Page NO.

1. 1 to 18 – Mid Term
2. 19 to 36- Final Term

MD IFTAKHAR KABIR SAKUR

25th BATCH

COMPUTER AND COMMUNICATION ENGINEERING

International Islamic University Chittagong

COURSE CODE: CCE-4803

COURSE TITLE: Artificial Intelligence

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CCE-4803 [Mid] 16.02.24

Artificial Intelligence

Intelligence:-

7 types:- ① Verbal
② Logical
③ Visual
④ Bodily
⑤ Musical / Rythmic
⑥ Social
⑦ Intra-personal

What is AI:-

AI means Artificial Intelligence. A new technical science that studies & develops theories, methods, techniques & application systems for simulating & extending human intelligence.

What is ML:-

A core research field of AI.

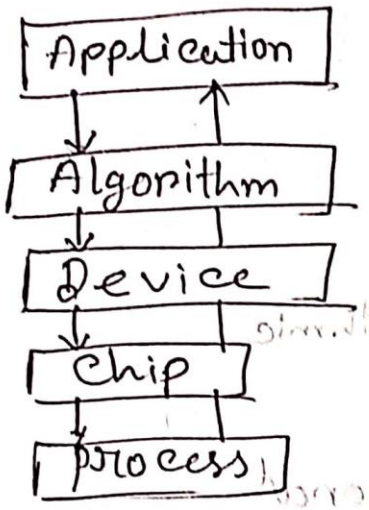
How computers can obtain new knowledge or skills by simulating or performing learning behavior of human beings. And improves its existence knowledge.

Deep learning:-

DL aims to simulate the human brains to interpret data such as images, sounds

& texts.

Overview of AI Tech:-



Types of AI:-

① **Strong AI:-** possible to create intelligent machines that can solve problems. Such machines are considered to be conscious & self aware. And can think independently. Can find optimal solutions to problems. Have their own system of values & world views. Survival & security.

② **Weak AI:-** The weak AI view holds that intelligent machines can't really reason & solve problems. This machines only look intelligent but don't have real intelligence or self awareness.

③ Super AI:- Also known as Artificial SuperIntelligent AI. A hypothetical s/w based AI system that surpasses human Intelligence.

Have various skills, advance thinking skills. It's an emerging technology that simulates human emotions, reasoning & experiences in AI systems

But ASI can lead to:-

- Genocide
- Job less
- The creation of biological weapons
- Human extinction etc.

Classification of Intelligent Robots:-

4 types:-

(1) Thinking like human beings :- weak AI (Watson, Alpha Go)

(2) Acting like Human beings :- weak AI (such as humanoid robot, iRobot etc)

(3) Thinking rationally (Strong AI [In real life there are none]

(4) Acting rationally :- Strong AI

AI Industry echo system:-

Four elements of AI:-

(i) Data
(ii) Algorithm
(iii) Computing power
(iv) Scenario.

Sub-Fields OF AI:-

① Computer visions	⑥ Robot
② NLP	⑦ Database Technology
③ Speech processing	⑧ visualization
④ Machine Learning	
⑤ Data mining	

Computer vision Application :-

Most matured technology among the three AI technologies.

Ex:- Image classification, Target detection, image segmentation, target tracking etc.

Voice processing Application:-

→ It includes voice recognition, voice synthesis, voice wakeup etc.

In a quite indoor environment the recognition accuracy can reach 96%.

Other application:-

→ Spoken language evaluation
→ Diagnostic robot
→ voiceprint recognition
→ Smart sound box

NLP Application Scenario:-

Main topic of NLP:- Machine Translation, Text mining & sentiment analysis.

NLP imposes high requirements on tech but confronts low tech maturity.

ex!- Knowledge graph, Intelligent copywriting, video subtitle

AI Application Field (Intelligent Security)

This field involves massive datas, images & videos laying a sound foundation for training of AI algorithms & models.

AI technologies are used in two direction in the security protection field

(i) Civil use (Facial recognition)

(ii) Police use (Suspect identification, vehicle analyses, Suspect tracking etc)

Smart Home

Based on IOT technologies smart home is formed with Hardware, Software & cloud platform

Smart City

Social Management :- AI + security
AI + protection
AI + Energy.

