Generator of Adaptive Dilemma-based Interactive Narratives

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For my brothers, without whom this would never have been possible

Abstract

This thesis presents a system for the Generation of Adaptive Dilemma-based Interactive Narratives (GADIN). An interactive narrative is a game world in which the user controlled character(s) can physically and mentally interact with ideally perceived total freedom while experiencing a dramatically interesting narrative which is fundamentally different on nearly every play — dependent on the user's actions. The creation of an interactive narrative system should be based on both narrative theory and principles from existing computer games. GADIN generates interactive narratives which are focused on dilemmas to create dramatic tension. The system is provided with knowledge of generic story actions and dilemmas based on those clichés encountered in many storytelling domains. The storyworld creator is only required to provide domain specific background knowledge, such as information on characters and their relationships, locations, actions and dilemmas. The dilemmas and story actions are instantiated for the given storyworld and a planner creates sequences of actions that each lead to a dilemma for a character (who can be the user). The user interacts with the storyworld by making decisions on relevant dilemmas and by freely choosing their own actions. Using this input the system chooses and adapts future storylines according to the user's past behaviour. To evaluate the success of an interactive narrative a series of criteria known as the compellingness criteria are used. These criteria are: interestingness; immersion; scalability; domain independence; agency; and replayability. A successful system will have a high degree of compellingness. This has not been achieved by any previous interactive narrative systems but is by GADIN, as demonstrated in this thesis.

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This thesis is the original work of Heather Barber and describes research carried out at the University of York. Some of the material contained in this thesis has appeared in the following published book chapters and conference papers.

Refereed book chapters

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Adaptive Generation of Dilemma-based Interactive Narratives. Heather Barber and Daniel Kudenko. In proceedings of *Adaptive Approaches for Optimising Player Satisfaction in Computer and Physical Games*, Rome, Italy, October 2006.

Interactive Generation of Dilemma-based Narratives. Heather Barber and Daniel Kudenko. In proceedings of *Narrative AI and Intelligent Serious Games for Education* symposium, AISB'07, Newcastle, England, April 2007.

Dynamic Generation of Dilemma-based Interactive Narratives. Heather Barber and Daniel Kudenko. In proceedings of *Artificial Intelligence and Interactive Digital Entertainment Conference*, Stanford, California, June 2007

A User Model for the Generation of Dilemma-based Interactive Narratives. Heather Barber and Daniel Kudenko. In Optimizing Player Satisfaction technical report, AIIDE'07, Stanford, California, USA, June 2007.

Generation of Dilemma-based Interactive Narratives with a Changeable Story Goal. Heather Barber and Daniel Kudenko. In proceedings of *International Conference on Intelligent Technologies for Interactive Entertainment*, Playa del Carmen, Mexico, January 2008.

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1

Introduction

This chapter begins by contextualising the concept of interactive narrative, from narratives and computer games. The contribution made by GADIN is then discussed. The chapter finishes with an overview of the thesis.

1.1 Narratives

Storytelling is appreciated by many people, whether they are the teller or audience. In the past stories were only told orally, with audience participation. It is still true that listening to a friend narrating a story is an enjoyable way to spend time. However, as storytelling has evolved — through drama, writing, print, film and television — interactivity has been neglected.

Receivers (listeners, readers or viewers) of a story will often believe that they know best as to how the story's characters should act, and can be frustrated by their lack of control over this. They may want to become more involved in the storyworld, to play a more active part — perhaps even to become a character. An interactive narrative offers a world in which the participant can have a real effect — both long and short term — on the story that they are experiencing. It is often said that the best stories transport their audience into the world of the story, yet the actions of the characters may be contrary to what the audience would imagine. Interactive narrative overcomes this problem as the user (the participant) is able to freely act within the world and still experience a unique, exciting and participatory story.

1.2 Computer games

A computer game is a game which is usually played within a computer-simulated virtual world. Such game worlds have become increasingly complex through years of development of computers and their games. Games have moved on significantly since the simplicity of early games such as Pong [36], with many

improvements and expansions. The computer game industry had reached a relative ceiling in this development, with the only significant innovations occurring in game graphics. This is beginning to change, with increasing AI in game characters and a stronger story element.

Most modern computer games involve a story. In general this is an essentially linear story or series of stories. As a result this element generally violates a basic requirement for such games — the need for interaction which has a clear effect. A player who is experiencing a game with a story element will expect to have a genuine impact on that story. Otherwise the player's enjoyment of the game, and their agency within the game world, will be reduced. There are games with no explicit story structure — in which the player is encouraged to perceive their own stories within the world. These stories are truly interactive but lack the skill of a playwright and subsequently lack a significant level of dramatic impact. An interactive narrative combines the free interactions of the player with this play writing skill to create a dramatically interesting game playing experience.

1.3   Interactive narrative

There are various definitions and conceptions of interactive narrative [9, 13, 16, 66, 73, 76, 81, 92, 95, 100, 111, 125]. These have core similarities and identify the same essential requirements. It is generally held that interactive narratives must take place "using a computer" [73] in "rich, highly interactive worlds" [9]. In these worlds there are "discrete computer characters, each playing specific roles in the story" and it is "the ability to create descriptions of compelling and novel action sequences that will be used to drive the plot experienced by the system's user." [125] The narrative generated must be one in which "the user can interact" [13] and is even "able to perform any action on the fiction[al] world that the other characters can perform" [111]. The overall experience should be "shaped by aesthetically pleasing stories" [9].

In some definitions it is felt that the "resulting story should be dependent both on the story world's author as well as the user's interactions with that world." [74] In such cases the system is "balancing the user's control over the environment with the need to preserve the coherence of the unfolding storyline." [125] Other systems necessitate only the storyworld being pre-defined, as the "plot is dynamically shaped by the interaction between the user and the rest of the cast." [100]

The existing definitions of interactive narrative generally consist of preferred components rather than a coherent full definition. Having considered these the concept of interactive narrative as it is used in this research can be defined. This is given here and elaborated on in section 2.4.1.

An interactive narrative is a game world in which the user-controlled character(s) can physically and mentally interact with ideally (perceived) total freedom while experiencing a dramatically interesting narrative which is fundamentally different on nearly every play — dependent on the user's actions.

1.4   GADIN

This thesis introduces a method of generating adaptive dilemma-based interactive narratives, GADIN. The GADIN system is demonstrated to satisfy essential criteria for interactive narrative which the architectures used by other systems are not capable of addressing.

Many storytelling domains make frequent use of clichéd storylines which focus on dilemmas to storyworld characters. These dilemmas can be generalised and provided to the GADIN system, which presents instantiations of these (to characters who may include the user) in the generation of an original narrative. This is the first system to use dilemmas to provide dramatic interest in a computer-generated narrative. The GADIN architecture uses planning to achieve such dilemmas, and the combination of plan and dilemma constitute a dramatically interesting sub-story of the generated narrative. An example of a dilemma is a character having to decide whether to cheat on their partner. This dilemma is shown in the context of a GADIN-generated narrative in appendix B (lines 2-19 show the build-up to an instance of this dilemma, which is presented to the user on lines 20-21).

Throughout the narrative characters make decisions and action choices depending on their individual properties and state. The user is able to freely select their own actions (from a number of available options) and make decisions when presented with dilemmas. These are then incorporated into the narrative, whether as part of a plan for a user, or other character, dilemma or in a way which will be otherwise responded to by other characters. No actions are ever imposed on the user. If they do not act in accordance with a plan an attempt can be made to coerce them to do so. The failure of the user to follow the plan causes the selection of another appropriate dilemma and plan combination. Various techniques are used to ensure that the user experiences as many dilemmas as possible while still maintaining their freedom within the storyworld.

To increase the dramatic interest for the individual user a user model is incorporated into the GADIN system. This models the user's actions, choices and dilemma decisions and predicts their likely future decisions. This is then used to select for presentation the dilemma which is likely to result in the most difficult decision for the individual user.

In generating a finite narrative the GADIN system is able to select, achieve and make clear to the user a story ending. This ending may change throughout the narrative, depending on how the user acts. The story ending may be any proposition which has not previously been true within the narrative.

In a conventional narrative the audience may know more than the characters and this represents a potential problem in an interactive narrative, which is addressed to some extent in the GADIN system through the incorporation of information which only certain characters may have knowledge of.

The incorporation of dilemmas to provide dramatic interest is an entirely novel approach to generating interactive narratives, which does not rely on any pre-defined structure for narrative generation. The use of a user model to increase the dramatic interest for the individual user has not been previously utilised by a first-person interactive narrative system. In addition the incorporation of a number of endings proportional to the number of possible propositions represents an improvement on other systems, which have a very limited number

of possible endings for generated narratives.

There are a number of criteria which must be satisfied by an interactive narrative system. These are known as the compellingness criteria, and are discussed in detail in section 1.6. They are: interestingness; immersion; scalability; transferability (domain independence); agency; and replayability. Previous systems have been unable to satisfy all of the criteria required for compellingness. The thesis hypothesis is thus that "a computerised dilemma based user adaptive interactive narrative generator based on the GADIN architecture can create a compelling interactive narrative experience".

Experiments presented in this thesis show that the GADIN narratives were found to be as interesting as those in the original domain. Immersion is limited by the interface but could be increased. The soap narratives will continue indefinitely, demonstrating scalability, and the transferability of the core architecture of the system to many domains demonstrates domain independence. The users felt that they experienced a reasonable level of freedom, but the number of available actions would ideally be increased. There is a clear immediate and long-term effect of these actions. The narratives were found to be sufficiently original, and users generally felt that they would replay. This shows that the GADIN system is capable of achieving a high degree of compellingness and is able to achieve full compellingness, demonstrating achievement of the research hypothesis.

1.5   Terminology

In the field of interactive narrative research there is much diversity regarding terminology. This is particularly the case for the research area, for which there are many terms used, including 'interactive narrative', 'interactive drama' and 'interactive storytelling'. In this research the term 'interactive narrative' is deemed to be the most appropriate as narrative is defined as the "part of a text, esp. a work of fiction, which represents the sequence of events, as distinguished from that dealing with dialogue, description, etc."[84], and the generation of this is the focus of this research. This has previously also been called a plot summary.

This thesis contains a glossary of the terms which are used in this research.

1.6   Compellingness criteria

Interactive narrative can be seen as the union of computer games with narrative theory. Most of the requirements of these fields, as discussed in sections 2.2 and 2.3, will thus apply to interactive narrative. There are additionally considerations unique to interactive narratives. Laurel's 1986 thesis (see [66] for a summary and continuation of this work) was the first to address the concept, and to identify the main such requirements, although the ideologies were never implemented. Subsequent work [9, 13, 16, 20, 74, 76, 79, 81, 83, 90, 92, 99, 109, 112, 126] has considered these in greater depth and breadth, and has resulted in the production of a range of interactive narrative systems.

In existing research certain criteria have been found to be inarguably essential for an interactive narrative. The criteria considered in previous research

provide the basis for those measures for the success of an interactive narrative system introduced here. These are known as the compellingness criteria, where compellingness is defined to include all required features of an interactive narrative. The compellingness criteria must be satisfied by an interactive narrative system. They are given and elaborated on in this section. Also discussed here are the methods for evaluating the system in accordance with particular criteria. These criteria address all of the issues given in the utilised definition of interactive narrative: "An interactive narrative is a game world in which the user-controlled character(s) can physically and mentally interact with ideally (perceived) total freedom while experiencing a dramatically interesting story which is fundamentally different on nearly every play — dependent on the user's actions."

Roberts and Isbell [91] discuss criteria for the evaluation of interactive narratives for which the system includes a drama manager. The disadvantage of these is that they focus only "on game analysis". These criteria are mainly specific to the drama manager and storyworlds with a fixed narrative, and to training worlds rather than those in which the main purpose is storytelling. The compellingness criteria have a greater focus on the user.

The compellingness criteria are: interestingness, immersion, scalability, domain independence, agency and replayability.

1.6.1   Interestingness

The objective measurement of the dramatic interest (or 'interestingness') of a narrative, what makes a story good, is a classic problem in storytelling and its analysis. Despite there being no formula for this, an audience will always know whether they found a narrative interesting or not. This means that the best way to measure the interestingness is through questionnaires in which users rate how interesting they found the narrative. An ideal interactive narrative system would have a very high level of interestingness according to the user.

The pre-defined components from which the narrative is generated will affect the interestingness of the experience. These should be identified in evaluating the interestingness of an interactive narrative system.

1.6.2   Immersion

Immersion requires a user to become fully absorbed in an experience, to the exclusion of all other stimuli. It is considered to be an essential criteria of interactive narratives. Immersion in computer games is discussed in more detail in section 2.3.3.

Given that it is dependent on an individual's playing experience, it is not possible to empirically measure the immersion of a system. However, it is possible to identify various factors as improving the immersion experienced. Whether the user found the other characters and the storyworld plausible will have a significant effect on their sense of immersion — as will the extent of their empathy with these. A questionnaire can be used to determine this for the user.

It would be possible to use a full immersion questionnaire, such as that designed by Paul Cairns et al [61]. This would be complex and has not been fully demonstrated to be accurate. A simpler method will suffice for the purpose of this evaluation. Most users will have their own conception of immersion, and

these have been shown by Paul Cairns' research to correlate quite closely with each other. It has thus been determined that a direct question can be used to evaluate the user's sense of immersion, in combination with the plausibility factors discussed.

1.6.3   Scalability

Traditional narratives vary in length depending on the medium in which they are told. A book may take days to complete, and will generally be read in instalments. It may have sequels which will make the overall narrative last even longer. Plays may last 2 or 3 hours. According to Field [21] the average film lasts 2 hours and this is given by him as the ideal length for a film. Modern films tend to vary from those which last around an hour and a half to, at the other extreme, 3 hour epics.

There also exist short versions of these storytelling methods. These include: short stories; short films [88]; and short plays or sketches (which tend to be strung together in a single performance, with perhaps a linking theme). Judging by their length those interactive narrative systems produced thus far seem to fall into this category — and perhaps will one day come to be known as short interactive narratives.

More recently television has added its own type of storytelling. The most common television storytelling mediums include: dramas (which are essentially between a play and a film), serials and soaps. Serialised stories (such as sitcoms) will generally have a story for each episode, a longer story for each series, and perhaps even an overall story arc for all of the series (of which there will be a finite number). Soaps consist of episodes, with each separate episode continuing, founding or concluding some of the ongoing storylines. It is unlikely that more than one storyline will conclude in the same episode, unless they have merged into one. There are always ongoing storylines, and the soap continues indefinitely.

Extending the length of interactive narratives will enable the user to become more involved in the narrative over a prolonged period of time. Current computer games involving a story may take days, weeks or even months to complete. More extensive research (with successful systems) would be required to determine the ideal length for an interactive narrative. This would result in the user being fully involved in the story and genuinely caring about the outcome and the narrative as well as the interaction.

To ascertain the scalability of the system it will not necessarily be essential to create an enormous storyworld. If the system can be demonstrated to be successful over a series of increasing time periods, with techniques that are applicable to a much longer time scale, this will be sufficient.

1.6.4   Domain independence

Domain independence is an essential criteria for interactive narrative systems. It is not sufficient to have a system which is successful only in a single domain, as this will only appeal to a restricted audience and will greatly limit the potential for narratives generated. It must be demonstrated that the techniques utilised in the design of the interactive narrative system will apply to a range of domains.

To demonstrate domain independence a number of entirely separate story-worlds must be created. A range of stories must be generated within each of these worlds.

1.6.5 Agency

The experience of agency is essential for the user of an interactive narrative. The concept of agency can be separated into two criteria. The first criterion, "the satisfying power to take meaningful action" [81], is discussed in section 1.6.5.1. The second criterion, the ability to "see the results of ... decisions and choices" [81], is discussed in section 1.6.5.2. Agency in computer games is discussed in section 2.3.2.

1.6.5.1 User freedom

In an interactive narrative it is necessary for the user to believe that they have complete freedom of action. Ideally the world they are in will enable them to move around and speak as in the real world. It can be argued that a virtual reality system is the only way to achieve this. As a criteria for compellingness it is expected only that the user is free to act at the level of the system as and when they want.

This can be evaluated objectively to some extent, by observing when and how the user is able to interact with the storyworld and its characters. It can also be evaluated through use of a questionnaire, to confirm the user's belief in this freedom to act.

1.6.5.2 Clear effect of user actions

In an interactive narrative the user should genuinely affect the story and understand (and believe) that this is occurring.

The effect of user actions must be clear at both micro and macro levels [97]. This means (at micro level) that they will be able to see an immediate and direct reaction to their actions within the system. They should also be able to see (at macro level) how their action affected the long-term plot of the interactive narrative. Thus the system must be able to understand every action made by the user (and not map it onto one of a limited number of pro forma actions). A clear reaction must be demonstrated for each of these actions. For demonstration of the effect of the user's action on the overall narrative it should be sufficient that the narrative is generated dynamically, as long as all previous actions are taken into consideration.

An objective measurement of this effect can be carried out by observing responses to and effects of user actions within the storyworld and on the overall narrative. A questionnaire can be used to ensure that the user felt that their actions were affecting the narrative experience at both micro and macro levels.

1.6.6 Replayability

Stories are to some extent re-experiencable. A good book will be read again and again, and this repeatability is also true of certain plays and films. A good computer game with a reasonably strong story element is not generally

replayable. This is because it will quickly become apparent how limited the player really was in their experience, and how little genuine freedom they have within the game world. Board games and computer games without a story element (for example *solitaire* or *Tetris* [53]) will be played repeatedly. The ideal interactive narrative will have this element of replayability. It will present the user with an entirely new and unique story on each experience.

The replayability of an interactive narrative system can be considered in two separate, but overlapping, ways. In one the issue is subjective, the other can be evaluated empirically.

As a subjective issue the replayability of a system is determined by whether the user will experience the system again. This depends partially on the interestingness of the experience. It will also depend on the originality of the generated narratives. This will differ for the individual and their preferences — although the system will ideally appeal to all users. To measure this, it may be feasible to allow the user to play as many times as they wish and observe how frequently they took the opportunity to do so. Since other factors will affect this it will not be an accurate measure. It is perhaps better to evaluate this criterion through a questionnaire in which the user is asked whether they would return to the system to experience another interactive narrative.

Replayability in an interactive narrative system can also be considered to require the system to generate a unique narrative on every play. This is a criterion which can be measured objectively. For this a number of narratives (with the same and different users) must be generated. These can then be examined to see where there are similarities — or a lack thereof. Satisfaction of this criterion requires that the narratives be truly distinct.

1.7   Thesis overview

This chapter has defined interactive narrative and a series of criteria considered to be essential for any interactive narrative system. These criteria, known as the compellingness criteria, can be used to evaluate the success of an interactive narrative system. A system will be considered to be a successful interactive narrative system if it is capable of achieving full compellingness — which requires satisfaction of all of these criteria.

Chapter 2 contextualises interactive narrative. This chapter first discusses narrative theory and the essential features which are required by a narrative (section 2.2). Aspects of computer games which are considered essential or preferable, and which may be adapted for use in an interactive narrative, are discussed in section 2.3. This leads to a detailed discussion of the definition of interactive narrative, a consideration of the feasibility of research in this area, and an evaluation of the main existing interactive narrative systems in accordance with the compellingness criteria (section 2.4). This evaluation demonstrates that none of the existing systems, or the techniques used in their creation, are capable of achieving full compellingness, as summarised in table 2.1.

As none of the techniques used by existing interactive narrative systems are capable of achieving full compellingness there is a need for a new system. The GADIN system is introduced in chapter 3, and its architecture is shown in figure 3.1. This includes a discussion of the GADIN characters (section 2.2.2), actions (section 3.3) and dilemmas (section 3.4), including their possible categorisations.

The planning algorithm is detailed in section 3.5. Section 3.7 discusses how the user's actions and decisions are incorporated into the narrative, the techniques used to ensure the user experiences dilemmas while maintaining their freedom, and the manner in which other characters respond to the user and to dilemma decisions.

The user model, and the method of selecting dilemmas which are likely to result in the most difficult decision for the individual user, is discussed in section 4.5. The additional features incorporated in the GADIN system to improve the quality of the narrative experience are discussed in chapter 4, including the selection of a story ending (section 4.8) and the use of knowledge which is not known to all characters (section 4.4).

The core components of the GADIN architecture are domain independent. To apply these techniques to a new domain it is necessary to define domain-specific dilemmas, actions, and character and state information — the full requirements are discussed in section 5.2. There are two existing applications of the architecture, to an infinite soap-style narrative (section 5.3) and to a dinosaur adventure designed for children, with additionally a changeable ending (section 5.4). The ease of applying GADIN to a new domain is discussed in section 5.5.

The interfaces for the current applications of GADIN are discussed in chapter 6. These are specific to the individual requirements for each domain, but are very similar. The interface for the soap version of GADIN, and the issues in enabling the online version, are discussed in section 6.2. The interface created for the dinosaur adventure version of GADIN — which uses pictures — is detailed in section 6.3.

To evaluate the quality of the narratives generated by GADIN a Turing-style test comparing a GADIN narrative to that from a soap was carried out, and there was concluded to be no discernible difference between the two (section 7.2). The user evaluations of the soap version of GADIN are discussed in sections 7.3, 7.4 and 7.5. The user model employed in the soap version of GADIN is evaluated in section 7.6. Section 7.7 discusses the evaluation of the dinosaur adventure version.

The evaluation of GADIN in chapter 7 is used in section 8.2 to evaluate the GADIN system according to the compellingness criteria. The benefits of the GADIN system are discussed further in section 8.3. The main limitations (the planning speed, interface and domain creation restrictions) are discussed — with methods which could be used to overcome them — in section 8.4. Possible extensions to existing aspects of the GADIN architecture and further possibilities are detailed in section 8.5. Extensions to current applications of GADIN and possible further application domains — including therapy, computer games and education — are discussed in section 8.6. The extension of GADIN to a multi-user version is discussed in section 8.7.

2

Background

2.1 Overview

Aristotle first proposed his theory of drama in 350 B.C.E. Section 2.2 discusses this and subsequent narrative research. This includes the essential aspects for inclusion in an engaging narrative.

For almost as long as there have been computers they have been used to play games. The computer games industry is a massive area with much undeveloped potential. Various texts [8, 15, 87, 97, 120] discuss computer game design, and propose elements which must be included in any successful and enjoyable game. These are discussed, with computer game examples, in section 2.3.

Section 2.4 looks specifically at interactive narrative. This is a concept which is rooted in both narrative theory and computer games but which has its own unique requirements. The feasibility of research in this area is discussed in section 2.4.2, and the successes and limitations of current interactive narrative systems are then described in the context of the compellingness criteria (as introduced in section 1.6). The research hypothesis for this thesis is given in section 2.5.

2.2 Narrative Theory

Throughout history there has been storytelling. Stories were originally told orally and passed down through the generations in this manner. People would remember different parts of a story, and interact in the telling. When people started to write (initially using pictures) they wrote stories. Many of these stories were tales of the writers' exploits. Others may or may not have been fantasy. As stories spread, they developed. From oral telling, to pictures, to text, to plays, to films and television. The next phase, in part a return to the early methods of storytelling, is likely to be interactive narrative.

It is arguable whether interactive media can ever be seen as narrative. It

appears to be the case (according to Ryan [95]) that all new introductions to the storytelling field bring with them controversy as to their status as narrative. This is a very poorly defined research term, and thus it is possible only to satisfy as many of its criteria as is feasible without having to become too concerned with satisfying every narratologist and their personal theories. There are a number of factors which are commonly considered to be essential in creating an engaging narrative [2, 16, 21, 22, 35, 66, 69, 70, 88, 93, 94, 95, 96, 98, 121, 123]. These are outlined here, along with examples of each.

2.2.1   Storyworld

"[A] storyworld: a universe of dramatic possibilities, revolving around a central theme and exploring all the variations on that theme." [16]

There must be a world in which the narrative will take place. This is often referred to [16, 94] as the storyworld. In many cases this is a bounded space of the 'real' world, in others it is more fantastical. This range is true of all narratives, from oral stories, to books, films and interactive narratives. In games, the storyworld tends to be as simplified a world as is possible while still maintaining its realism for the user. It is important that the user believes in the world in which they are acting. If the world does not seem real then all that happens within that world will lose its importance.

2.2.2   Characters

"A narrative text must create a world and populate it with characters and objects." [94]

The majority of stories contain characters. There are those which do not — such as the "Big Bang" story of the creation of the world. These characters do not have to be human — fables (for instance Aesop's) being an example of stories with no human characters. In such worlds the characters will still generally communicate, in a human-like fashion, mainly through speech.

Where there are characters they are part of and act within the storyworld (section 2.2.1). If there is no action, there cannot be a story. Aristotle [2] stated that characters are the second most important component of a narrative — the first being the action in which they participate.

In first person interactive narratives the user will be a character. It is generally the case that there will additionally be other characters, resulting in more interactions and dramatic interest. Section 2.3.6 discusses characters further, and in particular their use in games.

2.2.3   Audience empathy

"The participant who is caught up in the imaginative whirl of the work feels a fellowship and an intimate personal contact with the dramatic characters — empathy" [69]

For an audience to enjoy a story — whether it be orally told, read, or seen performed — it is advantageous if they feel some empathy with the characters involved in that story and the situations they are involved in. This is, in a sense, the 'human interest' aspect of the criteria discussed in sections 2.2.1 and 2.2.2. It is difficult to define this concept exactly. In a story such as that in the

film *Armageddon* [24] the audience will clearly not have personally experienced a similar end-of-the-world scenario. They can relate to the situation through the interactions and interpersonal relationships of the characters — and perhaps also through their own fantasies of wanting to become a hero as do the oil riggers in the film.

In some ways it may seem that this criteria would automatically appear in an interactive narrative. The user is a character so should naturally have empathy with themselves and their own actions (at least in a first person experience). However, the user must believe in the worlds they are involved in (and the situations in which they find themselves). If they do not, they will not act as themselves and the experience may no longer be enjoyable for them. This is due to a lack of empathy. If the user has third person control the challenge of achieving empathy becomes more similar to that in a conventional drama — although taking into consideration the interactions of the player is essential. The concept of empathy in conventional stories has, partially at least, become the issue of immersion in a first person interactive narrative. Immersion is discussed further in section 2.3.3.

2.2.4   Everything makes sense

"[S]tories must be coherent — causally connected — on many levels" [78] *"Within the action there must be nothing irrational."* [2]

Everything which occurs within the storyworld must appear to the audience to be consistent with everything which has occurred there previously. If this was not the case the story would make no sense. A story with scenes which contradicted previous events would confuse the audience, to the extent that they would no longer enjoy the experience. There can be scenes which may seem initially to make no sense, where it will later become clear that there was simply a sequence of events which had not yet been shown to the audience. The BBC drama *Hustle* [118] uses this technique to good effect.

Within an interactive narrative, techniques for manipulating the story (as in *Hustle*) become much more complex, if not impossible, to implement. It is essential to ensure that the user understands everything. If they do not, they will no longer enjoy the participatory experience as they will not know how to act. Once the technology has been developed to a greater extent it may be possible to utilise such techniques — perhaps a detective story would be relevant. For now consistency is of primary concern.

There are stories which reveal information to the audience in the form of character flashbacks (as in the case of the film *Memento* [26]). This would become more difficult in an interactive narrative, as it would not be possible to give the user a flashback to something that had happened to them previously (unless they were taking on a role in the interactive narrative). In a longer experience this may become more relevant — as a reminder to the user rather than as a method of revealing information.

2.2.5   Closure

"stories lead to closure" [123] *"The final resolution comes not as a surprise but as a reassurance."* [121]

At the conclusion of narrative, the audience should feel that the story has ended — they will experience a sense of closure. This is not always strictly the case, *The Italian Job* [23] being an example of a film with an 'open ending'. If such narratives are well created, the audience will still leave with a sense of closure, generally imposing their own ending which they imagine to be what will happen next. This may change as they consider the narrative further.

A narrative may contain a series of storylines, and at its conclusion all minor storylines must be resolved. It is not sufficient to resolve only the main storyline, as this would leave the audience in suspense about something which may not even have been particularly important to the narrative as a whole. They would thus be left with a sense of not having been satisfied by the experience.

2.2.6   Surprise

"Each successive action should be both unexpected and yet fully compatible with the character definition already established, so that although each new action takes us by surprise, it also strikes us as being "in character"" [88]

Surprise is an essential element of stories. Everything that happens in the storyworld must be entirely consistent with what has happened previously (section 2.2.4) but there must also be surprises for the audience. If they can predict what is going to happen in the story then it is unlikely to be as enjoyable.

Rules of Play [97] explains that the element of surprise must occur at both micro and macro levels. At micro level this could mean that within a conversation a character's next line is not entirely what might have been expected. At macro level it means that the overall story will take an unexpected course. This could be as blatant as a twist — as has been used to good effect in the film *Sixth Sense* [25] — or, more commonly, that the resulting plot arc could not have been predicted by the audience at the outset of the narrative.

There are more predictable narratives, such as 'boy meets girl' plots where the eventual outcome is obvious. In such narratives it is the 'getting there' rather than the final scene which creates the dramatic interest for the audience, and in this there will be much that is surprising or unexpected.

2.2.7   Perspective

Narratives can be told in either first, second or third person. The issue of perspective is not usually found in films, but is applicable to spoken or written stories. First person is used when the teller is relating the story of something that has happened to them, or that they wish to give the impression of having happened to them. Third person is used when it is advantageous to give the audience information about other aspects and opinions within the world than those of the main character. This can make the story more impersonal, but gives the reader more scope to identify with characters in the story other than the protagonist.

In conventional storytelling it is unusual to utilise the second person. In interactive narratives the user becomes a character in the story, thus to communicate with them (in a text-based system) use of the first person would be entirely inappropriate and the third person perhaps too impersonal for the user to experience immersion (as discussed in section 2.3.3). The most appropriate

method is to utilise the second person, referring to the user in the narration as 'you'.

2.2.8   Conflict

"Drama is conflict" [21]

A narrative would not be dramatically interesting without conflict. Characters in a storyworld are continually presented with conflicts. The way in which they act in response to these conflicts makes a narrative interesting. Section 2.2.9 explains how stories are created around conflicts.

2.2.9   Plot structure

In this section the most well known plot structures are introduced. These have much in common, and indeed build upon one another. These structures are designed to represent non-interactive storytelling but contain elements which can be adapted for use in interactive narratives.

Aristotle's theory of drama and narrative structure has been used many times and found to hold for all narratives. According to Aristotle every narrative must "have as its subject a single action, whole and complete, with a beginning, a middle, and an end." The beginning "does not itself follow anything by causal necessity" but once it has completed "something naturally is or comes to be" (i.e. the middle). The middle "is that which follows something as some other thing follows it." Finally there is the end, "that which itself naturally follows some other thing, either by necessity or as a rule, but has nothing following it." This seems simple, yet (in combination with the other elements discussed in *Poetics*) provides the basis for most modern theories of drama and narrative.

Freytag [35] proposed a graphical form for the analysis of plots. This is known as "Freytag's Triangle", and is shown in figure 2.1. In this figure (as described in [35]) B represents the drama as it "rises from the introduction" at point A. The "entrance of exciting forces" leads to point C, the climax. This is followed by the fall (D) "from here to the catastrophe" at point E. Freytag further notes that each "of these five parts may consist of a single scene, or a succession of connected scenes, but the climax is usually composed of one chief scene." [35]
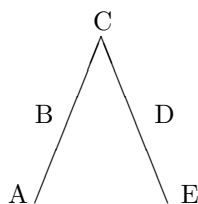
Figure 2.1: Freytag's plot structure (as given in [35], with identifiers changed to upper case).

The "contemporary version of the shape of dramatic action and its conventionally recognized parts" [66] remains essentially Aristotle's structure with additional detail. Laurel's version of this is shown in diagrammatic form in figure 2.2.

In figure 2.2 the y-axis, or complication, represents essentially the number of unanswered questions within the story. Initially there are none, but these
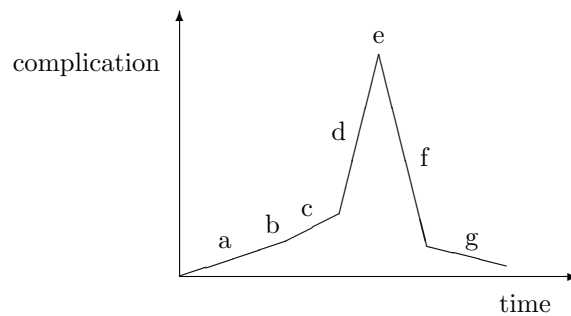
Figure 2.2: Laurel's [66] "contemporary" plot structure.

gradually build up, reaching a peak at point *e*. After this the remaining story 'questions' are answered, and finally everything is brought to a close as the story finishes. In this diagram section *a* represents the *exposition*, it introduces characters, objects and environments. This continues throughout but it becomes "less and less necessary and appropriate to introduce new potential." Section *b* is known as the *inciting incident*, "the action or event that begins what will become the central action". It is followed by section *c*, the *rising action*, in which "characters must make major decisions and take conclusive actions in pursuit of their goals." This leads to section *d*, known as the *crisis*, a "period of heightened activity and commitment, ... [which] usually proceeds at a faster pace than the preceding action." Point *e* is the *climax*, when the "[c]haracters either succeed or fail to achieve their goals." This is also the point at which the plot becomes fixed as having only one outcome. Section *f* sees *falling action* and "represents the consequences of the climax, as they reverberate through character and situation." It is "rather steep ... [as] things tend to fall into place rather quickly once the climax has been reached." This leads on to section *g*, the *dénouement* (or *resolution*), "the return to ... the *status quo* of the dramatic world." [66]

Figure 2.3 shows how *Jack and the Beanstalk* fits Laurel's plot structure. Additional peaks (representing points of conflict) could be added, for example to represent Jack stealing the harp from the giant. The storyline is clear even when only the major points are given, as required by this structure.

Syd Field is well-known as an expert on films. In [21, 22] he gives a general structure for a 2-hour, 120 page screenplay and advises any potential screenwriter on how to follow this structure in writing their own film. There are 3 acts in this structure (I, II and III), named respectively "Set-Up", "Confrontation" and "Resolution". "Act I sets up your story" and is followed by Act II, in which the main character encounters obstacles and the "story becomes ... [this] character overcoming obstacle after obstacle to achieve his or her dramatic need." Act III "is the solution" of the screenplay or film. Field also specifies types of points, including those which "provide the foundation of the narrative line of action" — plot points, and pinch points — each of which "ties it together and keeps ... [the] story on track". Approximate page numbers are given for each of these points, and the beginning and end of acts. Field's structure is in its essence reminiscent of Aristotle's, yet is more specific to films.
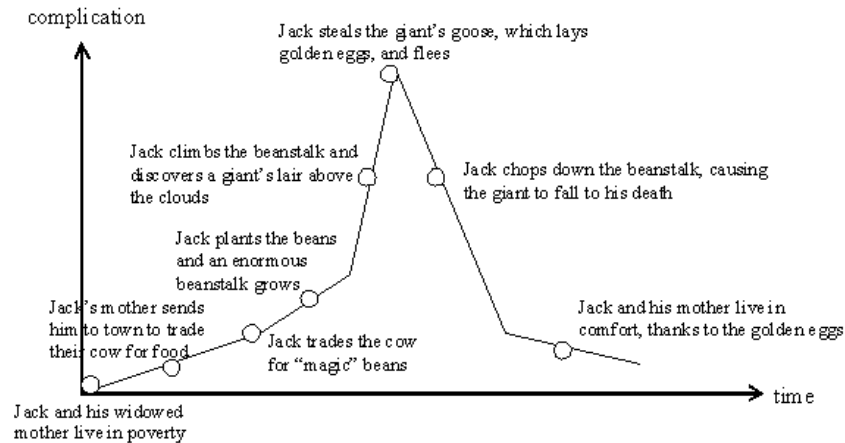
Figure 2.3: The plot structure of a simplified *Jack and the Beanstalk*, as given in [59]. The shape of the curve has been changed slightly to fit Laurel's [66] structure.

2.2.10   Story understanding systems

Schank and his research group carried out early computerised story-related research [98]. The group's work included systems for natural language understanding [10], story understanding [12, 17, 124] and story generation [77]. The systems utilise Conceptual Dependency (CD) meaning representation, which is "used to represent sentences with respect to the information they convey about events and states of the world". To achieve this the meaning of sentences is stored as a structure known as an "event" — defined by this group as consisting of an action, the actor performing the action, the object on which it is performed and "a direction in which that action is oriented". Some, if not all, of these components will be instantiated by each sentence. The event context is used to further instantiate events, and thus develop the system's model of the story.

By allowing for implicit events the story understanding systems can represent texts as "one enormous chain of events and states" [98]. In stereotypical situations, such as eating a meal in a restaurant, a representative "script" can be created to enable the system to understand implicit events. Telling only the main aspects of the story to the system will be enable it to infer the remainder according to the expected sequence of actions (once it has identified the appropriate script), as would be the case with a human reader. While applying the script the system will also assign roles to characters. SAM [17] makes use of scripts such as these in the "understanding" of (adapted) newspaper articles. This system is able to produce a summary of the story and answer questions on it.

When no known script applies to a given story planning can be used, as once the "plans and goals of a character in a story" have been "figured out" it is then possible to make "guesses about the intentions of an action in an unfolding story", helping "to make sense of the story." [98] The character's goal within the story is identified, then world knowledge and story events are utilised

in determining a plan for the achievement of that goal, in an attempt to recreate that character's plan within the story. Knowledge is stored as condition-action pairs and knowledge of goals characters are likely to have, which is used to better understand stories. Low level goals aid in the achievement of high level goals. PAM [124] makes use of plans and relationships between characters in story understanding. These relationships may be between a single character's or separate characters' goals, as the system recreation of the character's plan and reasoning depends on goal conflicts and concordances. This system is able to retell a story from the viewpoint of any of the characters, as it has an understanding of the goals of each character and has recreated their reasoning. It is also able to answer questions based on the story.

POLITICS [12] utilises application of scripts, similar to those used in SAM [17], to the more specific domain of US political reasoning — considering arguments from two opposing perspectives. Knowledge consists of: plans; goals possible within the world; and situation-action pairs. Political ideologies are represented by sets of goal trees, each of which "encodes the motivations of a political actor as perceived by the ideology in question." [12]. Given an event the system can determine whether it is positive or negative (from each political perspective), depending on the goals this event has the potential to achieve. POLITICS is also capable of outputting the reasoning behind its conclusions. The system can identify and justify a plan which should prevent a negative event from occurring, additionally giving the implications of action options available. This is "essentially a rule-based system where sets of rules are activated or deactivated by changes in the situational context." [98]

The discussed systems use themes to give reasoning to character actions and thus to predict which goals a character is likely to have. The Schank group's natural language processing system, Eli [10], uses conceptual analysis to translate English language sentences into CD representation in all of the aforementioned systems. Their story generation system, Tale-Spin [77], is discussed in section 2.2.11.

2.2.11 Story generation systems

There have been various attempts to design a computer which is capable of writing stories. The major contributing systems to this research area are discussed here.

The first of these was James Meehan's Tale-Spin [77, 78] in 1980. This system produces original fairy tales with morals. These are purely text-based and have a large number of inconsistencies. There is still dramatic interest to the stories generated by the system, all of which are set in a standard fairy tale world — with, for example, trees, rivers and fields. The system contains a large amount of background knowledge of possibilities for the world — which is created as the story is told. Characters have goals, emotions and relationships and are semi-autonomous within the game world.

Planning was used to create infinite soap opera style stories in Lebowitz's UNIVERSE [67]. In this it was necessary for the author to provide goals to the story-telling system, the system was not able to identify goals or provide dramatically interesting content. UNIVERSE used these goals and existing plot fragments to create a summary of a soap opera plot. System-created stereotypical characters are dynamically assigned roles in these fragments, with new

characters being added if no existing character is able to take on a particular role. The characters were unable to act except in accordance with the plot summary, which dictated sequences of actions for which the order was unable to vary. Character relationships are central to the interwoven storyline. The system is reliant on the reader assuming characters' motivations.

Turner's Minstrel [116] uses case-based reasoning to generate stories about knights and ladies in the days of King Arthur. The cases are existing stories and these are matched to desired stories — replacing variables where necessary — and recombined to create new stories. The system utilises its awareness of what is consistent within a world to ensure that the generated stories have this feature, and tries to present a twist at the end of each story. Both the characters and the story have goals, which are entered by the user before story generation begins.

More recent story generation research [89] has similarly focussed on generalising story segments. The system makes use of a number of short story segments, known as vignettes, which are assumed to be good. It then uses predefined mappings to apply these segments to new domains, where they can be joined in the generation of a new story. This technique strongly relies on the undemonstrated generality and dramatic interest of the story segments.

Although it is not strictly a story generation system, Daydreamer [80] is worthy of note. This system creates daydreams, the idea being that these will be generated when a computer is idle. These daydreams will be affected by previous events and will either reflect on these — to rationalise or learn from the experiences — or create idealised alternatives to them. Experiences are at this stage input by the user. Relaxed planning is used by Daydreamer, in combination with goals and domain knowledge.

All of the story generation systems created thus far produce very basic, not particularly dramatically interesting stories, generally within a limited domain. They are certainly not producing marketable fiction as yet. The current state-of-the-art for story generation is far behind even the least competent of published human authors. Yet even at this early stage in the development of the field there are moments of arguable originality and interest.

2.2.12   Narratives in computer games

Early computer games, which included *Pong* [36] and *Space Invaders* [38], did not contain a story element. A background story could be implied in these games by the player's imagination. According to Ryan [93] such background stories give narrative status to games — she gives the example of the game of *Tetris* [53], in which the player can imagine they are a "slave building a wall from bricks" which are thrown "at an increasing rate by a sadistic master". As a marketing technique in games such as Atari's *Breakout* [37] an explicitly given background story began to be sold with the game.

With the creation of adventure games a story began to be incorporated as an integral part of the action. In these text-based experiences, there is a story which the user is essentially trying to 'find' through their actions. They have the illusion of freedom, a keyboard and the ability to type whatever they want — within which the system will only recognise a very limited number of commands, and only those which correspond to the story will succeed at each stage. Thus the user must experiment until they determine the correct

combination of actions and can move on to the next stage of the story. *Adventure* [50] was the original adventure game, and was followed by classics such as *Zork* [51] and *The Hitchhiker's Guide to the Galaxy* [40]. Graphics were later added (for example in *King's Quest* [52]), initially with dropdown menus before giving the user the freedom to move around the world. Text adventure games still exist, and have a thriving online following, as 'interactive fiction'.

Another method used to tell stories in early computer games involved video clips being offered as rewards for completing each level of a game. This meant that the player would continue playing to see the next instalment of the story. Such action games included *Wing Commander* [39].

Modern computer games tend to incorporate elements of both action and adventure games. The story is integrated with the action to some extent in such games as *F.E.A.R.* [49] and *Half-Life 2* [46].

A wide range of techniques are used to create a story for the game player. This is increasingly considered an essential element of computer games, despite the story tending to remain essentially linear. As a result the player can generally interact freely at certain stages, before completing required actions to enable moving to the next interactive stage. This may be explicit but methods have become more subtle.

Stories in computer games increasingly involve multi-branching, in which a range of required player actions are possible following each interaction phase — and each leads to a different next phase. This multi-branching technique is used in commercial computer games such as *Fahrenheit* [48].

Games such as *Grand Theft Auto* [57] (the early versions) and *World of Warcraft* [47] do not include an overriding story arc. Instead they consist of a series of "mini-stories" [96]. These are known in the game worlds as "missions" and "quests" respectively, and are small, essentially linear stories which take place in the game world. Some such stories are interrelated while others are independent.

From the utilised definition *The Sims* [58] may be considered to be an interactive narrative. In this world, the user is free to act (or direct characters to act) as they wish. The narratives satisfy the immersion, scalability, transferability, agency and replayability criteria of compellingness. The users are able to experience a dramatically interesting story each time they play as there is no explicitly imposed narrative. This exists entirely within the user's imagination. An entire community has grown up around creation and imagination of such stories. As this is putting the onus on the player it can be argued that there is thus in reality no story in this game and, depending on the individual player, the player-created stories could lack the skill of a playwright. Therefore *The Sims* is not considered to be an interactive narrative system.

2.3 Aspects of computer games

As discussed in section 2.2.12 modern computer games tend to contain a story element, which can take any one of a range of forms. A well created story will cause the player to become more involved in the game. There are a number of additional elements which should be incorporated in a good computer game. Some are essential, such as interactivity (section 2.3.5). Others improve the game, for example the use of a player model (section 2.3.8). Each of the major

computer game elements is considered in this section.

2.3.1 Player freedom

In a good game the player will feel that they have control over the outcome. However this will generally only mean that the player may die or not die at certain points. The important requirement is the player's illusion of complete freedom rather than its necessary reality, as discussed in section 2.4.1. The player will thus not regard their inability to carry out these actions as a restriction on their freedom within the game world. In *Gran Turismo* [41], for example, the player is able to act freely only through controlling their car.

Most modern games limit the player within the game world. This is necessary for the narrative to be achieved, as discussed in section 2.2.12. Preventing the user from performing an action which will interfere with the story is a common technique. An example occurs in *Fable* [45] when the player is requested to guard some boxes. Another character tries to persuade the player to abandon their post and it is not possible for the player to shoot this character, despite carrying a working gun. Computer games aim to give the player a satisfactory level of freedom rather than absolute freedom.

2.3.2 Agency

"Agency is the satisfying power to take meaningful action and see the results of our decisions and choices." [81]

Murray explains that it is essential for the player to experience agency within a game world. The first criterion of agency, "the satisfying power to take meaningful action", is discussed in section 2.3.1. The second criterion is the ability to "see the results of ... decisions and choices". In most modern computer games the player will be able to see the immediate results of their actions. If they shoot another character that character will be injured or die. Over the game as a whole there will be more limited effects of the player's actions, as discussed in section 2.2.12.

A lack of agency will inhibit a player's enjoyment of a game. For example Master of Orion III [44] has a large amount of automaton, which means that players often do not feel that they have sufficient agency within the game.

2.3.3 Immersion

"Immersion can entail a mere flooding of the mind with sensation, the overflow of sensory stimulation" [81]

To be immersed in a game, the user should find its characters and storyworld plausible (sections 2.2.1, 2.2.2 and 2.3.6). They must also empathise with elements of the storyworld (section 2.2.3). The play must be immersive enough for the player to genuinely care about the outcome of the game and, in a first person perspective game (section 2.3.4), what happens to the character they control.

Whether a game is immersive is mainly determined by individual opinion and preferences. It is contingent on the game author only to ensure that the game is as immersive as possible for as many players, and player types, as is feasible — within the target audience. Ideally the game will adjust itself to

the individual player and thus create a personal immersive experience. This is beyond the scope of most existing computer games, as discussed in section 2.3.8.

2.3.4   Perspective

A player's perspective within a computer game will tend to belong to one of two categories: 'first person' or 'godlike'.

In a first person game the player will have complete control over at least one character. They will usually either see the world from the perspective of that character or have a world overview. Many modern computer games (in particular first person shooters) enable the player to choose how they will view the first person game world — as the character would see it or from behind that character. The player will only be able to control one character at a time and see the world which that character sees. A first person perspective is the most common perspective for computer games.

Fahrenheit [48] provides a changing perspective. When playing this game, the player has complete first person control of a character. This character is not fixed, and they are able to change which character they control throughout the game. These characters are several and may even be competing. The player is only able to control one character at a time. This is similar to a technique used in literature, where a story can be told through a series of first person perspectives.

In computer games which allow the player a godlike perspective they will have an overview of the whole game world. In such games the player will often be able to control multiple characters within the game. *Black and White* [43] and *The Sims* [58] fall into this category. The player is not limited to seeing the world as seen by only one of the characters and there do not even have to be any characters per se, as in games such as *SimCity* [55] (section 2.3.6).

2.3.5   Interactivity

"When a player interacts with the designed system of a game, meaningful play emerges." [97]

Interactivity is a key component of all computer games [8, 15, 87, 97]. As discussed in section 2.3.1 the player must believe that they are free to interact with the game world as and when they wish. If the player is not able to interact, there will not be a game. Interactivity is, essentially, the player's ability to participate in the game world.

Interactivity differs from agency (section 2.3.2) in that for agency to be experienced by the player within the game world the game must have interactivity. However a game with interactivity will not necessarily enable the user to experience agency.

Modern computer games tend to be very interactive. Most game players would not feel that their experience was complete if they were not able to interact with the game at a very low and frequent level.

2.3.6   Non-player characters

Non-player characters (NPCs) are included in most modern computer games. The role which NPCs take in a game depends on the game genre. If used

correctly they can make the game more realistic, enjoyable and immersive for the player. NPCs are particularly important in computer games with a story element as they add an extra dimension to the story, as discussed in section 2.2.2.

Various literature has considered the use of NPCs in computer games, and the requirements for such characters. The criteria given by [21, 66, 75] show that NPCs must: have goals, plans and knowledge about their world (and the ability to generate and modify these goals and plans); have an attitude (which can be "positive or negative, superior or inferior, critical or naïve" [21]), and the ability to express a definite point of view; be able to change, motivate themselves and initiate action; have a personality ("What makes characters interesting are [sic] their unique ways of doing things" [75]) and emotion; be able to form social relationships; and give the illusion of life ("requirements such as: pursuing multiple, simultaneous goals and actions, having broad capabilities ... and reacting quickly to stimuli in the environment" [75]).

The concept of believability in NPCs was first introduced by researchers on the Oz Project [9], and defined a believable character as "one who seems lifelike, whose actions make sense, who allows you to suspend disbelief." [75] In the same paper, Mateas points out that this is not realism, and gives the example of Bugs Bunny as "a believable character, but not a realistic character."

There are computer games which do not include non-player characters as such, for example *SimCity* [55]. In this game there are characters who live in the city but they exist only as a population and not as individual characters within the game. There is no story imposed and this may explain the lack of NPCs. Simple computer games — for instance *Tetris* [53] or *solitaire* — do not include NPCs. Computer games which impose a storyline tend to involve NPCs.

In many modern computer games the NPCs are equipped with a finite state machine which instructs them on their actions within the fixed storyline. In interactive narratives the issue changes as the story is not fixed at start-up, meaning that the NPCs must be able to decide for themselves what to do (or be able to take directions) when faced with novel scenarios.

2.3.7 User interaction with NPCs

In first-person shooters (FPSs), such as *F.E.A.R.* [49], the NPCs mainly exist to shoot the player and to be shot themselves. In modern-style adventure games (for example *Fable* [45], *Deus Ex* [42] and *Zelda* [54]) the player is occasionally put into situations where they must interact through speech with NPCs. These interactions will either take the form of non-interactive clips, or the NPC will have a limited number of standard phrases they can use — perhaps in order — to communicate with the player. It is unusual for the player to be able to talk for themselves within the system, although they are often presented with a list of speech options. This is due to the inherent limitations of natural language processing capabilities. In interactive fiction, there is no real interaction with NPCs, except as objects or in a low level pro-forma manner. In godlike games, such as *The Sims* [58], the player is able to control a number of characters and will not interact with any as a character themselves.

2.3.8   Player model

It is increasingly the case that computer games model the player in some way. Some games, notably the *Crash Bandicoot* series [56], use dynamic difficulty adjustment to adjust the difficulty of the game and ensure that the player is challenged but can complete the relevant level without too many attempts — which is likely to result in boredom. This means that the player will no longer find games too easy or too difficult. There are problems associated with this, not least the frustration which could result if the player was never able to win the game due to it becoming continually more difficult.

A form of player model can be used in multi-branching games (section 2.2.12). In this the player's long-term actions determine which direction is taken at each of the branch points in the story. *Deus Ex* [42] has two possible main branches the game can take — in one the player is evil, in the other good. The story experienced by the player will depend on the actions and choices they make throughout. *Black and White* [43] is another game which models the user to result in an overall experience dependent on the combination of choices they make.

2.4   Interactive Narrative

In this section the utilised definition of interactive narrative is discussed in further detail and feasibility of research in this area is considered. The main existing interactive narrative systems are then introduced and evaluated according to the compellingness criteria introduced in section 1.6. This is summarised in section 2.4.10 and demonstrates the shortcomings of these systems and the need for a new system which is capable of achieving a higher degree of compellingness, as discussed in section 2.5.

2.4.1   Definition

The definition of interactive narrative used in this research is: *An interactive narrative is a game world in which the user-controlled character(s) can physically and mentally interact with ideally (perceived) total freedom while experiencing a dramatically interesting narrative which is fundamentally different on nearly every play — dependent on the user's actions.* Each part of this definition is further elaborated in this section. The components of this definition are desired properties rather than strict requirements for an interactive narrative.

An interactive narrative is a game world...

An interactive narrative has many elements in common with a computer game, and thus should be set within a game world, a computer-simulated virtual world. The exact depiction of this world will depend on the genre of story to be experienced — which it would ideally be possible for the user to select.

...in which the user-controlled character(s)...

The user will control a character within the game world. This should be at a very low level of abstraction, so that the user can act in the computer-based

world in a way which is a true simulation of the way they act within the 'real' world. It may be possible for the user to control more than one character and to change which they control. This would become more complex as these characters interacted with one another. A higher-level scenario in which the individual characters are not important is also possible — the user will control groups rather than a specific character, or will control other aspects of the environment. This is less likely to result in a dramatically interesting narrative as most stories centralise on characters. It is also probable that the user will be more emotionally involved in a game world in which they participate at a character level.

...can physically and mentally interact...

The characters in the game world must have the ability to physically interact within that world, allowing them to move around it as and when they desire, interacting with other characters in the game world if appropriate. The ability to mentally interact means that they will ideally be able to speak freely and be understood, and have feelings for other characters. Narratives rarely involve a single character but rather have multiple characters interacting with one another.

...with ideally (perceived) total freedom...

The user of an interactive narrative is likely to become frustrated if they are not free to act as and when they wish. It can thus be hypothesised that they require a high degree of freedom within the game world. This is not entirely true, as what is important is the user perception of freedom rather than genuine 'freedom'. Laurel [66] explains that it "is difficult to imagine life, even a fantasy life, in the absence of any constraints at all", giving the example of gravity within a game world as being generally taken for granted rather than seen as limiting a user's freedom. There may be other implicit constraints on the user (particularly those involving moral values), but as long as these are consistent with the user's perception of the game world the user will still believe that they are free within that world.

...while experiencing a dramatically interesting narrative...

A boring narrative could be defined as interactive narrative but this is not considered to be sufficient here. For the interactive narrative system to be successful the narrative experienced by the user must be dramatically interesting for that user. There has been a wide range of research carried out into the creation of a dramatically interesting narrative and, although as yet no absolute rules exist, there are various guidelines that can be followed, as discussed in section 2.2.

...which is fundamentally different on nearly every play...

