SEMANTICS

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Chapter – VII

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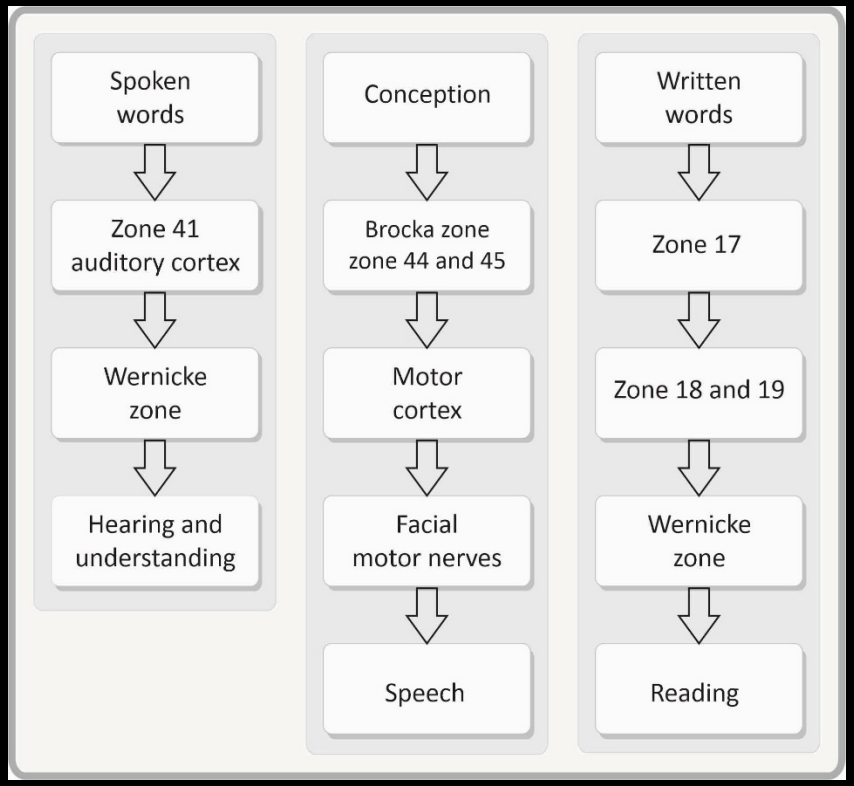
What is Semantics

- People first created words to describe objects, describe their feelings, and describe actions. When the words were insufficient, they started to form sentences. In cases where a single sentence was not enough, they formed phrases.
- In this chapter, information about the meanings of words, sentences and phrases will be given. The meaning of a word or a sentence can be different depending on the environment and conditions of the speaker and the listener. It also depends on the pre-speech and the content of the speech.
- Knowing what a word and a sentence means is extremely important for natural language processing studies. Because semantic knowledge is required in answering questions, summarizing texts and translation studies.

Human Processing of Language

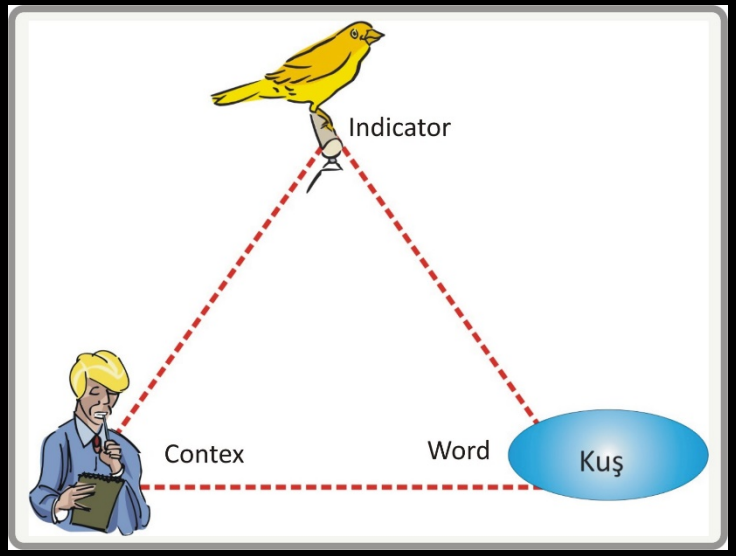
The language model proposed by Wernicke-Geschwind divides language into two functions: *Perception* and *speech*.

