The Virtual Storyteller: Story Creation by Intelligent Agents

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Abstract. The Virtual Storyteller is a framework for story creation by co-operating intelligent agents. In this framework, a collection of agents is responsible for the creation of different story levels: plot, narrative, and presentation. In the Virtual Storyteller, plots are automatically created based on the actions of autonomous characters whose plot creation is only constrained by general plot requirements. This approach lacks the disadvantages of pure character-based plot development, where the characters are fully autonomous, and of scripted approaches, where the plot content is pre-defined and the characters have no autonomy at all.

1 Introduction

In this paper we present the Virtual Storyteller [8], a multi-agent system for automatic story creation developed at the University of Twente. The Virtual Storyteller is part of the AVEIRO project, that is aimed at building virtual environments inhabited by autonomous embodied agents [13]. One environment is a 3D replica of a local theatre: the Virtual Music Centre (VMC). Among the embodied agents in the VMC are Karin, a virtual receptionist capable of natural dialogues about tickets and performances, and some entertainers: a piano player and a dancer performing on the stage of the VMC. The Virtual Storyteller will be added as another entertainer in the VMC. The current version of the system aims at story presentation by a traditional storyteller: an embodied, talking agent that tells a story using appropriate prosody, gestures etc. Extensions to virtual drama are envisaged, where the story is acted out by embodied characters.

In the Virtual Storyteller project, research areas such as intelligent agents, language and speech technology, humanoid animation and virtual reality are combined. Specific research issues to be addressed are the following:

- Automatic plot development by characters as intelligent agents
- Control of the character agents to achieve a well-structured plot
- Turning a plot into a narrative using natural language generation
- Story presentation by embodied, speaking agents in a virtual environment
- Involving the user in the story creation process (interactivity)

This paper focusses on automatic plot creation but also touches on the other issues mentioned above. We start with an introduction on the requirements we

put on plots (Section 2), followed by a discussion of existing approaches to automatic plot creation (Section 3). Next, we describe our current and future work on the Virtual Storyteller, focussing on plot development but also discussing other aspects of the story creation process (Section 4). We end with a brief discussion of related work (Section 5), followed by some concluding remarks.

2 About Plots

To lay the basis for our discussion in the remainder of this paper, we briefly explain what we mean by a plot and what we require minimally of a 'good' plot.

2.1 Story Levels

In this paper, we distinguish three story levels, which correspond to the *fabula*, *story* and *text* levels from narrative theory [2]. The first level is the *plot*. This is the level of the events that occur in the fictional world. The events make up the story's content and cohere in the sense that they are typically related by chronology or causality. The second level is the *narrative*: a representation of the plot from a particular point of view, where some of the plot's events may be left out or reordered. The third and last level is the *presentation*: a realisation of the story in a particular medium. In virtual storytelling, most stories are presented in the form of text or speech, or in the form of virtual drama, where the story is enacted on screen by animated figures in a virtual, graphical environment.

In virtual storytelling, it is not always easy to separate the plot from the other story levels. This holds in particular for character-based plot development in virtual drama, where plot creation and presentation go hand in hand: events are told or presented as they unfold in the virtual world. Making a distinction in this case between the different story levels may seem somewhat artificial. Nevertheless, the distinction is useful because in principle, one plot can be the basis for many different narratives, and one narrative can lead to many different presentations. Therefore, we will continue to speak of the plot as a separate level even in those cases where it is fully integrated with narrative and presentation.

2.2 Plot Requirements

To keep matters simple, we make the basic assumption that there are at least two essential requirements that any plot should meet. The first is that a plot must be *consistent*, meaning that its sequence of events is natural and in accordance with the story world; in particular, characters' actions are not "out of character" but in line with their own personality and their previous actions. The second requirement is that the plot should be *well structured*, meaning that it should have a beginning, where some problem is introduced and the action rises, a middle, containing the action's climax, and an ending (in success or failure), where the action falls. This is called 'Freytag's triangle' [10].

These two requirements are essential, in the sense that plots that fail to meet either of them are not very likely to result in an adequate story. On the other hand, the two requirements are minimal in that they do not provide any guarantees for an entertaining story.[1] For this, a plot should meet additional conditions such as unexpectedness, conflict, suspense, and the presence of interesting themes and/or characters. Also, it should be kept in mind that the quality of a story depends not only on the plot, but also on the presentation: an engaging presentation can make a good story out of a mediocre plot, and a good plot that is badly presented will not be very enjoyable.