A game world in which the user is free to act, and in doing so will experience a narrative, is not sufficient. The user's actions in that world must have a clear and genuine effect on the narrative. As a result, the narrative must be different each time — unlike in current computer games which tend to incorporate a

story which will not change. There may be various options within the narrative
— at various stages, or even in the potential for a range of endings, but there
will not be a sufficient difference between more than a few experiences. At a
low level, it is likely that the user will have a different experience each time,
particularly as they experiment with the world to see what is possible. However,
the aim is not to have the same story with a few variations. This is something
which occurs in many computer games, where the story is still fundamentally
the same. The aim in an interactive narrative is to generate a story which is
entirely different each time. As there are only a (theoretically) finite number
of narratives possible, particularly with an incomplete knowledge base, it is not
possible to strictly specify that the narrative be original on absolutely every
play.

... — dependent on the user's actions.

It is not sufficient for the narrative to be different simply because the system
is capable of generating original narratives. They must be different depending
on how the user has acted. In addition to the requirement that the user should
not just be exploring a world in which a narrative takes place, they should not
be exploring a world in which a limited tree of potential narratives can take
place. They must be exploring a world in which a large number of narratives
can be generated and in which the narrative experienced will genuinely depend
on the way the user acts within that world. The user is essentially finding
a path through the world in which they will be unnoticeably guided by the
computerised playwright. The user will be able to act as and when they desire
in ways which will have a perceivable long and short term effect on the narrative.

2.4.2   Feasibility

There are some [3, 4, 63, 62, 64] who believe that interactive narrative is an
unachievable concept. They claim that it is not possible to create a story around
a game player's interactions. Juul's thesis "A clash between game and narrative"
[62] in its very title puts forward the opposition to this concept. These opponents
believe that interactive narrative is an oxymoron and will never be a possibility.
Yet storytelling has for many years involved interactions. Games such as *The
Sims* [58] may involve the player dynamically self-imposing a story around their
interactions. In this section the main arguments against interactive narrative
will be discussed.

 Aarseth [4] states that "the pleasure of games is quite different from the
pleasures of the novel". Although this is a valid argument it does not mean
that it will not be possible to find a combination, a new form of pleasure which
combines the best of both mediums. The only differences between narratives
and games noted by Juul [62] in his definition of games are that a narrative does
not evaluate the efforts of the reader and that narratives cannot "be described
as formally defined". Juul's "evaluation of the efforts of the player" requires
that they will observe some feedback or reward from their interactions, such as
a higher score in a game. To achieve this in an interactive narrative the user
can be modelled rather than evaluated, and always 'rewarded' with an enjoyable
story. The claim of a lack of formal definition does not strictly hold given that
there is a large amount of structure to narratives, as discussed in section 2.2.9.

A narrative which is dynamically generated around the user's interactions would address the claimed contradiction between a narrative's essential element of "causal logic and inevitability" [62] and the fact that a game allows the player to "influence events now" [62]. It may be necessary to slightly limit the user towards the end of the narrative, but only once the narrative has passed its climax point (section 2.2.9). After this the final stages become an inevitability in which the user will not feel restricted by the logical chain of events concluding the narrative they have experienced. It has been argued [62] that the narrative will be ruined if it is not perfectly balanced and pre-composed. However, for many years narratives have been improvised as they have been told, such as a parent telling a child a bedtime story, or someone telling a 'tall tale'. Such narratives result in a different experience, one which is enhanced by the user's interactivity and genuine influence on the plot.

The opinion that in games "replaying is the norm, while most novels are read only once" [4] has also been expressed by [62]. While this is not necessarily true (computer games with a strong story element are often not replayed and a good story will be experienced many times), it is also largely irrelevant as an interactive narrative should add this repeatability to both computer games and stories. This is because the user would be experiencing a new story each time and would have a genuine effect on this. The argument that the addition of a storyline reduces gameplay appeal would also cease to apply with a dynamically generated narrative which does not centralise on a pre-determined storyline. The quality of the narrative may change as a result of dynamic plot generation, with the player's emotional involvement greatly increasing the compellingness (section 1.6) for them personally (section 2.3.8).

Juul [62] observes that when telling a story the exact parameters of time and space are often not fully detailed. This is an issue which must be addressed in an interactive narrative. This has been a problem in some computer games, one of the oft-cited drawbacks of games such as *The Sims* [58] is that they over-emphasise mundane tasks. Further consideration is required but it should be possible to address this issue in an interactive narrative, perhaps by allowing the user to control the progression of time in some way — although this may detract too greatly from the plausibility of the experience.

Research to demonstrate the validity of interactive narrative was carried out by the Oz research group [65]. This real-life experiment involved human actors wearing headphones and being directed through a plot graph (section 2.2.9) by a human director. The user was free to move around and act as they desired on-stage with these actors. The narratives were simple: the user waiting at a bus station and being brought into contact with a violent man; and a detective story. It was concluded that an interactive narrative is a very enjoyable experience for the participant (the first story being more so). The audience were frustrated by the slow-moving plot, but this is not of paramount importance as an interactive narrative is designed for the user.

2.4.3   The systems

The main existing interactive narrative systems are listed and briefly introduced in this section. The architectures and techniques used are discussed further in the following sections, in accordance with each of the compellingness criteria.

The Oz Project [9, 75] group created simple characters known as woggles. The user could give instructions to one of these characters and play with them. The characters interacted with each other in the game world. Where there was a story included the directions of the user to one of the characters would determine which of the possible (overlapping) narratives was experienced.

Chris Crawford's **Erasmatron** [16] (now called **Storytron**) system presents the user with a number of action options, generally relating to specific speech acts. Once the user has made their choice the system — or a storyworld character — responds appropriately. This continues until the narrative is finished. This is a text-based system.

While in the **DEFACO** [99, 100] system the user becomes a character in an Ancient Greek world. They are able to specify their actions within that world and will then be shown graphically the generated narrative. Until the graphical output is produced the user will not know the consequences of their actions.

Users of the **Virtual theatre project**'s [92] cybercafé system were able to give general directions to a character in a café. This character would be able to order drinks and flirt with others in the café. Although the group also worked on other systems, in those there was no guarantee that there would be a story in the user's experience.

The **Mimesis** [126, 125] system was created as part of the work of the **Liquid Narrative Group**. In this system there are goals which must be achieved by the narrative. If the user acts in a way which interferes with those goals then their action will be somehow prevented from occurring, for example by a control device jamming.

In **IDtension** [109, 110, 111] the user is able to specify text-based actions for any characters within the storyworld. There are certain goals which must be met by the story. The system will determine which actions the user avoids and manoeuvre them into situations where they have the choice of taking these actions or failing to achieve the objectives of the story.

A user of the **I-Storytelling** [13] system will see a graphically depicted story involving characters following individually pre-defined Hierarchal Task Networks (HTNs). They can make suggestions to characters which may or may not be followed. The user is also able to move certain key objects within the storyworld. This group's more recent work aims to create a system for Mixed Reality Interactive Storytelling (MRIS). The story generation component of this system is as in I-Storytelling.

In the **Façade** [76] system the user becomes involved in a couple's marital difficulties and battles. The user is able to speak to the other characters and what they say — as well as how and when they say it — will affect the story they experience. The user's actions will determine the final state of the couple's marriage.

At the start of an experience with the **Interactive Drama Architecture (IDA)** [73, 74] system the user finds their own dead body. As a ghost they must find their murderer and subsequently manipulate another character into finding the body and also discovering the identity of the murderer.

SASCE [83] is an adapted TD-learning method for interactive narrative. This method determines, based on a user-defined evaluation function, the apparent best route for the story, depending on the actions the user is expected to take at each stage, and thus that which will lead to the highest overall score.

The **OPIATE** [20] system creates stories based on Propp's [86] general structures for fairy tales. This has been applied to a very simple cartoon-style world. The user's actions are integrated into the Proppian structure where possible. For each storyworld one Propp-style story structure is used. Characters other than the user have flexible roles in the story.

U-DIRECTOR [79] uses decision theoretic networks to hint to the user those actions which they should be taking, so that one of the possible narrative plans can be followed. This enables achievement of the desired ending, which in the example case is solving a mystery.

PaSSAGE (Player-Specific Stories via Automatically Generated Events) [112] focuses on the user-specific adaptation of the story. There are a number of possible 'encounters' which involve characters in interactions with one another. These follow a particular order depending on their type. The encounter chosen depends on which type of game player the user has been modelled to be, which is based on their choices in an introductory phase.

The **IN-TALE** (Interactive Narrative Tacit Adaptive Leader Experience) [90] system is designed as a training system for soldiers. The user will find themselves in a scenario which could occur in the line of duty. They will be able to act as freely as they would in reality and their actions will determine whether they are able to successfully diffuse the situation. The ending will adapt to ensure that the problematic events will always occur — however the user chooses to act.

FearNot! [5] is designed to help users to cope with bullying situations. They are able to interact with a victim of bullying, giving them advice and observing the results of this. The bully and victim each create plans which are influenced by their current feelings, and the narrative emerges from interactions between these plans and the user's interactions.

2.4.4   Interestingness

Figure 2.4: A screenshot from an IDA experience

Not all of the considered research groups have evaluated their interactive narrative systems, or asked explicit questions on interestingness. Thus this section discusses the factors affecting the interestingness of each system and how dramatically interesting the narratives generated by each are likely to be.

The narratives produced by the Oz project were biased towards more interesting story creation paths through the plot graph — depending on an author-
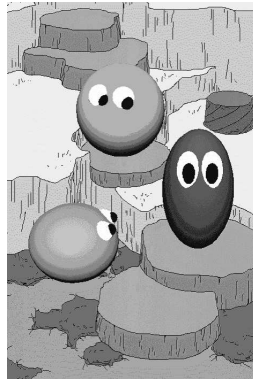
Figure 2.5: The Oz project characters, known as woggles.

defined evaluation function. The interestingness of the resultant stories thus depends on the plot graph and its evaluation function. In the Erasmatron and Mimesis systems there is the potential for authors to define their own storyworlds or game engines. The interestingness of the narratives produced will vary depending on these and their authors. The SASCE narrative interestingness depends on both the author-defined storyworld and evaluation function for this world.

The Virtual Theater Project and Façade storylines have an interestingness which depends on the dramatic interest of the pre-authored plot points, and also the sequence in which they are presented. Similarly the interestingness of PaSSAGE narratives is dependent on the author-created encounters, although the interestingness for the individual user should be increased by the selection of the story path depending on their modelled preferences. The IDtension system also utilises a user model to increase the dramatic interest, in this case to make the action options presented more conflicting.

The IDA (figure 2.4) and U-DIRECTOR narratives will be essentially the same each time. This means that the interestingness is dependent on the dramatic interest of this pre-defined narrative. In I-Storytelling the interestingness is dependent on the pre-defined HTNs associated with each character.

Narratives produced by the DEFACTO system have a twist incorporated to make them more interesting. Those of the OPIATE system have an interestingness dependent on how general Propp's functions are. If these can be instantiated (as is assumed) in any way then the interestingness will be similar to that of Russian folk tales. Dramatic interest is not of primary importance in the narratives produced by the IN-TALE and FearNot! systems.

2.4.5 Immersion

Due to the lack of availability of these systems for interaction, or questionnaires asking the appropriate questions, with most of these systems it is only possible to evaluate immersion according to how plausible the characters and storyworld are likely to be to the user.

Character believability (and thus plausibility) was a major focus of the work of the Oz project (figure 2.5 shows the Oz project's woggle characters). They

wanted users to become immersed in their worlds. While the Mimesis intervention techniques remain subtle the user has the potential to become immersed in the narrative. Similarly users of the IDA system should be able to become immersed — providing the hints remain subtle.

It should be possible for the user to become immersed in a PaSSAGE experience. There is a graphical interface which aims to increase the immersion and the characters are intended to be fairly believable — although this is not a focus of the system. Users of the U-DIRECTOR system should be able to become immersed and the creators certainly give consideration to character believability. There is the potential for the user to become immersed in the IN-TALE system, as it is created to be as similar to a real scenario as possible and plausibility is of paramount importance in such a training situation.

There is certainly the potential for the user to become immersed in the OPIATE world, although their survey suggested that participants did not feel themselves to be. With a better interface this would be more likely. Believability of characters was a central focus of the system. Users of the FearNot! system will ideally become immersed in the experience as it is necessary for them to empathise with the characters and situations.

It is unlikely that a user of the Erasmatron system will become immersed as they are limited to a small number of low-level action options which is likely to cause frustration. In the DEFACTO system the user will see the action graphically after they have finished interacting, meaning that it is unlikely that they will become immersed. When experiencing the story the user is no longer a character. In Façade the lack of response to user actions and the ignoring or misunderstanding of their speech acts are likely to reduce or even remove the user's sense of immersion.

Users of the Virtual Theater Project's cybercafé system are unlikely to feel immersed (in the game sense) in their experience as they are giving directions to a character rather than being a character themselves. This is true also of the I-Storytelling and IDtension systems in which the user does not have first person control of a character. Since a system involving real users has not yet been created by the designers of the SASCE system it is not possible to comment on the immersion likely to be experienced.

2.4.6   Scalability

The stories produced by the Oz Project and Virtual Theater Project systems are generally fairly short, perhaps a few minutes in length. These stories are generated by traversal of a plot graph and the user's interactions within that plot graph. There is a large amount of pre-definition required, resulting in a system which is not particularly extendable to a longer narrative.

The Erasmatron stories available for the PC last less than a minute. The length of the stories will depend on the path the user takes through the storyworlds, with an upper limit being imposed by the size of the world (as long as that is finite). The DEFACTO and IDtension stories will last only a few minutes. The systems are potentially scalable to longer narratives but would need a large number of changes for this to be possible.

The Mimesis bank robbery scenario lasts only 2 minutes. There is potential for greater length since this is a general architecture which is intended to be able to create interactive narratives with any game engine. The scenario (it is

Figure 2.6: A screenshot from a PaSSAGE experience.

probably not a story) they describe which involves the user visiting an aquarium would last much longer. The scalability of this system is thus debatable. The *Friends*-based [117] scenarios produced by the I-Storytelling group tend to last approximately 3 minutes. They have transferred the system to a party-planning scenario which is of a similar length. The techniques used do not lend themselves to a longer story due to the large amount of pre-definition required.

Experiences with the Façade system and the associated stories last around 15 minutes. This is far longer than most other interactive narrative systems, but is still short in comparison to most conventional narratives. Since the narrative generation centralises essentially on a plot graph — but with far more plot points at a much lower level than it is reasonably possible to explicitly draw — it is still not particularly scalable. It took 5 years to create this single short experience. Interactive narratives like Façade, with many pre-defined nodes, are impractical. Although they are very flexible there is too much pre-definition involved in their creation, especially for a longer narrative. The Façade creators aim to build a system which improves this process by autonomously pre-defining certain components.

The IDA and U-DIRECTOR experiences have fixed storylines. This means that any narrative length is possible — as long as the author is prepared to create both this story and its user model or dynamic decision network, either of which would be very complex with even a short narrative. Since all of the SASCE policies are determined off-line scalability is theoretically possible but this requires greater predictability in the user, which may be less likely over a longer time period. The IN-TALE techniques would be capable of generating longer stories, although since all possible endings must be pre-defined there will be a lot of initial input required to create these and still enable user freedom in the later stages of the narrative. In addition it is possible that a system designed for simple training scenarios would not be applicable to longer narratives. The FearNot! system is also unlikely to require longer narratives to achieve its aims, and a large amount of pre-definition would potentially be required for this.

The OPIATE and PaSSAGE (figure 2.6) experiences are more similar to computer games and will thus last longer than most interactive narratives. However the essential story structure of OPIATE is only as long as a Russian folk tale (due to the basis in Proppian structures), and it is likely that if the experiences last longer the dramatic interest will be lost due to the deviation from the Proppian structures. Scalability to a longer version of the PaSSAGE narratives
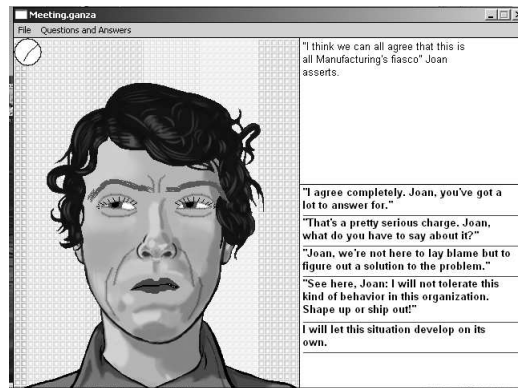
Figure 2.7: A screenshot from an Erasmatron experience

is considered and certainly appears to be possible.

2.4.7   Domain independence

The basic techniques involved in interactive narrative systems which utilise a
plot graph structure are applicable to any domain, as has been shown by the
Oz Project's work providing the basis for Façade. Such systems include the
Oz Project, the Virtual Theater Project and Façade. The application of these
techniques to new domains requires a large amount of pre-definition, essentially
consisting of re-writing the plot graph for the domain.

The DEFACTO system has only been implemented in a single storyworld
and does not give consideration to further applicability. Although the basic
techniques should apply to any domain this would require rewriting of core
components. The same restrictions limit the transferability of IDtension to
a new domain. As the story in the IDA system is mainly pre-authored the
application of these techniques to another domain will require an author to
create an entirely new story. Each possible story must also be pre-written
individually in the U-DIRECTOR system, and although the basic techniques
should apply in any domain the complexity involved will constitute a significant
constraint on this.

The Erasmatron and Mimesis systems are designed as general architectures
which will apply to any domain. There have been a number of storyworlds
created for the Erasmatron system (the interface can be seen in figure 2.7).
To aid in this Crawford has designed a story development tool — in the belief
that artists and not computer scientists are required to create dramatically
interesting storyworlds. The SASCE system has been utilised with a few stories
and will apply in any storyworld in which the creator can define an appropriate
evaluation function.

PaSSAGE is designed to be independent of domain and the encounters can
be defined to be game-specific. However it is very computer-game oriented and
the techniques will be less appropriate in more literate or story-focused domains,
particularly since inter-character relationships are not considered. Encounters
would need to be defined for each domain, and it is possible that their sequence

would not be appropriate for domains which are dissimilar to that currently used. In less computer game-oriented domains the model is less likely to be applicable as it is based specifically on computer game players.

If it is believed that Propp's functions are completely general then it is possible to apply the techniques used in the OPIATE system to any domain, although this would require an expert storyworld creator. The techniques used in IN-TALE are potentially applicable to any training scenario, but as the system is not designed for generality a fundamental re-writing would be necessary. The FearNot! system is designed specifically to address bullying scenarios but has further applicability to similar educational scenarios.

The IDtension, I-Storytelling and Façade systems have been, or are currently being, applied to more than one domain. For each new domain a significant amount of author time and effort is required in all of these systems.

2.4.8   Agency

2.4.8.1   User freedom

The Dramatic Presence experiment [65] carried out by the Oz Project group allowed the user complete freedom (within the limitations of the 'real' world). This demonstrates a situation in which the user believes that they have complete freedom but inherent constraints prevent this from being an actuality. In reality they are experiencing gravity. They may also, to a certain extent, be performing for the human audience.

In the computerised Oz Project storyworld the user has a reasonable level of freedom. In the SASCE system an attempt is made to give the user freedom and create an original story depending on them. The IN-TALE system is designed to allow the user the same freedoms as they would have in the real world so that the training is accurate and applicable. U-DIRECTOR also aims to give the user (at least the illusion of) freedom. The system provides hints to encourage the user to follow the desired story, but no explanation of the outcome if they repeatedly ignore such hints is given.

Users of the Erasmatron system are restricted to a list of action options. In [16] Crawford states his belief that all feasible options can be expressed in a limited number of ways. At each stage in an experience involving the Erasmatron system the user is presented with a range of options. It may be possible to utilise action option lists and maintain user freedom but not when the options are at such a low-level as they are in this system — in which the user is often choosing from various speech acts. The IDtension system also restricts the user to a list of action options, in this case for the narrative rather than an individual character. In IDtension the action options are very general, resulting in a much wider range of feasible options for the user. Total coverage of these options is not realistic. Such potential — but unavailable — actions will not necessarily be relevant to the story as conceived by the author in creating the storyworld but possibly would be actions which the user would expect to be able to select in their experience of the narrative.

The DEFACTO system allows the user to accept or reject each action chosen for the protagonist. Their choice will affect the story created. The user will only have this option in the story generation phase, and will be entirely unable to interact when seeing the story presented. In the Virtual Theater Project's

Figure 2.8: A screenshot from a Façade experience

cybercafé system the user does not directly control a character but is freely able to give high level directions to one of the storyworld characters. The user is free to give suggestions and move certain key objects in the I-Storytelling system but is neither playing nor controlling a character within the storyworld. They are also likely to be ignored by the characters. In the FearNot! system the user is able to give advice to other characters. This will influence the goal ordering priorities of those characters and thus change the way in which they act. This involves the user either selecting one of a number of speech acts or freely typing their required action.

The IDA system does not allow the user complete freedom but this lack of freedom is explained by the user taking on the role of a ghost. As discussed in section 1.6.5.1 the requirement of user freedom only requires the user's perception of such freedom given their current circumstances. According to these criteria the user is likely to have freedom in the IDA system.

An attempt is made to give the user of the Mimesis system the illusion of complete freedom. Following each user action not in accordance with the current plan the system decides whether the user's action can be "accommodated" or must be "intervened" with. An accommodated action must be incorporated into a new plan to achieve the story's goal. In the group's bank robbery scenario if the user opens the bank vault — which the plan requires another character to open — re-planning can accommodate this inconsistency by creating a plan in which that character does not open the vault but finds it open. If accommodation is not possible the system must intervene with the user's action. This could mean causing the user to miss when they attempt to shoot a character who must perform some role for the story's goal to be achieved, or perhaps a nuclear reactor's "control dial momentarily jamming ... [to] preserve the apparent consistency of the user's interaction while also maintaining safe energy levels in the story world's reactor system." [126]

The creators of the Façade system aim to give the user complete freedom but this is not achieved. The user is able to freely enter speech but they will often be misunderstood or ignored. The user's movements are very limited and have a high likelihood of being unnoticed by other characters. This restrictedness is due to every user action (speech or movement) being mapped onto one of a limited number of discourse acts. If no mapping is possible the system will continue the narrative without responding to the user. A screenshot from a

Figure 2.9: Some of the characters from the OPIATE system

Façade experience is shown in figure 2.8.

The OPIATE and PaSSAGE systems aim to give the user complete freedom (within the restrictive constraints of the respective domains) while still ensuring that they follow a fairly fixed structure as necessary for the narrative. In both systems the user is required to perform certain actions before the narrative will progress. In PaSSAGE the user is able to speak but is limited to pre-defined speech acts.

2.4.8.2 Clear effect of user actions

In some of the discussed interactive narrative systems the user will observe a short-term effect of their actions but will not be able to change the overall structure of the narrative, or the ending. This is true of the Oz Project, Erasmatron, Virtual Theater Project, Mimesis, IDtension, IDA, U-DIRECTOR and PaSSAGE systems.

The Oz Project group's work on agents involved ensuring a clear immediate effect of the user's actions, as did their real-life experiment. The use of a simple plot graph structure combined with an evaluation function restricting the possible paths through this graph means that it is unlikely that the user's actions will have a clear effect on the long-term narrative. The Erasmatron system responds to the user's actions (from a list of action choices) and the user's path through the story space will be determined by these. Unfortunately there is a large amount of looping, in which the system presents the user with the same options as they have experienced previously. This means that the user will not feel that their choices are having a long-term effect but that they are being manipulated into a particular overall course of action.

Users of the Virtual Theater Project's cybercafé system will see a clear immediate effect of the directions which they are able to give to one particular character. Whether this will affect the overall narrative is dependent on how that character carries out these directions, as they have some freedom in this. In the U-DIRECTOR system the user will see an immediate effect of their actions in the storyworld but the long-term course of the narrative will remain the same, and they will have to experience the same essential stages in the pre-defined plot.

Figure 2.10: A screenshot from an IN-TALE experience

In the Mimesis, IDA and IDtension systems the story ending is pre-defined and the user will be unable to change this. In the short term their actions will usually have an apparent effect. In the Mimesis system the user will see an immediate effect of their actions unless they are intervened with, and where accommodation occurs their actions are able to change the narrative in a small way. In IDA there is some story variability, for example determining where an action can take place, a short-term effect of the user's actions. As the user is selecting actions for the entire narrative in the IDtension system their actions will affect this, but as there is a story goal which must be achieved their actions will not have a long-term effect.

The PaSSAGE user's initial actions will have a long-term effect because these determine the player model (from one of 5 possibilities) and thus the future choices made in narrative generation. It is unlikely that this will be clear to the user, particularly since the authors do not want the user to know that they are being modelled, but only to have a better experience as a result of utilising a user model. The narrative will vary but will still fall into one of a fixed number of patterns and with the small number of encounters (9) available the user can never have a significant effect on the overall narrative, especially since there are only 5 possible endings. The user will see an immediate effect of their actions towards other characters.

There are systems in which the user will not always see an immediate effect of their actions but in which these affect the overall course of the narrative. This is the case in the DEFACTO, I-Storytelling and Façade systems. In the DEFACTO system the user will see the effect of their actions in the second phase, when the presentation of the story is carried out. Their choices will affect the eventual outcome and the nature of the twist presented. Within the I-Storytelling system, the user's interactions can be ignored as these are simply suggestions to the characters. In the videos available online it appeared that the user's (albeit very limited) actions were having an effect on the characters and thus on the plot. In Façade the short term effect of actions is not always apparent. This is because the system either maps the user's action onto a discourse act or, if this is not possible, ignores the action altogether. In this system the long term effect of user actions is more apparent — there are a large number of beats (sequences of action) and 5 possible outcomes, entirely depending on the user's actions — but this is still fairly limited.

As the SASCE interactive narrative system has not yet been created this cannot be fully evaluated, but the intention is certainly for the user to observe a clear effect of their actions on the story. The OPIATE (figure 2.9) and IN-TALE systems' users will observe both a long and short term effect of their actions. According to the OPIATE survey [20] when the users felt they were able to act they believed that these actions were having an effect. In the IN-TALE system (figure 2.10) there are various pre-defined possible endings, and the user can act in a way which can potentially change which of these endings is experienced. In the short-term the user should also see an effect of their actions within this system. The user of FearNot! will see characters adapting their action choices in response to advice given by the user. This advice and the adjustments it will cause to character plans will lead to variation in the overall outcome of the narrative.

2.4.9 Replayability

In this section only replayability as a subjective issue is considered. Those interactive narrative systems currently in existence tend not to encourage the user to experience them more than a small number of times. This is due to the limitations on the possibilities for action within these worlds. Not many experiences will be required before the user will feel that they have exhausted the possibilities of the system.

Those systems which utilise a plot graph (the Oz Project, the Virtual Theater Project and Façade) are limited in their replayability by the size of this plot graph. Erasmatron is limited in replayability by the size of the game world. Since the IDtension stories are so short its replayability is limited. If the system were to be scaled up (section 2.4.6) it is likely that the replayability would be increased.

The DEFACTO twist would quickly become predictable to users, thus limiting its replayability. It is not possible to discuss the replayability of Mimesis in general as this depends on the individual story. However the unchangeable story goal means that the user would perhaps try a few variations but would soon realise that the outcome would be the same each time. The I-Storytelling system relies on the random initial positions of the characters for a different narrative to be generated. These are unlikely to be distinct enough on each play for an entirely new story to be generated. Due to the volume of pre-definition required for each of these options they are likely to quickly run out.

Users of the OPIATE system are theoretically completely free but the use of only a subset of possible Proppian story structures means that the system will provide a restricted number of possible storylines. The SASCE trained stories tend to cluster around particularly similar narratives due to the evaluation function techniques — which tend to reduce the variation in selected stories. To increase replayability this must be addressed, as is currently being considered by the research group.

The PaSSAGE system adapts to the user according to their type. The limited scope means that the essential story does not vary greatly. If players correspond to one of the utilised types then they are likely to do so each time they play, meaning that they will experience the same narrative path every time — unless the user deliberately plays against their type, which in itself would change their experience in any game world. In IN-TALE the aim is to train
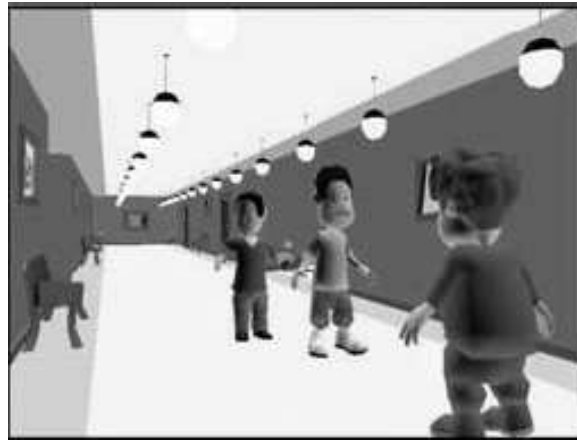
Figure 2.11: A screenshot from a FearNot! experience

the user to cope with a new scenario and thus replayability is not an issue. If the user replays they will be aware of the expectations. In addition the realisation that they cannot act pre-emptively to prevent the negative outcomes may become frustrating and unrealistic, which would undermine the benefits. In the FearNot! system (figure 2.11) the user will be able to replay and observe the implications of different advice. It is thus possible that they will replay to explore their available options. The U-DIRECTOR system is not particularly replayable as it imposes the same essential storyline each time.

The IDA ghost story would cease to be of interest once the user knew the identity of the murderer and how to communicate to other characters the relevant details pertaining to this murder. Replayability could be increased if the ideals discussed in [73] were implemented, "allowing scenes to be defined in an abstract fashion, giving flexibility into what specifically happens in that scene." This could involve the user model being utilised to select the identity of the murderer — perhaps that character who the user has grown closest to in the course of their experience. This would potentially also increase the dramatic interest of the user's experience.

2.4.10   Summary

The successes, shortcomings and failings, of each of the considered systems and their architectures are summarised briefly in this section. This is given numerically in table 2.1.

To satisfy the compellingness criteria a plot graph structure cannot be utilised. This structure will never be able to satisfy the criteria of transferability and scalability due to the large amount of pre-authoring required. This is also true of those systems which require a pre-defined story. Replayability will not be possible with such techniques due to the inherent limitations of a fixed story structure, even with flexibility built in. This means that the architectures used in creation of the systems of the: Oz Project; Virtual Theater Project; Façade; IDA; U-DIRECTOR; and PaSSAGE groups have architectures which are incapable of creating compelling interactive narratives. Although the

System	Criteria							Total
	Interest	**Immersion**	**Scalable**	**Transferable**	**Agency**		**Replayable**	
					User free	**Clear effect**		
Oz	0	2	0	1	2	1	1	7
Erasmatron	*	0	1	2	0	1	1	6
DEFACTO	1	0	1	1	1	1	1	6
Virtual Theater	1	0	0	1	1	1	1	5
Mimesis	*	1	1	2	1	1	1	8
IDtension	1	0	1	1	1	1	1	6
I-Storytelling	1	0	0	1	0	1	0	3
Façade	2	1	0	1	2	1	1	8
IDA	2	1	1	1	2	1	0	8
SASCE	*	0	1	2	1	1	1	7
OPIATE	1	1	1	1	1	2	1	8
PaSSAGE	1	1	2	1	1	1	0	7
U-DIRECTOR	*	1	1	2	1	1	0	7
IN-TALE	0	2	1	1	2	2	0	8
FearNot!	0	2	0	1	1	2	1	7

Table 2.1: A summary of the degree of compellingness in each of the main previous interactive narrative systems.
Notes:
Scale: 0 = no/very weak; 1 = some; 2 = yes; * = depends on storyworld creator (given 1 in totalling).
It is theoretically possible to apply the techniques used in the creation of any system to a new domain or storyworld, thus none have been assigned a score of 0 for this. Only those that have been specifically designed to be easily applicable to any story domain have been allocated a score of 2, as the remaining systems require rewriting of core components of the system to achieve this transferability.
In rating the effect of the user's actions the systems have been assigned a score of 2 only if they provide the user with both an immediate and a long-term effect of their actions. If they provide one of these the score assigned is 1, otherwise it is 0.
Transferability is equivalent to domain independence.

Mimesis system is transferable the same restricted replayability caused by the imposition of a fixed story ending also results in a lack of compellingness.

The compellingness criteria of user agency and immersion cannot be satisfied by a system in which the user does not have first person control of a character within the storyworld. This is true of the IDtension and I-Storytelling systems — the basic techniques of which will thus not be able to generate compelling interactive narratives.

The OPIATE and SASCE systems rely on assumptions which mean that their architectures will not generate compelling interactive narratives. OPIATE has a strong reliance on the generality of Propp's functions, both within the scope of a restricted fairy tale and in its potential for applicability to further domains. SASCE initially learns a method for incorporating the user's actions into the narrative, thus depending on the user acting consistently with one of the computer models. It is unlikely that any user will act in accordance with the expectations of a computer model and thus a compelling interactive narrative has a low chance of being experienced.

As the user is being presented with a list of low-level action options in the Erasmatron system they will be unlikely to feel that they are free to act or to become immersed, particularly since the stories tend to return to the same choice points multiple times within the same experience. The specificity of the DEFACTO system to a particular storyworld limits its transferability and the nature of its twist restricts its replayability. In creating the IN-TALE and FearNot! systems the focus was not on interestingness or replayability due to the specific training and educational scenarios. Therefore the Erasmatron, DEFACTO, IN-TALE and FearNot! systems each have inherent limitations which mean that the architectures used will not be capable of full compellingness.

2.5   Research hypothesis

As discussed in section 2.4 none of the interactive narrative systems created thus far address all of the compellingness criteria. It is not possible to extend the methods used in the creation of these systems to achieve full compellingness, meaning that a new system is required. Chapter 3 introduces the GADIN (Generator of Adaptive Dilemma-based Interactive Narratives) system which is used to achieve the research hypothesis, that:

A computerised dilemma based user adaptive interactive narrative generator based on the GADIN architecture can create a compelling interactive narrative experience.

3

The GADIN architecture

3.1 Overview

In this chapter the core components of the GADIN architecture are discussed.
This begins with an introduction to the proposed knowledge-based narrative
generation system. Figure 3.1 shows the overall structure of this. In the fol-
lowing sections greater detail is given for each component, with justifications
and explanations. A discussion of the methods used to incorporate the user's
interactions into a narrative dependent on these is given in section 3.7, with an
overview of the interactive narrative architecture in figure 3.7.

  The GADIN knowledge base consists of: the storyworld (which includes
information on the characters); story actions in which the characters can par-
ticipate; and dilemmas which can occur in the storyworld. This information is
partially domain dependent and provided by the storyworld creator, with the
remainder being hard coded. These components are drawn upon in the genera-
tion of a narrative. In this system planning is used to achieve the preconditions
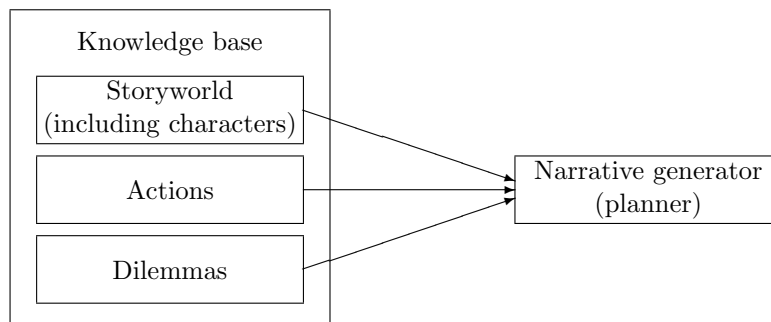
Figure 3.1: An overview of the GADIN architecture

of dilemmas through story actions, dependent on information in the knowledge base.

3.2   Storyworld

The storyworld is the world in which the narrative will be generated. It consists of all of the components which must be utilised in the generation of a narrative. There must be: characters who can act within the world; at least one location at which the narrative can take place; and objects which can be interacted with or participate in actions. The aspects of characters, locations and objects available within a GADIN storyworld are discussed in this section.

3.2.1   Characters

The specific details and instantiations of the character information will be domain dependent. For example: in some domains it will not matter if the character is male or female, in others this will be an essential feature. The GADIN system has available a number of traits through which characters can be defined — as discussed in this section. Only those traits which are appropriate to the current domain need be utilised.

3.2.1.1   Traits

Each character's potentially associated traits include: attributes, characteristics, personalities, aspirations, skills and dispositions. To create individual characters within the storyworld the creator instantiates each trait for those characters. It is also possible to allow the user to perform this instantiation, as discussed in section 4.11.

A character's associated attributes can include information such as attractiveness and gender. These are generally physical traits of a character. Characteristics are slightly more variable than attributes, and are generally features relating to the mentality of a character, for example generosity and morality. A range of values should be associated with each attribute and characteristic. Table 3.1 shows character attributes and characteristics, examples of each and the values it can take. For attractiveness and the characteristics the default values are on an integer scale of -1 to 1. This is a numerical representation of the scale low, medium, high and is translated to a numerical scale to make calculations, comparisons and changes by GADIN more efficient. It is also much easier with a numerical value to extend the scale without having to determine specific (and potentially controversial) wordings for each. The storyworld creator can easily set these values as required, with the default scale consisting only a guideline rather than a restriction on the values the creator can use.

Where required it is possible to specify domain specific character personality descriptions which are not fully deducible from other traits held by that character, such as being a fundamentally evil character. Storyworld principles, such as monogamy, which can be held by characters should be defined, to make their behaviour more believable — these may be broken. Characters may also have aspirations, for example wanting a baby. They may additionally have skills, such as being able to swim. These are domain-dependent and examples are given for the relevant versions of GADIN in sections 5.3.1 and 5.4.1.1.

Trait	Category	Values
Attractiveness	Attribute	-1, 0, 1
Gender	Attribute	male, female
Age	Attribute	child, teen, young, middle aged, old
Sexuality	Attribute	homosexual, heterosexual, bisexual
Generosity	Characteristic	-1, 0, 1
Morality	Characteristic	-1, 0, 1
Selfishness	Characteristic	-1, 0, 1

Table 3.1: The basic attributes and characteristics available within the soap version of the GADIN system.

3.2.1.2   Dispositions

Characters have an associated disposition, which is defined along each of a number of dimensions. A character's disposition determines how they act — both in the actions available to them and the manner in which they perform them. Some of the possible disposition dimensions are: happiness, outgoingness and agility (in its relation to a character's energy levels). The disposition dimensions used in the dinosaur adventure version of GADIN take integer values between -3 and 3 inclusive, this is discussed further in section 5.4.1.1.

Before the narrative generation begins each character is non-deterministically assigned a value for each disposition dimension. It is possible for a character's disposition to change throughout the narrative, depending on how other characters act towards them. An example of the possible changes is detailed for a dinosaur adventure in section 5.4.2.1.

3.2.1.3   Relationships

Characters will have storyworld relationships with one another. Depending on the domain these may include friendship, love and familial relationships. When involving feelings these relationships are unidirectional and have an associated strength, although feelings of one character for another can affect the reciprocity if it is appropriate for the domain. In the current system such relationships are only able to have an associated strength of 1 or -1.

3.2.2   Locations

A series of domain-specific locations can be defined for each storyworld. At any given time in the narrative it is possible for each character to be at only one of these locations. Certain interactions may be specified as only being able to take place if the characters are at the same location, where this is appropriate it is included in the preconditions of the action.

The specific requirements for each location are domain dependent, although there are common features. Each location has associated: a name, and a series of Boolean values which determine its nature. These may include whether the location is: appropriate for a party; a prison; a place where it is possible to steal; a place where it is possible to drink; or a place where drinks can be bought (for others). Skills required of characters, such as being able to swim, before they

can move to a location can also be defined. If the storyworld creator defines crimes punishable by jailing in the storyworld then there is a constraint on the locations that at least one must be a prison.

Examples of possible locations and their properties for created storyworlds are given in sections 5.3.1 and 5.4.1.2.

3.2.3 Objects

Where appropriate for the domain there will also be objects. Objects can be attached to an owner, after which they will belong to that owner and move with them. Objects which can be stolen will have a 'true owner'. For instance a shopkeeper may have a range of objects of which he is the true owner, if another character steals one such object then they become the owner, and can treat the object as such, but the object may be required to be returned to the true owner. If the object is given away or sold then the true ownership will change. Examples of storyworld objects are given for a dinosaur adventure in section 5.4.1.3.

3.3 Actions

Aristotle [2] observes that "life consists in action" and therefore within a drama "character comes in as subsidiary to the actions". To generate a narrative those actions which can take place within the storyworld must first be defined.

The actions which can occur in the course of a narrative must be specified for each domain, and every possible action should be included. There may be actions which will be appropriate in many domains. The domain specific story-world actions can include characters falling in love, moving between locations and being involved in crimes — such as drugging or murder. Associated with each crime are certain motivations for their being committed, some of which are specific to particular personality traits. Those actions which are possible within the current versions of GADIN are detailed in sections 5.3.2 and 5.4.2.

The instantiated values of an individual's traits should be apparent to the user from the actions that character takes within the storyworld. A character's traits will affect which actions they can participate in and, ideally, the user's opinion of that character. Each character acts in a manner which is consistent with their traits due to use of the applicability check, discussed in section 3.3.2.

For each action within the GADIN system there must be defined:

- Preconditions and effects. These are propositions which will be either true or false at every stage within the narrative. This follows the STRIPS representation and is discussed further in section 3.3.1.

- Conditions which must hold for the action to be made available for use by the planner, these are known as the applicability conditions and are discussed further in section 3.3.2.

The manner in which an action is performed is dependent on the character's disposition, as discussed in section 3.3.3. The effects of an action will cause changes to the storyworld which will affect characters' utilities, as discussed in section 3.3.4.

3.3.1   STRIPS formulation

Each action will have associated: conditions which must be satisfied before
execution (preconditions); and effects representing changes to the storyworld
following successful execution. For example the action of a character moving
between locations `l` and `k` has preconditions of the character being at location
`l` and there existing a path between locations `l` and `k`. The effects of this action
are that the character is at location `k` and is no longer at location `l`. This follows
the STRIPS representation and is shown in this form in figure 3.2.

```
Operation:  Move between location l and location k
Preconditions:  at(l) ∧ path(l , k)
Effects:  at(k) ∧ ¬at(l)
```

Figure 3.2: An example of an action in the STRIPS representation.

Not all of the actions will have a primary acting character, for example a
character finding an object will not be able to determine when they find it.
Although this is influenced by previous character actions it will not occur as a
result of an action initiated by the main involved character.

3.3.2   Applicability

Before an action is made available to the system for use within a storyline an
applicability check is performed on the involved character's traits and dispo-
sition. An action can only be utilised if its applicability holds for the acting
character. This check is supplementary to the preconditions of an action and
incorporates conditions which cannot be specified through use of STRIPS-style
preconditions. This helps to ensure that each character acts in a manner which
is consistent with their traits and how they have acted previously, while at the
same time avoiding predictability.

An example in the soap version of GADIN (and therefore based on actions
which have been observed to occur in soaps) is a character X `starting to`
`fancy` another, Y. The precondition is that X does not fancy Y and the effect is
that X does fancy Y. This action would not be appropriate for some characters,
for instance a particularly attractive character is unlikely to `start to fancy` a
very unattractive character. The applicability check ensures that each action is
appropriate for the acting character, in this case it should be ensured that Y has
attractiveness $\geq$ X's attractiveness. There may also be alternative applicability
conditions for this same action.

Throughout the narrative the applicability check ensures that characters will
choose to take actions which are consistent with their disposition. For example:
a charming character may consistently tell others they look nice and give them
objects; or a grumpy character may moan about the weather and not play with
other characters.

The applicability check ensures that the actions made available to the plan-
ner (section 3.5) are of the appropriate type for the acting characters within
the current domain. The preconditions will not necessarily be domain specific.
There are also conditions, such as those which specify percentage likelihoods and
require numerical comparisons, which do not follow the formulation required for

STRIPS preconditions. This adds greater flexibility to the action availability than would be possible through sole use of preconditions.

3.3.3 Manner

Adverbs are associated with character actions to give a clear impression of the character's disposition in the narrative. These are then presented in the output as a descriptor for actions — when and where it is appropriate. A range of possible adverbs reflecting the same disposition add more interest to this. The adverb selected as an action descriptor will be randomly chosen from those associated with the disposition dimension which has the greatest absolute value. For example a happy character may act happily or joyously. Modifying adverbs can be used if these dispositions are more or less extreme. This gives the user a clearer idea of the changes they are causing to character dispositions than attempting to choose an adverb which reflects the full disposition of that character. The association of an adverb with an action requires selecting an appropriate adverb randomly from the appropriate available possibilities. This is discussed for the dinosaur version of GADIN in section 5.4.2.1.

Character dispositions will become clear in the narrative — through the actions they choose and the manner in which they carry out these actions. For example to become friends with the user an artistic character may draw them a picture, whereas a bolder character may ask the user to play. In addition this bolder character would not just `move to the forest` but could `move to the forest buoyantly`.

3.3.4 Utilities

Each character has an associated utility (or score) in each storyworld state. This is changed as the state of the storyworld changes through character actions. This reflects the assumed positives and negatives of that state for each character. It is calculated appropriately for the domain, for example: in the soap domain a character will have a higher utility if another character fancies them; and characters who want a baby will have a higher utility in states in which they are pregnant.

Every possible proposition has an associated utility for each character. For example the proposition `X fancies Y is true` has an associated utility (in the soap domain) of 2 for Y. The total utility of a character in each state is the sum of the associated utility values of all propositions which involve that character. It is possible for the associated utility to be dependent on the individual's traits, for example the proposition `Z is pregnant is true` will have an associated utility of -2 if Z does not want a baby, but 2 if they do.

The effects of actions change the state and thus the utilities of characters, and this is the associated utility change of the action, which may vary depending on the involved characters. For example (in a soap domain) if X `starts to fancy` Y this has an associated utility reflective of the effect that X now fancies Y, meaning that Y has an increased utility in that state.

3.4 Dilemmas

3.4.1 Motivation

Narratives often centralise on clichéd storylines. These will generally culminate in a dilemma involving the main character. Such clichéd storylines will often follow one of a series of general forms. This is not true in all genres, but is found to be the case in a wide range of domains, for example 'chick flicks', *James Bond*-style adventures and soap operas (soaps). Within these domains writers will utilise such clichéd storylines in the generation of narratives, building up the narrative around dilemmas.

A range of such dilemmas can be identified and generalised. Once the general form of each dilemma has been determined, it is possible for a computerised storywriter to generate a narrative around these. It will not be possible to create great literature in this way — the use of clichéd storylines prevents this. However, such stories are enjoyed by many people. The narrative is built around the cliché, and it is the cliché as well as the narrative which the audience appreciate, the very repetitiveness and familiarity of the dilemmas adding to the dramatic interest.

The generation of a narrative in this manner provides a story which is original each time, as the variations in the clichés will result in new narrative. The techniques are applicable in any domain which makes use of such clichéd storylines, many of which are reusable between domains.

3.4.2 Dilemma categories

It was found — by empirically examining a wide range of dilemmas from various domains — that when more than two characters were involved in a dilemma it was either: expandable to multiple, two-character dilemmas; or the characters receiving payoffs naturally divided into two groups, each with the same resultant utility. Therefore a decision on a dilemma involves only two recipients of utility payoffs. Five such dilemma categories were identified. These consist of all payoff matrices with two recipients where there is a dilemma involved. This may require characters to be friends or enemies and, where relevant, this is stated with the dilemma utility matrices. The relevant categories are: Betrayal, Sacrifice, Greater Good, Take Down and Favour.

In these dilemmas:

- A_X represents the decision of character X being to take action A.

- $\neg A_X$ represents the decision of character X being to not take action A.

- u_C^i represents the utility of character C for the respective action.

- i denotes the relative value of the utility, i.e., u_C^1 is greater than u_C^2. These values are unrelated to u_D^i for any other character D.

Betrayal

When presented with a Betrayal dilemma a character must decide whether to take an action which would result in their best possible utility, but simultaneously the worst possible outcome for their friend (or someone close to them).

The decision would not involve a dilemma were the two characters not friends. This dilemma can be represented as a payoff matrix as shown here.

$$\frac{A_X \mid (u_X^1, u_Y^2)}{\neg A_X \mid (u_X^2, u_Y^1)} \land friends(X, Y)$$

A character having the opportunity to be unfaithful to their partner is an example of a Betrayal dilemma.

Sacrifice

A character facing a Sacrifice dilemma is able to choose an action which will result in their worst possible utility but also the best outcome for their friend. These characters must be friends for this to be a dilemma. The payoff matrix for this dilemma is shown here.

$$\frac{A_X \mid (u_X^2, u_Y^1)}{\neg A_X \mid (u_X^1, u_Y^2)} \land friends(X, Y)$$

An example of a Sacrifice dilemma occurs when a character has committed a crime which their friend has been accused of. Here a character has the opportunity to admit to their crime and thus accept the punishment rather than allowing their friend to take the blame.

Greater Good

Involvement in a Greater Good dilemma means that a character is able to take an action which will result in their best possible utility but also the best outcome for their enemy. This would not be a dilemma if the characters were not enemies. It is represented as a payoff matrix here.

$$\frac{A_X \mid (u_X^1, u_Y^1)}{\neg A_X \mid (u_X^2, u_Y^2)} \land enemies(X, Y)$$

An instance of a Greater Good dilemma involves a character deciding whether to give something (such as information or a friend) to their enemy to save themselves, and possibly also their family.

Take Down

In a Take Down dilemma a character has the option of an action which will result in their worst possible utility but also the worst outcome for their enemy. The characters must be enemies for the dilemma to exist. The payoff matrix for this dilemma is given here.

$$\frac{A_X \mid (u_X^2, u_Y^2)}{\neg A_X \mid (u_X^1, u_Y^1)} \land enemies(X, Y)$$

A character deciding whether to harm (or even kill) their enemy in full awareness that they will be punished for this is an example of a Take Down dilemma.

Favour

A favour dilemma causes a character X to have to choose between two actions where there will not be any immediate discernible benefit to X as a result of their decision. The utilities of characters Y and Z will change as a result of this action choice. If X chooses to take the action the outcome will be the best possible for Y, and Z will receive their lowest utility — and vice versa if X chooses not to take this action. When presented with a favour dilemma the character making the decision will not receive any direct utility from their action regardless of their choice, nor will there be any discernible benefit to the character making the decision of choosing one character over the other. The payoff matrix for this dilemma is shown here.

$$\begin{array}{c|c} A_X & (u_Y^1, u_Z^2) \\ \hline \neg A_X & (u_Y^2, u_Z^1) \end{array}$$

An instance of this dilemma occurs when a character must choose between potential partners.

The Betrayal and Sacrifice dilemmas are the inverse of one another, as are the Greater Good and Take Down dilemmas. This means that any dilemma which falls into one of these categories can be inverted to become a dilemma of the other category. All five categories are kept to increase ease of dilemma identification within specific genres. From these categories dilemma instances can be found and generalised within each domain. From the generalised form of the dilemma, the system will be able to create new dilemmas. In the presentation of these original narratives are generated.

3.4.3   GADIN dilemmas

When implemented within the GADIN system each dilemma has associated:

- Preconditions which must be true within the storyworld before the dilemma can be presented.

- Effects which will become true following the dilemma decision, with different effects being associated with each possible decision.

- A frequency of use, which determines how often the dilemma can occur within the narrative, as discussed in section 3.5.3.

- A utility value, which determines the change in utility which will result from the dilemma decision — this affects the responses to the dilemma in the manner discussed in section 3.5.5.

- A check on the deciding characters' traits to determine their decision when presented with the dilemma.

The formalism for a dilemma is shown in figure 3.3. A specific example of a dilemma can be found in section 3.6. Examples specific to existing applications of the GADIN system can be found in sections 5.3.3 and 5.4.3.

A$_X$:
```
The action which may or may not be taken by the deciding
character, X.
```
preconditions:
```
The conditions which must be true within the storyworld before
this dilemma can take place.
```
dilemma (to character X):
```
The decision which the deciding character must make.
```
effects:
```
The appropriate changes to the state which are the direct result
of X's decision.
```

Figure 3.3: The formalism for a dilemma.

3.5   Narrative generator

Dilemmas require characters to make fundamentally difficult decisions within the course of the narrative and thus create dramatic interest. Prior to a dilemma being presented certain conditions must be met within the storyworld. These are the preconditions of the dilemma. It is the task of the planner to achieve these preconditions, using actions which are possible within the storyworld, and thus to enable presentation of dilemmas. Such a plan constitutes the build-up — the essence of the story itself — and becomes a storyline when presented. The narrative will be made up of a series of such sub-stories, dynamically selected according to dramatic interest.

3.5.1   The planning algorithm

Early versions of GADIN utilised a simple Prolog planner which was insufficiently fast for real time narrative generation. It was decided to use an adapted GraphPlan algorithm, which was thus written in C#. GraphPlan [11] uses a particularly efficient planning technique. A specifically adapted planning algorithm was determined to be more appropriate than a 'black box' planner given the specificity of the narrative planning domain. This meant that the requirements (such as the constant finding of short plans) could be more easily incorporated. This section describes the basic GraphPlan algorithm. A discussion of the adaptations made to the algorithm can be found in section 3.5.2.

The planner takes as input: the current state of the storyworld; all storyworld actions with satisfied applicability; and a goal state (the preconditions of a dilemma). Each state is represented as a series of propositions. These propositions consist of everything which could be possible within the storyworld, each with an associated truth value and level. So for example there could be the proposition: `x is at k is true at level 1`.

The GraphPlan algorithm works by first creating a planning graph. A planning graph is made up of a number of propositions at level 0, followed by actions at level 0 which have their preconditions satisfied by propositions at level 0, and continuing to propositions at level n which are those made true by the effects of actions at level n - 1, followed by actions at level n which have their preconditions satisfied by propositions at level n. Each action or proposition only appears once in the graph at a given level, but will have a number of links cor-

Level 0 props	Level 0 acts	Level 1 props	Level 1 acts
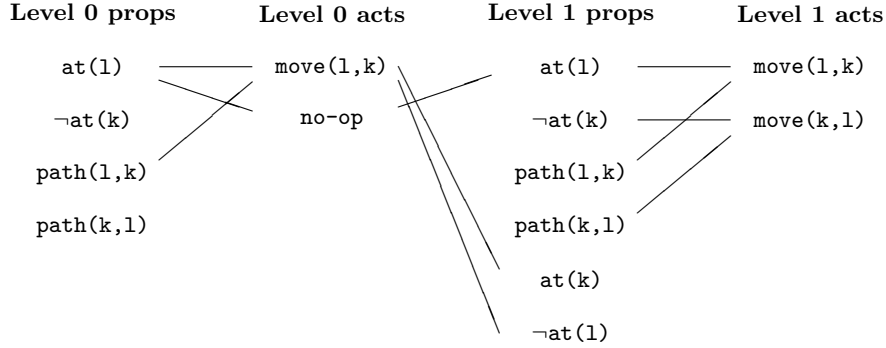
Figure 3.4: A simple planning graph.

responding to preconditions or effects. The applicable actions are re-calculated at each level of planning graph creation.

Planning graph creation can be demonstrated using the example of a character moving between locations `l` and `k`, as given in figure 3.2, and by adding the inverse action: moving between locations `k` and `l`, which has equal and opposite preconditions and effects to the previous action. The first two levels of the resultant planning graph are shown in figure 3.4. 'No operation' actions (`no-op` in the table) — which can occur following any precondition and for which the effect is that the proposition is still true — ensure that any proposition at one level will also appear at the following level. For clarity all of the 'no operation' actions and their links are not shown in figure 3.4, although their effects can be seen and a single 'no operation' action is included for demonstration purposes.

