Facilitating the Emergence of Educational Stories

Using emergent stories for pedagogical purposes

Rui Figueiredo, Ana Paiva [a] and Ruth Aylett [b]
[a] *Instituto Superior Técnico and INESC-ID*
Av. Prof. Cavaco Silva, IST Taguspark
Porto Salvo, Portugal
rui.figueiredo@tagus.ist.utl.pt,ana.paiva@inesc-id.pt
[b] *MACS, Heriot-Watt University, Riccarton*
Edinburgh EH10 4AS, United Kingdom
ruth@macs.hw.ac.uk

Abstract. This paper describes the narrative module used in the interactive learning environment called *FearNot!*. In *FearNot!* the agents are autonomous and therefore produce narratives that emerge through the interactions between themselves and the learner. We describe the problems that arise with this kind of approach and a way to tackle them, namely through the use of a narrative module that is responsible for ensuring that the emerging stories produce an educational message.

Keywords. Autonomous agents, synthetic characters, interactive storytelling, emergent narrative, interactive virtual environment

1. Introduction

Stories are not only part of us, of our memories and our lives, they also give us interpretations of our world, make us learn, and provide us the context for the events we constantly observe in our environment. That is why many learning situations are not only attached to stories, but promoted by them. In particular, when learning brings about changes in attitudes, or the development of social skills, stories are seen as a good and alternative way to promote such changes in behavior.

Educational role-play is a particular use of stories in education where social interaction is used as the stimulus for challenging existing beliefs [2] and can result in significant behavioral changes [11] making it highly relevant for social and emotional learning [3,4]. The basic premise of educational role-play is that it is easier to empathize with how another person might feel under certain circumstances if one has experienced something similar, even symbolically as part of a role-play [5].

As educational role-play is difficult to organize in a classroom (the students need to have acting skills in order to create and maintain the willing suspension of disbelief), its use in educational software might be a valuable alternative. The use of intelligent synthetic characters, in 3D environments, have been explored by several research

groups [12,13,14,8,10,9] as a way to provide the necessary suspension of disbelief to create the engagement needed to make the stories valuable experiences.

Because role-play is improvised rather than scripted, a virtual role-play system can not be achieved by branching narrative structures. The story should not take predefined paths but be emergent [15] in a supervised way, in the direction of an educational message.

To achieve this, besides the intelligent synthetic characters' capability to interact with the learner, there has to be a narrative module that, given enough information about the story, can choose the right episode that will compose each virtual role-play scene. Each of these episodes can be thought of as a part of the story, where the learner can perceive a set of events and their consequences.

This paper describes this narrative module, composed of a facilitating agent, named Story Facilitator, whose role is inspired by the facilitators of educational role-play. This narrative module was applied to *FearNot!* [16], an educational interactive environment developed as part of the EU-funded project VICTEC (Virtual ICT with Emphatic Characters) and now being further developed in the follow-on project eCircus (Education through Characters with emotional-Intelligence and Role-playing Capabilities that Understand Social interaction).

2. FearNot!

FearNot! is an Interactive Virtual Environment (IVE) developed for education against bullying behavior in schools. Bullying behavior is characterized as "a repeated action that occurs regularly over time, and usually involves an imbalance in strength, either real or perceived" [1] and may involve hitting, kicking or punching (direct bullying), or, in relational bullying, social exclusion or malicious rumor spreading. FearNot! offers a safe environment for individual children where they can witness (from a third-person perspective) bullying situations in virtual 3D scenarios. Each child takes the part of an *invisible friend* of the victimized character, discussing the problems that arise and proposing coping strategies. This advice influences the actions of the victim in the next episode.

Given that the child must be able to see that their advice influences the victimized character, and given the high branching factor, an emergent approach was a good choice. A scripted system would limit the child's interaction and pose serious scaling problems in authoring. Emergent narrative requires that a story is dynamically generated by the interactions between different characters and the causal relationships between its different elements. Thus, episodes are unscripted and result from the actions, interactions and reactions of autonomous agents.

To make such autonomous agents believable and empathic, we focus on two characteristics raised at an early stage by traditional animators and often explored by researchers working on synthetic characters: emotional expressiveness and personality. Personality and the character's goals associated with it are crucial in achieving pedagogical objectives in emergent narrative because of their role in producing agent behavior, allowing the facilitator to build an overall narrative by choosing the right set of characters and situations. Mechanisms were developed supporting models of agent emotions and personality, that can be used within characters to influence their reasoning and actions.

(a) Luke bullies John (b) The learner interacts with John

Figure 1. FearNot! application

FearNot! possesses such agent architecture and we have used it to create several bullying scenarios. Figure 1 illustrates a bullying situation (Fig. 1(a)) and the learner giving an advice to one of the characters (Fig. 1(b)).

