Narrative Construction in a Mobile Tour Guide

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Abstract. Storytelling capabilities are vital aspect of a tour guide. In this paper, we present a mobile tour guide that emulates a real guide's behaviour by presenting stories based on the user's interests, its own interests, its belief and its current memory activation. This research moves away from the concept of a guide that recites facts about places or events towards a guide that utilises improvisational storytelling techniques. Contrasting views and personality are achieved with an inclusion of emotional memories containing the guide's ideology and its past experiences.

1 Introduction

A tour guide should provide interesting stories to encourage learning so as to create a meaningful tour experience. Based on a brief survey of tour guide experiences, factors like role, interest, experience, type of tour, length of tour, guide's belief, guide's personality and visitor group are found to influence the presentation of information. Most guides tend to incorporate beliefs and past experiences, whether his/her own or that of others whilst narrating a story. Different guides have different presentation styles and some guides are more talkative than others. Most of the time, they present general information about the tour, particularly about what can be immediately seen. They usually welcome interaction in order to gain an indication of the visitors' interests before they provide in-depth information on a particular subject. Visitors' age, origin, race and group size also contribute to the type of story told and the level of detail in which it is told. Indoor tours are usually more continuous, while outdoor tours involve more idling moments due to walking from one place to another.

In recent years, many tourist guidance applications have been developed, to list a few: C-MAP [1], HIPS [2], SAGRES museum [3] and PEACH [4]. Our work differs from these systems in that the guide does not only present facts but also its own ideological perspectives, expressing its viewpoint about a particular event, just as a real guide does. This is consistent with Tozzi's finding that one of the most striking features of historical investigations is the coexistence of multiple interpretations of the same event, depending on the storyteller's perspective [5]. By seeing things from a particular perspective coupled with his own knowledge and understanding, a user will be able to analyse, reflect, evaluate and use the

source of information critically to reach a conclusion of why different historical interpretations exist, hence producing a deeper learning experience [6].

2 Inspiring our work

Terminal Time [7] is a history engine that combines historical events, ideological rhetoric, familiar forms based on TV documentary and artificial intelligence algorithms to construct custom-made historical documentaries for mass audiences taking into account the audiences' polls. The system utilises questionaires as the user interface and an applause meter measures the audience reaction to the possible answers to each question. The computer program creates historical narrative that strongly emphasizes the audience's ideological preference, with the history unfolding based on the winning choice. The engine uses multimedia material covering the past 1000 years of world history as the source for narrative construction. This system addresses questions concerning the relationship of perspective to the construction of history. Instead of trying to reconstruct alternative long views of history based on ideological biases, we attempt to make the users aware of the availability of different ideological perspectives on a specific historical event. Whilst Terminal Time generated stories in response to audiences' generic ideological viewpoints, we take into account both the user's and the guide's interests. Our system adopts improvisational story generation based on a variety of factors (discussed in Section 4) rather than following a pre-defined storyline in support of a winning ideology.

Ibanez [8] proposed a story generation agent that can generate short stories using inference rules that combine historical facts and common-sense knowledge. At each step, the guide decides where to go and what to tell dynamically. This system constructs stories by improvising, taking into account factors such as the distance from the current location to a destination, the already told story at the current moment and the affinity between story element and the guide's profile. Three scores corresponding to these factors are calculated each time, which are then combined to calculate an overall score for each candidate pair of story element and location. Finally, the pair with the highest overall score value is chosen. If the granularity of the selected story element is not large enough to make a story of acceptable length, more story elements are selected. These elements are then translated from the virtual guide perspective, incorporating the guide attitudes that reflect the emotional impact on it of these story elements. Next, the story elements are enhanced by means of new information items generated by inferences from simple common-sense rules.

Generating narrative from a guide's viewpoint is also the problem we address. Hence, we utilise the approach just discussed. In general, Ibanez's work brings us a step nearer to the creation of an 'intelligent guide with personality'. It adopts a storytelling technique that links the memory and interests of the guide to their spatial location so that stories relevant to what can be immediately seen can be produced. However, what it lacks is the incorporation of the user's interaction. Whilst Ibanez's system omits user interests, we consider these together with

feedback throughout the tour session as important factors that may affect the user's overall tour experience. Our guide makes use of interest attributes attached to story elements and locations that can be used to choose spots that interest the user and thus, allow personalised route planning and tours. While Ibanez' system generates stories by inferences based on facts and common-sense rules, we construct stories based on historical facts and the guide's past experiences. Instead of activating pre-defined attitudes and emotions, our guide behaviour is controlled by a biologically plausible model of emotion [9].

