**Ambiguity in NLP and how to address them**

Ambiguity in Natural Language Processing (NLP) **happens because human language can have multiple meanings**. Computers sometimes confuse to understand exactly what we mean unlike humans, who can use intuition and background knowledge to infer meaning, computers rely on precise algorithms and statistical patterns.

The sentence **"The chicken is ready to eat"** is ambiguous because it can be interpreted in two different ways:

1. The chicken is cooked and ready to be eaten.
2. The chicken is hungry and ready to eat food.

This dual meaning arises from the structure of the sentence, which does not clarify the subject's role (the eater or the one being eaten). Resolving such ambiguities is essential for accurate NLP applications like chatbots, translation, and sentiment analysis.

This article explores **types of ambiguity in NLP** and methods to address them effectively.

**Types of Ambiguity in NLP**

The meaning of an ambiguous expression often depends on the situation, prior knowledge, or surrounding words. **For example: *He is cool.*** This could mean***he is calm under pressure* or *he is fashionable* depending on the context.**

**1. Lexical Ambiguity**

Lexical ambiguity occurs when a single word has multiple meanings, making it unclear which meaning is intended in a particular context. This is a common challenge in language.

*For example, the word* ***"bat"*** *can have two different meanings. It could refer to a* ***flying mammal****, like the kind you might see at night. Alternatively, "bat" could also refer to a* ***piece of sports equipment*** *used in games like baseball or cricket.*

For computers, determining the correct meaning of such a word requires looking at the surrounding context to decide which interpretation makes sense.

**2. Syntactic Ambiguity**

Syntactic ambiguity occurs when the structure or grammar of a sentence allows for more than one interpretation. This happens because the sentence can be understood in different ways depending on how it is put together.

*For example, take the sentence,* ***“The boy kicked the ball in his jeans.”*** *This sentence can be interpreted in two different ways: one possibility is that the* ***boy was wearing jeans*** *and he kicked the ball while he was wearing them. Another possibility is that the* ***ball was inside the boy’s jeans****, and he kicked the ball out of his jeans.*

A computer or NLP system must carefully analyze the structure to figure out which interpretation is correct, based on the context.

**3. Semantic Ambiguity**

Semantic ambiguity occurs when a sentence has more than one possible meaning because of how the words are combined. This type of ambiguity makes it unclear what the sentence is truly trying to say.

*For example, take the sentence,* ***“Visiting relatives can be annoying.”*** *This sentence could be understood in two different ways. One meaning could be that* ***relatives who are visiting you*** *are annoying, implying that the relatives themselves cause annoyance. Another meaning could be that the* ***act of visiting relatives*** *is what is annoying, suggesting that the experience of going to see relatives is unpleasant.*

The confusion comes from how the words "visiting relatives" can be interpreted: is it about the relatives who are visiting, or is it about the action of visiting? In cases like this, semantic ambiguity makes it hard to immediately understand the exact meaning of the sentence, and the context is needed to clarify it.

**4. Pragmatic Ambiguity**

Pragmatic ambiguity occurs when the meaning of a sentence depends on the **speaker’s intent**, **tone**, or the **situation** in which it is said. This type of ambiguity is common in everyday conversations, and it can be tricky for computers to understand because it often requires knowing the broader context.

*For example, consider the sentence,* ***“Can you open the window?”*** *In one situation, it could be understood as a* ***literal question*** *asking if the person is physically able to open the window. However, in another context, it could be a* ***polite request****, where the speaker is asking the listener to open the window, even though they’re not directly giving an order.*

The meaning changes based on the **tone of voice** or **social context**, which is something that is difficult for NLP systems to capture without understanding the surrounding situation

**5. Referential Ambiguity**

Referential ambiguity occurs when a pronoun (like "he," "she," "it," or "they") or a phrase is unclear about what or who it is referring to. This type of ambiguity happens when the sentence doesn’t provide enough information to determine which person, object, or idea the pronoun is referring to.

*For example, consider the sentence,* ***“Alice told Jane that she would win the prize.”*** *In this case, it’s unclear whether the pronoun* ***"she"*** *refers to* ***Alice*** *or* ***Jane****. Both could be possible interpretations, and without further context, we can’t be sure. If the sentence was about a competition,* ***"she"*** *could be referring to Alice, meaning Alice is telling Jane that she would win the prize. However, it could also mean that Alice is telling Jane that Jane would win the prize.*

**6. Ellipsis Ambiguity**

Ellipsis ambiguity happens when part of a sentence is left out, making it unclear what the missing information is. This often occurs in everyday conversation or writing when people try to be brief and omit words that are understood from the context.

*For example, consider the sentence,* ***"John likes apples, and Mary does too."*** *The word* ***"does"*** *is a shortened form of "likes apples," but it’s not explicitly stated. This creates two possible interpretations:*

1. ***Mary likes apples*** *just like John, meaning both John and Mary enjoy apples.*
2. ***Mary likes something else*** *(not apples), and the sentence is leaving out the specific thing she likes.*

The ambiguity arises because it's unclear from the sentence whether **"does"** refers to liking apples or something else.

**Addressing Ambiguity in Natural Language Processing**

To address ambiguity in NLP, several methods are used to accurately interpret language.

* **Contextual analysis** is one of the key approaches, where surrounding words and context help determine the correct meaning of a word or phrase.
* **Word sense disambiguation (WSD)** resolves lexical ambiguity by using context to identify which meaning of a word is being used.
* [**Parsing and syntactic analysis**](https://www.geeksforgeeks.org/lexical-analysis-and-syntax-analysis/) help resolve syntactic ambiguity by breaking down sentence structures to understand different grammatical interpretations.
* **Co reference resolution** is used to clarify what pronouns or phrases refer to, solving referential ambiguity.
* **Discourse and pragmatic modeling** help capture speaker intent and the social context, which resolves pragmatic ambiguity.
* **Machine learning and deep learning** techniques, like BERT and GPT, leverage large datasets to learn language patterns, aiding in resolving ambiguity.