

# Lexical Semantics

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# Key points

- Difference between compositional and lexical semantics
- Semantic relations and how to use them for defining word senses (Aristotelian Genus-Differentia principle)
- Synsets and how to use them for defining word senses (Wordnet)
- Example of applications for Lexical Semantics

# Lexical Semantics vs. Compositional Semantics

- **Lexical semantics:** The study of the meaning of words
- **Compositional Semantics:** the study of the meaning of sentences (or more complex linguistic entities: paragraphs, texts, ...)

## Reading tests

- Consider the following text:

“Under Peter’s supervision, John is participating to an experiments consisting in placing on a table blocks with various shapes and colors initially lying on the floor.

The first day, he puts two triangle blocks on the table, one red and one green.

The second day, he replaces the red triangle block by a square block of the same color, and added a green triangle block.”

- Answer the following questions:
  1. Who is manipulating the blocks during the experiment?
  2. How many blocks are on the table at the end of the experiment?
  3. What is the shape of the red block(s) on the table at the end of day 1?
  4. How many triangles have been manipulated during the whole experiment?

## Reading tests (2)

- The test may seem trivial to (almost any, at least English speaking) human subject... however, it requires a lot of knowledge to be successfully passed!
  - Knowledge about involved objects: What is a block? What is a shape? What is a color? What is a table? What is a floor?
  - Knowledge about involved actions: What is participate? Consist? Lie? ...
  - Knowledge about people who are referred to: Who is John? Who is Peter?
  - Knowledge about the language: syntactic analysis (e.g. in “blocks (...) initially lying on the floor”, what is the subject of lying?); anaphora resolution (who is the pronoun “he” in the second sentence referring to?)
  - Knowledge about the real world: e.g. when a block is put on a table, it stays there (while a drop of water may evaporate or a feather may be blown away) or if somebody is participating to an experiments, s/he is performing the actions during this experiment, not the person who is supervising it! ...

# Intermediate conclusion

- Large scale Compositional Semantics is still out of reach,  
and
- This lecture will therefore restrict to a simpler form of semantics, the semantics of individual words, e.g. ***Lexical Semantics***

# (a bit) more formally: Lexemes

- Lexeme:
  - An individual entry in a lexicon/dictionary
  - A pairing of a particular orthographic and phonological form with some meaning representation

Orthographic form	Phonological form	Meaning
1. bass	[beys]	<i>adj.</i> low in pitch; a bass instrument
2. bass	[bas]	<i>n.</i> (...) freshwater or marine fishes (...)
3. wood	[woo d]	<i>n.</i> (...) substance of a tree (...)
4. would	[woo d]	<i>v.</i> A pt. and pp. of WILL

- ... And, the sense of a word is then the meaning component of the associated lexeme...

Hands-on...

## Dictionary definitions

- Propose a definition for the word “bee”...



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## Dictionary definitions (2)

- Definition of “bee” (according to the English Wiktionary):

“A [flying insect](#), of the superfamily [Apoidea](#), known for its organised societies and for collecting [pollen](#) and (in some species) producing [wax](#) and [honey](#).”

- The definition requires the meaning of the words it contains...
  - Apoidea: A taxonomic superfamily within the order Hymenoptera – the bees and some wasps.
  - To fly: To travel through the air, another gas or a vacuum, without being in contact with a grounded surface.
  - Insect: An arthropod in the class Insecta, characterized by six legs, up to four wings, and a chitinous exoskeleton.

# Homonymy, homophony, homography

- **Homophony:** two distinct words are homophones if they have the same pronunciation (i.e. the same “phonological form”)

Example: “die” and “dye”

- **Homography:** two words are homographs if they are spelled the same (i.e. have the same “orthographic form”) but not pronounced the same

Example: “bass” (the fish) and “bass” (the guitar)

- **Homonymy:** two words are homonyms if they are spelled and pronounced the same, but do not have the same meaning

Example: “bat” (the wooden club) and “bat” (the flying mammal)

# Homonymy vs. Polysemy

- Both homonyms and polysems are spelled and pronounced the same but ...
- homonyms have a different etymology and usually correspond to two distinct entries in a lexicon, while polysems share the same etymology but correspond to two different meanings of the same lexicon entry

Example:

- “bat” (the flying mammal) comes from a dialectal variant of the Middle English “bakke”, while “bat” (the wooden club) comes from the Old English “batt”

