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Semantic Analysis of Structurally Ambiguous Sentences

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Abstract

The use of English language and in fact other languages can lead to many ambiguous communications. Observations indicate that mere use of a word or a phrase in a sentence may change its meaning and relationship to other words or phrases, and this compels readers or listeners to construe its meaning in different ways. It is obvious that a sentence on its own can be ambiguous, but it can be disambiguated within a certain frame of context. This paper focused on the semantic analysis of structurally ambiguous sentences or phrases which are difficult to understand due to use of incorrect or imprecise possessive determiners. In some sentences, ambiguity may create humour among the audience thus, making the ambiguity to be acceptable in such a context. However, when the main purpose of the sentence is to convey information the point of the sentence should be as straightforward as possible. With this in mind, the present paper attempted to analyze the issue of ambiguity in written and spoken language by reviewing different areas of ambiguity, its causes, and some techniques used in disambiguation, so that readers and listeners can correctly interpret clear meaning of written and spoken sentences and discourses.

Keywords: Sentence, Structural Ambiguity, Analysis Technique, Disambiguation

Introduction

Structural or syntactic ambiguity is the potential of multiple interpretations for a piece of written or spoken language because of the way words or phrases are organized, or structured, and this makes it difficult for humans, or even artificial intelligence systems to determine meaning, unless further information is provided to clarify the context (Warren, 2012). Austin (2021) defined ambiguous sentences as phrases with two or more than two possible meanings within the same sequence of words. Structural ambiguity often results from the lack of clear indicators of how phrases and clauses relate to each other in a sentence. Context usually helps to resolve the ambiguity, but without additional information, multiple interpretations can be equally valid. They can confuse the readers and make the meaning of the sentence inexact. According to Wigmore (2019), most of structural ambiguities are as a result of writing errors, such as misplaced modifiers.

*S*tructural ambiguity is often contrasted with lexical (word-related) ambiguity, which often arises because words can have multiple meanings. However, both of them are examples of linguistic ambiguity which also results from other things including figurative language and vagueness.

When a speaker is having a conversation with an audience, some people may complain that he is being ambiguous. This means that the speaker is using ambiguous speech that is making you inexact or unclear. Sometimes, there are people who are not even aware that they are using ambiguous speech. Other times, people may use verbal ambiguity on purpose. There are also times when people prefer being unclear to make others feel as if they are solving a mystery. Ambiguity in writing and speech, however, can be quite useful as a tool. For instance, in speech, one might want to make the listeners consider certain things for themselves, so one can choose to be ambiguous. Or one can create a scene of resolution, climax, and conflict by using ambiguity in writing. So, being ambiguous can be used to one's own benefit if you know how to play around with it.

The concept of ambiguity in English is often confused with vagueness, but it is not actually the case. In ambiguity, distinct and specific interpretations of the meaning of the phrase are allowed even though some of them might be obvious to the eye at first glance. Vague information, on the other hand, is difficult to resolve and it is tough to form any plausible interpretations of it to the desired extent of specificity. Ambiguity in writing occurs when the meaning of some part of the text is uncertain, and there can be more than one meaning to it. Typically, it is no good to introduce any form of ambiguity in one's writing, because one may confuse one's reader, making the understanding intended meaning of tour text. However, in linguistics, ambiguity is used to add a deeper meaning to a text or literary work. Here, writers give their readers the liberty to use their own imagination to explore possible meanings thus, actively involving the readers in the poetry or prose they are reading. To make the ambiguous sentences unambiguous and grammatical, it is necessary to have some sort of formal signals which help the reader or hearer to recognize the sentence structure (Taha, 1983). Some of the signals include function words, inflections, affixes, stress, juncture (or word division and punctuation in writing), and other major class membership in a structure.

