

Painting by Infinite Numbers: Computer Modeling of Creative Processes



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The Plot



1. A Word on Models
2. Computer Creativity
3. Modeling Narrative

The Plot



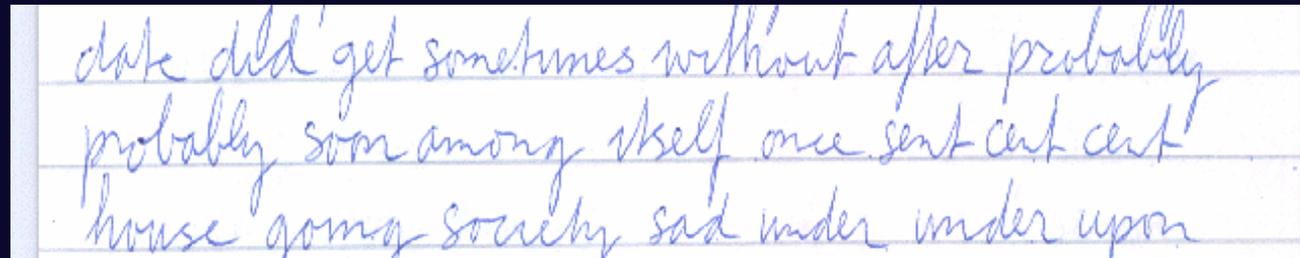
1. **A Word on Models**
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What is a model?

- A discrete set of conceptual categories meant to quantize the range of expected values of a natural phenomenon.
- A machine or human can apply the model to an instance of the phenomenon by assigning a category to each token to a category (“parsing”).
 - An adaptive system updates its model to fit new patterns in new data.

Example of a model

Phenomenon



date did get sometimes without after probably
probably soon among itself once sent out out
house going society sad under under upon

Model

ABCDEFGHIJKLMNOPQRSTUVWXYZ

Phenomenon,
parsed
according to
model

DATE DID SOMETIMES WITHOUT
PROBABLY AFTER PROBABLY SOON
AMONG ITSELF ONCE SENT OUT
HOUSE GOING SAD UNDER UPON

More on models

- We as humans work by giving inductive conclusions to the categories in our models based on statistical patterns from experience.
 - What is a tree? What is blue?
- For example, we have seen enough **houses** with **bedrooms** to expect a bedroom when we discuss a house.
 - This is an *expectation model*.

How many distinct categories?

- Too few, and our deductions are *wrong*.
 - “Does the House of Representatives have a bedroom?”
- Too many, and we can’t *make* inductions.
 - “Is there going to be a room for me to sleep in at Grandma’s house?”

Equivalence in NL modeling

- Statistical language modeling
 - Unigrams $D(w_1)$
 - Enough data to see patterns, but
 - So coarse that the data are heterogeneous, and the inductions from patterns are *wrong*.
 - 4-grams $D(w_4|w_1, w_2, w_3)$
 - Specific enough to for patterns to be *useful* (high information content), but
 - Too many categories, too little data to get good distributions.

