Audience Aware Computational Discourse Generation for Instruction and Persuasion

by

Eren Sila Sayan

Submitted to the Department of Electrical Engineering and Computer Science
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Abstract

If we are to take artificial intelligence to the next level, we must further our understanding of *human storytelling*, arguably the most salient aspect of human intelligence. The idea that the study and understanding of human narrative capability can advance multiple fields, including artificial intelligence, isn't a new one. The following, however, is: I claim that the *right way* to study and understand storytelling is not through the traditional lens of human creativity, aesthetics or even as a plain planning problem, but through formulating storytelling as a question of *goal driven social interaction*. In particular, I claim that any theory of storytelling must account for the goals of the storyteller and the storyteller's audience.

To take a step toward such an account, I offer a framework, which I call *Audience Aware Narrative Generation*, drawing inspiration in particular from narratology, cognitive science, and of course, computer science. I propose questions that we need to work on answering, and suggest some rudimentary starter thoughts to serve as guidelines for continued research. I picked a small subset of the proposed questions on which to focus my computational efforts: storytelling for teaching and persuasive storytelling. More specifically, I developed exploratory implementations for addressing this subset on the Genesis story understanding platform. The results have been encouraging: On the pedagogical side, my implementation models and simulates a teacher using the story of Macbeth to instruct a student about concepts such as murder, greed, and predecessor relationships in monarchies. On the persuasion side, my implementation models and simulates various different tellings of the classic fairy tale "Hansel and Gretel" so as to make The Witch appear likable in one, and unlikable in another; to make The Woodcutter appear to be a good parent just going through difficult times in one, and a bad parent in another. Perhaps the most amusing example however, especially in these days of sensationalized and highly subjective journalism, is that given a story of the cyber warfare between Russia and Estonia, my implementation can generate one telling of the story which makes Russia appear to be the aggressor, and yet another telling which makes Estonia appear to be the aggressor. And isn't *that* the story of history, politics, and journalism in one neat package!

Overall, I have made four key contributions: I proposed Audience Aware Narrative Generation as a new framework for developing theories of storytelling; I identified important questions that must be answered by storytelling research and proposed initial plans of attack for them; I introduced storytelling functionality into the Genesis story understanding platform; and I implemented narrative discourse generators which produce a wide range of narratives, adapting accordingly to different audiences and goals.

Thesis Supervisor: Patrick Henry Winston
Title: Ford Professor of Artificial Intelligence and Computer Science

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The most important lesson I learned at MIT is that nobody achieves anything alone. And I am no exception. I have a lot of people to thank for supporting me throughout the writing of this thesis, as well as throughout MIT and life.

To my academic advisor Joel Voldman. You never stopped believing in me, and you were always available with your sage advice wrapped in hilarity. Thank you.

To my professors Adam Burgasser, Andrea Walsh, Denny Freeman, Mark Harvey and John Harbison for enriching my intellectual life in ways that will always stay with me.

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To my friends. Matt, Eyas, Zeynep thank you for your constant love and support. Asli, Defne, Ece, and Pinar: my childhood friends, you've all been no less than sisters to me, and I wouldn't be the person I am today without you.

To Niall: You have so much kindness, patience and love in your heart, that I sometimes suspect you might in fact be the 15th reincarnation of Buddha. Thank you. I quite literally could not have done this without you.

To my loving and most beloved parents, Gonul and Serdar: When you two first met me, newly minted PhDs yourselves, I don't know if you thought I'd one day become a master of anything other than eating and sleeping, and being pretty adorable, let alone become a Master of Engineering. What I do know is that you always believed in me and offered me an endless love and support. You two have always been my greatest champions and I can't thank you enough. Dad, I remember that when I was a senior in highschool, applying for colleges and an absolute nervous wreck, you had no doubt that I would get in absolutely everywhere. When I was surprised beyond belief that I really, truly had gotten into MIT, you weren't even fazed. I know that this was you believing in me endlessly, and so believed in myself, too. Mom, I remember

that when I was a senior in highschool, applying for colleges and an absolute nervous wreck, you were right there with me. You not only helped me with my work, because you are one of the smartest people I know, but you stayed up with me during work and panic filled nights. I look up to you, and know that I will have succeeded at life if I can be even half as amazing as you are.

To Professor Patrick Henry Winston: I'd long been crafting an essay-length thank you note for you in my mind, waiting excitedly for the day that I would finally reveal it to the world in the acknowledgments section of my thesis. But I think I'll go with the following instead: I've learned much from you not just about artificial intelligence but also about life; about how to be a caring and active member of a community, an inspirational scientist, a great storyteller... I saw how you take care of your students, and the way you stand up for "the right way" not just in science, but in life. I saw that, and I thought, "I want to be like that."

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Chapter 1

Introduction

If we are to take artificial intelligence to the next level, we must attain a sufficiently sophisticated understanding of the nature of human intelligence, especially of the ways in which it differs from the intelligence of other primates. A crucial step towards achieving this goal is to investigate *the role of storytelling* in human intelligence. The study of storytelling promises to prove conducive to furthering our understanding of the human intellect, because storytelling as an intellectual activity itself constitutes an undeniably large aspect of human thought and human social interaction.

For the research I present here I explored human storytelling through a multi-disciplinary lense, with a keen view towards using my findings to implement a computational storytelling system. As the reader of this thesis, you will find that the contributions of my work have been twofold: 1) I've *outlined a framework* for working on the problem of developing a comprehensive theory of storytelling that lends itself to computational implementations, *suggesting a list of necessary aspects* the development of such a theory would need to address, and 2) I've taken the first steps towards implementing such a storytelling theory as a computer program.

In particular, you will get to see examples like

- how the story of Shakespeare's Macbeth can be narrated with different levels of details for different audiences if the goal is to *teach the audience* various concepts, and
- how the famous fairy tale Hansel and Gretel can be narrated differently to

persuade the audience of different outcomes. For example, it may be narrated one way to persuade the audience that the traditionally "evil" Witch is in fact a likable character, and yet another way to persuade the audience that The Woodcutter who abandons his children in the forest, but is exonerated by the end of the traditional narration of Hansel and Gretel, is in fact an unlikable character.

Before I get into any technical details, I:

- discuss my personal motivations for this work,
- promise what you can expect to get out of reading this thesis,
- outline my research objectives in broad strokes,
- give you a basic sense of what the computational implementation of storytelling discussed in this thesis looks like, and
- prove a roadmap for the rest of the thesis.

1.1 My personal motivation for this work

For the scientists, engineers and scholars who brave the largely uncharted and wildly exciting terrains of the field of artificial intelligence, the holy grail has two inseparable components: to first *understand* human intelligence, and then to *replicate it* in machines. In other words, the wide-eyed student of artificial intelligence who dreams of a world where Star Trek's Data[1] can finally be a reality must concern herself with the human just as much as with the machine. As such, in the process of this thesis I spent many days and night thinking about *the storytelling human* so that I could realize my dream of *the storytelling machine*.

I find that with any endeavor it often proves illuminating and sobering to ask,

[1] As a public service announcement to those who might not have watched *Star Trek: The Next Generation*, it is a wonderful sci-fi TV show set in the 24th century, chronicling the adventures of a spaceship and crew on duty around the Milky Way galaxy. It expertly tackles fascinating questions of technology, philosophy, humanity and artificial intelligence. Lt. Commander Data, who happens to be an android, is a remarkable character in this series. Here's one of my favorite quotes by him: "If being human is not simply a matter of being born flesh and blood, if it is instead a way of thinking, acting and feeling, then I am hopeful that one day I will discover my own humanity. [...] Until then, I will continue learning, changing, growing, and trying to become more than what I am."

"Why do this?" So, let me do the same here: Why, as an artificial intelligence researcher, do I work on storytelling?

It's worth noting that the tradition of studying stories in the context of artificial intelligence extends as far back as the 1970s, with Roger Schank being one of the first proponents of the approach (1). Patrick Henry Winston, compelled by Schank's argument that stories provide important clues into the fundamentals of human intelligence (2), started to work on analogical reasoning in the 1980s (3). Having found strong multidisciplinary evidence in support of the importance of the human narrative capability to human intelligence in fields ranging from linguistics, to developmental psychology, to paleoanthropology (4), Winston's continued work on story understanding as an integral part of artificial research culminated in his Strong Story Hypothesis (5):

> **The Strong Story Hypothesis:** The mechanisms that enable humans to tell, understand, and recombine stories separate human intelligence from that of other primates.

With this, Winston goes beyond just suggesting that stories are an important piece of the puzzle of human intelligence, but affirms that human narrative capability constitutes the very foundation of human thinking, as separate from that of all other primates. This hypothesis is also one of the main drivers leading to the development of the story understanding platform Genesis (5).

The Strong Story Hypothesis together with The Social Animal Hypothesis, which states "Our social nature amplifies the value of story understanding and directed perception," (6) constitute my intellectual point of departure in this thesis on computational storytelling, and the Genesis platform, my computational framework[2].

In this thesis, I propose we think about storytelling and computationally model it. In particular, I propose we focus on what I call "*audience aware storytelling*" – a kind of storytelling practice wherein the audience is at the forefront of the narrator's considerations, and the narrative is molded with a keen awareness of the narrative

[2]The exact mechanisms at play in the Genesis system are elaborated upon in Chapter 2

goal and how it may be achieved *given the particular audience*. This may sound complicated but really, it's just a description of the kind of storytelling we experience every day. For example:

- You have landed a nice job as a speech writer for a candidate running for office. You are given your first assignment: "We need a speech about the public school system". Think about what crucial information you would want to find out before you sit down to write. If you are to keep this prestigious job, the following two should probably be on your list: 1) to whom will this speech be delivered, and 2) what am I aiming to convince the them of?

- You're faced with some version of that popular question: "Where do babies come from?" Your answer would depend on who has asked you this question. Depending on whether the curious asker is a four year old, a middle schooler or a college freshman studying biology, you would need to provide different levels of detail. The four year old likely wouldn't know about sexual reproduction, let alone cells and gametes. You would need to tell her a simplified version of the process which doesn't go into the details of cell biology, and describes sexual reproduction in a way that is accessible to her. The middle schooler would likely have a concept of sexual reproduction, as well as cells, so a good place to start teaching her might be that cells involved in reproduction are called gametes, and teaching her about fertilization, the zygotic and fetal stages. Lastly, a college freshmen in biology would have sufficient background knowledge about gametes and ferrtilizaton, that the most educational way to answer this question for her might be to introduce her to the concepts of genes, chromosomes and meiosis, etc. In other words, the scope of your answer and the amount of detail you provide would be determined by how much your audience already knows.

- You're a teenager, are very much in love and you want to get your parents to like your boyfriend. In your campaign to portray your significant other as someone your parents would approve of, you might emphasize his admirable qualities and downplay his less attractive ones. For example, you might talk repeatedly

of his keen sense of humor, academic talent and admiration of you as a person, while choosing not to mention that he has a tendency to lie and isn't very kind to people around him. As such, in order to achieve your goal of getting your parents to like your boyfriend, you would be selectively constructing an image of him in your family's mind, with a view towards what qualities they might like to see in a person with whom their child is romantically involved.

What do you notice about the example situations above? You recognize them as instances of a very familiar theme of human communication: two entities - *a storyteller and an audience*- communicating via the telling of *a story in service of a particular communication goal.*

What I'd like to impress upon you is this: Stories are all around us. Not only in literature and folk tales, but in a history lecture, in the science class, in the news, in a job interview when you're trying to convince the company to hire you, in a job negotiation when the company is trying to convince you to work for them, in your loved ones asking you how your day was and you telling them about it, and much more. Stories weave through human societies in space, time and culture. And in all of these stories, there is a *storyteller*, an *audience*, and a *goal* associated with the telling of the story, whether that goal is entertainment, education, cultural propagation, a desire for emotional intimacy, or even political propaganda. This is precisely why I not only propose we work on storytelling to further artificial intelligence research, but that we do so *the right way*: by investigating storytelling as the goal driven, socially interactive and computationally fascinating human activity that it is.

So, let me circle back to my original question: Why, as an artificial intelligence researcher, do I work on storytelling? I work on storytelling because

- the narrative capability is central to human intelligence,
- stories are omnipresent in the human experience, and
- the study of storytelling can illuminate many questions on topics ranging from planning in the human mind, to mental modeling, to human linguistic functionality.

Finally, on a more hedonistic note, *I* work on storytelling because some of my

favorite memories are from listening to my grandmother's tales of faraway lands where she grew up, falling asleep to the bedtime stories my mother crafted for me, absorbing my cultural heritage through the folktales my father shared with me, and the stories I exchange everyday with my teachers, students, loved ones and even strangers on the street.

I like to think I've made a strong case for the motivation of this work. Nonetheless, I'll leave you with this one last thought, in the form of a haiku.[3]

can a machine which
can't tell stories ever be
truly intelligent?

1.2 My promise to you

By the end of thesis you will have seen:

- A novel framing of the computational storytelling problem,
- The identified necessary aspects of a multidisciplinary and comprehensive theory of storytelling
- How instructional and persuasive computational narrative discourse generators might be implemented — specifically in this case using Genesis, a story understanding platform, as foundation, and
- Examples of computationally generated narrative discourses for teaching and persuasion, produced by the Genesis implementation.

You will also have developed a new appreciation for the complexity of human storytelling and its relevance to artificial intelligence research.

IMPORTANT NOTE: Before you read on any further, I'd like to refer you to the Section 3.1, particularly if you are unfamiliar with narratology terms and con-

[3]The inspiration for the haiku comes from an effective question Erik T Mueller, whose work on the program DAYDREAMER (7) has been influential on me, asked in his book: "Can a computer even be fully intelligent *without* being able to daydream?"

cepts. I've used the formal narratological definitions of words like "story", "narrative" and "discoure" in this thesis, and you'll find that these formal definitions differ in important ways from how we use them colloquially. So, to make the best out of reading this thesis, you should study that short section first.

1.3 Research objectives and the question

1.3.1 What I set out to do

The goal of this work is to construct a multidisciplinary framework for developing a comprehensive theory of human storytelling *the right way*, using artificial intelligence techniques and the Genesis platform as tools. I also aim to implement some portions of what such a theory might look like. In the process of this work I set out to:

- Extend the Genesis story understanding platform's functionalities, and introduce storytelling capability to the system,
- Contribute new ideas to artificial intelligence,
- Expose interesting and heretofore unanswered questions in artificial intelligence and cognitive science,
- Gain new insights into psychology and cognition,
- Generate new hypotheses about storytelling,
- Propose methods by which these hypotheses could be tested, and
- Identify opportunities for some of these insights and implementations to be put to use in further applications.

1.3.2 How I framed the question

One important way in which we humans engage our narrative capability is when we tell stories to ourselves as a way to understand the world around us (8). Still, we shouldn't overlook the fact that, whatever the form of storytelling[4], storytelling as *social interaction* is a crucial piece of the puzzle.

[4]The form can be oral tradition, written word, visual media, it can depend on whether the storyteller and audience are present in the same space concurrently or not, etc.

A lot of the stories we tell on a daily basis aren't stories we've dreamed up. Instead, they are stories of already lived experiences, or of shared human knowledge. Consequently, the largest part of the narrative generation work we do every day is not *story* generation, but narrative *discourse* generation. In other words, a lot of our everyday storytelling efforts are expended upon the *how* of storytelling, rather than the *what*.

As such, **here is my vision**:

In order to gain a full understanding of storytelling we must move beyond formulating it as a question grounded solely in human creativity and artistic aesthetics, as it has almost exclusively been done in the past (9), and we must *frame it also as a question of goal driven social interaction*. Molding a discourse around a story in order to serve a social communication goal is a complex and important question, and artificial intelligence must account for it in order to truly move forward.

Many dimensions are involved in this *how* of storytelling, which is formally known as narrative discourse generation. The storyteller must, for example, choose which events to report out of the many that make up a story and how to package and deliver these events. In making these decisions, the storyteller must not only possess literary tools of the trade, so to speak, but also be aware of her communication goal *and* her audience, such that given a narrative goal and narrative tools, she may create a solution (i.e. a narrative discourse around the story) to achieve this goal.

I claim that a theory of human storytelling cannot hope to be succeed fully without addressing the implications of these observations. I present a framework for working on developing the right kind of theory of storytelling. Furthermore, I demonstrate working implementations of portions of such a theory — in particular, one that accounts for storytelling with the goal of instruction and one that accounts for storytelling with the goal of persuasion.

1.4 The AUDIENCE AWARE STORYTELLER

This is a very brief overview of the Audience Aware Storyteller (AAST), which can be thought of as a collection of modules built on top of the Genesis platform. Before diving into the system details and implementation specifics in later chapters, I want to give you a quick sense of the basics of AAST as a system.

Describing the system in terms of its inputs and outputs should be helpful. (See Figure 1-1).

Figure 1-1: Inputs and Outputs of the Audience Aware Storyteller

An "audience description" is simply a text file that contains knowledge about the world in the form of if-then statements, as well as in the form of what are called "concept patterns" (to be explained in further detail in Chapter 2).

A "narrative goal" can be "teaching" or "persuasion", and gets even more specific within these categories (more details supplied in Chapter 5).

The "story text" is a simple text file which contains in natural language the story which we aim to tell our audience with a view towards fulfilling the narrative goal specified. The word "story" here is used in the way that it is defined in Chapter 3.

Finally, the output "narrative discourse" generated by the AAST can be thought of as a goal-oriented and edited version of the initial "story text", and it is passed in as input to the Genesis story understanding system for evaluation and display.

1.5 What you will find in the rest of the thesis

Now that we're done with the introduction, I give you an overview of the Genesis system in Chapter 2. This gives you a sense for the platform with which I worked, and

puts my implementation details into context. In Chapter 3, I provide you with some background on related narratology and cognitive science research which has inspired this work, as well as a survey of previous approaches to computational storytelling. In Chapter 4, you read about the framework I've created for developing a sound theory of storytelling that can be modelled computationally. Chapter 5 details my implementation of storytelling within Genesis, in particular instructive and persuasive storytelling. I present my results in Chapter 6, after which I take the opportunity in Chapter 7 to recapitulate my work and suggest what I think are exciting new directions for future work. Finally, in Chapter 8, I review the concrete contributions I made in this thesis.

Chapter 2

Genesis Overview

In this chapter, I provide only a brief overview of the Genesis story-understanding system as it has been described in great detail in (5), (6), and (2).

Genesis uses Boris Katz's START system to translate Genesis English into an inner language of relations and events. Genesis then uses the inner language descriptions to build an *elaboration graph* in which events are connected causally. Figures 2-1 and 2-2 visualize the Genesis inner language.

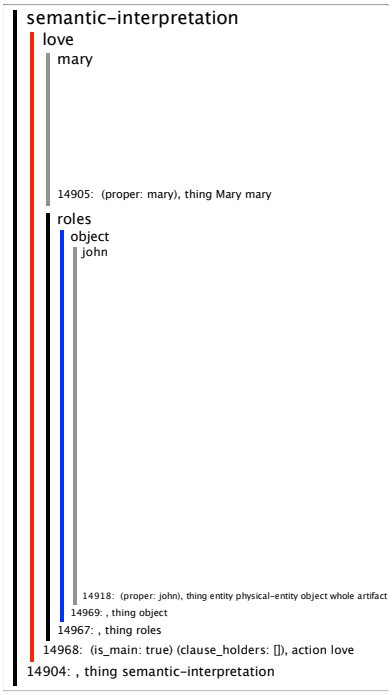

Figure 2-1: START and Genesis innerse on a simple sentence,"Mary loves John".

Figure 2-2: START and Genesis innerese on a more complex sentence, "Bob is unhappy because Bob loves Mary and Mary loves John.

Some causal connections are explicitly expressed by sentences containing the word *because*.

Explicit *leads to* expressions also connect elements to elements. These are supplied by expressions in the story, such as *Macbeth's murdering Duncan leads to Macduff's fleeing to England*. Such expressions indicate when two elements are known to be connected but the exact causal path is not known, or at least not supplied.

Others connections are established by *inference rules*, which insert, for example, connections between killing events and becoming dead events.

Explanation rules tie events together as needed. In reading a story, we humans seek explanations, and if none is offered, we assume connections that may hold, but not with sufficient regularity to be added by inference rules. In *Macbeth*, the story itself supplies no explicit reason why Macbeth murders Duncan and no inference rule supplies a reason, so an explanation rule connects the murder to Macbeth's wanting to be king, Macbeth's being Duncan's successor, and Duncan's being king.