There are certain propositions and actions which cannot occur at the same level of the planning graph. These are known as being mutually exclusive. The two possible conditions which cause two actions to be considered mutually exclusive are: if an effect of one action is the negation of a precondition or an effect of another action; or if a precondition of one of the actions is mutually exclusive of a precondition of another action. Propositions are mutually exclusive if every action preceding one proposition is mutually exclusive of every action preceding the other. For example, in the graph in figure 3.4 the level 1 actions of moving between `l` and `k` and between `k` and `l` are mutually exclusive because their preconditions negate one another: there can be no state in which the character is at both `l` and `k` simultaneously.

The creation of the planning graph will continue until one of the following two conditions has been satisfied:

1. All of the propositions in the goal state are also in the current level of the planning graph, and none are mutually exclusive of one another.

2. The graph has levelled, which means that all of the propositions at a given level in the planning graph are also in the previous level (with the same truth value associated), and all of the mutual exclusions are also equivalent.

If condition 2 is met then failure is returned. In the case of condition 1 having been satisfied a plan can be found.

The second phase of the GraphPlan algorithm involves finding a plan from the planning graph. This is done by working backwards through the graph, from the goal state. From the required goal elements the planning graph will show which actions may precede these propositions. The preconditions of these actions will then become the new goal state. This will continue until the initial state is reached. Backtracking will be required when mutual exclusions are found or it is not possible to continue with a particular sub-plan. It will always be possible to find a plan from a planning graph for which condition 1 has been satisfied.

For example if the goal state included only the single proposition `at(k)` then the planning graph shown in figure 3.3 would be complete at level 1. The back propagation to find a plan would thus look at the actions which had satisfied this proposition, `move(l,k)` being the only possibility in this case. First ensuring that this action was not mutually exclusive of any action already in the plan, the algorithm would then continue by looking at the preconditions of this action. These would become the new goal state, which consists of the propositions `at(l)` and `path(l,k)`. In this example both of these propositions are satisfied in the initial state and thus the planning algorithm completes, returning a plan containing the single action `move(l,k)`.

The GraphPlan algorithm is guaranteed to find the shortest possible plan. This is because planning graph creation will cease as soon as all of the goal propositions have been satisfied. The algorithm will always terminate as the planning graph is guaranteed to level (thus satisfying condition 2). This is due to the inclusion of 'no operation' actions which ensure that any proposition at one level will also appear at the following level with the same truth value.

3.5.2   Applying GraphPlan to GADIN

To apply the GraphPlan algorithm to the GADIN system a number of optimisations were required. These improve the speed of responsiveness to the user. The main problem is not that each individual plan takes too long to find, or to fail should no plan be possible, but that there is a large amount of planning and re-planning required. This is because plans must be found for each combination of characters for every dilemma. The adaptations which have been made to the GraphPlan algorithm to optimise planning within the GADIN system are discussed in this section.

The GraphPlan algorithm requires mutual exclusions to be identified between all actions and all propositions. In the type of plans required by GADIN finding proposition mutual exclusions requires a large proportion of planning time, yet does not provide an accompanying increase in accuracy or number of plans found. It was therefore decided to remove the identification and checking of proposition mutual exclusions. Action mutual exclusions are still found and used as required by the algorithm, for all preconditions, effects and combinations of these.

As each action has a large number of parameters, checking for the existence of action mutual exclusions can be slow. For this reason action mutual exclusions are stored and referenced as positions in the list of actions in the planning graph, rather than using the instantiated action each time.

Long and Fox [72] observe that if an action appears in one layer of the planning graph then 'no operation' actions mean that it will also appear in the

following layer. There is therefore no need to store that action again. When finding a plan from the graph actions which occur at any preceding levels can be utilised, rather than only those at the current level. Only new actions need to be added to the list of actions, and appropriate propositions at every level can be linked to this list of actions. This adaptation has been incorporated into the planner. As a result of this change the number of actions which must be stored is much fewer, and their traversal is much quicker. Although an attempt was made to apply the same technique to the list of propositions this adversely affected the speed of the planner.

It is generally the case that in C# ArrayLists are slower than Arrays. As a potential optimisation ArrayLists were replaced throughout the planner by appropriate Arrays. Although in some cases this was found to improve the time taken to find a plan, in others a significant negative speed impact resulted. This notably occurred in the case of the list of propositions in the planning graph. Experimentation was carried out to ensure that the optimal structures (ArrayList or Array) were used throughout.

As the number of characters within the storyworld increases the number of state propositions and possible actions available to the planner becomes intangibly large. Since within a dilemma there are never more than 3 characters involved a large proportion of the actions and propositions considered by the planner will be unnecessary. Given the overhead involved in linking and calculating mutual exclusions for these a lot of time is wasted. To reduce this two restrictions can be made, as discussed here. The first (which restricts action availability) is always made, the second (which involves proposition use in the planner) is optional.

When actions are found to be applicable (section 3.3.2) they are made available to the planner. To reduce the number of actions utilised in planning this was adapted to create only actions for the currently involved characters — this is possible since each dilemma involves at most 3 characters. In some cases it is necessary to have preconditions involving all characters (for example to ensure that characters were not already in a partnership before they could become involved in one) and this must be added by the storyworld creator where relevant. The increases to the speed following this improvement were substantial. There is no corresponding decrease in extendibility of the system as actions can be defined which use all of the characters, or which use only the involved characters — depending on the requirements of the domain and the specific action.

As a further speed improvement the current state propositions made available to the planner can be restricted to only consider the involved characters. This restriction is accompanied by a decrease in extendibility, and the storyworld creator may choose not to include it. For example to check that characters are not already in a partnership all partnerships must be known about, meaning that the limited state must be created for all partnerships. Determining those propositions which are created for only the limited number of characters, and which for all characters, is very domain specific. As a result additional considerations are contingent on the storyworld creator to incorporate this. However the consequent improvements to speed if this restriction is used are substantial.

The main overhead in the GraphPlan algorithm is the planning graph creation phase. The second phase, of traversing through this graph to find a plan, takes comparatively very little time. As GADIN requires frequent identification of short plans involving the same characters and different dilemmas, a number

```
repeat until narrative finishes
 for all characters c in storyworld
  for all characters d ≠ c in storyworld
   for all characters e ≠ (c or d) in storyworld
    create planning graph for these characters
    (planning graph creation only to the required level)
    for all dilemmas
     try to find a plan in the planning graph
     if a plan is found add it to the list of available dilemmas
```

Figure 3.5: The routine used by the plan finding thread to find plans for dilemmas to story-world characters.

of similar planning graphs were being found in sequence. To reduce this redundancy an adaptation was made to the planner. This involves creating a single planning graph for each combination of characters from which plans for many dilemmas can be found. Significant speed improvements result from using this technique. There is a potential disadvantage in that the planning graph used to identify plans will not be as up-to-date as it would be if it was re-created each time. The speed at which plans can be identified from the graph means that this will not be a problem, providing reasonable restrictions are made on the number of plans which are found from each graph.

A depth limit can be imposed on the planning graph which will mean that its creation is quicker. The disadvantage in this is that certain plans may not be found from the graph. However longer plans will decrease the dramatic interest due to the corresponding decrease in the number of dilemmas occurring. In larger domains a depth limit restriction is essential given the otherwise excessively large amount of time required for planning. The use of iterative deepening was investigated but the overhead involved meant that this negatively affected the overall time taken to find a plan.

3.5.3 Selecting dilemmas

A planning thread constantly creates planning graphs and finds possible plans for all available dilemmas from these. This routine is shown in figure 3.5. These plans are added to a list from which the main thread can select the most appropriate plan. The planning thread always utilises the most up-to-date version of the current state when creating the planning graph. This technique means that after each plan has been presented there will be another available for presentation. The disadvantage of wasted planning (for those plans which must be abandoned) is far outweighed by the advantage of a narrative generation process which involves less waiting (for the planner to complete) before presentation can be attempted.

Once the system is ready to present a dilemma it selects one of the currently available plans in the list created by the planning thread. The sequence in which the dilemmas are selected for presentation must depend on what has happened previously to become part of a consistent narrative. Following presentation of a dilemma the next most appropriate must be selected and its presentation will be attempted. The most appropriate dilemma is selected depending on the
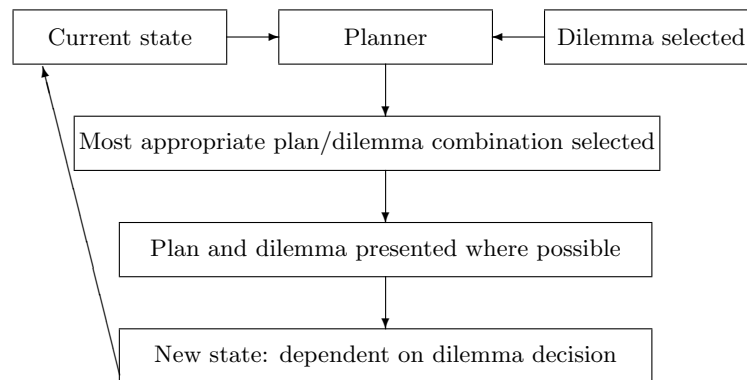
Figure 3.6: This figure gives an overview of the system moving between states dependent on plans, dilemmas and decisions.

previous dilemmas which have been presented and the frequency of dilemma use.

A record is kept of every dilemma which has been presented, as well as which characters each dilemma involved. This ensures that exactly the same dilemma will not be experienced by the same character more than once. For example if a character is pregnant and decides to keep the baby it would not be appropriate to present this dilemma again (at least within a reasonable time period).

It is important that good storylines (and corresponding dilemmas) do not become devalued by overuse. This would mean that the dramatic interest would be reduced. Each dilemma thus has an associated frequency rating which reflects its frequency in other narratives in the current domain. This determines the number of times this type of dilemma can occur within a certain time period of the narrative. If the number of times the next dilemma on the list of available dilemmas has occurred in the recent story history is lower than the dilemma frequency rating then this dilemma will be the next to be presented. Otherwise another will be selected and the frequency of use checked. This ensures that the content included in the generated narrative is reflective of the genre and not unrealistic.

3.5.4   Using the plans

Before execution of a plan is attempted its validity is first checked. The most appropriate (depending on the criteria discussed in section 3.5.3) valid plan in the list will thus be presented. After a plan has been selected the older plans on the list are removed to ensure that the number of impossible plans for dilemmas waiting is kept to a minimum. The planner cycles constantly through all dilemmas, searching from the updated state to find any possible plans for dilemmas. The plan is presented as a sequence of actions prior to a dilemma — of which the decision and outcome are shown.

The potential consequences of each decision must be clear to the deciding character before they make their choice. Once a choice has been made the system will update the storyworld state in accordance with that choice. The system then plans from the new state to be able to present another dilemma — thus continuing the narrative. This sequence of events is shown in figure 3.6.

When making decisions on dilemmas characters will act in accordance with their individual traits and circumstances. For example if they are married then they are less likely to have an affair.

3.5.5   Responding to dilemmas

Following presentation of a dilemma there will be immediate changes to the storyworld. For example if a character chooses to become partners with another this will subsequently be true in the new state. This is a definite and immediate outcome of the dilemma, and a direct result of the deciding character's decision. In addition to the state change effects of the dilemma decision there will be responses from other involved characters to the deciding character. These may be positive or negative and represent action implications of the dilemma decision. The specifics of the response depend on the individuals involved and their traits, dispositions and relationships. These responses take place, in the form of actions, immediately following the updates to the state in accordance with the dilemma decision.

The action responses to dilemma decisions depend on the category of the dilemma. This is possible due to the generality of the dilemmas and ensures greater extendibility. The responding characters and appropriate types of response for each dilemma category are as follows:

- *Betrayal* — if the betrayed character knows about the betrayal then they will respond negatively towards the deciding character.

- *Sacrifice* — if a character chooses to make a sacrifice for another then that character will in turn act positively towards the deciding character. If this sacrifice is not made a (slightly less strong) negative response will be made.

- *Greater Good* — the character who has benefited from this decision will act positively towards the deciding character. If this is not done there will be a negative reaction from that character.

- *Take Down* — the character who has suffered as a result of this decision will act negatively towards the deciding character.

- *Favour* — the character who has been rejected as a result of this decision will act negatively towards the deciding character.

To provide these responses in each story state a numerical utility value is assigned to each character, as discussed in section 3.3.4. Dilemma decisions change this value due to a pre-defined (and potentially character dependent) corresponding change to the affected characters' utilities. These characters will thus act to reduce the deciding character's utility in the manner outlined above. Each action changes the state and thus the utilities of characters. The value associated with each dilemma's utility change can be the same for each, or specified when defining the dilemma.

It is possible for each character to respond to a utility change with up to two actions, both of which will affect one character. Each possible action is checked to see if it will change the affected character's utility by the correct amount. If this is not possible, each will be attempted in combination with another

action, although only a limited (randomly selected) number of such actions are attempted. Having two layers of response actions reduces predictability by increasing possibilities, even if these are limited at the second layer. If this was extended the relevance would be reduced as the narrative would move too far from the focus, thus reducing the dramatic interest of the experience. To ensure greater unpredictability the action order is randomised before an attempt is made to find an appropriate response.

Rather than requiring response acts to exactly match the required utility it is only necessary that the utility change is 'sufficiently equal'. This means that responses are more likely to occur, and also makes the system more flexible and less predictable. Sufficient equality is determined using probability. If the values are exactly equal, then this will always be considered sufficient. The chance of being considered sufficiently equal decreases as the values become more different. Thus a value is considered sufficiently equal if it is within a certain range and a proportionately chosen random number is 0. This is a sliding scale with increasingly less chance of being considered sufficient as it deviates further from the target value. For example if the target value, the required change in utility, is 2 and the change caused by the current action is 1 the check will succeed if a randomly selected number between 0 and $2^{difference}$ (2 in this case) is equal to 0 — otherwise it will fail.

The characters' responses also depend on their individualities. This is ensured through use of the applicability check.

3.6   Example dilemma and plan

In this section an example of a dilemma is discussed. Basic information on imaginary storyworld state and characters is given and the creation of a plan is described.

The storyline of a character being presented with a dilemma involving cheating on their partner is frequently used in soaps. This dilemma can be categorised as being of type Betrayal. Its general form is:

A_X: `cheat on partner (X)`
`preconditions:  partners(X,Y)` $\wedge$ `fancies(X,Z)` $\wedge$ `fancies(Z,X)` $\wedge$ X$\neq$Y $\wedge$ X$\neq$Z $\wedge$ Y$\neq$Z
`dilemma (to character X):` ''`Will you cheat on your partner character Y with character Z who fancies you?`''
`if X chooses to cheat:`
    `add to state:  cheating(X,Y,Z)`
`if X chooses not to cheat:`
    `delete from state:  fancies(X,Z)`

A possible soap action involves X starting to fancy Y, which has preconditions: `fancies(Y,X)` $\wedge$ `not(fancies(X,Y))`, and effect `fancies(X,Y)`. In STRIPS form this is:
`Operation:  starts_to_fancy(X,Y)`
`Preconditions:  fancies(Y,X)` $\wedge$ $\neg$`fancies(X,Y)`
`Effects:  fancies(X,Y)`
One of the circumstances in which this action is considered applicable is when `attractiveness(Y)` is greater than `attractiveness(X)`.
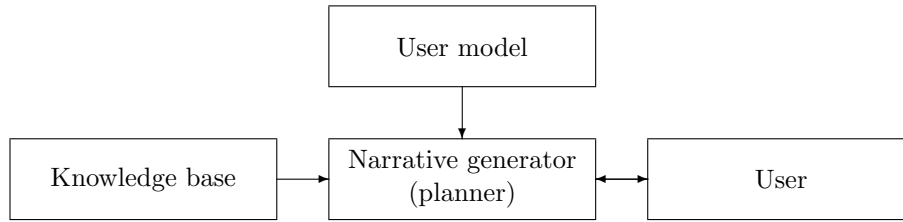
Figure 3.7: An overview of the interactive GADIN architecture.

In this imaginary storyworld there are three characters: Jim, Tina (both with attractiveness 0) and Liz (who has attractiveness 1). In the current state Jim and Tina are partners (`partners(jim,tina)`) and Liz fancies Jim (`fancies(liz,jim)`) but this is not reciprocated (¬`fancies(jim,liz)`).

The planner takes the current state and applicable actions and attempts to achieve all of the preconditions of the dilemma. It can be seen from this that two of the preconditions of the dilemma are satisfied (with X = `jim`, Y = `tina`, Z = `liz`) but the third is not. Since the action involving Jim starting to fancy Liz is applicable in this case the planner can use this action and thus achieve all of the preconditions of the dilemma. The one act plan is thus: `starts_to_fancy(jim,liz)`. If this dilemma is found to be the most appropriate of those available then its plan will be presented. The effect will be that the new state will contain the elements: `partners(jim,tina)` ∧ `fancies(jim,liz)` ∧ `fancies(liz,jim)`, and this instantiated Betrayal dilemma can thus be presented to Jim.

3.7 Interactivity

It is possible for the user to become a character in a GADIN experience. They are able to act freely and a dramatically interesting narrative will still result. The methods which are used to achieve this are discussed in this section. The incorporation of the user enables the essential research question to be answered: *How can clichés be incorporated into automatic interactive narrative generation?*

3.7.1 Architecture

It is necessary to incorporate the user into the GADIN architecture. An overview of the interactive GADIN architecture is given in figure 3.7. In this a user model may also be included (as shown). This is an optional component which can be employed to ensure that the narrative's dramatic interest is maximised for the user. The user model is discussed further in section 4.5.

The user is able to interact with the narrative generator by inputting their choices within the world. These affect the narrative experienced and the user will see the effect of these choices as the storyworld evolves through the course of the narrative.

3.7.2   User dilemmas

In the interactive GADIN experience the user becomes a character within the storyworld. Within the course of this experience the user encounters dilemmas which require the making of fundamentally difficult decisions. When presented with a dilemma the potential consequences of each decision must be clear to the user before they make their choice. Once they have chosen these repercussions on the storyworld are implemented. The resultant state is thus entirely dependent on the user's decision.

It is ensured that the user experiences a reasonable proportion and balance of dilemmas while the overall frequency is as would be expected for the domain. The proportion of non-user dilemmas is adjustable by the storyworld creator dependent on the domain. If required they can specify that only the user will experience dilemmas.

The outcomes of certain dilemmas affecting the user are adapted to ensure that the user does not feel any loss of control. If, for example, the dilemma presented to the user would result in a character choosing to run away with the user then where necessary this now involves the character asking the user to run away with them. This means that the user feels less controlled.

3.7.3   User actions

If the user is only making decisions on dilemmas then their actions are determined by the narrative generator. This will reduce the user's sense of immersion and involvement with the storyworld. Thus every act that other characters within the system can make is available to the user who is able to freely specify their own actions within the scope of the current domain.

Once a plan has been chosen its presentation to the user, in such a way as to incorporate their actions, can commence. This will be only as much as is possible before it is necessary for the user to act for the plan to continue, which is the case when satisfaction of an action or dilemma precondition requires a user action. If the user acts in a manner which satisfies the necessary preconditions at this stage then the presentation of the plan will continue until a user action is required again. As soon as it becomes possible to present the dilemma this is done. Another method involves each plan action being alternated with the potential for a user action, or all plan actions at a particular level being presented to the user before allowing them to act. Which method is used can be easily specified by the storyworld creator. An overview of the narrative generator which incorporates user actions is shown in figure 3.8.

In the planner it is assumed that the user will act consistently with the manner in which characters with similar traits would act within the current domain. In presenting the plan the user may choose not to take these actions. The user is entirely free to select their own actions and will not know the plan which the system is attempting to follow. If the user acts in a way which violates the plan the system will be required to re-plan. Where possible plans should be created which the user is more likely to act in accordance with.

It must be ensured that the user is as free as possible while still experiencing dilemmas. Any user action which satisfies the preconditions of the next stage of the plan is acceptable, but the user still has a wide range of options and may not act as required by the plan. To help overcome this problem shorter plans
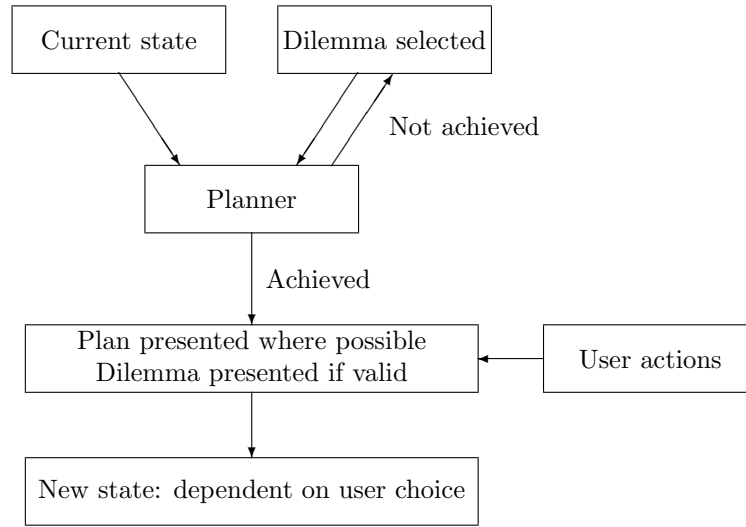
Figure 3.8: An overview of the interactive version of the system moving between states dependent on plans, dilemmas and user decisions.

are favoured. This means that there are less opportunities for the user to act outside the plan, while still creating plans in which their actions will have an effect. Narratives of the same length will involve more drama if storylines are shorter. The selection of only shorter plans is easily imposed due to the finding of a single planning graph for multiple dilemma plans (as discussed in section 3.5.2).

An attempt is made to coerce the user into acting in the way required by the current plan. For example if it is required that the user moves from location l to location k their friend can go to location l and ask the user to join them in going to location k — the user is always free to refuse this. The coercions which will be possible within a domain need to be defined explicitly, and will be utilised whenever a plan requires a user action which is not performed but can be coerced. A record of coercions is maintained and used to ensure that the user will never be repeatedly coerced for the same action or group of actions. When the user is able to act within the storyworld each action additionally (to the requirements given in section 3.3) has associated whether it can be coerced and how to attempt to coerce the user into taking the action.

The user inputs their action choices using a textual summary of the action. They are always able to see the current state of the storyworld and information on other characters. To ensure that the user does not feel constrained at least every act that other characters within the current domain can take is available to the user.

In its current version GADIN is control-based. This means that the user selects actions until they choose to pass control back to the system, which, depending on the domain, either: acts until a user action is required to satisfy required preconditions; or allows a single character action or a dilemma. When the user has control they can take any number of actions. The user can spend as long as they want considering their options.

Planning for user dilemmas takes place in an additional thread. In addition to the advantages discussed in section 3.5.3 this means that planning takes place as the user thinks about their action choices or dilemma decisions. Threads always utilise the most up-to-date version of the current state in planning graph creation, even if the user has not yet passed back control or the system is still in the process of presenting the plan for another dilemma. This means that the planner is more likely to have a valid plan available once it is appropriate to commence its presentation.

The user may try to avoid dilemmas. In this experience, as in life, however much the user tries to avoid dilemmas there will always be another. The adaptive nature of this narrative generation method means that there will always be dilemmas which can and will be experienced by the user. In some cases no user actions are required to lead to their being presented with a dilemma.

It is the user's decision how they choose to respond to dilemmas. They can ignore dilemma decisions or react to them in any way they consider appropriate. Other characters will react to the user's dilemma decisions in the manner discussed in section 3.5.5.

If the user is not involved in the plan it is still presented as a sequence of actions prior to a dilemma — of which the decision and outcome are shown to the user. When the plan for a dilemma requires user actions these can be attempted to be incorporated in the same way as for plans for user dilemmas, as has been discussed in this section.

3.7.4   Affecting characters

The user can act in ways which affect other characters within the storyworld. This can be by: changing their disposition; causing some utility-based response to actions or dilemma decisions; or causing them to experience a dilemma. These are discussed in more detail in this section.

It is possible for the user to act in a way which causes changes to the disposition of another character, and thus how that character will act in the following stages of the narrative. The user can change dispositions through their actions towards other characters, for example playing with a shy character may make them more outgoing, and these changes will be clear in the changed adverbs describing character actions, as well as in the future action choices of the involved character. This will give the user a clear effect of their actions in and on the storyworld and its characters. The user's future actions towards a character may be determined by the manner in which that character has carried out their actions, for example if an angry `Joe incredibly aggressively asks you to play` it is unlikely that the user will respond positively, unless they are intimidated.

When the plan for a dilemma requires user involvement the user's actions are integrated into the plan where possible. If this is not possible an adaptation of the utility-based method used to respond to dilemma decisions (section 3.5.5) is used to provide an immediate action response to the user. This method is used as identifying patterns in large numbers of user actions is complex and requiring this would reduce the extendibility of the system. When the user acts in a way which affects the utility of another character that character responds by acting to change the user's utility by the same amount. If the user's actions have not changed the utilities of any other characters then there is either no

response or a response which is deemed to be the most appropriate, dependent on the user's actions and how they have affected the other characters.

An example would occur when a character is fancied by the user, and thus has an associated positive utility in that state. If the user stops fancying that character then the character's utility is resultantly decreased. In this case it could be that the character responds by ceasing fancying of the user (if this is possible). There are many other action options available to the character, some which are less obvious and possibly more 'revenge' or 'reward' based. These are always consistent with action possibilities for the current domain. In this example the character might feel rejected and thus encourage (or bully) the user to betray their principle and to steal.

The use of utility values means that extension to additional actions and new domains requires only the association of a value with each. This method makes system responses less predictable and more versatile. The responses update the state and thus effect the future path of the story - both immediately and in the longer term. These are an immediate effect of the user's actions and result in a narrative more specific to the particular user. This method is likely to encourage the user to act more, as they see an immediate effect of their actions, and to increase the plausibility of the characters.

The user is able to act in a way which could lead to another character experiencing a dilemma. After the user has selected an action, and passed back control, the system checks the list of dilemma plans currently awaiting presentation to see if the user action corresponds to a required action in any of these. If this is the case then it attempts to present the remainder of the plan, or the dilemma itself. There will not always be an appropriate plan waiting, even if the user would expect there to be. In this case there is a utility-based and immediate response, which will be consistent with the storyworld.

If the user acts in a way which causes another character to experience a dilemma while a plan for a dilemma is already undergoing execution the user-caused dilemma is presented immediately while the other plan waits. Once this has completed the preconditions of the remainder of the first plan are checked to ensure that it is still valid, and if so presentation will continue. User actions which cause other characters to experience dilemmas take priority but will not cause plan abandonment unless this plan is violated as a result of the user's actions or the dilemma resulting from these.

3.8   The narrative generation process

In this section an overview of the basic narrative generation process is given. After each stage the user should be allowed to select an action, providing that there has been some other content in the narrative than a user action since their last action. If there is a utility-based response possible following this action then this should be made. The incorporation of the stages labelled 1 and 2a is dependent on whether the user is a character, and the inclusion of the stages labelled 2a and 2(b)i will only be appropriate if other characters experience dilemmas.

1. Check to see if there is a plan for a dilemma to the user awaiting presentation and if so present as much of it as possible, depending on (and integrating) user actions.

2. If there was no such plan available or presentation failed:

   (a) If the restrictions on dilemma experience ordering do not prevent it, check to see if there is a plan for a dilemma indirectly involving the user awaiting presentation and if so present as much of it as possible, depending on (and integrating) user actions.

   (b) If there was no such plan available or presentation failed:

       i. If the restrictions on dilemma experience ordering do not prevent it, check to see if there is a plan for a dilemma not involving the user awaiting presentation and if so present as much of it as possible, depending on (and integrating) user actions.

       ii. If there was no such plan available or presentation failed:

           A. If the user has still not been presented with anything and a long period of time has passed then select and present a random action.

4

Additional components

4.1 Overview

This chapter introduces the additional implemented components of the GADIN system. When applying GADIN to a specific domain it must be decided which of these features to include, depending on which are appropriate for that domain. The essential elements of each feature are pre-defined and it is only necessary to add domain-specific details for those which are required.

In section 4.2 the structure for events, which may take place in some storyworlds, is detailed. Section 4.3 discusses a method for concurrent plan presentation, in which the actions in plans for different dilemmas are overlapped. Not all of the information about the storyworld should always be known to the user, and the incorporation of knowledge in GADIN narratives is discussed in section 4.4. Section 4.5 discusses the user model, which can be used to improve the user's experience by presenting those dilemmas which will result in the most difficult decisions for them individually. Certain user actions may trigger dilemmas for other characters, as discussed in section 4.6.

GADIN is capable of maintaining the dramatic interest of a narrative over an indefinite time period and the techniques used to achieve this are detailed in section 4.7. Other domains will require an ending to the narrative, and section 4.8 discusses the techniques used to ensure that there is an ending — which may change during the narrative, depending on the user's actions. In narratives in which the user is the protagonist non-interactive narrative generation requires the creation of an automated user, the requirements for which are given in section 4.9. Before a narrative begins there must be a backstory for the characters and the storyworld, which determines the initial state. This may be generated by the system (section 4.10) or specified by the user (section 4.11). The process used by GADIN to generate a narrative is detailed in section 4.12. The interface requirements for presentation of a narrative to the user, independent of the domain, are discussed in section 4.13.

4.2   Events

An event is something which: takes place in the storyworld; is started by one or more characters; and involves at least the starting characters and potentially more. Events are dissimilar to actions (section 3.3) in that they directly involve more than one character. They do not form part of plans for dilemmas, nor are they planned for. Events can cause the likelihood of dilemmas to increase or can result from the outcome of dilemmas, and thus change the course of the narrative.

Examples of possible events include: weddings (and their interruption); funerals; and parties. An example of an event causing a dilemma is a party which causes two characters to be at the same location where they have the opportunity to start an affair.

Each event has associated:

- A motivation, which specifies the circumstances under which the event can take place. This is similar to the action applicability check, discussed in section 3.3.2.

- A numerical frequency of occurrence, the value of which should reflect the frequency in the domain. Before an event can be selected for presentation the history of the narrative should be checked to ensure that the event has not taken place more times than its specified frequency allows. Events make use of, and are part of, the global narrative history (which is used for dilemmas, as discussed in section 3.5.3).

- Preconditions which must be true within the storyworld before the event can take place.

- Effects which will be true following the event's successful completion. The effects may depend on decisions made by characters, such as whether to accept an invitation to a party.

In an interactive narrative either the user or other characters can initiate events.

After execution of the most appropriate plans and associated dilemmas the narrative generator will check for possible events — for which there is sufficient motivation and the preconditions have been satisfied. This is dependent on the specified frequency of occurrence. The same event will never take place twice sequentially. Examples of events, which are used in the soap domain application, are given in section 5.3.4.

4.3   Concurrent Plan Presentation

In most storytelling experiences the narrative does not consist of sequential sets of actions leading to a dilemma. Instead actions occur concurrently. Usually actions involving one group of characters will be presented for a period of time, before the narrative proceeds to another substory — with dilemmas occurring where appropriate in each one of the overlapping storylines. Each action will either relate to one of the storylines or be concerned with character development.

The methodology of GADIN allows for achievement of this effect. This involves presentation of one level of a plan, followed by the next level of another

plan, and so on throughout the narrative — with dilemmas being presented as they become possible.

To present concurrent plans in the GADIN system a number of plans which can be presented concurrently must first be identified. These must contain no mutually exclusive actions — which are actions that contradict the preconditions or effects of actions in other plans. In addition the preconditions of the potential dilemma must not contradict the preconditions of any already selected dilemma. If the exclusions are not checked then in presentation one plan will cause the other to be impossible to achieve and thus the presentation of some part of the invalidated plan will have lost its purpose. Once plans which satisfy these conditions have been identified their presentation will begin.

With this method there are two types of plans: those which have been returned from the planner; and those which have been selected for (and may be undergoing) presentation. Plans of the second type are known as the 'current plans'. Before a plan can be added to the current plans list it is necessary to check: that it is still valid from the current state; and that there are no contradictions of any elements in current plans in its preconditions or effects. There are always the same number of current plans, which means that once the dilemma associated with one plan has been presented another plan (which satisfies the required conditions) is added to the current plans list. The number of concurrent plans is defined by the domain creator, depending on the domain.

Once the next level of a current plan has been presented, another is selected non-deterministically. The next level of this plan is then presented, or the dilemma if its preconditions have been satisfied. The plan is then stored without the presented actions (to ensure that their preconditions do not prevent the addition of another plan to the list) and presentation continues with another current plan. The frequency of use and history is considered when selecting the plans for the current plans list (in the same way as for non-concurrent dilemma selection as discussed in section 3.5.3), and includes the plans already on the list as if they have been presented. A check to ensure that the dilemma is not the same as the last one presented is still carried out. This method means that the frequency is not biased by non-presented dilemmas.

It is conceivable that character actions and events will violate the plans. This is prevented before they are presented, by first ensuring that they do not violate anything in the current plans list.

This process becomes more complex once interactivity is added. Although the system is successful in presenting concurrent plans in the non-interactive version of GADIN, it is currently less so with the interactive version. This has been demonstrated to succeed but there are various problems which mean that the narrative quality may be reduced as a result of this. The main issues are outlined here.

The user can act at any time in a manner which violates a precondition of one of the current plans. All previous actions presented in that plan will thus be invalid and another plan must be found for the current plans list. This increases the number of plans which have to be added to the current plans list, which takes time and reduces the number of dilemmas experienced within the storyworld. This violation of plans will occur without concurrent presentation but is less likely in situations in which the user is focused on a particular storyline. This may become less of an issue with more characters as the user's focus will then be on a single storyline involving one set of characters — meaning that they

may be less likely to act in a manner which violates a plan involving other characters. Before the next level of any plan on the current plans list can be presented it must be checked that this plan is still valid. Currently the plan will be abandoned if it is no longer valid, although it can be kept temporarily in case its validity is re-achieved (the domain creator must limit this to ensure that there are not too many plans in this category).

Maintaining a balance in the proportion of plans presented to the user becomes more complex when the plans are concurrent. This is because it is necessary to choose the next current plan depending on this balance in addition to the next plan for which the next level of actions is to be presented.

Section 5.3.5 discusses the use of concurrent plan presentation in the soap domain.

4.4 Knowledge

In conventional storytelling information is often revealed to the audience but not to the characters. This may give the audience a sense of suspense and adds to their enjoyment of the narrative. The audience will know more than the characters and can use their knowledge to further interpret and understand the narrative.

Interactive narratives pose a more complex issue. If the user is told as much as the audience yet is simultaneously a character, the manner in which they act will be affected and there is the potential to fundamentally destroy the dramatic interest. For example if there is a murder committed and the user, as audience, has knowledge of this murder then they will be able to act, as a character, with this knowledge.

There are a number of possible ways in which the revelation of knowledge can be addressed in an interactive narrative. The user could be asked to separate their experience as audience from their experience as a character. They would thus be unable to use any knowledge they have from their god-like perspective of the storyworld and narrative to influence their actions in the first person. This would be difficult, if not impossible, for the user to do and has a high likelihood of ruining their enjoyment of the experience.

It would also be possible to only allow the user to see the storyworld, the narrative and the actions as a character in a non-interactive narrative would be able to — with only the knowledge that they would be expected to have from that perspective. They would thus only observe the actions and interactions between other characters at their current location (depending on the location, for example at a club they would not necessarily see everything). They may hear about other actions or dilemmas through gossip and rumours. Depending on the domain this could be the most appropriate technique. It means that the user is genuinely becoming a character in the storyworld. This technique is available in the GADIN system and can be selected depending on the domain, its use in a dinosaur adventure is discussed in section 5.4.5.

In some domains if the user is never able to see interactions between other characters they may become frustrated by the slowness and constant changes which they are unable to see the justification for. Character believability may also be decreased in domains where it is appropriate for other characters to experience dilemmas, as the user will not see this happening. A third possibility

is thus for the user to only be able to see actions involving other characters which are deemed unlikely to affect the user's actions within the storyworld. This can be more simply interpreted as concealing from the user certain actions and information, such as the identity of a murderer. This method is also available in GADIN, and can be selected if appropriate for the application domain. Its use is discussed further here and (for a soap domain) in section 5.3.6.

If information is hidden from the user it is also appropriate to hide this from other characters, as it would be unrealistic if they had complete storyworld knowledge but the user did not. This means that it is necessary to store the information characters, and the user, have about the storyworld. This is referred to as their 'knowledge'. Characters (and the user) can make up knowledge and also communicate it to one another — whether it is true or otherwise. In the current implementation if a character is told an item of knowledge they will believe that it is true, unless it is revealed otherwise. The user is able to decide for themselves whether to believe information. Each character (including the user) has a truth value associated with each possible knowledge item which may exist within the narrative, representing whether they believe that knowledge to be true or false. This changes (to true) when they make up or are told an item of knowledge, or (to false) when it is revealed that the knowledge was not true.

There are dilemmas associated with knowledge items, such as whether to reveal them, or how to react to their revelation. Certain knowledge items can be true when the storyworld is created, such as the location of a missing person. This may be known by some characters before the action begins and will subsequently be treated as any other knowledge item. Each knowledge item can be represented as a proposition, and as such can be a precondition or effect of actions and dilemmas.

Knowledge can be made up by characters. In some cases this may not be pure invention, but be based on their misinterpretation of situations. For instance a character may see another near the scene of a murder, and thus assume that they must have been the murderer. They can then pass on this knowledge as if it were true. There are various reasons why characters would tell others about knowledge they have. These are character and genre-specific and affect the spread of knowledge through the storyworld and between characters. Currently the reasons only include friendship or the potential to cause other characters to experience a dilemma. The user is able to determine their own reasons.

The knowledge which other characters have is always hidden from the user, even if they also have that knowledge. This is necessary as, for example, if character Z told the user that characters X and Y were having an affair, if the user were to then see all characters who held that knowledge they may see that X and Y did not — which would destroy the credibility of that knowledge. Actions and state elements relating to knowledge, or potential knowledge, are hidden from the user unless: the user is the character communicating or being informed of that knowledge; or the user is an acting character in the action which will subsequently result in the knowledge being created. For example if the user commences an affair with another character they will see that knowledge being created, but not its communication between other characters in the storyworld. The user will also not know when knowledge is being made up. To hide details of others' knowledge and actions involving knowledge from the user it is not ever shown to them or output to the interface. This reduces the transparency of the system and means that the storyworld state seen by the user is more reflective

of their understanding of the world and publically held information.

4.5   User model

The user of an interactive narrative system should be modelled rather than controlled. The narrative should adapt to the user's interactions rather than forcing the user to follow a particular storyline. The GADIN system creates a model of the user based on their dilemma decisions and action choices and uses this to select future dilemmas to be presented to them — depending on which are likely to be the most conflicting. The user model is also utilised to increase the likelihood of plan achievement.

To achieve the aims of the user model the system must be able to accurately predict the user's decisions on presentation of a dilemma. This model is used to identify the decision the user is most likely to make when presented with a dilemma. The model is built up by observing previous user decisions and actions and making assumptions. It is constantly changing to be more accurate and representative of the user and their current feelings, emotions, principles and disposition. The model is at all times fully reflective of everything that is known about the user by GADIN.

Each user is modelled according to various aspects and associated values. The specific aspects of the user which are modelled must be pre-defined for the application domain. Examples include: honesty, responsibility for actions and strength of character. The value the user puts on their relationships with other characters and storyworld principles are also modelled. Those aspects of the user to be modelled should be selected for their generality and applicability to as many dilemmas as possible within the application domain. The aspects of the user modelled in the soap version of GADIN are detailed in section 5.3.7.

Each modelled aspect has an associated value, which changes following observation of the user's behaviour. Each of the aspects is initially assigned a value of 0. Percentage value changes are utilised when a user model criterion is updated. This takes place within upper and lower limits and reduces the bias effect a number of sequential similar dilemmas could cause to the model.

Updates to the values associated with each of the user model criteria are made following each user action and dilemma decision. Changes follow all user choices to more accurately reflect the relevant aspects of the user. The user has to make a decision on a dilemma and this is thus a potentially less accurate reflection of their feelings for others, which it is necessary to supplement with a model reflective of the actions taken by the user. The model is still updated following the user's dilemma decisions as certain aspects of the model — such as strength of character — will only be observed when the user makes these conflicting decisions.

Each dilemma updates certain aspects, which should be specified as part of the definition of that dilemma. Since no single dilemma is more significant than any other — they are all required as components of the overall experience — each relevant aspect is updated by the same percentage regardless of the dilemma and its category. An example of the user model updates following a dilemma decision in the soap domain can be seen in figure 5.1.

It is necessary to model user actions as otherwise the model could become inaccurate. This is particularly likely in modelling the user's feelings towards

other characters. For example if the user flirts with another character then it is likely that they have a higher value for their relationship with that character. Following each user action the values associated with relevant criteria in the user model are updated.

A rule associated with each dilemma reflects the balance of criteria values which will lead to each possible predicted user decision. The performance of the model depends on the quality of these rules. Each dilemma will clearly appeal to a different type of user — the user model chooses those that will appeal to the current user. An example of the prediction criteria for a dilemma in the soap application of GADIN is shown in figure 5.2.

Those choices which the user is likely to make should be identified by the model. There are two ways in which the user model can be employed to select the next dilemma to be presented to the user. The first of these is through combination with a fixed 'interestingness' value. The interestingness values will be based on the experiences and opinions of those familiar with the domain. This is thus not particularly specific to the user.

For example, there may be two dilemmas possible at a given stage. In one the user might have to decide whether to cheat on their partner — with an interestingness of 7 if they choose to do so, and of 4 if they choose not to. The other dilemma may require the user to choose between potential partners and have an interestingness value of 6 irrespective of the user choice. The user model then estimates the likely user choice and accordingly selects the next dilemma. So, for instance, if the user is expected to cheat on their partner then this dilemma will be the next to be presented to the user.

A better method involves selecting dilemmas depending on the individual dilemma and user. Decisions which are the most difficult for the user are likely to cause the most conflict and thus greater dramatic interest in the narrative. The dilemmas which are most difficult to predict are likely to involve the most difficult decisions for the user. This can be determined by calculating the sum of the user model criteria which are expected to affect the likelihood of the user making each decision. The greater of these values is the expected decision. The difference between the values is used to select the next dilemma. The dilemma which has the smallest associated difference is the most difficult to predict and thus the most likely to involve conflict for the user in making their decision.

An example of this might occur in a dilemma in which the user has a friend who is encouraging them to betray a principle. If the user holds this principle particularly strongly, but also values that friendship highly, then the decision will be particularly difficult for them to make. An accurate user model will be able to predict this and thus present such a dilemma to the user. This will lead to greater dramatic interest in the narrative than a dilemma involving a less conflicting decision.

A further application of the user model involves coerced actions. To increase the likelihood of the coercion being successful, and thus the chance of plan success, the character coercing the user can be selected depending on the user model. For example if it is required that the user be at a particular location then a character who they are modelled to particularly like will invite them to move there, meaning that they are more likely to go than if invited by a character who they are modelled as being neutral towards, or disliking. In addition the user will not be coerced into certain actions which are unlikely given their feelings for other involved characters. For instance, if the user is

modelled as having a particularly low value for their relationship with another character then coercing them into fancying that character is unlikely to succeed, and should not be attempted. This also reduces the need for the coercion record list, since if the user rejects such a coercion they can be modelled as having a lower value for their relationship with that character and it is less likely that subsequent attempts to coerce them into such an action will be made.

The application of a user model in a soap domain is discussed further in section 5.3.7.

4.6   Trigger Actions

As discussed in section 3.7.4, once the user has returned control to the system a check will be carried out to see if any of their actions cause satisfaction of the necessary preconditions for another character to experience a dilemma, in which case the corresponding dilemma will be presented. There are some dilemmas in which the user's action will not satisfy a precondition but will instead be an integral part of the dilemma's presentation, for example for a character to experience the dilemma of deciding whether to cheat on their partner another character must ask them to start an affair. For other characters this would be presented with the dilemma but the user should be able to choose to take this action and cause another character to experience the corresponding dilemma. In such cases the user's action is known as a trigger action. If these did not cause dilemmas then the user may become frustrated, as there will not be the response to their actions which would be consistent with the narrative.

There is a list of trigger actions for dilemmas which the user can cause other characters to experience directly, for example the user asking a married character to start an affair with them. Once the user has acted in a way which could cause another character to experience a dilemma that action will be stored. A pre-defined (for each possible trigger action) standardised response acknowledging the user's action is made but no more than this. When the user passes back control to the system, it will check the trigger actions and potentially associated dilemmas. If the action matches one of these then the preconditions of the dilemma will be checked. If all of the preconditions are satisfied then that dilemma will be presented to the appropriate character. If this is not possible then a pre-defined default response is made, such as the married character choosing not to start the affair — as the lack of precondition satisfaction means this would otherwise be inconsistent with the narrative. Such a default action response is associated with each trigger action.

Dilemmas which have been caused to occur through a user's trigger action will be added to the list of dilemmas which have occurred within the storyworld. This list will only prevent their sequential presentation if they involve exactly the same characters. This constraint is necessary as otherwise it would be possible for a single user trigger action to cause an infinite loop of the same dilemma being presented to a character. With this constraint the dilemma will only be experienced once (within a reasonable time period) and it will then be possible for the narrative to continue.

Triggered dilemmas will be presented, where possible, in the corresponding order to the user's selected actions. Following this the standard utility-based response to all of the remaining actions will be made. The enabling of trigger

actions ensures that the storyworld is complete, as all characters are able to experience all dilemmas with all combinations of involved characters — where it is appropriate that they should.

Examples of the use of trigger actions in the soap domain are given in section 5.3.8.

4.7   Infinite narrative

In some storytelling domains it is necessary for the narrative to continue indefinitely, or for a long time period — for example in soaps. It is essential that the dramatic interest is maintained throughout the narrative. A number of techniques can be used to ensure that the narrative continues for as long as is required for the domain, and infinitely if necessary. These are discussed in this section.

When no action has taken place for a long period of time (by default 60 seconds) it is possible for characters to act randomly towards each other or the user. This enables the narrative to continue without waiting for time to be spent searching for a plan which may or may not contain this random action. Once one such action has taken place the next to be selected will, if possible, comprise a utility-based response to the action (and the character) taking the previous action (using the method discussed in section 3.5.5). This will only happen once, to reduce the likelihood of the narrative deteriorating into an interplay between two characters — unless one of the involved characters is the user in which case there will be a response whenever possible. To ensure that the frequency of dilemma use is not causing the lack of dilemma presentations, after a random action has taken place it is added to the history. The narrative's history list will have a bounded length in an infinite narrative (as otherwise it will not be representative of the domain, in which dilemmas will repeat after a certain time). The non-deterministic character actions never involve a major utility change, as there is no motive for this. The potential for a deciding character to change their own utility is allowed for, although no response is made to this.

After a certain number of planning graphs (by default 3) have been created without a valid plan having been found some of the applicability restrictions may be relaxed. The domain creator will determine the extent of this, and should ensure that the relaxation is never too extreme. An example might be that if characters are normally unable to start liking each other in plans they could be able to in relaxed applicability plans. This allows for the incorporation of those actions which are consistent with the narrative only if they occur less frequently than standard actions. It is acceptable for characters to occasionally act less strictly in accordance with their individual traits, and this can make the narrative more interesting. The relaxation of applicability may be layered, with each layer involving a greater degree of relaxation, depending on the domain. This is implemented through use of a variable, which determines whether relaxed applicability is used in the planning thread, and which will be changed as soon as presentation of a plan commences.

The infinite narrative is generated as follows:

- Plans are found and presented (whether to the user or other characters).

The user is able to act first. Whenever the user returns control
to the system it attempts the listed possibilities until one
succeeds, after which control will be returned to the user.
After each user or system action the state is checked to see
if any existing storygoal has been satisfied, with this process
continuing if not.

1. If a dilemma has previously been presented within this
   experience present the next action of the storyplan.

2. If the success of the storyplan has become unlikely find a
   new plan (for an existing storygoal or a new storygoal and
   plan combination if this is not possible).

3. Check if there are any dilemmas available for presentation
   to the user, and if so present as much of the plan as
   possible, or the dilemma.

4. Check if there are any dilemmas available for presentation
   to other characters, and if so present as much of the plan
   as possible, or the dilemma.

5. Allow a character to select an appropriate action depending
   on their individualities and relationships.

Figure 4.1: The GADIN finite narrative generation process.

- If no plan is found within the available planning time the applicability is
  relaxed as appropriate and another attempt is made.

- If nothing has been presented a random (or response) action is found and
  presented.

The generation of an infinite narrative in a soap domain is discussed in
section 5.3.

4.8   Finite narrative

As discussed in section 2.2.5 it is essential that narratives with a finite plot
structure have a clear ending. To apply GADIN to domains which involve a finite
narrative it is necessary for there to be an ending which is clear, satisfactory
and understandable for the user. The outline of the finite narrative generation
process is shown in figure 4.1, and the process is discussed in more detail in this
section. In section 4.8.1 selecting, constraining and communicating storygoals
is discussed. Section 4.8.2 discusses the storyplan, which achieves the storygoal,
and the circumstances in which re-planning or selection of a new goal will occur,
as well as methods for this. In section 4.8.3 further issues in the generation of
a finite narrative are detailed. Section 5.4 discusses the application of these
techniques to a finite dinosaur adventure narrative.

4.8.1   Storygoal

Before the narrative begins GADIN selects a storygoal. This is a condition which must be true for the narrative to end, and when it becomes true the narrative will be complete. The storygoal is selected randomly from everything which is not true in the initial state of the storyworld, but which is an available proposition within the current domain. For example if the user is initially in the desert the storygoal could require that they be in the cave. It could also be something more complex, such as that they must steal a certain object, or become friends with a particular character.

A character's disposition can affect the achievement of a storygoal. By acting in the correct manner the user can change that character's disposition and cause the storygoal to be achievable. This is not a fixed condition and will not be true every time this storygoal is selected, as it depends on the non-deterministic character disposition. It is made clear to the user that the problem is caused by the disposition, and along which dimension. For example if it is necessary that the user become friends with a particular character that character could be grumpy and thus refuse the user's overtures of friendship in a particularly grumpy manner. If the user changes that character's disposition (for example by giving them a gift) their later extensions of friendship will be accepted and thus the storygoal would be achieved. The potential combination of dispositions with the storygoal increases the scope of possibility and interest in narratives generated by GADIN.

Should it become unlikely that a storygoal will be achieved, due to the user's previous actions, then a new storygoal will be selected. As with the initial storygoal this is selected randomly from every predicate which could be true within the current domain. It is also necessary to consider the record of every predicate which has been true in the history of this narrative. It is required that the storygoal has never been true, or the narrative would become illogical to the user as it would appear that it could have ended at an earlier stage.

Once a new storygoal has been selected the previous storygoals will still be maintained as possible endings for the current narrative. As soon as any one of the storygoals is satisfied the narrative will complete. This is necessary as the user may still discover some way to achieve these storygoals, it is just less likely. For example the user may become friends with someone they were previously betrayed by.

For the ending of the narrative to be clear to the user it is necessary that they know that they have achieved the storygoal and that has caused the narrative to end. This requires that the user knows the storygoal from the outset, and is informed whenever a new storygoal is selected. If another character is at the same location as the user then they will hint at the storygoal to the user, for example telling them that `Going to the cave is good` if the storygoal requires that the user be at the cave. If there is no character at the user's current location then a character will move there to communicate the storygoal. If possible this will be a character who the user is friends with. It should be clear to the user that this storygoal is a possible way to end the narrative and not a mission which it is essential that they achieve.

The user knows what the ending of the narrative is, or could be, and can thus either act to achieve that ending or choose not to. This could be deliberate or accidental. For instance if it is required as the storygoal that the user steal an

object they could choose not to do so when presented with the opportunity. If the user chooses to avoid achievement of any of the storygoals then the narrative will still continue, with presentation of dilemmas and character actions. That is the user's choice and this should still be a dramatically interesting experience. Existing storygoals will still be possible throughout should they become true. To achieve this the techniques discussed in section 4.7 to ensure the generation of indefinitely long narratives are applied. New storygoals will still be selected if the appropriate conditions have been satisfied.

The potential for more than one storygoal does not mean that the resultant narrative will be poorly structured. This is consistent with the manner in which non-interactive narratives often develop, where it appears that one ending will finish the narrative before this becomes unlikely and another ending emerges and either (or a later emerging possibility) may become the final reality. To ensure that the narrative remains coherent and believable characters act consistently throughout, with the action applicability check ensuring this.

4.8.2   Storyplan

It is the task of the planning component of GADIN to find a plan to achieve the storygoal. Given actions (including those for the user) and dilemmas (separately for each possible outcome, with corresponding preconditions and effects) within the storyworld the system can plan to satisfy this storygoal. Such a plan guides the plot of the narrative. The plan to achieve the storygoal (the storyplan) takes into account the current storyworld state and background knowledge.

If achievement of a storyplan is not possible given the character dispositions then by default the planner will return failure and a new storygoal must be selected. To ensure that this does not happen, and that storygoals which require the dispositions of characters to change will be included, when planning for storygoals the action applicability check allows the values of each character disposition to be (by default) between ± 1 of the actual value (this is chosen for the dinosaur adventure version of GADIN in which the range of possible dispositions is between -3 and 3). This is because a single user action can cause at most such a change to a character's disposition value along a particular dimension. For example if the selected storygoal is that a grumpy character likes the user it is a prerequisite of storygoal achievement that the user change this grumpiness. The standard applicability check would prevent this from being made available to the planner but this flexibility in the applicability check allows for this change where it is appropriate.

The storyplan must be checked following each user action to ensure that the current storygoal is still achievable. For this a list of required state elements following every level in the plan is maintained. If the user's actions cause a predicate in the storyworld to contradict a predicate which is required to be in the state at the current or the next level (where the storyplan is followed) then the plan is assumed to have been violated. If this has happened then a new storyplan must be found, whether this be for an already existing or a new storygoal. The system first attempts to find new plans for all existing storygoals and only if no such plan is possible will a new storygoal be selected. If there are no new storygoals possible, the applicability can be relaxed in finding a plan for an old storygoal, to ensure that an ending will always be achieved.

If the user does not cooperate with the actions required of them by the

storyplan then an attempt can be made to coerce them to do so. If this is unsuccessful then the storyplan will be assumed to have failed. The storyplan will also be assumed to have failed if there is a predicate which the user must act to satisfy at the current or the next level but they do not do so. The re-planning in these cases will not be immediate — as the user may later act in the required manner — but instead will take place after 3 other character actions or a dilemma have occurred within the storyworld. An example of this occurs if the user does not move to the location where the next action is required to take place — even though (if appropriate) an attempt will have been made to coerce them into doing so.

In attempting to re-plan for the same storygoal actions which the user is required to initiate will be excluded from consideration, so that should a plan be found it is more likely to be adhered to. As a result there will be less wasted creation of storyplans with which in all likelihood the user will never cooperate. This does not mean that there is no user involvement in the plan, for example a character asking the user to become their friend will still be included. If this limitation results in the planner not being able to find a valid storygoal and plan combination then GADIN will once again consider such actions in the planning process.

