MEMORY IN STORY INVENTION

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AUTHOR is a story generating program (under development) being built as a model of how human authors make up stories. Like TALE-SPIN [4], AUTHOR requires human-like knowledge of the world, but unlike TALE-SPIN, AUTHOR also requires human-like memory organization of this knowledge. The two features of human memory most essential to the AUTHOR model of story generation are (1) reconstruction, and (2) reminding. The former is responsible for the directed nature of making up stories, the latter for the author's more "fortuitous" ideas and insights.

1. The Importance of "Re"construction

Directed story invention[1] is, according to the AUTHOR model, basically a matter of

1. having some initial idea of what one is trying to invent, and

2. applying the same reconstructive memory accessing techniques used in remembering something old to develop, flesh out, and successively reformulate that idea into a complete draft. (Of course in invention one is not actually reconstructing; hence the quotes in "re"construction.)

This view of invention is, of course, basically the converse of Bartlett's theory of remembering [1]: Bartlett viewed recall as very much akin to invention, while I am suggesting that invention is very much akin to recall. My reasons for turning Bartlett's theory around, for grounding a theory of invention in a theory of recall, are twofold:

1. There currently exists a better model of recall than of invention. In particular, Kolodner has developed a working process model of reconstructive recall of episodes from long term memory as part of the CYRUS system [5]. This could serve as a basis for modeling other reconstructive memory accessing tasks, including story invention if it turns out to be one.

2. While inventiveness appears to be a widespread human capability, it does not seem to be basic or essential in the same sense that remembering, learning, and understanding are. Therefore, if the "re"constructive invention hypothesis holds, it would account for the relative cognitive luxury of inventiveness as a free byproduct of the relative cognitive neccessity of remembering.

2. The Importance of Reminding

That reminding is a natural consequence of human reconstructive memory architecture has been proposed and argued for by Schank [7]. Basically the claim is that specific memories for some input are stored in memory at the points which provide the expectations used in understanding that input, particularly those expectations that are being violated. Reminding occurs when one later processes an input that one understands in terms of a shared memory structure. Reminding is a very common phenomenon, according to this theory, though we tend to only notice its occurance when it dredges up something relatively useless.

Given a reconstructive memory architecture, anything being understood is likely to be understood in terms of a great many different structures and can be retrieved from several of them. There can thus be several ways of being reminded of any given thing, but whatever the route to the reminding, recalling the complete experience entails reconstructing the other structures used initially in understanding it.

Reminding plays an important role in laying bridges from currently active memory structures to ones usefully, though not logically, related. Reminding thus underlies and helps explains informal reasoning. In the AUTHOR model, this form of reasoning is used heavily in story generation. One can never, of course, rely on getting reminded of something useful (i.e., encountering a useful bridge), but given the structure and contents of reconstructive episodic memory, one is bound to have some useful remindings if one is doing enough memory accessing. The process of directed reconstructive invention is just such a source of memory accessing.

In the normal process of memory access stemming from reconstructive invention, an author can be reminded of (1) experiences and observations external to the story thus far made up, such as of people she has known, things that have happened to her, ways people have reacted to various situations, etc., and (2) things internal to the story thus far made up characters, props, settings, situations, reactions, etc. The former is an important source of relevant material to be incorporated into the story. The latter helps the author

1. catch problems, such as unintentional expectation violations

2. pick up development of threads she was earlier distracted from by other narrative needs, and

3. further weave existing story threads into the fabric of the evolving story beyond that deliberately intended in the top-down initial invention of those threads

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[1] "Story invention" should be taken to mean the invention of stories and fragments thereof episodes, characters, props, settings, etc.

3. A Closer Look at Reconstruction

There is a (weak) sense in which SAM [3] was a model of reconstructive recall of stories.[2] It did not "record" stories verbatim in memory, but rather in terms of its prior schemas; in paraphrasing (recalling) such stories from these memory structures, it couldn't help but normalize/distort the stories, much as Bartlett's subjects did in reading "War of the Ghosts". By this simple model, the reconstructive process was one of filling in of details and connections not explicitly stored as part of the story itself, from the given schema. As in Bartlett's experiments, anything in the original story that was too normal was ignored (because it could always be easily inferred); anything that was too weird was remembered as weird but could not be represented well.

