Frames, Graphs and the Semantics of Storytelling

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Review: Five Roles of KR

- A surrogate for some part of the real world
- A set of ontological commitments
- A fragmentary theory of intelligent reasoning
- A medium for pragmatically efficient computation
- A medium of human expression

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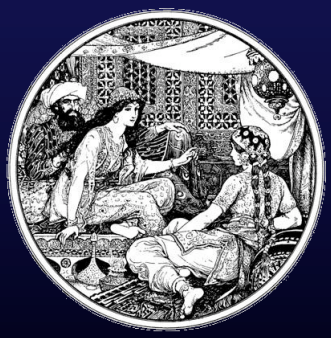
The Plan

- Semantic Networks
- Frames

- Example Domain: Story Reasoning
  - Other People's Work
  - My Work



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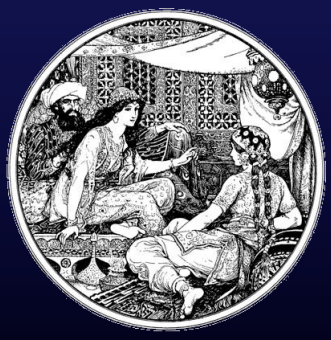

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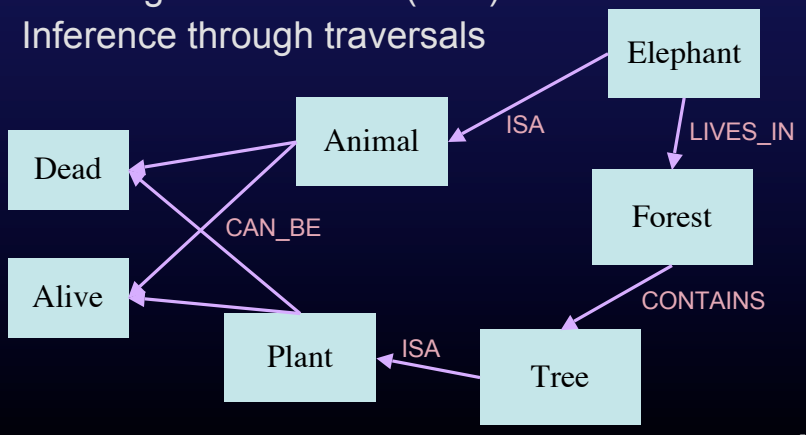
Semantic Networks

- Directed graphs with labeled nodes and arcs
- Meaning is in *relations* (arcs)
- Inference through traversals



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Properties of Networks

- Formal
  - Can reduce to first-order predicates
    - ISA(Tree, Plant)
  - Good for deduction
- Flexible
  - Easy to add new links, arcs within formal constraints
  - Can add probabilistic reasoning
    - Think Bayesian networks, neural nets
- But only as good as the algorithms that use them
  - A representation, not a reasoning system
  - No standards about graph topographies

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WordNet

- Most famous semantic network
  - Nodes for nouns, verbs, adjectives, adverbs
  - Links for meronymy, hyponymy, synonymy, antonymy, participles, related nouns, etc.
- Constructed as an ontology
  - 150K words, many with multiple senses
- Used widely in NLP/AI
  - Syntactic, semantic parsing
  - Ontological resource

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WordNet: 1 sense of "go"

