UNIT 4

UNIT 4

NON LINEAR PLANNING WITH CONSTRAINT POSTING

https://aithefuture.wordpress.com/2018/05/08/non-linear-planning-with-constraint-posting/

- A plan that consists of sub-problems, which are solved simultaneously is said to be a **non-linear plan.**
- In case of the goal stack planning, it poses some problems.
- Achieving a goal could possibly undo any of the already achieved goals and its called as Sussman`s anomaly.
- In linear planning, just one goal is taken at a time and solved completely before the next one is taken.
- Let us take an **example**. You want to take the car for servicing and have to make an important phone call. In case of Linear planning, First you will achieve the goal of making a phone call and then will take the car for servicing. Rather than completing both the tasks in a linear way, after completion of the task 1, as partial step, i.e., start the car and put on the Bluetooth, then complete the task 2 of phone call and then finally, complete the task 1 by leaving the car at the service station. This can be an **example of non-linear planning.**
- There is a technique called constraint posting that often comes with Non-Linear Planning.The idea of constraint posting is to build up a plan by incrementally,
    - Adding or Suggesting Operators
    - Ordering Operators
    - Binding the variable to the Operators
- At any given time in problem solving process, we may have a set of useful operators but perhaps no clear idea of how those operators should be ordered with respect to each others.

WHAT IS A PLANNING HIERARCHY?

https://help.sap.com/docs/SAP_ERP_SPV/04ed152d92884a6da49c778a13aecb21/cd6cbd534f22b44ce10000000a174cb4.html

Definition

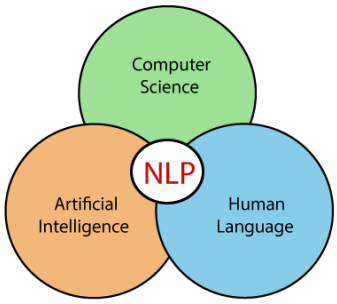
- A planning hierarchy represents the organizational levels and units in your company for which you want to plan.
- A planning hierarchy is a combination of characteristic values based on the characteristics of one information structure .
- Planning hierarchies provide a framework for your planning activities in consistent planning and level-by-level planning. With these planning methods, a planning hierarchy must exist for the information structure before you can plan its key figures.
- You can create only one planning hierarchy for an information structure. However, a hierarchy can have as many different branches as you like.

- When using consistent planning, you can create the planning hierarchies automatically using the Master Data Generator .
- For Standard SOP (info structure SO76), you can generate the planning hierarchy using report RMCPSOP or RMCPSOPP, based on the existing planning data in the info structure.

WHAT IS NLP?

https://www.javatpoint.com/nlp#What

- NLP stands for Natural Language Processing, which is a part of Computer Science, Human language, and Artificial Intelligence.
- It is the technology that is used by machines to understand, analyse, manipulate, and interpret human's languages.
- It helps developers to organize knowledge for performing tasks such as translation, automatic summarization, Named Entity Recognition (NER), speech recognition, relationship extraction, and topic segmentation.



Advantages of NLP

- 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.
- NLP helps computers to communicate with humans in their languages.
- It is very time efficient.
- Most of the companies use NLP to improve the efficiency of documentation processes, accuracy of documentation, and identify the information from large databases.

Disadvantages of NLP

- NLP may not show context.
- NLP is unpredictable
- NLP may require more keystrokes.
- NLP is unable to adapt to the new domain, and it has a limited function that's why NLP is built for a single and specific task only.

Components of NLP

There are the following two components of NLP -

1. Natural Language Understanding (NLU)

- Natural Language Understanding (NLU) helps the machine to understand and analyse human language by extracting the metadata from content such as concepts, entities, keywords, emotion, relations, and semantic roles.

- NLU mainly used in Business applications to understand the customer's problem in both spoken and written language.

NLU involves the following tasks -

- It is used to map the given input into useful representation.
- It is used to analyze different aspects of the language.

2. Natural Language Generation (NLG)

Natural Language Generation (NLG) acts as a translator that converts the computerized data into natural language representation. It mainly involves Text planning, Sentence planning, and Text Realization.

Note: The NLU is difficult than NLG.

DIFFERENCE BETWEEN NLU AND NLG

NLU	NLG
NLU is the process of reading and interpreting language.	NLG is the process of writing or generating language.
It produces non-linguistic outputs from natural language inputs.	It produces constructing natural language outputs from non-linguistic inputs.

APPLICATIONS OF NLP

There are the following applications of NLP -

1. Question Answering
Question Answering focuses on building systems that automatically answer the questions asked by humans in a natural language.

2. Spam Detection
Spam detection is used to detect unwanted e-mails getting to a user's inbox.

3. Sentiment Analysis
Sentiment Analysis is also known as **opinion mining**. It is used on the web to analyse the attitude, behaviour, and emotional state of the sender. This application is implemented through a combination of NLP (Natural Language Processing) and statistics by assigning the values to the text (positive, negative, or natural), identify the mood of the context (happy, sad, angry, etc.)

4. Machine Translation
Machine translation is used to translate text or speech from one natural language to another natural language.
Example: Google Translator

5. Spelling correction
Microsoft Corporation provides word processor software like MS-word, PowerPoint for the spelling correction.