3. Narratives with autonomous agents

FearNot! uses synthetic characters with reasoning capabilities and that are emotionally expressive [6]. The agents that control these characters take into account emotions in their reasoning process. The model of the agents is based on the OCC theory of emotions [7], where emotions are defined as valanced (good or bad) reactions to events.

As we use these agents as role-play characters we have to define their role. To do this we define a set of goals and properties, that have to be consistent with the character's personality. For example, if we want an agent to have the role of a bully we create several bullying goals, for instance throwing the victim's books, hitting the victim, calling names, etc. Each of these goals will have a set of preconditions that state when the goal should be active. In the case of the bullying goals they will have the precondition that the victim has to be weaker. This kind of information about the characters is described using properties (the bully has a *strength* property value which is higher than the victim's). The victim will have goals such as making friends, asking for help, etc.

After we have all the characters' roles defined, we can create several stories just by placing characters together. For example, if we place a bully character with a victim character (that is weaker than him), the bully character will build up a plan to bully the victim. For example, throwing the victim's books to the floor, if it has such an action available, and this action achieves the goal of bullying.

If we have competing goals, and if we allow the learner to influence the characters by giving them advice that change their behavior (for instance, the learner may advise the victim to fight the bully back, which makes that goal active for the victim character), we can achieve a high degree in story variability. However, this variability must produce consistent stories that carry a meaningful educational message.

This consistency is achieved by a good definition of the characters' roles, and by dividing the story into several episodes that can be combined together, and where each

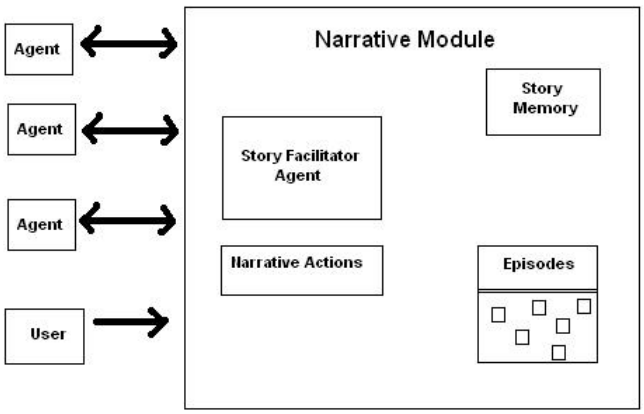


Figure 2. Narrative module

episode represents several possible situations involving the characters and/or the learner. Prior to creating the episodes, the agents's goals have to be carefully crafted to ensure they behave in a way that is consistent with their role in the story.

The entity that manages the episodes by choosing them and deciding when each should end is an agent named Story Facilitator that belongs to the narrative module used for *FearNot!* (Figure 2).

The narrative module is composed of the Story Facilitator agent, a set of episodes, narrative actions, and the story memory.

The Story Facilitator's (SF) role is to choose the right episode depending on the events that have previously occurred in the story. The selection is based on the information stored in the story memory.

Each time the SF chooses a new episode it will load the scenery (for example, a classroom), place the items for that scenery (some books, that have a property indicating they belong to a particular character) and finally place the characters (for example two characters, one named *Luke* which is a bully, and another named *John* that is a victim). After this setup phase, the SF monitors the agents, updating the story memory with new events that correspond to actions the agents perform, and properties of the agents or items that might change as a consequence of the agents' actions. When the SF detects that an episode should end, it selects another one and the process continues until the story ends.

3.1. Story Memory

The SF's choices depend on the state of the story memory, which is composed of *story events* and *properties* that might refer to items or characters. Each time an agent performs an action, a story event is created and stored. This story event will describe the action, how it was performed, and by whom.

The properties refer to attributes or states of the characters and items. For example, *John* could have a property called *hurt* that, when true, would indicate that he was hurt. The item *book* could have a property *location* whose value would be the books' location on the scenery.

Because the learner is represented by an (invisible) character, capable of performing actions and with properties that describe him/her, the other characters will perceive the

Name	A unique name that identifies the episode
Set	The set is the location on the virtual environment where the events of this episode will take place.
Characters	The characters of the story are defined through a set of properties like their name, position on the set, and all the properties the author may want to include to describe the character.
Preconditions	The preconditions are a set of conditions that specify when the episode is eligible for selection.
Goals	Characters' goals that are communicated to the agents in this particular episode.
Triggers	A trigger is a condition that when satisfied will cause the execution of a set of *narrative actions* (the concept of narrative action will be described later).
Finish Conditions	The finish conditions are a set of conditions similar to the preconditions that when satisfied indicate that the episode is finished.
Introduction	This section of the definition of the episode is composed of a set of *narrative actions*.