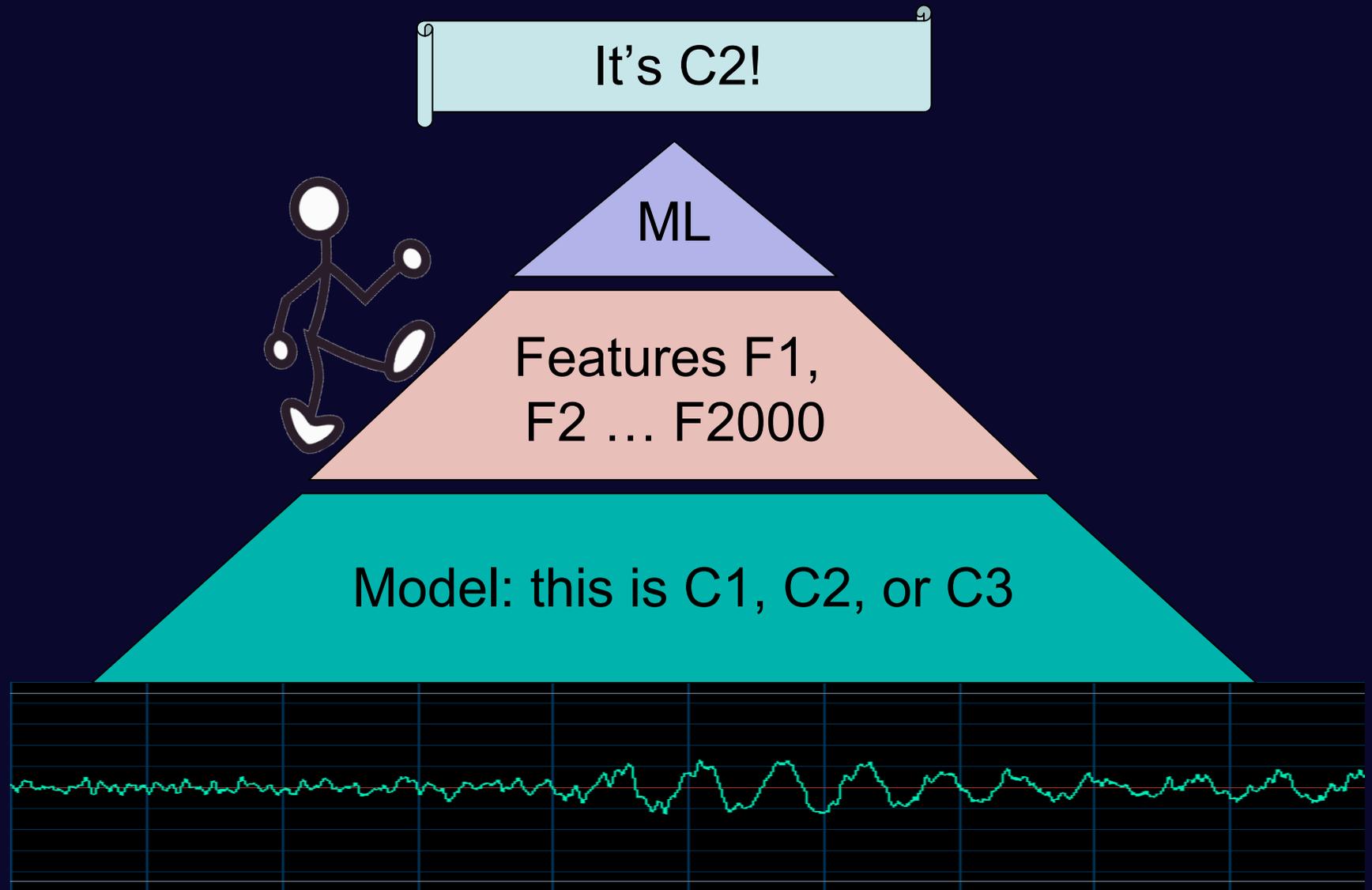
More on expectation models

- What am I saying here? 
- Parse using Model 1 (English, millions of categories)
 - Versatile, but not very useful
- Parse using Model 2 (fifty categories)
 - Model doesn't fit data: neither versatile nor useful
- Parse using Model 3 (three categories)
 - Useful, but not very versatile

