Module IV &VI

agenda

SEMANTIC ROLE LABELING

SEMANTIC PARSING

PRAGMATICS

DISCOURSE ANALYSIS

SPEECH

Semantic Role Labeling (SRL)

Semantic Role Labeling is the task of identifying the different roles that various words play in a sentence, with respect to a specific predicate (usually a verb or verbal phrase). In other words, it involves determining the relationships between words in a sentence and their respective roles like "who did what to whom." Let's take a sentence as an example:
Sentence: "John ate an apple.“

Here verb "ate" is the predicate. The roles associated with this predicate are typically Agent (who performed the action), Patient (what was affected by the action), and sometimes others depending on the verb. SRL would analyze the sentence like this:

- Agent: John
- Predicate: ate
- Patient: an apple

Roles in Semantic Role Labeling

The exact roles can vary depending on the specific annotation scheme or model used, here are some common roles:

1. **Agent:** The entity performing the action indicated by the predicate.
2. **Patient:** The entity that is affected or involved in the action.
3. **Instrument:** The tool or means used to carry out the action.
4. **Beneficiary/Recipient:** The entity that receives the benefit of the action.
5. **Theme:** The main entity or topic of the action.
6. **Experiencer:** The entity that experiences a certain state or emotion.
7. **Source:** The origin or starting point of an action or movement.
8. **Goal:** The destination or endpoint of an action or movement.

9.Location: The place where the action or event takes place.

10.Time: The time frame or temporal information associated with the action.

11.Manner: The way or manner in which the action is performed.

12.**Cause:** The reason or cause for an event or action.

These roles help provide a more comprehensive understanding of the relationships between words in a sentence and the roles they play in relation to the main verb or predicate.

Different languages and contexts might have variations in the roles, and the specific roles recognized by an SRL system can depend on the design of the model and the linguistic nuances of the language being analyzed.

Sentence: "Yesterday, John skillfully used a hammer to build a beautiful house for his family in the city."

- Time: Yesterday
- Agent: John
- Predicate: to build
- Patient:house
- Manner: skillfully
- Instrument: a hammer
- Theme: a beautiful house
- Beneficiary/Recipient: his family
- Location: in the city

Eg1:"On her birthday, Sarah baked a delicious cake with love for her best friend in her cozy kitchen."

Eg 2:"The skilled chef sliced fresh vegetables with precision to create a colorful salad for the customers in the busy restaurant.

Steps in SRL

1. **Preprocessing:**
   - Tokenization: Break the input sentence into individual words or tokens.
   - Part-of-Speech (POS) Tagging: Assign POS tags to each token in the sentence.
   - Parsing: Analyze the syntactic structure of the sentence to determine the relationships between words.
2. **Predicate Identification:**
   - Identify words in the sentence that serve as predicates (verbs). These are the main actions or events in the sentence.
3. **Argument Identification:**
   - Determine the potential argument candidates for each predicate. Arguments are words or phrases that play specific roles in relation to the predicate.
4. **Role Labeling:**
   - Assign semantic roles to the identified argument candidates. Common roles include agent, patient, location, time, instrument, etc.
5. **Disambiguation:**
   - Resolve any potential ambiguities in role assignments. This can involve considering the surrounding context, verb senses, and syntactic structure.
6. **Post-Processing:**
   - Refine the role assignments and potentially correct errors introduced during the previous steps.

7.Output Representation:

Represent the SRL output in a structured format, such as BIO (Begin, Inside, Outside) tagging or a labeled dependency tree, where each token is associated with its predicate and role label.

8.**Evaluation:**

Compare the predicted roles with manually annotated gold-standard roles to evaluate the system's performance. Common evaluation metrics include Precision, Recall, F1-score, and others.

9.**Model Training (Machine Learning-based Approach):**

Supervised Learning: Train a machine learning model (such as a neural network or a conditional random field) using annotated training data that includes sentences and their corresponding predicate-argument structures.

Feature Extraction: Extract relevant features from the input sentence, including word embeddings, POS tags, syntactic information, and contextual features.

10.**Inference (Prediction):**

Apply the trained model to new, unseen sentences to predict the semantic roles of words and their relationships.

sentence: "The cat chased the mouse."

