

RECOGNIZING AND REPRESENTING SITUATIONAL IRONIES

**John F. Reeves
Michael G. Dyer**

**April 1986
CSD-860075**

Recognizing and Representing Situational Ironies

**John F. Reeves
Michael G. Dyer**

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

Abstract

Situational ironies, i.e. situations that involve a discrepancy or contradiction between expectation and outcome, are easily recognized by human understanders. To model this recognition, a cognitive representation for the concept of situational irony is presented based on the elements that make up the ironic situation and the relationships between these elements. A situational irony is represented as a basis belief, either on the part of a character or understander, an event that leads to the ironic contrast, the outcome of the event that points out the irony, and a scale or object on which the irony operates. These components indicate the features of situations that must be tracked for situational irony to be recognized. Specifications of the general situational irony representation are given, and the characteristics of these types of irony are examined. Irony is then compared to other cross-contextual memory structures and high level thematic concepts. Finally, the purpose of the recognition of situational irony, in relation to affect, interest, and learning, is discussed.

1. Introduction and Motivation

Human understanders recognize ironies when they occur in everyday situations. Furthermore, situational ironies are interesting to understanders because they expose a contrast between intention and realization, and provides an extra level of depth in understanding. What exactly are understanders attending to when they characterize situations as ironic, and what are the processes that they are using to determine it? Why does the "extra level of depth" make a situational irony interesting? A computer model that recognizes situational ironies answers these questions by specifying the characteristics of a situation that make it ironic, and the processes that are used to determine irony. Since human understanders recognize ironic situations as they occur, instead of searching for irony as a problem solution, recognition must be a side-effect of the normal understanding process. A computational model of ironies will tell us what people are tracking and thus how they understand situations in general.

* This work is supported in part by a grant from the Hughes AI Center.

As an example of a situational irony, consider the following story:

HEART ATTACK

Joe Smith, the expert on running and author of *Jogging for Health*, suffered a heart attack while out jogging early Thursday morning.

A human understander would recognize the ironic element of this story as the relation between Smith's goal of improving his health, his advocacy of running as a method of achieving that goal, and his state of damaged health after the heart attack as a result of running. In order to computationally recognize the irony in HEART ATTACK a computer program would have to make the following inferences about the story:

- 1) The runner is executing a plan to improve his health, specifically to improve the function of his cardiovascular system.
- 2) Writing a book on running titled *Jogging for Health* advocates jogging as a plan for achieving improved health.
- 3) The victim of a heart attack has damaged health, specifically damage to the cardiovascular system.
- 4) The relationship between the damage to the runner's health and the expectation that the plan would improve his health, and that he had advocated it to others as such, constitute irony.

Now consider another ironic story:

LOTTERY PLAYER

Anna May Kelly, of Pittsburgh, Pennsylvania, unfailingly played the same numbers 3-13-16-25-31-37 in the state lottery 145 times over a two year period. On Friday the 13th her number came up, but where was she? "I got busy cleaning and I lost all track of time, so I didn't get to buy my ticket." Of the lone mistake that cost her approximately \$1 million Kelly said "I keep thinking my ship came in, then sunk."

The irony in this story centers around the expectation that Kelly would continue to execute her relatively low cost lottery playing plan, and the first time that this plan was not executed, the independent (yet necessary) element of the plan occurred. As in HEART ATTACK this relationship is extracted from inferences about the story content, but the

ironic relationship in **LOTTERY PLAYER** is between the expected and realized timing of plan execution. Both of the stories are clearly characterizable as being ironic, but share few other features, either at the content or structural level.

The ironic content of the stories is very susceptible to changes in the elements of the story. For example, if the actor in **HEART ATTACK** is changed, as in the following variants:

HA-1: A jogger had a heart attack.

HA-2: A child had a heart attack.

HA-3: A businessman had a heart attack.