6. Speech Recognition

Speech recognition is used for converting spoken words into text. It is used in applications, such as mobile, home automation, video recovery, dictating to Microsoft Word, voice biometrics, voice user interface, and so on.

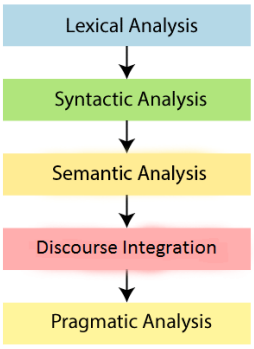
7. Chatbot
Implementing the Chatbot is one of the important applications of NLP. It is used by many companies to provide the customer's chat services.

8. Information extraction
Information extraction is one of the most important applications of NLP. It is used for extracting structured information from unstructured or semi-structured machine-readable documents.

9. Natural Language Understanding (NLU)
It converts a large set of text into more formal representations such as first-order logic structures that are easier for the computer programs to manipulate notations of the natural language processing.

PHASES OF NLP

There are the following five phases of NLP:



1. Lexical Analysis and Morphological
The first phase of NLP is the Lexical Analysis. This phase scans the source code as a stream of characters and converts it into meaningful lexemes. It divides the whole text into paragraphs, sentences, and words.

2. Syntactic Analysis (Parsing)
Syntactic Analysis is used to check grammar, word arrangements, and shows the relationship among the words.
Example: Agra goes to the Poonam
In the real world, Agra goes to the Poonam, does not make any sense, so this sentence is rejected by the Syntactic analyzer.

3. Semantic Analysis
Semantic analysis is concerned with the meaning representation. It mainly focuses on the literal meaning of words, phrases, and sentences.

4. Discourse Integration
Discourse Integration depends upon the sentences that proceeds it and also invokes the meaning of the sentences that follow it.

5. Pragmatic Analysis
Pragmatic is the fifth and last phase of NLP. It helps you to discover the intended effect by applying a set of rules that characterize cooperative dialogues.
For Example: "Open the door" is interpreted as a request instead of an order.

NLP LIBRARIES

1. **Scikit-learn:** It provides a wide range of algorithms for building machine learning models in Python.
2. **Natural language Toolkit (NLTK):** NLTK is a complete toolkit for all NLP techniques.
3. **Pattern:** It is a web mining module for NLP and machine learning.
4. **TextBlob:** It provides an easy interface to learn basic NLP tasks like sentiment analysis, noun phrase extraction, or pos-tagging.
5. **Quepy:** Quepy is used to transform natural language questions into queries in a database query language.
6. **SpaCy:** SpaCy is an open-source NLP library which is used for Data Extraction, Data Analysis, Sentiment Analysis, and Text Summarization.
7. **Gensim:** Gensim works with large datasets and processes data streams.

DIFFERENCE BETWEEN NATURAL LANGUAGE AND COMPUTER LANGUAGE

Natural Language	Computer Language
Natural language has a very large vocabulary.	Computer language has a very limited vocabulary.
Natural language is easily understood by humans.	Computer language is easily understood by the machines.
Natural language is ambiguous in nature.	Computer language is unambiguous.

NATURAL LANGUAGE PROCESSING - SYNTACTIC ANALYSIS

https://www.tutorialspoint.com/natural_language_processing/natural_language_processing_syntactic_analysis.htm

https://www.geeksforgeeks.org/syntactically-analysis-in-artificial-intelligence/

- Syntactic analysis or parsing or syntax analysis is the third phase of NLP.
- The purpose of this phase is to draw exact meaning, or you can say dictionary meaning from the text.
- Syntax analysis checks the text for meaningfulness comparing to the rules of formal grammar.
- For example, the sentence like "hot ice-cream" would be rejected by semantic analyzer.
- In this sense, syntactic analysis or parsing may be defined as the process of analyzing the strings of symbols in natural language conforming to the rules of formal grammar.
- The origin of the word ***'parsing'*** is from Latin word ***'pars'*** which means ***'part'***.
- Parsing is the process of studying a string of words in order to determine its phrase structure using grammatical rules.

Types of Parsing

Derivation divides parsing into the followings two types –

- **Top-down Parsing** : In this kind of parsing, the parser starts constructing the parse tree from the start symbol and then tries to transform the start symbol to the input. The most common form of topdown parsing uses recursive procedure to process the input. The main disadvantage of recursive descent parsing is backtracking.
- **Bottom-up Parsing :** In this kind of parsing, the parser starts with the input symbol and tries to construct the parser tree up to the start symbol.

We can start with the S sign and search **top-down** for a tree with the words as its leaves, or we can start with the words and **search bottom** up for a tree that ends in an S.

Top-down and bottom-up parsing, on the other hand, can be wasteful since they might result in the same amount of effort being used on parts of the search space that lead to dead ends.

