NetworkING: using Character Relationships for Interactive Narrative Generation

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ABSTRACT

In this work, we revisit the duality between character and plot in Interactive Storytelling, and demonstrate the important role of social relationships between virtual characters in the generation of narrative: an aspect that has hitherto been overlooked as a generation mechanism. We argue that the structure of social relationships between characters can be used as a powerful mechanism to determine a narrative, putting less emphasis on the details of plot structure. This enables character relationships in the network and the situations which naturally arise from character interactions to act as key drivers for narrative generation. The mechanism is fully implemented in a demonstration system which allows the exploration of the impact of changes in the social network on narrative diversity using a baseline set of narrative actions typical of the popular medical drama genre. Experimental results confirm our expectation that changes in the relationships between virtual agents in a social network can yield significant qualitative difference in system-generated narratives. This constitutes a new mechanism for narrative generation somehow closer to how modern dramas are shaped in specific genres, where situations and relationships are determinant.

Categories and Subject Descriptors

H5.1 [**Multimedia Information Systems**]: Artificial, augmented and virtual realities

General Terms

Algorithms, Performance

Keywords

Interactive Storytelling; Narrative Modeling; Planning

1. INTRODUCTION

Interactive Narrative is established as a key application for virtual actors [3, 20, 32, 37]. To date, the majority of approaches have been based on the generation of plot (in the tradition of [36] such as [30]. A clear advantage being that they provide a means to control the build up and release of tension, in the narratological sense [17]. In addition AI techniques, such as Planning [30] or Bayesian Networks [22], have been more frequently associated with the plot-based approaches because of their potential to generate causally-related action sequences. Despite the popularity of the plot-based approach, there has always been a duality between character and plot, with a more character-centric approach offering the promise of narrative variation: although this approach has failed to incorporate narrative elements beyond the projection of the plot onto individual characters' roles [7], especially when featuring more than two characters. Further, the type of character objectives and social relationships that are required in dramatic situations pose many challenges for cognitive modeling, in terms of representations and granularity. Indeed, narrative and cognitive logic are often at odds and regenerating the fine-grained determinants of narrative situations from first cognitive principles using basic motivations has proven elusive at best.

Interestingly, advice in the contemporary film and screen writing literature suggests that authors think initially, and perhaps primarily, of story in terms of characters, relationships and situations. This is the idea which we have explored in our work: to start from models of characters, the relationships between them, the situations that can occur and the stories that will necessarily arise from that. For example, McKee [5, 19] asserts that "stories involve characters in conflict with their social or physical world, in personal relationships with friends, family, lovers ..." [5, 19]. In addition, Phillips and Huntley [26] highlight the importance of relationships between central characters which add a "passionate" perspective in the story: "whether the relationship is romantic, professional, familial or otherwise, the conflicts in the relationship provide an emotional connection for the audience".

Social relationships and conflict dominate in serial dramas and soap operas: McKee cited the soap opera as a good example of personal conflict [19]; they present worlds filled with relationships that are in a constant process of dramatic change [1, 14]; and medical dramas, such as the series ER have been shown to elicit audience reactions to both dramatic events and character relationships [6]. Genres such as soaps, serial dramas and sitcoms can be seen as repetitive since they frequently feature different instances of the same elementary narrative actions. For example, the first series of ER included repeated instances of actions such as: seduction, romance, conflict over treatment, domestic conflict, professional rivalry and battles to save patients. Nevertheless, diversity is achieved within these genres as a result of

Appears in: *Proceedings of the 12th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2013), Ito, Jonker, Gini, and Shehory (eds.), May, 6–10, 2013, Saint Paul, Minnesota, USA.*

