A Planning Approach to Story Generation for History Education

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ABSTRACT
Effective history instruction often relies on taking historical episodes and making them personally relevant to the learner. One narrative-centered technique for accomplishing this is to tell a story about the historical episode in which significant historical events are witnessed or even, to some small degree, influenced by a fictional character. Given individual differences among users, the ability to generate historical fictions that are adapted to a particular learner is essential. Historical fiction generation is a special case of general narrative generation that imposes constraints on the form of the solution story. We describe how a narrative planner, specifically the Fabulist narrative planner, is capable of generating historical fictions for educational purposes.

1. INTRODUCTION
History is the chronological record of significant events. It is essentially the story of how the world has come to be in its present state. In some cases, history can be as interesting as any fictional tale (for example the extraordinary true story of Shackleton’s ill-fated expedition to Antarctica). More often than not, history is not viewed as interesting to many learners. One common technique in making history education interesting and relevant to a student is to present history to the student through historical fiction. Historical fiction is livelier than textbooks and often focuses on the personal choices of historical figures forced by historical events [5]. A historical episode is exposed to the reader through the perspective of a character in the story. Through the characters, readers vicariously experience the past and reinterpret it on the bases of their own experiences, values, hopes, and fears [4].

The historical record rarely includes a highly detailed description of the actions of historical figures from moment to moment. Instead the historical record enumerates the significant events. We call these events historical events. Historical fiction involves some degree of inaccuracy [5]. For the purposes of this paper, we concern ourselves with historical fiction that does not contradict the historical record, but instead “fills in the blanks” between historical events. One technique for historical fiction that satisfies our objectives is to introduce a fictional character that experiences the world during an historical episode and comes, through purpose or accident, to witness or become involved in the historical events that define that historical episode.

For example, the historical fiction novel, Quicksilver: Volume I of the Baroque Cycle [14], is an account of Newton and Leibniz and the political climate in which they independently discovered calculus as witnessed by fictional character Daniel Waterhouse. Although in the novel Waterhouse mediates disagreements between Newton and Leibniz, acts as Puritan advisor to a succession of English monarchs, and plays a small part in negotiating the Bloodless Revolution of 1688, Waterhouse is not recorded in history. However, through Waterhouse’s interaction with historical personages and Waterhouse’s peripheral involvement in historically significant events, the reader has no choice but to learn about the world and political climate in which
Waterhouse exists. It is the very concept of “edutainment” to slip education in the backdoor while entertaining the learner at the front door.

The effectiveness of historical fiction as an educational resource depends on the learner’s identification with the fictional character through whose personal experiences historical events are revealed. Individual differences between learners, including age, sex, and interest in particular themes [5], indicate that the ability to generate historical fiction computationally can be desirable. Most existing narrative-oriented education systems are built using pre-scripted action sequences; story world characters play out the same elements of the same story each time the system is run. In contrast, a system that generates a novel narrative for each user session can tailor its narratives to the individual preferences, needs, and abilities of the user instead of relying on scripted sequences prepared in advance. Narrative generation is one of the capabilities required for narrative-centered learning, which addresses the twin pedagogical goals of learning effectiveness and motivation [10].

2. REQUIREMENTS OF HISTORICAL FICTION GENERATION

Historical fiction generation imposes several constraints on the more general problem of narrative generation. The goal of historical fiction for educational purposes is for the audience to become familiar with a certain set of historical events, $H$. The success of the narrative is dependent on the learner’s retention of elements in $H$. The success of an historical fiction story can be empirically measured by testing student comprehension of historical facts [15]. We define a historical event as a significant event that occurred in the real world and was recorded by historians. A historical person is a person who existed in the real world and is involved in one or more historical event. A historical character is the story world representation of a historical person. A fictional character is a story world character that does not correspond to any historical person. The following is a list of constraints that differentiate historical fiction generation from general fiction generation.

