Ordering Events in Interactive Fiction Narratives

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Abstract

An interactive fiction system has been developed with a rich representation of simulated locations, actors, and things as well as events. This paper discusses one particular type of narrative variation that the system can generate: variation in order. To determine how to concisely specify a possibly non-chronological order for narrating events, a formalization of Genette's categories of order and his concept of the time of narrating is developed. An ordered tree representation for reply structures is introduced that uses Richenbach's concepts of speech time, reference time, and event time to determine grammatical tense.

Varying the Narrative Discourse in Interactive Fiction

Interactive fiction (typically abbreviated IF) is a venerable form of computer amusement. Some, including this author, believe it holds further literary and gaming promise (Montfort 2003). It is certainly rich as a platform for researching narrative text generation. There is a good deal of hand-crafted prose in existing IF, but a simulated world forms the basis for the textual exchange between user and program, providing a foundation for the generation of narratives. There is also an established form of IF interface that allows meaningful, ontological interaction. The standard IF world model is simple enough to be worked upon by a single author without commercial backing yet complex enough to provide compelling experiences.

Interactive fiction has objects and characters which are positioned in simulated space; simulated incidents involving these can happen. Current IF systems have not provided any facilities for arranging the way these incidents will be told, however. This paper deals with one particular capability of an IF system called *nn*. This system was developed to address the level of the telling, between underlying events and textual output. Its architecture has been described elsewhere (Montfort 2006, 2007).

A detailed and systematic treatment of how the telling of a narrative can be considered apart from the existents and events represented in it is found in Gérard Genette's *Narrative Discourse: An Essay in Method* (published in French in *Figures III* in 1972; English translation, 1980). In this discussion, Genette covers variations in temporal relationships or *tense:* how events can be narrated in a sequence that differs from their chronological sequence (order), how the telling can move morCe rapidly or more slowly and narrate events for shorter or longer periods of time (duration, later called speed), and how events can be narrated once each, one for several occurrences, or several times for each occurrence (frequency). Genette continues to consider the narrative analog of what is called in grammar *mood,* which includes the perspective from which a narrative is told (focalization). As part of the final category, *voice,* the time of narrating and its function in narrative is discussed. While the basic concepts have been extended, revised, and further discussed in various ways, the general outline of relationships was groundbreaking and has proven essential to decades of development in narratology.

The concepts introduced in *Narrative Discourse* and developed by other scholars pertain to the form and function of narrative and have developed from formalist and structuralist ideas, so they are formal in this sense. To implement different types of narrative variation in an interactive fiction system, however, additional refinement and formalization of narratological concepts is needed:

> In general, most Humanities models of narrative contain formalizations only at very abstract levels, if at all. By formalizations, we mean here a representation in some logic language (e.g., predicate calculus) or other structured representation, including tables, graphs, etc. Indeed, most works dealing with narrative and not going back directly to the structuralist tradition are composed in "plain prose". Especially, there seems to be a tendency to apply formal notions to the abstract *histoire* level only. Phenomena at *discours* level that apply to the *structure* of discourse (e.g., discourse relations) are sometimes formalized in linguistics and are usually described in words only — sometimes accompanied by tables — by literary scholars (Genette, 1980). Where models are based on the *discours* (text) layer of a narrative or include it, genuine Humanities models usually lack formality, though their descriptions might offer a variety of authentic examples. (Gervás et al. 2006)

The Narrator module of nn is a text generation system that follows a standard three-stage pipelined architecture (figure 1). The focus of this paper is on the first stage, the Reply Planner, where content selection and ordering are done. To achieve the sort of formalization necessary for implementation in a computer system, the inputs to the Reply Planner, the internal operations of the Reply Planner, and the output from the Reply Planner to the Microplanner are defined in detail alongside the concepts of narrative discourse that these operations are based on. The lower-level work of the Microplanner, and the lowest-level work of the Realizer, while important, are not covered this paper.

The input to the Reply Planner consists of a focalizer world, a set of indices to actions indicating what in that focalizer world has transpired in the most recent turn, and a plan for narrating. The focalizer world is a representation of the IF actual world from the standpoint of a particular actor. It includes existents, along with the capability to roll back to a point in the past and see what existents were like at that point. It also includes events with causal connections between them and temporal information about each.