Three phases of AI:-

There are three phases of AI:-

(i) Computing Intelligence → Storage & computing (Distributed computing & Neural Network)

(ii) perceptual Intelligence → Big data, quick process → [Capable of listening & seeing (Camera with facial recognition)]

(iii) Cognitive intelligence → [capable of understanding & thinking]

~~Ability~~

Search Algorithm in AI

properties :-

(i) Completeness:- Said to be Complete if it guarantees to return a solution if at least any solution exists for any random input.

(ii) Optimality:- If a solution found for an algorithm is guaranteed to be the best solution among all other solution.

(iii) Time complexity:- A measure of time for an algorithm to complete its task.

(iv) Space complexity :- Maximum storage space required at any point during the search.

~~Breadth First~~

Types of Search Algorithm :-

2 Types :-

① Uniformed / Blind Search :-

Iterative way. Brute Force Algorithm.

Uniformed search algorithms do not have additional information about state / search space other than how to traverse the tree.

6 types :-

(i) Breadth First Search :-

→ Most commonly used algorithm.

→ It traverse whole tree from root of a node on a current level & then moves to the other after finishing it.

→ BFS algorithm is an example of a general graph search algorithm.

→ FIFO data structure.

(ii) Depth First Search:-

- The process is similar to BFS.
- Uses recursion algorithm for traversing
- Uses stack data structure for its implementation.

(iii) Depth Limited Search Algorithm:-

- Similar to DFS.
- It solves the drawback of DFS.

(iv) Uniform Cost Search Algorithm:-

- Used for traversing a weighted tree or graph.
- Expands node according to the path cost from the root.
- Can be same to BFS if all cost are same.

(v) Iterative deeping Depth First Search:-

- Combination of DFS & BFS algorithm.
- Finds the best depth limit & does it by gradually increasing the limit until a goal is found.

(vi) Bidirectional Search Algorithm:- Runs two searches:-

- Search from initial position (Forward)
- " " goal " (Backward)

(2) Informed Search Algorithms :-

Information available which can guide the search. It is also called as Heuristic Search. Heuristic is a way which might not always be guaranteed to be the best but a good solution.

(i) Best First Search :-

→ Combination of BFS & DFS

↳ Always selects the path that is the best.

(ii) A* Search Algorithm

→ Known as best-first search

→ Uses heuristic function h(n).

→ Combination of UCS & Greedy Best-First Search

$$F(n) = g(n) + h(n)$$

17. Gradient Descent:-

A optimization algorithm used to find the values of parameters that minimizes the cost function.

Cost function is a measure of how well the model predicts the target values.

$$a_{n+1} = a_n - \gamma * \nabla F(a_n)$$

where

a = is the point

γ = is the step size

$F(x)$ = multi variable function

[Midterm - 24th Batch]

Explain AI, ML, DL

AI	ML	DL
① Simulating human intelligence.	① Learning from data	① Neural Networks with multiple layers.
② Broad scope.	② Subset of AI	② Subset of ML.
③ Human action	③ Algorithms & models	③ Neural Network based.
④ Various techniques & methodologies	④ Data driven learning	④ Representation learning.
⑤ Depend on ML & DL	⑤ Data-dependent	⑤ Neural Network dependent.
⑥ Ex:- Robotics	⑥ Decision trees, SVMs etc	⑥ CNN, etc.