3 Existing Approaches to Plot Development

Character-based and script-based approaches to plot development in virtual storytelling are diametrically opposed with respect to the amount of autonomy of the characters. Between these extremes, we find intermediate approaches where the characters have limited autonomy in acting out a given script. Here we discuss these approaches in the light of the plot requirements described above.

3.1 Character-based Plot Development

At the first extreme, the character-based approach to plot development, the characters in the story are implemented as autonomous, intelligent agents. Such agents can choose their own actions, informed by their internal state (which may include goals and emotions) and their perceptions of their virtual environment, both of which are continually updated based on their own and other agents' actions. It has been suggested that stories will naturally emerge when such agents are left free to act in response to each other and their changing environment [1, 27]. In other words, the plot is created in a bottom-up fashion, based on actions that are autonomously performed by the characters.

This approach was adopted in one of the first text-based story generation systems, Talespin [20]. More recent examples are the virtual drama systems of Aylett [1] and Stern et al. [27]. In general, plots resulting from a character-based approach are fairly consistent, since the characters' actions are ensured to be in line with their personality (if they have any), and their own and other characters' previous actions. The character-based approach is also attractive from the perspective of interactivity, as it makes it possible for the user to influence the story's progress by controlling one (or more) of the characters. An important disadvantage, however, is that the resulting plots often do not adhere to Freytag's triangle, rambling on without any climax or resolution and thus failing our second plot requirement. This risk is especially great with characters that mainly show reactive behaviour, and have no individual goals to pursue. In that case, "a suitable number of events outside the control of the characters" [1]

[1] The purposes of storytelling range from social bonding to giving lessons in morality. Here, we take entertainment as the main purpose of virtual storytelling.

will be needed to produce interesting plots. In other words, external intervention is needed, and the plot is no longer fully controlled by the characters. Plots created by goal-oriented characters appear to have a better chance of being well-structured, but here also the emergence of an adequate plot is by no means guaranteed. For instance, the plots of Talespin were sometimes cut short because the main character either immediately managed to achieve his or her goal, or simply died before much action had taken place.

3.2 Scripted Plots

At the script-based extreme, the characters have no autonomy or intelligence and therefore no control over the plot at all. Instead, the plot of the virtual story is either written by a human author (which more or less guarantees the result to be both consistent and well structured) or automatically generated. Most automatic plot generation systems, aimed at textual story presentations, make use of a story grammar as first proposed by Propp [24]. The story grammar encodes a global plot structure, which is automatically filled in with items from an inventory of characters and their possible actions. Examples of plot generation systems using this approach are [15] and [23].

In principle, the use of a story grammar for plot generation ensures that the resulting plot is well-structured. However, consistency in the sense of psychological plausibility may be low, since the characters in such systems are often interchangeable, having no distinct personality but just functioning as random building blocks for filling in the story grammar. (A notable exception is the Universe system [16], where plot construction is based on detailed character information.) A general disadvantage of scripted plots is that they are fully fixed, which in the worst case limits their interest to a one-time experience. Creating branching scripts, where the choice between branches is made either at random or by the user, can solve this problem. However, even in this case the possibilities for interaction and plot variation are limited.

3.3 Intermediate Approaches

As we see, there are disadvantages to both extremes (i.e., giving either full or no control to the characters), and therefore several intermediate approaches to plot development have been proposed. These solutions have in common that they give the characters limited autonomy in co-determining the plot. In most cases, this is done by using global scripts that leave some room for improvisation by the characters. In some systems, this script is given as part of the characters' knowledge [7, 12]; in other systems, the characters rely on a virtual director to give them instructions based on the script [14, 29]. In both cases, the autonomy of the agents is restricted; to which degree depends on level of detail of the script. In different approaches, this level of detail ranges between pre-specifying all script branches the characters can choose from [7], ensuring the occurrence of some essential 'plot points' [12, 14], and just making sure that small 'narrative fragments' are regularly inserted [26].

Although these intermediate approaches clearly represent a step forward from the two extremes sketched above, they also have their problems. One of these is that 'forcing' characters into actions prescribed by a global script may give rise to inconsistencies. For a discussion of this and other problems see [19]. Here, let it suffice to say that in our view, many of the remaining problems of intermediate approaches appear to stem from the fact that most of these still make use of a scripted plot (albeit a global one). This means that in any case, there are some pre-specified plot points, and the characters must somehow be made to reach these. In our Virtual Storyteller system, which we discuss in the following section, this is different: the characters are not guided through a pre-existing plot, but create the plot together with a virtual director.