HA-4: A elderly woman had a heart attack.

the degree of irony decreases as the heart attack sufferer's inferred characteristics change. Variants HA-1 are still slightly ironic, HA-1 because of the jogger's intention to prevent the heart attack and HA-2 due to the expectation failure, but HA-3 and HA-4 would not be considered ironic at all. Only where there is some kind of *incongruity* between the expectations associated with the actor and the realized event is irony recognized. So what are the qualities of this incongruity? Since heart attacks are generally not considered desirable, why is the realized health damage in all of the variants not considered ironic?

In **LOTTERY PLAYER**, the expectation that leads to the irony is created by the story, rather than being inferred from a characterization of the actor. If the outcome were changed, as in:

LP-1: Anna May Kelly played the same number in the lottery
500 times and finally won.

or the repeated application of the plan were missing, as in:

LP-2: Anna May Kelly played the lottery once and lost.

the irony in the story would be lost. The irony in **LOTTERY PLAYER** has to do with the coincident occurrence of the lottery player's failure to play, predicated by the expectation that she would play because of her repeated execution, and the numbers being chosen, which is the unexpected event that would have caused her plan to succeed. This juxtaposition of events is only vaguely similar to the events of **HEART ATTACK**, yet both stories are characterizable as ironic. What are the common features, shared by both stories, that a general model of irony recognition could track?

The phenomenon discussed in this paper is irony as it occurs and is recognized in everyday situations, thus termed *situational irony*. This type of irony is situational because it is recognized in the context of the situation and not as a function of the author's way of writing or speaking. Other types of irony are *verbal irony*, the discrepancy

between the intended meaning of a speaker's utterance and the literal interpretation (as an extension of sarcasm), and *dramatic irony*, where the characters in a story are acting in accordance with a belief that is known by the audience to be false [Perrine 1956]. While these other two types of irony share features with situational irony, they arise as a result of language devices, rather than as a function of the situational analysis.

High level thematic concepts are used by readers (and writers) to organize and understand narratives in terms of the point of the narrative. Concepts in the same class as irony include tragedy, danger, and dilemma. From the writer's point of view, these concepts are tools for provoking interest and evoking emotional reactions. For the reader, recognition of these concepts provides an extra level of depth to a narrative. A computer program that understands the concept of irony serves as a starting point for the examination of these broader issues.

2. The Elements of Irony

In this section ironic situations are broken down into the constituent elements that are common to all ironies; (1) a *basis* for the irony: the intention, belief or expectation that is violated by the ironic situation, (2) an unexpected event (*u-event*): an event or sequence of events that lead to the ironic contrast, (3) the *outcome* of the u-event that contradicts the basis, and (4) the force of the irony (*i-force*): the scale that the contrast between the basis and outcome are measured on, or an object that has causal connectives to both the basis and outcome. Each of these elements can have a variety of instantiations, generally aspects of goals, plans, events and states [Schank and Abelson 1973], and these instantiations influence the qualities of the other elements in the irony. The semantic network for the irony in HEART ATTACK, showing these elements and their connections, is given in figure 1.