- The words heard and read are processed in different places in the brain, but the decoding and perception processes are performed in the same place.
- Different parts of the brain are responsible for speech. The heard words are transmitted to the auditory cortex of the brain through the ear canals, and then the meaning of the sounds is formed in the Wernicke Region.



Meanings of Words

- A word is derived in every language to meet an object, emotion and movement.
- In fact, people with different languages think and perceive the same thing, but they oppose and vocalize a different word.
- A Turkish, an English and a French bird are visualizing the object in their mind. He refers to the object he envisions as Turkish kuş, English bird and French l'oiseau. Linguists call the source of the concept as indicator, the word as symbol or as sign.



- Birth is indicator
- Contex is a flying animal
- Word is kuş or bird or l'oiseau

Vocabulary

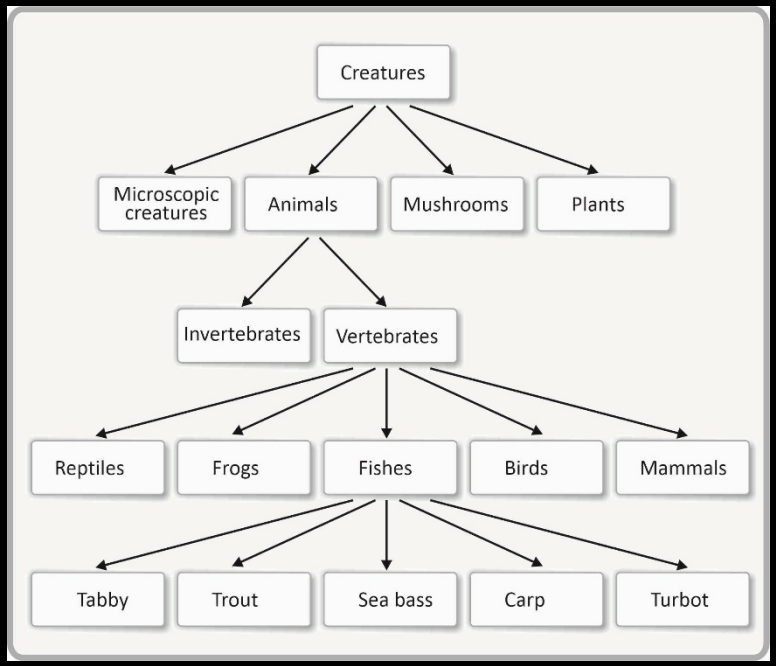
When the Turkish Dictionary of TDK is examined, the number of words in Turkish vocabulary according to their classes can be seen as given in Table.

- It can be said that the vocabulary of Turkish is small compared to the vocabulary of English.
- Turkish is an agglutinative language and new words can be derived by adding suffixes to the words in the dictionary.
- Studies show that a Turkish word has an average of 2.86 suffixes.
- A word has an average of 3.53 meanings.

Word classes	Numbers
Noun	53.451
Adjective	12.666
Verb	9.895
Adverb	2.563
Exclamation	299
Pronoun	88
Conjection	50
Preposition	40
Auxiliary verb	17
Total	92.600

Concept and Concept Area

- The concept formed by an object in the human brain can be considered the same for everyone, but the word corresponding to this object varies from language to language.
- Based on this idea, objects were tried to be classified. As a result of such a classification, it will be possible to see which words correspond to a concept in different languages.
- A simple example of classification is shown in the form of a syntax tree.
- Every object we see around us is an element of a class. Each class is an element of a superclass. This hierarchical relationship continues up to the main concept.



