Personal Statement: Ph.D. in Computer Science
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Every day we are encountering and absorbing a large amount of knowledge. The idea of "knowledge" first struck me in a movie recommendation project, I realized daily events could be transferred to knowledge graphs and contribute to the real problem, which is so surprising and exciting to me. Since then, I am always thinking about how to efficiently link 'knowledge' to AI in better service for our daily lives. I was exposed to AI during my graduate studies, and involved in research areas including computer vision, recommendation systems, data mining, and knowledge graph, which strengthened my knowledge of machine learning and shaped my interests in natural language processing(NLP), especially natural language understanding(NLU), information extraction(IE), information representation(IR), and their application to real life, I hope to make machines understand nature. Responsible for NLP as a speech algorithm engineer in the past three years, I came across several excellent researchers and Ph.D. students. I wish I could have a chance to heavily collaborate with salient researchers in the world and contribute to my fields with fulfillment. Getting research results inspires me, makes me no longer satisfied with my current easy life, and guides me to pursue a Ph.D.

I am a motivated NLP researcher with strong learning ability and rich experience. Apart from keeping pace with up-to-date techniques, I am enthusiastic about innovative approaches and applying them to solve real-world problems. I have prepared well for the Ph.D. research activities with hardcore programming and application development experience. During the past few years of working, I have mentored five interns, where I developed my teamwork ability and enhanced my problem-solving ability. Motivated by strong research interests in machine learning and making breakthrough contributions to my interested field, I was actively engaging in research projects during my work and study afterward. The following describes my research journey.

My internship in TAL AI Lab offered me research experience in **Knowledge Tracing**. We, as human beings, sometimes find it difficult to keep track of knowledge, and I was wondering how we can build a model to tackle this issue. I built a deep knowledge tracing(DKT) model to monitor student knowledge state or skill acquisition level. We considered the intrinsic relations of questions, and built question graph based on semantic and feature-based knowledge. We use a **graph embedding** method to obtain the node representations as supervision information to DKT. This method demonstrates the importance of the **question relation information** and the proposed framework outperforms state-of-the-art baselines significantly(verified in MovieLens, e.g.). The above research was completed by a Ph.D. and me and led to a co-author conference submission to AIED 2019. In this research, data mining provides me with powerful help to build a knowledge graph. At the same time, I innovatively extend my research to adaptive learning, which is critical for tutoring systems. I believe the Ph.D. program will enable future works of information extraction and knowledge acquisition and representation, and I am eager to bring up more research ideas in this field.

Apart from knowledge acquisition, I was interested in language understanding regarding semantics and emotions. I gained related research experience when I joined an AI company (Mobvoi) in 2019 as a speech algorithm engineer. I have mainly been involved in **text information extraction** and text-to-speech(TTS). I divided my work into two sides: semantic

NLP and emotional NLP. For TTS, the most fundamental work is converting non-standard text into representations with accurate pronunciation, prosody, stress, style and emotion. Modules include Tokenization, text normalization(TN), polyphonic disambiguation(Polyphone), Prosody, etc., based on cross-language (Mandarin, English, etc.). Earlier, I used feature-based and simple neural network(LSTM e.g.) to build these units separately, which had limited performance. Later, with the progress of text representation, I proposed a model architecture called **Unified Frontend**, which aims to transform complex joint models into end-to-end(E2E) models. I built an effective semantic extraction model (pre-trained), as the backbone of all units, combined with multi-task training and knowledge distillation to get the final model. I also verified the maximum capability of each model to ensure the final model's performance. My solution mitigated the problems of out-of-vocabulary(OOV), ambiguity, and performance of the online system. In **multi-level prosody** prediction, I use **prompt learning** to solve training difficulties due to data imbalance and inconsistency. This work led to a co-author conference submission to *PRML 2022* and five patents. From this project, I deepen my understanding of text semantics. However, the challenges of fine-grained tasks relying on more knowledge, semantic ambiguity, lack of context and robustness drive my motivation to further my study in the Ph.D. program.

The **Emotional NLP** project, on the other hand, focuses on the **emotional aspect of language understanding**. Language conveys precise information in social networks. For example, "I love you?" and "I love you!" express totally different meanings. Such tasks are often highly subjective, without clear definitions and benchmarks. First, I established the label criterion for style, emotion, and stress by reading related literature and referring to **linguistic knowledge**(definition of data is important). With a small scale of data, combined with **contrastive learning** and **semi-supervised learning**, a good style extraction model is obtained and used as guidance for TTS. With better expressive TTS, our research has attracted the attention of customers and other companies. In addition, for stress prediction, I propose a two-stage pipeline to construct the coarse-to-fine stress model with **auxiliary granularity supervision**, which decreases the model deviation and ensures global diversity. This work led to a first-author conference submission to *ICASSP 2023*(reviewing) and two patents. In this project, I realized that texts contain rich semantics and emotions that are critical to help us understand our society, such as fighting against toxic online comments. I hope to contribute to more precisely understanding and reconstruction of information during my Ph.D. study.

All these experiences shape my current research interests in NLU, knowledge acquisition, and representation. I'm particularly interested in the following directions. **(a)NLU:** It is critical to precisely understand and transmit semantics when it comes to ambiguity. **(b)Information Extraction and Representation:** The quality of the information representation will determine the maximum capability of the downstream task. My relevant experience with knowledge-based representation that incorporates the construction of information networks is helpful in filling the gap in introducing knowledge to NLP. **(c)Low Resource & Robust NLP:** A majority of current methods rely heavily on large-scale annotated data. However, some tasks have no well-defined definitions or require domain-specific knowledge, nor do we have the time and energy to label large-scale corpora manually. I believe that the Ph.D. program allows me to explore unsupervised and semi-supervised methods that deal with unlabeled data (e.g., granular stress).

Although I have research experience in NLP, I still need more training and professional theories to understand this field better. I believe that USC is a perfect fit for me because of its strong computer science program and its distinguished faculty members. I assume the communications with your esteemed faculty will inspire me to accelerate NLP to a new world scope. Specifically, I hope to collaborate with professor **Muhao Chen**(knowledge acquisition and language understanding), **Professor Sean (Xiang) Ren** (knowledge acquisition and robust NLP and **Professor Jieyu Zhao** 's work on efficiently learning knowledge and robust learning(bias reduction). As I have explored relevant fields, I have the confidence to work with professors and partners to solve practical problems and make further contributions in the future. I believe with their guidance and support, as well as the lively cultural and academic atmosphere at USC, I will be given the great opportunity to work on meaningful research projects and enjoy the journey along the way.

Thank you!