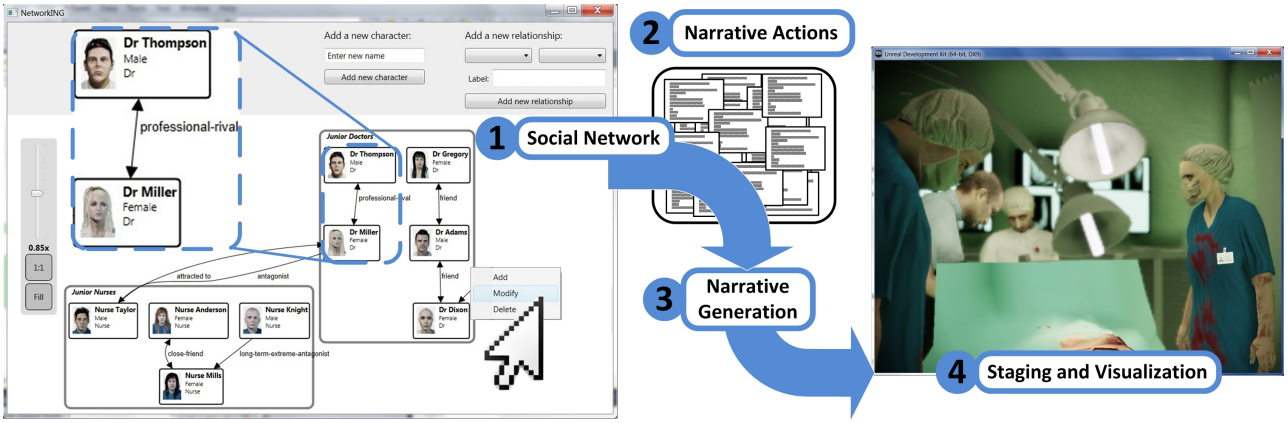

Figure 1: NETWORKING overview: (1) interface which enables users to make changes to the social network; (2) in combination with narrative actions typical of the genre; (3) narrative generation is then driven by the social relationships; (4) narratives are visualized on a 3D stage (using the Unreal® game engine).

changes in the relationships between characters and the conflicts and situations that arise as a consequence of this. We were motivated to explore a similar mechanism for diversity in narrative generation: the use of social relationships between characters and representative narrative actions from the genre as the determinants for narrative generation rather than authored variants around a baseline plot.

In this paper we introduce a novel approach to narrative generation based on a social network of characters, expressed using social relationships that best capture our target narrative genre. This approach has been fully implemented in a system called NETWORKING (social **Network** for **I**nteractive **N**arrative **G**eneration). The system features a visual interface to an Interactive Narrative set in a medical drama domain. Via the interface users can make changes to a social network of virtual characters and then these relationships, in combination with narrative actions typical of the genre, are used to generate narratives which are visualized on a 3D stage (see Figure 1). In this paper we also present experimental results that clearly demonstrate the impact of changes in character relationships in the social network on the diversity of generated narratives.

The paper is organized as follows: section 2 discusses related work. This is followed in section 3 with an overview of the social network at the center of our approach. Relevant aspects of narrative generation are considered in section 4. Section 5 presents an illustration of declarative control with the NETWORKING system. In section 6 experimental results are reported and we conclude in section 7.

2. PREVIOUS AND RELATED WORK

Models of the relationships between virtual agents have appeared in the literature but the focus has differed from our work: in some work the central focus wasn't social relationships and additionally the system wasn't aimed at narrative generation. For example, in the CYBERCAFÉ system [31] there was some consideration of character relationships, although the emphasis was more on personality traits and moods. The model of [8] was used as the basis of the character relationship model in MEXICA [25], although the emphasis of their work was the use of emotions in plot generation.

The GADIN system of [4] also included some description of character relationships, such as friendship, familial and love. However these are not the focus of reasoning in resolution of dilemmas or narrative generation in the system. Ware et al [35] introduced a computational model of conflict, which unlike the notion of dilemma is based on properties of the computation itself rather than requiring authored content. Within this model the level of conflict in a narrative is due to threats to the attainment of the narrative protagonists goals (in planning terms, their causal links).

Prom Week [18] features a playable model of social interaction where an author provides reusable and re-combinable representations of social norms and social interactions. For generation of narrative the system relies on rule based components and the model of character relationships isn't the driver for narrative generation in the system. The system of [23] attempted to simulate the dynamics of virtual characters' emotions and social relations. It incorporated aspects of the OCC model [24] and a model of interpersonal relations in conversation [33]. However the emphasis of this work was to simulate the dynamic nature of emotions and relations and not the generation of narrative. In [13], Gratch created characters whose emotions and social relations influence their social interactions with other virtual characters. A social reasoning layer was used to exercise control over a planning system but this employed social rules rather than employing the relationships as a control mechanism.

3. SOCIAL NETWORK OF CHARACTERS

The key objective of this work was to demonstrate how a social network could be used as a declarative basis for narrative generation. Hence it was necessary to model the social network at an appropriate level of granularity: on the one hand it was important to keep the size of the relationship classification manageable for users; and on the other, obtaining an acceptable degree of change was also important (in terms of narrative distance as a consequence of relationship changes).

