

Natural Language Processing

Discourse, Entity Linking, and
Pragmatics

Semantics Road Map

1. Lexical semantics
2. Disambiguating words
Word sense disambiguation
Coreference resolution
3. Semantic role labeling
4. Meaning representation languages
5. **Discourse and pragmatics**
6. Compositional semantics, semantic parsing

How Do Sentences Relate to Each Other?

John hid Bill's car keys. He was drunk.

* John hid Bill's car keys. He likes spinach.

Another Example

“Near-death experiences can help one see more clearly sometimes,” said Steve Jobs. He was speaking about struggling companies. Yet he could easily have been talking about his own life. In 1985 Mr Jobs was pushed out of Apple Computer, the firm he had helped found, only to return after a decade away. In doing so, he mounted one of capitalism’s most celebrated comebacks.

*Yet he could easily have been talking about his own life. “Near-death experiences can help one see more clearly sometimes,” said Steve Jobs. In doing so, he mounted one of capitalism’s most celebrated comebacks. In 1985 Mr Jobs was pushed out of Apple Computer, the firm he had helped found, only to return after a decade away. He was speaking about struggling companies.

What Is Discourse?

Discourse is the coherent structure of language above the level of sentences or clauses. A **discourse** is a coherent structured group of sentences.

What makes a passage coherent?

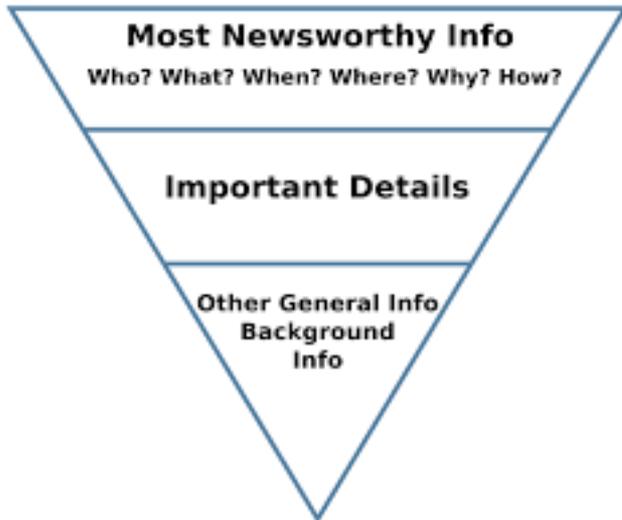
A practical answer: It has meaningful connections between its utterances.

Applications of Computational Discourse

- Automatic essay grading
- Automatic summarization
- Dialogue systems

Discourse Segmentation

Goal: Given raw text, separate a document into a linear sequence of subtopics.



- 1-3 Intro - the search for life in space
- 4-5 The moon's chemical composition
- 6-8 How early earth-moon proximity shaped the moon
- 9-12 How the moon helped life evolve on earth
- 13 Improbability of the earth-moon system
- 14-16 Binary/trinary star systems make life unlikely
- 17-18 The low probability of nonbinary/trinary systems
- 19-20 Properties of earth's sun that facilitate life
- 21 Summary

Cohesion

Relations between words in two units (sentences, paragraphs) “glue” them together.

Before winter I built a chimney, and **shingled** the sides of my **house**... I have thus a tight **shingled** and plastered **house**.

Peel, core, and slice **the pears and apples**. Add **the fruit** to the skillet.