1.Preprocessing:

- Tokenization: ["The", "cat", "chased", "the", "mouse", "."]
- POS Tagging: ["DT", "NN", "VBD", "DT", "NN", "."]
- Parsing: Syntactic tree (simplified):
  (S (NP (DT The) (NN cat)) (VP (VBD chased) (NP (DT the) (NN mouse))) (. .))

2.Predicate Identification:

- Predicates: "chased" (verb)

3.Argument Identification:

- Arguments: "cat", "mouse"

4.Role Labeling:

- Predicate "chased":
- cat" -> agent
- "mouse" -> patient

5.Output Representation:

- SRL output:

The cat [agent] chased the mouse [patient] .

8.Evaluation:

- Compare the predicted roles ("agent" and "patient") with the manually annotated roles to assess the model's accuracy.

9.Model Training:

- Use annotated training data with sentences and their corresponding predicate-argument structures.

10.Inference (Prediction):

- Apply the trained model to new sentences to predict semantic

Eg:"He saw the man with the telescope."

Semantic Parsing

Semantic Parsing is the process of converting a natural language sentence into a structured representation that captures the meaning of the sentence. This structured representation is often in the form of a logical expression, a query language, or another formal language that a computer can understand and use for further processing. Let's use a simple example:

- Sentence: **"Find the population of France.“**

In this case, the goal is to parse the sentence into a structured query that a computer can understand, like a database query. The parsed representation might look something like this in a simplified form:

- Query: **"SELECT population FROM countries WHERE country_name = 'France'"**

Pragmatics

- Pragmatics is a branch of linguistics that deals with how language is used in context to convey meaning beyond the literal interpretation of words. It focuses on the social and situational factors that influence communication. One key aspect of pragmatics is the study of implicature, where speakers convey meaning indirectly.
- Let's explore pragmatics with a simple example:

Eg:Statement: "Oh, you're eating chocolate cake?"

Let's consider two possible interpretations:

1.Literal Interpretation: You're genuinely asking about the type of cake being eaten.

2.Implicature Interpretation: You're expressing surprise or mild disapproval that the sibling is eating chocolate cake, possibly because it's unexpected or not appropriate given the time of day.

In the second interpretation, the meaning goes beyond the literal words you said. It relies on the context, your tone of voice, your relationship with your friend's family, and shared cultural knowledge to convey a subtle message. This is an example of how pragmatics plays a role in shaping the meaning of language based on the social and situational context of communication.

considering the social and situational factors that influence meaning beyond literal interpretations. Incorporating pragmatics into NLP tasks can be complex due to the nuances involved in human communication. Here are a few ways pragmatics is addressed in NLP:

- **Contextual Understanding**
- **Speech Acts Recognition**
- **Implicature and Inference**
- **Ambiguity Resolution**
- **Generating Contextually Appropriate Responses**
- **Reference Resolution**
- **Dialog and Discourse Modeling**
- **Politeness and Societal Norms**
- **Cultural and Contextual Sensitivity**
- **Common Ground and Shared Knowledge**

Discourse Analysis.

- Discourse analysis is a branch of linguistics that focuses on the study of language in its broader context, considering how language is used to convey meaning beyond individual sentences. It involves analyzing spoken or written communication to understand how language functions in various social, cultural, and situational contexts. Discourse analysis aims to uncover patterns, structures, and underlying meanings in conversations, texts, and interactions.

Here are some key aspects of discourse analysis:

- **Contextual Consideration, Coherence and Cohesion, Discourse Markers, Transcription and Annotation…..**

Eg:"Although the weather is gloomy, Sarah wished to go for a hike; her love towards the forest resulted in that decision" using discourse analysis:

- **Conjunction and Contrast:** The use of "although" introduces a contrast between the gloomy weather and Sarah's desire to go for a hike. This suggests that there might be some unexpected or contradictory elements in play.
- **Participant Identification:** "Sarah" is identified as the central participant in the discourse. This individual's perspective and actions are crucial for understanding the context.
- **Temporal and Causal Relationship:** The semicolon (;) indicates a separation of related ideas. "Her love towards the forest resulted in that decision" implies that Sarah's affection for the forest is causally linked to her decision to go for a hike despite the gloomy weather.
- **Descriptive Language:** The choice of the words "gloomy" and "love towards the forest" adds descriptive and emotional dimensions to the sentence. The contrasting imagery of the weather and her love creates a vivid mental picture for the reader……

