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1 Research Interests

My research interest in general lies in sequential decision making for spoken dialog system, such as turn-taking and dialog management using reinforcement learning. Specifically I am interested in pursing scalable, flexible and end-to-end trainable computational model that jointly optimize the decision making process of a conversational agent that can carry out meaningful dialogs with human users in multiple-domains. The following sections briefly introduce the research projects that I worked on in the past and the ones that are in my current and near future research focus.

1.1 Active Turn-taking with System Barge-in

One essential functionality of mixed initiative dialog is allowing users to interrupt systems utterances. Naive system interruption to users may be considered as inappropriate, recent studies, however, have shown that clever system barge-in can actually improve the task success rate (Ghigi et al., 2014). Our work (Zhao et al., 2015) investigates the effectiveness of active system barge-in in a more principled way by incorporating reinforcement learning and the theory of optimal stopping. The study first views a user utterance as a stream of partial hypotheses from the speech recognizer and constructs a cost model based on the number of correct and incorrect slots in each partial. Two possible actions: continuing listening and active barging in, are available to the the machine. Then the optimal action at each partial hypothesis is calculated according to the theory of optimal stopping and the authors apply a Support Vector Machine (SVM) to learn the optimal policy.

Results show that the trained classifier is able to correctly estimated the oracle actions with a F-measure of 85.9%. Moreover, the simulation results demonstrate that active system barge in can improve the average reward by 27.7% in the best case and is able to estimate user intention approximately in the middle of utterances. This suggests that machine should have its own motivations to actively take actions that are beneficial for the task successfulness.

1.2 DialPort: Connect the SDS community

DialPort[1] is one of the long-term project that I am focusing on. The basic idea behind DialPort is to construct a shared platform for the academic SDS community to collect real-user data and experiment with new systems. DialPort is formulated to be a multi-agent dialog system that each agent is a independent dialog system from external research labs. For the actual users, however, they observe a unified interface as if talking to a single virtual agent. Currently, DialPort has successfully connect to three external systems, including yelp API, a chat bot and the one form the Cambridge University. In the future, we will continue to conduct research in better ways of connecting various dialog systems and corporate with other research labs over the world to make DialPort more powerful. For more information, please refer (Zhao et al., 2016) and we sincerely welcome anyone interested in to join DialPort.

1.3 End-to-End Learning for Dialog State Tracking and Management

The second project in my current focus is developing end-to-end trainable task-oriented dialog system (Zhao and Eskenazi, 2016). Inspired by recent success in deep reinforcement learning (DRL), the proposed approach views the slot-filling as a part of the actions for a reinforcement learning agent and therefore jointly optimizing the policy for both dialog state tracking and dialog policy. Further, we also use the expressive power of recurrent neural networks (RNN) to automatically learn dialog state representation along with policy learning. This results in an end-to-end trainable model given the dialog success and slot-filling labels.

The experiments showed that the proposed algorithm is able to master in playing a conversational game with simulated user and our model analysis indicated compelling evidences that the embedding layer of the RNN is learning important state feature of a dialog. However, we also observed that the proposed model suffers from poor sample complexity, which will be investigated in the future work.

[1] https://skylar.speech.cs.cmu.edu

2 Future of Spoken Dialog Research

I believe that we are in the golden age of spoken dialog research since there are significant more attention to our field in recent years from both industry and academia. One of the reasons I believe is that the technologies of automatic speech recognition (ASR) and natural language processing (NLP) have evolved well enough so that it becomes plausible to build software that can carry out more complex reasoning and interaction with human users.

As one of the young researchers, I think we should pursue both practical and theoretical research. From practical perspective, constructing scalable development framework can allow both companies and research labs to better prototype various dialog systems, such as personal assistant, virtual tutor and many others. Meanwhile, it is important for researchers to pursue theoretical foundation that connects the bridge between traditional discourse theory with practical dialog development framework. Such theory is crucial to produce principled study in the field in the long term.

3 Suggestions for Discussion

I would like to suggest the following topics for discussion.

- **Evaluation of dialog systems:** Dialog system evaluation is known to be challenging. In other AI areas, such as translation or computer vision, that simple accuracy or BLUE score, though not perfect, provides a common metric for system comparison. Exploring novel methods to compare similar dialog system is a important and interesting topic for discussion.

- **Categorization of Dialog Systems:** Numerous types of systems have been proposed to conduct conversation with human users. Each of them uses different approaches and serve for various purposes. However, there is a lack of accepted categorization that classifies existing dialog systems into well-defined types with respect to their approaches or functionality. This would not only be helpful in identifying the unique and common challenges in each category, but also valuable for young researchers to obtain the "big picture" of spoken dialog research.

- **End-to-End Dialog Systems:** Recently, there have been increasing interest in developing end-to-end trainable dialog systems (Iulian et al., 2015; Wen et al., 2016; Zhao and Eskenazi, 2016; Williams and Zweig, 2016). An interesting discussion could be about the pros and cons of various approaches and the challenges that observed in these studies.

References

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Biographical Sketch

Tiancheng Zhao is a first year PhD student at Language Technologies Institute, in School of Computer Science Carnegie Mellon University, working under the supervision of Prof. Maxine Eskenazi and Prof. Alan W Black. His research interest lies in spoken language processing and sequential decision making for dialog systems. Currently he focuses on combining dialog expert knowledge and deep reinforcement learning, in order to efficiently develop end-to-end multi-domain conversation models that can conduct both goal driven and non-goal driven dialogs with human users. Previously, Tiancheng received his M.S in Language Technologies from Carnegie Mellon University in 2016. Prior to that, he received the B.S. in Electrical Engineering from University of California, Los Angeles in 2014, advised by Professor Abeer Alwan.