List of items	Rule
S	
$NPVP$	$S \rightarrow NPVP$
$NPVP$ Adjective	$VP \rightarrow VP$ Adjective
NP Verb Adjective	$VP \rightarrow$ Verb
NP Verb dead	Adjective $\rightarrow$ dead
NP is dead	Verb $\rightarrow$ is
Article Noun is dead	NP $\rightarrow$ Article Noun
Article wumpus is dead	Noun $\rightarrow$ wumpus
the wumpus is dead	Article $\rightarrow$ the

NATURAL LANGUAGE PROCESSING - SEMANTIC ANALYSIS

- The purpose of semantic analysis is to draw exact meaning, or you can say dictionary meaning from the text. The work of semantic analyzer is to check the text for meaningfulness.
- Semantic Analysis is a subfield of Natural Language Processing (NLP) that attempts to understand the meaning of Natural Language. Understanding Natural Language might seem a straightforward process to us as humans.
- *We already know that lexical analysis also deals with the meaning of the words, then **how is semantic analysis different from lexical analysis**? Lexical analysis is based on smaller token but on the other side semantic analysis focuses on larger chunks. That is why semantic analysis can be divided into the following two parts –*
- Semantic analysis starts with lexical semantics, which studies individual words' meanings (i.e., dictionary definitions).
- Semantic analysis then examines relationships between individual words and analyzes the meaning of words that come together to form a sentence.
- This analysis provides a clear understanding of words in context. For example, it provides context to understand the following sentences:
  - "The boy ate the apple" defines an apple as a fruit.
  - "The boy went to Apple" defines Apple as a brand or store.

Parts of Semantic Analysis

Semantic Analysis of Natural Language can be classified into two broad parts:

1. Lexical Semantic Analysis: Lexical Semantic Analysis involves understanding the meaning of each word of the text individually. It basically refers to fetching the dictionary meaning that a word in the text is deputed to carry.

2. Compositional Semantics Analysis: Although knowing the meaning of each word of the text is essential, it is not sufficient to completely understand the meaning of the text.
For example, consider the following two sentences:

- **Sentence 1:** Students love GeeksforGeeks.
- **Sentence 2:** GeeksforGeeks loves Students.

Tasks involved in Semantic Analysis

In order to understand the meaning of a sentence, the following are the major processes involved in Semantic Analysis:

1. Word Sense Disambiguation
2. Relationship Extraction

DISCOURSE AND PRAGMATIC PROCESSING IN NLP

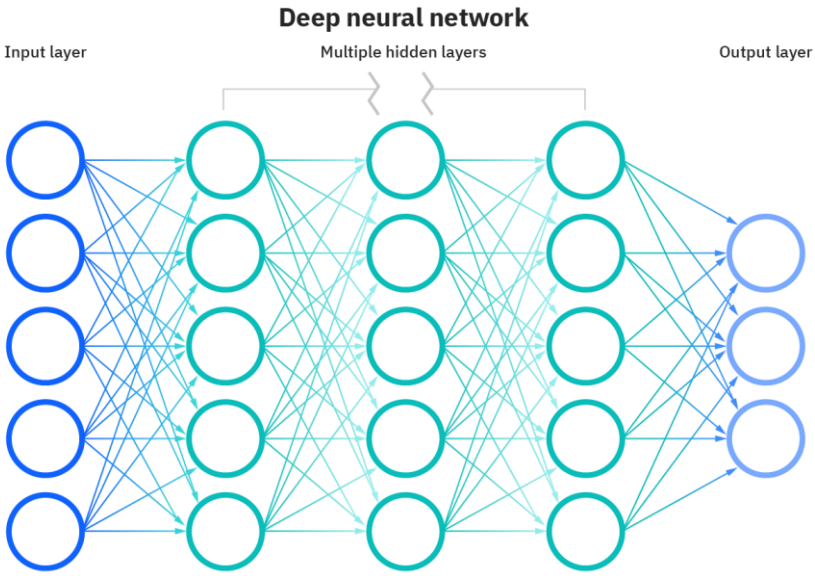
What is pragmatic processing?
It means abstracting the meaningful use of language in situations.
In this analysis, the main focus always on what was said is reinterpreted on what is intended.

What is discourse processing in language?
Studies of discourse processing focus on the ways in which readers and listeners comprehend language. The linguistic segments of interest to the field tend to be larger than sound, word, or sentence-level units they include the books and conversational communications that comprise our everyday cognitive and social.

What is difference between discourse and pragmatics?
Pragmatics and Discourse Analysis involve the study of language in its contexts of use.
Pragmatics focuses on the effects of context on meaning, and Discourse Analysis studies written and spoken language in relation to its social context.

ARTIFICIAL NEURAL NETWORK

- Neural networks, also known as artificial neural networks (ANNs) or simulated neural networks (SNNs) are a subset of machine learning and are at the heart of deep learning algorithms.
- Their name and structure are inspired by the human brain, mimicking the way that biological neurons signal to one another.
- Artificial neural networks (ANNs) are comprised of a node layers, containing an input layer, one or more hidden layers, and an output layer.
- Each node, or artificial neuron, connects to another and has an associated weight and threshold.
- If the output of any individual node is above the specified threshold value, that node is activated, sending data to the next layer of the network. Otherwise, no data is passed along to the next layer of the network.
- The term "Artificial neural network" refers to a biologically inspired sub-field of artificial intelligence modeled after the brain.
- Similar to a human brain has neurons interconnected to each other, artificial neural networks also have neurons that are linked to each other in various layers of the networks. These neurons are known as nodes.



Input Layer:
As the name suggests, it accepts inputs in several different formats provided by the programmer.

Hidden Layer:
The hidden layer presents in-between input and output layers. It performs all the calculations to find hidden features and patterns.