If it is necessary to find a new storyplan for an existing or new storygoal a search depth limit is imposed on storyplans. The effect of this is that only shorter action sequences will be considered and thus that an ending will be more likely to be reached without the continual requirement for re-planning or newly defined storygoals. If the storyplan is too long then it may become unrealistic in that the user will be less likely to take all of the actions which the planner expects of them. In addition it will take too long to plan and re-plan for new storygoals if no search depth limit is imposed, resulting in the user experiencing waiting times. If no plan is possible within the search depth limit then a new storygoal is selected.

4.8.3 Further issues

As the user may require time to consider their actions planning takes place while the user thinks. A thread continuously updates a global planning graph. When required this is used to find a new plan for the current storygoal, a previously attempted storygoal or a new storygoal. This means that the re-planning will be much faster. Although there is some risk of unreliability in the planning graph due to it not being fully up to date this risk is minimised by the reduced planning depth and by the continuous nature of the updates to the planning graph.

With certain storygoals (for example the user being at the cave) a dilemma will not be necessary prior to achievement. It is possible to constrain the planner so that only plans with dilemmas are accepted but these dilemmas are unlikely to pose sufficient conflict — and thus dramatic interest — for the user, given that they are aware of the storygoal of the narrative. Thus to ensure that the experience is dramatically interesting it is advantageous to also present dilemmas to the user which are supplementary to this plan. This will have the added advantages of maintaining the user's interest and ensuring that the narrative does not become predictable. The system will not cause the storygoal to be satisfied until the user has experienced a dilemma which is not directly

related to that storygoal.

At the commencement of the narrative various character actions and inter-actions will take place, as well as at least one dilemma, before the storyplan begins to be followed. This helps to ensure that there is dramatic interest and enables the user to build up familiarity with the characters and their disposi-tions before they become part of the storyplan (and its dilemmas) — resulting in these being more conflicting.

The user is free to act however they want, even if this means achievement of the storygoal before a dilemma has been presented. In a circumstance involving such a trivial storygoal — should it be the first storygoal selected — the initial state is changed to ensure that the disposition of another character must be changed (by the user) before the storygoal can be achieved. Each possible trivial storygoal has an associated appropriate disposition restriction which will be imposed in the initial state if such a storygoal is selected. This ensures that dramatic interest is achieved in the overall narrative even with trivial storygoals.

4.9   Automated user

When the user is the only character experiencing dilemmas the generation of a non-interactive narrative requires the creation of an automated user. This is a system-controlled character who takes the role of the protagonist. The automated user chooses actions and makes dilemma decisions depending on a pre-assigned personality and feelings towards other characters. The use of an automated user in a dinosaur adventure is discussed in section 5.4.8.

4.10   Initial state

The majority of stories involve characters who have a history which has shaped who they are and will influence their actions in the course of the narrative. The collective histories of the characters, and the storyworld, are known as the 'backstory' of the narrative. Not all of the backstory will necessarily be made explicit in the course of the narrative, although it will influence this in that it affects characters' traits and dispositions — and thus their actions and dilemma decisions.

It is possible for a backstory to be generated by GADIN, in a non-interactive manner. However this will only create a recent backstory, or will take a long time before the interactivity can begin. It is also possible to start the GADIN narrative with the backstory from an existing or imaginary narrative. There is additionally the option to use initial non-deterministic settings and thus an implied backstory, although the resulting narrative quality may be reduced by this. This randomisation is consistent with each character's individualities and traits. A final possibility is to allow the user to specify a backstory, as discussed in section 4.11.

There is never any backstory imposed on the user — although they can choose to have the initial feelings between themselves and other characters ran-domised initially. They are themselves (or whoever they want to be) in the narrative, and will accordingly never have a role or constraints imposed. In some domains the user may be able to initially see a non-interactive narrative

generated and choose at any stage to become a character. Even in this circumstance there are no restrictions on their actions as only the starting state and attributes (which are unchangeable) will be influenced. The user has the option to not take any role in the narrative for a while, taking and relinquishing the ability to select actions and decisions for a character as and when they choose.

In most narrative domains consistency in initial relationships will mean that there is unlikely to be a need for more than this. This should correspond to each character's traits and dispositions.

4.11   User created storyworld

It is possible for the domain creator to allow the user to create their own storyworld — either in its entirety or any components of that world. There may be defaults which the user can use as part of this, or they may be required to specify the entirety themselves. This means that they can define their own characters, locations and objects. The user will also be able to define the initial feelings between these characters and specify their locations at the outset of the narrative. If relevant to the domain the user will be able to specify principles and crimes, although they are only able to associate one crime with each principle. The user is able to save the storyworld which they have created and use this in future experiences. They are also able to share these with others.

Once the user has created a storyworld they are able to take the role of a character in this world. They may also choose to see a non-interactive narrative generated which uses this storyworld. The user will then be able to observe how the relationships change and develop, and also take on a role at any time, and influence the storyworld themselves.

This allows the user to optionally create their own backstory (section 4.10). This could be based on people they know, imaginary people, an existing soap, or anything else they choose. It is also possible for the user to create storyworlds and share them with friends, experiencing narratives within each others' storyworlds.

4.12   Narrative generation process

This section is a more detailed version of the basic narrative generation process given in section 3.8, which also shows how the features discussed in this chapter are incorporated into the process. Inclusion of each of the stages depends on the domain and the requirements of the creator. For example if only the user experiences dilemmas in the generated narrative then the stages which check for dilemmas for other characters (4(c)ii and 4(c)ivA) are excluded. This process will continue until the storygoal has been achieved (in a finite narrative) or the user chooses to end their narrative experience (in an infinite narrative).

1. If the narrative is finite check to see if the storygoal has been achieved. If so, end the narrative. If not, continue checking this after each stage in this process.

2. Let the user act if they did not act last, and respond appropriately to the user (with a triggered dilemma or utility-based response).

3. If there is a storyplan then present the actions (or dilemma) at the next level of it if possible.

4. If this was not possible:

    (a) Check to see if there is a plan for a dilemma to the user awaiting presentation and if so present as much of it as possible, depending on (and integrating) user actions.

    (b) Let the user act if they did not act last, and respond appropriately to the user (with a triggered dilemma or utility-based response).

    (c) If there was no such plan available or presentation failed:

        i. Let the user act if they did not act last, and respond appropriately to the user (with a triggered dilemma or utility-based response).

        ii. If the restrictions on dilemma experience ordering do not prevent it, check to see if there is a plan for a dilemma indirectly involving the user awaiting presentation and if so present as much of it as possible, depending on (and integrating) user actions.

        iii. Let the user act if they did not act last, and respond appropriately to the user (with a triggered dilemma or utility-based response).

        iv. If there was no such plan available or presentation failed:

            A. If the restrictions on dilemma experience ordering do not prevent it, check to see if there is a plan for a dilemma not involving the user awaiting presentation and if so present as much of it as possible, depending on (and integrating) user actions.

            B. Let the user act if they did not act last, and respond appropriately to the user (with a triggered dilemma or utility-based response).

            C. If there was no such plan available or presentation failed:
                - If the narrative history does not prevent it, check to see if there is an event available for presentation and if so present one.
                - Let the user act if they did not act last, and respond appropriately to the user (with a triggered dilemma or utility-based response).
                - If it is a finite narrative and the storyplan has been deemed to have failed then re-plan for the same or a new storygoal.
                - If the user has still not been presented with anything and a long period of time has passed then select and present a random action.

4.13   The interface

In this section the interface decisions which were made for presentation of the GADIN experience to the users are discussed. These are not the only possibilities but are the default for the GADIN system.

4.13.1   Initial state creation

Before the user begins their GADIN experience they are asked to specify some personal details. These will vary depending on the domain, but will always include at least the user's name. The other details will be those user attributes which it is preferable for the system to accurately represent, for example in the soap version the user's age grouping is very important. Certain details, such as the user's attractiveness, may take assumed values for the user, depending on the domain.

Once the user has been asked for their personal information they may (depending on the domain requirements) be asked to state their feelings towards other characters. This shows the user the relevant traits of each character selected for participation in the narrative. The user is then able to specify their initial feelings for these characters, for example whether they like the character.

If the user chooses to design their own storyworld (section 4.11) then they will be taken through a series of questions, the answers to which allow them to specify all of the details which the current domain's creator allows them to change. It may also be possible for the user to specify the initial feelings between other characters within the storyworld.

4.13.2   Action presentation

Each action has an identifier which is used to determine the form in which it is output. For example the action `X moves between L and K` has identifier `moves between`. For each possible identifier the format in which the action will be output in presentation to the user is specified. It is necessary for this 'printable form' to be defined for every possible action identifier within the domain. This is specified in a general form, with the involved characters' relevant details being added as appropriate.

For example the identifier `moves between` in the current text-based soap version of GADIN has the associated printable form `Action is X moves between L and K` where `X` is the acting character, `L` is their starting location and `K` is their final location. If this action were to take place within the narrative, with `joe` moving between the `house` and the `shed` then this would be output to the user as `Action is joe moves between house and shed`.

Where it is necessary to include pronouns in the action output these are selected appropriately for the gender of the involved characters wherever the gender of the characters is relevant for the domain. If the gender is not relevant then the neutral form is used.

4.13.3   User actions

Following each user action selection an acknowledgement of their choice is given. This will be a representation of the user's action in the form discussed in section 4.13.2 but adapted to be appropriate to the user. With a text-based interface this would involve the wording being adapted appropriately to give a second person perspective of the narrative as discussed in section 2.2.7. This adaptation is also made for other character actions involving the user.

If the user's action cannot be understood by GADIN then the system will give a standardised response. With a text-based interface this may identify the

missing words in the user's action selection, or inform the user that it was unable
to recognise their input.

4.13.4   Storygoal communication

Although the storygoal can be selected from any of the available propositions
which have not yet been true within the storyworld (section 4.8.1) there are
still a finite number of possibilities. For each possible proposition subject (for
example `likes`) a form in which the storygoal could be presented to the user is
defined. For example if the storygoal selected is `user likes joe is true` then
the communication to the user could be `try to get joe to like you`, thus
suggesting the storygoal as a possibility to the user. A range of possibilities
should be defined, by the domain creator, for each storygoal subject. These
are chosen between randomly, but otherwise the storygoal is communicated in
the same way for each storygoal subject (except for the appropriately changed
involved characters).

4.13.5   Dilemma presentation

Each dilemma has associated a form in which it will be presented to the user. As
with actions this will adjust to incorporate the involved character details, such
as the user being referred to in the second person and inclusion of appropriate
character pronouns where relevant to the domain and situation. The form in
which the dilemma is presented to the user differs from the presentation to other
characters, as for the user it must be presented as a question. Their possible
options will then be made clear to them and they will be able to make their
choice.

   Once the dilemma has been output and a decision has been made, by the user
or otherwise, the outcome will be shown to the user. This is also in pre-defined
form, with the ability to vary depending on the involved characters. There are
two possible generalised outcomes associated with each dilemma, depending on
the decision made.

4.13.6   Coercions

When a plan requires the user to take a particular action but they do not do
so an attempt can be made to coerce them into taking the required action,
as discussed in section 3.7.3. Whenever a coercion is possible and appropriate
it is presented to the user in a pre-defined form. For example if the required
action is `user moves between house and shed` and this is coercible then the
coercing character might ask the user to move to the shed with them. The
user will be presented with this as a question in a text-based interface, for
example `joe asks you to go to the shed with him, would you like to
go?`. The user is then able to input their decision.

4.13.7   User choices

There are other choices which must be made by the user through the course
of the narrative. This may be to add further clarification to an action choice
or as a response to a character action or dilemma decision. For example if

the user chooses to have a party then they will be asked which characters they would like to invite to the party. Another example would be if the plan required that the user become partners with another character, which would require that character to `ask out` the user and the user would then be able to choose whether to accept this.

4.13.8   Available information

When the user is experiencing the narrative a decision must be made regarding the information which will be presented to them. For example it may be appropriate for the user to be able to see the state of the storyworld, whether on request or at all times. The domain creator must design the specific interface to show all of the required information to the user in a clear and understandable manner. There are some aspects which are essential to include, these are:

- The availability for the user to act whenever they have control.

- The ability for the user to return control to the system when they choose to.

- The narrative, dynamically updated as the storyworld progresses.

- Presentation of appropriate options to the user (sections 4.13.5, 4.13.6 and 4.13.7).

- The objects (section 3.2.3) which the user currently has in their possession.

The additional optional information which can be communicated to the user (depending on the domain requirements) is:

- Relevant information pertaining to the current state of the storyworld (section 3.2), such as the locations of characters.

- Certain traits of storyworld characters (section 3.2.1.1).

- Information about storyworld locations (section 3.2.2).

- Information about storyworld objects (section 3.2.3).

The method of presentation, the layout of the interface, and which of these components should be included, will need to be determined for each domain. This is discussed in the context of the completed evaluations in chapter 6.

5

Application domains

5.1 Overview

This chapter begins by detailing the requirements for application of the GADIN architecture to a new domain (section 5.2). The GADIN system has been applied to two domains thus far: soap operas and children's dinosaur adventures. Section 5.3 gives the details of the application of GADIN to the soap opera domain, with an infinite narrative. In section 5.4 the application of the GADIN system to a children's story, a dinosaur adventure, with a finite narrative is described. Section 5.5 discusses the ease of applying GADIN to a new domain, or extending an existing domain application. Possible further applications of the system are discussed in section 8.6.

5.2 Applying GADIN to a new domain

In this section the steps which must be taken to apply the GADIN architecture to a new storytelling domain are outlined. The only restriction on domain selection is that it must be a domain which makes use of clichéd storylines of the type used in the GADIN system (section 3.4).

These requirements are summarised here:

1. Determine the domain.

2. Identify and define the storyworld requirements, and optionally instantiate these (section 5.2.1).

3. Identify and incorporate actions (section 5.2.2).

4. Identify, generalise, categorise and define dilemmas (section 5.2.3).

5. Decide which additional features are to be used and add instantiations where appropriate (section 5.2.4).

5.2.1   Storyworld

In applying the system to a new domain it must be determined which aspects of characters, objects and locations are appropriate. Principles, crimes and possible relationships between characters must also be determined. Section 3.2 gives details on this. It is not necessary at this stage to provide instantiations of these, as discussed in sections 4.10 and 4.11.

5.2.2   Actions

Actions which can take place within the current domain must be identified (as discussed in section 3.3), and then added to the background knowledge of the system. For each action there must be defined: preconditions; effects; a printable form (section 4.13.2 gives more detail on this); and an applicability check (section 3.3.2). If interactivity is required in the narrative generation process it is also necessary to make the actions available for selection by the user (section 3.7.3), and to determine whether each action can be coerced as well as how to coerce it if so (sections 3.7.3 and 4.13.6). Coercions will be utilised in interactive narrative generation where required by the GADIN system.

5.2.3   Dilemmas

As the chosen domain will be one which makes use of the clichéd dilemmas (section 3.4) used by GADIN it should be straightforward to identify these dilemmas. The generalised form of each dilemma must then be classified according to the dilemma categories identified in section 3.4.2. In this process each dramatic sequence is generalised so that it can be instantiated dynamically depending on circumstances and corresponding appropriateness.

Once the generalised form of each dilemma has been found and classified it can be added to the background knowledge of the system. The roles taken by characters in each dilemma will depend on whether the story generation will be interactive, and if so whether all dilemmas will be available to every character or only to the user. Ideally in creating the domain it should be possible for all characters, including the user, to take any role in the dilemma — and only in utilising these dilemmas will the restrictions become relevant. This is not essential but will increase the extendibility of the application to the current domain.

The utility responses to each dilemma are determined by their category, therefore it is not necessary for these to be defined when applying GADIN to a new domain, although exact numerical values can optionally be associated with each dilemma. All that remains is for the frequency of each dilemma to be specified if the default is inappropriate. The ability to select a frequency rating individually for dilemmas enables the domain creator to impose their own creativity, for instance by defining a particularly obscure dilemma (in general form) which will only rarely occur.

5.2.4   Additional features

It must be decided, depending on the specifics of the domain, which of the features discussed in chapter 4 should be made available as part of narrative

generation in the chosen domain. These must then be instantiated depending
on the domain. The framework for each feature is already in the system, and
those which should be included in the domain application can have domain-
specific details incorporated.

The possible additional features and associated issues which need to be con-
sidered are:

- Events (section 4.2) and whether these should be incorporated.

- Concurrent plan presentation (section 4.3) and whether this is appropriate
  for the domain.

- Knowledge (section 4.4) and how much will be revealed to and hidden
  from the user.

- The user model (section 4.5), and whether the incorporation of this will
  improve the user's experience. This includes determining the aspects of
  the user to be modelled.

- Trigger actions (section 4.6) and which dilemmas require these to be spec-
  ified within the domain.

- Whether the narrative will be infinite (section 4.7) or finite (section 4.8)
  and thus which techniques will be included.

- Whether an automated user (section 4.9) is relevant or appropriate for the
  domain and the details if one is required.

- How the initial state (section 4.10) will be determined.

- Whether the user will be able to design their own storyworld (section 4.11)
  and how much of this they will be permitted to specify.

- The specifics of the interface (section 4.13) also need to be considered.
  This is discussed for each application in chapter 6.

5.3   An interactive soap

Soap operas (or soaps) are a popular television and radio means of entertain-
ment. They consist a story which never ends, often involving characters — who
may be similar in many ways to the target audience — experiencing their (very
dramatic) everyday lives. In England television soaps are shown 4 or 5 times
a week. Each episode usually lasts half an hour and will see the continuation,
foundation or conclusion of some of the ongoing storylines. It is unlikely that
more than one storyline will conclude in the same episode, unless they have
merged into one. There are always storylines, and the soap continues through-
out the year — reflecting calendar events with, for example, a Christmas Special
episode. It is unusual for a soap to end, although this can happen if viewing
figures become too low, as in the case of *Brookside* [106]. In general soaps once
started will continue for many years, with *Coronation Street* [104] beginning in
1960 and still ongoing.

It was decided to initially focus on narrative generation in the soap domain.
There were a number of motivating factors in this decision. One reason was

the frequent use of clichéd storylines in soaps. Another was the familiarity and popularity of soaps. The infinite nature of soaps means that there is no overall plot structure but rather an infinite series of 'mini-stories'.

There are many British soaps but the most frequently broadcast (and popular) in England are *The Archers* [103], *Coronation Street* [104], *Emmerdale* [105], *Eastenders* [107] and *Hollyoaks* [108]. These are the soaps which are particularly focused on in the GADIN system.

Soaps are commonly known to consist of very similar and clichéd storylines. The clichéd storylines utilised in soaps are usually found to be essentially conflicts (or dilemmas). Writers utilise these dilemmas in the creation of soap stories. The story is built around the cliché, and it is the cliché as well as the story which the audience appreciate, the very repetitiveness and familiarity of the dilemmas adding to the dramatic interest. A general form of each such clichéd dilemma can be determined, and a computerised storywriter can create an interactive narrative around these.

Regular soap viewers were consulted in the identification of actions, dilemmas and character traits which would be of relevance for inclusion in GADIN as well as the appropriate frequency of occurrence of each of these. In the soap domain it is possible to take advantage of short-term soap memories, as although at times the past is brought up in general it will be ignored, for example in *The Archers* Cathy's affair was not mentioned when her husband later had an affair.

5.3.1   Storyworld

In the soap domain application of GADIN characters are assigned: attributes of 'gender', 'sexuality' and 'age'; characteristics of 'generosity', 'selfishness' and 'morality'; and genre-specific descriptions of 'bad boy' and 'busy body'.

The principles made available in the soap version of the GADIN system are 'not stealing' and 'not drugging others', with associated crimes of 'stealing' and 'drugging other characters'. The unidirectional feelings between characters consist of 'liking' and 'fancying'.

Associated with each location in the GADIN soaps is whether it is possible to: have a party; steal; drug others; drink; or buy others drinks. In each instantiated storyworld there is always at least one location which is a prison. This is necessary for the inclusion of those crimes which are punished by going to jail. It is also possible for characters to visit this location and not be imprisoned.

There are no objects included in the current soap application of GADIN.

5.3.2   Actions

A full list of the possible actions which can be taken by characters within the soap version of the GADIN system, with applicability conditions, is given in appendix A.1.

Any characters in the system can potentially participate in any action, depending on the applicability check. This ensures that their traits are appropriate to the action. For example, in a soap world (where looks are very important) if an attractive character fancies a less attractive character this satisfies an applicability check of the action meaning that the reciprocation action is possible. In the STRIPS representation this action becomes:

```
Operation:  X starts to fancy Y
```

```
Preconditions:  fancies(Y,X)
Effects:  fancies(X,Y)
Where the applicability conditions are:
    attractiveness X < 1 ∧ attractiveness Y = 1
```

In creating this application of the system there were some difficulties in determining preconditions. There are certain situations which are conceivable in a soap context but which could seem illogical in a GADIN narrative. For example, if a character drugs someone, then drugs that person again, in the system this may seem inconsistent but it is easy to conceive of this sequence in a soap (for example, the character drugged another and had such a good time that they chose to do so again). For this reason in some situations probabilities are used in the applicability check. This is one of the major problems in maintaining believability and it was necessary to make appropriate decisions in each individual circumstance.

5.3.3   Dilemmas

In identifying dilemmas from soaps it was found that they fell into only three of the five possible categories, namely: Betrayal, Sacrifice and Favour. Although the dilemmas included in this version of GADIN do not incorporate all of the possibilities for soaps, categorising the dilemmas led to the conclusion that there are a finite number of generalised forms of dilemmas which appear in soaps.

An example dilemma is the *Hollyoaks* storyline involving Andy encouraging Sam to betray his principle of 'not drugging' to spike girls' drinks with Rohipnol and thus take advantage. This is an example of a Sacrifice dilemma, in which a character must decide whether to choose the action which results in the worst possible outcome for themselves (they will no longer hold their principle) but the best for their friend (who will be joined by a friend in not holding this principle). It is known as the BetrayPrinciple dilemma, and has preconditions of: the encouraged character liking the encourager; the encourager not holding a particular principle; and the encouraged character holding this principle. If this dilemma is instantiated with the principle of 'not stealing', and the characters of Michaela and Sonny, another *Hollyoaks* storyline is identified.

The dilemmas available in narrative generation in the current version of the GADIN soap system are given here. There are further dilemmas which occur in soaps but many of these are prevented from being included due to other aspects of this instantiation of this version of the GADIN system, for example dilemmas which involve familial relationships. The GADIN system can be extended to include such dilemmas (section 8.6.1).

Betrayal dilemmas

- CheatOnPartner: In this dilemma a character must decide whether to cheat on their partner.

- DumpCheater: In this dilemma a character finds out that their partner is cheating on them and must decide whether to continue the relationship. If they decide not to then the cheater may offer to end the affair, and the cuckold will then have to decide whether to continue under these circumstances.

- DisruptWedding: In this dilemma a couple will be getting married, and one will be having an affair. The character with whom they are having an affair must decide whether to disrupt the wedding by sharing this information at that event or not.

- TellOnFriend: In this dilemma a character's friend commits a crime. The character is aware of this and must decide whether to report their friend for this crime.

Sacrifice dilemmas

- BetrayPrinciple: In this dilemma (as discussed above) a character must decide whether to betray their principle given that their friend is encouraging them to do so.

- KeepBaby: In this dilemma a (female) character discovers that they are pregnant and must decide whether to keep the baby.

- AdmitCrime: In this dilemma a character has committed a crime. Their friend has been accused of this crime and they must decide whether to admit to the crime and accept the punishment themselves or allow their friend to be punished for it.

Favour dilemmas

- WhoToPartner: In this dilemma a character mutually fancies two other characters, and must decide which of the two to become partners with.

- ChangePartners: In this dilemma a character is partners with another and having an affair with a third. They are required to choose whether to stay with their current partner (and end their affair) or become partners with the third character instead.

- DisapproveRelationship: In this dilemma a character's friend disapproves of their relationship and the character must decide whether to continue with it.

- DisapproveAffair: In this dilemma a character's friend disapproves of their affair and the character must decide whether to continue with it.

- FriendOrPartner: In this dilemma a character mutually fancies another, but their friend also fancies that character (and they are aware of this). They must decide whether to go out with the potential partner.

Although the DisapproveAffair dilemma is very similar to the DisapproveRelationship dilemma it has sufficient differences to be defined as a separate category. It also has two distinct cases: if X is cheating on their partner with Y it must be possible for both X and Y to experience this dilemma. The majority of the instantiations are the same in both cases and it was considered advantageous for this dilemma to occur with the same frequency whichever circumstance was used. Since only the preconditions differed, alternative preconditions were added to the dilemma definition. These are used additionally but separately to the first

preconditions when this dilemma is planned for — since both sets of preconditions can never be simultaneously satisfied the alternate preconditions are checked if the original preconditions fail. The methodology used in this is sufficiently general that it can be easily re-applied to further dilemmas as required. It may be that in other domains it will be necessary to incorporate further sets of preconditions for the same dilemma, representing all circumstances in which the dilemma may occur. This would result in more versatile and less predictable dilemmas and is possible within the framework of the GADIN system.

Directly following a dilemma decision the involved characters may have to make choices dependent on the outcome. In the soap version such situations arise mainly through affairs. If a relationship ends, the characters involved will have to decide whether to continue their affairs (if they were having any). They will be asked to decide whether they want to become partners with any of the (single) characters they are having an affair with, and if not then all affairs with single characters will be ended. If another character decides that they want to further an affair with the (single) user by making it a relationship then the user will be asked if they wish to accept this or not.

An example of a possible dilemma, its classification and general form is given here. The storyline of a character being presented with a dilemma involving cheating on their partner has been used in all of the examined soaps. This demonstrates the frequent use of clichéd storylines in soaps. More specific examples of this include:

- *Hollyoaks*: Becca has the opportunity to cheat on her husband Jake with Justin, a schoolboy in her class.

- *Eastenders*: Jane has to decide whether to cheat on her husband Ian with the local bad boy, Grant.

- *Coronation Street*: Danny has the opportunity to cheat on his wife with Leanne, his son's girlfriend.

- *The Archers*: Emma has to decide whether to cheat on her husband Will with his brother Ed.

- *Emmerdale*: Katie has the opportunity to cheat on her fiancé Andy with his adopted brother Robert.

This dilemma can be categorised as being of type 1, Betrayal. Its general form is:

A_X: cheat on partner (X)
preconditions: partners(X,Y) $\wedge$ fancies(X,Z) $\wedge$ fancies(Z,X)
dilemma (to character X): ``Will you cheat on your partner character Y with character Z who fancies you?''
if X chooses to cheat:
   add to state: cheating(X,Y,Z)
if X chooses not to cheat:
   delete from state: fancies(X,Z)

An instantiation of any dilemma can be presented to any character in the narrative, including the user.

5.3.4   Events

Events (section 4.2) are particularly common within the soap domain so have been included in the soap version of the GADIN system. Those events which are available are: proposals, weddings (with interruptions), divorces and parties. The user can initiate any of these events.

The possible motivations for each of these events are:

- Proposals: any characters in a relationship are currently likely to propose.

- Weddings: these occur when there is sufficient motivation for an interruption, currently that the interrupting character fancies one of the characters getting married and does not like the other.

- Divorces: if a character no longer fancies the character they are married to they are motivated to request a divorce.

- Parties: if characters get engaged they may choose to have a party. There is also a small random chance that a character will decide to have a party without further motivation.

5.3.5   Concurrent presentation

The techniques for concurrent presentation of dilemma plans (section 4.3) have been applied to the soap version of the GADIN system. As in soaps, the number of concurrent storylines is variable. This technique is currently only utilised in the non-interactive experience and it may be that the number of concurrent storylines should be different when the user becomes a character. In this it should always be ensured that the user is involved in one of the concurrent plans.

With this method of narrative generation the speed decreases are significant. The reason for this is that for the concurrency to be truly applicable (with mutually exclusive plans) it is necessary to include a larger number of characters within the storyworld, and the resulting increase in potential plans is thus intangibly large. With more characters it would be possible to have different sets of characters undertaking completely separate actions at the same time — each leading towards different dilemmas. This is the manner in which the action is presented in television soaps. Since the GADIN actions are currently at such a high level of abstraction concurrent plan presentation and overlapping of actions did not improve the narrative. This will change if the actions become more complex and have more stages in implementation.

5.3.6   Knowledge

As discussed in section 4.4 it is important not to conceal too much action from the user. If they never observe interactions between other characters then they are likely to become frustrated by the constant changes for which they will not understand the reasoning. There is also the potential for decreased dramatic interest in a narrative in which the user is only aware of the dilemmas which they are experiencing or directly involved in. However if the user sees all of the action then there can be none of the gossip and misunderstandings which are a central component of soaps.

The current application of knowledge to the soap version of the GADIN system involves affairs. Whenever a character has an affair with another, and either character is in a relationship with the user, the user will not know about that affair. Any information regarding that affair being communicated between other characters will not be shown to the user — unless it is a character talking to the user. There is also knowledge regarding characters' mothers being in institutions, but although this has been implemented it was not used in the evaluation instantiation, as it lacks sufficient generality.

When two characters embark upon an affair only they will have knowledge of the affair, and if a dilemma was involved this will not have been shown to the user. Characters are able to tell others about affairs. All characters, including the user, will only have knowledge pertaining to affairs if they are directly involved, have been told about it, or have come to believe it is true (whether correctly or otherwise). All knowledge and actions regarding affairs is hidden from the user, unless they are either aware of the details or an involved character.

Unsubstantiated knowledge in soaps is generally not made up but is the result of situations being misinterpreted. In the GADIN system it is also possible for characters to make up affairs between other characters, and this will generally occur as a result of some motivating factor, as in the case of soap misunderstandings, such as those characters being alone in a particular location together. Once false knowledge exists it will be passed between characters as if it were true. The dilemma and state updates will still exist internally but will not be seen by the user either when they take place or in the representation of the current state visible to the user.

The inclusion of hidden knowledge can lead to the user being informed that their partner is cheating on them, and thus experiencing a dilemma in which it is necessary to decide whether to believe the informant and subsequently to continue with or end their relationship. Depending on the character and circumstances they may then reveal to the user that the affair never existed. Other characters may also experience this dilemma, as they will be assumed not to know about their partners' affairs unless told by another character.

If an affair ends knowledge regarding it is removed. It is possible to extend this so that gossip of the end of the affair can also be passed around, but in general when an affair ends in a soap it is as a result of it being discovered publically, therefore this was the method used.

5.3.7 User model

The user model (section 4.5) has been applied within the GADIN soap system. Those aspects of the user which are modelled are: honesty, taking responsibility for actions, faithfulness, selfishness, whether they prefer friendships or relationships, strength of character, morality, the value they put on each of their relationships (which is related to fancying), the value they put on each of their friendships (which is related to liking), and the strength with which they hold each of their principles. The aspects of the user to be modelled were selected for their generality and applicability to as many dilemmas as possible. These were chosen for their appropriateness to not only current system dilemmas but also to other soap dilemmas, considering important traits which are likely to affect decisions made in real soaps. Although some of these may seem too similar, or

perhaps too specific, they each apply to various different dilemmas, in a range of combinations, and all are necessary.

Figure 5.1 shows an example of the updates to the user model following a dilemma decision. A rule associated with each dilemma reflects the balance of criteria values which will lead to each possible predicted user decision. An example of this is shown in figure 5.2. If these values are equal, in the case of some dilemmas a second attempt at a prediction will be made (using less accurate criteria combinations) before a random prediction is made. The performance of the model depends on the quality of these rules.

```
Dilemma:  ''Will you cheat on your partner X with Y?''

 If yes:
  decreased:
   value for faithfulness
   value for morality
   value for relationship with X
  increased:
   value for relationship with Y

 If no:
  decreased:
   value for relationship with Y
  increased:
   value for faithfulness
   value for morality
   value for relationship with X
```

Figure 5.1: The updates to the user model which result from the user deciding whether to cheat on their partner. In this example the updates are symmetrical, although this is not always the case.

```
Dilemma:  ''Will you cheat on your partner X with Y?''
 negatives:
  value for relationship with X
  value for faithfulness
  value for morality
 positives:
  value for relationship with Y
```

Figure 5.2: The criteria used by the system in predicting the expected response of the user when asked to decide whether to cheat on their partner. This depends on the balance of values in the user model. If the sum of the positive criteria is greater than the sum of the negative criteria then the user will be expected by the model to choose 'yes', and thus to cheat. The difference between these values determines the expected difficulty of the decision for the user.

This model is fairly general. It is thus applicable to further dilemmas and will still be valid as the system develops.

The user model is also used to affect coercions of the user, in the following ways:

- If the user has a particularly low value for their relationship with another character they will not be coerced into fancying that character.

- If the user has a high associated value for their relationship or friendship with a character, and it is required that the user get drunk, then that character will offer to buy them a drink.

- To encourage the user to move to a given location a character who they have a particularly high value for their friendship with will invite them to go to that location. This may require that character to first move to the user's original location.

5.3.8   Trigger actions

The user is able to cause (section 3.7.4) or trigger (section 4.6) a dilemma for another character. The possibilities for this within the soap version of the GADIN system are:

- The user asking a character who is in a relationship to have an affair with them triggers that character experiencing a CheatOnPartner dilemma.

- The user telling another character about their partner having an affair leads to that character having to decide whether to end their relationship with their unfaithful partner — a DumpCheater dilemma.

- The user disapproving of a character's relationship or affair (if that character likes the user) will cause that character to have to decide whether to continue with this, a DisapproveRelationship or a DisapproveAffair dilemma.

- The user encouraging a character who likes them to betray a principle will cause that character to experience a BetrayPrinciple dilemma.

- The user accusing a character of a crime which another character who likes the first character committed will lead to the second character experiencing an AdmitCrime dilemma.

5.3.9   Non-interactive narrative generation

Characters other than the user experience dilemmas within this domain. This means that it is only required for the user to be removed as a character for an non-interactive soap to be generated by GADIN. This is done by changing a single Boolean value within the system. The user can choose to join or leave as a character at any time during the narrative generation process.

5.3.10   Interactive narrative generation

This section discusses the specific techniques that were used to incorporate the user into the soap storyworld to ensure that they have a dramatically interesting and enjoyable experience. These are used in addition to those techniques discussed in section 3.7.

To ensure that the user remains central to the narrative it was necessary to decide whether to have a restriction on the dilemmas experienced by characters other than the user. The most appropriate restriction involved not permitting

sequential dilemmas in which the user was not involved, but instead that following each there should be a user dilemma. The disadvantage of this is that it can lead to long waiting times. It was found through experimentation that neither method was consistently better, and it was therefore determined to utilise a combination. At the outset of the narrative the restriction is imposed, but when the plan-finding begins to take too long the restriction is removed for the remainder of the experience. Thus the user becomes more involved in the narrative and the storyworld before the frequency of dilemmas experienced by other characters is increased. This is an extension of the use of a 'hook' in soaps — which involves a viewer in a particular storyline and they may therefore continue to view the soap.

When there are multiple dilemmas awaiting presentation a dilemma for the user will be selected in preference to a dilemma for another character. The advantage of this is that as many user dilemmas as possible are presented while still valid. The only exception occurs when the user acts in a way which leads to another character experiencing a dilemma, which always takes preference (to ensure that the user has a clear and immediate response to such actions).

In certain dilemmas to characters other than the user the outcome must be adapted so that the user is able to decide whether they want to accept the decision made by the deciding character. For example in a WhoToPartner dilemma the decision involves the deciding character potentially starting an affair with the user, therefore they must ask them to start an affair rather than this being an assumed outcome — unless this dilemma has been triggered by the user asking that character to start an affair with them.

5.3.11   Infinite narrative generation

Although occasionally soaps are no longer broadcast, and thus have a final episode (as in the case of *Brookside* [106]), in general they will continue indefinitely. The techniques discussed in section 4.7 for generation of an infinite narrative have thus been applied to this version of the GADIN system. This means that GADIN is able to create a soap of infinite length in which the user becomes a character.

5.3.12   History

The past of a soap world tends to only affect its present through what has happened since, rather than directly. The reason for this is that it is necessary for viewers to be able to miss episodes, or start to watch an existing soap, and still understand the interactions and appreciate the dilemmas. The history stored and considered when selecting future events and dilemmas in the soap version of GADIN consists of a list the length of the number of generalised dilemmas available within the system.

The history list is used to keep a record of the frequency of occurrence of each dilemma relative to the total number of dilemmas which have been experienced thus far in the narrative. It ensures that the relative frequency of occurrence of each dilemma is appropriate for the soap domain and is more accurate than an absolute frequency which would not allow for the same level of flexibility in the dilemmas experienced. All dilemmas will not necessarily occur within the

list at all times. This history is similarly used to prevent events from occurring more often than their specified frequency allows.

5.3.13   Initial state

When a new soap is aired it is unlikely to begin with characters who do not know one another. In general there will be background information already existing in the soap world — some of which will be revealed to the viewer, although potentially not all. The future actions of characters will be affected by this backstory. All of the ways in which a backstory can be created in the GADIN system (as discussed in section 4.10) are possible in the soap version. These are: randomly; built-up; based on existing soap; and user created. In all of the alternatives, when interactive, the user is able to determine their own feelings for other characters. Each of these is discussed further in this section.

Random initial state

In this, the default option, some pre-defined generic soap-style characters and locations are used. At the outset of the narrative the characters are non-deterministically assigned feelings for one another — based to some extent on their individual traits.

Built-up initial state

It is possible for the user to choose to leave or join the storyworld at any time. As a result the narrative can build up in a non-interactive manner, before they choose to become a character. The disadvantage of this is the long initial waiting times for the user, before they begin to become a character within the narrative.

Soap specific storyworlds

The soap version of the GADIN system is also able to exploit backstories from existing soaps. The high level of reusability and generality in the soap storylines means that this system can be applied to any soap of this type, simply by adapting the involved characters (and their initial feelings) appropriately. This involves characters, locations and backstory as for the selected storyworld.

The advantage of this is that the user is able to become a character in a soap of their choice, possibly their own favourite soap. This will make the characters seem more real, and means that the user will already have feelings for them. As a result the user is likely to experience more conflict within the dilemmas.

The soap-specific storyworlds currently available for the GADIN system are detailed in appendix A.2.

User created

The user is able to create their own storyworld (as discussed in section 4.11). In this they can specify any of: characters; locations; principles; and crimes. They are also able to determine each of the characters' feelings for one another, their initial locations, partnerships and held principles. The user can choose to specify as much or as little of this as they wish, with the remainder being

assigned by GADIN, either randomly or based on the pre-defined generic initial state settings where necessary (for example in defining locations).

5.3.14   Example

An extract from one user's experience with the system is given in appendix B. Lines 2-23 show the user interacting with the plan for a dilemma, and subsequently being presented with that dilemma. A number of other dilemmas are presented to the user throughout this extract. One of the dilemmas to characters other than the user is on lines 74-81, with a plan not involving any user actions. The user acts in a manner which causes a character dilemma on lines 55-59. On lines 30-34 the system responds to the user in a manner unrelated to a specific plan. If the user does not cooperate with the plan, as on lines 63-66, the system continues the narrative with the next dilemma and corresponding plan.

5.4   Dinosaur adventure

The GADIN system has been applied to a children's short story. In this the user is transported into a prehistoric world in which the other characters are all dinosaurs. The user is able to interact with the dinosaurs — and objects in the world — in the ways which they might expect to in a children's story. They will experience a unique adventure story, with a changeable ending.

In the dinosaur adventure the user begins by being transported to the prehistoric world. Although this is an inevitable beginning, it is simply a device which takes the user into the storyworld. When the user achieves a storygoal they are taken back to their original world. There is also predictability in this return to the original world, but the manner in which the user returns is changeable (depending on the storygoal) which adds variety and interest to the ending of the narrative. The sense of inevitability, that they will always get home at the end, is common in children's literature and will be necessary to provide them with a happy ending, this is discussed further in section 5.4.6. This is not an essential requirement of finite narrative generation in the GADIN system.

5.4.1   Storyworld

5.4.1.1   Characters

In this application of GADIN the dinosaurs (storyworld characters) have associated skills which determine whether they can: swim; fly; or go on land. They have dispositions which take one of 7 values — between -3 and 3 inclusive — along each of 3 dimensions. The dimensions are happiness, outgoingness and agility.

The characters currently available within the dinosaur adventure are: trex, diplo, ptero, steg and whaley. They each have associated a line of text which informs the user about the dinosaur which their name implies that they are an instance of. For example if the user asks `about trex` they will be given the information: `trex walks on two legs and has teeth strong enough to bite through bone`.

Unidirectional feelings of characters for one another consist of liking or not. Characters can hold the principle of 'not stealing', with the associated crime of 'stealing'. Only the user holds this principle at the outset of the narrative.

5.4.1.2   Locations

Locations have associated certain skills which characters must have to be at that location (for example a character must be able to swim to move to the ocean location). Currently all storyworld locations are accessible to characters with any skills. Each dinosaur has a nest, which contains a non-deterministic number of eggs. The location of these nests is determined at the start of the narrative, depending on the attributes of the associated dinosaur. Nests have a location, an owner, an original number of eggs and a current number of eggs associated.

There is a prison location, the pit. Only the user is able to go to the pit without having committed any crime, and it is only possible for the user to leave this location. This is plausible since the user is a human and can use a ladder to escape from the pit whereas the other characters — being dinosaurs — are not able to. The dinosaurs can only go to the pit as a punishment for a crime.

When the user moves to a new location they are presented with a simple description of that location, for example `You are in a vast and sandy desert.  It is very hot here.`.

5.4.1.3   Objects

In this domain objects become more significant and relationships become less significant. This is true in both the conventional and GADIN narratives.

There are two possible objects within the dinosaur version of the GADIN system: marbles and eggs. The user arrives in the dinosaur world with a marble in their possession. Eggs are associated with the appropriate dinosaur's nest at the outset of the narrative, but the user is able to remove them from these nests and give them to other characters. Each nest initially has a non-deterministic finite number of eggs in it. The original owner of the eggs will want them back throughout the narrative.

5.4.2   Actions

The possible actions within the current dinosaur adventure application of the GADIN system are listed here:

- Characters can become friends, so can extend friendship to any other character (including the user). There are a number of different ways in which this can be done:

  - Asking the other character to be friends.
  - Telling the other character they look nice.
  - Drawing a picture for the other character.
  - Asking the other character to play.

The user's attempts to extend friendship to other characters will be refused if the character does not like the user, and accepted if they are neutral towards or like the user.

- Encouraging another character to betray a principle.

- Finding a nest — this is controlled by the narrative generator, the user can find a nest if they are at the right location and a non-deterministic factor causes them to find it, or it is appropriate to the storyplan (section 4.8.2) that they do so.

- Starting to like, or stopping liking, another character.

- Moving between locations.

- Throwing a stone at another character. Stones are not objects but are assumed to always be possessed when required for throwing.

In the basic GADIN system relationships can currently only take Boolean values. This means that at the outset of the narrative each dinosaur must either like or not like the user, when it would be more appropriate for them to have neutral feelings until the user has acted to change this. To overcome this problem an additional 'likes 0' proposition was added for each character. If this is true (which it can only be at the creation of the initial storyworld or if it has never been changed) then liking is considered to be neutral and no dilemma which requires the involved characters to like or not like one another can be presented. This is extended to also mean that before the user can be considered to like or not like a dinosaur they must have encountered that dinosaur and have either accepted or rejected their extensions of friendship.

5.4.2.1   Dispositions affecting actions

The characters' dispositions affect their action choices. This is a specific instance of the applicability check as discussed in section 3.3.2. This occurs in the following ways:

- A character with the lowest possible agility ($<$ -2) will never throw a stone.

- An introverted (outgoingness $<$ -1) character will never ask the user to play. These characters will instead extend friendship in other ways.

- A very outgoing character (outgoingness $>$ 2) will always extend friendship through playing.

- A grumpy character (happiness $<$ -2) will never initiate a friendship.

The disposition of a dinosaur will also affect their response to the user's actions:

- If the user extends friendship to a grumpy character (happiness $<$ -2) by asking them to be friends or to play they will be told this is why they are being ignored.

- If the user invites a shy character (outgoingness $<$ -2) to go somewhere with them they will be ignored, and given this reason.

- If the user tries to give a shy character (outgoingness < -2) a gift it will be refused.

It is possible for the user to cause a dinosaur's disposition to change. This can only be done in a positive way, to improve their disposition (using the conventional conception of what is good as is appropriate in a children's story), as follows:

- If the user draws a grumpy character a picture or tells them they look nice then that character will become less grumpy.

- If the user asks a shy character to play with them they will become less shy.

Only the user can act to change the dispositions of other characters but their dispositions affect their actions towards and between each other even when the user is not involved.

The characters' dispositions affect not only the actions they take but also the manner in which they perform those actions. Shown here are the positive and negative adverbs currently associated with each dimension:

- *Happy*: delightfully, brightly, happily, joyfully, playfully, enthusiastically, aggressively, grumpily, angrily, resentfully

- *Outgoing*: loudly, brightly, boldly, abundantly, slowly, nervously, carefully, softly

- *Agile*: easily, agilely, languidly, shakily, clumsily, lazily

A character will act in accordance with their dominant dimension, that with which they have the highest absolute value associated. For example a character with happiness = 2, outgoingness = 1, agility = 0 could `move brightly`. Agility is only considered to be the dominant dimension if the others are equal, or (with one in every three actions by that character) to complement the adverb of another dimension. If the action is chosen to be complemented a character could act `brightly and agilely`.

If a character's disposition is at the greatest value extreme for the dominant dimension a strongly modifying adverb (selected randomly from a range of possibilities) may be associated with the action, for example a character with a happiness value of 3 may act `incredibly joyfully`. If the value is at the lowest extreme, a slightly modifying adverb may be randomly selected. This means that a character with a happiness value of -1 could act `almost angrily`. Modifying adverbs will be used for two in every three actions of a character, reflecting the range of behaviour intensity within their overall disposition. The modifying adverbs available within the system are as follows:

- *Strongly modifying adverbs*: extremely, incredibly, exceptionally, very

- *Slightly modifying adverbs*: slightly, quite, almost

5.4.3 Dilemmas

As this is a children's story the narrative focuses on the main character. This means only the user experiences dilemmas. Dilemmas for all of the possible categories have been identified for use within this domain.

Betrayal dilemmas

- ThrowAtFriend: In this dilemma the user must decide whether to throw a stone at their friend who has accidentally hit them with a stone which they threw.

Sacrifice dilemmas

- BetrayPrinciple: In this dilemma the user has to decide whether to betray their principle when a dinosaur they like is encouraging them to do so.

- AdmitCrime: In this dilemma the user will have committed a crime (stolen an egg). If they do not admit to having done so a dinosaur will be punished in their place for this crime.

Take Down dilemmas

- ThrowAtEnemy: In this dilemma the user must decide whether to throw a stone at a dinosaur who they do not like.

Greater Good dilemmas

- SaveFriend: In this dilemma the user has possession of an item which they have the opportunity to give in exchange for rescuing a dinosaur they like — who has been kidnapped by another dinosaur.

Favour dilemmas

- WhoToGive: In this dilemma the user has possession of an item which two characters — both of whom the user likes — both want. The user must decide which character to give this item to.

- WhoToAccompany: In this dilemma two dinosaurs are both liked by the user and the user will have to decide which of the characters to play with — as they will not play together.

For those dilemmas which involve throwing stones it is assumed that throwing a stone is considered by the user to be a negative action, with a target audience of young children this is likely to be the case. The user will only experience such a dilemma if they have never previously thrown a stone at another dinosaur as the dilemma will be unlikely to be as conflicting if the user is already in the habit of throwing stones.

5.4.4   Child friendly

Since this version of the GADIN system generates an interactive narrative for children it was necessary to make the experience child-friendly. It was thus decided that no characters will die, and there will be no system pre-conception of dinosaurs (in particular `trex`) being nasty. All have the potential to be equally friendly.

The language used in communicating with the user is selected to be appropriate for children, for example `your friend x thinks it would be fun to`

`steal an egg from the nest`. Simple English is used by preference throughout. When the user asks about a character they are given information about the dinosaur which it represents. This means the system is applicable to education at a very simple level.

One of the key changes which was made for this application of GADIN is the assumption that the user likes or does not like other characters. This represents the user's feelings without requiring them to be explicitly expressed.

Consultation with a teacher led to the system being adapted so that dinosaurs never expressed their dislike of each other or the user. This is felt to be a negative way to communicate and is discouraged in schools. Instead characters will `chase` others to express their dislike. This is represented internally by the GADIN system as no longer liking and future dilemmas and actions take place accordingly.

Descriptions are used to make the storyworld seem more plausible to the user, since this prehistoric world is not one which they are likely to be familiar with. Whenever the user moves to a new location they are presented with a description of that location. When required, the system will also provide the user with a description of the storyworld characters, the dinosaurs.

To make the narrative experience more original the final words shown to the user on their return to the initial world vary depending on the goal and also non-determinism.

5.4.5   Knowledge

As is appropriate with a target audience of children the information given to the user should be limited (section 4.4). Thus the state will never be output and the user will only observe action at their current location. The user will be able to see which objects they own at any time, as well as which dinosaurs are at their location.

It is not necessary in this domain for the user to see other characters moving around and interacting with one another when they are not at the user's location. They will see the dinosaurs arriving at and leaving their location, but will not be told the other locations involved in these movements. This information is not important to the narrative — in which the focus is the user.

5.4.6   Finite narrative

As the GADIN dinosaur adventure requires an ending the techniques discussed in section 4.8 are applied here. There is a storygoal which must be achieved before the narrative can end. This is in accordance with Aaron Shepard's requirement that in a children's story there must be "a problem the main character must resolve" [102]. This storygoal will be clear to the user throughout the narrative, but will be dynamically determined for each experience and will potentially change during the narrative, depending on the user's interactions.

The user will always return to their starting world at the end of the dinosaur adventure experience. This is the clichéd and predictable ending which is appropriate for the domain. The way the user returns home is the 'true ending' of the narrative — and this changes every time. The specifics of the journey also vary completely, and these provide the dramatic interest and enjoyment for

the user. The variation in the narrative and the ending depends on the user's interactions and choices.

The justification for the narrative ending must be clear to the user. In this it is necessary that the user understands that the storygoal has been achieved. The user must therefore be aware of the storygoal for as long as it has existed as such. This will inevitably have similar elements to a computer game, the difference is that in this GADIN experience there is an original, coherent and hopefully dramatically interesting narrative each time. This is discussed further in section 5.4.6.1.

5.4.6.1 Storygoal

The storygoal is non-deterministically selected from all propositions which could be true within the storyworld but have not been so far. A storygoal must be true for the narrative to end. The system is able to identify a new goal if the user does not cooperate with the old goal. This gives the user a clear effect of their actions on the long-term of the narrative. It also increases the originality and thus the replayability.

The storygoal is made clear to the user by being communicated to them by a friend at the outset of the narrative. If the storygoal changes a dinosaur at the same location as the user will communicate the new storygoal to them — this may require a dinosaur to move to the user's location. The goal is communicated as a suggestion rather than in an absolute way to make it less a mission but rather a possible way to get home, depending on the user's preferences. Section 4.13.4 discusses how the storygoal is translated from a predicate to be communicated to the user.

5.4.6.2 Ensuring dramatic interest

Following the storyplan means that every action has a purpose and there is structure to the plot (section 2.2.9). However, it must be ensured that the storygoal is not achieved without dramatic interest in the narrative. It is ensured for all finite narratives that characters will not act to achieve the storygoal until a dilemma has been experienced. In the dinosaur adventure this is extended to ensure that no characters will act in accordance with the storyplan until a dilemma has been presented to the user. A number of additional techniques are used to ensure that the narrative is dramatically interesting and these are discussed in this section.

Although it is possible to plan for dilemmas which are supplementary to the storyplan this is not done in the dinosaur adventure version of GADIN. This increases the efficiency by reducing the time spent attempting to follow plans which later fail, and the associated coercions and expectations of the user. Instead these dilemmas are only presented when they become possible through the actions of characters and the system. This is the case when all of the preconditions of the dilemma are satisfied within the current state of the storyworld. The selection of a dilemma for presentation must also depend on the storyworld history, and the appropriate frequency of use for each dilemma, to become part of a consistent narrative.

A constraint is added to ensure that dilemmas which are required by the storyplan cannot occur in the narrative unless they involve the required char-

acters (and are thus part of the storyplan). This ensures that these dilemmas will not have occurred more often than their specified frequency before they are required by the storyplan and thus that the dramatic interest of the dilemma in the storyplan is maintained.

As any proposition can be selected as a storygoal there may be a trivial goal, one which the user can achieve without having previously experienced a dilemma. To ensure that there is still a dramatic element to the narrative, character dispositions are assigned to ensure that at least one must be changed before the user can achieve the storygoal. The assignments used to achieve this in the dinosaur adventure version of GADIN are:

- A character will become particularly shy if it is required that the user give them a gift, and will refuse to accept until they become less shy.

- A character will become particularly grumpy if the user must cause that character to like them and will not accept overtures of friendship until becoming less grumpy.

- A character will become particularly shy if it is required that they be at a particular location and will ignore the user's invitations to go there until becoming less shy.

A specific adjustment required for the dinosaur adventure version of GADIN involves throwing stones. It is necessary for characters to be able to throw stones multiple times. When stone throwing is the storygoal this should not happen until a dilemma has been experienced. This is not a standard precondition but is required as a constraint if it is a goal. There are therefore additional preconditions associated with these actions, which are only checked if the effect of the action causes the storygoal to be achieved.

5.4.7   Character actions

The dinosaurs are able to act in three different ways in the course of the narrative. Where it is possible they are required to act as dictated by the storyplan. When this is not possible they are able to act randomly. The third way is in direct response to the user's actions, and this takes priority over both other possibilities, when an appropriate action which does not violate an element of the next storyplan state is available.

Once the storygoal has been selected a plan is found which achieves this goal, as discussed in section 4.8.2. There is also a guiding series of states corresponding to the storyplan. Actions which violate an element of the next required state are not permitted by characters.

Characters will be given the opportunity to act freely when not directed by the storyplan or acting in response to a user action. This will occur if it has not been possible to present the next part of the storyplan — but this has not yet been deemed to have failed — and if there has not been a dilemma presented to the user but an attempt to do so has been made. This is at the final stage in the narrative generation process loop as given in section 4.12. At this stage an appropriate random action will be selected for one of the characters (selected randomly from those characters at the user's location, or to be another character moving to the user's location).

An action record list is maintained to ensure that the same character action will not occur more than once within a certain period of the narrative. This makes the narrative less repetitive and increases the chance of a dilemma being experienced. Characters act non-deterministically in accordance with their disposition and traits, which is ensured through use of the applicability check in selecting actions. As a result of this freedom characters act more frequently than they would be able to if they only acted when directed by the storyplan. This results in more opportunity for the user to become aware of the characters' dispositions and traits and thus means that they will be likely to develop stronger feelings for and greater attachments to these characters, leading to increased conflict in the dilemmas.

