

Natural Language For Communication

A brief overview

Applications

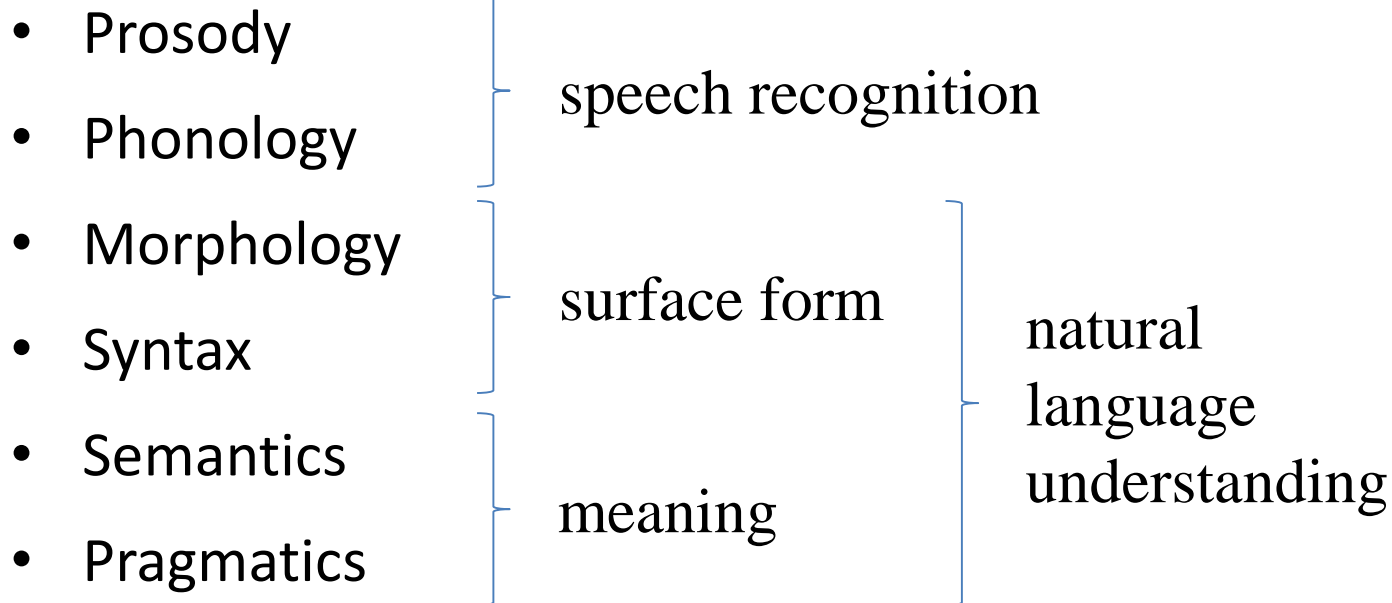
Agents for:

- summarization
- computer-aided instruction
- machine translation
- sentiment analysis
- speech understanding
- interface search engines
- ...

Levels of analysis in understanding natural language

- Prosody
 - rhythm and intonation of language (e.g. sarcasm)
- Phonology
 - basic sounds and how they combine to form words
- Morphology
 - rules for formation of words (e.g. plurals, tense)
- Syntax
 - rules for forming phrases and sentences
- Semantics
 - meaning of words and how these combine to form meaning of sentences
- Pragmatics
 - study of how language is used, role of context in meaning

Levels of analysis in understanding natural language



Communication as action

- Speech actions:
 - inform other agents about what it knows
 - query other agents to gather knowledge
 - answer questions
 - request or Command other agents to perform actions
 - promise or offer to do actions
 - acknowledge requests and offers
 - share feelings and experiences
- Planning and plan recognition

What makes it hard?

- Formal languages:
 - no ambiguity at sentence level
 - compositional semantics
- Natural languages:
 - highly ambiguous
 - not necessarily “grammatical”
 - constantly evolving
 - semantics or meaning is non-compositional and context-dependent

What makes it hard?

- Pragmatics: role of context in meaning of language
 - beliefs & goals of participants
 - culture
 - current situation
 - conventions
 - background knowledge
 - world knowledge
 - language knowledge
 - shared knowledge
 - ...