The Reply Planner uses this input to build an ordered tree called a reply structure (RS), with proposed expressions (PEs) as leaves. The PEs indicate how the narration of an event, the description of something in the content plane, or the creation of some non-diegetic text is to be done. For instance, a standard transformation to produce the sort of narration often used in existing IF would result in chronologically-ordered PEs being placed in an RS of depth 1; each PE would be marked with the default speed (.5). For every PE that is in the output RS, some text will be generated — all content selection is done in the Reply Planner, and nothing selected at that point may be elided at a later stage. The details of what text is generated from PEs are handled by the Microplanner and the Realizer. The Microplanner will output a longer abstract paragraph or sentence representation (to whatever extent this is possible) when the speed is slower and less when it is faster. In the last stage, the Realizer, the abstract representations provided by the Microplanner are converted into strings of English for formatting and output.

Narrative Tense

Varying the representation of events in the content plane, or how "story" is expressed, involves being able to output different signs of the narrated for the same underlying events. About three decades ago, it was asserted that "Gérard Genette's elegant analysis of the time-relations between story- and discourse-time must form the basis of any current discussion. Genette distinguishes three categories of relations: those of order (*ordre*), duration (*durée*), and frequency (*fréquence*)." (Chatman 1978:63) Genette's foundation for the discussion of story-time and discourse-time has remained very helpful to theorists of narrative. There are some difficulties with analyzing narratives while assuming an underlying chronological

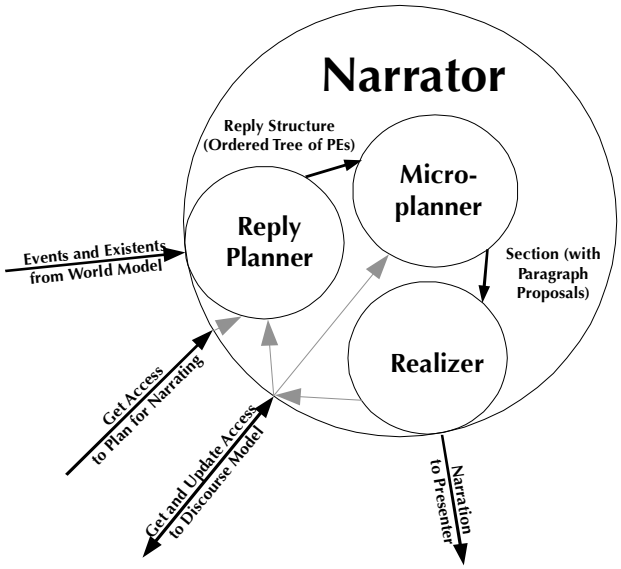

Figure 1: *The architecture of the Narrator module. The Reply Planner first converts events, existents and a plan for narrating into a reply structure, an ordered tree of proposed expressions that represents what is to be narrated and in what order. Next, the Microplanner accepts this and uses discourse information to do aggregation and referring expression generation, converting the RS into a list a paragraph proposals. The Realizer renders each sentence in these as text and outputs them, updating the Discourse Model as it does this.*

order for events in the content plane (see Adams 1999 and Adams 1999 and Herman:211-261), but these problems do not manifest themselves when generating a narrative based on a known underlying simulation.

The current project concerns itself only with generating a narrative (sometimes a very short one) given a representation of events and existents in the simulated world and information about which of these have transpired since the last input from the interactor. For this reason, the discussion that follows restricts itself to the reasonably well-established framework of *narrative* time, leaving aside, for now, the question of how this fits into the interactive situation.

Pure Order of Events in the Narrative

Order is a feature of all narratives, although it may not be a very significant one in narratives that are as simple as possible (narrating only one event) and in ones that provide the least possible information about time. The telling of a single event can be considered a narrative (Prince 2003:58) and can be thought of as being told in a chronicle, but it might just as easily be considered a degenerate case of any possible order. And if there is nothing to indicate that events are chronologically related at all, nothing can be said about how the order in which

they are narrated relates to their order in the content plane. But for other sorts of narratives, order is meaningful and is usually very important. The claim that "[o]rdering of events in time is one of the most fundamental characteristics of any story" (Prince 1973: 23) has hardly proved controversial. It has been validated by the efforts of literary writers and those who create narratives in other media to resist this principle and to confound the attempts of readers to make sense of a narrative's chronology. From one perspective, "the straining against the 'tyranny of time' throughout the ages, in modernism, for example, only reaffirms and redefines the tyrant's power with each abortive rebellion" (Sternberg 1990:901). A milder comment would be that there would be no drive to continually subvert or play with chronology if it were not in some way a particularly powerful organizing principle.

