CHAPTER 5

NATURAL LANGUAGE PROCESSING

CHAPTER OUTLINE

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5.1 NATURAL LANGUAGE

Natural Language Processing (NLP) is a subfield of artifcial intelligence (AI). It helps machines process and understand the human language so that they can automatically perform repetitive tasks. Example include machine translation, summarization, ticket classification and spell check. It is the technology that is used by machines to understand, analyse, manipulate and interpret human's languages.

Take sentiment analysis, for example, which used natural language processing to detect emotions in text. This classification task is one of the most popular tasks of NLP, often used by businesses to automatically detect brand sentiment on social media. Analyzing these interactions can help brands delect urgent customer issues that they need to respond to right away, or monitor overall customer satisfaction.

The field of NLP involves making computers to perform useful tasks with the natural languages humans use. The input and output of an NLP system can be :

- Speech.
- Written text

5.1.1 COMPONENTS OF NLP

There are two components of NLP as given :

1. **Natural Language Understanding (NLU) :** Understanding involves the following tasks.
   - Mapping the given input in natural language into useful representations.
   - Analyzing different aspects of the language.
2. **Natural Language Generation (NLG) :** It is the process of producing meaningful phrases and sentences in the form of natural language from some internal representation.

   It involves :
   - **Text Planning :** It includes retrieving the relevant content from knowledge base.
   - **Sentence planning :** It includes choosing required words, forming meaningful phrases, setting tone of the sentence.
   - **Text Realization :** It is mapping sentence plan into sentence structure.

Phases of Natural Language Processing : There are general five steps :

- **Lexical Analysis :** It involves identifying and analyzing the structure of words. Lexicon of a language means the collection of words and phrases in a language.

Lexical analysis is dividing the whole chunk of txt into paragraphs, sentences, and words.

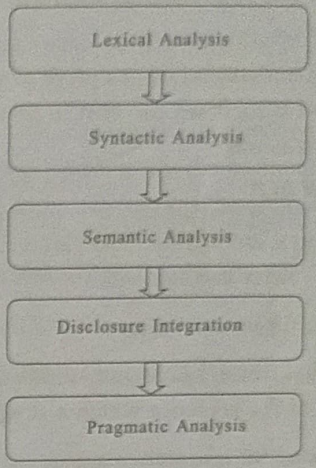


FIG 5.1 : Steps in Natural Language Processing

- **Syntactic Analysis (Parsing) :** It involves analysis of words in the sentence for grammar and arranging words in a manner that shows the relationship among the words. The sentence such as "The school goes to boy" is rejected by English syntactic analyzer.
- **Semantic Analysis :** It draws the exact meaning or the dictionary meaning from the text. The text is checked for meaningfulness. It is done by mapping syntactic structures and objects in the task domain. The semantic analyzer disregards sentence such as "hot ice-cream".
- **Discourse Integration :** The meaning of any sentence depends upon the meaning of the sentence just before it. In addition, it also brings about the meaning of immediately succeeding sentence.
- **Pragmatic Analysis :** During this, what was said is re-interpreted on what it actually meant. It involves deriving those aspects of language which require real world knowledge.

Why NLP is Important?

- One of the main reasons natural language processing is so critical to businesses is that it can be used to analyze large volumes of text data, like social media comments, customer support tickets, online reviews, news reports, and more.
- It does this by helping machines make sense of human language in a faster, more accurate, and more consistent way than human agents.

- NLP tools process data in real time, 24/7, and apply the same criteria to all your data, so you can ensure the results you receive are accurate – and not riddled with inconsistencies.
- Once NLP tools can understand what a piece of text is about, and even measure things like sentiment, businesses can start to prioritize and organize their data in a way that suits their needs.

5.1.2 CHALLENGES IN NLP

- Human language is complex, ambiguous, disorganized, and diverse. And every human language is with its own syntax and semantics.

  There are the following three ambiguity :

  (i) ***Lexical Ambiguity :*** Lexical Ambiguity exists in the presence of two or more possible meanings of the sentence within a single word.

  Ex : Manya is looking for a **match**.

  In the above example, the word match refers to that either Manya is looking for a partner or Manya is looking for a match. (Cricket or other match)

  (ii) ***Syntactic Ambiguity :*** Syntactic Ambiguity exists in the presence of two or more possible meanings within the sentence.

  Ex : I saw the girl with the binocular.

  In the above example, did I have the binoculars? Or did the girl have the binoculars?

  (iii) ***Referential Ambiguity :*** Referential Ambiguity exists when you are referring to something using the pronoun.

  Ex : Kiran went to Sunita. She said, "I am hungry."

  In the above sentence, you do not know that who is hungry, either Kiran or Sunita.

- For machines to understand natural language, it first needs to be transformed into something that they can interpret.
- Transforming text into something machines can process is complicated.

5.2 ADVANTAGES OF NATURAL LANGUAGE PROCESSING

- NLP helps computers to communicate with humans in their languages.
- It is very time efficient.

- NLP helps users to ask questions about any subject and get a direct response within seconds.
- NLP offers exact answers to the question means it does not offer unnecessary and unwanted information.
- Most of the companies use NLP to improve the efficiency of documentation processes, accuracy of documentation, and identify the information from large databases.

5.3 STEPS INVOLVED IN COMMUNICATION AGENT

There are the following steps to build an NLP communication agent

STEP-1 : SENTENCE SEGMENTATION

Sentence Segment is the first step for building the NLP pipeline. It breaks the paragraph into separate sentences.

Ex : Consider the following paragraph -

Independence Day is one of the important festivals for every Indian citizen. It is celebrated on the 15th of August each year ever since India got independence from the British rule. The day celebrates independence in the true sense.

Sentence Segment Produces the Following Result :

(i) "Independence Day is one of the important festivals for every Indian citizen".

(ii) "It is celebrated on the 15th of August each year ever since India got independence from the British rule".

(iii) "This day celebrates independence in the true sense".

STEP-2 : WORD TOKENIZATION

Word Tokenizer is used to break the sentence into separate words or tokens.

Example : RKTutor offers Corporate Training, Summer Training, Online Training, and Winter Training.

Word Tokenizer generates the following result :

"RKTutor", "offers", "Corporate", "Training", "Summer", "Training", "Online", "Training", "and", "Winter", "Training", "."

STEP-3 : STEMMING

Stemming is used to normalize words into its base form or root form. For example, celebrates, celebrated and celebrating, all these words are originated with a single

root word "celebrate." The big problem with stemming is that sometimes it produces the root word which may not have any meaning.

For Example : Intelligence, intelligent, and intelligently, all these words are originated with a single root word "intelligen." In English, the word "intelligen" do not have any meaning.

STEP-4 : LEMMATIZATION

Lemmatization is quite similar to the Stemming. It is used to group different inflected forms of the word, called ***Lemma***. The main difference between Stemming and lemmatization is that it produces the root word, which has a meaning.

Ex : In lemmatization, the words intelligence, intelligent, and intelligently has a root word intelligent, which has a meaning.

STEP-5 : IDENTIFYING STOP WORDS

In English, there are a lot of words that appear very frequently like "is", "and", "the", and "a". NLP pipelines will flag these words as stop words. **Stop words** might be filtered out before doing any statistical analysis.

Ex : He is a good boy.

STEP-6 : DEPENDENCY PARSING

Dependency Parsing is used to find that how all the words in the sentence are related to each other.

STEP-7 : POST TAGS

POS stands for parts of speech, which includes Noun, verb, adverb, and Adjective. It indicates that how a word functions with its meaning as well as grammatically within the sentences. A word has one or more parts of speech based on the context in which it is used.

Ex : "Google" something on the Internet.

In the above example, Google is used as a verb, although it is a proper noun.

STEP-8 : NAMED IDENTITY RECOGNITION (NER)

Named Entity Recognition (NER) is the process of detecting the named entity such as person name, movie name, organization name, or location.

Ex : Steve Jobs introduced iPhone at the Macworld Conference in San Francisco, California.

STEP-9 : CHUNKING

Chunking is used to collect the individual piece of information and grouping them into bigger pieces of sentences.

5.4 MORPHOLOGICAL ANALYSIS

Morphological analysis is about exploring all possible solutions to a complex problem. It is used when exploring new and different ideas. Morphological Analysis provides a structured inventory of possible solutions.

It is a question of splitting the problem into partial problems and looking at possible options for each part of the problem. In this way, all aspects of a problem are thoroughly investigated. This makes Morphological Analysis a relatively simple technique that produces good, useful results.