The problem of generating real-world tours has been explored in Geist [10], a project that developed an interactive storytelling system where stories are stored in the form of dramatic scenes, containing virtual characters, virtual buildings, storyboards, etc. By using pre-defined scenes to handle the virtual characters' behaviour, and by giving scene results back to the Story Engine, it selects the next scene to be played, in relation to the interaction of the user. Within the scenes, conversational interaction is used to permit a humanlike communication with the actors. Conversation is modelled taking into consideration social and emotional factors, story content sequences, immersion, user's perceptual focus, content information and navigational aspects. In a sense, our proposal deals with the same problem as Geist but we do not model the conversational aspects. Alternatively, a very simple interface for user's feedback is included. While Geist uses a database of explicitly pre-generated stories, our system constructs stories, step by step as in Ibanez's system.

3 The Mobile Tour Guide

The Mobile Tour Guide is an attempt to create guides with different personalities and beliefs, presenting users with different versions of stories about the same events or places. It is implemented on a PDA integrated with embedded text-to-speech system and a Global Positioning System. A server holds the guide's memories and performs processing. It sends the results of processing to the PDA on demand through wireless communication.

The guide commences the tour by introducing itself. There follows an ice-breaking session where the guide extracts information about the user's name and interests. After the user has entered and submitted the required data, the guide chooses attractions that match the user's interests, and plans the shortest possible route to the destinations. The guide navigates the user to the chosen locations via directional instructions as well as via an animated directional arrow. Upon arrival, it notifies the user and starts the storytelling process. The system links electronic data to actual physical locations so that stories are relevant to what is in sight. During the interaction, the user continuously expresses his/her interest in the guide's stories and agreement to the guide's argument through a rating bar on the graphical user interface. The user's inputs affect the guide's emotional state and determine the extensiveness of stories. The system's outputs are in the form of speech, text and an animated talking head.

4 The Narrative Constructor

4.1 Emotional Memory

Since a life story is always more interesting than simply bare facts, we argue that an emotional memory is important and necessary for the guide. The emotional recollection of past experiences will allow the guide to tell more believable and interesting stories. The user will be 'Walking Through Time' as the guide takes them through the site presenting its life experiences and reflecting the emotional impact of each experience. Holding to this view, the guide possesses a long-term memory that is made up of declarative memories, both semantic and emotional. Additionally, the guide's current memory holds information relating to recent processing.

Semantic memory is a memory for facts, including location-related information and the user's profile, while emotional memory is memory for experienced events and episodes. The guide's emotional memories are generated through simulation of past experiences. Consistent with Kensinger and Corkin's [11] proposal, the guide's emotional memory holds not only information about when, what and how an event happened, but also an 'arousal' tag and a 'valence' tag. The inclusion of the 'arousal' tag is analogous to the *Emotional Tagging* concept [12]. 'Valence' denotes how favorable or unfavorable an event was to the guide. When interacting with the user, the guide is engaged in meaningful reconstruction of its own past [13], at the same time presenting facts about the site of attraction. This recollective experience is related to the evocation of previously experienced emotions through the activation of the emotion tags.

4.2 Ontologies and Entities

The guide defines two informal ontologies. First, a story element attributes ontology, which consists of the attributes used to annotate the story elements. These attributes and their corresponding interest areas - *General, Science, Military, Politics* and *Social* are hierarchically structured. Figure 1 shows the attributes ontology for the prototype version - the narrative domain being the 'Los Alamos' site of the Manhattan Project. Second, the guide profile ontology describes the guide's role and interests. In the prototype version, two guides are implemented, a scientist who is interested in topics related to *Science* and *Politics*, and a member of the military who is interested in topics related to *Military* and *Politics*. Both guides also have *General* knowledge about the attractions.

Besides these ontologies, the system contains definitions for basic entities, including *event, concepts, personnel* and *divisions*. These definitions are used to introduce related events, concepts, personnel and 'Los Alamos' divisions respectively, the first time they appear in the narrative process. These entities are tags in the story elements that serve as triggers to the remembering process during story activation and extension.