Supervised Discourse Segmentation

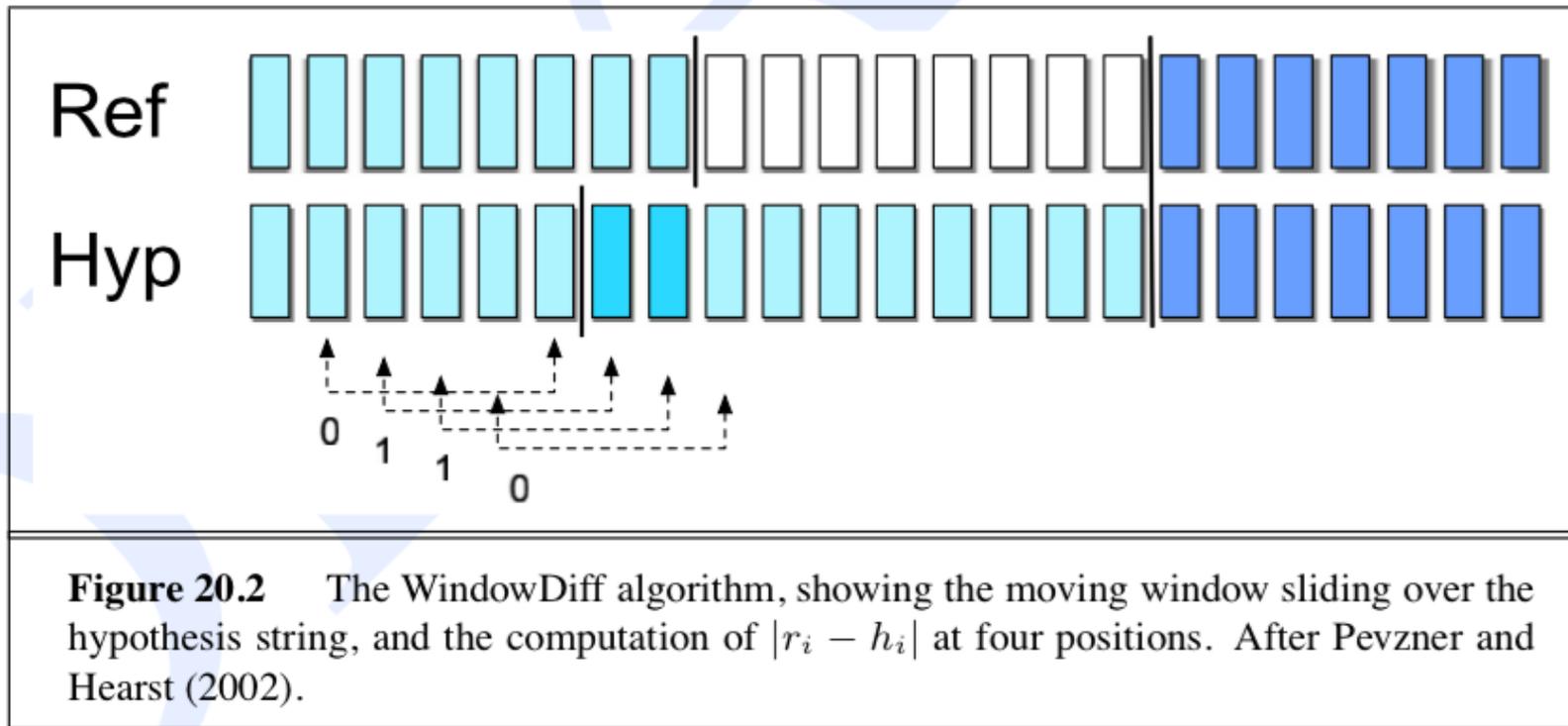
Our **instances**: place markers between sentences (or paragraphs or clauses)

Our **labels**: yes (marker is a discourse boundary) or no (marker is not a discourse boundary)

What features should we use?

- Discourse markers or cue words
- Word overlap before/after boundary
- Number of coreference chains that cross boundary
- Others?

Evaluating Discourse Segmentation



More formally, if $b(i, j)$ is the number of boundaries between positions i and j in a text, and N is the number of sentences in the text:

$$\text{WindowDiff}(ref, hyp) = \frac{1}{N - k} \sum_{i=1}^{N-k} (|b(ref_i, ref_{i+k}) - b(hyp_i, hyp_{i+k})| \neq 0)$$

Some Coherence Relations

How can we label the relationships between utterances in a discourse? A few examples:

- **Explanation:** Infer that the state or event asserted by S_1 causes or could cause the state or event asserted by S_0 .
- **Occasion:** A change of state can be inferred from the assertion of S_0 , whose final state can be inferred from S_1 , or vice versa.
- **Parallel:** Infer $p(a_1, a_2, \dots)$ from the assertion of S_0 and $p(b_1, b_2, \dots)$ from the assertion of S_1 , where a_i and b_i are similar for all i .