Morphological analysis is a field of linguistics that studies the structure of words. It identifies how a word is produced through the use of morphemes. A morpheme is a basic unit of the English language. The morpheme is the smallest element of a word that has grammatical function and meaning. Free morpheme and bound morpheme are the two types of morphemes. A single free morpheme can become a complete word.

For instance, a bus, a bicycle, and so forth. A bound morpheme, on the other hand, cannot stand alone and must be joined to a free morpheme to produce a word. ing, un, and other bound morphemes are examples.

Inflectional Morphology and Derivational Morphology are the two types of morphology. Both of these types have their own significance in various areas related to the Natural Language Processing.

5.4.1 MORPHOLOGICAL ANALYZER

In inflected languages, words are formed through morphological processes such as affixation. For example, by adding the suffix '-s' to the verb 'to dance', we form the third person singular 'dances'.

A morphological analyzer assigns the attributes of a given word by evaluating what morphological processes the form has undergone.If you give it the word 'bailaré' in Spanish, it will tell you it is the first person, singular, simple future, indicative form of the verb 'bailar'.

5.4.2 MORPHOLOGICAL PARSING

It is the process of determining the morphenes from which a given word is constructed. Morphenes are the smallest meaningful words which cannot be divided further.

Morphenes can be stem or afix. Stem are the root word whereas afix can be prefix, suffix or infix.

For Example :

Unsuccessfull → un success ful

(prefix) (stem) (suffix)

Order of words also decide the morphological parser. To design a morphological parser we require three things- lexicon, morphptactics and orthographic rules.

5.4.3 TYPES OF MORPHOLOGY

1. **Inflectional Morphology :** Inflectional morphology is the study of processes, including affixation and vowel change, that distinguish word forms in certain grammatical categories. Inflectional morphology consists of at least five categories, provided in the following excerpt from Language Typology and Syntactic Description: Grammatical Categories and the Lexicon. As the text will explain, derivational morphology cannot be so easily categorized because derivation isn't as predictable as inflection.

   Examples : Cats, men etc.

2. **Derivational Morphology :** Is defined as morphology that creates new lexemes, either by changing the syntactic category (part of speech) of a base or by adding substantial, nongrammatical meaning or both. On the one hand, derivation may be distinguished from inflectional morphology, which typically does not change category but rather modifies lexemes to fit into various syntactic contexts; inflection typically expresses distinctions like number, case, tense, aspect, person, among others. On the other hand, derivation may be distinguished from compounding, which also creates new lexemes, but by combining two or more bases rather than by affixation, reduplication, subtraction, or internal modification of various sorts. Although the distinctions are generally useful, in practice applying them is not always easy.

5.4.4 APPLICATIONS OF MORPHOLOGICAL ANALYSIS

1. **Machine Translation :** Machine translation mainly helps the people who are belonging to the different communities and want to interact with the data present in the different languages, for this machine translation is one of the prominent solution. For few languages Machine translation have been developed but for the few other languages the work is going on.

   In lack of Morphological analysis ,we need to store all the word forms ,this will increase the size of database and will take more time to search. One more benefit of this

analyzer is, it provides the information of the word such as number, gender. This information can be used in target language to generate the correct form of the word.

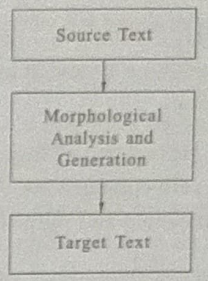


FIG 5.2 : Machine Translation

5.5 PARSING

The word 'Parsing' whose origin is from Latin word 'pars', is used to draw exact meaning or dictionary meaning from the text. It is also called Syntactic analysis or syntax analysis. Comparing the rules of formal grammar, syntax analysis checks the text for meaningfulness. The sentence like "Give me hot ice-cream", for example, would be rejected by parser or syntactic analyzer.

Parsing may be defined as the process of analyzing the strings of symbols in natural language conforming to the rules of formal grammar.

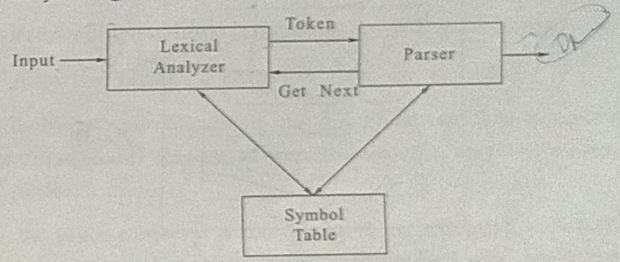


FIG 5.3 : Parsing a Sentence in NLP

We can understand the relevance of parsing in NLP with the help of following points :

- Parser is used to report any syntax error.
- It helps to recover from commonly occurring error so that the processing of the remainder of program can be continued.
- Parse tree is created with the help of a parser.
- Parser is used to create symbol table, which plays an important role in NLP.
- Parser is also used to produce intermediate representations (IR).

5.6 PARSING A SENTENCE WITH AN EXAMPLE

The following example demonstrates the common case of parsing a computer language with two levels of grammar: lexical and syntactic.

Parsing is the process of dissecting a sentence into its grammatical components and describing their syntactical roles.

Parsing in linguistics involves highlighting all the constituents in a sentence and taking note of things like tense and verb conjugations. Analyzing language in this way helps us understand the intended meaning and purpose of a sentence and the relationship between words.

For Example : The most common constituent relationship within a sentence is the subject + its predicate. The subject is who/what the sentence is about, and its predicate is the part of a sentence that adds detail or information to the subject.

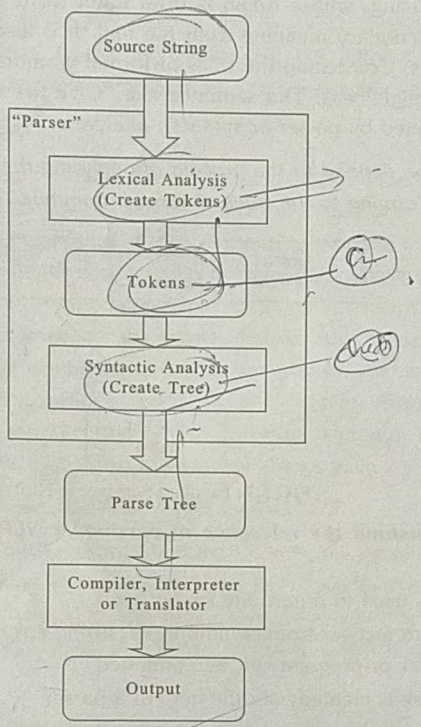


FIG 5.4 : Process of Parsing / Generating Parse Tree

Let us consider an example and trace the parsing procedure.

"The woman with the sparkly black backpack is my sister."

In this example, we can see two main constituents: the subject (The woman with the sparkly black backpack) and its predicate (is my sister).

Parsing helps us to recognize which group of words is the subject and which ones are the predicate.

Constituents : Constituents are the units of language that work together to build a sentence. They can be morphemes, phrases, and clauses. The smaller constituents (**Eg :** Morphemes) combine to form larger constituents (**Eg :** Phrases), which can again combine to form larger constituents (**Eg :** Clauses or predicates).

For Example : In the above example (The woman with the sparkly black backpack is my sister), we highlighted two main constituents, but those larger constituents can be further divided into their own constituents.

The constituent "*The woman with the sparkly black backpack*" is a noun phrase that also contains the prepositional phrase constituent "*with the sparkly bag,*" which contains the adjective phrase constituent "*the sparkly black.*"

Noun phrase constituent = *The woman with the sparkly black backpack*

Prepositional phrase constituent = *with the sparkly bag*

Adjective phrase constituent = *the sparkly black*

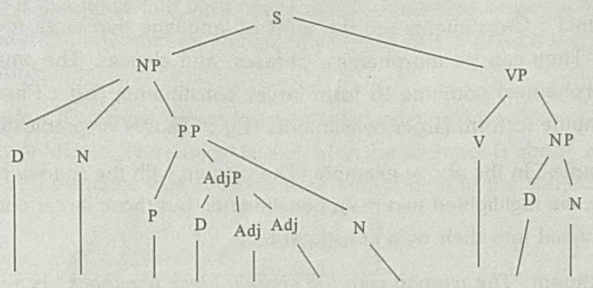
Parsing Technique : In linguistics, the most common way to conduct parsing is by creating a **parse tree.** Parse trees comprise **branches** and **root nodes, branch nodes, and leaf nodes.**

Typically, the **main sentence is the root node** as it doesn't have any branches above it, the **phrases are the branch nodes**, and **individual words are the leaf nodes**. The **branches** are the lines that show the relationship between the nodes.

