Situation Creator: A Pedagogical Agent Creating Learning Opportunities

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Abstract. In a multi-user, real-time, and situation-based learning environment, the availability of enough and appropriate situations is crucial for success. In order to improve effectiveness and efficiency of learning, we develop a new type of pedagogical agent: situation creator. Such an agent intentionally creates specific situations in the shared virtual driving place according to users' performance information. We conduct a pilot evaluation and found that the situation creators significantly increase the number of situations that a learner can expect to encounter while using the system.

Introduction

In a typical training course with a simulator, an individual trainee interacts with the simulation system through a series of pre-defined situations. We adopted an alternative design approach to a car-driving simulation environment for learning. Rather than a single user going through a series of pre-defined driving scenarios, in our learning environment geographically distributed users can learn to handle various situations by virtually driving in a shared driving place in a way analogous to driving in the real world. If a user needs help or can not behavior correctly, an *coach agent* will provide a specific guidance to the user based on the user's experience concerning the current situation [1]. In addition, in order to increase the volume of traffic and traffic situations, we introduced *driver agents*, which head for random destinations on the roads and never consider the needs of learners. The problem of using randomly acting driver agents is that they are not highly effective in situation generation, although they make the virtual driving place more crowded.

In order to improve effectiveness and efficiency of learning, we develop a concept of *situation creator* [2]. Such an pedagogical agent intentionally creates specific situations in the shared virtual driving place according to users' performance information. In this paper, we present the design and implementation of a situation creator example and report the result of a pilot study with the system.

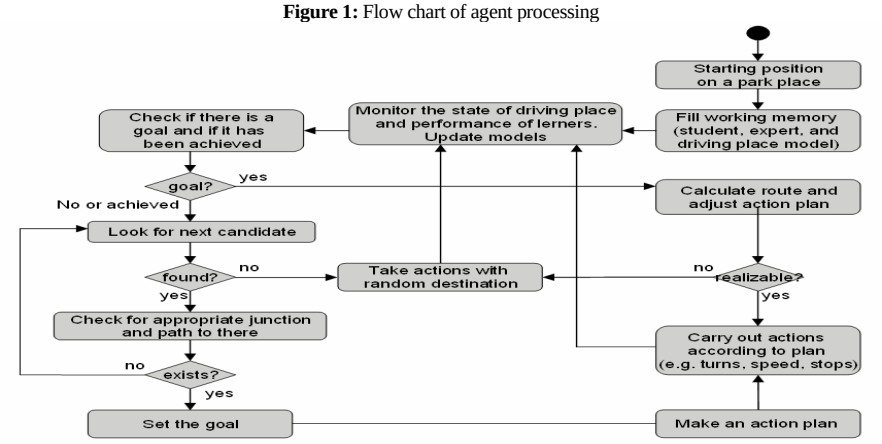
1. Design and Implementation of an Situation Creator

Figure 1 shows the algorithm for the situation creator example. Once it becomes active, it starts to automatically navigate from a parking place to the shared driving place where the learners practice driving. The situation creator then seeks cars controlled by learners. As long as there are learners in the shared driving place, the situation creator will try to create a learning opportunity for one of them. The agent first selects its "target" learner as the one whose car is closest to his own. It looks up in the learner model in which situations the

candidate needs training according to his/her past performance. If a realizable situation for the candidate can be determined, it means that the agent has a goal. Otherwise, the agent tries to consider the next candidate. Whether a situation is realizable or not depends on the current state of the learner's car (e.g., direction and velocity), the driving place (e.g., road network and an adequate location for creating the situation), and the state of the agent's car. For example, when considering a situation "junction without right of way", the situation creator looks for a junction on the prospective way of the learner. The junction has to fulfill the condition that the learner has to give the right of way to crossing cars. Thus it looks for a yield or stop sign. If there is such a junction on the way that the learner's car is driving, the agent checks if there is an appropriate route for himself to reach this junction just a little earlier than the learner. If all conditions can be met, the goal is determined.