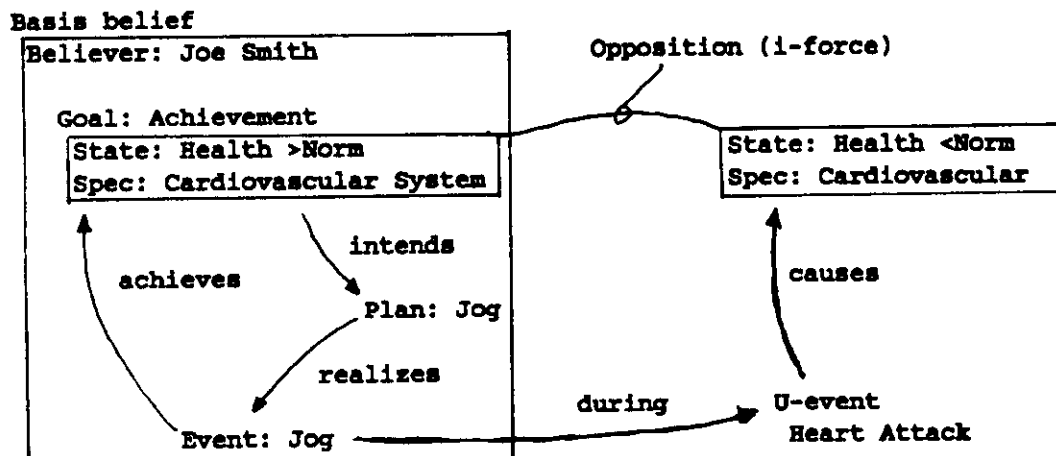


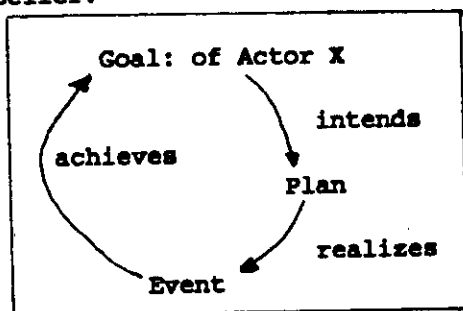
Figure 1. Representation of the Situational Irony in HEART ATTACK

The recognition of irony is achieved by tracking these elements as a situation is processed. For example, if the understander is a personal friend of the runner in HEART ATTACK, who knows many other things about him besides his belief that running will improve health, and is an M.D. who has a lot of knowledge about the causes and effects of heart attacks, this extra knowledge does not interfere with the immediate recognition of the irony present in the story. This method is a generalization of the frame-activation method of recognizing irony presented in [Norvig 1983]. A human understander does not work top-down, examining each event to see if it could be ironic, but rather irony is recognized as a natural consequence of how stories are understood. A process model that recognizes irony has to 1) keep track of character beliefs, 2) recognize unexpected events, and 3) match the consequences of the unexpected event with the belief.

2.1 The Basis of a Situational Irony

The basis of an irony is the belief that will be violated in the ironic situation. Beliefs are represented as networks of *intentional-links* [Dyer 1983] as shown in figure 2, attributed to the character who holds the belief, or the understander if the belief represents an expectation about the way the world works. In this representation, a goal state G intends a plan P, this plan is realized by plan-execution E, which achieves goal state G. More intensive work on belief systems has been done by Abelson [1973], Carbonell [1979], and Alvarado, Dyer and Flowers [1985], but this simpler notion will serve for the discussion here.

Belief:



Character/Understander believes that X's realization of the plan will achieve the Goal

Figure 2. Belief Network

For example, the basis in HEART ATTACK is the belief that running will lead to an improvement in health, and in LOTTERY PLAYER it is the belief that repeated plan application will result in goal achievement, e.g. the lottery jackpot. In both of these cases, the belief is held by the character in the ironic situation. Consider the following story:

TRAFFIC ACCIDENT

Parnelli Doe, the famous race driver and 5 time winner of the Indianapolis 500, was involved in a minor traffic accident yesterday.

Doe rear-ended another driver at the corner of Main and First streets who was stopped for the traffic light.

Here, the basis is the belief that race drivers should be skilled drivers, and thus is an expectation that the understander brings to the story.

A basis can be built during the situational understanding through two primary methods: active pursuit and advocacy. In active pursuit, a character demonstrates their belief that a plan will achieve a goal by repeatedly or continually executing that plan. For example, in **LOTTERY PLAYER**, we infer that the player believes she can win the lottery by repeatedly executing her lottery playing plan. A specification of active pursuit is plan execution, where the u-event occurs during or as a result of the plan for the active goal. In the following story:

MERCURY POISONING

Frank decided that the only food that was not harmful was tuna fish, so that would be all that he would eat. He died a year later of mercury poisoning.

Frank's execution of the eat-only-tuna plan to achieve good health, and his execution of that plan, form the basis for the irony.

If a character advocates a belief, then that belief can be used as the basis for an irony. As an example, the story:

REVEREND'S REVELATION

It was recently revealed that Reverend R, who has spoken out repeatedly against 'the sins of pornographers', owns a significant portion of Playboy Enterprises.