- **Root Nodes :** Root nodes should appear at the top of the tree and have no nodes or branches above them. There can only be one root node in a sentence. A root node is the parent to branch nodes.
- **Branch Nodes :** These are typically phrases or individual words that appear below the root nodes. Branch nodes act as parents to leaf nodes.
- **Leaf Nodes :** Leaf nodes are the last element in a parse tree and cannot be the parent to any other nodes. They are individual words.

Parsing Examples : Now that you know all about parse trees let's look closely at an example. You should be aware that parse trees usually follow the same key :

S = Sentence	NP = Noun Phrase	VP = Verb Phrase
AdjP = Adjective Phrase	AdvP = Adverb Phrase	PP = Prepositional Phrase
D = Determiner	N = Noun	V = Verb
Adj = Adjective	Adv = Adverb	P = Preposition

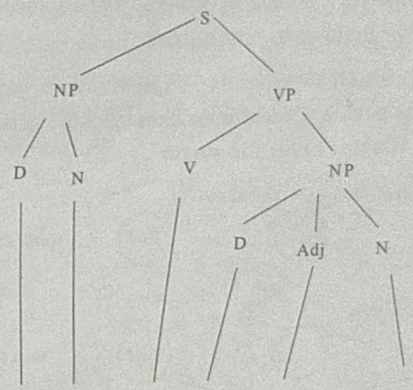


The woman with the sparkly black backpack is my sister

- **Root Node :** *The woman with the sparkly black backpack is my sister* (sentence)
- **Branch Nodes :**
  - *The woman with the sparkly black backpack* (noun phrase)
  - *With the sparkly black backpack* (prepositional phrase)
  - *The sparkly black* (adjective phrase)
  - *Is my sister* (verb phrase)
  - *My sister* (noun phrase)
- **Leaf Nodes :**
  - *the* (determiner)
  - *woman* (noun)
  - *with* (preposition)
  - *the* (determiner)
  - *sparkly* (adjective)
  - *black* (adjective)
  - *backpack* (noun)
  - *is* (verb)

  - *my* (determiner)
  - *sister* (noun)

Here are some further examples of conducting constituent parsing analyses of sentences using parse trees.



The children ate the strawberry cake

5.7 TRANSITION NETWORKS

A transition network is a finite state automaton that is used to represent a part of a grammar. A transition network parser uses a number of these transition networks to represent its entire grammar. Each network represents one non-terminal symbol in the grammar.

A transition network is a method of parsing which represents the grammar as a set of a finite state machine (FSM).

Finite State Machine : A FSM is a model of computational behavior where each node represents an internal state of the system and the arcs are the means of moving between the states. They are used in automata theory to represent grammar. In the case of parsing of natural language, the arcs in the networks represent either a terminal or a non-terminal symbol.

Transition networks (TN) are made up of a set of finite automata and represented within a graph system. The edges indicate transitions and the nodes the states of the single automata. Each automaton stands for a non-terminal symbol and is represented by its own network. The edges of each single network are denoted by non-terminal or terminal symbols and thus refer to other networks or final states.

If the structure of a transition network also allows for recursive processes, for example, in the substitution of an object by another object belonging to a higher hierarchy level (**Eg :** A verb becomes a verbal phrase), this type of network is known as a recursive

transition network. A path traversing the transition network starts at a first network and, beginning at the starting node, passes along the single edges. When it encounters a non-terminal symbol, the system branches like a sub-program to the corresponding network until finally all non-terminal symbols have been substituted. If different substitution possibilities are available, several paths between starting state and final state of the respective finite automaton exist.

Fig 5.5 shows a transition network for expressions in natural language which may generate expressions such as "conductor likes singer," "a singer hates the conductor," "a singer likes a conductor hates the singer".

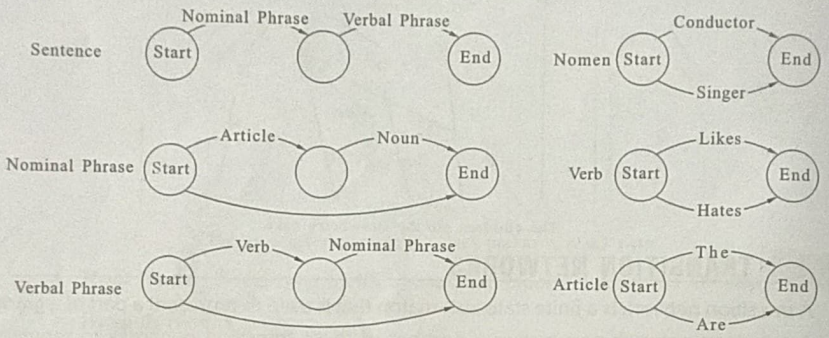


FIG 5.5 : Transition Network

5.7.1 TYPES OF TRANSITION NETWORKS

1. **Augmented Transition Networks (ATNs) :** ATN was developed by William Woods in 1970. The ATN method of parsing sentences integrates many concepts from Chomsky's (1957) formal grammar theory with a matching process resembling a dynamic semantic network.

2. **Recursive Transition Networks (RTNs):** RTN is a recursive transition network that permits arc labels to refer to other networks and they, in turn, may refer back to the referring network rather than just permitting word categories used previously.

5.8 AUGMENTED TRANSITION NETWORK

An ATN is a modified transition network. It is an extension of RTN. The ATN uses a top down parsing procedure to gather various types of information to be later used for understanding system. It produces the data structure suitable for further processing and capable of storing semantic details. An augmented transition network (ATN) is a

recursive transition network that can perform tests and take actions during arc transitions. An ATN uses a set of registers to store information. A set of actions is defined for each arc and the actions can look at and modify the registers. An arc may have a test associated with it. The arc is traversed (and its action) is taken only if the test succeeds. When a lexical arc is traversed, it is put in a special variable (*) that keeps track of the current word. The ATN was first used in LUNAR system. In ATN, the arc can have a further arbitrary test and an arbitrary action. The structure of ATN is illustrated in figure. Like RTN, the structure of ATN is also consisting of the substructures of S, NP and PP.

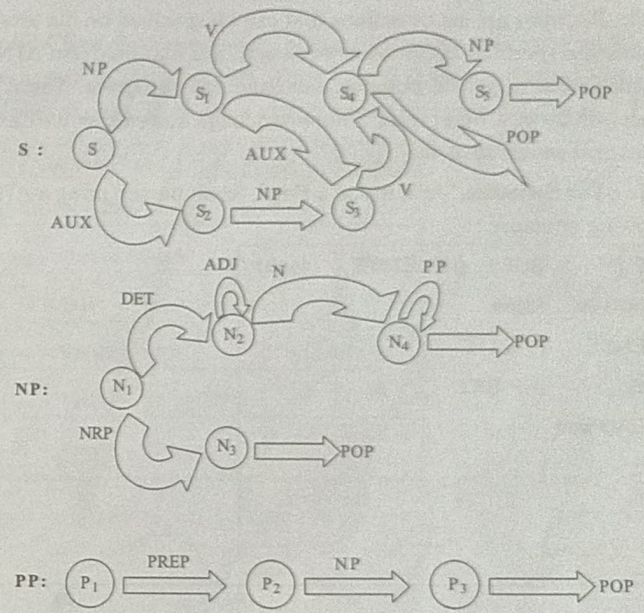


FIG 5.6 : Augmented Transition Network (ATN)

The ATN collects the sentence features for further analysis. The additional features that can be captured by the ATN are; subject NP, the object NP, the subject verb agreement, the declarative or interrogative mood, tense and so on. So we can conclude that ATN requires some more analysis steps compared to that of RTN. If these extra analysis tests are not performed, then there must some ambiguity in ATN. The ATN represents sentence structure by using a slot filter representation, which reflects more of the functional role of phrases in a sentence. For example, one noun phrase may be identified as "subject" (SUBJ) and another as the "object" of the verb. Within noun

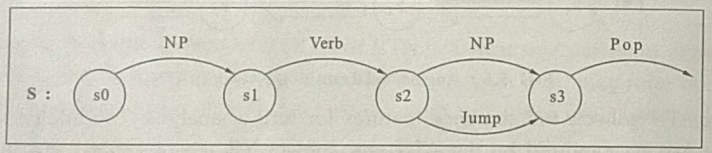
phrases, parsing will also identify the determiner structure, adjectives, the noun etc. For the sentence "Ram ate an apple", we can represent as :]

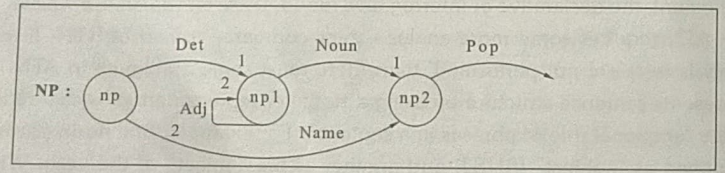
```
(S SUBJ (NP NAME Ram)
    Main_V      ate
    TENSE       PAST
    OBJ (NP     DET    an
    HEAD        apple))
```

The ATN maintains the information by having various registers like DET, ADJ and HEAD etc. Registers are set by actions that can be specified on the arcs. When the arc is followed, the specified action associated with it is executed. An ATN can recognize any language that a general purpose computer can recognize. The ATNs have been used successfully in a number of natural language systems as well as front ends for databases and expert systems.

