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### **Authors**

Turner, Scott R.

Dyer, Michael G.

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Thematic Knowledge, Episodic Memory and  
Analogy in MINSTREL, a Story Invention System \*

Scott R. Turner  
Michael G. Dyer

Artificial Intelligence Laboratory  
Computer Science Department  
University of California  
Los Angeles, CA 90024

### Abstract

This paper examines the process of storytelling and story invention. It focuses on the use of themes, episodic memory, analogical mappings, planning and literary goals. A computational model of storytelling is presented and its implementation as the program MINSTREL is discussed. MINSTREL contains an episodic memory of stories and themes and uses these memories along with knowledge about the world of King Arthur's knights to invent interesting new stories.

### Introduction

This paper is an overview of the MINSTREL project. MINSTREL is a computer program (under development) that models human story-telling behavior. MINSTREL tells stories in the King Arthur domain.

### Previous Work

Meehan's TALESPIN program [Meehan 76] told stories about the lives of simple woodland creatures. The thrust of TALESPIN was planning; the process of telling a story involved giving some character a goal and then watching the development of a plan to solve that goal. In this example from [Meehan 76], John Bear has been given some initial knowledge about the world and a goal to satisfy his hunger. The resulting story:

*John Bear is somewhat hungry. John Bear wants to get some berries. John Bear wants to get near the blueberries. John Bear walks from a cave entrance to the bush by going through a pass through a valley through a meadow. John Bear takes the blueberries. John Bear eats the blueberries. The blueberries are gone. John Bear is not very hungry.*

This story illustrates the strengths and weaknesses of TALESPIN. First, the story is very believable and logically consistent. This is a reflection of

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TALESPIN's strong planning component and illustrates (at least intuitively) that planning is an important component of storytelling. On the other hand, the story seems pointless and somewhat boring because TALESPIN is a planner operating on the level of character planning and not at any higher level. (Meehan realized this and added a component that forced the story to follow a pre-canned template.) So an interesting negative result of Meehan's work was that story invention based on planning could not produce interesting or memorable stories, thus requiring an ad hoc, pre-canned template. This result showed that a general theory of themes, morals or interesting situations is needed.

### Story Themes

What is a story theme and what makes them interesting to the reader? Dyer [Dyer 1983] pointed out that one class of themes (or morals) consist of planning advice and some explanation for its validity, often provided in terms of the negative consequences that result when the advice is not followed. In "The Fox and the Crow" the theme is "Don't trust flatterers"; this says to avoid assuming a goal at the behest of someone else if they do so by appealing to some facet of you in an exaggerated way. Some examples of story themes are:

1. "Be kind to strangers": Choose plans that benefit others.

#### POOR WOMAN AND THE PRINCE

*An old, poor woman finds a stranger who has been robbed and beaten. She nurses him back to health and discovers that he is a prince, and she is richly rewarded.*

2. "Never say die:" Don't abandon goals when no solution is apparent.

#### CANCER CURE

*Ethan suffered from terminal cancer and was in constant pain. The doctors said he might live another six months, but he despaired and decided to commit suicide. He went down to the drugstore to buy some poison and when he got there the druggist told him that a new miracle drug had just been discovered that would cure his cancer.*

Story themes cover a broad range of planning advice at many levels. If we assume that these story themes arise from a knowledge structure the author possesses, then what can we say about these structures?

Dyer [Dyer 1983] suggested Thematic Abstraction Units (TAUs) as a knowledge structure to represent thematic knowledge. TAUs are characterized by adages and represent planning advice that can be couched either as a typical planning failure (i.e., "Throwing good money after bad") or as a rule for making a choice during planning (i.e., "Don't throw rocks if you live in a glass house.").

The theory of TAUs has two parts. The first says that TAUs represent important planning advice. The themes presented above represent rules that can apply at various points in the planning process. For instance, "Never say die" is advice to the mechanism that decides when to extinguish goals. Knowing to keep a goal alive even in the face of a lack of plans may avoid a failure. Thus these themes also deal with avoiding plan failures.

The second part of the theory of TAUs claims that TAUs organize episodic memory so that an episode containing a TAU is likely to cause a reminding of a related episode that contains the same TAU. For instance, the story:

#### FELLOWSHIP

*John realized that he only had money for two more quarters of college, and decided to drop out immediately to look for a job. He went to Murphy Hall to fill out the proper forms and discovered that he had been awarded a fellowship.*

tends to remind people of the previous story, "CANCER CURE" because they both embody the same TAU.