The Reverend's belief that producing pornography is a bad plan forms the basis for the irony. Another example of advocacy is given in this fragment:

MC-1: The Marlboro cowboy contracted lung cancer.

where the cowboy has advocated cigarette smoking through his role as an advertising icon.

The primary method for motivating an understander's belief as the basis for an irony is to use an exemplar as the character involved in the ironic situation. A character can have expectations about his behavior as an attribute of his role in a situation. These expectations are inferred by the reader, for instance Carbonell [1980] has shown how to dynamically compute character beliefs based on knowledge of their roles and personality

traits.

In **TRAFFIC ACCIDENT**, the basis of the irony is that race drivers are skilled at driving, so the driver should be an exemplar for driving skill. A similar basis exists in the following fragments:

BP-1: A bank president bounced a check.

TW-1: A tightrope walker slipped in the shower on a bar of soap.

In most cases, a combination of these techniques is used to make explicit the belief that forms the basis for the irony, and to underscore the strength of the belief. For example in **HEART ATTACK**, the runner's belief that jogging will improve the health of the cardiovascular system is shown through his execution of the jog-plan, his advocacy of jogging by the authorship of a book, and he is an exemplar of this belief because he is an "expert on running".

2.2 The U-Event of a Situational Irony

Situational ironies center around an unexpected, unintended, or uncontrollable event (u-event) in the situation. The u-event triggers recognition of the irony by realizing a quality or causing a state that is in *opposition* to the basis, thus the outcome of the irony is a result of the u-event.

The u-event can be unintended or uncontrollable by the character, or unexpected by the understander, in many cases overlapping. Examples of uncontrollable events are the heart attack in **HEART ATTACK** and the winning number choice in **LOTTERY PLAYER**. The heart attack could also be considered unintended, like the poisoning in **MERCURY POISONING**, if it is inferred that jogging caused the heart attack, rather than being understood as a random, low probability event.

Unintended events are unintended by the character with relation to the intention expressed in the basis. Unintended events can result from three sources: 1) non-execution of an act in an intended plan, as in the woman's not playing the lottery one day in **LOTTERY PLAYER**, 2) an unforeseen event or side-effect resulting from plan execution, as in contracting cancer in the Marlboro cowboy story (**MC-1**), and 3) an error in plan execution, as in the bank president's bounced check (**BP-1**).

An unexpected event is an expectation failure for the understander of the situation [Schank 1982], which motivates explanation processes. It is also important to note that not all expectation failures are ironic, for example:

HD-1: Harry drank a bottle of Mr. Clean.

HD-1 violates expectations with respect to what is suitable for eating, but does not contain the elements necessary to produce irony. For an expectation failure to serve as the

u-event in a situational irony, only the recognition that a character has violated expectations about how he will perform an intended plan is required. For example, to understand the irony in **TRAFFIC ACCIDENT**, the realization that the accident violates an expectation about the race driver's driving skill must be made, but an explanation for the accident is unnecessary. Also, expectations take precedence over character's unintended planning failures, for example in:

TAX RETURN

After years of doing his taxes honestly and never getting audited, Tom finally got sick of paying thousands of dollars to the I.R.S.. He cheated on his tax return to save \$50. On April 16th, he receive a call from an I.R.S. audit examiner.

If Tom had cheated for \$10,000, or not filed an income tax at all, the audit is expected, and therefore not ironic.

The u-event is normally a single event, but it can be a sequence of events, or the coincidental occurrence of events, in more complex cases. For example, in the story (paraphrased from [Dyer 1983]):

IRONIC DIVORCE

Richard and his lawyer, Paul, were having lunch to discuss the fact that Richard's wife wanted to divorce him, take the kids, and make him pay a lot of alimony, when Paul spilled a glass of coke on Richard. When Richard went home to change, he found his wife in bed with another man. Richard was ecstatic.

There are two u-events, the coke-spilling event, unintended by the lawyer Paul, and catching his wife committing adultery, also unexpected. When this sequence of events leads to Richard's winning of the divorce case, it is ironic that Paul's clumsiness, rather than his skill as a lawyer, was responsible.

