Coherence

Intuition that the parts of a discourse hang together

- Local coherence: Consecutive thoughts are related
  - Indicated through coherence relations
    - Often, but *not always*, accompanied by transition cues
  - Indicated through stability of "aboutness" or salience of entities
    - Don't bounce across entities
  - Indicated through stability of topicality
    - Draw from a single conceptual space
    - Exhibit lexical cohesion
- Global coherence: respect the conventions of their genre
  - Organization of academic paper or legal brief
  - Recurring plots in stories
- Accommodation
  - When there isn't natural coherence, people tend to force one anyway by preferring an coherent reading

RST: Rhetorical Structure Theory

- Discourse Unit or *unit*: A span of text
  - Typically a clause
- Nucleus
  - More central to the writer's purpose
  - Interpretable independently
- Satellite
  - Less central to the writer's purpose
  - Interpretable only in dependence to the nucleus
- Several coherence relations
- Elementary Discourse Unit (EDU): one that doesn't contain units linked by coherence relations

RST Coherence Relations

78 in 16 classes, https://www.isi.edu/~marcu/discourse/tagging-ref-manual.pdf

Relation	**Nucleus**	**Satellite**
Reason	Action by animate agent	Reason for nucleus
Elaboration	Situation	Elaboration for nucleus
Evidence	Situation	Data or justification, usually independent of the agent's will
Attribution	Report	Source for that report
List	Series of nuclei	None

RST Relation Classes

Highlighting those in the book (previous page)

Attribution	**attribution**, attribution-negative
Background	background, circumstance
Cause	cause, result, consequence
Comparison	comparison, preference, analogy, proportion
Condition	condition, hypothetical, contingency, otherwise
Contrast	contrast, concession, antithesis
Elaboration	**elaboration-additional**, elaboration-general-specific, elaboration-part-whole, elaboration-process-step, elaboration-object-attribute, elaboration-set-member, example, definition
Enablement	purpose, enablement
Evaluation	evaluation, interpretation, conclusion, comment
Explanation	**evidence**, explanation-argumentative, **reason**
Joint	**list**, disjunction
Manner-Means	manner, means
Topic-Comment	problem-solution, question-answer, statement-response, topic-comment, comment-topic, rhetorical-question
Summary	summary, restatement
Temporal	temporal-before, temporal-after, temporal-same-time, sequence, inverted-sequence
Topic Change	topic-shift, topic-drift

Exercise Discourse: Text

Identify elementary discourse units

- Notice that some of the EDUs don't have verbs

Mars
With its distant orbit—50 percent farther from the sun than Earth—and slim atmospheric blanket, Mars experiences frigid weather conditions. Surface temperatures typically average about –60 degrees Celsius (–76 degrees Fahrenheit) at the equator and can dip to –123 degrees C near the poles. Only the midday sun at tropical latitudes is warm enough to thaw ice on occasion, but any liquid water formed in this way would evaporate almost instantly because of the low atmospheric pressure.

- A sufficiently complete thought to enter into a relation with another thought

Example Discourse: Elementary Discourse Units

Identify coherence relations between them

Consider these relations:

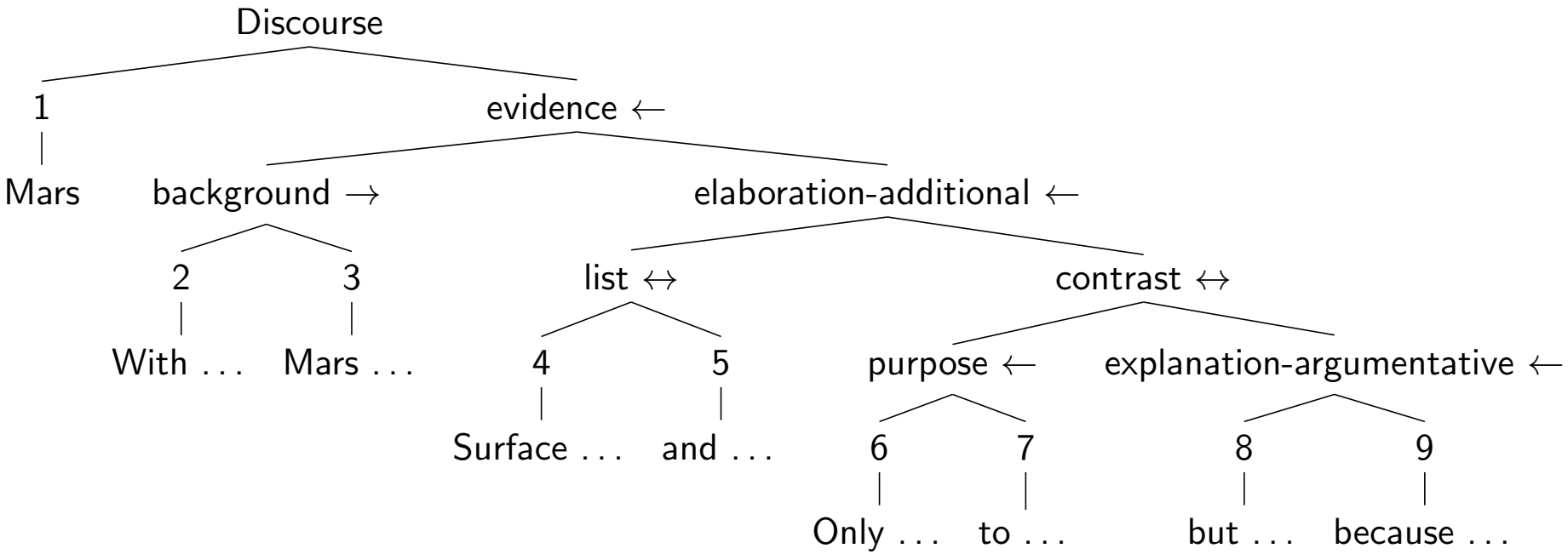
Evidence	Explanation-Argumentative
List	Background
Purpose	Elaboration-Additional
Contrast	

[$_1$Mars]
[$_2$With its distant orbit—50 percent farther from the sun than Earth—and slim atmospheric blanket,] [$_3$Mars experiences frigid weather conditions.] [$_4$Surface temperatures typically average about –60 degrees Celsius (–76 degrees Fahrenheit) at the equator] [$_5$and can dip to –123 degrees C near the poles.] [$_6$Only the midday sun at tropical latitudes is warm enough] [$_7$to thaw ice on occasion,] [$_8$but any liquid water formed in this way would evaporate almost instantly] [$_9$because of the low atmospheric pressure.]

Exercise Discourse: RST Tree

Build out a tree whose leaves are EDUs, root is DISCOURSE, and internal nodes are RST relations

Example Discourse: RST Tree



PDTB: Penn Discourse TreeBank

Lexically grounded: Based on discourse connectives

- Because, since, though, as a result, . . .
- Identify discourse relations in a corpus
  - 18,000 explicit relations: A discourse connective exists
  - 16,000 implicit relations: No discourse connective exists

PDTB Sense Hierarchy

Those in italics are rare

Temporal	Asynchronous	
	Synchronous	Precedence, Succession, Concurrence
Comparison	Contrast	Juxtaposition, Opposition
	Pragmatic Contrast	*Juxtaposition, Opposition*
	Concession	Expectation, Contra-expectation
	Pragmatic Concession	
Contingency	Cause	Reason, Result
	Pragmatic Cause	Justification
	Condition	*Hypothetical, General, Unreal Present/Past, Factual Present/Past*
	Pragmatic Condition	*Relevance, Implicit Assertion*
Expansion	*Exception*	
	Instantiation	
	Restatement	Specification, Equivalence, Generalization
	Alternative	Conjunction, Disjunction, Chosen Alternative
	List	

Exercise: Identify Text Spans and Discourse Relations

Made up example

The U.S. wants the removal of what it perceives as barriers to investment; Japan denies there are real barriers. Not only does Japan impose a duty on imports of computers, it also charges a surcharge on smartphones. A stated reason for imposing such duties is to protect Japanese industry but at the same time they lower the quality of life for Japanese consumers.

Look for

- Implicit contrast
- Conjunction
- Justification
- Synchronous

Possibly other relations?