Module V

Phonetics

- Phonetics is the branch of linguistics that focuses on the study of the physical properties of speech sounds, including their production, transmission, and perception. It examines the articulation, acoustic properties, and auditory perception of sounds used in human language. Phonetics plays a crucial role in understanding how speech sounds are produced and how they contribute to linguistic communication. Here are some key aspects of phonetics:**Articulatory Phonetics, Acoustic Phonetics, Vowels and Consonants, Phonetic Transcription….**

Vowels and Consonants

Phonetics classifies speech sounds into two main categories: vowels (produced with relatively open vocal tract) and consonants (produced with constriction or closure of the vocal tract).

Consonants - Place of Articulation: The place of articulation refers to where in the vocal tract the airflow is obstructed or modified to produce a consonant sound.

- **Bilabial:** The articulators are the two lips. Examples include the sounds in "bat" and "pie."
- **Labiodental:** The lower lip contacts the upper teeth. Examples include the sounds in "fit" and "vat."
- **Interdental:** The tongue is placed between the teeth. This is seen in sounds like the "th" sounds in "thin" and "this."
- **Alveolar:** The tongue contacts the alveolar ridge (the bony ridge right behind the upper front teeth). Examples include the sounds in "tip" and "dog."
- **Palatal:** The tongue contacts the hard palate near the front of the mouth. Sounds like the "sh" sound in "she" are palatal.
- **Velar:** The back of the tongue contacts the soft palate (velum). Examples include the sounds in "key" and "go."
- **Glottal:** The space between the vocal cords is used to create sounds. The "h" sound in "hat" is a glottal sound.

Consonants - Manner of Articulation: The manner of articulation refers to how the airflow is modified or obstructed at the chosen place of articulation. There are several manners of articulation:

1.Plosive (or Stop): The airflow is completely blocked and then released. Examples include the sounds in "pat" and "cat."

2.Fricative: The airflow is constricted to create a turbulent sound. Examples include the "f" sound in "fun" and the "s" sound in "sun."

3.Affricate: This is a combination of a stop and a fricative. The airflow is blocked and then released with some friction. The "ch" sound in "cheese" is an affricate.

4.Nasal: The airflow is directed through the nose. Examples include the sounds in "man" and "sing."

5.Approximant: The airflow is constricted but not to the point of creating turbulence. Examples include the "r" sound in "red" and the "w" sound in "way."

Vowels

Vowels are produced with a relatively open vocal tract, allowing for the free passage of air. They are defined by their tongue height (high, mid, low) and advancement (front, central, back). The shape and openness of the mouth determine the quality of the vowel sound.

Vowels are crucial for syllable formation and often carry the most audible part of a syllable. In many languages, the changing of vowel sounds can alter the meaning of words significantly.

Understanding both the place and manner of articulation for consonants and the qualities of vowels is essential for comprehending the phonetic elements that make up spoken language. These concepts help explain why different languages have distinct sounds and phonetic patterns.

Graphical Models for Sequence Labelling in NLP

Graphical models are widely used in Natural Language Processing (NLP) for sequence labeling tasks, where the goal is to assign labels to individual elements in a sequence of data. Sequence labeling is common in tasks like named entity recognition (NER), part-of-speech tagging (POS tagging), and speech recognition, where each token in a sequence is assigned a label.

- Two popular graphical models used for sequence labeling tasks in NLP are Hidden Markov Models (HMMs) and Conditional Random Fields (CRFs).

Hidden Markov Models (HMMs)

HMMs are probabilistic models that assume there is an underlying hidden state sequence that generates the observable sequence of data. In the context of sequence labeling, the hidden states correspond to the labels, and the observable sequence corresponds to the input data (words or tokens). HMMs consist of:

- **Hidden States:** These represent the labels you're trying to predict, such as named entity types or part-of-speech categories.
- **Observations:** These are the input data, which could be words, phonemes, or other features.
- **Transition Probabilities:** These model the probabilities of transitioning from one hidden state to another.
- **Emission Probabilities:** These model the probabilities of observing a certain observation given a hidden state.

Thank you