3.1 Rationale for use of Social Relationships

Figure 2 shows the categories of social relationships we selected for use in our social network. The relationships are classed as either Affective, Romantic or Default, and the figure includes the relationship names and their types.

The Affective and Romantic relationship categories have featured in earlier relationship models for virtual charac-

	Relationship Name
Affective	friend close-friend long-term-close-friend antagonist extreme-antagonist long-term-extreme-antagonist professional-rival
Romantic	long-term-partner dating secretly-dating attracted-to romantic-rival
Default	indifferent-to

Figure 2: Virtual Character Social Relationship Classification split into Affective, Romantic and Default. See section 3 for classification rationale.

ters. For example, the MEXICA system [25] used the model of Dyer [8], which distinguished between brotherly love and romantic love. Similarly the model of Svennevig [33] included a measure of the degree of liking. However, these models had numeric scales to refer to affective and romantic relationships (e.g. a range of -3 to +3 [8]) whereas our model uses names for ease of use given the narrative context.

The vocabulary for the Affective and Romantic relationships shown in Figure 2 came in part from relevant ontologies such as FOAF [9] and RELATIONSHIP [28]. For instance those concerning affective relationships such as: *Friend Of* and *Antagonist Of*. It was decided to exclude family ties, such as: *Child Of, Parent Of* and work relationships, such as: *Apprentice To*, and *Colleague Of* since they are not strictly social relationships. These aspects are part of the characters respective roles' and are qualitatively different (for instance, they do not change simply as a result of social interaction). Hence they are not part of the social network: rather they are part of the narrative domain model (see section 4).

The relationship names also incorporate some common concepts from Social Network Analysis (as proposed for ontologies such as FOAF [21]): "tie strength" [11], relationship history and duration. In our classification these are reflected in the distinction between depth of feeling and relationship duration between for example, friend and long-term-close-friend. Also, incorporated is relationship provenance: individual participants can view relationships differently and hence we allow for asymmetrical relationships.

Finally, the relationship classification also included key social relationships relevant for the medical drama genre, identified through analysis of episode synopses of *ER, House and Scrubs* [34]. These relationships include: professional-rival e.g. *"bitter rivals Cox and Kelso"* Scrubs (season 2, 19); secretly-dating e.g. *"Carter embarks on a secret relationship"* ER (season 3, 7); and attracted-to e.g. *"Benton hides his attraction to a married woman"* ER (season 1, 23).

3.2 Social Network User Interface

Figure 1(1) shows a screenshot from the NETWORKING Editing Interface. It shows a graphical representation of the current state of the social network, with characters as nodes, relationships as arcs and characters clustered according to their role (such as Junior Doctors). Users can add, delete and change relationships, with graph drawing and layout of the social network handled automatically [12].

The system allows a virtual character to have exactly one relationship with each other character in the narrative domain. These relationships are explicitly represented in the graphical representation, with exception of the default relationship, indifferent-to, which is not represented to avoid over cluttering the graph. To illustrate: there is a friend relationship between Dr Gregory and Dr Adams, as shown by the bidirectional edge (symmetrical); Nurse Taylor is attracted-to Dr Miller but this is not reciprocated and she is antagonistic to Nurse Taylor hence the differently labeled edges (asymmetrical); and Nurse Taylor and Nurse Anderson are indifferent to each other hence no arc between them.

4. NARRATIVE GENERATION

Following in the dominant tradition [30,36], narrative generation in the system uses planning: our decomposition-based approach where interesting narrative situations or landmarks can be used to control generation [27]. Within this approach, generating a narrative is a search problem for a plan: an ordering of pre- and post-condition actions for a goal and initial state from the narrative domain of interest.

For our medical domain, the basic planning actions are those that characterize the genre, such as conflicts over patient diagnosis, treatment, professional rivalries, battles to save patients, romance, domestic conflicts and support for friends and colleagues[1]. The process of modelling narrative actions is as detailed in [27], with the inclusion of sets of actions whose relevance to a narrative is dependent on the relationships between characters e.g. the action *spread-malicious-gossip* (action A4 in Fig. 4) is relevant when the relationship is one of extreme antagonism, whereas an action such as *show-appreciation-treatment-advice* (action C9 in Fig. 4) is relevant when the relationship is friendly. Narrative goals are also characteristic of the genre and relate to the resolution of situations that arise e.g., the narratives shown in Fig. 4 feature goals relating to the resolution of a medical conflict between doctors over a risky treatment and a conflict arising out of pressures of work (these narratives are discussed further in section 5).