Given several events with a known chronological relationship, there are many ways these events can be ordered in a narrative. There is also a repertoire of conventional types of orderings which have been observed in literary, conversational, and other narratives. The categorization that follows is based on Genette's discussion of order in *Narrative Discourse*. It was noted almost three decades after the French publication this discussion that "[m]ost subsequent narratologists have adopted Genette's analysis of anachronies, either explicitly or implicitly, and none have extended it" (Adams 1999:114). The variations in order that Genette discusses are:

Chronicle. Events are narrated in the order in which they occur. Simultaneous events can be narrated in any order, relative to each other, in a chronicle. This ordering, as natural as it may seem, has been called "more hypothetical than real" (Genette 1980:36). Nevertheless, stretches of chronological narrative can be seen in many works of historiography, including the Bible and Thucydudes's *The Peloponnesian War* (see Sternberg 1990:921-922). Conversational stories also are often told as chronicles, e.g., "The Baddest Girl in the Neighborhood" and "Eating on the New York Thruway" (Polanyi 1985:21-22, 36-37). There is a great deal that has been written and that still remains to be said about the chronicle as a type of narrative, but at least two extreme views can be rejected. First, chronicle is not always the default arrangement for events in a narrative. It may be that causality, the categories into which the events falls, the associations they occasion to the narrator, or many other factors are as important as the order in which they transpired; these other factors may lead to a different ordering. Second, it is not reasonable to think that the chronicle is always absent from interesting or even avant-garde forms of narrative. For instance, in Harry Mathews's first three novels, *The Conversions, Tlooth,* and *The Sinking of the Odradek Stadium,* and in his most recent novel, *My Life In CIA: A Chronicle Of 1973,* chronological order predominates, although these novels (or "chronicles," as Mathews originally called all of them) are far from conventional.

Modern interactive fiction, while it is based on an essentially chronological simulation of events, nevertheless often deviates from the chronicle. In Adam Cadre's *Varicella* and Emily Short's *Bronze*, for instance, there is extensive use of analepsis. Of course, the events that are narrated during these analepses are not simulated; their narration is hand-written into strings of text. This can result in a powerful interactive experience. The system described here attempts to allow such sorts of recounting, and other sorts of narrating, to be generated in much more flexible and general ways, and to use not only fixed, non-simulated events from the past but the full store of events that have happened.

Retrograde. Events or temporal sections are narrated in the reverse of the order in which they occur. Examples with different levels of granularity include the basic structure of opening lines of the *Iliad* (Genette 1980: 36-37), Charles Baxter's *First Light,* the main sequence in Christopher Nolan's *Memento,* Martin Amis's *Time's Arrow,* and Alexander Masters's biography *Stuart: A Life Backwards*. Outside of literature, film, and fictional narrative, retrograde narration does make some appearances: The typical résumé has milestone events grouped by category (education, work experience) within which the events are presented in retrograde order.

Zigzag. Events or temporal sections from period 1 (the "now") are interleaved with those from period 2 (the "once") as they are narrated in order: One example is a passage from Marcel Proust's *Jean Santeuil* (see Genette 1980: 37-38). There is a correspondence between the sections and a comparison of a sequence of events in the past to ones in the "now" of the narrative. It is possible to either narrate the "now" first, followed by the "once," or to do the opposite. As with syllepsis, which is discussed further on in this section, the events that are paired must be similar in some way: the character entered a crowded room then, she enters a crowded room now; someone spoke to her then; someone speaks to her now. A strict zigzag has an even number of events or temporal sequences, since there is a series of alternations between "once" and "now."

