Conversational Norms for Human-Robot Dialogues

Maitreyee Tewari
Department of Computing Science
Umeå University
maittewa@cs.umu.se

Thomas Hellström
Department of Computing Science
Umeå University
thomash@cs.umu.se

Suna Bensch
Department of Computing Science
Umeå University
suna@cs.umu.se

ABSTRACT

This paper describes a recently initiated research project aiming at supporting development of computerized dialogue systems that handle breaches of conversational norms such as the Gricean maxims [2], which describe how dialogue participants ideally form their utterances in order to be informative, relevant, brief etc. Our approach is to model dialogue and norms with co-operating distributed grammar systems (CDGSs), and to develop methods to detect breaches and to handle them in dialogue systems for verbal human-robot interaction.

KEYWORDS

Robot-Human dialogues, Cooperative principle, Gricean maxims, Co-operating Distributed Grammar Systems

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1 INTRODUCTION

Natural language is one of the easiest and most efficient means for humans to communicate, and has recently also been the focus for extensive research in human-robot interaction (HRI). A social robot with language capabilities has to understand not only single utterances but must also be able to conduct a dialogue with a human.

Human dialogues follow conversational norms in order to be successful, and phenomena such as sudden changes of topic, need of clarification, ambiguity, turn taking, misunderstandings, and non-understandings influence the character and quality of a dialogue. Current approaches to computerized dialogue systems do not explicitly handle conversational norms.

The overall goal of our research is to conduct work in this area by formalizing dialogue and conversational norms, and by developing dialogue system components that take breaches of norms into account.

Our work is divided into the following three parts

(1) Formalizing dialogue structure and mental states of dialogue participants.
(2) Formalizing conversational norms occurring in dialogue.
(3) Developing computational methods to detect and handle violations of conversational norms in dialogue management.

We believe that a formalization and understanding of how and why dialogue structure, conversational norms and changes of mental states co-evolve in the course of utterance exchanges is essential for the development of computational methods for dialogue management in HRI.

2 BACKGROUND

Dialogues are conversations, intentionally focused to question thoughts and actions, address problems, increase common knowledge and hence bring greater understanding [10]. The dialogue structure or dialogue flow is currently not well understood and existing paradigms to model dialogue structure fail to generalize or provide insight. The two main paradigms to dialogue management are knowledge-based approaches and data-driven approaches [6]. The data-driven paradigm learns how a dialogue should be conducted from dialogue corpora, whereas the knowledge-driven paradigm relies on handcrafted dialogue flows and thus on expert knowledge. Data-driven approaches (for example, [5, 11]), fall short of providing an understanding into the problem of dialogue management and can lead to serious ethical consequences[1]. The knowledge-based approaches (for example, [3, 9]) are insufficient in real-world setting as these approaches do not

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[1] In March 2016, Microsoft's chatbot *Tay* parroted racist language after having learned from anonymous public data. It was taken offline by Microsoft around 16 hours after its launch.

scale for real applications. Recent hybrid approaches to dialogue management combine the benefits of both approaches trying to avoid the disadvantages [7]. Our approach is a hybrid approach combining a finite-state and data-driven methods.

Gricean maxims were introduced in [2] as a way to describe how dialogue participants ideally form their utterances (and thus also what dialogue participants may assume utterances to be). Grice views a conversation as a collaborative action where the participants agree upon a common intention or a predefined direction. The Gricean maxims are stated as follows:

(1) Quantity: Make your contribution as informative as possible.
(2) Quality: Do not say what you believe to be false or which lacks evidence.
(3) Relation: Be relevant.
(4) Manner: Avoid obscurity and ambiguity. Be brief and orderly.

The author in [8] analyzed and proposed a model for ambiguous expressions in multi-agent systems, while in [4] the authors provided a formal model for Grice's Quantity implicature for a given utterance.

3 APPROACH

In line with viewing dialogues as collaborative actions, we formalize dialogues (e.g. turn takes and general dialogue structure), the mental states of dialogue participants, and conversational norms with co-operating distributed grammar systems (CDGSs). CDGSs are abstract devices for describing multi-agent systems, such as a human and a robot, by means of formal grammars based on the blackboard architecture (see, for example, [1]).

Using CDGS to model dialogue structure allows us to reflect conversational norm as a public string that all agents (e.g. dialogue participants) work on together, transforming and extended the string during the dialogue. How the string is transformed (i.e. how a robot recovers from violations of conversational norms) is defined by a so-called derivation mode that the agents are in.

Within our formal framework we investigate how and why conversational norms are reflected in utterances and the entire dialogue structure. That is, by formalizing conversational norms we are able to develop computational methods to identify breaches. For instance, the maxim of brevity (i.e. be brief) can be expressed using the number of words in a dialogue turn. To express the maxim of relevance, topic modelling can be used, based on Latent Dirichlet allocation (LDA) or automated semantic analysis (e.g. analyzing thematic roles). The topic identification is formalized within our CDGS framework in order to investigate how and why topics occur during a dialogue (i.e. dialogue structure).

We further develop computational methods to handle breaches of conversational norms. For example, if a human in a dialogue is not brief the robot might be allowed to interrupt the human. After a topic change is identified, the robot can either follow up the new topic or resume the previous topic depending on the extent of the violation of the relevance maxim. If the maxim of informativeness is violated, the robot switches to a mode in which it either asks for more information (if the information by the human was too sparse) or interrupt the human (if the information was too detailed).

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