Culturally Based Story Understanding

by

Hiba Awad

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Author .....
Department of Electrical Engineering and Computer Science
May 23, 2013

Certified by .....
Prof. Patrick H. Winston
Ford Professor of Artificial Intelligence and Computer Science
Thesis Supervisor

Accepted by .....
Prof. Dennis M. Freeman
Chairman, Masters of Engineering Thesis Committee

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Abstract

Culture has a strong influence on how stories are understood. Accordingly, a full account of human intelligence must include an account of cultural influences on story understanding. The research reported takes a step toward accounting for cultural differences computationally by extending the Genesis story understanding system so as to enable Genesis to model Chinese and American differences in human story understanding and question answering. I focused on two murder stories discussed in a classic study by Morris and Peng, identified extensions to Genesis needed to model Chinese and American understanding and question answering biases, and developed rules and concepts not already in the Genesis libraries. I determined that one extension, a question-induced story augmentation capability, was needed to handle questions such as "Did Lu kill Shan because America is individualistic?" Another extension, the introduction of abduction rules, was needed to handle common sense background rules such as "If person X kills person Y, then person X must be insane." I also conceived and implemented computational metrics to measure story coherence. I survey the field of cultural psychology and suggest further steps toward an account of culturally variant cognition.

Thesis Supervisor: Prof. Patrick H. Winston
Title: Ford Professor of Artificial Intelligence and Computer Science

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Chapter 1

Introduction

1.1 Vision

Story telling and understanding are integral to human intelligence. Stories pervade the human experience and for many centuries humans have used them to think and learn about the world. Patrick Henry Winston (Winston, 2011) has posited the role of stories in human intelligence in the Strong Story Hypothesis: "The mechanisms that enable humans to tell, understand, and recombine stories separate human intelligence from that of other primate." So to build intelligent machines, we must understand and model human story understanding. The Genesis System is a research platform that aspires to model human story understanding (Winston, 2012a,b).

Culture is a "suitcase word", a term first used by Marvin Minsky, to refer to words that encompass a wide jumble of different ideas. For the purposes of this work, culture is best considered as a collective phenomena composed of both socially shared meanings such as beliefs, values, ideas, and behavior patterns, such as customs and conventions. Geerd Hofstede puts it nicely: "Culture is the collective programming of the mind which distinguishes the members of one category of people from another." (Hofstede, 1980) Another pertaining definition of culture is that of anthropologist Adamson Hoebel: "[culture is] an integrated system of learned behavior patterns which are characteristic of the members of a society and which are not a result of biological inheritance." (Hoebel, 1966) Culture patterns the human experience and

strongly impacts cognition. Much research in the field of cognitive psychology has discovered specific differences between Eastern and Western cultures in several basic cognitive processes such as attention and perception. (Markus and Kitayama, 1991)

One way to better understand culture in general, and its influence on story understanding in particular, is to model culturally influenced story understanding in the Genesis System, taking it to a level where it begins to reflect humanlike interpretations of stories that show cultural biases. My research takes a step towards this goal by investigating, demonstrating, and describing how Genesis can reflect culturally sensitive story understanding consistent with particular research findings from cognitive science.

1.2 Foundation in Cognitive Science

Violent murders are strikingly senseless. Yet despite their senselessness or perhaps because of it, we invariably obsess over understanding the motives and reasons causing this seemingly incomprehensible aberrant behavior. As I was writing this thesis, Boston fell victim to a shocking episode of senseless violence. Everyone struggled to make sense of the events and reconstruct a coherent narrative. The question "Why?" hung heavily on everyone's mind. Were the Boston bombers brainwashed by Jihadists ideology, were they disillusioned immigrants, hateful for failing to assimilate, or were they simply mentally insane murderers?

1.2.1 Culture and Cause by Morris and Peng (1994)

The cognitive science paper that inspired this research is "Culture and Cause" (Morris and Peng, 1994). In one of the studies in the paper, the researchers set out to understand how subjects from Eastern and Western cultures explain similar cases of senseless violence. The paper presented three studies, all of which found that Chinese tend to attribute the cause of social behavior to situational factors whereas Americans attribute the same behavior to the inherent disposition of the murderer. In the first study presented in the paper, differences in causal attribution of behavior,

were examined for a physical event as well a nonhuman event in a social context. The physical event involved an object moving across a field, and the social event involved an individual fish swimming in front of a group of wish. Morris and Peng found that causal perceptions of social events but not physical events differed between American and Chinese students. American subjects attributed the fish behavior to internal factors such as an individual leading a group, while Chinese subjects would attribute it to an external situational force such as pressure from the group. In the second study researchers analyzed stories of the same murder incident from English and Chinese newspapers and found that English language newspapers explained the crime as a result of the murderer's disposition more than their counterpart Chinese newspaper. In return Chinese language newspapers explained the crime as a result of situational factors more than their English counterpart. In the third study presented by this paper, American and Chinese graduate students were surveyed about their causal attributions for two murder stories. Researchers presented subjects with two reports of recent murders, one committed by a Chinese student in Iowa, named Lu, and another by an American post office worker in Michigan, named McIlvane. The reports were based on descriptions given in both English and Chinese language media and were of equal length. The reports also contained equivalent amounts of information about the murderer's personal dispositions, situational pressures, and actions, in order to balance the information about each murder. The study presented subjects with a series of parallel sets of causes for each murder, drawn from media reports. Half of the causes were dispositional and the other half were situational. The sets of causes were presented in random order and subjects were instructed to weight the importance of each factor from a scale of 1 to 7 where 1 is not a cause at all, and 7 is a very strong cause. The results of the experiment are summarized in Figure 1-1 extracted from the Morris-Peng paper. I attempted to replicate the results computationally within the Genesis system, as an exploratory analysis of culturally based story understanding, and to shed light onto the knowledge and knowledge representations required to capture and model some effects of culture on cognition

Lu murder		McIlvane murder	
Personal dispositions		Personal dispositions	
Lu was mentally imbalanced because his life consisted only of work, without other activities which relieve stress.	A 4.5**** C 1.8	McIlvane was mentally imbalanced because his life consisted only of violent activities such as hunting and martial arts.	A 2.4 C 2.5
Lu drove himself crazy by putting too much pressure on himself.	A 4.6**** C 2.4	McIlvane drove himself crazy by worrying too much about getting his job back.	A 2.9 C 3.1
Lu had chronic personality problems.	A 4.2* C 2.4	McIlvane had chronic personality problems.	A 4.3 C 3.7
Lu was a psychological time bomb—someone with a hidden mental illness that suddenly explodes.	A 3.1* C 1.8	McIlvane was a psychological time bomb—someone with a hidden mental illness that suddenly explodes.	A 2.8 C 2.8
If Lu couldn't win, he didn't care about anything else.	A 4.1* C 2.6	If McIlvane couldn't get his way, he didn't care about anything else.	A 3.2 C 4.2
Lu was obsessed with the award and lost his grip on reality.	A 4.5 C 3.5	McIlvane was obsessed with getting his job back and lost his grip on reality.	A 4.1 C 3.8
Situational factors		Situational factors	
America's extremely individualistic, selfish values corrupt foreign students.	A 1.2** C 2.5	This was an extreme example of behavior that follows from America's individualistic, selfish values.	A 1.8** C 3.5
American movies and television glorify violent revenge tactics.	A 1.5*** C 3.6	American movies and television glorify violent revenge tactics.	A 2.7* C 3.8
The advisor failed in his duties to help Gang Lu and respond to his increasing frustration.	A 2.4*** C 4.6	The supervisor and labor relations specialist failed in their duties to respect McIlvane and respond to his increasing frustration.	A 4.1 C 4.4
The ruthless and brutal behavior of Chinese Communists set an example for him.	A 1.5 C 1.3	The daily violence of the Detroit area set an example for him.	A 2.4*** C 4.0
The chaotic times of the Cultural Revolution in China (persecution of intellectuals, etc.) created a generation lacking traditional morals and respect for others.	A 1.8 C 2.2	The chaotic times of the 1960s in America (hippie culture, drugs, sexual freedom) broke down families and traditions, creating a generation without self-discipline and respect.	A 1.8*** C 3.8
The recession has hurt the job market, which places stress on people seeking a new job.	A 2.4* C 3.5	The recession has hurt the job market, which places stress on people seeking a new job.	A 3.6 C 3.6

Note. A = American; C = Chinese. Shown are the six items of each kind with greatest cultural differences in ratings of casual importance. Ratings can be interpreted with scale labels: 1 = *not a cause at all*, 4 = *a major cause*, 7 = *most important cause*.
* $p < .05$. ** $p < .01$. *** $p < .005$. **** $p < .001$.

Figure 1-1: Results from Culture and Cause (Morris and Peng, 1994).

1.3 Overview

I succeeded in modeling aspects of the Morris-Peng results within the Genesis framework. In particular, I equipped Genesis with the knowledge and additional mechanisms needed to interpret and to answer questions about the two parallel murder stories from Eastern and Western perspectives. In Chapter 2, I discuss the details of various experiments and the Genesis augmenting mechanisms. I follow with the detailed results and analysis of the experiment in Chapter 3. In Chapter 4, I review some related work mostly from the cognitive science literature, and in Chapter 5, I follow with a discussion on further augmentations based on the related work. Finally in Chapter 6, I conclude by articulating the contributions of my research.

Chapter 2

Genesis and Genesis Enhancements

2.1 Genesis

2.1.1 Overview

The Genesis Story Processing system is an AI research platform developed by Patrick H Winston and his students based on the Strong Story Hypothesis. Genesis takes as an input a story written in plaintext English, translates it to Genesis's internal representations, and then preforms bottom-up narrative understanding of simple common sense information, and top down narrative interpretation of higher level concepts. The system is motivated by the belief that intelligent story understanding systems should mirror natural human story understanding. Hence Genesis is based on computational human-like reasoning methods instead of statistical analysis. The system has visual representations to display the processed story, mainly the elaboration graph which is a causally connected graph of each of the elements in the story. Genesis also answers questions about its own operation, thus modeling humans introspection. Inspired by the Propagator Model (Sussman and Radul, 2009), Genesis's design is based on the wire-box design paradigm. In the wire-box design, the Genesis system is composed of many independent modules, represented as boxes which perform various tasks, such as parsing, finding concept patterns, finding relations between events, or visualizing events. The modules are connected through "wires" and interact with

each other via signals sent across these wires. Signals consist of messages, such as a sequence of events. A wire-box design allows the implementation of modules to be done in parallel. In addition, each module can output a signal without knowing the destination, and can also process a signal as an input, without knowing the source or implementation of this signal. Thus, the wire-box design promotes a high degree of modularity and abstraction.

2.1.2 Language Processing

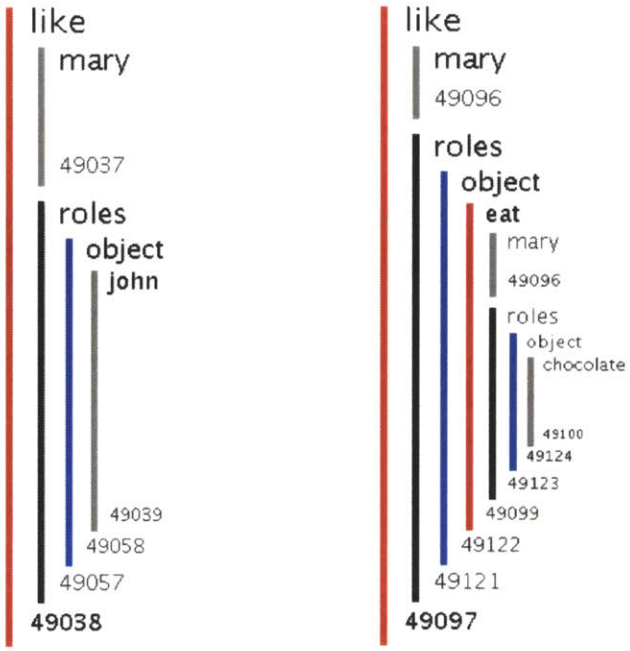
All the stories in Genesis are stored as English text, so the story texts can be read and interpreted by both human readers and Genesis in their original form. In order to parse the language of the story, the Genesis story understanding framework uses the START language developed by Boris Katz and his students (Katz, 1997). The START parser translates English sentences into semantic nets. A semantic nets models the correlation between multiple objects to gain a better understanding of the objects and their relations. The semantic net can identify and track objects across sentences, which allows Genesis to keep track of characters and objects as stories evolve.

2.1.3 Representations

Genesis captures information in both physical and abstract worlds with a variety of knowledge representations for concepts such as class, transition, trajectory, cause, goal, belief, mood, possession, social relations, time, and role-frame. On the implementation level, all these representations are built on a substrate of four foundational Java classes: entities, functions, relations, and sequences.

2.1.4 Events and Elaboration Graphs

Story text files are interpreted by Genesis into a series of events. An event consists of an action relating concepts together, but the action can be complex. For example in Figure 2-1a, the verb "like" relates Mary to John, a subject and a direct object. The verb is depicted spanning both of its arguments, the subject and object. In



(a) Event representing the sentence "Mary likes John" in Genesis.

(b) Event representing the sentence "Mary likes to eat chocolate" in Genesis.

Figure 2-1: Examples of events in Genesis. The red bars represent relations, the blue bars represent derivatives, the gray bars represent things, and the black bar represents a sequence. The numbers next to object names are unique identifiers for those specific objects for use by Genesis.

this case, the concepts are both threads, the simplest representation, but the action "like" could handle more complicated concepts, such as eating chocolate, as portrayed in Figure 2-1b. Event models can relate concepts of varying degree of complexity together, resulting in a possibly complicated arrangement of events and relations to model an overall concept.

