

RESEARCH STATEMENT

INDUCING PO-EM IN USER ORIENTED CONVERSATIONAL SYSTEMS

KSHITIJ MISHRA

Introduction

Current Conversational AI (CAI) systems excel at assisting with daily chores such as booking flights and scheduling movies, which involve a fixed action space with predefined goals and utterance-response pairs. However, in today's dynamic environment, users seek information and assistance directly through their mobile devices. Beyond goal-oriented tasks, there is a growing need for CAI systems capable of handling more intricate tasks such as persuasion, medical care, and counseling. Unlike fixed action spaces, these tasks require adaptive responses, as actions taken by persuaders, doctors, or counselors vary based on user queries and responses. These systems face additional challenges, including incorporating varying levels of politeness, empathy, and personas tailored to individual user personalities or emotions.

My Ph.D. research primarily explores the intersection of **Natural Language Processing (NLP)**, **Natural Language Understanding (NLU)**, **Dialogue Management (DM)**, **Natural Language Generation (NLG)**, **Deep Learning (DL)**, **Reinforcement Learning (RL)**, **Supervised Fine-Tuning (SFT)**, and **Learning from Human Feedback (LHF)**. Further, in a nine-month internship at Amazon, my work focused on optimizing the performance of Large Language Models (LLMs) through Salient Layer Editing Models. This approach aimed to reduce time and memory costs by updating only the relevant layers associated with erroneous outputs using Rank-1 editor networks, thereby enhancing efficiency without compromising overall model integrity.

Ph.D. Research Work (2019-2024)

Conversational AI Systems

The primary research focus has been on developing Conversational AI (CAI) systems that excel in *context adequacy*, *naturalness*, *non-repetitiveness*, and *personalization*. Conversational AI systems like Task-oriented CAI, Persuasive CAI, Counseling CAI, and Physical Disability Support CAI Systems are developed by leveraging Large Language Models (LLMs). To adapt politeness, empathy, and persona in these systems, respective models are trained in a **reinforcement learning framework with human feedback (RLHF)** employing proximal policy optimization loss (PPO) loss. To develop novel reward models for these systems, several NLU models are trained and employed within the RL framework as reward models. This ensures that the responses consistently align with the desired conversational attributes.

Outputs:

- Publications in top conferences such as **ACL** (2023), **EMNLP** (2023, 2024), **NAACL** (2022), **COLING** (2022), **EACL** (2023, 2024), **AAAI** (2023), and **IJCAI** (2023).
- Two papers are under-review in **COLING-2025**, and one in Phase-2 of **AAAI-2025**.

Sevak Project (2019-2022)

Alongside my Ph.D. research, I worked as a research scholar on the *Sevak - An Intelligent Indian Language Chatbot* project. This project aimed to develop a conversational AI system in both native and Roman scripts for languages like Hindi, Bengali, Telugu, English, and Code-mix of all these languages for three domains: Railways, Judiciary, and Healthcare.

Outputs:

- Deployment of 14 interactive ChatBots, significantly enhancing user interaction across multiple domains.

Collaborative Work (2023-2024)

In addition to my thesis work, I collaborated on two significant projects aimed at advancing logical reasoning in both extractive and abstractive question-answer generation. In Medicare question-answering (QA) tasks, current methods often struggle with the intricate logical structures and relationships inherent in medical contexts, leading to limitations in generating precise and nuanced answers. To address this challenge, we utilized first-order logic-based rules extracted from both context and questions to enhance the grounding of generated answers. These rules are used to train a Logic-Understanding (LU) model which generates logical triples from given contexts, questions, and answers, which are then integrated into the proposed system to support reasoned and coherent answer generation.

My Contribution: Ideation, Methodology Formulation, Implementation, and Paper Writing.

Outputs:

- Publication in **EMNLP-2024 Findings**.

Internship Experience at Amazon (2023)

During my internship at Amazon, I worked on a Salient Layer Model Editing Project to reduce fine-tuning costs for large language models (LLMs). This project focused on two key aspects: (i) Editing, which involved modifying parameters responsible for inaccurate predictions, and (ii) Unlearning, which targeted parameters associated with privacy-compromising outputs. By constructing layer saliency profiles based on parameter gradients, we identified the most impactful layers for targeted edits. Utilizing Rank-1 editor networks, we selectively updated these layers, significantly improving model efficiency and accuracy. This experience demonstrated my problem-solving skills and ability to enhance model training processes.

Outputs:

- Publication at the EACL conference.
- Filing of a patent.
- A positive Bar Raiser review result.

Throughout all research works, I worked with SLMs and LLMs like GPT-2, GPT-J, LLaMA2-7B, Mistral-7B, Zephyr-7B, Phi-2, Mistral-8B, LLaMA3-8B, and Phi-3 to develop the proposed systems. My Google Scholar profile can be [here](#).