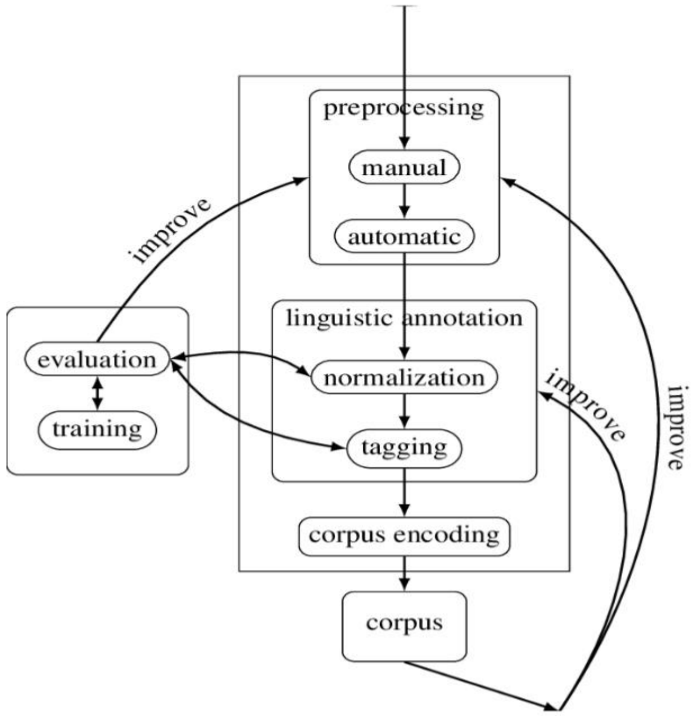
MODULE 2
Design Principles for Cognitive Systems

Components of cognitive system: -
There are 3 essential components of a cognitive computing system.

- **A way of interpreting input**: A cognitive computing system needs to answer a question or provide a result based on an input. That input might be a search term, text phrase, a query asked in natural language, or it may be a response to an action of some sort.
- **A body of content/information that supports the decision**: The purpose of cognitive computing is to help humans make choices and solve problems. But the system does not make up the answer. Even synthesis of new knowledge is based on foundational knowledge.
- **A way of processing the signal against the content/info corpus:** This is where machine learning for example comes into play. ML has for long been applied to categorization and classification approaches, and advanced text analytics. The processing might be in the form of a query/matching algorithm or may involve other mechanisms to interpret the query, transform it, reduce ambiguity, derive syntax, define word sense, deduce logical relationships or otherwise parse/process the signal against the corpus.

Let's dive a bit deeper by looking at some of the pieces that make up such components.

