Storyboarding Serious Games for Large-scale Training Applications

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Abstract: Beyond the limits of conventional media such as motion picture and theater dominating the passed centuries, storyboarding means the design of interaction to meet anticipated affective and effective human experience. Storyboarding plays a key role in research and applications in areas such as interactive digital storytelling, but in e-learning, in general, and in game based learning, in particular, there shows an enormous deficiency. There is abundant evidence for the need of establishing storyboarding in the design of game based learning. Large-scale training applications reaching thousands of trainees in operation are particularly demanding. A certain game developed and implemented for training of staff in disaster management demonstrates the inevitability of storyboarding as a key technology of design supporting adaptive system behavior, in particular. Storyboards are digital objects within a systematic design and development process. Storyboarding supports the completeness and correctness of the design. Visual features of a storyboard allow for checking different balances such as the one between learning about a human learner and adapting to the learner's individual needs, desires, and preferences. Furthermore, storyboards allow for an intuitive editing of the interaction scenario.

1 THE AUTHORS' POSITION

Digital games to be deployed for realistic large-scale learning and training applications are highly complex digital systems. The manifold of possible interaction sequences is enormous; the storyboard in use throughout this paper, just for illustration, contains 13 006 893 219 840 paths from the start node to one of the end nodes.

Games purposefully designed and implemented challenge the human imagination of forthcoming sequences of human-system interactions and their potential points of branching or confluence. Storyboards are tools to represent anticipated experiences (Jantke and Knauf, 2005).

Consequently, one should imagine storyboarding investigations to play a certain role in educational research and reflections thereon. Far from it, just for illustration, the whole proceedings of the last CSEDU conference contain only a single paper dealing with storyboarding (Jantke and Knauf, 2012) and one more paper using the term (Colasante and Lang, 2012).

In response, the authors present this submission to advocate storyboarding by means of a large-scale training application currently used by the German agency for civil protection and disaster management.

2 TRAINING OF PREPAREDNESS FOR DISASTER MANAGEMENT

The German Federal Agency for Civil Protection and Disaster Management (German acronym: BBK)–an Agency of the Federal Ministry of the Interior–in its academy located near Ahrweiler is providing training to more than 1,000 people of staff per year to be well-prepared for any type of natural or technical disaster.

The present authors provide software modules for game based training to the BBK's academy.

It is difficult to predict, especially the future, is a saying ascribed to the Danish physicist Niels Bohr. This applies to forthcoming disasters, in particular.

Staff members of crisis management groups can not be confronted to all possibly forthcoming details. In addition to some large amount of knowledge and to the acquisition of behavioral skills and patterns, staff needs to familiarize with acting in the conditions of a crisis. Repeated game play in varying situations is an appropriate methodology of developing preparedness.

The aim of this paper is to advocate the authors' position that storyboarding is a valuable technology of serious games design and implementation and to convince the readers by means of a certain practically relevant serious game for real training operations.

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3 STORYBOARDING FOR PURPOSES OF EDUCATION

This paper uses storyboarding as a technology, but does not aim at anything such as an introductory course to storyboarding. The authors rely on the ideas introduced by (Jantke and Knauf, 2005) and confine themselves to those notions and notations needed for storyboarding game-based learning. Recent work on storyboarduing digital games such as (Jantke and Knauf, 2012), e.g., is worth some comparison.

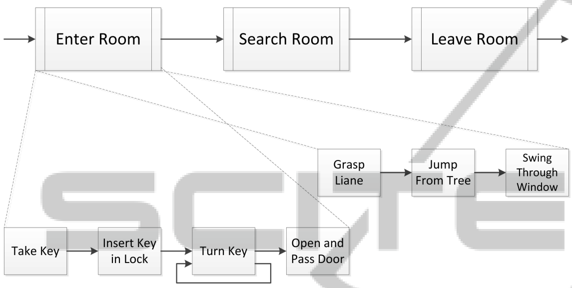

Figure 1: Cutout of some storyboard of a digital game showing two alternative graph substitutions for one episode.

Storyboards are hierarchically structured graphs. The composite nodes are named episodes, whereas the atomic nodes are named scenes. Composite nodes may be subject to substitution by other graphs. Atomic nodes, in contrast, have some semantics in the underlying domain. They may represent documents such as videos, pictures, or text files in any format, but they may also represent some activities of human learners, teacher, tutors, or those actions performed by certain digital systems. The usage of composite nodes in a graph allows for the representation of anticipated experiences on different levels of detail.