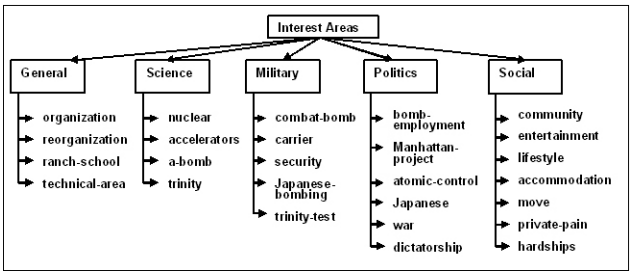

Fig. 1. Attributes ontology for the prototype version

4.3 Memory Organisation

As mentioned before, the guide possesses a long-term memory that is made up of declarative memories, both semantic and emotional. Semantic memory is memory for facts, including location-related information, ontologies and the definition of the entities. Facts form the basic *story elements (SEs)* used to construct stories and are basically free from any ideological perspective. Each element of the guide's semantic memory is composed of the properties presented in Table 1 with example, referring to the *SE* in Figure 2.

name	CU2
type	Plutonium-bomb
subjects	physics
objects	Oppenheimer plutonium-bomb
effects	CU3 1
event	Plutonium-gun-problem
concepts	plutonium
personnel	Robert-Oppenheimer
attributes	a-bomb 1
location	UCM 1
text	Not chemistry or metallurgy but <s> physics </s> nearly condemned the plutonium bomb to failure in summer, 1943 causing Oppenheimer to agonize over the problem to the point that he considered resigning his directorship.

Fig. 2. Sample story elements

While the semantic memory contains facts, emotional memory is a memory for those events that have an emotional impact on the guide. Each *emotional story element (EE)* has similar structure to the *SE* without *effects* and *subjects* attributes because the *EE* itself is the effect of a *SE* and the guide itself is the subject. In addition, the following tags are included:

arousal : the arousal value when an event took place
valence : the emotional valence value when the event occurred

4.4 Finding the Spot

The storytelling process, presented in Figure 3 starts upon arrival at a particular site of interest or upon user activation. Similar to Ibanez's system, the guide

Property	Description	Example
name	identification of the story element	*CU2*
type	the topic of story element	*Plutonium-bomb*
subjects	the subjects in the story element	*physics*
objects	the objects in the story element	*Oppenheimer, plutonium-bomb*
effects	the *SEs* that are caused by this *SE*, each effect has a weight associated	*CU3* with *weight 1*
event	a description of the event that took place, used to retrieve the guide's emotional response to the event (entity tag)	*plutonium-gun-problem*
concepts	basic entities of which the definition will be given on the first occurrence of these entities in the story (entity tag)	*plutonium*
personnel	the personnel involved in the story, not necessarily the subjects (entity tag)	*Robert-Oppenheimer*
division	the 'Los Alamos' division at which the story element happened (entity tag)	not applicable in this SE
attributes	each attribute has a weight associated and falls under one of the interest areas presented in the ontology	*a-bomb*
location	the physical location where the event occur, it can be of type "ANY" which means that the story element is general and applicable to any location, each location is also associated with a weight	*UCM*
text	the text encoding the event	refer Figure 2

Table 1. The features of story element

decides what to tell dynamically at any particular instant of time. The guide usually starts with a general description of the site before any interest-specific information is provided. This is achieved by assigning a higher weight to the *SEs* in the *General* interest group so that they receive higher priority. The guide's interests and the user's interests are persistent triggers of recollections and selections of stories. Additionally, the already told story elements aid recall by association of other related story elements.

Reminding is a crucial aspect of human memory and it can take place across situations. The story elements of the guide are retrieved based on processing-based reminding [14]. Processing-based reminding occurs during the normal course of understanding or processing new information. A *scene* or *location* is a kind of structure that provides a physical setting serving as the basis for reconstruction. Therefore, the first step involves filtering out *SEs* that are not related to the current location. This is to ensure that the *location* of the story spot always corresponds to the user location. Furthermore, the changeability of dynamic memory makes people's memory act differently in apparently similar situations. We are usually reminded by similar events, those close to previously experienced phenomenon. Thus, *attributes* and *story type* are used to link and retrieve the guide's memories of similar events or circumstances. Additionally,

an object or a person may also remind us of other similar or related object or person. Thus, *concepts* and *personnel* are also sources for remembering.

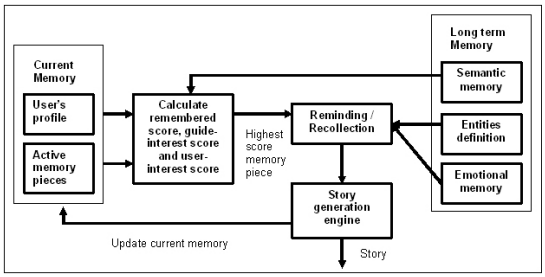

Fig. 3. The Storytelling Process

Three scores corresponding to: previously told stories; the guide's interests; and the user's interests are calculated. These scores are combined to obtain an overall score for each *SE* in the current location. A *SE* with the highest overall score will become the starting spot for extension. Only stories that relate to the user's interests, the guide's interests and to previous stories should be presented, which means that the spot needs to have an overall greater than zero value to be passed to the next and final phase. The algorithm involved in finding the spot is presented in Figure 4.