Building the Corpus: -

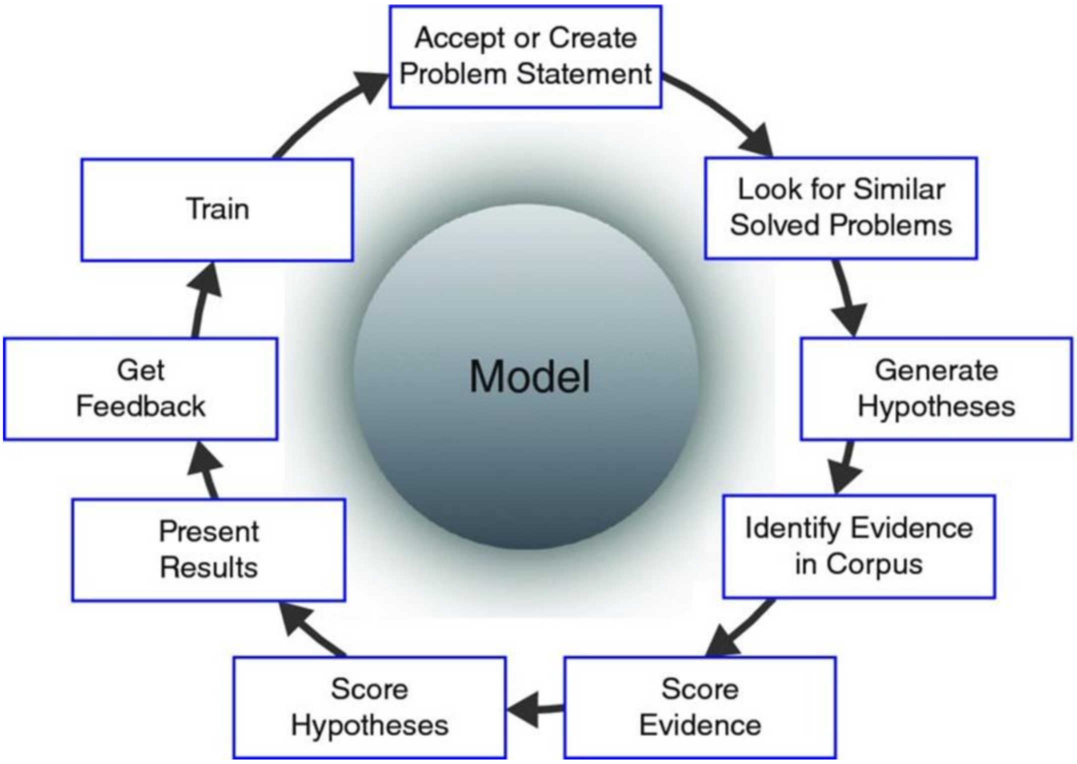


Machine Learning:-

- Machine Learning refers to algorithms that can learn from data without relying on standard programming practices such as object oriented programming.
- Machine learning algorithms analyze data, learn from them and make decisions. It uses input data and uses statistical analysis to predict outputs.
- The most common languages to develop machine learning applications are R and Python.

- Machine learning divides into two types. They are called supervised learning and unsupervised learning.
- In supervised learning, we train a model, so it predicts the future instances accordingly. A labeled dataset helps to train this model.
- The labeled dataset consists of inputs and corresponding outputs.
- Based on them, the system can predict the output for new input.
- Further, the two types of supervised learning are regression and classification.
- Regression predicts the future outcomes based on the previously labeled data whereas classification categorizes the labeled data.
- In unsupervised learning, we do not train a model.
- Instead, the algorithm itself discovers the information on its own.
- Therefore, unsupervised learning algorithms use unlabeled to data to come to the conclusions.
- It helps to find groups or clusters from unlabeled data. Usually, unsupervised learning algorithms are difficult than supervised learning algorithms.

Cognitive Computing	Machine Learning
The technoology that refers to new hardware and/or software that mimics the functioning of the human brain and helps to improve the decision making process.	Algorithms that use the statistical techniques to give computers to learn from data and to progressively improve performance on a specific task.
It basis on a Technology	It basis on set of algorithms
It gives the ability for a computer to simulate and complement human's cognitive abilities to make decisions.	Allows developing self-learning algorithms to analyze data, learn recognize patterns and make decisions accordingly



Hypothesis Generation and Scoring: -
Hypothesis generation is an educated “guess” of various factors that are impacting the business problem that needs to be solved using machine learning.
Hypothesis Generation is a category that includes three specific techniques:

- Simple Hypotheses is the easiest to use but not always the best selection.
- Use the Multiple Hypotheses Generator to identify a large set of all possible hypotheses.
- Quadrant Hypothesis Generation is used to identify a set of hypotheses when the outcome is likely to be determined by just two driving forces.