1. The narrative must include all historical events in $H$. That is, the audience must be told of all events in $H$.
2. The historical events in $H$ must occur in their proper chronological order.
3. Nothing can happen in the narrative that prevents a historical event from occurring. This ensures that the historical events in $H$ that are told are plausible.
4. Nothing can happen in the narrative that can be misinterpreted as an historical event that is not already in $H$. Anything fictional cannot be important enough that, had it actually happened, historians would have recorded it.
5. The fictional character that the audience identifies with must be present to observe all historical events in $H$.
6. The actions and behaviors of the fictional character must appear intentional. That is, the narrative will be unconvincing if the fictional character has no reason to be performing actions in the places and times that the historical events in $H$ occur.

The constraints on the form of historical fiction ensure that a story does not deviate too far from the historical record to be an educational resource. The constraints also suggest that any fictional character have some immediate relevance to the historical events that the student is to learn about. Minimally this means the fictional character with which the student identifies and emphasizes with observes all historical events, although it can also mean that the fictional character be part of the main causal chain that connects all historical events.

3. NARRATIVE GENERATION

Narrative generation is the process of creating, from a minimal set of inputs, the plot of a story. We distinguish between story – the sequence of actions and happenings that
occur in the story world – and storytelling – the discourse process of transferring knowledge about story from narrator to audience. For the purpose of this paper, we concern ourselves with the process of story generation with the assumption that some external process reasons about how to tell the story to an audience.

3.1. Related Work
Tale-Spin [9], the Oz Project [2], and the I-Storytelling Project [3] are examples of emergent storytelling systems. In these systems, narrative emerges from the autonomous character pursuing their individual goals [1]. The emergent nature of these systems makes it difficult to achieve some of the constraints of historical fiction. Unless the agents accurately model the historical figures that they portray, there is no guarantee that the required historical events in \( H \) will occur, violating Assertion 1. The Oz Project, however, utilizes a drama manager [18] that discreetly manipulates the agents’ goals in order to force a certain narrative structure to emerge. The drama manager could be used to ensure that historical events occur (Assertion 1) and in the appropriate order (Assertion 2), but is unlikely to prevent fictional events with historical significance from occurring (Assertion 4).

Façade [8] uses a reactive behavior planner that iteratively selects, orders, and executes fine-grain plot elements called beats that describe action/reaction behaviors that story world characters will perform. Façade generates narrative from a global perspective, avoiding the pitfalls of other, emergent systems. Façade, however, has limited look-ahead capability for beat selection. Façade could be adapted to historical fiction, but would require deliberative crafting of the beats to guarantee that all historical events are eventually achieved and in the correct temporal order.

The Universe system [7] uses a hierarchical planner to select plot fragments and piece together a narrative involving many story world characters. As a system with global access to the narrative structure, Universe can ensure that the constraints imposed by historical fiction are met. The planner in Universe incorporates character actions into the narrative sequence that contribute to the systems storytelling goals. Storytelling goals are high-level descriptions of plot such as “keep lovers apart” (Universe operates in the domain of soap-operas). The next section describes the benefits and limitations of planners, such as that used by Universe, for historical fiction generation.

3.2. Narrative Planning
Young suggests that planning has many benefits as a model of narrative [16]. One of which is that causal dependency planners rely on causal relationships between plan steps, ensuring consistency and coherence of narrative. Plan steps are defined as having preconditions – propositions that must be true in the world for an step to execute successfully – and effects – propositions about the world that are changed by successful completion of the step. A causal link [11] connects two steps \( s_1 \) and \( s_2 \) via condition \( e \), written \( s_1 \rightarrow e s_2 \), when \( s_1 \) establishes condition \( e \) in the world needed by subsequent action \( s_2 \) in order for \( s_2 \) to execute.

Causal dependency planning operates in a backward chaining fashion as a process of flaw repair. A flaw is an annotation on an incomplete plan that specifies how the plan will fail to execute. A flawed plan is revised into children plans where each sibling represents a different way of repairing the same flaw. The children plans themselves have flaws that are inherited from the parent plan or introduced when other flaws are repaired. Planning is thus a search through a tree of partial plans.

