

# Syntax and Semantics

Semantic Analysis Phase

# Semantics

- Semantics is the study of the meaning of linguistic utterances.
- **Representing Meaning**
  - The process whereby representations are created and assigned to linguistic inputs is called **semantic parsing or semantic analysis**
  - Tasks that require some form of semantic processing
    - **learning to use a new piece of software** by reading the manual
    - **Deciding what to order at a restaurant by reading** a menu, or following a recipe
    - **Answering an essay question** on an exam.

# Semantic Analysis

- Semantic analysis describes the process of understanding natural language—the way that humans communicate—based on meaning and context.
- Semantic analysis is the process of finding the meaning from text. This analysis gives the power to computers to understand and interpret sentences, paragraphs, or whole documents, by analyzing their grammatical structure, and identifying the relationships between individual words of the sentence in a particular context.
- Therefore, the goal of semantic analysis is to draw exact meaning or dictionary meaning from the text. The work of a semantic analyzer is to check the text for meaningfulness.

# Semantic Analysis

- In order to understand language, we need to know its meaning.
- What is the meaning of a word? (Lexical semantics)
- What is the meaning of a sentence? ([Compositional] semantics)
- What is the meaning of a longer piece of text? (Discourse semantics)

# Semantic Analysis

- **How is Semantic Analysis different from Lexical Analysis?**

- Lexical analysis is based on smaller tokens but on the contrary, the semantic analysis focuses on larger chunks.
- Since semantic analysis focuses on larger chunks, therefore we can divide the semantic analysis into the following two parts:

- **Studying the meaning of the Individual Word**

- It is the first component of semantic analysis in which we study the meaning of individual words. This component is known as **lexical semantics**.

- **Studying the combination of Individual Words**

- In this component, we combined the individual words to provide meaning in sentences.

# Semantic Analysis

- **For Example**, consider the following sentence:

Sentence: **Ram is great**

- In the above sentence, the speaker is talking either about Lord Ram or about a person whose name is Ram. That is why the task to get the proper meaning of the sentence is important.

Sentence: I like you and You like me.

# Semantic Analysis

- While we implement a semantic-based approach, there are various sub-tasks involved including
  - Word sense disambiguation
  - Relationship extraction.
- **Word Sense Disambiguation**
  - Natural language is ambiguous and polysemic; sometimes, the same word can have different meanings depending on its use in the sentence.
- Therefore, in semantic analysis with machine learning, computers use Word Sense Disambiguation to determine which meaning is correct in the given context.
- **For Example**, Consider the word: **Orange**
  - The above word can refer to a color, a fruit, or even a city in Florida!

# Semantic Analysis

- **Relationship Extraction**

□ In this task, we try to detect the semantic relationships present in a text. Usually, relationships involve two or more entities such as names of people, places, company names, etc.

- These entities are joined through a semantic category, like “works at,” “lives in,” “is the CEO of,” “headquartered at.”

- **For Example**, Consider the following phrase

- Phrase: **Steve Jobs is the founder of Apple, which is headquartered in California**

□ The above phrase contains two different relationships:

Steve Jobs founder of Apple.  
[Person] [Company]

Apple headquartered in California.  
[Company] [Place]



# Lexical Semantics

- What do individual words mean?
- Say for example: forward. Let us take two sentences.
  - “Forward into the ocean.”
  - “She was leaning forward.”
- We can separate forward in both these cases.
- ‘Forward’ or ‘forward’ operates in two different contexts relating to other words.
- **Lexical semantics:** is about individual words in context.
- There are lexical relations, how meaning relate to each other.

# Lexical Semantics

- The study of lexical semantics looks at:
  - “The classification and decomposition of lexical items”
  - The differences and similarities in lexical semantic structure cross-linguistically
  - The relationship of lexical meaning to sentence meaning and syntax.”
    - “Forward into the ocean.” Is a sentence where the forward is referring to ‘ocean’ connected by into.
    - “She was leaning forward.” This on the other hand refers to ‘she’ and a past tense action.
    - How can we recognise the meaning of these two?

