A Computational Model of Narrative Generation for Surprise Arousal

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***Abstract*—This paper describes our effort for a planning-based computational model of narrative generation that is designed to elicit surprise in the reader's mind, making use of two temporal narrative devices: flashback and foreshadowing. In our computational model, flashback provides a backstory to explain what causes a surprising outcome, while foreshadowing gives hints about the surprise before it occurs. Here, we present Prevoyant, a planning-based computational model of surprise arousal in narrative generation, and analyze the effectiveness of Prevoyant. The work here also presents a methodology to evaluate surprise in narrative generation using a planning-based approach based on the cognitive model of surprise causes. The results of the experiments that we conducted show strong support that Prevoyant effectively generates a discourse structure for surprise arousal in narrative.**

***Index Terms*—Artificial intelligence, cognitive models, interactive narrative, surprise generation.**

I. Introduction

According to narrative theorists focusing on the structural aspect of narrative, narrative can be viewed as having two parts: story and discourse [1]–[3]. Here story briefly refers to a temporal sequence of the events in the narrative; discourse refers to a verbal or written representation of the story in which the story events are recounted by a storyteller or a narrator. Thus, in a narrative discourse, some story events are omitted, shortened, lengthened, repeated, transposed, or described in detail by the storyteller for dramatic effect. The listener or the reader experiences the discourse part of a narrative, which is told by the storyteller, and reconstructs a version of the story part of the narrative in his or her mind by building a mental representation of the discourse. We present a computational framework designed to generate discourse that effectively recounts story events in order to elicit a sense of surprise in the mind of a reader.

Three temporal narrative devices, particularly associated with cinematic narratives [4], [5], are often used by storytellers to manipulate the presentation order of story events: flashforward, foreshadowing, and flashback. Flashforward (or prolepsis [2], [3], [6], [7]) shows to the reader ahead of time some story events that will occur later as the story unfolds. As a result, the viewer focuses his or her expectations on a specific story outcome, wondering how (or why) the outcome will happen. Flashforward is realized in various ways in literature and in film media. For instance, a narrator can directly tell the reader about an important story outcome at the beginning of the story. A particular character in the story (e.g., a prophet or one who has a special ability to see the future) can foretell or show future events in the story. Foreshadowing is also a narrative device that makes reference to later events in the story. Unlike flashforward, however, foreshadowing is implicit in nature, so the underlying meaning of the foreshadowing becomes clear only when the target event occurs later in the story [3], [5], [6]. In contrast to flashforward and foreshadowing that refer to some future events, flashback (or analepsis) provides the reader with information relating to a backstory that has occurred in the past, typically associated with a particular character, object, or event [2], [3], [5].

There are two main goals of the work we report here. The first is to develop a computational model of surprise arousal in narrative considering a reader's emotion as a cognitive response that is elicited by the surprising events. This model focuses on the creation and use of foreshadowing and flashback. The second is to evaluate the computational model empirically. This paper concludes our previously published works [8]–[10], including the results of our main studies.

We employ the concept of surprise explained by Prince [3]: "Surprise in narrative refers to the emotion of a reader, which is obtained when expectations about what is going to happen are violated by what in fact does happen." Based on this definition, we focus on the structural aspect of narrative using the bipartite story and discourse model of narrative described above. We propose a system that can elicit surprise by identifying surprising events, important outcomes in the story, and the initial and crucial information related to the surprising outcome. For presentation of this kind of discourse structure, our system makes use of a narrative model with flashback and foreshadowing. As a result, our system produces narratives with nonchronological time—that is, narratives in which some story events are presented out of chronological order—including a surprising event (which is associated with an important story outcome), flashback as an explanation of the surprising events, and foreshadowing to mention the flashback in advance.

Our approach is also based on a cognitive model of surprise [11], [12] and empirical studies of the reader's emotions due to narrative discourse structure [13], [14]. To select the best discourse structure to produce surprise, the surprise evaluation process in our system makes use of four factors: expectation

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failure based on a cognitive model of surprise causes, importance of events on the basis of causal relations between story events, emotional valence considering a reader's preference, and resolution of incongruities in surprise. This evaluation process is described in Section III in detail.

II. Related Work

Since the 1970s, a number of research efforts have addressed the computational generation of narrative, but only a few have made an attempt to incorporate the notion of the temporal rearrangement of story events such as flashback or foreshadowing. For example, MINSTREL, a story generation program written by Turner [15], used foreshadowing technique to avoid a sense of contrivance for uncommon and important events. In the project named Carmen's Bright IDEAS [16], flashback and flashforward were used: flashback to represent a character's past events; flashforward to represent a character's imagination of future events.

Suspenser [17] is a narrative generation system focusing on the content-selection process from story to discourse. The goal of Suspenser is to create a feeling of suspense—a combined emotion of anticipation and anxiety about a significant event's (SE's) uncertain outcome—in the reader's mind by selecting appropriate contents for the discourse from the events in the story. Suspenser does not consider the ordering of the story events at the discourse level during the discourse construction process. Rather, Suspenser selects important actions for inclusion in a story using a plan-based reader model that measures the suspense level of the reader at a certain point while reading a story. To achieve high suspense during the content selection process, Suspenser employs a way of limiting the number of solutions available to a protagonist in the story. While Suspenser concentrates on the selection of story content for suspense, our system stresses the presentation ordering of story content for surprise.

While these AI systems have addressed the importance of temporal aspects of storytelling, they have not provided a systematic framework for its manipulation that considers a reader's emotion as a cognitive response.

Many of the previous cognition-focused efforts to study surprise differ in their details, but are in agreement when considering the notion that expectation failure or expectancy disconfirmation elicits surprise [11], [12], [18], [19]. In particular, Ortony and Partridge [12] describe three causes for surprise: active expectation (or prediction) failure, passive expectation (or assumption) failure, and unanticipated incongruities. Active expectation failure occurs when an input is in conflict with a situation that is actively inferred by an agent. Passive assumption failure occurs when an input, which is not actively entertained by an agent at the time, is in conflict with an agent's knowledge base or belief. Unanticipated incongruity includes "deviation from normalcy" (e.g., one watches one's favorite TV show in which one's favorite character suddenly talks to the camera, addressing the audience directly). Although these distinctions are often blurred in both real life and in narrative, their analysis sheds some light on the cognitive models of surprise.

Surprise, in narrative, can serve to stimulate the reader's attention and cognitive interest [20], which can be drawn out from the narrative structure rather than the emotional impact of the story [13], [14]. The reader's surprise then contributes to his or her story interest [21], [22]. Specifically, the evoked surprise should be resolved without any conflicts against other narrative elements in the story, that is, surprise should be postdictable [23]. Surprise without proper resolution—particularly associated with the story ending—would severely harm the reader's overall story appreciation. The notion of postdictability is compatible with the concept that achieving story coherence with proper surprise resolution is essential in the assessment of surprise [24], [25].

With regard to the generation of surprise in narrative, the structural affect theory [13], [14] suggests that surprise can be evoked in the reader's mind by sudden presentation of a significant story event with the reader's unawareness of the omission of its initiating events (IEs; i.e., the critical information related to the SE). Empirical studies have shown that the temporal manipulation of discourse structure can produce different cognitive and emotional responses by influencing the reader's inferences and anticipation [22]. Our research combines the empirical result of structural affect theory with two narrative devices (flashback and foreshadowing) for surprise arousal in narrative generation. We also suggest the use of foreshadowing as a way of enforcing postdictability as well as a persuasive device [26].