2.3 Outcomes and Ironic Degree

The outcome of a situational irony is usually a unexpected goal success or failure as a result of the u-event, indicating a discrepancy between the basis and the realized situation. The ironic force (i-force) of the irony depends on the importance of the goal, the nature of the plan, and its degree of goal failure or success. Important goals are tracked by understanders because of personal interest [Schank 1979], and the common character's and understander's high-level goals.

One way of judging plans is by means of *planning metrics* [Dyer 1983], which measure of a planning characteristics. For example, the planning metric *skill* measures a planner's ability to successfully carry out a plan, and, when this metric is applied to the drive-plan, it alters the i-force in **TRAFFIC ACCIDENT**, where high driving skill was expected for the race car driver, and low driving skill was realized. In **IRONIC DIVORCE**, the planning metric is also *skill* this time in isolation; we expect the lawyer to win the divorce case with high *skill* (at lawyering), the case was won because of his low *skill* (at drinking a coke).

There are two ways of increasing the i-force of the irony: 1) the specificity of the i-force, and 2) increasing difference along a scale, if the i-force is a scaled value. If irony were only an opposite modality on an expected and realized quality the following variants of **HEART ATTACK** would all be considered equally ironic:

HA-5: A jogger stubbed his toe.

HA-6: A jogger pulled a muscle.

HA-7: A jogger was hit by a bus.

But when we have the expectation that jogging is done to specifically improve the health of the cardiovascular system, and it is that system that fails as a result of a heart attack, the irony is of greater degree. In **TAX RETURN**, the degree of the irony increases as the difference between what Mike owes the I.R.S. and what he attempted to save increases.

2.4 Types of Irony

Within this general framework for situational ironies, a taxonomy of more specific types of irony at different levels of abstraction can be created. The first of these types is called the *first-time* irony, where the first time a character doesn't perform in accordance with their basis belief, they suffer a goal failure. The first-time irony is illustrated in the following story:

GOING GOLFING

The first time Jerry didn't check the weather report before he went to play golf, it rained.

as well as **LOTTERY PLAYER** and **TAX RETURN**. The specifying characteristic for this irony is the coincident occurrence of an uncontrollable event for the character, the event that fails/succeeds the plan, with their first-time plan non-execution. The outcome is that the character has a failure on the basis goal, with the i-force being the difference between the realized state and the basis goal state on the scale that the goal is measured. The first-time irony is shown in figure 3, instantiated for the **LOTTERY PLAYER** story.

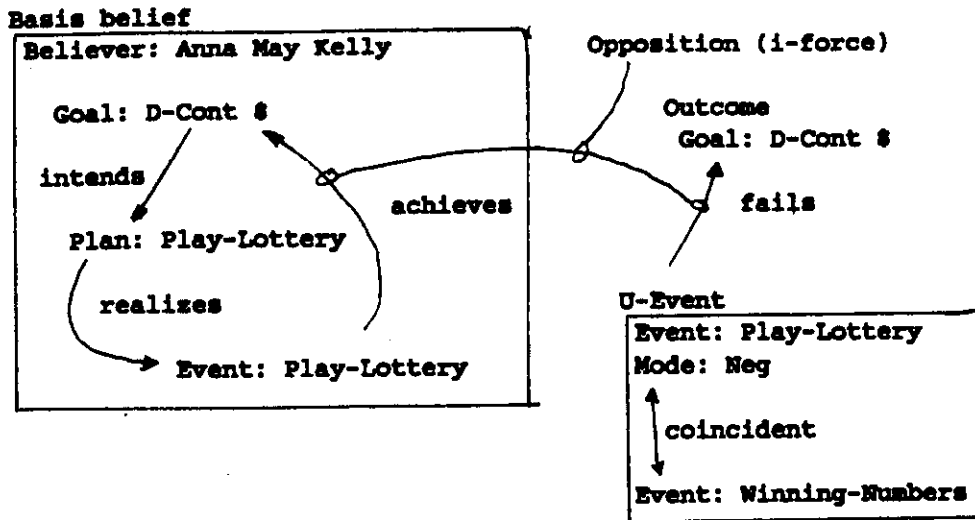


Figure 3. The First-Time Irony for the LOTTERY PLAYER Story

A second type of irony is the *just-desert* irony, where the basic idea is that a belief held by a character backfires on them, causing a goal failure. This irony is shown in the following story:

GAS PEDAL

Scott, an assembly-line manager at an auto plant, got a complaint from an employee about a possible design flaw in the accelerator of the new Pinto. Scott fired the employee. That night, as Scott was driving home, the gas pedal in his Pinto stuck, and he had a serious wreck.

Just-desert also characterizes the Marlboro cowboy story, and HEART ATTACK. In just-desert, the i-force is the element in the basis that corresponds to the outcome, i.e. the flawed accelerator in GAS PEDAL, cigarette smoking in the Marlboro Cowboy story.

A further specification of the just-desert irony is the *role-reversal* irony, where the i-force in the just-desert irony is a role in the basis that has goal failures because of the basis belief. Examples of this irony are in Richard Connell's short story *The Most Dangerous Game*, in which Rainsford, the celebrated hunter, is marooned on General Zaroff's private island, and becomes the hunted, and the film *The Watermelon Man*, in which a racist is turned black, and suffers the injustices he once forced on others. The role-reversal irony is shown in figure 4, instantiated for *The Most Dangerous Game*.

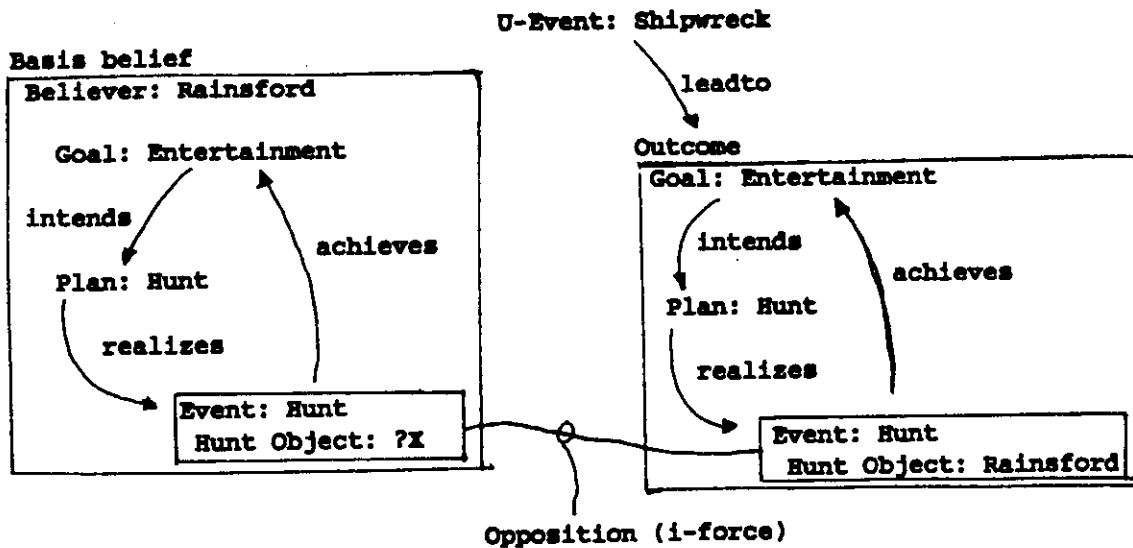


Figure 4. The Role-Reversal Irony for the *The Most Dangerous Game*

3. Irony and Other Cross-Contextual Memory Structures

In this section, the representation developed for situational irony is compared to other cross-contextual memory organizing structures. Cross-contextual memory structures were introduced by Schank [1982] to explain reminders across settings and index abstract information about situations. Clearly irony is in this category, but where does it fit into the memory abstraction hierarchy? The recognition of irony captures more than problem-solving behavior, but less than global character motivations. These other memory structures, and the comprehension problems that they serve, are related to irony, but fail to capture all that the concept entails.

