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Creating a Model of an Operator of a Simulator Complex Using Commonsense Reasoning

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Abstract

The task of creating a simulator complex is an urgent task in specific professional fields. To improve training efficiency it seems reasonable to create an intellectual agent able to make the best decisions in every situation during the training and to explain why a certain decision was made. The explanation should be obvious and clear for a trainee. The paper proposes a way for creating an operator model. It is based on event calculus. The event calculus includes methods to solve the frame problem, the ramification problem and the qualification problem. It allows solving deduction, abduction and postdiction problems, so the agent based on event calculus is able to make its own solution and judge a trainee's solution. As an example of simulator complex, we used the simulator complex for marshalling yard operators.

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Keywords: commonsense reasoning, event calculus, simulator complex, intellectual agent

1. Introduction

Simulator complexes are widely used today because they significantly improve training process and efficiency. The main advantages of using simulators are safety of training process, cost-effectiveness, and availability of modelling abnormal situations. Advantages of using simulator complexes in flying trainings are reviewed by

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European Helicopter Safety Team (2013). De Winter *et al.* (2007) investigate effectiveness of driving simulators. Popovici and Marhan (2008) consider using virtual reality-based environments for learning and training. Virtual reality in simulator complex is also reviewed by LaValle (2016). Filtness *et al.* (2013) research how simulators help to acquire skills and review advantages and disadvantages of diving simulators.

The aim of this work is to create an artificial intelligent agent that is able to perform the teacher role in real-time learning systems using commonsense reasoning - a branch in artificial intelligence dealt with modelling the human ability to make presumptions about processes of daily routine based on experience. Various simulator complexes can be considered as examples of such systems. In the case when an experienced specialist plays the teacher role the training process rather strongly depends on the experience of the teacher. The skills the trainee obtained in the training process depend on the teacher's skills. Using an artificial intellectual agent makes the learning process be more effective due to possibility of an artificial agent to contain knowledge of many teachers. The motivation of the research is that the industry of simulator complexes is rapidly developing and there is a need for skilled persons in many professional fields.

The use of the commonsense reasoning allows designing a behaviour model that is very close to the one that is used by a real operator in his work. Real-time learning is characterized by a large number of events occurred during the training. Trainee's actions and various state changes of a modelled environment are expels of such events. Agent must respond to these events also in real-time. So, we chose the event calculus by Kowalski and Sergot (1986) to build an agent's behaviour model. This formalism has a sophisticated axiomatization that allows reasoning about actions of agents and changes in the world. It is based on a many-sorted first-order logic. There are three main sorts in the event calculus: the event sort, the fluent sort and the time sort. Events and fluents are expressed in terms of domain sorts.

The event calculus is used in various fields of artificial intelligence. Cicekli and Yildirim (2000) review the use of the event calculus in workflow modelling applications. A lot of works deal with using event calculus in natural language processing. Lambalgen and Hamm use event calculus to represent semantics of language. Natural language understanding systems are considered by Ram and Moorman (1999). The use of the event calculus for robot perception is discussed by Shanahan (1999, 2005). Yolum and Singh (2004) use event calculus to create payment protocol application. Articles that deal with the event calculus within simulator complexes were not found.

This article considers possibility of using the event calculus for creating a behaviour model of a tutoring agent. First, we introduce auxiliary predicates and axioms needed to create the model. Next, we discuss the braking position agent for the simulator complex for marshalling yard operators. This training complex was developed in Siberian Transport University in association with Novosibirsk State Technical University and SoftLab-NSK Co.Ltd.

2. An intelligent tutoring agent based on event calculus

The main purpose of the tutoring agent is knowledge checking of a trainee. The agent must be able to detect mistakes and to evaluate the trainee training based on the presence and severity of mistakes. In addition, the agent must be able to explain what exactly the error was and how it can be corrected. The use of event calculus allows us to make such an agent. Error detection is performed by comparing a solution proposed by the trainee with an agent solution. Event calculus supports solution of abductive tasks. It make agent able to consider correct trainee solution that is different to agent one but leads to the same result. Having a correct solution allows agent to show how to act in very situation. The fact that the main element of this calculus is an event makes an agent possible to respond flexibly to trainee actions, in case of an action is regarded as an event.

To identify mistakes of the trainee the tutoring agent needs to offer its own solution to the problem of the training and then compare it with the trainee's solution. This solution does not have to be perfect, but it certainly should be correct. The priority task is to create a world model for the tutoring agent in which he will search a suitable solution. Let us introduce some auxiliary predicates which were used in our model.

Trainee actions are often a response to an event occurred during the training. In other words, some events, both dependent and independent on previous actions of the trainee, can trigger new actions of the trainee. Event calculus allows formalizing such cases in the following form: