Building Synthetic Actors for Interactive Dramas

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Abstract

We discuss the extension of an emotionally-driven agent architecture already applied to the creation of emergent narratives. Synthetic characters are enhanced to perform as actors by carrying out a second cognitive appraisal, based on the OCC model, of the emotional impact of their projected actions before execution. We present the evaluation of this approach and some initial results on whether it produces more 'interesting' narratives.

Introduction

Narrative has become a topic of great interest in video and computer games development as a way of drawing the player into the game play [16], and is seen as a focus for the development of mobile and Augmented Reality-based gaming [21]. Much active research addresses the generic use of interactive graphical environments and intelligent synthetic characters to extend the power of narrative in new ways [16]. Specifically it has played a central role in a number of interactive graphics-based e-learning systems both for adults [24] and children [9, 18]. Narrative is also used as a generic method for adding intelligence to virtual environments, for example, through the development of virtual guides [4].

The key characteristic of all these environments is interactivity: users expect to move freely and interact at will with objects and synthetic characters. Yet this interactional freedom clashes badly with the conventional narrative requirement for a definite structure, creating a narrative paradox [13]. A plot-based narrative structure supposes the right actions at the right places and times but these may not be those the user chooses to carry out [19]. More generally, an authorial plot-based view of narrative where particular actions must execute in a particular order conflicts with a character-based view where characters autonomously select their actions in response to their sensing of the state of the virtual world – strong autonomy [15].

Merging the roles of spectator and author evades rather than reconciles the contradiction since authoring merely allows a plot-based approach to be maintained; this approach has been exploited in a number of systems [9, 18, 20]. The God-like perspective of games such as 'The Sims' gives the privileged user overall responsibility for the activity within the virtual world in a similar fashion. Creating a branching narrative is another solution [24, 14], though either the user is constrained into a few key choices, breaking their immersion in the narrative world, or characters must be supplied with "universal plans" [23] covering every possible response to whatever the user does. Façade [15] is an impressive example of the result of doing this, using the concept of 'beats', based on an adaptation of Aristotelian theory, but required substantial authoring effort for a short (20 minute) narrative, with clear implications for scalability. Limiting the interactive stance of the user is a third solution: one may apply concepts such as Boal's [3] spect-actors, in which participation and spectating are episodically interleaved [2]. In [5] characters have universal plans expressed as AND/OR trees but the role of the user is confined to manipulation of key objects, forcing character re-planning.

Strong autonomy for characters offers a potential solution to the problem of interactivity since if synthetic characters are allowed to autonomously select actions, then a participating user can also be allowed to do so on the same terms. Given that in general, structure can emerge from interaction between simpler elements, it seems possible that interaction between strongly autonomous characters could under specific circumstances produce narrative structure, or an emergent narrative (EN) [1].

The main objection to character-based narrative based on strong autonomy is that there is no guarantee that interesting narrative structure will result precisely because characters are responding to their internal state and individual goals in choosing actions and not to the overall story structure. However, an existential proof of the EN approach can be found in interactive forms such as improvisational drama and human RPGs: in the former actors start from a well-defined initial state and strong roles and select 'dramatically-interesting' actions, while in the second, a game-master dynamically manages the experience of the autonomous participants [13]. In this

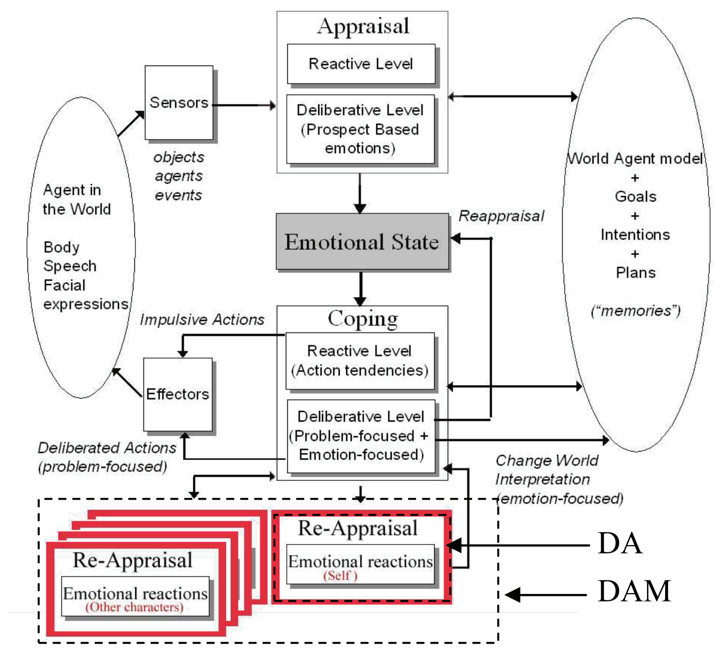
work we discuss the application of both these ideas within the additional framework of affective appraisal theory.
The novel hypothesis being explored is that an autonomous agent that explicitly assesses the emotional impact of its actions on other agents around it, much as an actor would, will produce a more engaging emergent narrative than one that only uses its own 'in-role' emotional state to select its next action. Other virtual actors [22] have not tried to assess the differential emotional impact of a set of possible 'in-role' actions, making this a novel approach. Because it uses emotional impact, it is also different from assessing the goals or plans of other agents [11].

Narrative and emotions

If narrative is to emerge from interaction between characters, then the character architecture is fundamentally important. It is the contextual relevance and richness of the actions selected by each character that will or will not produce sequences with the post-hoc structure of a story: that is a coherent compound of external interest and surprise (causal chains of actions) with internal perceived intentionality and emotional impact (motivation and expressive behaviour). Displaying role-specific emotional reactions to the actions of other characters and the emotion behind their own actions is an important component of successful human acting.
For this reason a number of researchers in synthetic characters, starting with Elliot's Affective Reasoner [7] have integrated affect into their agent architectures [8, 2], usually drawing on cognitive appraisal theory. Appraisal is the human perceptual process through which objects, other characters and events are related to the needs and goals of an individual, generating a resulting emotional response and thus linking emotion to cognition. The most widely implemented system is the taxonomy of Ortony, Clore and Collins (OCC) [17], used by the FatiMA agent architecture which formed the basis for the work described here. The OCC model is an approach based on a valenced (good or bad) reaction to an event and the structure of emotions it defines can be seen as a hierarchical taxonomy organising 22 emotion types.

Affective agent architecture

The FatiMA (Fearnot Affective Mind Architecture) [6] agent architecture is shown in **[Figure 1]** (with the additions of the work reported here added in red) and is that used in FearNot!, an application that generates episodes of emergent virtual drama relating to bullying for educational purposes [2]. In this architecture, an agent's emotional status affects its drives, motivations, priorities and relationships, with an OCC-based appraisal system and resulting coping behaviour [12] - those internal emotional adjustments made or external actions taken in order to deal with negative emotions. Characters may also have different thresholds and decay rates for each of the 22 OCC emotions, implicitly defining a large set of different personalities.
As shown in **[Figure 1]**, the appraisal mechanism consists of both a reactive and deliberative layer [2,6]. The former is handled by a set of emotional reaction rules consisting of an event that triggers the rule and values for the OCC appraisal variables affected by the event (desirability, desirability-for-other, praiseworthiness etc).
The deliberative layer is responsible for appraising events according to the character's goals, thus generating prospect-based emotions like hope and fear. These emotions relate to future events: those congruent with the IVA's goals (hope) or those threatening them (fear). They thus connect the affective system to the planning component of coping behaviour [8].



[Figure 1] DA/DAM architecture

The action selection process is also composed of reactive and deliberative levels. Reactions consist of a set of action rules: each contains a set of preconditions that must be true in order to execute the action and an eliciting emotion that triggers this particular action, for example sadness may trigger weeping. The action set is matched against all the emotions present in the character's emotional state (arising from appraisal) and the set of rules with positive matches is activated. The action rule triggered by the most

intense emotion is selected for execution. If more than one action rule is selected, the most specific one is preferred.
The deliberative coping process - deeply connected to the deliberative appraisal process - is more complex. More than one goal can be active at the same time, so the first stage of the deliberative reasoning process is to determine which goal to attend to. In the original architecture, the intentions generating the strongest emotions are the ones that require the most attention from the agent, and thus are the ones selected by the planner to continue deliberation.
The next step is to choose the most appropriate existing plan to execute or to continue planning. An evaluation metric is used that: weights plans that achieve the same conditions but use fewer steps more highly; weights plans with more instantiated pre-conditions more highly; and plans with fewer inter-goal threats more highly. For example, within the bullying scenarios to which FatiMA has so far been applied, a plan by a victim to hit the bully threatens the victim's own goal of not getting hurt. At this point, the best plan is brought into focus for reasoning, as if in the forefront of the agent mind, and at this point it generates/updates the corresponding emotions [6]. It is here that there is an opportunity to have the agent considers what the emotional impact of plans on other characters might be.

Double appraisal

The design of an agent action-selection mechanism that selects dramatically interesting actions is a technical and conceptual challenge. In particular, the subjective nature of drama and its perception makes the development of a reliable and quantifiable assessment measure very difficult. The idea explored here is to take emotional impact (EI) as a surrogate for dramatic interest, hypothesizing that the EI of a specific action relates to its dramatic impact and could thus substitute for dramatic value. A character would therefore take an action not solely on the basis of its emotions, goals and motivations but also on the EI of these actions for both itself and other characters. This approach would allow the characters to conjointly assume in a distributive manner the dramatic weight of an unfolding story without relying on a pre-determined plot.

Architectures

We argue that the implementation of such a concept requires a novel agent action-selection mechanism whose function is not only to make action decisions but also to project the possible impact of these decisions. The mechanism described in this section features a double appraisal cycle as opposed to the single approach discussed above. This allows the agent to appraise events as in any conventional appraisal-based system but then carry out conflict resolution over a set of possible actions by running another appraisal cycle (in parallel), assessing each member of the feasible in-role action set according to its potential emotional impact. Thus the selection of an action is made not just on the inherent value of a particular action but on its ability to generate EI. The mechanism has been implemented within the already existing FAtiMA architecture, at the coping level, and features two related approaches for evaluation purposes.
In the first implementation, [Double Appraisal (DA)], the agent generates a set of possible actions using its emotions and goals and then assesses the emotional impact each action would have *if directed at itself*. An extra loop is added into the appraisal process by recasting each possible action into an event and feeding it back into the agent's own appraisal system. This corresponds to a "Theory of Mind" approach [25] in which the agent assumes that everyone else would react as they would: "how would I feel if someone did this action to me?" In order not to affect the actual current emotional state of the agent, this re-appraisal cycle is executed in parallel with the agent "appraisal-coping" cycle and takes place within an instance of the agent's mind that is not connected to its running emotional state.
The second application [Double Appraisal with Modelling (DAM)] **[Figure 1]** draws on the same principles but conducts the re-appraisal with respect to the emotional reactions sets of all the agents present in the scenario. It aims at selecting the action that would have the highest emotional impact of that on all the characters within a scenario. This corresponds to "how would the most-affected of the people around me feel if I did this action?"
A significant parameter in either approach is the size of the set of possible actions. Each of the implementations DA and DAM has been evaluated with a low value for the number of actions in the possible set (3) and with a higher number (9). The aim here is to establish whether the number of actions presented to the re-appraisal cycle significantly impacts the decisions made by the agent.

Evaluating double appraisal

Evaluation of generative narrative is known to be very difficult and there is no agreed approach to doing so [20]. The subjective nature of storytelling is a major issue for the design of efficient and reliable evaluation procedures. Evaluating applications based on satisfaction and user experience is very different from the usual task oriented evaluation designs and is therefore still very much an open research question [10].
Another issue arises from the emergent nature of the storytelling form. Depending on the agents' minds, moods and emotions, a story might not unfold in the same way twice making a direct comparative analysis difficult. The EN approach is character-based and is aimed at participation rather than spectating. It is therefore necessary to devise an evaluation framework that focuses on the characters' decisions and behaviour, rather than

'the' story displayed. However combining a participant/spectator perspective in evaluation supports a direct comparison of data from both participant and spectator users.

Evaluation set

In this evaluation, the original FearNot! agent framework without any double appraisal has been used as a benchmark against which the implementations DA (DA.1/DA.2[1]) and DAM (DAM.1/DAM.2*) have been compared. The scenarios are composed of interacting agents who act a role and have their own personalities and goals and a Game-Master (GM) whose aim is to provide narrative events and make decisions about the world environment (outcome of physical actions, entry of new characters, removal of characters etc). In this implementation, the role of the Game-Master is played by a disembodied agent dedicated to story management. Like the actors, the Game-Master agent has been extended by DA and then by DAM. The combinations of different types of agents and Game-Masters resulted in 25 simulations. These simulations were all run with identical configuration setups and resulted in 5 different story-variations of the same scenario with identical configuration set ups.

