

CIE-2 - IMP

PART-A

- Q1) Define speech synthesis.
- Q2) Define lexical semantics.
- Q3) What is parsing & shallow parsing.
- Q4) Define phonetics.
- Q5) Define gestural phonology.
- Q6) What is ambiguity.

PART-B

- Q7) Write in detail about word sense disambiguation.
- Q8) What is articulatory phonetics and also write place of articulation (POA).
- Q9) Write in detail about phonetic analysis.
- Q10) Discuss in detail about prosodic analysis.
- Q11) Explain in detail about acoustic phonetics.
- Q12) Write about probabilistic CFG.

1Ans) Speech Synthesis:

Speech synthesis, also known as text-to-speech, is the process of generating spoken language from written text.

It involves converting textual input into artificial speech that closely resembles human speech patterns and characteristics.

2Ans) Lexical semantics:

The first part of semantic analysis, studying the meaning of individual words, is called lexical semantics. It includes words, subwords, compound words and phrases also.

All the words, sub-words 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.

3Ans)

Parsing:

Parsing is the process of analyzing a string of text, like a sentence or a paragraph to determine the grammatical structure and identify the relationship b/w the words that the text contains.

(Or)
Parsing process involves identifying the parts of speech such as nouns, verbs, and adjectives & determining how they are related to each other through syntactic rules.

Shallow Parsing:

Also known as light parsing or chunking. where the sentence is divided into shorter chunks or phrases such as noun phrases and verb phrases.

4Ans) Phonetics :
Phonetics is the study of human ability to make and hear sounds which use the vocal organs of speech, especially for producing oral language.

5Ans) Gestural Phonology :

Gestural phonology is phonological model in which each sound is broken down into the individual articulatory actions that are used to produce a sound.

6Ans) Ambiguity :

A word can have multiple meanings according to the sentence which is known as ambiguity. so the word sense disambiguation helps us to resolve such syntactic ambiguity.

7Ans) Word Sense Disambiguation:

Word sense disambiguation is one of the processes of semantic analysis. It is the ability that helps to map the actual meaning of the word used in a particular context. The parts of speech Tagging is one of the prime stages of the entire NLP process that deals with word sense disambiguation & it helps in achieving a high level of accuracy of the meaning of the word.

→ A word can have multiple meanings according to the sentence which is known as ambiguity. So, the word sense disambiguation helps us to resolve such syntactic ambiguity.

→ More formally, we can define WSD as an automatic process that identifies the context of the words present in a sentence. This helps in removing the ambiguity of the word and thus help the NLP model in better training. So, once the model is trained well it can predict the accurate output & can match the level of human

accuracy in sentiment analysis.

⇒ There are different tags that are essential in order to get the correct output. We need to have proper datasets that can be used in order to process different algorithms being used in the above section. WordNet is a good source of resources that can be used to train the same model or algorithm.

Example:

consider the word 'bank' in the following sentences:

"I went to the bank to deposit money."

"I sat on the bank of the river."

⇒ Types of WSD:

1) Supervised WSD:

Involves training a model on labeled data with word senses.

2) Unsupervised WSD:

Uses statistical patterns or clustering techniques without labeled data.

3) Knowledge-Based WSD:

utilize external knowledge resources like WordNet to disambiguate word senses.

Pros & Cons of WSD in NLP:

Pros:

Enhanced Precision

WSD improves the precision of NLP applications by ensuring accurate interpretation of word meanings in different contexts.

Better Experience

Resolving ambiguity leads to improved user experiences in applications like search engines & virtual assistants.

Improved Machine Translation

WSD contributes to more accurate translation by selecting the correct meaning of words in different contexts.

Cons:

Challenges in Training

Supervised WSD requires labeled datasets for training.

Context Dependency

Some words may have context-dependent meanings that are challenging to capture accurately.

Computational cost.

8Ans) Articulatory Phonetics

- Articulatory phonetics is concerned with how the sounds of language are physically produced by the vocal apparatus.
- The units articulatory phonetics deals with are known as gestures.
- Most speech sounds are produced by pushing air through the vocal cords.

- Glottis = the opening between the vocal cords

- Larynx = 'voice box'

- Pharynx = the part of the throat above the larynx.