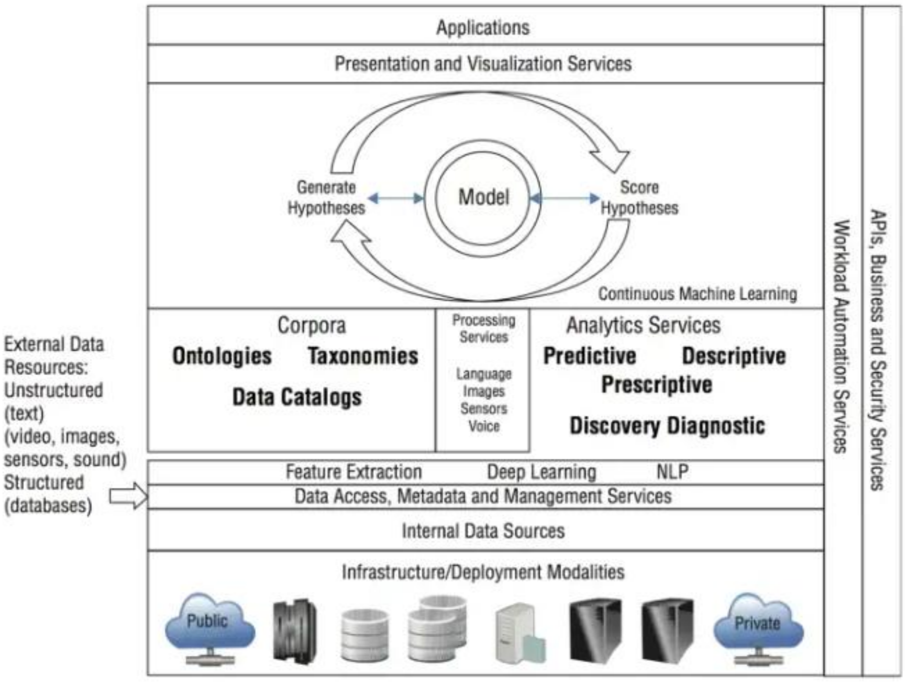
Example: -

- A hypothesis is formulated to answer a question about a phenomenon based on some evidence that made it plausible(seeming likely to be true, or able to be believed).
- The experimental process is designed to test whether the hypothesis applies in the general case, not just with the evidence that was used to develop the hypothesis.
- In a typical cognitive computing system, there are two key ways a hypothesis may be generated. The first is in response to an explicit question from the user, such as “What might cause my fever of 102 and sore throat?”
- In this scenario, the cognitive computing application must look for plausible explanations.
- It could, for example, start by presenting all the possible conditions in which you might expect to see these symptoms. (Each condition would be a candidate hypothesis explaining the symptoms.)
- Alternatively, it may recognize that there are too many answers to be useful and request more information from the user to refine the set of likely causes.
- This approach to hypothesis generation is frequently used when the goal is to detect a relationship between cause and effect in a domain
- The second type of hypothesis generation does not depend on a user asking a specific question. Instead, the system constantly looks for anomalous data patterns that may indicate threats or opportunities.
- Detecting a new pattern creates a hypothesis based on the nature of the data.
- For example, if the system is monitoring network sensors to detect threats, a new pattern may create a hypothesis that this pattern is a threat, and the system must either find evidence to support or refute that hypothesis.
- The next step is to evaluate or score these hypotheses based on the evidence in the corpus, and then update the corpus and report the findings to the user or another external system.

Hypothesis scoring: -

- Hypothesis scoring is a process in which the representation of the hypothesis is compared with data in the corpus to see what evidence exists to support the hypothesis, and what may actually refute it (or rule it out as a valid possible explanation).
- In fact, scoring or evaluating a hypothesis is a process of applying statistical methods to the hypothesis-evidence pairs to assign a confidence level to the hypothesis.
- The actual weights that are assigned to each piece of supporting evidence can be adjusted based on experience with the system and feedback during training and during the operational phase.

Presentation and Visualization Services: -



- Infrastructure → A highly parallelized and distributed environment, including compute and storage cloud services, must be supported.
- Data Access , Metadata & Management Services → Use of ingested data requires an understanding of the origins and lineage of that data and, as such, a way to classify the characteristics of that data (ex: when that text or data source was created, by whom, etc) which by the way are not static.
- Corpus, Taxonomies & Data Catalogs → Corpus is the knowledge base of ingested data and is used to manage codified knowledge. Such data is primarily be text-based (documents, textbooks, patient notes, customer reports, and such) but contemporarily there's support also for unstructured and semi-structured data (ex. videos, images, sounds)
- Data Analysis Services → these are the techniques used to develop understanding of the data ingested and managed within the corpus. A set of advanced algorithms are applied to develop the model for the cognitive system. The continuous machine learning procedure embraced by Cognitive Systems typically involves two sets of dynamics: (a) Hypotheses Generation and (b) Hypotheses Evaluation.
- Data Visualization → Last but not least, outcomes and results need to be represented visually to help make sense of recommendations/ findings. Patterns and relationships in data are easier to identify and understand when visualized with structure, color, and such.

Visualization Services: -

- Visualization services present data in non text forms, including:
- Graphics, ranging from simple charts and graphs to multidimensional representations of relationships between data.
- Images, selected from the data to be presented or generated from an underlying representation. (For example, if feature o extraction detects a "face" object, a visualization service could generate a "face" or pictograph from a standard features library.)
- Gestures or animation of data designed to convey meaning or emotion.

The two major design considerations for cognitive computing infrastructure decisions are:

- Distributed Data Management—For all but the smallest applications, cognitive computing systems can benefit from tools to leverage distributed external data resources and to distribute their operational workloads. Managing the ongoing ingestion of data from a variety of external sources requires a robust infrastructure that can efficiently import large quantities of data.

- Parallelism—The fundamental cognitive computing cycle of hypothesis generation and scoring can benefit enormously from a software architecture that supports parallel generation/scoring of multiple hypotheses, but performance ultimately depends on the right hardware.