#### MINSTREL

**Inspiration:** "Every good play must have a well formulated premise." – Lajos Egri [Egri 1960]

How does an author decide upon a theme in the first place? How does a theme come to mind? Often the selection is based upon an interaction between the author's values and his personal experiences. We believe that the author recalls an episode from memory and its related theme and uses this as the basis for a story. This recall is based on the many inputs an author has: his immediate goals, the environment around him, things he has lately been told, and so on.

MINSTREL models this behavior by accepting as input conceptualizations which are then used to index memory. If the conceptualization recalls an episode with a related TAU, then this is used to start the story telling process. If not, then MINSTREL awaits more input.

#### The Use of Theme in Plotting

Once a theme has been selected, how is it used to guide the story telling process? The theme of a story is instantiated in the events that make up the story (the plot). Some of these events are very crucial to the theme, others are less important or entirely irrelevant. The theme is used to build the initial skeleton of events for the story. How is this derived from the theme?

One way to derive a skeleton plot from a theme is to build it. A theme of the form "Planning behavior X is good" lends itself to a plot of the form:

1. Give character A behavior X. Have character A

use behavior X in goal/plan situation G. Have character A receive some good effect as a result of G.

This scheme has a number of problems. First, it produces a limited number of plots, and makes learning new plots very difficult.

Second, the plot as built by these rules is too general. Filling in such a plot requires "guessing" appropriate behaviors, roles, etc., to fill in the plot.

Finally, it creates some difficult planning problems. Given some behavior X (i.e., "Never say die" – don't abandon goals when out of plans), generating a situation that requires this behavior is a potentially expensive problem since it involves undirected search through a large space of goals, plans and world knowledge. A better method for deriving a skeletal plot from a theme is to recall a story involving the same theme and borrow the plot (or plot elements) from it.

#### The Role of Episodic Memory in Plotting

At the time the author is searching for a plot, he has available to him his theme, his initial inputs, and at least one recalled episode (the one that prompted the theme). This material may be enough to provide him with further reminders. Even if it does not, he has one episode to borrow a plot from.

This method avoids the above objections to plot rules. The number of plots is limited only by the number of relevant reminders, the episodes recalled provide a great deal of material for later use by the story teller, the planning problem is already solved and new plots can be learned by generalizing and mutating the recalled episodes. Given an episode that illustrates the theme, borrowing a plot from the episode involves mapping the pieces of the episode into the story domain.

#### Plotting Through Analogical Mappings

There are two facets to this analogical process. First, we must maintain our story knowledge through the mapping. That is, we must remember how the elements of the episode relate to and exemplify the theme. Secondly, we must map world features of the recalled episode into our story domain.

Maintaining the story knowledge can be done by retaining the high level memory structures (such as TAUs) that index the remembered episode. Maintaining the TAU through the mapping retains the abstract knowledge about the theme that is embodied in the episode. Through the TAU we can identify important components of the theme, such as the planning failure and the negative consequence.

Performing an analogy on world features requires recognizing elements of the episode in terms of their functions, and mapping these into elements with equivalent functions in the new domain. Thus, a car

in a 20th century story might map into a chariot in the medieval domain because they both function as vehicles, and a job interview might map into an audience with the king, because they both are examples of social interactions with a possible social superior.

### From Plotting to Story

Given a theme and an initial plot, what more is left to do before we have a story? One task left is fleshing out the plot. A character at this stage might be represented as a role (i.e., KNIGHT) and have no other features.

Instantiating features of a plot requires planning and world knowledge. Suppose, for example, that we need to develop a situation where our main character, a KNIGHT, faces a physical risk. Using our world knowledge about KNIGHTs we consider some typical KNIGHT-ly plans that can result in physical damage, namely, fighting a monster.

### Author-level Goals

Another task at this stage of inventing a story is fulfilling author-level goals. The importance of author-level goals to storytelling has already been pointed out by Dehn [Dehn 1981]. Author-level goals embody "good writing techniques," goals like building suspense, character development, creating pathos, etc. There are two facets to such goals. First, we must know when to activate these goals. Second, we must have some techniques or plans for achieving them.

MINSTREL looks at a class of author-level goals that are intended to create an emotional response in the reader. One example of this kind of goal is creating suspense. MINSTREL has the following rules that indicate *when* it is useful to try and create suspense:

1. When you are developing a scene in which a character is about to achieve a solution to a crisis goal.
2. When you are developing a scene in which a character is at physical risk.
3. When you are developing a scene in which two characters have competing goals.