- S: (v) travel, **go**, move, locomote (change location; move, travel, or proceed, also metaphorically) *"How fast does your new car go?"; "We travelled from Rome to Naples by bus"; "The policemen went from door to door looking for the suspect"; "The soldiers moved towards the city in an attempt to take it before night fell"; "news travelled fast"*
  - *direct troponym / full troponym*
  - *verb group*
    - S: (v) move, displace (cause to move or shift into a new position or place, both in a concrete and in an abstract sense) *"Move those boxes into the corner, please"; "I'm moving my money to another bank"; "The director moved more responsibilities onto his new assistant"*
  - *antonym*
    - W: (v) stay in place [Opposed to: travel] (be stationary)
  - ***derivationally related form***
  - *phrasal verb*
    - W: (v) go on [Related to: go] (move forward, also in the metaphorical sense) *"Time marches on"*
    - W: (v) go up [Related to: go] (go upward with gradual or continuous progress) *"Did you ever climb up the hill behind your house?"*
    - W: (v) go by [Related to: go] (pass by) *"three years elapsed"*
    - W: (v) go off [Related to: go] (run away; usually includes taking something or somebody along) *"The thief made off with our silver"; "the accountant absconded with the cash from the safe"*
    - W: (v) go out [Related to: go] (go out of fashion; become unfashionable)
    - W: (v) go by [Related to: go] (move past) *"A black limousine passed by when she looked out the window"; "He passed his professor in the hall"; "One line of soldiers surpassed the other"*
    - W: (v) go up [Related to: go] (move upward) *"The fog lifted"; "The smoke arose from the forest fire"; "The mist uprose from the meadows"*
    - W: (v) go down [Related to: go] ((/))
    - W: (v) go down [Related to: go] (disappear beyond the horizon) *"the sun sets early these days"*
    - W: (v) go down [Related to: go] (move downward and lower, but not necessarily all the way) *"The temperature is going down"; "The barometer is falling"; "The curtain fell on the diva"; "Her hand went up and then fell again"*
    - W: (v) go under [Related to: go] ((/))
    - W: (v) go on [Related to: go] (continue talking) *"I know it's hard," he continued, "but there is no choice"; "carry on--pretend we are not in the room"*
    - W: (v) go around [Related to: go] (become widely known and passed on) *"the rumor spread"; "the story went around in the office"*
    - W: (v) move on [Related to: move] (move forward, also in the metaphorical sense) *"Time marches on"*
    - W: (v) move out [Related to: move] (move out of one's old house or office)

The Plan

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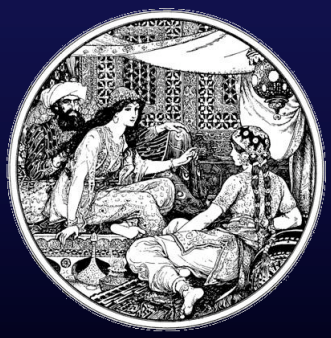

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Frames

- "Slot filling" theory of linguistic semantics
  - "Fleeing" requires fillers for roles
    - Self-mover moving under own power
    - Direction of movement
    - Source for start of motion
    - Goal for intended destination
    - Duration of movement
    - Explanation for action
    - Place
    - Manner of fleeing
    - Etc.

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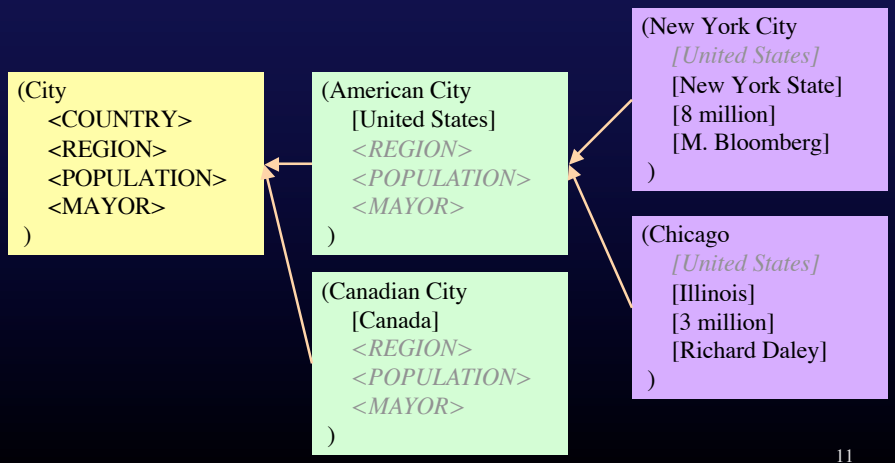
Hierarchical Frames

- ISA relationships determine hierarchy
- Slots are inherited by descendants



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Using Frames for Understanding

- Create ***expectation models***
  - "Parse" tokens into appropriate frames
  - Narrows down interpretations
  - Guides further questions
- Example: *A large number of people are singing in a room with a cake.*
  - *Party Frame?*
    - *Birthday Party Frame?*
      - Whose birthday?
    - *Retirement Party Frame?*
      - Who's retiring?
    - *Holiday Party Frame?*
      - Which holiday?