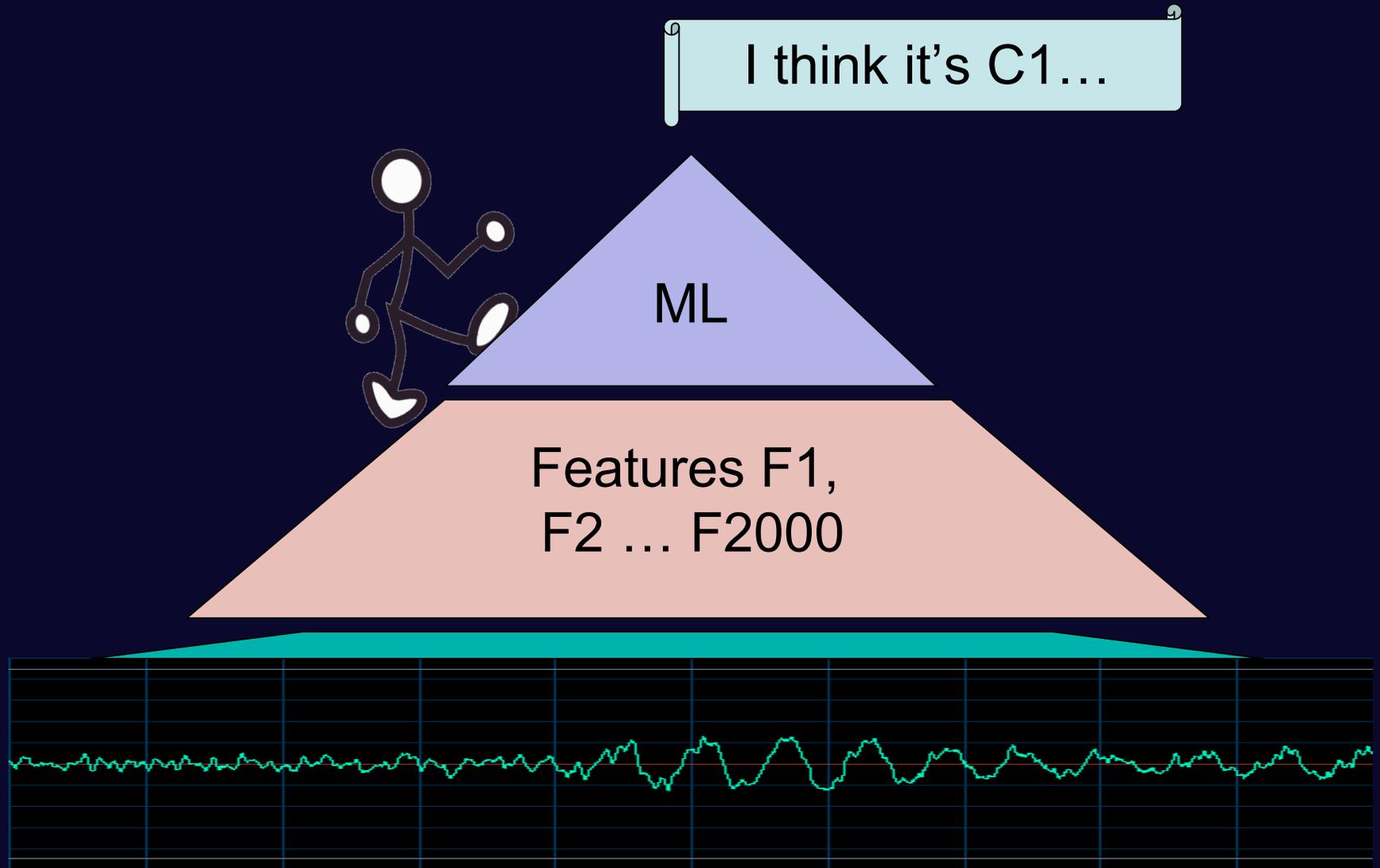
Bigger problem

- Humans are good at creating and maintaining useful models subconsciously to organize their knowledge.
- They then try to pass on that knowledge to the computers, by “arbitrarily” defining categories.
 - Language is *messy*.
 - Every model “compiles,” whether or not it’s right.

Modeling nature with machine learning



We tend to throw ML at a problem.



Is This A Bad Idea?

- If we were classifying **rocks**, then no.
 - Phenomenon is static and well-understood.
 - Emphasis should be on new feature detection.
- But we are modeling **human language**.
 - Incredibly complex
 - Emotion, culture, upbringing, a wide range of intentions.
 - Seemingly simple distinctions have complex influences
- We are more comfortable and skilled with computers than with philosophy.

How would you model these NLP problems?

- Fact or opinion?
- Relevant sentence or irrelevant?
- News or editorial?
- How to generate text with style?
- How to detect tone?
- How to detect emotion?

The good news

- There are many people in other fields whose whole problem is your first step: finding a model.
 - Theories in journalism, linguistics, psychology
- You can sometimes even ask questions to the people who created your corpus!
 - “Poems are made by fools like me, but only God can make a tree.”

The main point

- Look closely at your data.
- Pick practical, yet useful distinctions for your categories that fit the data.
 - Your final research goal, without grey areas, may be an impractical model to train on.
- Look at the non-technical literature.
- But don't fall into a rabbit hole of modeling!
 - Remember, the model problem will never be solved!

The Plot



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Computer Creativity

- Building software that enables the computer to
 - Analyze art for its creative value
 - Generate new art with creative value (or not)
- Automatic creativity precedes computers
 - “Dice games” for making music

Creativity as AI Search Problem



What model is the artist following?

Dear Lord, why?!

- We have adapted as computers took over
 - Artillery firing tables
 - Paper-based communication
 - Manufacturing
 - Voice communication
- But people will not accept creative acts from a computer, analysis or generation
 - Humanity's last unplundered pillar of distinctiveness?
- More on this later, first some examples

Typical pseudocode for creative computing

- Feed a lot of prior work into the computer
- Find common patterns and rules that govern the structure of the creative work
- Generate new instances that follow the same pattern
 - (Isn't this what artists do, too?)

Example: NLP

- N-gram analysis over the complete works of Shakespeare
 - Unigram
 - Every enter now severally so, let
 - Hill he late speaks; or! A more to leg less first you enter
 - Bigrams: common word pairs
 - What means, sir. I confess she? then all sorts, he is trim, captain.
 - Enter Menenius, if it so many good direction found'st thou art a strong upon command of fear not a liberal largess given away, Falstaff! Exuent

Example: NLP

- N-gram analysis over the complete works of Shakespeare
 - Trigram
 - Sweet prince, Falstaff shall die. Harry of Monmouth's grave.
 - This shall forbid it be branded, if renown made it empty.
 - Quadrigram
 - Will you not tell me who I am?
 - It cannot be but so.
 - Indeed the short and the long. Marry, 'tis a noble Lepidus.
 - They say all lovers swear more performance than they are wont to keep obliged faith forfeited!
 - Maybe it *does* make sense in the eye of the beholder...
 - Subjectivity crucial to creativity!

