Towards a Composition Tool for Personalised Simulations

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Abstract. Simulations provide highly interactive experiences in which users can learn a variety of skills and competencies in a situated and active learning environment. Pedagogic scaffolding within simulations has typically been an after taught of the design process. To promote "serious learning" in simulations, this pedagogic scaffolding must be an implicit part of the design process. To support pedagogic diversity in simulations, a further requirement for adaptivity is introduced. This makes the existing simulation composition process even more cognitively complex. This paper illustrates and describes a composition tool for designing and implementing dialectic based simulations.

Introduction

Simulations are widely used and although there is no *de facto* definition of what a simulation is they are generally accepted to be a model of a real world environment, normally with the facility for a user to interact with that environment [1]. The focus of this paper is with educational simulations, in particular dialectic based simulations. These are simulations that teach the learner social skills and communication skills through interactive dialogue. The major advantage in using these simulations in education is their pedagogical benefits in achieving certain types of learning outcomes, such as those associated with situated or social constructivist learning scenarios [1].

The focus of this research is not only to provide a framework and composition tool for designing pedagogically sound simulations but for them to also be adaptive to the learners needs; for the simulations to become personalised to the learner making their learning more efficient [2] by adapting to, for example, their role, their prior experience or their competence levels. In the past, simulation adaptivity has been embedded within the content of the simulation such as simulations used with ITS (intelligent tutor system) [3]. The progression of adaptive hypermedia has led to the application of the adaptivity *across* the content, example Multi-Model Metadata Driven Approach to Adaptivity [4]. The key for adaptive educational simulations is to also apply adaptivity across the models of the simulation rather than embedding the adaptivity technology within the simulator. Due to several complexities, applying adaptivity to simulations in this manner has never been achieved.

The core obstacle to the mainstream adoption of adaptive simulations is the complexities of designing and composing the simulations. This problem is twofold; 1) the composition of the simulation, which takes up considerable time and resources [5], and 2) the application and representation of adaptivity across the simulation. The major difficulty in the composition of simulations is the designing of their knowledge models which is the back-end logic upon which a simulation will operate. Adding to the complexities of designing the knowledge models is the need to express adaptivity across the models. In this paper we examine several aspects of composing personalised simulations, with a particular focus on adaptive dialectic based simulations.

Simulations in Education

An educational simulation can be described as a computer based activity which makes use of a model to represent a process, event or phenomenon, which has some learning significance [6]. Although the benefits of eLearning are well documented [7], there are many advantages that simulations have over other eLearning strategies and education in the real world [8] [9] in the context of situated and higher order skills and competencies. Educational simulations can be divided into two categories based on the educational objectives they wish to achieve; to teach *about* something or teach *how to do* something [8]. The goal of the "teach *about* something" educational simulation is for the user to interact with a representation of what they are learning about. In the second category of educational simulation, to "teach *how to do* something", the goal is for the user to learn a particular skill set through the simulation of that real world interactivity

Some of the advantages in using simulations include reduced cost, safety to the user, simplification of the real world, efficiency and flexibility [8]. Their main advantage, preceding all others, is the effectiveness simulations have in teaching. It is in fact argued that serious learning only occurs if it takes place in the social and physical context in which it is to be applied [10]. Simulations, therefore, support and scaffold the learner in constructing their own perceptions of what they are learning, by putting the learner in control to learn 'by doing'.

However, one clear disadvantage of educational simulations is the complexity of their construction; a process which is further complicated by the addition of adaptivity.

Key Requirements for Compositing Personalised Simulations

Through analysis of the state of the art [11] and through initial design meetings with experts in dialogue composition, two core criteria were identified as key to making the composition tool of this research a success *Dialectic Based Simulation* and *Adaptive Dialectic Based Simulation Application and Representation*. These two areas are now detailed further.

Dialectic Based Simulation

The key challenge of constructing a dialectic based simulation is the representation of dialogue. This is required to be intuitive for the user and expressive enough to capture the complex knowledge models needed to generate simulations. To achieve this, it is necessary to decompose a communication scenario into its basic elements. **Communication Scenario:** a definition and description of the dialogue type, e.g. interview. Also includes the role of the learner within the dialogue and role of the person to be simulated, e.g. interviewer and interviewee. The scenario also details the dialogue circumstances, such as where it might take place, e.g. a doctor's office. Associated with each scenario are one or more dialogues. **Dialogue:** a representation of the semantics and flow within and across a communication dialogue. This can consist of a collection of semantically interrelated dialogues and/or dialogue elements. **Dialogue element:** is either an entire dialogue in itself (a sub-dialogue) or it contains a one-to-one mapping of a dialogue *'statement'* and a corresponding dialogue *'response'*, so each *'statement'* has one *'response'*. **Relationships between the dialogue elements:** a directed graphical representation of how dialogues and dialogue elements related to each other.

In graphically representing dialogue and dialogue elements and the relationship between them, one tends to produce a graph [12]. For simple dialogues these graphs tend to be quite small and manageable. However, as scope of the dialogue increases, the graph can become very difficult to visualize and manage. Several key challenges for composing dialogues in this manner revolve around navigating, searching and developing within these large and semantically rich dialogue spaces.

