Process-Aware Dialogue System With Clinical Guideline Knowledge

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ABSTRACT

Task-oriented dialogue systems aim to engage in interactive dialogue with people to ultimately complete specific tasks. Typical application domains include ticket booking, online shopping, and healthcare providing. Medical dialogue systems can interact with patients, provide initial clinical advice, and improve the efficiency and quality of healthcare services. However, current medical dialogue systems lack the ability to utilize domain knowledge. This paper extracts regular domain knowledge as well as medical process knowledge from clinical guidelines to improve the performance of dialogue systems. Regular knowledge is used to generate accurate responses for a given input, and process knowledge is used to steer the conversation. The authors divide the task of multi-turn conversation generation into four sub-tasks and propose a four-layer knowledge-based process-aware dialogue model that incorporates the domain knowledge to generate responses. Results indicate that the approach can lead medical conversations actively while providing accurate responses.

KEYWORDS:

Clinical Guidelines, Generation-Based Models, Hierarchical Model, Representation Learning, Process Knowledge, Retrieval-Based Model, Task-Oriented Dialogue System, Topic Shifting

INTRODUCTION

Task-oriented Dialogue Systems (TDSs) have recently attracted increasing interest. TDSs aim to use human–machine conversations to help users complete specific tasks efficiently. Incorporating deep learning techniques in dialogue systems can significantly increase the accuracy and timeliness of the generated responses (Zhao et al., 2020; Wu et al., 2019). Furthermore, the knowledge-driven dialogue systems using domain knowledge also improve the quality of responses (Zhang et al., 2020; Zhou et al., 2020). Therefore, many researchers are focusing on the impact of domain knowledge on dialogue systems.

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In the clinical domain, a dialogue system for clinical diagnosis converses with patients to obtain additional symptoms and make a diagnosis automatically, which has significant potential to simplify the diagnostic procedure and reduce the cost of collecting information from patients (Tang et al., 2016; Wang et al., 2021). More importantly, the clinical guidelines (CGs) documents provide clinical knowledge about diagnostic indicators of disease, pathogenesis, relevant drugs, prognosis and so forth, which are the natural source of knowledge for generating responses in the clinical dialogue system. CGs also provide process-related knowledge, such as how a disease develops or how a treatment plan spans over a period. Such process-related knowledge can be used to steer the conversation towards a specific goal, just like how human doctors control the topic shifts based on their expert knowledge.

Figure 1. Application of process knowledge and triple knowledge in the conversation

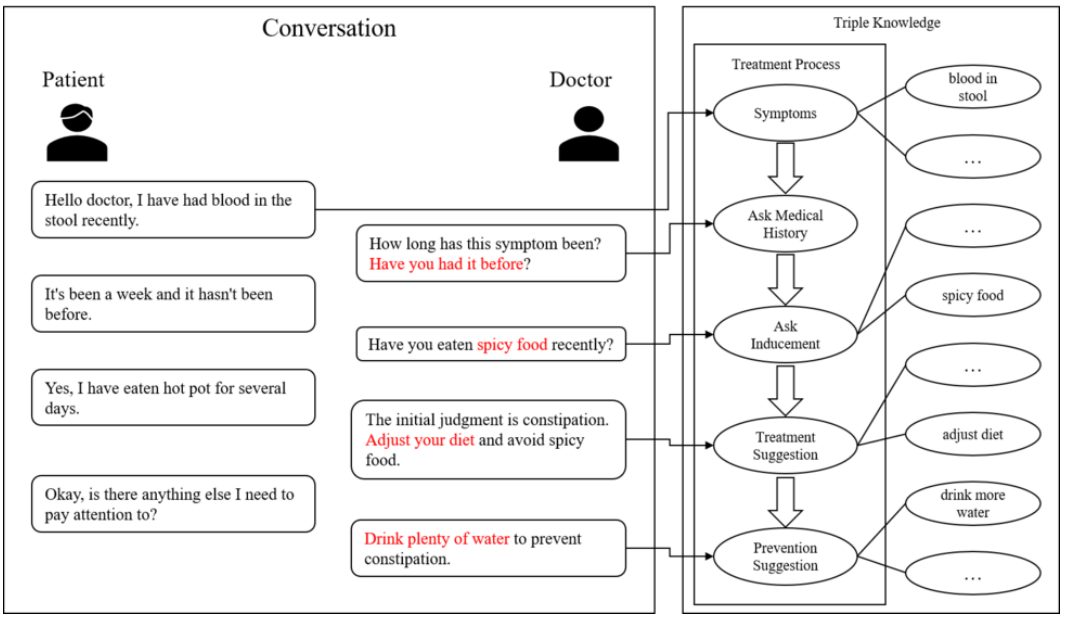

Figure 1 illustrates an exemplifying scenario. The left part shows the conversation, and the right part depicts the relevant process and knowledge grounding. The authors correlate the key part (marked red) to a triple or a topic on the right in the picture. In this example, most parts of the conversations are initiated by the doctor with a question, and it is observable that the questions are chosen based on the process knowledge as well as the answers provided by the patient. Figure 1 shows that the physician always leads the dialogue and controls the topic shifting, such as "Symptoms -> Ask Medical History -> Ask Inducement -> Treatment Suggestion -> Prevention Suggestion." Therefore, the strategy of topic shifting is of great importance in the consultation task.

Based on the analysis of real-world conversation records and clinical guideline documents, it can be concluded that the treatment procedures are essential references for the topic selection in the consultation process. In addition, reasonable topic selection and utilization of knowledge are essential to the task of clinical consultation; however, current dialogue systems cannot realize this. Thus, it remains a challenge for automated diagnosis to allow the TDS to communicate with the patient as guided by the treatment process. To address this issue, in this paper, the authors first divided the generation task into four sub-tasks, and propose a Process Aware Hierarchical Decision model (PAHD model). The PAHD model leverages regular knowledge to improve the accuracy of responses as well