5.4.8   Non-interactive narrative generation

It is possible for the user to choose not to interact in the dinosaur storyworld but to see a narrative generated in which the computer directs the protagonist. In the non-interactive version of the GADIN dinosaur adventure only the human character experiences dilemmas. It is therefore necessary to create an 'automated user' (as discussed in section 4.9) who will select actions and make decisions on dilemmas.

The automated user will not know the storyplan, nor will they necessarily act in accordance with it. This is because if they are aware of the storyplan the narrative will have a reduced dramatic interest, due to the lack of dilemmas experienced prior to it. It will also cause them to interact less with other characters and thus potentially reduce the plausibility of those characters within the narrative. There is a model of the automated user's personality and feelings which will affect how they act. As the narrative is short, initial impressions will be of high importance. It is thus possible for the model of the automated user to remain constant throughout.

The automated user model is initially set non-deterministically. It consists of a precedence ordering for feelings towards other characters — this reflects how well disposed to each of the other characters the automated user is and determines the outcome of Favour dilemmas. There is also a non-deterministic numerical rating associated with each character which is reflective of the precedence ordering. This more fully represents feelings for the other characters and determines whether the automated user accepts friendships.

The automated user's personality takes values for how nice, outgoing, generous, giving, happy, peaceful, forgiving and honest they are. In combination with the automated user's feelings for other characters this is used to select the decisions on dilemmas, as well as the action choices, made by the automated user.

5.4.9   History

Since the dinosaur adventure narratives are short there is a restriction on the history which means that the same dilemma will never be experienced more than once by the user, whichever characters are involved, within the course of a single narrative.

5.4.10 Story record

As the user interacts with the system a record is kept, in the third person, of everything which occurs within the storyworld. This outputted story record is available to the user following their experience, as a non-interactive narrative. This adds another layer to the narrative experience of the user, making it re-visitable and allowing them to easily share the experience with others. For children it may also make them feel more important, as they are a character in a 'proper' story — which is a record of a 'real' experience. This record is in third person present tense, as is common in children's literature of this type.

5.4.11 Responding to the user

As discussed in section 3.3.4, each proposition within a state has an associated utility, and this affects the manner in which characters respond to the user (sections 3.5.5 and 3.7.4). These utilities can take any appropriate value, but since the dinosaur adventure storyworld is simple and the narratives are short utilities are restricted to only -1, 0 and 1. Randomness and character relevance considerations still determine exactly which response is appropriate, but this limitation means that a response is more likely — resulting in a narrative which will be more consistent with the user's likely expectations.

5.4.12 Example

An example of a dilemma being presented to the user is given here.
```
You like trex and diplo.  They both want your marble
Who will you give it to?
```
diplo
```
You have chosen diplo, diplo now owns the marble.
trex chases you
```
This shows the presentation of a dilemma to the user, the user's decision (in italics) and the subsequent utility-based response.

Story records (section 5.4.10) from two user experiences with the dinosaur adventure version of the GADIN system are given in appendix C.

5.5   Ease of creating new domains

In this section the ease of applying GADIN to new domains is discussed. This is also relevant to the effort required to extend an existing application of GADIN, for example by adding further dilemmas or actions. The complexities are discussed for each of the requirements for creating a new domain detailed in section 5.2. This discussion focuses on the ease of implementation rather than design, as this is more quantifiable.

In considering the ease of creating new domains it is assumed that the domain creator has a good knowledge of C# and of the GADIN techniques. They will not usually be required to have familiarity with the GADIN code other than those components which are directly relevant to the specification of the new domain, which are discussed in this section. Certain optional features require the domain creator to have a greater knowledge of the code, and details are given whenever this is relevant.

5.5.1   Storyworld

There must be specific instantiations of the characters and their traits, the locations and the objects within the storyworld. This determines the initial state of the storyworld. This can easily be created randomly by GADIN. The ease of defining these in accordance with specific requirements is discussed further in section 5.5.4. Alternatively it could be contingent on the user to provide this information, and the effort required for this is also discussed in section 5.5.4.

Each character has default traits associated. It is possible for these to be extended, depending on the domain, but this should not be necessary for most domains. It is fairly easy to extend these traits but does require a slightly greater knowledge of the code. The same is true of the requirements associated with locations and objects. Such extensions will become increasingly less necessary as GADIN in applied to more domains and the knowledge base is extended.

5.5.2   Actions

Adding actions to the GADIN knowledge base is relatively straightforward. It follows a fixed and general structure. There is more complexity if the preconditions or effects require the creation of new categories of propositions. As the knowledge base grows the addition of new propositions will become less necessary.

In applying GADIN to a new domain many actions from previous applications are likely to be reusable, for example the action of moving between locations. Once the relevant actions have been identified it is simple to specify which actions will and will not be appropriate for the current domain. There are also many actions which will have core similarities, such as any characters embarking on a mutual relationship (for example a partnership or friendship). These actions are defined in general form in GADIN, and only the relationship (and output form) need to be changed for each new action of this type.

The applicability of actions is likely to vary depending on the domain. It is necessary for the domain creator to specify all of the possible applicability conditions for each new action which is added to the knowledge base. This can be complex, depending on the number of possibilities for each action.

There may be other requirements for actions which are specific to certain domains. For example section 5.4.2 discusses the use of a 'likes 0' proposition in the dinosaur adventure version of GADIN, which was not applicable in the soap version. These will be more difficult and require greater knowledge of the GADIN code to incorporate. However such specifics are optional features of narrative generation in a new domain.

5.5.3   Dilemmas

The greatest potential difficulty in incorporating dilemmas into GADIN is in their identification. Following this each dilemma should be generalised and can then be easily instantiated — utilising the general form for dilemmas of that category. The specifics of each dilemma are mainly dependent on their category, and are thus already present. This means that, for example, in the dinosaur adventure version of GADIN the Betrayal dilemma in which a character must decide whether to throw a stone at their friend — although dissimilar to any

Betrayal dilemma in the soap storyworld — does not take too long to define using the specifics relevant to the general form of this dilemma.

There are many dilemmas which will be reusable between domains. For instance the BetrayPrinciple dilemma will be the same regardless of the principle, and it is only required to specify individual principles for this dilemma to be utilised in narrative generation (if it is appropriate for the domain). Those dilemmas which have already been defined within GADIN follow the very clear and adaptable structure which has been defined for each dilemma category. This increases the ease of applicability to further domains. For example the Who-ToAccompany dilemma in the dinosaur adventure domain is very similar to the WhoToPartner dilemma in the soap domain and adapting it was not difficult.

5.5.4   Additional features

This section considers the ease of incorporating each of the additional features discussed in chapter 4 when applying GADIN to a new domain.

Events

If the incorporation of events is appropriate for the new domain then these need to be identified. They can then be made available to GADIN. There is a clear general structure for events (section 4.2) and it is relatively straightforward to add a new event. Some events will be reusable between domains. For example a party will be applicable to many domains, and although the motivations may differ this is easy to adjust without changing anything further regarding that event.

Concurrent plan presentation

The incorporation of concurrent plan presentation in narrative generation is general and not specific to a particular domain. This means that it is only necessary for the domain creator to determine whether this will be used, and to change the associated Boolean value appropriately.

Knowledge

In some domains the use of knowledge is very simple to implement, for example in the dinosaur adventure version of GADIN the information available to the user is restricted by their current location. When the domain requires that there is a more intricate representation of knowledge, as discussed in section 4.4, it will be necessary for the domain creator to decide what will be represented in this manner. Once this has been determined the knowledge items must be added to the list of possibilities. Each knowledge item must then have associated: preconditions; reasons to share it; and when it will become (un)known by characters. Initial knowledge held by characters must also be specified. There is a reasonably large amount of complexity in creating knowledge items, due to a lack of generality.

The user model

If a user model is to be incorporated in the narrative generation process the aspects of the user which should be modelled must be identified by the domain creator. Each dilemma and action should then have associated the aspects it updates. Each dilemma will also have associated the balance of criteria involved in predicting its outcome. Once the user model aspects and appropriate updates have been determined this is straightforward to implement.

Trigger actions

For each dilemma trigger actions (or their absence) must be identified. The general architecture of dilemmas means that it is then only required to associate the trigger action and default response with the dilemma. This is easy to do and is an integral component of creating each new dilemma for a domain.

Infinite or finite narrative

It must be determined whether a finite or infinite narrative will be generated. The main code loop must then be adapted appropriately, this is discussed in section 5.5.5.

If the narrative is infinite then there are no further requirements for the domain creator. If the narrative is finite the domain creator may add restrictions on the possibilities for the storygoal. This is optional (depending on the domain) and is more complex, requiring greater knowledge of the GADIN code.

Automated user

If the generation of non-interactive narratives within the application domain is required then it must be determined whether an automated user is necessary. This will be the case if the user is the protagonist of the narrative. It is then required that the personality aspects for the automated user be determined. The greatest difficulty is in the identification of these aspects. GADIN will then be able to utilise these aspects — and assign feelings for other characters to the automated user — and generate a non-interactive narrative in which the automated user is the protagonist.

Initial state determination

If the domain creator chooses to specify the initial state of the storyworld then — depending on the size and complexity of the storyworld — this can require a large amount of time to complete. However it is simple to do and follows a clear structure. Each character, location and object which may appear in the narrative must have all of the traits or requirements for the domain individually instantiated.

User created storyworld

If the user is able to create their own storyworld, as discussed in section 4.11, then the domain creator is easily able to specify this possibility. There are a number of possible traits and requirements associated with each character,

object and location. These will not necessarily all be appropriate for the application domain, and in allowing the user to specify their own storyworld the creator should limit the user's options to exclude irrelevant traits and requirements. As this is not complex it can be easily implemented.

The interface

For each new component of the knowledge base all of the output must be predefined (in general form), as discussed in section 4.13. This is the most time-consuming aspect of applying GADIN to a new domain. When more components are able to be reused between domains the effort involved will be reduced. The dinosaur adventure output text was adapted to be more child-friendly, which would be a major change with a larger storyworld. If the narrative is finite then an appropriate presentation of the beginning and ending of the narrative to the user must be defined, although this can be general.

5.5.5   Narrative generation process

The process for narrative generation, as given in section 4.12, must be adapted depending on which of the additional features are incorporated. This has a generalised form, and it is only necessary for the domain creator to remove those components which are not required, such as: checking for storygoal satisfaction in an infinite narrative; or checking for events in a storyworld in which they do not occur.

6

Application interfaces

6.1 Overview

In this chapter the specifics of the interfaces which have been implemented for the current applications of GADIN (chapter 5) are discussed. The general requirements for a GADIN interface are given in section 4.13. Section 6.2 discusses the specifics of the interface used for the soap version of GADIN and section 6.3 details the interface for the dinosaur adventure version, which uses pictures in addition to text. This includes a discussion of state seen by the user (section 6.2.1) and the method by which the user selects actions (section 6.2.2). The main issues which it was necessary to address in creating the online version of GADIN are discussed in section 6.2.5.

6.2 The soap world interface

In creating the interface for the soap domain application of GADIN iterative design, with continual user tests, was used. This meant that feedback from users regarding the interface was obtained and the design of the interface was determined by this. The evolution of the interface for the soap version of GADIN, and the final design decisions, are discussed in this section. The interface was originally purely text-based with a single output window, and later — since users found this difficult to use and to have a significant negative impact on their experience — both Windows Forms and Web Forms were utilised. Users found this easier to follow as it enables more information to be provided simultaneously. In the final evaluation users were able to use either of the Form-based interfaces, in which the major design decisions were the same. These interfaces can be seen in figures 6.3 (the Windows Forms interface) and 6.4 (the Web Forms interface).

To reduce the reliance on users sending their results (which many neglected to do) the system was designed to automatically email these using a specifi-

```
tess is at the club
tess likes:  fred
tess fancies:
tess holds the principle of not stealing
tess holds the principle of not drugging

fred is at the house
fred likes:  tess
fred fancies:  tess
fred does not hold the principle of not stealing
fred holds the principle of not drugging

fred committed the crime of steal
tess is pregnant with fred's baby
```

Figure 6.1: The state of a storyworld in the soap version of GADIN, which involves two characters, as output in the purely text-based version of the interface.

cally created account. The online implementation was created as early testing showed that some potential users were unwilling to download the executable. The requirement to install the .NET framework and the associated platform dependency had isolated further potential users. The online version uses ASP.NET in combination with the existing C# code, and the issues involved are discussed further in section 6.2.5.

6.2.1 State presentation

Throughout the narrative the user must be able to see the current state of the storyworld. In the early versions, with only one output window, it was necessary for the user to request this information. This was given as a list of characters and their location, feelings and principles followed by other information about the storyworld. Figure 6.1 shows the storyworld state for two characters in this form. The necessity to continually request information made it difficult for the users to remember what was happening and often resulted in confusion and a lack of clarity.

With a Forms-based interface it is possible for the current state to always be visible to the user. To further increase clarity the basic method of presenting the state was adapted so that the state was shown by location, with each character being shown (with their basic information) in the relevant location and the additional information positioned in a separate area of the screen. The amount of information provided was still felt by some users to be confusing as they were uncertain of what was relevant and found it difficult to process the volume of detail provided. The interface was thus further adapted to always provide simple state information and to give additional information when the user requested this, through use of buttons. To achieve this the characters' names are shown in their correct current location, and the user then has a number of options to obtain further information about those characters. These possibilities are:

- **About characters**, which shows the attributes and characteristics of the characters.

- **Feelings**, which shows which characters each likes and fancies.

- **Principles**, which shows the principles currently held (or not) by each character.

- **Relationships**, which shows the relationships (partnerships, engagements, marriages and public affairs) of each character, and disapprovals of these.

- **Crimes**, which shows crimes committed by each character, who has been accused of the crime, and whether or not the crime has been punished.

- **Flirtings**, which shows which other characters each character is flirting with.

- **Pregnancies**, which shows which characters are pregnant.

- **Drunkenness**, which shows which characters are currently drunk.

After each selection by the user only the information they requested will be shown. This is associated with each character in the area of the screen representing their current location within the storyworld.

6.2.2   User involvement

Section 4.13.3 discusses the general method by which the user selects actions in GADIN. The purely text-based version requires the user to select these options by typing them. For example to move between their current location and the club the user would enter `move club`. The user is required to enter between 1 and 5 words, the combination of which represent their required action. A range of possibilities are recognised for each action. As this method implies a higher level of user freedom, suggesting that anything is possible, it was initially also implemented in the Forms version. Due to the lack of natural language processing ability, and the large number of unrecognised possibilities, users found this difficult to use. There was also a steep learning curve for the available possibilities and the unusual (for most users) method of communicating them.

Action menu options were later implemented. These enable users to select each component of their action from a drop-down menu. The menus adapt to represent the possibilities depending on the user's choice in the previous menu. For example if the user selected `move` from the first menu the second menu would show all possible locations. There are certain logical limitations in these menus, such as the user's current location not appearing. However if only the possible actions appeared the user might feel that they were being restricted by the system — since the reasons for their inability to perform certain actions might not be clear to them. The user is able to select these options but the system will then communicate this reasoning to them, as discussed in section 4.13.3. To add further clarity additional words are added so that the user's action selection becomes a full sentence, for example if the user selects `move` in the first menu the words `to the` will appear before the second menu. Users felt the action menu options to be much clearer than typing actions.

An alternative method, using buttons, was also implemented. This first requires the user to select the type of action from a number of categories. These categories are quickly and easily explored should the user wish to identify their

Figure 6.2: The user selecting an action using the action button options method. This user has chosen a crime-based action and wants to encourage `tess` to betray a principle. As soon as a principle from the final set of buttons (to the far right) has been selected this action will be executed.

options. They also limit the number of action options presented to the user at one time. The categories of action available in the soap version of the GADIN system are:

- Feelings-based actions

- Relationship-based actions

- Actions involving others' relationships

- Principle-based actions

- Crime-based actions

- Movement-based actions

- Socialising actions

Once the user selects an action category the possibilities within that category will appear as a second set of buttons. Subsequently selected buttons will lead to new buttons appearing, representing the next component of the action. To make the action clear the buttons will contain more than just a word wherever it is relevant. For example if the user selects a movement-based action, and then the option to `move`, a set of buttons with every possible location preceded by `to the` will appear. Each button selected by the user will be highlighted and either cause another set of buttons to appear or the action to be executed. The user is able to change their selection at any time and the buttons representing subsequent stages of the action will be changed (or removed) accordingly. The same logical limitations as in the action menu options are imposed on the action button options presented to the user. An example of the user selecting an action using buttons is shown in figure 6.2.

In the evaluation discussed in section 7.4 both action options methods were used. The action button options method was used in the later Windows Forms testing versions, and the earlier and online versions used the action menu options method. The user observation discussed in section 7.5 used the action button options method.

When the user is required to make a decision — either on a dilemma, following a coercion or under other circumstances (sections 4.13.5, 4.13.6 and 4.13.7 discuss the general presentation of user options) they are presented with buttons representing their possible options. When using the Windows Forms interface a pop-up option box shows one button for each user option. In the Web Forms interface the option buttons are integrated into the interface and are shown in the same area as the user action menus (which will have been temporarily disabled as the user will not be able to act until they have selected an option). The user makes their choice by selecting the appropriate button and the implications will be implemented within the narrative and the storyworld.

When the user is not able to act, the action options are replaced by a `Please wait a moment` request. Whenever the user is able to act the options are visible again. Once the user has selected an action (or returned control to the system) all of their selected options are reset.

A control-based method is used throughout, as discussed in section 3.7.3. With the purely text-based interface it was necessary for the user to signify that they had finished selecting actions — by entering `n` as their action option. With the Forms interface it was initially decided to utilise a more complex set of options, which enabled the user to: `Perform this action and select another`; `Perform this action and then let other characters act`; or `Let other characters act`. This more clearly communicates to the user the need to return control to the system. However, it was felt by users to be overly complicated and thus they were reduced — in the action menu options version to `Perform this action` and `Let other characters act`. When using action button options the action is executed as soon as the user selects the final button. Following execution of a user action they are able to act again, until they select the button to `Let other characters act`.

Once users have finished their experience, in both Forms versions, they must signify this by selecting the button to `Finish this experience and answer questionnaire`. This terminates all of the running threads and also presents the user with the questionnaire — which they can choose whether to complete. If the user finishes their experience in another way they are not considered (in this discussion) to have 'properly' finished their experience. The user is able to select this option at any stage in the narrative.

6.2.3 Help feature

Some users were initially unsure of the possibilities available to them and which buttons were and were not going to be essential or useful. It was thus decided to implement a help feature to enable these users to more easily understand the interface and thus increase their ability to interact with the system. This feature can be easily enabled and disabled by selecting the `help` button which is centrally located at the top of the screen. Once help has been enabled each button or area of the interface is able to communicate its role to the user. When the user hovers the mouse over any component on which they would like further information that information is shown. Enabling help means that the user is informed of this potential and requirement.

6.2.4 Interface layout

There are a number of elements of the interface which it is essential to include, as discussed in section 4.13.8. The first of these is an area in which the user can select their options. This contains either action menu or button options, and where relevant an execute action button. It also includes the button allowing the user to return control to the system. To ensure that the user is aware of their options and role in the narrative this is situated to the top left of the screen. The narrative output requires enough space for all of the recent narrative to be immediately seen by the user. The narrative is output into the right hand half of the interface. New output appears at the bottom of this area, as most users will be more familiar with reading from top to bottom. The user's actions and decisions are also output into this area, as they are a major component of the narrative. The final area of the screen shows the current state of the storyworld — which is considered essential for the soap domain. This is below the user's action buttons or menus, enabling it to be clearly seen by the user when required without detracting from the other elements of the interface. The button which enables the user to leave their experience (and to answer the questionnaire) is situated just above the current state area.

The final main interface used in the executable (Windows Forms) version is shown in figure 6.3 (a and b). The final main interface used for the online testing version is shown in figure 6.4.

The incorporation of pictures to make the characters and locations more plausible to the user was investigated. It was found that users mainly ignored the pictures or found them confusing. If the users are familiar with the storyworld then they will not need pictures. If they are not then the pictures selected may be contradictory to their imagination.

6.2.5 Web implementation issues

In creating the online version of GADIN it was necessary to adapt the code so that the state of the application resided in the session variables. In addition, there were CPU usage problems. When GADIN runs it uses between 50% and 100% of the total CPU at all times. This meant that when a remote web hosting company was used the session was ended on a regular basis — whenever the CPU usage exceeded 75%. A solution to this involved saving the session state and retrieving it whenever it was ended. However there was a long-term high usage prevention issue which could not be overcome, and which completely terminated such experiences after less than 10 minutes.

A dedicated machine was thus used to host the online version of GADIN. Since this was a desktop computer rather than a high-speed server the CPU issues mean that when there are more users there is an inevitable negative impact on the performance. The number of users able to use the system at one time was explicitly limited to 2. When initially posting on forums this unfortunately meant that many potential users were faced with the 'too busy' screen and never returned, but those users who were able to access it had a usable experience.

Another problem was that users would not finish their experience properly (using the appropriate button) when leaving but would just stop acting (presumably closing the browser window). This meant that the planning threads

GADIN

Please wait a moment...

Help

UserChoice

Yes   No

Leave this GADIN experience

The current state is:

About characters | Feelings | Principles | Relationships
Crimes | Flirtings | Pregnancies | Drunkenness

shop

house

club

tess likes:
tess fancies: edna, mary, fred, you,

edna likes: mary, fred,
edna fancies: tess, mary, fred,

fred likes: tess, edna,
fred fancies: tess, edna, mary, you,

you like: fred,
you fancy: tess, mary, fred,

shed

mary likes: tess, edna, fred, you,
mary fancies: tess, edna, fred,

jail

park

tess asks you out.
You fancy tess and she also fancies you.However, your friend fred also fancies her.
Would you like to go out with tess despite the potential expense of your friendship with fred?
You have chosen to go out with tess, You and tess are now partners

Action is fred stops liking you

Action is tess moves between park and club

Action is edna moves between jail and club

Action is fred moves between house and club

Action is tess gets drunk

Action is edna gets drunk

Action is fred starts to go out with edna

tess starts to mutually fancy edna

Action is fred moves between club and park

Action is fred starts to fancy you

Action is fred moves between park and shop

Action is fred moves between shop and club

You move between shed and shop

You move between shop and club

You are going out with tess
Would you like to cheat on tess with fred who you fancy and who fancies you?

Figure 6.3 (a) In this figure the user is observing the feelings of the characters in the state while they are being presented with a dilemma.
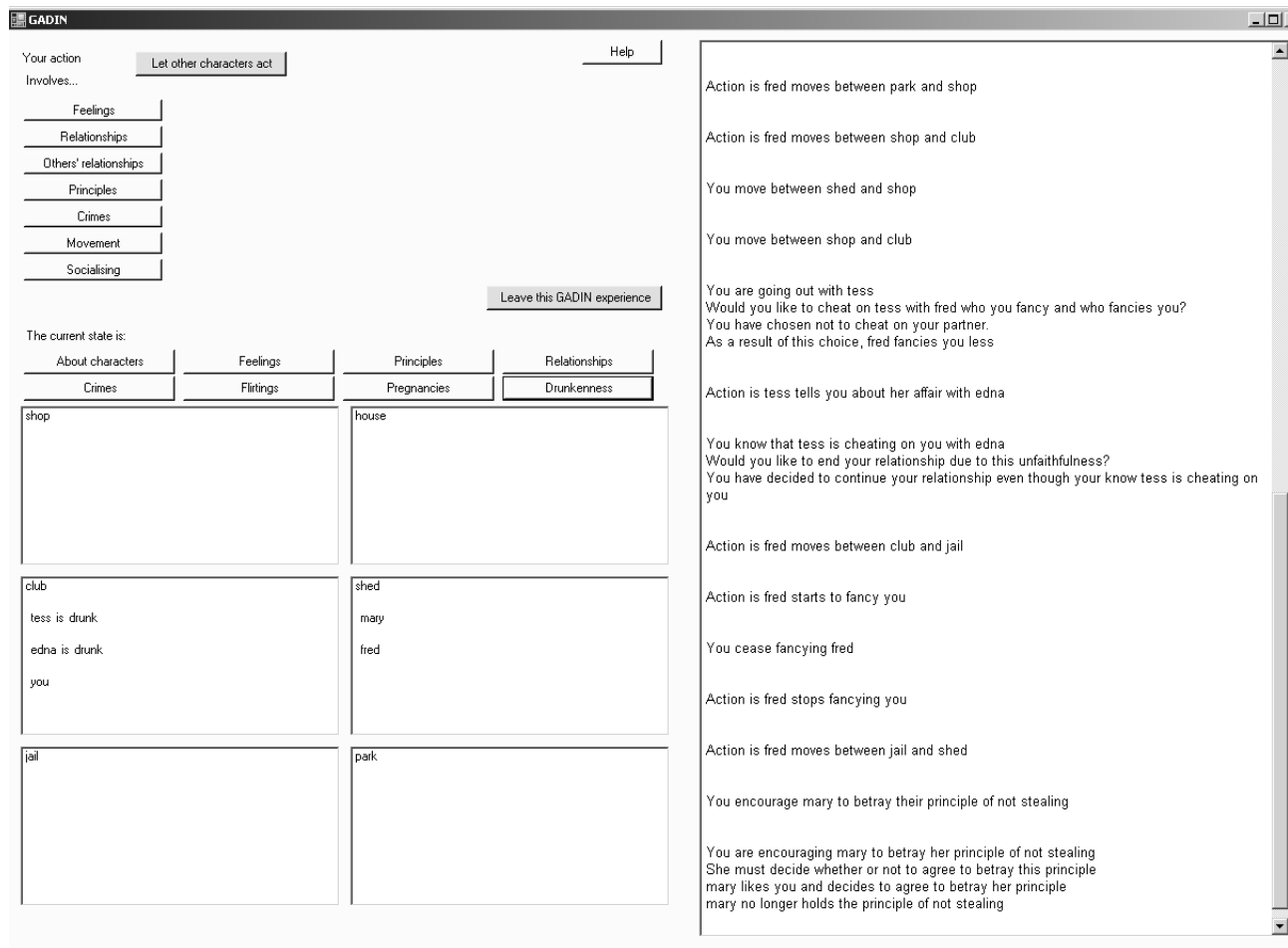
Figure 6.3 (b) In this figure the user is observing which characters are currently drunk, has just caused another character to experience a dilemma and has control within the narrative.

Figure 6.3: These figures (a and b) show the interface for the executable soap version of GADIN.
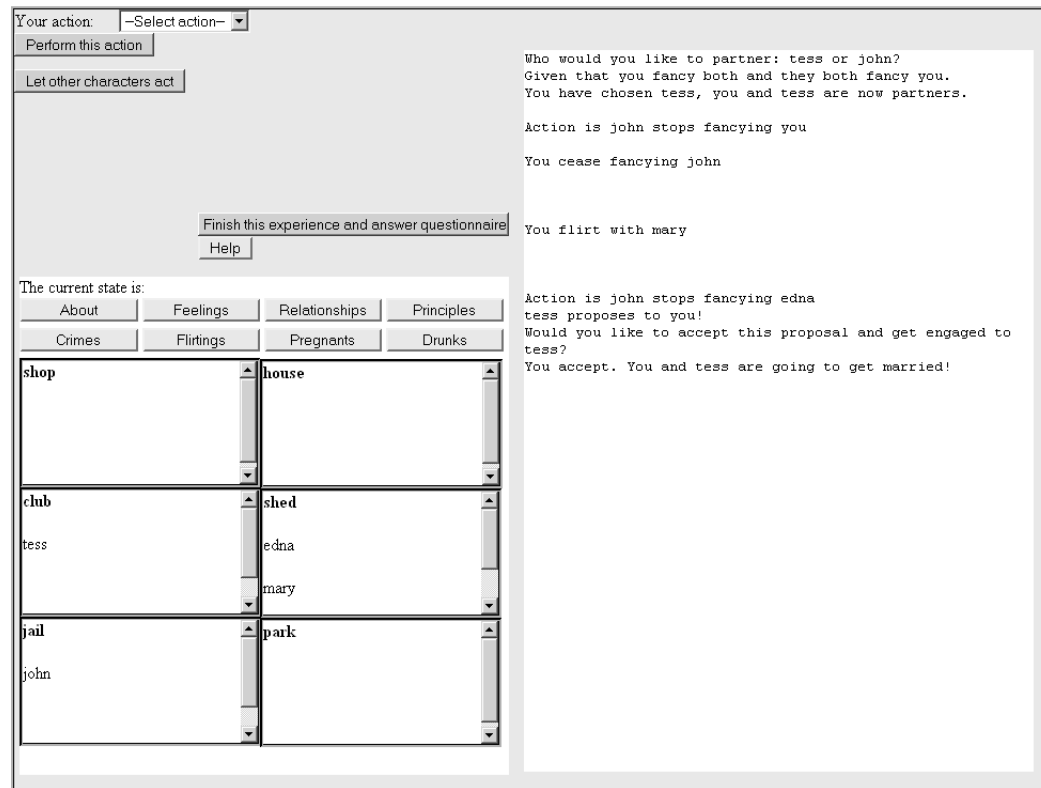
Figure 6.4: The interface for the online version of GADIN. In this figure the user is looking at the standard state and has control within the narrative.

would continue to use the CPU. Thus when the planning threads detect a lack of activity for the last 10 minutes they are suspended. If the user returns to their experience the threads are restarted. Once the threads have been suspended it is possible for other users to start a GADIN experience.

In the online implementation there were initially problems in that when the user acted the system waited until it had a response before reloading the page. This meant that the interface implied that the user could act throughout (although such an action would have no effect) and a progress bar could not be included. A continual refresh was not possible as this would cause problems at other stages of the narrative, for example while waiting for the user to select an action. To overcome this problem a 'waiting page' was added. This was loaded as soon as the user acted and was able to continually refresh (although not too frequently as this causes flashing in some browsers). To pass control back to the user the system returns to the main page and enables the user action selection options. Additional advantages of this are that while the user is waiting for the system to act they are able to: select which state information to see; and leave the experience properly and immediately.

6.3   The dinosaur adventure interface

Windows Forms were used for the dinosaur adventure interface. As the world is simple it is not necessary for the users to be presented with all of the state information. It is required that the user be informed of: which items they currently possess; their current location; and which dinosaurs are at that location. The user should also be able to see the most recently generated part of the narrative. The style of children's storybooks can be emulated to some extent in this, with each action being presented as the only text which is visible to the user, and a large picture of the main acting character appearing above this. The layout can be seen in figure 6.5.

As there is a reasonably large amount of reading required of the user font selection was important. `Comic Sans MS` is the font which is used in the classroom, as it has letters which the children find easier to read (in particular the 'a'). This was thus used for all text, including the option box text. The font size was also made slightly larger so that the children would not strain their eyes. In the evaluation discussed in section 7.7, for which this interface was used, the system was made available for use on an interactive whiteboard. This meant that the users did not have to have good mouse control (which is often an issue with young children).

As shown in figure 6.5 all of the user's potential options were visible at the same time, with the appropriate wording, so that they could select these and clearly see their available options. This is easier to use than drop-down menus, especially for children — and is possible since there are not a large number of actions available. The action menus are created in the same way as for the soap domain application, as discussed in section 6.2.2. After selecting an action (or if they chose not to select an action) users select the `Go` button. This is clearly marked and easily understandable.
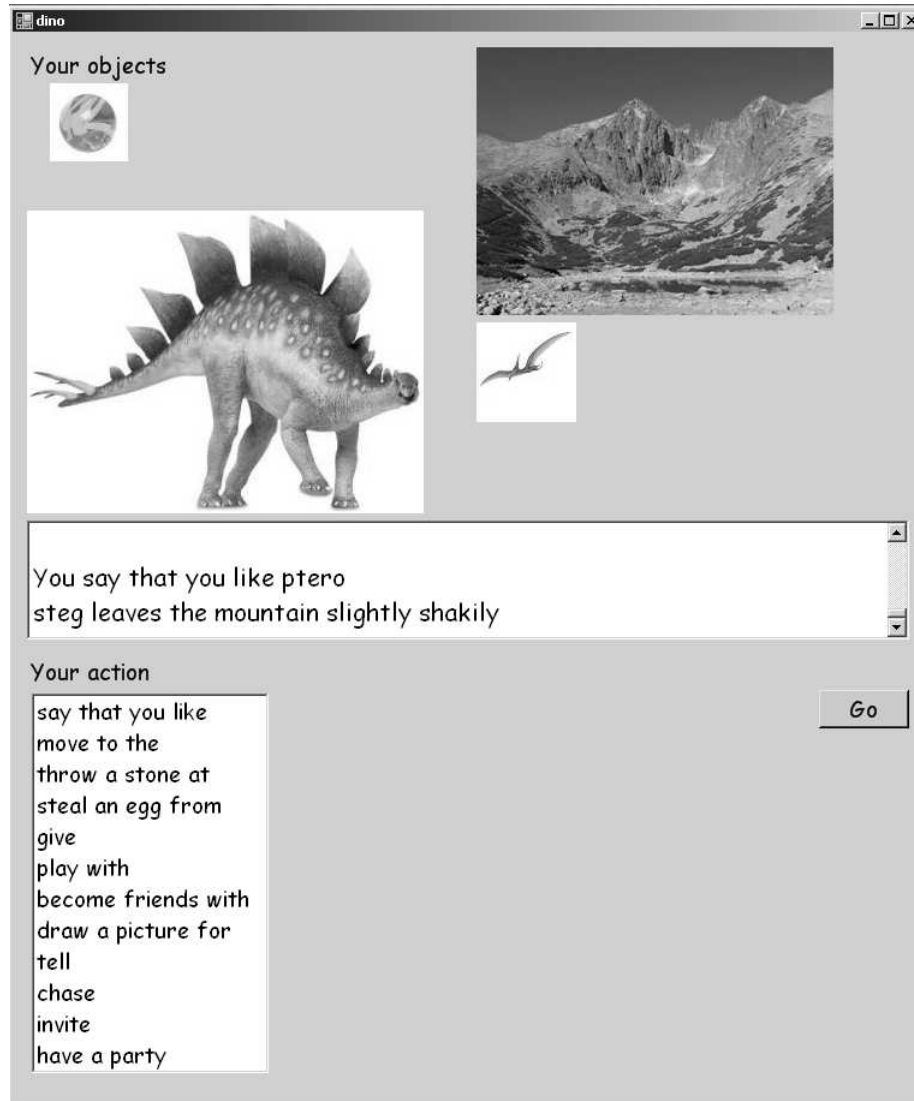
Figure 6.5: The interface for the dinosaur adventure version of GADIN. The main picture changes to represent the subject of each action, or the other involved character in a user-selected action. The location picture shows the user's current location, and below this are all dinosaurs currently at that location. There are further action option menus which will appear as and when they become relevant.

7

Evaluation

7.1 Overview

Due to the complexities involved in evaluating an interactive narrative system with many aspects, such as GADIN, a number of different, but complementary, evaluation methods have been used. These are discussed in this chapter.

To evaluate the quality of the narratives generated by the GADIN system a Turing-style test was used to compare two non-interactive soap narratives, as discussed in section 7.2. Since it is likely that the interface inhibits the user's experience an experiment involving human actors and a physical space was carried out to evaluate the user's experience without a computer and with the actions taking place at a lower level of abstraction. This experiment is discussed in section 7.3.

The soap world application of GADIN was then evaluated on a larger scale (section 7.4), using the interface discussed in section 6.2. This evaluation was completed by 47 users in two groups, in one of which there were no dilemmas experienced. To ensure that the narratives are sufficiently original the Levenshtein distances [68] between the narratives with dilemmas was calculated, as discussed in section 7.4.4. To supplement this evaluation, and to discover further information about the users' experiences with GADIN, 3 users were observed interacting with the system, while answering questions (section 7.5). Some of these experiences, in addition to longer narratives with 3 users, were used to evaluate the accuracy of the user model — as discussed in section 7.6.

The evaluation of the dinosaur adventure application, which ensures that GADIN succeeds in more than one domain, is discussed in section 7.7. The GADIN system has been independently evaluated and this evaluation is summarised in section 7.8.

7.2   Story quality

The Turing Test was originally designed by Alan Turing [115]. It is commonly interpreted, in particular by the Loebner prize [71], as requiring a human to be unable to tell whether they are conversing with a human or a computer. The Turing Test can be adapted to domains other than conversation, for example narrative. In the version of the Turing Test used here two narratives are given to a human reader, one written by a human, the other by a computer. The reader must then decide which they think was written by a computer.

The purpose of this evaluation was to determine the quality of the generated narratives without the additional component of user interaction. This experiment thus compared a narrative generated by GADIN with a narrative which occurred in a soap, this was written in the same form as a GADIN narrative to ensure that the comparison was of this basic framework of the story.

To ensure a fair comparison both narratives began with the same storyworld state. Thus the GADIN system was given an initial storyworld equivalent to that at the start of the selected television soap storyline. The characters were limited to only those included in the selected story, but the actions and dilemmas included all of those available to the GADIN system which are appropriate to the soap domain (as detailed in sections 5.3.2 and 5.3.3).

It was important to ensure that subjects who were familiar with the television soap narrative selected did not answer the survey. The names were changed to be the same in both narratives, to anonymous names. This meant that any bias due to familiarity with the soap, even if not the evaluated narrative, would be removed. A narrative which had taken place a year previously to the evaluative comparison was selected to further reduce the chance of familiarity due to casual observation.

To make the narratives more readable they were adapted slightly. For example, the actions of a character moving between locations were removed in both versions — this is relevant in the experience but not in the subsequent telling. For the television soap it was necessary to transcribe the events in the form output by GADIN. Using this style of writing is an obvious limitation of the narrative quality, but in this evaluation only the core components of the narrative and its structure are required to be compared and thus this is sufficient. In both versions it was essential not to impose any reasoning on the characters in the wording. In the summary of the television narrative the characters' actions when not part of the main storyline are excluded. This is not important to this particular narrative and is thus not relevant for the purposes of this comparison of a single narrative involving one set of characters.

The human-authored narrative used in this experiment has been taken from a television soap opera. This was chosen as randomly as possible, although there were certain restrictions due to limitations of the system. The two restrictions were: there could be no familial relationships in the selected narrative as these have not yet been implemented in GADIN; and there should be a strictly bounded subset of characters in the chosen narrative. Given the applicability of the GADIN system to any soap of this type these were the only restrictions in selecting the narrative for comparison.

The GADIN-authored narrative used in this experiment was not selected but was the first one to be generated from the given storyworld state. The only restriction imposed was that it was the same length as the television soap

narrative. Although the GADIN system (like the television soap) would continue infinitely from this point the later narrative content was not relevant for purposes of this comparison.

The question asked of the participants, which includes the two story transcriptions, is shown here:

If you recognise one of these stories, or think you might, from a soap then please do not continue as you will bias our results. One of the following two stories is from a real soap opera and the other was generated by a computer.

Please read the two stories, and decide which you think was written by a computer.

STORY 1: Jane and Tom are in a relationship. Jane becomes pregnant. She decides not to keep the baby. Tom proposes but Jane rejects him, ending the relationship. Nick and Sally go to the shop. Nick flirts with Tom. Sally flirts with Tom. Tom must choose whether to partner Sally or Nick. He decides to go out with Sally. Nick no longer fancies Tom. Nick starts to go out with Rich. Sally wants to start an affair with Rich but he chooses not to. Tom expresses his disapproval of Rich's relationship with Nick, but Rich decides to continue the relationship anyway. Jane and Sally stop liking one another. Tom starts an affair with Jane.

STORY 2: Tom and Jane are in a relationship. Rich and Sally flirt with each other, and start going out. Rich wants to start an affair with Tom but he chooses not to. Rich splits up with Sally. Tom stops liking Rich. Rich and Sally start going out with each other again. Rich ends the relationship with Sally. Rich starts a relationship with Nick. Tom expresses his disapproval of this relationship but Rich ignores him. Rich and Tom start having an affair. Tom proposes to Jane and she accepts. Rich tells Jane about his affair with Tom. Jane ends her relationship with Tom. Tom and Rich start a relationship.

Which story do you think was written by a computer? [1]

The survey was divided into two groups of participants. One consisted of those who regularly view soaps (although not the soap in question). These participants were targeted through posts on 4 British soap forums [31, 32, 33, 34]. Given the focus on British soaps throughout it was important that these forums were used only by an British audience, as the style and content of soaps does vary to some extent between nationalities. The second group contained those who regularly play computer games and are thus more familiar with computer-based stories. For this the survey was posted on 2 British games forums and 1 international [28, 29, 30]. To ensure that those familiar with the television narrative did not answer the survey it was additionally requested in the forums that anyone who felt that either story was known to them did not continue.

The results were as follows:

Participant type	Number	Correctly identified stories (%)
Soap viewer	42	24 (57.1)
Game player	85	49 (57.6)
Total	127	73 (57.5)

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[1]Story 1 was written by the GADIN system. Story 2 is from Hollyoaks, with the original characters changing names with the following mappings: Craig Dean → Tom ; Sarah Barnes → Jane ; John-Paul McQueen → Rich ; Hannah Ashworth → Sally ; Spike → Nick

Under the null hypothesis, participants are guessing randomly which story is computer generated. However, with a one-tailed alternative hypothesis that they are more likely to discern that story 1 is computer generated, then from a Binomial test, this sample is significantly different from random guessing ($z = 0.055$, $p < 0.05$). With a two-tailed test, there is no significant difference ($p = 0.110$) suggesting that whilst there is an effect, it is a quite small one — which is probably due to the ordering bias in the narratives (due to the speed of the responses it was not possible to vary this ordering within the evaluation).

These results imply that the GADIN system is capable of generating a narrative which is not discernibly different from an outline of a story occurring in a television soap opera.

7.3   Real life evaluation

An experiment to investigate the potential for the GADIN system with an idealised interface was carried out. In this the characters were played by human actors. The actors were directed by the computer system and they improvised the visualisation of these and their other interactions with one another. The user, also a human, was able to act as freely as they would in the 'real' world. This experiment aims to evaluate the quality of the user's experience of GADIN without the interface restricting this by providing (as much as is possible) an idealised interface in which they have true freedom to act and the other characters are also humans who act accordingly, while still experiencing the dramatic interest provided by GADIN.

Each action output by GADIN was verbally communicated to the appropriate actor. They were then able to improvise to represent this action within the dramatic realisation of the narrative. For example, if the action was `emma flirts with fred`, Emma would be instructed to flirt with Fred and was able to impose her own interpretation on the details of this. This meant that the participants knew what was about to happen, but this did not appear to detract from their experience. Dilemmas were presented by requiring all characters to pause and then explicitly posing the dilemma to the user — who then had to make their decision before the drama continued. It was important for the dilemmas to be explicit as they are a key component of the system and it was crucial to make these as clear as possible to the user.

Each user was involved in the experience for approximately 10 minutes, and was presented with between 3 and 4 dilemmas in that time. They were instructed to simply "be yourself" and were able to act in any way they chose. Their actions were interpreted by a human for use within the computer system. This was a shortcoming of the experiment as it is reliant on an accurate interpretation by the human — but the simplicity of the actions in the GADIN system meant that this was always clear.

The experiment was carried out in the University of York Drama Barn[2], a room with tiered viewing and a central stage area. The stage area was fully lit up and furnished to resemble a pub, which the users were explicitly informed to be the nature of their location. For simplicity only one location was used in the experiment. There were a number of areas within this location and the characters were able to move between these, as well as going off-stage.

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[2]In association with the University of York Drama Society.

Depending on the directions given by GADIN, the actors were not always in the pub initially — but might be offstage. This increased the variation between the narratives.

The system was set up to generate a soap-style narrative. Due to the single location and short time period a restricted number of dilemmas were possible. This meant that there was repetition between experiences. The repetition was disadvantageous as all but the first participant were previously members of the audience and thus familiar with the narratives and dilemmas of others' experiences. The inherent limitations of a single venue and continuous time prevented complications such as pregnancies, meaning that a restriction on experience time was imposed. The advantage of this was that a larger number of users could participate within the total time available for the experiment (1.5 hours).

The presence of an audience did prevent some users from acting completely freely. Those users with more experience of acting were more comfortable with the experience and enjoyed it more. As the actors' presence alone would restrict the user this must be considered to be a necessary limitation of this approximation of an idealised interface.

The actors were assigned alternating roles depending on the participant and their personal preferences. For example with a female participant the actors would play the parts of two males and one female, with the option (decided non-deterministically by GADIN) for one of the males to be middle aged. The characters had fixed initial feelings for one another, which limited the variety of the dilemmas produced. Their feelings for the user were initially non-existent, and the user began the experience assumed to like all of the actors. These are not necessarily representative but were selected to provide the most plausible and dramatic experience for the user given the limitations of the environment.

After participating the users were asked to complete a short questionnaire. A questionnaire was also given to the audience members who did not participate and to the actors. The questionnaire used is found in appendix D.1 — with an additional open question asking whether the subject would "try the experience on a computer-based system". The audience and actors were asked not to answer questions which were irrelevant to their experience. The results obtained from this questionnaire are given in full in appendix E.1 and summarised here.

The users

There were 8 participants in this experiment. They found the story interesting (a mean score of 3/5), and the experience very enjoyable (4/5). They did not particularly believe in the storyworld (2/5), but did care about the other characters (3/5). Major decisions were not particularly hard to make, with an mean rating of just over 2 out of 5 (this is probably due to the short length of the experience and the consequent lack of time to build up relationships with others). However they strongly felt that their actions were having an effect (4/5). 7 of the 8 participants said that they would like to repeat the experience and all but two would try it on a computerised system, depending on ease of use.

The same questionnaire was completed by different users of a similar version of the system with a purely text-based interface. The results of this are in appendix E.2. The real-life experiment participants found their experience slightly more interesting, and much more enjoyable (the mean ratings from the comput-

erised interface users were 2/5 and 3/5 respectively). The computer users felt that major decisions were slightly harder to make (3/5). The participants in both experiments rated their belief in other characters and their level of caring for these characters similarly. The participants in the real life evaluation rated the belief in the effect of their actions more highly (for the computerised interface the mean was 3/5). However when considering only the text-based interface users who are familiar with computer games these ratings become much closer. This suggests that a familiar interface is crucial to this aspect, perhaps because users need to be aware of what is possible before they will feel it is having an effect.

The actors

The actors said that they really enjoyed the experience (rating this with a mean of nearly 5 out of 5) but felt that each experience should have been longer. They perhaps overacted at times — performing for the audience rather than as if in a soap opera — which affected the experiences of the participants. Improvisation to carry out high-level GADIN actions was a successful technique and made the narrative much more understandable for the users.

The audience

Only 4 audience members completed surveys. It was the audience who found the narratives the most interesting (rating this with a mean of 3.5 out of 5). It is possible that first person involvement results in the user not realising the full dramatic interest of the stories, and that only afterwards and with hindsight will they appreciate this.

That the audience also enjoyed the experience despite this not being an aim of the system suggests that these techniques have potential not only in entertaining a user but also perhaps in the users allowing others to observe their interaction or the subsequently generated narratives.

7.4   Interactive soap evaluation

Section 5.3 introduced the soap version of the GADIN system. In this section an evaluation involving 47 users is discussed. The interface design used in this evaluation is detailed in section 6.2. The questionnaire and other design decisions made for the final evaluation of GADIN are discussed in sections 7.4.1 and 7.4.2, followed by an analysis of the results obtained. Section 7.4.4 discusses an evaluation to ensure that the narratives are different.

This experiment evaluates the users' experience with the soap version of GADIN in accordance with the compellingness criteria. The reason for some users being involved in an experience without dilemmas was to determine the effect of dilemmas on the dramatic interest of the experience. In addition this experiment evaluated: the immersion felt by the users; their beliefs in their freedom to act and the effects of these actions — both immediately and in the long-term of the narrative; and determined how likely they would be to re-play, as well as whether they had already done so and how different they felt the narrative to be in this subsequent experience.

7.4.1 Questionnaire

The questions included in the questionnaire were selected to enable evaluation of the system in accordance with the compellingness criteria. The wording was carefully considered to ensure that there was no ambiguity, and that they were not overly formal — while avoiding colloquialisms. This reduces the likelihood of alienating subjects. At both ends of the scales for each question a word describing what was meant by that end of the scale was given, these are known as anchors for the scale and reduce the variance in interpretation of the scales. For example the question "How interesting would you say the narrative was?" has a scale which begins at "dull" and ends at "fascinating". This further clarifies the question for the user. The questionnaire used is given in appendix D.2.

A 7-point scale has been used, as in the semantic-differential technique, as this enables the user to express their opinion while leaving a mid-point so that they can choose to be neutral. In designing the questionnaire [85] provided invaluable advice. This led to none of the scales using "never" or "always" — as these are too rigid as descriptors — but instead "rarely" and "frequently".

It was important in the evaluation that the user's opinion of the interface, and the many limitations and problems with that, did not affect their answers to the questions and their evaluation of the fundamental aspects and the core benefits of the system. It was thus decided to ask separate interface questions. This would mean that either: the user would see these questions as separate; or there would be the potential to draw conclusions comparing the user's opinion of the interface to their answers to other questions.

The questionnaire is optional. Once the user chooses to finish their experience they are asked if they will complete the questionnaire. If they choose to do so then it is presented to them, as given in appendix D.2, with radio buttons to enable the user to select the most relevant options for each question.

7.4.2 Experiment design

There were a number of problems in obtaining results. The initial download prevented some users from starting an experience, and even once the system was online some users started and then immediately ended their experience. Other users did not answer the questionnaire, even after a long experience. To address these issues a progress bar was incorporated and users were offered an incentive (a prize) for experiencing the system for more than 5 minutes and subsequently answering the questionnaire.

A number of different strategies were used to target potential users, namely:

- Posting on games forums;

- Posting on soap fan forums;

- Posting on competition forums;

- Emailing subscribers to known mailing lists;

- A facebook [19] group.

Searching for users using only the internet was decided to be appropriate as the selected demographic are those who are familiar with computers and likely

to use the internet. Early tests showed that those unfamiliar with computers found the system hard to understand and were reluctant to explore (appendix E.2).

The users were able to become a character in an imaginary new soap, *Eastenders*, *Hollyoaks*, *Coronation Street* or *The Archers*. The specific storyworld settings used in each of these options, which included a set of characters and locations from each of the available soaps, are given appendix A.2. It was also possible for users to create their own initial storyworld settings. The user was always able to specify their own initial feelings for other characters.

Two testing versions were used. The majority of the users experienced the standard soap version of GADIN. The other version did not incorporate dilemmas but instead relied on responses to the user and random character actions. This allows observation of the effect of dilemmas on the user's experience. It was decided to have different users for each version rather than giving both to a single user. The main reason for this was that it was easier to ask people to experience the system once than many times, and this method is easier to implement with an online evaluation. Additionally this removes the issue of bias due to familiarity with the system.

7.4.3   Results

There were a total of 47 users of the final soap version of the GADIN system. Of these 12 experienced a version in which there were no dilemmas, and thus no planning, but still utility-based responses and random character actions. The full and averaged results from these experiences are given in appendix E.3 and are discussed in this section. In this discussion users are considered to be 'regular' viewers of soaps or players of games if they stated that they do so more than once a fortnight. All of the averages are given as means with associated standard error.

Users were asked to spend at least 5 minutes experiencing the narrative before they would be eligible for the offered prize. On average users of the version with dilemmas played for 19±2 minutes, significantly longer than they were asked to play for. Since experiences which were shorter than 5 minutes, or in which the questionnaire was not completed, were disregarded there is bias in these results. Users of the experience without dilemmas played for a shorter time, on average 14±1.5 minutes, again excluding shorter experiences and those with an incomplete questionnaire. Those users of the version with dilemmas who regularly both watch soaps and play computer games played for significantly longer than any other group, over 25±5 minutes on average. This is approximately the length of the utilised soap opera episodes.

In the questionnaire only three of the criteria scored below 4 out of 7 on average, as discussed in this section. This is very positive given that this was achieved despite the limitations on the system — in the number of actions and dilemmas available. For some of the criteria these ratings were higher for particular groups of users, as discussed. This discussion is divided according to the questions presented to the users. This is accompanied by a summary of the mean ratings given in answer to each of the questions, each with associated standard error, in the order:

- All users of the experience with dilemmas (*all*);

- Users of the experience with dilemmas who regularly play games (*games*);

- Users of the experience with dilemmas who regularly watch soaps (*soaps*);

- Users of the experience with dilemmas who regularly both play games and watch soaps (*both*);

- Users of the experience without dilemmas (*without*).

Were your options always clear to you?

all	games	soaps	both	without
4.1 ± 0.2	4.4 ± 0.3	4.0 ± 0.3	4.4 ± 0.5	4.0 ± 0.5

Was what was happening in the storyworld always clear to you?

4.2 ± 0.3	4.5 ± 0.4	4.3 ± 0.4	4.5 ± 0.5	4.3 ± 0.5

Users felt that their options and the happenings in the storyworld were generally clear. This is similar for all categories of user. The remainder of the criteria can thus be discussed with the knowledge that the users were evaluating an experience which was reasonably clear for them.

How interesting would you say the story was?

all	games	soaps	both	without
3.5 ± 0.3	3.8 ± 0.4	3.8 ± 0.4	4.5 ± 0.7	3.3 ± 0.4

How dramatic would you say the story was?

3.5 ± 0.2	3.8 ± 0.3	3.7 ± 0.3	3.8 ± 0.4	3.1 ± 0.4

The mean ratings for how interesting and dramatic the experience was were below average. However for regular soap viewers and regular game players these were slightly higher. Those who both regularly watch soaps and regularly play computer games (the expected audience of such an experience) considered the interestingness of the narrative to be higher still. In the version in which the users did not experience any dilemmas the interestingness of the experience was rated lower, with a similarly lower rating for how dramatic they felt their experience was.

How immersed were you in the experience?

all	games	soaps	both	without
3.0 ± 0.2	3.3 ± 0.3	3.0 ± 0.3	3.0 ± 0.7	3.3 ± 0.3

Users generally experienced a below average level of immersion. This mean was the same for all categories of user. Many users made comments implying that the interface had a negative effect on this. For example one user commented that they did not become immersed as "the interface meant that I was quite aware that I was conducting an experiment". Without dilemmas a similar level of immersion was achieved.

Did you feel that the storyworld was plausible?

all	games	soaps	both	without
4.3 ± 0.3	4.4 ± 0.4	4.1 ± 0.4	4.5 ± 0.4	4.1 ± 0.5

Did you feel that the other characters were plausible?

4.1 ± 0.3	4.3 ± 0.4	3.9 ± 0.3	4.3 ± 0.5	4.2 ± 0.4

The plausibility of the storyworld was rated around average, as was the plausibility of the characters. The plausibility of both the storyworld and the characters were rated similarly by users of the experience without dilemmas.

In domains where there are likely to be many complicating factors [14] considers a correlation coefficient of: 0.1 to be a 'small' effect size; 0.3 to be a 'medium' effect size; and 0.5 a 'large' effect size. There was a large effect size for the correlation between the ratings for plausibility of the characters and that of the storyworld (a Pearson correlation coefficient of 0.45). These values also correlated (as expected) with the ratings for immersion, with a medium effect size (0.3 and 0.25 respectively).