Discourse Structure from Coherence Relations

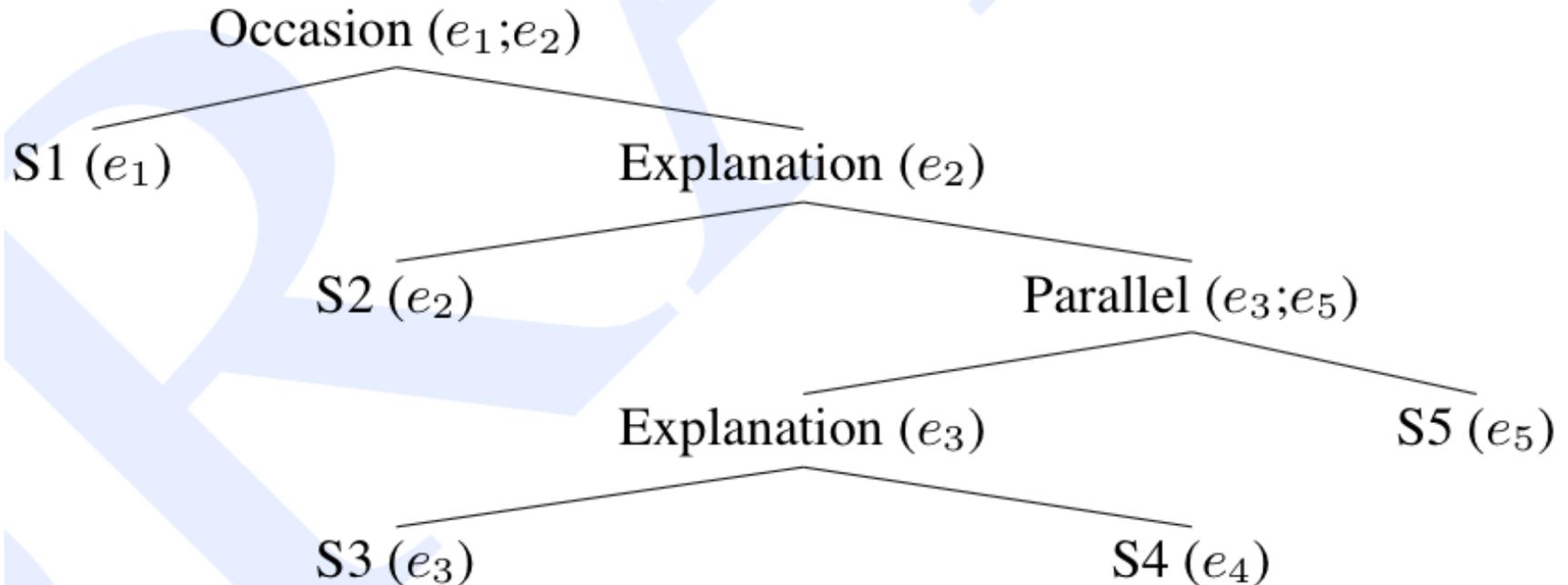
John went to the bank to deposit his paycheck. (S1)

He then took a train to Bill's car dealership. (S2)

He needed to buy a car. (S3)

The company he works for now isn't near any public transportation. (S4)

He also wanted to talk to Bill about their softball league. (S5)



Automatic Coherence Assignment

Given a sequence of sentences or clauses , we want to automatically:

- determine coherence relations between them (coherence relation assignment)
- extract a tree or graph representing an entire discourse (discourse parsing)

Automatic Coherence Assignment

Very difficult. One existing approach is to use cue phrases.

John hid Bill's car keys because he was drunk.

The scarecrow came to ask for a brain. Similarly, the tin man wants a heart.