Genesis visually presents the story it reads in an elaboration graph. An elaboration graph consists of boxes, where each box represents a story element, an encapsulation of a relation or event in the story, along with connections that show how the relations and events are tied together casually. Figure 2-2 below displays the elaboration graph for a snippet of Romeo and Juliet. The story text that rendered the elaboration graph is the following:

```
Romeo loves Juliet.
Romeo poisoned himself because he thought Juliet was dead and Romeo loves Juliet.
Juliet killed herself with a dagger because Romeo poisoned himself.
```

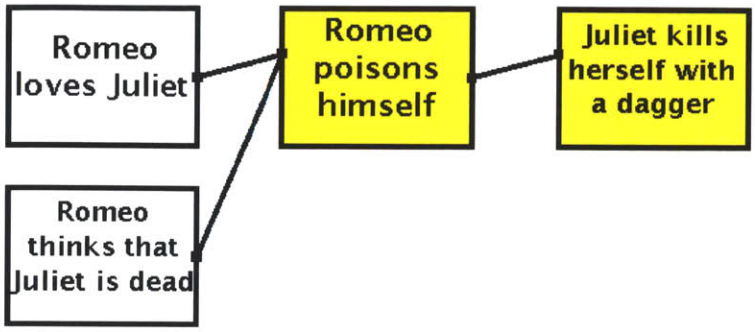


Figure 2-2: Example of an elaboration graph from *Romeo and Juliet.*

When humans read stories they make causal inferences about events in the story without needing them to be explicitly stated. For example, if the story states Juliet kills herself, then humans will automatically infer that Juliet is now dead. Genesis makes similar inferences, connecting events using commonsense rules, provided outside of the story.

2.1.5 Commonsense Rules

Commonsense rules are applied to the story to causally connect explicit knowledge in the story with inferred knowledge. Commonsense rules are articulated separately for the story and can be applied to any story. Genesis employs two types of rules: prediction rules and explanation rules. Prediction rules predict consequents as in "If X kills Y then Y becomes dead." Once these rules are provided for a story, if at anytime during the story analysis process Genesis discovers a story element matching an antecedent, the rule fires, and the consequent is automatically inserted to the story representation with a causal link from the antecedent to the consequent. The highlighted yellow boxes in the elaboration graphs are the inferred events from prediction rules.

Explanation rules infer connections when an action would otherwise have no known cause. Explanation rules have the structure of "If..., then... may..." The *may* keyword is crucial, implying that when the antecedent "if... " appears in the story, the consequent "then..." may potentially follow. Thus if the consequent itself appears in the story, it is then explained as a consequence of the antecedent as long as no other explanation is available. Another interesting behavior of the explanation rule emerges when it is declared with a negated antecedent, for example, "If X is not sane, then X may kill Y." In this case, when the consequent appears in the story, the rule will actually trigger and the antecedent gets inserted in the story with a causal link to the consequent, provided that the unnegated antecedent does not appear in the story. So, for example, if X kills Y, and nowhere in the story does it declare that X is sane, then one can assume that X is indeed not sane, and that is why X kills Y.

By way of illustration, consider the following:

```
Start commonsense knowledge .
X is a person.
Y is a person.
If X stabs Y, then X harms Y.
If X stabs Y, then Y may become dead.
If X is not sane, then X may stab Y.

Start story titled "Brutus and Ceasar".
Caesar is a person.
Brutus is a person.
Brutus stabs Caesar.
Caesar becomes dead.
The end.
```

The resulting elaboration graph is shown in Figure 2-3. Note the different behavior of the three type of rules. The first prediction rule causes Genesis to insert the event "Brutus harms Ceasar" in the story, highlighted in the elaboration graph to denote

that it is an inferred event. The inferred element is causally linked to its antecedent "Brutus stabs Ceasar." The events "Brutus stabs Caesar" and "Caesar becomes dead" are also linked into the elaboration graph through explanation rules, as are "Brutus stabs Caesar" and "Brutus isn't sane."

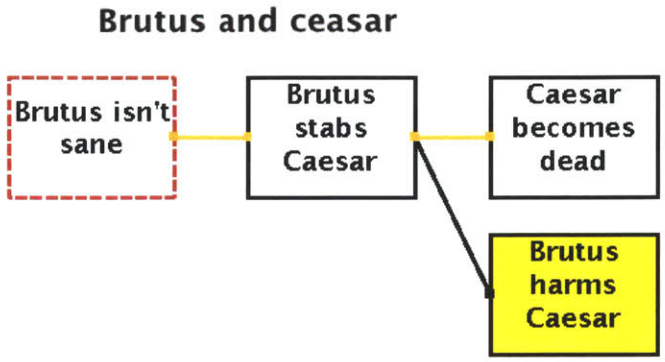


Figure 2-3: Elaboration graph for *Brutus and Ceasar* story with all three commonsense rules.

2.1.6 Concept Patterns

As the name implies, commonsense rules allow a very basic instinctive story interpretation. However humans engage in deeper reflective thinking when they read stories. They identify themes such as revenge or victory, composed of several events linked to each other. Similarly Genesis also discovers higher level concepts in a top-down interpretation of a narrative, based on user-defined concept patterns. Concept patterns are narrative structures that specify roles and actions, such as villainy, revenge or reward. They are composed of a group of connected events where each event is causally connected to at least one other event, though a "leads to" relation. "Leads to" relations enables Genesis to recognize concepts even if many additional elements are present between the antecedent and consequent in the leads to relation. The concept pattern can be of any size and can have any structure as long as all the events are connected and there are no loops. Like commonsense rules, a concept pattern is expressed to the Genesis system in plain English. Revenge, for example, is a harm event leading

to a second harm event where the actors are reversed. Revenge can thus be defined as following: X and Y are entities. X's harming Y leads to Y's harming X. Genesis can thus discover one or more instantiations of these concept patterns in a given story. As an example consider the elaboration graph in Figure 2-4 for Shakespeare's Julius Ceasar, in which Genesis discovers multiple concept patterns. The concept patterns are displayed as clickable buttons below the graph, which show the instantiations of the concept pattern in the elaboration graph when clicked. While simple stories may contain little to no instantiations of concept patterns, more complex stories may contain numerous examples.

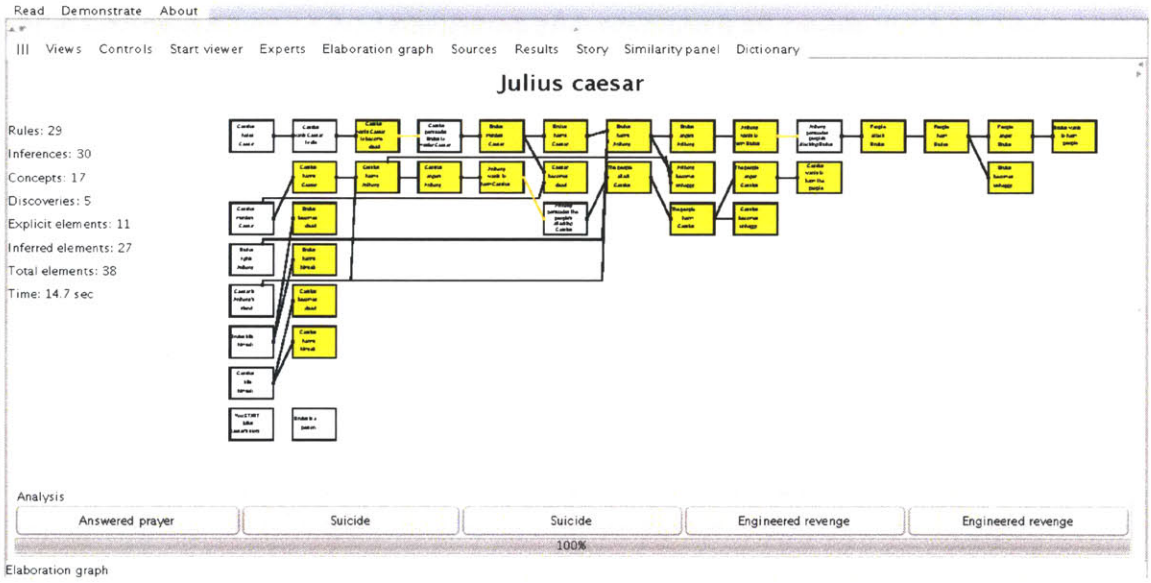


Figure 2-4: Elaboration graph for *Julius Ceasar* story.

2.1.7 Mental Models

A mental model is a hypothetical internal representation of the external world or reality that humans construct in order to think about the world. Marvin Minsky Minsky (1988) describes a mental model in a person's head, nominally Mary, "as all the structures in Mary's head that Mary's agencies can use to answer questions about things in the world." It seems obvious or perhaps just useful that such an internal

conceptualization of the external world should exist. Hence much of people's mental activity, their views of the world, of themselves, or of the tasks they are to perform should depend on these internal representations that we label as our mental model.

2.1.8 Traits

Humans constantly engage in portraying personalities in the form of traits especially in story telling. We constantly use statements such as "John is aggressive." "Mary is timid." Despite how difficult it is to grasp the mechanisms of the mind, personalities are somehow much easier to portray and label. Indeed traits are crucial to story telling and understanding in particular. As a result, the Genesis system includes a capability that allows traits to be assigned to characters in stories by encapsulating trait characteristics in mental models. With Genesis's current trait capability, a trait definition can include a particular set of rules only applicable to characters possessing the trait. In addition it can include concept patterns, also associated with characters possessing those trait. For example a definition for the greedy trait can include the following:

```
Start commonsense knowledge.
X is a person.
Y is a person.
Z is a person.
aa is an action.
if X is greedy and X is the wife of Y, then X may persuade Y to want to become king.
Start reflective knowledge.
Start description of "Tragic greed".
X is Y's relation.
X's being greedy leads to Z's harming Y.
The end.
```

As a result of this trait definition, if Lady Macbeth is declared greedy in the Macbeth story, Genesis will infer that Lady Macbeth may persuade Macbeth to want to become king. In addition Genesis now discovers an instance of "tragic greed" in the Macbeth story.

2.2 Murder Stories

In the research paper "Culture and Cause" (Morris and Peng, 1994), the two murder stories resulted in culturally variant causal analysis of the murder causes, indicating culturally variant underlying interpretations of the story. So these stories can serve as an anvil on which to hammer out ideas on how culture can be modeled in a computational story understanding system such as Genesis.

To do my research, I needed the original texts that were used in the Morris-Peng experiment, which were courteously supplied by the authors via personal communication. Both stories are included in their original form in Appendix A.

The START language parser used by Genesis could not handle the stories in their original form because the sentence structures and phrases are too complex. So I simplified as necessary, aiming to preserve the original content and meanings in the story and not oversimplify. The simplified stories used in this experiment are also included in Appendix A.

2.3 Causal Attribution Module

The computational system to reproduce Morris-Peng results has three variable components: the commonsense rules to connect the story elements, concept patterns to detect higher level meanings in the story, and the causal attribution module that takes as an input a causal factor and returns a rating for its causal importance. The causal attribution module can use the elaboration graph and concept patterns to evaluate the causal importance of each factor. Figure 2-5 below outlines the basic structure of the computational system.

I decided to keep the causal judgment module uniform across cultures and as simple as possible. This decision is justified as being cognitively plausible because the cultural variation in causal attribution discovered in cognitive science research can be a result of culturally dependent beliefs, rules, and concepts, not necessarily a difference in the machinery that manipulates these beliefs, rules, and concepts.

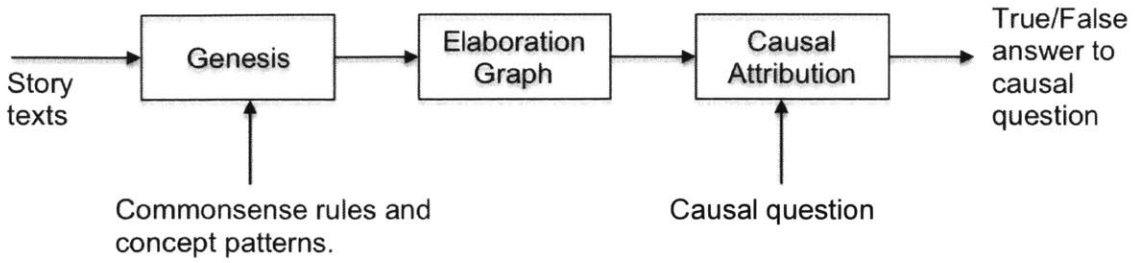


Figure 2-5: Experimental Setup.

Regarding the implementation of the causal attribution module, I developed a simple hypothetical module. Because the elaboration graph already connects the events that are casually related to each other, it seems that evaluating the causal importance simply depends on whether the two factors are connected together or not.

In the cognitive science experiment, the result of the casual analysis task was a rating from 1 to 7. However, it's difficult to hypothesize a computational module that outputs a result so finely grained on a scale from 1 to 7. Instead I proposed a simplified binary result, where a rating of above 4 translates to a possible cause, while anything below 4 is not. In addition I proposed that causal factors which differ statistically significantly will also be analyzed differently in the computation even if they were rated as below 4, simply to emphasize the variation in cultural thinking. For example, although the first situational factor in the experiment had an analysis of below 4 by both cultural groups, it will have a positive result for Chinese and negative result for Americans because it was statistically higher for Chinese, and I intended to demonstrate this significant variation.

I proposed a simple implementation of the module such that if the two factors are connected casually in the elaboration graph, not necessarily directly, but perhaps through a chain of plot units, then the output of the causal analysis is true, and otherwise false. I considered using the distance between the two factors to evaluate causal importance, but I did not find that greater complexity useful.