Analepsis. An event or temporal sequence is narrated that is from the past, relative to what is being narrated. An analepsis has reach (the distance backward in time) and extent (the duration of the past event or temporal sequence). There are many different sorts of analepsis even when only order is considered (e.g., external, internal, partial, complete) but all of these can be specified by in terms of reach and extent.

Prolepsis. An event or temporal sequence is narrated that is from the future, relative to what is being narrated. A prolepsis also has reach (the distance forward in time) and extent (the duration of the future event or temporal sequence).

Syllepsis. The order of events is based on some grouping that is not chronological. For instance, in recounting a stereotypical adventure, all the encounters with monsters might be narrated, all the arrivals in new places, and then all the acquisitions of treasures. Examples from off the computer include the spatially-organized *La*

Vie mode d'emploi by Geroges Perec and Stendhal's *Mémoires d'un touriste*. Another example of spatial syllepsis is seen in how "Proust sometimes presents a whole series of events, all of which have occurred in the same place" (Bal 1997:99). The tree representing zigzag has the same form as the one representing syllepsis; Zigzag can be seen as a restricted form of syllepsis with the additional constraints that in each category, one event from the "once" and one from the "now" are narrated and that the overall progress is chronological.

Achrony. In this case, the relationship between the order in which events are narrated and the order in which they occur is impossible to establish, or is exceedingly difficult to establish and seems arbitrary, as in Alain Robbe-Grillet's *La Jalousie*. The full effect of achrony is usually achieved by omitting discourse markers and the typical signs of chronological relationship provided by tense and aspect, and this type of disassociation of an event from time is what Genette refers to as causing an achrony (1980:83), but these are concerns that will be taken up after the basic issue of ordering events.

Pure Ordering of Events in the Narrating

The order in which events are represented is something that is seen in the narrative (what Genette calls *narration*), but the process that ordered these events is in the narrating (*recit*), "the producing narrative action" (Genette 1980:27). To have a system that can generate narratives with events in several different orders, it is necessary to have algorithms for ordering events. The processes of ordering have to be discussed, not just the outcomes of such processes.

It seems meaningless to discuss the order of events in an narrative that represents only one event, but it is meaningful to discuss whether such a narrative is consistent with particular ordering processes. For instance, consider two narrators, one that has always narrated events in a retrograde manner and one that always narrates chronologically. If both narrators produce a very brief narrative, representing a single event, we can ask whether the narratives are told in a consistent way. In both cases, since a single event cannot be narrated in the "wrong" way in either a chronological or retrograde scheme, their narrations will be consistent with their previous behavior as narrators. If there were a narrator who always included an analepsis in narratives, on the other hand — always narrated, at some point, one event followed by some other event that happened earlier — no single-event narrative could be consistent with this characteristic. While it isn't meaningful to say that a single-event narrative has a particular order, it is possible to determine that some processes for ordering can produce it while others cannot.

Another example can be seen in random narrating. Four events that are ordered 1234 (with 1 being the earliest, 2 next, and so on) are, of course, chronologically ordered. But 1234 is also a valid choice for a random narrator (assuming that there is some probability mass on 1234). For a narrator that selects sequences uniformly at random, this is as probable as any other sequence. So, 1234 is consistent with both processes. It will always be produced by the former, of course, while it will never be produced by certain other processes, such as a process of retrograde narrating.

With this in mind, it is possible to define particular processes whose characteristic output falls into the categories described by Genette:

Chronicle. Sort a set of events into chronological order. "Chronicle" will not always specify a unique order, even when a timestamp is required for each event, because the set of events may include some that are simultaneous.

Input: *E*, a set of events
return sort(E, time)

Retrograde. Sort a set of events into reverse chronological order. Again, because of simultaneity, this may not be enough to specify a unique order.

Input: *E*, a set of events
return reverse(sort(E, time))

Zigzag. The process of zigzagging between two related chronological sequences of events requires that two such sequences are designated. Beyond this, a rule for moving between sequences is needed. This could be as simple as "narrate a single event before switching," or it could involve specifying that all the events in a single physical location are narrated in the "now," then the corresponding events in the "then," and then similarly with the next physical location. Whatever the case, the process of ordering simply involves applying this rule to the two sequences specified.