4 The Virtual Storyteller

In this section, we first sketch the architecture of the Virtual Storyteller, and then provide more details on plot creation and presentation within our system. We also discuss the possibilities for adding interactivity to the Virtual Storyteller.

4.1 Architecture

In the Virtual Storyteller, plots are not pre-defined but created by the actions of the characters, guided by a virtual director. For a clear task division within the system, we choose to use a separate director agent who has general knowledge about plot structure, rather than giving such knowledge directly to the characters. Both characters (or 'actors') and director are implemented as intelligent agents, capable of reasoning within their own domain of knowledge. The characters can make plans to achieve their personal goals using story-world knowledge: knowledge about their virtual environment and the actions they can take in it. The director is able to judge whether a character's intended action fits into the plot structure, using both story world knowledge and general knowledge about what makes a 'good' plot. In addition to the actors and the director, the Virtual Storyteller also comprises a narrator and a presentation agent, which are responsible for the creation of the narrative and presentation levels of the story. The global architecture of the Virtual Storyteller is shown in Fig. 1.

The multi-agent framework for the Virtual Storyteller was built using JADE (Java Agent Development Environment [3]). JADE offers an agent development package and agent platform (including management tools and agent communication functionality) which comply to the FIPA[2] standards for agent development. With JADE, it is possible to design the core characteristics of the agents in our storytelling environment. To make these agents 'intelligent', we have extended the basic JADE agents with a rule based reasoning system consisting of a knowledge base (containing facts and rules) and a reasoning mechanism (the inference engine). We have chosen Jess (Java Expert System Shell [11]) as the tool for

[2] Foundation for Intelligent Physical Agents [9].

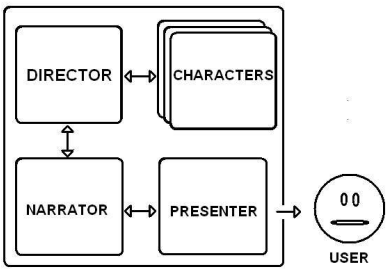

Fig. 1. Architecture of the Virtual Storyteller

creating each agent's rule base. Since both JADE and Jess are Java-based, these choices allow a future coupling with other Java-based virtual environments. Jess is based on forward chaining, but it also supports backward chaining of rules in order to obtain goal-directed inferencing for our (goal-directed) agents. To specify the concepts that our agents may reason about, we use a freely available, Java-based tool for ontology and knowledge-base editing called Protegé [21].

Summarising, JADE allows us to design the core characteristics of the agents, Jess allows us to convert these basic agents to rational ones, and Protegé helps us to design the story world that can be reasoned about by our director, characters, and narrator. The presenter (see Section 4.3) is a different sort of agent, not included in this framework: it is an MSAgent[3] that has been coupled to our environment with the help of a Java-MSAgent API developed elsewhere [25].

4.2 Plot Creation as a Combined Effort

The approach to plot development adopted in the Virtual Storyteller can be categorised as an intermediate approach, in the sense that the characters do not have full autonomy in making up the plot, but are guided in their actions to achieve a well-structured plot. An important difference with other approaches is that our director agent does not work with a pre-specified (possibly branching) plot, but only has general knowledge on what makes a good plot. This means that the content of the story is not known in advance, but determined by the characters pursuing their individual goals in their virtual environment. This is much like the approach in systems like Talespin [20], with the essential difference that in our system, there is a director who watches over the structure of the unfolding plot. The characters themselves ensure the consistency of the plot. The director can use the following methods to control the characters' actions (based on the classification given in [4]):

Environmental: introducing new characters and objects into the story world.
Motivational: giving a character a goal to pursue.
Proscriptive: disallowing a character's intended action.