I generalized this attribution module to take an input in the form of a question "Did X because Y?", where "X" and "Y" are both events. The module then returns

Lu murder		McIlvane murder	
Lu is insane	American: true Chinese: false	McIlvane is insane	American: false Chinese: false
America is individualistic	American: false Chinese: true	America is individualistic	American: false Chinese: true
America's media glorifies violence	American: false Chinese: true	America's media glorifies violence	American: false Chinese: true
Lu's advisor fails to help Lu	American: false Chinese: true	McIlvane's supervisor fails to help McIlvane	American: true Chinese: true

Table 2.1: Causal judgement result for factors from experiment simplified for Genesis.

true or false if X and and Y are causally related.

In another substantial step, I simplified the questions used in my modeling because I had to get them through the Genesis language understanding apparatus. Also, some of the questions involved were semantically quite similar, so I pruned the question list to address three situational factors and one dispositional factor. Table 2.1 outlines the causal factors selected, and the simplified expected outcome of each causal factor in this simplified system.

As for the concept patterns, it seemed at first that they didn't fit anywhere in such an implementation. However I decided to add a clause to the causal attribution module that would return a positive result if it discovers that the causal factor was an element of a concept pattern instantiated in the story. It seems cognitively plausible that if a given factor contributes to a theme or concept pattern discovered in the story, then that factor would have causal importance.

2.3.1 Explanation Attribution Module

An interesting capability added to Genesis in the course of this research was the ability to answer question such as "Why did X?" where "X" is an event in the story, with a subject and a possible object such as "Macbeth kill Duncan" or "Lady Macbeth become happy." Genesis can then answer this question on three different levels: the personality level, commonsense level, and the concept pattern level. The personality level identifies if a trait associated with the character caused the event, based on the trait definition. The commonsense level identifies the commonsense rules that fired connecting to the event in question. The concept pattern level identifies a higher level

concept associated with the event. Figure 2-6 shows the results of asking the system: "Why did Macbeth murder Duncan?" for the Macbeth murder story in which the characters are assigned particular traits.

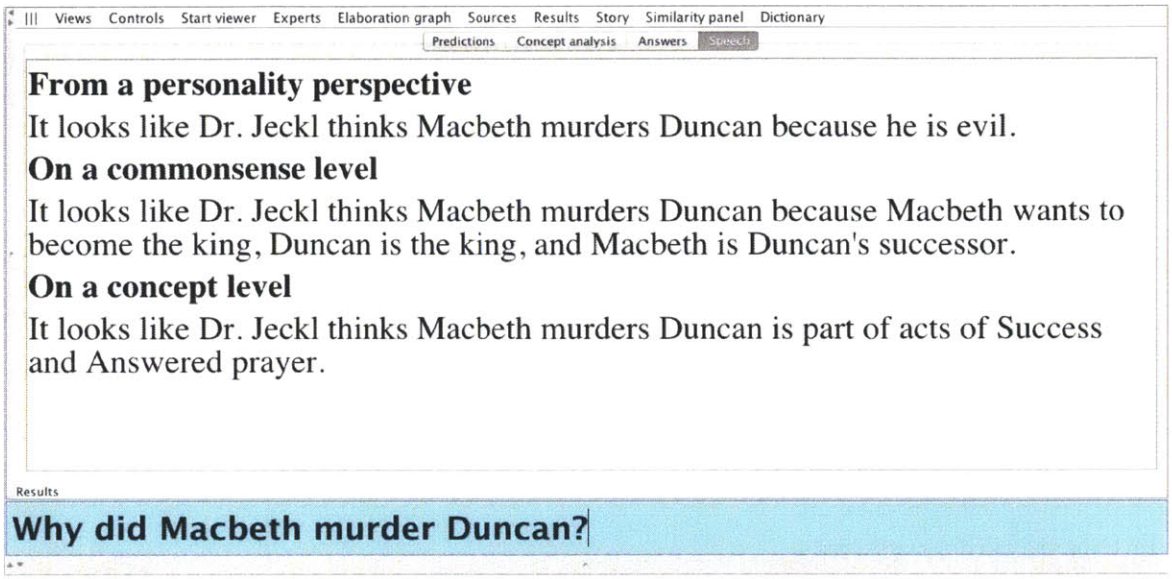


Figure 2-6: Genesis can answer question of why on three different levels.

You can see that because Macbeth is declared as "evil" in the story, he is then capable of murder. So in effect, the personality level of reasoning represents the depositional reasoning associated with Western cultures, whereas the commonsense level represented a more situational reasoning, associated with Eastern culture. The concept level represents a higher level of reasoning, for which Genesis associated the event with a larger abstract concept.

2.4 Enhancements

In order to raise Genesis to a level where it can model the Morris-Peng experiment, as simplified, three general enhancements had to be made to the Genesis framework. The first was the addition of commonsense rules and concept patterns to handle the story. The second enhancement was a representation of prior beliefs in the reader's mental model that are not explicitly declared in the story, and a mechanism allowing

Genesis to inject these beliefs in the story when a question is asked about them. The third is an additional type of rule, labeled hereafter as an abduction rule, allowing a form of backward causal inference.

2.4.1 Commonsense Rules and Concept Patterns

A substantial step was the development of commonsense rules and concept patterns to model human handling of the selected stories. The objective was to encode one possible set of commonsense rules specific for each culture, and one general set, which enables the interpretation of both stories. My goals were plausibility and generality; I tried not to develop rules and concept patterns that would apply only to the particular stories at the center of my work. Instead, I sought to develop rules and concepts that would produce elaboration graphs in which Morris-Peng like results emerge without being tightly tied to the particular stories involved.

2.4.2 Prior Beliefs

Several of the factors presented to the subjects for causal judgement in the study were not actually present in the original story text, thus raising an interesting challenge. That is, these factors are hypothetical factors that could have played a role in the murder, such as "America's individualistic values corrupt foreign students", or "American media glorifies violence." In that case, I proposed and implemented a computational method of modeling prior beliefs and reflective thinking on hypothetical scenarios within Genesis. Genesis can now represent "prior beliefs" by associating a personality trait with the reader, if the story text declares the reader's personality such as, "I am Asian" for example. In the Asian personality file, Genesis allows you to declare certain beliefs such as "I believe that America is individualistic." or "I believe that American media glorifies violence." These beliefs can then be injected into the story when probed with a question such as "Did Lu become violent because American media glorifies violence?" Upon being asked this question, Genesis searches for the event "American media glorifies violence in the story." When it does not find

that event in the story, Genesis then loads the trait mental model associated with the reader and searches for beliefs matching the statement that "American media glorifies violence." If it finds a matching belief, it then injects that belief into the story, determines the consequences of that newly added belief, and checks to see if the belief now connects to the consequence in question. So essentially this feature allows Genesis to represent prior beliefs associated with the reader, which get injected in the story after being probed with a question. An illustrating example is the following story text:

```
Start commonsense knowledge.

X is a person.
Y is a person.
SS in an entity.

If SS is individualistic then SS is corrupt.
If X inhabits SS and SS is individualistic, then X becomes corrupt.
If X becomes corrupt, then X may kill Y.

Start story titled "Murder in America".
"Asian" is a kind of personality trait.
I am asian.
John is a person.
James is a person.
America is an entity.

John inhabits America.
John kills James.
The end.
```

The text generates a story with disconnected story elements because none of the rules fire, as shown in Figure 2-7.

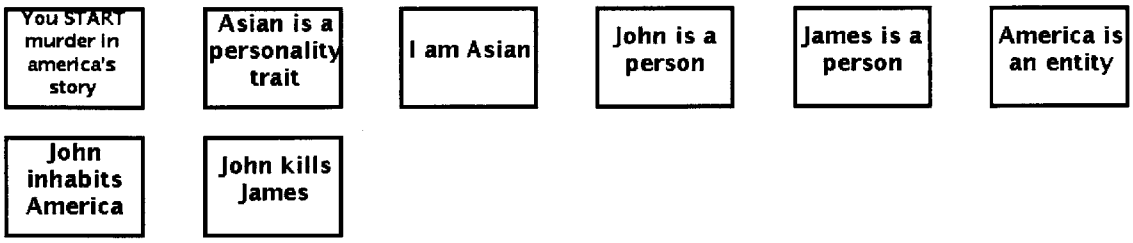


Figure 2-7: Initial reading of murder in America story.

However when I ask Genesis the question "Did John kill James because America is individualistic?" Genesis produces the elaboration graph in Figure 2-8. Note that the story element "America is individualistic" is now inserted in the story, because in the mental model of the "Asian" reader I had declared that:

```
I believe that America is individualistic
```

.

Additionally the insertion of this element fires some common sense rules, resulting in a path that results in a "Yes" answer. Genesis highlights this path of causally connected events in green, as shown in Figure 2-8.

2.4.3 Abduction Rules

An abduction rule is a commonsense rule rendered with "must" be, rather than "is" as in "If X kills Y then X must be insane." This abduction rule is in a sense, the reverse of the prediction rule, because instead of inferring the causal consequent of the behavior, it infers the cause, where causal flow is from the consequent to the antecedent. That is, if a killing appears in the story, the rules fires connecting insanity as a cause rather than consequent of the killing. This was an interesting and necessary rule to enable Genesis to infer the cause, rather than consequence of a particular event during story

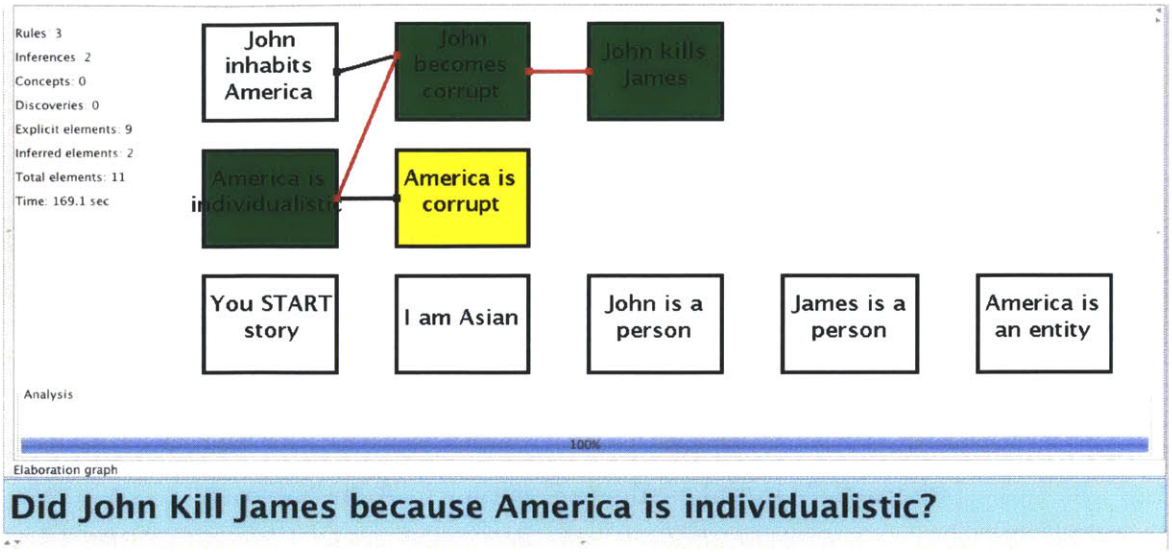


Figure 2-8: Murder in America adjusted with prior beliefs when probed.

understanding reasoning. I could have used the explanation rule "If X is not sane then X may kill Y," which would also infer that "not sane" is a possible cause of the murder. However such explanation rules are presently limited to explaining actions when no other explanation of an action is known. Consider the following simple story:

```
Start commonsense knowledge.

X is a person.
Y is a person.
If X kills Y then X is nasty.
If X kills Y then X must be insane.

Start story titled "Abduction test".
George is a person.
George kills James because James insults George.
The end.
```

Figure 2-9 is the resulting elaboration graph. Note the difference in causal flows, where the regular prediction rule, added the consequent, as causal result on the

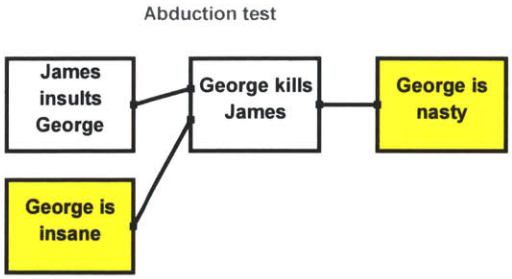


Figure 2-9: Elaboration graph for story abduction test.

antecedent, thus connecting nasty to be a consequence of murder. One the other hand, the abduction rule infers that insanity was a cause of the murder, thus the causal flow was from the inferred element, insanity, it to the antecedent, the killing. Note also that an explanation rule would not make the insanity connection because there is an existing reason for the killing.

2.5 Story Coherence

It seems that we often judge the relevance or causal importance of an event based on how crucial it is to the coherence of the story. It makes sense that if an event seems vital to the story coherence, then we grant it importance. If an event does not contribute to the coherence of the story then it seems trivial. Furthermore, if an event renders a story incoherent, then we seem to think it's nonsensical or untrue. These thoughts brought me a brief investigation of coherence in stories. The guiding question was how to assess the coherence of a story qualitatively, as well as quantitatively, in a computational story understanding system.

Narrative coherence can be thought of as how well the story hangs together or the degree to which it makes sense. Causation stands out as an obvious metric to evaluate coherence. A story can be deemed coherent if it includes enough details that we can infer causality between the events of the story. Accordingly, I introduced three simple computational metrics indicative of how connected the events in the story are: 1) Number of chains 2) Longest chain 3) Number of caused events. I hypothesized that the higher the value of these metrics, the more causality between events in the

story and hence the more coherent the story. I implemented a basic visual component to calculate and compare values for a set of stories, normalizing to the highest value found in the set, believing that relative values are more meaningful than the absolute values. For example the number of chains is divided by highest number of chains in the story set. Figure 2-10 is a screen shot of the visual component displaying the coherence metrics of three Shakespeare stories in the Genesis test set. Each metric is on one axis of the plot, forming the "spider plot."