The simulation plan **[Table 1]** reflects the narrative elements necessary for the development of an EN scenario (i.e. characters and game-master) and shows the appearance of story variations across the different simulations. It also includes different versions of the GM. For the purpose of this evaluation, different versions of the GM (i.e. DA, DAM) were also implemented, just as for characters, in order to test the validity of both DA and DAM for an agent playing the GM role.

	GM v1.0	GM DA.1	GM DA.2[1]	GM DAM.1	GM DAM.2[1]
FAtiMA v1.0	S1	S2 Story 1	S3	S4 Story 2	S5
FAtiMA DA.1	S6	S7	S8	S9	S10
FAtiMA DA.2	S11	S12 Story 3	S13	S14 Story 4	S15
FAtiMA DAM.1	S16	S17	S18	S19	S20
FAtiMA DAM.2	S21	S22	S23	S24 Story 5	S25

[Table 1] Simulation plan and story repartition

[1] Note that both implementations have two entries in **[Table 1]** since they present two slightly different versions (i.e. small and high ranges of pre-selected eligible actions (cf. section 3.2.1)). The same versioning design applies to the different implementations of the game-master (i.e. GM v1.0, GM DA.1/DA.2, GM DAM.1/DAM.2).

Evaluation methodology

For this evaluation, we reduced the output of the stories created by the software to a text form (actions and speech actions) to avoid graphic quality or specific user interaction modalities influencing the outcome. Stories record the interactions between characters and were generated by the software itself. **[Table 2]** shows an example.

Agent	Action
Colonel	Let's be clear about what we are all about to do! No one has ever been down there! Our intelligence reported this site has a potential threat to our land security! We all know why we are here today! The technology possibly hidden in there is all that matters to us. In the unlikely event of an encounter of any type, we are to wipe this place down and make sure no one or nothing ever come out of this temple! Dead or alive!
Colonel	God bless you all. Military personnel in formation, others behind me, keep an eye for traps, and loose sight of each other. All right, let's go!
The party	Following your order Sir!
Sergeant	Colonel! Here! Here come here. I have something odd here; it looks like a metal door with strange writings on top of it!
Colonel	Professor! Are these hieroglyphs there above the door say anything of what might be behind it?
Professor	Hum Yes Colonel!, Well, this is strange, these do not appear to be conventional hieroglyphs! There are actually two sets of text there. One that can be interpreted as a death threat to any mortal disturbing the lizard gods, no idea whose these can be! The other one although looks like Egyptian hieroglyphs contains many symbols I have never encountered and does not make any sense to me I am afraid!
Colonel	Ok, Everybody step back! We are going to blow this one up and see what it is hiding. Bellini, MCLean hold assault position!
Professor	Colonel, this temple is thousands of years old, this door is magnificent and such artefact has never been discovered before! Surely we can't just blow it up, we need to find a way to open it or leave it as it is. This is an archaeological wonder!
Colonel	I am not sure you are getting the whole picture there Professor! Right here and right now I am in charge! You do what I tell you to do when I tell you to do it!
Colonel	Destroys the door and the door opens

[Table 2] An example of story generated (Story 1)

The stories were presented to a test-audience whose reactions, dramatic perceptions and judgment of dramatic intensity were documented with respect to character-based actions and plot events.

The evaluation plan designed for this application was composed of 5 different tests that aimed at assessing the dramatic values of the stories generated by the system. The first two tests (T1, T2) assess stories from a spectator perspective by presenting the user with a set of stories and asking them to mark and rank them by order of preference. Although T1 and T2 display the same stories to their test audience, these are slightly modified in T2 so all are of the same length. This is to establish whether the length of stories plays a role in the marking or ranking by the user.

The final three tests (T3, T4 and T5) aimed at assessing stories from a participative perspective and presented the users with the possible game-master (T3) and character (T4, T5) decisions at every cycle allowing them to choose for themselves what would happen. These stories, like their counterparts in T1 and T2 are then marked by the user. When the marking/ranking has been executed, the users are given further indications on the character's motivations and are asked about their decisions. This part of the evaluation could be related to the de-briefing session common to Role-Playing Games (RPGs).
The evaluation methodology has been designed in order to achieve the aims summarized in **[Table 3]**.