In the figure, *PAIRS* is the set of SE-loc pairs such that *loc* refers to the current location, there exists an entry in the database that relates *SE* to *loc*, and the *SE* has not been narrated yet. *concepts(SE), attributes(SE)* and *personnel(SE)* give the sets of entities from the story element, *SE*. *type(SE)* denotes the type of the current *SE*. *recentMemory(c)* gives the value of the concept c in the current memory. *constantA, constantP* and *constantT* are fixed values between 0 and 1 that are added to the *rememberedScore* when entities in the current story element match the corresponding entities in the story elements of the previous step. *attributeValue(SE, a)* is the value associated with the attribute a in the *SE* while *guideInterestValue(a)* and *userInterestValue(a)* are values of the guide's interests and the user's interests relative to attribute a respectively. The user's profile, like the guide's profile contains a set of attributes that are related to his/her chosen interest area. Hence, a higher score will be obtained when the user's or the guide's interest attributes match the story attributes. *rememberedScoreWeight, guideInterestScoreWeight* and *userInterestScoreWeight* are the weights of the remembered score, guide's interest score and the user's interest score. Since we view the user's interest as the most important factor, followed by the guide's interest and finally the remembered score, these weight are in the ratio 20:15:12. It has to be noted that the choice of parameters' weight in the equations was for purely empirical reasons. Changing these values will change the pattern of *SEs* selection and the focus of stories.

Fig. 4. The algorithm for finding the spot of story

4.5 Extending the spot

After the spot has been selected, the guide proceeds to extend it. Given that one person can remind us of another person, one object can remind us of another object or one event can remind us of another event, story extension is activated based on *subject-object* links and *cause-effect* links as in Ibanez's system. Moreover, our guide uses *type, concepts, attributes* and *location* as activation factors. A story element with the *location* of type "ANY" can be activated during extension. Two story elements A and B are connected by subject-object link if one of the following conditions is satisfied: the subject of A and B is the same; the object of A and B is the same; the subject of A is the object of B; or the object of A is the subject of B. On the other hand, if A is the cause of B; or if A is the effect of B; or if A and B are causes of the third story element C; or A and B are effects of the third story element C, then a cause-effect link is established. These story elements can be organised using a network-like structure so that associative activation can be performed during extension.

The guide story extension process is the second step in Figure 5. All extensions are performed by JESS [15], a Java based rule engine to perform reasoning. Only *SE* that succeed the preceeding phases will continue to the subsequent phases of rule firing. At each extension cycle, the *SE* with the highest final evaluation value is selected. If the *SE* is extended through cause-effect link, then it will be ordered in such a way that the effect follows the cause. On the other hand, the order of selection is preserved if the *SE* is selected through the firing of subject-object link. When the desired granularity is reached and the combina-

tion of the story elements is large enough to generate a short story, the extension process is complete.

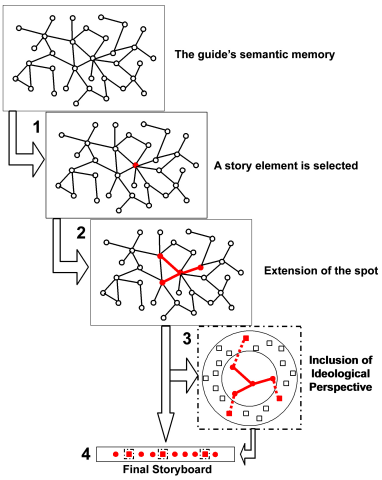

Fig. 5. The Story Extension Process (modified from [8])

4.6 Ideological Perspectives

Whilst it is true that the guide tells facts, at the same time it should not hide its feelings, beliefs and opinions. Hence, it includes its own experiences related to the facts during the storytelling, just as a real guide does. These experiences or events can be related to itself or others. We construct the guide's perspective from its emotional memory elements which lead to re-experience of emotions. The user rating on his/her degree of interest in the stories and the degree of which he/she agrees with the guide's argument after each story cycle, served as a determination factor for inclusion of ideological perspective. It is noteworthy that the guide includes its ideological perspectives only if it is currently competent and highly certain of the user's interests, that is, when user shows interest in the stories or agrees with its argument. Referring to Figure 5 again, this step is represented by the process in the dotted frame. The *EEs* are selected based on the activated *SEs* to ensure a smooth flow of storyline. To reduce complexity in the current version, a *SE* will lead to inclusion of only one *EE*. Hence, the number of *EEs* added is always less than or equal to the number of *SEs*.