Output Layer:
The input goes through a series of transformations using the hidden layer, which finally results in output that is conveyed using this layer.

The artificial neural network takes input and computes the weighted sum of the inputs and includes a bias. This computation is represented in the form of a transfer function.

$$\sum_{i=1}^{n} \mathrm{Wi} * \mathrm{Xi} + \mathrm{b}$$

It determines weighted total is passed as an input to an activation function to produce the output. Activation functions choose whether a node should fire or not. Only those who are fired make it to the output layer. There are distinctive activation functions available that can be applied upon the sort of task we are performing.

$$\sum_{i=1}^{m} w_i x_i + bias = w_1 x_1 + w_2 x_2 + w_3 x_3 + bias$$

∑wixi + bias = w1x1 + w2x2 + w3x3 + bias

$$\text{output} = f(x) = \begin{cases} 1 \text{ if } \sum w_1 x_1 + b \geq 0 \\ 0 \text{ if } \sum w_1 x_1 + b < 0 \end{cases}$$

TYPES OF NEURAL NETWORKS

Feed-Forward Neural Networks

- Feed-forward neural networks are one of the more simple types of neural networks.

- It conveys information in one direction through input nodes; this information continues to be processed in this single direction until it reaches the output mode.
- Feed-forward neural networks may have hidden layers for functionality, and this type of most often used for facial recognition technologies.

Recurrent Neural Networks

- A more complex type of neural network, recurrent neural networks take the output of a processing node and transmit the information back into the network.
- This results in theoretical "learning" and improvement of the network. Each node stores historical processes, and these historical processes are reused in the future during processing.
- This becomes especially critical for networks in which the prediction is incorrect the system will attempt to learn why the correct outcome occurred and adjust accordingly.
- This type of neural network is often used in text-to-speech applications.

Convolutional Neural Networks

- Convolutional neural networks, also called ConvNets or CNNs, have several layers in which data is sorted into categories.
- These networks have an input layer, an output layer, and a hidden multitude of convolutional layers in between.
- The layers create feature maps that record areas of an image that are broken down further until they generate valuable outputs.
- These layers can be pooled or entirely connected, and these networks are especially beneficial for image recognition applications.

Deconvolutional Neural Networks

- Deconvolutional neural networks simply work in reverse of convolutional neural networks.
- The application of the network is to detect items that might have been recognized as important under a convolutional neural network.
- These items would likely have been discarded during the convolutional neural network execution process.
- This type of neural network is also widely used for image analysis or processing.

Modular Neural Networks

- Modular neural networks contain several networks that work independently from one another.
- These networks do not interact with each other during an analysis process.
- Instead, these processes are done to allow complex, elaborate computing processes to be done more efficiently.
- Similar to other modular industries such as modular real estate, the goal of the network independence is to have each module responsible for a particular part of an overall bigger picture.

APPLICATIONS OF ARTIFICIAL NEURAL NETWORKS

1. Social Media

- Artificial Neural Networks are used heavily in Social Media.
- For example, let's take the **'People you may know'** feature on Facebook that suggests you people that you might know in real life so that you can send them friend requests. Well, this magical effect is achieved by using Artificial Neural Networks that analyze your profile, your interests, your current friends, and also their friends and various other factors to calculate the people you might potentially know.
- Another common application of Machine Learning in social media is **facial recognition**. This is done by finding around 100 reference points on the person's face and then matching them with those already available in the database using convolutional neural networks.

2. Marketing and Sales

- When you log onto E-commerce sites like Amazon and Flipkart, they will recommend your products to buy based on your previous browsing history. Similarly, suppose you love Pasta, then Zomato, Swiggy, etc. will show you restaurant recommendations based on your tastes and previous order history.
- This is true across all new-age marketing segments like Book sites, Movie services, Hospitality sites, etc. and it is done by implementing **personalized marketing**.
- This uses Artificial Neural Networks to identify the customer likes, dislikes, previous shopping history, etc. and then tailor the marketing campaigns accordingly.

3. Healthcare

- Artificial Neural Networks are used in Oncology to train algorithms that can identify cancerous tissue at the microscopic level at the same accuracy as trained physicians.
- Various rare diseases may manifest in physical characteristics and can be identified in their premature stages by using **Facial Analysis** on the patient photos.
- So the full-scale implementation of Artificial Neural Networks in the healthcare environment can only enhance the diagnostic abilities of medical experts and ultimately lead to the overall improvement in the quality of medical care all over the world.

4. Personal Assistants

- We have heard of Siri, Alexa, Cortana, etc. These are personal assistants and an example of speech recognition that uses **Natural Language Processing** to interact with the users and formulate a response accordingly.
- Natural Language Processing uses artificial neural networks that are made to handle many tasks of these personal assistants such as managing the language syntax, semantics, correct speech, the conversation that is going on, etc.

5. Weather Forecasting

- The forecasts done by the meteorological department were never accurate before artificial intelligence came into force.
- Weather Forecasting is primarily undertaken to anticipate the upcoming weather conditions beforehand.
- In the modern era, weather forecasts are even used to predict the possibilities of natural disasters.
- Multilayer Perceptron (MLP), Convolutional Neural Network (CNN) and Recurrent Neural Networks (RNN) are used for weather forecasting.
- Traditional ANN multilayer models can also be used to predict climatic conditions 15 days in advance.
- A combination of different types of neural network architecture can be used to predict air temperatures.