[Table 3] Evaluation aims and objectives

Aim	Description
1	Determine which story is judged most interesting by the test audience (spectators)
2	Determine if the length of the story is a factor in determining its dramatic factor and general level of interest
3	Rate the meaningfulness/interest of agents and game-master actions/decisions from a spectator perspective
4	Determine whether a better understanding of the characters and roles would influence the ranking and marking of stories
5	Determine which story would be generated by the user if given authorial powers
6	Determine which story is judged most interesting by the test audience (interactive users)

Results

The evaluation has been carried out on a total of 47 subjects (males (68.1%) and females (31.9%)).

Evaluation pointers

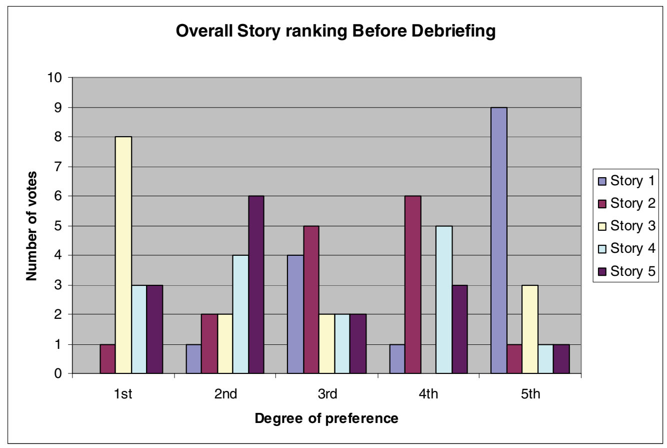
As with every evaluation process, it is essential to identify pointers that would indicate whether or not a given hypothesis possesses some tangible truth. In the case of this evaluation, we have identified a series of questions **[Table 4]** that require to be answered positively in order to demonstrate the validity of our approach. This list is not exhaustive by all means and focuses on the main aspects of the double appraisal theory (i.e. Dramatic efficiency, and comparison of the two implementations). It covers the basis for a more complete data analysis.

Evaluation question	Analysis pointer
(Q1) Does a double appraisal mechanism contribute in generating stories dramatically more interesting than if generated by a simple appraisal mechanism?	**(P1)** Story 1 (original FearNot!) should ranked and score lower than stories 2,3,4,5 (generated via double appraisal)
(Q2) Does an implementation considering the Emotions of all characters better at generating interesting stories than one only considering one character (self)?	**(P2)** Based on our assumption that DAM is potentially more complete than DA, Story 4 should score lower than Story 5.
(Q3) Is the consideration of all characters in a double appraisal contributes in generating overall more interesting stories?	**(P3)** Story 5 should score high on dramatic marking since it incorporate a double appraisal mechanism that takes into consideration all the characters of the scenario for both agents and game-master.

[Table 4] Evaluation pointers and questions

Results

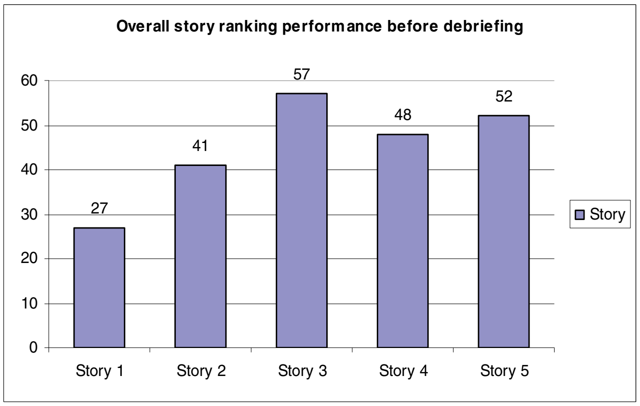
Q1. The overall story ranking (before debriefing) shown below in **[Figure 2]** provides elements of answers to Q1. The results have been provided by the test T1 and T2 and reflect a spectator's perspective on the ranking of our 5 stories. Whilst it shows a high ranking for story 3 (to be acknowledged in section 5.2.3), it also shows a poor ranking for Story 1.