Two examples stories without and with an inclusion of ideological perspectives are as below:

– *Estimates place the number of deaths caused by Little Boy in Hiroshima up to the end of 1945 at one hundred and forty thousands where the dying continued, five-year deaths related to the bombing reached two hundred thousands.*

– *Estimates place the number of deaths caused by Little Boy in Hiroshima up to the end of 1945 at one hundred and forty thousands where the dying continued, five-year deaths related to the bombing reached two hundred thousands. The experience of Hiroshima and Nagasaki bombing was the opening chapter to the possible annihilation of mankind. For men to choose to kill the innocent as a means to their ends, is always murder, and murder is one of the worst of human action. In the bombing of Japanese cities it was certainly decided to kill the innocent as a means to an end.*

4.7 Generating the Story

The result of the above steps is a set of inter-related story elements and optional emotional story elements. These elements are stored in a structure with meta information about the extension process, including the relations among them, the reason for selection and the evaluation values. With this information, the system is ready to generate a complete story.

Since the set of *SEs* has been ordered during extension process, the next step is to order the *EEs*, where available. Each *EE* usually follows its associated *SE*. However, if two *SEs* have a cause-effect relationship, then the associated *EEs* will come after both *SEs*. Next, all the selected elements are combined taking into consideration the existence of *entities*. The guide retrieves the definition for each *entity*, (*event, concept, personnel* and *division*) that appears for the first time whether in *SEs* or *EEs*. This recall process - Schank [14] termed this dictionary-based reminding - occurs when the we search for the definition of an infrequent word or concept in our memory.

Each *subject* in the *SE* text is embraced in begin and end tags defined as <*s*> and </*s*>. These tags allow the system to recognise the *subject* of the *SE* and substitute it with an appropriate pronoun, retrieved from the database. With the completion of this step, the final storyboard is obtained. The resulting story is sent to the PDA and presented to the user.

```
Reinforcement
First appearance of a concept
For each concept c ∈ conceptsJustUsed and c ∉ previouslyUsedConcepts
      recentMemory(c) = 1

Successive appearances of a concept
For each concept c ∈ conceptsJustUsed and c ∈ previouslyUsedConcepts
      recentMemory(c) = recentMemory(c) x timesOfAppearance(c) x
            reinforcementMemoryFactor

Forgetting
For each concept c ∉ conceptsJustUsed and c ∈ previouslyUsedConcepts
      recentMemory(c) = recentMemory(c) - forgetMemoryFactor
      If recentMemory(c) ≤ 0
            remove recentMemory(c)
```

Fig. 6. Algorithm for reinforcement and forgetting of *concept* strength

After each story presentation, the guide updates its current memory so that it can be reminded of the current active memory elements in the next retrieval

cycle. We have seen that the guide stores the current activation of *concept, personnel, attribute* and *type* in its recent memory. Analogous to human memory, a *concept* strength in the guide's memory increases when it is activated frequently and will be forgotten if not used after a few iterations. In contrast, the current activation of *personnel, attribute* and *type* remain in the current memory only for a single story cycle. The reinforcement and forgetting of *concept* strength are performed using the algorithm in Figure 6. *conceptsJustUsed* refers to the list of concepts that is active in the current story telling cycle while *previouslyUsedConcepts* refers to the list of concepts that was active in preceeding cycles. *timesOfAppearance(c)* is the number of times c appears in the current cycle. *reinforcementMemoryFactor* specifies the degree of enhancement whilst *forgetMemoryFactor* defines the degree of forgetting of a concept c in the guide's memory.

5 Conclusion

This paper presents a mobile guide that adapts its story presentation based on the user's interests and opinions. We move away from a tour guide that recites facts to a guide that tells stories by improvising. Additionally, emotional memories is included so that the guide can tell its own autobiography, hence present a more believable and engaging narration. This point is confirmed by the evaluation with real users discussed in [16], which showed that with the inclusion of attitude, more interesting stories were generated and an enhanced tour experience was achieved.

For future work, we would like to explore on mood congruency effect in stories retrieval. People usually retrieve memory files that are directly consistent with their current mood [17], hence, it could be possible that a guide who tells stories based on its active emotions will be perceived as more realistic and believable. Moreover, to improve coherence for narrative construction, natural language approaches such as Rhetorical Structure Theory [18] ought to be considered.

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