Input: *S* and *T,* sequences of events; *R(x,y),* a rule
U ← ()
while |*S*| + |*T*| > 0
  if R(S,T): append(U, pop(S))
  else: append(U, pop(T))
return U

Analepsis. This indicates an anachronism inserted into a main sequence, one which is presumably chronological. For this process to work, both a main sequence and the point of insertion of the analepsis need to be designated. From the standpoint of the analysis of narrative, is it sensible to discuss the reach and extent, but when generating an analepsis, the difference in time and the duration of the analepsis are not the most useful things to specify. It is more useful for a rule to specify what should be included in the analepsis based on features of events. For instance, "select the most salient event from the first time the focalizer encountered this character" or "select the most salient things that the focalizer has seen happen in this room in the past, up to three of them." Given the main sequence, the point of insertion, and the rule for selecting events from the past, the process of ordering events so as to include an analepsis is straightforward.

Input: S, main sequence of events; *A,* all events; *R(x),* rule for selecting past events; *n,* events before analepsis
U ← ()
while |*U*| < *n: append(U, pop(S))*

append(U, R(A))
append(U, S)
return U

Prolepsis. To insert a prolepsis, the same three inputs are needed: a main sequence, a point of insertion, and a rule for selecting events from the future. Of course, when some newly-simulated events are being narrated for the first time, there will not be a supply of simulated events waiting in the future. However, there are still circumstances under which a prolepsis can occur. An IF author can prepare "inevitable" events with future timestamps, representing things like the sun going down, a storm beginning, an election happening, nuclear missiles arriving, and so on. In general, the main sequence of events being recounted will often be from the past, perhaps because a character is recounting it in direct or indirect discourse or because the top-level narrator has chosen to recount it. In such a case, there will be plenty of future events to include proleptically.

The algorithm is the same as for analepsis; the rule *R* simply selectes from the future instead of the past.

Syllepsis. Beyond the original set of events, only a sequence of categories seems essential for specifying sylleptic narrating. For instance, such a sequence might have these three categories of events in it: "the adventurer entering a new area," "the adventurer defeating a monster," and "the adventurer acquiring a treasure." If all events are in exactly one category (the categories partition the set of events), this will specify a unique ordering. The narrator can move through each of the categories in order and, within each category, can represent each of the events chronologically. There is no reason to restrict a sylleptic narration to chronological order within categories, though. It is most flexible to allow any principle for ordering based on time alone (chronicle, retrograde, achrony) to be specified for ordering the narrative within categories.

Input: *E*, a set of events; *S,* a sequence of pairs *(C,R)* of categories and rules for ordering within them
U ← ()
foreach (C,R) in S: append(U, R(C(E)))
return U

Achrony. Ordering events at random seems the most suitable way to produce the type of order needed for achrony. As discussed earlier, there is always the chance that choosing an order uniformly at random will produce an order such as 1234, which is probably not convoluted enough. To specify a narrator truly capable of "privileging confusion," something Janet Murray has accused postmodern writers of doing, it would be enough to use a distribution over sequences that has reduced or no probability mass on obvious, non-confusing sequences such as 1234, so that it would prefer more unusual ones. But a narrator that orders events uniformly at random is probably confusing enough for all practical purposes.

Input: *E*, a set of events
return shuffle(E)

Time and Grammatical Tense in Ordering Events

So far the discussion has only covered how events can be rearranged from a chronological sequence into a narrative one. But reordering is not best seen as simply producing a sequence. An analepsis, for instance, is not well represented by the sequence 3451267. The sequence of events that is in the past, relative to the main sequence — the 12, in this case — is embedded in a way that cannot be seen in this simple representation. When the main sequence is being told in the present tense, the 12 is almost certainly be told in the past. If the main sequence is already being told in the past tense, there will almost certainly be some cue that 12 occurs at a much earlier time: a phrase such as "before that," an explicit reference to the earlier date, some statement about habitual occurrences in the past, or a statement in the perfect leading into the analepsis. Even without attempting to generate all of these sorts of transitions, or many of them, there is clearly a need to designate more about the order of events than a simple sequence does. The representation should not force the tense of the analepsis to be different, but it should allow for this difference. It should also integrate the times at which events occurred into the decision about tense. Simply associating an arbitrary tense with the main sequence and another arbitrary tense with the analepsis would not accomplish this. The grammatical tense should be a result of the position of the simulated events in time — and other essential parameters.

