Visual Conversation Starters for Human-Robot Interaction[*]

Ruben Janssens, Thomas Demeester, and Tony Belpaeme

IDLab, Ghent University - imec, Ghent, Belgium
rmajanss.janssens@ugent.be

Abstract. In this demonstration, a Furhat social robot will engage in a conversation with a user and adapt this conversation based on information about the user that the robot has visually identified, such as the apparel of the user. This interaction showcases that data-driven methods in natural language processing and computer vision offer promising possibilities to create personalised, adaptive and natural human-robot interactions, which is essential for robots to support humans in an effective way.

Keywords: conversational agents · human-robot interaction · multimodal interaction · natural language processing · computer vision

1 Introduction

In human-human interactions, we expect the other to see us and to understand the context that we are both in. This is important in order to establish a common ground in these interactions, i.e. the set of propositions in a conversation which we treat as 'true' [10]. For this, situational awareness is necessary: the concept of knowing what is going on around oneself [3] and being able to use that knowledge effectively in an interaction with the environment and with social others.

Yet, when we try to have a conversation with a robotic partner, it is unlikely that the robot is able to meet the criteria we have for human interlocutors, which in turn leads to a less natural interaction and experience. Getting robots to both understand their environment, and allowing them to reference it in a conversation, is a challenging objective in the fields of Human-Robot Interaction (HRI) [2] and Natural Language Processing (NLP). Nevertheless, having robots understand their surroundings, with the ability to weave that understanding into an open-domain conversation, is key to a successful HRI.

This demonstration will show how data-driven methods in NLP and Computer Vision can enable such a visually grounded conversation in an interaction with a social robot. In this interaction, the robot will greet the user with a question that is based on a visual feature of the user, e.g. "How long have you had glasses?". This question will be generated by the Visual Conversation Starter system previously described by the authors [5].

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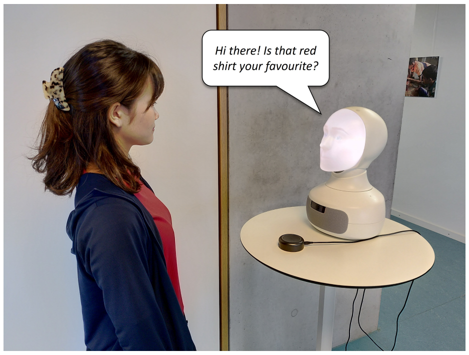


Fig. 1. Illustration of the interaction between a user and a Furhat robot, with the robot inviting the user to have a conversation through a polite question referring to a visual feature of the user.

This research is novel as it constructed a new dataset of images and conversation-starting questions that are appropriate for HRI instead of only human-chatbot interactions, such as previous work by Mostafazadeh and others [8]. Furthermore, it focuses on open-domain conversations instead of specific tasks, e.g. in collaborative robots [6,4]. Finally, we demonstrate the usefulness of data-driven language models for HRI, with image captions as intermediate representation, instead of rule-based systems or scene graphs as intermediate representation [9]. Future work will focus on investigating the effect of such visually grounded conversation starters on the human experience of a human-robot interaction.

2 Demonstration

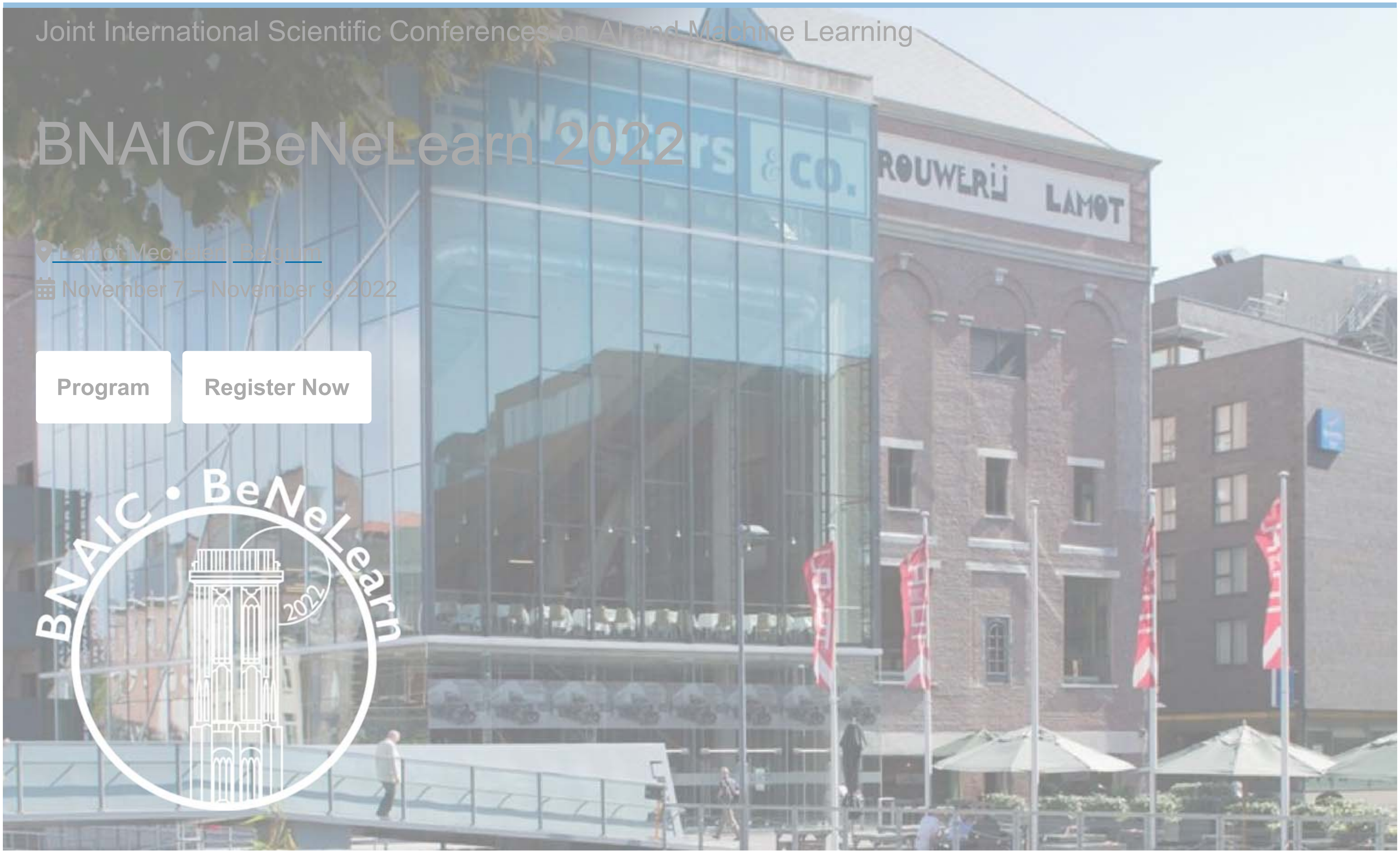
To demonstrate the Visual Conversation Starter system in the wild, we deploy it on a Furhat social robot [1]. Furhat has a camera, text-to-speech software, three-dimensional face with pan-tilt neck, lip syncing, and gaze recognition through which it can 'engage' with people and follow their movements. Fig. 1 shows the setup with the robot and the video accompanying this paper also showcases this demonstrator (accessible at `https://youtu.be/DPTqGCBiMwE`).