[3] `http://www.microsoft.com/msagent/`

The director's use of these control methods depends on the rules in his knowledge base. In our current implementation, the director has knowledge about global plot structure in the fairy tale domain, which is encoded in his knowledge base in the form of a set of rules stating that a story must have a beginning (where the characters and the environment are introduced), a middle (where the main action takes place, i.e., the characters attempt to achieve their respective goals), and a happy end. To get the plot going, the director creates a setting (environmental control) and gives the characters a goal (motivational control). Before performing any action, the characters must ask the director for permission, which is where proscriptive control comes into play. For example, the director might keep the antagonist from killing the protagonist early on during plot development, to prevent a premature ending to the story. Alternatively, the director might allow the killing but introduce a new character to save the protagonist (using, e.g., a magic potion). Note that the director does not have *prescriptive* control: he cannot force a character to perform a specific action. However, he may try to 'push' the plot in the desired direction using environmental and motivational control. This way, the consistency of the characters' actions remains ensured.

Figure 2 shows a part of the communication between a character agent and the director during the creation of a simple example story. The lines between *** are printed only for the user's benefit; the other lines are the agents' messages, which are in ACL format (Agent Communication Language, [9]). In the first message shown in Fig. 2, the director tells the character (a dwarf named Plop) that it is hungry, which causes the character to adopt the goal of finding some food. The character's knowledge base contains the fact that something edible (an apple) is located in a house nearby, so the character makes a plan to go to the house and eat the apple. Before executing this plan, the character sends a message to the director asking permission to perform the first step, i.e., walking to the house. The director returns a message saying that permission is granted, so the character proceeds with the action and informs the director of this.

Currently, the knowledge bases of the characters and the director are very limited, allowing only for the creation of extremely simple stories. In the near future, we intend to give the characters more (story) world knowledge, so that they can make more, and more sophisticated, plans. Even more important for achieving interesting plots, is to give each character its own personality, story role, and emotions, and let it choose its actions accordingly. It will also be necessary to develop more refined story rules for use by the director. The current plot structure is very global and places hardly any constraints on the characters' actions. To improve on this, a more fine-grained structure is needed, e.g., based on Propp's functions [24], which represent essential plot elements of fairy tales. Non-structural rules by which the director could judge the characters' intended actions include user-centred criteria such as surprise and impressiveness, which could be evaluated through a user model [28]. Our next step will be to experiment with different story worlds and genres, requiring different character roles and plot structures. Our framework is well suited for this, since new Jess rule bases can be easily loaded into both the director and the character agents.

```
[...]
[Plop]: AbsContentElement received: (hungry :starveling (dwarf :NAME Plop :SEX male))
** I am asking permission to walk ***
[Director]: received REQUEST message....
[Director]: Request for permission to storyagents.complexstoryworldontology.WalkTo@2c1e22
[Plop]: received INFORM message....
[Plop]: AbsContentElement received: (permitted :ACTION (walk-to :DESTINATION (locale :NAME
at-house) :AGENS (dwarf :NAME Plop :SEX male)))
*** I am walking from in-forest to at-house ***
[Director]: received INFORM message....
[...]
```

Fig. 2. Communication between character (Plop) and director during plot creation.

4.3 Narration and Presentation

The Virtual Storyteller currently aims at story presentation by a virtual narrator rather than by embodied characters. In this respect, it is more closely related to systems producing textual output than to virtual drama. However, most textual story generation systems focus on automatic plot creation and pay little attention to narration and presentation, whereas the Virtual Storyteller explicitly takes the latter levels into account. The agents responsible for this are the *narrator* and the *presenter*. The narrator converts the plot into a textual narrative by translating system representations of states and events into natural language sentences. This is done using templates, i.e., sentence patterns with open slots for words or phrases that express variable information. An important subtask carried out by the narrator is pronoun generation. As shown by Callaway and Lester [6], the use of appropriate pronouns is one of the factors that most influence the enjoyment of a narrative. In the current version of the system, when a character performs any action this is immediately expressed by the narrator, the result being a chronological narrative. It will be interesting to extend the narrator so that it can generate non-linear story lines as well. This requires the plot to be entirely known before the generation process starts. Eventually, we also want the narrator to be capable of narrating the same plot at different levels of detail, for instance aiming at different audiences.

The natural language sentences produced by the narrator are sent to the presentation agent, which is currently implemented as an MSAgent that uses text balloons accompanied with speech synthesis to present the narrative (see Fig. 3). This is a temporary solution: in the future, we intend to integrate our own work on speech synthesis and emotional facial expressions [5] in the Virtual Storyteller. This will offer more advanced possibilities for using prosody and facial gestures to enhance story presentation. The resulting presenter will be an agent embodied in 3D that is part of the VMC environment. Additional future work is story presentation in the form of virtual drama. To achieve this, the character agents need to be extended with a body and animation capabilities. In this scenario, the presentation agent will be no longer needed (its role will be taken over by the characters), and the function of the narrator will be changed

from text generation to play writing, a task for which new, theatre-oriented knowledge will be required.