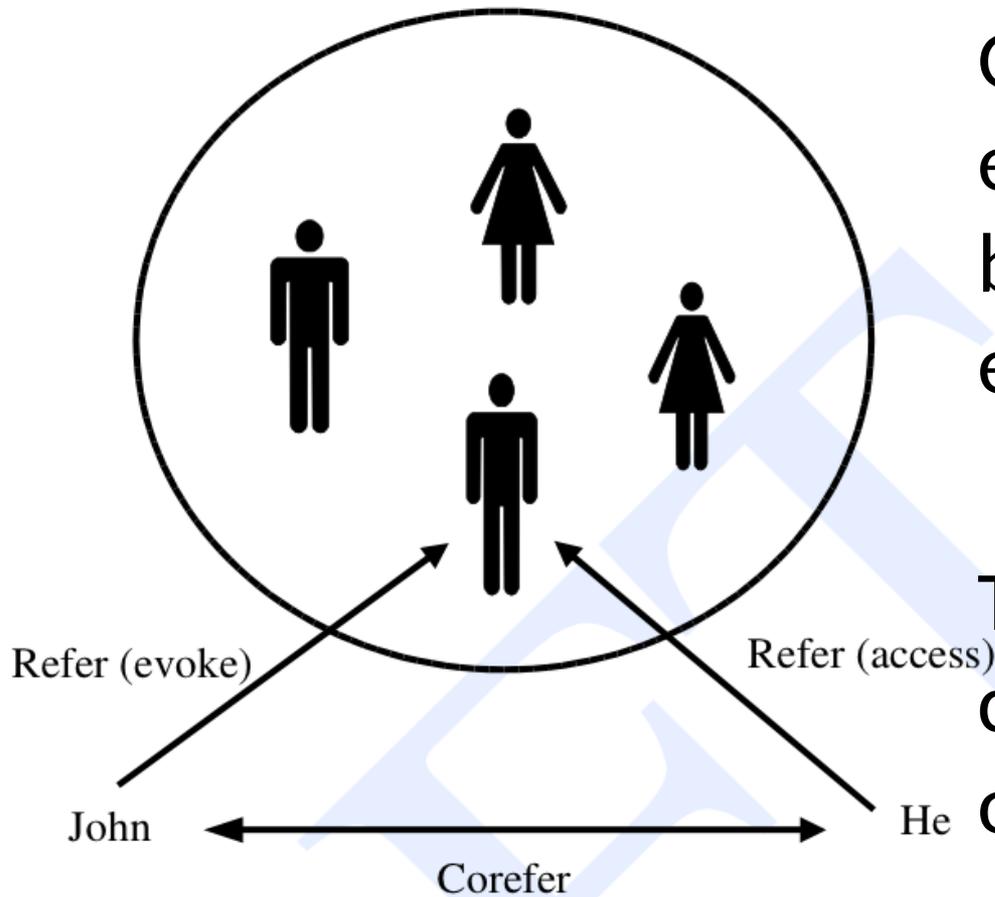
- 1) Identify cue phrases in the text.
- 2) Segment the text into discourse segments.
- 3) Classify the relationship between each consecutive discourse segment.

Entity Linking

A Lead-In: Reference Resolution

John Chang, Chief Financial Officer of Megabucks Banking Corp since 2004, saw his pay jump 20%, to \$1.3 million, as the 37-year-old also became the Denver-based financial-services company's president. It has been ten years since he came to Megabucks from rival Lotsabucks.

Reference Resolution



Goal: determine what entities are referred to by which linguistic expressions.

The **discourse model** contains our eligible set of referents.

Five Types of Referring Expressions

- Indefinite noun phrases

I saw a beautiful Ford Falcon today.

- Definite noun phrases

I read about it in the New York Times.

- Pronouns

Emma smiled as cheerfully as she could.

- Demonstratives

Put it back. This one is in better condition.

- Names

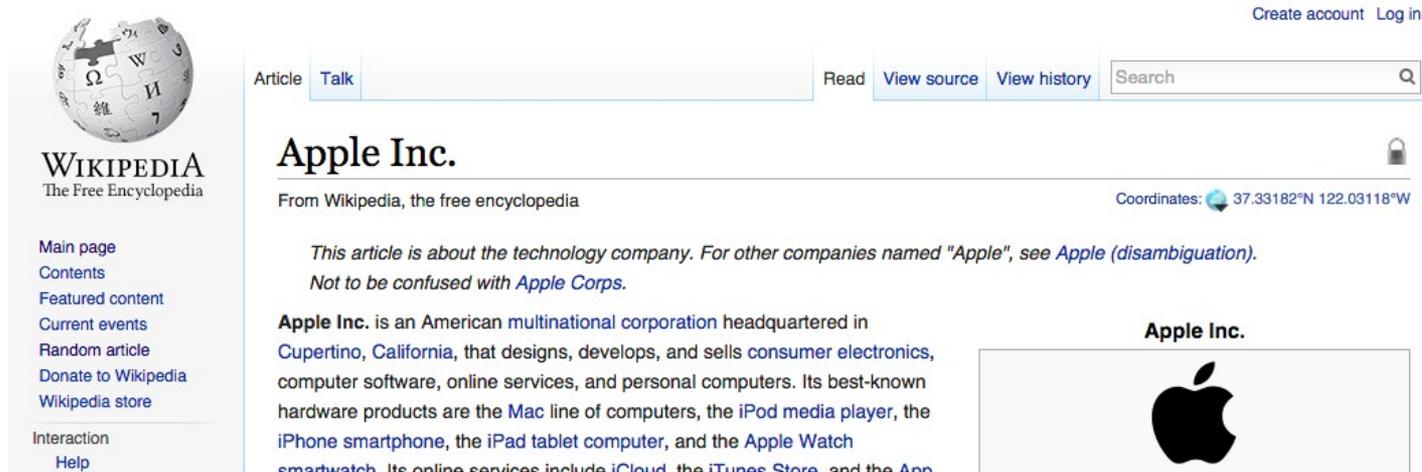
Miss Woodhouse certainly had not done him justice.