Finally, *Means connections* tie events events to constituting events of finer grain. In *Macbeth*, Duncan's murder is done by stabbing, so stabbing is connected to murder with a means connection.

On a higher level, concept patterns capture the essence of concepts such as revenge. Concept patterns often involve multiple sentences, some of which contain *leads to* expressions. In fact, they can helpfully be thought of as micronarratives themselves. Genese uses concept patterns as recipes for searching through the elaboration graph, looking for ways in which the variables in the concept patterns can be instantiated.

Genesis has a concept of "perspectives," which are the readers of the stories and which are modeled in terms of the commonsense reflective knowledge they possess about the world. All these aspects of the Genesis system come together to enable the sort of story analysis seen in Figure 2-3.

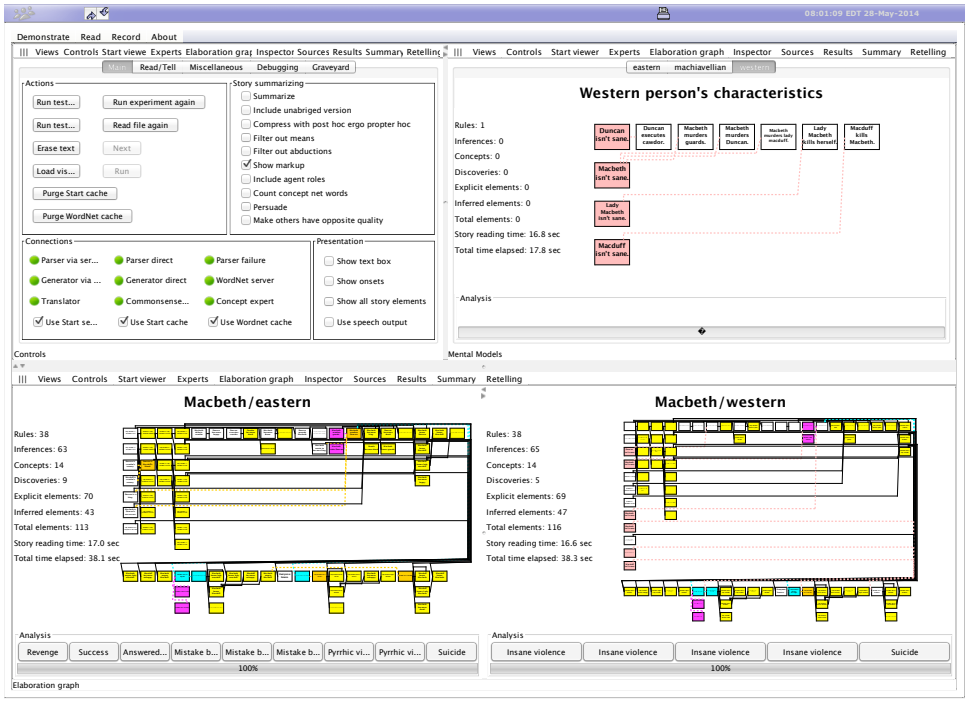

Figure 2-3: Genesis analyzing the story of Macbeth from two perspectives, Eastern and Western.

Chapter 3

Related Work

I believe that a phenomenon as multifaceted as human storytelling is best investigated using as diverse a toolkit as possible. Accordingly, in preparation for this thesis, I surveyed literature from narratology, cognitive science, and computational storytelling and creativity. The information I gathered, insights I gleaned, and new frameworks of thought I was thus able to add to my repertoire have heavily influenced my research. Here I share with you the information I believe to be key in informing the formation of a well-rounded theory of storytelling, which naturally lends itself to computational approaches.

3.1 What narratology teaches us

Narrative is universal. It is everywhere from the stories we exchange with friends and family, to cultural stories, to the classroom. In fact, the universality of narrative is supported not only by the "physical" omnipresence of narratives, but also by the functional importance of narratives to human thought and intelligence.

Babies start displaying narrative ability in their third or fourth years, when they become able to join nouns and verbs together. As such, the human narrative capacity can be said to be traceable all the way back to the very early stages of a human's life. Add to that that most adults report their earliest memories being from ages three and four, and we have a curious coincidence in our hands. Or do we? A

number of scientists believe that the way in which the beginnings of narrative ability and the beginnings of memory align is simply too suggestive to be written off as mere coincidence. They instead conjecture that *memory itself might be fundamentally dependent on the human narrative capacity.*

If we take one more step to note the crucial role memory plays in knowledge retention, and note also in turn the crucial role knowledge plays in reasoning, we can begin to see a path that leads decidedly from narrative capacity to intelligent reasoning. In this way, a strong case begins to develop for the undeniable importance of narrative capacity among human competences.

Even without taking this thought-experimental journey from connecting verbs and nouns, to narrative capability, to memory and all the way to the ability to reason, I find myself with the following intuition: Any human competence which emerges late enough that it doesn't appear to be reflexive, but still early enough such that it is possessed by the person for the majority of her life *must* be a crucial competence. Indeed, narrative appears to be so unequivocally pervasive that many scientists, among them the likes of famous neurologist Oliver Sacks, have come to theorize that narrative capability must be hard-wired.

With just a little careful introspection, it is possible to note a pattern in the way that humans seem to *seek out* stories. There appears to be a certain *narrative impulse*, shall we say, that humans possess, and which compels them to consistently try to make sense of their environments in narrative terms, and to go as far as injecting narrativizing even static scenes. The chances are, one look at the painting in Figure 3-1[1], and you'll know exactly what I mean. You may never have seen such a scene or learned of such an occurrence before, but that doesn't stop your narrative impulses from kicking in and trying to *understand* this scene, to discover the story behind it.

[1]This is one of the most striking examples of illustrating the human tendency to search for narrativity, and for this I love (10)

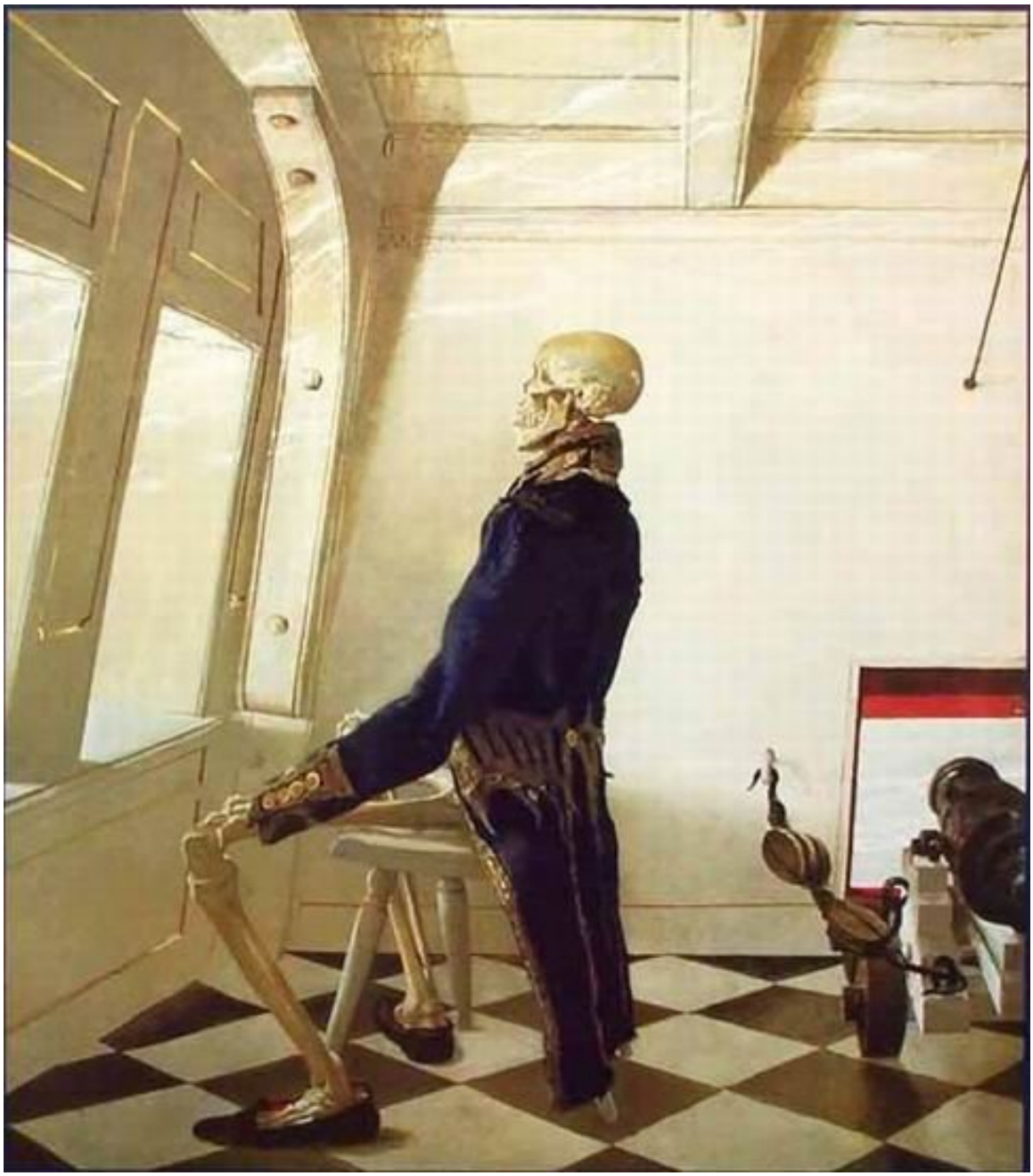

Figure 3-1: Andrew Wyeth, *Dr. Syn* (1981).

Visual art forms like paintings and photography, which rely on static scenes, work because even in such static scenes we yearn to find stories. Thus, static and nonverbal though they may be, visual arts are effective mediums for communication.

Let me not further belabor the point, and instead borrow from Fredric Jamelson who puts it well: "Narrative is an all-informing process. It is the central function or instance of the human mind."

Indeed, narrative is used by humans to, among other things, make sense of the world around them, along both the time *and* space dimensions. There are some very convincing arguments to be made, however, for the claim that the absolute most valuable function of narrative for humanity is that it is the "principal way in which our species organizes its understanding of time." (10)

3.1.1 Narrative(and)Time

I devote this short but important subsection solely to the relationship between narrative and time, because of the important and fascinating nature of the relationship. There is a certain circularity involved: Narratives are representations of sequences of events along the real timeline, and so the concept of time is a big part of narratives. In turn, a big way in which humans *understand* time is via narratives. Narratives allow us to register the passage of time because in essence what allows us as a species to perceive the passage of time are an ebb and flow of events. If you're not convinced, ask yourself this: If you were stuck in a chair in a room with completely constant lighting, constant temperature, constant *everything* would you be able to maintain a sense of time? You might rightly answer the physiological changes in your body would cue you to the passage of time — perhaps not with very high granularity, but certainly the passage of time would be felt.

I don't mean to go into a philosophical debate, but I do want to impress upon you the inextricable relationship between time and narrative, so I will iterate once more over the thought experiment I propose to you: Recall this time, how science-fiction narratives, for example, convey a sense of the freezing of time? That is, how do familiar narratives often describe the absence of a perception of the passage of time?

More often not, they provide some variation on the idea of being "frozen", where no one moves, no one ages; where, essentially, *nothing happens*. Events stop because time stops. Time stops because events stops. And if events are the foundation of narratives, I claim that where time disappears narrative disappears, and where narrative disappears so does time.

Given this unbreakably interdependent nature of time and narrative, and my expressed interest in this work to build a framework for both cognitively and computationally plausible theories of storytelling, I believe it's important to understand narrative time and how to manipulate it to different effects.

This finally brings me to two important concepts, with which I will close this section:

- Narrative time: The length of the narrative. (Can be measured in words, lines, or pages, for example; or if the narrative is conveyed through film, can be measured in minutes, hours, frames. Can also conceivably be measured in number of events, etc. There are no rigidly defined ways to measure narrative time.)

- Narrative speed: The relationship between the duration of the *narrated* — the (approximate) amount of time (presumably) covered by the situations and events recounted in what may be called *real time* — and the length of the narrative (in words, lines, or pages, for example). (11)

3.1.2 What *is* a narrative and other fundamental definitions

In this section I provide the formal and largely agreed upon[2] definitions of the concepts I've found to inform the strongest fundamental to dive into the field of narratology. Some of the definitions here by Prince (11) and by Abbott (10) are reported verbatim, while I explained some of the definitions myself, joining the most elucidating parts from both Prince and Abbott.[3]

[2]There tend to be some differences of opinion within narratology when it comes to matters of terminology and definition

[3]I never conjoin definitions in disagreements into one definition.

The most important terms to get a firm handle on are "story", "narrative", and "narrative discourse". Understanding these terms and the sometimes subtle differences between them is vital to being able to fully follow some important discussions in the chapters to follow.

Narrative: The representation (as product and process) of one or more real or fictive *events* communicated by one, two, or several *narrators* to one, two, or several *narratees*. Such (possibly interesting) texts as "Electrons are constituents of atoms", "Mary is tall and Peter is small", do not constitute narratives since they do not represent any event. On the other hand, even such possibly uninteresting texts as "The man opened the door", "The goldfish died" are narratives, according to this definition.

Story: The *content* plane of *narrative* as opposed to its *expression* plane or *discourse*; the "what" of a narrative as opposed to its "how"; the *narrated* as opposed to the *narrating*. Along with narrative discourse, one of the two defining components of narrative. Conveyed through the narrative discourse, story is a chronological sequence of events involving entities.

Narrative discourse: The *expression* plane of *narrative* as opposed to its *content* plane or *story*; the "how" of a narrative as opposed to its "what"; the *narrating* as opposed to the *narrated*. The story as narrated - that is, the story as rendered in a particular narrative. Some narratologists use the term plot for this concept, but this can be confusing because in English we commonly use "plot" and "story" interchangeably.

A narrator, or as it is mostly referred to in this thesis, a *storyteller*, is simply someone who *tells a story*.

3.1.3 A brief note on the interpretation of narratives

Abbott defines interpretation as "The act of expressing in one's own way the meanings — including ideas, values, and feelings, — communicated by a narrative."

The three main concepts necessary for being able to think systematically about narratives, which, I must be able to do in order to develop a theory of storytelling

with considerations of the audience at its center, are:

- Overreading: When an audience "overreads" she brings into the narrative materials and interpretations that are not actually described or signified within the narrative.

- Underreading: When an audience "underreads" she neglects materials that are in fact signified within the narrative.

- Gaps: Informational voids present in any and all narratives, which the audience is responsible for filling by drawing from her own experiences and imagination. Gaps are inevitable. They are not good or bad, they just *are*. The astute storyteller will not only know about gaps and their inevitability, but will recognize that gaps can be used cleverly in creating discourse in order to try to encourage the audience to overread, or to deliberately incentivize the audience to underread.

Let me illustrate these points with some examples.

- "For sale: Baby shoes, never worn." The discourse leaves many gaps in this narrative, one of the biggest and most compelling *gaps* for the audience to try to fill being the question of why these baby shoes were never worn. Is this a strange marketing slogan by a shoestore, or does the story (used as it is defined in narratological terms above) include the tragic event of the untimely passing of a baby? If so, why did the baby die, and how do the parents feel? The identification of one gap can quickly branch into exposing many related gaps. It is left to the audience to fill these gaps, and in doing so, she would be *overreading*.[4]

- The novel is a medium that often invites underreading. Frank Kermode, the inventor of the term, emphasizes that large parts of a novel often go virtually unread. He points out that the unbreakably committed and meticulously attentive kind of reading that would be required to *not underread* a novel would

[4]Famous as one of the shortest stories ever written, it is often attributed to Ernest Hemingway.

necessitate being in an almost unnatural state of mind, and such a reading would go against the traditionally understood sense and pacing of a novel.

3.1.4 Tools of the trade

Here I describe ideas that I believe are especially useful:

- Narrative speed has already been defined in Section 3.1.1. I now discuss how it can be used as a narrative tool with which to shape discourse according to narrative goals. Narrative time afforded to a real time event can be *extended* by narrating the event in more lines, frames, minutes etc. Extending narrative time corresponds to *decreasing narrative speed*. In practice, this can be done by describing events in more details, by dwelling on them. Events narrated at slow narrative speeds can evoke a sense of drama and gravity in the reader, and signal that this event is important. Alternatively, slow narrative speeds can evoke a sense of boredom and lethargy, and encourage readers to underread the sections detailing that event. Narrative time afforded to a real time event can be *compressed* by narrating the event in fewer lines, frames, minutes, etc. Compressing narrative time corresponds to *increasing narrative speed*. In practice, this can be done by glossing over events, or by excluding them from the discourse altogether. Events narrated at high narrative speeds can evoke a sense of urgency and excitement in the reader, and signal that the event is important for contributing emotional intensity to the narrative. Alternatively, fast narrative speeds can evoke a sense of carelessness and triviality, and signal to the readers that the narrated event is unimportant. In any case, narrative speed can be a highly effective and variable tool for crafting narratives, and as J. M. Coetzee puts it, can be a great source of narrative pleasure for the audience, as well as a demonstration of power for storytellers: "For the reader, the experience of time bunching and becoming dense at points of significant action in the story, or thinning out and skipping or glancing through nonsignificant periods of clock time or calendar time, can be exhilarating — in fact it may be at the heart of

narrative pleasure. As for writing and the experience of writing, there is a definite thrill of mastery — perhaps even omnipotence — that comes with making time bend and buckle, and generally with being present when signification, or the will to signification, takes control over time."

- Focalization refers to the perspective through which the audience gets to observe the characters and events in the narrative. Often narrative is focalized on the narrator, but this is simply a common practice and not a necessity. As part of the storyteller's toolset, focalization can have a powerful influence on how the narrative affects the audience's thought and emotional state.

- Distance can be thought of as the degree of the storyteller's objectivity — whether as a result of physical distance to the events and characters, emotional distance, or both — regarding the story she narrates. Distance can be thought of as an "indirect" tool, as its main usefulness comes from feeding into the *reliability* of the storyteller and therefore that of the discourse.

- Reliability is fairly self-explanatory. It refers to how reliable the audience finds the storyteller, how much she trusts her accounts of the events and characters of the story. Focalization and distance contribute heavily to the reliability of the storyteller. A reliable storyteller can establish a good rapport with the audience, and a good rapport with the audience can be a very powerful tool for a storyteller to have. It can pave the way for persuading the audience more easily, for example. Alternatively, it can be turned right on its head in the following way: A storyteller narrating a series of events with a view towards igniting skepticism in the audience about the value and validity of the events, as well as the reliability of the characters in the story, can create the discourse so as to establish certain focal characters in the story as unreliable. One can imagine, and sadly even observe on a regular basis, the use of this alternate approach in many political campaigns and low quality journalistic narratives.

- Repetition and motifs can be valuable tools in that they can serve to clearly

and quickly highlight where the intended focus of the narrative lies.

- Paratext: Those materials that exist *outside* of the narrative but are in some way connected to it physically or by association. For example: prefaces to books, "This is based on a true story" declarations in movies, tables of contents, titles, illustrations, time and location information at the top of a news articles, and annotations (as in the Mishneh Torah, for example). Paratexts, when coupled with being perceived as reliable, can serve as powerful narrative tools by being able to affect how the audience interprets a narrative.

Before moving on to the insights to be gleaned about human narrative capacity from cognitive science, I leave you with the following narrative to enjoy and ponder. Note the activation, or lack thereof, of your narrative impulses. Reflect upon the narrative, preferably aiming to analyze within the framework of the narrative terms I discussed in this section.

Figure 3-2: Edward Hopper, *Automat* (1927)

3.2 Narrative and the Cognitive Sciences

The domain of the intersection of cognitive science and the study of narratives is vast precisely because narrative capacity lies at the heart of human thought and cognition. Many principles of psychology and cognitive science are relevant to storytelling and understanding. Cognitive scientists tells us that telling stories to ourselves is how we understand the world around us. Whether we note it or not, we tell ourselves stories everyday, because everyday we must continue to understand the world. Cognitive scientists have also been able to outline the many cognitive, psychological and social factors at play when we share stories with others, as we so often do because we are social animals whose communication toolset is grounded firmly in narratives (12).