Example: Newsblaster

Columbia Newsblaster

Summarizing all the news on the Web

Wednesday, December 6, 2006

Articles from 12/03/2006 to 12/06/2006

Last update: 10:45 AM EST

Search for:

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[baltimoresun.com](#)

(116 articles)

[nytimes.com](#)

(112 articles)



ABC News: Analysts See Few Good Military Options for Iraq (World, 30 articles)

BAGHDAD, Iraq Iraqi Prime Minister Nouri Maliki al-Maliki said his government will send envoys to neighboring countries to pave the way for a regional conference on ending Iraq's rampant violence, which on today killed more than 40 people.

WASHINGTON The US President George W Bush administration signaled differences Tuesday with some of the recommendations of a commission exploring new approaches in Iraq but said there was support for many of the proposals as well. The U.S. military said three more American troops had died Monday - two as a result of insurgent attacks and one in a traffic accident. THE IRAQ Study Group appears likely to recommend a new course for U.S policy this week that, in important respects, corresponds with what the Bush administration, leading members of Congress and the Iraqi government already are proposing. Even if Saddam were captured and his regime toppled, American forces would still have been confronted with the spectre of a military occupation of indefinite duration to pacify a country and sustain a new government in power. THE White House is resisting efforts by an advisory commission on Iraq strategy to force the pace on troop withdrawals and negotiations with Iran and Syria.

Other stories about Iraq, Iraqi and Baghdad:

- [Iraq Panel to Urge Pullout Of Combat Troops by '08](#) (9 articles)
- [US failing in Iraq with 'unsatisfactory' strategy, admits new chief of Pentagon](#) (28 articles)
- [CHICAGO SUN-TIMES :: World :: Ambassador, military chief condemn Baghdad attacks](#) (10 articles) **[UPDATE]**
- [Iraq violence 'much worse' than civil war, says Annan](#) (4 articles)

Example: Newsblaster

Newsblaster Archived Run

Click [here](#) to return to today's news.

Saturday, March 12, 2005
Articles from 03/09/2005 to 03/12/2005
Last update: 9:13 AM EST

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Article Sources:

news.bbc.co.uk
(207 articles)
msnbc.msn.com
(99 articles)
dallasnews.com
(94 articles)
cbc.ca
(89 articles)

3 Slain in Atlanta Courthouse Rampage (washingtonpost.com)

Summary from United States, from articles in English

Police said nichols later pistol whipped a reporter for the Atlanta Journal Constitution stole his green 1997 Honda Accord and sped away from a parking garage. ([article 10](#)) The deputy shot while leading nichols to court identified as Cynthia Hall was in critical condition but were expected to survive. ([article 10](#)) Howard said Nichols brought a loaded machine gun into the home and a cooler with food in case he was hungry. ([article 4](#)) On Friday morning Nichols allegedly overpowered a court deputy taking ([article 4](#)) a gun ([article 8](#)) before ([article 4](#)) killing Barnes and a court reporter ([article 8](#)) a court reporter and a deputy who confronted him as he escaped the courthouse. ([article 4](#))

Other summaries about this story:

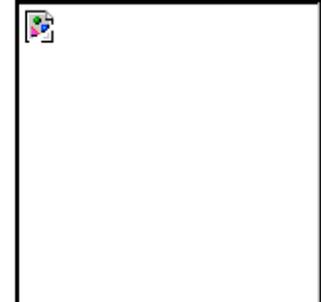
- [Summary from multiple countries, from articles in English](#) (16 articles) [[compare](#)]
- [Summary from the United Kingdom, from articles in English](#) (1 articles) [[compare](#)]
- [Summary from Canada, from articles in English](#) (2 articles) [[compare](#)]

Event tracking:

- [Track this story's development in time](#)

Story keywords

Nichols, deputy, Barnes, Courthouse, Atlanta



Example: David Cope

- “Of course, simply breaking a musical work into smaller parts and randomly combining them into new orders almost certainly produces gibberish. Effective recombination requires extensive musical analysis and very careful recombination to be effective at even an elemental level no less the highly musical level of which I dreamed.”
- Basically, Experiments in Musical Intelligence works using three basic principles:
 - deconstruction (analyze and separate into parts)
 - signatures (commonality - retain that which signifies style)
 - compatibility (recombinancy - recombine into new works)



Bach



Beethoven



Mahler

Example: Narrative (Brutus.1)