Referring Expression Ordering

- He now earns over \$1.3M. The new president started at Lotsabucks last month. John Chang came from Megabucks Corp.
- John Chang came from Megabucks. The new president started at Lotsabucks last month. He now earns over \$1.3M.
- **First Mention:** often full name, can be indefinite
- **Second Mention:** can be reduced, can be definite can be pronoun
- Mention rules can be broken, but not often.

Entity Linking

Apple updated its investor relations page today to note that it will announce its earnings for the second fiscal quarter (first calendar quarter) of 2015 on Monday, April 27.



The image shows a screenshot of the Wikipedia article for Apple Inc. The page layout includes a sidebar on the left with navigation links such as 'Main page', 'Contents', and 'Featured content'. The main content area features the article title 'Apple Inc.', a sub-header 'From Wikipedia, the free encyclopedia', and a disclaimer: 'This article is about the technology company. For other companies named "Apple", see Apple (disambiguation). Not to be confused with Apple Corps.' Below this, the article text begins with 'Apple Inc. is an American multinational corporation headquartered in Cupertino, California, that designs, develops, and sells consumer electronics, computer software, online services, and personal computers. Its best-known hardware products are the Mac line of computers, the iPod media player, the iPhone smartphone, the iPad tablet computer, and the Apple Watch smartwatch. Its online services include iCloud, the iTunes Store, and the App Store.' To the right of the text is a search box and a lock icon. At the bottom right, there is a section titled 'Apple Inc.' with a placeholder for an image of the Apple logo.

One Approach to Entity Linking

Use supervised learning: Train on known references to each entity. Use features from context (bag of words, syntax, etc.).

iPhone

From Wikipedia, the free encyclopedia

This article is about the line of smartphones by Apple. For other uses, see iPhone (disambiguation).

iPhone (/ˈaɪfoʊn/ *EYE-fohn*) is a line of **smartphones** designed and marketed by **Apple Inc.** It runs Apple's **iOS** mobile operating system.^[13] The **first generation iPhone** was released on June 29, 2007; the most recent iPhone models are the **iPhone 6** and **iPhone 6 Plus**, which were unveiled at a special event on September 9, 2014.^[14]



Pragmatics

Pragmatics

Pragmatics is a branch of linguistics dealing with language use in context.

When a diplomat says yes, he means 'perhaps';

When he says perhaps, he means 'no';

When he says no, he is not a diplomat.

(Variously attributed to Voltaire, H. L. Mencken, and Carl Jung)

In Context?

- Social context
 - Social identities, relationships, and setting
- Physical context
 - Where? What objects are present? What actions?
- Linguistic context
 - Conversation history
- Other forms of context
 - Shared knowledge, etc.

Speech Act Theory

“I’ll give the lecture today.”

“It’s cold in here.”

"This administration today, here and now, declares unconditional war on poverty in America.”

“I now pronounce you man and wife.”

Speech Act Theory in NLP

Let's say that I'm building a system that will interact with people conversationally.

Is speech act theory relevant? Why?