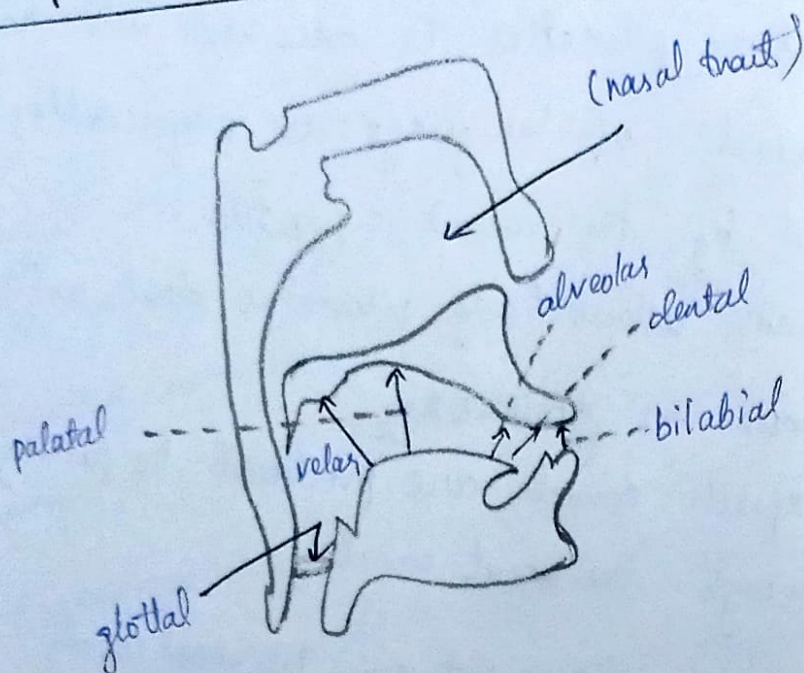
- Oral cavity = mouth

- Nasal cavity = nose & the passages connecting it to the throat & sinuses.

Major places of articulation are:

bilabial, labiodental, interdental, alveolar, palatal, velar, uvular, and glottal.

Place of Articulation (POA)



Bilabial: Two lips coming together.

- [p] as in possum
- [b] as in bear.

Dental: Tongue against the teeth.

- [θ] of thing

Alveolar: Alveolar ridge is the portion of the roof of the mouth just behind the upper teeth.
Tip of the tongue against the alveolar ridge

- [s], [z], [t], [d]

postalveolar: shin.

Palatal: Roof of the mouth.

- sounds [ʃ] (shrimp), [tʃ] (china)

Velar: Movable muscular at the back of the roof of the mouth.

• sounds [k] (cuckoo), [g] (goose)

Glottal: closing the glottis (by bringing the vocal folds together).

Q.4) Phonetic Analysis:

Phonetic analysis is the study of speech sounds in language. It involves examining the production, transmission, and reception of sounds, as well as their acoustic properties. Phonetic analysis aims to understand the physical characteristics of speech sounds, their classification, and their role in human communication.

Articulatory phonetics:

This branch of phonetics focuses on how speech sounds are produced by articulatory organs, such as lips, tongue, teeth, and vocal cords. Articulatory phonetics describes the movements & configurations of these organs involved in producing specific sounds.

Acoustic Phonetics:

Acoustic phonetics deals with the physical properties of speech sounds as they are transmitted through air. It involves analyzing the sound waves produced by speech & characterizing them in terms of their frequency, intensity, duration & spectral properties.

Auditory phonetics:

Auditory phonetics focuses on how speech sounds are perceived & interpreted by the human auditory system. It involves studying the psychological processes involved in speech perception.

Comparative & Contrastive Analysis:

Phonetic Analysis often involves comparing & contrasting speech across different languages. This comparative approach helps linguists identify similarities and differences in phonetic inventories, phonological patterns & pronunciation norms.

Overall, phonetic analysis plays a fundamental role in understanding the structure and function of speech sounds in language. By examining the articulatory, acoustic, and auditory properties of speech.

example: 'cat'

[k], [æ], [t]

10Am) Prosodic Analysis:

Prosodic analysis involves the study of the suprasegmental features of speech, which extend over multiple segments and play a crucial role in conveying meaning, discourse structure, and emotional expression. Prosody encompasses various aspects of speech rhythm, intonation, stress, and timing, all of which contribute to the overall melody or expressiveness of spoken language.