In this approach, the planner is initialized with a root plan which is typically an empty plan containing goal propositions that must be made true in the world. The goal
propositions are open conditions in the root plan (i.e. flaws indicating that conditions are not yet marked as established). Open conditions are repaired by extending a causal link from a preceding step in the plan that has an effect that unifies with the open condition. Although planners are typically initialized with an empty plan, causal dependency planners such as [11] can be initialized with partial plan descriptions. A partial root plan for historical fiction generation, \( p_H \), includes plan steps for every required historical event in \( H \) plus ordering constraints. The planner cannot exclude any of these steps nor violate any ordering constraints in successive plan nodes. This ensures that all events in \( H \) are represented as plan steps in the solution plan (Assertion 1) and that those steps occur in the proper temporal order (Assertion 2).

Besides satisfying open conditions, the planner also resolves causal threats. A causal threat occurs when the effect of some step, \( s_t \), negates condition \( e \) of a causal link relating two steps, \( s_1 \) and \( s_2 \). \( s_1 \) establishes some condition \( e \) in the world which \( s_2 \) relies on for execution. But after \( s_1 \) occurs and before \( s_2 \) occurs, step \( s_t \) may occur, causing \( e \) to become false in the world and jeopardizing \( s_2 \)'s ability to succeed. Causal threats are repaired by temporally ordering \( s_t \) before \( s_1 \) or after \( s_2 \). By resolving causal threats, a narrative planner can ensure that no action in the solution narrative plan that renders an historical event impossible because of causal threat resolution (Assertion 3).

Planning algorithms are ultimately problem-solvers. In that regard, they are concerned only with finding a solution plan that is guaranteed to achieve a goal (a description of propositions that must be true in the story world) and not necessarily concerned with the quality of the solution. There are no mechanisms in causal dependency planners that prevent them from inserting character actions that could be considered historically significant had they actually happened. Thus a narrative generator based on causal dependency planning is not constrained to support Assertion 4. However heuristic functions that guide the search through the tree of partial plans can be provided that evaluate each plan node with an eye for historical significance of character actions that are not part of \( H \). Plans that violate Assertion 4 can be ranked at infinity (where zero is most desirable).

While a narrative planner can be coerced through heuristics to reject plans with certain qualities, they cannot be coerced into generating plans with certain qualities. Thus a narrative planner will only find narrative plans that satisfy Assertions 5 or 6 by happenstance unless the planning algorithm is extended. Section 4 describes a narrative planner, Fabulist, which extends causal dependency planning in order to satisfy Assertions 5 and 6.

4. THE FABULIST NARRATIVE PLANNER
The inability of pure causal dependency planners to satisfy the constraints of historical narrative fiction is due to the mismatch of intention in general planning and narrative planning [13]. General planning assumes that the agents in the world intend to achieve goal state of the plan. Thus, under general planning, all actions that agents perform while executing the plan are, by definition, intentional. Within the domain of narrative planning, the goal of the planning problem represents the outcome of an episode and does not necessarily correspond to the intentions of the agents (characters) in the story world. For example, James II of England does not intend to be dethroned, although that is the consequence of the “Bloodless Revolution.” The intentions of the characters in the story world must be determined distinctly from the outcome of the narrative.

Fabulist addresses the limitations of causal dependency for historical fiction generation by extending the basic causal dependency planning algorithm in order to ensure certain desirable narrative structures, such as character intentionality, are always present in the
narrative plans it constructs. Fabulist combines causal dependency planning and a simulated intention recognition process that searches the space of possible character intentions in order to generate narratives that are consistent with all the constraints of historical fiction generation problem.

4.1. Intention Recognition in Narrative Planning

Gerrig suggests that an audience actively performs problem-solving in order to predict the fate of favorable story world characters [6]. The audience is only able to draw upon the observable actions of the story world characters as a source for their problem-solving conclusions. It makes sense, therefore, for a narrative planner to emulate this problem-solving process as the narrative plan is generated providing a check of story “goodness”. The intent-driven narrative planner performs intention recognition on character actions as a way of guiding the plan construction process. Unlike a heuristic that orders alternatives, Fabulist incorporates explicit intentional structures into plans to drive content creation [13].