Table 1. Elements of an episode

learner's actions the same way as if it was another synthetic character performing them. Also, because the actions will generate events that will be stored in the story memory, the SF's choices will be influenced by the learner.

3.2. Episodes

An episode represents a set of possible situations played by the characters that are part of it. The various elements that compose it are listed in Table 1.

The key elements of the episode are its preconditions and its finish conditions that indicate when it can be selected to start and when it should end, respectively.

The preconditions of the episode are tests to the story memory. For example, we might want a certain episode to be selected only if *Luke* has thrown *John's* books to the floor and *John* has started crying. Also, the finish conditions indicate when the episode should end, for example after *Luke* makes fun of *John*. These conditions can contain tests to the learners' actions, for example, an episode can have a condition that states it can only be selected if the learner has advised the victim to fight back.

There are situations where several episodes will have their preconditions satisfied. This indicates that each one of them can be selected as the next episode. The criteria used to decide which one is the best choice is flexible. In *FearNot!*, we choose the one that is most closely linked to the learner's advice to the victim. For example, if the learner advises the victim character (*John*) to talk to a friend, the SF gives priority to the episodes where *John* is with another character that is his friend.

Insert Character	This action allows the author to insert a character in the current episode.
Insert item	Similar to the *Insert Character Action* but applied to items.
Narrate	Allows the author to write text to the interface
Change Story Mode	Changes the interface.
Act for Character	Makes a specific character execute an action specified by the author.
Remove item	Removes an item from the set.
Remove Character	Removes a character from the set.

Table 2. Narrative actions available to the author

An aspect that is important to mention about the episode definition is that there is a section where we can define a set of goals to be communicated to the agents that take part in that episode when it begins. This set of goals are not new goals created specifically for the episode. Instead, they are merely references for the goals that make up the character's personality.

Due to the use of autonomous agents, the story emerges from the interactions between the characters. As a consequence of that autonomy, the way the story emerges may sometimes be difficult to predict. In order to constrain the behavior of the characters in a way that allows an author to predict it, the author has the ability to specify a subset of the goals defined in the character's personality. The character will consider this subset and ignore the goals that are not contained in it.

However, it is up to the author to decide how much the goals of the characters should be constrained. The author has freedom to include all the characters goals, or to even include none. In the first case the author might have more difficulty writing the finish conditions for the episode, and in the second case the characters will not perform any action autonomously. Although the second case seems useless, there are some cases where it can be useful. As it will be described in section 3.2.1, through the use of the *Act For Character narrative action*, it is possible to write scripted actions for the characters to execute.

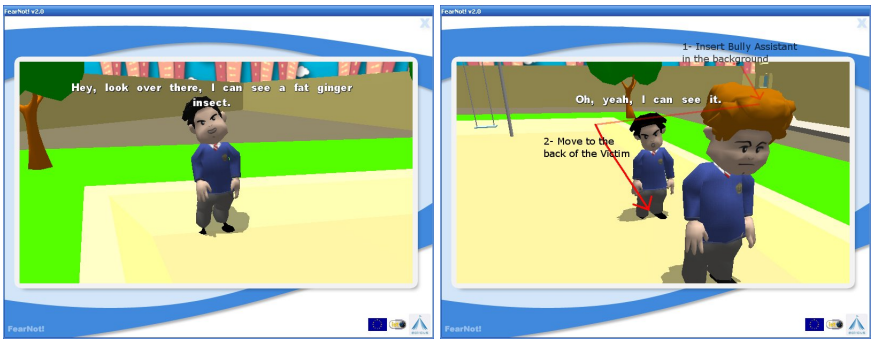
3.2.1. Introduction and triggers

In the definition of an episode there are two parts, its introduction and its triggers, where it is possible for the author to use a set of actions named *Narrative actions*. The narrative actions are the actions that the Story Facilitator can perform during an episode. These actions are used to set-up the episode and to create situations that could not be created by the characters alone. The available narrative actions are listed in Table 2.

The set-up of an episode is done in its introduction, where the characters and items that compose an episode are inserted in the set. Figure 3 shows the introduction of *Ollie* and *Rob*. In this example two characters were inserted using the *Insert Character* narrative action. These characters walked to a position on the set near the camera and then introduced themselves (*Act For Character* narrative action).

During an episode it might be useful, for example, to insert a new character. Imagine a situation where we want the character with the role of bully assistant to make an

Figure 3. Example of the introduction of an episode



(a) Luke mocks John (b) The bully assistant intervenes

Figure 4. Trigger that is fired when Luke mocks John

appearance when the bully starts mocking the victim (Figure 4). To achieve this kind of behavior we use the episode's triggers. A trigger is a rule that is fired when a condition is verified (bully mocking the victim). The firing of a trigger causes the execution of a set of narrative actions (inserting a character and making it walk behind the victim).