Here are some selected structural ambiguous sentences and their possible interpretations:
'Mrs. Okonkwo was proved guilty of keeping an item in the Owerri Magistrates Court after being charged with stealing a television set from her neighbour's property.'
The ambiguity:
It can't be determined whether Mrs. Okonkwo was guilty of stealing the television set in the Owerri Magistrates Court, or guilty of stealing the television set after she collected it from a resident's property
The correct sentence:
In the Owerri Magistrates Court, Mrs. Okonkwo was proved guilty of keeping a stolen item, television set, after stealing it from a neighbour's property.
- The lecturer said on Friday she would take a pop quiz.

- ❖ *This can either mean that it was on Friday that the lecturer told the students about the pop quiz or that the pop quiz would be held on Friday.*
- The goat is ready to eat.
- ❖ *This can either mean that the goat is cooked and ready for everyone to eat it or that the goat is ready to be fed some food.*
- The burglar robbed the woman with the knife.
- ❖ *This can either mean that a knife-wielding burglar robbed a woman or the woman that the burglar robbed was holding a knife.*
- Visiting friends can be annoying.
- ❖ *This can either mean that the act of visiting one's friends can lead to annoyance or that visiting friends can feel annoying.*
- Every single person at the game saw her duck.
- ❖ *This sentence can either mean that the word duck is referring to the action of ducking or everyone saw the bird 'duck'.*
- The nearby shop owners assisted the dog bite victim.
- ❖ *This can either mean that the nearby shop owners helped a dog bite someone or they helped someone who was bitten by the dog. The meaning is not clear.*

However, use of ambiguous sentences occurs in our daily lives without even knowing, this paper therefore, provided semantic analysis of structurally ambiguous sentences, aimed at improving language understanding systems to handle structural ambiguities better. This will aid in the creation of clearer communication by identifying and resolving potential ambiguities in written and spoken language. Also, understanding and resolving ambiguous sentences will ensure that messages are interpreted as intended thus, reducing misunderstandings in critical areas such as legal documents, medical instruction, and technical manuals.

Types of Structural Ambiguity
Global and local ambiguities are two different types of structural ambiguity that can occur in sentences.
Global Ambiguity: This occurs when a sentence, as a whole, can be interpreted in multiple ways and there is no clear interpretation without additional context (Bellmer and Möller, 2023). The ambiguity persists regardless of where you are in the sentence. This is characterized by having the entire sentence parsed in more than one way, leading to different overall meanings, and the context beyond the sentence itself is often required to resolve the ambiguity.
Example:
"The spy saw the man with the binoculars."
- Interpretation 1: The spy used binoculars to see the man.
- Interpretation 2: The spy saw a man who had binoculars.
Global ambiguity often requires external context or additional information to be resolved.
Types of Global Ambiguity
Attachment Ambiguity: This occurs when it is unclear which part of the sentence a modifier (such as a phrase or clause) is associated with.
Example: "She saw the man with the telescope."
- Interpretation 1: She used a telescope to see the man.
- Interpretation 2: She saw a man who was holding a telescope.

Coordination Ambiguity: This arises when it is unclear how words or phrases are grouped in a sentence due to the presence of conjunctions like "and" or "or."
Example: "I will eat pizza and drink soda or water."
- Interpretation 1: I will eat pizza and (drink soda or water).
- Interpretation 2: I will (eat pizza and drink soda) or (drink water).

Scope Ambiguity: This occurs when it is unclear how far the scope of a quantifier or negation extends.
Example: "Every student didn't pass the exam."
- Interpretation 1: Not every student passed the exam (some did not pass).
- Interpretation 2: None of the students passed the exam.

Elliptical Ambiguity: This arises when a sentence omits information that can lead to multiple interpretations.
Example: "John likes his coffee black, and so does Mary."
- Interpretation 1: Mary likes her coffee black.
- Interpretation 2: Mary likes John's coffee black.

Prepositional Phrase (PP) Ambiguity: This occurs when it is unclear which part of the sentence a prepositional phrase is modifying.
Example: "He shot the man with the gun."
- Interpretation 1: He used the gun to shoot the man.
- Interpretation 2: He shot a man who was carrying a gun.