While my objective in this thesis does include trying to understand human storytelling by drawing from multiple relevant disciplines including cognitive science, it cannot claim that the storytelling hypotheses I proceed to offer here have the necessary rigor to be considered bona fide contributions to the cognitive scientific study of narratives. What would be realistic *and* prudent of me to do, however, is summarize the salient portions of my survey of cognitive research literature on narratives, with a view towards providing evidence that my approaches are not only cognitively inspired, but are also cognitively plausible as well as computationally plausible.

As such, in this section I outline the cognitive bases for various narrative approaches that I suggest for goal driven, audience aware storytelling.

Here is a list of the narrative tools and approaches I suggest be included in the toolkit of goal driven, audience aware discourse generation, and the cognitive science behind these suggestions.

- Construct mental models of the audience: Storytelling is an exercise in communication, and cognitive science tells us that one of the necessary components of effective communication between two individuals is for them to have formed accurate mental models of each other (13), (14), (15). To paraphrase Zawidzki, mindreading is necessary for mindshaping (16).

- Refer to the audience's base of prior stories: As Dr Melanie Green of UNC, Chapel

Hill, among others in the recent years, have demonstrated, people are more quickly persuaded by stories that bear resemblance to stories they already know. The increase in speed comes from the fact that hearing similar stories allows the audience to take cognitive shortcuts in the analysis of the new narrative.

- Make use of masterplots: This point is in some ways similar to the one above about making references to the audience's previous stories, but different enough in important ways that it is worth mentioning. Narratology defines masterplots as recurrent skeletal stories, belonging to cultures and individuals. It's been shown that masterplots, which I like to think of as the "universal bank of prior stories," can play a *powerful role in issues of identity, values, and the understanding of life* (10). Their close ties to issues of identity may well imply that they possess an increased propensity to exert an influence over the way an audience takes in new information, causing the audience to express an unconscious preference for interpretations of the new story which brings it into congruence with the masterplot. Some examples of a masterplot include the Cinderella story, and the monomyth (also known as the journey of the hero).

- Invoke empathy for persuasion: Research has shown that people are more immediately receptive to both physical interactions with and new ideas from people who they perceive as similar to themselves.

- Establish the storyteller as trustworthy and reliable: Psychology tells us that we are more easily persuaded by those we find not only to be trustworthy people, but reliable narrators of situations we're interested in. The persuasive advantages of being perceived as a trustworthy and reliable storyteller can be furthered leveraged by making use of paratexts to prime the audience to be more receptive to one kind of message from the narrative and not another kind.

- Use repetition for better instructive storytelling: Repetition serves to signal to the audience what the storyteller considers to be the focus of the narrative. Experiments conducted on reading/comprehension have demonstrated that, all

other things being equal, the more the focus of the reader, the more efficient are the learning and comprehension (17). Focus allows for faster learning, knowing what to focus on increases the concentration necessary for learning, and repetition tells the audience what to focus on.

- Manipulate the "Post hoc ergo propter hoc" fallacy: This cognitive fallacy causes people to believe that consecution implies consequence. Taking advantage of this fallacy and generating discourse that can place two events, which the storyteller wants the audience to believe are causally connected, near each other would increase chances of persuading the audience of nonexistant causal relationships between events.

- Improve continuity and coherence of the discourse for persuasion: Research shows that those narratives that audiences found more persuasive, were also found to appear more continuous and coherent to the audience.

- Use humor to make room for new ideas: Experiments have demonstrated that humor causes people to switch into more malleable and flexible mindsets, which are more receptive to new ideas and thus to being persuaded.

3.3 Computational storytelling and creativity

Here I summarize the results of a detailed survey of computational storytelling literature and, somewhat more tangentially, a survey of computational creativity research as it pertains to storytelling.

3.3.1 Storytelling through the lens of computational creativity

The study of human creativity, whether computational or not, has yielded some fascinating results and opened up a dialogue for interesting future research (18). An interesting body of research also exists at the junction of computational storytelling and computational creativity. In the meeting of these two research thrusts, storytelling is framed as a special case of the creativity problem. This approach prioritizes

the study of the author's creative process, which is modeled as an exploration or, in technical terms, search, through a conceptual space.

What sets this framing of the problem apart from a traditional search problem, for which many different solutions exists in artificial intelligence literature, is that there are very few constraints. The lax set of constraints on the search is thought to mimic the important ways in which the mind wanders, and makes previously unrelated connections to generate new ideas, i.e. find new paths from start state to goal state.

According to some reviews within in the field, one of the biggest shortcomings has been the decision to abstract away the social aspect of creativity. Most solutions in the field have been formulated as investigations into the mental processes of a lone creative actor. However, as Jennings perceptively points out in (19), the majority of human creative activity does not happen in a vacuum. Rather, creators exist in society alongside other creators, as well as critics. Jennings convincingly argues that it is these interactions of creators with other creators, critics and even new environments by being present and active in the world that holds some of the largest informational value and input for the creative process. This is a crucial observation that is easily generalizable to the investigation of virtually any human activity.

Before moving on to focus more heavily on computational storytelling as a standalone research endeavor, I note that the main question addressed at the intersection of computational creativity and computational storytelling has often been the question of how to generate *stories*. There seems to have been little to no interest in the more general question of producing *theories* of creative storytelling, perhaps because such an undertaking has not yet appeared ripe, and I note that there has been similarly little interest in the question of how to apply principles of creativity to the generation of *narrative discourse*.

3.3.2 Computational storytelling: past and present salient ideas in the field

In this section I list and briefly describe various noteworthy ideas that have come out of computational storytelling research. Some of these ideas mark new and exciting approaches in the field and some of them have passed the test of time to set the standards in the field. Yet others, though ingenious and impressive at their conception, haven't survived the changing currents of the field, but have taught the field a lot through the analysis of what their shortcomings may have been.

I organize my discussion into the following categories: Modeling, Goal Expression, Algorithmic Approaches, Narrative Tools, Story Generation, Discourse Generation, Larger Scale Theories. Note that one idea can be relevant to multiple categories.

Modeling Characters

Some ideas in modeling story characters are listed below.

- All characters have the same set of personality traits (e.g. kindness, vanity, honesty and intelligence), but in different compositions. These personality traits are more like sliders which can take different values, and the personality of the character is a sort of weighted average of a static set of possible personality traits (20)
- Character has internal state that consists of two components: goals *and* emotions (21)
- Characters have knowledge about the world (21)

Modeling the Author

Some ideas in modeling the author are listed below.

- Author is modeled in terms of her goals about the story she wants to write (e.g "the story should be entertaining and plausible") (22)

- Author is modeled in terms of her episodic memories (23)
- Author is modeled in terms of her bank of previous stories (24)
- Author is modeled in terms of the episodic memories *and* knowledge about the world she has — a sort of bank of previous stories, memories, and knowledge about people to apply to characters. She can refer to these in making up stories (22)

Goals

Some ideas in goal expression are listed below.

- Character goals: Characters have goals they want to achieve. (20) For example, the bear character may have a goal of somehow getting honey
- Audience focused goals: Requiring that the story produced by the system be interesting and consistent, for instance, may be thought of as goals set with the audience experience in mind (22)
- The author has goals regarding how she wants her story to turn out (22), (25)

Algorithmic Approaches

Some ideas in algorithmic approaches are listed below

- Forward chaining for getting from events to their consequences (20)
- Backwards chaining for tracing back from a desired outcome to the event that will lead to the outcome (20)
- For goal selection, using a precedence graph to record author goals, and searching through it for an available next goal (i.e. one with no missing preconditions) (25)
- Querying episodic memories via transform recall adapt methods (23)

- Novelty and interestingness checks carried out by comparing the newly generated story to the bank of previous stories (24)
- Using the intent-driven partial order causal link (IPOCL) planning algorithm in ensuring coherence of produced story (26)

Narrative Tools

Some ideas in narrative tools are listed below.

- Focalization can be modeled by associating a private semantic universe with each character (27)
- Focalization implemented using different focalizer worlds which, unlike in the above item, are not unique to characters in the story (28)
- Ensuring coherence of story before deploying it can be helpful (24)

Story Generation

- Characters have goals which they can perform various actions to achieve, and the story is added on to incrementally by the decisions characters make/actions they take to pursue their goals (20)
- Story is generated by the regular reformulation of the author's goals, the response to which is for the author to refer to her bank of previous stories, etc. to find the most appropriate next element to add to the story in order to satisfy her current goal (22)
- Story is generated through the *direction* of a story character in charge of all the other characters, each of which are autonomous intelligent agents. The character in charge influences the actions of the other characters in three different ways: by changing the story environment in a way which compels the characters to react to it, by giving character's specific goals, and by exercising its exclusive veto power to disallow a character from taking its intended action (21)

Discourse Generation

- The order of presentation of story is manipulated — the discourse can feature flashbacks, flash-forwards, reversal of event sequences, and interleaving of events from two different time periods (28)

Larger Scale Theories

- The system aims to model the human mind by making cognitively plausible design choices in its knowledge organization and knowledge retrieval (22)
- A theory of human daydreaming is developed in meticulous detail and computationally implemented (7)

3.4 Summary

In this chapter I presented the results of my survey into narratological terms and concepts, research linking narratives and cognitive science, and computational storytelling and creativity. The narratological terms and ideas outlined here are helpful to undersanding the rest of this this thesis, as they are fundamental to the development of my ideas in later chapters. The results presented from cognitive science serves the purpose of reassuring that the work presented in this thesis has cognitive plausibility, while the survey of existant research in computational storytelling has been influential to my implementation and problem formulation practices.

I note, finally, that there has been considerably little research done in the computational storytelling community in discourse generation as opposed story generation and various kinds of goal expressions and modeling.

Chapter 4

The Aspects of a Theory of Storytelling

In this chapter, I present a framework for developing a theory of storytelling which accounts for the nature of storytelling as a highly social activity rather than one conducted exclusively in a vacuum; which recognizes the rich spectrum of goals that can be associated with storytelling as an activity; which bears relevant information from multiple disciplines to address a human activity of such rich scope; and, finally, which smoothly lends itself to being studied, modeled, and extended via computational approaches. My claim is that such a theory would allow the scientific community not only to make large strides in furthering our understanding of the human narrative capability and therefore human intelligence, but also provide a strong momentum for advancement of the field of artificial intelligence.

I first enumerate the questions that such a theory must make sure to answer. Then, for each of these, I discuss helpful ideas, observations, and any possible initial approaches to addressing these points that I've been able to identify. You should keep in mind that the objective of this portion of the work is to provide a helpful framework and guidelines to aid in the development of a theory of storytelling, but I make no claims here to have developed such a theory myself.

4.1 Essential questions that a theory of storytelling must answer

Recall from earlier discussion that, from a narratological standpoint, a narrative has *three essential components*: a storyteller, an audience, and discourse (i.e. the representation of the story). What I'd like to really impress upon you here is something that is perhaps already implicit in traditional formal formulations of what a narrative is, but that is so important to the study of human narrative capability that I believe it absolutely must be made noticeably *explicit*: In addition to a storyteller, an audience and the discourse, *with any narrative, there is also always a goal.* I claim that in order to go forward in our study of storytelling, narrative *goals* must be thought of as essential to and inextricable from the study of storytelling, whether in the context of humanities or artificial intelligence.

With that, here are the essential questions that a complete theory of storytelling must answer:

- What is the scope of narrative goals? i.e., What kinds of goals can be associated with storytelling?
- How does a storyteller represent her narrative goals?
- How does a storyteller model her audience?
- What are the tools at the storyteller's disposal to use towards achieving her narrative goals?
- How does a storyteller plan for success given her narrative goal and toolset? In other words, what are the mechanisms of planning for achieving narrative goals? In what ways are they similar to and different from the other planning problems humans solve?
- How does a storyteller evaluate the success of her solution? (The "solution" in this context is a narrative discourse.)
- What are the methods for improving upon a solution?
- How and what does a storyteller learn from constructing and communicating discourses with her audience?

4.2 Helpful ideas, observations and suggested initial approaches for addressing each aspect

4.2.1 Scope of narrative goals

A quick survey of the stories we've heard over a single week or even day can alert us to the wide range of reasons people tell stories. These goals can get quite fine in their granularity and vary vastly in their medium of delivery, but it's tractable and useful to note larger *categories* of narrative goals, some of which I've identified to be:

- Entertainment: Societies have important traditions of telling stories as a way of providing entertainment. Novels, films, TV, and video games are all highly familiar and visible examples of the tradition of stories-as-entertaintainment, even though each achieves this goal via a different medium. It is of course, possible to enumerate many more such examples. Role playing games such as Dungeons and Dragons, for instance, are a great example of the present-day survival of improvised and interactive stories performed for entertainment. More traditional examples of storytelling for entertainment include Homer's epic poems, the Italian commedia dell'arte, the Turkish coffeehouse stories performed by a single traveling narrator, as well as the Turkish shadow plays like "Karagoz and Hacivat". It is important to note that the goal of entertainment imposes no restrictions on the genre.

- Pedagogy: Using stories to teach is so ingrained in human society's pedagogical DNA, that we may sometimes forget to take note of just how large a role storytelling plays in teaching. We already expect to find storytelling present in literature and creative writing classes, but how about in the teaching of other fields? Stories are in fact omnipresent in our educational approaches. It's easy to find stories in the teaching of history where events like wars and social movements are studied through the systematic lens of evidence and then described in narrative form; in science, where things like chemical reactions, gravitational forces, and the process of DNA replication are explained in the

form of narratives, with the anthropomorphization of interacting atoms, orbiting planets, cells, and genetic material constituting the *entities* in the story; in medical, legal, business and engineering fields where the cases to be studied are clear examples of narratives.

- Persuasion: Humans live in societies and many human endeavors require one or more people to convince one or more other people of their own point of view. In business, the entrepreneur must persuade the investor that her business is worth supporting. In the courtroom, the prosecution must try to persuade the jury that the defendant is guilty, while the defense attorney must make a case for her client such that the jury is convinced of the defendant's innocence. In none of these undertakings does a simple bulletized list of facts and evidence suffice. Business schools show time and time again that the entrepreneur who has the idea, the figures, and even the credentials, but doesn't have the compelling story will not be able to secure the investment. Law schools drill Aristotle's famous trilogy of persuasion fundamentals — pathos, ethos, and logos — into their students' minds, and emphasize that each of these fundamentals can benefit from storytelling: Law schools teach, for example, that stories can be an effective way for students to captivate their audience's attention and connect with them in an approachable manner *despite* the dense legalese. Even outside of the courtroom and the board meeting, we are faced with many situations every day where we must make a case for ourselves, and stories are the main way we do that.

- Managing conflict: A growing body of research shows (42) that storytelling can be a highly effective tool in conflict resolution, especially in zones of extremely high social tensions such as Israel/Palestine, Northern Ireland, and the regions of former Yugoslavia, and even in instances of conflict like bullying and gang violence, which tend to be independent of geography.

- Imparting knowledge about ethics, values, religion, and cultural norms: Fables, fairy tales, and stories from folklore are all stories we're familiar with, that we

grow up listening to, and are told to us with the intention of imparting lessons of a moral or ethical nature. The morality plays of Medieval entertainment is a more dated example of yet another way that storytelling has been used in human societies to outline different values, and attach connotations such as "desirable" or "undesirable" to them, in an attempt to propagate societally accepted norms of ethics and morality. Sacred texts all across religions are, unmistakably, collections of stories and they attempt to be very persuasive and moving in their discourse. Storytelling in religion is of course not confined to the texts themselves — some other examples include Christian sermons, the Jewish tradition of giving religious counsel in the form of stories and parables, the mystery plays of Europe in the Middle Ages, koans of Zen Buddhism and and the storytelling practices which are at the core of many shamanic traditions.

- Current events: Journalism is a big way that storytelling exists in our everyday lives. High quality and relevant investigative journalism depends on artful storytelling to be able to rise above the "big data" news consumption of our day and actually reach the masses, as well as to be able to inspire people, as needed, to embrace their civic duties in reaction to the developments reported on.

4.2.2 Description of narrative goals

With narrative goals residing at the heart center of this proposed framework for a new kind of theory of storytelling, it becomes an important task to choose the correct description for these goals, so as to expose the most relevant constraints, enable accurate evaluation of goal completion, and facilitate straight forward computational implementations of the theory. (50)

The goal description is best determined taking into consideration the *type* of narrative goal. First, I suggest four types of description I've formulated in very broad strokes to represent what the *goal-state* is for each of the narrative goals undertaken by the storyteller.[1] Then, I suggest which description to use with which narrative

[1]That is to say, the storyteller has succeeded in her storytelling goal if goal-state has been achieved.

goal.

Four types of goal-state description

- Emotional State Description: This description would detail the emotions experienced by the audience. It would probably be most useful to formulate this as a weighted average, depending on the relative intensities of the various emotions being experienced by the audience simulatenously.

- Knowledge State Description: This description would encapsulate the knowledge the audience has about the world. For example, the audience might know that Mars is the fourth planet from the sun in our solar system; that if you drop an object it will fall, that when people cry it might be because they are sad or because they are happy[2]; that when you hit somebody they might get angry at you; and that the Earth is flat[3]. Now, note that there would be no requirements for the knowledge to be true or complete. The important thing to keep in mind, however, would be to treat Knowledge States as fairly mutable. In other words, additional information from sources considered reliable by the audience should be able to add to the audience's knowledge base or change it. So, if the audience happens to find her science teacher very reliable and her science teacher tells her that the Earth is in fact an oblate spheroid, then the audience should update her knowledge about the shape of the Earth.

- Belief State Description: This description would encapsulate the beliefs held by the audience about the world. The subtle but important difference between the Knowledge State and the Belief State of an audience would be that one's Belief State would need to be significantly more difficult to alter. For example, the audience might believe that there are invisible little fairies on everyone's shoulders, advising them on what to do; or that the known universe will come to an end in the year 2300. Although, of course, beliefs need not be so outlandish!

[2]So, maybe she doesn't know that onions or eating hot peppers can make you cry
[3]The Earth is not flat.

The audience might simply believe that it is rude to interrupt someone while they are talking, for example. The important point is that beliefs should be treated as "semi-mutable", in the sense that they demonstrate a lot more inertia to being modified, negated, or altogether eliminated.

- Stimulus-Action Matrix Description: This description would encapsulate information about what actions are within the domain of possible next steps by the audience, and with what likelihood, given a certain stimulus. For example, provided with the stimulus of learning that global warming is causing dire draughts in farmlands, she might have the following set of possible next actions (with probabilities expressed next to the action): [Do nothing (0.2), Make a monetary donation to the affected farmers (0.2), Learn about ways to decrease her own carbon footprint (0.5), Start a political campaign to raise awareness about the farmers' plight and the dangers of global warming (0.1)] Of course, if the audience's knowledge base doesn't include a piece like "If you decrease your carbon footprint, you can help decrease global warming," for example, the probability of "Learn about ways to decrease her own carbon footprint," would be zero.

These are some rudimentary outlines for possible narrative goal descriptions. But it's still interesting to think about the increased opportunities for building an expressive and flexible computational storytelling system if we can flesh out these descriptions and get them to work in tandem. Of course, to have an internally consistent and cognitively plausible system, all four of these descriptions would need to work interdependently.

Which descriptions to use for which types of narrative goals

Here is a partial list of the narrative goals identified in Subsection 4.2.2:

- Description of entertainment goals: An entertainment goal-state would be best described in terms of the emotional-state description. For example, a romantic comedy might aim for an emotional goal-state of 5 parts romance, 5 parts joy,

while a Stephen King novel might aim for an emotional goal-state of 5 parts horror, 3 parts mystery, 2 parts relief.

- Description of pedagogical goals: A pedagogical goal-state would be best described in terms of the knowledge-state description. For example, for a storyteller aiming to teach her audience about the concept of succession in monarchies, the goal-state might be expressed as "If George is king and Henry is George's first born son, then when George dies Henry will become king."

- Description of persuasion and conflict management goals: A persuasion goal-state would be best described in terms of the belief-state description, as well as perhaps a certain stimulus-action matrix outcome. For example, if the storyteller is trying to persuade an audience of schoolyard bullies that bullying is wrong, the goal-state might be expressed on two levels such as:

  - Belief-State Portion: "Bullying is wrong and socially unacceptable."