Example : The Sentence "Jack found a Bag", when parsed using a ATN may produce the following structure :

```
(S (      SUBJ  (NP NAME     jack)
MAIN–V    found
TENSE     PAST
OBJ       (NP DET      a
HEAD bad
          }
   }
}
```





5.9 CHART PARSING

The chart is a record of all the substructures build during parsing. It is also known as a well-formed substring table. Chart parsing works on the principle of Dynamic Programming. It uses and stores solutions of the smaller part of a sentence to solve larger problems.

Chart parsing works incrementally word by word. In the worst case, chart parsing will parse a sentence of n words in O(n3) time. In many cases, it will perform better than this and will parse most of the sentences in O(n2) or even O(n) time.

Parsing by Chart Parser : There are two valid parse structures for the sentence, "the girls saw a man in the park with a cat" using grammar defined below in Table with propositional phrases. Both parse structures are shown in the *figures 5.7 and 5.8* below.

Grammar Rules	Rule Number
<S> → < NP > < VP >	1
< NP > → < Det> < Noun >	2
< NP > → < Det > < Noun > < PP >	3
< VP > → < Verb > < NP >	4
< VP > → < Verb > < NP > < PP >	5
< PP > → < Prep > < NP >	6

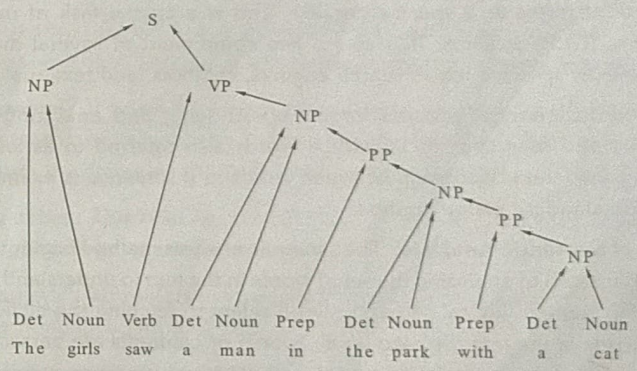


FIG : 5.6. Parse Structure 1

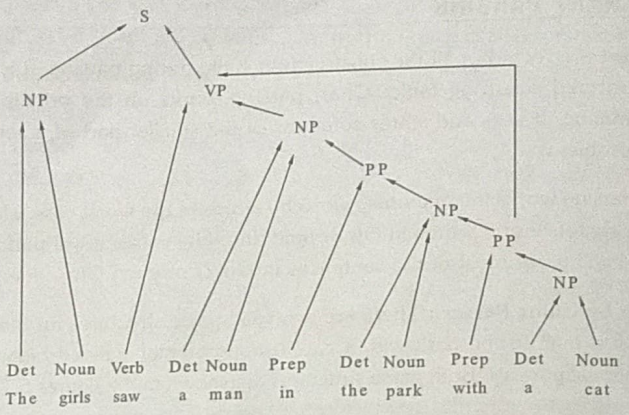


FIG 5.7 : Parse Structure 2

5.10 HOW SEMANTIC ANALYSIS IS PERFORMED IN NATURAL LANGUAGE PROCESSING

Semantic analysis refers to a process of understanding natural language (text) by extracting insightful information such as context, emotions, and sentiments from unstructured data. It gives computers and systems the ability to understand, interpret, and derive meanings from sentences, paragraphs, reports, registers, files, or any document of a similar kind.

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. This is a crucial task of natural language processing (NLP) systems. It is also a key component of several machine learning tools available today, such as search engines, chatbots, and text analysis software.

The semantic analysis process begins by studying and analyzing the dictionary definitions and meanings of individual words also referred to as lexical semantics. Following this, the relationship between words in a sentence is examined to provide clear understanding of the context.

Process of Semantic Analysis : The semantic analysis method begins with a language-independent step of analyzing the set of words in the text to understand their meanings. This step is termed 'lexical semantics' and refers to fetching the dictionary definition for the words in the text. Subsequently, words or elements are parsed. Each element is designated a grammatical role, and the whole structure is processed to cut down on any confusion caused by ambiguous words having multiple meanings.

Upon parsing, the analysis then proceeds to the interpretation step, which is critical for artificial intelligence algorithms. For example, the word 'Blackberry' could refer to a fruit, a company, or its products, along with several other meanings. Moreover, context is equally important while processing the language, as it takes into account the environment of the sentence and then attributes the correct meaning to it.

For Example : 'Blackberry is known for its sweet taste' may directly refer to the fruit, but 'I got a blackberry' may refer to a fruit or a Blackberry product. As such, context is vital in semantic analysis and requires additional information to assign a correct meaning to the whole sentence or language.

Technically, semantic analysis involves :

1. Data processing.
2. Defining features, parameters, and characteristics of processed data.
3. Data representation.
4. Defining grammar for data analysis.
5. Assessing semantic layers of processed data.
6. Performing semantic analysis based on the linguistic formalism.

The following are the critical elements used in semantic analysis. They are :

- **Hyponyms :** This refers to a specific lexical entity having a relationship with a more generic verbal entity called hypernym. For example, red, blue, and green are all hyponyms of color, their hypernym.
- **Meronomy :** Refers to the arrangement of words and text that denote a minor component of something. For example, mango is a meronomy of a mango tree.
- **Polysemy :** It refers to a word having more than one meaning. However, it is represented under one entry. For example, the term 'dish' is a noun. In the sentence, 'arrange the dishes on the shelf,' the word dishes refers to a kind of plate.
- **Synonyms :** This refers to similar-meaning words. For example, abstract (noun) has a synonyms summary–synopsis.
- **Antonyms :** This refers to words with opposite meanings. For example, cold has the antonyms warm and hot.
- **Homonyms :** This refers to words with the same spelling and pronunciation, but reveals a different meaning altogether. For example, bark (tree) and bark (dog).

Semantic Analysis Techniques : The semantic analysis uses two distinct techniques to obtain information from text or corpus of data. The first technique refers to text classification, while the second relates to text extractor.

1. **Semantic Classification :** Semantic classification implies text classification wherein predefined categories are assigned to the text for faster task completion. Following are the various types of text classification covered under semantic analysis:
   - **Topic Classification** : This classifies text into preset categories on the basis of the content type. For example, customer support teams in a company may intend to classify the tickets raised by customers at the help desk into separate categories so that the concerned teams can address them. In this scenario, ML-based semantic analysis tools may recognize tickets based on their content and classify them under a 'payment concern' or 'delayed delivery' category.
   - **Sentiment Analysis** : Today, sentiment analysis is used by several social media platforms such as Twitter, Facebook, Instagram, and others to detect positive, negative, or neutral emotions hidden in text (posts, stories). These sentiments, in a way, denote urgency and may raise 'call to action' alarms for respective platforms. Sentiment analysis helps brands identify dissatisfied customers or users in real-time and gets a hint on what customers feel about the brand as a whole.
   - **Intent Classification** : Intent classification refers to the classification of text based on customers' intentions in the context of what they intend to do next. You can use it to tag customers as 'interested' or 'not Interested' to effectively reach out to those customers who may intend to buy a product or show an inclination toward buying it.
2. **Semantic Extraction** : Semantic extraction refers to extracting or pulling out specific data from the text. Extraction types include :
   - **Keyword Extraction** : This technique helps identify relevant terms and expressions in the text and gives deep insights when combined with the above classification techniques.

     For example, one can analyze keywords in multiple tweets that have been labeled as positive or negative and then detect or extract words from those tweets that have been mentioned the maximum number of times. One can later use the extracted terms for automatic tweet classification based on the word type used in the tweets.
   - **Entity Extraction** : As discussed in the earlier example, this technique is used to identify and extract entities in text, such as names of individuals, organizations,

places, and others. This method is typically helpful for customer support teams who intend to extract relevant information from customer support tickets automatically, including customer name, phone number, query category, shipping details, etc.