III. Prevoyant: A Model of Surprise Arousal Using Flashback and Foreshadowing in Narrative

Prevoyant, our system, is a computational model of surprise arousal using flashback and foreshadowing in narrative generation. Prevoyant produces as output a story-containing structure intended to evoke surprise in the reader's mind. Given a source story described using a plan data structure, Prevoyant determines the content and insertion point in the story for flashback and foreshadowing events. Prevoyant makes use of a reader model which reflects the reader's conception of a story world constructed while reading. The story plan requires a specific medium to be realized. Prevoyant passes the output story plan to a module responsible for realization that could then generate text, machinima, or other medium-specific realizations of the story. The output of Prevoyant is for telling the story events in a specific order, not for executing the story events dynamically in real time.

A. Architecture

A functional role of surprise, like suspense and curiosity, is to maintain and focus a reader's attention [20]. Prevoyant aims to create surprise at an important story outcome, which can make the reader more engaged in the story. In order to create this sense of surprise in a reader, Prevoyant uses two narrative techniques (foreshadowing and flashback) and employs a generate-and-test design incorporating three major components: the generator, the evaluator, and the implementer (see Fig. 1).

Given a story with a partial-order planning structure, Prevoyant rearranges the story's temporal order by selecting flashback and foreshadowing events, aiming at evoking surprise in the reader's mind. During this temporal rearrangement process, the generator and the evaluator work together to reconstruct a given story based on the anticipated inferences made by the reader, as predicted by the reader model. The

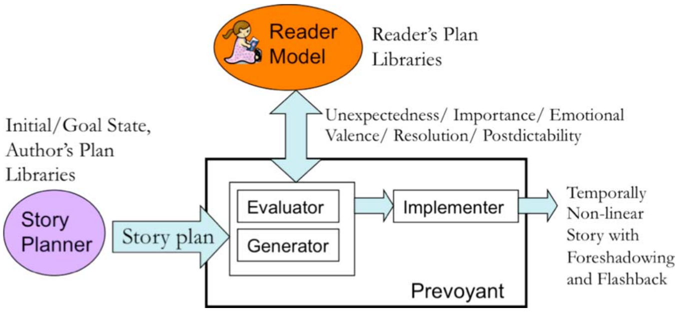

Fig. 1. System architecture.

generator selects candidate discourse structures that can elicit unexpectedness. Since unexpectedness alone is not sufficient to increase a reader's surprise in narrative, the evaluator checks each candidate discourse structure based on four factors related to surprise arousal in narrative: unexpectedness, importance of the events, a reader's emotional valence, and resolution of the incongruities within the unexpectedness. After the reconstruction of story events is complete, the implementer determines how to realize the story based on the specific medium in which the story is being told. The overall system architecture is shown in Fig. 1.

Prevoyant makes use of an explicit reader model to reflect three characteristics of a reader: the reader's plot-related inference process, the reader's plan-based reasoning capability, and the reader's story-related preferences. The detailed structure and use of the reader model is described below.

B. Input: The Story Plan

Prevoyant's input is a story that is represented as a plan structure created by Longbow, a discourse planner employing a partial-order causal link planning algorithm with hierarchical action decomposition [27]. The partial-order plan structure that Prevoyant uses includes a set of plan steps, a set of binding constraints over variables in the plan's steps, a set of temporal ordering constraints over the plan's steps, and a set of causal links between the effects of the plan's steps and the preconditions of other steps in the plan. A binding constraint denotes a variable that is bound to a constant in a plan step. A temporal ordering constraint represents the ordering constraint between two plan steps. A causal link connects two plan steps where an effect of the first step (i.e., a source step) achieves a precondition of the second step (i.e., a destination step). The information for instantiating plan steps from a set of plan operators is stored in the plan libraries designed by a domain engineer (for details of the plan structure used in Longbow, see [27] and [28]).

C. The Reader Model

Prevoyant uses a plan-based reader model using the Longbow planning system, motivated, in part, by work that has shown that planning systems can serve as proxies for the human planning process [29] and for the ways that humans reason about complex activities when considering text or machinima-based characterizations of them [30]–[32]. In this work, we use the Longbow planning system as a reader model to check whether a story event is unexpected, considering both the story events so far (i.e., plan steps that have been executed in the story) and the reader's knowledge represented by the reader's plan library (which consist of plan operators and domain descriptions reflecting the reader's knowledge, belief, and preferences) [9]. Fig. 2 shows a schematic representation example of a plan operator for Longbow planner to use for the generation of a story plan.

```
Operator: Buy-Gun
  Parameters: ?user
  Constraints: (is-person ?user)
  Preconditions: (has-cash ?user)
  Effects: (has-gun ?user)
       (not (has-cash ?user)
```

Fig. 2. Example of a schematic representation of a plan operator Buy-Gun.

The Longbow planning system is based on refinement search [33], a model of planning that views the planning process as a search process through a space of plans. The refinement search process is represented using a directed arc graph, where nodes denote (possibly partial) plans and arcs denote refinement of plans. The plan refinement process is characterized by fixing any flaws in a plan. Our system considers two types of flaws: open preconditions and threats. An open precondition refers to a precondition that is not achieved by actions in the plan. A threat occurs when there is an action whose effect conflicts with established causal links in the plan. A story plan produced by Longbow planner is a complete plan, that is, there are neither open preconditions nor threats in the story plan.

The reader model simulates plot-related inferences performed by the reader, where the (possibly partial) plans in the plan space represent possible completions of the story that could be considered by the reader. The current reader model employs a resource/reasoning bound function to characterize the resource limits on the reader's ability to infer plans. This function places a limit on the number and type of nodes in a plan space that can be searched during the planning process. A heuristic function is used to guide the best-first search process during planning; this function characterizes the reader's preference for plans in the planning process such as the preference for content selection. The reader's current knowledge while reading a story is represented by a set of plan steps, which are instantiated from the reader's plan library. This reader's plan library characterizes the reader's understanding of the story based on the reader's world knowledge.

D. Prevoyant: The Generator and the Evaluator

The generator and the evaluator are Prevoyant's two main components that rearrange the presentation order of an input story plan's events (i.e., plan steps). The overall procedure consists of the following three steps: 1) the generator first creates a set of flashback candidates for surprise arousal; 2) the evaluator then decides the best candidate among the created set of flashback candidates by evaluating the factors that can contribute to narrative surprise arousal; and finally 3) after the best flashback candidate for surprise arousal is determined, the generator creates foreshadowing that alludes to the flashback events. The rest of this section discusses the three steps in detail.

1) The Generator (Selection of Flashback Candidates): Based on the empirical results of the structural affect theory, we adopt a surprise-evoking narrative structure that is characterized by “sudden presentation of an unexpected outcome,” where some IEs associated with the outcome are presented after the outcome, or even omitted [13], [14], [21]. Here the outcome refers to the story events that are not presented until the last moment for surprise. The IEs refer to essential causal antecedents for the outcome. In our work, a story outcome is represented by one of the goal conditions specified explicitly in the goal state, assuming that a story plan’s goal conditions are important outcomes in the author-centric story generation system.