Word Meaning Classes

- Concrete and Abstract Meaning
- Basic Meaning
- Connotation
- Analogy Meaning
- Real and Metaphor Meaning
- Synonym and Antonym
- Near and Far Meaning
- Quantitative and Qualitative Meaning
- Duplicates
- Homonymy
- Term meaning
- Idiomatic Meaning

Some Defination

Word : is a unit of language which has meaning. Word consists of one or more morpheme which are linked more or less tightly together, and has a phonetical value. Typically a word will consist of a root or stem and affixes or not affix

Lexeme: The set of forms taken by a single word. For example;

Look
Looks
Looked
Looking

are forms of the same lexeme : **Look**

Lexicon: A collection of lexemes

Lemma or Citation : is the grammatical form that is used to represent a lexeme. In a dictionary

The lemma *mouse* represents *mouse, mice*
The lemma *go* represents *go, goes, going, went, gone*

The lemma *bridge* has many senses:

The game bridge was created in Karaköy, Istanbul
The Bosphorus Bridge was constructed in 1973
Some people will bridge weekend and new year eve vacation.

A sense is a discrete representation of one aspect of the meaning of a word

Semantics

The title of a news article published in a newspaper.

Köprücüler İstanbul'da toplanıyor.

(Bridgers gathers in Istanbul)

Köprücüler İstanbul'da toplanıyor.

20 Kasım 2009 günü İstanbul'a köprücüler geliyor. 22 Kasımda yapılacak olan büyük turnuvanın çok çekişmeli geçeceği anlaşılıyor.

Dünya Köprücüler Birliği başkanı yaptığı açıklamada, bu yılki turnuvaya yüzden çok oyuncunun katıldığını söyledi. Böyle bir turnuvayı, oyunun icat edildiği bu güzel şehir İstanbul'da yapmaktan çok mutlu olduklarını söyledi.

- Translation was: *Bridge constractors will attend a meeting in Istanbul.*
- However, when the rest of the news is read, it is seen that there is a translation error. Because, in the original text, the word 'bridge' was used to mean bridge game.
- As can be seen from this example, a word can be used with different meanings. The meaning of a word can be ambiguous even in a sentence, and its exact meaning can be revealed when the full text is evaluated.

What is Semantics

Semantics focuses on the meanings of words, phrases and sentences in the language.

NLP reveals the possible meanings of a word by itself, then tries to find the meaning of this word in the text it is in. This work is called *lexical disambiguation*.

NLP reveals the possible meanings of a phrase then tries to find the meaning of this phrase depending on the text it is in. This work is called the *phrase disambiguation*.

A sentence reveals its possible meanings. Then NLP tries to find the meaning of this sentence in the text. This work is called the *sentence disambiguation*.

NLP reveals possible meanings of a text, then it tries to find the meaning of this text in context. This work is called *text disambiguation*.

Lexical Semantics

- Homophones
- Polysemy
- Metaphor
- Metonymy
- Synonymy
- Antonymy
- Hyponymy
- Hypernomy

Semantic Relations of Words

- Homophones
- Polysemy
- Metaphor
- Synonymy
- Antonymy
- Hyponymy
- Hypernymy

Homonymy

Homonymy is one of a group of words that share the same spelling and the same pronunciation but have different meanings

Term	Spelling	Pronunciation	Meaning
Homonym	Same	Same	Different
Homograph	Same	Same or different	Different
Homophone	Same or different	Same	Different
Heteronym	Same	Different	Different
Heterograph	Different	Same	Different

Homonym

left (opposite of right)
left (past tense of leave)

Homograph

bear (animal)
bear (carry)

Homophone

write
right

Heteronym

bow (the front of a ship)
bow (a ranged weapon)

Heterograph

to
too
two

Problems of Homonymy in NLP

Text-to-Speech : Same spelling but different pronunciation

Heteronym : bow (the front of a ship) vs bow (a ranged weapon)

Speech-to-Text : Same pronunciation but different spelling

Heterograph : write *(print)* vs right *(*opposite of left*)*

Machine translation : Same spelling but different meaning

Homonym : left (opposite of right) vs left (past tense of leave)

Homograph : bear (animal) vs bear (carry)

Heteronym : bow (the front of a ship) vs bow (a ranged weapon)

Information retrieval : Same spelling but different meanings

Homonym : left (opposite of right) vs left (past tense of leave)

Homograph : bear (animal) vs bear (carry)

Heteronym : bow (the front of a ship) vs bow (a ranged weapon)

Polysemy

Polysemy is a word or phrase with multiple, related meanings.

Verbs

I'll get the drinks (take)
She got scared (become)
I've got three dollars (have)
I get it (understand)

Nouns

The school is in Murray Street (the building).
The boys love their school (the institution).
The school will visit the old age home (the pupils).
Working abroad is a hard school for anyone (opportunity for learning).
The ABC School of Linguistics...(Proper name).