Genette noted that the nature of Western languages means that the temporal position of the narrating *vis-a-vis* the narrated has a special status:

> I can very well tell a story without specifying the place where it happens, and whether this place is more or less distant than the place where I am telling it; nevertheless, it is almost impossible for me not to locate the story in time with respect to my narrating act, since I must necessarily tell my story in present, past, or future tense. (Genette 1980:215)

These tenses lead to the "three major possibilities" for the temporal position of the narrating relative to the narrated: posterior, anterior, and simultaneous narration (Prince 1982:27). While Genette deals with this in the category *voice* rather than in his discussion of *order,* from the standpoint of generating narrative and determining the grammatical tense to use, the temporal relationship of the narrator to events is as important as the temporal relationship of events to one another, and they must be dealt with jointly.

The discussion that follows explains how the tense of a proposed expression (PE) is necessary for realization; how this tense can be determined from three points in time assigned to the PE that are called E, R, and S; and how these points can be defined using general rules (specifically, FOLLOW, MAX, MIN, *N,* and HOLD) that reside in the reply structure on internal nodes.

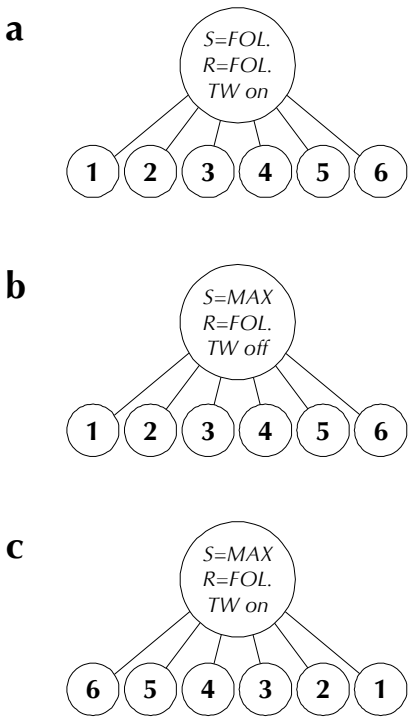

Figure 2. *Three reply structures: (a) represents a present-tense chronicle with time words used; (b) represents a similarly-ordered chronicle, but with no time words and told in the past tense; (c) represents a retrograde narration in the past tense.*

To allow the timestamps of the events and the temporal position of the narrator to participate in the determination of tense, an ordered tree of internal nodes and proposed expressions (PEs) of events is used. This complete representation of order is the reply structure, specifying what content to include, what order to include it in, and how to embed sequences. To realize a particular PE, there must be enough information about it to fully specify its syntax; in particular, this means that the system must be able to determine the tense of the sentence or sentences that are to be generated.

The determination of tense is based on Reichenbach's theory of how three points in time — speech time (S), reference time (R), and event time (E) — are adequate to specify grammatical tense (Reichenbach 1947:287-298). Three times are identified as necessary by Reichenbach because in a sentence such as "Peter had gone," there are three relevant points of time that are needed to explain the tense: the time at which the sentence is spoken (S, the time of speech); the time at which Peter left (E, event time), and another time which is being referred to, in this case after the event time and before the time of speech, by saying "had gone" rather than something else, such as "went" or "was going." This last time is R, the time of reference. Specifically, "The position of R relative to S [corresponds to] 'past', 'present', and 'future'. The position of E relative to R ... 'anterior', 'simple', and 'posterior'" (Reichenbach 1947:297).

Absent any context and any information about the temporal position of the narrator, a particular proposed expression of an event will still have the necessary information about when the event occurred, corresponding in Reichenbach's system to E. The Narrator would not be very helpful if it were necessary for the author to write code to determine every value of R and S for every PE. Instead, the Reply Planner uses the topology of the reply structure to assign R and S in a systematic way across each embedded sequence. Each embedded sequence has a parent, an internal node. On each internal node, a rule for determining the R and S values for children is provided. For each of R and S, the rule can be:

FOLLOW. Set the value of R or S to E, so that reference time or speech time "follows" the events.