Structural affect theory mentions the difference between surprise-evoking narrative structure and curiosity-evoking narrative structure. In both, an outcome event (OE) first appears without presenting its IEs. The difference is in whether the reader is aware of the omission of the IEs. If the reader knows that the IEs are missing or only partially depicted, curiosity occurs; if the reader is not aware of the absence of the IEs, surprise occurs [13], [14].

Motivated by this surprise model drawn from the structural affect theory, the generator selects flashback events by identifying an SE and its IEs in the story plan. An SE is a plan step whose causal effect directly achieves a story outcome (i.e., a goal condition). IEs are characterized as a series of plan steps that serve as a causal antecedent of a relevant SE.

The flashback selection process is outlined by four phases described below. During phases 1 through 3, the generator identifies a set of separable causal chains, which includes flashback candidates, and passes it to the evaluator. In phase 4, after the best candidate for flashback is determined by the evaluator, the generator selects the temporal position of the flashback.

Phase 1 (Selecting a Set of SEs): Given an input story plan, the generator first identifies a set of SEs that directly achieve goal conditions in the goal state.

Phase 2 (Identifying a Set of Causal Chains): Consider each SE in the SE set in phase 1. Let the IEs for this set be just a series of events which are causally linked from the initial state to the SE, considering the closed-world assumption in which any condition not explicitly marked as true in the initial state is considered to be false. An SE will have possibly more than one relevant IE. For each IE of a given SE, the generator creates a pair consisting of the SE and an IE that originates from the initial state. We call this pair a causal chain. The generator identifies all the distinct causal chains in the story plan and creates a set of distinct causal chains.

Phase 3 (Selecting a Set of Separable Causal Chains and the Best Separable Causal Chain): Once the distinct causal chains are determined, the generator then selects separable causal chains from the causal chains set. Here we say that a causal chain is separable just when the IE in the chain can be omitted from the story plan without causing any open preconditions for the steps that occur prior to the relevant SE. This separability of the IE ensures that the reader does not detect the absence of the IE from the rest of the story until the relevant SE occurs.

The main idea of separability here lies in how the temporal position of IEs, which are causally related to one another, can be moved as a separable group—from before the presentation of the relevant SE to after the presentation of the SE—without affecting the causal relationships of the other events in a story. As a result, readers would not detect the omitted IE until the presentation of its SE. This omitted IE is presented after the SE as a form of flashback, which explains how the relevant SE could actually happen. To this end, the generator checks two conditions that a separable causal chain should meet as follows.

Conditions of Separable Causal Chains

1) There are no outgoing causal links initiating from a step (except the initial step) in the IE of a causal chain to the steps outside the IE and prior to the SE.
2) There are no dedicated incoming causal links to a step in the IE of a causal chain, initiating from a step that is prior to the SE and does not belong to the IE of the causal chain.

The first condition of separability helps to ensure that the reader does not detect the omission of the events (i.e., plan steps of the IE in a separable causal chain) until the presentation of its corresponding SE. This is possible because the plan steps of the IE in the separable causal chain do not causally contribute to the other story events prior to the SE. However, if there is an outgoing causal link initiating from a plan step of the IE in a causal chain to a plan step that is outside the chain and prior to the SE, the omission of the plan steps in the IE will make the plan step occur without its causal antecedent. As a result, the reader will detect the omitted plan steps of the IE in the causal chain.

The second condition of separability also helps to ensure that the omission of the IE in a separable causal chain does not affect the reader’s unawareness of the omitted IE. Suppose there is a causal link established between two steps: s_1 (a source step) and s_2 (a destination step). Here we say that this causal link is a dedicated incoming causal link to s_2 when the causal link is the only outgoing causal link of s_1. In other words, when a dedicated causal link is established between a source step and a destination step, the source step causally contributes only to the destination step.

The selected set of separable causal chains is sent to the evaluator and then the evaluator evaluates each separable causal chain to select the best separable causal chain that can contribute to the reader’s surprise. Algorithm 1 shows a pseudocode for the selection of a set of separable causal chains. The detailed evaluation process for the section of the best separable causal chain is discussed in Section III-D2.

Algorithm 1: The selection of a set of separable causal chains

Procedure: Find-Separable-Causal-Chains

Inputs:
L: set of causal links in the input story plan where a causal link connects a headstep (i.e., source step) to a tailstep (i.e., destination step);
S: Set of chronologically ordered plan steps in the story plan;
I: Initial step (dummy step that has no preconditions and

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whose effects are the initial conditions in the story plan)
G: Goal step (dummy step that has no effects and whose
preconditions are the goal conditions in the story plan)

Output:
SCC (set of Separable Causal Chains)

Identify a set of SE
SE ← {}
for each causal link l in L do
  if (l.tailstep ∈ G AND l.headstep ∉ I)
    then Mark l.headstep as Significant
      SE ← SE ∪ {l.headstep}

Identify a set of Causal Chains (CChains)
CChains ← {}
CC (Causal Chain consisting of IEs and an SE) ← {}
for each plan step s in SE do
  Create a tree T where the root ← s, the children nodes
  ← all the causal ancestors of the root (s)
  for each distinct path from s to a leaf (Initial step) in T
  do
    CC ← a series of plan steps consisting of the path
      from the leaf (Initial step) to the root (s)
    CChains ← CChains ∪ {CC}

Identify set of separable causal chains (SCC)
SCC ← {}
for each causal chain cc in CChains do
  IE ← remove a Significant-marked step from cc
  Separability condition1 ←True
  Separability condition2 ← True
  for every outgoing causal link ocl from inside IE
    if ocl.tailstep ∉ cc
      then Separability condition1← False
  for every incoming causal link icl from outside of IE
    if (icl.headstep has only one outgoing causal link to
      a step that belongs to IE)
      then Separability condition2 ← False
  if (Separability condition1 AND Separability
  condition2)
    then SCC ← SCC ∪ {cc}