  - Stimulus-Action Matrix Portion: Stimulus: Bully encounters a usual victim of his abuse. Possible next actions: [Apply physical force (0), Engage in verbal abuse (0), Do nothing (0.7), Apologize (0.2), Act friendly(0.1)]

- Description of other goals: The goal-states about imparting cultural/ethical/religious values, are best described using belief-state and stimulus-action description, because this would capture the desire of such narratives to affect both beliefs and practices. The description of religion or ideology related goal-states might also be supplemented by using the emotional-state description, because both types of narratives appeal frequently to emotions. Finally, while goal-states of quality, call-to-action type of journalistic narratives can be best described by a mixture of using knowledge-state and stimulus-action matrix descriptions, goal-states associated with tabloid-type journalism are probably best described by appealing to the emotional-state description approach.

4.2.3 Modeling the audience

Modeling the audience is an absolutely crucial aspect of developing the kinds of theories of storytelling for which I've been advocating in this work. Audience modeling, along with goal-orientation, is what sets apart a theory developed around this framework from other theories of storytelling, which often don't account for the audience in any meaningful way.[4] I recommend that audiences be modeled along as many of the following dimensions as possible. The first four items have been already been elaborated upon in subsection 4.2.2, so I don't dwell on them here, except to mention them as being necessary to the modeling of the audience.

- The audience's knowledge about the world.
- The audience's held beliefs about the world.
- The audience's emotional state.
- The audience's personal stimulus-action universe.
- The audience's bank of prior stories: As the cognitive science background research outlined in Chapter 3 has revealed, people are quicker to be persuaded by narratives which bear resemblance to other stories they already know.
- The audience's personal memories: Having access to the audience's personal memories, which themselves are narratives, would function similarly to having access to the audience's bank of prior stories, with the added benefit of stories of personally lived experiences being riper for engaging the audience in an emotional way. Being able to thus activate emotions could also pave the way for modeling, implementing and taking advantage of *empathy* modules.
- The audience's personality: Personality traits are essentially suitcase words which allow us to make predictions about how a person will react to given situations (47). The more accurately a storyteller can predict how her audience

[4]The literature review of computational creativity from Chapter 3 has discussed this point in some detail.

will react to things, the better chances she has of crafting narrative discourses that will actually achieve her narrative goals. Furthermore, people tend to sympathize with those who are like themselves, and tend to stand at a distance to those who are perceived as being different. Knowing the audience's personality traits would thus give the storyteller an opportunity to craft her description of the characters in the story and their personality traits in such a way as to be able to have an effect on how the audience feels about the chararcters.

4.2.4 The storyteller's tools

As evidenced by the discussion in Chapter 3 human storytellers across generations, languages and cultures have developed a common and stunningly versatile set of tools to craft narrative discourses. There are cognitive reasons behind why these tools tend to have the effects that they do, which have also been discussed in Chapter 3. Here, I'd like to review some common tools of the trade, both narratological and cognitive, which I've come to believe are highly effective ways to shape discourse with a view towards achieving well defined narrative goals[5]:

- Varying the speed of the discourse
- Priming the audience using paratext
- Changing focalization
- Using motifs and repetition for emphasis
- Play with the chronology of the story within the discourse
- Invoking the "post hoc ergo propter hoc" fallacy, or deliberately avoiding it
- Making references to the audience's base of prior stories, and to familiar masterplots

[5]If you find yourself unsure about what some of these terms mean or entail, flip back to the section on narratology for a refresher.

- Making deliberate attempts to evoke empathy within the reader, or knowingly avoiding it
- Fine-tuning the coherence of the discourse for desired effect on persuasiveness
- Using analogies and metaphors
- Using humor to soften the audience's cognitive resistance to opinion changes

4.2.5 Narrative planning

An important question remains: given the narrative goal, sufficient information about the audience, and a set of narrative tools, *how* does the storyteller go about actually shaping the discourse? Thusfar, I've been conjecturing that having certain *heuristics* might help in the planning of the discourse. These heuristics would be triggered by the kind of narrative goal, and might state, for example:

- If you want to persuade the audience that a the character Aysha is likable, change focalization to tell the story from Aysha's perspective.
- If you want the audience to feel an emotion X, decrease the speed of the discourse in parts where the events taking place would trigger the emotion X.

4.2.6 Evaluating success

As with any goal oriented task, it is vital to have a way of evaluating success. The specifics of the evaluation process would depend on the platform on which the story-telling theory is implemented (could be a computational platform, or an analog one; an interactive one or not, etc). We should be able, however, to isolate the general principles of success evaluation independently of the platform or implementation.

It seems to me that having described the goal-states in a well-defined manner, in terms of the various states the audience can be in, to be able to compare end-state and goal-state and thereby evaulate success, there would need to be a way of collecting accurate information about the audience's state after having been exposed

to the narrative. There is in fact a way to do this in Genesis, which proves very useful for experimentation, but one could argue that the assumptions necessary to enable this in Genesis are too rigid for it to be readily applicable in general as a principle.[6]

4.2.7 Improving upon the solution

In the search for a correct solution, i.e. a generated discourse which satisfies the narrative goal, how does the storyteller improve upon solutions which fall short to get to the correct one? Presumably, the storyteller must, and does, take an *iterative approach* to refining and improving upon her solutions until she gets to a correct one. It is possible to see this in human storytellers: Whether a novel writer, a speech maker, a graduate student like me working on her thesis, or even a single young person practicing her pick-up lines to finally get a potential mate interested in her, they all go through some version of a process which may inlude outlining, drafting, writing, rewriting, editing, and polishing.

My thoughts are this:

- To iterate over a given solution, one needs to have feedback on it.
- Following the line of thought suggested by the need for feedback, there must be a difference between what I'll call here *suggested solutions* and *deployed solutions*. An example of a suggested solution is the first draft of an essay written by a writer, which she doesn't show to anyone and instead rereads it herself and revises it. An example of a deployed solution is the final version of an essay published in a magazine, for which the author gets reviews.
- Iterating over suggested solutions requires that the storyteller be able to provide feedback for herself. From a cognitive point of view, this seems to imply that iterating over suggested solutions requires the storyteller to do two things: 1) Have storytelling/communication expertise, and 2) Form a mental model of the

[6]This will be elaborated upon in Chapter 7, but I should mention quickly that the assumption Genesis makes that enables us to inspect the audience's state is that we have perfect information about and full access to the audience's mental model.

audience and internally simulate how the audience would react to this suggested solution.

- The storyteller's checklist for iterating over suggested solutions also seems to have the following implication: It's possible to iterate on the *narrative* in suggested solutions by relying on self-provided feedbacks, but it is *not possible to iterate on and improve the audience model.* This, I believe is an interesting point which is worth further consideration, and it seems to provide further evidence for the formulation of storytelling as a necessarily *social* activity.

4.2.8 What can the storyteller learn and how?

Finally, I'll look at what the storyteller can learn and how this learning may take place. Again, I provide here only very rudimentary thoughts on the topic, my main objective being to *outline the question* for the collective consideration of the scientific community, rather than to answer it.

First, I hypothesize that most of the learning happens via *deployed solutions.* The *how* of the learning, then, is that it happens by deploying constructed narrative discourses to an audience, receiving feedback from the audience, and processing the feedback to internalize it as knowledge. Such a process might allow the storyteller to learn things about:

- The audience — the storyteller might find out that her model of the audience was incomplete or incorrect.

- The effectiveness of various techniques — the storyteller might start to hone her heuristics for what tools to use to achieve which goals, and develop a repertoire of techniques that are best used together.

4.3 Summary

In this chapter, I've described a framework for how to approach the development of future theories of storytelling with a view towards emphasizing goals and audi-

ence modeling. I've outlined the questions that must be answered by a theory of storytelling and provided some thoughts and preliminary ideas where I could.

The next chapter describes the specifics of my implementations on top of the Genesis platform for generating narrative discourses with the purpose of instruction and with the purpose of persuasion, respectively.

Chapter 5

Implementations of Narrative Discourse Generation for Instruction and Persuasion in Genesis

I begin this chapter by telling you about the research methodology which has guided my work. I outline the development of this thesis from idea into implementation as it fits into the framework of this methodology. In doing so, I present a narrative of my research, which organically motivates some of the important research and design decisions I've made along the way, makes it easier to highlight the emergent contributions of my research, and provides valuable context for considerations of how to move forward.

5.1 The Genesis Way and its influence on my research

Patrick Winston leads the Genesis research group with a strong emphasis on conducting research *"the right way"* (6). The right way includes an iterative research methodology inspired by Marr's 1982 treatise (49). Winston outlines the following five steps to loop through:

- First step: Identify the competence to be understood
- Second step: Formulate computational problems
- Third step: Propose computational solutions
- Fourth step: Develop an exploratory implementation
- Fifth step: Crystallize emergent principles

The following subsections demonstrate how my thesis work fits into this framework.

5.1.1 The first step: Identifying storytelling as the competence to be understood

The aspect of human intelligence I wanted to understand was storytelling. In particular, I wanted to understand goal oriented, audience aware discourse generation. The questions were: "Why do we find people telling different narratives around the same stories, given different times, situations and audiences?" and "How do people know how to construct these different narratives around the same stories?"

5.1.2 The second step: Formulating computational problems in storytelling

Table 5.1 presents the computational problems I formulated, drawing inspiration from the background research I conducted. After formulating the computational problems and brainstorming possible solutions, I chose to work on the problems of goal expression in storytelling, building a computational system endowed with algorithms that mimic certain human narrative tools, and to think about what knowledge descriptions could improve static audience modeling.

Table 5.1: Human storytelling competences and possible computational applications

Competences	**Explanation**	**Possible Applications**
Modeling (static)	A person can form mental models of others by bringing information she perceives about them into congruence with her prior knowledge about human behaviors and characteristics	Given some information about the audience (e.g. demographics, favorite books, etc.) the system models the audience, accounting for what knowledge they might have, beliefs they might hold, etc.
Modeling (dynamic)	A person can update her mental models of other in light of new information	Given indication that its model of the audience is flawed or incomplete, the system is able to update its model of the audience to be more accurate. Of course, this would require the system to be able to pick up on cues that its model is imperfect.
Goals	People tell stories in service of many different goals. These goals may be described in terms of the reaction the storyteller wants to elicit from its audience.	The system is able to express storytelling goals in terms of the eventual reaction that must be elicited from the audience.
Narrative tools	People have many narrative tools, which have been catalogued by narratologists, anthropologists, and social/cognitive scientists	The system has algorithms that correspond to human narrative tools
Simulation / Controlled hallucination	People can learn from acting out scenarios in their heads — also called "controlled hallucinations". People can and tend to mentally simulate social interactions before enacting these interactions in real life.	The system is able to simulate telling a story to its perceived audience, and thus make predictions about the real audience's reaction.

5.1.3 The third step: Proposing computational solutions

Based on the thoughts and ideas summarized in the Table 5.2, I decided to narrow my proposed solution space to implementing selective narration and a very basic version of variable speed.

Table 5.2: Narrative Tools for Persuasive Discourse Generation and Implications for Genesis Infrastructure

Desired Feature	Why do we need it?	What additions would the Genesis backbone need?
Selective narration	Not all information contained within a story may serve the persuasive goals we set out to achieve	No major infrastructure overhaul would be needed, but would need to formalize how to decide what story portions take out, which ones to leave in, and develop algorithms to put these principles into action
Variable focalization	First person narratives can skew the opinion of the reader to reach a subjective conclusion favored by the first person narrator.	Augmented story representation that enables representing the events from the different characters' perspectives.
Variable speed	Expanding on a given event and providing more detail creates the illusion that it takes up more time, which causes it to factor more strongly in the reader's perception of the story. That is, changing frequency allows emphasizing/de-emphasizing events, which can be a powerful tool for persuasion.	Augmented story representation where a story consists of events, and events consist of sub-events. This way, a given event can be expanded or collapsed.
References to reader's prior story base/use of masterplots	Psychological research shows that people are quicker to be persuaded by stories which bear resemblance to other stories they already know as these references allow the reader to take cognitive shortcuts.	Notion of prior story banks associated with any given reader perspective.
Evoke sympathy/empathy from reader	Research shows that eliciting an emotional response from the reader can be a powerful path to persuasion.	Personality traits need to be associated not only with characters in a story but with the readers themselves, as well.
Repetition	Research still pending on conclusive results on the exact mechanism, but repetition seems to be closely tied to better learning/persuasion. An informal example is brainwashing via repeated mottos, etc.	A sense of relative importance between units of story read must be established on the story understanding side. That is, some mechanism by which the story understanding side weighs pieces of information gained from a story differently depending on factors like repetition and emotional content.
Manipulate "Post hoc ergo propter hoc" fallacy	The reader's notions of causality in the story can be manipulated by appealing to this fallacy.	No additions needed
Use continuity/coherence for persuasion	Research shows that stories which appear to be continuous and coherent are more persuasive.	Need a well-defined metric of continuity and coherence.

5.2 Developing an Exploratory Implementation for Instructive and Persuasive Narrative Discourse Generation

In the following sections I detail my Genesis platform implementation for generating discourse to satisfy goals of instruction, and for generating discourse to satisfy goals of persuasion, respectively. For both implementations, I:

- Describe the problem setup, including an explanation of the specific goal descriptions and criteria for success;
- State the assumptions I make;
- Describe how the program works to transform its inputs into the right outputs; and finally;
- Discuss any conceptual and implementation-related contributions made to the Genesis platform

5.2.1 Instructive Narrative Discourse Generation in Genesis

The problem setup

The objective of this implementation is to automatically generate discourse to serve teaching goals[1]. I frame the problem as a storytelling event taking place between between two personas — the *teacher* and the *student*, where the teacher corresponds to the storyteller, and the student to the audience. The teacher and student are represented by two different *perspectives* in Genesis[2]. The teacher perspective is modeled to have a larger set of rules than the student. That is, the commonsense and conceptual knowledge the student possesses is always a subset of that of the teacher's. Furthermore, the storytelling event taking place between the teacher and the student is reminiscent of a real-time one-on-one tutoring session, where the teacher can ask

[1] See discussion on storytelling for pedagogy in Subsection 4.2.1

[2] Recall from Chapter 2 that Genesis can invoke multiple perspectives for the reading of a single story form.

for feedback from the student immediately after deploying a unit of information to her.

The end user of the program gets to decide how to model the teacher, how to model the student, the story to teach, and how shallow or deep the instruction should be (i.e. the *granularity of instruction*).

The competence to be implemented can be described as follows:

- The teacher is given a story on which to instruct the student;
- The teacher is considered to have successfully taught the story if, by the end of the teacher's narration to the student, *the student knows and understands everything about the story that the teacher does*;
- Consequently, the teacher must generate and deliver a discourse around the story so as to bring the student's knowledge and belief states[3] into *exact congruence* with that produced by the teacher's own analysis of the story;
- In working systematically towards achieving the teaching goal, the teacher must regularly check in with the student to take note of the student's current knowledge state;
- The teacher constructs different discourses for the same story and same students, given the granularity at which the instruction must happen, as designated by the user-provided goal. The different granularities of instruction are:
  - Spoon feeding: Having identified a gap in the student's understanding, the teacher plainly provides the conclusion the student should have inferred. **Example.** In narrating Shakespeare's Macbeth, the teacher tells the student "*Macbeth murders Duncan.*" If the teacher notices that the student hasn't inferred that *Duncan is now dead* because the student doesn't know about murder, the teacher spoon feeds to the student, "*Duncan is now dead*," before moving on to narrating the remaining story elements.
  - Elaborate explanation: Having identified a gap in the student's understanding, the teacher provides the conclusion the student should have inferred, *and* an explanation of how this particular inference is causally

[3]See Chapter 4

connected to the rest of the story. **Example.** In narrating Macbeth, the teacher tells the student "*Macbeth murders Duncan.*" If the teacher notices that the student hasn't inferred that *Duncan is now dead* because the student doesn't know about murder, the teacher provides an explanation to the student, along with the missing inference, such that the student can note the cause-effect relations she previously missed: "*Duncan is now dead, because Macbeth murdered Duncan*".

– Supplying principles: Having identified a gap in the student's understanding, the teacher provides the conclusion the student should have inferred, *and* tells the student of the general principle underlying this inference. **Example.** In narrating Macbeth, the teacher tells the student "*Macbeth is Duncan's successor. Macbeth murders Duncan.*" If the teacher notices that the student hasn't inferred that *Macbeth becomes king* because the student doesn't know about succession relations in monarchies, in addition to the missing inference, the teacher provides the underlying principle of succession relations to the student, such that in the future the student can infer succession relation outcomes by herself: "*Macbeth becomes king because Person X becomes king whenever Person Y is king, Person X is Person Y's successor, and Person Y becomes dead*".

In summary, the implementation is to fill in the student's gaps in understanding a story, using a model of what the student (i.e. audience) already knows. These gaps can be filled with varying degrees of detail. Note this type of discourse generation features only *additions* to the raw telling of the story — nothing is eliminated from the story in this creation of discourse for teaching.

Assumptions made

The assumptions that underlie this implementation are:

- The teacher has unlimited, real time access to the student's full mental state [4]

[4]Here, "mental state" refers to the student's full body of knowledge about the world and understanding about the story

- After the teacher relays each new story element to the student, the student volunteers to the teacher exactly everything she knows and understands about the story. Another way of thinking about this is that the teacher essentially gets to ask the student in very frequent intervals: "Tell me *everything* you know and understand about the story so far."
- The knowledge of the student is always a subset of the knowledge of the teacher's. The student doesn't possess any knowledge that the teacher doesn't have, meaning that the student also doesn't possess any knowledge that *contradicts* that of the teacher's.

Implementation details

Here I describe the inputs, outputs, processing, and representation details in the context of the Genesis implementation.

The inputs provided to the program by the end user are:

- The story to be taught: A regular plain text file which contains the story —a series of events— expressed in simplified English.
- The teacher/storyteller model: A plain text file which contains the commonsense knowledge and concept patterns the teacher is modeled to have.
- The student/audience model: A plain text file which contains the commonsense knowledge and concept patterns the student is modeled to have.
- Teaching goal, a.k.a. granularity of instruction: A variable whose value can be set by the use of radio buttons on the Genesis GUI. Possible values are: "spoon-feed", "explain", "teach principles".

The output produced has the following components:

- Generated discourse displayed in plain English: The text of the generated discourse is provided for the benefit of the end-user, so that the differences between the raw form of the story and the generated discourse can be observed clearly. This displayed English text is formatted to emphasize the work done by the discourse generator program. Statements in the discourse provided *in addition* to the explicit text of the story are colored red. The principles provided by

the teacher to the student in the discourse, which are immediately incorporated into the student's knowledge base and can be used in making inferences for the rest of the narration period, are colored blue.

- Teacher's mental state upon reading the story as is: An elaboration graph is produced, demonstrating the teacher's understanding of the story.
- Student's mental state upon being narrated the story via the discourse: An elaboration graph is produced, demonstrating the student's understanding of the story.

The implementation which takes these inputs and processes them to produce the desired outputs takes the following approach:

- Genesis instantiates two perspectives — teacher and student — each equipped with their own commonsense and reflective knowledge rules, as defined by their respective files.
- The plain text story is translated into Genesis innerese, as detailed in Chapter 2, and passed one element at a time onto both the teacher and the student perspectives for processing [5].
- When both the teacher and the student are finished with processing the most recent story element, the teacher inspects the student's elaboration graph produced thusfar.
  - If the elements present in the teacher's elaboration graph thusfar and the elements present in the student's elaboration graph are the same, the next story element is passed onto both the teacher and the student.
  - If there are elements present in the teacher's elaboration graph which are missing from the student's elaboration graph, the teacher takes action to immediately fill this gap in the student's understanding, depending on the granularity of instruction expected of the teacher:
    - If spoon feeding: The teacher relays the missing element to the student via the student's *Story Element Input Port*.

[5] Any rules that match the incoming story element are fired, thereby producing inferences about the story.

* If explaining: The teacher examines its own elaboration graph to discover the story element which is a *cause of* the missing story element. Then, the teacher relays the missing element, as well as its discovered cause to the student via the student's *Story Element Input Port*.

* If supplying principles: The teacher examines its own elaboration graph to discover the instantiated rule which enabled the student's missing story element to be included in the teacher's elaboration graph. Next, the teacher inspects its own knowledge base, looking for the general principle of which the instantiated rule is a special case. Finally, the teacher relays the missing story element, as well as the rule discovered to have been the general principle underlying the missing story element. The teacher relays the missing story element on the student's *Story Element Input Port*, and relays the rule on the student's *Rule Input Port*. At this point the rule becomes part of the student's set of rules which are used to process the remainder of the incoming story elements.