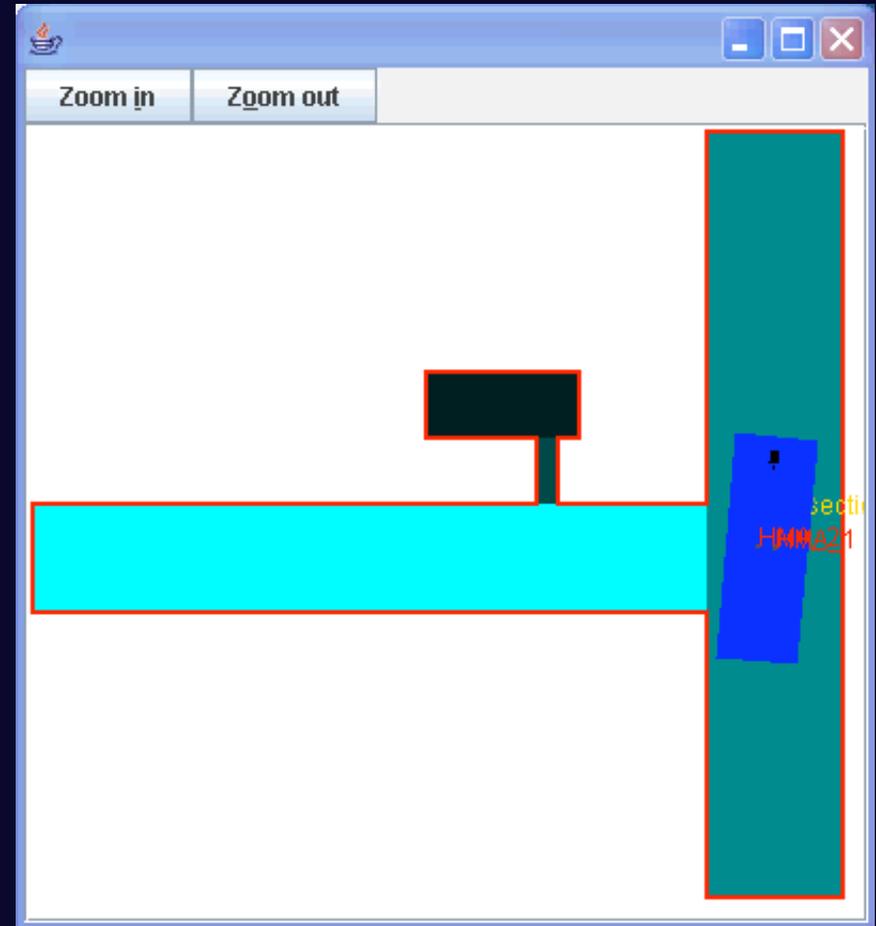
Dave Striver loved the university. He loved its ivy-covered clocktowers, its ancient and sturdy brick, and its sun-splashed verdant greens and eager youth. He also loved the fact that the university is free of the stark unforgiving trials of the business world -- only this isn't a fact: academia has its own tests, and some are as merciless as any in the marketplace. A prime example is the dissertation defense: to earn the PhD, to become a doctor, one must pass an oral examination on one's dissertation. This was a test Professor Edward Hart enjoyed giving.

Dave wanted desperately to be a doctor. But he needed the signatures of three people on the first page of his dissertation, the priceless inscriptions which, together, would certify that he had passed his defense. One of the signatures had to come from Professor Hart, and Hart had often said -- to others and to himself -- that he was honored to help Dave secure his well-earned dream...

Useful, not versatile model

Example: Robotic Movie Director

- Institute for Creative Technologies
- Given a script, balance...
 - Where best to block actors
 - Which locations are best
 - Which camera angles are best
 - Which *sequences* of angles are best



Example: Robotic Movie Director



Style: quick cuts, static shots

Example: Robotic Movie Director



Style: few cuts, moving shots

What's the pattern here?

- Computers can find and follow *rules*.
 - So do Hollywood executives, genre publishers, etc.
- True creativity is about *breaking* rules, defying expectations.
- Can a computer be *creative*?
 - Answer #1: No.
 - Answer #2: No, but it can be *diverting*.
 - Answer #3: Yes, but not with today's technology.

Can computers be *creative*?

- Why so?
 - If creativity is about breaking from rules and making original statements, that is simply making the model more general, more versatile.
 - Build faster computers and better algorithms
 - Public often doesn't like rule-breaking
- Why not?
 - The *evaluation* of aesthetics and creative value depends on the shared human experience -- culture -- that computers lack.
 - Creativity is an AI-complete problem.
 - Difficult even for humans.

Segue: Narrative context





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Outline of my research

- Conceptual modeling of narrative
 - A symbolic “language” allowing interpretation, analysis, comparison, generation
- Automatic processing over implemented models
 - Algorithms for the above
- Interdisciplinary
 - Collaboration with School of the Arts, GK-12

Why focus on narrative in NLP?

