Negotiation-Driven Learning: A New Perspective of Learning Using Negotiation

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Abstract. Negotiation mechanisms used in the current implementations of Open Learner Models are mostly position-based and provide minimal support for learners to understand why their beliefs contradict with that of the system. In this paper, we propose the paradigm of Negotiation-Driven Learning with the aim to enhance the role of negotiations in open learner models with special emphasis on affect, behavior and metacognitive abilities of the learners.

Keywords: Intelligent tutoring systems · Open learner models · Negotiation · Metacognition · Affect · Learner behavior · Interest-based negotiation

1 Introduction

Open Learner Model (OLM) [1] was introduced in Intelligent Tutoring Systems (ITS) to involve learners further in the learning process. OLMs provide learners with the opportunity to view and edit their Learner Models (LM). Allowing the learner to edit their LM results in scenarios where the learner's belief about their own knowledge is different from that of the system. Such events trigger an interrupt where the system tries to negotiate the changes made by the learner in an effort to remove this difference of beliefs. The underlying principle of the negotiation in OLMs is to test whether the learner can justify the change they made to their LM.

Although this strategy of OLMs has shown to produce significant learning gains, the negotiations in OLM follow a very Position-Based Negotiation (PBN) [4] approach, since the dialogues primarily focus on the *"positions"* held by the learner. This strategy of negotiation is often challenging because as the negotiations advance, the negotiating parties become more and more committed to their positions and without any information about why a certain position is held by the learner, any agreement that is reached produces unsatisfactory results.

Improving the metacognitive abilities of the learner has always been a key role of OLMs, however the current OLMs rarely scaffold the metacognitive processes.

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Since the system is actively involved in testing the learner about their knowledge, how they are reflecting or evaluating themselves is mostly left on the part of the learner.

1.1 Problem Definition

OLMs use a strict negotiation protocol which limits the system's ability to cater for a vast array of learner inputs. More often than not learner utterances & behaviors have little or no implications on the system's strategy which limits its ability to provide adequate scaffolding to engage the learner in a deeper learning dialogue.

2 Related Work

Most OLMs have deployed PBN as a negotiation strategy to resolve the conflicts. Mr.Collins [3] and STyLE-OLM [3] use a close-ended questioning approach where the learner is confined to a menu-based interface. They are allowed to challenge the system, and the system engages the learner in only directed-questions related to the domain knowledge. CALMsystem [3] provides a chatbot facility in order to engage the learners more actively. The dialogue functionality provided to the learner is a choice-based system where the system offers the learner the ability to choose from a predefined set of choices primarily focusing on learner's domain knowledge. Interest-Based Negotiations (IBN) [2] have been shown as a good alternative to PBN. IBN sees the negotiating parties as allies working for a mutual gain, hence allows each party to seek underlying interests of the other party in order to reach a mutually beneficial agreement. AutoTutor [5] is an ITS that does not use the OLM, and provides a Natural Language dialogue to interact with the learner. This natural dialogue ability has shown to promote learner engagement resulting in positive learning gains. Research has shown that a learner's affective and behavioral states play a vital role in their overall learning experience [6]. An approximate understanding of these states can allow the system to engage learners more effectively. The terminology of "caring systems" encompasses such systems which are meta-affectively and meta-cognitively aware.

3 Negotiation-Driven Learning

This paper proposes a learning paradigm of Negotiation-Driven Learning (NDL) which aims at enhancing the role of negotiations in OLMs to facilitate constructive learning. When a learner is involved in a learning exercise, they are not only learning something new, but they are also implicitly involved in learning how to learn. NDL aims at encouraging learners to use these skills more actively and effectively. We believe that when a learner negotiates their LM with the system, they are actively involved in a dialogue, intrinsically motivated to justify their claim, hence more likely to conceive new knowledge. This provides an

excellent opportunity to engage the learner in metacognitive-guided learning, where they build knowledge by actively using and enhancing their cognitive and metacognitive skills.

3.1 Proposed System

Unlike most OLM implementations, NDL allows learners to interact with the system in a Natural Language environment. The system engages the learner in a mixed-initiative dialogue session where both the learner and the system can ask and provide justification for their answers. Both parties have the capability to challenge any justification and ask for further information.

Engaging the learner in self-reflection and evaluation during and after the dialogue session trains them to use these skills more actively. NDL deploys the strategy of repetition to reinforce such skills in a learner. Encouraging self-assessment has been shown to have positive effect on learner's metacognitive abilities.

3.2 System Architecture

IBN is more suited for NDL since it allows for the parties to share information that was not available at the start of the negotiation. In order to automate the IBN in NDL, extend the model of Interest-Based Negotiation Automation [7] with the following functional components:

- *State Engine*: It generates the State Model (SM) for the learner by translating learner inputs to the corresponding affective, behavioral and metacognitive states.
- *Reasoning Engine*: uses the information from the SM in conjunction with the LM in order to select the next system move with the maximum utility. The *Context_Analyzer* submodule articulates the current context.
- *Plan Base*: holds the different negotiation moves available to the system according to the current context.
- *Dialogue Engine*: this is the core module for providing a Natural Language interface to the learner. NDL does not require a complete NLP understanding as we are interested in the concept-level cognition of the learner's input. To accomplish this, the DE consists of submodules which include; i) *Concept_Classifier*: uses a minimum-distance matcher to return a list of concept identifiers that most closely match the learner input. ii) *Normalizer*: manages stemming and spell checking for the learner input. iii) *History_Manager*: stores information about the concepts used by the system and the concepts

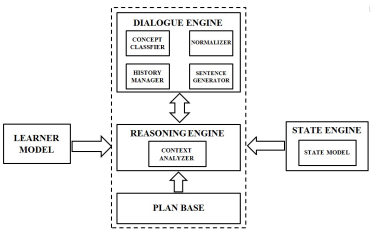

Fig. 1. Extended Interest-Based Automated Negotiation Agent

expressed by the learner. This information is passed to the RE, which uses it to classify the current context. iv) *Sentence_Generator*: uses the concepts identified along with the current context to generate a list of possible utterances of the system. These possibilities are matched with the library of template phrases and the best matching phrase is selected to generate sentences automatically.

4 Conclusion and Future Work

In this paper we proposed a paradigm of Negotiation-Driven Learning which follows the notion that learning is maximized by learner participation by exploiting opportunities provided by negotiation in OLM contexts. NDL finds its roots in the theory of repetition in learning. Continuously engaging learners in dialogue that encourage them to utilize their metacognitive abilities allows them to use such abilities more efficiently over time. Providing an NL interface to learners can ease the communication process but adds to the overall complexity. To minimize this complexity, we use the minimum-distance classifier which has been widely used for pattern recognition because it is simple and fast as compared to other complex classifiers.

Current Status: In order to realize the envisioned dialogues in NDL, a Wizard-of-Oz experiment was conducted. The goal of this experiment was to collect data in scenarios which require complex interactions between the learners and the system. The information we have gathered in the experiment has allowed us to generate rules that will power the automatic sentence generation by merging the template phrases with the concepts and context of the current interaction. We are currently acquiring rules for handling dialogues in the collected dialogues.

Future Work: Since in NDL, a dialogue is not based solely on the domain knowledge of a learner, therefore we believe that such a dialogue will have deeper implications on a learner's ability to transfer their learning skills to other domains. In order to test our hypothesis, we plan to evaluate NDL by testing the transferability of a learner's skills to a different domain.

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