Metaphor and Metonymy

Metaphor:

I spent five hours on my project.
Turkish economy will take off in year 2009.

Metonymy

The White House announced that…. *(The president said that….)*
This book talks about NLP. *(This book consists of NLP)*

Synonymy - I

Synonymy are different words with identical or at least similar meanings.

baby and *infant* (noun)
buy and *purchase* (verb)
sick and *ill* (adjective)
on and *upon* (preposition)
freedom and *liberty* (noun)

Two lexemes are synonyms if they can be successfully substituted for each other in all situations. If so they have the same propositional meaning.

Synonymy is a relation between senses rather than words:

It is really a *large* car.
It is a *big* car.

He is *older* brother.
He is *bigger* brother.

He is a *high* boy.
He is a *tall* boy.

Antonymy

Antonymy are different words with opposite meanings.

hot and *cold*
fat and *skinny*
up and *down*

Antonyms can also be defined a binary opposition or at opposite ends of a scale:

long vs *short*
fast vs *slow*

Hyponymy and Hypernymy

Hyponym of another if the first sense is more specific, denoting a subclass of the other

car is a hyponym of *vehicle*

cat is a hyponym of *animal*

banana is a hyponym of *fruit*

superordinate	hyponym
vehicle	*car*
animal	*cat*
fruit	*banana*
vessel	boat
surf	wind surf
tree	pine
vegetable	eggplant

Conversely

vehicle is a hypernym (superordinate) of *car*

animal is a hypernym of *cat*

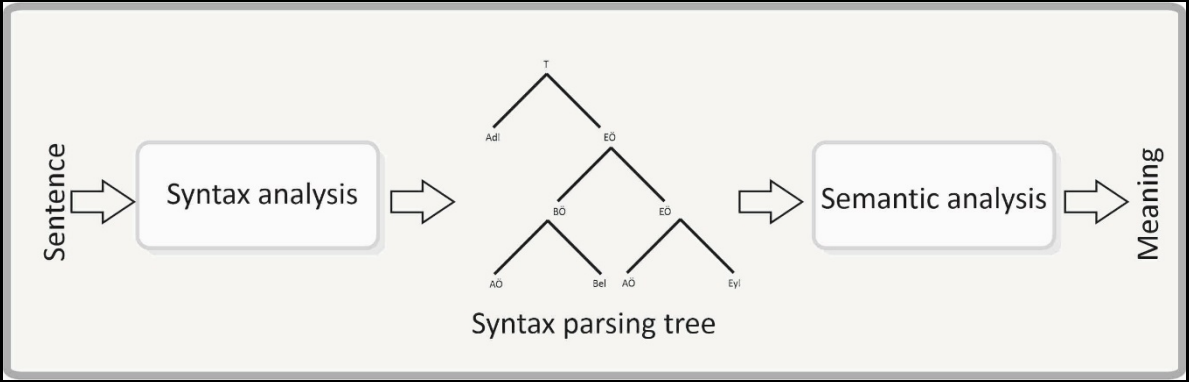
fruit is a hypernym of *banana*

Analysis of Meaning

- By starting from the idea that a sentence consists of words, it can be thought that the meaning of the sentence can be formed by combining the meanings of these words.
- But this reasoning is both right and wrong. When we look up the meaning of a word in the dictionary, we see that it has more than one meaning.
- In a study conducted on Turkish, it was seen that a Turkish word has an average of 3.53 meanings.

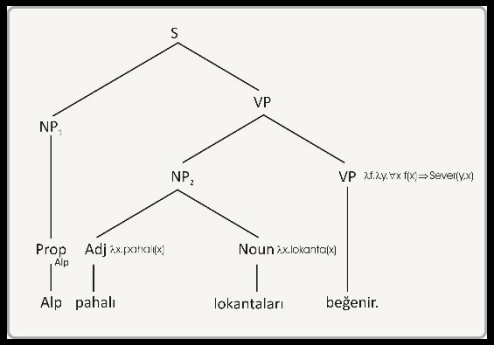
Lexicon and Semantic Relation

- One of the methods followed to extract the meaning of a sentence is to convert the sentences into first order logic representation.
- This process is also called logical analysis. In a sense, this process is the literal analysis of the meaning of a sentence. Therefore, it is meaning-free and cannot be inferred.