Entity-Based Coherence: Centering

Aboutness of a discourse

- At any point in a discourse there's one *center* entity
  - Unit of analysis: utterance
  - Utterance $\neq$ sentence: could be a smaller text span
- The center is a *semantic entity*
  - In the real or imagined world the discourse is about
  - And may be realized through some expression, including unrealized expressions such as zero anaphors
- Salience at a point: whatever is the center
  - The center corresponds to what's most salient, i.e., the "topic"

    John had frequented the store for many years

    It was a store John had frequented for many years
  - Center selection preference: Subject $>$ Object $>$ other roles
- Provides a basis for assessing coherence
  - The center transitions between entities as a discourse progresses
  - Coherence: fewer shifts

Centering Theory

- An utterance may be of a phrase, not necessarily of a clause
- An utterance *directly realizes* an entity that is its semantic interpretation
- An utterance *realizes* an entity that it directly realizes as well as any entity that exists in the situation the utterance describes
- C_b: backward looking center at utterance U_n
  - The center as understood immediately at the end of U_n
  - Unique salient entity realized in U_{n-1}
    - Thus, $C_b(U_n)$ is confirmatory: picks something from $C_f(U_{n-1})$
  - Also realized in U_n (Grosz, Joshi, Weinstein 1994, p8)
- C_f: forward centers at utterance U_n
  - Set of potential backward centers for U_{n+1}, each realized in U_n
  - Partially ordered by salience or grammatical role
  - C_p: *Preferred (predicted) center*—most preferred to be $C_b(U_{n+1})$

Centering Constraints and Transitions

Transitions apply for $n \geq 2$ since U_1 is the first utterance

	$C_b(U_n) = C_b(U_{n-1})$ or $C_b(U_{n-1})$ is undefined	$C_b(U_n) \neq C_b(U_{n-1})$
$C_b(U_n) = C_p(U_n)$	CONTINUE	SMOOTH SHIFT
$C_b(U_n) \neq C_p(U_n)$	RETAIN	ROUGH SHIFT

- Rule: pronominalization
  - If U_n realizes some member of $C_f(U_{n-1})$ via a pronoun, then $C_b(U_n)$ is a pronoun as well
  - Pronouns (including zero anaphora) indicate salience
- Rule: transition priority (in descending order of coherence)
  - CONTINUE: maximal coherence
  - RETAIN: think of as a prelude to a SMOOTH SHIFT
  - SMOOTH SHIFT: moving the center C_b while aligning it with C_p—indicates following up on previous RETAIN move
  - ROUGH SHIFT: a surprising shift

Example

		C_b	C_f (showing $\underline{C_p}$)
U_1	John went to his favorite music store to buy a piano		John, music store, piano
U_2	He was excited that he could finally buy a piano	John	John, piano
U_3	He arrived just as the store was closing for the day	John	John, music store
U_4	It was closing just as John arrived	music store	John, music store

- U_1: not applicable
- U_2: CONTINUE
- U_3: CONTINUE
- U_4: ROUGH-SHIFT

Connectedness is not Coherence

Lakoff's example: The statements are not meant to be true

1. Little Johnny wanted a bicycle
2. Bicycles were invented by Abner Doubleday in 1776
3. In that year, the Charles River overflowed, drowning two flea circus entertainers in Canton, Ohio
4. Ohio's manure industry provides thirty-eight percent of the state's gross revenue
5. Gross earnings of professional tennis players are rising

Disconnectedness is not Incoherence: 1

Henry Reed's Poem: Naming Of Parts

Today we have naming of parts. Yesterday,
We had daily cleaning. And tomorrow morning,
We shall have what to do after firing. But today,
Today we have naming of parts. Japonica
Glistens like coral in all the neighboring gardens,
And today we have naming of parts.

This is the lower sling swivel. And this
Is the upper sling swivel, whose use you will see,
When you are given your slings. And this is the piling swivel,
Which in your case you have not got. The branches
Hold in the gardens their silent, eloquent gestures,
Which in our case we have not got.

This is the safety-catch, which is always released
With an easy flick of the thumb. And please do not let me
See anyone using his finger. You can do it quite easy
If you have any strength in your thumb. The blossoms
Are fragile and motionless, never letting anyone see
Any of them using their finger.

Disconnectedness is not Incoherence: 2

Henry Reed's Poem: Naming Of Parts

And this you can see is the bolt. The purpose of this
Is to open the breech, as you see. We can slide it
Rapidly backwards and forwards: we call this
Easing the spring. And rapidly backwards and forwards
The early bees are assaulting and fumbling the flowers:
They call it easing the Spring.

They call it easing the Spring: it is perfectly easy
If you have any strength in your thumb: like the bolt,
And the breech, the cocking-piece, and the point of balance,
Which in our case we have not got; and the almond blossom
Silent in all of the gardens and the bees going backwards and forwards,
For today we have the naming of parts.