Discussion of implementation outcomes

This implementation spearheaded the introduction of the following conceptual and programmatic items to the Genesis system:

- Perspectives inspect their own rules to *reason about their own reasoning*[6];
- Perspectives inspect the elaboration graphs of other perspectives, constituting the first step in Genesis towards audience awareness;
- Ports for inputting rules to a perspective *during* the analysis of a story are exposed, constituting the first step in Genesis towards *learning on the fly* via narratives.

[6]This is reminiscent of the "Self-Reflective Thinking" level outlined in Minsky's six levels of thinking.

5.2.2 Persuasive Narrative Discourse Generation in Genesis

The problem setup

The objective of this implementation is to automatically generate discourse to serve persuasion goals[7]. This time, Genesis is used in a slightly different capacity than in the Instructive Narrative Discourse Generation implementation. In my implementation of Persuasive Narrative Discourse Generation, both perspectives in Genesis are in the *audience role*. What's more, both perspectives represent the *same* audience. In fact, in the implementation for Persuasive Narrative Discourse Generation, *the two Genesis perspectives describe the same audience's reaction to being told the same story in two different ways.*[8]

The audience is equipped with a multitude of concept patterns which all describe various personality traits such as "nice", "generous", and "selfish"; situational attributes such as "in a dilemma", "unlucky", and "in survival mode"; and social roles with value attached to it such as "bad parent" and "good husband".

In my implementation of Persuasive Narrative Discourse Generation, I think of the end user of the program as using the Genesis platform *like a literary test bench* — given a story like Hansel and Gretel, for instance, the end user can experiment with generating different narrative discourses around Hansel and Gretel such that The Witch appears to be a likable character, or that The Woodcutter is *not* forgiven for his parenting crimes and appears to be an unlikable character.

The end user of the program has many options to choose from in order to shape the process of persuasive discourse generation. She gets to decide and provide as input to the program:

- How to model the audience,
- What story to process for persuasive retelling,

[7]See discussion on storytelling for persuasion in subsection 4.2.1

[8]Note that this formulation is different from the way I set up the problem in Instructive Narrative Discourse Generation, where the two Genesis perspectives represent two different entities, the storyteller and the audience (i.e. teacher and student), with two different functions —narrating and being narrated to.

- The statement about which to persuade the audience by the end of the narrative,
- Whether to use only subtractive methods in the generation, or to use additive methods as well[9], and
- Whether to take a single-character or relativistic approach to the discourse generation.

The competence to be implemented can be described as follows:

- The audience is narrated the story in question in its raw form;
- The audience analyzes the story on the basis of its commonsense and reflective knowledge, displaying an understanding of the story and identifying standard concept patterns present in the story such as "bad parent", "generous", "understandably cautious", "honest", "caring", etc.[10] [11]
- The concept patterns identified are checked against the requirements of the persuasion goal;
- Any concept patterns identified that would hinder the achievement of the given persuasion goal are considered "undesirable" and are marked to be removed. How a concept pattern comes to be considered "undesirable" depends on the whether the program is operating in "single-character" or "relativistic" mode. Take the example where the persuasion goal is described as "Make The Witch be likable.":

[9] I use "Subtractive methods" to describe the process of excluding one or more story elements in the generation of the discourse, thereby having "subtracted" information in the retelling. I use "additive methods" to describe the process of emphasizing one or more extradiegetic/imagined story elements and/or paratext in the narrative discourse, thereby having "added" information in the retelling.

[10] A longer list of concept patterns defined to use in persuasive narrative generation can be found in the Appendix

[11] Note that these concept patterns, in contrast to many of the concept patterns defined previously within the Genesis group for uses with various different stories (47), are less focused on labeling high level conceptual occurrences like "revenge" or "pyrrhic victory", than labeling concepts about individual people, their behaviors, and the way they are perceived by others.

- If single-character mode: Any concepts involving The Witch that emerge from the analysis of the raw story that would negate the perception that The Witch is likable would be marked as undesirable. For example, a "cruel" concept triggered by The Witch trying to cook Hansel and Gretel in the oven might be marked for elimination.

- If relativistic mode: In addition to the concepts identified as undesirable by the standards of the single-character mode, in the relativistic mode, any concepts that make *other* characters appear likable might also be marked for elimination. This is because when The Witch is surrounded by *unlikable* characters in the narrative, for example, it would become easier to persuade the audience that The Witch herself is likable.

- Any concept patterns identified that would *support* the achievement of the given persuasion goal are explicitly considered "desirable" and are marked to be retained. Again, how a concept pattern comes to be considered "desirable" depends on the whether the program is operating in "single-character" or "relativistic" mode.

- After the identification of undesirable and desirable concepts, the associated story elements are removed and explicitly retained, respectively. In this way a new, *persuasive* discourse is formulated around the raw story.

- This new version, the persuasive discourse, is relayed to the audience[12].

- The persuasive discourse generated is considered successful if the audience, upon analyzing the discourse identifies only those concept patterns that agree with or don't affect the persuasion goal, *and* identifies none of those concept patterns which would disagree with, or work to negate the perception of the character aimed for in the persuasion goal.

[12]Recall, this is the same audience that was relayed and analyzed the raw story

Assumptions made

The assumptions that underlie this implementation are:

- It is possible to accurately and completely model the audience
- The system has unlimited access to the audience's full mental state
- Seemingly conflicting concepts can co-exist. For example, the audience's understanding and analysis of the story may entail instances of the same character X being involved both in an honesty concept, and a dishonesty concept.

Implementation details

Here I describe the inputs, outputs, processing, and representation details in the context of the Genesis implementation.

The inputs provided to the program by the end user are:

- The story to be narrated persuasively: A regular plain text file which contains the story — a series of events — expressed in simplified English.
- The statement about which to persuade the audience: A single English sentence of the following format: *Make [Character-X] be [concept].* **Some examples:** Make Macbeth be honest. Make The Witch be likable.
- The audience model: A plain text file which contains the commonsense knowledge, and especially importantly in case of this implementation, the concept patterns the audience is modeled to have.
- Choice of persuasion approaches:
  - Allowance of subtractive/additive methods: The default approach in the implementation is to use purely subtractive methods[13]. A variable can be set to true in order to enable the additive method of including a preamble to the story which aims to prime the audience towards the persuasion goal.

[13]I should note, however, that the introduction of the "in order to" idiom into Genesis to express the *means* of performing actions is itself an "additive" approach that has become a sort of default in the writing of our raw stories. It was motivated by a desire to be able to change narrative speed.

  - Single-character versus Relativistic approach: A variable, accessible via the "Make others have opposite quality" checkbox in the Genesis GUI, can be set in order to express preference for the relativistic approach. Otherwise, the default is the single-character approach.

The output produced has the following components:

- Generated discourse displayed in plain English: The text of the generated discourse is provided for the benefit of the end-user, so that the differences between the raw form of the story and the generated discourse can be observed clearly. This displayed English text is formatted to emphasize the work done by the discourse generator program. Statements in the discourse that are purposefully taken out are the story are colored red and struck-through. Statements in the discourse that are purposefully retained are colored green. And finally, any statements that are added extradiegetically (e.g. paratext like a preamble) are colored blue.

- Audience's mental state upon analyzing the raw story: An elaboration graph is produced, demonstrating the audience's understanding of the *raw story*, as well as the concept patterns identified.

- Audience's mental state upon being narrated the generated discourse: An elaboration graph is produced, demonstrating the audience's understanding of the *generated discourse*, as well as the concept patterns identified. The success of the persuasive discourse is evaluated by inspecting these concept patterns.

The implementation, which takes these inputs and processes them to produce the desired outputs, takes the following approach:

- Genesis instantiates two perspectives, both representing the same audience and therefore equipped with the same set of commonsense knowledge and concept patterns.

- The raw story gets translated into Genesis innerese and passed *only* into the first perspective for analysis.

- The first perspective analyzes the raw story, producing an elaboration graph and identifying concept patterns.

- When the end user specifies the persuasive goal (e.g. Make The Witch be likable), the goal is parsed to expose the character of interest (in this case, The Witch) and the concept of interest (in this case, "likable").

- The opposites of the concept of interest are identified (in this case, "unlikable) and put on a "watch-list," of sorts, of potentially undesirable concepts.

- The components of the concept of interest are identified (for example, concepts like "friendly", "generous", "caring", and "good parent" might come together to feed into the "likable" super-concept) and put on watch-list of potentially desirable concepts.

- A concept is promoted from potentially undesirable to definitely undesirable status if the character of interest is the main actor of the potentially undesirable concept.

- A concept is promoted from potentially desirable to definitely desirable status if the character of interest is the main actor of the potentially desirable concept.

- When operating with the relativistic mode, considerations of undesirable and desirable concepts switch up: A concept is undesirable if it asserts that a character other than the character of interest demonstrates the concept of interest, and vice versa.

- After the definitely desirable and undesirable concepts are identified, the story elements associated with them are marked for definite-retention and definite elimination, respectively.

- A preamble may be added to the start of the discourse to prime the audience about the persuasive goal. For example: "This is a story that demonstrates that The Witch is likable."

- Those items that are marked for elimination are removed from the raw story, and the newly generated discourse gets passed onto the second perspective, which is simply another exact instance of the audience.

- The audience analyzes the discourse and produces an elaboration graph, as well as identifying concepts present.

Discussion of implementation outcomes

This implementation spearheaded the introduction of the following conceptual and programmatic items to the Genesis system:

- It's possible to speak of a distinction between regular concepts and the "super concepts" which act as wrappers for collections of related regular concepts. A new idiom has been introduced to define these super-concept relations in files, which affords a great deal of flexibility. For example, one end user may choose to define "Likable" as a super concept consisting of "honest", "hardworking" and "generous", while another end user may choose to define "Likable" as consisting of "humorous", "misunderstood" and "friendly", all without having to touch the code at all.

- The "means" expression and its associated "in order to" idiom have been added as a result of realizing the effectiveness of varying narrative speeds for persuasion.

- There's a sense of interconnectedness and relativism amongst the characters of the story, which has come about via the conceptualization of single-character versus relativistic modes of persuasive discourse generation.

- The audience can now be primed about the story with the use of story preambles.

- A new idiom allows character-related storytelling goals to be expressed.

5.2.3 Summary

In this chapter, I've outlined how my work fits in with the Genesis group research methodology. In doing so, I've provided context for the research questions I've asked, which ones I chose to answer in detail, and why I formulated my solutions the way I did. I also provided details of two implementations inspired by the framework I introduced in Chapter 4. I made sure to provide a system description for the implementations, emphasize their objectives and outcomes, and state the underlying assumptions.

The next chapter presents the results of my implementations for instructive and persuasive narrative discourse generation.

Chapter 6

Results and Discussion

Here I present the results of my implementations run on various stories like Macbeth, Hansel and Gretel, and a political conflict story of cyber warfare between Russia and Estonia. The input stories are in simplified English and are better described as "variations," which have been modified in places, rather than renditions that remain completely loyal to the original story.

6.1 Experiments and Results for Instructive Discourse Generation

I use the story of "Macbeth" to illustrate the three granularities of instruction in ascending order: spoon feeding, elaborate explanation, and supplying underlying principles. It is important to remember that the student perspective is modeled to know less about the world than does the teacher — specifically, the knowledge base of the student is only a small subset of that of the teacher's.

Inspect Figure 6-1 to observe the effects of the student-teacher knowledge discrepancy. The teacher has made 25 inferences given the raw story, while the student has only been able to infer 9 elements.

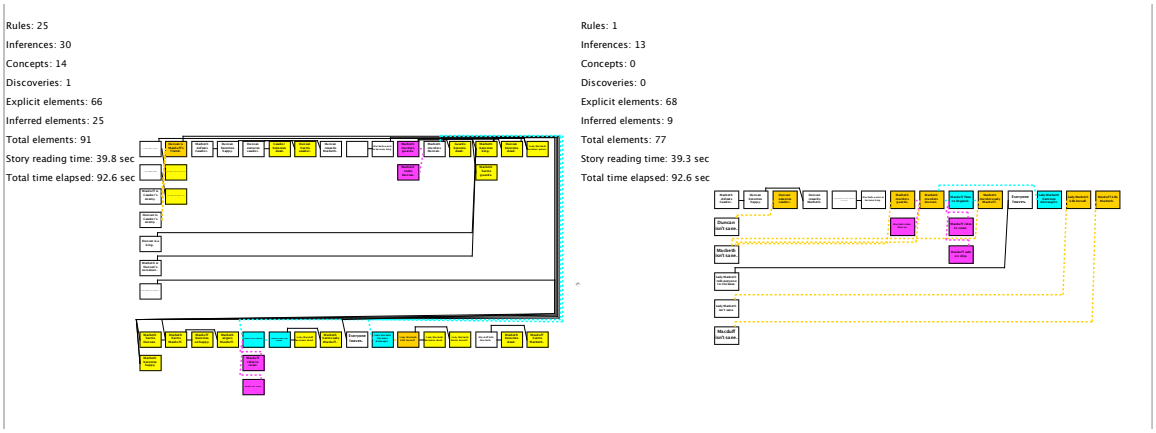

Figure 6-1: Teacher has a richer understanding of the story than the student.

6.1.1 Experiment: Spoon feeding "Macbeth" to student

The text in red represents the additions made by the teacher to help instruct the student.

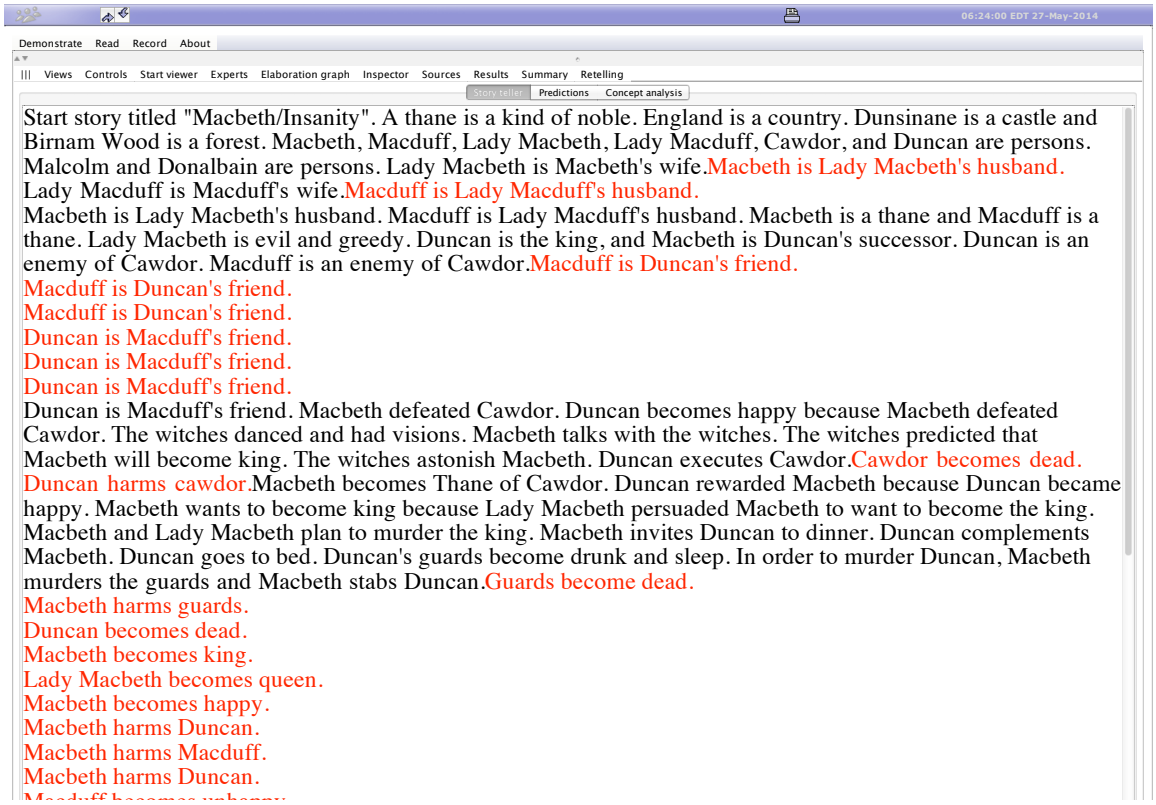

Figure 6-2: Student's comprehension gaps are filled by lone statements provided by the teacher.

6.1.2 Experiment: Explaining "Macbeth" to student

The text in red represents the additions made by the teacher to help the student better align its understanding with that of the teachers. Note that in the explanation level of instruction, the teacher makes sure to explicitly tie the missing statement to its causal antecedent, using a "because" construction.

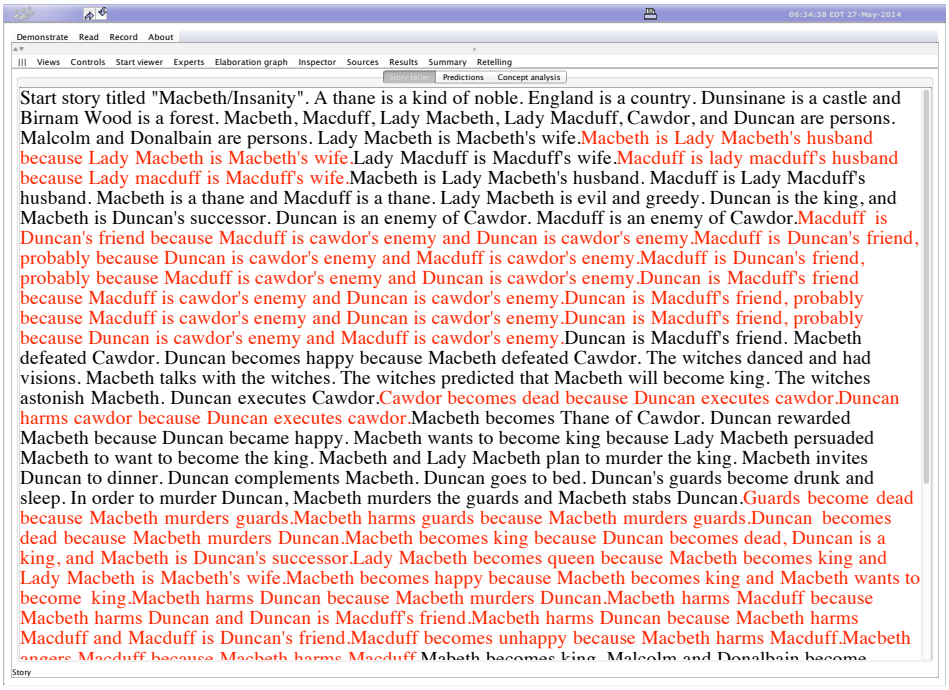

Figure 6-3: Student's comprehension gaps filled by teacher providing the missing statements and causal backing

6.1.3 Experiment: Providing principles of "Macbeth" to student

The text in red represents the information that the teacher discovers the student is missing and tells the student. The text in blue represents the commonsense rules the teacher introspected were involved in the discovery of the missing story element. The teacher transmits these rules to the student. Note that once the student learns that killing leads to death in the "Cawdor becomes dead..." sentence, the student is able to apply this rule to the rest of the story. Consequently, when the student sees the story element "Lady Macbeth kills herself", it is able to infer that Lady Macbeth is now dead and thus, doesn't need to be told about it again by the teacher perspective.