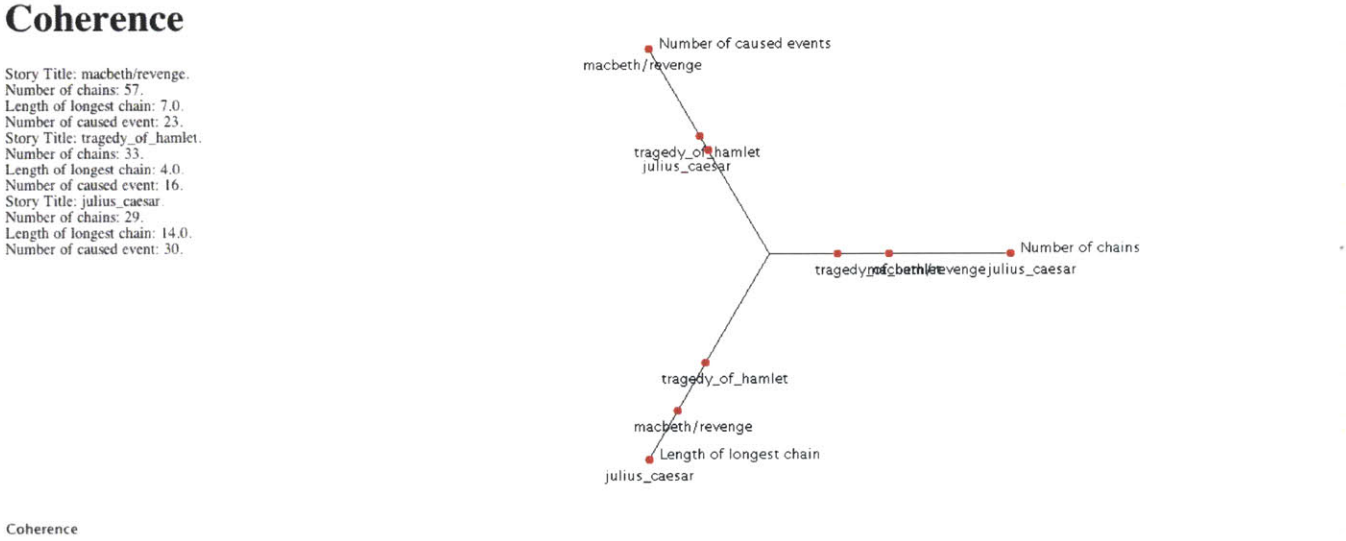


Figure 2-10: Coherence metrics displayed for the three Shakespeare stories in Genesis.

Chapter 3

Experiment Results and Analysis

3.1 Experiment Results

I succeeded in developing a model that yielded encouraging results with a simplified version of the Morris-Peng stories and questions, resulting in different importance ratings for the causal factors according to cultural perspective.

3.1.1 Elaboration Graphs

The resulting elaboration graphs for the Lu story as interpreted by each culture are shown in Figures 3-1 and 3-2. Similarly, elaboration graphs for the McIlvane murder story are shown in Figures 3-3 and 3-4.

3.1.2 Commonsense Rules

The set of commonsense rules devised for and used in the experiment are included in Appendix B. In total, thirty eight commonsense rules were created, of which only three rules belonged exclusively to the Western perspective, eight belonged exclusively to the Eastern perspective, and the rest belonged to the general set of rules. One abduction commonsense rule was used to infer insanity as cause of the murder for the Western perspective of the Lu murder story. Using the commonsense rules, Genesis connected the events in the story to emotions experienced by the actor such

as dishonor and anger. In addition, the rules connected the events in the story to traits such as violent, corrupt, murderous.

3.1.3 Situational Rules

A distinct difference between the Eastern and Western commonsense rules was that the Eastern commonsense rules connected the emotions and traits arising from the situational events in the story to a "murderous" personality capable of killing, while the Western commonsense rules did not make that connection. So for example an Eastern commonsense rule was:

```
If X becomes corrupt and X becomes violent and X feels dishonored
then X becomes murderous.
```

3.1.4 Abduction Rule to Infer Causal Trait

The Western rule set instead inferred insanity from the actor's actions, causally connecting insanity to the murder with the abduction rule. Significantly however, the Western rules were encoded to exhibit a out-group bias, in which insanity was only inferred for non Americans committing murder. This out-group bias matched the results of the Morris-Peng paper as well as other research in cognitive science which suggests that Western cultures exhibit more out-group bias (Heine and Lehman, 1997).

3.1.5 Causal Attribution Results

Figures 3-5 to 3-10, are screenshots of the Genesis system when asked a causal question about the Lu or McIlvane murder story, based on the causal factors defined in table 2.1. The answers are based on the causal attribution module outlined, and are in line with results from Table 2.1. The system allows the user to enter any question into the question expert box in the form of "Did X perform action Y because of Z?" Next Genesis displays the results based on the causal attribution module discussed. If event Z does not exist in the story, Genesis injects Z in the story if it matches

the beliefs in the reader's mental model, then checking for causality as discussed in section 2.4.2.

3.2 Experiment Analysis

The experiment has given us some insight into how to manipulate commonsense rules to model cultural effects on story understanding computationally. However this research remains a work in progress. This section outlines some points of inadequacy in each component of this experimental setup.

3.2.1 Commonsense Rules

Although my commonsense rule set was intended to be as general as possible, it is still only one possible set of rules from the space of many possible rules. The rule set was also aimed to mirror how humans would interpret the events in the story. However, in fact there is little "commonsense" involved in understanding or explaining such aberrant human behavior as murder.

Still, the rule sets are plausible to me, which means that they at least model my mental model of how representative people from various cultures must think. Moreover, they provide a starting point for discussing adequacy and variation from person to person.

3.2.2 Concept Patterns

> "Most of our concepts come from the communities in which we are raised."
> (Minsky, 1988)

Although culture Somewhat surprisingly, the need for culturally specific concept patterns did not emerge in the course of my work. I do not have a good sense of whether this was a result of the character of the stories involved in my study or some deeper consideration.

3.2.3 Causal Attribution

Human behavior is often inexplicable. Even when asked to explain our own behavior, even mundane behavior, we are often at a loss for words as we try to think about our feelings, motives, and intentions, as well as external factors, such as situations and coincidental events. Cognitive psychologists have thus posited many theories on how humans perceive and attribute causes of behavior. Understanding and modeling accurate causal attribution remains a complex task under research. Thus, I think of my modeling effort as just a first step toward understanding the extreme complexity of human causal attribution.

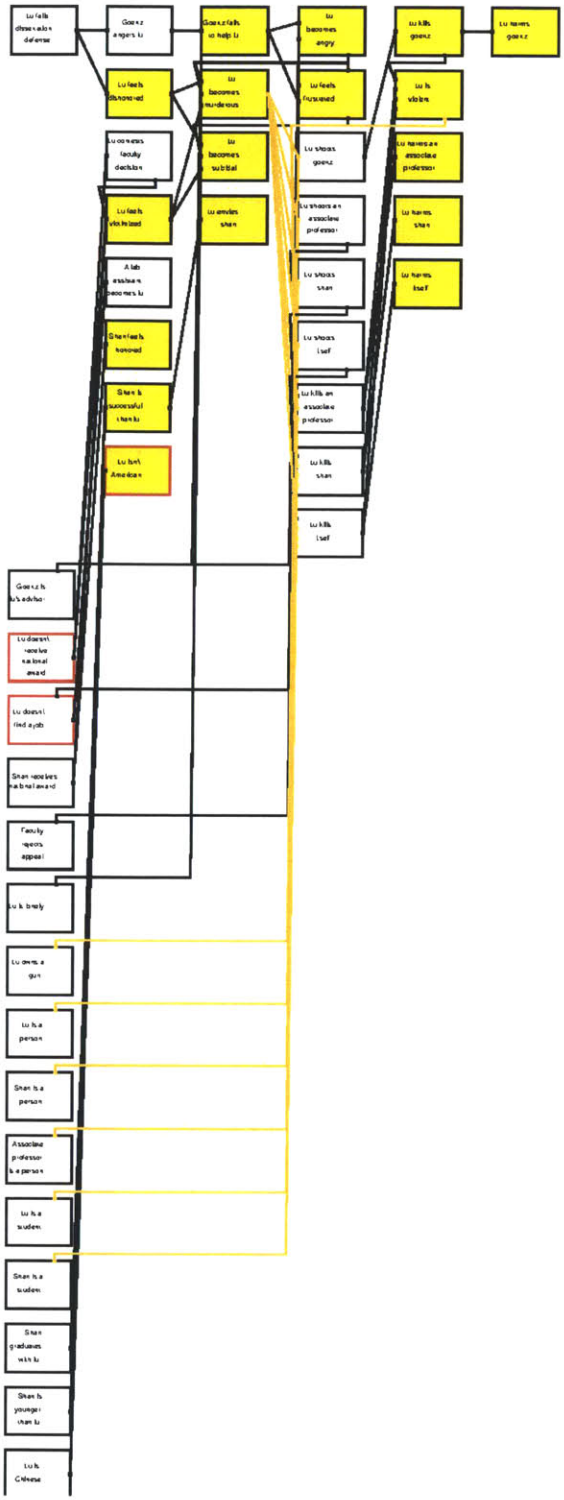


Figure 3-1: Lu murder story from Chinese perspective.

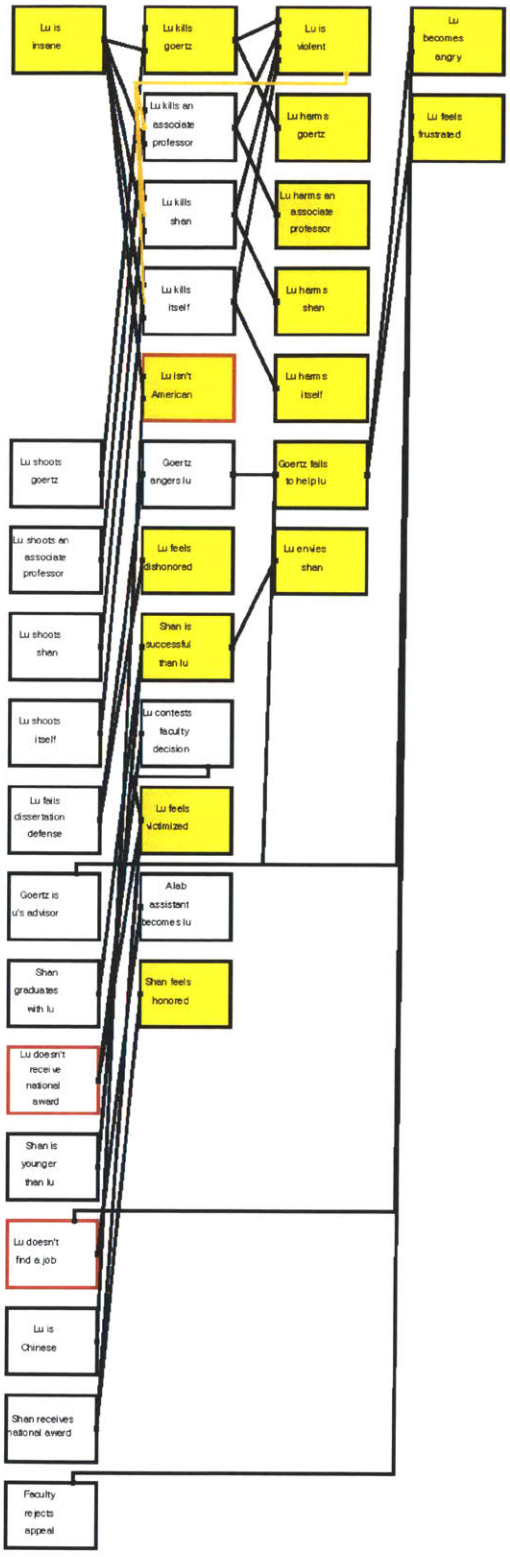


Figure 3-2: Lu murder story from American perspective.

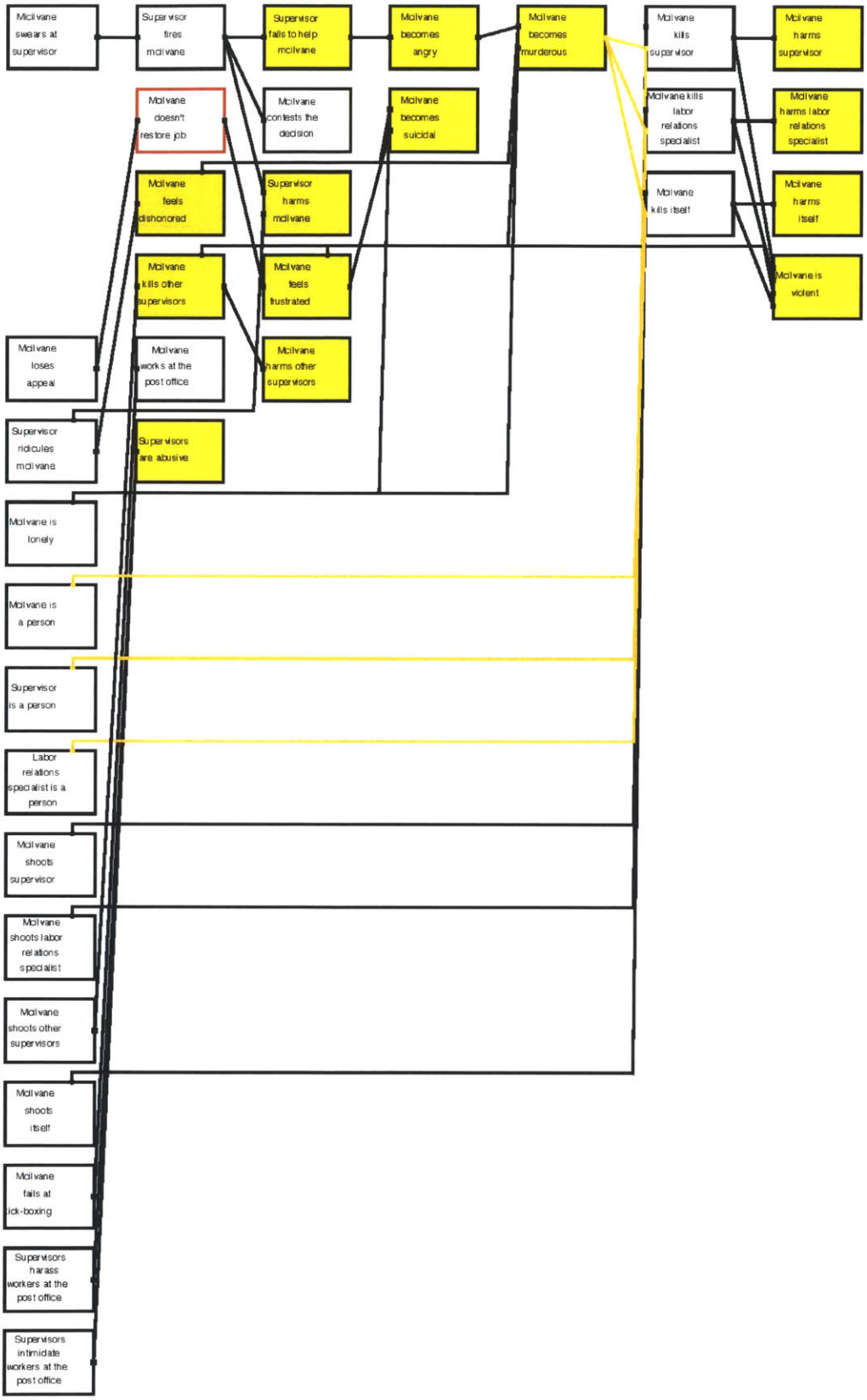


Figure 3-3: McIlvane murder story from Chinese perspective.

