A Reusable Interaction Management Module: Use case for Empathic Robotic Tutoring

Srinivasan Janarthanam, Helen Hastie, Amol Deshmukh, and Ruth Aylett
School of Mathematical and Computer Sciences
Heriot-Watt University, Edinburgh

Mary Ellen Foster
School of Computing Science,
University of Glasgow, Glasgow

Abstract

We demonstrate the workings of a stochastic Interaction Management and showcase this working as part of a learning environment that includes a robotic tutor who interacts with students, helping them through a pedagogical task.

1 Introduction

We demonstrate the workings of a stochastic Interaction Management (IM) module, show-casing a use-case where this IM has been implemented as a part of a robotic tutor who can sense the user's affect and respond in an empathic manner. The IM is designed to be re-usable across interactive tasks, using a scripting language. We use an Engine-Script design approach, so that the IM can be used as part of the conversational agent as well as user simulations.

2 An Empathic Robotic Tutor

An empathic robotic tutor was designed as part of the Emote FP7 project[1] to aid students aged between 10-13 years in two different scenarios: a map reading task and a serious game on sustainable development (Deshmukh et al., 2013). The architecture of the system is shown in Figure 1.

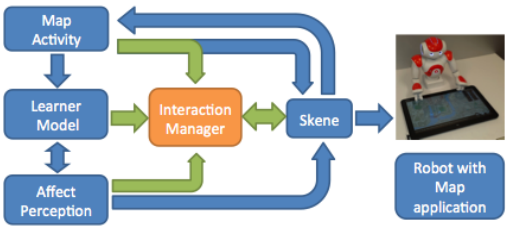

Figure 1: Architecture of the system

[1] http://emote-project.eu

3 Interaction Management

The IM can be seen as the central decision making body in the architecture. It is responsible for updating and maintaining the context of the interaction and also for deciding how to respond to the input received.

The module was designed in two parts: Engine and Script. The engine is a generic implementation of the functionalities of the IM while the script presents the details of the interaction task to the engine. The major advantage of keeping the engine and the script separate is the reusability factor: the IM can be reused for other interactive tasks by simply changing the script.

3.1 IM Engine

The IM Engine implements the Information State Update approach (Larsson and Traum, 2000), extended further to include stochastic behaviours and learning capability. When presented with an input, the IM engine executes a two-step process: update context and select next action. Both steps are driven by a set of rules specified in the script. All rules to update context whose preconditions are satisfied are executed. However, for action selection rules, the IM follows one of the following approaches:

1. First Fire: Execute the rule whose precondition is satisfied first. In this approach, the order in which the rules are placed in the script file is important.

2. Collect and Select: Collect all actions whose preconditions are satisfied and select one at random.

Action selection rules can be stochastic. Within a given rule there can be several actions, each set with a probability of execution, provided the preconditions are met. In addition, the IM can be set

to run as a Reinforcement Learning agent, to optimise its choice of actions for a given reward function, instead of randomly selecting one (i.e. in *collect and select*).

3.2 IM Script

The IM script defines context and behaviour of the Interaction Manager. It informs the IM Engine on how state update and action selection needs to be carried out for any given interactive task. The script also defines the state of the interaction, which is used to maintain the context of the conversation. The script is written in a formal language in the form of an XML document. The top level elements of the script is shown in Figure 2. These include the dialogue state and input specifications, state update and stochastic action selection rules (Figure 3).

```
<dialogueScript>
    <dialogueState>
        <var/>
    </dialogueState>
    <input>
        <var/>
    </input>
    <!-- STATE UPDATE RULES -->
    <stateUpdateRules>
        <rule>
            <precondition />
            <action />
        </rule>
    </stateUpdateRules>

    <!-- ACTION SELECTION RULES -->
    <actionSelectionRules>
        <rule>
            <precondition />
            <action />
        </rule>
    </actionSelectionRules>
</dialogueScript>
```

Figure 2: Dialogue Script (Top level elements)

The IM engine can manifest both as a conversational agent as well as a simulated user by using two instances of the IM engine with different IM scripts.

4 EMOTE Tutor

We combined both empathic and pedagogical strategies in a unique and natural way in order to provide an effective learning experience using the IM script. We will demonstrate how the above IM tool was used in the context of the EMOTE empathic robotic tutor. During the demonstration, we will describe the design of the dialogue states for the two scenarios, the modelling of input and trigger events and the implementation of update and

```
<rule id="user_answers_1">
    <precondition>
        <equals>
            <op1 var="userCommunicativeFunction"/>
            <op2 value="answerAttempt"/>
        </equals>
        <equals>
            <op1 var="responseCorrect"/>
            <op2 value="true"/>
        </equals>
    </precondition>
    <action>
        <assign>
            <assignee var="systemCommunicativeFunction"/>
            <assigner value="positiveFeedback" />
        </assign>
    </action>
</rule>
```

Figure 3: Example Action Selection Rule

action rules. We will demonstrate how the IM was used both as part of the tutor as well as for learner simulations. We will also explain the key features of the scripting language and show how new interactive tasks can be designed and implemented using the framework.

5 Conclusion

The IM has been evaluated in three different studies in May 2015. We propose to demonstrate the workings of the reusable stochastic Interaction Manager built to power human robot interactions. This will be done with a NAO robot and touch enabled 18" tablet running the learning scenarios. The conference delegates will be able to interact with the system and experience the empathic behaviour of the robot[2]. We also hope that the SEMDIAL community will be interested in using the IM tool as a part of their future projects.

6 Acknowledgements

This work was supported by the European Commission (EC) and was funded by the EU FP7 ICT-317923 project EMOTE. We would like to acknowledge the other Emote partners for their collaboration in developing the system described here.

References

A. Deshmukh, G. Castellano, A. Kappas, W. Barendregt, F. Nabais, A. Paiva, T. Ribeiro, I. Leite, and R. Aylett. 2013. Towards empathic artificial tutors. In *Proceedings of the 8th HRI conference*, pages 113–114.

S. Larsson and D. Traum. 2000. Information state and dialogue management in the TRINDI dialogue move engine toolkit. *Natural Language Engineering*, 6:323 340.

[2]Demo video of an early prototype of the system: `https://youtu.be/Rm7pE70KFn0`