Were you able to act whenever you wanted to in the story?

all	*games*	*soaps*	*both*	*without*
5.1 ± 0.3	5.3 ± 0.3	5.1 ± 0.4	4.8 ± 0.5	4.4 ± 0.5

Were you able to act in the way you would expect to be able to?

3.9 ± 0.2	4.1 ± 0.3	4.2 ± 0.3	4.1 ± 0.5	3.4 ± 0.5

The users felt that they were able to act when they wanted to, which may suggest that the interactive nature of the system has been successful. They also felt that they were able to act as they wanted. These were slightly lower for the version without dilemmas but not significantly, except perhaps to suggest that users felt more need to select actions when there was less narrative structure.

Did you feel that your actions were having as much immediate effect as in the real world?

all	*games*	*soaps*	*both*	*without*
4.2 ± 0.3	5.0 ± 0.3	3.6 ± 0.4	4.3 ± 0.4	3.5 ± 0.4

Did you feel that your actions were having as much long-term effect as in the real world?

3.9 ± 0.3	4.4 ± 0.3	3.1 ± 0.3	3.6 ± 0.5	2.8 ± 0.3

Users found that there was a fairly clear immediate and long-term effect of their actions. Regular game players rated both of these with a higher average. As these users will be more familiar with computer games this suggests that the effects are in accordance with their expectations in that medium.

In the experience without dilemmas users felt that there was less effect of their actions. They rated the immediate effect of their actions slightly lower. The greater difference is in the long-term effect of their actions, without dilemmas users rated this much lower. This may imply that the dilemmas allow the user to see a long-term effect of their actions on the overall narrative.

How hard would you say major decisions were to make?

all	*games*	*soaps*	*both*	*without*
4.7 ± 0.3	4.8 ± 0.4	5.1 ± 0.3	5.1 ± 0.5	4.3 ± 0.4

Users felt that major decisions were fairly hard to make. Since users always took at least 10 seconds to make their decisions on dilemmas (between 10 and 30 seconds) it appears that a reasonable amount of thought was put into such decisions and that these were fairly hard for them to make. Those users who did not experience dilemmas still rated the difficulty of major decisions quite highly. This is probably due to the lack of direct relation between this question and the dilemmas — but users never took as much time to make other decisions.

How likely would you be to play again?

all	*games*	*soaps*	*both*	*without*
4.1 ± 0.3	4.9 ± 0.4	3.9 ± 0.4	5.0 ± 0.6	3.5 ± 0.4

If this was not your first GADIN experience, how different was the narrative this time?

Users generally wanted to repeat their experience, particularly regular computer game players. This was slightly lower in the experience without dilemmas. Most of the users were experiencing the system for the first time. However the 3 who were not all felt that their experience was significantly different from the last (giving this question ratings of 4, 6 and 6 — all out of 7).

Overall how would you rate your experience?

all	*games*	*soaps*	*both*	*without*
3.9 ± 0.2	3.9 ± 0.3	3.7 ± 0.3	4.0 ± 0.5	3.8 ± 0.4

The overall experience rating was the same for both the experience with dilemmas and that without. The mean of these ratings is the same as that for all of the other scores, implying that these criteria accurately reflect the user's opinion of their overall experience.

7.4.4   Originality of narratives

A method which is often used (for example in fields as diverse as spell checking and DNA analysis) to determine the difference between two strings is Levenshtein distance [68]. In this the minimum number of insertion, deletion and replacement operators required to obtain the second string from the first is calculated. This sum is the distance between the strings.

To analyse the difference between the narratives generated by GADIN, and thus their originality, the Levenshtein distances between the narratives was calculated. The purpose of this experiment is to demonstrate that the GADIN system generates narratives which are fundamentally different from one another in their narrative content, at a reasonable level of abstraction.

Only those narratives in which dilemmas were utilised are considered here, as this is the standard GADIN experience. To achieve this it was necessary to translate the narrative into a string of symbols. Each symbol represents an action, dilemma, event or coercion — character, location, principle and crime specifics were excluded. The meanings of each of these symbols are given in section E.4.1 and the 35 narratives which were experienced with dilemmas are transcribed using this mapping in section E.4.2. The Levenshtein distance between each pair of narrative strings was then calculated, and the full results of this are in appendix E.4.3.

The distances between each of the pairs of narratives were compared to the maximum possible distance (which is equal to the length of the longer of the compared strings). The least significant of these distances is 60% of the maximum possible. All of the remaining results are between 70% and 100% of the maximum possible distance. The mean of these results is 85±0.2%. This shows that the narrative strings have a significant distance between them. The narratives experienced by the users, in their essential form, are thus very different from one another.

7.5   Soap user observation

To supplement the main evaluation of the soap version of GADIN, and further investigate their experiences, users of the system and their interactions were observed. The purpose of this experiment was to further investigate the users' experiences in accordance with the criteria discussed in section 7.4. The action button options interface discussed in section 6.2.2 was used. Three users, who had various levels of familiarity with the system, were observed. They were asked to use the 'think-aloud protocol' [85] and express their thoughts throughout. They were also asked questions, which prompted responses on: their awareness of the state; their opinions on their actions and responses to these; how difficult they found decisions; and their feelings for other characters. The full transcripts of these experiences are given in appendix E.5 and the main observations are discussed in this section.

Users appeared to find the interface fairly easy to use and used all of the available options. They easily obtained state information of which they were uncertain, for example "now where's the fitty, Tess or Mary ... about characters... right, Mary". Users always knew the main state information when questioned, for example who was in a relationship. These factors suggest a reasonable level of immersion in the experience.

For those users who had some previous familiarity with the involved characters there did not seem to be an opinion that these characters were acting out of accordance with their perceived traits. There was a general feeling that other characters acted 'strangely' at times, although not that this was because the system was causing them to but rather assigning it to the characters themselves. For example "Zoe is terrible, honestly" and "Zoe's a complex being" were comments made (by different users) when Zoe acted in what could have been perceived as an inconsistent fashion. This suggests a personification of these characters. The users also expressed feelings for these characters, for example, of a "girlfriend", "I kind of like Zoe... I wish Zoe would stop fancying Russ."

Reasoning was imposed by the users on the characters. This sometimes demonstrated an understanding of the system-imposed reasoning (for example "she's starting to like me... Probably because I flirted with her"), and otherwise was entirely user-imposed (for example "She's probably stopped liking me because I got her drunk, flirted with her and then left"). This assumed logic in the actions of other characters seemed to demonstrate a belief that these were (at least partially) a result of the user's actions, whether their immediate previous or long-time previous actions.

The users' comments suggested that they did not find the dilemmas particularly difficult decisions, although they always spent some time considering the implications of each choice. For example, "ordinarily I would accuse her of this ... [but] I'm trying to mess up my relationship with Mercedes so I think that I'll keep quiet about it for now...".

There were actions which the users would have liked to take but could not. Their experience would have been enhanced if there were more action options available but the users recognised that it was necessary to limit the options and did not seem to feel that within the scope of the system there was an excessive limitation in this, although one user did feel that the actions are too abstracted (for example "I want to go on a slide").

Although none of the users are at all violent, all said that they would like to select violent actions. For example: "I'd like to ... take out some of my anger on Justin. Beat him up maybe."; "can I start a fight with someone?"; and "I'd want to ... Maybe bash the place up a bit, get in a fight". This suggests that they were taking on a role in the experience which was not how they would act in the 'real' world.

All of the users finished their experiences as a result of external commitments. They played for significantly longer than the twenty minutes that they were asked to commit to prior to beginning the experience.

7.6   User model evaluation

When a dilemma is presented to the user the system predicts their most likely decision. The user model is continually updated which means that the predictions should become more accurate as the story progresses. Each decision and prediction is recorded. The purpose of this experiment was to evaluate whether the user model was accurate, by determining whether it correctly predicted the user's decisions when presented with dilemmas. It is possible to utilise a user model if it is first determined that it is accurate.

To test this users were asked to interact with a system which did not apply the user model. The model was still updated after each user decision. The model would be deemed accurate if it was able to predict the decisions the user made when presented with a dilemma. Initially the model was tested by 3 users, who each experienced between 1 and 3 GADIN narratives. These tests involved narratives consisting of between 8 and 10 dilemmas. The results are given in appendix E.6. When excluding the first 2 dilemmas 84% of the predictions made were correct. These results indicate that the user model is very accurate in the later stages of the narrative, once it has sufficient information about the user.

It is possible to use the output from the user experiences in the evaluation discussed in section 7.4 to further evaluate the accuracy of the user model. Unfortunately most of these experiences were short and thus only a small number of dilemmas were experienced by each user (a mean of 1.6 ± 0.2). Since the user model will not be reliable in the early stages of the experience the first 2 dilemmas are always ignored. With this restriction and the short nature of most user experiences there were only 17 dilemmas available for analysis. Of these 11 involved correct predictions. The 3 dilemmas which were estimated to be more difficult to predict (as discussed in section 4.5), were all among those which were incorrectly predicted. This suggests that the user model is reasonably accurate, although due to the small sample size statistical analysis is not possible.

As there are only a limited number of dilemmas experienced by users in this evaluation it was not possible to evaluate the effect the user model had on their experience. The limitations on planning speed also meant that the user model was rarely applicable.

The users in the observation experiment (section 7.5) felt that none of the dilemmas they experienced were particularly interesting. This was supported by the user model, which estimated the interestingness of all of these dilemmas as 0. Informal user feedback has further implied that more difficult decisions are correctly modelled by the system as such.

7.7   Dinosaur adventure evaluation

The dinosaur adventure version of GADIN is detailed in section 5.4. In this section an evaluation of that version is discussed. This experiment evaluates similar aspects of the users' experiences to those discussed in section 7.4 in a different domain, thus ensuring that the relevant criteria can be satisfied by GADIN in more than one domain.

The target audience of this version is children between the ages of around 7 and 10. Younger children would need someone to read for them and older children are less likely to enjoy the world. This experience was provided to 6- to 9-year-old pupils at a first school as one of their available activities during a school day. The interface used for this evaluation is discussed in section 6.3.

Each user was asked questions following their experience. It was decided to ask the questions verbally and transcribe the answers, as this is a communication method which the children are more comfortable with. They were still reluctant to give much information and it was necessary to limit the number and scope of questions as a result of this. The full results of the questionnaire are given in appendix E.7. Although some conclusions can be drawn from this questionnaire it is necessary to supplement this with observations of the users and their responses to the experience.

The children appeared to really enjoy their experiences with GADIN. They wanted to continue playing for as long as possible, with one child using his lunch-break to play, although another unfortunately had to leave as it was hometime. At one stage there were a large number of children gathered around the interactive whiteboard asking if their turn could be next. All of the users' comments on the story were positive, suggesting a high level of interestingness.

When they started their experience the users had some questions about what they had to do, in particular with regard to the `Go` button, which most users had to be told to use on their first action but not more than once. They soon realised that their action choices were entirely up to them and understood the interface well enough to be left to interact. They appeared to find the interface easy to use, indeed one child said "this is actually quite easy" after the first action.

The only questions later asked were when presented with dilemmas, with one user asking "what do I do?", greatly perplexed. This suggests that the dilemmas did represent difficult decisions for the users. It is believed that not enough dilemmas were experienced and this needs to be improved, possibly by planning for dilemmas or by incorporation of additional dilemmas.

One of the major expressed disadvantages of the interface was not everything being interactive, in particular the pictures. The users wanted to be able to click on the pictures and observe a response. This may suggest that it would be an improvement if the users were able to choose their actions from a combination of graphics and words as opposed to purely textually. This would require the interface to be redesigned appropriately. There was also some confusion when there were references in the text, for example to dinosaur nests, for which no accompanying picture was shown.

The users did not feel that they needed to know where the dinosaurs were, especially since usually moving location meant that they found them. Some even saw it as a challenge to find the other characters so that they would be able to interact with them. One user did think that the dinosaurs "didn't do very

much" which may be changed if they saw the interactions of other characters at different locations — but this was felt to be likely to add more confusion than advantage.

The level and volume of reading was right for the older users, but the younger (6-year-olds) found it difficult, and with one user it was necessary to read aloud the longer sections of text — to prevent this from having an adverse effect on their experience. The dinosaur names were confusing for those children who knew nothing about dinosaurs.

The majority of the users expressed emotions regarding the characters and the storyworld which suggested that they found these plausible. For example one referred to the dinosaurs as being "mean". This may have been influenced by their previous knowledge of the dinosaurs rather than the experience, but many did not have any such prior knowledge.

Observation of the users showed that even when they had to wait to be able to select an action they remained interested in the system and were not distracted by the other activities around them. As soon as they were able to do so they started to select their next action.

Over half of the children felt that they changed nothing through their presence in the storyworld, mainly the younger users (6 and 7 year olds). This is interesting since they were present and thus their actions were having an effect, even if only to make dinosaurs like them. That they were not aware of this perhaps suggests that they see stories unchangeable and did not understand the effect of their actions. This implies that interactive narratives may be inappropriate for the younger end of the evaluated age group as they will be more accepting of being directed towards particular actions — and perhaps even expect this.

The children tended to feel that they could not always do what they wanted. The reasons for this varied greatly but were generally ambitious and required for example "to be there in real life". None of the expressed reasons for not being able to do what they wanted were related to the actions which were available to them within the world, except where they were restrained by consistency, such as being able to steal an egg only when they had found a nest.

There were problems with the storygoal. Since it is communicated before the narrative begins some of the children did not understand it due to a lack of familiarity with the characters. Others quickly forgot it, with one later expressing frustration as she "wanted to get back to the beginning" and find out what the storygoal was. The 9-year-old users generally understood and remembered the goal and were pleased when they were able to achieve it. This may suggest that this method of communication of the ending is inappropriate for younger children.

Although nearly half of the users said that they did not want to play again this is thought to be due to a lack of understanding of the question. Some of those users who said they would not want to play again returned later to see others interacting with it and asked if they would be allowed another turn. It is believed that they understood the question as requiring them to play again straight away and they did not want to since the evaluation was being performed at the same time as other activities, and the children had art projects to finish. One user enjoyed the experience so much that he asked for a copy of the system.

The story record (section 5.4.10) was greatly appreciated by the children. They liked having a record of their experience and did not want to go home

without this.

7.8   Independent evaluation

Roberts and Isbell [91] give a number of 'desiderata' (desired features) for an interactive narrative. It focuses on those systems which utilise a drama manager — "a coordinator that tracks narrative progress in the environment and directs the roles and/or responses of objects and agents to achieve a specific narrative or training goal." These criteria are: speed, coordination (of NPCs), replayability, authorial control, player autonomy (or freedom), ease of authoring (of new storyworlds), adaptability, soundness, invisibility (essentially also user freedom), measurability of satisfaction of both author and user. The authors of this paper [91] assign satisfaction of 7 of these 9 criteria to GADIN. GADIN arguably also satisfies the criteria of soundness (which requires that "verifiable claims" can be made about the system), but the ease of authoring is not considered to be satisfied as it requires the author's knowledge of AI. This level of criteria satisfaction is unsurpassed by any of the other evaluated systems, and is only equalled by this group's own system.

Section 8.2 evaluates GADIN in accordance with the compellingness criteria introduced in section 1.6. This demonstrates that the GADIN system achieves a high degree of compellingness.

8

Conclusions and outlook

8.1 Overview

In this thesis the concept of interactive narrative has been introduced (chapter 1), justified and contextualised (chapter 2). The compellingness criteria for the evaluation of interactive narratives have been discussed (section 1.6), and existing interactive narrative systems have shown to not be capable of achieving full compellingness (section 2.4). The GADIN system has been evaluated (chapter 7).

In this chapter GADIN is evaluated according to the compellingness criteria (section 8.2) in support of the research hypothesis. The benefits of the system are discussed in section 8.3. Section 8.4 discusses the main limitations — the planning speed, the interface and the domain creation restrictions. The thesis finishes with a consideration of the possible extensions, additions and future of the GADIN system. This begins with possible extensions to existing features of the architecture (section 8.5), followed by a discussion of further application domains and areas for the GADIN system in section 8.6 and a consideration of generation of a multi-user narrative in section 8.7. A summary of this thesis is given in section 8.8.

8.2 Compellingness evaluation

In this section the GADIN system is evaluated according to the compellingness criteria (as introduced in section 1.6). The results used to support these conclusions are discussed in detail in chapter 7, and the questionnaire referred to is that for which the results are analysed in section 7.4.3. The system is able to satisfy most of these criteria, providing a high degree of compellingness, and should be capable of achieving full compellingness.

8.2.1   Interestingness

The interestingness of a GADIN narrative is dependent on the dramatic interest of the dilemmas which are defined, in general form, for the domain. That the dilemmas are interesting is suggested by the comparison of experiences with and without dilemmas in which users found the experience with dilemmas to be more interesting. The interestingness will also depend on the appropriateness of the narrative to the audience. It has been shown that the target audiences of the existing versions of GADIN find these narratives interesting, as discussed here.

The story quality evaluation discussed in section 7.2 demonstrates that narratives generated by the soap version of the GADIN system are indistinguishable from those of real soap operas. This suggests that the interestingness of these will be potentially equivalent to the interestingness of soaps.

The questionnaire demonstrates that users of the GADIN system found it reasonably interesting, especially given that not all of the users would necessarily find soap narratives interesting. Those users familiar with this type of narrative, those who regularly play computer games and watch soaps, rated the interestingness more highly. In this experience the users felt that the dilemmas required making difficult decisions, implying a reasonably high level of dramatic interest.

All of the users of the dinosaur adventure spoke positively about the narrative, suggesting that they found it interesting.

8.2.2   Immersion

The immersion felt by users of the GADIN system is below average for this criterion, which can thus not be considered to have been fully satisfied. This is believed to be at least partially due to the interface restrictions and waiting times (section 8.4.1).

Plausibility of characters and the storyworld are a significant factor in user immersion and are the other component of satisfaction of this criteria. These were shown to correlate with the users' ratings for immersion. The questionnaire shows that users felt that the characters were reasonably plausible, as was the storyworld. Users of the dinosaur adventure version and those in the soap user observation experiments spoke of the dinosaurs and storyworld in a way which suggests they felt these to be plausible.

Users in the observation experiment were simultaneously talking about their experience which decreases their susception to distraction as they are also concentrating on this. They remained focused on the experience and the narrative. The participants in this experiment were continually aware of the state of the storyworld which suggests a fairly high level of immersion.

The users of the dinosaur adventure appeared to be very immersed in the experience. They were not distracted even when they had to wait and despite the surrounding potential for distractions.

8.2.3   Scalability

The techniques discussed in section 4.7 ensure that the GADIN system is capable of generating a narrative of infinite length. The method of relaxing restrictions

on applicability leads to reachability between states, meaning that from any storyworld state there will be another state possible and thus the narrative — and presentation of dilemmas — can continue. Although the state information is finite and thus for the narrative to continue infinitely there will be repeated dilemmas, the context of and prior history to these will be different each time. Dilemmas are used by GADIN to provide dramatic interest in the narrative. The continuation of these dilemmas indefinitely within the narrative means that the dramatic interest will be sustained.

The generation of infinite soap-style narratives and finite dinosaur adventures by the GADIN system is sufficient demonstration for satisfaction of the scalability criterion. A narrative which can maintain dramatic interest for as long as is required is truly scalable.

8.2.4   Domain independence

The fundamental techniques used in the GADIN system are applicable to interactive narrative generation in any domain which makes use of generic storylines of the type discussed in section 3.4. The core architecture of the GADIN system is the same, and reusable, for any application domain. Once the domain specific knowledge base, as discussed in sections 5.2 and 5.5, has been created within GADIN the system will be able to generate narratives within that domain.

The exploitation of the high level of reusability and generality in the soap storylines means that the soap version of the GADIN system can be easily applied to any soap of this type, simply by adapting the involved characters (and their initial feelings) appropriately. This demonstrates a certain independence as the system is applicable to any existing soap of this type (and the storylines will be appropriate), to a new soap or to the user's self-defined soap world.

The application of the GADIN system to a generic children's story domain demonstrates that the techniques are applicable to any children's story of this type, for example a *My Little Pony* [114] adventure.

Soap stories are very relationship-centric. The audience will become involved due to the relationships between the characters, how they interact with one another and their changing feelings for each other. This is not true of the dinosaur domain, but the techniques used by GADIN are still applicable within this domain. Ensuring that a narrative ends in a timely and coherent manner is a very different challenge to maintaining the dramatic interest of the narrative for an infinite length of time. That the techniques used by this system can be applied to both types of storytelling demonstrates the robustness and fundamental generality of the core of the system.

All of the additional features discussed in chapter 4 have been implemented in at least one of the two systems. This demonstrates that all are possible and thus any domains which make use of these, or could require such features, can be implemented in GADIN.

8.2.5   Agency

8.2.5.1   User freedom

In all applications of the GADIN system the user will be able to select any actions within the system which other characters are able to perform. Depend-

ing on the domain there may also be additional actions available to the user. This will not necessarily include all actions which the user would be able to conceive of within the domain. This means that the user is free to act within the constraints of those actions which have been defined. The user never has any action imposed on them, although they do have to make decisions when presented with dilemmas.

Users were generally able to act as they expected to according to the questionnaire. The user observation experiment showed that the restrictions felt by the users tended to be consistent with the narrative, and only to require extending its boundaries rather than being unreasonable. It would be incredibly difficult to fully satisfy all of the possibilities for user action within any domain and the users did not seem to find it a significant restriction that they could not select these actions, but only expressed that ideally they would be able to.

Since the system is currently control-based (section 3.7.3) users were always able to act when they would expect to be able to, and the questionnaire showed that they felt this to be the case.

Users of the dinosaur adventure version of GADIN seemed to feel a lack of freedom but not within the constraints of what was reasonably possible, stating inconsistent impossibilities as their desired actions.

The level of freedom experienced by users of the GADIN system is reasonable but not as high as would be preferable or as is achievable. This would need to be improved for this criterion to be considered fully satisfied. An improved interface and the ability for GADIN to create further narrative content (as discussed in sections 8.4.2 and 8.4.3) is likely to aid in increasing the user freedom.

8.2.5.2   Clear effect of user actions

The user's actions have a clear effect on the short-term of the narrative. This is ensured through utility-based responses to user actions and trigger actions for dilemmas (as discussed in sections 3.7.4 and 4.6). Users in the evaluations tended to feel that these effects were clear to them.

The long-term of the narrative is clearly dependent on the user's actions, choices and decisions as these change the storyworld and thus the future dilemmas and corresponding course of the narrative. The presented dilemmas are selected dynamically based on the state of the storyworld (among other things, section 3.5.3). When the user acts in a way which changes this state they are acting to change the future dilemmas which will be selected as their action will change the state of the storyworld, the user model and the story history. The user's actions may cause other characters to experience dilemmas which will also change the frequency of dilemma use. In a finite narrative the user can choose to act to achieve the storygoal, or to avoid it — thus potentially changing the ending.

The questionnaire shows that users felt their actions to be having both an immediate and a long-term effect on the narrative. The long-term effect in particular was felt to be lower in the experience without dilemmas, which may suggest that the incorporation of dilemmas gives the user a clearer long-term effect of their actions.

Users in the observation experiment were asked why they felt certain things were happening or characters were acting as they were. In answering they imposed a logic on other characters' actions which demonstrated a belief that

these were based on the user's actions — both those immediately preceding and their less recent actions.

Only half of the users of the dinosaur adventure version of the system felt that they were changing the narrative through their actions. However the older children, who perhaps had more understanding of what this meant, did feel that their actions had an effect.

8.2.6   Replayability

The GADIN experiences were analysed by calculating the Levenshtein distances between each pair of narratives (section 7.4.4). They were considered to be significantly different to one another with unique dilemmas, build-ups and combinations being experienced in each. There is a level of non-determinism in GADIN which increases the originality of the narratives while maintaining the consistency.

The GADIN system makes it easy to extend the knowledge base, in the form of characters, actions or dilemmas (section 5.5). There is a clear and simple formulation for this and it does not require changing any internal components, but simply adding more information to the knowledge base of the system. As the size of this knowledge base increases the repeated narrative content will be reduced, thus further increasing the replayability.

Users generally felt that they would like to experience a GADIN soap narrative again. This was particularly the case for regular computer game users who are the most likely to enjoy (and be familiar with) this type of narrative. Those who experienced the GADIN system more than once generally felt that the narrative on subsequent experiences was significantly different. Although only half of the users of the dinosaur adventure interactive narrative said that they would like to replay, their later actions suggested that this was due to a misunderstanding of the immediacy of the question.

8.3   Benefits

The GADIN system is able to generate original narratives in which dilemmas are incorporated to add dramatic interest. These dilemmas represent fundamentally difficult decisions for characters. In the interactive version the user will also experience dilemmas. These are selected to present the hardest possible decisions for the user to make, based on their previous action choices and dilemma decisions. No previous system has incorporated such dilemmas into narratives, nor has a user model previously been utilised to increase the dramatic interest of the interactive narrative for each individual user.

In the finite version of GADIN the story ending is able to be any proposition which has not yet been true within the storyworld. This may change throughout the narrative, depending on the user's actions, but will always be clear and coherent for the user. No previous system has had this level of variability available in the story ending. The incorporation of knowledge which is not held by all characters has not been considered by other interactive narrative systems.

The evaluation of the GADIN system according to the compellingness criteria in section 8.2 demonstrates the success of the research hypothesis: *A computerised dilemma based user adaptive interactive narrative generator based on the*

GADIN architecture can create a compelling interactive narrative experience.

Applying the numerical analysis discussed in table 2.1 indicates that the GADIN system has a greater degree of compellingness than any other interactive narrative system (section 2.4). The highest degree achieved by any other system was 8, whereas GADIN achieves a compellingness score of 12. Unlike the other systems the architecture of the GADIN system is such that this can be improved to achieve full compellingness. The numerical comparison of the compellingness of GADIN to that of other systems is shown in tabular form in appendix F.

The methodology used in GADIN allows authorial control — in the definition of dilemmas, frequencies, and utilities — but these are general and are implied by the application domain. The system exploits the generality of a given domain in the generation of narratives which are fundamentally dependent on the user's action choices and dilemma decisions.

An interactive narrative experience with the GADIN system is potentially enjoyable for both current game players and those who enjoy stories within each of those domains in which the system is applied. For game players the narrative aspect of their game-playing experience is enhanced, and they have more control over the narrative path of the game and its outcome. Others are likely to find satisfaction in being able to play a genuine part in the storyworlds they love (as shown by the evaluation of the applications of GADIN in chapter 7).

8.4   Limitations

In this section the major limitations of the GADIN architecture are discussed and potential solutions are proposed. These are: planning speed; the interface; and the domain creation restrictions.

8.4.1   Planning speed

As more characters and actions are included the time spent planning becomes unreasonably long, thus reducing the extendibility of the GADIN system within a given domain. It is possible that a different planning algorithm would improve the speed. Barros and Musse [7] analyse potential planners for interactive narratives, but the adjustments made to ensure specificity of the GraphPlan planning algorithm to the requirements mean that changing the planner is unlikely to resolve this issue. The problem is not the time taken to find a single plan but the volume of plans that must be found.

A potential solution would be the use of a form of hierarchical planning in which there is default knowledge of possible plans, with variables, which lead to certain propositions. This could be generated for each new storyworld and stored so that it could be referenced whenever a narrative was generated in that storyworld.

Another possibility would be for the actions currently available in GADIN to be considered as directions rather than the full actions. Storyworld characters would then improvise to act out these directions, in a manner dependent on their personality — in similar fashion to the actors in the experiment discussed in section 7.3. They could create low-level plans to achieve the effects of the required action.

An improved planning speed would mean that the users would experience more dilemmas in the narrative, which should increase the interestingness (section 8.2.1). It will also mean that it will be possible to include more generalised forms of dilemmas which will increase the variety within the narrative and thus the replayability. An additional advantage of this would be the ability to apply the user model more frequently — which it is believed would improve the user's experience (section 4.5).

8.4.2 Interface

The GADIN system generates the dramatically interesting components of a narrative. It does not create the visualisation of these. The narrative is abstracted to some extent but the essential elements and the components of dramatic interest remain. From the analysis in accordance with the compellingness criteria it is apparent that immersion and user freedom must be improved for this to be a fully compelling interactive narrative system. It is believed that an improved interface would increase at least the user's sense of immersion.

Although a graphical interface is likely to complicate the further applicability and extendibility of the GADIN system it should increase the sense of immersion and plausibility to the user of the characters and the storyworld. It may be possible to utilise an existing graphical engine for GADIN, for example *Second Life* [119]. With a graphical interface it may be possible for the dilemmas to become less explicit — by being integrated more subtly into the narrative experience while maintaining the dramatic interest, as in the original forms.

The ideal interface for the GADIN system may depend on the domain. For example an interactive soap could have an interface with an appearance more similar to that in conventional soaps. For a children's dinosaur adventure simple animations or diagrams may be the most appropriate. In other domains a Virtual Reality experience might be the most applicable. This should be determined by the domain creator.

It would be advantageous if the user were to use a different method to communicate their actions, such as: freely typing text which could be understood by the system (this would require advanced natural language processing abilities); and moving around and interacting with objects in a highly graphical world — as in most modern computer games.

For the system to properly utilise a graphical interface the actions could no longer be at the current level of abstraction. To achieve this layered planning may be used, although it will be necessary for the user to be able to select actions from the lower layer. For example rather than a character simply moving between locations they will be required to walk between these locations — and this could lead to meeting others, or requirements for further actions on the journey. The incorporation of natural language processing would additionally mean that the user could speak to other storyworld characters where appropriate. If other characters are able to speak to the user there will be the potential for further detail, for example a comic element, in the narrative.

To improve the speed of responses to the user the interface could be partially reactive. There could be certain intermediate actions, which should not be able to contradict any actions which can appear in plans, and which are only able to occur in response to the user or while there were no available plans. This would ensure that there were no periods of inactivity in the narrative.

8.4.3   Domain creation restrictions

It is essential that there is sufficient content and dramatic interest in the narratives to ensure that each experience is enjoyable and that there will always be new, dramatically interesting narratives. The cross-domain reusability of many dilemmas means that this limitation will become less significant as the knowledge base of the system grows.

Applying GADIN to a new domain relies on the domain creator's knowledge of C# (section 5.5). An interface which would simplify this process is feasible, but this would still be reliant on awareness of the techniques, in particular the STRIPS planning mechanism. There are also limitations on the selection of a domain due to the necessity for clichéd storylines. This restriction means that the GADIN system will never be capable of generating 'great' literature.

Ideally it would be possible to extend the system to enable it to define dilemmas in general form, rather than this requiring a human author. This would require a greater system awareness of what would and could cause a dilemma, and also the ability to define related actions. With this extension the GADIN system would potentially be able to generate less clichéd literature.

8.5   Extending components

This section begins with a discussion of possible extensions to existing aspects of the GADIN architecture, namely: characters; relationships; locations; principles and crimes; the user model; finite narrative generation (in the context of incorporating a plot arc); the history; and knowledge. This is followed by a discussion of roles, plan management, saving the game state, time issues and the inclusion of occurrences.

8.5.1   Characters

This section discusses the characters in GADIN storyworlds and how they could be made more plausible and interesting to the user. Character development throughout the narrative is essential to maintain the user's interest in a character.

8.5.1.1   Character model

GADIN characters are currently able to act in accordance with their individual traits (section 3.2.1.1) and each action's associated applicability (section 3.3.2). This could be extended, and potentially combined with the user model, to further ensure that characters act in a manner consistent with and reflective of their potentially more intricately defined individualities throughout the narrative. This character model would build on the applicability check to further determine the characters' actions, choices and decisions when presented with dilemmas. The model of the automated user in the dinosaur version of the GADIN system demonstrates the potential for the inclusion of a character model on a small, simple scale.

Those aspects of each character to be modelled would be similar to those in the user model. They would also need to be reflective of the explicit character feelings, as seen by the user, and be updated with the state of the storyworld

where appropriate. The character model would be updated in a similar fashion to the user model, although the updates should also depend on how other characters have acted towards that character. It should be initialised in creating the character, and would affect that character's actions, choices and dilemma decisions. The associated utility for each response action following dilemma decisions would be able to depend on this model.

An example of a potential use of the character model would occur if the user were to `ask out` a character and be rejected due to the low opinion of the user held by that character. If the user then `flirts` with the character their opinion of the user may be increased. If the user `asks out` that character again they may be more likely to be accepted. Similarly a character would not `ask out` the user unless their opinion was high enough. The use of a character model would also ensure that a character's future actions were more reflective of other characters' previous actions towards them. For example a character should not `stop fancying` another solely on the basis of the rejection of an offer of an affair — this should also depend on their individualities (their traits and character model). This is done to some extent with the applicability check (section 3.3.2), and this would supplement that.

The incorporation of character models would have the potential to negatively affect the planner, for example if a particular dilemma's preconditions require that character X fancies character Y their modelled feelings may cause this to be an impossibility. This can be incorporated as an additional layer in the applicability check, as the character model would not change drastically over a short period of the narrative.

In selecting dilemmas for presentation those which would involve the hardest decision for any involved character could be selected if these characters have associated character models. This is currently done by the user model in selecting dilemmas to be presented to the user, and this would be a generalisation to any character. This should increase the dramatic interest of each dilemma and thus the overall narrative. The use of a character model should improve the plausibility of characters. The character model would be influenced by the past of the narrative and would influence the future course of the narrative.

8.5.1.2   Belief values

It would be possible to have a belief value rather than a Boolean associated with each knowledge item. For example if a character X tells another character Y about X's affair the belief value is likely to be high as it is the character's own affair, unless they have frequently lied previously. If Y then passes on this information to Z it will be less likely to be believed, and dependent on Z's belief of how trustworthy Y is. If another character tells Z about the same affair their belief in its existence will be increased.

The belief value associated with each knowledge item would depend on the trust placed in each character who has communicated the item and their assumed closeness to the circumstances. A character would only share their knowledge, or act on it, if their belief value was sufficiently high. The required value would vary depending on the involved characters. Other circumstances, such as seeing characters rumoured to be having an affair alone together, would also cause the belief value to increase.

The association of belief values with knowledge items is extendible to a model

of the whole storyworld being held by each character. The belief value would be high for facts, such as characters being partners, and would vary depending on the circumstances and involved characters — for example if a character is flirting with another the belief that they fancy that character may be increased.

Each character could have a model of how they believe each of the other characters feels about them. This would be determined by the history of the narrative (the actions, dilemmas and gossip) and would affect the way they act. The individualities of characters, how they feel about others, and how they might think others feel would all be considered in determining character actions.

The use of belief values would mean that the absolute state of the storyworld would be less significant, each character's belief of the state would instead influence their choices. This would complicate the calculations of the utility scores in each state, as this has to depend on a character's perception of their score in the state rather than the absolute value.

Characters in a storyworld involving belief states would have to decide when to lie and the purpose this would serve, while considering how doing so would affect them, others' opinions of them and their reliability — and thus their future status within the storyworld. It would be necessary for characters to remember the factors which had affected their associated belief in each knowledge item.

Arinbjarnar [1] uses extended Bayesian nets and subnets to model characters' knowledge and beliefs of other characters' knowledge (and their assumptions of other characters' knowledge). These nets are used, in combination with characteristics and emotions, by the characters in generating rational (according to game theory and their personal goals) sentences and replies to other characters. Characters' opinions of the reliability of other characters varies depending on their previous communications. This method could be adapted for use by GADIN characters.

8.5.1.3   Other aspects of characters

Additional character features could be included. These could be used to determine: their job; their interests; why they would want a particular object; and so on. It may also be possible to use personality types, such as the Myers-Briggs type indicator [82], to define characters' personalities and thus influence them within the storyworld.

Rather than requiring a domain creator GADIN could generate characters and their traits in accordance with patterns for the genre. This could result in a more original narrative. There may be implications for the backstory (section 4.10) with this technique.

The characters who will participate in actions, dilemmas or events should be selected depending on factors other than randomness. This could involve more participation from those characters who the user is modelled to have the highest values for their relationships with, which may improve the user's experience. The selected characters could also depend on the history of the narrative.

There are many narratives in which characters leave the storyworld. This is particularly true in infinite or very long narratives, such as soaps. Determining when it is appropriate for characters to leave the narrative will need to be given careful consideration. This could involve removing those characters who the user has been modelled as finding less plausible or interesting, or — to invoke a response — those who they have the highest associated feelings for. There may

be certain dilemmas or actions appropriate to the domain which will cause the demise of characters. New characters will also be introduced to the narrative, and they will need to have a backstory (section 4.10). Their past may become directly relevant to the narrative or influence their actions, choices and dilemma decisions.

8.5.2   Relationships

The GADIN system represents relationships between characters with truth values, for example that a character does or does not like another (section 3.2.1.3). This is inaccurate as strengths of feelings vary, for example a character might 'dislike', 'be ambivalent towards', 'quite like' or 'really like' another. This division would be more appropriate than a truth value and can be translated to a numerical scale, in this example 'quite like' would have an associated strength of 1 if the values were on an inclusive scale of -1 to 2. Each relationship should take a range of values, both negative and positive. These values would change in accordance with actions and their effects. The use of 'likes 0' values (section 5.4.2) in the dinosaur adventure version of GADIN demonstrates one potential use of this extension.

Another improvement could result from strengths of feelings for other characters being affected by changes in utility caused by those characters. A simple example would be if a character X acts in a way which decreases character Y's utility by a certain amount then Y's liking for X will be decreased by the same amount.

Characters who like one another may be able to act cooperatively, where appropriate for the domain. This could lead to utility responses which are not necessarily initiated by the character whose utility has been changed, but by a friend of theirs. It would also be possible for utility-based responses to not always be directed towards the character who caused the change in utility. For example if a character `asks out` another and is rejected, they may go on to `ask out` another character in an attempt to restore their utility.

8.5.3   Locations

There are many additional domain-specific details which could be associated with each location. For example in appropriate domains locations could be: a home to a character who could own or rent the house; a shop or restaurant with opening times, characters who work there and corresponding timetables for work hours.

Characters' access to locations could be restricted where relevant. For example there could be football matches which characters can only attend if they have tickets. Certain actions should only be possible at certain locations, and all actions which are conceivably possible at a given location (such as having a sandwich in the café) should be made available within each GADIN application domain.

8.5.4   Principles and crimes

In the current version of the GADIN system only one crime can be associated with each principle. This could be extended to a more representative model of

crimes and principles. The system should also be extended so that punishments 'fit' the crime, the circumstances and the committer. This should include a relevance of prior record affecting punishments for crimes.

Characters should have an associated strength of belief in principles rather than a truth value. If a character is encouraged to betray a principle their associated strength of belief may be reduced, possibly by an amount depending on their individualities. Only with enough encouragement will the strength of belief be low enough for the character to act to commit the associated crime. Other factors could also cause the associated strength of belief to be reduced, for example a hungry character may be more likely to steal food.

Currently principles can only be broken. This should be extended to allow characters to hold principles again (or for the associated strength of belief to be increased). For example a character might discover a religious belief and thus once more hold the principle of not stealing.

8.5.5   User model extensions

A user model has been included in the soap domain application of the GADIN system (sections 4.5 and 5.3.7). There are many other aspects of the system which could utilise this model, in ways which may improve the experience for the user. Ultimately the user model could be utilised to identify which domain the user would prefer and to immerse them in narratives within that domain. Some of the further possibilities for the user model are discussed in this section.

8.5.5.1   Evaluation

A more extensive evaluation of the user model will be required. The user model has been shown to be accurate (section 7.6) but there has been no formal evaluation of its effect on the user's experience. Before further extensions were made to the user model this would need to be investigated. With an increased planning speed (section 8.4.1) and resultant increase in dilemma choices at each stage it is likely that the user model would have a more clearly discernible effect on the user's experience, and whether this represented an improvement would need to be confirmed.

The effect of the user model could be evaluated by asking users to experience the system. They could either experience it twice, once with the user model and once without, or different users could experience different versions.

8.5.5.2   Selecting dilemmas

The next plan to be presented could be selected depending on those actions which the user is most likely to select and thus that plan which is most likely to succeed. This may depend only on the user's feelings for characters involved in the plan, or could involve more complex predictions of expected user actions. Predicting user actions in choosing between possible plans will mean that the chosen plan is more likely to be followed and thus reduce the presentation of unnecessary actions and increase the number of dilemmas experienced within the narrative.

Other advantages of being able to predict the user's most likely actions include: the ability to present the dilemma which is most likely to be caused

by the user's actions when there has been a long wait between dilemmas; and selecting dilemmas which will provide further information for the user model and thus improve later predictions.

A model may be created which identifies the dilemmas that the individual user will find most interesting and presents these. This is an extension of the implemented method discussed in section 4.5, which associates a fixed 'interestingness' value with each dilemma, to enable this value to adapt to the user. The relevance of this is apparent when the use of the 'hook' in soaps is considered. If there is a storyline which the viewer particularly relates to then they are more likely to start watching that soap. Subsequently other storylines may begin to intrigue them, to a lesser extent. This might lead to regular viewing of the soap, although more 'hooks' will be required to keep the viewer interested. This could be adapted for use in GADIN with a user model which would determine storylines likely to be a 'hook' for the particular user (possibly through user categorisation). Regular 'hooks' (which should become more relevant as the narrative progresses and the user model is developed) can then be incorporated.

The disadvantage of selecting plans likely to be followed and the user-specific 'hook' is that these will not necessarily coordinate with the current method of selecting dilemmas likely to result in the most difficult decisions for the user. A balance of these methods in dilemma selection would need to be determined to identify the combination of these techniques which would result in the best experience for the user.

8.5.5.3 Lookahead

Szilas [110] observes that "during the narrative, the audience is constantly making anticipations on what could happen, both immediately and on a longer period of time". The user model could be extended to predict the user's expectations from the narrative. This could then be exploited to provide a surprise, or twist, an essential element of narrative as discussed in section 2.2.6. The user may choose to avoid dilemmas which they are expecting, and the system would ideally be able to predict this and present another dilemma which could involve a more difficult decision (if the model is accurate). Such surprises should not be overused in the narrative or their impact would be reduced.

The user model could be used to look ahead in planning. Rather than continually searching from the current stage, it can be determined which choices the user is likely to make and this can be used to plan from later stages. As a result responses to user actions should be more prompt. This would involve finding all possible story paths to a pre-determined fixed depth (dependent on the size of the search space and the speed of the search and planning algorithms). As the search becomes deeper the predicted path will become less accurate. The probability of the user making a particular dilemma decision would be approximated by the user model. The narrative generator could then select that dilemma which had the highest chance of leading to the most dramatically interesting dilemma outcome over a greater number of dilemmas, the path which has the highest expected dramatic interest. In an infinite narrative those dilemmas which lead to less subsequent possibilities can be avoided and in a finite narrative those which lead to an ending could be preferred.

Behavioural cloning [6] could be used to improve the lookahead. This could create a clone based on the user's previous behaviour. The clone of the user

could then be used to determine the expected course of the narrative and the dilemmas to present to the user. The clone could also be used by the planner to determine which actions the user would be most likely to select.

8.5.5.4 Beliefs

The user should not be required to explicitly state their changed feelings for other characters. These should be realised by the user model according to their actions and expected reactions. This method is utilised in the dinosaur adventure version of GADIN, but would be more accurate if based on a user model rather than general expectations of feelings. To achieve this the preconditions of actions and dilemmas would need to correspond to the user model rather than the state of the storyworld. For this to be fully effective character models would also be required (section 8.5.1.1). Another complication is that as other characters may not be aware of the user's feelings towards them, it may be necessary for them to be able to access the user model or to individually model the user's feelings (section 8.5.1.2).

The user model could be extended to model the way which the user views their world. This could include how they are believed to think others are feeling. It might also include their perception of the honesty of others, and thus how likely they are to believe knowledge. This could be similar to the belief states of characters discussed in section 8.5.1.2.

8.5.5.5 Assumption model

In making actions available to the planner in the current system it is assumed that the user will act in accordance with the standard applicability check. An assumption model could be created to replace this applicability check with one more appropriate to the individual user, depending on their previous actions and decisions. This assumption model would develop and become more accurate as the narrative progressed. The likelihood of the user acting consistently with the plan would be higher as the planner would have a more accurate idea of how the user is likely to act. This would increase the frequency and interestingness of dilemmas presented to the individual user.

The assumption model would determine the applicability of actions dependent on the individual user and how they had acted in the past. For example if it was observed that the user tended to start to fancy characters who flirted with them, this could then be used in applicability checks when making actions available to the planner. Each observation would need to be generalised to be applicable to as many future circumstances as possible.

The assumption model could be created by associating a series of criteria with each action. These criteria would be updated if the user selected that action, and would be used to determine if the action was one which the user was likely to take. For example if the user had been observed to prefer relationships with characters who had a high value for the attractiveness trait an action which involved them starting to fancy an unattractive character would be unlikely to be selected and so would not be made available to the planner.

A basic reinforcement learning method could be used to build up the assumption model. This could give positive feedback to the system if the user

acted in accordance with the prediction and negative if they did not. The initial predictions could be based on the standard applicability check.

8.5.5.6 Further user model extensions

A user who consistently chooses not to participate in the action should be modelled as such and an attempt could be made to coerce them into acting more. It may also be appropriate for other characters' actions to influence the user model, although this requires prediction of the expected changes to the user model following the actions of other characters.

The initial user model could be influenced by the initial settings the user chooses for their feelings towards others. It was decided against this as it does not reflect the user's actions towards these characters. However, with short narratives this may be more appropriate.

The credibility given to the user model could be adapted to depend on how recently the criterion being utilised was updated. This would be advantageous as the user and their opinions are likely to change throughout the interactive narrative.

8.5.6 Plot arc

In generating a finite narrative in the GADIN system it is ensured that a dilemma is presented between the outset of the narrative and achievement of the storygoal by any character other than the user. Once a dilemma has been presented, if this storygoal fails and a new storygoal is selected, either goal can be immediately achieved. This could become frustrating for users and reduce the dramatic interest of the narrative, with potentially no dramatic tension between the presentation and achievement of the newly created storygoal. A possible improvement would involve ensuring that there is a dilemma experienced between creation and achievement of each new storygoal. If an old storygoal becomes possible before there has been a dilemma associated with the new storygoal this should not prevent its achievement.

In a longer finite narrative it may be necessary to add more structure to the overall experience. The narrative should follow a regular plot structure (section 2.2.9) but also be dynamically generated dependent on the user's actions. To achieve this it may be appropriate to categorise dilemmas according to where they can appear in the plot arc. A large number of general dilemmas would need to be defined for each of these stages. It would be necessary to consider how many of each category of dilemma should occur at each stage in the narrative. The initially selected dilemmas would affect which would be possible in the later stages of the narrative, meaning that more such dilemmas would need to be defined to reduce predictability in the narrative. In this way the plot structure could be designed to fit Aristotle's 3 stages [2] or Laurel's 7 [66]. There may be overlap, with some dilemmas being possible at multiple stages.

8.5.7 History

Currently the storyworld dilemma and event histories are stored to prevent their occurring more often than their defined frequencies permit. In addition to this, the storyworld action history could be stored, and utilised in choosing

between plans to achieve the preconditions of a dilemma. This could be used to avoid the same actions being repeated or inverted in future plans — causing anti-immersive looping. The history may also be utilised when considering, for example, the possibility of two characters falling in love. If they have already been partners perhaps the likelihood will be higher, depending on why the relationship ended. This would reduce the potential for contradictions in the narrative. The history should influence future actions, conflicts and character relationships.

8.5.8   Knowledge

In the current version of the GADIN system it is possible to share knowledge being true but not its falsification (section 4.4). This ability would create a more accurate representation of the way gossip works. There should also be further motivations for characters to share knowledge of the truth or falsehood of a knowledge item. Possible reasons for this could include friendship, revenge and manipulation. In addition, relationships between characters could be further influenced by knowledge. Characters may be more likely to share knowledge with those who have previously and reliably shared with them.

Knowledge should be able to be revealed at any stage in the narrative, even if it is outdated. For example a character could reveal that another character had previously cheated on their partner even after the affair has ended. A history of knowledge is thus required, including whether the involved items were true. This would influence the subsequent narrative and behaviours of characters. To achieve this each character should have associated knowledge that they currently know and knowledge that they previously knew. The previously held knowledge could include details regarding when it was known, and possibly how the character came to believe that it was no longer true. Characters' knowledge items could also have associated a record of how they gained that knowledge and who they have told about it.

Knowledge could have a greater influence on the dilemmas experienced within the GADIN system, through revelations pertaining to previously experienced dilemmas in addition to the current state of the storyworld. This would influence the response and the knowledge held by characters. An example could follow the dilemma requiring a character X having to decide whether to partner character A or character B and choosing character A. Character A may later discover that X made this decision and thus must decide whether to continue with the relationship given that there was a considered alternative to becoming partners with them.

8.5.9   Roles

Rather than being a single consistent character in an interactive narrative the user could be able to take the role of any character for a period of time until they choose to change, or are forced to. The user already has the option to not take any role in the narrative for a while, taking and relinquishing the ability to select actions and decisions for a character as and when they choose, and this could be extended to enable them to change which character they take control of. The incorporation of hidden knowledge (section 4.4) in the narrative would be complicated, if not made impossible, with this technique.

It would also be possible with a user created storyworld (section 4.11) for users to share experiences with their friends which they have started (section 8.5.11). There could also be a multi-user (section 8.7) option in which the narrative would continue and users would be able to join (or leave) at any time, without knowing which characters were human and which automated.

8.5.10   Plan management

If there is more than one plan currently available with the same starting action then it would be advantageous to present that action, and store all of the possible plans following it. These could then be abandoned when actions contradicted requirements of the plan. This would increase the likelihood of one of the plans being followed by the user and thus the chance of a dilemma being presented. The dramatic interest of the dilemmas would still need to be considered.

When the user selects an action it is currently checked to see if that action is included in a plan for a dilemma to another character (in a domain in which other characters are experiencing dilemmas). This could be extended to attempt to match each user action to actions at any level in any possible plan, which would increase the chances of a successful plan being presented.

8.5.11   Saving

It is currently possible for users of the GADIN system to save the storyworld state which they have created (section 4.11). This could be extended to enable users to save the state at any stage within the narrative experience. This would be particularly useful within an infinite narrative as the user would be able to continually return to their previous experience — or begin a new one.

Additional options possible could include:

- Allowing the user to be shown all characters and choose which they become, or to become a new character. Section 8.5.9 discusses the possibility of allowing the user to change which character they control.

- Allowing the user to save the storyworld but not their character. This would enable other users to participate in that storyworld.

- When the user enters an existing storyworld they could be able to choose to add or remove characters and locations. This would improve the specificity of the storyworlds for the individual user.

- A version which stores user models and enables these to be used as character models (section 8.5.1.1) for future users' experiences. This would be likely to make these characters more plausible.

In infinite narratives with storyworlds based on those already in existence, such as in soaps, the ability to store and re-use the state of the storyworld could be used to 'update' the state of a user's storyworld to correspond to that currently in the soap in which they have chosen to interact. This could change the entirety of the storyworld and force the user to re-start their experience, or be a more complex technique which would enable the individual's current state to be entwined with the state in the non-interactive version of their chosen soap. This may require the user to make decisions, such as whether they will

continue their relationship or allow their partner to go out with their partner in the non-interactive version.

8.5.12   Time issues

In the current version of the GADIN system there is no sense of time. The actions and effects take place instantaneously, for example a character has a drink and is immediately drunk. This is appropriate for some actions but others would be better represented by taking place over a longer period of time. The incorporation of such issues is not appropriate to every domain, for example it is of very little importance in a short narrative such as that experienced by users of the dinosaur adventure. In other domains its absence is a significant disadvantage, this is particularly true of soaps in which time is important. Some of the issues and possibilities involved in the incorporation of time in an interactive narrative are discussed in this section.

A 'time to complete' could be associated with each action. This could be represented by a global clock, starting at the current time and moving forwards by the appropriate associated amount after each action. This would be complicated by the necessity for actions involving different characters to take place simultaneously. Also for some actions the relevant time will be for the effect of the action rather than the action itself, for example how long a character will be drunk for — which could be dependent on their traits. The advantage of this method is that there could be a delay permitted in making decisions, giving the character time to think while other actions take place. If no decision is made the implications of this may still occur, for example in *Hollyoaks* Amy chose not to make a decision about her pregnancy and thus had a baby — there was a decision but it was not explicitly made.

With a sense of time in the narrative characters may (or may not) be required to be at particular locations at certain times, for example to work, or not to have access to a public service out of hours. There may also be certain events which will take place at fixed times in the calendar, such as Christmas day or characters' birthdays. This will only be appropriate in certain domains, for example in *James Bond* [27] films the time of year is mainly irrelevant.

A sense of time will make concurrent plan presentation (section 4.3) more interesting. Every action at the same level in the plan does not necessarily have to take place simultaneously, but only within the same time period as other actions at that level — dependent on the time period of the previous level's actions. For example there may be a dilemma for which the preconditions require two characters to mutually fancy each other. If drunkenness lasts 2 hours and X gets drunk (a second level action) Y can then move to the club, a first level action, and get drunk. Providing Y gets drunk within 2 hours of X becoming drunk the preconditions of them starting to mutually fancy one another will have been satisfied and thus the dilemma will be possible and presented. At the same time, in another location, Z could be encouraging W to betray a principle, and W may only experience the betray principle dilemma after an hour of encouragement from Z.

The narrative could take place in real time. This would mean that the game was a simulation of the real world. If the user is free to act at a very low level and the narrative is generated in real time then a large number of acts will be mundane and boring, thus reducing the dramatic interest of the experience for

the user. This is one of the shortcomings of *The Sims* [58] in which the user must instruct characters to take menial actions such as going to the toilet. It is unnecessary to involve the user of the GADIN system in such actions and is likely to detract from the dramatic interest of their experience.

In non-interactive narratives the action generally shifts between compelling scenes involving major storylines. The audience will observe the important aspects of the narrative but not every detail. The user of an interactive narrative may feel a loss of control if they are not aware of these details. A compromise which allows the user to feel fully in control of their actions within the virtual world without occupying them with low-level irrelevant tasks must be found. It is unnecessary for the user to have to sleep within the storyworld as this would be boring. A potential solution would be to allow jumps in time.

The control of time jumps could be by the system, which would identify likely periods of no action and jump to an appropriate time, for example the morning. Even if there were no actions or dilemmas involving other characters in this period the user may still feel that they had missed something. They might also have preferred to have been able to act during that time, and thus would experience a loss of control within the storyworld. It might be more appropriate to allow the user to determine when time would be skipped and for how long. However they would then have the potential to destroy the narrative or to not see any action involving other characters which might take place within this time period.

Allowing the user to choose to 'jump time' but still presenting other characters' actions in this time (if appropriate for the domain) may be the most appropriate option, or allowing the user to choose to let the system jump to the next period of activity. Fast forwarding action may allow the user to see that they are not missing anything, and to pause this when they feel that they want to re-join the narrative. In a narrative in which the action takes place in more detail it might be possible for the fast forwarding option to involve the action taking place with a similar level of abstraction to that in the current version of the GADIN system. This would thus mean that the user would still see all of the action and experience dilemmas but would not observe mundanities. It would detract from the detail of the experience but would not be necessary for the entire experience.