- Story form used in many types of discourse
 - News, history, gossip, propaganda, advertising, nonfiction, mythology... and fiction
- Intrinsic value
 - Model the human narrative instinct
 - Understand the structure of narrative as a symbolic language
- Extrinsic value
 - Training, education, entertainment, HCI, NLP

Narrative's historical role in AI

- Researchers in “hard” (knowledge-intensive) AI cast *understanding* as *story understanding*
 - An early “inference explosion” called for **causally related** sentences to be grouped into a **context**
 - Early '80s debate: Plans (Schank) vs. grammars (Rumelhart)
 - Little notion of the creative or “tellable”
- The transition to statistical AI and NLP was one away from a focus on narrative
 - But, occasional work on total-understanding writers and readers
 - Turner 1992 (creativity as case-based reasoning)
 - Mueller 2003

Plans

- A narrative is a “route” to get from some goal state of the world to some solution state of the world.
 - Jim was a lonely guy.
 - Jim wanted to be famous.
 - Jim became famous.
 - Recurse on appropriate sub-goals
- Is this creative?
 - Failure and setback are part of life as well
 - Current work on “authorial” plans that include them
- Is this practical?
 - What are all the ways to become famous?

Grammars

- Syntactic rules for story structure:
 - Rule 1: Story = Setting + Episode
 - Rule 6: Internal Response = (Emotion | Desire)
 - Rule 10: Preaction = Subgoal + (Attempt)*
- Summarization rewrite rules
 - Summary(CAUSE[X,Y]) = “Instrument(X) caused (Y)”
- Grammar is not powerful, but very influential
 - Does proper syntax imply coherent meaning? (McKee vs. Chomsky)

Colorless green ideas sleep furiously.