Just for illustration, fig. 1 above is showing two alternative substitutions for an episode. The graphs for substitution on display contain only scenes which have a particular operational semantics. In general, subgraphs may also contain episodes.

Graphs may contain branches and loops, where there are different branches for indicating alternatives, multiple choices, parallelism of action, and the like.

Every storyboard specifies a usually rather large number of paths through the storyboard describing, for instance, varying experiences of game playing or different ways of learning.

The art of storyboarding is to anticipate and to specify in detail the manifold of forthcoming actions including human-computer interaction. It takes into account off-line activities as well as human-human communication and physical interaction.

4 STORYBOARDING FOR EDUCATIONAL ADAPTIVITY

There is no need at all to advocate adaptivity on a conference of computer supported education, because every good teacher is used to adapt to the needs of his students. There are excellent publications in the field such as (Brusilovsky, 1996), (Brusilovsky, 2001), and (Brusilovsky and Maybury, 2003).

Adaptivity came first up in natural language processing research (Perrault et al., 1978) and found some consolidation in the middle of the nienties of the last century (Oppermann, 1965).

Nowadays, adaptivity is widespread and opinions vary largely. Many authors prefer a low expectations approach seeing adaptive hypermedia systems as anything *which reflects some features of the user in the user model and apply this model to adapt various visible aspects of the system to the user*, as expressed by (Henze and Nejdl, 2004), for instance.

Largely independent and unrelated research work in educational and developmental psychology, in particular, and cognitive science, in general, suggests deeper modeling approaches like, e.g., *Conceptual Change Theory* (see (Carey, 1985), (Carey, 2000), and (Thagard, 2012)).

Taking such background research of adaptivity into account, apparently user modeling may be seen as theory induction (Jantke, 2013). A system being adaptive is inductively building some theory about its current user's needs and desires. The digital system's behavior, at every moment in time, is based on the recent state of the hypothesized theory.

This view does perfectly apply to all the well-established learner models, user model, and player models currently in use.

For demonstrating *storyboarding serious games* in use in *large-scale training applications*, the authors have chosen the learner model of (Felder and Silverman, 1988) which meets the requirements of learning to act in the focused application domain.

After the two short introductory sections on the present page of the position paper, the following pages will contain detailed material of the authors' application project.

When certain user profiles are on display, they represent Felder-Silvermann-based theories on some current learner. The storyboards report the authors' design process in which human playing and learning experiences are anticipated.

The storyboards are represented in XML (more precisely: RDF) such that the running system works by interpreting the specified interaction opportunities.

5 PRACTICAL STORYBOARDING OF STAFF TRAINING TOWARD DISASTER MANAGEMENT PREPAREDNESS

This section is demonstrating the authors' position by means of a report about some relevant application.

The TRAST system developed for the German Federal Agency for Civil Protection and Disaster Management has been implemented in UNITY as a 3D game module. For major roles in a crisis management staff, storyboards like the one on display in fig. 2 have been developed. It is not intended to read any of the inscriptions in the storyboard graph below, but to get an impression of some storyboard as a whole.

The rectangular nodes represent particular scenes in the game story. A node includes some actions activated by the system when the game state is reaching the node. Actions may be any atomic system behaviors such as showing a text message dialog, showing some pictures, or setting up an interaction button on