There are two ways to increase the drama or suspense of a scene. The first is by increasing the importance of the main character's goal in that scene. The second is by increasing the reader's anticipation of the solution to the goal.

Increasing the goal importance:

1. Make the goal more important to the main character.
2. Create goal conflicts.
3. Increase the rewards and punishments.

Increasing the reader's anticipation:

1. Eliminate favorable solutions to the goal.
2. Make the main character use a dangerous plan.
3. Insert a secondary incident between the assump-

tion of the goal and its conclusion.

4. Make the goal important to the reader.

Above we showed how a scene with a KNIGHT fighting a monster might arise when we needed the KNIGHT to be at physical risk. When this scene is created, the suspense rules fire (it is a scene involving physical risk) and suspense techniques are applied to make the scene more dramatic. For instance, if the technique "Insert a secondary incident" was used, the KNIGHT would lose his sword in the midst of the battle, forcing him to suddenly scramble for another weapon.

### A Control Structure for Storytelling

To this point we have discussed the process of storytelling as a linear one: discover a theme, build a plot, flesh out the plot, fulfill literary goals. The storytelling process is not at all linear.

To see why this is, consider the example above where we constructed a scene with a KNIGHT fighting a monster in the course of fleshing out another scene. Constructing this fight scene would cause us to be reminded of other memorable fight scenes. This reminding brings with it a wealth of imagery that can be used to further flesh out the current fight scene, and it may also recall a new theme and plot. Suddenly the author, concerned with fleshing out a scene, has become reminded of another story, and finds himself thinking about the theme and plot of that story. He has suddenly shifted back to the stage of storytelling concerned with theme and plot.

How is this situation to be handled in a storytelling program? These reminders are the essence of creativity; what we would like to do is jump from concern to concern as they arise. This suggests a task agenda-style control mechanism. This is very similar to the agenda mechanism Lenat used in his AM program [Lenat 1976]. It is very interesting that two programs concerned with creativity in vastly different domains should use the same control structure, and it is likely that this reflects something important about the nature of creativity. The ability to be interrupted with fortuitous reminders and the ability to be able to react to this by jumping from task to task, level to level, seems to be crucial to creativity.

### Episodic Memory

In this section we briefly discuss how the process of storytelling affects episodic memory.

Once finished, and at its various stages of development, the story is a conceptual representation of an episode, much like any episode in episodic memory. These episodes are added to episodic memory, to be available during future storytelling sessions as an index to themes, sources for fleshing out and so on.

Similarly, fragments of stories may be built and discarded during the course of fleshing out a story. If



our story initially contains a scene where a knight finds a sword in a tree, only to have that scene excised in order to raise the suspense in a subsequent scene, the scene where the knight finds the sword is not discarded. It remains, indexed in memory, where it may later be recalled.

Thus episodic memory becomes a rich storehouse not only of the finished stories, but also the partially completed stories and story fragments that were generated along the way. Writers become better writers by writing, a process that builds their store of episodes, and provides them with a greater range of material for future writing endeavors.

### Interactions and Examples

In this section we give some examples of the material presented above and show how it might interact to produce a story. In this case, episodic memory already contains a conceptual representation of the following story (a simplified synopsis of "It's a Wonderful Life"):

*A banker is kind to many of the members of his community and loans them money when they are in need. He then misplaces some money and is threatened with loss of his bank. At the height of his despair his friends arrive with the money needed to save the bank.*

This story is indexed by TAU-GOOD-DEEDS-REWARDED, which also contains the advice "Be generous to others and they may return the favor." Episodic memory also contains information about bankers in addition to knowledge about the King Arthur domain.

The input to MINSTREL is: A banker died.

In this particular case, the input recalls "It's a Wonderful Life," not because it involves TAU-GOOD-DEEDS-REWARDED, but because they are both interesting incidents involving bankers (for a discussion of indexing by content see [Kolodner, 1980]). When the banker incident is recalled MINSTREL decides to tell a story about generosity (specifically, TAU-GOOD-DEEDS-REWARDED). In addition, the mention of "death", an important goal to the author, brings the goal of P-HEALTH to mind.

The theme has been selected, so now plotting gets priority. Looking at the recollected episode, the plotter finds this skeleton:

*Person X has skill Y. X uses Y to help Z. Z is grateful to X. (1) Calamity befalls X. Z saves X from calamity (because of 1) X is grateful to Z.*

We now map the first help situation into the King Arthur domain. There is no analog of banking in the King Arthur domain, so we abandon the direct analogy. Instead we attempt to recall an interesting help situation - using the P-HEALTH goal we've been thinking about - and recall an event where a

hermit helped to heal a knight.