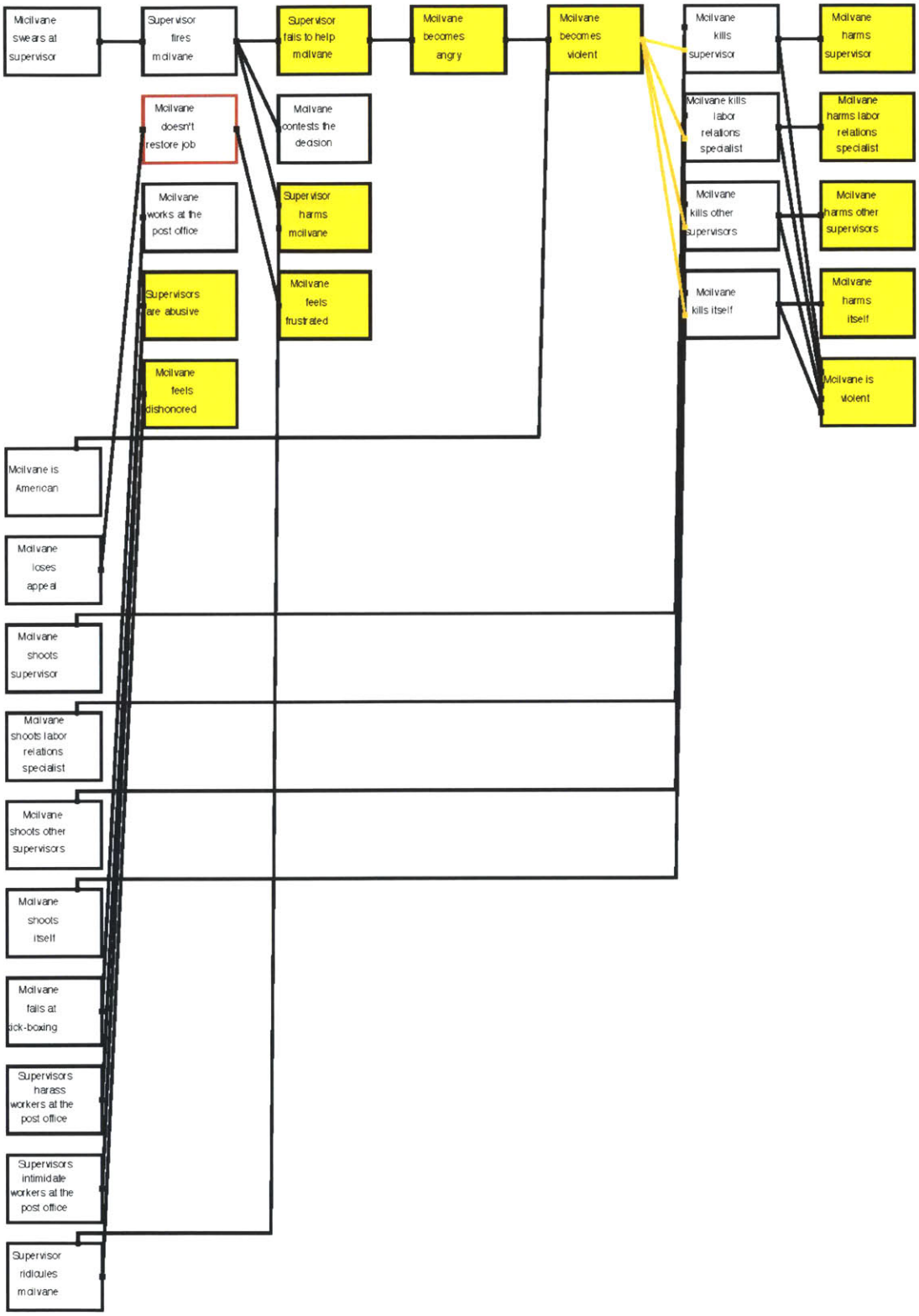


Figure 3-4: McIlvane murder story from American perspective.

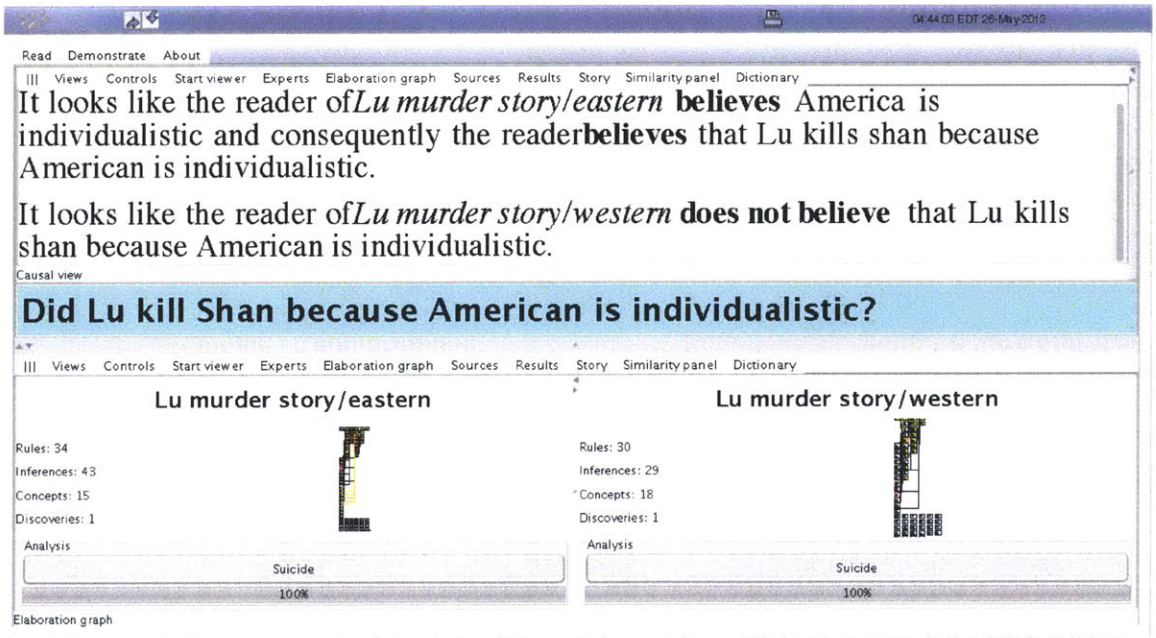


Figure 3-5: Results of causal attribution module for factor: America is individualistic.

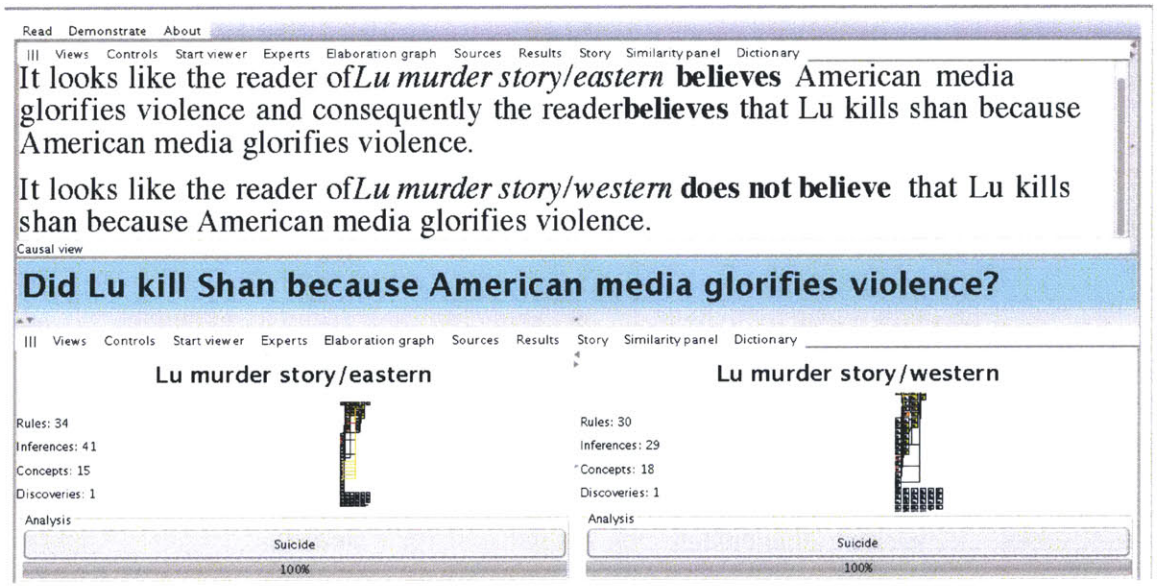


Figure 3-6: Results of causal attribution module for factor: American media glorifies violence.

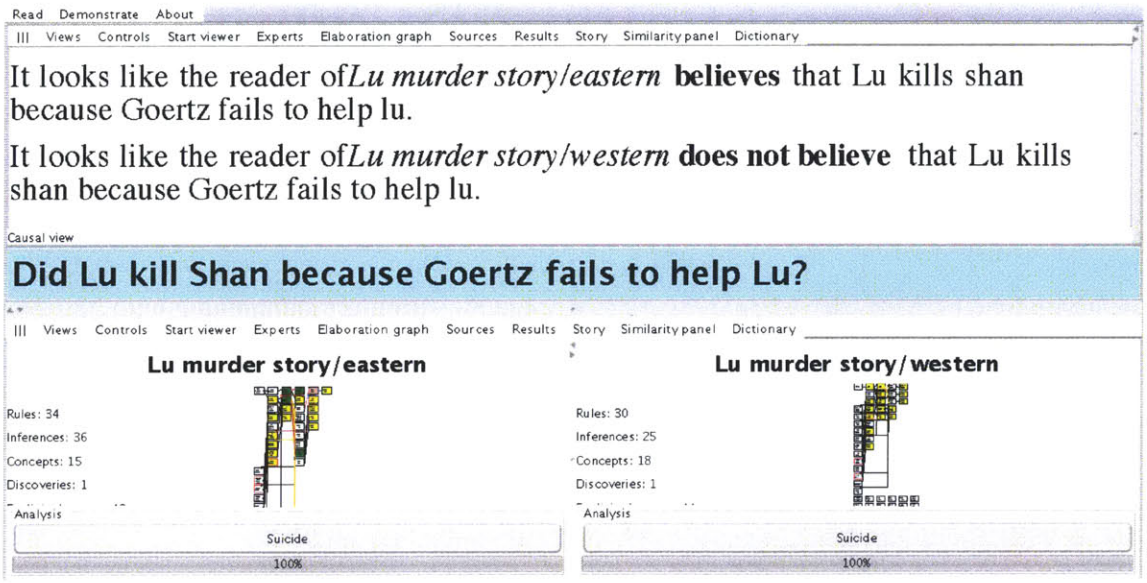


Figure 3-7: Results of causal attribution module for factor: Goertz (Lu's advisor) fails to help Lu.