The domain model used in our experiments included 10 doctors, 5 nurses, 3 patients and close to 100 narrative actions (resulting in approximately 25,000 action instances when parameters were grounded to virtual characters and objects). For a given narrative only some of these characters and objects will be included as required by the subgoals. For example, the narratives in Figure 4 include 8 out of the 10 doctors.

4.1 Idioms in Narrative Generation

When narrative generation produces a significant number of alternative stories, their properties can no longer be analyzed by simple visualization or inspection. The automatic detection of key situations through *idioms* [2] offers an efficient mechanism to exploit inner mechanisms and representations (e.g. for automatic camera control). For the evaluation (section 6) idioms are used to capture the importance of characters within a narrative. A *S-V-O* syntax is adopted for narrative events; *S* is the character acting as subject, *V*

[1]We note that interactions between virtual characters can cause changes in their social relationships however discussion of these dynamic aspects is beyond the scope of this paper.

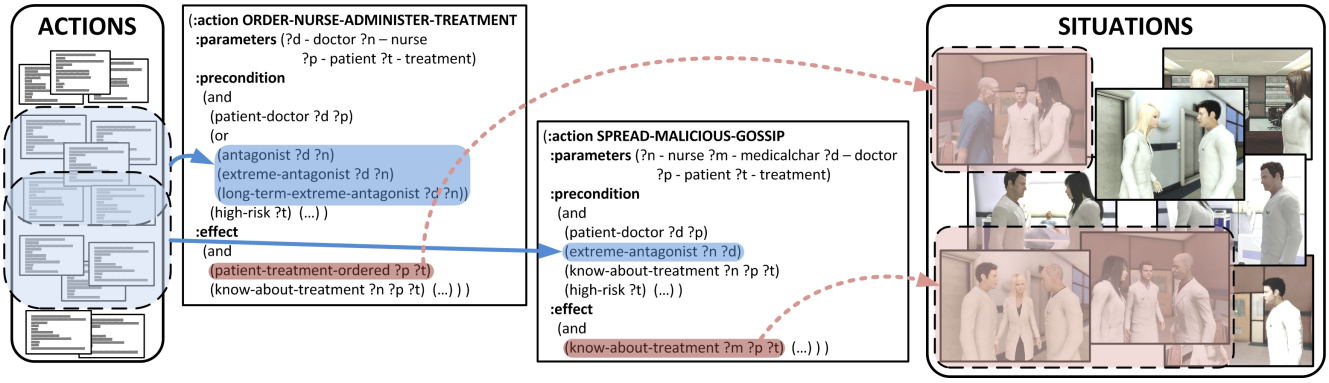

Figure 3: Narrative actions formalised as PDDL operators. Changes in social relationships impact on the applicability of pre-conditions of narrative actions, thereby modifying the action selection process.

the action performed and O the narrative object acted upon.

We distinguish between *Feature* and *Supporting Characters*. Feature characters are central within the context of narrative sub-plots and can appear as S in narrative events. We use a domain modeling convention where they are explicitly named in narrative goals. As their name suggests supporting characters play a secondary role in the context of a given sub-plot although they can be S in some actions. As an illustration, in Figure 4 in the context of the goal *medical-conflict-resolved* Dr Gregory and Dr Adams are feature characters and Nurse Knight is a supporting character.

4.2 Narrative Social Relationships

Social relationships between virtual characters serve a number of functions for narrative generation. Firstly, the state of the social network changes the possibility of different narrative actions appearing in a generated narrative. For example, if characters have positive relationships, such as the friend relationship that features in our classification in Figure 2 then they are more likely to support, discuss, arbitrate and so on, whereas characters with negative relationships (such as antagonist in Figure 2) are more likely to confront, argue, gang up on others and so on.

Another function of the social relationships is that, as a consequence of different action selections, the possibility of different situations occurring in the narrative is changed. Although this does not result in a SIMS^{TM} like system in which actions will be directly dictated by local relationships. This is because the use of planning supports the generation of causally connected narratives with strong causal cohesion and long-distance effects propagated through the narrative.