Example : For example, *"A rock smelled the colour nine."* It is syntactically correct as it obeys all the rules of English, but is semantically incorrect. The semantic analysis verifies that a sentence is abiding by the rules and creates correct information

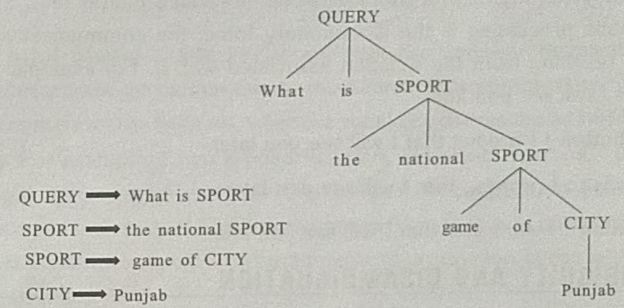


FIG 5.8 : Semantic Analysis

5.11 PRAGMATIC ANALYSIS IN UNDERSTANDING NATURAL LANGUAGE

It deals with outside word knowledge, which means understanding i.e external to documents and queries. PA that focuses on what was described is reinterpreted by what it actually meant, deriving the various aspects of language that require real-world knowledge.

It deals with overall communicative and social content and its effect on interpretation. It means abstracting the meaningful use of language in situations. In this analysis, the main focus always on what was said is reinterpreted on what is intended. It helps users to discover this intended effect by applying a set of rules that characterize cooperative dialogues

Example : "Close the window?" should be interpreted as a request instead of an order.

Pragmatics is an important part of learning language because it helps learners to avoid miscommunication and to communicate as they wish across cultures and languages.

Below are the FOUR aspects of Pragmatics which are used in understanding the pragmatics of the natural language.

They are :

1. Speech Acts
2. Rhetorical Structures
3. Conversational Implicature
4. Management of Reference

Pragmatic is the study of how more gets communicated than is said. Speech acts in the pragmatic processing is the illocutionary force, the communicative force of an utterance, resulting from the function associated with it. For example: Suppose the sentence *is I will see you later.*

Prediction : I predict that I will see you later.

Promise : I promise that I will see you later.

Warning : I warn you that I will see you later.

5.12 AMBIGUITY AND DISAMBIGUATION

1. **Ambiguity :** Ambiguity, generally used in natural language processing, can be referred as the ability of being understood in more than one way. In simple terms, we can say that ambiguity is the capability of being understood in more than one way. Natural language is very ambiguous.
2. **Disambiguation :** Disambiguation is the act of interpreting an author's intended use of a word that has multiple meanings or spellings.

There are two popular methods to address disambiguation:

- Shallow method and
- Deep method.

(a) The **shallow method**, which uses nearby words to determine what the intended meaning, is the more commonly used method.

(b) The **deep method** goes further into the meanings of the words, pulling from lexicons of dictionaries and thesauruses to determine all the possibilities for a word's meaning.

Disambiguation is the process of recovering the most probable intended meaning of an utterance. In one sense we already have a framework for solving this problem: each rule has a probability associated with it, so the probability of an interpretation is the product of the probabilities of the rules that led to the interpretation. Unfortunately,

the probabilities reflect how common the phrases are in the corpus from which the grammar was learned, and thus reflect general knowledge, not specific knowledge of the current situation.

To do disambiguation properly, we need to combine four models :

(i) ***World Model :*** The likelihood that a proposition occurs in the world. Given what we know about the world, it is more likely that a speaker who says "I'm dead" means "I am in big trouble" rather than "My life ended, and yet I can still talk."

(ii) ***Mental Model :*** The likelihood that the speaker forms the intention of communicating a certain fact to the hearer. This approach combines models of what the speaker believes, what the speaker believes the hearer believes, and so on. For example, when a politician says, "I am not a crook," the world model might assign a probability of only 50% to the proposition that the politician is not a criminal, and 99.999% to the proposition that he is not a hooked shepherd's staff. Nevertheless, we select the former interpretation because it is a more likely thing to say.

(iii) ***Language Model :*** The likelihood that a certain string of words will be chosen, given that the speaker has the intention of communicating a certain fact.

(iv) ***Acoustic Model :*** For spoken communication, the likelihood that a particular sequence of sounds will be generated, given that the speaker has chosen a given string of words.

5.13 DIFFERENT FORMS OF AMBIGUITY IN DETAIL

NLP has the following types of ambiguities :

- **Lexical Ambiguity :** The ambiguity of a single word is called lexical ambiguity. For example, treating the word silver as a noun, an adjective, or a verb.
- **Syntactic Ambiguity :** This kind of ambiguity occurs when a sentence is parsed in different ways. For example, the sentence "The man saw the girl with the telescope". It is ambiguous whether the man saw the girl carrying a telescope or he saw her through his telescope.
- **Semantic Ambiguity :** This kind of ambiguity occurs when the meaning of the words themselves can be misinterpreted. In other words, semantic ambiguity happens when a sentence contains an ambiguous word or phrase.

Consider the Example :

Seema loves her mother and Sriya does too.

The interpretations can be Sriya loves Seema's mother or Sriya likes her own mother.

Semantic ambiguities born from the fact that generally a computer is not in a position to distinguishing what is logical from what is not.

- **Anaphoric Ambiguity :** This kind of ambiguity arises due to the use of anaphora entities in discourse. For example, the horse ran up the hill. It was very steep. It soon got tired. Here, the anaphoric reference of "it" in two situations cause ambiguity.

  Consider the Example : The horse ran up the hill. It was very steep. It soon got tired. The anaphoric reference of 'it' in the two situations cause ambiguity. Steep applies to surface hence 'it' can be hill. Tired applies to animate object hence 'it' can be horse.

- **Pragmatic Ambiguity :** Pragmatic ambiguity refers to a situation where the context of a phrase gives it multiple interpretation, One of the hardest tasks in NLP. The problem involves processing user intention, sentiment, belief world, modals etc.- all of which are highly complex tasks.

  Consider the Example :

  - **Tourist** (checking out of the hotel): Waiter, go upstairs to my room and see if my sandals are there; do not be late; I have to catch the train in 15 minutes.
  - **Waiter** (running upstairs and coming back panting): Yes sir, they are there.

  Clearly, the waiter is falling short of the expectation of the tourist, since he does not understand the pragmatics of the situation.

  Pragmatic ambiguity arises when the statement is not specific, and the context does not provide the information needed to clarify the statement. Information is missing, and must be inferred.

5.14 DISCOURSE UNDERSTANDING

Discourse Analysis is extracting the meaning out of the corpus or text. Discourse Analysis is very important in Natural language Processing and helps train the NLP model better.

Discourse refers to any linguistic construction with multiple sentences. A disclosure is used in understanding and generating natural language. A variety of text mining applications can be supported by discourse processing, which is a collection of Natural

Language Processing (NLP) tasks used to extract linguistic structures from texts at different levels. Identifying the conversational discourse's topic structure, coherence structure, co-reference structure, and conversation structure is required for this. Together, these structures can guide information extraction, sentiment analysis, machine translation, question answering, essay scoring, text summarization, and thread recovery.

Discourse takes various modalities, structures, and mediums. Among the commonly experienced mediums are face-to-face chats, telephone conversations, television news broadcasts, radio news, talk shows, lectures, books, and scientific articles

So, we can see that the real problem is the processing of the Discourse in NLP and hence we need to work on it so that our model can be trained well which will help in better processing of Natural Language data by the computers and hence the Artificial Intelligence can predict the desired result.

In simple terms we can say that discourse in NLP is nothing but coherent groups of sentences. When we are dealing with Natural Language Processing, the provided language consists of structured, collective, and consistent groups of sentences which are termed discourse in NLP. The relationship between words makes the training of the NLP model quite easy and more predictable than the actual results.

Concept of Coherence : Coherence in terms of Discourse in NLP means making sense of the utterances or making meaningful connections and correlations. There is a lot of connection between the coherence and the discourse structure. We use the property of the good text, coherence, etc. to evaluate the quality of the output generated by the natural language processing generation system.

Coherence Relation Between Utterances : When we say that the discourses are coherent then it simply means that the discourse has some sort of meaningful connections. The coherent relation tells us that there is some sort of connection present between the utterances.

Relationship between Entities : If there is some kind of relationship between the entities then we can also say that the discourse in NLP is coherent. So, the coherence between the entities is known as entity-based coherence.