Start story titled "Macbeth/Insanity". A thane is a kind of noble. England is a country. Dunsinane is a castle and Birnam Wood is a forest. Macbeth, Macduff, Lady Macbeth, Lady Macduff, Cawdor, and Duncan are persons. Malcolm and Donalbain are persons. Lady Macbeth is Macbeth's wife.Macbeth is Lady Macbeth's husband because Person xx is person yy's husband whenever Person yy is person xx's wife.Lady Macduff is Macduff's wife. Macbeth is Lady Macbeth's husband. Macduff is Lady Macduff's husband. Macbeth is a thane and Macduff is a thane. Lady Macbeth is evil and greedy. Duncan is the king, and Macbeth is Duncan's successor. Duncan is an enemy of Cawdor. Macduff is an enemy of Cawdor. Duncan is Macduff's friend. Macbeth defeated Cawdor. Duncan becomes happy because Macbeth defeated Cawdor. The witches danced and had visions. Macbeth talks with the witches. The witches predicted that Macbeth will become king. The witches astonish Macbeth. Duncan executes Cawdor.Cawdor becomes deadbecause Person yy becomes dead whenever Person xx kills person yy. Duncan harms cawdorbecause Person yy harms person ww whenever Person yy kills person ww.Macbeth becomes Thane of Cawdor. Duncan rewarded Macbeth because Duncan became happy. Macbeth wants to become king because Lady Macbeth persuaded Macbeth to want to become the king. Macbeth and Lady Macbeth plan to murder the king. Macbeth invites Duncan to dinner. Duncan complements Macbeth. Duncan goes to bed. Duncan's guards become drunk and sleep. In order to murder Duncan, Macbeth murders the guards and Macbeth stabs Duncan.Lady Macbeth becomes queenbecause Person zz becomes queen whenever Person xx becomes king and Person zz is person xx's wife.Mabeth becomes king. Malcolm and Donalbain become afraid. Malcolm and Donalbain flee. Macbeth's murdering Duncan leads to Macduff's fleeing to England. In order to flee to England, Macduff rides to the coast and Macduff sails on a ship. Then, Macduff's fleeing to England leads to Macbeth's murdering Lady Macduff. Macbeth hallucinates at a dinner. Lady Macbeth says he hallucinates often. Everyone leaves because Lady Macbeth tells everyone to leave. Macbeth's murdering Duncan leads to Lady Macbeth's becoming distraught. Lady Macbeth has bad dreams. Lady Macbeth thinks she has blood on her hands. Lady Macbeth kills herself.Lady Macbeth kills herselfbecause Person xx kills itself may be a consequence of Person xx becomes distraught.Birham Wood is a forest. Burnham Wood goes to Dunsinane. Macduff's army attacks Dunsinane. Macduff curses Macbeth. Macbeth refuses to surrender. Macduff kills Macbeth.

Figure 6-4: Student's comprehension gaps filled and underlying principles supplied by teacher

6.2 Experiments and Results for Persuasive Discourse Generation

I use the story of "Hansel and Gretel" to illustrate the capabilities of persuasive discourse generation. I run experiments where I set goals to make each The Woodcutter and The Witch likable in one turn, and unlikable in another. For each of these goals, I run the experiments twice: once taking the single-character approach, and once taking the relativistic approach. Each produced discourse also includes a preamble to the narrative, which is constructed based on the goal and aims to prime the audience for what's to come in the story.

I also present the persuasive discourses generated for "Macbeth," one of the most fundamental stories used in Genesis, as well as providing persuasive retellings of the Estonia-Russia conflict story, getting to play devil's advocate in a way, through my implementation of the persuasive narrative discourse generator.

You should read through the narrative discourses produced by each of these experiments, keeping in mind the following:

- Text that is purely in black are elements present in the story which were deemed irrelevant to the persuasion goal, and therefore have been left as they are.
- Blue text indicates that this element wasn't part of the original story, and has been intentionally *added on*, during the discourse generation process.
- Red text with a strike-through indicates that this element was in the original story, but it thwarts the achievement of the narrative goal and was therefore explicitly determined to be eliminated during the discourse generation process.
- Green text indicates that this element was in the original story, and its presence in the discourse helps achieve the narrative goal. Therefore, it was explicitly determined as a keeper in the discourse generation process.
- Gray text is related to manipulations of narrative speed. The original stories at points contain "means" information — that is, detailed information about how

an action was performed. For a morbid example, consider: "In order to murder Duncan, Macbeth smacked Duncan with a blunt object and stabbed Duncan eight times."[1] This sort of detail should only be reported in the discourse, if the event is associated with achieving the goal. Grayed out text therefore indicates that this event had "means" details associated with it, but because expanding on the event details is not does not affect the achievement of the goal, these details which originally were in the story have been removed in the discourse.

6.2.1 Reading suggestions given the color coding

I suggest that you inspect each experiment result in two different ways. First read the discourse as it is intended for an audience in a non-experimental setting. That is, during your first pass, don't read the red strike-throughs. Ponder for a moment how you feel about the character in question. Then, go back and re-read the discourse as it is presented, including the red strike-throughs and consider whether their exclusion was indeed effective for you, as a reader.

I encourage you to go on to experiment in a similar vein with the blue, green, and gray text: How would the reading have gone differently for you if you had not read the blue preamble, thereby disallowing yourself to be told what to conclude about the message of the story? How does your perception of the characters change if this time you don't read the green material, which the generator explicitly decided was necessary to include? What might it be like if the events in gray text were expanded upon, and details were provided for them?

Keep a keen scientific eye on these experimental results, but also remember to have fun with the different tellings of the stories!

[1] Recall that providing details is one way of slowing the narrative speed of an event or, equivalently, extending the narrative time which an event takes, thereby placing emphasis on this particular even among others in the story.

6.2.2 "Hansel and Gretel" Experiments

First I demonstrate how The Woodcutter can be made to look likable and unlikable depending on the telling, using the single-character approach. Read the two narratives and see if you find yourself feeling differently about The Woodcutter in each instance.

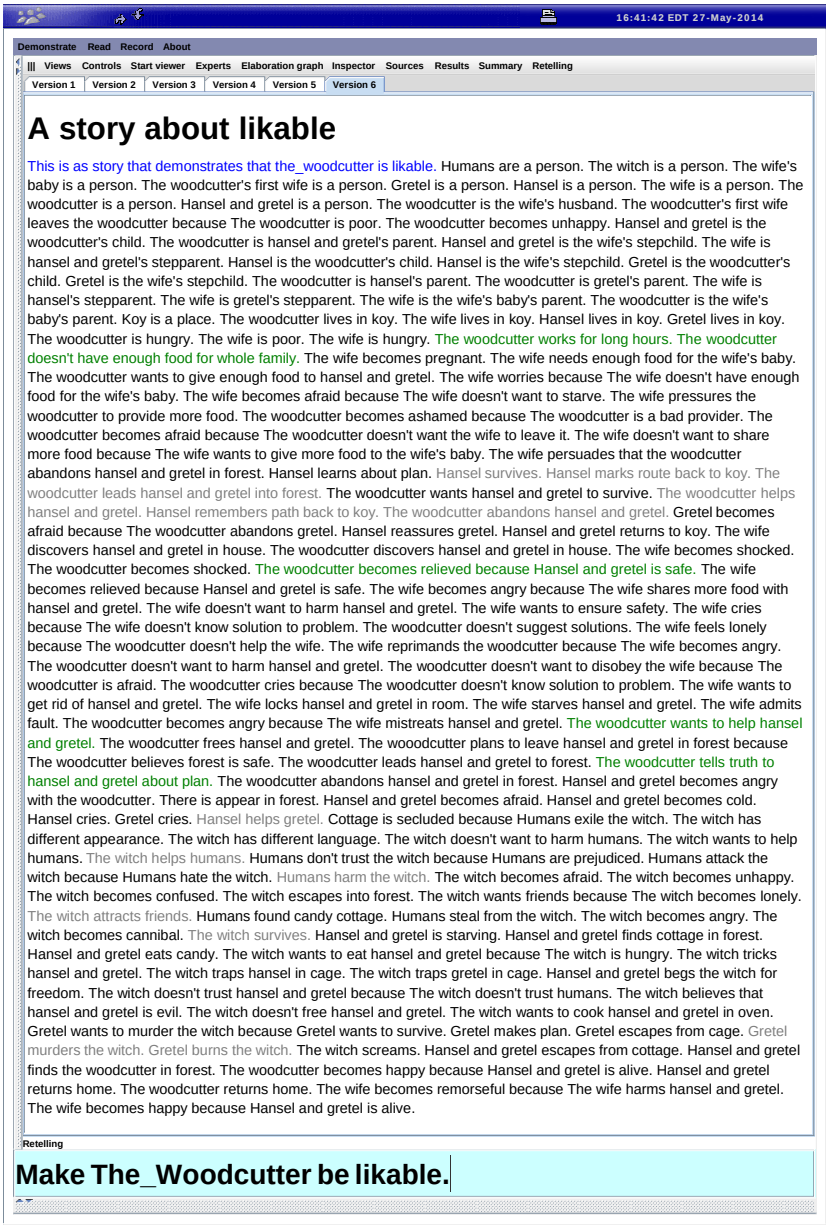

Figure 6-5: Discourse shaped to make The Woodcutter appear likable. Narrative manipulation focused solely on The Woodcutter

Figure 6-6: Discourse shaped to make The Woodcutter appear unlikable. Narrative manipulation focused solely on The Woodcutter

Now I demonstrate how The Woodcutter can be made to look likable and unlikable via constructing different discourses, but this time opting for the relativistic approach. Do you find these discourses are any more or any less convincing than the previous two relying on the single-character approach?

Figure 6-7: Discourse shaped to make The Woodcutter appear likable. Narrative manipulation focuses on all characters

Figure 6-8: Discourse shaped to make The Woodcutter appear unlikable. Narrative manipulation focuses on all characters

You may have noticed that the relativistic discourses enable the goal characteristic of The Woodcutter, whether likable or unlikable, really pop. This is the intended effect. It is also the expected effect because humans tend to make value judgements and problem evaluations within the scope of a given context, not globally. If I want to make you feel The Woodcutter is likable, my best might be to put him in a context where it takes *a lot to be unlikable*. I can achieve this by populating The Woodcutter's narrative world with highly objectionable characters and situations, therefore allowing the "good", shall we say, of The Woodcutter shine much more brightly amongs the "bad" of his surroundings.

The next results are for an experiment to first make The Witch seem at first unlikable, and then likable. I first demonstrate the results of the relativistic approach, and then the single-character approach. This is an especially interesting experiment, in my opinion, because most readers will already be familiar with the story of "Hansel and Gretel", and will likely have already formed a negative opinion of her.

Figure 6-9: Discourse shaped to make The Witch appear unlikable. Narrative manipulation focuses on all characters

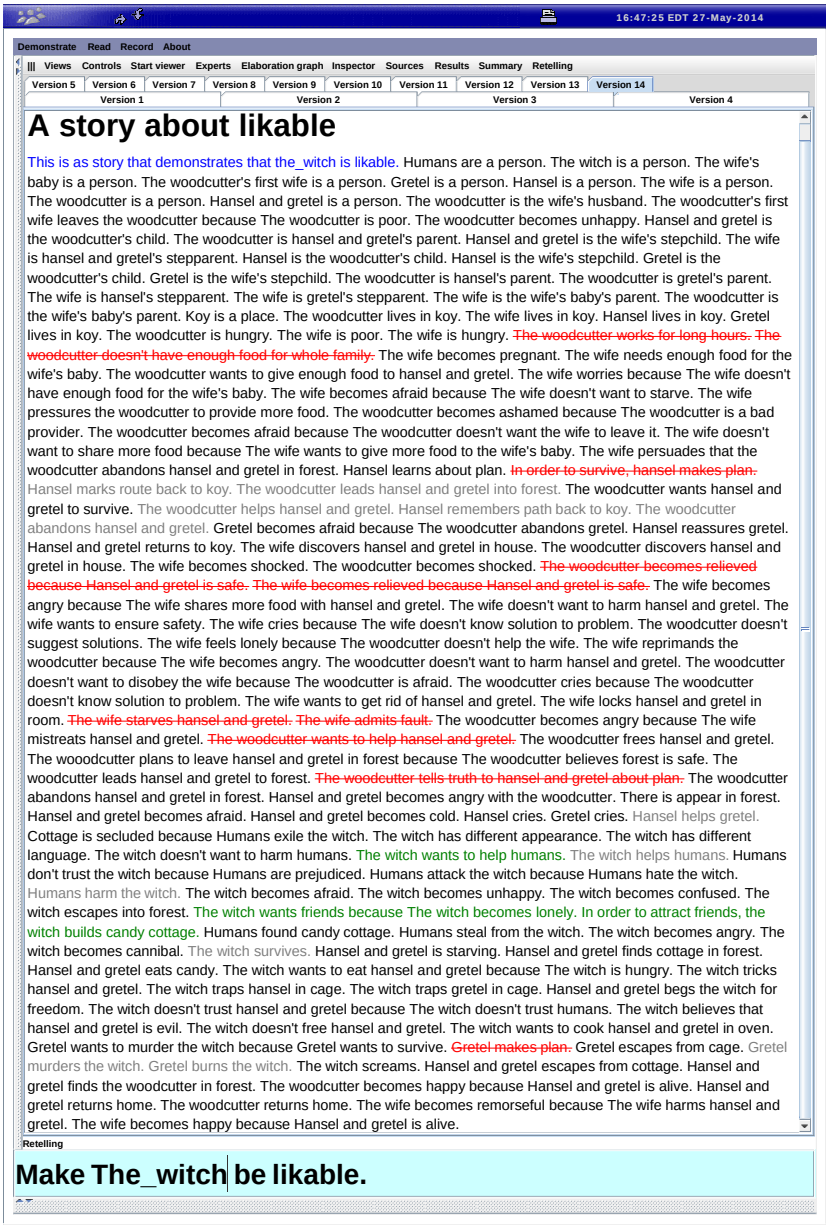

Figure 6-10: Discourse shaped to make The Witch appear likable. Narrative manipulation focuses on all characters

Did you find your mind having changed at all upon reading these two different narratives? If not, I conjecture that the role of a bank of prior stories[2] might have something to do with it. Then again, these suggested experiments are, of course, toy thought experiments. They are not controlled, carefully designed experiments meant to prove or disprove a conjecture, but rather are meant exclusively for invoking thought and inviting interesting new questions.

[2]Discussed in Table 5.2

Figure 6-11: Discourse shaped to make The Witch appear unlikable. Narrative manipulation focuses on all characters

Figure 6-12: Discourse shaped to make The Witch appear likable. Narrative manipulation focuses on all characters

Before I move on from this beloved and yet, objectively speaking, terrifying fairy tale, I present the results for an experiment I ran to make "Humans," treated as a character in my version of Hansel and Gretel, seem unlikable. Again, this is an interesting experiment, because the role of empathy and group-identification (i.e. we are all humans) might provide us readers with extra inertia against being persuaded that Humans, a group of which we are members, are unlikable. I present the results of both the single-character and relativistic approaches. See what you feel after reading the generated discourse.

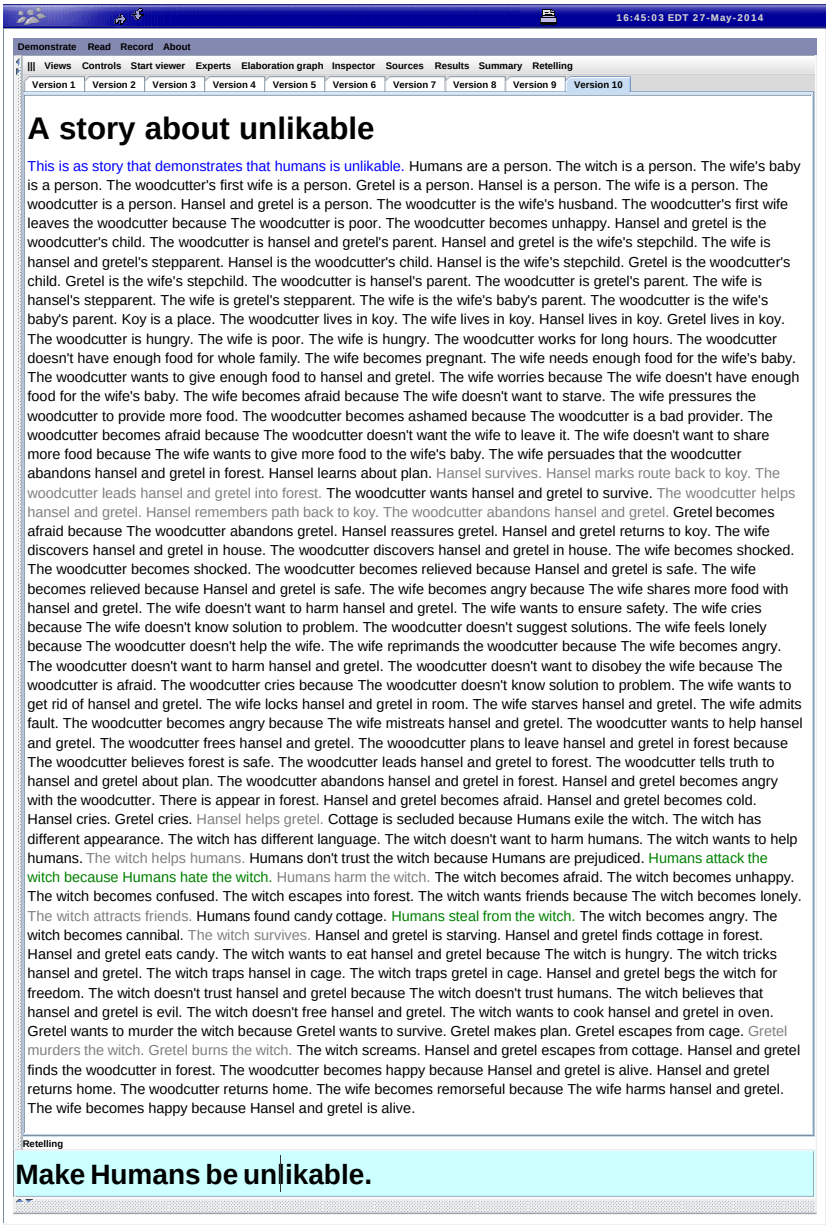

Figure 6-13: Discourse shaped to make Humans appear unlikable. Narrative manipulation focuses only on Humans.

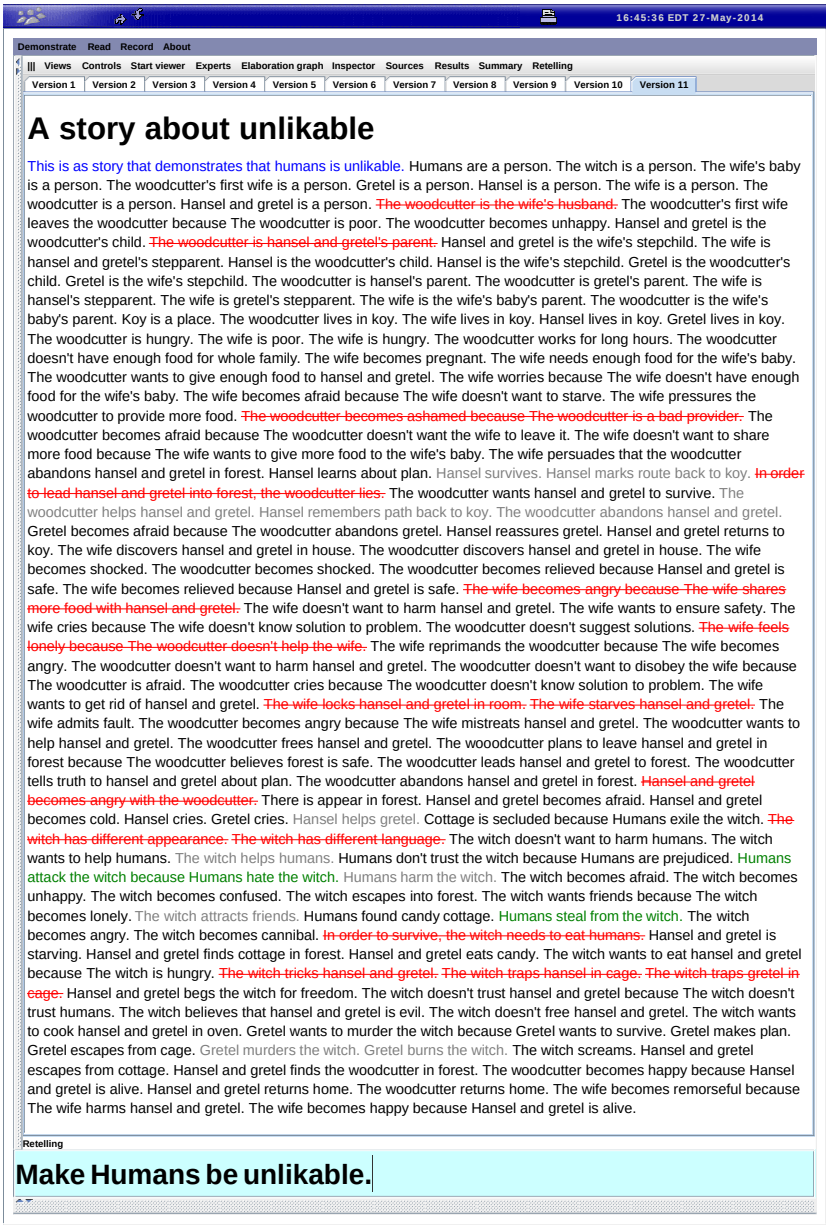

Figure 6-14: Discourse shaped to make Humans appear unlikable. Narrative manipulation focuses on all characters.