Fabulist applies intention recognition simulation [13] is an incomplete plan when a character action is newly instantiated or when a character action is reused. The purpose of intention recognition is to realize that a new character action may be intended as part of some goal that is distinct from the outcome of the episode. Character actions are instantiated in order to causally satisfy open conditions in a plan. However, whenever a new character action, \( s \), is instantiated or used to causally satisfy more than one open condition, the simulated intention recognition process non-deterministically determines whether

- One of the effects of \( s \) is an intended consequence – called an \textit{internal character goal} – of performing that action, or
- \( s \) is part of a sequence of actions to be performed by the character to achieve some internal character goal.

A character action for character \( c \) in a Fabulist plan is intentional if it is associated with some internal character goal committed to by \( c \). Fabulist ensures that all plan steps in a solution plans that it finds are intention. If a plan step is not intentional, Fabulist throws out the plan and backtracks to find a new solution.

Determining all character actions to be intentional is irrelevant unless the audience of the story is aware that the characters have those intentions. When an internal goal is found for a character, the planner also finds a \textit{motivating step} that causes the character to intend to act. Specifically, the plan is refined to include a new or existing step whose effect is \((\text{intends } c \ g)\) where \( c \) is the character and \( g \) is the internal character goal for \( c \).

Figure 1 is a graphical representation of a Fabulist plan. The square boxes represent character actions. The dashed enclosures associate character actions with internal character goals. The arrows represent causal links. To construct the plan in Figure 1, Fabulist searches the space of plans that solve the goal proposition, \( p_1 \), as well as searches through the space of possible internal character goals. In the example, character \( c_1 \) intends to achieve \( p_5 \) which is the desired effect of step \( s_1 \) (whereas \( p_1 \) is the effect that is relevant to the human author). As part of the attempt of \( c_1 \) to achieve \( p_5 \), step \( s_5 \) is performed, which motivates character \( c_2 \) to commit to...
achieving \( p_2 \). In the example, step \( s_e \) is an action in the story world that causes character \( c_1 \) to commit to the goal of achieving \( p_5 \).

Within the context of historical fiction generation, incorporating character intentionality into causal planning affords the enlivenment of an historical episode by motivating why the fictional character observes and/or influence the historical events (Assertion 6). A solution narrative plan would be less than satisfying if the fictional character merely walked from place to place just in time to witness something historic without explaining why the fictional character wanted to be in each of those places or what the fictional character was trying to achieve when he or she became involved.

To ensure that Fabulist does not discover intentions for historical characters that do not match the intentions of their real world counterparts, information about historical character intentions needs to be provided as input into the partial initial plan, \( p_H \). That is, steps that correspond to historical events in \( H \) are actions performed by historical characters and internal goals for those characters must be given. Fabulist considers the intentionality of those steps solved and will not consider intentions for historical characters further.

4.2. Involving Fictional Characters in Historical Fiction Planning

Most of the discussion so far has involved the pragmatics of using Fabulist to create historical fiction that is sound and plausible. Fabulist takes a partial plan consisting of temporally ordered historical events and fills in the historically insignificant aspects of how those historical events come to be. This ensures that the necessary historical characters and props are in the appropriate states for the historical events to occur in their proscribed order. There is no guarantee, however, that the fictional character will be involved in establishing the causal dependencies between actions or that the fictional character will be in a state to observe any historical events (Assertion 5). Fabulist must be coerced with the use of author goals to incorporate the fictional character in the narrative plan.

Author goals are partial descriptions of world states provided as initial inputs by the human author. Author goals describe sets of propositions about the story world that must be true simultaneously at some point between the beginning of the narrative plan and the end of the narrative plan. Author goals are temporally ordered with respect to each other. That is, if the human provides author goals \( g_1 \) and \( g_2 \) and designates \( g_1 \) occurs before \( g_2 \) then Fabulist must find a solution plan in which \( g_1 \) is true in the world before \( g_2 \) is true in the world. In conjunction with temporally ordered historical events in \( H \), Fabulist can be instructed to ensure that the fictional character observes historical events (e.g. by providing an author goal, \((\text{observes } c \ h_1)\)), where \( c \) is a symbol that refers to the fictional character and \( h_1 \in H \) or comes to possess resources necessary for historical events to occur (e.g. by providing an author goal, \((\text{has } c \ \text{letter})\)), where \( c \) is a symbol referring to the fictional character and letter is a symbol referring to a letter from powerful Protestant forces in England inviting William of Orange to bring his army to the island country).