Logical Analysis

1

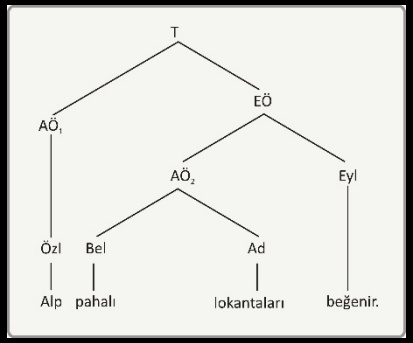


1) Prop → Alp {Alp}

2) Adj → Pahalı {λx.Pahalı(x)}

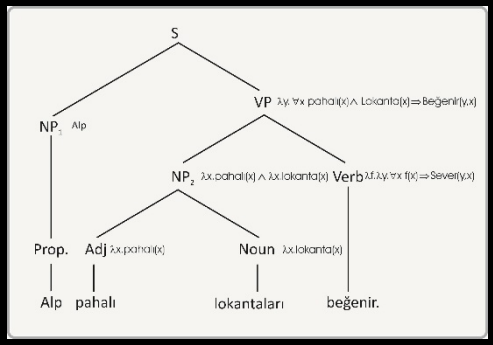
3) Nome → Lokanta {λx.Lokanta(x)}

4) Verb → Beğenir { λf.λy.∀x f(x) > Beğenir (y,x)}



Alp pahalı lokantaları beğenir.

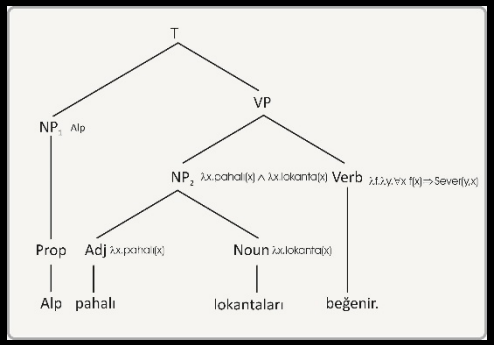
3



VP → NP Verb {Verb.anl(NP.mn)}

VP: λy.∀x Pahalı(x) ∧ Lokanta(x) > Beğenir(y,x)

2



1) NP1 → Prop {Prop.mn}

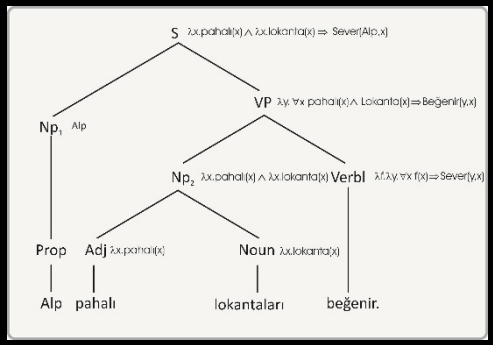
2) NP2 → Adj Nome {λx. Adj.mn(x) ∧ Nome.mn(x)}

Here:

NP1: Alp

NP2: λx. pahalı(x) ∧ Lokanta(x)

4



S → NP VP {VP.anl(NP.mn)}

Here

T: ∀ x Lokanta (x) ∧ Pahalı(x) > Beğenir(Alp, x)

Wordnet

A hierarchically organized lexical database
On-line thesaurus + aspects of a dictionary

Category	Unique Forms
Noun	117,097
Verb	11,488
Adjective	22,141
Adverb	4,601

http://www.cogsci.princeton.edu/cgi-bin/webwn

Concept Used in Wordnet

Concept	Concept
Hyperonym	Mero Portion
Hyponym	Subevent
Holo Part	Is Event of
Mero Part	Causes
Holo Member	Is Caused By
Mero Member	Be in State
Holo Portion	State of
Near Antonym	Near Synonym

Format of Wordnet Entries

The noun "bass" has 8 senses in WordNet.