Fig. 3. The presentation agent

4.4 Interactivity

The current version of the Virtual Storyteller is not interactive: the system cannot yet receive any input or feedback from the user, who therefore has no way of influencing the story generation process. However, different forms of interactivity are envisaged for future versions. The first step will be to allow the user to choose the characters and their goals at the start of the storytelling process, thus taking over some of the director's current responsibilities. This may be taken further by having the user take on the role of the director during plot development as well, deciding which of the characters' intended actions are allowed. All this can be done through a dialogue with the presentation agent, which functions as the natural language interface to the Virtual Storyteller. For instance, the presenter could start by offering the user a choice of characters and asking what each character should be like in terms of personality, goals etc. During the course of the story, the presenter could (occasionally) ask the user to select an action for one or more of the characters.

Alternatively, the system could be extended to give the user direct control over the actions of one of the character agents, without intervention of the presenter. Since the Jade multi-agent platform may be distributed across several machines, it would even be possible to have multiple users controlling their favourite characters from different physical locations. This would transform the Virtual Storyteller into a kind of role playing game. It is an interesting research question how, in such a situation, the director agent could be employed to automatically steer the interaction in the desired direction.

In the longer run, we intend to develop a version of the system where the story is presented in the form of virtual drama, with the characters acting on the stage of the Virtual Music Centre (shown in Fig. 4). In this situation more direct interactions will be possible, for instance by having a user-controlled avatar join the actors on the stage, communicating with them through natural language and

performing actions that directly influence the unfolding plot. Alternatively, one or more users can be seated in front of the stage as part of the performance's audience, and influence the performance by actively expressing enthusiasm or disapproval. For a detailed discussion of the possibilities for user interaction in the VMC environment, see [22].

Fig. 4. The stage of the Virtual Music Centre

5 Related Work

The following approaches to digital storytelling are related to our work on the Virtual Storyteller, in that they do not make use of pre-scripted plots (not even global ones).

Szilas [28] proposes an approach to interactive drama where a 'virtual narrator' chooses the actions to be performed in the story, based on several narrative criteria including consistency and progression ("how much the action makes the intrigue evolve, rather than stagnate" [28]). This is similar to the task of the director in the Virtual Storyteller. An important difference is that Szilas' approach is not character-based. Instead, the candidate actions originate from a story grammar ('narrative logic' in Szilas' terms). The narrative logic ensures that the candidate actions fit into the general plot structure, and the virtual narrator judges their effect on the user.

The Teatrix system for virtual drama [18] is designed for collaborative story creation by children. In Teatrix, some of the story characters are controlled by the children using the system; the other characters are autonomous agents. There is also an omniscient director agent which can insert new items and characters into the story world, and which can control the characters' actions on behalf of the story coherence. The director cannot control the children's characters. The main difference with the Virtual Storyteller is that in Teatrix, the character and director agents function as aids in the children's story creation process, rather than creating the story by themselves.

Of text-based story generation systems, the most similar to the Virtual Storyteller is the system designed by Lee [17]. In his system, the characters do their own planning within the structural limits set by a story grammar. The system has no director, but does make use of devices such as introducing new characters when the plot gets stuck. Unlike the Virtual Storyteller, Lee employs a top-down story creation procedure, starting from the grammar rather than the characters.

6 Conclusion

In our approach to virtual storytelling, the characters are implemented as intelligent, semi-autonomous agents. A virtual director, an agent with general knowledge about plot structure, guides their actions and ensures that a well-structured plot emerges. We do not make use of pre-defined scripts, which means that the plot is not prescribed but really created by the characters, and which has the important advantage that the characters are never forced to carry out potentially inconsistent actions. Our approach has been implemented in a general multi-agent framework, the Virtual Storyteller, which covers all story levels and allows for further development in many different directions. The framework for the Virtual Storyteller has been fully implemented, but the knowledge bases are still quite limited. We will extend these in the near future, to further explore the creative potential of our framework. In addition, we will investigate possible extensions to virtual drama and different forms of interactivity.

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