Reduced Relative Clause Ambiguity: This happens when a relative clause is reduced, creating multiple interpretations.
Example: "The horse raced past the barn fell."
- Interpretation 1: The horse that was raced past the barn fell.
- Interpretation 2: The horse raced past the barn and then it fell.

Comparative Ambiguity: This occurs when the comparison in the sentence is unclear.
Example: "She is taller than her sister is smart."
- Interpretation 1: She is taller than her sister.
- Interpretation 2: She is taller in comparison to how smart her sister is.

Noun Phrase Ambiguity: This arises when a noun phrase can be interpreted in more than one way.
Example: "Old men and women."
- Interpretation 1: Old men and women of any age.
- Interpretation 2: Old men and old women.

Local Ambiguity: This occurs when a part of a sentence can be interpreted in multiple ways as you read through it, but the ambiguity is resolved by the time you reach the end of the sentence (Bellmer and Möller, 2023). This is characterized by the ambiguity being temporary and is resolved within the sentence, that is to say, as you continue reading, the structure clarifies and the correct interpretation becomes clear.
Example:
"The old train..."
- Initial Ambiguity: "The old train" could mean an elderly person training or an outdated locomotive.
- Resolution: "The old train left the station on time." Here, it's clear that "train" refers to a locomotive.

Local ambiguity is resolved by the sentence itself as more information is provided.

Type of Local Ambiguity:
Lexical Ambiguity: This can be global or local, depending on context. It occurs when a word in the sentence has more than one meaning.
Example: "He saw her duck."
- Interpretation 1: He observed the woman's pet duck.
- Interpretation 2: He observed the woman lowering her head.

Syntactic Sources of Ambiguity
Syntactic sources of ambiguity arise from the structure of sentences and the way words and phrases are arranged. These ambiguities can lead to multiple interpretations of the same sentence. There are two sources of ambiguity according to Gause and Weinberg(1989): missing information and communication errors.

However, ambiguity in language can arise from various sources. One source is lexical ambiguity, which occurs when a word has multiple meanings or senses. This can be due to polysemy, where a word has multiple related meanings, or homonymy, where a word has unrelated meanings that sound the same (Onuh, 2022). Another source is syntactic ambiguity, which occurs when a phrase, clause, or sentence has more than one meaning due to its structure. This can happen with coordinators, gerunds, and adjectives, followed by an infinitive (Berry, Kamsties, & Krieger (2003). Additionally, ambiguity can arise from the misuse of language, particularly in heavily used and seemingly unambiguous words and phrases. For example, words like "all", "each", and "every" can lead to ambiguity in defining or referencing sets (Charina, 2017). Nevertheless, the context in which language is used always plays a role in determining whether a sentence can be interpreted differently and become ambiguous.

On the other hand, Dai (2021) identified phonetics, grammar, sentences, syntax, as small as punctuation and intonation as other cause of ambiguity. It was based on this that, linguists classified ambiguity into different categories such as phonetic ambiguity, lexical ambiguity, syntactic ambiguity, and pragmatic ambiguity.

Challenges posed by Structural Ambiguity
In addition to the confusion it creates, Structural ambiguity poses several challenges in various fields, particularly in natural language processing (NLP), computational linguistics, and human communication. Some of the key challenges include:
1. Natural Language Processing (NLP) and Computational Linguistics
- **Ambiguity Resolution:** Developing algorithms that can accurately disambiguate sentences is complex. Ambiguities often require understanding context, which can be difficult for machines to grasp without sophisticated models.
- **Contextual Understanding:** Machines need to understand context to resolve ambiguities effectively, which involves integrating diverse types of information and reasoning about it.
- **Resource Requirements:** Training models to handle ambiguities typically requires large, annotated datasets that cover a wide range of scenarios. These resources are expensive and time-consuming to create.
- **Computational Complexity:** Parsing ambiguous sentences can be computationally intensive, especially when dealing with multiple possible interpretations.

