLMs aligns with Prof. Klein's work on studying the trade-offs between large and small models. Open challenges also exist in using prompts to guide PLMs, including PLM performance varying greatly with small changes to prompts and prompting not aligning well with the training objectives of PLMs. Thus I aspire to contribute to Prof. Klein's research on making PLMs better zero-shot and few-shot learners. Additionally, since large PLMs exceed human performance on existing benchmarks, but still struggle with basic causal and common-sense reasoning, I wish to work with Prof. Marti Hearst on creating new datasets and tasks to better evaluate such desired capabilities in these models. Prof. David Bamman's work on studying the social biases in current models and better generalizing PLMs to the space of literature aligns with my interests as well. It would be great to work with Prof. Bamman on exploring NLP for underserved domains like medicine and law. I would also love to contribute to Prof. John DeNero's work on NLP for healthcare and education.

Beyond research, Berkeley's exceptional offering of courses like *Statistical Learning Theory* and *Designing, Visualizing and Understanding Deep Neural Networks* will provide me with the intellectual depth and breadth that I seek. Berkeley will also bring together some of the best minds, and I am excited to collaborate with and learn from the incredible peers at BAIR. I also dream of contributing to Berkeley's energizing community by taking on leadership roles in organizations like the Association of Women in EE & CS (AWE). With its excellent CS curriculum, dynamic student body, and record of trailblazing research, Berkeley will be an ideal place for me to obtain my Master's and bring the power of NLP to people worldwide.