8.5.13   Occurrences

An occurrence is not initialised by any character, but affects a character or more than one character. The characters involved are passive participants in an occurrence, unlike in events in which they are an active participant. Examples include accidents, illnesses and unexpected extreme weather. In some domains it may be appropriate to incorporate occurrences in the narrative. Occurrences are likely to lead to further action and related dilemmas. For example if the system makes a character ill there may be gossip spread about the illness, or possibly fundraising to help the family.

8.6   Extending application domains

This section begins by discussing possible improvements to the current versions of GADIN (sections 8.6.1 and 8.6.2) and further narrative potential for the system (section 8.6.3). Although the GADIN system is designed for entertainment it also has further applicability. The applicability of GADIN is discussed in the context of computer games (section 8.6.4), therapy (section 8.6.5) and education (section 8.6.6).

8.6.1   Extending the soap version

In addition to the extensions already discussed (section 8.5) there are a number of domain-specific improvements which could be made to the soap version of the GADIN system. These include (but are not limited to):

- Relationships can be extended to involve:
  - A link between fancying and liking for characters with an appropriate nature.
  - Familial relationships, and associated actions and dilemmas.

- More events could be included, and have more effects associated.

- Different reasons for interrupting weddings should have unique probabilities associated.

- Action responses should occur following event outcomes, for example if a proposal is refused the rejected character should have a change in utility and a resultant response — which may or may not involve ending the relationship.

- There should be more which characters are able to disapprove of, for example friendships as well as relationships.

- Characters should be able to persuade others further, for example to propose (or not to).

- The dilemma involving a character deciding whether to keep their baby can be extended to after it is born, and to family members making a similar decision regarding the fate of that baby.

- Knowledge of further items, such as pregnancies, should be incorporated.

- Pregnancies should not always have a known father.

- Knowledge of affairs should not necessarily involve a character knowing who the affair is with.

- Characters should be (potentially) told about affairs that they are rumoured to be involved in and be able to deny these, in which they may not be believed. Other circumstances involving changing or losing knowledge could be incorporated (section 8.5.8).

- Characters being incarcerated in a prison should be removed from the narrative, at least temporarily.

- A drugged character should be drugged (and thus temporarily more vulnerable) in the state.

- Betraying a friend by reporting them for a crime should involve hidden crime knowledge. It should also be possible for characters to be disbelieved when accusing another.

- It should be possible for characters to make accusations with incomplete information which may lead to revelations.

- Threats could be added, for example of violence if characters do not cooperate — these may be perceived threats. Violent actions should also be possible.

- With more characters it would be possible to cycle character involvement in dilemmas.

Using the soaps available within the GADIN system it would be possible to create a combination of these. This would enable the user to become a character (or observe a non-interactive narrative) in a mixed soap, containing their preferred characters from each. This could result in interesting interactions.

8.6.2 Extending the dinosaur version

The dinosaur adventure version of the GADIN system could be extended to include further characters, objects, locations, actions and dilemmas, as appropriate for the domain. It may also be an improvement if a map of the world is generated dynamically to add further originality as in Tale-Spin [78]. Rather than only moving between significant sites the user could then move between sub-locations, which would be dynamically defined by a continuum of co-ordinates during the experience.

8.6.3 Other narratives

In the soap version of GADIN the dilemmas are selected from British 'family' soaps and are also particularly applicable to Australian soaps such as *Home and Away* and *Neighbours*. The system could be extended to be more applicable to soaps from other countries and their peculiarities, such as American, Hindi and Mexican soaps — all of which have large audiences. These have many similarities to British soaps but differ in some of the dilemmas experienced, although still within the same dilemma categories. Similar techniques would allow the application of the GADIN system to serials, as many of the dilemmas are similar. Serials are more complex as they require some of the techniques for generation of a finite narrative (sections 4.8 and 8.5.6) to ensure that over the series a plot arc is experienced, and in some serials each episode also requires a plot arc.

The techniques and style of narrative used in the dinosaur adventure could be applied to similar scenarios. Rather than the user being transported to a dinosaur world they could be transported to a pirate ship on which the other characters are pirates, where they might share treasure and sing shanties together. Other possible storyworlds include an island with monkeys, or more

commercial worlds such as a *My Little Pony* [114] storyworld. It would be possible for the system to select between these possible worlds. This would be more appropriate if the system had previous knowledge of the user and their preferences and could thus choose the most appropriate storyworld for them to be transported to.

The GADIN storyworld can be applied to any narrative which utilises clichéd storylines. Some of the possibilities are:

- A *James Bond* [27] style narrative. In this the user could take the part of James Bond, and other characters will experience less dilemmas, if any. The user will be unable to die even when in situations where they should — as in *James Bond* adventures a 'miraculous' occurrence will prevent this. In such action-based narratives the dilemmas could be adapted to incorporate non-conflicting situations. For example there could be a 'deadline' situation in which James Bond must prevent a bomb from going off — this is similar to a Betrayal dilemma but the characters are enemies. However there will still be tension created within the narrative as it is not a definitely achievable action.

- A Dickensian narrative [18]. To achieve this all of Dickens' characters could be incorporated into a world, with associated likely actions. Dilemmas which have occurred in his novels could be generalised and made available to GADIN. The system could then generate original interactive narratives within this domain.

- A *Lord of the Rings* [113] adventure, in which the user may take the part of Frodo or one of his companions and experience dilemmas appropriately. The restriction on this is that *The Lord of the Rings* will always result in the same narrative and it may be contrary to the user's expectations to experience an original narrative in this.

As discussed it is difficult for existing well-known narratives to be made into narratives in the GADIN system as the generation of a unique narrative will contradict the structure and inevitability of the original narrative. It may alternatively be possible for existing narratives to be utilised by the system in another way. This would take the storyworld at a certain (user-selected) stage and allow the user to become a character from that state. They would then be able to explore other alternatives for this existing narrative, while still experiencing a dramatically interesting narrative. For example a user may choose to explore what could have happened if Romeo had not killed himself in Shakespeare's *Romeo and Juliet* [101]. This is possible due to the capability of the GADIN system to generate a variety of narratives given the same starting point — which may be any stage in an existing, established narrative.

8.6.4   Computer Games

An interactive narrative experience can be considered as a game. It can also be utilised as a component of the overall gameplay of existing computer games. For example in an exploratory game, such as *Fable* [45], a player could enter a town and could experience an original narrative within that town. This narrative would probably not have an effect on the overall game as there is no

correct way to experience a GADIN interactive narrative. In a game such as *Grand Theft Auto* [57] it may be possible for the player to experience a GADIN narrative as a mission, which may result in their gaining money. As money is such a fluctuating commodity in this game the value of this would be unlikely to affect the gameplay or the player's perception of the narrative experience. The advantage would be the experience of a completely original narrative as a mission. This would potentially be extendible to any games which use missions, or quests, and to all such missions — as discussed here.

Quest creation is problematic in massively multi-player online role playing games (MMORPGs). It is time-consuming for the author and often unsatisfactory for the players. These quests are linear and tend to be very similar in structure to one another. It would be advantageous for the quests to be automatically generated, non-linear and adaptive to the player. If GADIN were used for this all that would be required is the definition of applicable actions, dilemmas and characters. Within an MMORPG most of the characters and all of the actions will already be defined. This only leaves the creator to define dilemmas, and these are defined generally so that they will be reusable between quests, unrecognisably, depending on applicability — as defined by the author and recognised by GADIN. With this method the player will be given quests in the achievement of which they will experience a number of obstacles, or dilemmas. Within the structure of the GADIN system such quests may be relationship-based, or more traditionally mission-based. This will result in quests which are truly unique for each individual player, and which have an original and interesting outcome.

8.6.5 Therapy

The ability for users to create their own storyworld means that they can design it to represent a familiar, or feared, scenario. They will then be able to explore the possibilities which could result from their actions. The user may also choose not to become a character and instead observe the action that may result from certain scenarios. This may help users to deal with new or difficult situations as they will be more aware of the potential implications of their actions. They will be able to explore many different possibilities from any starting point. It may be feasible for the user to utilise such a system to help them to cope with addictions or phobias — by exposure to realistic, simulated scenarios within a GADIN narrative.

In the GADIN system the user is able to 'be themselves', they are not required to take on a role. Yet when users are observed interacting with the system they tend to take on a (self-defined) role, for example choosing to be flirtatious. This is necessary in experiences in which they are interacting with characters of whom they have no previous knowledge. It also gives them the opportunity to perhaps act as the person who they would be if there were no implications. Although the user is not taking on an explicit role they are becoming someone other than themselves. In many ways this is the appeal of the genre. The crucial aspect is that the role is defined by the user. If the system were applied in therapy this may be different as sometimes a role would be necessary or useful for therapeutic purposes. In these circumstances it is more likely that the user would act in a manner consistent with their real world actions and the relevant constraints would need to be applied initially.

Drama therapy is a well-known psychological technique [122]. In this the subject may interact with other humans. To reduce the need for this, and the inevitable restrictions on actions that could result from the presence of others, a computerised therapy system — using system-controlled characters — could be utilised. The role-playing scenarios often used in therapy could also be applied within GADIN, these may then become more personal and more true to the other characters involved. This would still require the involvement of a psychiatrist and would not be a stand-alone technique. It would need to be ensured that the user did not experience dilemmas or outcomes which could negatively affect their condition.

The relevance and applicability to autism, and Asperger syndrome, of the GADIN system could be explored further, as the techniques seem to be particularly relevant to such conditions.

8.6.6 Education

The GADIN system could be applied to an educational domain. The dilemmas could represent social norms or lessons that it is required that the user learn. The dilemmas should not be too explicit as otherwise this could become a clearly educational medium which would reduce the quality of the narrative experience for the user. In teaching moral values to users there is not always a clear right and wrong choice. It would be possible to incorporate this into the GADIN system due to the non-deterministic factors. Some research has been carried out into applying the GADIN planner and core techniques to an educational domain [60]. In this the dilemmas are known as 'teaching moments' and present the users with such moral dilemmas.

It would also be possible to apply the techniques used in the dinosaur adventure version of GADIN to education. In this the users could be transported into a storyworld in which the other characters were appropriately selected for the world which the children were currently studying. The users may then be able to select characters, objects and locations to learn about them. In this the users would be able to explore a world about which they had learnt while experiencing an original narrative. This technique may be particularly useful for children with short attention spans or learning difficulties, in that it adds an additional element of fun to learning.

8.7 Multi-user

A type of multi-user narrative would result from the use of the techniques discussed in section 8.5.11. This would involve a user interacting with a storyworld for a period of time before passing on the state of that world to another user. They would then be able to interact as any character, before potentially passing it on again. In this the users could each control a set character, or swap depending on their preferences.

It would be possible to allow more than one user to interact within the storyworld simultaneously. The users could remain consistent and aware of one another, or be unaware of whether the other characters were human or system-controlled. With the latter option and an infinite narrative users could join whenever they wanted, whether as a new or existing character. There could be

virtual communities in dramatically interesting interactive worlds which may be closed to others, or allow non-participants to view the interactions. This would result in planning complexities and potentially reduce the likelihood of plans being followed. Coercions would also be more difficult with less, or even no, system-controlled characters.

In the prototype online version of the GADIN system it was found that it is possible to extend the system to enable more than one user to interact simultaneously, through the use of global classes. When a user enters the system the previous users are already present in the narrative and their actions affect the narrative experienced by the new user. There are complexities which prevented this from being easily investigated further, for example the assignment of a reference number of 1 to each user and the lack of an ability to allow the system to take control of a user who is no longer interacting — particularly if the user does not signify that they have left.

A narrative in which only the protagonist experiences dilemmas, such as the dinosaur adventure application, could be extended to a multi-user version by allowing more than one user to be transported to the storyworld at the same time. These users may or may not be previously aware of one another and be transported together. They may cooperate to be able to leave the world. Such an experience would be less similar to those in existing narratives and more like a computer game.

A multi-user version of GADIN would enable studying of group behaviour and how this affects the individual's enjoyment.

8.8   Summary

In this thesis a system which generates adaptive dilemma-based interactive narratives (GADIN) has been described. This system has been demonstrated to improve on the state of the art in previous interactive narrative systems by achieving a higher level of compellingness, which requires: interestingness; immersion; scalability; domain independence; agency; and replayability. This system generates interesting and potentially immersive interactive narratives. GADIN is easily applicable to a wide range of domains, and is able to sustain the dramatic interest of the narrative indefinitely if required for the domain, or achieve a changeable storygoal. The users rated their level of freedom reasonably highly, and this can be increased. Participants observed a clear immediate and long-term effect of their actions. Each GADIN narrative has been shown to be unique.

A
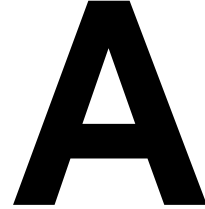
The soap version of GADIN

In this appendix the available actions and soap-specific worlds for the soap version of GADIN are detailed.

A.1 Actions

In this section the actions which are available within the current soap version of GADIN are given, with their applicability conditions where relevant.

- Friendship-based actions:

  - Starting to like another character
    * Applicable if the character is not the user (the system never assumes that the user will start to like another character).
  - Stopping liking another character

- Relationship-based actions:

  - Flirting with another character
    * Applicable if the genders of the characters are appropriate.
  - Starting to fancy another character
    * Applicable if the genders of the characters are appropriate and, for X starting to fancy Y, one of the following conditions is true:
      · Y has the highest possible attractiveness and fancies X, who has a lower level of attractiveness;
      · Y has the highest possible attractiveness and X has a lower level but has the highest level of generosity and fancies Y;
      · Y has a 'bad boy' personality.

* It is applicable for characters to start to mutually fancy one
  another if their genders are appropriate and one of the following
  conditions is true:
    · The characters have the same level of attractiveness and are
      flirting with one another;
    · The characters are both drunk;
    · The characters are both old.
* Relaxed applicability conditions allow any character to start to
  fancy any other character.
  – Stopping fancying another character
  – Asking another character to go out with them, which can be accepted
    or rejected by that character
  – Asking another character to start an affair with them, which can be
    accepted or rejected by that character
  – Ending a relationship or affair with another character
    * Applicable if the deciding character is not the user (the system
      never assumes that the user will end their relationship with an-
      other character).

- Actions concerning the relationships of other characters:
  – Disapproving of a relationship between two other characters (whether
    it be an affair or a partnership)
    * Reasons for disapproval which are dependent on applicability are:
      · 'Age difference', which requires that the age groups of the
        characters in a relationship be different;
      · 'Homosexuality', which requires that the genders of the char-
        acters in a relationship be the same;
      · 'Private reason', which requires that the disapproving char-
        acter be the user (this enables the planner to plan for the
        user disapproving of relationships for a reason which may
        not be known to the system).
  – Telling another character about an affair between two characters
  – Trying to persuade another character to disapprove of the relation-
    ship between two characters
  – Making up an affair between two characters

- Actions involving principles and crimes:
  – Betraying a principle
  – Encouraging a character to betray their principle
  – Trying to persuade a character to encourage a third character to
    betray a principle
  – Committing a crime (possibly with a victim)
    * Applicable if it is possible to commit that crime at the location.
  – Accusing a character of having committed a crime

- Movement-based actions:

  - Moving between two locations

  - Inviting another character to join in a move between two locations, which can be accepted or rejected by that character

- Socialising actions:

  - Getting drunk

    * Applicable if the location is one at which it is possible to drink.

  - Buying a drink for another character, which can be accepted or rejected by that character

- Miscellaneous actions

  - Becoming pregnant

    * Applicable if the character who becomes pregnant is female and the character who they are pregnant by is male.

For the genders of the characters to be appropriate it should be required that they have genders and sexualities that correspond to their being likely to fancy one another. However in the implementations used for the full evaluation of the interactive soap the default for this was overridden to increase the dilemmas experienced by characters other than the user, this was found to be necessary due to the limited number of characters available.

The crime of drugging another character will optionally have an applicability check which ensures that it will only be made available to the planner once in every two times it is otherwise applicable, as discussed in section 5.3.2.

A.2   Storyworlds

In this section the storyworlds available for the evaluation of the soap version of the GADIN system are detailed. Soaps change quickly and thus these settings were only accurate at the time of creation. For some of the soaps there are two alternative versions, because the original version became outdated — and the majority of the testing (although not all) used the more recent, updated storyworld settings. The state was updated to remove no longer present characters and end no longer existing relationships, and feelings were updated wherever this was relevant.

In the tables showing the storyworld details some abbreviations are used, namely: A = attractiveness; G = generosity; M = morality; S = selfishness; b.d.f.o. = buying drinks for others (to drink at the characters' current location), m.a. = middle aged, homo = homosexual, hetero = heterosexual, bi = bisexual. The restrictions on each location are based on observation of possibilities within soap worlds rather than the 'real' world.

The default characters and locations (the 'imaginary new soap' option) available in the soap version of the GADIN system are shown first. Those characters included in each narrative generation are selected non-deterministically from the possibilities. All of the locations are included.

- Characters:

Name	Gender	Sexuality	Age group	A	G	M	S
adam	male	hetero	young	1	1	1	-1
tess	female	hetero	young	0	1	-1	1
joe	male	hetero	m.a.	1	0	-1	1
fred	male	homo	teen	0	-1	-1	-1
edna	female	hetero	old	-1	0	1	0
mary	female	hetero	young	1	1	1	0
john	male	hetero	m.a.	1	1	1	-1
bob	male	hetero	m.a.	-1	-1	-1	1
bert	male	hetero	old	-1	1	1	-1
jill	female	homo	young	1	0	-1	0
tim	male	homo	young	1	0	0	0

- Special cases: joe is a 'bad boy'; edna is a 'nosy parker'

- Locations:

	What is possible there				
Name	Parties	Stealing	Drinking	b.d.f.o.	Prison
club	Yes	No	Yes	Yes	No
shop	No	Yes	No	No	No
house	Yes	No	Yes	No	No
shed	No	No	Yes	No	No
jail	No	No	No	No	Yes
park	Yes	No	No	No	No

Existing soaps (with characters and locations) currently available in the GADIN system are shown below. The characters included in each experience are selected non-deterministically. All of the locations given here are included in each experience. The location names are simplified versions of locations in the existing soaps. Initial partnerships are only utilised if both of the involved characters are selected for the current narrative generation. The initial feelings of characters for one another are representative of those at the time which the storyworld was created. Since the state of soap storyworlds constantly changes this is now outdated. The initial settings for each existing soap used in the full evaluation are given here.

- *Hollyoaks*
  There are two possible groups of *Hollyoaks* characters available to GADIN. One is that used for the Turing test comparison (section 7.2), and this was not updated in the later testing, but was offered as a special option. This involved Hannah, John-Paul, Sarah, Craig and Spike.

    - Characters:

Name	Gender	Sexuality	Age	A	G	M	S
mercedes	female	hetero	young	1	-1	0	1
russ	male	hetero	young	1	1	1	0
zoe	female	hetero	young	1	1	1	0
clare	female	hetero	young	1	-1	-1	1
darren	male	hetero	young	1	-1	0	1
justin	male	hetero	young	1	0	0	1
hannah	female	hetero	young	1	0	0	-1
johnpaul	male	homo	young	1	1	1	0
sarah	female	hetero	young	1	0	1	1
craig	male	bi	young	1	0	0	1
spike	male	homo	young	1	0	0	0

− Initial feelings:

Character	Likes	Fancies
mercedes	russ	russ
russ	mercedes, zoe, darren	mercedes, zoe, clare
zoe	mercedes, russ	russ
clare	justin	justin
darren	mercedes, russ, zoe	mercedes, zoe, clare
justin	mercedes, russ, zoe, clare, darren	mercedes, zoe, clare
hannah	johnpaul, sarah, craig	johnpaul
johnpaul	hannah, sarah craig, spike	hannah, sarah, craig, spike
sarah	johnpaul, hannah, craig	craig
craig	johnpaul, sarah, hannah	sarah
spike	johnpaul, sarah	johnpaul

− Potential initial partnerships: mercedes and russ; craig and sarah

− Updated characters:

Name	Gender	Sexuality	Age	A	G	M	S
mercedes	female	hetero	young	1	-1	0	1
russ	male	hetero	young	1	1	1	0
zoe	female	hetero	young	1	1	1	0
steph	female	hetero	young	1	-1	-1	1
darren	male	hetero	young	1	-1	0	1
justin	male	hetero	young	1	0	0	1

− Updated initial feelings:

Character	Likes	Fancies
mercedes	russ	russ
russ	mercedes, zoe, darren	mercedes, zoe, steph
zoe	mercedes, russ	russ
steph	darren	
darren	mercedes, russ, zoe, steph	mercedes, zoe, steph
justin	mercedes, russ, zoe, darren	mercedes, zoe

− Locations:

	What is possible there				
Name	Parties	Steal	Drink	b.d.f.o.	Prison
loft	Yes	No	Yes	Yes	No
drivenbuy	No	Yes	No	No	No
ilgnosh	Yes	No	Yes	Yes	No
laundry	No	No	No	No	No
jail	No	No	No	No	Yes
dog	Yes	No	Yes	Yes	No

- *Eastenders*

  - Characters:

Name	Gender	Sexuality	Age	A	G	M	S
dawn	female	hetero	young	1	0	0	1
minty	male	hetero	young	0	1	1	0
gary	male	hetero	young	0	0	1	0
chelsea	female	hetero	young	1	-1	0	1
max	male	hetero	m.a.	0	0	0	1
ronnie	female	hetero	young	0	0	0	0

  - Initial feelings:

Character	Likes	Fancies
dawn	minty, gary, chelsea	
minty	gary, max, ronnie	dawn, chelsea, ronnie
gary	minty, dawn, max, ronnie	dawn, chelsea
chelsea		
max	minty, gary	chelsea, ronnie
ronnie	minty, gary, max	

  - Updated characters:

Name	Gender	Sexuality	Age	A	G	M	S
dawn	female	hetero	young	1	0	0	1
minty	male	hetero	young	0	1	1	0
gary	male	hetero	young	0	0	1	0
chelsea	female	hetero	young	1	-1	0	1
jack	male	hetero	m.a.	0	0	0	1
ronnie	female	hetero	young	0	0	0	0

  - Updated initial feelings:

Character	Likes	Fancies
dawn	minty, gary, chelsea	jack
minty	gary, jack, ronnie	dawn, chelsea, ronnie
gary	minty, dawn, jack, ronnie	dawn, chelsea
chelsea		
jack	minty, gary	chelsea, ronnie
ronnie	minty, gary	jack

  - Locations:

	What is possible there				Prison
Name	**Parties**	**Steal**	**Drink**	**b.d.f.o.**	**Prison**
queenvic	Yes	No	Yes	Yes	No
shop	No	Yes	No	No	No
club	Yes	No	Yes	Yes	No
cafe	No	No	No	No	No
jail	No	No	No	No	Yes
park	Yes	No	No	No	No

- *The Archers*

  - Characters:

Name	**Gender**	**Sexuality**	**Age**	**A**	**G**	**M**	**S**
helen	female	hetero	young	1	1	0	0
joe	male	hetero	old	-1	0	-1	1
will	male	hetero	young	1	1	0	0
brian	male	hetero	m.a.	0	0	-1	0
jennifer	female	hetero	young	1	0	1	0
siobhan	female	hetero	young	1	0	0	1

  - Initial feelings:

Character	**Likes**	**Fancies**
helen	siobhan, jennifer, will	will
siobhan	helen, will, brian	brian
jennifer	helen, will, brian	brian
will	helen, siobhan, jennifer, joe, brian	helen
joe	helen, siobhan, will, brian	helen, siobhan
brian	helen, siobhan, jennifer, will	helen, siobhan, jennifer

  - Potential initial partnerships: jennifer and brian

  - Locations:

	What is possible there				Prison
Name	**Parties**	**Steal**	**Drink**	**b.d.f.o.**	**Prison**
bull	Yes	No	Yes	Yes	No
villageshop	No	Yes	No	No	No
homefarm	Yes	No	Yes	No	No
stables	Yes	No	Yes	No	No
jail	No	No	No	No	Yes
villagehall	Yes	No	No	No	No

- *Coronation Street*

  - Characters:

Name	Gender	Sexuality	Age	A	G	M	S
leanne	female	hetero	young	1	1	-1	0
janice	female	hetero	m.a.	0	0	0	0
becky	female	hetero	young	1	1	1	1
liam	male	hetero	young	1	1	0	0
jason	male	hetero	young	1	0	0	0
steve	male	hetero	young	0	1	1	0

– Initial feelings:

Character	Likes	Fancies
leanne	janice, sarah, liam, steve	liam
janice	leanne, sarah, liam, jason, steve	
sarah	leanne, janice, liam, jason	liam, jason
liam	leanne, janice, sarah, steve	leanne, sarah
jason	leanne, janice, sarah, liam, steve	leanne, sarah
steve	leanne, janice, sarah, liam, jason	leanne

– Potential initial partnerships: sarah and jason

– Updated characters:

Name	Gender	Sexuality	Age	A	G	M	S
leanne	female	hetero	young	1	1	-1	0
janice	female	hetero	m.a.	0	0	0	0
sarah	female	hetero	young	1	1	1	1
liam	male	hetero	young	1	1	0	0
jason	male	hetero	young	1	0	0	0
steve	male	hetero	young	0	1	1	0

– Updated initial feelings:

Character	Likes	Fancies
leanne	janice, becky, liam, steve	liam
janice	leanne, becky, liam, jason, steve	
becky	leanne, janice, liam, jason	liam, jason
liam	janice, becky, steve	becky
jason	leanne, janice, becky, liam, steve	leanne, becky
steve	leanne, janice, becky, liam, jason	leanne

– Locations:

	What is possible there				
Name	**Parties**	**Steal**	**Drink**	**b.d.f.o.**	**Prison**
rovers	Yes	No	Yes	Yes	No
cornershop	No	Yes	No	No	No
newsagents	Yes	No	Yes	No	No
factory	No	No	No	No	No
jail	No	No	No	No	Yes
allotments	Yes	No	No	No	No

B

An example soap story

An extract of the narrative generated in one user's (jim) experience with the soap version of GADIN is shown here. Line numbers are listed for reference purposes. User input is shown in bold, with a **n** used to signify the user returning control to the system. Jim is male and young. In the initial state the other characters are tess, edna, mary and fred. The initial feelings, locations and principles held are as follows:

- tess likes edna, mary and fred and fancies edna and jim. She is at the park and holds both principles.

- edna likes tess and fred and fancies tess. She is at the park and holds both principles.

- mary neither likes or fancies any other characters. She is at the house and holds both principles.

- fred likes tess and mary but fancies none of the other characters. He is at the house and holds the principle of not drugging but not the principle of not stealing.

- jim (the user) likes mary and fancies edna. He is at the club and holds both principles.

1 -**n**

2 Action is mary moves between house and club

3 -**move club**

4 You are already at the club!
5 -**n**
6 Action is edna starts to fancy you

7 Action is mary gets drunk

8 -**n**
9 mary offers to buy you a drink. Will you accept?
10 **y**
11 You accept the drink from mary and get drunk

12 -**n**
13 edna asks you out.
14 Will you go out with edna who you fancy and who fancies you?
15 **y**
16 You are now partners with edna

17 Action is mary starts to fancy you

18 -**fancy mary**
19 You start to fancy mary

20 You are going out with edna.
21 Will you cheat on edna with mary who you fancy and who fancies you?
22 **y**
23 You are now cheating on your partner edna with mary.

24 **n**

25 Action is fred encourages edna to break their principle of not stealing

26 fred is encouraging edna to betray their principle of not stealing
27 edna likes fred and decides to agree to betray their principle
28 edna no longer holds the principle of not stealing
29 As a result of this choice, fred likes edna more.

30 -**flirt tess**
31 You flirt with tess

32 -**n**

33 Action is tess moves between park and club
34 Action is tess flirts with you

35 -**n**
36 You are going out with edna, and cheating on edna with mary.
37 Will you leave your partner edna to go out with mary?
38 **y**
39 You are now partners with mary and no longer going out with edna.

40 -**n**
41 You have found out that your friend mary's mother is in an institution
42 Will you tell them ('y') or keep this a secret ('n')?
43 **y**

44 You have chosen to share this news
45 Everyone now knows this.

46 **-n**
47 Action is fred moves between house and club
48 Action is fred gets drunk
49 Action is tess gets drunk
50 tess starts to mutually fancy fred

51 tess has to choose whether to partner edna or fred
52 Where tess fancies both potential partners and the feeling is mutual
53 tess decides to go out with fred
54 They are now partners, and edna no longer fancies tess

55 **-disapprove tess fred**
56 You express your disapproval of the relationship between tess and fred

57 **-n**
58 You disapprove of tess's relationship with fred
59 tess ignores your opinion as they do not like you.

60 **-drunk**
61 You get drunk
62 **-n**

63 Action is fred gets drunk

64 **-n**
65 Action is fred starts to fancy you

66 **-n**

67 Action is edna starts to fancy you

68 You are going out with mary.
69 Will you cheat on mary with edna who you fancy and who fancies you?
70 **n**
71 You have chosen not to cheat on your partner.
72 As a result of this choice, edna fancies you less.

73 **-n**
74 Action is edna begins to disapprove of fred's relationship
75 due to the age difference

76 edna disapproves of fred's relationship with tess
77 fred likes edna and must thus decide whether or not to respect their opinion
78 and end the relationship
79 fred decides to end their relationship.
80 fred and tess are no longer partners
81 edna now likes fred more.

C

Dinosaur adventures

This appendix gives the story records (section 5.4.10) from two users' experiences with the dinosaur adventure version of GADIN. In these examples the user's selected actions and dilemma decisions are shown in bold. The dinosaur actions are shown in italics and dilemma points are underlined. Goal communication points are given in italics and underlined for clarity.

C.1   Billy's story

The relation of the story experienced by a user, Billy, is shown in full here.

```
Billy is playing with Timothy.
Timothy has a new toy, which he says is a time machine.
He says that he will show Billy, says
```
"Try to get ptero to like you!",
```
    grabs Billy's hand and presses a button...
Billy is in a forest!  The forest is densely packed with trees.
Billy can see diplo but can't see Timothy anywhere
```
Billy asks diplo to play
diplo decides to play with Billy
```
Billy finds steg's nest
```
diplo is encouraging Billy to steal an egg from steg's nest
Billy likes diplo and decides to agree to steal an egg
```
Billy now owns this egg
```
ptero goes to the forest extremely grumpily and clumsily
Billy says ptero looks nice
ptero is pleased and becomes Billy's friend
```
'Wake up Billy!'
It's Timothy.  Billy is at home, and Timothy has just arrived.
```

C.2   Lucy's story

The relation of the story experienced by another user, Lucy, is shown in full here. In this case achievement of the first story goal becomes unlikely, so a new goal is chosen and communicated to Lucy.

Lucy is playing with Timothy.
Timothy has a new toy, which he says is a time machine.
He says that he will show Lucy, says *"An egg might be a portal"*,
    grabs Lucy's hand and presses a button...
Lucy is suddenly alone in a forest!
The forest is densely packed with trees.
Lucy looks around
Lucy moves to the mountain
The mountain is very rocky, and has beautiful views
Lucy finds steg's nest
Lucy asks diplo to play
diplo decides to play with Lucy
ptero aggressively asks Lucy to play
Lucy decides to play with ptero
ptero throws a stone at diplo aggressively
ptero and diplo both want to play with Lucy
They refuse to play together
Lucy chooses to play with diplo.
ptero leaves the mountain agilely
Although Lucy has now found steg's nest, she has shown no interest in taking an egg from it. Since achievement of this goal now looks unlikely, a new storygoal is selected and planned for and the story continues accordingly. There is no break.
diplo says 'See if you can get ptero to throw a stone at you'
Lucy moves to the forest
Lucy draws a picture for steg
steg likes the picture so steg and Lucy become friends
Lucy asks steg to go with them to the desert
steg decides to join Lucy in moving to the desert
Lucy and steg are now at the desert
trex wants to be Lucy's friend
Lucy and trex become friends
Lucy likes diplo and steg
Both of them want Lucy's marble
Lucy decides to give the marble to diplo
diplo now owns the marble.
ptero throws a stone at Lucy angrily
Lucy hears a whooooosh!
    and before there is time to blink is back at home.
Lucy never found that marble.

D

Soap evaluation questionnaires

In this appendix the questionnaires used in the evaluation of the soap version of the GADIN experience are given. Section D.1 shows the early questionnaire, used for the first formal evaluation and the real life experiment. The questionnaire used in the later evaluation is given in section D.2.

D.1 Early questionnaire

(1 is lowest, 5 is highest)

How would you rate your computer ability?	1	2	3	4	5
How interesting would you say the story was?	1	2	3	4	5
How enjoyable would you say your experience was?	1	2	3	4	5
Did you believe in the storyworld?	1	2	3	4	5
Did you care about the other characters?	1	2	3	4	5
Did you feel that your actions were having an effect?	1	2	3	4	5
How hard would you say major decisions were to make?	1	2	3	4	5

How long did you play for? _____

How likely would you be to replay?	1	2	3	4	5

   Please could you give any other thoughts or feedback? (Anything at all)

D.2 Full questionnaire

How often do you usually play computer games?

At least once every...
day   week   fortnight   month   year   very rarely

How often do you usually watch soaps?

At least once every...
day   week   fortnight   month   year   very rarely

Were your options always clear to you?

confusing   1   2   3   4   5   6   7   obvious

Was what was happening in the storyworld always clear to you?

confusing   1   2   3   4   5   6   7   obvious

How interesting would you say the story was?

dull   1   2   3   4   5   6   7   fascinating

How dramatic would you say the story was?

no drama   1   2   3   4   5   6   7   very dramatic

How immersed were you in the experience?

not at all   1   2   3   4   5   6   7   completely

Did you feel that the storyworld was plausible?

very artificial   1   2   3   4   5   6   7   like real soap

Did you feel that the other characters were plausible?

very artificial   1   2   3   4   5   6   7   like real soap

Were you able to act whenever you wanted to in the story?

rarely   1   2   3   4   5   6   7   mainly

Were you able to act in the way you would expect to be able to?

rarely   1   2   3   4   5   6   7   mainly

Did you feel that your actions were having as much immediate effect as in the real world?

not at all   1   2   3   4   5   6   7   very much so

Did you feel that your actions were having as much long-term effect as in the real world?

not at all   1   2   3   4   5   6   7   very much so

How hard would you say major decisions were to make?

really struggled   1   2   3   4   5   6   7   always clear choice

How likely would you be to play again?

 never would   1   2   3   4   5   6   7   really want to

If this was not your first GADIN experience, how different was the narrative this time?

 not at all   1   2   3   4   5   6   7   significantly

Overall how would you rate your experience?

 poor   1   2   3   4   5   6   7   excellent

E

Results

This appendix gives detailed results from all of the evaluations of GADIN. Section E.1 gives the results of the experiment with human actors. In section E.2 the results of the first formal test are discussed. The results from the full evaluation of the soap version of GADIN are given, with averages, in section E.3. Section E.4 gives a discussion of and the results from the Levenshtein distance analysis of the narratives. Section E.5 shows the full transcripts from the soap user observation experiment. The results from the user model accuracy evaluation are in section E.6. The results of the dinosaur adventure evaluation are in section E.7.

E.1 Real life experiment

This section gives the responses to the questionnaires in the experiment with the soap version of the GADIN system and human actors. Section E.1.1 shows the results from the participants' questionnaire. In section E.1.2 the results from the questionnaire given to the actors is given, and section E.1.3 shows the results from the audience questionnaire. Each set of results is divided by the questions, followed by a tally of the number of questionnaire participants who gave each response.

E.1.1 Participants

In total there were 8 participants in this experiment. All were familiar with acting, they were mainly unknown to me and the questionnaires were anonymous.

How interesting would you say the story was?

1
2   1
3   6
4   1
5

How enjoyable would you say your experience was?
1
2
3   1
4   6
5   1

Did you believe in the storyworld?
1   3
2   3
3   2
4
5

Did you care about the other characters?
1
2   5
3   3
4   1
5

Did you feel that your actions were having an effect?
1
2
3   3
4   2
5   3

How hard would you say major decisions were to make?
1   1
2   4
3   2
4   1
5

Would you like to repeat the experience?
Yes   7
No   1

Would you try the experience on a computer-based system?
Yes   4
Perhaps (if easy to use)   1
Maybe   1
No   2

Please could you give any other thoughts or feedback? (Anything at all)[1]

---

[1] These comments are given exactly as they were written by the users, but comments given as different sentences are shown separately.

- Make sure the mellodion and dilemma voice-over stay in the computer-based system

- More variation of scenario

- Clearer aims, e.g. developing morality, etc.

- Could do with more options — lots of chatting up made it quite repetitive

- Other characters werent as involved

- A few more questions that werent just yes or no

- More realistic characters rather than caricatures

- Very innovative — not a familiar experience at all

- Because of audience actors and participants tried harder (too hard) to be funny

- Twist and cleverness makes it more interesting — this is too simple

E.1.2   Actors

There were 3 actors in this experiment. Two of these were male, with one playing the part of a female where necessary. All were previously known to me but the questionnaires were anonymous.

How interesting would you say the story was?
 1
 2
 3   3
 4
 5

How enjoyable would you say your experience was?
 1
 2
 3
 4   1
 5   2

Did you believe in the storyworld?
 1   1
 2   1
 3   1
 4
 5

Did you care about the other characters?
 1
 2   2
 3
 4   1
 5

Did you feel that your actions were having an effect?

 1
 2
 3
 4   2
 5   1

How hard would you say major decisions were to make?

 1   1
 2   1
 3   1
 4
 5

Would you like to repeat the experience?

 Yes   3

Would you try the experience on a computer-based system?

 Yes   3

Please could you give any other thoughts or feedback? (Anything at all)[2]

- Really enjoyable, would work really well as a game but would need more storylines.

- Could you get a TV expert to collaborate through watching soap operas and finding out the variety of things that can happen?

- More real and smaller circumstances and events

- With a bit more detail and levels of relationship, it could have been more successful

- Was great fun for the actors

- Perhaps initially a bit confusing

- Would like to see more dilemmas

E.1.3   Audience

Of the audience members 5 answered questionnaires, although they varied as to which questions they answered. All of the audience members who answered questionnaires were previously unknown to me, and the questionnaires were anonymous.

How interesting would you say the story was?

 1
 2
 3   3
 4   2
 5

---

[2]These comments are given exactly as they were written by the users, but comments given as different sentences are shown separately.

How enjoyable would you say your experience was?
 1
 2
 3
 4   2
 5   2

Did you believe in the storyworld?
 1
 2   3
 3
 4
 5

Did you care about the other characters?
 1
 2   1
 3   1
 4
 5

Did you feel that your actions were having an effect?
 1
 2
 3
 4
 5

How hard would you say major decisions were to make?
 1
 2
 3   1
 4
 5

Would you like to repeat the experience?
 Yes   2
 On a longer scale   1

Would you try the experience on a computer-based system?
 Yes   3
 No   1

Please could you give any other thoughts or feedback? (Anything at all)[3]

- Scenarios typical of soaps

- Not long enough to get attached to other characters

---

[3]These comments are given exactly as they were written by the users, but comments given as different sentences are shown separately.

E.2 First formal test results

A total of 8 people were experienced an early version of the soap opera version of the GADIN system and answered a questionnaire. Of these 4 were experienced game players (group A), the remainder were not (group B). The users played for an average of 7 minutes. Although the game world was very limited at the time of testing, resulting in a lack of breadth in the stories, this serves to demonstrate the usability and potential of these techniques. The following tables show the total number of participants who gave rated each question with the given score.

This table shows the results from group A's experiences.

Question	Rating				
	1	**2**	**3**	**4**	**5**
How interesting would you say the story was?	1	1	2		
How enjoyable would you say your experience was?		1	2	1	
Did you believe in the storyworld?	2	1	1		
Did you care about the other characters?		2	1	1	
Did you feel that your actions were having an effect?		1	1	2	
How hard would you say major decisions were to make?	1	3			
How likely would you be to replay?			1	1	2

This table shows the results from group B's experiences.

Question	Rating				
	1	**2**	**3**	**4**	**5**
How interesting would you say the story was?		3	1		
How enjoyable would you say your experience was?		3		1	
Did you believe in the storyworld?	1	2	1		
Did you care about the other characters?		4			
Did you feel that your actions were having an effect?		2	2		
How hard would you say major decisions were to make?		1		2	1
How likely would you be to replay?	1	2			1

This table shows the full results from all of the users' experiences.

Question	Rating				
	1	**2**	**3**	**4**	**5**
How interesting would you say the story was?	1	4	3		
How enjoyable would you say your experience was?		4	2	2	
Did you believe in the storyworld?	3	3	2		
Did you care about the other characters?		6	1	1	
Did you feel that your actions were having an effect?		3	3	2	
How hard would you say major decisions were to make?	1	4		2	1
How likely would you be to replay?	1	2	1	1	3

The comments given by the users on the system are shown, exactly as they were written by the users, here.

- Comments from group A users:

  - Needs 2 screens

  - Potential to be good but needs glitches ironed out

  - Keep going!

- Comments from group B users:

  – Set context so story is more understandable
  – More imaginative introduction to other characters pictures/actions
  – Would like to see picture of characters
  – Need graphics, sound and rewards

The users in group A found the narrative to have a reasonable level of interest, rating this and their enjoyment with an average score of 3/5. There was a strong belief that their actions were having an effect on the storyworld. None of these users believed in the storyworld but all felt that they would replay.

It was found that the users in group B struggled with the system. They felt a need for graphical depictions of other characters and their available options. In general, this group felt that the story had low interest and believability and only one enjoyed the experience. However they all felt that their actions were having some effect and all but one would almost certainly replay.

E.3   Interactive soap evaluation results

In this section the results from the main interactive soap evaluation are given. In these results the following abbreviations are used: d = daily; w = weekly; f = fortnightly; m = monthly; y = yearly; r = very rarely. A frequency of daily, weekly or fortnightly is considered to be regularly. Some questions were unanswered and these have been left blank. These users were excluded from averages for those criteria. The questions correspond to those in section D.2 and shown in the tables are a summation of those questions rather than the full question.

Tables E.1 and E.2 show the results from the user experiences with the soap version of GADIN in which dilemmas were experienced. Table E.3 gives the significant means and standard errors for these results: for all users; for users who regularly play computer games; for users who regularly watch soaps; and for users who regularly both play computer games and watch soaps. Table E.4 shows the results for the experience in which the users did not experience dilemmas, with the mean ratings and standard errors for each question also given. Averages for sub-groups of users were not considered to be appropriate for these results given the small number of users. Averages for the frequency of playing computer games and of watching soaps have not been calculated as this question was used solely to obtain demographic information which aids in analysis. The means for the total time the users spent experiencing GADIN have been rounded to the nearest half minute. The remaining means have been rounded to one decimal place, as have the standard errors for these results.

Shown below, exactly as they were entered by the users, are all of the user comments following their experience with the soap version of GADIN. Comments in separate paragraphs from the same user have been separated here for clarity.
The comments made by users of the experience with dilemmas were:

  • It was a typical soap story. I rarely find such stories interesting, and when i do, it is because i have developed an interest in the the characters. There was no character development, merely a list of actions. Therfore, the story was unengaging, yet very realistic in terms of what you would find in a real soap.

Length of experience (mins)	10	20	15	25	5	5	30	20	10	20	10	30	35	10	10	10	5	5	10
Frequency of playing computer games	r	w	d	r	w	w	r	f	r	m	m	w	m	y	r	r	r	m	r
Frequency of watching soaps	w	r	r	r	d	r	d	w	w	w	w	d	r	d	d	w	d	d	r
Clear options	6	3	4	4	6	5	3	6	2	3	5	3	3	4	2	5	3	4	5
Clear happenings	6	7	1	3	6	6	2	4	2	5	7	5	3	5	2	4	3	5	3
Interesting	4	5	1	2	7	1	4	5	1	3	5	1	3	4	2	3	4	3	3
Dramatic	4	3	3	2	5	3	5	4	1	3	3	2	3	5	5	3	4	3	3
Immersed	4	4	5	1	6	3	4	5	2	3	4	1	3	4	1	3	2	3	2
Plausible storyworld	6	7	5	7	6	3	6	4	2	5	5	2	4	4	2	2	2	4	5
Plausible characters	6	7	5	4	7	6	4	5	2	4	5	2	4	4	3	2	2	4	6
Able to act when wanted	6	7	5	6	4	5	3	4	6	7	7	6	5	6	2	4	6	6	4
Able to act as expected	6	6	5	3	5	3	4	3	3	5	6	2	3	5	2	3	3	5	4
Immediate effect of actions	5	7	5	7	4	5	2	3	2	3	5	3	4	4	1	3	1	5	1
Long-term effect of actions	4	4	7	4	5	6	1	3	3	4	5	1	4	2	1	3	1	3	3
Decisions were hard	4	6	6	5	5	5	6	6	5	6	7	6	4	3	4	4	7	5	3
Would play again	4	6	5	3	6	2	3	5	2	5	4	1	2	3	2	2	2	3	3
Overall	5	5	5	4	7	3	4	5	2	4	4	3	4	4	2	3	2	4	2
Significantly different to previous				4	6						6								

Table E.1: The first set of results from the full evaluation of the experience with dilemmas.

Length of experience (mins)	25	40	15	30	50	30	10	10	10	10	20	30	10	10	40	30
Frequency of playing computer games	m	d	r	d	w	w	w	w	f	d	r	f	w	w	w	w
Frequency of watching soaps	r	r	r	r	d	w	f	m	m	r	r	w	r	r	r	d
Clear options	3	6	3			5	5	2	6	4	5	5	5	2	3	5
Clear happenings	4	3	1			6	5	5	5	6	5	3	3	2	3	7
Interesting	1	4	6	3	4	5	6	6	4	6	3	5	4	2	1	3
Dramatic	2	5	1	4	4	5	3	5	3	6	2	3	2	3	4	5
Immersed	3	2	6			5	2	3	4	4	4	2	3	1	3	3
Plausible storyworld	5	1	3	6	4	5	5	5	4	2	3	5	5	4	6	5
Plausible characters	6	6	3	1	4	4	4	2	4	2	3	3	5	3	6	5
Able to act when wanted	4	3	1	6	5	6	2	5	5	6	6	5	6	6	7	7
Able to act as expected	2	5	5	2	5	4	4	4	4	4	2	3	5	2	4	7
Immediate effect of actions	3	6	1	5	5	5	3	5	4	7	6	6	5	5	7	5
Long-term effect of actions	4	7	6	5	4	3	3	4	4	6	5	5	5	3	4	5
Decisions were hard	5	2	2	2	2	6	4	4	2	6	4	6	5	6	7	6
Would play again	2	7	6	4	5	5	6	6	7	7	4	6	4	3	2	6
Overall	3	4	3			5	3	3	6	6	4	5	5	2	3	4
Significantly different to previous																

Table E.2: The second set of results from the full evaluation of the experience with dilemmas.

Question	All users		Regular computer game players		Regular soap viewers		Regular 'both'	
Length of experience (mins)	19	2	21	3	18	3	25.5	5
Clear options	4.1	0.2	4.4	0.3	4.0	0.3	4.4	0.4
Clear happenings	4.2	0.3	4.5	0.4	4.3	0.4	4.5	0.5
Interesting	3.5	0.3	3.8	0.4	3.8	0.4	4.5	0.7
Dramatic	3.5	0.2	3.8	0.3	3.7	0.3	3.8	0.4
Immersed	3.0	0.2	3.3	0.3	3.0	0.3	3.0	0.7
Plausible storyworld	4.3	0.3	4.4	0.4	4.1	0.4	4.5	0.4
Plausible characters	4.1	0.3	4.3	0.4	3.9	0.3	4.3	0.5
Able to act when wanted	5.1	0.3	5.3	0.3	5.1	0.4	4.8	0.5
Able to act as expected	3.9	0.2	4.1	0.3	4.2	0.3	4.1	0.5
Immediate effect of actions	4.2	0.3	5.0	0.3	3.6	0.4	4.3	0.4
Long-term effect of actions	3.9	0.3	4.4	0.3	3.1	0.3	3.6	0.5
Decisions were hard	4.7	0.3	4.8	0.4	5.1	0.3	5.1	0.5
Would play again	4.1	0.3	4.9	0.4	3.9	0.4	5.0	0.6
Overall	3.9	0.2	3.9	0.3	3.7	0.3	4.0	0.5

Table E.3: The averages and standard errors of the results from the full evaluation of the experience with dilemmas. These are for all users, those users who regularly play computer games, those users who regularly watch soaps and those users who regularly both play computer games and watch soaps. Each category has two columns associated, the first shows the mean rating and the second the standard error.

Time	15	30	10	10	15	10	10	10	10	15	15	15	14	1.5
Computer games	m	m	r	w	r	m	d	r	w	w	f	d		
Soaps	f	w	r	f	w	w	d	r	d	w	w	r		
Clear options	3	3	2	2	4	5	3	3	6	7	4	6	4.0	0.5
Clear happenings	5	1	6	3	5	2	4	3	5	6	5	6	4.3	0.5
Interesting	4	3	2	3	4	5	3	2	6	3	2	3	3.3	0.4
Dramatic	5	2	2	3	3	5	3	2	6	2	2	2	3.1	0.4
Immersed	5	1	2	4	4	3	4	3	4	2	3	4	3.3	0.3
Plausible storyworld	6	1	3	2	3	5	6	2	6	5	6	4	4.1	0.5
Plausible characters	5	2	3	2	3	4	6	3	6	5	6	5	4.2	0.4
Able to act when wanted	5	7	4	3	1	5	2	3	6	5	6	6	4.4	0.5
Able to act as expected	5	4	3	3	2	1	2	3	5	2	6	5	3.4	0.5
Immediate effect of acts	3	4	2	5	3	3	1	5	4	2	4	6	3.5	0.4
Long-term effect of acts	3	4	3	2	2	3	1	4	4	1	3	3	2.8	0.3
Decisions hard	4	5	5	5	4	4	3	5	3	2	4	7	4.3	0.4
Play again	5	1	2	3	4	6	3	2	4	4	3	5	3.5	0.4
Overall	5	2	2	3	4	5	4	3	6	3	4	5	3.8	0.4

Table E.4: The results for the evaluation in which the users did not experience any dilemmas. The second last column shows the means for these results and the final column shows the standard error.

- No goals to achieve means it can feel pointless without an empathy with the characters. There is also very little opportunity for positive feedback given the style of gameplay.

- I can imagine GADIN writing the next story line for Hollyoaks given a bit more depth to the available situations.

- As i dictated when the timeline progressed, there was no problem with the storyline advancing before i had chance to perform all actions i wanted to.

- The array of available commands was very narrow.

- There was a definite response to my actions.

- Characters had their alignments altered after player interaction, this ensured actions were not 'forgotten'.

- As i held no empathy with the characters, the decicions were always easy to make. decisions that were intended to cause a moral choice (let your friend take blame for a crime you commited) were'nt effective as i didnt care much about the outcome.

- It creates a storyline remarkably similar to a real soap within the interactions and events that are available to it. Given more events, commands, situations, better GUI and a means of turning the underlying system into an actual 'game', i would be very interested to see how it developed.

- The principles were named a little strangely, but otherwise everything seemed quite clear!

- It seemed quite clear. There seemed to be a bit of duplication of information in the left-most and middle panels.

- I was quite aware that I was conducting an experiment.

- It met my expectations for a prototype virtual soap: it felt a little artificial, but with a team of soap writers, I'm sure that'd be quite different!

- visual direction and interaction would make the expereince enjoyable along with dailog and plot (in the narrative sense of substantial description. As is it is pretty labourious and tiring!

- clear in the most basic of senses. stripped down and hollow. confusing to keep up with what each characters developments.

- Its kinda tedius to have to read it all, and then forget it almost instantly as its hard to connect with dry statements of fact, and read it all again.

- Felt like a simulation. Interest would really require this to be hidden, probably by fancy graphics!

- It felt too much like real life. One of them could have at least turned out to be an alien.

- I know its research, but the interface does detract quite a lot — you need to be able to figgure out whats going on at a glance. Some icons or colour coding might help. Playing with the layout also — obviously I doubt you could justify or find time for graphics! For selecting your next action mybe show a tree, where you expand it before selecting the final decision — so you can see all options quickly.

- The ongoing 'story' in the right-hand box was very clear, however the location (?) infomation in the left-hand boxes was not. It almost felt like 'behind-the-scenes' information I wasn't meant to see.

- Certainly, the location of characters is necessary, as well as their current attitudes, but perhaps this could be organised by person instead of location, or perhaps users could have the option to alternate?

- It wasn't the most interesting story that was generated. I think the problem was that it didn't seem to lead to anything. For example, flirting didn't lead to anything else. Drinking didn't lead to anything else. There were no real events around which the story could be focused.

- The story had elements of drama, but unfortunately these never developed into anything. The most exciting it got was flirting or being encouraged to betray one's principle of not drugging!

- The experience felt a little random. I didn't feel like my actions were having any real impact upon those of others.

- The storyline was strong enough to draw me in, and the presentation of information was a little distracting. The focus of the interface seemed to be more about actions and data rather than the storyline itself.

- Although the locations seemed a bit peculiar, I appreciate they are typical locations that can be found in numerous soaps. I didn't have any sense of the relation between each location however — e.g. was the shed near the house? A map would have been nice!

- They seemed to perform rather erratically, flitting from one action to another, but the description of them seemed quite reasonable, if a little extreme!

- I felt like I could act at any time, or leave the other characters to act if I did not have anything to input.

- I felt the options were far too restricting. For example, the "persuade" option only led to a limited set of options, when really there may be many things I want to persuade someone to do. I appreciate that many of the options reflected typical things that happen in soaps, but this did not provide me with the freedom I would have liked — particularly as I chose the "new soap" situation at the start.

- All of my actions seemed to cause some immediate effect, and it was nice to have things play out in a short space of time, instead of potentially waiting days or weeks for the same things to occur!

- the characters seemed to change quite quicky, and I didn't have any impression that there was anything long-term going on. I think real world interactions have much more long-term implications.

- I didn't feel particularly invested in the characters, so major decisions were easy to make. In fact, I was encouraged to go for more dramatic actions, just to see what would happen!

- It would be good if the system introduced 'cliff-hangers' that allowed for a more session-based interaction. Like episodes of soaps, this would encourage users to return to see what happens.

- I found the interface a bit confusing, the options quite limited, and the storyline rather random.

- I think that tidying up the interface would clarify the options available and the purpose of the system. Perhaps if information about your character was in one area, and information about the other characters was is another area, this would make this clearer.

- I think the location information is necessary, although this could be presented more clearly. Certainly a map, or some sort of visualisation would be helpful.

- Could information about the characters be presented in a profile structure?

- The wording of some of the actions is a bit clunky — e.g. "persuade to betray principle of not drugging"!

- Could the story line progress automatically, and you interact with it when you desire?

- People move between places whith out reason. Thei also go to jail with out reason. I was even invited to go to jail! I never got any reson for why anyone did what he / she did

- I became pregnant and someone went to jail so things where certainly happening

- If I stoped liking someone then that person would do so to but that will not hold true in the real world. In reality that person would not really know whether I liked the person or not.