Using this recollection, we build the first help scene and instantiate the roles of the two main characters:

*An old woman of the woods knows how to heal. The old woman heals a knight. The knight is grateful to the old woman. Calamity befalls the old woman. The knight saves the old woman. The old woman is grateful.*

As new scenes are created, tasks fire which check the scene for consistency. One of these tasks notes that the knight is healed without being in need of healing, and so creates a scene where the knight is injured (and again, creates a scene which places the old woman near the knight).

*A knight is travelling through the woods and encounters a troll. The knight defeats the troll but is injured. An old woman of the woods is picking berries and finds the knight. The old woman heals the knight. The knight is grateful to the old woman. Calamity befalls the old woman. The knight saves the old woman. The old woman is grateful.*

Note that these new scenes have just been created backwards from the order in which they will be told. In general, the storytelling process skips around through the story, not necessarily attacking it in temporal order. The planning component in particular sometimes works backwards, determining things which should have happened, and sometimes forward, determining what will happen. This reduces the cognitive load. Telling a story only requires a theme and key scenes. The entire story does not need to be solved at once.

We generate the second help situation in a similar way:

*An old woman of the woods knows how to heal. A knight fights a troll and is injured. The old woman is out picking berries and finds the injured knight. The old woman heals a knight. The knight is grateful. The old woman is attacked by a dragon. The knight saves the old woman. The old woman is grateful.*

At this point the previously mentioned rule for building suspense in scenes involving physical danger fires on the scene of the old woman being attacked by the dragon. One of the rules for building suspense is:

Build suspense in a physical fight scene by making the protagonist physically weaker.

Unfortunately, the old woman is already weak (knowledge we have about the role of being an old woman), so this rule fails. Another rule is:

Build suspense by eliminating all solutions to the problem except the one that will work.

In this case, one plan for saving one's life is to run

from the threat. MINSTREL eliminates this by trapping the old woman in her cottage:

*An old woman of the woods knows how to heal. A knight fights a troll and is injured. The old woman is out picking berries and finds the injured knight. The old woman heals a knight. The knight is grateful. The old woman is trapped in her cottage by a dragon. The knight saves the old woman. The old woman is grateful.*

Now focus turns to the knight saving the old woman. Again this is recognized as a scene worthy of suspense, so the above rules fire again. This time, the first rule:

Build suspense in a physical fight scene by making the protagonist physically weaker.

can fire. The knight is made physically weaker by making him injured. The planner now looks for a way that he might be injured. One way is if he was involved in battle. Another way is if a previous healing wasn't completely effective. This is chosen and we have:

*An old woman of the woods knows how to heal. A knight fights a troll and is injured. The old woman is out picking berries and finds the injured knight. The old woman heals a knight. The knight is grateful. The old woman is trapped in her cottage by a dragon. The knight, still weak from his old wounds, saves the old woman. The old woman is grateful.*

At this point, knowledge of style and storytelling generation devices come into play.

**Galahad was out in the woods one day when he encountered a troll. He did battle with the troll, and killed the troll, but was himself injured and laid near death on the forest floor. He was discovered by Glinda, an old woman of the woods, who applied her healing art to him and helped him recover from his wounds. Galahad thanked the old woman and promised to return the favor someday.**

**Later, Glinda found herself trapped in her cottage by a dragon. She was terrified. Just then Galahad rode up. Still weak from his wounds, he battled the dragon and killed it, saving Glinda. Glinda wept her thanks on Galahad's shoulder.**

### Future Work

MINSTREL currently generates a few simple stories in the King Arthur domain. Up until now, most work has been done on the planning and episodic memory components of MINSTREL. The heuristics

for suspense have also been developed, but these parts have not yet been combined. There are a number of interesting topics left to address. Some of these are:

1. A large class of TAU's were recognized as arising out of planning failures. What other classifications of themes and thematic memory structures are there?
2. MINSTREL currently does nothing with multiple themes or plots. How can two themes be woven together into a single story?
3. MINSTREL ignores a large number of literary goals. Characterization, for instance, is recognized as being very important for good writing.

We believe that MINSTREL will provide a good environment within which to examine these more complex issues.

### Conclusions

MINSTREL is a program to model human story telling behavior. We have seen that the basis for story-telling is a cycle of writing-rewriting that is fueled by information derived from the theme of the story and from fortuitous reminders that occur during the process of fleshing out the story. This process involving episodic memory and reminding-driven construction is one of the basic processes behind human creativity.

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