Rhythm:

Prosodic analysis includes the study of speech rhythm, which refers to the patterns of stressed and unstressed syllables and the timing of speech events. Rhythm is influenced by factors such as language structure, sentence length, and speaker characteristics.

Intonation:

Intonation refers to the pattern of pitch variations in speech as it plays a crucial role in conveying sentence-level meanings, such as declarative statements, questions, commands, and emotional tone.

stress:

stress refers to the emphasis placed on certain syllables or words in a sentence, which can affect the meaning and interpretation of utterances.

Timing:

Prosodic analysis also encompasses the timing of speech events, including the duration of individual sounds, syllables, and pauses between words or phrases.

Emotional Expression:

Prosody plays a crucial role in conveying emotional state & attitudes in spoken language. Prosodic analysis of emotion involves temporal patterns associated with different emotional expressions, including happiness, sadness, anger & surprise.

Discourse Structure:

Prosodic analysis of discourse structure involves identifying prosodic cues such as pitch rises, falls & pauses that mark boundaries between conversational turns, sentences, and thematic units.

11 And Acoustic Phonetics:

Acoustic phonetics deals with the physical medium of speech - that is, how speech manipulates sound waves.

⇒ Sound is composed of waves of high & low pressure areas which propagate through air.

The most basic way to view sound is as a wave function. This plots the pressure measured by the sound-recording device against time. Loudness may be found by looking at the amplitude of the sound at a given time.

⇒ As sound is produced by/in the oral tract, the column of air in the tract serves as a harmonic oscillator, oscillating at numerous frequencies simultaneously. Some of the frequencies of oscillation are at higher amplitudes than others, a property called resonance.

⇒ The resonant frequencies of the vocal tract are known in phonetics as formants.

The formants in a speech sound are numbered by their frequency: F_1 has the lowest frequency, followed by F_2, F_3 -

spectrogram

spectrogram of American English vowels (i, u, a)

showing the formants f_1 & f_2 .

Another way to view formants is by using a spectrogram.

Formants show up as dark bands & their movements may be tracked through time.

12Am)

Probabilistic Context Free Grammar:

Probabilistic context free Grammar (PCFG) is an extension of context free Grammar (CFG) with a probability for each production rule.

Ambiguity is the reason why we are using probabilistic version of CFG.

For instance, some sentence can be parsed in more than one ways. In ^{our} case, the parse of the sentence become ambiguous.

- to eliminate this ambiguity, we can use PCFG
- to find the probability of each parse of the given sentence.

⇒ A PCFG G is quintuple $G = (N, T, S, R, P)$.

where. $N \rightarrow$ set of non-terminals (variables)

$T \rightarrow$ Terminal symbols.

$S \rightarrow$ start symbol

$R \rightarrow$ set of production rules.

$P \rightarrow$ probability.

⇒ The value of each probability lies b/w 0 & 1

⇒ The sum of all probabilities of rules with A as the left hand side nonterminal should be equal to 1,

$$\sum_{A \rightarrow \alpha \in R; A \text{ nonterminal}} P(A \rightarrow \alpha) = 1.$$

Example PCFG

Probabilistic context Free Grammar $G = (N, T, S, R, P)$

- $N = \{S, NP, VP, PP, Det, Noun, Verb, Pre\}$
- $T = \{'a', 'ate', 'cake', 'child', 'fork', 'the', 'worm'\}$
- $S = S$
- $R = \{S \rightarrow NPVP$

$NP \rightarrow Det Noun \mid NP PP$

$PP \rightarrow Pre NP$

$VP \rightarrow Verb NP$

$Det \rightarrow 'a' / 'the'$

$Noun \rightarrow 'cake' / 'child' / 'fork'$

$Pre \rightarrow 'worm'$

$Verb \rightarrow 'ate'$

Rule	prob	Rule	prob
$S \rightarrow NPVP$	1.0	$Det \rightarrow 'a'$	0.5
		$Det \rightarrow 'the'$	0.5
$NP \rightarrow NP PP$	0.6	$Noun \rightarrow 'cake'$	0.4
$NP \rightarrow Det Noun$	0.4	$Noun \rightarrow 'child'$	0.3
		$Noun \rightarrow 'fork'$	0.3
$PP \rightarrow Pre NP$	1.0	$Pre \rightarrow 'worm'$	1.0
$VP \rightarrow Verb NP$	1.0	$Verb \rightarrow 'ate'$	1.0