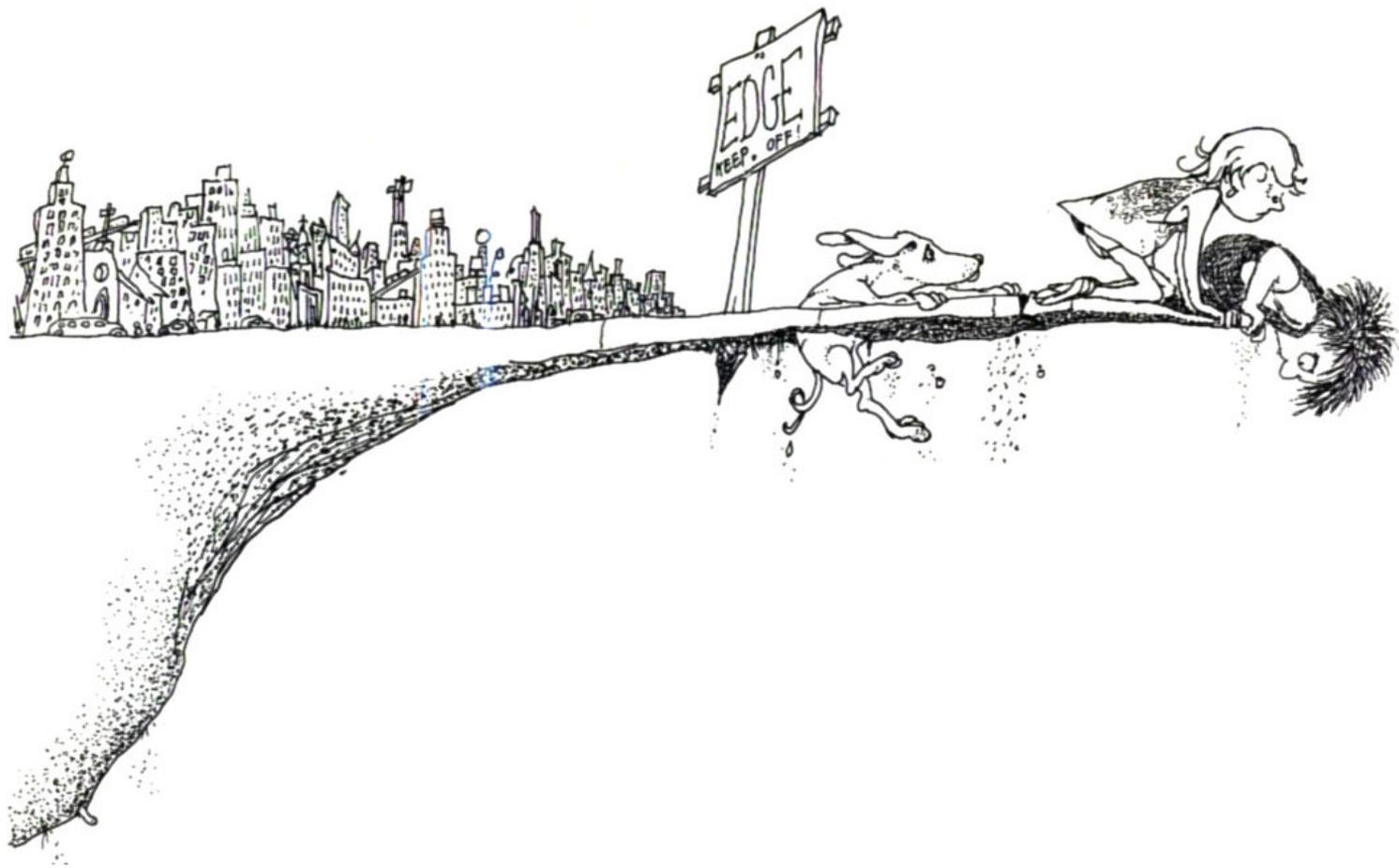
Grice's Maxims

1. Quantity: Make your contribution as informative as required, but no more
2. Quality: Try to make your contribution one that is true
3. Relation: Be relevant
4. Manner:
 1. Don't be obscure
 2. Avoid ambiguity
 3. Be brief
 4. Be orderly

Grice's Maxims in NLP

Let's say that I'm building a system that will interact with people conversationally.

How are Grice's Maxims relevant?



Cover of Shel Silverstein's *Where the Sidewalk Ends* (1974)