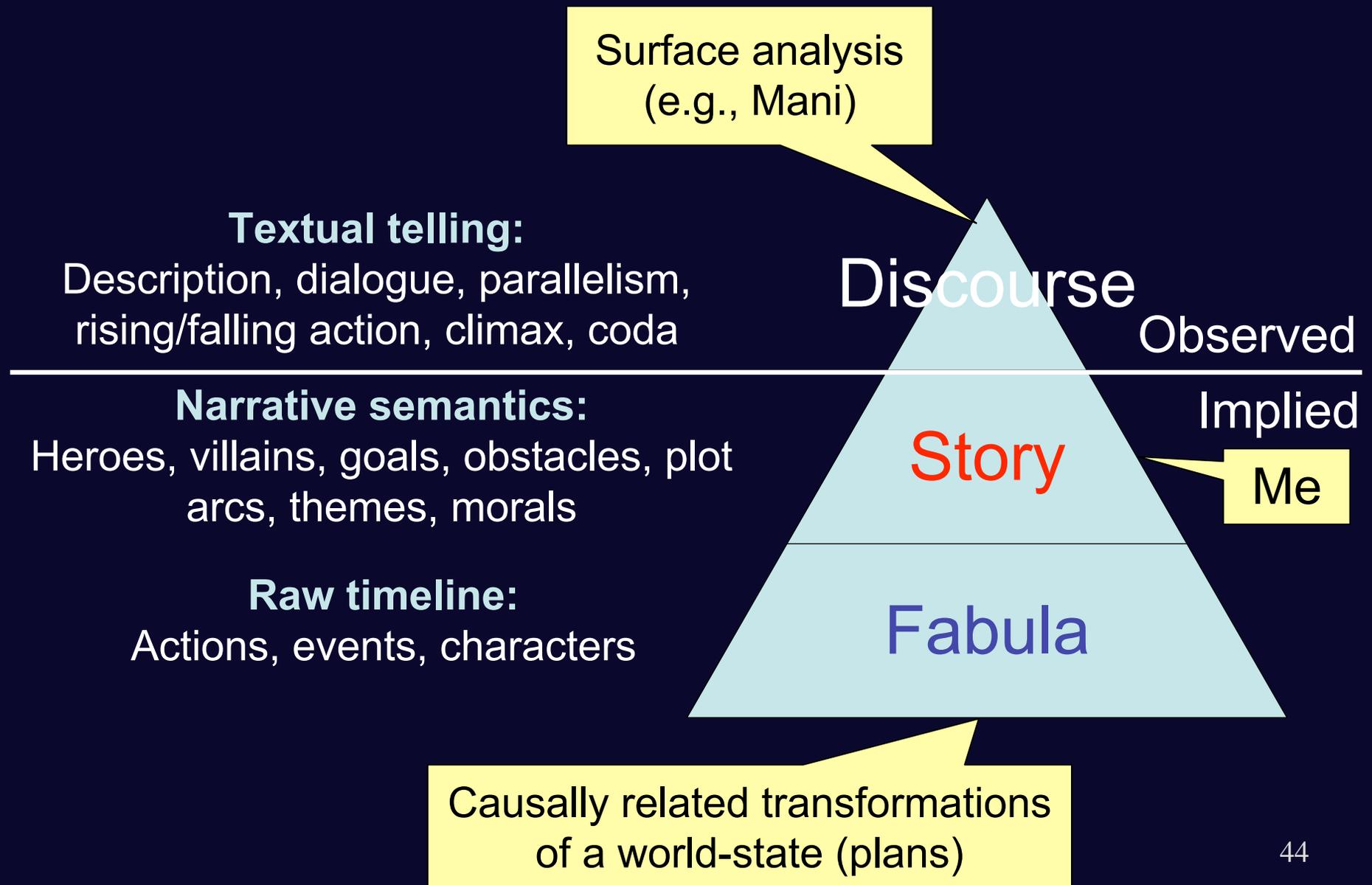
Current Work in Narrative

- Plan-based games and simulators
 - “Liquid Narrative” group at NCSU (Young)
 - Experimental Game Lab at Georgia Tech (Mateas)
 - Institute for Creative Technologies (Riedl)
- Surface-level processing
 - Content selection for narrative summarization (Mani 2004)
 - Affect of spoken children’s stories (Alm and Sproat 2005)
 - Visualization of textual affect (MIT Media Lab)
 - Dialogue systems for child development, HCI (Cassell)
 - Surface generation of narratives from plans (Lonneker 2005)
- Many fields, many models of narrative

Narrative *is*...

| | |
|---|---|
| Literary theorists | Interpretation (e.g., structuralism, deconstructionism, other “isms”) |
| Linguists | Language “telling” (e.g., Labov) |
| NLP researchers | Content selection, categorization |
| AI researchers | Plans, problem-solving, common-sense reasoning |
| Cognitive psychologists | Mental constructions of human perception |
| Critics, mythologists, creative professionals, historians | Categories of common “tropes” of stories and conflicts (genres, themes) |

Formalist layers of narrative



Non-computational story automation conflate these

- Narrative by formula
 - Propp, *Morphology of the Folk Tale*
 - Polti, *The Thirty-Six Dramatic Situations*
 - Madlibs
- Interactive story creation
 - *Choose Your Own Adventure*

Middle Layer:

Many stories *reducible* to...

- “Value Systems,” which order competing WANTS
 - Plots where characters learn to prioritize WANTS differently
 - Selfless heroes vs. selfish villains
- “Clans,” groups of related characters
 - Instances: Ethnic group, socio-economic group, special interest group, family, gang, gender, etc.
 - Plots: love across clan boundaries, struggling to join or leave a clan, war between clans, providing a WANT for a clan member, overcoming prejudices against the clan
- Interpersonal contrasts that compare outlooks
 - Organized, logical introvert vs. free-associating extrovert
 - Private and closed off vs. connected and generous
 - Type-A (driven) vs. type-B (patient)
 - Analytical and detached vs. emotional and impulsive

Modeling narratives with symbols

- Not an attempt to list all possible stories
 - Linguistics analogy: Can't list all possible sentences, but we can make a dictionary
- Creativity is in selecting the *best* combinations to achieve **affect**
 - An “expectation model” to be used or abused
 - Stories recognized as being parts of other stories
 - Anticipated plot developments, other tropes
- What about the “horoscope effect”?
 - How fine is too fine? How fine is fine enough?

Modeling narratives with symbols

- Model of perceiver's subjective **understanding**, not stories themselves
 - Multiple “parses” possible from same actions
 - Abstraction happens on receiving end
- Better to design an algorithm for **learning** a model, not provide a single *a priori* model
 - If “narrative expectation model” is correct approach, it should be learnable from a corpus
 - What's the best representation?

Using your expectation model

- There was once a beautiful princess who fell in love with a poor but noble woodworker.
- The king rejected the woodworker's request for his daughter's hand and banished him from the kingdom.
- A dragon then kidnapped the princess and took her up to the peaks of the Misty Mountains. None of the king's men were brave enough to follow.