Examples of ambiguity

- Lexical (word sense) ambiguity

The man went to the bank to get some cash.

The man went to the bank and jumped in.

A bank is a place for money or the side of a river

Examples of ambiguity

- Syntactic ambiguity—phrase with multiple parses

John saw the Rockies flying to Vancouver.

Is John or the Rockies flying?

He saw her duck.

Is duck a verb or a noun?

Salespeople sold the dog biscuits.

Syntactic ambiguity leads to semantic ambiguity

Examples of ambiguity

- Referential ambiguity

I took the cake from the table and ate it.

What was eaten: the table or the cake?

Replace “ate” with “cleaned”

- Intersentencial referential ambiguity

After John proposed to Alex, they found a justice of the peace and got married. For the honeymoon, they went to Hawaii.

Who is in the group that the pronoun “they” refers to?

Examples of ambiguity

- Figure of speech—metonymy

Let me have your ear.

A thing or concept is not called by its own name, but by the name of something closely associated with it

- Figure of speech—metaphor

The inside of the car was a refrigerator.

A phrase with one literal meaning is used to suggest a different meaning by way of an analogy

Examples of ambiguity

- Pragmatic ambiguity

I'll meet you at the coffee shop next Friday.

Suppose it is Saturday. What day is “next Friday”?

Examples of pragmatics

- Conventions, knowledge of culture

Q. Are you sure you don't mind?

A₁. Oh, no.

A₂. Well, yes.

A₃. Yes.

- Shared background knowledge

Tom: Who do you like tonight, Toronto or Montreal?

Mary: Leafs. You?

Examples of pragmatics

- Consider the word “open” in the window of a store and on a large banner hanging outside a store



- What does the word mean?

Examples of pragmatics

- Conventions on cooperative answers

Q. Can I switch to the other section of the course?

A₁. Yes.

A₂. Yes, but you should know that it is taught by the same professor.

- Conventions on cooperative answers

Q. How many students failed CS 586 last term?

A₁. None.

A₂. It wasn't offered last term.

Examples of pragmatics

- Situation, knowledge of other agent's knowledge

Q. Can you open the door?

A. Yes.

Examples of pragmatics

- Goals, beliefs, shared knowledge

Q. Do you know what time it is?

A. Yes.

Syntax—grammar

S	→	NP VP aux NP verb NP
NP	→	pronoun noun det NP det NP PP
VP	→	verb aux verb VP adj VP NP VP PP
PP	→	prep NP prep NP PP

Syntax—lexicon (vocabulary)

pronoun → me | you | I | it | they

noun → dog | biscuits | gold | salespeople | east

det → the | a

aux → is | are

verb → see | smell | shoot | sold | is

prep → to | in | on | near

adj → right | left | east | south | dead | smelly

Semantics

- Assume compositional semantics is adequate
 - semantics of any phrase is a function of the semantics of its sub-phrases
- Basic idea
 - parsing drives translation into meaning representation (logical form)

Noun phrase (NP) semantics

- Basic paradigm: construct a meaning representation for set of all possible referents of NP in domain
- For each noun, adjective, and PP that appears in the NP, and recursively for each embedded NP
 - build / retrieve logical form
 - add to existing logical form

Example sentence semantics

- The smelly wumpus in the living room is dead.

$\exists!x (\text{Wumpus}(x) \wedge \text{Location}(x, \text{livingroom}) \wedge$
 $\text{Smelly}(x) \wedge \text{Dead}(x))$

- Is the smelly wumpus in the living room dead?

$\text{Query} \leftarrow \exists!x (\text{Wumpus}(x) \wedge \dots)$

- Is there a dead wumpus in the living room?

$\exists x (\text{Query}(x) \leftarrow \text{Wumpus}(x) \wedge \dots)$

More information

- Current research:
 - Proceedings of the 2016 Conference of the Association for Computational Linguistics
 - <http://aclweb.org/anthology/N/N16/>
- Text books:
 - Speech and Language Processing, 2nd Edition, D. Jurafsky and J. H. Martin
 - Foundations of Statistical Natural Language Processing, C. D. Manning and H. Schütze