

CS5740: Natural Language Processing
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Lexical Semantics

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Overview

- Word sense disambiguation (WSD)
 - Wordnet
- Semantic role labeling (SRL)
- Continuous representations

Lemma and Wordform

- A lemma or citation form
 - Basic part of the word, same stem, rough semantics
- A wordform
 - The “inflected” word as it appears in text

Wordform	Lemma
banks	bank
sung	sing
duermes	dormir

Word Senses

- One lemma “bank” can have many meanings:

Sense 1: • ...a **bank**₁ can hold the investments in a custodial account...

- “...as agriculture burgeons on the east

Sense 2: **bank**₂ the river will shrink even more”

- **Sense** (or **word sense**)
 - A discrete representation of an aspect of a word’s meaning.
- The lemma **bank** here has two senses

Homonymy

Homonyms: words that share a form but have unrelated, distinct meanings:

*bank*₁: financial institution, *bank*₂: sloping land

*bat*₁: club for hitting a ball, *bat*₂: nocturnal flying mammal

1. Homographs (bank/bank, bat/bat)

2. Homophones:

1. Write and right

2. Piece and peace

Homonymy in NLP

- Information retrieval
 - “bat care”
- Machine Translation
 - bat: [murciélagos](#) (animal) or [bate](#) (for baseball)
- Text-to-Speech
 - **bass** (stringed instrument) vs. **bass** (fish)

Quick Test for Multi Sense Words

- Zeugma
 - When a word applies to two others in different senses

Which flights **serve** breakfast?

Does Lufthansa **serve** Philadelphia?

Does Lufthansa serve breakfast and San Jose?

- The conjunction sounds “weird”
 - So we have two senses for *serve*

Synonyms

- Word that have the same meaning in some or all contexts.
 - filbert / hazelnut
 - couch / sofa
 - big / large
 - automobile / car
 - vomit / throw up
 - Water / H₂O
- Two words are synonyms if ...
 - ... they can be substituted for each other
- Very few (if any) examples of perfect synonymy
 - Often have different notions of politeness, slang, etc.

Synonyms

- Perfect synonymy is rare
- Can we define it better in term of senses?
- Consider the words **big** and **large**
- Are they synonyms?
 - *How big is that plane?*
 - *Would I be flying on a large or small plane?*
- How about here:
 - *Miss Nelson became a kind of big sister to Benjamin.*
 - *Miss Nelson became a kind of large sister to Benjamin.*
- Why?
 - big has a sense that means being older, or grown up
 - large lacks this sense
- Synonymous relations must be defined between senses

Antonyms

- Senses that are opposites with respect to one feature of meaning
- Otherwise, they are very similar!

dark	short	fast	rise	hot	up	in
light	long	slow	fall	cold	down	out

- Antonyms can
 - Define a binary opposition: **in/out**
 - Be at the opposite ends of a scale: **fast/slow**
 - Be reversives: **rise/fall**
- Very tricky to handle with some representations – remember for later!

Hyponymy and Hypernymy

- One sense is a **hyponym** of another if the first sense is more specific, denoting a subclass of the other
 - *car* is a hyponym of *vehicle*
 - *mango* is a hyponym of *fruit*
- Conversely **hypernym/superordinate** (“hyper is super”)
 - *vehicle* is a hypernym of *car*
 - *fruit* is a hypernym of *mango*
- Usually transitive
 - (A hypo B and B hypo C entails A hypo C)

Superordinate/hyper	vehicle	fruit	furniture
Subordinate/hyponym	car	mango	chair

WordNet

- A hierarchically organized lexical database
- On-line thesaurus + aspects of a dictionary
 - Word senses and sense relations
 - Some other languages available or under development (Arabic, Finnish, German, Portuguese...)

