CALMsystem: A Conversational Agent for Learner Modelling

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Abstract

This paper describes a system which incorporates natural language technologies, database manipulation and educational theories in order to offer learners a Negotiated Learner Model, for integration into an Intelligent Tutoring System. The system presents the learner with their learner model, offering them the opportunity to compare their own beliefs regarding their capabilities with those inferred by the system. A conversational agent, or “chatbot” has been developed to allow the learner to negotiate over the representations held about them using natural language. The system aims to support the metacognitive goals of self-assessment and reflection, which are increasingly seen as key to learning and are being incorporated into UK educational policy. The paper describes the design of the system, and reports a user trial, in which the chatbot was found to support users in increasing the accuracy of their self-assessments, and in reducing the number of discrepancies between system and user beliefs in the learner model. Some lessons learned in the development have been highlighted and future research and experimentation directions are outlined.

1. Background

Intelligent Tutoring Systems (ITS) provide their users with an adaptive learning environment, with personalized tutoring and testing customised to meet the needs of the individual student. This adaptation is based on the contents of the learner model, a representation of the student’s knowledge, gaps in understanding and misconceptions. Traditional ITSs have not made the contents of the learner model visible to the learner. However, it has been argued that an Open Learner Model (i.e. one that can be inspected by the student) can offer opportunities for learner reflection, metacognition and deep learning, which may enhance learning (e.g. [1], [2], [3], [4] and [5]), as well as improving the accuracy of the learner model. Educational theorists have emphasised the importance of learner reflection ([6], [7] and [8]). Some researchers have developed Open Learner Models (OLM) that
encourage negotiation as an approach to improve learner reflection and model accuracy ([1] and [2]). In such systems the learner model is collaboratively constructed and maintained by both the system and the learner. The learner is required to discuss their beliefs about their knowledge with the system, to argue against the system’s assessment if they disagree, and provide supporting evidence or argument for their own beliefs when they differ from the system. [1] and [2] found that this method of negotiating the learner model supported increased learner reflection, and produced a more accurate learner model on which to base system adaptivity. This negotiation based approach has been adopted in the current research.

Metacognition (defined as cognition about cognition: thoughts about thoughts, knowledge about knowledge or reflections about actions [9]) may be considered to capture two essential features: self-appraisal and self-management of cognition [10]. It is also recognised that the most effective learners are self-regulating [11] and that effective self-regulation is reliant on accurate self-assessment of what is known or not known [12]. In the context of Intelligent Tutoring Systems, it has been argued that it is necessary for educational systems to model the student’s meta-knowledge in addition to their domain knowledge [13]. It has also been found that not all students are good at evaluating their knowledge, and suggested that allowing the student to visualize the learner model may help their self-evaluation [14].

After a period of neglect of formative assessment in classroom practice [15], modern UK educational policy is starting to recognise the importance of metacognition, and now promotes ‘Assessment for Learning’ (AfL). Pupil self-assessment is regarded as an essential component of this [15]. The aims of AfL (promoting reflection, using assessment to modify teaching, conducting pupil self-assessment and providing formative feedback) closely mirror the ethos of OLM, as reported in [16]. The practice of opening the system-held learner model for viewing by the learner has been implemented in an increasing number of cases with school age pupils (e.g. [5], [17] and [18]).

Previous learner modelling negotiation methods (menu selection and construction of conceptual graphs) may be difficult for some learners (especially younger users) or require learning a new communications method. It is envisaged that a conversational agent (or chatbot) will provide a more intuitive and convenient method for negotiation. Natural language dialogue has been employed in ITS for tutoring dialogues, avatars, and pedagogical agents. Animated pedagogical agents have been argued to engage the student without distracting or distancing them from the learning experience [19]. Natural language dialogue has not previously been used in the negotiation of an Open Learner Model. It is hypothesised that the use of a conversational agent in negotiating the learner model will be similarly engaging and non-distracting.

This paper describes CALMsystem – an Open Learner Model environment with an integrated Conversational Agent for Learner Modelling. The inclusion of a chatbot provides learners with a flexible and intuitive method with which to query the system’s beliefs about their knowledge, explain or modify their own beliefs, answer questions about the topic being studied, and for the chatbot to initiate discussions.