Towards Dialogue-Based Natural Language Interfaces to Databases

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Introduction

Even though natural language interfaces to databases has been studied for decades in academia and industry, the real breakthrough has been blocked by the limited meaning representation and domain specific setting. To address these fundamental obstacles, we present Dialog2SQL, a collection of human-human conversations on querying over databases in different domains. It brings two important tasks, dialogue and semantic parsing, together in a single task and enhances each of them. Firstly, its dialogue belief states are SQL queries which can represent more powerful semantic meanings. Also, since there is no need to pre-define domain specific ontology and slot-value pairs, the system built upon the dataset can generalize to any arbitrary unseen databases. Second, by expressing complex questions in the context of a conversation, our task introduces challenges in the dialogue into the semantic parsing area. The dataset can be used for multiple topics including dialogue act and response generation and contextual dependent data-to-text generation. Moreover, we introduce a new task, dialogue SQL belief tracking. Our studies on these tasks show that Dialog2SQL presents strong challenges in multiple fields for future research.

Related Works

To build such a practical NL conversational query systems, it mainly involves two important research areas, dialogue and semantic parsing. In the past, they are studied separately. Recent research in dialogue has focused more on building task-oriented dialogue systems that can help with specific tasks such as flight reservation or hotel booking. Even though some dialogue tasks that cover different application domains such as MultiWOZ have been introduced, they are still limited to a few domains, require predefined ontology, and could only handle simple semantic requests.

There has been great progress in querying data via natural language (NL). However, most NL query systems expect the query to be stated in a single sentence. Such a sentence is likely to be unnaturally complex when the query is complex. Our complex needs are usually expressed in the context of a conversation. Also, most of users don't know how to ask complex questions in a single turn. In some cases, multiple turns of interactions between users and the system are needed to clarify some questions, verify returned results, and suggest some hints. Even for simple queries, people tends to explore the database by asking multiple inner related simple questions. This requires systems that are capable of sequential processing of conversational requests to access information in relational databases. Developing such

systems introduces several challenging tasks including conversational query specification, access to multiple target information sources, and comprehensible and reliable result presentation.

Dialogue Interfaces to Database

The usage scenarios are that users with any database backgrounds have a query goal or would like to explore a database; these users know to which database they are querying. However, they don't know how to write SQL queries or don't want to write them by themselves. Thus, the usage scenarios of our system are more professional working environment.

The goal of our task is to help users query or explore databases in general purpose instead of conducting some domain specific task such as booking hotel or taxi etc. Because of this, the number of turns in our task is less than domain specific task oriented dialogue. Also, we have no predefined must-to-ask information to request from the system side in order to accomplish a goal. Instead, the system in our task focuses on converting users' questions into SQL queries, and providing returned results.