2. Machine Translation

- **Translation Accuracy:** Ambiguous sentences can lead to incorrect translations if the system chooses the wrong interpretation.
- **Idiomatic Expressions:** Ambiguities often occur in idiomatic expressions, which can be particularly challenging to translate accurately without losing meaning.

3. Speech Recognition

- **Homophones and Pronunciation Variations:** Speech recognition systems must deal with homophones (words that sound the same but have different meanings), which can introduce ambiguity (Andriani, 2009).
- **Contextual Clues:** Spoken language often relies heavily on context, tone, and inflection, which are challenging for machines to interpret accurately.

4. Information Retrieval and Extraction

- **Query Interpretation:** Ambiguous queries can lead to irrelevant or incorrect search results. Systems must interpret user intent accurately to provide useful responses.
- **Data Extraction:** Extracting meaningful data from text with structural ambiguities can lead to errors, reducing the reliability of the information extracted.

5. Human-Computer Interaction

- **User Experience:** Ambiguities in natural language interfaces, such as virtual assistants and chatbots, can lead to misunderstandings and user frustration.
- **Clarification Dialogues:** Designing effective clarification dialogues to resolve ambiguities without annoying users is a significant challenge.

6. Legal and Medical Texts

- **Precision and Clarity:** Ambiguities in legal and medical texts can have serious consequences. Misinterpretations can lead to legal disputes or medical errors.
- **Standardization:** Ensuring that legal and medical documents are unambiguous requires strict adherence to standard terminologies and structures.

7. Linguistic Research

- **Psycholinguistics:** Understanding how humans resolve ambiguities involves complex experimental designs and analyses to study cognitive processes (Khanbutayeva , 2007).
- **Cross-Linguistic Variability:** Ambiguities may manifest differently across languages, complicating comparative studies and the development of multilingual systems.

8. Language Learning and Education

- **Learning Materials:** Creating learning materials that address structural ambiguities effectively is challenging, as learners need to be exposed to various contexts to understand different interpretations.
- **Assessment:** Testing language proficiency in a way that accurately measures a learner's ability to handle ambiguities is complex.

9. Writing and Editing

- **Clarity in Writing:** Writers must be vigilant to avoid unintentional ambiguities, which can obscure meaning and confuse readers.
- **Editing Tools:** Developing tools to automatically detect and suggest revisions for ambiguous sentences is challenging.

10. Search Engines and Information Systems

- **Relevance:** Ambiguous queries can lead to search results that are not relevant to the user's intent, requiring sophisticated algorithms to interpret and refine queries.

Semantics Analysis Techniques

Semantic analysis, often referred to as meaning analysis, is a process used in linguistics, computer science, and data analytics to derive and understand the meaning of a given text or set of texts (Palii, 2023).

Semantic analysis analyzes the grammatical format of sentences, including the arrangement of words, phrases, and clauses, to determine relationships between independent terms in a specific context. Semantic analysis is a crucial component of natural language processing (NLP) that concentrates on understanding the meaning, interpretation, and relationships between words, phrases, and sentences in a given context (Kanade, 2022). It is also a key component of several machine learning tools available today, such as search engines, chatbots, and text analysis software. It goes beyond merely analyzing a sentence's syntax (structure and grammar) and delves into the intended meaning. Tools based on semantic analysis can assist businesses in automatically extracting useful information from unstructured data, including emails, support requests, and consumer comments.

Depending on the type of information you would like to obtain from a data, you can use one of two semantic analysis techniques: a text classification model (which assigns predefined categories to text) or a text extractor (which pulls out specific information from the text). This is extensively used in complier design in computer where it ensures that the code written follows the correct syntax and semantics of the programming language. In the context of natural language processing and big data analytics, it delves into understanding the contextual meaning of individual words used, sentences, and even entire documents. By breaking down the linguistic constructs and relationships, semantic analysis helps machines to grasp the underlying significance, themes, and emotions carried by the text.