[Figure 2] Overall Story ranking before debriefing

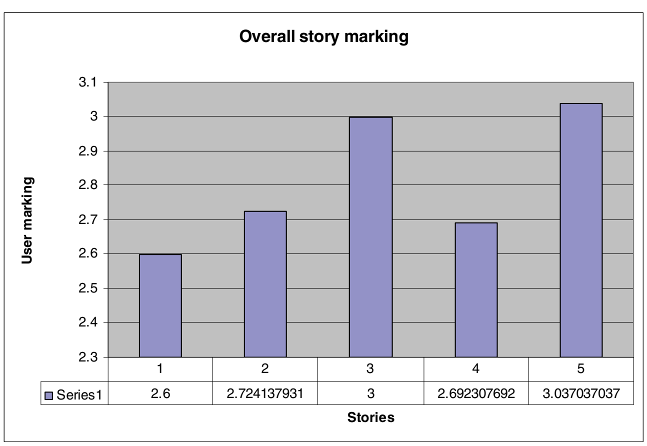
The story generated by the original single appraisal mechanism (Story 1) did not perform well in spectator ranking and has been perceived as the worst story of the test batch. This trend is also confirmed in **[Figure 3]** where individual story rankings have been translated into values in order to get a clearer picture of a story performance (averaging). This diagram shows to which extent Story 1 has been negatively perceived by spectator/reader users.Note that there are no significant differences in performance for story 1 between pre and post debriefing markings by users.

The results presented in this section indicate clearly that the single appraisal-based implementation (SA) scored lower than its double appraisal-based counterparts (DA/DAM). On another hand, whilst the DAM.2 implementation of the game-master generated a different story (Story 2) than the original SA-based approach (Story 1), its counterpart in DA did not make any difference on the outcome of the scenario and still resulted in Story 1. The two stories using the SA-based agents (Story 1 and Story 2) score also sensitively lower than agents fitted with either DA (Story 3, Story 4) or DAM (Story 3, Story 4 and Story 5).



[Figure 3] Overall Story ranking

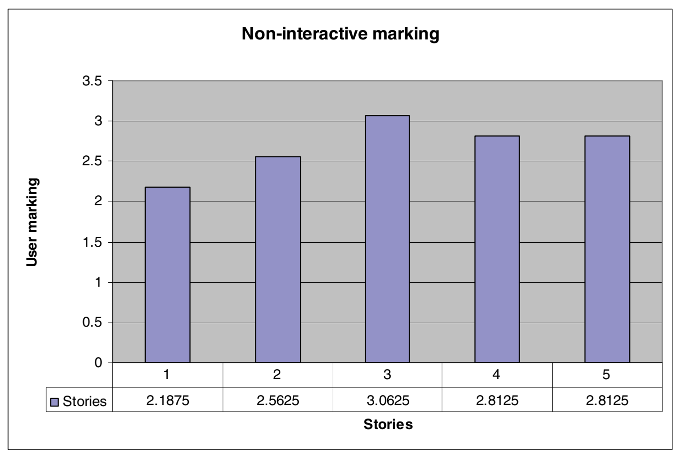
Q2. The results presented in this paper also show that agents or game-masters conforming to DAM tend to score higher than the ones conforming to DA. **[Figure 3]** demonstrates this by showing that Story 2 (game-master DAM) scores better than Story 1 (game-master DA). On another hand, the results detailed in **[Table 1]** indicate that they are no major changes in the actions of the agents unless they are interacting with a game-master of type DAM. The distinction between the two implementations discussed herein can however still be highlighted by the performances of stories 4 and 5. Both stories whilst, they feature the same version of the game-master DAM, present agents of the two different implementation types (DA = Story 4 and DAM = Story 5]). Both **[Figure 2]** and **[Figure 3]** show that overall, Story 5 outperformed Story 4 in the spectator/reader user ranking. This is further confirmed in **[Figure 4]** where the overall marking by all users (i.e. spectator/reader and interactive user) shows a net difference of appreciation between Story 4 and 5 in favor of the latter.



