Social robots skills learning from demonstration

Sascha Griffiths†
Research Centre
ORTELIO Ltd.
Coventry, U.K.
sg@ortelio.co.uk

Thomas Gees
Institut Digital Enabling
Berner Fachhochschule
Bern, Switzerland
thomas.gees@bfh.ch

Adamantios Koumpis
Institut Digital Enabling
Berner Fachhochschule
Bern, Switzerland
adamantios.koumpis@bfh.ch

ABSTRACT

In the paper we address the issue of deploying a learning-from-demonstration approach to acquire skills for carrying out conversational tasks with humans. The core idea is to have the robots exploit curated data resulting from human end-user training on dedicated simulators. This will be employed to train social skills in robots using AI models. The resulting social robot will incorporate the trained models.

CCS CONCEPTS

•Computing methodologies ~ Artificial intelligence ~ Knowledge representation and reasoning ~ Cognitive robotics • Human-centered computing ~ Human computer interaction (HCI) ~ Interaction paradigms ~ Natural language interfaces • Computing methodologies ~ Artificial intelligence ~ Natural language processing

KEYWORDS

Social robots, natural language generation, conversational agents, learning from demonstration

ACM Reference format:

FirstName Surname, FirstName Surname and FirstName Surname. 2018. Insert Your Title Here: Insert Subtitle Here. In *Proceedings of ACM Woodstock conference (WOODSTOCK'18). ACM, New York, NY, USA, 2 pages.* https://doi.org/10.1145/1234567890

1 Introduction

Groundhog Day is a now about 30 years old film – that had a lasting cultural impact as it seems. The phrase 'groundhog day' has become a common term to describe any kind of repetitive or unpleasant situation, where events are continuously repeating. In the movie, it is the main character, played by Bill Murray who gets trapped in a time loop forcing him to live again and again and … again the same day, namely February 2, and the awakening of the groundhog from its winter sleep.

∗Article Title Footnote needs to be captured as Title Note
†Author Footnote to be captured as Author Note

WOODSTOCK'18, June, 2018, El Paso, Texas USA

In life, there are many situations that give us a feeling of needing to repeat ourselves – sometimes to different people but sometimes to the same person.

One of the authors draws on their experience from holding a chat with their senile 88-year old mother who lives in a nursing home. Every week – usually a Saturday or Sunday – that they talk on the phone, there is a dialogue that at a great part repeats itself. Drawing on our experience from the MARIO research project [1, 2], where the main aim was to offer people with dementia the opportunity to hold dialogues with a humanoid robot that might carry out simple discussions with the patients, the idea we came along with was to build some archetypical discussion patterns that might be considered for use by service robots in some archetypical situations.

As such we indicatively consider the following use cases:

- a museum/exhibition guide robot that would be capable to carry out a simple dialogue with the visitors and "understand" or acquire their preferences so that it would guide them to specific exhibits
- a service robot used in the reception space of a hotel, or a hospital or some other public space to provide, same as in the museum case mentioned above, customised information on some service or facility offered
- a general purpose conversational robot – so not necessarily a humanoid one as the case of a chatbot – that would have as its purpose the provision of some sort of entertainment or the provision of some – same as we humans do in our conversations with other humans – exhibit some sort of human-like empathic conversational skills that could lead to a more engaging experience.

There is of course a part that is strongly related to the ethical consideration: is the provision of such an artificial empathy ethical?

2 The (unavoidable) learning aspect

Sometimes humans project their shortcomings or failures to technology artifacts – same as we (since thousands of years now) do with analogies and metaphors we use in our everyday language for animals, may now be comfortably attributed to a robot or some other type of a 'machine'. The bottom line, however, is that in many cases we seriously consider the need to deploy routine dialogues in our everyday life.

When a colleague in the office shares with us some news about them related to an incident like a death in the family e.g. loss of a parent, a new arrival in the family as in the case of a baby that is born, an engagement, a marriage or, as it happens, a divorce, etc., we are usually inclined to avoid improvising something from scratch and take the safe(r) way in terms of relying on the use of a routine – what we above called 'archetypical' dialogue. This can be something we read or watched in a movie, something that we very well remember our parents have been using in a similar occasion, or something that we developed on our own and with the time we have brought to quite a 'level of perfection'.

What we suggest is to look in real life and imitate it by means of adopting a simulation-based environment to train robots using a user-centred, learning-from-demonstration approach.

This will take place by means of developing a robot trainer application to exploit curated data resulting from end-user training on dedicated simulators. This will be employed to train social skills in robots using AI models. The resulting social robot will incorporate the trained models. The goal is to develop tools that impact the design of social skills in advanced robotic systems.

Research in this direction can be regarded as the next step in advancing the symbiotic relationship of robots and humans. Capitalizing on the skills and knowledge demonstrated by end-users during the performance of a specialized task, such a human-robot collaboration can improve robot adaptation and learning.