6. Signature Verification and Handwriting Analysis

- Signature Verification , as the self explanatory term goes, is used for verifying an individual's signature. Banks, and other financial institutions use signature verification to cross check the identity of an individual.
- Usually a signature verification software is used to examine the signatures. As cases of forgery are pretty common in financial institutions, signature verification is an important factor that seeks to closely examine the authenticity of signed documents.
- Artificial Neural Networks are used for verifying the signatures. ANN are trained to recognize the difference between real and forged signatures. ANNs can be used for the verification of both offline and online signatures.

- For training an ANN model, varied datasets are fed in the database. The data thus fed help the ANN model to differentiate. ANN model employs image processing for extraction of features.
- Handwriting analysis plays an integral role in forensics. The analysis is further used to evaluate the variations in two handwritten documents. The process of spilling words on a blank sheet is also used for behavioural analysis. Convolutional Neural Networks (CNN) are used for handwriting analysis and handwriting verification.

DISTRIBUTED REPRESENTATIONS IN NLP

- The name "distributed representation" is mainly driven by the fact that the representation of any single concept is distributed over many, if not all, processing units. In many cases, the unit values in the vectors are continuous values, instead of just 1's and 0's.
- Neural networks use distributed representation to store knowledge which means that a concept is represented not by a single neuron, but by a pattern of activation over a large number of neurons.
- Distributed representation has two evident advantages with respect to a distributed local representation: it is more efficient (in the example, the representation uses only 3 numbers instead of 9) and it does not treat each element as being equally different to any other
- This is the true value of a distributed representation: its ability to capture meaningful "semantic similarity" between between data through concepts.

WHAT IS SYMBOLIC AI?

(https://medium.com/codex/the-difference-between-symbolic-ai-and-connectionist-ai-c6a2556f9847)
(https://towardsdatascience.com/symbolic-vs-connectionist-a-i-8cf6b656927)

- Symbolic AI is more commonly known as rule-based AI, good old-fashioned AI (GOFA), and classic AI. Earlier AI development research was based on Symbolic AI which relied on inserting human behavior and knowledge in the form of computer codes.
- We humans have used symbols to drive meaning from things and events in the environment around us. For example, imagine you told your friend to buy you a bottle of Coke. Your friend would first have an image of a bottle of coke in his mind. This is the very idea behind the symbolic AI development, that these symbols become the building block for cognition.
- Any application made with Symbolic AI has a combination of characters signifying real-world concepts or entities through a series of symbols. These symbols can easily be arranged through networks and lists or arranged hierarchically. Such arrangements tell the AI algorithms how each symbol is related to each other in totality.
- Information in Symbolic AI is processed through something that is called an expert system. It is where the if/then pairing directs the algorithm to the parameters on which it can behave. These expert systems are man-made knowledge bases. The inference engine is a term given to a component that refers to the knowledge base and selects rules to apply to given symbols.

WHAT IS A CONNECTIONIST AI?

- Earlier experts focused on the symbolic type AI for many decades however, the Connectionist AI is more popular now. This AI is based on how a human mind functions and its neural interconnections. This technique of AI software development is also sometimes called a perceptron to signify a single neuron.
- An application built with Connectionist AI tends to get more intelligent as we keep on feeding data and learning patterns and relations associated with the environment and with itself. On the other hand, symbolic AI gets hand-coded. To understand connectionist AI let's take the **example** of an artificial neural network. Each one is made up of hundreds of single units processing elements and artificial neurons. They are a layered format with weights forming connections with this structure where weights are adjustable parameters.
- In Connectionist AI all the processing elements have weighted units, output, and a transfer function. However, it is to keep in mind that the transfer function assesses multiple inputs and then it combines them into a single output value. Each weight in the algorithm efficiently evaluates directionality and importance and eventually the weighted sum is the component that activates the neuron. When all is done then the activated signal passes through the transfer function and produces one output.

NLP VS NLU VS. NLG SUMMARY

Natural language processing (NLP)

- NPL seeks to convert unstructured language data into a structured data format to enable machines to understand speech and text and formulate relevant, contextual responses.
- Its subtopics include natural language processing and natural language generation.
- Natural Language Processing (NLP) is a subset of Artificial intelligence which involves communication between a human and a machine using a natural language than a coded or byte language.
- It provides the ability to give instructions to machines in a more easy and efficient manner.

Natural language understanding (NLU)

- NLU focuses on machine reading comprehension through grammar and context, enabling it to determine the intended meaning of a sentence.
- Natural Language Understanding(NLU) is an area of artificial intelligence to process input data provided by the user in natural language say text data or speech data.
- It is a way that enables interaction between a computer and a human in a way like humans do using natural languages like English, French, Hindi etc.

Natural language generation (NLG)

- NLG focuses on text generation, or the construction of text in English or other languages, by a machine and based on a given dataset.
- Natural Language Generation(NLG) is a sub-component of Natural language processing that helps in generating the output in a natural language based on the input provided by the user.
- This component responds to the user in the same language in which the input was provided say the user asks something in English then the system will return the output in English.