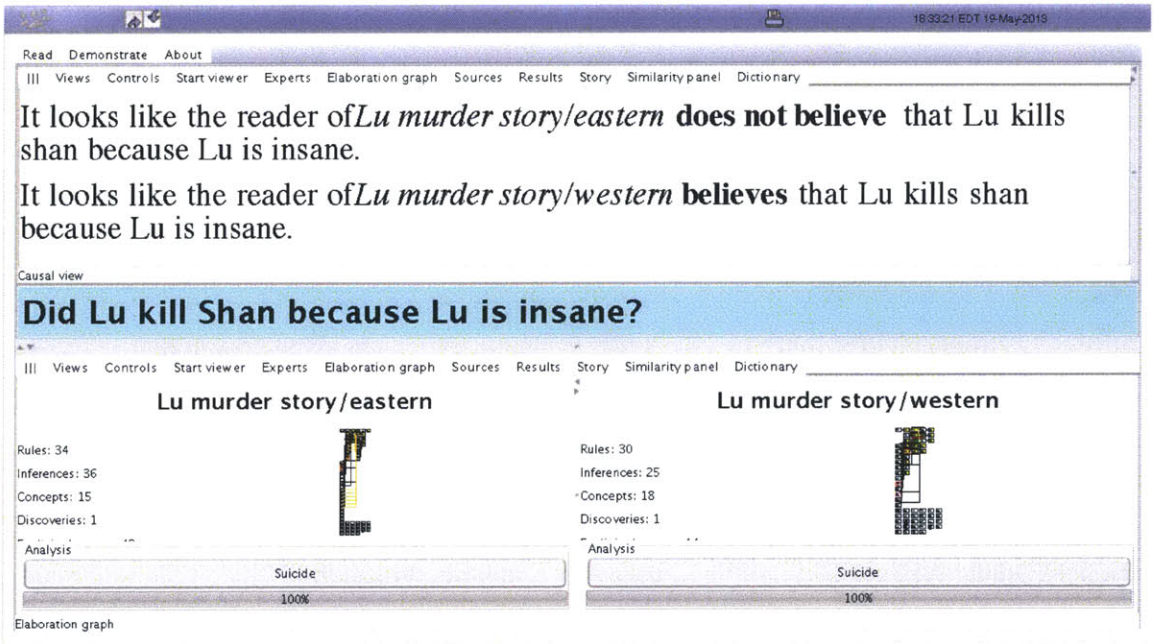


Figure 3-8: Results of causal attribution module for factor: Lu is insane.

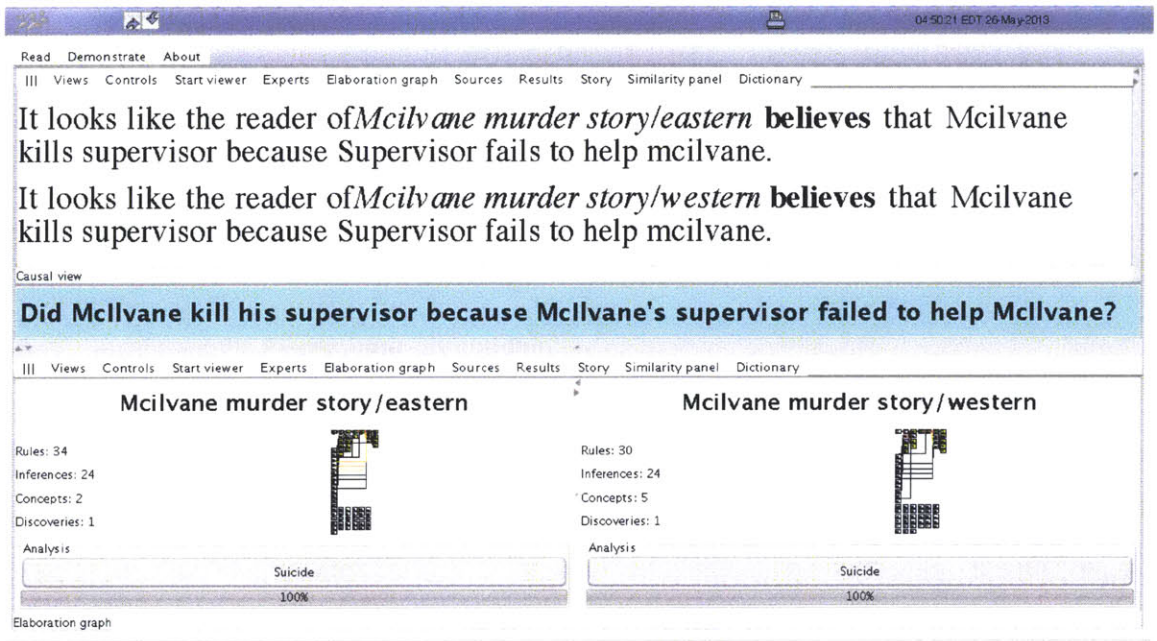


Figure 3-9: Results of causal attribution module for factor: McIlvane's supervisor failed to help McIlvane.

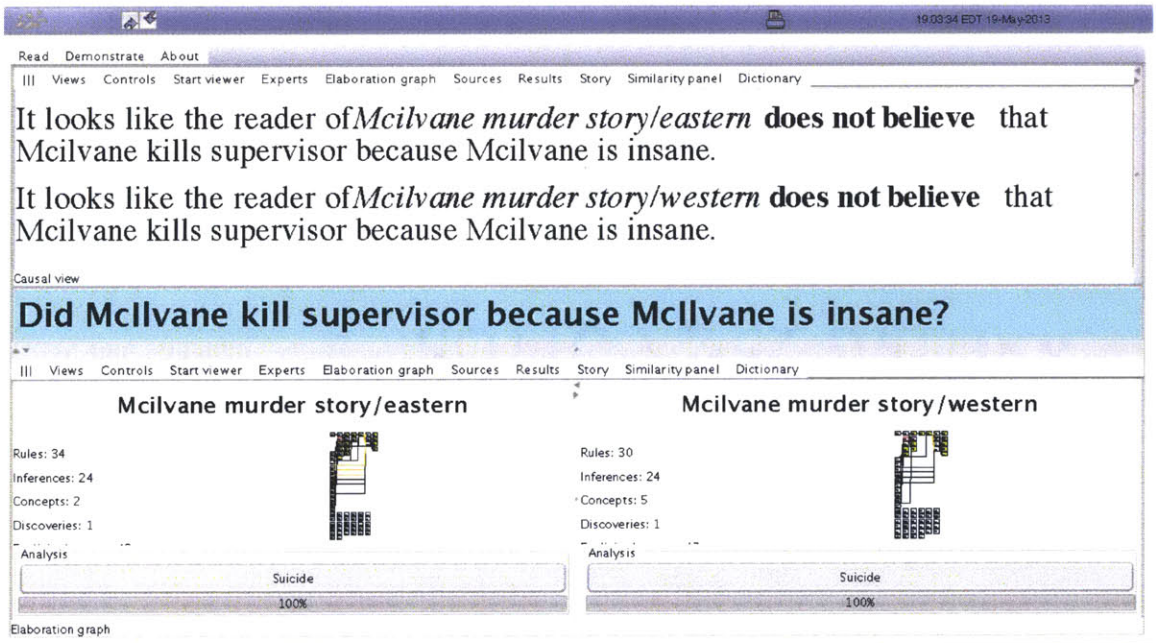


Figure 3-10: Results of causal attribution module for factor: McIlvane is insane.

Chapter 4

Related Work

This chapter surveys the field of cognitive psychology for related literature on understanding and modeling cultural effects on cognition. These research findings guided my work and led to suggestions for further research provided in the next chapter.

4.1 Causal Attribution

Causal attribution is the cognitive process by which humans explain the behavior of others. People make explanatory attributions to understand the world around them and to seek reasons for a particular event. Cognitive researchers have proposed numerous paradigms to explain the causal attribution process in terms of underlying perceptual or judgement processes, but have traditionally assumed that the attribution patterns did not vary across cultures.

Fritz Heider is considered one of the pioneers of psychological research in attribution. Heider divided explanation of behavior into two groups, internal (personal) and external (situational attributions), where internal attributions refer to the individual characteristics such as ability, personality, moods, efforts, attitudes, or disposition and external refers to the situation in which the action took place, such as the other people or luck (Heider, 1944). This distinction between internal and external explanations was influential to attribution theory, and continued to be used in understanding attribution. Motives played a very important role in Heider's personal attribution

model, where "motives, intentions, sentiments ... the core processes which manifest themselves in overt behavior." (Heider, 1944)

The correspondent inference theory, proposed by Edward E. Jones and Keith Davis in 1965 to explain causal attribution, states that people make internal inferences about a person when his or her actions are perceived as voluntary, unexpected, and have undesirable social effects (Jones and Davis, 1965). The covariation model of attribution (Kelley, 1973), another theory of causal attribution, provides a three dimensional pattern for how humans make personal attributions, stating that people judge attribution on the basis of three factors: Consensus, which is how other people in the same situation behave, distinctiveness, which is how differently the individual responds to different situations, and consistency, which is how frequently the individuals behavior is observed across varied situations. Kelley posited this theory of covariation, inferring that people make causal attribution in a rational logical fashion assigning the cause of a behavior to the factor that co-varies most closely with the action. So people make personal attribution when the behavior has low consensus and distinctiveness, but high consistency. On the other hand, people make situation attributions when the behavior has high consensus and distinctiveness. Kelley's theory and the examples of prediction are illustrated in Figure 4-1.

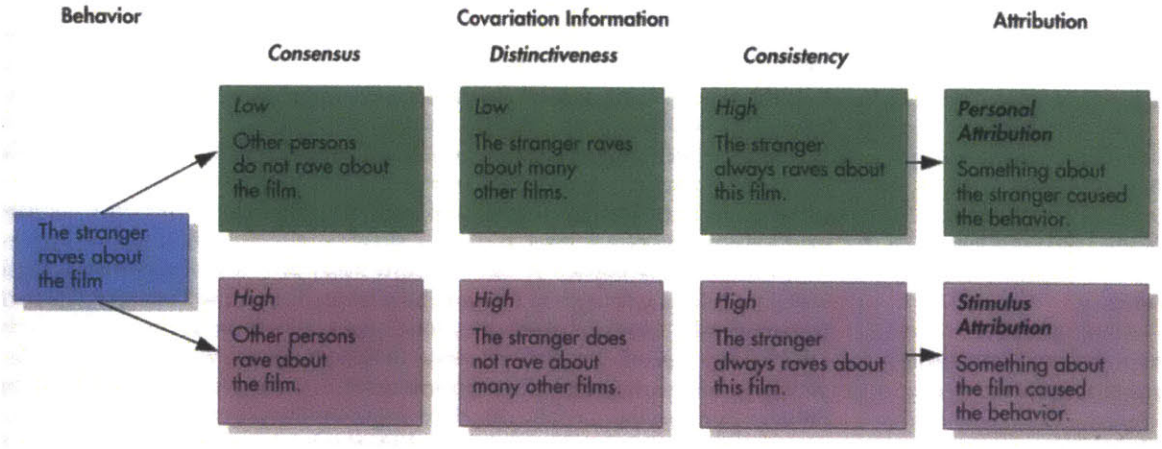


Figure 4-1: Kelley's covariation model of attribution. When behavior has low consensus and distinctiveness, but high consistency people make personal attributions (top row). On the other hand, people make situational attributions when behavior has high consensus and distinctiveness (bottom low)(Kassin, 2008).

Attribution theory has been criticized as being reductionist for assuming that people are rational, logical and systematic thinkers. It also fails to account for the social, cultural, or linguistic factors that can influence causal attributions.

4.1.1 Fundamental Attribution Error

A now classic experiment, conducted decades ago, showed that subjects upon viewing behavior of another person tend to draw strong inferences about the person's disposition, such as traits, attitudes and other qualities, even when obvious compelling situational factors are presented (Jones and Harris, 1967). This tendency to overemphasize the effects of internal disposition and underestimate the effect of situation to explain behavior is recognized as a cognitive bias and was first coined as the fundamental attribution error by Ross (1977), to emphasize its "pervasiveness, robustness and illogicality."(Fiske et al., 1998) Empirical evidence for the tendency to attribute behavior to personal dispositions was so pervasive that it was described as a universal human tendency (Gilbert and Malone, 1995). Although there is no universally accepted explanation for the fundamental attribution error, social psychologists have proposed numerous theories for the causes of this error. One model proposed by Ross (1977) explains the prevalence for making attributions to personal dispositions by defining a set of judgmental heuristics: "availability", "representativeness", and "consistency." Hence people tend to make more depositional attributions due to personal dispositional causes having higher availability and representativeness than situational causes. Another theory first proposed by Lerner and Miller (1977) is the "fair-world" belief "that people get what they deserve." So humans would attribute failures and successes to dispositional rather than situational causes because dispositions are perceived as more changeable and controllable than situations, thus satisfying the belief that the world is fair. Another explanation for the fundamental attribution error is the "salience of the actor." (Robinson and McArthur, 1982) That is, when we observe behavior, the person is the primary reference point, and hence the situation tends to be overlooked. Jones and Nisbett (1971) have discovered that the bias for making dispositional attributions is more prevalent when explaining other's

behavior than one's own, thus belying an "actor-observer difference." The salience of the actor can explain the actor-observer bias because when the observer is the actor he is more aware of the situational constraints imposed upon him and his situation becomes the primary focus of his perception as he cannot see himself from an external primary point of view. Consequently the observer makes situational explanations for his own actions and dispositional ones for other people's actions.

4.2 "Lay Dispositionism"

"Lay Dispositionism" refers to the human tendency to use traits as the basic unit of analysis to explain or predict social behavior (Ross and Nisbett, 1991). A common behavior associated with dispositional thinking is the tendency to automatically infer a personality trait from a person's behavior, a tendency labeled as spontaneous trait inference (Winter and Uleman, 1984, Gilbert and Jones, 1986). Another inferential practice associated with lay dispositionism is the belief that behavior in a particular situation can be predicted from knowledge of the relevant trait (Kunda and Nisbett, 1986, Ross and Nisbett, 1991). Similarly lay dispositional theory is associated with the expectancy that behavior will be consistent across situations (Kunda and Nisbett, 1986).

4.2.1 Implicit Personality Theory

Psychologists have increasingly recognized that implicit theories about the nature of the self and others influence an individual's judgements (Chiu et al., 1997). Implicit theories are the knowledge structures or patterns that an individual uses implicitly when making judgements and are thought to comprise of abstract representations and prepositions about things and their causal properties, applied to any stimulus within a domain (Morris et al., 1999). Thus like scientists, humans are guided by these implicit theories in the questions they ask and answers they construct when interpreting perceptive data. Implicit personality theory is the specific knowledge patterns pertaining to the nature of personality that the individual uses to form per-

sonal impressions based on behavior. Studies exploring the relation between implicit theories about the nature of personal attributes and lay dispositional thinking have predictably found that those who believed that traits are fixed and static engaged in more "lay dispositional" thinking. That is they had an increased tendency to use traits to explain or predict behavior. On the contrary, those who believed that personal attributes are malleable and evolvable engaged in less dispositional thinking (Chiu et al., 1997). Moreover the relation between implicit personality theory and lay dispositionism was found in both United Sates and Hong Kong, suggesting that this relation is generalizable across cultures (Chiu et al., 1997).