1. bass[1] - (the lowest part of the musical range)
2. bass[2], bass part[1] - (the lowest part in polyphonic music)
3. bass[3], basso[1] - (an adult male singer with the lowest voice)
4. sea bass[1], bass[4] - (the lean flesh of a saltwater fish of the family Serranidae)
5. freshwater bass[1], bass[5] - (any of various North American freshwater fish with lean flesh (especially of the genus Micropterus))
6. bass[6], bass voice[1], basso[2] - (the lowest adult male singing voice)
7. bass[7] - (the member with the lowest range of a family of musical instruments)
8. bass[8] - (nontechnical name for any of numerous edible marine and freshwater spiny-finned fishes)

The adjective "bass" has 1 sense in WordNet.

1. bass[1], deep[6] - (having or denoting a low vocal or instrumental range)
   "a deep voice"; "a bass voice is lower than a baritone voice"; "a bass clarinet"

Wordnet Noun Relations

Relation	Also called	Definition	Example
Hypernym	Superordinate	From concept to Superordinate	breakfast[1] - meal[1]
Hyponym	Subordinate	From concept to subtypes	meal[1] - lunch[1]
Member Meronym	Has-Member	From groups to their members	faculty[2] - professor[1]
Has-Instance		From concept to instances of the concept	composer[1] - Bach[1]
Instance		From instances to theirconcepts	Austen[1] - autor[1]
Member Holonym	Member-of	From members to their groups	copilor[1] - crew[1]
Part Meronym	Has-Part	From wholes to parts	table[2] - leg[3]
Part Holonym	Part-Of	From parts to wholes	course[7] - meal[1]
Antonym		Opposition	leader[1] - follower[1]

Wordnet Verb Relations

Relation	Definition	Example
Hypernym	From event to superordinate events	fly[9] - travel[0]
Troponym	From a verb (event) to a specific manner elaboration of that verb	walk[1] - stroll[1]
Entails	From verb (event) to the verb (event) they entail	snore[1] - sleep[1]
Antonym	Opposition	increase[1] - decrease[1]

Wordnet Hierarchies

```
Sense 3
bass, basso --
(an adult male singer with the lowest voice)
=> singer, vocalist, vocalizer, vocaliser
   => musician, instrumentalist, player
      => performer, performing artist
         => entertainer
            => person, individual, someone...
               => organism, being
                  => living thing, animate thing,
                     => whole, unit
                        => object, physical object
                           => physical entity
                              => entity
               => causal agent, cause, causal agency
                  => physical entity
                     => entity


Sense 7
bass --
(the member with the lowest range of a family of
musical instruments)
=> musical instrument, instrument
   => device
      => instrumentality, instrumentation
         => artifact, artefact
            => whole, unit
               => object, physical object
                  => physical entity
                     => entity
```

“Sense” Defined in Wordnet ?

- The set of near-synonyms for a WordNet sense is called a **synset (synonym set)**; it is their version of a sense or a concept

Example:

chump as a noun to mean *‘a person who is gullible and easy to take advantage of’*

Chump[1], fool[2], gull[1], mark[9], patsy[1], fall guy[1], sucker[1], soft touch[1], mug[2]

- Each of these senses share this same gloss. Thus for WordNet, the meaning of this sense of chump is this list.