Research is focused on Machine Learning (ML) methodologies which enable the robot to *learn tasks by observing human experts* that train themselves in the same context by means of Learning from Demonstrations (LfD) as well as practise and optimize the acquired / learned skills by receiving feedback on the execution performance. The novelty of combining training platforms with virtual reality and LfD for robotics is something that has been attempted before [3, 4, 5] but not in the context like the one we suggest for deploying for building social robots.

3 The (unavoidable) learning aspect

Robots can acquire new skills by learning from demonstrations from external experts [6]. Learning from demonstration can be seen as a supervised learning paradigm in which robots learn new skills by processing examples of an external expert performing a task. Learning from demonstration is beneficial over other forms of learning when an ideal behaviour or skill is difficult to be scripted or cannot be expressed as an optimization problem [7, 8]. As recent research results [10] shows, there is an increasing research interest in teaching robots new skills from demonstration. This is stressed by the fact that the number of papers published in this domain has more than tripled in the last ten years [9]. Learning from demonstration presents the usual challenges common in Human-Robot interaction contexts:

- there must be an *adequate interface* that humans can use to demonstrate a given task,
- *variability of human performance* during demonstration must be accounted for as well as
- *different knowledge of human subjects* and the robot to robot variability which is greater than human to human variability.

Learning from demonstration is dependent on the quality of the human trainer but also on the specifics of the robot trainee. As pointed out by Billard [10] decisions of what to learn, when to learn, from whom to learn and how to learn are central in the set-up of a learning from demonstration scenario. If we look at the domains in which learning from demonstration is used, we can see that it is applied predominantly in Manufacturing, Assistive and Care Robots, Human-Robot collaboration and Mobile robots.

Reinforcement learning is a technique that relies on feedback from the environment to learn a new task by exploring a finite set of actions [21]. Its main idea resides in allowing an algorithm to learn by executing random actions, while it receives feedback in the form of positive and negative reward, which differs from learning from demonstration, where the main idea is that robots learn how to imitate the movements and behaviour of an expert executing the target task [17].

4 Conclusions

Most of the research on learning from Demonstration has either focused on driving vehicles or targeting non-critical tasks. The literature and data sets focused on the area we address are rather scarce. Finding also the correct balance on experimentation data and pre-training from demonstration has mainly been investigated in the context of games.

REFERENCES

[1] Kouroupetroglou C., Casey D., Raciti M., Barrett E., D'Onofrio G., Ricciardi F., F. Giuliani, A. Greco, D. Sancarlo, A. Mannion, S. Whelan, G. Pegmann, A. Koumpis, D. Reforgiato Recupero, A. Kouroupetroglou, A. Santorelli, *Interacting with Dementia: The Mario Approach*, 14th AAATE Conference, 11-15th September 2017, Sheffield, UK.

[2] Casey D., Felzmann H., Pegman G., Kouroupetroglou C., Murphy K., Koumpis A., and Whelan S., *What People with Dementia Want: Designing MARIO an Acceptable Robot Companion*, 15th International Conference on Computers Helping People with Special Needs, July 13-15, 2016, Linz, Austria.

[3] Haidu, Andrei & Beetz, Michael, "Action recognition and interpretation from virtual demonstrations", 2016 2833-2838. 10.1109/IROS.2016.7759439.

[4] A. K. Bozcuoğlu and M. Beetz, "A cloud service for robotic mental simulations", 2017 IEEE International Conference on Robotics and Automation (ICRA), Singapore, 2017, pp. 2653-2658.

[5] P. Mania and M. Beetz, "A Framework for Self-Training Perceptual Agents in Simulated Photorealistic Environments", 2019 International Conference on Robotics and Automation (ICRA), Montreal, QC, Canada, 2019, pp. 4396-4402.

[6] Ravichandar, H., Polydoros, A. S., Chernova, S., & Billard, A. (2020). Recent Advances in Robot Learning from Demonstration. Annual Review of Control, Robotics, and Autonomous Systems, 3.

[7] Argall, B., Chernova, S., Veloso, M., & Browning, B. (2009) A survey of robot learning from demonstration, Robotics and autonomous systems, 57(5), 469–483.

[8] Billard A., Calinon S., Dillmann R., Schaal S. (2008) Robot Programming by Demonstration. In: Siciliano B., Khatib O. (eds) Springer Handbook of Robotics. Springer, Berlin, Heidelberg

[9] Chernova S, Thomaz AL. 2014. Robot Learning from Human Teachers. San Rafael, CA: Morgan & Claypool

[10] Billard, A. G., Calinon, S., & Dillmann, R. (2016) Learning from humans. In Springer handbook of robotics (pp. 1995-2014). Springer, Cham.