3.1 Irony and Story Points

Story Points [Wilensky 1982] represent goal relationships (e.g. goal competition, competition removal) as problem and solution components. While irony can be seen as an internal story point (a point that is used to generate reader interest) situational ironies occur and sometimes encompass a problem solving representation of a situation. For example, HEART ATTACK and LOTTERY PLAYER present problems, unfulfilled goals for characters, that are left unresolved, but would not be characterized as incomplete stories because of the irony present. By the same token, IRONIC DIVORCE presents a problem, the goal competition between Richard and his wife, and its resolution, but this analysis fails to capture the irony of how the divorce case was won. So irony appears to be at a higher level of abstraction than story points.

3.2 Irony and Plot Units

Plot units [Lenert 1982] were motivated by summarization process to capture the plot structure of a narrative. Plot units label events by their affect state and link them into atomic units (e.g. perseverance, mixed blessing). These units are combined into complex plot units for multiple actors. Plot units give a concise, high-level representation of the affect and interaction in a narrative, but the level of abstraction is too high to capture the nuances of a situational irony, particularly the i-force measurement. For example, the representation of O. Henry's "The Gift of the Magi" in plot units reflects the symmetry of the story, but not its ironic content, because of the lack of a representation for expectations. In this case the ironic representation is more abstract, because it allows reconstruction of both the plot and ironic content of the story.

3.3 Irony and TAUs

Thematic Abstraction Units (TAUs) [Dyer 1983] capture information about errors in planning. Since many situational ironies revolve around planning errors which lead to unexpected events, TAU's capture the relationship between the u-event and outcome in ironies. For example, in LOTTERY PLAYER the planning error made by the woman when she forgot to buy her lottery ticket is explained by TAU-POST-HOC, that neglecting to perform an enablement condition will cause a plan to fail. This plan failure recognition is necessary to understand the outcome of the irony, but without the recognition of the first-time-irony basis preceding the plan failure, the TAU cannot capture the situational irony. Irony is therefore more abstract than TAUs, and dependent upon TAU recognition.

3.4 Irony, TOPs and Themes

Themes were introduced in [Schank and Abelson 1977] to organize high level goal orientation on the part of characters. Irony is not a theme in this sense because it organizes elements of situations, and does not provide their global motivations. Irony is related to Schank's Thematic Organization Packets (TOPs) [Schank 1982], as both involve organizing goal situations under constraints, but is not dealt with directly. Irony is more complex than an individual characterizing constraint on goal situations, and thus may be thought of as a special category of TOPs. For example, the TOP Mutual Goal; Outside Opposition captures the theme of *Romeo and Juliet*, but there is also an irony in Juliet's false report of death, intended to bring Romeo to her, causing his suicide.

4. Conclusions and Future Work

A cognitive model that recognizes ironic situations is being implemented as a part of the SOB-SISTER program [Reeves 1985], a computer model of human-interest news story generation. Irony is a type of ANGLE, a situation that is known to be interesting to news readers because of the emotional reaction it intends and the method by which reader affect is achieved. As a specification of the techniques for determining general interestingness presented in [Schank 1979], an ANGLE is a known interesting concept,

which, when recognized, provides an organizing memory structure for the situation where it appears. The recognition of an ironic situation by a journalist (as modeled by SOB-SISTER) serves as a starting point for 1) the elaboration of the irony, 2) an organization for the character affects in the situation, 3) the creation of reader empathy, and 3) a method of indexing generational plans, or ways of telling the story, to maximize reader affect. In this way, the recognition of irony provides link between understanding and generation.