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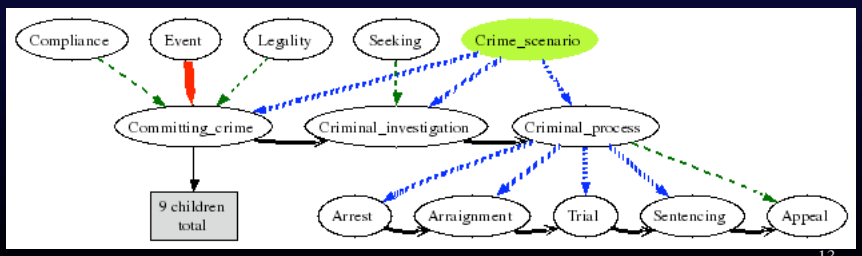
Frames: State of the Art

- FrameNet
  - 825 semantic frames
    - 10,000 words related (out of 500K)
  - 135K sample annotated sentences



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Feigning

Definition:

An Agent acts in such a way as to give the incorrect impression to observers that a particular State_of_affairs holds.

Jordan FEIGNED a love of jazz music to get her phone number .

FEs:

Core:

Agent [agt] **Semantic Type** Sentient	The Agent is the person who acts in a misleading way to create the impression that a State_of_affairs holds. A year after Audrey Seiler FAKED her own kidnapping while at college in Wisconsin, her lawyer says she's getting help and paying restitution.
Copy [Copy]	The Copy produced by the Creator most commonly occurs as the External Argument of a predicative use of an adjective or noun target: The painting is a FAKE.
Original [Orig]	This is the entity which is copied. With verbs it is frequently expressed as an NP Object: Pat FALSIFIED the papers.
State_of_affairs [soa]	The State_of_affairs is a an event, a state, or a property that the Agent wants others to believe have occurred or hold. A college student who STAGED her own disappearance last month will

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Evaluating Frames

- Pros
  - Provide semantics above word level
  - Encode wide breadth of real-world knowledge
  - Mimic cognitive “expectation models”
    - Helpful for understanding, recognition
  - Easy to implement with OO
    - Inheritance, fields…
- Cons
  - Rigid, labor-intensive, static
  - Difficult to find right depth of detail to model

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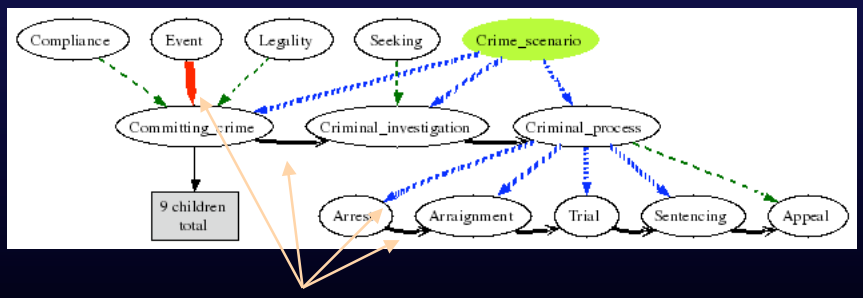
Semantic Nets + Frames

- Notice how FrameNet combines both approaches



Slot fillers are arcs to other frames

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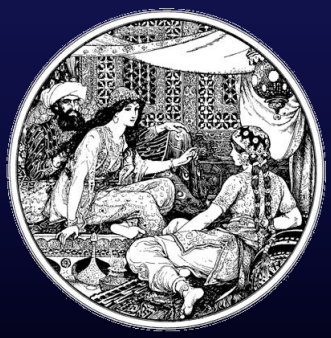

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Why focus on narrative in AI?