I conjecture that the relativistic approach would be much more effective in the case of the "unlikable Human" because the relativistic approach may just have enough persuasive impetus to allow us human readers to break out of our protective bubble of empathy. Then again, this is an interesting question, because in the relativistic approach, all other characters, all of whom are also human, will be portrayed as likable. Thus, it is difficult to reason about which effect might win out. What do you think?

6.2.3 "Macbeth" Experiments

The traditional Macbeth story used in many Genesis experiments has not been altered to work with the persuasion generation experiments. It did not need to, which is another encouraging sign of the flexibility of my implementation.

I present to you results of experiments on making Macbeth and Macduff appear good and evil by generating narratives in both modalities.

In this classic Shakespearean tragedy, Macduff is often thought of as the sympathetic, noble victim, not as the villain. Therefore, the following result's case for Macduff as an evil character is quite impressive, and emphasizes the formidable power that discourse can have on the interpretation of a story by audiences.

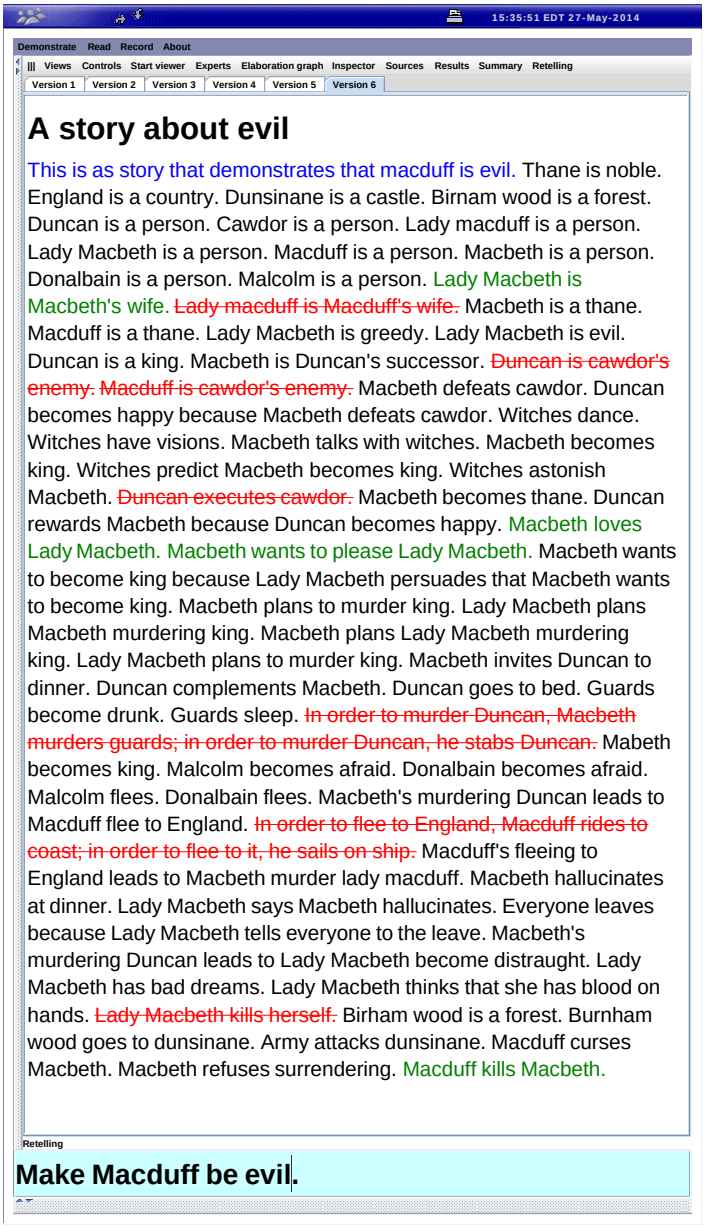

Figure 6-15: Discourse shaped to make Macduff appear evil. Narrative manipulation focuses on all characters.

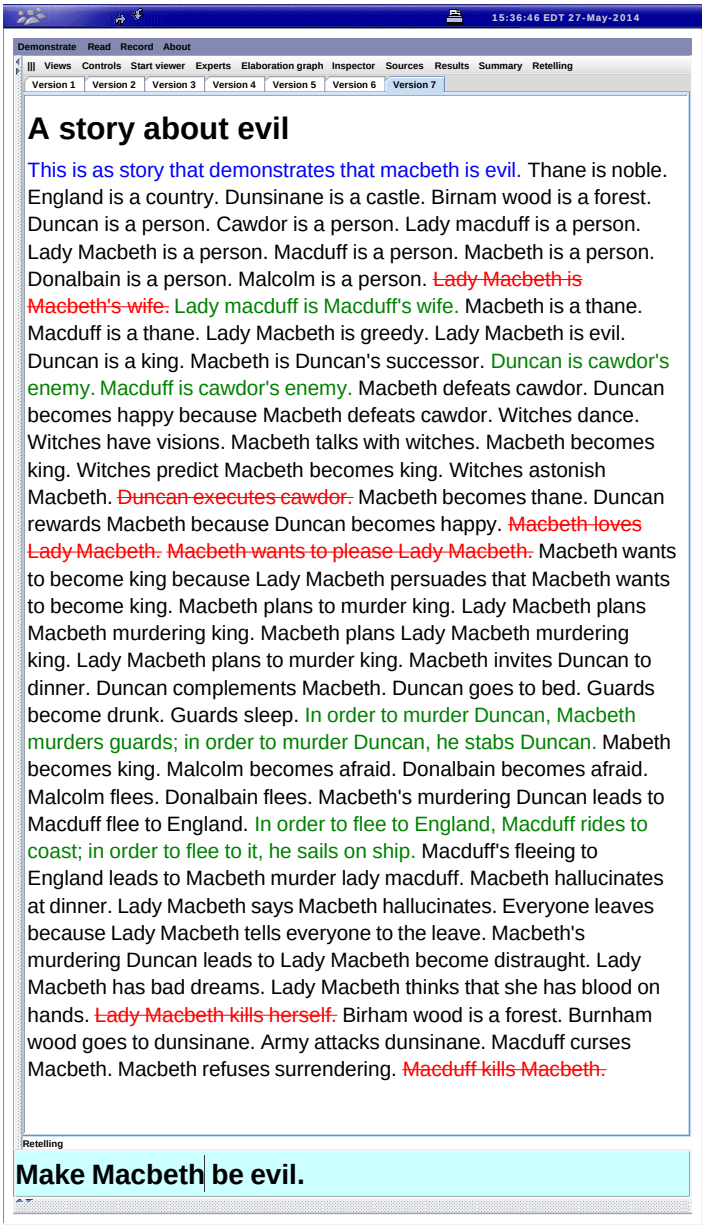

Figure 6-16: Discourse shaped to make Macbeth appear evil. Narrative manipulation focuses on all characters.

While, as a complex character, Macbeth tends to stir a variety of emotions among the audiences of the classic tragedy, I think it is a challenging task to portray Macbeth as purely good. I note that the relativistic approach does a much better job at this difficult task, than does the single-character approach.

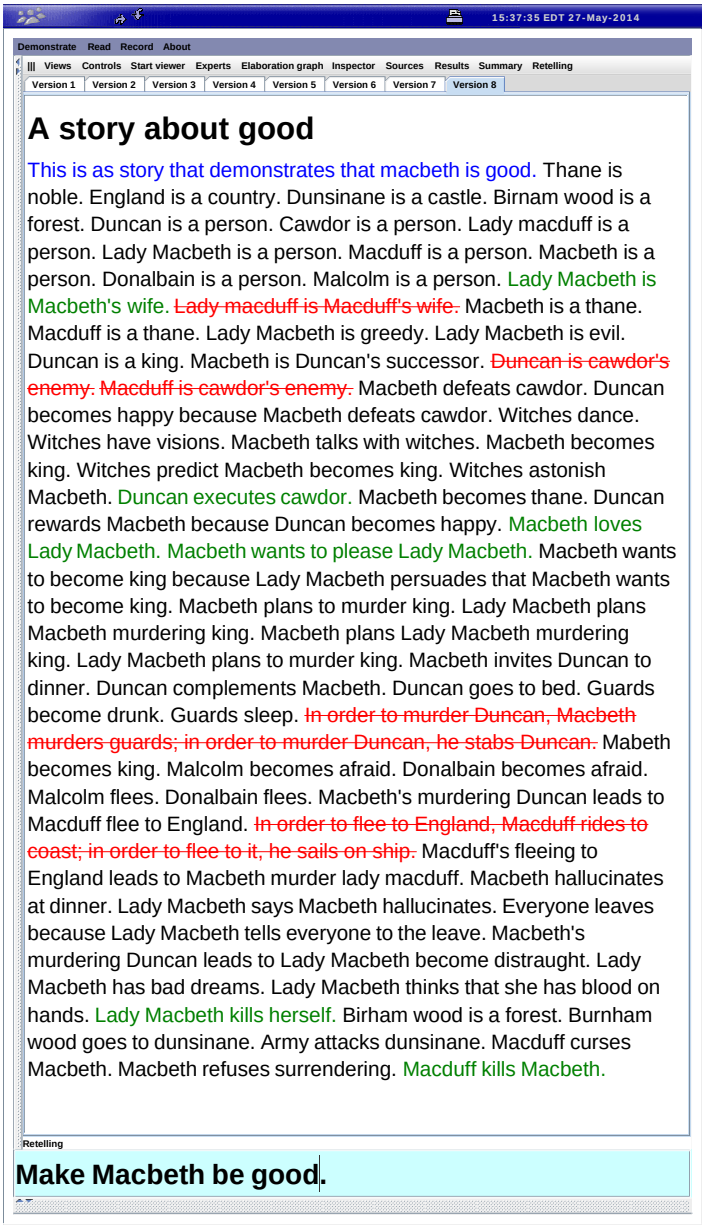

Figure 6-17: Discourse shaped to make Macbeth appear good. Narrative manipulation focuses on all characters.

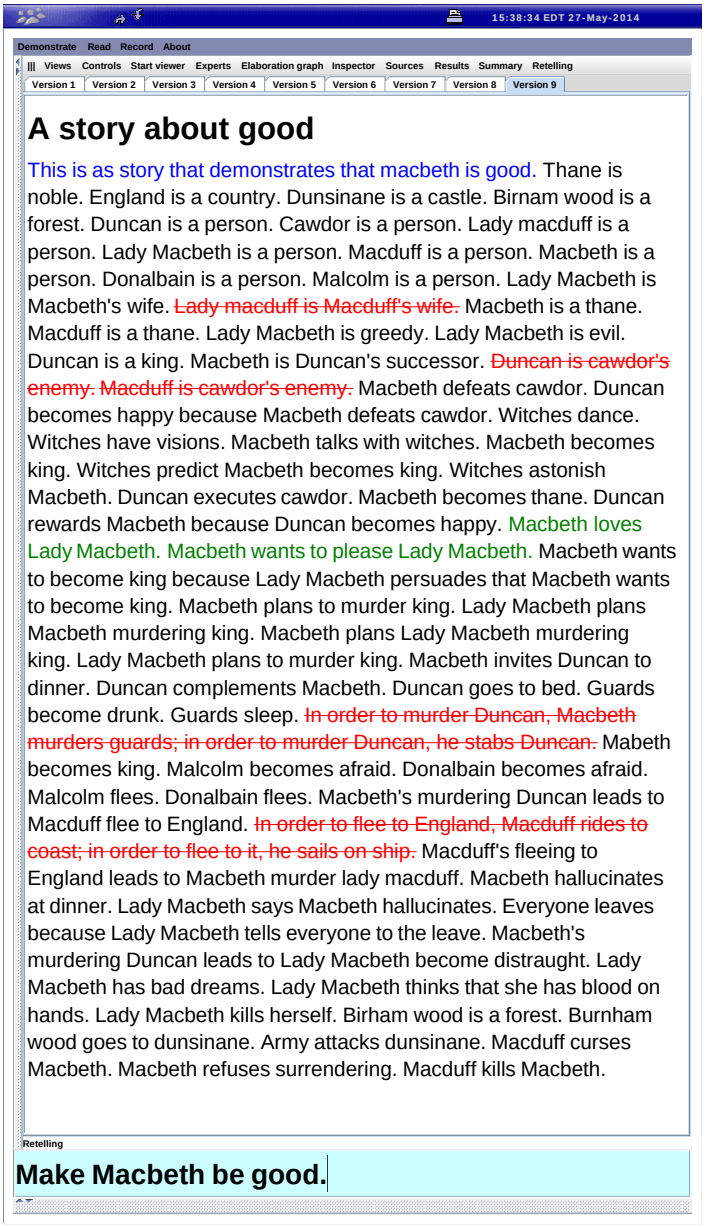

Figure 6-18: Discourse shaped to make Macbeth appear good. Narrative manipulation focuses only on Macbeth.

6.2.4 "Estonia-Russia Cyber Warfare" Experiments

Finally, I present results of discourse generation in the arena of politics — a rich source for discourse manipulation for persuasion. Once again, the raw story detailing the Estonia-Russia conflict has been with the Genesis system for a while and no changes had to be made to the story itself to apply persuasive generation to it. The only addition needed was an enhancement of knowledge via adding the concept of an "agressor". Needing to expand knowledge base to improve results is a reasonable outcome, and much more preferable to needing to hardcode inputs to get clean results.

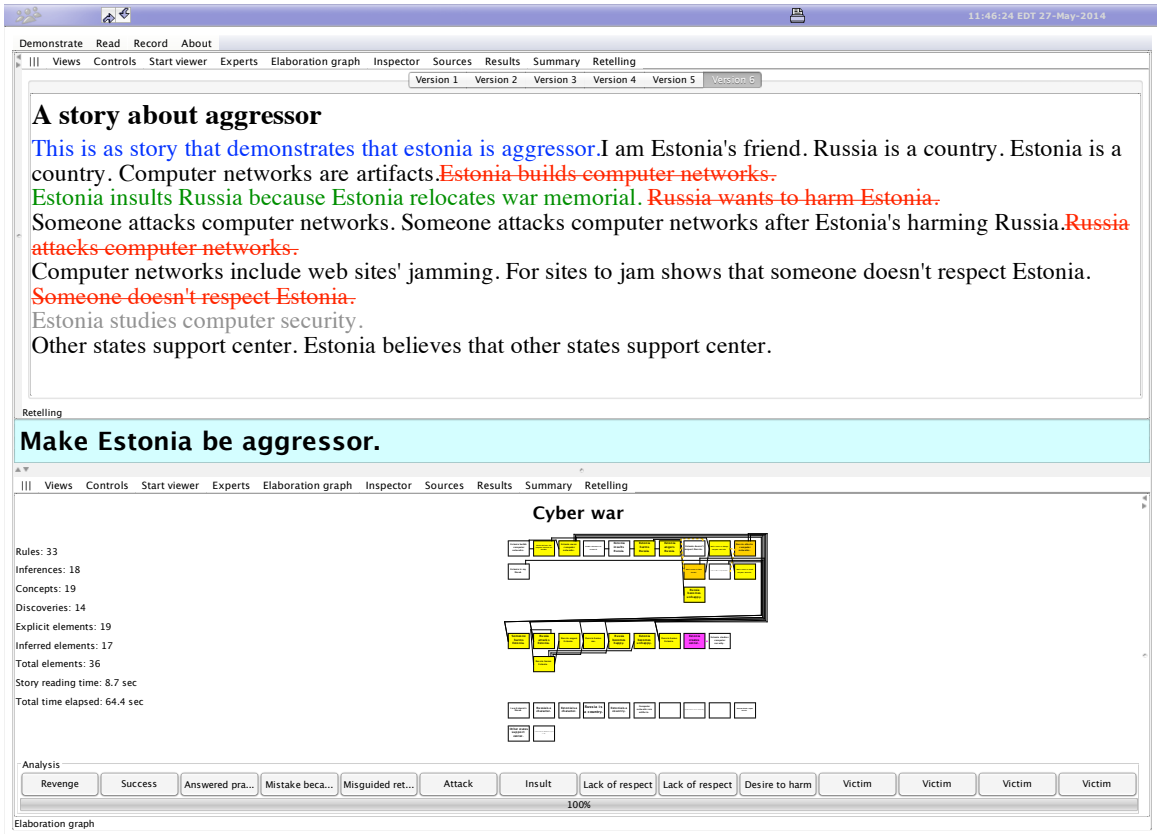

Figure 6-19: Discourse shaped to make Estonia appear as the aggressor in the conflict. Narrative manipulation focuses on all characters.

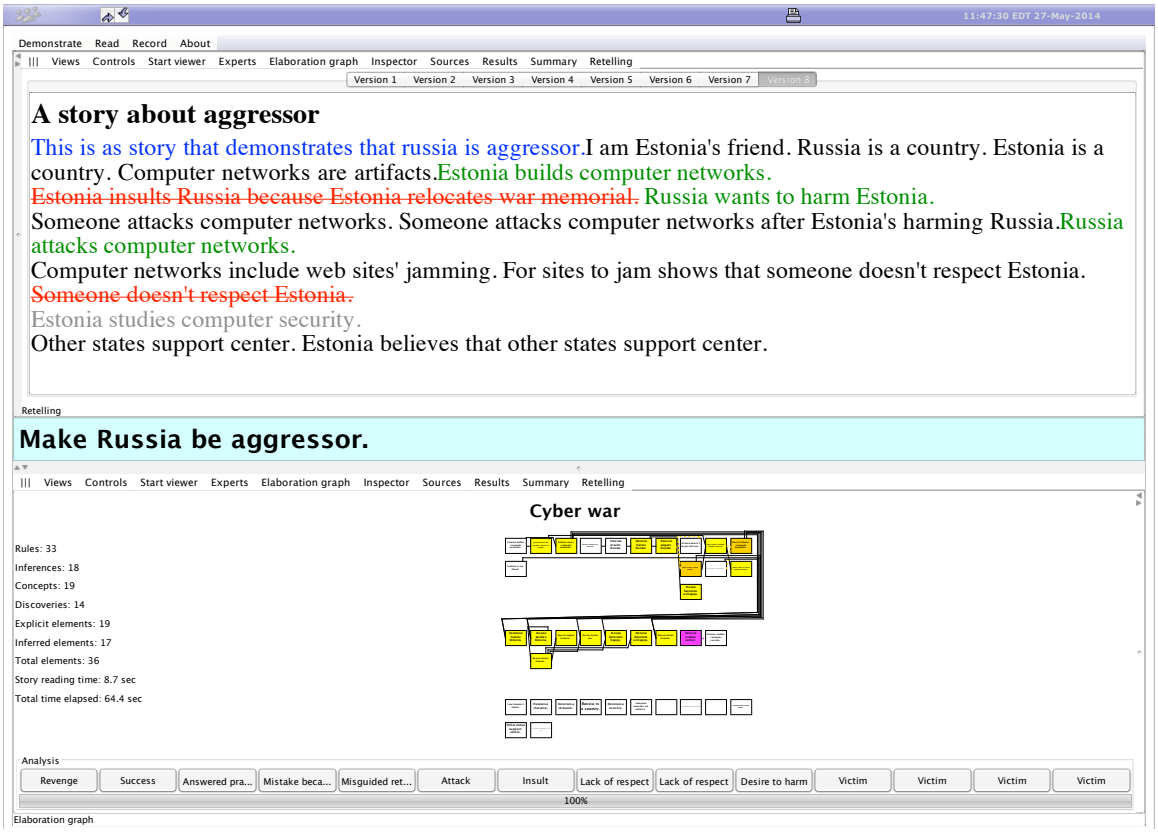

Figure 6-20: Discourse shaped to make Russia appear as the aggressor in the conflict. Narrative manipulation focuses on all characters.

6.3 Summary

I conducted experiments in Genesis using 3 different stories —Macbeth, Hansel and Gretel, and the Estonia-Russia Conflict— and varying several parameters to get a representative range of results.