return SCC
```

Phase 4 (Selecting the Temporal Position of Flashback): When the generator receives the best separable causal chain from the evaluator, the generator defines an OE (unexpected event or surprising event) and flashback from the received causal chain. The OE is the SE in the best separable causal chain; the flashback is the IE in the best separable causal chain.

After identifying the OE and a flashback, the generator determines the temporal position of the flashback. Flashback is often associated with a particular character in the story, so the character's memory about some important past events can be revealed to the reader, explaining how a current situation is connected to the past events. We employ this notion of flashback to explain to the reader how the unexpected OE actually could happen. To simplify the process of determining where a flashback is placed in the plan and to make the relationship between the OE and flashback clear, the generator always places the flashback immediately after presentation of the OE.

2) The Evaluator (Checking Surprise Factors in Narrative): When the evaluator receives a set of separable causal chains (which was determined by the generator during phase 3), the evaluator selects the best separable causal chain to elicit surprise. As criteria, the evaluator checks four factors for surprise arousal: expectation failure, importance of events, the reader's emotional valence, and resolution of incongruities in surprise. The evaluator first filters out the separable causal chains that do not meet the criteria for surprise arousal using the three factors: expectation failure, the reader's emotional valence, and resolution of incongruities in surprise. Then, the evaluator selects the best separable causal chain by using the importance factor. In the following, we discuss the four surprise evaluation factors in detail.

a) Expectation failure and sources of surprise: Expectation failure is a central concept for surprise arousal. According to Ortony and Partridge [12], there exist three different types of surprise sources: active expectation failure, passive assumption failure, and unanticipated incongruities.

Both active expectation failure and passive assumption failure are based on the notion of expectation failure in which a given situation is in conflict with what one expects. In active expectation failure, one is actively expecting a situation that conflicts with a given situation. In passive assumption failure, one does not actively expect any situations that conflict with a given situation, but the given situation is in conflict with one's own beliefs or knowledge. Unanticipated incongruities refer to any violation or deviation from social or common norms.

While Ortony and Partridge give a rough guideline on the formalization of different surprise sources, their arguments have some limitations. For example, the concept of "conflict" between a given situation (defined as an input proposition using propositional logic) and one's expectation is not clearly defined. The criteria for differentiating passive assumption failure from unanticipated incongruities are also vague, depending on the definition and range of norms. In spite of the limitations, however, many AI researchers and cognitive scientists have leveraged the relationship between unexpectedness and surprise [34], [35]. In Section III-D2b, we model the notion of expectation failure (i.e., unexpectedness) using a planning-based approach.

b) Modeling of expectation failure (or unexpectedness) using a planning-based approach: As mentioned in the previous text, we characterize an agent's unexpectedness as a conflict between a given situation and the agent's expectation, belief, and knowledge. In our planning-based approach, a situation or an event is represented as a plan step; the reader's initial beliefs and knowledge are encoded as initial conditions and plan operators in the reader's plan library. The reader model (explained in Section III-C) maintains the reader's plan library which can be different from the author's plan library (i.e., the plan library used for the story generation) in four ways: 1) differences of plan operator sets; 2) differences in the heuristic functions to find a complete plan; 3) differences in reasoning bound; and 4) differences in initial conditions.

These differences allow the reader model to build a different story plan from the input story plan, though it is the burden of a domain engineer to design different plan libraries.

The evaluator checks whether an event (i.e., a plan step) is expected or unexpected using the reader model. When a plan step is given to check its unexpectedness, the reader model makes a new planning problem where the goal conditions are made up of the given plan step's preconditions; the initial conditions consist of the story plan's initial conditions including the changes made by the executed plan steps so far. If the reader model successfully finds a complete plan to achieve the new planning problem's goal conditions using the reader's plan library, the evaluator decides the given event as expected. Otherwise, if the reader model fails to find a complete plan to achieve all the goal conditions, the evaluator decides the event as unexpected, that is, expectation failure occurs. More specifically, the evaluator decides that active expectation failure occurs when any newly updated conditions during the story progression are in conflict with (i.e., negation of) a precondition of the unexpected event; likewise, the evaluator concludes that either passive assumption failure or unanticipated incongruity occurs when the reader model finds a complete plan that negates a precondition of the unexpected event.

c) Importance of events: The importance of unexpected events can influence the intensity of surprise. The more important an unexpected event is, the more surprising it will be [36]. This is consistent with structural affect theory claiming that surprise can be aroused by the sudden presentation of a significant story outcome [13], [14]. To determine a story event's importance, the evaluator considers four factors: causal relatedness, story goals, character importance, and item importance [30].

To measure an event's causal relatedness factor, the evaluator adopts the notion of the causal network model devised by Trabasso and Sperry [37], where the number of direct causal connections between story events is closely related to a reader's ability to recall the events and the reader's judgment of the events as significant within the story. The plan-based representation of story plans is motivated by and consistent with this causal network representation.

Based on the causal network model, the evaluator classifies story events into three types: opening acts, closing acts, and motivating acts [17], [37]. Opening acts are the first actions in the story; closing acts are the last actions that occur in the story; motivated acts are plan steps that directly connect to the goal state.

To compute the causal importance of a story event (i.e., a plan step), two factors are considered. One is the number of incoming and outgoing causal links of the step. The incoming causal links number reflects the number of steps added to the story that establish conditions needed for the step to execute correctly; the outgoing causal links number refers to the number of steps in the story dependent upon this step for their successful execution. The other factor is the number of goal conditions that are achieved directly by the step. The greater number of goal conditions a plan step achieves directly, the more importantly the step is rated.

Determining a story event's importance based only on the event's causal connections may be insufficient to capture all the elements within a story that express an author's weighting of significance. For instance, the author may want to put more importance on specific characters or items regardless of their causal importance, particularly in narrative-oriented computer games. To this end, the evaluator also weighs an event's importance based on the characters and items that play a role in the event. Here we say that the characters and items that play a role in an event are just those characters and items that are referred within the event's corresponding plan step data structure (i.e., via a binding constraint that links a step's variable to a character or item or via the appearance of the character's or item's name constant in the step's definition) [28]. The evaluator calculates the importance of characters and items on the basis of the frequency with which the character or items play a role in the story action relative to the overall set of events in the story. Thus, the total importance of an event (i.e., a plan step) can be calculated by