- 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

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Narrative's historical role in AI

- Early research in AI tried to create *total understanding* models from text (e.g., news)
  - What if computers could read and *learn?*
- Understanding is a sequence of first-order predicates
  - "A man crashed his car in the tree and went to the hospital."
    - Crashed(Car, Tree)
    - WentTo(Person, Hospital)
    - WasIn(Person, Car)
    - Owned(Person, Car)
    - Gender(Person, Male)
    - Followed(WentTo(Person,Hospital), Crashed(Car,Tree))

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Narrative's historical role in AI

- People realized they needed *causality*
  - Reduce possible interpretations by assuming relationships
    - A car crashed: Why? So what?
    - A person was injured: How?
- This led them to cast *understanding* as *story understanding*
  - Causality is the cornerstone of storytelling
- But what's the right KR?
  - Do we inherit work in stories from other disciplines?
  - Is there more to stories than causality?

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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 subjective interpretation
Critics, mythologists, creative professionals, historians	Categories of common "tropes" of stories and conflicts (genres, themes)

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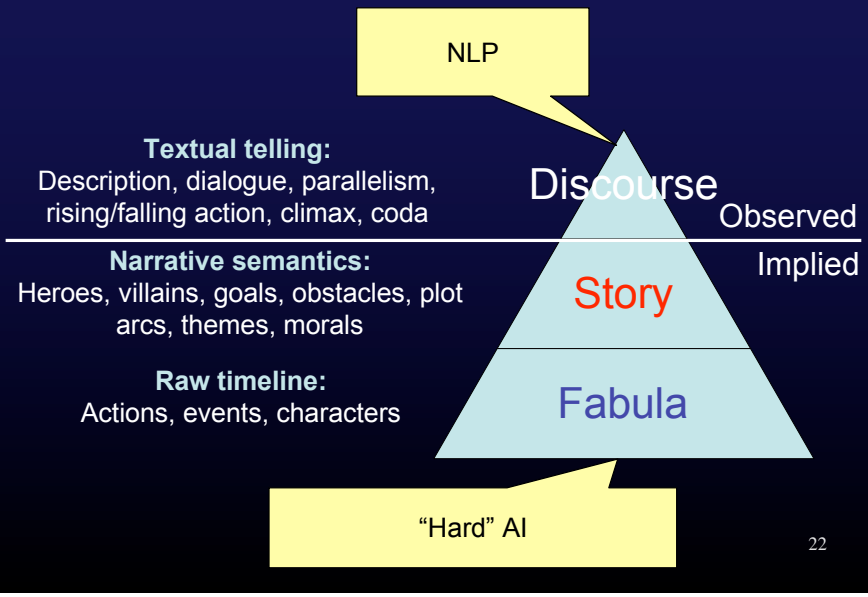
Formalist layers of narrative



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Goals for a KR for Stories

- Expressiveness
  - Power to represent wide range of narrative constructs
- Robustness
  - Handles different granularities of world knowledge, specification
- Formality
  - Meets degree of understanding required for the task
    - Answering questions, offering advice, etc
- Usability
  - Intuitive for programmers and end-users to populate or use

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Idea #1: Scripts, 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.
    - In order to do that, Jim had to do certain actions…
    - Each of those actions becomes a sub-goal
- Find the script/plan that applies to the text you're reading
  - What's the problem here?
- Enduring idea because of its high formality
  - Current total-understanding work returning to plans

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Idea #2: 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)

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Colorless green ideas sleep furiously.