Some common semantic analysis techniques include:

1. Lexical Semantics: **This** focuses on the meaning of individual words and their relationships, such as synonyms, antonyms, and hyponyms.
Techniques:
- **WordNet:** A lexical database that groups words into sets of synonyms (synsets) and provides definitions and usage examples.
- **Distributional Semantics:** Uses statistical methods to study the distributional properties of words in large corpora to understand their meanings based on context.

2. Sentence and Document Semantics: **This** analyzes the meaning of sentences and larger text units, considering word order, syntactic structure, and context.
Techniques:
- **Bag of Words (BoW):** Represents text as a set of words disregarding grammar and word order but keeping multiplicity.
- **TF-IDF (Term Frequency-Inverse Document Frequency):** A statistical measure used to evaluate the importance of a word in a document relative to a corpus.
- **Word Embeddings:** Techniques like Word2Vec, GloVe, and FastText that map words to high-dimensional vectors based on their context in large corpora.

3. Contextual Embeddings: **This** uses context to generate dynamic word representations that vary depending on the surrounding text.
Techniques:
- **BERT (Bidirectional Encoder Representations from Transformers):** A transformer-based model that generates contextualized word embedding.

- **GPT (Generative Pre-trained Transformer):** A transformer model designed for generating human-like text based on context.

4. Named Entity Recognition (NER): **This i**dentifies and classifies named entities (such as people, organizations, and locations) within text.
Techniques:
- **Rule-based Methods:** Use predefined patterns and regular expressions.
- **Machine Learning Methods:** Use supervised learning with annotated corpora to train models.
- **Deep Learning Methods:** Use neural networks, such as LSTM and transformers, for higher accuracy.

5. Semantic Role Labeling (SRL): **This i**dentifies the predicate-argument structure of a sentence, labeling the roles of different sentence constituents.
Techniques:
- **FrameNet:** A lexical database that maps words to semantic frames.
- **PropBank:** Provides annotations of verb arguments and their roles in sentences.

6. Sentiment Analysis: **This** determines the sentiment expressed in a text (positive, negative, neutral).
Techniques:
- **Lexicon-based Methods:** Use predefined lists of sentiment-bearing words.
- **Machine Learning Methods:** Train classifiers on labeled data.
- **Deep Learning Methods:** Use neural networks, such as CNNs and RNNs, for improved performance.

7. Co-reference Resolution: **This i**dentifies when different expressions in a text refer to the same entity.
Techniques:
- **Rule-based Methods:** Use heuristic rules to link expressions.
- **Machine Learning Methods:** Use features extracted from text to train models.
- **Neural Networks:** Apply deep learning for context-aware co-reference resolution.

8. Textual Entailment: **This d**etermines if one sentence logically follows from another sentence.
Techniques:
- **Machine Learning Methods:** Train models on pairs of sentences labeled as entailment, contradiction, or neutral.
- **Neural Networks:** Use models like BERT for higher accuracy in predicting entailment relationships.
- **Non-negative Matrix Factorization (NMF):** A matrix decomposition technique for uncovering latent structures in text data.

9. Word Sense Disambiguation (WSD): **This d**etermines which sense of a word is used in a given context.
Techniques:
- **Supervised Learning:** Train models on annotated corpora with sense labels.
- **Unsupervised Learning:** Use clustering algorithms to group similar contexts.
- **Knowledge-based Methods:** Use dictionaries and thesauri like WordNet.

10. Semantic Parsing: **This c**onverts natural language into a formal representation of meaning.
Techniques:
- **Grammar-based Methods:** Use predefined grammars to parse sentences.

- **Neural Networks:** Use sequence-to-sequence models and transformers to map text to logical forms.