$$w(a) = {k_{\rm c}}^{{\rm CC}(a)} \cdot (k_{\rm i}{\rm IN}(a) + k_{\rm in}{\rm INIT}(a) + k_{\rm o}{\rm OUT}(a)) + k_{\rm ch}{\rm CH}(a) + k_{\rm it}{\rm IT}(a). \quad (1)$$

Here, ${\rm IN}(a)$ returns the number of incoming causal links to step a except the links that originate from the initial state; ${\rm INIT}(a)$ returns the number of incoming causal links from the initial state to step a; ${\rm OUT}(a)$ returns the number of step a's outgoing causal links; ${\rm CC}(a)$ represents the causal chain value of an event that is determined by the event's causal chain type: opening, closing, and motivated. Since ${\rm CC}(a)$ gets to be exponential to $k_{\rm c}$, it contributes exponentially when $k_{\rm c}$ (the coefficient for causal importance) is assigned a value greater than 1; $k_{\rm c}$, $k_{\rm i}$, $k_{\rm in}$, and $k_{\rm o}$ are assigned for causal relationships; $k_{\rm ch}$ and $k_{\rm it}$ are coefficients for character importance and item importance respectively; ${\rm CH}(a)$ and ${\rm IT}(a)$ return the frequency-based character importance and the item importance, respectively. The more frequently a character (or item) appears in step a, the higher its assigned value. The particular values for the coefficients in the formula can be determined empirically. For instance, to increase the contribution of causal relationships to the importance of an event, the coefficients $k_{\rm i}$, $k_{\rm in}$, $k_{\rm o}$, and $k_{\rm c}$ are set to any positive real numbers greater than 1. In contrast, setting these coefficients to real numbers between 0 and 1 reduces their effects on the importance.

d) The reader's emotional valence: In narrative, a reader's emotional valence to a story outcome can contribute to her assessment of surprise. Depending on the reader's emotional valence, a purely aroused emotional state can become either pleasant or unpleasant. Specifically, according to Gendolla and Koller [36], surprise intensity elicited by an important outcome with negative valence is higher than that elicited by an important event with positive valence in the context of a character's goal achievement. To decide whether an event is positively valenced (i.e., desirable) or negatively valenced (i.e., undesirable), plan-based approaches have been used [38]. For example, positive emotions (such as happiness) can be triggered when subgoals are achieved; negative emotions (such as sadness, anger, or fear) can be elicited by frustrated actions or loss of an active goal. Extending this idea, we characterize surprise as positive when it is associated with unexpected goal achievement; negative when associated with unexpected goal failure or threats.

In this work, we assume that the reader's standing point is the same as that of a protagonist in the story. In other words, a protagonist's goal achievement corresponds to a reader's positive valence. Thus, the evaluator checks whether the achieved goal condition is associated with a protagonist's goal (or subgoal) achievement. In the current version of Prevoyant, for simplicity, specific goal conditions are marked manually as the protagonist's subgoals.

e) Resolution: Proper resolution of the cause of unexpectedness influences the reader's surprise assessment, increasing the story interestingness [23]–[25]. In Prevoyant, flashback resolves the incongruity, that is, the gap between the reader's expectation or assumption and what has happened, in unexpectedness-based surprise. Since Prevoyant generates flashback by rearranging the temporal order of story events rather than by creating new events from scratch, flashback events can fit into the whole story coherently as long as a coherent story plan is initially given as input. As a result, from the viewpoint of coherence, the flashback can resolve the incongruity in surprise, but may not be sufficient to contribute to increasing story interestingness or reader's satisfaction. Other factors such as plausibility or novelty will be needed to assess the flashback quality as the function of incongruity resolution. Although both plausibility and novelty are important factors to story interestingness, the current version of the evaluator does not take them into account, leaving them to the story author's responsibility.

While the evaluator does not consider the plausibility or novelty of the flashback, it considers the flashback's importance and length relative to the overall set of story events. As described, the importance of story events is calculated in terms of three types of importance: causal importance, character importance, and item importance. The selection of the flashback with high causal importance contributes to the story interestingness, increasing the postdictability in retrospect. Either character importance or item importance can make up for causal importance when the story has a weak causal structure. With regard to the flashback length, the current evaluator takes a naive approach. To avoid a trivial one, the minimum length of the plan steps included in the flashback is greater than one. To serve as a backstory rather than a main story, the proportion of flashback events relative to the entire set of story events is less than 50%. The closing step, which is presented last in the story plan, is also excluded for proper ending.

f) A pipeline evaluation process using four factors: The evaluator, given a set of separable causal chains as input, selects the best separable causal chain for surprise arousal. The IEs of the best separable causal chain will be presented as flashback after presentation of the OEs (the SE of the best separable causal chain). To this end, the evaluator carries out a pipeline evaluation process using the four surprise evaluation factors.

The overall pipeline evaluation process consists of four phases. The first three phases filter out the separable causal chains that do not meet the evaluation criteria in terms of three factors: expectation failures, emotional valence, and resolution. First, the evaluator selects the resulting set consisting of just those separable causal chains having the SE that will result in either active or passive expectation failure. Then, the evaluator selects the separable causal chains having the SE that enables a protagonist's goal achievement (for positively valenced surprise). Next, the evaluator selects, from the working set, the separable causal chains having the IE that meets the minimum length condition of the flashback events. As the last phase, after carrying out these three filtering phases, the evaluator computes the importance of the plan steps in each separable causal chain and selects one with the highest average importance value (breaking ties arbitrarily). The finally selected separable causal chain is the output of the evaluator, that is, the best separable causal chain.

3) The Generator (Selection of Foreshadowing): Foreshadowing provides hints about events that will happen later in the story. While there are various ways to manifest the hints via foreshadowing, we employ a method motivated by the narrative technique known as Chekhov's Gun [39, p. 176]. In Chekhov's Gun, casual introduction of characters or items in the beginning of the story can signal the reader that they can become of importance later in the story.

Motivated by the Chekhov's Gun technique, our system selects foreshadowing as a hint for a flashback event that will be presented after the SE. Once the evaluator determines the best separable causal chain (consisting of an IE and an SE where the IE is presented after the SE as a flashback), the generator identifies the first plan step of the IE and makes a copy of it. During the copy process, some important information can be hidden. The detailed realization of foreshadowing is left to the implementer.

a) Temporal position for flashback and foreshadowing: In our work, foreshadowing is a hint about the flashback (IE in the best separable causal chain). The current version of Prevoyant places a flashback right after the temporal position of a surprising event (i.e., the SE in the best separable causal chain). Regarding the temporal position of foreshadowing, it can be inserted at any temporal positions between the initial position of the IE's first step and the antecedent step that is causally related to it.

b) Postdictability and coherence: Surprise is postdictable [23] if every part in the narrative makes sense when the reader reconstructs the whole story in retrospect. Since flashback and foreshadowing in our system are based on a complete story plan that is created from a sound discourse planner, we assume that the temporally reconstructed story satisfies the postdictability concept.