System mainly response with query results, summarize returned results, sometimes question clarification. No need to request info from user much.
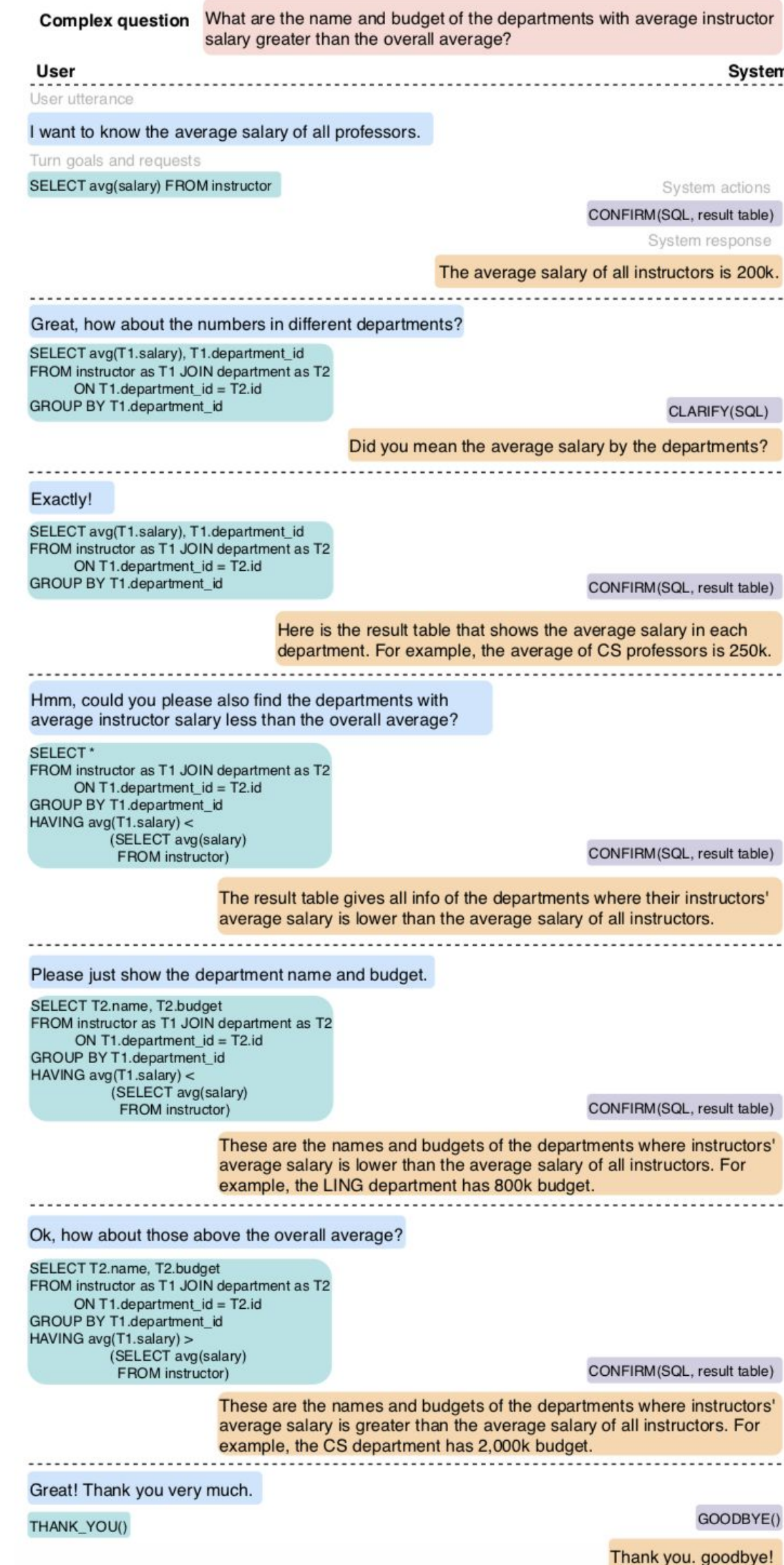

Figure 1. Dialogue2SQL example.

Dialog2SQL Tasks

Dialog2SQL can be used as a great benchmark for a range of dialogue, semantic parsing, and generation tasks.

The first task is Dialogue SQL State Tracking. This task maps natural language questions against cross-domain databases to corresponding SQL states as a dialog progress between users and systems. It introduces complicated and dynamic dialogue states to text-to-SQL task. In this task, the system is given multi-turn natural language interactions and database schema, then it has to map each dialogue interaction to SQL query or actions.

The second is Dialogue-Act-to-Text Generation. The task is to generate natural language responses from system dialogue acts that are structured meaning representations. The last one is Dialogue-Data-to-Text Generation. The task is to generate natural language description from the returned result table.

Conclusion

Here we introduce the Dialog2SQL dataset, a large-scale multi-turn conversational text-to-SQL corpus with dialogues spanning across about 200 different domains. The goal of each dialogue is to query and explore an arbitrary database. Each is annotated with a sequence of SQL or action dialogue states and corresponding system dialogue acts. Hence, Dialog2SQL can be used for some traditional tasks including dialogue state tracking, dialogue management and response generation, and data-to-text generation. Dialog2SQL is the first dataset integrating semantic parsing and dialogue together, it introduces some new challenges and exiting ongoing research in both two areas. First, belief states in Dialog2SQL are general SQL queries instead of predefined domain specific slots and values.