Disambiguation Strategies in Sematic Analysis

Disambiguation strategies are methods used to resolve ambiguities in language, ensuring that the correct meaning or interpretation is identified from multiple possibilities (Akim, 2009). These strategies are essential in natural language processing (NLP), machine translation, information retrieval, and human-computer interaction (Bei & Du, 2004). In semantic analysis, word sense disambiguation refers to an automated process of determining the sense or meaning of the word in a given context.

Some disambiguation strategies include:

1. Contextual Analysis: Utilizes the context in which a word or phrase appears to determine its meaning.
Techniques:
- **Contextual Embedding:** Models like BERT and GPT generate embedding that consider the surrounding context, helping to disambiguate words.
- **Window-based Approaches:** Analyze words within a specific window of context to infer meaning.
- **Co-occurrence Statistics:** Examine how frequently words co-occur with other words in large corpora to infer meanings.

2. Lexical Resources: Use of lexical databases and dictionaries to provide information about possible meanings.
Techniques:
- **WordNet:** A lexical database that provides sets of synonyms (synsets) and semantic relations among words.
- **Thesauri and Ontologies:** Provide hierarchical structures of concepts and their relationships.

3. Syntactic Parsing: Analyzes the grammatical structure of a sentence to resolve ambiguities.
Techniques:
- **Dependency Parsing:** Identifies the dependencies between words in a sentence to determine their relationships.
- **Constituency Parsing:** Breaks down sentences into sub-phrases (constituents) and uses these structures to clarify meaning.

4. Semantic Role Labeling (SRL): Identifies the roles that words play in a sentence to understand their meaning.
Techniques:
- **FrameNet:** Maps words to semantic frames, capturing relationships between predicates and their arguments.
- **PropBank:** Annotates texts with information about predicate-argument structures.

5. Co-reference Resolution: Identifies when different expressions refer to the same entity.
Techniques:
- **Rule-based Methods:** Use heuristic rules to link references.
- **Machine Learning Methods:** Train models on annotated datasets.

- **Neural Networks:** Use deep learning models to resolve co-references contextually.

6. Word Sense Disambiguation (WSD): Determines which sense of a word is used in a given context (Farooq, 2015).

Techniques:

- **Supervised Learning:** Train models on annotated corpora with sense labels.
- **Unsupervised Learning:** Use clustering algorithms to group similar contexts.
- **Knowledge-based Methods:** Utilize dictionaries and thesauri like WordNet.

7. Pragmatic Analysis: Considers the practical aspects of language use and the intentions behind statements.

Techniques:

- **Speech Act Theory:** Analyzes the intentions behind utterances, bearing in mind that every utterance has a communicative force.
- **Conversational Implicature:** Considers implied meanings based on context and social norms.

Conclusion

This paper has reviewed a variety of issues concerned with ambiguity. It is really not possible to give assert that a sentence does not have two or more unrelated meanings due to phonetic, lexical, pragmatic and syntactic indeterminacy. However, in order to help people to get a clearer understanding of a sentence, this paper reviewed the issues bothering on ambiguity. As a phenomenon of language, ambiguity has its structural causes and effects on understanding both written and spoken language. This paper equally focused on exploring the syntactic analysis of ambiguity in English sentence, citing some examples as illustration. It tried to explain the semantic and pragmatic aspects of ambiguous sentences which would be the more practical usage of the language. Different strategies employed in making sentences unambiguous were discussed in this paper. The paper also noted that ambiguity is not just about the different meanings we are trying to avoid or eliminate, but that, ambiguity can be useful, and is a powerful device used in humors, advertisements, literature works and so on.

It is expected to be logical when handling ambiguous sentences, to put it in its proper context. To make correct logical judgments, we must have a wide range of knowledge other than language. In general, ambiguity is a more complicated issue in language and communication, which deserves to be taken seriously. Analyzing ambiguity can help us better to understand and use language properly.

Recommendation

Following the analysis given to structural ambiguous sentences in this paper, it is therefore recommended that readers or listeners of written or spoken discourses can use any of disambiguation strategies to make sentences clearer for better understanding in its proper context.

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