MAX. R or S are assigned to have the maximum value, always greater than E; if both are set to Max, R=S.

MIN. R or S are assigned to have the minimum value, so that this value is always less than E.

N. Any integer value; R or S are set to this.

HOLD. Use the current rule for R or S as determined by a higher-level internal node, given this point in the parent's embedded sequence.

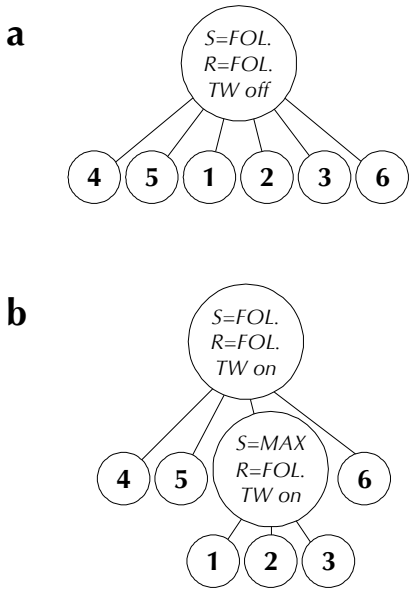

Figure 3. *Two reply structures: (a) represents achrony, with events represented in the present tense; (b) generates a present-tense narration of events 4, 5, and 6 with a past-tense analepsis (including 1, 2 and 3) embedded within it. The sequence of events is the same in both cases; the ordered tree representation allows for the same sequence to be generated coherently in the latter case and confusingly in the former, corresponding in both cases to types of order identified by Genette.*

For example, consider a reply structure that consists of just a root (a single internal node) with one level of n PEs beneath it, their event times indicated by E1 ... En. Setting speech time to MAX and reference time to FOLLOW in this internal node will assign S1 ← Max, S2 ← Max ... Sn ← Max, and R1 ← E1, R2 ← E2 ... Rn ← En, so that throughout the sequence, E = R < S. This corresponds to simple past-tense narration for the entire reply.

Setting both speech and reference time to FOLLOW will similarly assign the event time to S and R at each node, so that S = R = E everywhere, producing simple present-tense narration. When narrating events and moving back in time to narrate previous events, in an analepsis, the speech time can be held at the current point in the main sequence using HOLD while the reference time is set to FOLLOW, so E = R < S for past-tense narration throughout the embedded sequence. Finally, in narrating some events that happened between time 500 and time 600, R can be set to 600 and S to MAX to generate representations of the events in the past perfect. A narrative sequence can be generated in any of Reichenbach's nine fundamental forms (<anterior, simple, posterior> ⊗ <past, present, future>) by specifying S and R in such ways.

The internal nodes also carry some additional information. They have a time words (TW) setting to determine to what extent expressions such as "before that," "then," and "meanwhile" will be used to link representations of events. Using information stored on the internal nodes and in commentary nodes at the beginning and end of sequences of proposed expressions of events, more complex effects could be achieved. Framing statements from the narrator such as "I remember" and "anyway" could be added around an analepsis, and a preface such as "I foresee" could be inserted before a prolepsis.

The Reply Planner also implements other variations, including variations in speed and frequeny. The Microplanner's determination of grammatical tense from R, S, and E and the Realizer's conversion of a paragraph proposal into strings of text are the next steps in the Narrator's pipeline. These are important but are less specific to narrative. The other functions of the Reply Planner and the rest of the Narrator's pipeline have been discussed in detail elsewhere (Montfort 2007:106-123).

With this model established, it is possible to precisely define what distinguishes achrony from a random reordering of events that is related in a coherent way. In achrony, speech and reference time are equal and either remain greater than, remain less than, or follow the event times for the entire interval, so that everything is narrated in the same tense, and helpful time words such as "then" and "before that" are suppressed. If an event moved to the past is instead treated as an analepsis (with a shift in tense), or if time words are generated to indicate how events are related, the result is not as disorienting.

Three example narratives generated from these sorts of reply structures, all relating the same set of events, follow. The first two are generated from reply structures similar to th ones shown in figure 2a and 2b, although there are more events and some of the events are simultaneous. The second one is generated from a reply structure like the one in figure 3a, although the particular shuffling shown is not the same.