4.3. An Example

As an example, we recreate a simplified version of the Bloodless Revolution in England in which William of Orange is invited to invade England and depose the ruling monarch, James II. In our historical fiction version, a fictional character becomes the messenger between Tories in England and William of Orange in Amsterdam. The historical events that we wish to have present in our story are:

- William receives an invitation from the Tories to invade England
William invades England and deposes King James.

The single goal of the episode is that James II is not the king in England. These actions, along with the goal are given to Fabulist as initialization parameters. Also known and provided to Fabulist are the facts that the Tory1 – a leader of the Tory political party – and William intend that James not be king. The final input parameter to Fabulist is an author goal declaring that the fictional character, FC, has the invitation letter in her possession at some time during the story. The following is a trace through one path through the plan search tree.

Beginning with the open condition that William has the letter of invitation and working backwards, Fabulist non-deterministically determines that FC gives the letter to William. Fabulist reasons about why FC gives the letter to William and non-deterministically decides that FC intends William to have the letter and that intention is initiated by Tory1 hiring her to deliver the letter. For FC to have the letter, Fabulist determines that the Tory1 gives the letter to FC. This satisfies the author goal and distinguishes this plan from unsuccessful plans where Tory1 delivers the letter directly to William. Fabulist determines that hiring FC and giving her the letter are part of Tory1’s intentions to overthrow the king. The solution plan that Fabulist finds is shown in Figure 2. The shaded portions of the plan indicate structures provided as initial input into Fabulist. The action, Read, is a special type of action that does not need an explicit intention, assuming that everyone wants to read their mail.

5. NARRATIVE PLAN EXECUTION AND INTERACTIVITY

Fabulist computationally represents stories as plans that contain temporally and causally ordered character actions. The presentation of a story in a virtual world that the user can enter and participate directly in can greatly improve a student’s motivation to learn [10]. Ideally, the user will be the fictional character interact directly with the historical figures and participate directly in historical events. Direct interactivity creates a narrative paradox [1]; the user is not constrained to follow the narrative plan and can perform actions in the virtual world that directly interfere with the structure of the narrative plan [12]. Fabulist can be combined with the Mimesis architecture [17]. The Mimesis architecture combines a story generation component with an execution substrate that executes a story plan in a 3D graphical virtual world. Unexpected user actions are handled by pre-computing a tree of contingency story plans that replace the current story plan when the user performs an action that threatens to unravel the causal structure of the current story plan. More information about how Mimesis handles an interactive user in an interactive storytelling environment can be found in [17] and [12].

6. CONCLUSIONS

One technique to motivate students to learn about an episode of history is to use a narrative-centered approach that presents that episode as a story in which a fictional character that the student can relate to observes or participates in some small way in the
significant historical events of that period. To maximize the student’s receptivity to the fictional character, we advocate a narrative generation approach in which historical fiction is adapted to the individual student’s interests and abilities. Historical fiction generation, however, differs from the more general case of narrative generation in that it imposes some constraints on the form and content of the solution story that are difficult for previous story generation systems to meet.

We present a narrative generation system, Fabulist, which uses a combination of causal dependency planning and simulated intention recognition to meet the constraints of historical fiction. It is assumed that by achieving all the constraints of historical fiction and by initializing the story world according to the student’s learning profile (e.g. choosing a fictional character that the learner will identify and emphasize), the pedagogical objectives of learning a set of historical events will be achieved. Fabulist, however, does not directly reason about how individual story components impact learning without the use of complicated heuristics that have not been invented yet.

Fabulist can realize a narrative plan as natural language or as execution in a virtual world. If the story is told in a virtual world, the student can enter the virtual world as an interactive participant, further motivating and enhancing the relevance of the historical lesson. Fabulist is fully implemented and historical fiction domains are being engineered.

6. REFERENCES