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Idea #3: Semantic Networks

- Nodes for *actions, goals*
- Arcs for *causality*, *implications*, *subgoals*
- More flexible, less formal than plans
  - Very difficult to construct a graph automatically
  - We can process graphs for QA, other tasks

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Narrative in the AI Winter

- None of these approaches solved the story understanding problem
  - KR too brittle, too shallow to work
  - Generation attempts were brittle as well
  - Some still working on “hard” understanding
- Much of AI went statistical in the 90s
  - Systems that build models from large sets of data

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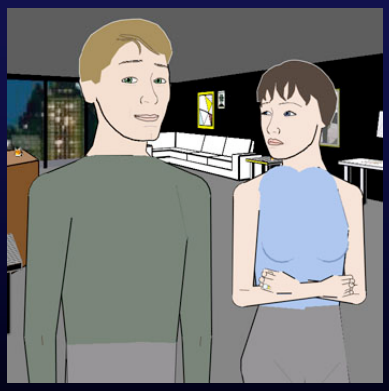
Narrative in AI: State of the Art

- Virtually all models still top-down
  - Structure: Plans, goals, FOL
  - Content models lifted from literary theorists
- Work in creativity has gone to games
  - Dynamically adjust story progress based on user input
- Other task-based lines of work
  - E.g., virtual reporting inside an MMORPG



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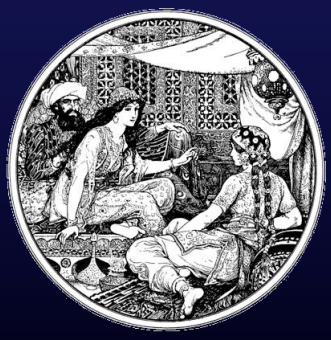

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Idea #4?

- Apply *statistical learning* approach to narrative
  - Learn theory bottom-up
- Focus on *thematic understanding*
  - Expectation models
  - Genre categories
  - Human affect
  - Interpersonal interpretations
- Don't focus on total understanding
  - Ease formality constraints on model

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Hypothesis: Data-Driven Analysis

- We all build "expectation models" based on stories we've heard before
- There is an active listening process based on the "story so far"
  - Interpret a new story in the context of past ones
- We continuously update model
  - Bring it to bear on all new stories
- We can reproduce this using machine learning
  - With the right story representation

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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.

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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

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What Can We Get?

- Moral models
  - Selfishness punished
- Plot patterns
  - Goal obtained at beginning, attained at end
- Character patterns
  - The protective father, the greedy businessperson…
- Affectual patterns (reader's perspective)
  - Suspense vs. surprise
  - Expectation of tragedy vs. comedy

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What Would We Do with It?

- Inform other generation, understanding systems
  - "Auto-Propp" over custom corpus
- Authoring and co-authoring tools
  - Feedback based on similarity to corpus
- Perception experiments
  - Individual differences in story understanding
- Story summarization, retelling

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Scheherazade

- Implemented Java library
- Input: API accepts *narrative assertions (discourse)*
  - Actions, states, character declarations…
  - Compiles a semantic network (*fabula)*
- Output: Query language searches graph for patterns
  - Hierarchical types (ISA) allow for some inference

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Example "fable"

Character

- There was once a donkey who wanted a carrot to snack upon.

  Goal (possible future action)

DECLARE Donkey
Donkey WANTS carrot

Same character *New character*

- He said to a farmer, "if you provide me the carrot, I will carry your load today, and relieve you of it."

  Promise of future action with precondition action

DECLARE Farmer
Donkey SAYSTO Farmer
IF Farmer GIVE carrot TO Donkey, THEN Donkey ADOPT carry(load1) FROM Farmer

- The farmer said…

  Same character

Farmer SAYSTO Donkey

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KR approach

- Combine frames and semantic networks
  - Frames allow separation of knowledge types and instances
    - ME: “A character can feel envious toward another charcter.”
    - ENCODER: “Bob felt envious toward Janet at this point in the story, for this reason.”
  - Semantic networks are very flexible
    - Story can be as big or small as necessary
    - No total understanding provided or required