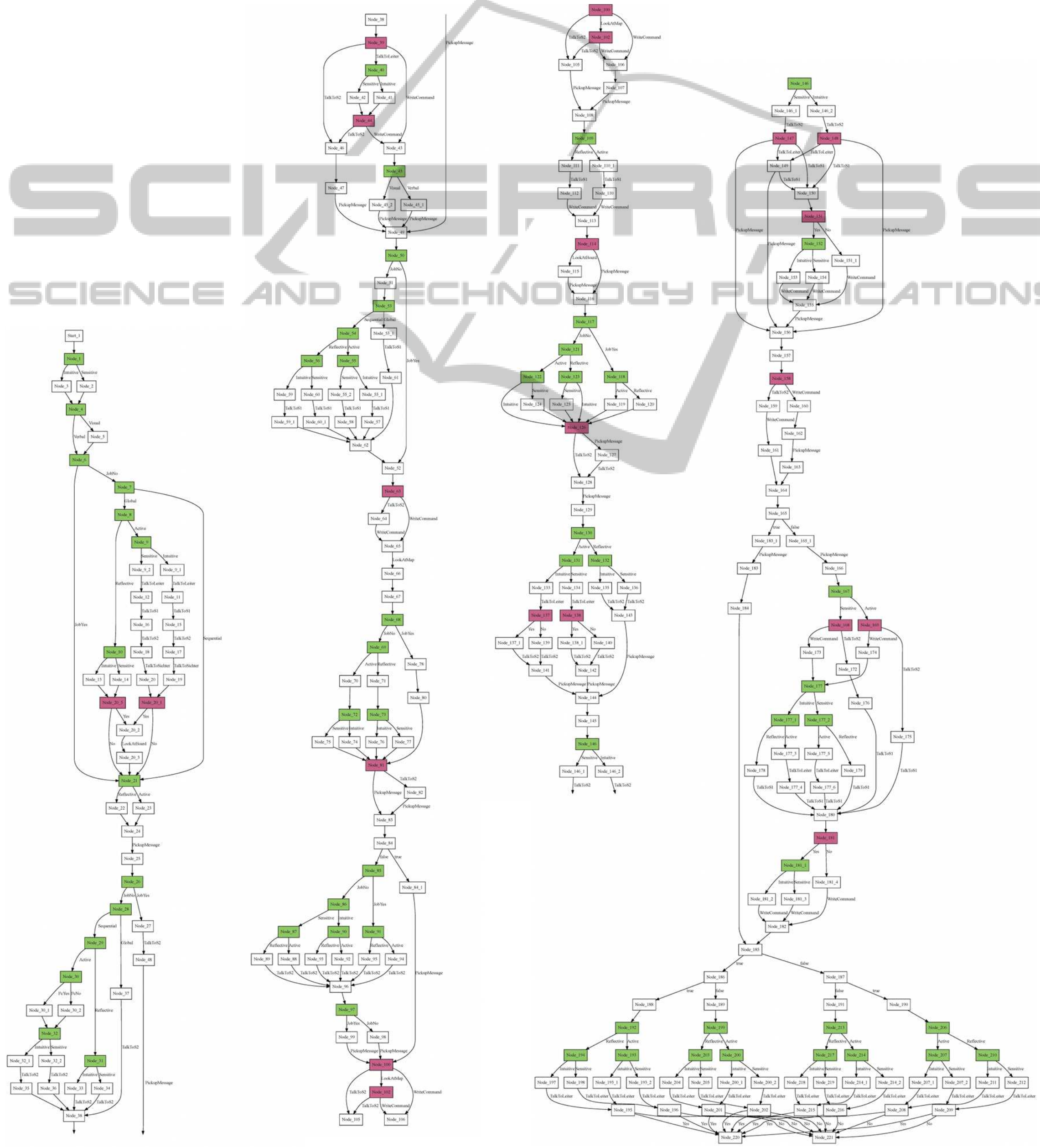

Figure 2: Storyboard of one of the seven staff positions in the training system TRAST; storyboard cut into four pieces.

an object in the game. Nodes are connected with transitions (represented as arrows in the figs. 2 and 3). Some transitions have labels which indicate names of

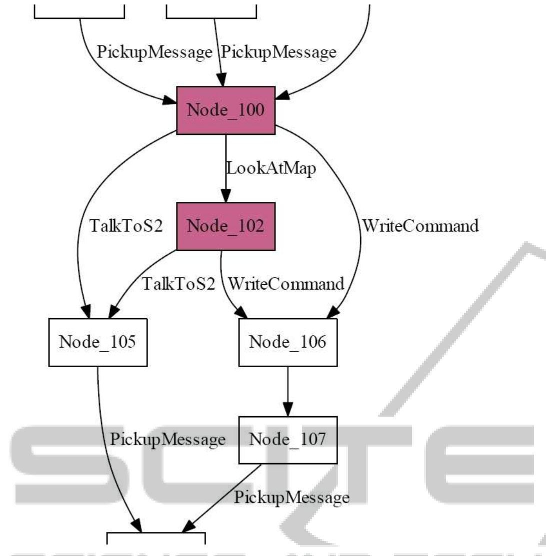

Figure 3: Cutout of the TRAST storyboard at node 100.

events fired by the system according to users' choice in the game play or their profiles. When the system detects an event in a specific node, the system selects the transition which is labeled with the corresponding event name and takes the transition to proceed.