4.3 Cultural Psychology

Relying heavily on experimental methods, two decades of research in the field of cognitive psychology have highlighted cultural differences in fundamental aspects of basic psychological processors such as emotion, attention and perception (Markus and Kitayama, 1991). A common hypothesis emerging and often guiding the research is that independence versus interdependence or individualism versus collectivism are the key differences underlying cultural variation in cognitive thinking. For example research has shown that Westerners are more likely to define the self in terms of personal independent factors whereas Easterners more commonly define the self in terms of interdependent, relative or collective attributes (Cousins, 1989, Triandis, 1989). Research has also shown that Westerners engage in greater analytic object-processing activity while East Asians are more holistic and context aware, during both visual perception and also reflective thinking (Kitayama et al., 2003, Masuda and Nisbett, 2001). Masuda et al. (2004) presented subjects with a visual cartoon figure presentation of a person in the center of a group of people and asked them to analyze the central person's expression. The experiment showed that Japanese's judgments on the target character's facial expression are more influenced by surrounding faces than those of the Americans. Masuda and Nisbett (2001) also concluded from their underwater scenes experiment that Americans are also more likely than Japanese

participants to mark references to focal objects such as fish instead of contexts such as rocks and plants.

4.3.1 Cultural Bias in Causal Attribution

Research in cultural psychology has raised doubts on the universality of the fundamental attribution error and suggested that it's more specific to Western cultures. Asian cultures instead tend to causally attribute social behavior to more situational factors, showing markedly less tendency to commit the fundamental attribution error (Morris and Peng, 1994, Markus and Kitayama, 1991, Miller, 1984).

Despite the growing body of evidence for Western depositional and East Asian situational thinking, the sources of cultural differences in causal attribution are still a subject of debate. One interpretation suggests that attributors in Western and East Asian cultures have different orientations to social perception. That is, while Western culture attributes behavior to properties of the individual agents, many non-Western cultures interpret behavior as a "non-generalizing occasion-bound, context specific manner" (Shweder and Bourne, 1984). A more moderate interpretation is the suggestion that social perceivers in collectivist cultural settings attribute an actors's behavior to stable properties of the situations rather than the stable properties of the individual (Krull, 1993). This position is more moderate because it retains previous theorists ideas that perceivers attribute causes to stable properties of the objects. The variance in causal attribution between the two cultures also seems consistent with Western versus Eastern construal of the self; an interdependent view of the self implies that actions should be viewed as products of relations or interactions with others and are thus best understood with respect to these relations in the social context. Perceivers with independent view of the self however will attribute actions to the inherent disposition of the actor.

4.3.2 Culturally Differences in Conceptions of Agency

Morris et al. (2001) have proposed that social perception is best understood as guided

by implicit theories of "agency." Similar to Minsky's conception of mindless "agents" interacting together to construct intelligence, an agent is a source of planned action (Taylor, 1985). Thus agents are considered to act autonomously and intentionally. In proposing that perceivers have implicit theories of agency, it means that perceivers have implicit concepts of which kinds of actors have an internal intention, and are also autonomous with respect to their environment (Morris et al., 2001). Agency conceptions allow perceivers to make sense of outcomes by asking questions such as "Who is behind this? What purpose does it reflect?" Cognitive theorists (Morris et al., 2001) have argued that cultures have contrasting implicit theories of agency about both the person and group. Whereas North American theorists hold the person to be an agent, the theories in East Asian cultures conceptualize agency in groups or non human actors. Beliefs about the autonomy of individuals and groups were studied by Menon et al. (1999) who found that compared with Americans, Singaporean students were less likely to believe in the autonomy of individual persons and less likely to endorse statements such as "individuals possess free will and "follow their own internal direction" but were likely to endorse parallel statements about organizations. In one study Menon et al. (1999) presented students with a vignette about a transgression, but varied among the participants whether the actor in the story was an individual or a group. In one condition the actor was a bull, and the other, a herd. The vignette was about a farmer grazing the bull (or the herd under the second group condition), and the bull (or herd) changes direction suddenly, knocking the farmer to the ground. Participants were asked to rate several possible causes of the outcome, that included both dispositions such as aggressiveness of the bull or herd, and situational factors such as provocation by the farmer's behavior. The same dispositional and situational factors were present in both the individual actor and group actor conditions. Americans made more dispositional attributions for acts by individuals and Chinese made more dispositional attributions for acts by groups. Thus, interestingly, this experiment showed that the differences between American and Chinese participants reverse depending on whether the actor is an individual or a group. Other experiments have also pointed to domain specificity in cultural biases

towards dispositional attributions. In the Morris and Peng (1994) experiment for example, cultural divergences in causal attribution did not extend to physical events involving inanimate objects. These domain specific divergent cultural tendencies do not seem to reflect general differences in orientations towards actor versus situation, but instead seem to correspond to predictions made by the implicit theory of agency model.

4.3.3 Cultural Differences in Dispositional Thinking

Dispositional thinking, closely tied to the fundamental attribution error, was also found markedly more in Western cultures. The inferential practice of spontaneous trait inference for example was found to be culture specific to Western cultures (Na and Kitayama, 2011). In an experiment performed by Na and Kitayama participants were first asked to memorize pairings of facial photos with trait-implying behavior. In a subsequent lexical decision task, participants were primed with a previously memorized face. European Americans subjects showed clear evidence of spontaneous trait inference: the decision for the word for the implied trait associated with that face was facilitated, and the antonym of the implied trait elicited an electrophysiological sign associated with processing of semantically inconsistent information. However, the Asian American subjects showed neither of these effects. Some cognitive scientists believe that people from Western cultures are more prone to lay dispositional thinking because they are raised to assume that behavior is a reflection of personal characteristics (Jellison and Green, 1981). The suggestion by Chiu et al. (1997) that different implicit theories of personality traits entail different uses of dispositions, suggests that Westerners and Easterners have contrasting implicit theories of personality: Whereas individualist cultures tend to use dispositions to explain internal causes of behavior, collectivists perhaps use them to describe trends of behavior that are context specific. Consistent with this possibility are findings from self-description tasks. Cousins (1989) compared the self-descriptions of American high school and college students with the self-descriptions of Japanese high school and college students and found that the Japanese self-descriptions focused more on behavior and were

more role and context specific ("I play tennis on the weekend", "I am a student). In contrast, the American descriptions included more abstract psychological characterizations such as "I am optimistic." or "I am friendly." Interestingly however, when a specific interpersonal context was provided so that subjects can envision the situation (e.g. me at home) then this pattern of results was reversed. The Japanese showed a stronger tendency to describe themselves in personal attributes than Americans. In contrast, Americans tended to qualify their self-descriptions, describing for example, "I am sometimes lazy at home."

4.4 Traits in Genesis

Previous work in the Genesis group by Susan Song has demonstrated the use of concept patterns within the Genesis framework to represent intentional personality traits (Song, 2012). Song identifies intentional personality traits as traits that underly strong intention not only summarizing habitual patterns of behavior. For instance "vindictiveness" is a trait and "revenge" is an action arising from this trait. To describe someone as "vindictive," means that person has a strong tendency and desire to harm other people in retribution. So Song defined the concept pattern for vindictiveness as the following:

```
Start description of  ''vindictive''.
X is a person.
Y is a person.
Y's harming X leads to X's wanting to harm Y.
The end.
```

The concept pattern for vindictiveness expresses vindictive intention, in the idea of "harming leading to wanting to harm" via the "Y's harming X leads to X's wanting to harm Y" statement in the concept pattern. At the same time, the concept pattern for revenge has already been defined in previous work in Genesis as the following:

```
Start description of ''revenge ''.
```

```
X is a person.
Y is a person.
X's harming Y leads to Y's harming X .
The end.
```

Song's work takes a step towards enabling Genesis to represent and understand traits in stories. Her work also suggests concrete steps to equip Genesis with the capabilities to learn, infer and apply traits to characters in stories, thus illuminating the potential of Genesis to model the fundamental activities of dispositional thinking.

4.5 Cultural Narratives

Research also points to the importance of cultural narratives in studying and understanding culture. Cultural narratives are the collections of stories tied to a particular cultural group, such as stories from religious texts or folk tales. Cultural narratives are often used to express a shared cultural identity (Barbour, 1974). Kilpatrick (1992) hints that cultural stories give rise to sacred values. "Our 'sacred' memories may find their source in stories." Moreover, MacIntyre (1981) argues that cultural narratives are in essence the "historical memory" of a culture. Narratives are transmitted across many generations, retaining only what is culturally relevant or important. Thus because cultures transform these narratives over centuries, the narratives themselves are a reflection of cultural knowledge. Mark Finlayson has highlighted the importance of folktales as a window into culture and developed a new machine learning algorithm to extract culturally-relevant plot patterns from sets of folktales (Finlayson, 2012). Thus because cultural narratives are a window into cultural knowledge and thought, they are of central importance to studying and modeling culture.

Such findings from cognitive and cultural psychology, as well as previous work within the Genesis group guided me to a panoply of next steps, that I articulate in the next chapter.

Chapter 5

Next Steps

5.1 Causal Attribution

A robust human-like story understanding system must be capable of making sense of behaviors by causal attribution. Although Genesis already infers causality with commonsense rules, research shows that the human causal attribution process is complex as well as individually and culturally variant. The cognitive mechanisms of causal attribution and the implicit theories guiding them are still a subject of research and debate, but substantial research has pointed to recurring patterns and biases in causal attribution, such as the division between internal and external attributions, as well as the fundamental attribution error. Genesis has already taken a step in distinguishing between internal and external causes of behavior with its current mental models of personality traits. I envision extending that capability to model entire characters including their traits, motives, desires, beliefs or intentions. Such a model would enable Genesis to distinguish internal from external causes of social behavior, and also to commit the fundamental attribution error, common to humans, especially those from Western cultures.

5.2 "Lay Dispositionism"

> "A personality is merely the surface of a person. What we call traits are only the regularities we manage to perceive." (Minsky, 1988)

Modeling the inferential practices associated with lay dispositional thinking is a compelling step towards story understanding. Research indicates that humans engage in dispositional thinking to varying extents so a robust story understanding system should be able to fine tune the level of dispositional thinking to reflect different cultural or individual perspectives.

5.2.1 Trait Representation

While important work has been done to model "intentional traits" using concept-level patterns, further work seems possible to model and implement a more nuanced and humanlike representation of traits in Genesis. For example, often humans associate a trait with a particular trend of actions or stories, perhaps tied to how the meanings of this trait was learned. A more accurate trait representation in Genesis could be composed of several stories or events exemplifying the behavior of characters with those traits.

5.2.2 Trait Inference

An important step towards modeling culturally variant cognition in particular, but also story understanding in general is modeling trait inference. Trait inference is the process by which humans infer personality traits from behavior. Genesis has the basic framework in place to permit an implementation of trait inference. Genesis simply needs to match learned patterns of traits against the character's thoughts or behaviors. These patterns can be in the form of commonsense rules or concept patterns that represent the trait. They could also be in the form of stories or typical events that are typical of these traits. In his thesis "Enabling Imagination Through Story Alignment" Matthew Fay designs and implements a structural alignment engine

that can compare two stories by aligning their plot units (Fay, 2012). Story alignment can thus be utilized to match stories or concepts characterizing personality traits in order to both learn and infer new traits. For example, a mental model for a trait could include a list of events, or concept patterns, as evidence for that trait. So if a pattern from this list is discovered in a story, Genesis can maintain a count of these matched patterns and increase belief of the trait as the count increases. If the count exceeds a particular threshold, the trait can be assigned. So for example Genesis can infer that an actor is violent, if the actor harms other actors, more than a threshold, x number of times.

With such a capability we can account for cultural influence on thinking or story understanding by recognizing different levels of trait inference, and varying the counts or threshold, for each level. Cognitive science experiments indicate Westerners engage in a higher level of trait inference, so that tendency can be modeled by a decreased threshold in assigning traits to characters.

Consider this simple story composed of two events as an example that ties trait inference to causal attribution: Henry was sick. He performed badly on the Math exam. We can assume that both the Western and Eastern perspectives had a representation of lazy as entailing a disinclination to doing things, hence leading the lazy character to underperform. So upon reading this simple story, a lay dispositional thinker, embodied in the Western perspective, would infer that Henry is lazy because he underperforms on the exam, and would causally link laziness to Henry's bad performance. Additionally a dispositional thinker would encode an "inability in Math" as a disposition that causes bad performance on a Math exam. On the other hand, a situational thinker, embodied in the Eastern perspective would not infer laziness from a single episode of underperformance. Furthermore they would have commonsense rules linking sickness to an inability to work or study, and hence to underperformance. As a result they would causally link sickness to the bad performance. So a Westerner or dispositional perspective would answer the question of why Henry performed badly on the exam with Henry was lazy or Henry is not good at Math, whereas from an Eastern or situational perspective, the answer would be Henry was sick and hence he

couldn't perform well on the exam.

5.2.3 Behavior Prediction from Trait

Behavior prediction from traits is also a common practice associated with lay dispositional thinking. When an actor is characterized with a trait, the story reader can employ the trait to predict the behavior of the actor. For example if a character X is characterized as "vindictive" the reader should be able to predict that X will harm Y, if Y has harmed X. In addition, after reading the story, the reader can also explain if their behavior makes sense or violates expectations. If their behavior violates expectations then the reader may need to update their perceptions, whether it's the trait assignment or the definition of the trait. Song (2012) presents an analysis on how behavior prediction from traits can be accomplished within the Genesis framework using concept patterns to define traits. While reading the story Genesis can essentially set up expectations for characters based on the trait definitions and verify that the results are inline with expectations.