Once the agent has determined a realizable goal, it tries to create the target situation. A goal is relatively stable. It maintains unchanged for a period of time until it is achieved or turns out to be unrealizable. To check this, the agent contineously monitors the road map and the states of the cars. E.g., if the learner does not head for the "target junction" anymore, or the agent is delayed for any reason so that the learner is expected to pass the junction before the agent can arrive, the situation creation is aborted and a new search will start. If the state of the environment changes unexpectedly (e.g., the learner's car slows down and is expected to arrive later) but the situation is still realizable, the agent can adjust its action plan (e.g., it slows down or even stops and to wait for the learner to arrive) and still create the target situation.

Figure 1: Flow chart of agent processing



2. Methods

In order to verify whether our approach of using situation creators to create learning opportunities for learners really works as intended, we have conducted a small pilot study. Since the effectiveness of the whole approach essentially relies on the prerequisite of agents being able to actually create the learning opportunities, we measured how many learning opportunities the situation creators could create, compared to the driver agents.

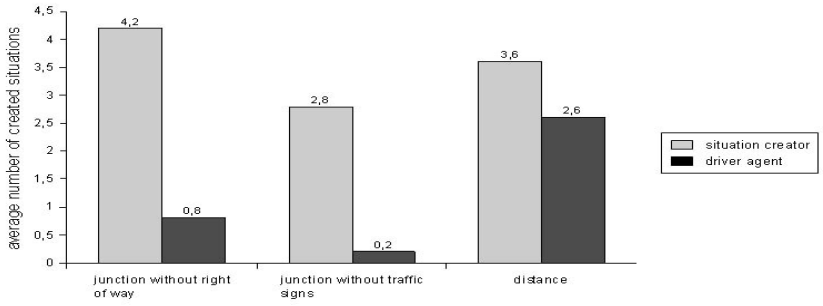
In our pilot study, the system has been used by 5 groups of 2 learners each. Each group used the system for two sessions of 10 minutes. In the first session we asked the groups to drive together with driver agents. In the second session we replaced these driver

agents with situation creators. In each session the two learners drove together with five agents. To analyze the results of the two sessions, the number of occurred situations was counted. In addition to this, we used agent log files to track how often a situation creator tried to create a situation for a particular learner, and whether it was successful in this or not. For our evaluation, we focused on three situations: "junction without right of way", "junction without traffic signs", and "safety distance to another car".

3. Results

Our data analysis shows two immediate results. First, the data confirms that without agents learners rarely encounter the three situations (of course, this heavily depends on group size and driving place size). The average number of situations created by learners was 0.8 for the junction situations and 1.7 for the safety distance situation. Both values are rather low considering the driving time of 10 minutes. Our second finding is that situation creators can solve this problem and that driver agents are not sufficient for creating complex situations. This is illustrated in figure 2, which shows the average number of situations created by driver agents and situation creators in the test sessions. Situation creators generated significantly more situations of all three types than the learners created themselves (t-tests, $p<0.01$ for all three situations). Also, situation creators generated significantly more situations of the two "junctions" types than driver agents ($p<0.0001$). In summary, the results of our evaluation show that the situation creators are effective and superior to driver agents.

Figure 2: Situation creation by agents



4. Conclusions

We have presented the design and imeplementation of a simple situation creator as an example that creates situations involving the right of way rules at traffic junctions. We conducted a pilot study. The evaluation results indeed confirmed that the situation creators generated much more learning situations for a learner than the random driver agents, and significantly increased the number of situations that a learner can expect to encounter.

References

[1] Miao, Y., Pinkwart, N., and Hoppe, U. (2006) A Collaborative Virtual Environment for Situated Learning of Car Driving. *Advanced Technology for Learning Journal*, 3(4), 233-240, ACTA Press.

[2] Miao, Y., Hoppe, U. Pinkwart, N., Schilbach, O., Zill, S., and Schloesser, T. (2006) Using Agents to Create Learning Opportunities in a Collaborative Learning Environment. *Proceedings of the 8th international conference on Intelligent Tutoring Systems.* p 798-800, Berlin, Springer.