CHAPTER 6

APPLICATIONS OF ARTIFICIAL INTELLEGENCE

CHAPTER OUTLINE

6.1 SPEECH RECOGNITION WITH DIFFERENT MODELS

Speech recoginition is also known as automatic speech recognition (ASR), computer speech recognition, or speech to text (STT), which means understanding voice by the computer and performing any required taks. It develops methods and technologies that implement the recognition and translation of spoken language into text by computers.

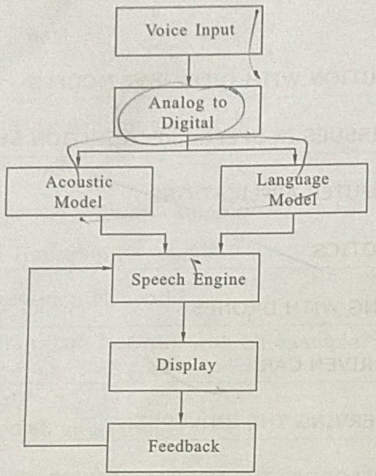


FIG 6.1 : Working Mechanism of Speech Recognition

Speech Recognition System can be used in :

- System control/navigation, e.g., GPS-connected digital maps.
- Commercial/industrial applications in the car steering system.
- Voice dialing hands-free use of mobile in the car.

6.1.1 SPEECH RECOGNITION TECHNIQUE

The main objective of speech recognition is for a machine to be able to "listen", "understand", and "act upon" the information provided through the voice input. Automatic speaker recognition aims to analyze, extract, characterize and recognize information about the speaker's identity.

Hence, the speaker recognition system works in three stages, as follows :

1. Analysis.
2. Feature extraction.
3. Modeling.

1. **Speech Analysis Technique :** Speaker identity can be shown by a different type of information that is present in speech data. This incorporates speaker-specific information due to the vocal tract, excitation source, and behavior feature. This stage deals with a suitable frame size for segmenting speech signals for further analysis and extracting.
2. **Feature Extraction Technique** : The speech feature extraction technique is the process of placing words in groups or classes is about decreasing the dimensionality of the input vector while maintaining the discriminating power of the signal. From the basic formation of speaker identification and verification system, we know that the number of training and test vector needed for the classification problem grows with the dimension of the given input; therefore, we need feature extraction of the speech signal.
3. **Modeling :** The modeling technique aims to create speaker models using a speaker-specific feature vector. Further, Speaker recognition and Speaker identification are the parts of Modeling. The speaker identification technique identifies by itself, who is speaking based on individual information integrated into a speech signal.

What Is an Acoustic Model?

In brief, an acoustic model is a file that consists of statistical representations of each of the distinguishable sounds that makes up a word. Statistical representations assigned to the label called a phoneme. The English language has approximately 40 different sounds used in speech recognition. Therefore, we have 40 different phonemes.

What Is a Language Model?

In brief, language models are used to limit the search in a decoder by limiting the number of possible worlds that are required to consider at any one point in the search. Finally, the result is faster execution and higher accuracy of the model.

6.1.2 TYPES OF SPEECH RECOGNITION SOFTWARES

1. **Speaker Dependent :** Those individuals who will be using the system train the Speaker dependent systems. These systems are capable of achieving a high better command count than 95% accuracy for word recognition. The drawback of this approach is that the system only responds accurately only to the individual who trained the system. This is the most common approach implemented in software for personal computers.
2. **Speaker Independent** : Speaker independent is a system trained to respond to a word regardless of who is speaking. Therefore the system must respond to a large variety of speech patterns, inflections, and enunciation is of the target word. The command word count is generally lower than the speaker-dependent, whereas high accuracy can still be maintained within processing limits. Industrial requirements need

Let's take the self-driving car as an example. In this case, artificial intelligence is used to replace the human driver that would normally be in control of the vehicle. The car has sensors that detect obstacles, cameras to recognize traffic signals, and powerful processors that interpret all this data. This allows the car to "see" the road. It can then decide when to accelerate, brake, or turn without a driver.

6.5 AI ROLE IN FLYING WITH DRONES

Drones are unmanned, aerial devices used for a variety of purposes. When first developed, these devices were manually, remotely controlled. Now, however, drones often incorporate artificial intelligence, automating some or all operations. The incorporation of AI enables drone vendors to use data from sensors attached to the drone to collect and implement visual and environmental data.

This data enables autonomous or assisted flight, making operation easier, and increasing accessibility. As a result, drones have become part of the smart mobility offerings that are now commercially available to businesses and consumers. AI-based drones rely largely on computer vision. This technology enables drones to detect objects while flying and allows the analysis and recording of information on the ground.

Computer vision works through high-performance, onboard image processing performed with a neural network. A neural network is a layered architecture that is used to implement algorithms in machine learning. Neural networks enable drones to perform object detection, classification, and tracking. This information is combined in real-time to enable drones to avoid collisions and locate and track targets.

To implement neural networks in drones, researchers must first train the machine learning algorithms to recognize and correctly classify objects in a wide variety of contexts. This is done by feeding specially marked images into the algorithm.

These images teach the neural network which traits classes of objects have and how to differentiate one type of object from another. More advanced neural networks continue learning without supervision during operation, improving detection and analysis with use.

Drones have three main applications.

Surveillance : Drones can be equipped with various types of surveillance equipment that can collect HD video and still images day and night. Drones can be equipped with technology allowing them to intercept cell phone calls, determine GPS locations, and gather license plate information. The high payload compatibility allows the use of different surveying systems such as lidar scanners, multi- and hyperspectral devices and much more – around the clock, with low staffing requirements and low costs.

Weather Forecast : The climate is changing. So is the face of natural catastrophes. Admittedly, drones fall short in matching the efficacy of satellite imagery in forecasting adverse weather events. However, when disaster does strike, they are capable of providing valuable assistance. Government authorities as well as insurers are waking up to the potential of using them to assess post-disaster damages, especially at sites not marked safe for humans to enter.

Delivery : There are several applications in which delivery drones are used.

- **Health Care :** Drones can be used to transport medicinal products such as blood products, vaccines, and other supplies such as pharmaceuticals and medical samples. During the COVID-19 pandemic, drones began making medical deliveries of personal protective equipment and COVID- 19 tests in the United States and in Israel.
- **Food :** Drones have been proposed as a solution for rapidly delivering prepared foods, such as pizzas, tacos, and frozen beverages.
- **Postal** : Different postal companies from Australia, Switzerland, Germany, Singapore, the United Kingdom and Ukraine have undertaken various drone trials as they test the feasibility and profitability of unmanned delivery drone services.

6.6 FUTURE OF AI-DRIVEN CAR

Autonomous cars are said to be a safer ride and more convenient. That is, if human error accounts for as much as 94% of all road accidents, according to the National Highway Traffic Safety Administration, then perhaps it makes sense to rely more on technology to help keep us safe.

A driverless car won't put its driver or others at risk in accidents caused by potentially dangerous human behaviors or conditions like speeding, reckless driving, drowsiness, distracted driving or impairment due to alcohol or drugs.

Autonomous vehicles may also lead to less congestion on the roads because cars could communicate with one another and change routes based on traffic, accidents or construction.

What is AI in Autonomous Driving?

In simple terms, artificial intelligence is the ability of a machine to think logically, learn, and make decisions. To distinguish signs from pedestrians, or perform any action on the road without the involvement of drivers, autonomous vehicles use a complex combination of AI processing units mainly based on deep neural networks. Feeding computers with loads of data, we rely on them to analyze, process, and

6.3 AI ROLE IN COMPUTER APPLICATIONS

As technology improves, there are going to be many new applications of artificial intelligence. One of the most obvious connections is how artificial intelligence can help change and improve the related field of computer science through more advanced programming techniques and data organization.

Computers essentially function by following sets of programming instructions, and artificial intelligence is a field that is helping transform this process into something much more dynamic where the programs can find ways to learn on their own without having to receive new instructions all the time.

1. **Self-Modifying Coding :** Artificial intelligence is now being put into programming languages to create self-modifying groups of code. These can be directed by benchmarks, such as a score, to continuously try new combinations that get closer to the goal. Ideally, over time this ability to make intelligent programs could give them the ability to create their own updates or patch their own errors.
2. **Robotics :** Robots often have shared sets of programming that allow them to function and communicate. However, as robots are used in a variety of settings, they may need to be programmed or given instructions to make decisions and value judgments in changing environments. This will require them to possess artificial intelligence.
3. **Speech and Language Processing :** It is becoming more and more common for computers to be able to speak and be spoken to, in order to take directions and give answers. Most computers do this by being able to recognize and signal and process a set of instructions, but artificial intelligence will be necessary to make this feel like a more complete and natural interaction than talking to a machine that can give basic responses.
4. **Data Mining :** Data is "mined" or sorted and analyzed to find certain patterns, anomalies, or other values within extremely large volumes of information. Artificial intelligence should ideally make this process more efficient and come up with unforeseen responses to aid those who must view the data and make decisions.
5. **Visualizations and Visual Data :** Computer programs can now make visualizations based on certain variables, but artificial intelligence will greatly enhance this process. By having smart programs that guide users through visual analytics and make suggestions for interpreting and organizing data, artificial intelligence can aid in creating new kind of visual aids.

