Returning home late one night, I was greeted by my agitated mother, “Working very hard on your applications?” Though infuriated I marveled at the profound ability of my brain to detect sarcasm, anger and concern. My brain had immense potential to make sense from contextual sources as voice - tone and body language to accomplish a more nuanced understanding of the language than that offered by its literal sense. This was in some contrast to the language models I was working on/improvising/ fine tuning during my internship at the Indian Institute of Technology, Bombay. We were developing a linguistic model for post-correction of OCR text, as part of an ambitious project to translate and digitize text books into native Indian languages for the advantage of students constrained in English. I deployed masked language modeling on Indic Bert, which is a multi lingual pre-trained language model. However the limitations of the approach soon became apparent. I realized grammar based language models like BERT have an excellent understanding of the “form or structure” of language, making them immensely advantageous for high-resource languages but less fitting for data scarce languages. Drawing inspiration from Prof Neubig’s (CMU) research on preservation of endangered languages, we tried a novel learning approach that used a multi-source model comprising Sanskrit as the language encoder and a parallel corpus of its high-resource language translation in Hindi. Using minimal data, we could successfully reduce word-error-rate (WER) in OCR Sanskrit text by over 25%. The project has exposed me to the power of optimizing multiple sources of data for ML problems. The idea seems even more promising for NLP because language, as a repertoire of complex “meanings”, cannot be acquired through learning its form alone. For instance, human language acquisition is a function of diverse interactions with the environment, and incorporates heterogeneous visual, auditory and experiential inputs. Thus, the larger question that I want to explore is- How can we train machines to process and integrate data from multiple sources, for more nuanced understanding of the meanings contained in natural languages ? With this purpose, I seek to apply for an MS in ML at CMU.

The graduate program at CMU offers exciting opportunities for exploring the interdisciplinary niche comprising Machine Learning , Natural Language Processing and human communications. Courses as 11-711 Algorithms for NLP and 11-777 Multi Modal Machine learning would help my understanding of the discipline. The prospect of aligning with faculty at the Multicomp lab and contribute to cutting edge research in the field compel me to apply. CMU's unorthodox culture, and a strong emphasis on innovative and impactful work inspire me to join the community. Most exciting however, is the opportunity to work under Prof. Tom Mitchell and Prof. Brad Myers. Prof. Tom Mitchell’s work on conversational ML, has played a crucial role in my understanding of Multi Modal Machine Learning. I would like to explore if NELL and NEIL (Never Ending Language Learner and the Never Ending Image Learner) can co-learn , especially now that they are communicating. Equally intriguing is Prof. Brad Myers' work on PUMICE. I wonder if introducing statistical NLP approaches into PUMICE, such as seq2seq models, would help in conducting more natural conversations.

Perfect as the opportunity may seem, I am aware that the formidable challenges of ML require more than abstract ideation. My research and professional internships coupled with intense coursework at Manipal have placed me on a strong theoretical and practical foundation to cope with the rigors of the program.

Research in NLP : As discussed earlier, my internship in NLP , under the supervision of Dr. Ganesh Ramakrishnan (IIT - Bombay) focused on utilizing and improving Prof Neubig’s model for post-processing OCR Sanskrit text and developing “OpenOCR Correct”, a post-editing Desktop application based upon the Qt framework. I specifically contributed towards developing and integrating modified Wagner–Fischer algorithm, that could report word level Levenshtein distance for a sentence, into “OpenOCR Correct”. This algorithm allowed us to provide edit steps in addition to the edit distance between two sentences, thus enabling us to track text changes, provide recommendations, and develop

labeling functions. One of the limitations of the application was it froze during resource intensive functions. I circumvented the problem by making it multi threaded. I also used this modified algorithm for aligning OCR and post corrected text to pre train and fine tune Prof. Neubig's model for optimal results. **(One more line for future work here).**

Research in Wireless Technologies : Working under the supervision of Dr. Arani Bhattacharya (IIIT-Delhi) and Dr Samir Das (Stony Brook University), my research focused on improving the reliability of GPS by identifying vehicles that used Software Defined Radios (SDRs) to conceal their locations. The research has strong implications as GPS is commonly used by businesses including stock exchanges. We used data from a sensor that captured Radio Frequency (RF) signals emanating from vehicles equipped with SDRs. My contributions included training a multi class classifier on RF data to predict the lane and speed of the flouting vehicle with 90% accuracy. I further fused the sensor data with the video data of vehicles, to successfully identify vehicles using SDRs. Using the fused data, we plotted a regression line to predict the spoofing vehicle's trajectory accurate to a distance of 20m. The project gave me useful training in solving issues arising out of heterogeneity of multi-modal data, for instance alignment of the signal and video data, especially since the two data sets lacked temporal information.

Corporate Experience: I have also explored the field of ML in a corporate setting at Tata Mutual Funds, a leading asset management company. Here, I developed a recommender system to suggest mutual funds to clients. I used a collaborative filtering (CF) model, deploying matrix factorization with a mean squared error loss to compute user and item embeddings.

Pursuing simultaneous research internships at IIIT-D and IIT-B, while sustaining academic rigor at Manipal, have prepared me well to balance diverse academic goals. My undergraduate curriculum introduced me to Machine Learning, while my minor in Big Data and Deep Learning specialization (through Coursera) further streghtened my knowledge of self-learning machines. Courses like Parallel Computing Architecture introduced me to the beauty of parallelizing computations across multiple cores using the powerful CUDA architecture. Courses in Statistics, Linear Algebra, Calculus, Probability, and Discrete Mathematics have provided me with a strong theoretical foundation to understand and pursue ML and DL algorithms.

I can use my learnings …….to contribute to the program at CMU. I hope to be part of the emerging research that focuses on computer's ability to acquire "meaning" through multi modal mechanisms. I apply to the prestigious ML / CS graduate program at CMU, with the hope of making a contribution to the above field.