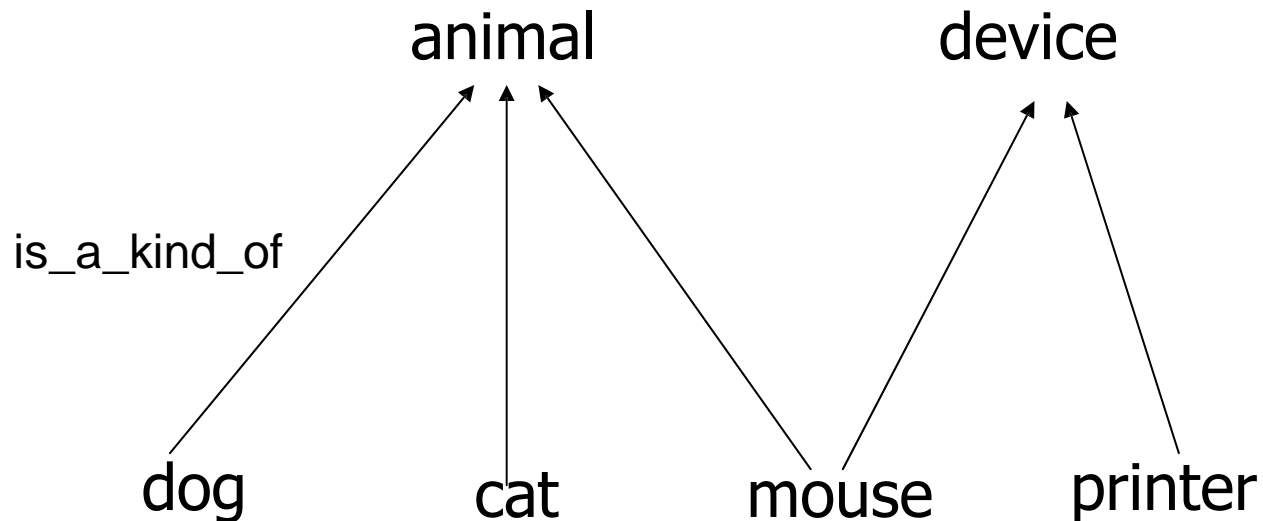
but

- “crown” (the headgear) and “crown” (the highest part) both come from the Anglo-Norman “coroune”

# Semantic Relations

# Hyponymy/Hypernymy

A hyponym is a word whose meaning contains the entire meaning of another, known as the *superordinate* or hypernym.



# Meronymy/Holonymy

- A word  $w_1$  is a meronym of another word  $w_2$  (the holonym) if the relation **is-part-of** holds between the meaning of  $w_1$  and  $w_2$ .
  - Meronymy is transitive and asymmetric
  - A meronym can have many holonyms
  - Meronyms are distinguishing features that hyponyms can inherit.
    - Ex. If “beak” and “wing” are meronyms of “bird”, and if “canary” is a hyponym of “bird”, then (by inheritance), “beak” and “wing” must be meronyms of “canary”.
  - Limited transitivity:
    - Ex. “A house has a door” and “a door has a handle”, then “a house has a handle” (?)

# Defining word senses with semantic relations

- A standard way of defining word senses with semantic relations is to follow the Aristotelian principle of “Genus-Differentia”:
  - Genus: each word meaning is first associated to a hypernym through a “hyponymy/hypernymy” relation (this is equivalent to defining the superclass associated with a given class in an object oriented model)
  - Differentia: each word meaning is then uniquely differentiated from the other hyponyms of its hypernym by additional relations (e.g. Meronymy/Holonymy) associating it with other words meanings
- Of course, to make this type of approach realistic on a large scale, more than two semantic relations are required!

## Lexical Semantics with semantic relations

- Consider the following meanings of the word “mouse”:

1. Any small rodent of the genus Mus.



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2. An input device that is moved over a pad or other flat surface to produce a corresponding movement of a pointer on a graphical display.



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How could you use semantic relations to distinguish between these two meanings?



## Lexical semantics with semantic relations (2)

- Mouse:
  1. hyponym of “rodent”
  2. hyponym of “device”

## Lexical Semantics with semantic relations (3)

- Consider the following meanings of the word “wood”:
  1. The substance making up the central part of the trunk and branches of a tree.  
*example: this table is made of wood*
  2. A forested or wooded area.  
*example: he got lost in the wood*
  3. A type of golf club, the head of which was traditionally made of wood.  
*example: he played golf with a wood*

How could you use semantic relations to distinguish between these two meanings?