Entity-Grid Model

Barzilay and Lapata

- Build a grid showing which utterance includes which entity
  - In which grammatical role
    - Subject: S
    - Object: O
    - Neither: X
    - Entity not present: –
- Transitions from one utterance to the next
  - Show which roles are added, removed, or changed
  - Compute probability estimates for each transition sequence (e.g., of length two) within a discourse
  - The vector of probabilities becomes a signature for a discourse
- Train a classifier for coherence
- Data
  - Positive: actual discourse with utterances in the original order
  - Negative: actual discourse with utterances randomized

Example Discourse

1	[The Justice Department]$_S$ is conducting an [anti-trust trial]$_O$ against [Microsoft Corp.]$_X$ with [evidence]$_X$ that [the company]$_S$ is increasingly attempting to crush [competitors]$_O$.
2	[Microsoft]$_O$ is accused of trying to forcefully buy into [markets]$_X$ where [its own products]$_S$ are not competitive enough to unseat [established brands]$_O$.
3	[The case]$_S$ revolves around [evidence]$_O$ of [Microsoft]$_S$ aggressively pressuring [Netscape]$_O$ into merging [browser software]$_O$.
4	[Microsoft]$_S$ claims [its tactics]$_S$ are commonplace and good economically.
5	[The government]$_S$ may file [a civil suit]$_O$ ruling that [conspiracy]$_S$ to curb [competition]$_O$ through [collusion]$_X$ is [a violation of the Sherman Act]$_O$.
6	[Microsoft]$_S$ continues to show [increased earnings]$_O$ despite [the trial]$_X$.

- Identify entities that occur in at least one utterance
- Identify each entity's *highest* grammatical role in each utterance

Example Entity Grid

Showing only the head noun for the NP for each entity and roles {S, O, X, –}
When multiple, take the strongest, i.e., S ≻ O ≻ X

	Department	Trial	Microsoft	Evidence	Competitors	Markets	Products	Brands	Case	Netscape	Software	Tactics	Government	Suit	Earnings
1	S	O	S	X	O	–	–	–	–	–	–	–	–	–	–
2	–	–	O	–	–	X	S	O	–	–	–	–	–	–	–
3	–	–	S	O	–	–	–	–	S	O	O	–	–	–	–
4	–	–	S	–	–	–	–	–	–	–	–	S	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–	S	O	–
6	–	X	S	–	–	–	–	–	–	–	–	–	–	–	O

- Computing probabilities for this discourse
  - Number of transitions: $75 = (6-1)$ utterances $\times$ 15 entities
  - Possible transitions (sequences) of length two: $16 = 4^2$
  - Example: Occurrences of the [S,–] transition (row i to $i+1$): 6
  - Estimated probability: $\frac{6}{75} = 0.08$
- Each discourse maps to a feature vector of length 4^2 (or 4^n)

Lexical Cohesion

Cohesion: similar words or words from overlapping conceptual spaces recur

- Lexical chains
  - Similar words across nearby sentences
  - Similarity: same or linked thesaurus entries
- Cosine similarity of neighboring text spans (sentences or paragraphs)
  - Text tiling
    - Vector: raw word counts
  - Latent Semantic Analysis (LSA) coherence
    - Vector: sum of embeddings of individual words
- Overall coherence: mean of adjacent pairs

$$\text{coherence}(s_1 \dots s_n) = \frac{1}{n-1} \sum_{i}^{n-1} \cos(s_i, s_{i+1})$$

Evaluation Tasks and Approaches

Assume: an original discourse is coherent
Generate discourses that are not (as) coherent

- Sentence order discrimination
  - Compare original document to permuted sentences
  - Use pairwise comparisons for training and testing
- Sentence order insertion
  - Move *one* sentence to different positions in the document
  - Limited form of permutation
  - Harder challenge than arbitrary permutation
- Sentence order reconstruction
  - Begin with a permutation of a document
  - Train and test a method to determine original order
  - Harder than just classifying or comparing