Figure 4: Moment of the learner's choices when playing.

Due to the restricted space within this position paper, the authors confine themselves to an illustration of the storyboard's relevance for implementing the key feature of adaptivity.

At all nodes colored in red, the players have choices which are interpreted by the digital system and reflected in the user profile. The nodes colored in green include different system behaviors according to the user profile.

The scenery on display in fig. 4 shows the system's interpretation of the storyboard cutout in fig. 3. In scene 100, the learner has three different choices to act indicated by orange buttons (from left to right): Writing a message, talking to the staff member next to the map, inspecting the map.

The player's choices are interpreted as preferences and used for another step of user profile induction.

The following picture illustrates different changes of some user profile in dependence on the observed player's behavior.

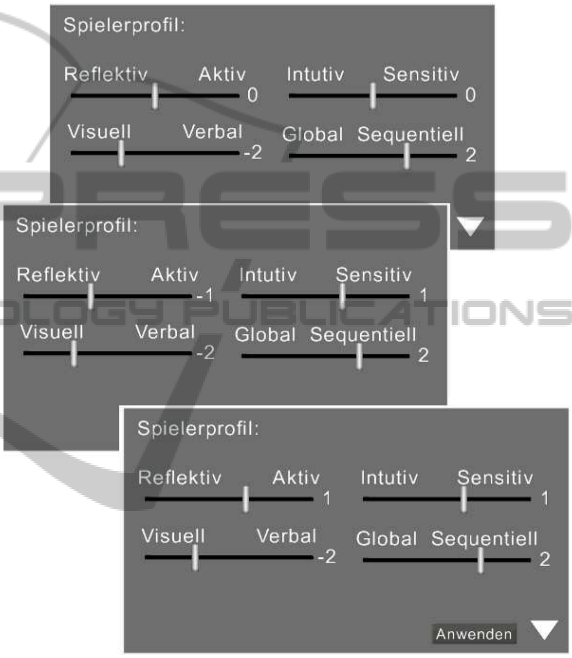

Figure 5: FELDER/SILVERMAN Theory Induction.

Assume the player did arrive at the scene denoted by node 100 having a profile in the background which is shown by the topmost configuration on display in fig. 5. When players prefer to write a message, profiles change to the one displayed in the middle. When talking to the staff member at the map instead, the profiles change to the one displayed at the bottom of fig. 5 because an "active" person tends to prefer conversation with others.

According to the user profile, the system behaves differently in the green nodes. For example, for a player modeled as a "visual" person, as it is assumed that such a person prefers visual representation to text-based representation, the system shows more pictures or videos for giving information to the player.

The visual appearance of storyboards supports didactic design as well as goal-oriented adaptivity. The location and distribution of branching points, where theory induction is triggered, may easily be controlled as well as the location and distribution of points where the system behaves adaptively. By means of direct modifications in the storyboard, alternatives may be easily checked.

Storyboards form a suitable basis for interdisciplinary discourse, because domain specialists, educational specialists, and system developers may take the same document as a basis for inspection, for asking question, for making proposals, and the like.

Note that the RDF storyboard is not only a specification of forthcoming playful interactions, but at the same time an implementation of the system's part in the interaction. This system is reading in the storyboard and acting accordingly. This bears potentials for further extensions of adaptive behavior in practice.

6 CONCLUSIONS

The project TRAST reported in the present paper is a proper application case of game based learning in use for quite serious purposes of learning and training.

When projects of computer supported education are under development, a large number of aspects have to taken into account and a wide spectrum of needs and desires have to be satisfied. There arises abundant evidence for the need of planning.

Storyboarding is the methodology advocated to plan the rich manifold of potential human learners' experiences.

In particular, the authors advocate throughout the present paper the position that the developed storyboards are not only design documents, but may serve as components of the digital system anticipated.

If this is the case, the crucial problem of transforming storyboards into some semantically correct implementation disappears. The digital game system is reading the storyboard and is interpreting the flow of control and data specified by means of the graph structure. Digital storyboarding is advantageous.

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