- Optimize the running of the engine and give some more reasons for the characters actions.

- Not clear a priori what some options such as 'betray' were without choosing them and seeing what options it revealed

- Moments of interest such as someone being accused of a crime I committed, but quite a lot of just flirting with each other

- More proactive computer characters would have helped me feel I was in the story not trying to cause it

- Needs more characters. Didn't have the sense of a lot going on.

- Didn't change attitude to each other quite often enough in response to actions

- People's attitude towards me didn't seem to change much when I acted nicely or badly towards them

- Little consequence to the actions. For example, when I broke up with people, the option to go out with them again seemed to reoccur soon.

- Interface is a little tricky to get used to and could use some polish. It made the game seem to go slower than it otherwise could've. The one thing off the top of my head that might improve the experience would be to pre-load the different menu combinations (i.e., not have to reload the page as I select each menu option, but rather dynamically changing the page thru javascript as the user clicks menu options).

- Firstly, this was my first go. I had a fairly long session. Things happened very quickly (apparently I am getting married!). The more I did, the longer the program took to calculate an action for the other characters.

- First impression was pritty impressive, I'll see more next time.

- slow to get other characters to act. needs more dilemmas.

- I found the storyline confusing, and the options limited.

- it was really slow to load and the options were very restricting

- I like the idea and using soaps as a variation on drama with certain stylised actions and consequences. I'd like to try the same setting again varying my start point and seeing the effect on the same set of characters. However, the slow responses times make it hard work as an online experience.

- More attention to proper grammar!

- bit messed up the story. but don't watch soaps. maybe this actually happens.

The comments made by users of the experience without dilemmas were:

- I used the imaginary soap — it didn't really have a story line to help me begin the drama.

- I didn't get it. Every character I tried to interact with just kept rejecting me or saying no etc. No-one liked me!

- It's promising!

E.4 Levenshtein distances in narratives

To analyse the difference between the narratives experienced by users of GADIN Levenshtein distances were calculated. To achieve this it is necessary to create a string of symbols from the narrative. Each symbol represents one action, dilemma, event or coercion. In this the specific instantiations — such as character, location, principle and crime details and reasons for disapprovals — have been ignored. These details do not fundamentally change the narrative. The decisions on dilemmas and other questions (such as agreeing to move location) have also been excluded. These change the future course of the narrative and will thus be represented in the following encoding.

Section E.4.1 gives the symbols used to represent each action, dilemma, event and coercion. These have been used to translate the narratives experienced by the 35 users of the GADIN experience with dilemmas, as shown in section E.4.2. The narratives are numbered so that the distances between them can be clearly given, as in section E.4.3. The table in section E.4.3 shows the maximum possible distance between the narrative strings, the actual Levenshtein distance and the percentage difference between these distances.

E.4.1 Symbol meanings

In this section the symbols used to represent GADIN narratives are given with their meanings. This is divided into actions, dilemmas, events and coercions for clarity.

Identifier	Represents
Actions	
M	move
l	flirt
B	buy drink (for another character)
L	start to like
S	start affair
E	encourage to betray principle
r	disapprove of relationship
C	commit crime
A	Accuse of crime
v	stop liking
w	stop fancying
F	start to fancy
D	drink
a	tell about affair
o	ask out
b	betray principle
I	invite character to move
x	make up affair
u	dump
p	become pregnant
Dilemmas	
1	cheat on partner dilemma
2	dump cheater dilemma

3	disrupt wedding dilemma
4	tell on friend dilemma
5	betray principle dilemma
6	keep baby dilemma
7	admit crime dilemma
8	who to partner dilemma
9	change partners dilemma
0	disapprove relationship dilemma
(	disapprove affair dilemma
)	friend or partner dilemma

Events

e	proposal event
!	party event

Coercions

G	flirt coercion
H	fancy coercion
J	crime coercion

E.4.2 Encoded narratives

In this section the narratives are translated into strings, using the mapping given in section E.4.1. Each narrative is assigned a reference number.

Reference	Narrative
1	MlBMBBLlMlSMlBGFE5BMr0MMCA4EMDe
2	FMwMlalobLb!bEDAFDl5IEbDlMSIJICADlMSIJICADll-wovMCvlDloMSDCS9v
3	CsvwMFHMFMoIMIBDlMMIr0wFLlDMFIFMIo!lFo
4	SLMllBolEvlDlIFMD
5	EA5vvMbEvwBlDBlFFoBep6!LMMIlLlBB0bMMLwEvM-Ix
6	MMEIlDDGEbDMMGl4vSFFl)IeEboCIJA7IxwDESvoalo-euwMwl
7	CdDMoE1!IDeCDIFFww
8	llMMIlloGE5LMC4p6r0vJ7eMIl
9	loEE5GC4IMlMJo4Bl!ellBJaeowMA79v)v
10	Ml)wMEbB!5wuMIBlbECB4loSFlLIDJA7DFFFDI)w
11	LE5xvMlIllDDlopD6FI1xL
12	lloMMBlllBGE!l5LrDMIMIlIDlFFllLlFHloIwMlBIF!pe6l-BxwEISElMlCpvExLMMlxLIlllBMFBMlBC4xa2LMD4vl-xLLll
13	MllBllEvoIBMFMl1BbED5DxMFMl1IwEE!xeMFllvFFll)-vvxbMlLMllFFS3aua2MDwDMMor0wMDLlllvF5vr0wM-MMlllFFFCOpeF)lLlILlBMllMII1lxMwwww9vllLbMbM-FxMMww
14	F8wxSMevLMLCLlw
15	lMl)EBILeEl5oTa
16	)vwebFlLCv
17	MDDDMBMllDMD8wIMIaleE5vMDDAMl!LDL
18	)vLlIIE

19	EbvM!vFoooeB	
20	MMBlMboIBFlMpvMeovMlll	
21	Mlw)v!ebIMB8wLLuMlDlMLbLBvDCvbL	
22	)EI5eIolMl)MvAIlMLbF	
23	!FvLLwwwllMbDBMvMv	
24	MB8wDeDwL!v	
25	IMIlvDBlllo)wMloeMFlBb!ELBwLBGvlBllvlllLlvllvJAD-DSb	
26	Mvo)wMIMwvlMllFllooMlabll	
27	F8wBMoaelEIa5FlIM3IlbC19EBMFL	
28	o)MvBB)wu8weo	
29	MwM)wMl	
30	baoEBMl	
31	8wb)lBeolbeFSMlelSMSl	
32	8Mvlvab	
33	lMl)Mweoew	
34	E8wlvoBMBIeM	
35	!bElDI5EEL!ML	

E.4.3 Levenshtein distances

This table shows the distances between the narratives experienced by the users of the GADIN experience with dilemmas. The numberings refer to those given in section E.4.2. For each pair of strings the maximum possible distance is given first (Max dist). This is equal to the length of the longer of the two compared strings. The Levenshtein distance between the narratives is then given. The final column shows the percentage difference between the maximum possible distance and Levenshtein distance between the two strings. This is consistently high which suggests a significant difference between the narratives.

Narrative 1	Narrative 2	Max dist	Distance	% difference
1	*2*	61	50	81
1	*3*	38	31	81
1	*4*	31	24	77
1	*5*	43	34	79
1	*6*	49	40	81
1	*7*	31	28	90
1	*8*	31	24	77
1	*9*	34	29	85
1	*10*	40	31	77
1	*11*	31	28	90
1	*12*	96	78	81
1	*13*	138	120	86
1	*14*	31	27	87
1	*15*	31	26	83
1	*16*	31	29	93
1	*17*	33	24	72
1	*18*	31	28	90
1	*19*	31	29	93

1	20	31	22	70
1	21	31	27	87
1	22	31	26	83
1	23	31	26	83
1	24	31	29	93
1	25	51	39	76
1	26	31	26	83
1	27	31	25	80
1	28	31	28	90
1	29	31	27	87
1	30	31	28	90
1	31	31	26	83
1	32	31	29	93
1	33	31	27	87
1	34	31	27	87
1	35	31	28	90
2	1	61	50	81
2	3	61	49	80
2	4	61	50	81
2	5	61	52	85
2	6	61	46	75
2	7	61	52	85
2	8	61	51	83
2	9	61	49	80
2	10	61	50	81
2	11	61	51	83
2	12	96	76	79
2	13	138	112	81
2	14	61	54	88
2	15	61	54	88
2	16	61	55	90
2	17	61	48	78
2	18	61	57	93
2	19	61	55	90
2	20	61	48	78
2	21	61	50	81
2	22	61	51	83
2	23	61	51	83
2	24	61	56	91
2	25	61	49	80
2	26	61	50	81
2	27	61	49	80
2	28	61	57	93
2	29	61	55	90
2	30	61	56	91
2	31	61	51	83
2	32	61	58	95

2	33	61	56	91
2	34	61	55	90
2	35	61	54	88
3	1	38	31	81
3	2	61	49	80
3	4	38	29	76
3	5	43	36	83
3	6	49	44	89
3	7	38	31	81
3	8	38	31	81
3	9	38	34	89
3	10	40	32	80
3	11	38	31	81
3	12	96	80	83
3	13	138	115	83
3	14	38	33	86
3	15	38	33	86
3	16	38	33	86
3	17	38	30	78
3	18	38	33	86
3	19	38	33	86
3	20	38	28	73
3	21	38	32	84
3	22	38	31	81
3	23	38	33	86
3	24	38	33	86
3	25	51	44	86
3	26	38	28	73
3	27	38	30	78
3	28	38	33	86
3	29	38	33	86
3	30	38	34	89
3	31	38	32	84
3	32	38	36	94
3	33	38	33	86
3	34	38	32	84
3	35	38	34	89
4	1	31	24	77
4	2	61	50	81
4	3	38	29	76
4	5	43	36	83
4	6	49	41	83
4	7	18	15	83
4	8	26	21	80
4	9	34	28	82
4	10	40	31	77
4	11	22	16	72

4	*12*	96	83	86
4	*13*	138	126	91
4	*14*	17	16	94
4	*15*	17	14	82
4	*16*	17	16	94
4	*17*	33	25	75
4	*18*	17	14	82
4	*19*	17	16	94
4	*20*	22	17	77
4	*21*	31	25	80
4	*22*	20	16	80
4	*23*	18	15	83
4	*24*	17	14	82
4	*25*	51	42	82
4	*26*	25	20	80
4	*27*	29	23	79
4	*28*	17	15	88
4	*29*	17	15	88
4	*30*	17	14	82
4	*31*	21	16	76
4	*32*	17	14	82
4	*33*	17	15	88
4	*34*	17	13	76
4	*35*	17	14	82
5	*1*	43	34	79
5	*2*	61	52	85
5	*3*	43	36	83
5	*4*	43	36	83
5	*6*	49	41	83
5	*7*	43	37	86
5	*8*	43	34	79
5	*9*	43	35	81
5	*10*	43	37	86
5	*11*	43	33	76
5	*12*	96	76	79
5	*13*	138	115	83
5	*14*	43	36	83
5	*15*	43	38	88
5	*16*	43	37	86
5	*17*	43	37	86
5	*18*	43	39	90
5	*19*	43	35	81
5	*20*	43	35	81
5	*21*	43	34	79
5	*22*	43	36	83
5	*23*	43	34	79
5	*24*	43	37	86

5	25	51	43	84
5	26	43	35	81
5	27	43	34	79
5	28	43	38	88
5	29	43	38	88
5	30	43	39	90
5	31	43	35	81
5	32	43	39	90
5	33	43	38	88
5	34	43	35	81
5	35	43	36	83
6	1	49	40	81
6	2	61	46	75
6	3	49	44	89
6	4	49	41	83
6	5	49	41	83
6	7	49	42	85
6	8	49	38	77
6	9	49	40	81
6	10	49	41	83
6	11	49	43	87
6	12	96	75	78
6	13	138	115	83
6	14	49	44	89
6	15	49	41	83
6	16	49	44	89
6	17	49	38	77
6	18	49	44	89
6	19	49	40	81
6	20	49	39	79
6	21	49	42	85
6	22	49	41	83
6	23	49	43	87
6	24	49	44	89
6	25	51	44	86
6	26	49	40	81
6	27	49	42	85
6	28	49	44	89
6	29	49	43	87
6	30	49	44	89
6	31	49	40	81
6	32	49	44	89
6	33	49	41	83
6	34	49	42	85
6	35	49	42	85
7	1	31	28	90
7	2	61	52	85

7	3	38	31	81
7	4	18	15	83
7	5	43	37	86
7	6	49	42	85
7	8	26	23	88
7	9	34	29	85
7	10	40	32	80
7	11	22	18	81
7	12	96	88	91
7	13	138	128	92
7	14	18	16	88
7	15	18	15	83
7	16	18	17	94
7	17	33	28	84
7	18	18	16	88
7	19	18	16	88
7	20	22	20	90
7	21	31	29	93
7	22	20	19	95
7	23	18	17	94
7	24	18	14	77
7	25	51	47	92
7	26	25	24	96
7	27	29	24	82
7	28	18	17	94
7	29	18	17	94
7	30	18	16	88
7	31	21	20	95
7	32	18	17	94
7	33	18	15	83
7	34	18	16	88
7	35	18	16	88
8	1	31	24	77
8	2	61	51	83
8	3	38	31	81
8	4	26	21	80
8	5	43	34	79
8	6	49	38	77
8	7	26	23	88
8	9	34	29	85
8	10	40	32	80
8	11	26	24	92
8	12	96	79	82
8	13	138	122	88
8	14	26	24	92
8	15	26	22	84
8	16	26	22	84

8	17	33	27	81
8	18	26	24	92
8	19	26	23	88
8	20	26	20	76
8	21	31	28	90
8	22	26	23	88
8	23	26	23	88
8	24	26	23	88
8	25	51	42	82
8	26	26	24	92
8	27	29	25	86
8	28	26	23	88
8	29	26	22	84
8	30	26	22	84
8	31	26	23	88
8	32	26	23	88
8	33	26	21	80
8	34	26	21	80
8	35	26	22	84
9	1	34	29	85
9	2	61	49	80
9	3	38	34	89
9	4	34	28	82
9	5	43	35	81
9	6	49	40	81
9	7	34	29	85
9	8	34	29	85
9	10	40	32	80
9	11	34	27	79
9	12	96	80	83
9	13	138	121	87
9	14	34	31	91
9	15	34	27	79
9	16	34	32	94
9	17	34	32	94
9	18	34	33	97
9	19	34	29	85
9	20	34	26	76
9	21	34	30	88
9	22	34	27	79
9	23	34	28	82
9	24	34	29	85
9	25	51	43	84
9	26	34	27	79
9	27	34	31	91
9	28	34	29	85
9	29	34	30	88

9	30	34	31	91
9	31	34	28	82
9	32	34	31	91
9	33	34	28	82
9	34	34	27	79
9	35	34	30	88
10	1	40	31	77
10	2	61	50	81
10	3	40	32	80
10	4	40	31	77
10	5	43	37	86
10	6	49	41	83
10	7	40	32	80
10	8	40	32	80
10	9	40	32	80
10	11	40	31	77
10	12	96	80	83
10	13	138	119	86
10	14	40	35	87
10	15	40	33	82
10	16	40	34	85
10	17	40	32	80
10	18	40	36	90
10	19	40	36	90
10	20	40	32	80
10	21	40	31	77
10	22	40	32	80
10	23	40	36	90
10	24	40	35	87
10	25	51	41	80
10	26	40	32	80
10	27	40	34	85
10	28	40	34	85
10	29	40	34	85
10	30	40	36	90
10	31	40	34	85
10	32	40	38	95
10	33	40	34	85
10	34	40	35	87
10	35	40	35	87
11	1	31	28	90
11	2	61	51	83
11	3	38	31	81
11	4	22	16	72
11	5	43	33	76
11	6	49	43	87
11	7	22	18	81

11	8	26	24	92
11	9	34	27	79
11	10	40	31	77
11	12	96	82	85
11	13	138	121	87
11	14	22	20	90
11	15	22	20	90
11	16	22	20	90
11	17	33	26	78
11	18	22	18	81
11	19	22	18	81
11	20	22	21	95
11	21	31	26	83
11	22	22	18	81
11	23	22	19	86
11	24	22	19	86
11	25	51	45	88
11	26	25	20	80
11	27	29	24	82
11	28	22	20	90
11	29	22	20	90
11	30	22	20	90
11	31	22	21	95
11	32	22	20	90
11	33	22	19	86
11	34	22	18	81
11	35	22	19	86
12	1	96	78	81
12	2	96	76	79
12	3	96	80	83
12	4	96	83	86
12	5	96	76	79
12	6	96	75	78
12	7	96	88	91
12	8	96	79	82
12	9	96	80	83
12	10	96	80	83
12	11	96	82	85
12	13	138	104	75
12	14	96	84	87
12	15	96	86	89
12	16	96	90	93
12	17	96	77	80
12	18	96	91	94
12	19	96	90	93
12	20	96	78	81
12	21	96	80	83

12	*22*	96	84	87
12	*23*	96	84	87
12	*24*	96	89	92
12	*25*	96	73	76
12	*26*	96	79	82
12	*27*	96	80	83
12	*28*	96	91	94
12	*29*	96	90	93
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32	*18*	7	6	85
32	*19*	12	10	83
32	*20*	22	19	86
32	*21*	31	26	83
32	*22*	20	16	80
32	*23*	18	15	83
32	*24*	11	10	90
32	*25*	51	46	90
32	*26*	25	20	80
32	*27*	29	24	82
32	*28*	13	11	84
32	*29*	7	7	100
32	*30*	7	7	100
32	*31*	21	18	85
32	*33*	10	9	90
32	*34*	12	10	83
32	*35*	13	12	92
33	*1*	31	27	87
33	*2*	61	56	91
33	*3*	38	33	86
33	*4*	17	15	88
33	*5*	43	38	88
33	*6*	49	41	83
33	*7*	18	15	83
33	*8*	26	21	80
33	*9*	34	28	82
33	*10*	40	34	85
33	*11*	22	19	86

33	*12*	96	89	92
33	*13*	138	129	93
33	*14*	15	12	80
33	*15*	15	9	60
33	*16*	10	10	100
33	*17*	33	28	84
33	*18*	10	9	90
33	*19*	12	9	75
33	*20*	22	17	77
33	*21*	31	27	87
33	*22*	20	15	75
33	*23*	18	16	88
33	*24*	11	10	90
33	*25*	51	45	88
33	*26*	25	21	84
33	*27*	29	26	89
33	*28*	13	10	76
33	*29*	10	8	80
33	*30*	10	10	100
33	*31*	21	17	80
33	*32*	10	9	90
33	*34*	12	10	83
33	*35*	13	12	92
34	*1*	31	27	87
34	*2*	61	55	90
34	*3*	38	32	84
34	*4*	17	13	76
34	*5*	43	35	81
34	*6*	49	42	85
34	*7*	18	16	88
34	*8*	26	21	80
34	*9*	34	27	79
34	*10*	40	35	87
34	*11*	22	18	81
34	*12*	96	88	91
34	*13*	138	129	93
34	*14*	15	12	80
34	*15*	15	14	93
34	*16*	12	11	91
34	*17*	33	28	84
34	*18*	12	10	83
34	*19*	12	10	83
34	*20*	22	16	72
34	*21*	31	26	83
34	*22*	20	15	75
34	*23*	18	14	77
34	*24*	12	11	91

34	25	51	45	88
34	26	25	21	84
34	27	29	23	79
34	28	13	11	84
34	29	12	10	83
34	30	12	10	83
34	31	21	16	76
34	32	12	10	83
34	33	12	10	83
34	35	13	11	84
35	1	31	28	90
35	2	61	54	88
35	3	38	34	89
35	4	17	14	82
35	5	43	36	83
35	6	49	42	85
35	7	18	16	88
35	8	26	22	84
35	9	34	30	88
35	10	40	35	87
35	11	22	19	86
35	12	96	87	90
35	13	138	129	93
35	14	15	14	93
35	15	15	13	86
35	16	13	12	92
35	17	33	27	81
35	18	13	10	76
35	19	13	12	92
35	20	22	19	86
35	21	31	25	80
35	22	20	17	85
35	23	18	15	83
35	24	13	10	76
35	25	51	46	90
35	26	25	23	92
35	27	29	24	82
35	28	13	13	100
35	29	13	12	92
35	30	13	10	76
35	31	21	18	85
35	32	13	12	92
35	33	13	12	92
35	34	13	11	84

E.5 Transcriptions from user observation

In this section the transcriptions from the user observation evaluation are shown. In this the users were requested to use the think-aloud protocol and were also asked certain 'prompting' questions throughout. All of the transcriptions use the abbreviations: U = user; I = interviewer.

Neil Forster

Neil had experienced a GADIN narrative once previously, with a much earlier version of the interface.

User: Do I need to put my full name?
Interviewer: No, that's fine
U: What should I go for, think I'll go for Hollyoaks... going to say I don't like Mercedes, but I fancy her — cos she's quite fanciable on the program, but she's a bit of a slag ... they've all got high attractiveness — it's Hollyoaks! yeah, I like Zoe, Clare... no, she's the bitch one, Justin: well, I don't fancy him, ... no I don't like him... It looks different from last time! Ok... These are the different areas where people are... the current state is... does it tell you who's pregnant if you click on that? ... ok... My action involves... relationships. where am I? oh, yeah, the Laundry .... do I need to move somewhere to flirt with someone .... ok, I'll flirt with Mercedes, ok, right, movement, ... I'm by myself there! ... ok, I'll move to Il Gnosh. Right.... going to flirt with Mercedes ...
I: Is there anything that you're thinking right now that you really want to do, and you can't?
U: Er... not really ... cos I'm not sure what I can do yet ... flirt with Mercedes, don't seem to be many characters? ...
I: If you want them to act you need to let characters act
U: Oh yeah, I'll do that... she's starting to like me... let's see ...
I: Why do you think she started to like you?
U: Probably because I flirted with her , I suppose if I flirt with her she could've started to like me or she might not have done. But then I put down that I don't like her ... but I can change that, can't I? start to like... which one is Zoe again... Ok, I'm going to ask out Mercedes now, since she started to like me. Ok, she's started to go out with me ... so ... what can I do now? Let other characters act... Can I sleep with other characters? ... Zoe betrays her principle of not stealing, ok..
I: How do you feel about that?
U: Well, what's that got to do with what I've been doing? Anything? Nothing. ok. ... I'm going to accuse Justin of something ... oh, ok, I want to accuse him of a crime ... so if I commit a crime I can then accuse him of it... I'll steal something... Drive'n'Buy, ok, let's go there ... move to Drive'n'Buy ... why can't I steal anything at Il Gnosh? ... right, I'm going to steal from Il Gnosh, no sorry Drive'n'Buy
I: Why do you want to do that?
U: Because I don't like Justin, I want to accuse him of it, and see what happens as well
I: Who are you in a relationship with?
U: Mercedes, I think, well I should be, if I ask someone out and they say yes I

should be in a relationship with them? Ok ... so ... right ... crimes ... accuse Justin of crime of steal ... [BUG: DIDN'T WORK] Ok .. I'm going to start fancying Zoe, because I think I made a mistake of not fancying her at the start.... right ... ok ... I'm going to flirt with Zoe

I: Is there any reason why you're not passing back control?

U: I'm going to now, I just wanted to flirt with Zoe and see what happens ... well, I've done a few things ... it might be interesting to see what happens if I do a few things and then pass back... move to... Il Gnosh... can you make other characters move around? ... oh yeah, ok ... You can have a party! Cool. I might try that in a bit. ... Right, I'm going to flirt with Zoe ... I'm going to ... Let other characters act, see what happens... Why's she encouraging me, I've stolen twice! .... Right, now I'm going to... I want to start an affair with Zoe now ... she decided not to??? How dare she?! ... hmm... who's in relationships then? ... oooh, ok let's have a party ... at Il Gnosh ... yes ... yes ... no, ok I won't invite Clare, but I'll invite Justin — he's rejected! ... but Clare's still there anyway, so I'm having a party without her and she's there ... right. ... so we had a party, let's see what happens there ... Your friend Zoe is encouraging you to betray your principle ... but I've already stolen twice! Ok, I'll accept.

I: Because you don't find it a dilemma, because you've already stolen?

U: Yep. ... It can be a good thing if you do it then blame it on someone else. So ok ... what other principles do I have ... right ... I hold the principle of not drugging but don't hold the principle of not stealing. Ok ... ooh! Zoe starts to like me. See, I was thinking that might happen if I...

I: Why do you think it's happened?

U: Because I've agreed to her principles. She encouraged me to not think stealing is a bad thing and I did that, so now I'm going to try and start an affair with her I think. Again. She's got to accept this time... What??????????

I: Why do you think she's rejected you?

U: Maybe because I'm still going out with Mercedes. She doesn't want to have an affair, she would only want a proper relationship. Maybe. ... it said she started to like me... right I'm going to end my relationship now with Mercedes, then I'm going to try and go out with Zoe ... right, I've split up ... does that mean Mercedes might commit suicide or something? ... yeah!!!.... Zoe is flirting with me! I bet that's because I split up with Mercedes, see. So now ... I could flirt back ... or, I could ask her out ... I'm going to ask her out. Ask out Zoe. She's got to say yes now, surely... what??????? Go away! Fight.... I don't know ... Zoe's a complex being! So ... yeah, so she'll flirt with me, well yeah I suppose she might do that. I gave up my principle of stealing for her, and I split up with Mercedes. And she likes me and flirts with me, and still won't go out with me. ... Eight ... what can I do?

I: What would you really like to do, right now, ideally, without the restrictions?

U: I'd like to ... take out some of my anger on Justin. Beat him up maybe. Or... either that or have sex with Zoe, that's a restriction, but you said if you could do anything... Right... how about ... um ... what if I move to jail... how can I voluntarily go to jail? visiting... Right... let's invite Zoe to jail. ooh, you can, ah, ok... let's invite Zoe to the Dog. she's a tricky one that Zoe. she's at Il Gnosh, you're at jail, you must be at the same location. damnit! oh well, I'll just let other people act for now, start again .... right, Justin's stopped liking Zoe... right, ok I'll move back to Il Gnosh because that's where everyone is... right, I'll try inviting Zoe to the Dog again... hmm, we're now at the Dog. Ok.

I: Who's in a relationship at the moment?

U: Noone, I don't think, but I'll check. Is that... ah ok, right I'll buy a drink for Zoe, if I buy a drink for her I'll get her drunk and then she might agree ... socialising, buy a drink for Zoe, and then I might be... action is Zoe gets drunk ... refused my offer of a drink?? Oh ... right, let's let other characters act again ... Clare's accused Zoe of the crime of steal committed by me!

I: How do you feel about that?

U: Well... I suppose, she did bring it on herself because she hasn't got the principle of not stealing so it makes sense. What can I do? Can I do anything about that?

I: What would you want to do about it?

U: Beat up Clare! ... I'd like to sort of stand up for Zoe, and show her that I care about her... Right... I'm just going to ask out Zoe once more. Maybe now she's been accused of stealing she'll be vulnerable! Right, she's decided not to go out with me again. That's the last time I'm asking! ... Ok... you committed the crime of stealing but your friend Zoe's been accused of the crime, would you like to admit the crime or...

I: How do you feel about that?

U: Well, to allow Zoe to take the blame for it would be pretty evil, and also if I do it maybe she'll respect me and then go out with me later on, I'm going to admit to it. If it was in real life it'd be more difficult, I don't want to go to jail. But in this, you just move across the screen... Oh, I'm released without charge, that's good.

I: Do you think your actions are having a long-term effect on what happens?

U: Well, it doesn't really feel like it at the moment but then I think I need to play it for longer to find that out. I think they probably are but I cant really tell that they are ... I'm going to let the characters act again. ... Zoe has moved to the Drive'n'Buy ... I'm still in jail even though I've been released... ooh! Zoe's stolen something. from the Drive'n'Buy! Right, that's it, I'm going to accuse her of stealing because she did steal. [BUG: DIDN'T WORK] ... Well, I think I'm going to stop now. ... I enjoyed it...

I: Why are you quitting?

U: Because I've got to go out, and I sort of feel like I've tried most of the things.

I: So would you do it again?

U: Yeah. I'd try it with maybe some different characters, and try sort of ... maybe I concentrated too much on asking people out, maybe I should've tried different things.

I: Did you find the narrative fairly interesting?

U: Yeah.

I: And did you feel fairly immersed?

U: I wouldn't say immersed ... but ... I think maybe it would've been good if there were more of those things, more of the dilemmas, but... I sort of felt like I ran out of things to do.

Mark Read

Mark had not previously experienced a GADIN narrative, although he had created a storyworld in which no narrative was generated.

User: So I just play this and talk as I'm doing it. Is this part of the experience or am I just setting it up? I am young, I am male, there's only Hollyoaks really [worth doing], isn't there? Ok... Oh I can relate to this, this is wonderful! I am young and male, I'm even being complemented. They're all high attractiveness... I don't fancy her though ... Clare was that horrible one wasn't she? And he's the idiot. I certainly don't fancy him, but he's ok, just a bit of an idiot. Ok... My action involves, ok, let's start by going somewhere, I was in the Laundry apparently, ok. Well, I went to the Drive'n'Buy and then I ... I can drink ... Il Gnosh, Loft or Dog... Excellent. Ok... So I've got drunk and been to some place, the current state is, do these buttons, wow, ok this is good, Mercedes is in jail although she doesn't steal or drug things. So I'll let the other characters do something. Does this display all the characters that are currently going on? Oh, apparently I couldn't get drunk. Russ has moved apparently. So... continuing my effort to get drunk... Socialising... It would be very clever if this was constrained to stuff that you could do [button options]. Ok... so I'm buying a drink for Clare. Clare has refused my offer. Well, that's an even better reason to get drunk. and since I am drunk I think I'll go to the jail and... accuse Mercedes ... oh, right, so I can't accuse anyone of committing a crime until something's been committed. In that case I'm going to steal something from Mercedes. I can't steal from jail, I can only steal from Drive'n'Buy, ok... let's see what happens there, that's great. And these buttons here, oh, I am drunk, noone else is, noone else is going out with anyone else. Ok, I think I'll make myself a bit more interesting and betray these principles... So Clare steals from people, that's very good. Ok, I've done some stuff let's see what the other people are going to do... Why is Mercedes in the jail or is she just at the jail? Mercedes just likes me but she's flirting with me anyway. She's a bit awful. Relationships... so noone is going out with anyone at the moment. Persuade... Do I have to be in the right place for this to take effect? Ok, so I'm going to persuade Clare... Ok, so I can't do that until something happens... How much stuff should I be doing every go?

I: As much or as little as you want, nothing to everything inclusive. What would you like to do?

U: Create some havoc. I could... at least I haven't found out yet how to persuade a character that another might be worth pursuing. That would be fun, from a havoc perspective. Ok... what happened? Clare has gotten drunk, I'm going to move to loft, Clare is drunk apparently, apparently I'm drunk too, how long does it take for me to be not drunk... get drunk... oh, Clare's a bit of a bitch isn't she? Clare doesn't appear to like anyone... ok... in which case let's go find Zoe, Zoe's at the Dog, move to the Dog. I don't know what's going to happen here... Would I like to invite Mercedes, if she's gotten out of jail that would be just dandy, yes why not. Clare... well, there's no need to be rude to anyone just yet. So this is a good way of getting everyone to one place, very nice... Ah but the text boxes don't resize. Ok... as long as they don't all disappear. Ok... well I've been in this game for a whole four turns or something and I have not yet got laid so it's time to... how do I flirt again? ... [dilemma] oh, blimey, now that is confusing, um... well, since my current objective in the game is just to make interesting stuff happen and I don't really care what happens to the character mark in this I think I would go with whatever makes it more interesting. Well this is easy isn't it, my friend Russ also fancies her. I'll stop liking Russ if that makes it better. action is Russ stops liking me. That's ok. We can do some-

thing fun there. Feelings... I'll stop liking him. In fact, I'll go one better than that. Commit the crime of stealing — can I not steal from another character? Apparently I'm still drunk so this'll be very fun, is it possible for me to get put in jail? I think I'll let others act now... Oh, is Russ depressed? This is why I want to commit the crime of stealing from Russ. So this is the Dog, let's go to the Dog. We're all here. Crimes, drugging... you've got to be kidding me, what kind of drug is that? I see, well he's started to fancy me. Oh, that is a twist. Ok... I've already done that. These are only options that can come into effect when other people are in relationships, so I cant persuade someone to do something. I can encourage someone to do something, that's good.

I: Who are you going out with?

U: Zoe I think. Um... You want me to say what's going on? Ok, well I started to try and instigate something with Mercedes for no particular reason other than I wanted something interesting to happen. I don't like Mercedes... and then the GADIN decided to throw Zoe at me, which because I hadn't gotten any action in the whole game yet I decided to go along with but Russ liked Zoe so Russ got drunk and depressed and stopped liking me. And then in an effort to do interesting things I went to the shop and stole something, then went to Russ, drugged him and he apparently now fancies me. And I've just persuaded Mercedes to try stealing something. And apparently because she likes me she's going to do that. She's a very strange woman. I think it's probably worth trying to mess with her head a bit if such a thing is possible in this game, I'm not going to be a very upstanding citizen in this, I think it's probably the best way to have an interesting experience... I'm not really sure what to do here, other than changing my feeling... I'll have another party, at the loft, yeah I'll invite Mercedes, oh what happens if I don't invite my girlfriend, but I will invite Clare, and I wont invite Russ... so Mercedes came and then immediately left. she's gone to the shop, I can imagine the only reason to go to the shop is to steal something so I'll let her carry on stealing stuff... I'm the only one who's done anything interesting so far. Who's pregnant? How do I make someone pregnant? Oh, right, ok well, if memory serves me correctly Zoe is going out with me. So how do I... that's a good one. Oh, really this is kinky we're going to start an affair in the shop are we? Ok, start an affair with Mercedes... Oh. Why not? She likes me. At least I thought she did.

I: How does that make you feel?

U: very, very sad. My attempt to provoke anger in this game has failed so I'm going to have to try a little bit harder. By... flirting with Mercedes... ah, Mercedes is stealing. Cool. I can... no... I will go to the loft and in the loft I am going to try and persuade Clare to do illegal things. Clare... to drug people... well, ordinarily I would accuse her of this

I: Can you clarify?

U: Oh, right, apparently I know Mercedes has committed a crime, stealing, and I'm asked if I'd like to report her or keep quiet about it. I'm trying to mess up my relationship with Mercedes so I think that I'll keep quiet about it for now... from the point of view of me trying to get something interesting to happen it is a difficult decision, from my character's perspective it shouldn't be hard because I persuaded her to do it in the first place so I'm not exactly... that's great, I'm going to let other characters do stuff...

oh, that's fun, Russ has finished being drugged and has accused someone else of doing it. Let's see what happens if I let them act again. Well, I don't think

I'm really going to admit to that.

I: Is it a hard decision?

U: Not really, I think I'd feel a lot worse about me going to jail, but she didn't... why's she stopped liking me? She knows that I did it?... can I still accuse her of stealing? ... crimes... accuse. If she's going to stop liking me I'm going to accuse her of stealing. Oh, my, that's unexpected... I'm going to accuse Russ of drugging himself... It went to court but it hasn't been punished! Let's see what happens... Is Russ going to say anything about this?... That's an interesting result. Clare is presumably gone to steal something, I can't see why anyone else would go to the shop... apparently I'm in a relationship so let's see how I can get out of that. First I'm going to propose to her though. Well, I've been a bit of a dick so it's not surprising.

I: How does it make you feel?

U: Sad. I wanted this result but not like that. I was hoping to do something really evil and then have her break up with me. Instead I did something nice and she broke up with me. Ok... so let's go to the shop. What does invite do? Clare, to go to the loft... oh, I see, I couldn't just text message her. I'll go to the shop, and I will invite Clare to go to the loft with me... I thought she did like me? Or did she decide that she fancied me but didn't like me? That's very complicated. Ok, how can I make Clare like me? I could start by stealing something. Well, I'm still at the ... excellent, ok.

I: Why did you do that?

U: Because I want interesting things to happen. Mercedes has started to dislike me, my sweetheart just broke up with me, so the best thing to do is steal something and then get drunk. I'm going to move to the Dog, can I start a fight with someone? no? Oh, Russ and Zoe are in the Dog. They're probably flirting. Let's see what Zoe thinks... Zoe is terrible, honestly. Ok... just now I proposed to Zoe, who was my girlfriend, very insincerely. She rejected the proposal and I guess broke up with me. And I have just offered to buy her a drink which she has drunk. Zoe's principles regarding me are a bit screwy. So I will... do I have to already be in a relationship to start an affair? ... well I'm going to ... oh, she agrees to go out with me. Let's see what happens if I propose to her, again. Oh, my, we're going to get married! Ok... it would be a shame to be here and not drug Russ again... I'm going to let the other characters act for a second... Wow Mercedes and Clare. Really. Um... well I may as well continue my spree of awfulness. I'm going to go to Drive'n'Buy and I'm going to... first Clare then the other I think. What? Why can I not commit that crime here, it has to be dropped in some drink does it? Ok... well the easiest thing is to have a party somewhere isn't it... I'll have a party at the Dog... would you like to, I'll invite everyone. Right... all here. What was I doing? Drug... which ones did I just do? Mercedes, Clare, these two apparently like each other so I'm going to drug the pair of them, see what happens. Am I married? Just engaged... for some reason I feel less desire to screw with Zoe for the moment, must be some part of my feelings that don't want to hurt her now. It's a big thumbs up for the experience though!... I'll keep going for a bit longer but I should probably go home at some point...

I: How do you feel about the other characters now?

U: I feel fairly indifferent to Russ. In fact I feel pretty indifferent to all of them. they're fairly interesting to screw around with. I kind of like Zoe. I should probably... do I even like Zoe? I wish Zoe would stop fancying Russ. I'm going

to do... stop liking Mercedes. Mercedes likes Russ. Wouldn't that be fun if the real story gets recreated. Clare is not very sociable is she? She doesn't like anybody. I might, no, I'll carry on fancying Mercedes, it could be interesting... I think I will, ah... right, I'm going to try and flirt with Mercedes again, although she apparently doesn't like me so that could be tricky, how do I... socialising, buy a drink for Mercedes... this woman doesn't like me but she's accepting a drink from me anyway. I'm going to be really nasty to Zoe here and see if I can get something on with a different... so I'll start to like Mercedes and I'll start to fancy Mercedes although I think I already did anyway. Oh, yeah, Clare accused me of drugging her, what happened with that? Russ is a very confused young man. right... Mercedes is down here, she still doesn't like me, what other nice things can you do to make people like you? Learning all of this dating stuff from a game... It's like an instruction book for real life... so... Mercedes, I asked her to start an affair with me, I think I'm engaged! Noone else is in a relationship. I would have expected more stuff to have happened outside my direct influence by now. I'm not really sure what to do... I came in wanting to play rather than observe. So if I stop doing stuff and just let them act on their own for a few goes what would happen? [explanation given] I'm going to have to stop in a second, there's a lot I am supposed to do today that I haven't done yet. Ok...

[questionnaire answering phase]
How long do I normally... once every year, that's pretty rare! I mean, I play chess occasionally on my laptop
[answer: weekly]
Watch soaps... maybe weekly
[answer:weekly]
Were the options always clear to you? they were fairly clear, there were things I couldn't do [answer: 5]
That was pretty clear too, although the, the interface of who is where is very good but when you click on things like feelings etc it doesn't help to have people all over the place it would be better if they were just listed and then if you clicked back on where everyone is it went back to that interface again. [answer: 6]
How interesting would you say the story was... I think it's a 4... not a lot seemed to happen other than me doing stuff [answer: 4]
How dramatic... about a 4 again, there were a few turn of events that I wasn't expecting... [answer: 5]
How immersed was I in the experience? I started off not really caring about anything but... yeah at some point I didn't want to screw with Zoe any more but then I did because nothing interesting happened. [answer: 3]
The storyworld was plausible... like a real soap, well I'd say it was about a crazy as a real soap might have been [answer: 6]
Characters were plausible, Clare was certainly believable. Some of the others did things I wouldn't have expected them to. If you invite someone to have a drink when they don't like you and they don't fancy you I would not expect them to come along... [got feelings wrong] so, I don't know. It's hard to gauge in all of this, because not a lot really seems to happen very quickly. If I'd been playing for two hours in half an hour I'd have a far better idea of what people are really like and they have feelings and principles, there must be material to make them act in certain ways. [answer: 5]

Were you able to act whenever you wanted, well absolutely because I work on a much quicker timescale than they do [answer: 7]

Pretty much. There were still things I'd like to be able to do that I couldn't. [answer: 5]

As much effect as in the real world, hard to say because you don't know the timing, was that all in the course of a day?... [answer: 5]

Yeah, probably, why not. [answer: 6]

How hard were the major decisions to make? I didn't really struggle but I think the longer you would play it the more you would struggle [answer: 3]

Would you like to play again? yes [answer: 6]

Incredible... I'd give it 5! [answer: 5]

The characters seem to be quite animated.

Do I have any comments? [answer (exactly as entered): other characters have to act quicker in relation to the user. I was driven to do stuff, but was apparently 'doing' too quick for the other characters. Would be interesting to have some time scale, ie, counting the days that go by so that i know how quickly i'm doing thigns. getting married, flirting with other people, drugging poor Russ two or three times might take longer than one day to complete. Would be nice to encourage other relationships to happen, I was given the choice of encouraging or dissuading existing relationships, but could not bring into affect new ones.]

Christian Wood

Christian had experienced a large number of GADIN narratives (between 5 and 10) prior to this one. He was thus familiar with the experience, although not the action button options interface.

User: Hello GADIN! My name is... same as my name has always been. I'm young — that's not bad, middle of 5. Imaginary new soap... it's Tess, Edna, Mary and Bob this time. Tess is... she's still young, medium, high generosity, high selfishness, yeah I like her, but I don't really fancy her actually she's only got medium attractiveness and she's pretty selfish so I definitely don't fancy Tess. Edna... she's old, low attractiveness... don't like her because she's old. Mary... high attractiveness, medium selfishness... I don't like or fancy Mary. maybe I do, I probably fancy her, she's a bit selfish. Bob is male heterosexual and middle aged, low attractiveness, low morality, high selfishness, nobody likes Bob, and that's me included. Right... Now, where am I? I am apparently in the park with Bob, so I really need to get out of there, so I need to move. Movement... move to, now where's the fitty, Tess or Mary I can't remember... I think Mary was the attractive one, about characters... right, Mary, that's right. Let's move to, where is she — at the club. Ooh how convenient. Let other characters act... Bob encourages Edna to break her principle of not drugging... Bob's in the park and Edna's in the jail, maybe they're using some form of mobile phone. Mary. In the club. Let's... yeah, I could drug Mary, why not. No, let's flirt... relationships, flirt with Mary. I've flirted with her, let's see what she does about that. Hmm. Bob is encouraging Edna to betray her principle of not drugging, Edna must decide. Even though Edna likes Bob she decides to hold her principle. Well done Edna, well done. She's in jail with Tess. Ah, bet they're going to turn gay. Bob stops fancying Edna, well you would wouldn't you... ah, ok, well I've flirted with Mary but she hasn't responded so it's time

for a stronger approach I think. So it's time to get her drunk. Buy a drink for Mary. Mary accepts the drink from you and gets drunk, yes she does. Now, where's the option to get her more drunk. Buy her a drink... she refuses. Oh, she must be drunk enough... let's see what she does about that then. So... Tess has moved between jail and house. She hasn't been in there 5 minutes. Bob has moved between the park and the house but at least Mary's still in the club, so that's good. Let's see if she'll accept another drink. No, she's blatantly had enough so it's time to make my move. Right, no, I've already flirted with her. I don't want to go out with her I just want to pull her, don't want to start an affair with her, don't want to propose, and I'm not married... let's do something else with her then... commit the crime of... can't steal anything from the club. Ok... what can I do in the club then?

Interviewer: What would you ideally like to do now?

U: I'd want to pull her. Or, commit some crime of some form. Maybe bash the place up a bit, get in a fight. Or maybe steal her purse or something, that would be quite fun. If she turned me down of course. Or maybe if she didn't turn me down I'd steal her purse as well. Win win situation. So... crimes, I can accuse Mary of something, oh there haven't been any crimes so I can't accuse her of anything. I want to accuse her of being a dirty ho, but she seems to be a bit uptight does Mary so that wouldn't really go down well. Ok, well I'm bored of Mary and the club now so I'm going to move. Mary's really dull so I'm going to stop liking her now. Bye Mary, stopped liking her. You can all do something now...

I: Who's in a relationship at the moment?

U: Noone's in a relationship at the moment... Right, I'm going to see what's happening. I know all these people so that's all right. Feelings. Tess likes me, now how attractive is Tess, medium. That's not as good as Mary but she's frigid so I'll stay away from her and Edna's old and ugly so looks like it's going to have to be Tess then. She holds the principle of not drugging or stealing ... she's not in a relationship, no crimes... pregnancies, none. Ok... Tess is drunk, Bob is drunk, Mary is drunk. Fair enough. Let's go try it on with Tess then. So we need to move to house. Bob's here, don't want him to be a gooseberry so we need to get rid of Bob somehow. How can we communicate with Bob, tell him to go away? Movement, could invite Bob to go somewhere else. Invite Bob to go to shed with you... could we invite Bob to go somewhere without me? Just go away Bob. No, ok... maybe if I offend him somehow... let's try drugging him, that might piss him off... I have chosen to commit the crime of drug with victim Bob. Ok, so let's see what happens when I've drugged Bob then, see if he minds. So... action is Mary stops liking me.

I: Why do you think that is?

U: She's probably stopped liking me because I got her drunk, flirted with her and then left. So I've drugged Bob but he's still there, he's not getting the hint, so what I'm going to do — since I can't tell him to piss off — is go to the park with Tess. Invite Tess to go to the park with me, she's done it, she's there, you and Tess are now at the park. Ok, so what can I do with her. Socialising, well we're not going to get drunk in the park. We could, but I don't particularly want to. Can't we go on the swings or something, do something. Well, I don't want to change my feelings for her, I don't want to have relationships with her, I just want to do something in the park... Others' relationships... tell... ok, I will tell Tess something. Ok, I'll tell Tess about someone's affair. I don't think

an affair exists but I'll start spreading tales, because I want to cause trouble. So I'll tell her about Mary's affair with Bob, see what she says about that then. See if she cares... oh, right yeah, she fancies me now. Score!...
I: What do you want to do?
U: I want to do some actions, I want to steal something or go on a slide or go shopping or talk to her... That's pretty much everything I want to do, so I'm just going to let everyone act, see if they peak my fancy in any way...
[RECORDER BROKE. Experience continued for another 10 minutes without a record. The user experienced one dilemma in this time.]

E.6 User model evaluation results

This table shows the number of correct and incorrect predictions made by the GADIN system in the user model evaluation with 3 users and experiences involving 8-10 dilemmas.

	All dilemmas		Excluding first two dilemmas	
	Correct	Incorrect	Correct	Incorrect
User 1	6	3	5	2
User 2	7	1	6	0
User 2	5	3	5	1
User 3	4	4	4	2
User 3	7	2	6	1
User 3	26	5	25	4
Total	55	18	51	10
Percentage correct	75%		84%	

E.7 Dinosaur adventure results

In this section the questions asked of the children who used the dinosaur adventure version of GADIN are shown, along with their responses to these questions. A numerical tally is given where more than one user gave the same response.

What did you think of the story?

"Ok"
"Good"   7
"Fun"
"Strange, kind of liked it"
"Liked it"

What did you think of the characters?

"Not very good"
"Very good, especially Trex"
"They were being mean"
"Good"
"Didn't do much"
"Silly"

"Trex was grumpy when he left the mountain"
"Funny"   2
"Cool"
"Little boring"

What did you think of the dinosaur world?

"Ok"   2
"Good"   3
"Fun"   2
"Strange"
"Nasty"
"Scary and fun"
"Minted" ("really cool")

Could you always do what you wanted?

Yes   2
No   9
"Wanted to be able to click on pictures"
"Wanted to become a trex"
"Couldn't steal egg until found nest"
"Wanted to get back to the beginning" (to find out what the goal had been)
"Wanted to be there in real life"

Did you change the story?[4]

Yes   5
No   6
  "All the meateaters would still eat all the herbivores"

Do you want to play again?[5]

No   5
Yes   5
Maybe   1

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[4]Clarified by asking if it would have been the same had they not been there.
[5]Many of the children thought that this meant immediately.

F

Summary of compellingness

Table F.1 shows a summary of the degree of compellingness found in each of the existing interactive narrative systems, including GADIN.

Notes on the table:

- Scale: 0 = no/not really ; 1 = some; 2 = yes; * = depends on storyworld creator (given 1 in totalling).

- It is theoretically possible to apply the techniques used in the creation of any system to a new domain or storyworld, thus none have been assigned a score of 0 for this. Only those that have been specifically designed to be easily applicable to any story domain have been allocated a score of 2, as the remaining systems require rewriting of core components of the system to achieve this transferability.

- In rating the effect of the user's actions the systems have been assigned a score of 2 only if they provide the user with both an immediate and a long-term effect of their actions. If they provide one of these the score assigned is 1, otherwise it is 0.

- Transferability is equivalent to domain independence.

System	Criteria							Total
	Interest	**Immersion**	**Scalable**	**Transferable**	**Agency**		**Replayable**	
					User free	**Clear effect**		
Oz	0	2	0	1	2	1	1	7
Erasmatron	*	0	1	2	0	1	1	6
DEFACTO	1	0	1	1	1	1	1	6
Virtual Theater	1	0	0	1	1	1	1	5
Mimesis	*	1	1	2	1	1	1	8
IDtension	1	0	1	1	1	1	1	6
I-Storytelling	1	0	0	1	0	1	0	3
Façade	2	1	0	1	2	1	1	8
IDA	2	1	1	1	2	1	0	8
SASCE	*	0	1	2	1	1	1	7
OPIATE	1	1	1	1	1	2	1	8
PaSSAGE	1	1	2	1	1	1	0	7
U-DIRECTOR	*	1	1	2	1	1	0	7
INTALE	0	2	1	1	2	2	0	8
FearNot!	0	2	0	1	1	2	1	7
GADIN	2	1	2	2	1	2	2	12

Table F.1: A summary of the degree of compellingness in each of the main interactive narrative systems.

Glossary

Action   An action is something which a storyworld character can do, providing its preconditions and applicability check have been satisfied. Following successful completion of an action its effects will become true within the storyworld, potentially affecting other characters.

Agency   "Agency is the satisfying power to take meaningful action and see the results of our decisions and choices"[81]. This is one of the compellingness criteria.

Applicability   An applicability check is carried out to ensure that actions made available to characters are appropriate given their traits.

Aspiration   Characters may have aspirations within the storyworld, these are personal states which they wish to achieve.

Attribute   Each character can have associated a number of attributes, these are generally physical features of the character which cannot change throughout the narrative.

Automated user   An automated user is a system-controlled character who takes the role of the protagonist in the narrative.

Backstory   The collective histories of the characters and the storyworld prior to commencement of the narrative are known as the backstory of the narrative.

Character   Characters act within the storyworld as directed by GADIN. The user is a character and does not have any direct control over the actions of any other characters.

Characteristic   Each character can have associated a number of characteristics, these are generally features relating to the mentality of the character and could potentially change slightly, but not significantly, throughout the narrative.

Compellingness	An interactive narrative system which satisfies all of the compellingness criteria is considered to be a successful system. The criteria are: interestingness, immersion, scalability, transferability, agency and replayability.
Current plans	The list of those plans which have been partially presented – when concurrent presentation is being utilised – are known as the current plans.
Dilemma	A point of conflict within the narrative which involves a character having to make a difficult decision is a dilemma for that character.
Disposition	Each character may have a disposition which is defined along each of a number of dimensions. A character's disposition is changeable throughout the narrative and determines the manner in which a character performs actions. It is also a factor in determining which actions they can perform.
Domain independence	If the core architecture of a system is transferable between domains then it has domain independence. This is one of the compellingness criteria.
Event	An event is something which takes place within the storyworld. It can be started by any character, or more than one character, and can involve any number of characters – providing the motivation is sufficient.
GADIN	GADIN is a **G**enerator of **A**daptive **D**ilemma-based **I**nteractive **N**arratives which is capable of achieving full compellingness.
Game world	A game world is a computer-simulated virtual world.
History (list)	Those dilemmas which have been presented within the current GADIN experience are known as the history of the narrative and are stored in the history list.
Immersion	Immersion is a determiner of how involved the user is in the experience. The plausibility of characters and the storyworld is likely to increase the user's sense of immersion. Immersion is one of the compellingness criteria.
Individualities	A character's individualities comprise their traits and modelled values.

Interactive narrative	An interactive narrative is a game world in which the user-controlled character can physically and mentally interact with ideally (perceived) total freedom while experiencing a narrative which is fundamentally different on nearly every play – depending on the user's actions. There are various terms which could be used instead of 'interactive narrative', such as 'interactive drama', 'interactive fiction', 'interactive stories' and 'interactive storytelling'. It was decided that 'interactive narrative' is the term that is most appropriate to GADIN.
Interestingness	The dramatic interest of a narrative is known as its interestingness. This is one of the compellingness criteria.
Knowledge	The information characters have about the storyworld which is not known by all characters is their knowledge.
Location	A location is a place within the storyworld where the narrative can take place.
Narrative	A narrative is the "part of a text, esp. a work of fiction, which represents the sequence of events, as distinguished from that dealing with dialogue, description, etc."[84]
Object	Objects within the storyworld will always be associated with at least one character and will belong to that character.
Occurrence	An occurrence is something which is not initiated by any character, but which affects a character or more than one character.
Personality	A character's personality description provides additional information regarding that character which is not fully implied by their other traits.
Player	The term player is used to refer to someone who plays a game.
Principle	A principle is something that a character believes they should or should not do.
Replayability	The likelihood of users re-experiencing the system, and the ability of the system to generate original narratives, determine the replayability. This is one of the compellingness criteria.

Scalability   The ability of a narrative generator to maintain the dramatic interest of narratives over a longer, even infinite, time period means that it is scalable. This is one of the compellingness criteria.

Skill   Each character can have associated a number of skills. These determine the actions they can take and locations they can move to.

Story   A story is a "narrative of real or, more usually, fictitious events, designed for the entertainment of the hearer or reader; a series of traditional or imaginary incidents forming the matter of such a narrative; a tale."[84]

Story record   The story record of a GADIN experience is a transcript of the generated narrative written in the third person and available after the experience.

Storygoal   In a finite narrative once a possible storygoal becomes true the narrative will end.

Storyplan   A storyplan is the sequence of actions which is a plan for achievement of an associated storygoal.

Storyworld   The world in which the narrative will be generated is known as the storyworld. It includes characters, locations and objects.

Trait   Each character has a number of associated traits, which can include: attributes, characteristics, personalities, skills and dispositions. A character's traits determine the applicability of their performing an action.

Transferability   Transferability is equivalent to domain independence. This is one of the compellingness criteria.

Trigger action   A user action which causes another character to experience a dilemma is known as a trigger action.

User   The term user is used to distinguish users of interactive narratives from game players, to represent the balance between games and narrative.

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