5.3 Cultural Narratives

Researchers have shown that cultural narratives are a window into cultural values, morals and cultural reflective thinking. An interesting next step for Genesis would be to identify and collect repositories of cultural narratives. Encoding these stories for Genesis and developing commonsense rules and concept patterns to handle them could highlight the rules and patterns characterizing mental models of different cultures. Additionally, an interesting experiment would be to perform machine learning techniques on different features of these stories such as concept patterns, commonsense rules or plot units. Training a cultural classifier based on different feature vectors would grant insights on the features that distinguish the stories of one culture from another. Clustering the stories based on different distance functions, and comparing the clustering results to their cultural classification would also be very interesting. Caryn Krakauer's work on story comparison using concept patterns be-

comes valuable in comparing cultural narratives (Krakauer, 2012). Krakauer built a similarity module that can automatically extract and compare concept patterns in stories to asses the similarity between stories. An interesting experiment would be to use Krakauer's similarity module as a distance function to cluster cultural narratives and next compare the clustering results with the cultural origins of the stories. Additionally, the concept patterns used to compare the stories in Krakauer's similarity module can also be varied, and the clustering experiment repeated, to investigate which concepts would enable the similarity module to match the stories from the same culture. These concept patterns would also be very valuable because they are indicative of the concepts shared across a culture's narratives and are thus characteristic of the culture's mental model.

5.4 Coherence

Further steps can also be taken to understand and model narrative coherence.

5.4.1 Characteristic Behavior

One way to judge coherence is by how "characteristically" the characters in the story behave. For example if the story presents a husband who is loyal and loving to his wife, but then he cheats on her or abuses her, he is behaving uncharacteristically. Walter Fisher who proposed the narrative paradigm, that all meaningful communication is a form of storytelling, declares that the ultimate test of narrative coherence is "if we can count on the characters to act in a reliable manner" (Fisher, 1987). The process of determining whether characters are behaving reliably, is very similar to applying traits in order to predict or explain behavior, and checking if the behavior fits or violates expectations. Another perhaps similar measure to judge a story's coherence is consistency. Consistency can be with regards to the actions or events in the story. For example if the husband loves his wife but then kills her, his actions are deemed as inconsistent. Moreover sometimes we judge consistency of a story by comparing the story to other stories we know that fall along the same line. If the story suddenly

differs drastically from a very similar precedent, it seems incoherent. Fay's work on story alignment and Krakauer's work on story comparison become very valuable in retrieving similar stories and discovering sudden inconsistencies. Additionally it would be interesting to perform a human study on which stories are most coherent and compare the results with the computational metrics suggested in this research.

Chapter 6

Contributions

My purpose in undertaking the research reported in this thesis was to model aspects of culturally determined biases in story understanding as reported by Morris and Peng in their ground-breaking experiments with Chinese and American readers of murder stories (1994). In the course of the research, I made the following contributions:

- Created the common sense rules needed to interpret the Morris-Peng murder stories from culturally different perspectives, thus providing representative examples of common sense rules characterizing mental models of different cultural actors.

- Determined a need for and implemented a mechanism for question-induced story augmentation, enabling the answering of questions such as "Did Lu kill Shan because America is individualistic." This mechanism induces the reader to ask if the reader believes the premise, inserts the premise into the story if so, and finally looks for a causal chain connecting the premise and the conclusion.

- Determined the need for abduction rules, and with their addition to the Genesis system, enabled the answering of questions such as "Did Lu kill Shan because Lu is insane," given the abductive rule, If person X kills person Y, then person X must be insane."

- Suggested and implemented computational metrics for story coherence.

Appendix A

Stories

A.1 Original Lu murder story

On October 31, a physics student at the University of Iowa shot a fellow student, several professors and several university employees and then shot himself. The murderer Gag Lu, was a 38 year old male from Beijing, China. In 1985 Gang Lu had graduated from the Physics Department of Beijing University (the most elite university in China) where he placed at the top of his class in examinations. He came to the University of Iowa Physics department to pursue a Ph.D. and continued his academic success by recording the highest score ever on the qualifying exam there. Gang Lu was a bachelor and had few friends in Iowa. He spent most of his time alone. one of his few extra-curricular activities was a gun club He bought a gun in 1990 and practiced shooting it a a club. In 1991, he changed from a small gun to a powerful .38 revolver.

Gang Lu's research was highly regarded in the department. However at his dissertation defense in 1990, his committee did not pass him. Lu did not have a close relationship with his advisor, Professor Geortz. After his unsuccessful defense, Gang Lu was heard to say that he was so angry at his advisor that could kill him. IN his second dissertation defense, Gang Lu passed and he got a Ph.D. in May 1991. He did not get a job last year and took a job as a laboratory assistant.

Gang Lu ended up finishing his dissertation at the same time as a younger student

in the same research group named Linhua Shan. Shan, from a small village in china, had graduated from the Chinese University of Science and Technology and come to Iowa in 1987. Shan was married, socially active and had good relationships with others in the department. He was also very successful, receiving several awards during his studies and receiving the highest score on the qualifying exam his year (although no breaking Lu's record). The faculty in this research group had to decide which of these two excellent students would be Iowa's nominee for a national award. They nominated Shan over Lu. Lu appealed this decision to the vice President for Academic Affairs, but his appeal was rejected.

On October 31, Lu sent five letters to news media and friends and sent a package to China. Then he went to the weekly meeting of his research group, carrying his gun. According to witnesses, he shot his advisor, an associate professor and Shan. Then he walked upstairs, who the apartment chairman and started to leave the building. One of the dying professors cried out for help, and several propel form nearby offices came to his assistance. Upon hearing this, Lu re-entered the room and told the people to leave. Despite their please he shot the professor several more times. then Lu walked across the entire campus to the Vice President's office, gun in his hand. It was snowing heavily, but Lu wore only a t-shirt. There he shot the Vice President and a staff member. Then Lu shot himself.

A.2 Original McIlvane murder story

On November 14, a former employee at the Royal Oak Post Office shot three former coworkers and then himself. The murderer, Thomas McIlvane, was a 31-year old male from Michigan. He came from a family of Irish descent. McIlvane was raised by his after a tough ex-Marine, after his mother ran off abandoning the family. Since high school, McIlvane had trained in the martial arts and had won competitions. He entered the US Marine Corp after high school, which took him to Japan and California. He returned to Michigan in 1982 when his father died and started a brief unsuccessful career as a professional kick-boer. Afterwards, he got a job as a

mail carrier at the Royal Oak post office. He was able to buy a house in a quiet neighborhood where he lived alone. He was a quiet man with few friends but he was well-liked by his neighbors. His activities were working out and hunting.

In the Royal Oak post office, relationships were strained between supervisors and workers. May workers hard complained to their union, recently that supervisors had harassed and intimidated them. Supervisors pursed workers to be more efficient and disciplined workers over matters such as whether their uniforms fit right and where they took their coffee breaks. When a union official complained that workers' morale was low, the supervisor said "Morale's not in my dictionary. "

In the summer of 1990, McIlvane was fired from his job for swearing at his supervisors. Hc appcalcd this decision and his union caught the Postal Service for over a year to restore his job. He worked part-time cleaning carpets. During this time, McIlvane made many telephone threats to his former supervisors. Over the past five years there have been many publicized incidents of postal workers shooting their bosses. In McIlvane's threats he mentioned this incidents. For making these threats, he was taken to court but acquitted. Witnesses said that his supervisor ridiculed McIlvane when he fired him and laughed at thin again in the courtroom. On November 13, 1991 McIlvane learned that he had lost his appeal –he would not get his job back. Workers who had heard rumors of McIlvane's threats asked for security guards at the post office but nothing was done.

On November 14, McIlvane entered the Royal Oak post office with a rifle. He fired several rounds in a mail sorting area, then he headed toward the supervisor's office and shot the man who had fired him. Many terrified postal workers smashed windows and escaped through them. McIlvane worked his way toward the personnel office and shot the labor relations specialist who had handled his case. Then he went upstairs and shot several other supervisors who were not involved in his case. Finally, he walked back downstairs and host himself in the head.

A.3 Genesis Lu murder story

Lu is a person.
Shan is a person.
Geortz is a person.
America is an entity.

America is individualistic.
America's media glorifies violence.
Lu is a student.
Shan is a student.
Lu inhabits America.

Lu fails his dissertation defense.
Goertz is Lu's advisor.
Goertz and Lu are not friends.
Lu was angry at Goertz because Lu failed his dissertation defense.

Lu is Chinese.
Lu went to US to do phD.
Lu had highest entrance exam score.

Lu is a bachelor.
Lu is lonely.
Lu has a gun.
Lu practices shooting for fun.

Lu passes his second dissertation defense.
Lu becomes a lab assistant because Lu does not find a job.

Shan is younger than Lu.

Shan graduates with Lu.
Shan received national award.
Lu did not receive national award.
Lu contested faculty decision because Lu did not receive national award.
Faculty rejected Lu's appeal.

Shan comes from a small Chinese village.
Shan is married.
Shan is social.
Shan has friends.
Shan is successful.

Lu shoots Goertz.
Lu shoots an associate professor.
Lu shoots Shan.
Lu shoots himself.

The end.

A.4 Genesis McIlvane murder story

Start story titled "McIlvane murder story".

McIlvane is a person.
McIlvan's supervisor is a person.
McIlvane comes from Michigan.
McIlvane is American.
McIlvane's mother abandoned him.
McIlvane was raised by his father.

McIlvan's father was a tough ex–Marine.
McIlvane won competitions in martial–arts.
McIlvane entered US Marine corps.
After McIlvane's father died, McIlvane returned to Michigan.

McIlvane failed at kick–boxing so McIlvane worked at the post office.
McIlvane bought a house in a quiet neighborhood.
McIlvane lived alone.
McIlvane was quiet.
McIlvane was mean.
McIlvane was lonely.
McIlvane's neighbors liked McIlvane.
McIlvane worked out.
McIlvane hunted.

Supervisors intimidated and harassed workers at the post office.

MicIlvane swore at his supervisor so McIlvane's supervisor fired McIlvane.
McIlvane's supervisor fired McIlvane, so McIlvane contested the decision.
McIlvane threatened supervisors.
McIlvane's supervisor ridiculed him.
McIlvane loses his appeal so McIlvane doesn't restore job.

McIlvane shot his supervisor.
McIlvane shot the labor relations specialist.
McIlvane shot other supervisors.

McIlvane shot himself.

The end.

Appendix B

Commonsese rules

B.1 Eastern Commonsense Rules

```
Start commonsense knowledge.

XX is a person.
YY is a person.
ZZ is a person.
SS is an entity.

// corrupt society
If SS is individualistic then SS is corrupt.
If XX inhabits SS and SS is corrupt, then XX becomes corrupt.

// violence glorifying society.
If XX inhabits SS and SS's media glorifies violence, then XX
   becomes violent.

// murderer personality.
If XX becomes corrupt and XX becomes angry and XX feels
```

dishonored then XX becomes murderous.

If XX becomes violent and XX becomes angry and XX feels dishonored then XX becomes murderous.

If XX becomes angry and XX is lonely and XX feels dishonored then XX becomes murderous.

// suicidal personality

If XX is lonely and XX feels frustrated then XX becomes suicidal.

If xx becomes suicidal then xx may kill xx

B.2 Western Commonsense Rules

Start commonsense knowledge.

xx is a person.

yy is a person.

// self-serving bias by adding clause xx is American. infer insanity only when culture is American.

If xx isn't American and xx kills yy then xx must be insane.

// accommodate situation for westerners. self-serving bias.

If xx is American and xx becomes angry, then xx becomes violent.

If xx becomes violent, then xx may kill yy.

B.3 General Commonsense Rules

XX is a person.

YY is a person.

```
//killing and violence
If XX shoots YY, then XX kills YY.
If xx kills yy, then xx is violent.

//harm
If XX fires YY, then XX harms YY.
If XX ridicules YY, then XX  harms YY.
If XX kill YY then XX harms YY.

//social success
If YY is social and YY is married and XX is lonely and YY is
   single then YY is more successful than XX.

//academic success
If XX has highest exam score then XX succeeds.
If YY is younger than XX and YY graduates with XX then YY is
   more successful than XX.

//academic honor
If XX succeeds then XX feels honored.
If XX receives awards then XX feels honored.
If XX fails dissertation defense then XX feels dishonored.

// academic victim
// If XX is a student and YY is a student and XX feels
   dishonored and YY feels honored then XX feels victimized.
   <- did not get parsed.
If XX is a student and YY is a student and YY received
   national award and XX did not receive national award and
```

```
   XX contested faculty decision then XX feels victimized.
If XX had highest entrance exam score and XX fails
   dissertation defense then XX feels victimized.

//academic frustration
//If XX contested faculty decision and faculty rejected XX's
   appeal then XX feels frustrated.<-failed
If XX is student and ZZ is XX's advisor and ZZ angers XX then
    ZZ fails to help XX.
If ZZ is XX's advisor and ZZ fails to help XX and faculty
   rejects appeal then XX feels frustrated.

//professional frustration:
If XX does not find a job then XX feels frustrated.

//envy
If YY is more successful than XX then XX envies YY.
//If YY feels honored and XX feels dishonored then XX envies
   YY. <- failed.

// suicidal personality
If XX is lonely and XX feels frustrated then XX becomes
   suicidal.
If xx becomes suicidal then xx may kill xx.

//murderer personality with a weapon.
If XX becomes murderous and XX has a gun then XX may shoot YY
   .

//murderer may kill
```

If XX is a murderer then XX may kill YY.

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