6. **Marketing Programs :** There are artificially created programs that can now handle areas such as customer service, SEO, and content marketing. This is appealing for businesses who do not want to have to invest large sums of money into building marketing or public relations departments staffed with experienced professionals. However, this field is also still in its infancy and it may be some time before programs that replicate traditional human marketing campaigns with real creativity and empathy will feel legitimate to consumers.

Image Recognition : While computers are getting better at recognizing voice commands, the ability of a program to remember and decode an image is equally appealing and has many applications for everything from security to graphic design. Large databases of tagged images are now available to tech giants like Google and Facebook, and these volumes of graphic data are being used in creative ways to create computer programs that recognize what they see in front of them, even if it is for the first time.

Cloud Computing : The ability to store and access data in the cloud is revolutionizing how people can access information from many locations and is eliminating the need for traditional physical storage tied to one place. Artificial intelligence is going to help make this process more organized and systematic in the future. Users will be able to get intelligent responses when storing and accessing files from a cloud-based network.

6.4 AI ROLE IN ROBOTICS

Robotics is the science of designing, constructing, programming, and testing robots for various purposes. A robot is any machine that can be programmed to perform specific tasks autonomously or semi-autonomously. Robots have certain characteristics that make them distinct from other machines. Among other things, they are usually designed to interact with their environment and can be programmed to carry out specific tasks.

Many aspects of life are now dependent on robots due to their ability to work accurately and quickly. As robots become more sophisticated, they will continue to play a larger role in our day-to-day lives. Robotics aims to ensure these machines' efficiency, accuracy, and safety.

Essentially, the role of artificial intelligence in robotics is to mimic human intelligence and enable robots to respond and act independently in various situations. AI is used to provide robots with the ability to learn, adapt, and make decisions on their own.

AI-enabled robots are programmed with algorithms that allow them to process data from their surroundings, interpret it, and act accordingly. We can compare these algorithms to the human brain. It will enable the robot to "think" and react without any human input.

perform actions just like human beings. We call them electronic brains and expect them to function like our own to eventually exceed our intelligence.

AI-based systems are fundamental in the automotive industry as they form the core of Advanced Driver Assistance Systems (ADAS) and contribute to the infotainment human-machine interface. The year of 2018 has been a successful reset season for the automotive game-changers, especially in these categories. AI already helps the infotainment systems inside the cars recognize speech and gestures, perform eye-tracking and virtual assistance. The cars can now learn from shared experience and make accurate predictions and suggestions.

But fully autonomous vehicles have to learn to contend with all other factors. The main challenge out there in front of autonomous vehicle manufacturers, though, is to process data collected from numerous sources, such as cameras, LIDARs, GPS, ultrasonic sensors, and many more. The turning point would be to provide autonomous transport with cognitive and intuitive capabilities and make sure that vehicles of the new generation can think and reach decisions as drivers would normally do.

General Motors' 2018 Self-Driving Safety Report has just presented a new zero-emission self-driving vehicle of level-4 — the Cruise AV with the highest levels of automation in perception, planning, and control processes in the world.

6.7 AI ROLE IN OBSERVING THE UNIVERSE

Space travel, exploration, and observation involve some of the most complex and dangerous scientific and technical operations ever carried out. This means that it tends to throw up the kinds of problems that artificial intelligence (AI) is proving itself to be outstandingly helpful with.

Because of this, astronauts, scientists, and others whose job it is to chart and explore the final frontier are increasingly turning to machine learning (ML) to tackle the everyday and extraordinary challenges they face.

So, from steering rockets through space to studying the surface of distant planets, measuring the size of the universe, and calculating the trajectories of celestial bodies, here are some of the most interesting and exciting use cases for AI in space.

AI is used during the take-off and landing of spacecraft to automate engine operations and manage functions such as deploying landing gear. This helps to optimize the use of fuel.

SpaceX uses an AI autopilot system to enable its Falcon 9 craft to carry out autonomous operations, such as docking with the International Space Station (ISS), where it is contracted to carry out cargo deliveries for NASA. The system calculates the trajectory of the rocket through space, taking into account fuel usage, atmospheric interference, and "sloshing" from liquids within the engine.

SpaceX uses AI algorithms to ensure that its satellites don't collide with other orbital or transitionary objects in space. Their autonomous navigation systems enable them to detect nearby hazards in real-time and take evasive action by adjusting the speed and trajectory of the satellite.

The UK Space Agency has also developed autonomous systems that allow its spacecraft and satellites to take autonomous action in order to avoid space debris.

Mars Rovers are robots that explore the surface of the red planet, sending data back to Earth where we can analyze and learn from it. These robots are able to autonomously navigate the terrain, thanks to ML algorithms, avoiding craters and drops that could damage them or put them out of action.

Astronomers use AI to map the universe by recognizing patterns in star clusters that form distant nebulae and classifying other features that are detected in deep space.

AI is also used to predict the behavior of stars and galaxies, helping to understand where cosmic events such as supernovae are likely to occur.

6.8 AI ROLE IN DEVELOPING THE NEURAL NETWORKS

Artificial intelligence is a very popular term and its recent development and advancements have given AI recognition in various industries. The role of AI is to teach the machines to learn from their mistakes and do the tasks more effectively. One of its breakthroughs is the artificial neural network (ANN) in artificial intelligence, which works similarly to the tasks performed by neurons of the human brain.

A Neural Network is a computing system made up of a number of simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs.

Neural networks are a bunch of neurons working together and solving some mathematical calculations to decode a complex problem. It includes various technologies like deep learning and machine learning as a part of artificial intelligence.

Artificial neural networks try to replicate the way we humans learn. It consists of an input layer, a hidden layer, and an output layer. Each node in each layer is connected to one another and has an associated weight and threshold. If the threshold of a particular node is greater than some specified threshold, then the node gets activated.

Nowadays most businesses and companies make use of these technologies to solve complex problems like facial recognition, which helps the companies to have tight security.

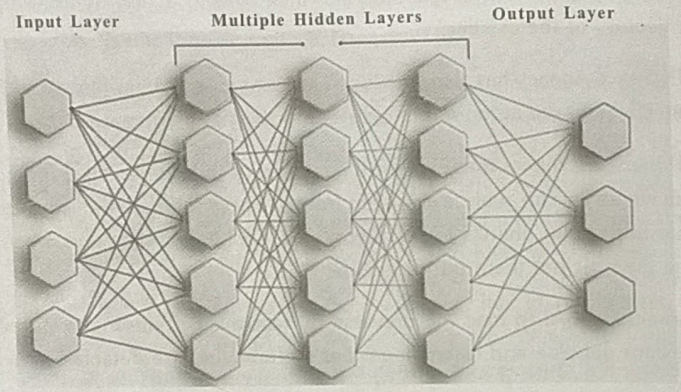


FIG 6.2 : Deep Neural Network

Having facial recognition means no outsider can enter the company without the identified person. Due to their parallel architecture, these are especially suited for real-time systems, as they respond quickly.

There are several other applications that include speech-to-text transcription, data analytics, handwriting recognition, weather prediction, etc. The most fascinating feature of neural networks is the possibility of developing 'conscious' networks in the future.

These networks have the potential to analyze the raw data and reveal new insights for which they might not even be trained. It can also learn and improve over time based on the user's behavior.

For example, consider a neural network that automatically suggests music by analyzing your music taste. Let us assume that the model was trained to play Rock and Metal genres songs. However, if you frequently listen to Jazz, the neural network can automatically learn and start suggesting types of songs that you usually like to listen to.

Neural networks can always prove helpful in the banking and business sector to identify frauds. Big start-ups like Uber and Swiggy use artificial neural networks to identify frauds and prevent losses.

6.9 AI ROLE IN THE MEDICAL FIELD

Artificial intelligence in medicine is the use of machine learning models to search medical data and uncover insights to help improve health outcomes and patient experiences.

AI algorithms and other applications powered by AI are being used to support medical professionals in clinical settings and in ongoing research.