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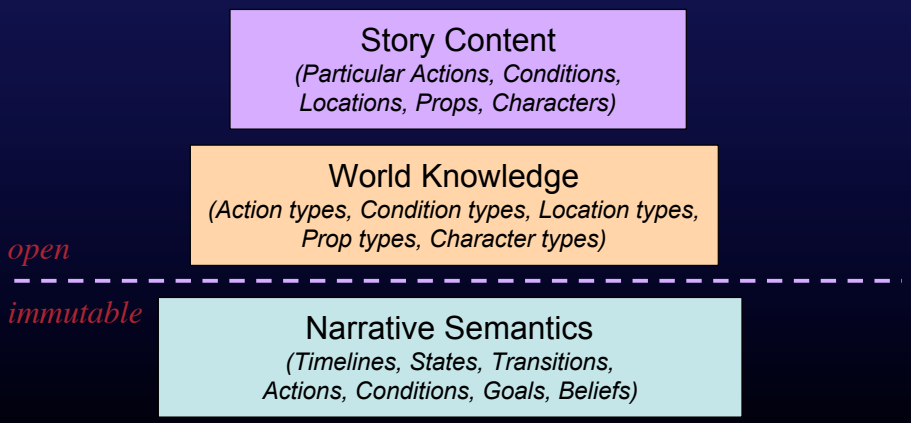
KR for Stories

- Three classes of symbols



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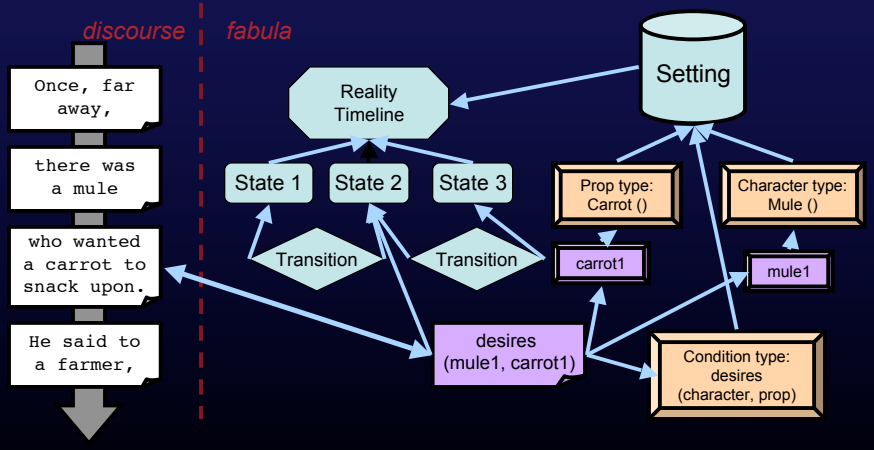
Semantic network representation



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Features of Representation

- Timelines
  - Sequences of states and transitions
  - Diegetic (nested) for plans, goals, beliefs
- Actions
  - Intentional acts, happenings
- Conditions
  - Emotions, goals, etc.
- Story assertions (original telling)

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Ongoing work

- Build corpus of story encodings
  - Multiple stories, multiple encodings per story
  - Serve as basis for learning experiments
    - Deriving “canonical” encoding
    - Subjective interpretations
    - Machine learning over narrative features

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Corpus: Aesop’s Fables

- Many stories in a shared story-world
- Relatively simple story-world
- Thin rhetorical layer
  - Simple prose easier to model through
- Conventional use of structure
  - Moral clarity
  - Well-defined goals, plans, beliefs

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Demo

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Conclusions

- "Best KR" completely task-dependent
  - Formality required?
  - Robustness required?
  - Depth of knowledge required?
  - Breadth of knowledge required?
- Semantic networks good for associations between elements
  - Graph topography task-dependent
- Frames good for type/instance distinctions
  - When you are sure they are correct…
- Data-driven approaches compatible with strong KR

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FIN

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