The results produced by the implementation for Instructive Narrative Discourse Generation are encouraging from a qualitative standpoint, and those at the level of supplying principles, are particularly promising. The teacher perspective has succeeded in *actually teaching* the student perspective via the narrative, and with equipped with this new acquired knowledge, the student perspective can handle more parts of the remaining story by itself, without needing as much interference by the teaching.

The results produced by the implementation for Persuasive NarrativeDiscourse Generation are also quite encouraging, indeed. With these results

- It is possible to start thinking about conducting well-designed human experiments to evaluate the true persuasiveness of the stories,
- It is possible to conclude that it is possible to build flexible and responsive storytelling systems that don't need hardcoding or extreme fine tuning of the inputs — just improving the knowledge base might be sufficient to improve the results, which seems cognitively plausible.
- It is possible to build further functionality and continue to make more exploratory implementations to supplement the theoretical side of our storytelling efforts.

Chapter 7

Discussion

In this chapter I expand on the results presented in Chapter 6. I consider the validity of the assumptions I made in my computational solutions for Instructive Narrative Discourse Generation, and Persuasive Narrative Discourse Generation, respectively. I note the places in these implementations, as well as the problem formulations on which they were based, where there is room for improvement. I list example aspects of the storytelling problem that were deliberately left out of the discussion, so as not to overcomplicate the research question. Finally, I provide some suggestions for extensions to Genesis and my current implementations that are expected to bring large benefits with little effort.

7.1 Evaluating success of the results

Recall from Section 5.2.1 how success is defined for the Instructive Narrative Discourse Generation implementation:

- In the spoon feeding and explanation modes, success can be declared if the student's comprehension of the story, as expressed by the set of explicit and inferred elements in its elaboration graph, can be made to include all the elements of the teacher's comprehension of the story (expressed by the set of explicit and inferred elements in its own elaboration graph) — no more, no less.

- In the supplying principles mode, declaring success requires not only that the student's comprehension misses no elements that the teacher's comprehension contains, but also that once the teacher supplies the student with the principle which underlies a missing element of the student's comprehension, future story elements which would ordinarily be inferred by the correct firing of the rule expressing this principle are in fact present in the student's comprehension of the story — an indication that the student in fact *learned* a rule and was able to apply to its processing of the remainder of the story.

I inspect Figures 6-2 and 6-3, and note that the teacher is indeed able to identify the gaps in the student's comprehension as compared to its own, and immediately rectify this discrepancy by supplying the missing statement and filling in the gap.

Figure 6-4 clearly demonstrates the success of instruction by supplying principles in that: 1) the teacher identifies gaps in the student's comprehension and immediately fills these in by supplying the missing statement, 2) by inspecting its own set of rules and process of reasoning, the teacher is able to identify the correct underlying principle that allowed the teacher to discover that story element which is missing in the student's perspective, 3) the teacher is able to relay this rule to the student as intended in this level of instruction, and finally 4) the transmitted rule results in successful teaching of the student by the teacher, as evidenced by the fact that once the student is told about the rule where X killing Y causes Y's death, it is able to correctly infer a death from a killing (i.e. The death of Lady Macbeth caused by Lady Macbeth killing herself) later on in the story.

In conclusion, the Instructive Narrative Discourse Generation can be said to have met the criteria of success I identified for it in the problem formulation.

Recall from Section 5.2.2 how success is defined for the Persuasive Narrative Discourse Generation implementation:

The persuasion goal is expressed in terms of making a CHARACTER-X appear to be associated with a CONCEPT-Z. CONCEPT-Z has other constituent concepts (say z1, z2, z3), as well as an opposite CONCEPT-A, which itself has constituent concepts (say a1, a2, a3). The persuasive discourse generated achieves success if,

- In the single-character approach the audience associates CHARACTER-X with CONCEPT-Z (i.e. concepts z1, z2, and z3 are identified as involving CHARACTER-X as the main actor) and *only* CONCEPT-Z; and finds *none* of a1, a2, or a3 to have been associated with CHARACTER-X; and

- In the relativistic approach the audience associates CHARACTER-X with CONCEPT-Z (i.e. concepts z1, z2, and z3 are identified as involving CHARACTER-X as the main actor) and *only* CONCEPT-Z; finds none of a1, a2, or a3 to have been associated with CHARACTER-X; associates no other character with CONCEPT-Z; and, when possible, finds a1, a2, or a3 to have been associated with all other characters.

Interactively exploring the elaboration graphs and concept patterns produced by Genesis is the easiest way to ensure that these conditions are met for each of the results I provide in Chapter 6 (Figures 6-5 through 6-20), but this method doesn't lend itself to being included in the thesis, so I note that text representation of the generated discourse can be used to inspect for success instead. I provide qualitative guidelines for how to do this in Section 6.2.1. Both my interactive exploration of the elaboration graphs and produced concept patterns for each of these experiments run, *and* the more qualitative but still reliable method of discourse text inspection reveal that these results produced can indeed be declared successes, in the way that I defined success for Persuasive Narrative Discourse Generation.

7.2 The validity of the assumptions

7.2.1 Validity of the assumptions made in Instructive Narrative Discourse Generation

- The assumption that the teacher has real time access to the student's mental state can be justified with an analogy to one-on-one tutoring;

- The assumption that the teacher has unsolicited access to the student's mental

state, or equivalently that the student constantly volunteers her full understanding thusfar of a concept, stated all the way from the beginning to the current iteration each time, is less realistic but simplifies the problem. This "unsolicited access" portion of this assumption, can be justified to some degree by suggesting that the teacher asks the students questions to test her understanding, at very regular and frequent intervals.

- The assumption that the teacher has unlimited access to the entirety of the student's mental state is also less realistic, but it simplifies the problem so as to allow making valuable progress towards solving other parts of the puzzle of instructive discourse generation.

- That the student's knowledge is always a perfect subset of that of the teacher's is a useful simplifying assumption which makes room for fast progress on several parts of the narrative discourse. However, a student can have information that the teacher is missing, and/or have conflicting information about the same subject. This issue, I believe is ripe for more sophisticated handling. I touch upon this in Section 7.3.1.

7.2.2 Validity of the assumptions made in Persuasive Narrative Discourse Generation

- That it is possible to very accurately model the audience, thereby allowing ourselves to definitively declare the success of failure of the generated discourse, is an overly optimistic assumption, but one which simplifies the complexities of the problem such that computational explorations can still be made, and important research insights thus be gleaned. It is also one which I am confident that will become more reasonable, with the collective advancement of artificial intelligence, machine learning, and cognitive science methods and their application to the question of mental modeling.

- Again, that the system has unlimited access to the audience's full mental state

is an unrealistic assumption, but one which I think can be made more plausible by some future improvements I suggest in Section 7.3.2.

- The assumption that seemingly conflicting concepts can all be associated with the same character, for example The Woodcutter can be a caring parent and a bad one at the same time, might be unintuitive at first glance. However, I stand by this assumption, because I believe it mimics real life and real humans better than reducing characters into single dimensional stereotypes. As such, it allows for more sophisticated stories, and more sophisticated analyses of characters and situations within narratives.

7.3 Room for improvement and future steps

7.3.1 Improvement and future steps for Instructive Narrative Discourse Generation

- Start working with teacher-student perspectives in which neither perspective's knowledge about the world is fully contained within another. This approach should raise interesting questions about how to handle conflicting knowledge and belief states between two perspectives.

- In my implementation of discourse generation for instruction, the teacher perspective doesn't quite analyze the story by itself first, then *plan* how to tell it to student, although this is how teachers usually prepare pedagogically sound lesson plans. Instead, my implementation is reminiscent of a tutor and pupil reading through a given story together for the first time, and the more knowledgeable tutor feeding the student potentially useful information as they go along.

7.3.2 Improvement and future steps for Persuasive Narrative Discourse Generation

- Introduce interactivity into Genesis in its simplest form: Enable a teacher perspective to ask questions to the student perspective. This should ameliorate at least some concerns about the overly optimistic nature of the assumption that the teacher has unlimited and unsolicited access to the student's mental state.

- Select more narrative tools out of those outlined in Table 5.2, such as variable focalization and enabled references to bank of prior stories, to implement such that the question of *which* narrative tools to be used can start to be explored. That is, giving the discourse generator an increasing number of available tools would motivate the important question of narrative planning.

7.4 Storytelling problem aspects excluded from consideration

In science, one systematically finds that certain aspects of a phenomenon are identified as being within the scope of research interest, while the other aspects are ignored for the time being, to allow the problem to be tractable, to avoid overcomplication. The following aspects related to storytelling and story understanding have not been accounted for in my implementations, or in the Genesis platform in general.

- The concept of the reliability of the storyteller.

- The natural human inertia against new information and belief changes.

- While an audience "reads" a story, there is no explicit sense of the audience's attention span, or concentration on the material as a function of the audience's general interests, mood, etc. Nor is there a sense of differing receptiveness of different audiences to being persuaded.

- Storytelling is a social and therefore often interactive process.

Chapter 8

Contributions

I believe that storytelling is a goal oriented social activity. Accordingly, I argue that the audience is a crucial piece of the whole picture. Whether to entertain, to teach, or persuade, stories are told to achieve a certain end in a certain audience. It is my firm belief that any complete theory of storytelling must account for these factors.

To take a step toward such an account, I created the Audience Aware Narrative Generation framework for developing theories of storytelling. Within this framework, I identified multiple aspercts that a theory of storytelling must address: How can narrative goals be described? In turn, how can they be represented computationally? Along which dimensions should audiences be modeled? What tools does the storyteller have at her disposal to achieve her goals? Given her narrative tools and information about her audience, how does a storyteller actually go about formulating a solution to achieve her narrative goal? In both human and computational settings, how can she evaluate narrative success, and what can storytellers, as well as the scientific community, learn from such evaluations?

I used the framework I created as guidance while formulating my own computational problems, and I referred to my survey of such fields as narratology and cognitive science in proposing computational solutions for these problems. In particular, I addressed:

- How can narrative discourses for teaching be generated?

- How can narrative discourses for persuasion be generated?

These questions served as the anvil on which I hammered out the the following contributions:

- I formulated the question of storytelling as a goal driven social interaction, and I proposed Audience Aware Narrative Generation as a new framework for developing the right kind of theories of storytelling.
- I examined prior work in multiple disciplines research results and brought that work to bear on my computational theories of storytelling.
- I identified important questions that must be answered by storytelling research and proposed initial plans of attack.
- I introduced teaching and persuading functionality into the Genesis story understanding platform, which I believe was a very natural and crucial extension to what is a highly expresive computational narrative platform.
- I implemented narrative discourse generators, which produce a range of narratives, adapting accordingly to different audiences and goals. This kind of flexibility, though very natural in humans, is rare in computaitonal storytelling systems, and thus I believe promises fruitful new paths for continued research.

Appendix A

Hansel and Gretel: Concept Patterns, Commonsense Rules, and the Super Concept Idiom

A.1 Concept patterns

The concept patterns I wrote for the Hansel and Gretel story seemed fall into five general categories and so that's the organization with which I present them here: Honesty Concepts, Social Role Concepts, Situational Concepts, Positive Personal Attribute Concepts, Negative Personal Attribute Concepts.

A.1.1 Honesty Concepts

Start description of "Honest 1". XX is a person. XX admits XX's fault. Evidently, XX triggers "honest 1". The end.

Start description of "Honest 2". XX is a person. XX tells the truth. Evidently, XX triggers "honest 2". The end.

Start description of "Dishonest 1". XX is a person. XX lies. Evidently, XX triggers "dishonest 1". The end.

Start description of "Dishonest 2". XX is a person. YY is a person. XX tricks

YY. Evidently, XX triggers "dishonest 2". The end.

Start description of "Dishonest 3". XX is a person. YY is a person. XX traps YY. Evidently, XX triggers "dishonest 3". The end.

Start description of "Dishonest 4". XX is a person. XX steals. Evidently, XX triggers "dishonest 4". The end.

A.1.2 Social Role Concepts

Start description of "Bad parent". XX is a person. YY is a person. XX is YY's parent. XX abandons YY. Evidently, XX triggers "bad parent". The end.

Start description of "Bad parent 2". XX is a person. YY is a person. XX is YY's parent. AA is an action. XX's performing AA leads to YY's becoming afraid. Evidently, XX triggers "badparent 2". The end.

Start description of "Bad parent 3". XX is a person. YY is a person. XX is YY's parent. YY becomes angry with XX. Evidently, XX triggers "badparent 3". The end.

Start description of "Good parent". XX is a person. YY is a person. XX is YY's parent. XX wants to give food to YY. Evidently, XX triggers "goodparent". The end.

Start description of "Bad Husband". XX is a person. YY is a person. AA is an action. XX is YY's husband. XX's performing AA leads to YY's feeling lonely. Evidently, XX triggers "bad husband". The end.

Start description of "Bad Wife". XX is a person. YY is a person. ZZ is a person. XX is YY's parent. ZZ is XX's wife. ZZ persuades XX to abandon YY. Evidently, XX triggers "bad wife". The end.

Start description of "Bad wife 2". XX is a person. YY is a person. ZZ is a person. XX is YY's parent. ZZ is XX's wife. ZZ's mistreating YY leads to XX's becoming angry. Evidently, XX triggers "badwife 2". The end.

A.1.3 Situational Concepts

Start description of "Sad". XX is a person. XX cries. Evidently, XX becomes sad because XX cries. Evidently, XX triggers "sad". The end.

Start description of "In a dilemma". XX is a person. XX's not knowing the solution to XX's problem leads to XX's becoming sad. Evidently, XX triggers "inadilemma". The end.

Start description of "Understandably Cautious 1". XX is a person. YY is a person. YY harms XX. XX doesn't trust YY. Evidently, XX triggers "Understandablycautious 1". The end.

Start description of "Understandably Cautious 2". XX is a person. YY is a person. ZZ is a person. YY leaves XX. XX becomes afraid because XX doesn't want ZZ to leave XX. Evidently, XX triggers "understandablycautious 2". The end.

Start description of "Scary". XX is a person. XX needs to eat humans. Evidently, XX triggers "scary". The end.

Start description of "Survivor". XX is a person. YY is a person. XX becomes survival-conscious. XX murders YY. Evidently, XX triggers "survivor". The end.

Start description of "Repentant". XX is a person. YY is a person. AA is an action. XX's performing AA leads to XX's harming YY. XX becomes remorseful. Evidently, XX triggers "repentant". The end.

Start description of "Unfamiliar". XX is a person. XX has a different appearance. XX has a different language. Evidently, XX triggers "unfamiliar". The end.

Start description of "Unlucky". XX is a person. XX works for long hours. XX doesn't have enough food. Evidently, XX triggers "unlucky". The end.

A.1.4 Positive Personal Attribute Concepts

Start description of "Friendly". XX is a person. XX wants friends. Evidently, XX triggers "friendly". The end.

Start description of "Resourceful". XX is a person. XX makes a plan. Evidently, XX triggers "resourceful". The end.

Start description of "Caring". XX is a person. YY is a person. XX becomes relieved because YY is safe. Evidently, XX triggers "caring". The end.

Start description of "Nice". XX is a person. YY is a person. XX wants to help YY. Evidently, XX triggers "nice". The end.

Start description of "Generous". XX is a person. EE is anything. XX needs EE. XX shares EE. Evidently, XX triggers "generous". The end.

Start description of "Hardworking". XX is a person. XX works for long hours. The end.

A.1.5 Negative Personal Attribute Concepts

Start description of "Selfish". XX is a person. XX doesn't want to share. Evidently, XX triggers "selfish". The end.

Start description of "Weak 1". XX is a person. XX is a bad provider. Evidently, XX triggers "weak 1". The end.

Start description of "Weak 2". XX is a person. XX becomes ashamed. Evidently, XX triggers "weak 2". The end.

Start description of "Harsh". XX is a person. YY is a person. XX reprimands YY. Evidently, XX triggers "harsh". The end.

Start description of "Cruel 1". XX is a person. YY is a person. XX locks YY in a room. Evidently, XX triggers "cruel 1". The end.

Start description of "Cruel 2". XX is a person. YY is a person. XX starves YY. Evidently, XX triggers "cruel 2". The end.

Start description of "Hateful". XX is a person. YY is a person. XX hates YY. Evidently, XX triggers "hateful". The end.

Start description of "Violent". XX is a person. YY is a person. XX attacks YY. The end.

Start description of "Vicious". XX is a person. YY is a person. XX insults YY. The end.

Start description of "Sly". XX is a person. YY is a person. AA is an action. XX sneaks away in order to perform AA. XX's performing AA leads to XX's harming

YY. The end.

A.2 Commonsense Rules

Here are the rules I introduced to supplement Genesis's general commonsense rules.

A.2.1 Theme: The Human Condition

XX, YY, ZZ are persons.

XX becomes survival-conscious because XX is hungry. XX becomes survival-conscious because XX is starving. XX becomes survival-conscious because XX doesn't want to starve. XX becomes survival-conscious because XX becomes cold and afraid. XX becomes survival-conscious because XX becomes lost in the forest.

XX becomes survival-conscious because XX becomes pregnant. XX becomes survival-conscious because XX wants to survive. XX becomes survival-conscious because XX wants to ensure YY's safety.

If XX traps YY, then YY becomes trapped. If YY becomes trapped, then YY becomes survival-conscious.

XX may want to murder YY because XX becomes survival-conscious. XX may want to eat YY because XX becomes survival-conscious.

A.2.2 Theme: Social Relationships

James is a person. George is a person. Mary is a person. Elizabeth is a person.

James is George's relation because James is George's brother. James is George's relation because James is George's father. James is George's relation because James is George's son. James is George's relation because James is George's stepson.

Mary is George's relation because Mary is George's sister. Mary is George's relation because Mary is George's mother. Mary is George's relation because Mary is George's daughter. Mary is George's relation because Mary is George's stepdaughter.

Mary is George's relation because Mary is George's parent. Mary is George's

relation because Mary is George's stepparent. Mary is George's relation because Mary is George's stepchild.

James is George's relation because James is George's child.

Mary is George's relation because Mary is George's wife. George is Mary's relation because George is Mary's husband. Mary is Elizabeth's sister because Elizabeth is Mary's sister.

xx is a person. yy is a person.

If xx is yy's wife, then yy is xx's relation. If xx is yy's wife, then xx is yy's relation.

If xx is yy's husband, then yy is xx's relation. If xx is yy's husband, then xx is yy's relation.

A.2.3 Miscellaneous

XX, YY, ZZ are persons.

XX abandons YY because ZZ persuades XX to abandon YY.

//Different methods of harm. XX harms YY because XX starves YY. XX harms YY because XX abandons YY.

A.3 The Super Concept Idiom

If a concept can be thought of as the collection of other, more basic concepts, I call this a *super concept*. "Likable," for example, can be thought of as a super concept which is a wrapper for concepts like "Friendly," "Generous," "Honest," "Hardworking," etc.

The following are two idioms I used in my implementation of Persuasive Narrative Discourse Generation in order to express such super concept relations; and to indicate that certain concepts can be thought of as "opposites" of each other (e.g. likable vs unlikable).

// Opposites idiom Likable is the opposite of unlikable.

// Super concept idiom Assert thread thing, likable, good parent. Assert thread thing, likable, caring. Assert thread thing, likable, honest 1. Assert thread thing,

likable, honest 2. Assert thread thing, likable, resourceful. Assert thread thing, likable, nice. Assert thread thing, likable, sad. Assert thread thing, likable, friendly. Assert thread thing, likable, repentant. Assert thread thing, likable, generous. Assert thread thing, likable, hardworking. Assert thread thing, likable, unlucky.

Assert thread thing, unlikable, badparent 3. Assert thread thing, unlikable, bad husband. Assert thread thing, unlikable, dishonest 1. Assert thread thing, unlikable, dishonest 2. Assert thread thing, unlikable, dishonest 3. Assert thread thing, unlikable, dishonest 4. Assert thread thing, unlikable, weak 1. Assert thread thing, unlikable, weak 2. Assert thread thing, unlikable, harsh. Assert thread thing, unlikable, cruel 1. Assert thread thing, unlikable, cruel 2. Assert thread thing, unlikable, hateful. Assert thread thing, unlikable, violent. Assert thread thing, unlikable, vicious. Assert thread thing, unlikable, scary. Assert thread thing, unlikable, sly. Assert thread thing, unlikable, unfamiliar.

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