# Relations between word meanings

- **Hyponymy and hypernymy:** “...refers to a relationship between a general term and the more specific terms that fall under the category of the general term.”
  - Color (hypernym) → red, green, yellow, blue (hyponyms)
- Then there are synonyms, and this may be more commonly known.
- **Synonymy** refers to: “...words that are pronounced and spelled differently but contain the same meaning.”
  - Happy, joyful, glad
- **Antonymy** refers to words that are related by having the opposite meanings to each other. There are three types of antonyms: graded antonyms, complementary antonyms, and relational antonyms.
  - dead, alive
  - long, short

# Elements of Semantic Analysis

- **Homonymy** is about the relationship between words that are spelled or pronounced the same way, but hold different meanings.

□ *Bank (of river)*

*bank (financial institution)*

- Lexical items can map onto events too.
- There can be states, processes and transition.

□ a. The door is **closed**.

b. The door **closed**.

c. John **closed** the door.

- (1a) defines the state of the door being closed; there is no opposition in this predicate. (1b) and (1c) both have predicates showing transitions of the door going from being implicitly open to closed. (1b) gives the intransitive use of the verb close, with no explicit mention of the causer, but (1c) makes explicit mention of the agent involved in the action.”

# Elements of Semantic Analysis

- **For example,**
- The word “Bat” is a homonymy word. - To hit a ball
  - Bat is a nocturnal flying mammal also.
- **Polysemy**
- Polysemy is a Greek word, that means “**many signs**”. It is a word or phrase with a different but related sense. In other words, we can say that polysemy has the same spelling but different and related meanings.
- **the word "Bank" is a Polysemy word.**
  - The above word is a polysemy word having the following meanings:
    - A financial institution.
    - The building in which such an institution is located.
    - A synonym for “to rely on”.

# Elements of Semantic Analysis

- **Difference between Polysemy and Homonymy**

- Both polysemy and homonymy words have the same syntax or spelling but the main difference between them is that in polysemy, the meanings of the words are related but in homonymy, the meanings of the words are not related.

- **For Example**, if we talk about the same word “Bank” as discussed earlier, we can write the meaning as

- ‘a financial institution’ or

- ‘a river bank’.

- In that case, it becomes an example of a homonym, as the meanings are unrelated to each other.

# Elements of Semantic Analysis

- **Synonymy**

- It represents the relation between two lexical items of different forms but expressing the same or a close meaning.

- **For Example- ‘author/writer’, ‘fate/destiny’**

- **Antonymy**

- It is the relation between two lexical items having symmetry between their semantic components relative to an axis. The scope of antonymy is as follows –

- **For Examples,- ‘life/death’, ‘certitude/incertitude’**

- Application of scalable property:

- **For Examples,**

- **‘rich/poor’, ‘hot/cold’**

- Application of a usage:

- **For Examples,**

- **‘father/son’, ‘moon/sun’**

# Compositional semantics

- The principle of compositionality: the meaning of a complex expression depends upon its constituent parts and the way they are combined.
- The general theory in compositional semantics: **The meaning of a phrase is determined by combining the meanings of its sub phrases, using rules which are driven by the syntactic structure.**
- **Simple Example: Event sentence**
- Consider the following sentence and plausible representations of meaning.
- **Sentence:** "John ate a ripe apple."



# Compositional semantics

- **Sentence:** "John ate a ripe apple."

**Syntax tree :**

- S ---> NP ---> Name ---> John |  
    |-> VP ---> Verb ---> ate |  
        |-> NP ---> Det ---> a |  
            |-> Adj ---> ripe |  
                |-> Noun ---> apple

- **Representation**

- Person(p1).
- Name(p1,"John").
- Ripe(o1). Apple(o1).
- Event(e1,Eat).
- Actor(e1,p1).
- Object(e1,o1).

Thank you.