Chronological, Simultaneous, with Time Words

You look at the center of the plaza.
Your senses are humming as you view the broad, circular, encircling Plaza of the Americas. The morning has concluded. It is midday now.
From here, you see a statue and a flaneur to the north, a fountain to the east, a trash collector to the southwest, a ball and a boy to the northeast, a mime and an obelisk to the south, and some punk and a tree to the west.
Then, the punk kicks the tree.
Meanwhile, the flaneur conveys himself to the northern area.
Then, the boy throws the ball.
Then, the flaneur looks at the northern area.
Then, the mime waves.
Meanwhile, the trash collector takes something.
Then, the ball falls to the ground.

Chronological, Subsequent, without Time Words

You looked at the center of the plaza.
Your senses were humming as you viewed the broad, circular, encircling Plaza of the Americas. The morning had concluded. It was midday then.
From there, you saw a statue and a flaneur to the north, a fountain to the east, a trash collector to the southwest, a ball and a boy to the northeast, a mime and an obelisk to the south, and some punk and a tree to the west.
The punk kicked the tree.
The flaneur went to the northern area.
The boy threw the ball.
The flaneur looked at the northern area.
The mime waved.
The trash collector picked up something.
The ball fell to the ground.

Achrony, Simultaneous

Some punk kicks a tree.
A trash collector picks up something.
A mime waves.
A ball falls to the ground.
You look at the center of the plaza.
Your senses are humming as you view the broad, circular, encircling Plaza of the Americas. The morning has concluded. It is midday now.
From here, you see a statue and a flaneur to the north, a fountain to the east, the trash collector to the southwest, the ball and a boy to the northeast, the

mime and an obelisk to the south, and the punk and the tree to the west.

The boy throws the ball.

The flaneur looks at the northern area.

The flaneur conveys himself to the northern area.

Discussion

From Genette's description of how one sequence (the order in which events are narrated) relates to another sequence (the chronological order in which these events transpired), this enriched model using ordered trees and temporal information has been developed and the algorithms needed to produce different types of order have been specified. Variations in narrative order have been formally described by defining algorithms to sort events into chronicles and retrograde narratives, to disarrange them in achrony, and to categorize events using zigzag and sylleptic schemes. The time of narrating and narrative order have been connected so that all the necessary information is represented in the reply strucutre. This scheme has been implemented in a working interactive fiction system, so that any set of events can be arranged in numerous different ways in the telling.

There is more to be done to provide a highly usable system, and there are certain limitations to the approach taken here. While it is currently possible to code *ad hoc* rules for determining salience and selecting past or future events to include in an analapsis or prolepsis, more general methods for doing this selection will be needed. The importance of causality is also understated in the current, temporally-based system. nn does represent causality, but time is the basis for the determination of narrative order. This may or may not work well from the standpoint of IF authors. However, temporal relations will need to be tracked and expressed in syntax no matter what principle for ordering them is used, so what has been learned about the arrangement of events here will still be relevant to a system that prioritizes causality.

The capability to arbitrarily and generally order events in the telling is an promising one, but it remains to be seen how this affordance can be exploited by IF authors. Only in use will it be possible to determine whether this system offers control over order at the right level, or a useful level. The question of how narrative order can react to interactive situations can also only be addressed in the context of new creative work from multiple authors with different sorts of projects in mind.

For these reasons, the public release of nn as free, open source software, while not yet accomplished, is a goal and will be an important next step. There are certainly many research questions that can be explored by further development of the system in the lab — for instance, drama managers can be added, aesthetic text generation capabilities can be integrated, planning for NPCs can be implemented, and different forms of deeper or multilingual text generation can be developed. These are worthy projects. But a special advantage of interactive fiction is that it is rather widely developed and played, and is used by the public more than other text-generation and narrating systems are. To advance in compelling ways, nn should be part of this context of interactive fiction development and use. If a somewhat polished public release can be completed well enough to embody the research advances and overall concept of the system, nn will be able to connect to the community of interactive fiction authors and players. This group can show researchers what a system for narrative variation can do and what it should be able to do in the future.

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