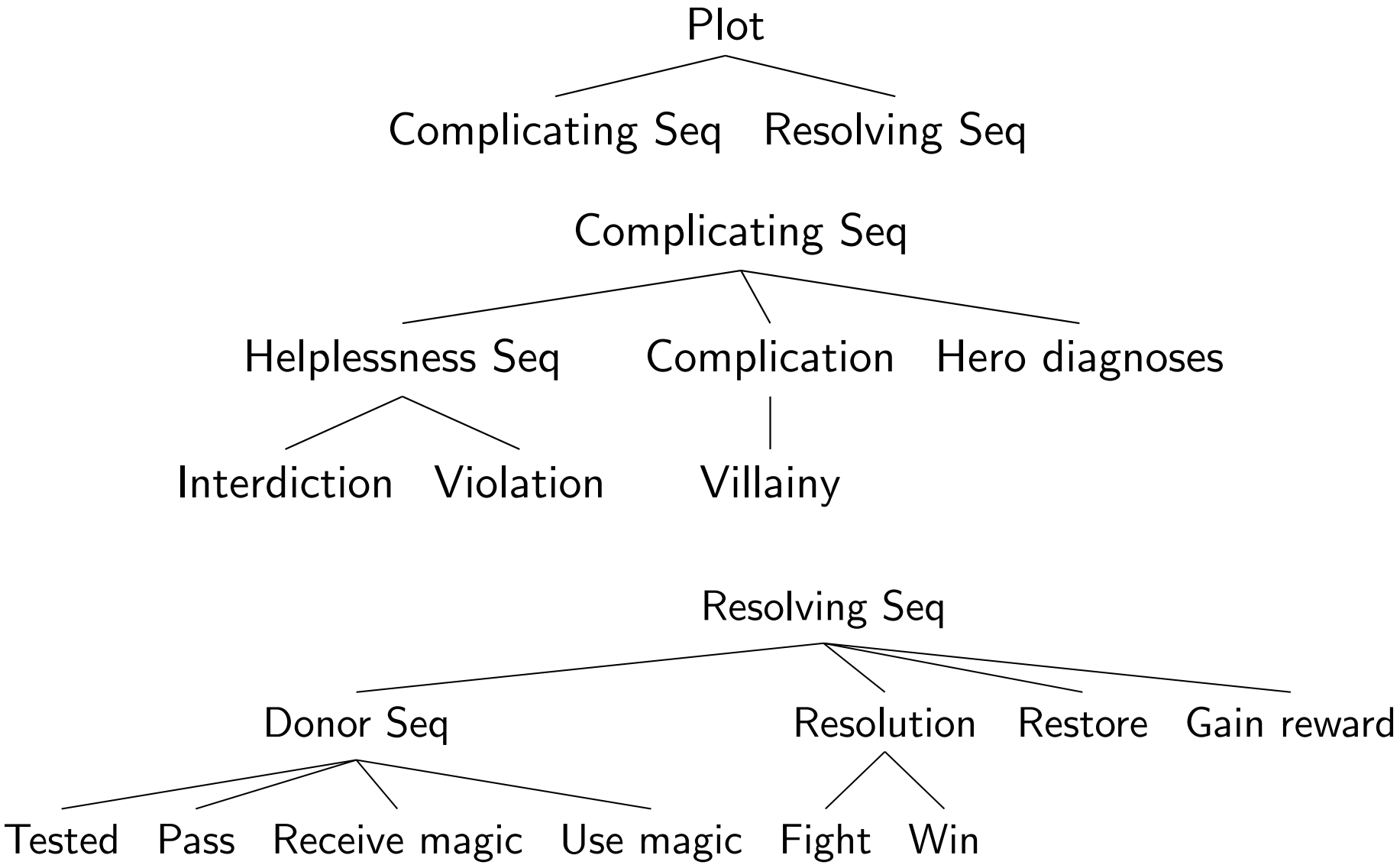
Global Coherence: Propp's Theory of Folktales, 1928

Lakoff's formalization of part of it, 1972

- What are the units of structure?
  - Not *motifs* since there are too many of them
    - A father has three sons
    - A stepdaughter leaves home
  - Not actions since they have differing functions
    - Hero marrying a princess
    - Hero's father marrying a widow with daughters
  - But *functions* in a narrative, even when objects and characters change
    - A hero receives an eagle from a king, who carries him somewhere
    - Ivan gets a boat from a sorcerer, which take him somewhere
- The number of functions is small
- The "sequence" (more generally *structure*) is stable

Lakoff's Discourse Grammar for Propp's Theory

Primarily a CFG, albeit with transformations (CSG)



Lakoff's Parody of a Russian Folktale

Identify the constituents from the discourse grammar

Ivan is warned not to leave his sister alone at home
Ivan ignores the warning
A dragon kidnaps his sister
Ivan discovers the misdeed and rushes out in pursuit
Ivan encounters an old man who asks him a riddle
Ivan answers correctly
The old man gives Ivan a horse and a sword
The horse takes him to the dragon's kingdom
Ivan fights the dragon
Ivan kills the dragon with the sword
Ivan rescues his sister
Ivan is awarded the 4-H Club Heroism Medal