

Natural Language Processing

Word Meaning Word Senses

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lemma and wordform

- A **lemma**
 - stem
- A **wordform**
 - The “inflected” word as it appears in text

Wordform	Lemma
banks	bank
sung	sing
duermes	dormir

Lemmas have senses

- One lemma “bank” can have many meanings:

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

Sense 2: • “...as agriculture burgeons on the east **bank** 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:

- **bank₁**: financial institution, **bank₂**: sloping land
- **bat₁**: club for hitting a ball, **bat₂**: nocturnal flying mammal

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

2. Homophones:

1. **Write** and **right**
2. **Piece** and **peace**

Polysemy

- 1. The **bank** was constructed in 1875 out of local red brick.
- 2. I withdrew the money from the **bank**
- Are those the same sense?
 - Sense 2: “A financial institution”
 - Sense 1: “The building belonging to a financial institution”
- A **polysemous** word has **related** meanings
 - Most non-rare words have multiple meanings

Metonymy or Systematic Polysemy:

A systematic relationship between senses

- Lots of types of polysemy are systematic
 - School, university, hospital
 - All can mean the institution or the building.
- A systematic relationship:
 - Building ↔ Organization
- Other such kinds of systematic polysemy:

Author (Jane Austen wrote Emma)

↔ Works of Author (I love Jane Austen)

Tree (Plums have beautiful blossoms)

↔ Fruit (I ate a preserved plum)

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 lexemes are synonyms
 - if they can be substituted for each other

Synonyms

- But there are few (or no) examples of perfect synonymy.
 - Even if many aspects of meaning are identical
 - Still may not preserve the acceptability based on notions of politeness, slang, register, genre, etc.
- Example:
 - Water/H₂O
 - Big/large
 - Brave/courageous

Synonymy is a relation between senses rather than words

- Consider the words *big* and *large*
- Are they synonyms?
 - How **big** is that plane?
 - Would I be flying on a **large** or small plane?
 - 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

Antonyms

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

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

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*

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

Hyponyms and Instances

- WordNet has both **classes** and **instances**.
- An **instance** is an individual, a proper noun that is a unique entity
 - San Francisco is an **instance** of `city`
 - But `city` is a class
 - `city` is a **hyponym** of `municipality...location...`

WordNet

- A detailed database of semantic relationships between English words.
- Developed by famous cognitive psychologist George Miller and a team at Princeton University.
- About 144,000 English words.
- Nouns, adjectives, verbs, and adverbs grouped into about 109,000 synonym sets called *synsets*.

WordNet Synset Relationships

- **Antonym**: front → back
- **Attribute**: benevolence → good (noun to adjective)
- **Pertainym**: alphabetical → alphabet (adjective to noun)
- **Similar**: unquestioning → absolute
- **Cause**: kill → die
- **Entailment**: breathe → inhale
- **Holonym**: chapter → text (part to whole)
- **Meronym**: computer → cpu (whole to part)
- **Hyponym**: plant → tree (specialization)
- **Hypernym**: apple → fruit (generalization)

WordNet 3.0

- A hierarchically organized lexical database
- On-line thesaurus + aspects of a dictionary
 - Some [other languages](#) available or under development
 - (Hindi, Indo-wordnet, Arabic, Finnish, German, Portuguese...)

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

Senses of “bass” in Wordnet

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

How is “sense” defined in WordNet?

- The **synset (synonym set)**, the set of near-synonyms, instantiates a sense or concept, 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`
- Each of **these** senses have this same gloss
 - (Not **every** sense; sense 2 of gull is the aquatic bird)

WordNet Hypernym Hierarchy for “bass”

- 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))

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	Member-Of	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		From members to their groups	<i>copilot</i> ¹ → <i>crew</i> ¹
Part Meronym		From wholes to parts	<i>table</i> ² → <i>leg</i> ³
Part Holonym	Has-Part	From wholes to parts	<i>course</i> ⁷ → <i>meal</i> ¹
Antonym	Part-Of	From parts to wholes	<i>leader</i> ¹ → <i>follower</i> ¹
		Opposites	

Lexical Ambiguity

- Most words in natural languages have multiple possible meanings.
 - “pen” (noun)
 - The dog is in the pen.
 - The ink is in the pen.
 - “take” (verb)
 - Take one pill every morning.
 - Take the first right past the stoplight.
- Syntax helps distinguish meanings for different parts of speech of an ambiguous word.
 - “conduct” (noun or verb)
 - John’s conduct in class is unacceptable.
 - John will conduct the orchestra on Thursday.