Currently, the most common roles for AI in medical settings are clinical decision support and imaging analysis. Clinical decision support tools help providers make decisions about treatments, medications, mental health and other patient needs by providing them with quick access to information or research that's relevant to their patient. In medical imaging, AI tools are being used to analyze CT scans, x-rays, MRIs and other images for lesions or other findings that a human radiologist might miss.

The challenges that the COVID-19 pandemic created for many health systems also led many healthcare organizations around the world to start field-testing new AI-supported technologies, such as algorithms designed to help monitor patients and AI-powered tools to screen COVID-19 patients.

AI has been involved in medicine since as early as the 1950s, when physicians made the first attempts to improve their diagnoses using computer-aided programs. Interest and advances in medical AI applications have surged in recent years due to the substantially enhanced computing power of modern computers and the vast amount of digital data available for collection and utilization.

AI is gradually changing medical practice. There are several AI applications in medicine that can be used in a variety of medical fields, such as clinical, diagnostic, rehabilitative, surgical, and predictive practices.

Another critical area of medicine where AI is making an impact is clinical decision-making and disease diagnosis. AI technologies can ingest, analyze, and report large volumes of data across different modalities to detect disease and guide clinical decisions.

AI applications can deal with the vast amount of data produced in medicine and find new information that would otherwise remain hidden in the mass of medical big data. These technologies can also identify new drugs for health services management and patient care treatments.

speaker-independent voice systems more often, such as the AT&T system are used in the telephone systems.

Example of Speech Recognition :

Speech Recognition is implemented in the front end or the back end medical document processes. Front end speech recognition is where the provider dictates the speech recognition engine.

Spoken words displayed as recognized. The dictator is answerable for editing and signing off the Document. Back end recognition, also known as deferred speech recognition, is where the provider dictates into a digital dictation system. The voice is routed through a speech-recognition machine, and the draft document is recognized. It is routed along with the original voice file to the editor (where the draft file is edited and report finalized). Back end or deferred recognition is widely used in the industry currently.

Substantial efforts dedicated in the last decade to the test and evaluation of speech recognition in fighter aircraft. Speech recognizers operated successfully in fighter aircraft. Applications like setting radio frequencies, commanding an autopilot system, setting steer-point coordinates and weapons release parameters, and also controlling flight display.

In-car systems, simple voice commands used to initiate phone calls, select radio stations, or play music from a compatible Smartphone, MP3 player, or music-loaded flash drive. In addition, voice recognition capabilities vary between car make and model.

6.2 MAJOR DESIGN ISSUES IN SPEECH RECOGNITION SYSTEMS

The below are the Four challenges you will face building your automatic speech recognition system (ASR) :

1. **Lack of Lingual Knowledge :** What makes speech recognition difficult is the lack of language training.

   Companies often seem to overlook the fact that English is not the universal language. So expecting users from different geographies to have the same level of proficiency is unrealistic. In fact, 38% of users are hesitant to adopt voice technology because of AI's language coverage.

   If you are trying to deploy your voice assistants in a location, the ASR will likely tank if not trained on specific language models of the region. And even when it is trained for the language, another challenge for ASR is the ability to differentiate between varying dialects and accents for more accurate interpretation.

For Example : A user who needs groceries may say "Buy vege-table" to the voice assistant, pronouncing the word a bit differently than the widely accepted "veg-tible" – also the only one AI is familiar with. A poorly trained bot may mistake this input as "buy a veggie table" assuming the speaker wants to buy a table – Highly inaccurate!

2. **Peripheral Background Sounds :** Another top speech recognition problem that needs a solution is – noise. It is everywhere! And so, it becomes the job of the ASR solution to accurately catch the speech input through unwanted sounds. An ASR should be able to pick up the input's sound waves even from a distance in a room riddled with white noise and cross-talk. Echo, for example, also adds to the imprecision. Reflected sound waves from surfaces in the space distort the receptor's ability to process the actual input unerringly.

3. **Low Data Reliability of ASR :** Another challenge of speech recognition is Data privacy. While we are making progress in the field of AI, many users are still hesitant to use ASR bots to handle tasks that involve sensitive data and money. Data privacy is sovereign to users who wish to exercise some level of governance and transparency with their information.

   PWC says that one of the three main reasons why users are scared to experiment with voice tech is simply a lack of trust. Where more than half of the users use their voice assistant to buy online, all of these purchases are trivial with low spending. And so, data concerns remain the challenges and issues businesses face in adopting speech recognition technology. Users don't trust voice assistants as much, so businesses must be prepared to face reluctance in adoption from their market.

4. **Costs and Deployment :** Other reasons why speech recognition is difficult to implement in real-time environments are because of the capital and infrastructure needed.

   Implementing an ASR system needs a far-sighted vision. It's a long game and not a change that occurs overnight. Bearing this in mind, you need to be prepared to handle the time, resources, and capital involved in building, testing, and deploying the system in the market. For example, the lack of visual elements makes designing interactive voice user interfaces (VUIs) more complex than designing UI for chatbot.

   Another disadvantage of speech recognition can be that training language models take considerable time and expertise. Gathering enough language resources or effectively making do with the available ones may not come cheap. All in all, manual development would rain heavily on your pockets.

6.10 AI ROLE IN MILITARY APPLICATIONS

Artificial Intelligence (AI) is becoming a critical part of modern warfare. Compared with conventional systems, military systems equipped with AI are capable of handling larger volumes of data more efficiently. Additionally, AI improves self-control, self-regulation, and self-actuation of combat systems due to its inherent computing and decision-making capabilities.

AI is deployed in almost every military application, and increased research and development funding from military research agencies to develop new and advanced applications of artificial intelligence is projected to drive the increased adoption of AI-driven systems in the military sector.

The following are the Military application where AI is extensively used :

Warfare Platforms : Defense forces from different countries across the globe are embedding AI into weapons and other systems used on land, naval, airborne, and space platforms.

Using AI in systems based on these platforms has enabled the development of efficient warfare systems, which are less reliant on human input. It has also led to increased synergy and enhanced performance of warfare systems while requiring less maintenance. AI is also expected to empower autonomous and high-speed weapons to carry out collaborative attacks.

Cybersecurity : Military systems are often vulnerable to cyber attacks, which can lead to loss of classified military information and damage to military systems. However, systems equipped with AI can autonomously protect networks, computers, programs, and data from any kind of unauthorized access.

In addition, AI-enabled web security systems can record the pattern of cyber attacks and develop counter-attack tools to tackle them.

Logistics & Transportation : AI is expected to play a crucial role in military logistics and transport. The effective transportation of goods, ammunition, armaments, and troops is an essential component of successful military operations.

Integrating AI with military transportation can lower transportation costs and reduce human operational efforts. It also enables military fleets to easily detect anomalies and quickly predict component failures. Recently, the US Army collaborated with IBM to use its Watson artificial intelligence platform to help pre-identify maintenance problems in Stryker combat vehicles.

Target Recognition : AI techniques are being developed to enhance the accuracy of target recognition in complex combat environments. These techniques allow defense forces to gain an in-depth understanding of potential operation areas by analyzing reports, documents, news feeds, and other forms of unstructured information. Additionally, AI in target recognition systems improves the ability of these systems to identify the position of their targets.

Capabilities of AI-enabled target recognition systems include probability-based forecasts of enemy behavior, aggregation of weather and environmental conditions, anticipation and flagging of potential supply line bottlenecks or vulnerabilities, assessments of mission approaches, and suggested mitigation strategies. Machine learning is also used to learn, track, and discover targets from the data obtained.

Battlefield Healthcare : In war zones, AI can be integrated with Robotic Surgical Systems (RSS) and Robotic Ground Platforms (RGPs) to provide remote surgical support and evacuation activities. The US in particular is involved in the development of RSS, RGPs, and various other systems for battlefield healthcare. Under difficult conditions, systems equipped with AI can mine soldiers' medical records and assist in complex diagnosis.

Combat Simulation & Training : Simulation & training is a multidisciplinary field that pairs system engineering, software engineering, and computer science to construct computerized models that acquaint soldiers with the various combat systems deployed during military operations. The US is investing increasingly in the simulation & training applications.

Threat Monitoring & Situational Awaraeness : Threat monitoring & situational awareness rely heavily on Intelligence, Surveillance, and Reconnaissance (ISR) operations. ISR operations are used to acquire and process information to support a range of military activities.

AI & Data Information Processing : AI is particularly useful for quickly and efficiently processing large volumes of data in order to obtain valuable information.

AI can assist in culling and aggregating information from different datasets, as well as acquire and sum supersets of information from various sources. This advanced analysis enables military personnel to then recognize patterns and derive correlations.