	Natural Language Processing (NLP)	Natural Language Understanding (NLU)	Natural Language Generation (NLG)
1	It was first started by Alan Turing to make the machine understand the context of any document rather than treating it as simple words.	This explores the ways which enable the computers to grasp instructions provided by users in human languages like English, Hindi etc.	This enables the computers to produce the output after understanding the input given by the user in natural languages like English, Hindi etc.
2	It came into existence around 1950.	This concept began around 1866.	It came into existence around 1960.
3	It has 5 phases which are lexical analysis, syntax analysis, semantic analysis, disclosure integration and pragmatic analysis.	It has 3 phases, first paraphrasing the input information, second text conversion to other languages and third drawing inferences from the given information.	It also has 3 phases, first understanding the information, second formulating ways to provide output and third achieving the realization of giving output in natural languages.
4	Applications of NLP are Smart assistance, language translation, text analysis etc.	Applications of NLU are Speech recognition, sentiment analysis, spam filtering etc	Applications of NLG are Chatbots, Voice assistants etc.
5	It makes use of sensors for input and uses different layers for processing data and then provides output.	Sensors and processors are used to take input and process the information.	After understanding and processing, actuators are used to provide output.
6	It converts instructions from natural language to computer language and then the computer returns the information again in natural language after processing.	Converts the unstructured data provided by the user to structured or meaningful information.	It generates structured data for the user.
7	It utilizes different strategies to understand the natural language and give feedback accordingly.	It involves different analysis phases.	It has different generation phases.
8	It utilizes a learning mechanism to provide efficient results.	It first converts the natural language to machine language for understanding.	It formulates the plan for text utterance.

UNIT 5

DEVELOPMENT PROCESS IN AI

- The AI development process generally involves three parts: Big Data, Machine Learning, and Deep Learning.
- There are three phases of AI: Artificial Narrow Intelligence (ANI) Artificial General Intelligence (AGI) Artificial Super Intelligence (ASI)

Big Data

- When taking the AI journey, there are still many businesses don't realize the importance of data management.
- Businesses bring data scientist experts to extract, consolidate, clean, and analyze data is indeed a critical step in the process.
- By analyzing data, useful and essential information is kept, organized, and used appropriately.
- Having your data finely sorted will help you avoid null values, duplicated, and disparate data sources in the future.
- We can apply Big Data into many industries, the education industry is just one of many.
- We can customized programs and schemes for each individual needs according to their learning history and goals.
- Not only the learning programs can be tailored but the course material can also be reframed.

Machine Learning

- Although machine learning is indeed a type of AI, there are some notions that separate them apart.
- AI is a much bigger concept of creating intelligent machines that can imitate human behavior and thinking ability while machine learning is a subset of AI that indicates a machine learning from data without being programmed.
- To be precise, machine learning allows computers to make predictions and decisions according to structured and semi-structured big data.
- But the machine learning algorithm only works for specific domains, for instance, we are creating a machine learning model to detect pictures of cars; it will only give out the result for car images.
- Machine learning is like how marketers use and compare data to predict trends and come up with strategies influence customer behaviors.
- From cleaning to analyzing data and defining KPIs.
- Virtual assistants like Siri, Alexa, and Google are the three most well-known products of machine learning.
- Another example of machine learning is email spam and malware filtering detected automatically.

Deep Learning

- Because machine learning's capability still relies on the data available, human actions are still needed when there is an absence of information or when machine learning makes an error.
- This is where deep learning jumps in. Deep learning is also a subfield of AI, and it powers the most human-like artificial intelligence.
- Deep learning and machine learning share some similarities; however, what makes them different is its ability to establish where their prediction is accurate or inaccurate.
- Deep learning has the capability to reflect on the decision it made and improve the skills based on past experiences.
- Deep learning is the critical technology behind voice control in consumers' smart devices and driverless cars. Its applications are widely used in various industries like automated driving, medical devices, aerospace, and defense, industrial automation, and electronics, etc.
- This cutting edge technology brings multiple benefits, one of which is the ability to create new features and establish advanced analysis capabilities.
- Deep learning algorithms can create new tasks to solve the issues it's facing now. Data scientists can save much time when working with big data.
- One of the clear examples of Deep Learning is Chatbot. This tool is incredibly useful to help customers more effectively and efficiently. It recommends all necessary answers for almost every confusion.

KNOWLEDGE ACQUISITION IN AI

Expert systems (ES) are one of the prominent research domains of AI. It is introduced by the researchers at Stanford University, Computer Science Department.

What are Expert Systems?

The expert systems are the computer applications developed to solve complex problems in a particular domain, at the level of extra-ordinary human intelligence and expertise.

Components of Expert Systems

The components of ES include –

- Knowledge Base
- Inference Engine
- User Interface

Knowledge Base

- It contains domain-specific and high-quality knowledge.
- Knowledge is required to exhibit intelligence.
- The success of any ES majorly depends upon the collection of highly accurate and precise knowledge.

What is Knowledge?

The data is collection of facts. The information is organized as data and facts about the task domain. **Data, information,** and **past experience** combined together are termed as knowledge.

Components of Knowledge Base

The knowledge base of an ES is a store of both, factual and heuristic knowledge.

- **Factual Knowledge** – It is the information widely accepted by the Knowledge Engineers and scholars in the task domain.
- **Heuristic Knowledge** – It is about practice, accurate judgement, one's ability of evaluation, and guessing.