These types of consequences of changes to the social network are illustrated in Figure 3. For example, the action *order-nurse-administer-treatment* relates to a situation where the doctor in charge of a patient case has an antagonistic relationship with a nurse with whom they conflict in the process of ordering the administering of a high risk treatment. An effect of this action is that the nurse knows about the high risk treatment, opening up the possibility of the narrative developing in different ways depending on how they view the relationship (for instance, whether they reciprocate the antagonistic feelings, are attracted to the doctor and want to "win them over" or if they are indifferent). The other action in the figure, *spread-malicious-gossip*, captures the situation where the nurse has extremely antagonistic feelings towards the doctor and thus opens up the possibility of spreading gossip to others about the high risk treatment.

Actions of virtual characters can also be determined, in part, by their non-social roles. For example, the characters in a medical genre are required to act appropriately as medical personnel, patients and so on although social relationships will effect this. For example, despite their social relationships, the nurse and doctor in the actions in Figure 3 are still required to carry out their professional duties.

5. EXAMPLE: NETWORK-DEPENDENT NARRATIVE GENERATION

The key objective of this work was to demonstrate that a social network could be used as a declarative basis for narrative generation. Our approach to this has been implemented in the NETWORKING system: an interface enables users to make changes to social relationships which, in combination with genre-typical narrative actions, are used to drive narrative generation. Figure 4 shows sample output that illustrates the diversity of narrative that can result from user changes to the social network.

Across the top of the figure are three different configurations of the social network resulting from a series of user changes to relationships (e.g. one relationship changed is Dr Thompsons' relationship to Dr Laverick: the user has changed it from antagonist in (A); to extreme-antagonist in (B); to friend in (C)). Below each network are shown traces of 3 narratives, generated for the same goal conditions, and an initial state which differs only with respect to the relationship facts that change in the social network (updated by the system immediately before narrative generation).

The system-generated narratives are illustrated as traces running down Figure 4. The traces show the names of the narrative actions, a brief synopsis of the action and screen shots indicative of the 3D visualization. Colors have been used to link the different configurations of the social network to the corresponding generated narrative: green for (A), blue for (B) and red for (C). Within each narrative, causal chains for the sub-goals are shown via solid and dotted black lines.

From the figure, it can be seen that the 3 narratives contain very different narrative actions: out of the total of 28 actions appearing in the narratives only 4 are shared.

Further, if one considers the synopses of each action, it can be seen that the narratives contain very different content. For the sub-goal *medical-conflict-resolved*: (A) features a rival doctor who tries to gain advantage but fails because the boss is a good friend of the rival, willing to give the