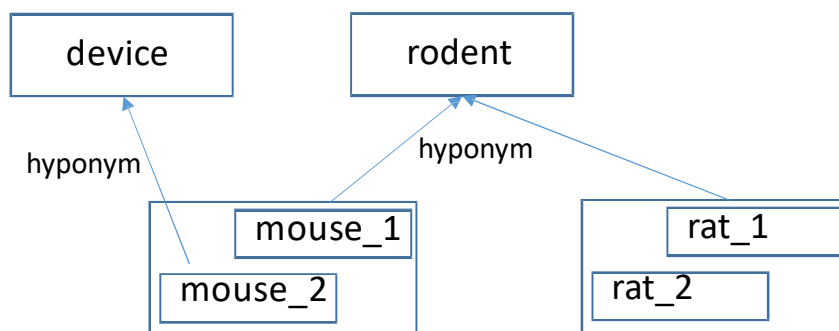
## Lexical semantics with semantic relations (4)

- Wood:
  1. hyponym of “substance”
  2. hyponym of “area”
  3. hyponym of “club”

## Review...

# Let us go further!...

- The definitions based on semantic relations given so far are good enough for distinguishing the meanings of various polysemic words but they do not allow to distinguish between the hyponyms of a given hypernym!...



But how to distinguish between mouse\_1 and rat\_1?

## Let us go further!... (2)

- Let us recall the definitions of mouse\_1 and rat\_1:
  - mouse\_1: Any small rodent of the genus Mus.
  - rat\_1: Any medium-sized rodent belonging to the genus Rattus.
- To distinguish between mouse\_1 and rat\_1, additional semantic relations may be used...

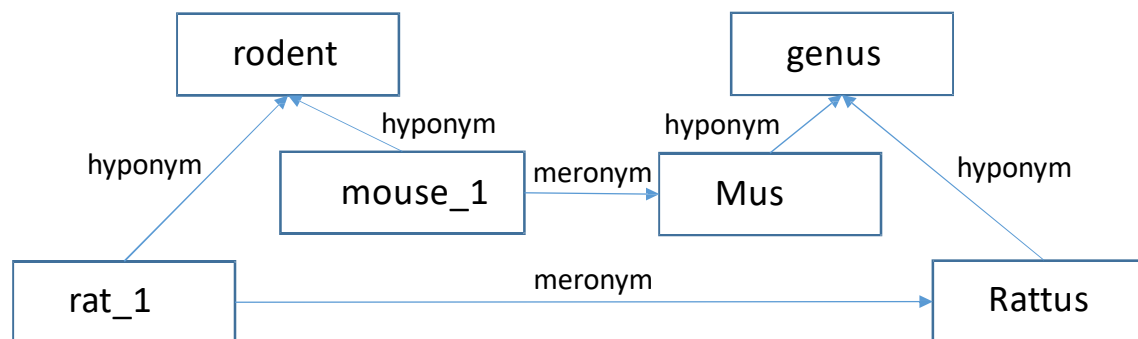
## Let us go further!... (3)

- For example:

➤ mouse\_1: hyponym of “rodent” and meronym of “Mus”

➤ rat\_1: hyponym of “rodent” and meronym of “Rattus”

which, if we add the fact that “Mus” and “Rattus” are both hyponyms of “genus” would lead to the following graph based representation:



## Let us go further!... (5)

- Exercise: Apply the Genus-Differentia approach to differentiate:
    - wood\_1: The substance making up the central part of the trunk and branches of a tree.
- from
- stone\_1: A hard earthen substance that can form large rocks.

# Synsets

- Hypothesis: A *synonym* is often sufficient to identify a sense.
  - Example
    - “**board**” means 1) piece of lumber 2) group of people assembled for some reason
    - Sense 1: {board, **plank**} Sense 2: {board, **committee**}

*(Note that this is true for English which is rich in synonyms but may not be true for all languages...)*
- A synset is a set of words (surface forms) that share a given sense/meaning/concept
- Synsets do not explain what senses are, they simply express that they exist, and allow to differentiate them from each other



## Lexical semantics with synsets

- Use synsets to represent the meanings of “mouse”:
  1. Any small rodent of the genus *Mus*.
  2. An input device that is moved over a pad or other flat surface to produce a corresponding movement of a pointer on a graphical display.

and of “rat”:

1. Any medium-sized rodent belonging to the genus *Rattus*.

## Lexical semantics with synsets

- mouse\_1: {mouse, rodent}
- mouse\_2: {mouse, device}
  
- rat\_1 : {rat, rodent}