A better model of reconstructive memory (MOPs) evolved out of scripts, in response to Bower, Black, and Turner [2]. MOPs [7] entail decomposition during understanding, thus allowing a great deal more sharing (and hence confusions). With this model arose the additional problem of "collecting" pieces spread all over memory. Recall became largely a matter of figuring out where in all of LTM to look.

This problem was addressed by Kolodner in the CYRUS system. CYRUS has a great deal of episodic knowledge about Vance and Muskie, culled from news stories about each of them. This knowledge is "stored" in CYRUS's long term memory, from which it can be reconstructively retrieved. Consider, for instance, how CYRUS responded to the following question:

Q: Mr. Vance, has your wife ever met Mrs. Begin?
A: Yes, most recently at a state dinner in Israel.
What is especially interesting about this response is that to come up with it, CYRUS had to "deduce"[3] that a likely place for it to have "stored" such an occurance in memory, if it did so, is at some social political event, such as a state dinner. (For details of how exactly it did so, again, see [5].)

It is also interesting to consider this example of recollective reconstruction from the perspective of story invention. Suppose, for instance, an author were writing a story in which she needed to have an encounter between the wife of the American Secretary of State and the wife of the Israeli Prime Minister, or in which she needed to get these two characters at the same place at the same time — how would the author set this up? Well, one plausible place to have them meet is at some social political event, such as a state dinner; more specifically, a state dinner in Israel would do nicely. Realizing that that is a likely place for the two diplomatic wives to meet (which is the hardest part of the reconstructive process) — i.e., finding where to look in memory — is thus the same for reconstructive recall and reconstructive invention.

4. Successive Reformulation

Reconstructive invention, like all difficult reconstruction, is a matter of successive reformulation.[4] When probing memory, one may, rather than finding exactly what one is looking for, come up with a partial answer plus ideas about where to look further; pursuing these ideas may again fail to immediately lead to a solution, but rather further partially specify the answer and suggest yet further ideas.

For instance, the author may have previously decided that she wants the story to be about a shy person encountering difficulties because of his shyness. This may be a good idea but it is too vague to include as is in the final story. One possible reformulation is that the shy person have to face a job as a door-to-door salesman.[5] This reformulation will itself undergo considerable reformulation. For one thing, there is still a good deal of further concretization needed - the details of his route, product line, colleagues, etc. For another, there is now a plausibility problem - why would a shy person ever become a salesman?! This plausibility question will lead to yet a further reformulation, and the "re"construction of an explanation — e.g., he was forced into it, or he didn't know what he was getting into. Each of these explanations need to be further reformulated into something more concrete - the former, for instance, into the character's severe financial problems. This, in turn, may be reformulated into his being out of work and with a mother dying of cancer unless she can get some expensive therapy.

Concretization and Plausibility Maintenance are just two sources of reformulation driving story generation. Another is Dramatization (making more hang on a decision, making an action harder). Yet another is Presentation of a Narratively Neccessary Fact: As the story world and events within it develop, some facts about the storyworld will turn out to be especially causally significant, such as that a particular character is shy, or that a particular door was left unlocked.[6] In such a case, it is important to make sure that fact is introduced in the eventual story narrative, sufficiently strongly that the reader will have it available when need. One way of doing so is reformulating the fact into a complete episode (or episodes). Thus, if the critical murder scene hinges on the door being unlocked, the author will

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[2]TALE-SPIN's invention of bears and caves was also weakly reconstructive in this same sense.

[3]"Deducing" where in memory something might be is not, of course, a matter of formal reasoning for CYRUS, but rather a matter of successive selection and application of search and instantiation strategies, as discussed in [5].