Category	Unique Strings
Noun	117,798
Verb	11,529
Adjective	22,479
Adverb	4,481

WordNet

WordNet Search - 3.1

- [WordNet home page](#) - [Glossary](#) - [Help](#)

Word to search for:

Display Options:

Key: "S:" = Show Synset (semantic) relations, "W:" = Show Word (lexical) relations
Display options for sense: (gloss) "an example sentence"

Noun

- [S:](#) (n) **bass** (the lowest part of the musical range)
- [S:](#) (n) **bass**, [bass part](#) (the lowest part in polyphonic music)
- [S:](#) (n) **bass**, [basso](#) (an adult male singer with the lowest voice)
- [S:](#) (n) [sea bass](#), **bass** (the lean flesh of a saltwater fish of the family Serranidae)
- [S:](#) (n) [freshwater bass](#), **bass** (any of various North American freshwater fish with lean flesh (especially of the genus Micropterus))
- [S:](#) (n) **bass**, [bass voice](#), [basso](#) (the lowest adult male singing voice)
- [S:](#) (n) **bass** (the member with the lowest range of a family of musical instruments)
- [S:](#) (n) **bass** (nontechnical name for any of numerous edible marine and freshwater spiny-finned fishes)

Adjective

- [S:](#) (adj) **bass**, [deep](#) (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

- **S: (n) bass, basso** (an adult male singer with the lowest voice)
 - direct hypernym / **inherited hypernym** / sister term
 - **S: (n) singer, vocalist, vocalizer, vocaliser** (a person who sings)
 - **S: (n) musician, instrumentalist, player** (someone who plays a musical instrument (as a profession))
 - **S: (n) performer, performing artist** (an entertainer who performs a dramatic or musical work for an audience)
 - **S: (n) entertainer** (a person who tries to please or amuse)
 - **S: (n) person, individual, someone, somebody, mortal, soul** (a human being) *"there was too much for one person to do"*
 - **S: (n) organism, being** (a living thing that has (or can develop) the ability to act or function independently)
 - **S: (n) living thing, animate thing** (a living (or once living) entity)
 - **S: (n) whole, unit** (an assemblage of parts that is regarded as a single entity) *"how big is that part compared to the whole?"; "the team is a unit"*
 - **S: (n) object, physical object** (a tangible and visible entity; an entity that can cast a shadow) *"it was full of rackets, balls and other objects"*
 - **S: (n) physical entity** (an entity that has physical existence)
 - **S: (n) entity** (that which is perceived or known or inferred to have its own distinct existence (living or nonliving))

Senses and Synsets in WordNet

- Each word in WordNet has at least one sense
- The **synset** (synonym set), the set of near-synonyms, is a set of senses with a gloss
- Example: chump as a noun with the gloss:
“a person who is gullible and easy to take advantage of”
- This sense of “chump” is shared by 9 words:
`chump1, fool2, gull1, mark9, patsy1, fall
guy1, sucker1, soft touch1, mug2`
- All these senses have the same gloss

WordNet Noun Relations

Relation	Also called	Definition	Example
Hypernym	Superordinate	From concepts to superordinates	<i>breakfast</i> ¹ → <i>meal</i> ¹
Hyponym	Subordinate	From concepts to subtypes	<i>meal</i> ¹ → <i>lunch</i> ¹
Member Meronym	Has-Member	From groups to their members	<i>faculty</i> ² → <i>professor</i> ¹
Has-Instance		From concepts to instances of the concept	<i>composer</i> ¹ → <i>Bach</i> ¹
Instance		From instances to their concepts	<i>Austen</i> ¹ → <i>author</i> ¹
Member Holonym	Member-Of	From members to their groups	<i>copilot</i> ¹ → <i>crew</i> ¹
Part Meronym	Has-Part	From wholes to parts	<i>table</i> ² → <i>leg</i> ³
Part Holonym	Part-Of	From parts to wholes	<i>course</i> ⁷ → <i>meal</i> ¹
Antonym		Opposites	<i>leader</i> ¹ → <i>follower</i> ¹

WordNet 3.0

- Where it is:
 - <http://wordnetweb.princeton.edu/perl/webwn>
- Libraries
 - Python:
 - NLTK: <http://www.nltk.org/Home>
 - Java:
 - JWNL, extJWNL on sourceforge