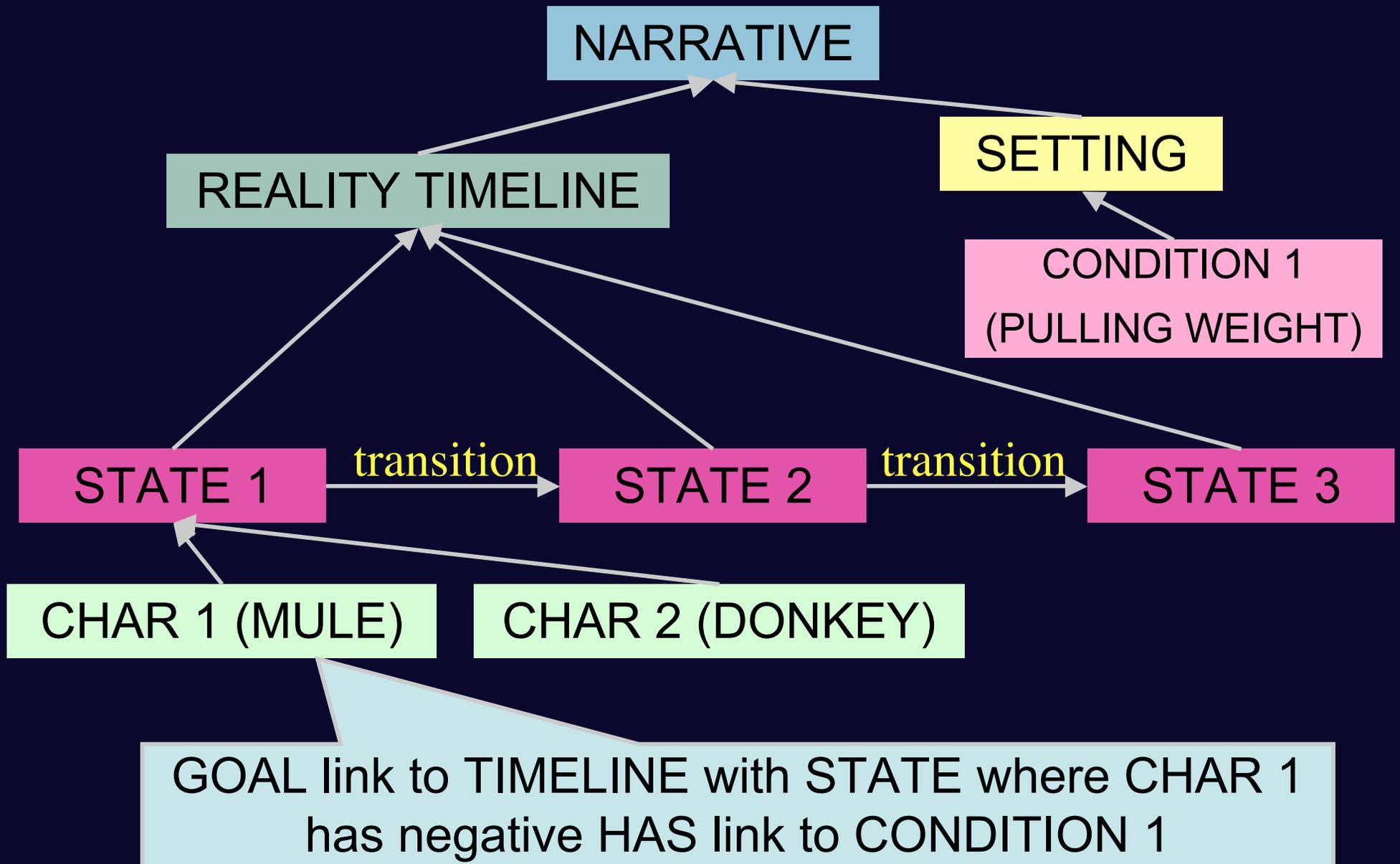
Using your expectation model

- Mr. Skittle was mowing his lawn. He drove his ride-on mower around the lawn's edges, a technique he learned from watching zambonis as a kid.
- He then turned his mower and started going in an inward spiral.
- Once he was in the middle of his lawn and had nothing left to mow, he took the bag off the mower and put it on the curb. THE END

An optimal model would...

- Allow an algorithm to capture expectations
 - Detect patterns (e.g., common plots) across stories
 - Identify a “pattern in progress” in a new narrative
- Not get hung up on knowledge
 - “Abstract out” enough to be tractable
 - Allow infusion of knowledge where appropriate
 - Be tolerant of partially formed narratives, unlike plans

Semantic graph representation



Relationship to plans

- Borrows some of the structure of a plan
 - States, actions, goals
- Crucial differences
 - Non-executable
 - States cannot be computed from past states + actions
 - Data structure for **mining**, not algorithm for reasoning and problem solving
 - Goals are relative to characters, not complete states

Is The Model Useful?

- Implement structure in semantic network
 - Apply it to corpus of Aesop's Fables
 - Manual annotation with documented procedure
- Determine what useful analysis can be performed
 - Automatic learning of common plots, themes
 - Protagonist identification
 - “Moral endorsement” detection
 - Similarity metrics to compare multiple stories
 - Genre categorization
 - Recognition of “predicates in progress”
 - Categorization of affective response, per-state
 - Detection of tension, climax and other structural features

Can Computers Tell Stories?

- This model won't allow them to tell coherent, creative stories from scratch.
- It will give insight into the *creative telling* that occurs between fabula and discourse.
- Computer creativity is not about *replacing* human creativity, but *understanding* it through example.
 - “Computer science is as much about computers as astronomy is about telescopes.”

FIN