

Introduction to NLP

EMERGENCY MEDICINE WORKSHOP




neuralmechanics.net

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NATURAL LANGUAGE PROCESSING

 MonkeyLearn

Very **intuitive platform**, I'll **definitely recommend** it.
The **chat support** is **excellent**, really **fast** in their replies
and very **helpful**.

Usability**Positive****Customer Support**

understanding

Taking some spoken/typed sentence and working out what it means

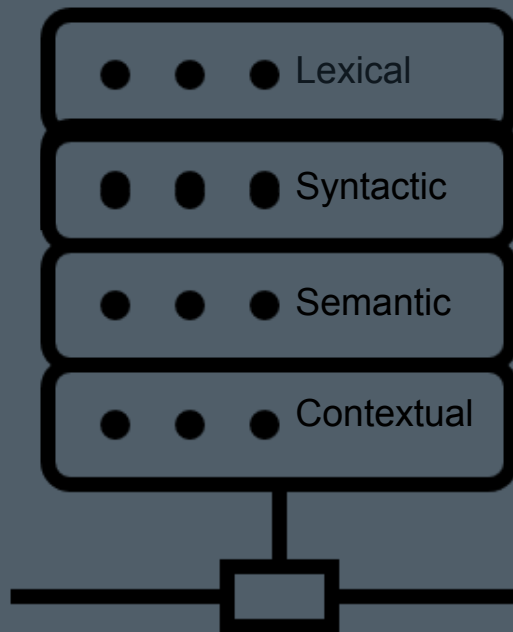
NATURAL LANGUAGE PROCESSING



generation

Taking some formal representation of what you want to say and working out a way to express it in a natural (human) language (e.g., English)

NLP Layers



- Basic properties of words → Spell check, NER
- Order and structure of words → Grammar check
- Meaning of words → WordNet, etc.
- Overall meaning of text → Topic modeling, sentiment analysis

Call me
a cab!



Ok, you're
a cab!



Natural Language Understanding

01 Raw Speech Signal

Speech Recognition



02 Sequence of words spoken

Syntactic analysis using knowledge of the grammar



03 Structure of the sentence

Semantic analysis using the info about the meaning of words



04 Partial representation of the meaning of sentence

Pragmatic analysis using info about context



05 Final Representation of meaning of sentence

Natural Language Understanding

Input/Output data

Processing Stage

Other data used

**Frequency
spectrogram**

**Word
sequence**

"He loves Mary"

**Sentence
structure**

He loves Mary

**Partial
Meaning**

$\exists x \text{ loves}(x, \text{mary})$

**Sentence
meaning**
Neural
MECHANICS

$\text{loves}(\text{john}, \text{mary})$

speech recognition

syntactic analysis

semantic analysis

pragmatics

Frequency of different sounds

Grammar of language

Meanings of words

Context of utterance

Speech Recognition



Input

Microphone records voice



Analog Signal



Frequency spectrogram

e.g. Fourier transform

Speech Recognition

Typical communication episode

- Frequency spectrogram (basic sound signals, e.g. phonemes)
- Words

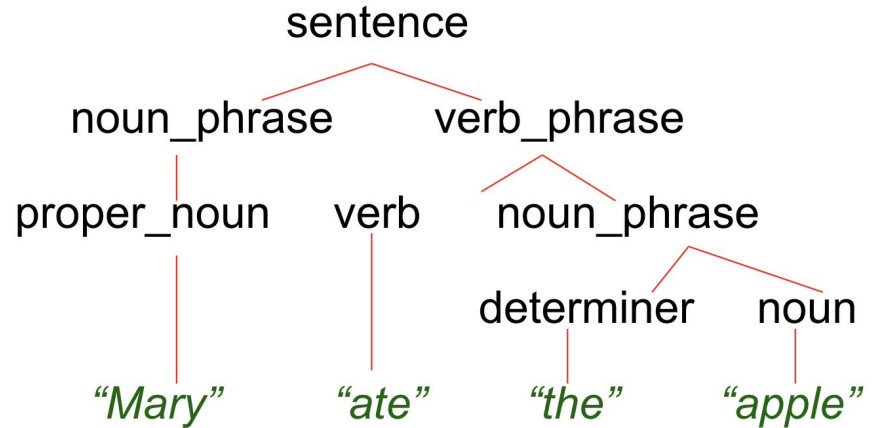
Complications

- No simple mapping between sounds and words
 - Variance in pronunciation due to gender, dialect, ...
 - Restriction to handle just one speaker
 - Same sound corresponding to diff. words
 - e.g. bear, bare
 - Finding gaps between words
 - “how to recognize speech”
 - “how to wreck a nice beach”
 - Noise
 - Pitch and Loudness

Syntactic Analysis

Complications

- Rules of syntax (grammar) specify the possible organization of words in sentences and allows us to determine sentence's structure(s)
 - “I saw Mary with a telescope”
 - I saw (the man with a telescope)
 - I (saw the man with a telescope)
- Parsing: given a sentence and a grammar
 - Checks that the sentence is correct according with the grammar and if so returns a parse tree representing the structure of the sentence



Syntactic Analysis

Complications

- Syntactic ambiguity
 - "Fruit flies like a banana."
- Gerunds and adjectives
 - "Frightening kids can cause trouble."
- Having to parse syntactically incorrect sentences
 - "John talked drugs to the children about."

Semantic Analysis

Complications

- Handling ambiguity
 - Semantic ambiguity: “I saw the prudential building flying into Boston”

Newspaper Headlines

- Ban on Nude Dancing on Governor's Desk
- Iraqi Head Seeks Arms
- Juvenile Court to Try Shooting Defendant
- Teacher Strikes Idle Kids
- Stolen Painting Found by Tree
- Local High School Dropouts Cut in Half
- Red Tape Holds Up New Bridges
- Clinton Wins on Budget, but More Lies Ahead
- Hospitals Are Sued by 7 Foot Doctors
- Kids Make Nutritious Snacks

Pragmatics

Complications

- Uses context of utterance
 - Where, by who, to whom, why, when it was said
 - Intentions: inform, request, promise, criticize, ...
- Handling Pronouns
 - “Mary eats apples. She likes them.”
 - She=“Mary”, them=“apples”.
- Handling ambiguity
 - Pragmatic ambiguity: “you’re late”: What’s the speaker’s intention: informing or criticizing?

NATURAL LANGUAGE PROCESSING



generation

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Natural Language Generation

- Talking back! ☺
- What to say or text planning
 - flight(AA,london,boston,\$560,2pm),
 - flight(BA,london,boston,\$640,10am),

How to say it

- “There are two flights from London to Boston. The first one is with American Airlines, leaves at 2 pm, and costs \$560 ...”
- Speech synthesis
 - Simple: Human recordings of basic templates
 - More complex: string together phonemes in phonetic spelling of each word
 - Difficult due to stress, intonation, timing, liaisons between words