4.1 Irony, Affect, and Other High Level Memory Structures

What is the relation of irony to affect? In [Dyer 1983], character affect is predicated on the failure/success of the character's goals. If the reader has a positive relationship with the character, then the reader should have a similar emotional reaction. However, the reader reaction is different if the realized goal situation is the outcome of a situational irony. For example, the emotional response of a reader to HEART ATTACK is much different than the reaction to HA-2, where a child is the heart attack victim. In IRONIC DIVORCE, the reader is happy that Richard won the divorce case, but is also bemused because of the method by which it was won. If the emotion-evoking component of irony can be identified, methods of relating ironies should be available to invoke this emotion in the reader.

There is also a close relationship between the just-desert irony and the concept of "fate", predicated on the value of the planning metric legitimacy in the basis plan. For example, in TAX RETURN it is only fair that Tom's decision to cheat on his taxes should coincide with an I.R.S. audit. Personal interest plays a role here as well, if the understander has a low opinion of jogging, the heart attack in HEART ATTACK can be interpreted as "retribution".

4.2 The Purpose of Irony

The recognition of situational irony points out a problem with the way the world is understood. The belief of a character, or expectation of the understander has been shown to be in error in a situational irony. If memory is failure driven [Schank 1982], why aren't ironies indexed as exceptions and built into expectations? The point here is that ironies *do* support failure-driven memory, as they provide an evaluation process for multiply indexed expectations in memory. For example, in TRAFFIC ACCIDENT the expectation that "race drivers are skilled drivers" is violated, but this expectation failure is explained by the reasoning that race drivers are human, and humans have traffic accidents. The first-time irony points out the value of continuing to perform low-cost prevention plans, but for LOTTERY PLAYER, the irony should point out the futility of playing the lottery. Thus ironies support learning, correcting expectations after the situational irony is recognized.

REFERENCES

- Abelson, R.P. (1973) *The Structure of Belief Systems*. In Schank, R.C. and Colby, K.M. (Eds.), *Computer Models of Thought and Language*. Freeman, San Francisco CA.
- Alvarado, S.J., Dyer, M.G., and Flowers, M. (1985) *Understanding Editorials: The Process of Reasoning Comprehension* Research Note 9, Artificial Intelligence Laboratory, Department of Computer Science, University of California, Los Angeles CA.
- Carbonell, J.G. (1979) *Subjective Understanding: Computer Models of Belief Systems* Technical Report #150 (Ph.D. Dissertation), Department of Computer Science, Yale University, New Haven CT.
- Carbonell, J.G. (1980) Towards a Process Model of Human Personality Traits *Artificial Intelligence*, volume 15, pp. 49-74.
- Dyer, M.G. (1983) *In-Depth Understanding: A Computer Model of Integrated Processing for Narrative Comprehension*. MIT Press, Cambridge MA.
- Lehnert, W.G. (1982) Plot Units: A Narrative Summarization Strategy. In Lehnert, W. and Ringle, M. (Eds.), *Strategies for Natural Language Processing*, LEA, Hillsdale NJ, pp. 375-412.
- Norvig, P. (1983) "Frame Activation Inferences in a Story Understanding Program", in *Proceedings of the Eighth International Joint Conference on Artificial Intelligence*, Karlsruhe, West Germany. pp. 624-626.
- Perrine, L. (1956) *Literature: Structure, Sound, and Sense*, Harcourt Brace Jovanovich, Inc. New York NY.
- Reeves, J.F. (1985) *Writing Human-Interest News Stories*, Research Note 4, Artificial Intelligence Laboratory, Department of Computer Science, University of California, Los Angeles CA.
- Schank, R.C. and Abelson R.P. (1977) *Scripts Plans Goals and Understanding*, LEA, Hillsdale NJ.

- Schank, R.C. (1979) Interestingness: Controlling Inferences. *Artificial Intelligence*, volume 12, pp. 273-297.
- Schank, R.C. (1982) *Dynamic Memory: A Theory of Learning in Computers and People*. Cambridge University Press, Cambridge MA.
- Wilensky, R. (1982) Points: A Theory of the Structure of Stories in Memory. In Lehnert, W. and Ringle, M. (Eds.), *Strategies for Natural Language Processing*, LEA, Hillsdale NJ, pp. 345-374.