[Figure 4] Overall Story marking

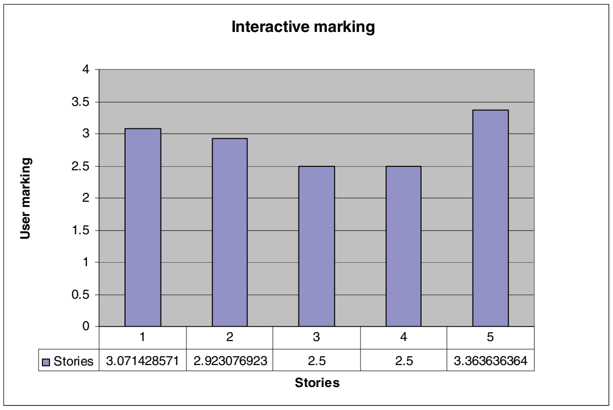
Q3. The results calculated for Q3 are interesting in the sense that two opposing claims could be regarded as significant in answering this particular question.
Claim 1: **[Figure 3]** seems to indicate a better performance and appreciation of Story 3 over Story 5.
Claim 2: **[Figure 4]** shows that Story 5 is the preferred story from a marking perspective.
The interpretation of these results alone is not sufficient for us to claim that the consideration of all characters in a double appraisal contributes in generating overall more interesting stories (Q3). It is necessary at this point of our analysis to focus on the nature of the tests performed in order to get a clearer idea of the validity of each claim. Claim 1 is based on spectator/reader user types whilst Claim 2 relies on interactive users. It is important to regard the marking for both perspectives (i.e. spectator/reader and interactive user) in order to make an educated decision on the validity of each claim.

[Figure 5] shows the overall story marking for non-participant users (Spectator/reader). It confirms, to a certain extent the results observed in **[Figure 3]** (Story 3 ranked better than Story 5) and shows that Story 5 is not the story receiving the better marks. It therefore contributes negatively to the hypothesis developed in this paper that a double-appraisal mechanism considering all the characters of a given scenario performs better than both its self-centered counterpart and a single appraisal mechanism.



[Figure 5] Non-interactive Story marking

On another hand, **[Figure 6]** presents another picture by showing a net marking advantage for Story 5 over the rest of the stories by interactive users. It is also interesting to notice in **[Figure 6]** the high marking performance of Story 1. This reinforce some of the claims made in [1] that an emergent narrative might not be perceived as interesting from a spectator/reader perspective as it would be from an interactive perspective.



[Figure 6] Interactive Story marking

In consideration to Q3, since the aim of this work is to produce interactive emergent narrative, we could understandably consider Claim 2 rather than Claim 1 as being the most significant for our results in the scope of this evaluation.

Conclusion

In this paper, we have demonstrated that synthetic characters can be enhanced to perform as actors by carrying out a second appraisal of their projected actions. The results presented herein show that the implementations proposed to extend an emotionally-driven agent architecture applied to the creation of emergent narratives (FearNot!) have positive impacts on the perceived dramatic values of the generated stories. Whilst these implementations were not equally as good in generating dramatic interest for the user (i.e. both spectator/reader and interactive user), they still produced simulations that scored higher than the original single appraisal-based architecture. On the basis of a direct comparison between the two different implementations carried out, DAM which considered the emotions of all of other characters in a scenario in order to make dramatic choices scored consistently higher than the more self-focused DA. This leads us to consider that DAM possesses a stronger dramatic potential than DA.

Finally, when comparing user marking for all stories, Story 5, which features DAM in both its agents and game-master architectures, scored the highest overall mark and was considered as the most interesting story to experience by interactive users. The results presented in the previous section show the validity of our approach and establish firmly our belief that narrative control can be exercised at character level in a distributive manner with satisfying results as long as the agents (i.e. characters) are provided with a mechanism that allows them to assess the emotional consequences of their actions on others.

This work is part of a larger theoretical work that has been investigating the emergent narrative concept for several years. Whilst significant, the results presented in this paper should be regarded as an early insight of what the overall evaluation process should come to deliver once the analysis of the data collected completed. Further work will consist in measuring the reactions, decisions and motivations of the participants in both marking and ranking the stories (spectator/readers and interactive users). Data will also be analyzed with regard to the dramatic weight associated to particular actions of the scenario and their potential impact on the user rating/marking. Finally, further theoretical work will investigate the areas of real-time narrative control, character-based narrative authoring and emergent narrative user interaction interfacing.

This work could also be extended to look at emotional trajectories rather than one-shot double-appraisal by considering sequences of planned actions rather than the goal-achieving action as at present. This would allow actors to explicitly consider the issue of dramatic climaxes.

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This work was partially supported by European community (EC) 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.