The questions are generated based on an image taken by the camera situated in the base of the robot. This image is given to a captioning model [11], which generates a text containing short sentences describing what is visible in the image. This text is then transformed into the question by a version of the BART sequence-to-sequence language model [7] that was fine-tuned by the authors [5].

Both the captioning model and the question generating model are running in a separate VM on a cloud server, each with an NVIDIA GeForce GTX 1080 Ti GPU. A local computer running a Python script connects all the different components by forwarding Furhat's camera feed to the captioning model, sending the caption to the question-generating model, and using that output to drive Furhat's text-to-speech system.

References

1. Al Moubayed, S., Beskow, J., Skantze, G., Granström, B.: Furhat: a back-projected human-like robot head for multiparty human-machine interaction. In: Cognitive behavioural systems, pp. 114–130. Springer (2012)
2. Bartneck, C., Belpaeme, T., Eyssel, F., Kanda, T., Keijsers, M., Šabanović, S.: Human-robot interaction: An introduction. Cambridge University Press (2020)
3. Endsley, M.R., Garland, D.J.: Situation awareness analysis and measurement. CRC Press (2000)
4. Hough, J., Schlangen, D.: Investigating fluidity for human-robot interaction with real-time, real-world grounding strategies. In: Proceedings of the 17th Annual SIGdial Meeting on Discourse and Dialogue (2016)
5. Janssens, R., Wolfert, P., Demeester, T., Belpaeme, T.: "cool glasses, where did you get them?" generating visually grounded conversation starters for human-robot dialogue. In: Proceedings of the 2022 ACM/IEEE International Conference on Human-Robot Interaction. pp. 821–825 (2022)
6. Lemaignan, S., Warnier, M., Sisbot, E.A., Clodic, A., Alami, R.: Artificial cognition for social human–robot interaction: An implementation. Artificial Intelligence **247**, 45 – 69 (2017). https://doi.org/https://doi.org/10.1016/j.artint.2016.07.002, http://www.sciencedirect.com/science/article/pii/S0004370216300790, special Issue on AI and Robotics
7. Lewis, M., Liu, Y., Goyal, N., Ghazvininejad, M., Mohamed, A., Levy, O., Stoyanov, V., Zettlemoyer, L.: BART: denoising sequence-to-sequence pre-training for natural language generation, translation, and comprehension. CoRR **abs/1910.13461** (2019), http://arxiv.org/abs/1910.13461
8. Mostafazadeh, N., Brockett, C., Dolan, B., Galley, M., Gao, J., Spithourakis, G.P., Vanderwende, L.: Image-grounded conversations: Multimodal context for natural question and response generation. CoRR **abs/1701.08251** (2017), http://arxiv.org/abs/1701.08251
9. Pantazopoulos, G., Bruyere, J., Nikandrou, M., Boissier, T., Hemanthage, S., Sachish, B.K., Shah, V., Dondrup, C., Lemon, O.: Vica: Combining visual, social, and task-oriented conversational ai in a healthcare setting. In: Proceedings of the 2021 International Conference on Multimodal Interaction. p. 71–79. ICMI '21, Association for Computing Machinery, New York, NY, USA (2021). https://doi.org/10.1145/3462244.3479909, https://doi.org/10.1145/3462244.3479909
10. Stalnaker, R.: Common ground. Linguistics and philosophy **25**(5/6), 701–721 (2002)
11. Yang, L., Tang, K., Yang, J., Li, L.J.: Dense captioning with joint inference and visual context. In: IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (Jul 2017)



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