Adaptive Dialectic Based Simulation Application and Representation

The second key requirement in the composition tool is to support the application and representation of adaptivity across the dialogue model to support personalisation. Due to the complexities of representing adaptivity, it is modelled separately from the dialogue model [13]. The first and most important issue to address is how adaptivity should be applied to the dialogue models. Examining the structure of the dialogue model there are two areas in which adaptivity is most beneficial, Dialogue Element Adaptivity and Dialogue Sequence Adaptivity (similar to Adaptive Presentation and Adaptive Navigation in traditional Adaptive Hypermedia).

Dialogue Element Adaptivity (comparative to Adaptive Presentation in AH) is adaptivity at an elemental level, where each dialogue element contains its own unique information. While this information remains fixed, the manner in which it is presented is adaptable, allowing each individual dialogue element to be communicated in several different ways. As described in the previous section a dialogue element can contain a *'statement' and 'response'*, these could for example be *"How are you?"* and *"Yes, I'm fine"*. There could then be several different types of *'response'* associated with this dialogue element, each conveying the same message but communicating it in a different manner. *"Yes, I'm fine"* could then be communicated is several different ways, such as angrily, happily or indifferent. The element could then be adapted so its *'response'* as suited to the situation/context of the simulation.

Dialogue Sequence Adaptivity (comparative to Adaptive Navigation in AH) is adaptivity over an entire scenario based on the inclusion of certain topics or learning outcomes that are to be covered by the simulation. These topics relate to certain sections of the dialogue space and are only included if the adaptive sequencing indicates so based on the type of learner. Topics not to be included are 'pruned' from the dialogue space. The flow of a simulation is the progression of the dialogue from one element to another; it is this flow that sequence adaptivity affects. For example, in a simulation communication scenario where the learner is a lawyer, cross examining a simulated witness. As part of the simulation, one of the learning outcomes to be included is for the lawyer to ask the witness about their medical history. The sequence of the simulation would then be adapted so as to include dialogue on the witnesses' medical history.

Adaptivity needs to be represented within in the composition tool to support the user in describing the kind of adaptivity they wish the simulation to support and can be done so in a very straight forward manner. The graphical view of the dialogue and nature of adaptivity to be asserted on individual elements and sequences of elements could be as simple as the dialogue elements appearing in a different colour or as a different shape. From a usability perspective, these approaches are currently under evaluation.

Design of a Composition Tool for Personalised Simulations

The design of the composition tool, as seen in Figure 1, is based upon the procedure used in creating a dialectic simulation. This procedure is now described along with corresponding composition tool component. The first step is for the simulation designer to describe the communication scenario, provided for with a text editor interface. Next, the learning outcomes are defined by the designer, this is completed with a graphical list view and editor. This is followed by a description of the pedagogical approach, which again is provided for in the composition tool with a graphical list view and editor. The final step is for the designer to design the dialogue. As this is the most cognitively complex step it is now described in more detail.

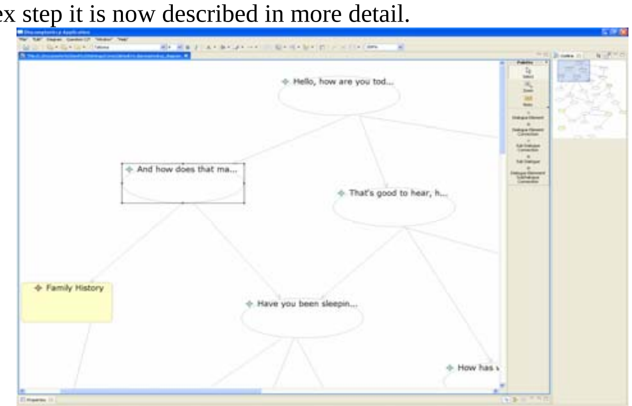

Figure 1: Composition Tool for Dialectic Based Simulations

The main component for the design of the dialogue is a canvas upon which the dialogue space is represented, the largest window in Figure 1. There is also provided a palette, beside the canvas on the right, from which the user can choose their different dialogue elements (nodes) and relationships between them (edges). Along with dialogues, elements (displayed as ellipses on the canvas) there are sub-dialogue elements (rounded rectangles), which contain sub-sequences of the dialogue. The properties of the tool are accessible through double clicking of the element. Sub-dialogues allow for encapsulation of sequences, making it easier for the user to navigate the large data space constructed. Other tools provided for navigation of these spaces include; zoom in/out; search; and a map. The composition tool was implemented with Eclipse [14] and an array of plug-ins, including GMF, EMF, GEF, SWT and RCP.

Conclusions and Future Plans

Simulations are a very effective teaching tool, yielding a very high transfer of learning and allowing the user to be educated in a safe environment. In fact one of the main reasons to use simulations is to teach practical skills whereby the user can practice a skill set repeatedly without having to fear the consequences that would be present in the real world.

What is proposed in this paper is to not just take advantage of the benefits that simulations yield but to also employ personalisation to maximise the resources of the simulation and present the learner with a tailored learning experience. Through research, the core challenges for personalised simulation have been identified and a research plan for addressing them formulated.

As the tools being developed are highly user driven, they must be intuitive and follow the design process outlined. It is recognised that each component in the composition tool must support this procedure. For the initial evaluation strategy, to be completed this month, a group of users are asked to perform certain tasks using the composition tool described in this paper. While these users are not technically inclined, they are experts in the area of teaching communication skills. The tasks they are to perform include describing a scenario, defining learning outcomes and designing, implementing and scripting content for a communication scenario. Analysis is to be performed on the simulation models produced and questionnaires completed by the users.

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