3.3. Episode cycle

When an episode is selected, its introduction is played. During the introduction the agents do not have control. The SF loads the scenery and then executes the narrative actions the

author specified in the episode's introduction.

When the introduction finishes, the SF gives control to the agents and their goals dictate their behavior. The SF merely monitors their execution and updates the story memory with story events that represent their actions and the properties that are changed.

If one of the triggers gets its conditions satisfied, control is taken from the agents while the set of narrative actions of that trigger is executed. When the trigger finishes, control is given back to the agents.

Finally, when the episode's finish conditions are satisfied, another episode is selected, and the process is repeated until there are no more selectable episodes.

It is interesting to note that, even if the same set of episodes is selected during two runs of a story, the resulting stories might be different. This is a consequence of the emergent nature of the episodes themselves, since during each episode the agents that control the characters have autonomous behavior and can act differently, thus producing two different outcomes.

4. Conclusions

In this paper we described *FearNot!*, an interactive learning environment that applies ideas from educational role-play to build emergent stories. The stories produced by *FearNot!* depend on the learner interaction and on the autonomous synthetic characters that inhabit *FearNot's* virtual environment.

We described the narrative module used in *FearNot!* that is responsible for ensuring that the stories produced convey an educational message while maintaining their emergent nature.

Current work has produced a version of *FearNot!* that is capable of producing several stories about relational and physical bullying, and will be trialled in schools over a period of months in the second semester of 2007.

Acknowledgements

This work was partially supported by European Community (EC) under the IST RTD programme, contract IST-2001-33310-VICTEC, and is currently funded by the eCircus project IST-4-027656-STP. The authors are solely responsible for the content of this publication. It does not represent the opinion of the EC, and the EC is not responsible for any use that might be made of data appearing therein. This work was also supported by Kaleidoscope network of excellence, contract IST-2004-507838.

References

[1] Olweus, D. (1991). Bully/victim problems among school children: basic facts and effects of a school-based intervention programme. In D. Pepler and K. Rubin (Eds.), The Development and Treatment of Childhood Aggression pp411-38. Hillsdale, NJ: Erlbaum

[2] Piaget, J. (1972). The Principles of Genetic Epistemology. London: Routledge & Keegan Paul Ltd.

[3] Davison, J.; Arthur, J. (2003). Active Citizenship and the Development of Social Literacy: a case for experiential learning. Canterbury: Citizenship and Teacher Education.

[4] Henriksen. (2004). On the Transmutation of Educational Role-Play: a critical reframing to the Role-Play to Meet the Educational Demands. In M. Montola & J. Stenros (Eds.), Beyond Role and Play - Tools, Toys and Theory for Harnessing the Imagination (pp. 107-130). Helsinki

[5] Robertson, J.; Oberlander, J. (2002). Ghostwriter: Educational Drama and Presence in a Virtual Environment. Journal of Computer Mediated Communication, 8(1).

[6] Dias, J.;Paiva, A. (2005). Feeling and Reasoning: A Computational Model for Emotional Characters. EPIA

[7] Ortony, A.;Clore, G., A. Collins (1988). The cognitive structure of emotions Cambrige University Press, UK

[8] Mateas, M.; Stern,A. (1992). Architecture, authorial idioms and early observations of the interactive drama Façade. Technical report, Carnegie Mellon University, 2002.

[9] Kelso, M.; Weyhrauch, P.; Bates, J. (1992). Dramatic Presence PRESENCE: The Journal of Teleoperators and Virtual Environments, Vol 2, No. 1, MIT Press.

[10] Mateas, M.; Stern, A (2003). Façade: An Experiment in Building a Fully-Realized Interactive Drama. Game Developers Conference

[11] Lewin, K. (1951). Field Theory in Social Science. New York: Harper and Row.

[12] Young, M.;Riedl, M.;Brandly, M.;Jhala, A.;Martin, R.;Sareto, C. (2004) An architecture for integrating plan-based behavior generation with interactive game environments. Journal of Game Development

[13] Cavazza, M.;Aylett, R.;Dautenhahn, K.;Fencott, C.;Charles, F. (2000) Interactive Storytelling in Virtual Environments: Building the Ḧolodeck. Virtual Systems and MultiMedia

[14] Cavazza, M.;Charles, F.;Mead, S. (2001) Agent's Interaction in Virtual Storytelling. Intelligent Virtual Agents

[15] Aylett, R. (1999). Narrative in Virtual Environments - Towards Emergent Narrative. AAAI Fall Symposium, Technical Report FS-99-01

[16] Aylett, R.; Louchart, S.; Dias,J.; Paiva, A. (2005). FearNot! an Experiment in Emergent Narrative In proceedings of Intelligent Virtual Agents Conference (IVA 2005), 305-316, Springer 2005.