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1 Research interests

I am interested graph-based **dialogue management** for dialogue systems, specifically the use of **knowledge-graphs**. Representations of knowledge combining information about the world with dialogue or user-specific information, such as personal knowledge graphs (Balog and Kenter, 2019) are of particular interest to me. Knowledge graphs have the flexibility to represent diverse information such as dialogue specific information, general world knowledge, and even situated knowledge in the case of embodied dialogue systems. Much of my previous work has investigated knowledge graphs in an HRI context that combined these attributes (Walker et al., 2022b).

Beyond my work with knowledge graphs and dialogue systems, I am also interested in how dialogue systems communicate **uncertainty**. In many situations, it is important for dialogue systems to communicate where uncertainty exists, and improving LLMs ability to engage with humans under uncertainty is an interesting challenge. Some work has investigated how well LLM expressions of uncertainty relate to human perceptions of it (Sileo and Moens, 2022), and I believe further work in this direction will be useful in making interaction with dialogue agents more natural and engaging. The interaction of communicating uncertainty with other factors such as user personality or confidence in the model's predictions is also a potential challenge in this direction (Zukerman and Maruf, 2024).

1.1 Previous and Current Work

My previous work has investigated graph-based approaches to dialogue management. The core approach to this work was the use of **dynamic knowledge graphs** as the representation of dialogue state. These dynamic knowledge graphs can be modified throughout the dialogue to represent dialogue-specific and situational information (Walker et al., 2022a). Further, the dialogue state can be enriched and extended by applying rules expressing common-sense inferences which are later verbalized for use by a language model (Walker et al., 2023). For this purpose, my work made use of ProbLog (De Raedt et al., 2007), which enables *probabilistic* logical inferences whose results can be added as new facts to the existing knowledge graphs.

In my current work, I have continued investigating graph-based dialogue management methods. Recently, I have worked on evaluating graph retrieval methods that take into account graph-structure to enable subgraph retrieval of facts in the knowledge graph. An additional element of my current work is the development of a model for conversational agents based on the classical *Beliefs-Desires-Intentions* model. My approach to this work is to extend the original BDI model to include new elements, specifically notions of purpose and behavioral guidelines to models in order to help guide their output. This model is also aimed at characterizing a wide range of approaches to dialogue systems, so that both modular and more highly LLM-centric dialogue systems can benefit from the framework. Implementation and evaluation of approaches using this framework, specifically how system purpose and behavioral guidelines can be realized, is an important current focus for my work.

1.2 Future Work

In my future work, I am most interested in further investigating both the design of conversational agents within an extended BDI framework and how dialogue systems communicate and handle uncertainty. The need for reliable means of controlling dialogue system behavior suggests that behavioral guidelines for these systems will be a promising area for research. How the designers of a dialogue system should craft and integrate such guidelines to systems can be investigated both within the context of LLM prompts and in auxiliary modules. The ultimate goal of this approach is to enable the creation of dialogue systems that can be easily adapted to situational or domain requirements.

With regards to uncertainty in dialogue systems, I would like to investigate how both understanding and expression of uncertainty in different kinds of information can impact task-oriented dialogue systems. For instance, understanding human expressions of uncertainty can assist a system with planning and communication in diagnosing patients in a medical domain (Hu et al., 2024).

Both the perception and communication of uncertainty by a dialogue agent are of interest for my future work.

2 Spoken dialogue system (SDS) research

I believe that current SDS research is at an exciting juncture where many approaches to the use of large language models will be promising avenues for exploration.

- I believe that the field of SDS research will continue to develop rapidly and that among the most pressing topics will be multimodal approaches. In my view, recent improvements in system language capabilities resulting from the use of large language models will be paired with more effective integration of non-language modalities to create systems with impressive new capabilities.

- The use of diverse modalities within a SDS is a challenge for both representational modelling and computational efficiency. New systems like GPT-4o demonstrate impressive capabilities, but it will be important for open-source and potentially more lightweight models to be developed.

- Along with these research questions, I believe it will also be important for young researchers in SDS to think about the societal implications of ever more capable dialogue systems. How we can responsibly develop these systems and communicate their strengths and limitations to the public is in my view and important role for researchers in this field.

3 Suggested topics for discussion

In current SDS research, I am especially interested in how multimodal systems will evolve and be applied in new scenarios. The ability of systems to learn in a multimodal space and reason over visual and spatio-temporal perceptions is an area of interest for me.

- Multimodality: What new approaches are becoming prominent for combining information from different modalities in SDS? How can systems better integrate real-time information such as visual data?

- Applications: What new domains or practical applications of SDS are now possible with the current generation of large language models? Are there new areas this can help society in but are in development / yet to be developed?

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Biographical sketch

Nick Walker is a postdoctoral researcher at Otto-Friedrich University of Bamberg. He completed his bachelor's degree in linguistics and master's degree in human language technology at the University in Arizona, and defended his PhD at the University of Oslo in October of 2024.