Knowledge representation

It is the method used to organize and formalize the knowledge in the knowledge base. It is in the form of IF-THEN-ELSE rules.

Knowledge Acquisition

- The success of any expert system majorly depends on the quality, completeness, and accuracy of the information stored in the knowledge base.
- The knowledge base is formed by readings from various experts, scholars, and the **Knowledge Engineers**.
- The knowledge engineer is a person with the qualities of empathy, quick learning, and case analyzing skills.
- He acquires information from subject expert by recording, interviewing, and observing him at work, etc. He then categorizes and organizes the information in a meaningful way, in the form of IF-THEN-ELSE rules, to be used by interference machine. The knowledge engineer also monitors the development of the ES.

Benefits of Expert Systems

- **Availability** – They are easily available due to mass production of software.
- **Less Production Cost** – Production cost is reasonable. This makes them affordable.

- **Speed** – They offer great speed. They reduce the amount of work an individual puts in.
- **Less Error Rate** – Error rate is low as compared to human errors.
- **Reducing Risk** – They can work in the environment dangerous to humans.
- **Steady response** – They work steadily without getting motional, tensed or fatigued.

PROLOG

What is Prolog

- Prolog stands for programming in logic.
- In the logic programming paradigm, prolog language is most widely available.
- Prolog is a declarative language, which means that a program consists of data based on the facts and rules (Logical relationship) rather than computing how to find a solution. A logical relationship describes the relationships which hold for the given application.
- To obtain the solution, the user asks a question rather than running a program. When a user asks a question, then to determine the answer, the run time system searches through the database of facts and rules.
- The first Prolog was 'Marseille Prolog', which is based on work by Colmerauer. The major example of fourth-generation programming language was prolog. It supports the declarative programming paradigm.
- In 1981, a Japanese computer Project of 5^{th} generation was announced. After that, it was adopted Prolog as a development language. In this tutorial, the program was written in the 'Standard' Edinburgh Prolog. Prologs of PrologII family are the other kind of prologs which are descendants of Marseille Prolog.
- Prolog features are 'Logical variable', which means that they behave like uniform data structure, a backtracking strategy to search for proofs, a pattern-matching facility, mathematical variable, and input and out are interchangeable.
- To deduce the answer, there will be more than one way. In such case, the run time system will be asked to find another solution. To generate another solution, use the backtracking strategy. Prolog is a weakly typed language with static scope rules and dynamic type checking.
- Prolog is a declarative language that means we can specify what problem we want to solve rather than how to solve it.
- Prolog is used in some areas like database, natural language processing, artificial intelligence, but it is pretty useless in some areas like a numerical algorithm or instance graphics.
- In artificial intelligence applications, prolog is used. The artificial intelligence applications can be automated reasoning systems, natural language interfaces, and expert systems. The expert system consists of an interface engine and a database of facts. The prolog's run time system provides the service of an interface engine.

Applications of Prolog

The applications of prolog are as follows:

- Specification Language
- Robot Planning
- Natural language understanding
- Machine Learning
- Problem Solving
- Intelligent Database retrieval
- Expert System
- Automated Reasoning

Types of Prolog

Prolog is used to provide the Tuples, lists, numbers, atoms, and patterns.

1. Simple Types

This type of Prolog is implementation-dependent. The following table shows the implementation of a simple type of prolog:

TYPE	VALUES
Boolean	true, fail
Variables	variables
Integer	integers
Atom	character sequence
Real	floating point number

- The Boolean constants are not passed as an argument.
- Variables describe the character string.
- The character strings start with a capital letter or upper case letter.
- Atoms are constants that have no numerical value.
- All the atoms start with a lower case letter or small letter.

2. Composition Types

- The distinction between data and program are blurred in prolog.
- In the argument, data is often passed to predicates.
- In prolog, the most common data structure is lists. Lists are much like the stack in which we can only sequentially access the lists of elements, and much like the array in which we have a list of elements sequentially.
- Prolog is used to allow arbitrary patterns as data, and that pattern represents tuples.
- An array is not provided by Prolog. But single or multidimensional arrays may be represented as a list or list of lists. The array can also be represented by a set of facts in the database.

TYPE REPRESENTATION [comma separated sequence of items] list pattern sequence of items

Using the square brackets ([]+), a prolog list can represent.

The following example shows a list of fruits: [mango, grapes, orange]

The above list shows the elements mango, grapes, and orange. In prolog list, the elements are ordered. If there are no indexes, the elements will also be ordered. Using the patterns, the tuples can be represented.

Example

book(author(aaby,anthony),title(lab$_m$anual),data(1991))

Using the pattern matching, the elements of tuples can be accessed.

book(Title,Author,Publisher,Date).author(LName,FName).

LIST MANIPULATION

Includes functions for list manipulation.

ListAppend Function **:** `ListAppend (lList, aElem)` : Adds an item to the end of a list.

ListCount Function **:** `iCount = ListCount (lList)` : Returns the number of items in a list.