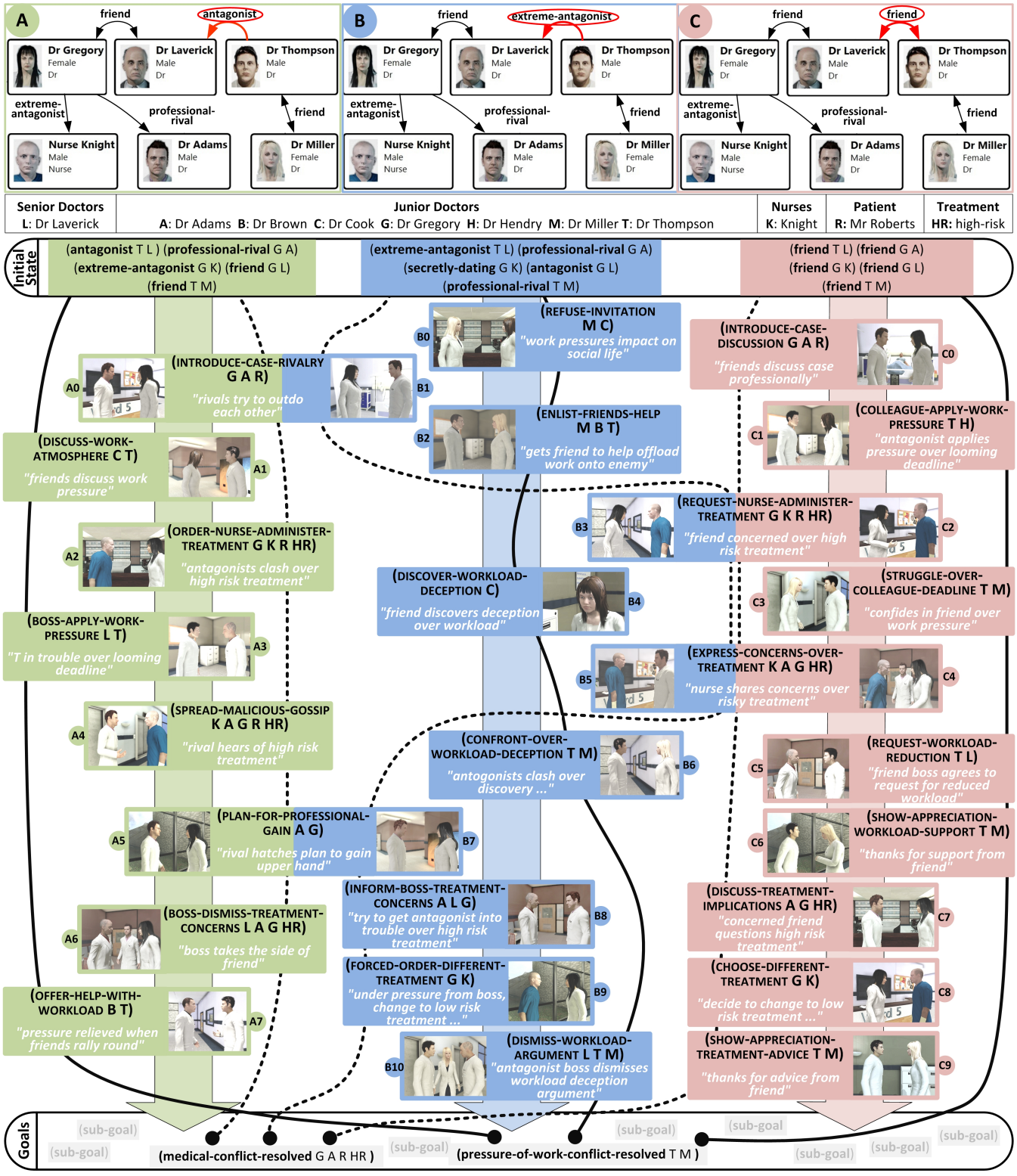

Figure 4: Illustration of Declarative Control: (A-C) show user generated social network configurations and 3 narratives generated using those specifications below them (with solid/dashed lines indicating the causal chains for each sub-goal). Narratives contain different actions with only A0/B1, B3/C2, B5/C4, A5/B7 shared. Narrative content and endings differ e.g. for the sub-goal *medical-conflict-resolved*: (A) boss sides with a friend; (B) doctor forced to change treatment; (C) doctor accepts friends low-risk advice.

