Analyzing the Meaning of words and Sentences

Semantics of English Sentence

The semantics of English sentences refers to the meaning conveyed by the arrangement of words, phrases, and clauses within a sentence.

- Word-Level Semantics

Lexical Meaning: Individual words carry inherent meanings

Polysemy and Homonymy: Some words have multiple meanings depending on context

- Sentence -level semantics

Compositionality: The meaning of a sentence is derived from the meanings of its parts and the rules used to combine them

Ambiguity:

Lexical Ambiguity: Words with multiple meanings (e.g., "light" as not heavy or illumination).

Structural Ambiguity: Sentence structure leading to multiple interpretations (e.g., "The man saw the woman with a telescope").

Compositional semantics

- **Compositional Semantics** in **Natural Language Processing (NLP)** refers to the study and implementation of how the meanings of individual words or phrases combine systematically to determine the meaning of a larger structure, such as a sentence.

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).
```

Lexicon

```
"apple" ---> Content: Apple.
"ate". --> Content: Eat.
"John" --> Create symbol S. Assert Person(S) and Name(S,"John").
           Denotation = S.
```

Compositional rules

Rule 1:

```
Given: NP ---> Name ---> W.
   Denotation(NP) = Denotation(W).
```

Rule 2:

```
Given: NP ---> Det
               |
               |-> Adj
               |
              ...
               |-> Adj
               |
               |-> Noun.

Create a new symbol S. For each Adj/Noun P, assert P.Content(S).
    Denotation(NP) = S.
```

Rule 3:

```
Given: S ---> NP1
              |
              |-> VP ---> Verb
                         |
                         |-> NP2

Create a new symbol E. Assert Event(E,Verb.Content).
    Assert Actor(E,Denotation(NP1))
    Assert Object(E,Denotation(NP2))
```

Meaning Representation

- Semantic analysis creates a representation of the meaning of a sentence. But before getting into the concept and approaches related to meaning representation, we need to understand the building blocks of semantic system.

Building Blocks of Semantic System

- **Entities** – It represents the individual such as a particular person, location etc. For example, Haryana. India, Ram all are entities.
- **Concepts** – It represents the general category of the individuals such as a person, city, etc.
- **Relations** – It represents the relationship between entities and concept. For example, Ram is a person.
- **Predicates** – It represents the verb structures. For example, semantic roles and case grammar are the examples of predicates.

Approaches to Meaning Representations

- First order predicate logic (FOPL)
- Semantic Nets
- Frames
- Conceptual dependency (CD)
- Rule-based architecture
- Case Grammar
- Conceptual Graphs

Lexical Semantics

The first part of semantic analysis, studying the meaning of individual words is called lexical semantics. It includes words, sub-words, affixes (sub-units), compound words and phrases also. All the words, sub-words, etc. are collectively called lexical items. In other words, we can say that lexical semantics is the relationship between lexical items, meaning of sentences and syntax of sentence.

- Classification of lexical items like words, sub-words, affixes, etc. is performed in lexical semantics.
- Decomposition of lexical items like words, sub-words, affixes, etc. is performed in lexical semantics.
- Differences as well as similarities between various lexical semantic structures is also analyzed.

Word sense disambiguation

- Word sense disambiguation, in natural language processing (NLP), may be defined as the ability to determine which meaning of word is activated by the use of word in a particular context.
- Lexical ambiguity, syntactic or semantic, is one of the very first problem that any NLP system faces. Part-of-speech (POS) taggers with high level of accuracy can solve Word's syntactic ambiguity.
- On the other hand, the problem of resolving semantic ambiguity is called WSD (word sense disambiguation). Resolving semantic ambiguity is harder than resolving syntactic ambiguity.

- I can hear bass/frequency sound.
- He likes to eat grilled bass/fish.

Evaluation of WSD

The evaluation of WSD requires the following two inputs −

- **A Dictionary**

The very first input for evaluation of WSD is dictionary, which is used to specify the senses to be disambiguated.

- **Test Corpus**

Another input required by WSD is the high-annotated test corpus that has the target or correct-senses.

Approaches and Methods to Word Sense Disambiguation

- Dictionary-based or Knowledge-based Methods
- Supervised Methods
- Semi-supervised Methods
- Unsupervised Methods