ListDelete Function : Deletes an item from a list. `ListDelete (lList, iIndex)`

ListFind Function : Finds an item in a list. `iPos = ListFind (lList, aItem)`

ListInsert Function : Inserts a new item into a list at any position. `ListInsert (lList, iIndex, aItem)`

ListMerge Function : Merges two lists. `ListMerge (lOrig, lMerge [, iMergePos])`

ListPrint Function : Prints a list to the results file.
ListRead Function : Reads a list from a file into a list variable.
ListSort Function : Sorts a list based on the type of data it contains and replaces the original list with the sorted list.
ListWrite Function : Writes the contents of a list to a newly created file or overwrites the contents of an existing file.
SYS_ListRead Function : Reads a list from a file on a target machine into a list variable.
SYS_ListWrite Function : Writes the contents of a list to a file on a target machine.

DIFFERENCE BETWEEN RECURSION AND ITERATION

1. **Time Complexity:** Finding the Time complexity of Recursion is more difficult than that of Iteration.
   - **Recursion**: Time complexity of recursion can be found by finding the value of the nth recursive call in terms of the previous calls. Thus, finding the destination case in terms of the base case, and solving in terms of the base case gives us an idea of the time complexity of recursive equations.
   - **Iteration**: Time complexity of iteration can be found by finding the number of cycles being repeated inside the loop.

2. **Usage:** Usage of either of these techniques is a trade-off between time complexity and size of code. If time complexity is the point of focus, and number of recursive calls would be large, it is better to use iteration. However, if time complexity is not an issue and shortness of code is, recursion would be the way to go.
   - **Recursion**: Recursion involves calling the same function again, and hence, has a very small length of code. However, as we saw in the analysis, the time complexity of recursion can get to be exponential when there are a considerable number of recursive calls. Hence, usage of recursion is advantageous in shorter code, but higher time complexity.
   - **Iteration**: Iteration is repetition of a block of code. This involves a larger size of code, but the time complexity is generally lesser than it is for recursion.

3. **Overhead:** Recursion has a large amount of Overhead as compared to Iteration.
   - **Recursion**: Recursion has the overhead of repeated function calls, that is due to repetitive calling of the same function, the time complexity of the code increases manyfold.
   - **Iteration**: Iteration does not involve any such overhead.

4. **Infinite Repetition:** Infinite Repetition in recursion can lead to CPU crash but in iteration, it will stop when memory is exhausted.
   - **Recursion**: In Recursion, Infinite recursive calls may occur due to some mistake in specifying the base condition, which on never becoming false, keeps calling the function, which may lead to system CPU crash.

- **Iteration**: Infinite iteration due to mistake in iterator assignment or increment, or in the terminating condition, will lead to infinite loops, which may or may not lead to system errors, but will surely stop program execution any further.

On the basis of	Recursion	Iteration
Basic	Recursion is the process of calling a function itself within its own code.	In iteration, there is a repeated execution of the set of instructions. In Iteration, loops are used to execute the set of instructions repetitively until the condition is false.
Syntax	There is a termination condition is specified.	The format of iteration includes initialization, condition, and increment/decrement of a variable.
Termination	The termination condition is defined within the recursive function.	Here, the termination condition is defined in the definition of the loop.
Code size	The code size in recursion is smaller than the code size in iteration.	The code size in iteration is larger than the code size in recursion.
Infinite	If the recursive function does not meet to a termination condition, it leads to an infinite recursion. There is a chance of system crash in infinite recursion.	Iteration will be infinite, if the control condition of the iteration statement never becomes false. On infinite loop, it repeatedly used CPU cycles.
Applied	It is always applied to functions.	It is applied to loops.
Speed	It is slower than iteration.	It is faster than recursion.
Usage	Recursion is generally used where there is no issue of time complexity, and code size requires being small.	It is used when we have to balance the time complexity against a large code size.
Time complexity	It has high time complexity.	The time complexity in iteration is relatively lower. We can calculate its time complexity by finding the no. of cycles being repeated in a loop.
Stack	It has to update and maintain the stack.	There is no utilization of stack.
Memory	It uses more memory as compared to iteration.	It uses less memory as compared to recursion.
Overhead	There is an extensive overhead due to updating and maintaining the stack.	There is no overhead in iteration.

Property	Recursion	Iteration
Definition	Function calls itself.	A set of instructions repeatedly executed.
Application	For functions.	For loops.
Termination	Through base case, where there will be no function call.	When the termination condition for the iterator ceases to be satisfied.
Usage	Used when code size needs to be small, and time complexity is not an issue.	Used when time complexity needs to be balanced against an expanded code size.
Code Size	Smaller code size	Larger Code Size.
Time Complexity	Very high(generally exponential) time complexity.	Relatively lower time complexity(generally polynomial-logarithmic).

DIFFERENCE BETWEEN ARRAY AND LIST

Now, we have a brief introduction and features. Here, we will discuss the differences between the Array and List.

Sr. No	List	Array
1.	The list can store the value of different types.	It can only consist of value of same type.
2.	The list cannot handle the direct arithmetic operations.	It can directly handle arithmetic operations.
3.	We need to import the array before work with the array.	The lists are the build-in data structure so we don't need to import it.
4.	The lists are less compatible than the array to store the data.	An array are much compatible than the list.
5.	It consumes a large memory.	It is a more compact in memory size comparatively list.

6.	It is suitable for storing the longer sequence of the data item.	It is suitable for storing shorter sequence of data items.
7.	We can print the entire list using explicit looping.	We can print the entire list without using explicit looping.
8.	It can be nested to contain different types of elements.	It must contain either all nested elements of same size.