[4]This is related to the successive refinement paradigm in planning of Sacerdoti [6]

[5]This reformulation would be arrived at by reconstruction: what sort of situation might a shy person find especially stressful? How exactly a particular author would arrive at this particular reformulation (or any of the others given below) is partially a matter of her idiosyncratic memory organization and content, but the point behind all these examples is to give a flavor of the process of successive reformulation in story invention.

[6]These especially significant storyfacts are typically invented by the author as post hoc justification for something already incorporated into the storyworld. An example of this we have already seen is the invention of the cancerous mother to motivate the shy salesman. Nonetheless, they must precede what they were invented to justify, both in storyworld time and in the narrative order of presentation.

invent a secondary episode for the express purpose of introducing this fact. (This is not to say, of course, that the episode cannot also be made to accomplish other purposes.)

When something is especially important (such as a critical character trait of the protagonist), the author may want to repeat it, for emphasis. While there is a stylistic role for literal repetition, far more interesting are conceptual repetitions. Such repetitions can be produced by successive reconstruction in multiple contexts. For instance, if it is essential to the main part of the story to realize how pathologically shy the protagonist is, the author needs to communicate before that point that he is shy. She may therefore reformulate this storyworld fact into two or more episodes - for instance, the time that he crossed the street because... and the time he flunked a course because he was afraid to explain to the teacher that ....

Successive reformulation also has the interesting side effect, when viewed from the perspective of the memory accessing it entails, of greatly enhancing one's chances for dredging up useful remindings!

5. Memory and the Process of Story Invention

It should by now be apparent why human-like memory organization is needed in a model of story generation. Long term memory is, in fact, the single most important component of the AUTHOR system.

AUTHOR LTM is reconstructive and reminiscent, drawing heavily in its design both from Schank [7] and Kolodner [5]. The AUTHOR program is starting with a prebuilt version of such a memory, supplying it with prior knowledge about such things as human goals, social roles, and interactions; the prebuilt memory is also richly studded with episodic traces of (faked) experiences that would have given rise to such knowledge.

AUTHOR LTM evolves, however, in the process of story invention. This follows from a prediction stemming from the underlying Schankian theory that memory gets modified where accessed whenever something interesting results. Thus, as characters, situations, relations, etc. are invented and developed reconstructively from prior memory structures, they are remembered in appropriate places in memory. This may, in turn, lead to partial memory reorganization.

There are two important effects of such memory modifications:

1. They allow the author, in the process of making up a story, to be reminded of prior story decisions, important for reasons discussed previously.

2. They partially account for the nonduplication of stories made up by an author, without appealing to randomness: given how critical the details of memory are to the exact "reasoning" paths an author takes in story invention, this model predicts that the same person making up two stories, even if starting from the same idea, will come up with something different the second time. Human authors, of course, have their memory still further altered between stories, from external experiences.

A further prediction of this memory model concerns what is commonly referred to as "inspiration" and what is here seen as an especially useful reminding. Such a reminding experience is most likely to occur when the author has very rich indexing - which is, indeed, the case once the author has "gotten into" the story.

Yet another thing partially explained by this model is what makes a good story idea. A good idea is something that serves as an index into a rich enough part of LTM to get the reconstructive process going to the point of self-sustaining momentum; thus one person's good idea is another person's dud because of the idiosyncratic differences in memory organization and contents. There appears to be a consensus among authors (or at least among those who write about it) that good ideas are very hard to come up with deliberately, or even to recall once thought of. They are likely, rather, to be discovered fortuitously (such as in a deep and sudden feeling of insight), frequently when the author is engaged in some outside activity, and are likely to get lost again if left to their own devices. Given a good idea, though, experienced authors can sit down and start deliberately inventing.

Thus, a minor, yet critical aspect of memory for story invention, needed to supplement human reconstructive LTM is "paper memory". It is in most ways vastly inferior (memory organization and indexing being very crude) but it is just what is needed as auxiliary storage of reconstructive pointers into LTM that are themselves very hard to remember.

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