Statement of Purpose

Karan Grewal (Draft #1)

I want to pursue a Ph.D. to create intelligent algorithms that can think and behave like humans. My long-term goal is to become a professor and lead a research laboratory. My previous research experience includes applying intelligent algorithms to solve problems rooted in Human-Computer Interaction and designing state-of-the-art Deep Learning algorithms.

My motivation for pursuing research stems from my previous experience as a software engineering intern (at Rubikloud Technologies in Toronto). Although my role was specific to data engineering, I was heavily involved in the companys holistic objective of harnessing cutting-edge artificial intelligence to provide insightful data analysis to clients. This experience made me realize the profound impact of intelligent algorithms in the retail industry and instilled in me the ambition to create better algorithms with greater capacity and minimize the gap between algorithmic and human intelligence.

I took the first step towards my goal when I started working with Professor **Khai Truong** in the Dynamic Graphics Project at the University of Toronto. Our goal was to identify inappropriate conversational behaviour between two individuals, such as shouting, slandering and interruptions. However, no dataset came equipped for this task, so we first needed to collect audio clips of conversations from hundreds of hours of media sources. I performed acoustic analysis by extracting Mel-Frequency Cepstral Coefficients (MFCCs) from the audio clips and training a Support Vector Machine (SVM) classifier to identify shouting. To perform semantic analysis, I used a speech-to-text and sentiment analysis tool together to quantify an individual's valency. Furthermore, I was able to identify interruptions by breaking up sentences into fragments and then performing clustering on the MFCCs to identify sentence fragments. This project introduced me to the challenges of doing research, most notably the importance of a readily available dataset. I gave a talk about my work at an undergraduate conference and our work is available as a pre-print on ArXiv.

I then joined Professor **Yoshua Bengio**'s research group at the Montréal Institute for Learning Algorithms (formerly part of Université de Montréal). There, I was fortunate to work together with **Devon Hjelm**, a postdoctoral researcher who served as my mentor. Our research focus was on improving and stabilizing Generative Adversarial Networks (GANs), a popular framework for generative models. Despite their recent successes, GANs are notoriously difficult to train; we developed and tested a regularization technique with the objective of alleviating vanishing gradients and mode collapse, two major problems that arise during training. Our method escaped both failure modes and demonstrated robustness to a wide range of training scenarios. Based on our empirical results, we were able to reason about why GANs often fail to train and provided theoretical justifications for our regularization technique. I presented a poster on our work at the International Conference on Machine Learning (ICML) and submitted a conference-track paper as a first author, which is currently under review, to the International Conference on Learning Representations (ICLR).

More recently (also at the Montréal Institute for Learning Algorithms), I became interested in how humans can reason about certain tasks having seen one or zero experts perform it, as opposed to the large-dataset paradigm which forms the basis for contemporary learning algorithms. I tackled the problem of zero-shot generalization in the context of image similarity comparison where the similarity metric can vary based on the task. For this, I

used deep convolutional neural networks (CNNs) in which batch normalization parameters are conditioned on a programmatic input which specifies the similarity metric, as though the network is being told which task to perform or which features to focus on in the image. E.g. any intelligent human should be able to identify whether an object is blue, even if they have never seen a blue instance of that object before. Together with other students, I submitted a workshop paper to Neural Information Processing Systems (NIPS) as a first author.

My most recent research project demonstrates my interest in creating intelligent algorithms whose perceptions are similar to those of humans. Although my research experience has mostly been within the realm of Deep Learning, I am open to a variety of active research problems which proceed from my underlying goal of understanding and recreating human intelligence, such as learning meaningful representations, probabilistic reasoning, inductive pattern recognition and understanding natural language. I aspire to solve such problems while creating human-like intelligence in the process.

I wish to continue my research pursuit at Stanford due to the strong research groups which focuses on the problems I stated. I am particularly interested in working with Professors **Tengyu Ma**, **Stefano Ermon**, **Surya Ganguli**, **Percy Liang** and **Emma Brunskill**. Much of my own research has involved reading papers of these professors, which has led me to believe that my interests and skills makes me a great match for Stanford's Ph.D. program.