While foreshadowing and flashback contribute to ensuring the postdictability because of its backward causality (that is, foreshadowing does not bear importance until the relevant flashback is presented), it may also distract the reader's attention from the main story because of its ambiguity and surplus nature [40]. It can also cause interruption of the story flow. As a result, the coherence of the entire story may be harmed. We leave the issues related to the maintenance of story coherence as a future work.

c) Prevoyant (the implementer): The implementer's functional role is to represent nonchronologically arranged story events through a specific medium such as text, video, or virtual environment. Currently, Prevoyant considers only text realization in which a plan step is mapped into a sentence in text.

For the textual realization of flashback events, specific discourse markers are used to specify the temporal rearrangements caused by flashback in the discourse. For instance, in the flashback discourse, the implementer uses the discourse marker "actually" and past tense verbs to let the reader know that these sentences are flashback, while representing other events in the present tense. For example, an instantiated plan step *PutOn (President, BulletProofVest)* can be realized as a sentence "The President puts on a bulletproof vest," which will be rephrased in the flashback sentence as "Actually, the President put on a bulletproof vest."

As for the textual realization of foreshadowing events, some crucial information can be hidden using particular pronouns such as someone, somebody, or something. For example, a realized plan step "Smith hides a diamond in his shoe" can be rephrased in the foreshadowing sentence as "Someone hides a diamond in his or her shoe."

IV. Evaluation

We conducted an experimental study to evaluate the effectiveness of our system in terms of a discourse structure generation for surprise arousal. In the study, participants read two stories and then were asked to indicate specific story elements that contributed to surprise arousal. Surprise levels were measured by each participant's self-reports. We used two stories as materials, which are named the Bond story and the Xmas story, respectively (see the Appendix for the story materials). These stories were previously used in experimental studies measuring suspense in narrative generation [17]. The story plans corresponding to the stories were originally created by an implementation of the Longbow planning system [27], [28] and share the same plan structure characteristics. Some minor changes from the original stories were made to the design of the story plans we used, including the specifications of the plan libraries, initial states, and goal states. The final story materials contained an initial background setting, which was written by hand on the basis of the initial conditions, and a main story consisting of sentences based on 20–23 plan steps.

In our study, we examined how such factors as unexpectedness, importance of events, a reader's valence, and resolution can be employed within a planning-based framework to evaluate surprise from a narrative text having flashback and/or foreshadowing in it. The independent variables were the texts that were produced by our system with three variants: 1) chronological, where story events are presented in chronological order; 2) flashback, where an OE is presented without its relevant IEs and then the IE is presented as a form of flashback; and 3) flashback with foreshadowing, where foreshadowing gives a hint about an event in the flashback. We also measured each participant's suspense and curiosity levels for reference. Our hypotheses were that the mean surprise and coherence ratings of flashback and flashback with foreshadowing participant group would be higher than those of the chronological participant group.

As discussed, our system Prevoyant employs four factors to evaluate surprise arousal in narrative: expectation failure, importance of events, a reader's emotional valence, and resolution. Among the four factors, the constant values in (1) for the determination of an event's importance were set as the same values that were used in the experimental study for suspense (see [17, p. 73] and [10, p. 69]).

Our evaluation methodology has similarity with that used in Grimes-Maguire and Keane's study [24]. In their study, three different versions of a short story (predictable, neutral, and unpredictable, consisting of four to five sentences, respectively) were used as story materials to measure the relationship between early expectation and a story's ending. In our study, we employed longer stories (consisting of 20 sentences) with inclusion of more than two characters.

The experiment was conducted online. Participants viewed the story materials through their computer monitors by accessing a specified website. The story sentences were displayed one by one and the data were gathered using a repeated measure design with counterbalancing, that is, each participant read two different stories with different text types (e.g., first read a story text in the chronological type and then read another story in the flashback type).

A. Method

1) Participants and Experiment Design: A total of 54 participants, undergraduate and graduate students (19 women, 35 men) at the North Carolina State University (Raleigh, NC, USA), including their family members and friends, were volunteer participants in the main experimental study. Their ages ranged from 20 to 60 years old. For reliability, we only counted the participants who specified their name, discarding the data from anonymous participants.

2) Materials: Two sets of story materials were used: the Bond story and the Xmas story. Each story had three distinct text types: chronological, flashback, and flashback with foreshadowing. (See the Appendix for the two story materials, where story events are chronologically ordered. For flashback, events E7 and E14 are presented after event E15 in the Bond story and events E14, E15, and E16 are presented after event E21 in the Xmas story, respectively. For foreshadowing, event E7 in the Bond Story and event E14 in the Xmas Story were presented with hidden important information, e.g., "Someone sends an e-mail.")

The chronological text type was created using the Longbow planner by defining a planning problem and a plan library, which were designed by a domain engineer who was not involved in this research. The other two text types (flashback and flashback with foreshadowing) were created using Prevoyant. Each story contained description of a background setting and a main story. The background setting was necessary to provide the story's background information (e.g., each character's goals) to the participants. The text of the background setting was manually written based on the initial conditions of the story plan. The main story consisted of sentences having direct one-to-one mappings to the steps of the story plan. For example, a plan step *Leave (Smith, Cell)* in the Bond story was translated into the sentence "Smith leaves the cell." The number of plan

TABLE I
PARTICIPANTS' MEAN RATINGS OF SURPRISE

Story \ Text Type	Chrono-logical	Flashback	Flashback with Foreshadowing	**Means of Story Types**
Bond	1.89	3.11	2.78	**2.59**
Xmas	2.11	2.50	2.63	**2.41**
Means of Text Types	**2.00**	**2.81**	**2.70**	
			Grand Mean	**2.50**

TABLE II
PARTICIPANTS' MEAN RATINGS OF COHERENCE

Story \ Text Type	Chrono-logical	Flashback	Flashback with Foreshadowing	**Means of Story Types**
Bond	3.72	3.22	2.56	**3.17**
Xmas	3.06	3.42	3.06	**3.18**
Means of Text Types	**3.39**	**3.32**	**2.81**	
			Grand Mean	**3.17**

TABLE III
RESULT OF ANOVA ANALYSIS FOR SURPRISE AND COHERENCE RATINGS

Surprise					
Source	*SS*	*df*	*MS*	***F***	***p***
Text	13.63	2	6.813	**6.734**	**.002**
Story	.93	1	.926	**.915**	**.340**
Text*Story	3.25	2	1.614	**1.595**	**.205**
Error	103.19	102	1.012		
Total	121.0	107			
Coherence					
Source	*SS*	*df*	*MS*	***F***	***p***
Text	7.394	2	3.697	**4.732**	**.011**
Story	.009	1	.009	**.011**	**.921**
Text*Story	6.580	2	3.290	**4.211**	**.018**
Error	79.68	102	.781		
Total	93.66	107			

steps in the Bond story and the Xmas story was 20 and 23, respectively. These plan steps were manually translated into sentences.

3) Procedure: Each participant individually participated in the study by accessing the designated website. All the interactions with participants were made through their web browsers. After completing a demographic survey, each participant was assigned to one of six participant groups (designed to counterbalance the ordering inference from the repeated measuring method), and was given two texts. Brief instructions for the process were given before reading the first story. The story events were grouped together for the relevant questions. In the Xmas story, for example, a question about expectation like "Would you expect that Dr. Evil could achieve his goal to assassinate the President?" was asked after event E18 ("The President is shot in the chest and falls to the floor"); a question about the importance of flashback events (E14, E15, and E16) was given either after the presentation of event E21 in the chronological text or after the presentation of the flashback events; questions about the ratings of cognitive interest (surprise, curiosity, and suspense), overall interestingness, important events in the story, and favorite characters were asked after the last event (E23) was presented. Participants read the story sentence by sentence by clicking the "next" button on the screen and then were asked to provide ratings on a five-point scale ranging from not at all (1) to extremely (5). The definitions of surprise, suspense, and curiosity were provided as follows [3].