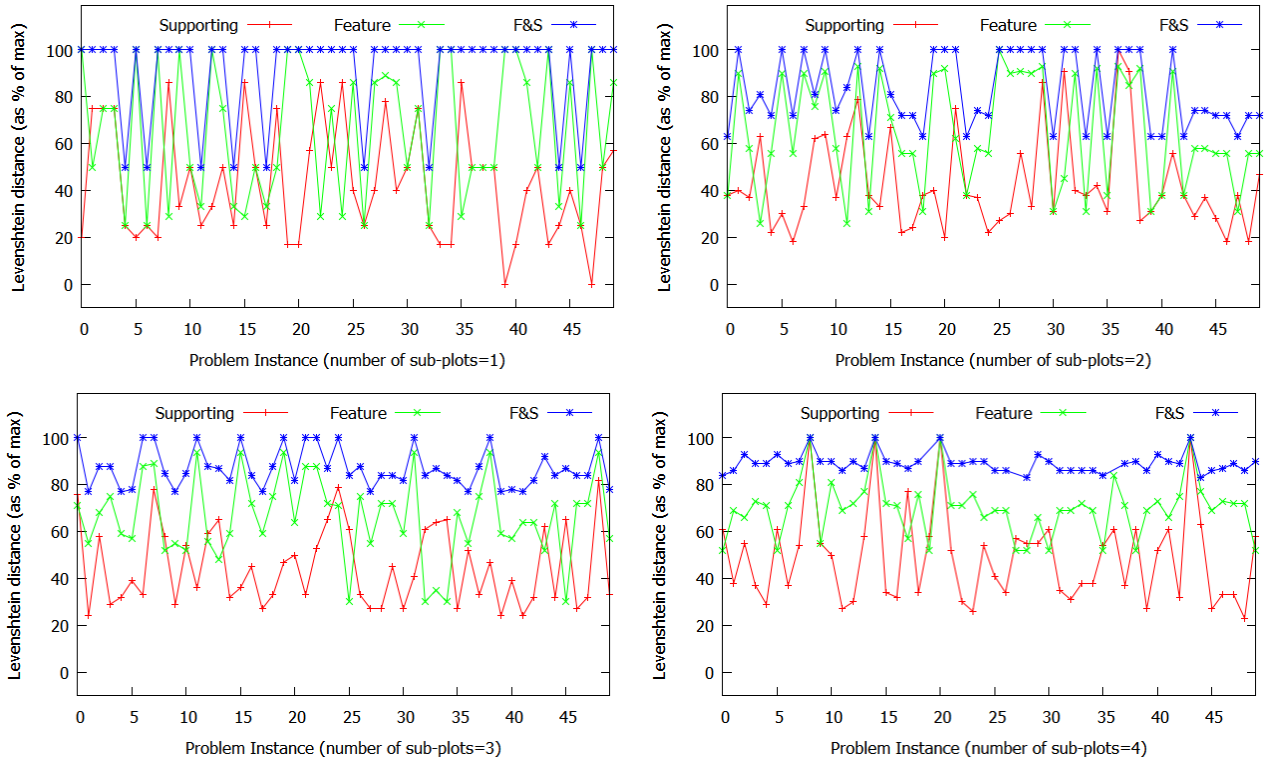

Figure 5: Experimental results: tests were run on problems with 1-4 sub-plots; Levenshtein distance was used to measure the difference between pairs of narratives; the results show increasing levels of diversity resulting from changes in relationships to supporting characters (v_2), feature characters (v_3) and a combination of both (v_4); the highest level of diversity occurs for variants with changes to both supporting and feature characters with a difference of 87.69% over the whole problem set (37.5% achieving 100% difference).

"benefit of the doubt"; (B) features the same rival doctor but here they win out since the boss is an antagonist of the rival who is forced to change the patient treatment; and in (C) the conflict over risky medical treatment comes from a doctor friend who manages to talk the doctor into a process of self-reflection and eventual change in treatment.

For the sub-goal *pressure-of-work-conflict-resolved*: (A) features the doctors friends who offer to help with their workload; (B) has an overworked doctor who enlists the help of a friend to offload their work onto another doctor, who, on discovering what is going on fails to get help from their boss with whom they have an antagonistic relationship; and in (C) a doctor who is struggling with the work pressure being placed on them by a colleague, gains support from a friend and is able to successfully present their case for assistance to their boss.

In addition, other characters appear in narratives e.g., Dr Brown is required in (A) as Dr Thompsons' friend and an ally of Dr Miller in (B), whilst Dr Hendry causes Dr Thompsons' work pressure in (C).

6. EVALUATION

In our earlier work, where similar narratives to those discussed in this paper were generated, the results of user studies demonstrated their quality in terms of narrative interest and story understanding [10]. Narrative interest was assessed using physiological measurement of surface electromyography and galvanic skin response, with users demonstrating significant appropriate responses to narrative events. It was also shown, via the use of QUEST graph analysis [29], that users gained a proper understanding of the narratives they watched. Hence the focus of this evaluation was to demonstrate the impact of changes to social relationships on the diversity of these interesting narratives.

Our working hypotheses were: firstly, that the level of granularity of relationships in our social network would result in an acceptable balance between number of relationships changed and variation in generated narratives; and secondly, that increasing levels of diversity in generated narratives would result from changes in relationships between supporting characters, feature characters and a combination of both.

6.1 Measuring Narrative Variability

Narrative comparison can be seen as a sequence comparison problem as in Bioinformatics where measures must take into account features such as common subsequences [15]. For the purposes of our evaluation the base unit used for comparison was narrative action name, with parameters ignored, to ensure that the units of comparison were qualitatively different. As an example, this would prevent narrative sequences being judged different when one contained multiple instances of some action, say *spread-rumor* between a series of characters, and the other only a single instance of it.

The metric we used for measuring distance between two narratives was the Levenshtein Distance [15, 16] which is based on the notion of the edit distance between two strings

i.e. the minimum number of editing operations needed to transform one string into another (edit operations are insertion of a symbol, deletion of a symbol, and substitution of one symbol for another) and which allows comparison of strings of different lengths. Action names are mapped to unique characters to obtain suitable strings for comparison.

The Levenshtein distance can in some cases be misleading when plans have shared but re-ordered sequences of actions. To guard against this for the problem test set used in our experiments, we ran a series of tests to show that the occurrence of such common subsequences was low and when they did occur the Longest Common Subsequence (LCS) [15] was relatively small with respect to the maximum possible. The tests confirmed that shared subsequences did indeed occur infrequently (20% of 800 narrative instances) and when they did, the LCS length was less than 25% of the maximum possible (the length of the shortest compared string). For our medical domain the semantic explanation for the occurrence of such subsequences is the requirement for actions relating to diagnosis, treatment and care of patients.