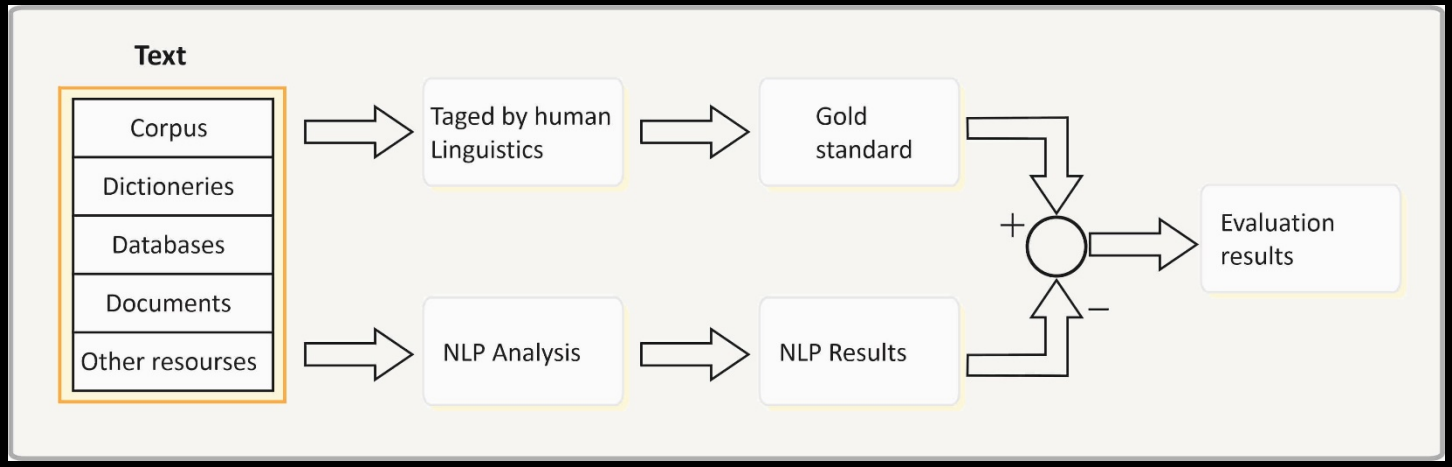
Word Sense Disambiguation (WSD)

Yüz

- face
- 100
- swim

- Kara: (TR), siyah (Farsi): Black
- Ak: (TR), beyaz (Arabic): White
- Giriş: (TR), antre (FR): Entrance

How the SemEval Workshop works



Word Sense Disambiguation (WSD)

Word sense ambiguity is a pervasive characteristic of natural language.

The word "**cold**" has several senses:

a disease, a temperature sensation

a natural phenomenon

The specific sense intended is determined by the textual context in which an instance of the ambiguous word appears.

"I am taking aspirin for my cold"

In this sentence the disease sense is intended.

"Let's go inside, I am cold"

In this sentence the temperature sensation sense is meant.

Works on WSD

Lexical Sample

Pre-selected set of target words
Inventory of senses for each word
Use supervised machine learning

- *Line-hard-serve* corpus : 4000 examples of each
- *Interest* corpus : 2369 sense-tagged examples

All-words

Every word in an entire text
A lexicon with senses for each word
Sort of like part-of-speech tagging
Except each lemma has its own tagset

- Semantic concordance: a corpus in which each open-class word is labeled with a sense from a specific dictionary/thesaurus.
  - SemCor: 234,000 words from Brown Corpus, manually tagged with WordNet senses
  - SENSEVAL-3 competition corpora : 2081 tagged word tokens

Inventory of Sense Tags

Example : *bass*

WordNet Sense	Spanish Translation	Roget Category	Target Word in Contex
bass^4	lubina	fish/insect	…fish as pasific salmon and stript bass and …
bass^4	lubina	fish/insect	…produce filets of smoked bass or stugeon…
bass^7	bajo	music	…exciting jazz bass player since ray brown…
bass^7	bajo	music	…play bass because he does not have to solo…

Collocational and Bag-of-Words

Collocational

Features about words at **specific** positions near target word

Often limited to just word identity and POS

Bag-of-words

Features about words that occur anywhere in the window (regardless of position)

Typically limited to frequency counts

An electric guitar and **bass** player stand off to one side not really part of the scene, just as a sort of nod to gringo expectations perhaps

Assume a window of +/- 2 from the target

Collocational

Position-specific information about the words in the window

guitar and **bass** player stand

[guitar, NN, and, CC, player, NN, stand, VB]

$Word_{n-2,}$ $POS_{n-2,}$ $word_{n-1,}$ $POS_{n-1,}$ $Word_{n+1}$ POS_{n+1}…

In other words, a vector consisting of

[position n word, position n part-of-speech…]

Bag-of-Words

- Information about the words that occur within the window.
- First derive a set of terms to place in the vector.
- Then note how often each of those terms occurs in a given window.

Co-occurrence Example

Assume we've settled on a possible vocabulary of 12 words that includes **guitar** and **player** but not **and** and **stand**

guitar and **bass** player stand

[0,0,0,1,0,0,0,0,0,1,0,0]

Which are the counts of words predefined as e.g.,

[fish, fishing, viol, guitar, double, cello…

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