- Surprise: The emotion felt when expectations about what is going to happen are violated by what in fact does happen.
- Suspense: An emotion or state of mind arising from a partial and anxious uncertainty about the progression or outcome of an action, especially one involving a positive character.
- Curiosity: An intrinsically motivated desire for information or knowledge which is partially described or has some missing gaps at the time.

B. *Results*

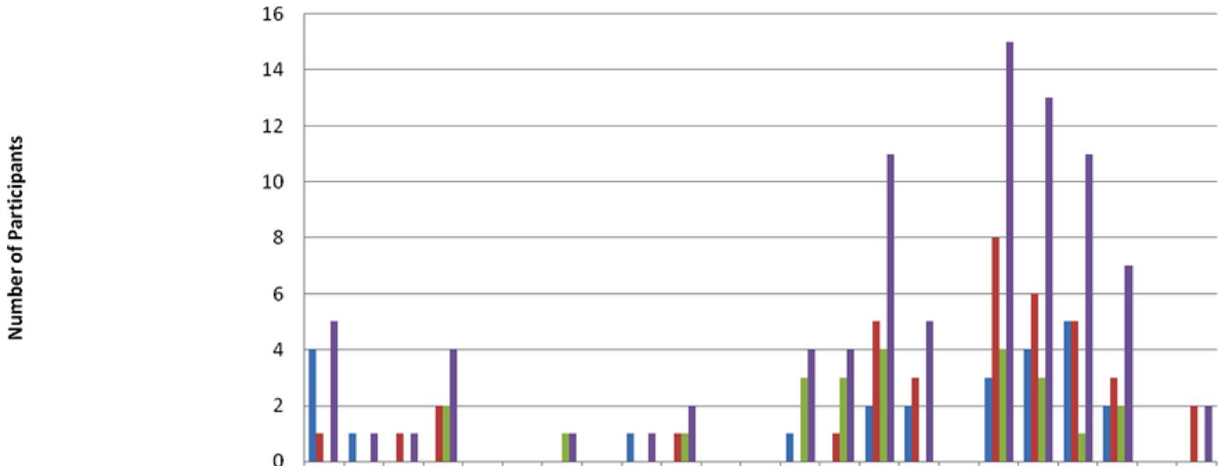
From the collected data the mean ratings of surprise and the mean ratings of coherence were compared. Table I shows the mean surprise ratings and Table II shows the mean coherence ratings (in the five-point Likert scale).

We performed a 2×3 factorial analysis of ANOVA to examine effects of the two factors (the story type and the text type). The text factor has three levels (chronological, flashback, flashback with foreshadowing) and the story factor has two levels (the Bond story and the Xmas story). The interaction between factors in the means of surprise ratings was not significant, where $F_{\text{Text*Story}}(2\ df) = 1.595$, $p = 0.2049$, at the 99% confidence level. The interaction between factors in the means of coherence ratings, however, was significant, where $F_{\text{Text*Story}}(2\ df) = 4.211$, $p = 0.018$, at the 95% confidence level (see Table III for the analysis result).

Because the interaction in the surprise ratings was not significant, the Tukey honestly significant difference (HSD) test was conducted to compare the three levels within the text factor in the means of surprise ratings. The Tukey HSD showed that there were significant increases of the surprise ratings between the mean for the chronology text and the mean for the flashback text, where HSD $= 8.323$, $p < 0.01$. There was also significant increase in the surprise ratings between the mean for the chronology text and the mean for the flashback with foreshadowing text, where HSD $= 7.247$, $p < 0.01$. There was no significant difference between the mean for the flashback text and the mean for the flashback with foreshadowing text, where HSD $= 1.076$, $p > 0.05$.

As shown in Fig. 3, in the Xmas story, the OE (E21) and the flashback events (i.e., the IEs, which are E14, E15, and E16) were marked as surprising events. Although E18 ("The President is shot in the chest and falls to the floor") was neither the SE nor the IEs, it was also marked as surprising.

The interpretation of interaction and main effects in the means of coherence ratings is not straightforward because of the significant interaction. In this experiment, we took into account a single independent variable, that is, text, assuming that there would be no difference between the two stories. Based on the data, it is not clear what factors of the story caused



	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E17	E18	E19	E20	E21	E14	E15	E16	E22	E23
Chronological	4	1							1				1		2	2		3	4	5	2		
Flashback	1		1	2						1				1	5	3		8	6	5	3		2
Flashback with foreshadowing				2			1			1			3	3	4			4	3	1	2		
Sum	5	1	1	4			1		1	2			4	4	11	5		15	13	11	7		2

Fig. 3. Proportions of participants who marked surprising events in the Xmas story, where E21 is the OE (i.e., the surprising event); E14, E15, and E16 are flashback events.

the interaction. The factors could be either at the story syntax level (e.g., the number of story plan steps, the number and structure of causal links, etc.) or at the story semantics level (e.g., novelty or plausibility of events). The coherence mean ratings of nonchronological texts are rated lower than that of chronological text in the Bond story, but not in the Xmas story. The coherence mean rating of flashback with foreshadowing text was the lowest among three discourses in both stories (see Table II). We posit that the low coherence ratings in the foreshadowing discourse may come from the foreshadowing sentences (e.g., "Someone sends an e-mail" in the Xmas story), which possibly interrupt the story flow and undermine the reader's comprehension of the story.

Concerning interestingness, suspense, and curiosity, there was no significant difference of the means for texts.

C. Discussion

The results from the analysis of the collected data have shown that Prevoyant is effectively generating texts that can arouse surprise in the reader's mind. In the survey questionnaire, a question on expectation "Would you expect that Dr. Evil achieve his goal to assassinate the President?" was asked after the presentation of event E18 ("The President is shot in the chest and falls to the floor"). Seventy percent of the total participants answered "no" to this question. The proportions of the participants reported for the formation of this expectation varied depending on the texts. In the chronological and the flashback with foreshadowing texts, 83% and 88% of the participants answered "no," respectively. In the flashback text, by contrast, only 42% of the participants answered "no." As reasons for their expectation, the participants specified some specific facts (such as "Mr. President's wearing a bulletproof vest"), context-based guesses (such as "Tom or Mr. Greenpeace would help"), or general assumptions (such as "the bad guys never win").

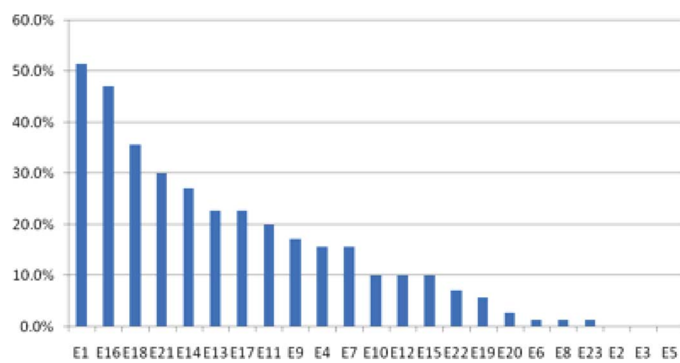


Fig. 4. Average importance of events in the Xmas story (e.g., 51% of the participants chose E1 as one of the six important events in the story).

After reading the whole story, participants were asked to select six important events in the story. As shown in Fig. 4, the three surprising events (E16, E21, and E14) were ranked high. E21 was the SE; E14 and E16 are two of the three flashback events (i.e., the IEs) in the story. This corresponds to the evaluator's surprise criterion that selects important events as surprising events.

Besides the three surprising events, the events E1 and E18 were also ranked high. E1 is causally linked to E14, that is, the sentence "After meeting Dr. Evil, Tom suspects that Dr. Evil is planning something evil against the President" is an effect of the plan step E1, which satisfies a precondition of E14 ("Tom, suspecting Dr. Evil's evil plan, sends a warning e-mail to the White House"). E18 ("The President is shot in the chest and falls to the floor") is important in terms of the antagonist's (i.e., Dr. Evil) goal achievement.

The relations between incongruity resolution in surprise and story interest were not directly measured, but the post-questionnaire comments point toward the importance of plausibility for incongruity resolution in surprise. In the Xmas story, for example, it seemed implausible for Tom, an ordinary computer programmer, to send an e-mail to the President directly, which could have failed to maintain the willing suspension of disbelief of the reader. As for story resolution, the participants pointed out the lack of explanation about characters' background (including motivation) or the lack of uniqueness (i.e., cliché) as factors that could have harmed the story interestingness.

V. Conclusion

This paper presents Prevoyant, a planning-based computational model of surprise arousal in narrative generation, and analyzes its effectiveness. The design of our system is strongly motivated by structural affect theory [13], [14], which claims that reader's emotions such as surprise or suspense are closely related to narrative structure, and the bipartite model of narrative in which a narrative is described using two levels: story (i.e., content) and discourse (i.e., presentation). To produce a discourse structure for surprise, we manipulate temporal ordering of story events using flashback and foreshadowing in narrative. In this work, flashback provides a backstory to explain what causes a surprising outcome, while foreshadowing gives a hint about the surprise before it occurs.