6.2 Narrative Impact of Social Relationships

A test set for experiments was created by randomly generating problem instances, which described an initial state of the narrative domain along with a number of sub-goals for the narrative (as outlined in section 4) and a random assignment of relationships in the social network. Then for each problem instance, v_1, variants v_2, v_3 and v_4 were created by changing relationships between **S**upporting characters (v_2), between **F**eature characters (v_3) and between **S** and **F** (v_4).

A total of 50 random problem instances (initial state and goal condition), variant v_1, were generated for 1, 2, 3 and 4 sub-goals. Then for each of those 200 problems, variants v_2, v_3 and v_4 were generated by changing the relationships as outlined above. Then narratives were generated (using our plan-based approach [27]) for each of these 800 problem instances. The generated narratives were then compared using Levenshtein distance: pairwise comparisons between (v_1, v_2), (v_1, v_3) and (v_1, v_4). The results are plotted in figure 5, expressed as a % of the maximum possible difference.

With respect to the difference in variation between changes to Supporting characters and Feature characters the plots clearly show that the impact of making changes to the feature characters is greater than changes to the supporting characters. Further, the largest amount of narrative difference is obtained by making alterations to the relationships between both feature and supporting characters.

It can also be seen that when changes are made to the relationships between Feature and Supporting characters the average pairwise difference between narratives is 87.69% across the problem samples with 100% difference on 37.5%.

6.3 Quantifying impact of relationship changes

The impact of relationship change is a measure of how much narrative difference results from making a change to a relationship in the social network. To assess this, we randomly generated a test set of 10 problem instances (consisting of initial state and 4 sub-goals) and then generated a number of variants of each instance where incremental changes to relationships between characters (v_1 is the original problem instance, in v_2 1 relationship was changed, in v_3 2 relationships, ..., and in v_n n-1 relationships).

Our narrative planner was used to generate narratives for this problem set and then the Levenshtein distance between each variant v_1, and then incrementally differing variants $v_2, v_3, ..., v_n$ were calculated. Figure 6 shows the number of actions required before the amount of narrative change reached a threshold of 60% of the maximum possible. The figures show this being reached as a result of 4 relationship changes, for 90% of the generated narratives. Since the problem set used for these experiments featured 4 sub-goals these figures were seen as acceptable: they suggest a considerable yield from changing a single relationship per sub-plot, with yield increasing with the number of changes.

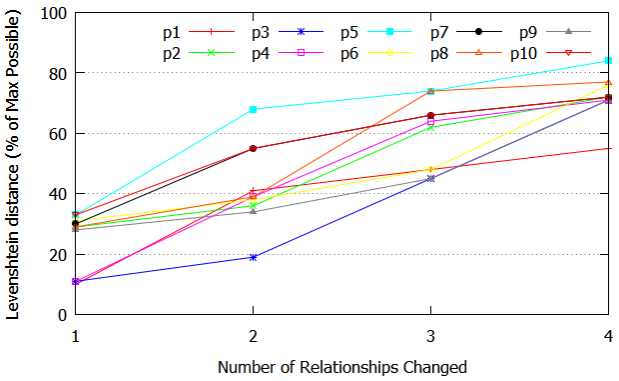

Figure 6: Impact of relationship changes on narrative diversity: Levenshtein distance plotted against number of character relationships changed (for 10 problem instances). A 60% threshold was reached for 9 instances for changes to 4 relationships.

7. CONCLUSIONS

The results presented in the paper confirm our expectation that, in a genre where baseline actions are recurrent, such as the serial medical drama, social network modifications can be a powerful mechanism for narrative generation.

Our approach constitutes a novel direction for narrative generation with a move towards an authoring approach that is closer to how modern dramas are shaped in specific genres: those where situations and relationships are determinant. Also novel is the scale of narrative generation that has been demonstrated, with relatively small changes in social relationships yielding large changes across hundreds of narratives generated in the course of our experiments.

8. ACKNOWLEDGEMENTS

This work was funded in part by the European Commission through the FP7 Open FET "MUSE" Project (ICT-296703). Visual content developed by Catherine Dixon and Matthew Laverick of Teesside University. Character models purchased from aXYZ Design http://www.axyz-design.com.

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