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1 Research Interests

Within the broad area of Statistical Spoken Dialogue Systems, my research interests lie on **online adaptive dialogue management**, on **socially skilled agents**, and on **multi-domain dialogue**. Regarding dialogue management (DM), during my PhD I have specifically focused on applications of Robot Dialogue Systems (RDS) for Assistive Living Environments (ALE), where the users are by definition not competent with technology. I then moved on to socially skilled virtual humans, focusing on building and maintaining long-term rapport with users, for education (peer tutoring) and other applications. My current focus is on multi-domain statistical dialogue management, using methods that can scale well.

1.1 Online Dialogue Management

Reinforcement Learning (RL) has been used for many years in dialogue systems research and has many benefits, including the fact that there is a plethora of mature and proven algorithms, many of which are scalable. During my PhD, we performed extensive evaluations of standard and state of the art (at the time) RL algorithms for dialogue management. We then applied these methods on adaptive RDS, in ALE scenarios. Having a physical robot adds a whole new dimension, impacting many aspects of the interaction, for example proxemics, gaze, gestures, etc. ALE pose even more challenges, including the fact that users in such environments have difficulties interacting with standard technology interfaces, either due to physical (injuries, age, chronic conditions etc.) or mental disabilities and the vast amounts of available data, such as real-time streams from sensors that need to be fused, interpreted and stored in an efficient manner.

To address some of these challenges, we proposed two batch learning algorithms, able to learn how to combine basic system actions into complex ones and achieve mandatory system goals (such as rehabilitate user) while achieving as many optional goals as possible (such as entertain user) (Papangelis et al., 2012). Our next step was to create a system able to help users suffering from psychological disorders such as Post-Traumatic Stress Disorder (PTSD) (Papangelis et al., 2013; Papangelis et al., 2014a). We then used a similar system to collect multimodal data from human users (Tsiakas et al., 2015).

Other work of mine focused on dialogue management using RL to learn good two-party multi-issue negotiation dialogue policies (Papangelis and Georgila, 2015). In this work, we used a simulated user for training an RL agent and human users for evaluation. Our simulated user extends the agenda-based paradigm to fit the negotiation scenario. In this scenario, each negotiator has goals and preferences as well as strong and weak arguments for each issue and can make a variety of moves, for example propose an offer or trade-off, provide an argument, accept or reject an offer, etc.

1.2 Socially Skilled Agents

Recently, I have worked on intelligent virtual agents that employ sociocultural models in order to build or maintain rapport between themselves and human users and thus more efficiently perform tasks. This work is in line with a broader research area that I am interested in: socially skilled agents, i.e. agents that behave in a socially acceptable manner. There are many challenges involved in such efforts, including recognising the social intentions behind the user's behaviour, responding in a manner that achieves the system's social and task related goals and properly realizing this response. To accomplish this, we did an extensive analysis of sociopsychological findings about how people build, maintain and break rapport and proposed a theoretical model of managing rapport between humans and virtual agents (Zhao et al., 2014). Based on this model, we proposed a computational architecture (Papangelis et al., 2014b).

To meet some of the challenges, I worked on a *social reasoner* that, similar to a DM, deliberates about the social dimension of the interaction and decides what is the best social strategy to follow in the next dialogue turn, and a *social state tracker*, a module that can map features extracted from the input (audio / video) into the social functions that lead to rapport (mutual attentiveness, face management, coordination) and keep track of the dynamics of these social functions, following our proposed architecture (Papangelis et al., 2014b).

My work with virtual humans focused on two projects, a virtual peer tutor and a mobile personal assistant. While the social goals in both systems are similar (build and maintain rapport over the long-term), the task is quite different: the first system is a teenager who can teach and be

taught and the second is a personal assistant that connects the user to Yahoo! services.

1.3 Multi-domain Dialogue Management

I am currently working on methods that allow information-seeking dialogue systems to operate across multiple domains. More specifically, I am investigating how we can apply transfer learning methods to design a multi-domain dialogue manager.

2 Future of Spoken Dialogue Research

There is an increasing number of interactive systems (embodied or not, virtual or physical) that take sociocultural norms into account. There is also an increasing number of works that use Neural Networks and Deep Learning to handle the complexities of human conversation. In the near future, I expect these to intersect and create socially skilled agents that can handle lifelong learning, form relationships with users and act as companions in their daily activities and replacing traditional interfaces such as command line search. Moreover, I expect such agents to be fully integrated with online services, fostering personalisation across platforms.

3 Suggestions for Discussion

Topics for discussion that I think are interesting:

- Deep Neural Networks in place of traditional approaches.

- Long-term interaction with a spoken dialogue system.

- Deep understanding of the user's input.

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Biographical Sketch

Alexandros Papangelis is a Research Engineer at the Speech Technology Group of Toshiba Cambridge Research Lab, working on statistical spoken dialogue. Before that, he was a Post Doctoral Fellow at the ArticuLab at CMU, working in Dialogue Management and Socially-skilled virtual agents. He received his B.Sc. degree from the National and Kapodistrian University of Athens in 2003, in Informatics and Telecommunications, he received his M.Sc. from University College London in 2009, in Machine Learning and his Ph.D. from the University of Texas at Arlington in 2013 and the National Center for Scientific Research "Demokritos", in Adaptive Dialogue Systems for Assistive Living Environments.