Prevoyant consists of three main components: the generator, the evaluator, and the implementer. The generator takes a story (defined by a partial-order plan data structure) as input and produces a discourse structure with foreshadowing and flashback. The evaluator tests each potential flashback produced by the generator to determine if it will contribute to evoking surprise in the reader's mind. As criteria, the evaluator employs four factors for surprise evaluation: expectation failure using a planning-based approach, importance of events, a reader's emotional valence, and resolution. The implementer, given a temporally reconstructed story plan with flashback and foreshadowing, realizes it in a specific medium. The current version of Prevoyant focuses only on the generator and the evaluator.

Experimental results show strong support that Prevoyant effectively generates a discourse structure for surprise arousal. A two-way ANOVA and the Tukey HSD *post hoc* test show that there was a statistically significant increase in the surprise mean ratings between the input story text (which is presented in chronological order) and Prevoyant's output (which is presented with flashback and/or foreshadowing in nonchronological order) at the 99% confidence level.

There are two central limitations to this work that should be addressed in follow-on research: 1) the relations between pleasant surprise and story interestingness; and 2) the relations between narrative comprehension and cognitive interest resulting from the temporal variation in narrative structure.

First, pleasant surprise is desirable for the surprise in narrative. Surprise is distinct from other emotions in that it can be viewed as a purely aroused emotional state with neutral valence, that is, surprise itself is neither positive nor negative. Therefore, depending on the cognitive appraisal of a given situation, surprise can be either pleasant or unpleasant [11]. Pleasant surprise will positively contribute to our narrative experiences; unpleasant surprise will harm the experiences. In this work, we focus only on the arousal of surprise. As mentioned, novel and plausible resolution of incongruities in surprise will be essential to increase the story interestingness.

Second, it can be challenging for some readers to comprehend a narrative out of chronological order because it requires the reader's extra effort to reconstruct the whole story in chronological order again. Therefore, it is important to balance between cognitive interest evoked by discourse structure and the reader's story comprehension; if discourse structure is too straightforward, it may make the reader bored; if the way of story unfolding is too complicated, it may make the reader frustrated. In this paper, we have dealt with one flashback and one foreshadowing in a relatively short story. As narrative space and narrative time extend, more careful consideration about the reader's story comprehension will be necessary.

Appendix
Story Materials (in Chronological Order)

The Bond Story (Adapted From [16, p. 119])

Background Setting

I1. The lunatic villain known as Jack has been developing biological weapons of devastating proportions.
I2. To accomplish the final stages of weapon development, he kidnapped the famous scientist Dr. Cohen and brought him to his private fortress on Skeleton Island.
I3. Jack expected that the CIA would soon send Smith, their top agent, to rescue Dr. Cohen.
I4. To keep the troublesome Smith out of his hair, Jack ordered his own agent Erica to monitor Smith and capture him if he were assigned to Dr. Cohen's rescue operation.

Main Story

E1. Erica installs a wiretap in Smith's home while he is away.
E2. Erica eavesdrops on the phone conversation in which Smith is given the order to rescue Dr. Cohen.
E3. Erica meets with Smith.
E4. Erica tells Smith that her father was kidnapped by Jack and taken to Skeleton Island, and she asks Smith to save her father.
E5. Erica gives Smith the blueprints of Jack's fortress, with her father's cell marked.
E6. Erica provides Smith with a boat for transportation to Skeleton Island.
E7. Before going to the island, Smith hides a diamond in his shoe.
E8. Smith goes to the port containing Erica's boat.
E9. Smith rides the boat to Skeleton Island.
E10. Smith sneaks into the cell marked on the map containing Erica's father.
E11. Jack and his guard capture Smith as he enters the cell.
E12. The guard disarms Smith.
E13. The guard locks Smith in the cell.
E14. Smith bribes the guard with the diamond in his shoe.
E15. The guard unlocks the door.
E16. Smith leaves the cell.
E17. Smith sneaks to the lab where Dr. Cohen is being held.
E18. Smith fights the guards in the lab.

E19. Smith takes Dr. Cohen from the lab.
E20. Smith and Dr. Cohen ride the boat to shore.

The Xmas Story (Adapted From [16, p. 120]):

Background Setting

I1. In 2012, mankind faces severe environmental problems. The process of deforestation has spread to North America. The sea level has been raised significantly by shrinking glaciers.
I2. An environmentalist named Mr. Greenpeace, head of the World Environmental Foundation and an ex staff sergeant in the British special forces, is aware of these urgent problems, planning to persuade the U.S. President to take prompt actions to prevent the coming disaster. Mr. Greenpeace is at his office in London, about to fly to Washington DC.
I3. Meanwhile, Dr. Evil, a billionaire psychopath, plans to assassinate the U.S. President. His plans are complicated by the security at the White House, where only invited people can enter.
I4. In a nearby suburb of Washington DC, a man named Tom, who is a single father of a three-year-old girl named Iris, is hoping to give his daughter a Christmas present. Tom, a computer programmer, has been unemployed for six months.
I5. Tom has a shiny silver ring that was given to him by his wife a long time ago. Unknown to Tom, the ring is magical; when worn, whispering a special spell "etaudarg anna wi" will cause the ring to send out a magical pulse that will put anyone within a ten foot radius to sleep. Dr. Evil knows about the secret of this ring.
I6. Tom's goal is to get a limited special edition *Dora The Explorer* doll for Iris's Christmas present. The limited special edition *Dora The Explorer* doll is very popular but rare and expensive. Tom tries to sell or trade his ring for the special edition *Dora The Explorer* doll through Craigslist. One day before Christmas, Tom receives an e-mail from Dr. Evil explaining that he has the limited special edition *Dora The Explorer* doll and he is willing to trade it for Tom's ring. Tom is invited to Dr. Evil's billionaire castle.

Main Story

E1. Tom visits Dr. Evil's castle and trades his ring for the limited special edition *Dora The Explorer* doll. As a result, Tom obtains the special edition *Dora The Explorer* doll that Iris wants; Dr. Evil obtains the ring. After meeting Dr. Evil, Tom suspects that Dr. Evil is planning something evil against the President.
E2. Tom puts the special edition *Dora The Explorer* doll under the Christmas tree.
E3. Dr. Evil withdraws some cash from an ATM in his bank.
E4. Dr. Evil buys a gun from an arms dealer. The gun is made out of composite materials designed to avoid detection by metal detectors.
E5. Mr. Greenpeace travels from London to Washington DC, the U.S. capitol.
E6. Mr. Greenpeace gives a speech about the importance of taking prompt actions to save Earth.
E7. Being impressed by Mr. Greenpeace's speech, the U.S. President announces that he will raise funds to support Mr. Greenpeace's environmental foundation and whoever donates more than $1 million will be invited to the White House for a fund-raising party. The president also invites Mr. Greenpeace to the fund-raising party at the White House.
E8. Mr. Greenpeace travels to the White House.
E9. Dr. Evil watches the TV and finds out that a donation will get him invited to the White House.
E10. Dr. Evil donates $1 million to the White House.
E11. The President invites Dr. Evil to the fund-raising party.
E12. Dr. Evil travels to the White House with the ring and the gun.
E13. Dr. Evil uses the ring of power to put all the secret service agents to sleep. As a result, there is no one guarding the president.
E14. Tom, suspecting Dr. Evil's evil plan, sends a warning e-mail to the White House.
E15. The President receives Tom's e-mail and reads it on his smart phone.
E16. As a precaution, the President puts on a bulletproof vest before going to the fund-raising party.
E17. Dr. Evil aims his gun and fires it at the President.
E18. The President is shot in the chest and falls to the floor.
E19. Mr. Greenpeace arrives and seizes Dr. Evil.
E20. After being seized, Dr. Evil looks at the President collapsed on the floor and laughs hysterically.
E21. The President slowly stands up.
E22. The President gives his press conference, committing considerable support to the World Environment Foundation in order to save Earth.
E23. The next day on Christmas, Iris finds a Christmas present for her, the special edition *Dora The Explorer* doll that she wants to have. Iris holds the *Dora The Explore* doll preciously. Tom is happy watching Iris holding the doll.

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