1[b] AI Industry Ecosystem:-

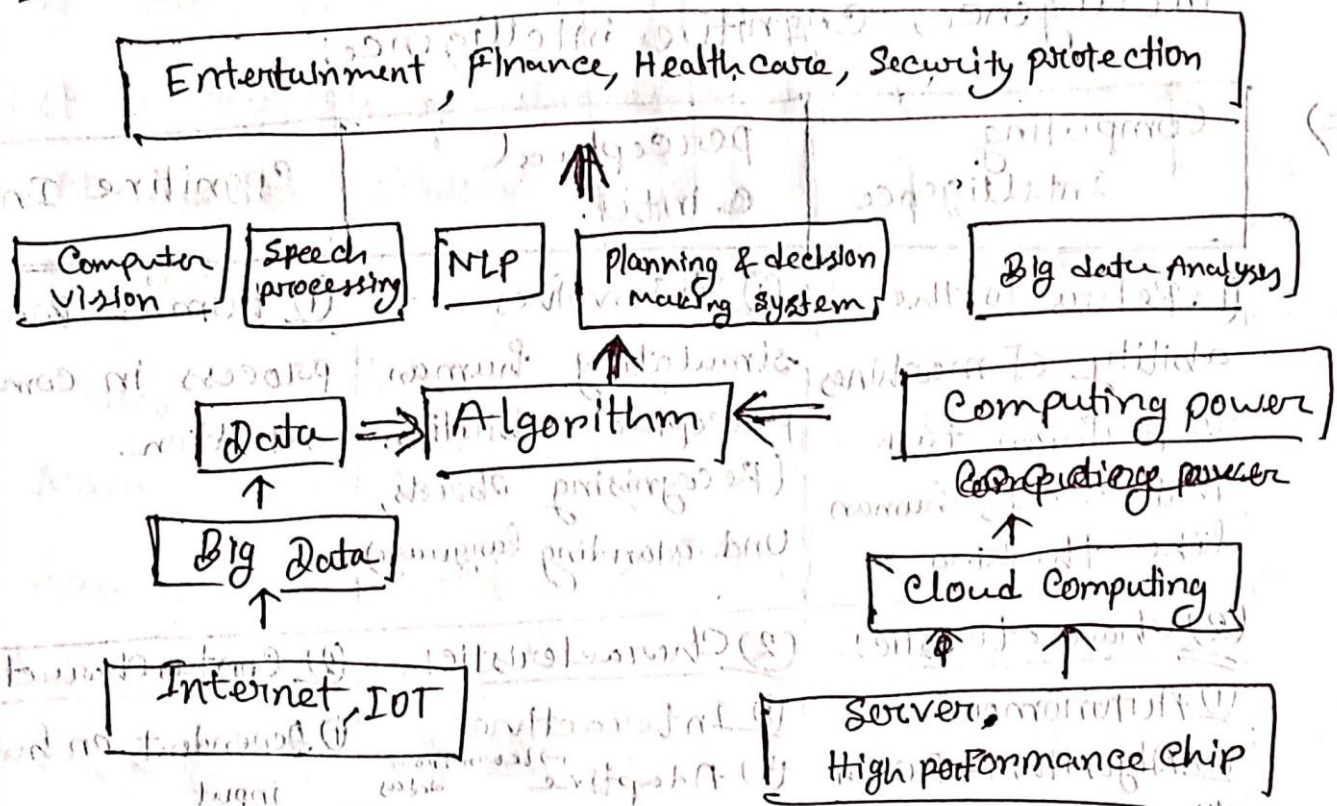


Fig:- AI, Industry Ecosystem.

[4] Compare between

1(c)

Compare between computing intelligence, perceptual intelligence, cognitive intelligence:-

⇒

Computing Intelligence	perceptual Intel.	Cognitive Intl.
(1) Refers to the ability of machines to perform task that needs human like thinking.	(1) Involves simulating human perceptual abilities. (Recognising Objects, Understanding language)	(1) Human Brain process in complex situation
(2) Characteristic:- (i) Autonomous (ii) Algorithm-Driven (iii) Areas of Focus	(2) Characteristic:- (i) Interactive (ii) Adaptive → Learn from data (iii) Stateful (iv) Contextual	(2) ~~Cont~~ Characteristic:- (i) Dependent on human input (ii) Agent of Business process (iii) Human Interaction.
(3) Limitations:- (i) Lack of self-explanation (ii) Data Dependance (iii) Not expressive	(3) Limitation:- (i) Handling large data is a problem (ii) Complex training (iii) Non-Adaptability	(3) Limitation → Dependency → Purpose → Authorship
(4) Example:- Autonomous vehicles	(4) Example:- Voice assistance like Siri	(4) Example:- IBM's watson

2(a) Single Layer perception:-

It is one of the simplest types of Artificial Neural Network.

It is a feed-Forward Network based on a threshold transfer function.

Main function is it takes input from the input layer & computes their sum. Then the sum is passed through a nonlinear activation function to produce the output.

2(b) what is hidden layers? Show it with necessary diagram, describe the impact of hidden layer.

=> Hidden layers:- This is what makes neural networks deep & enable them to learn complex data representations.

This layer process the data by applying complex non-linear functions.

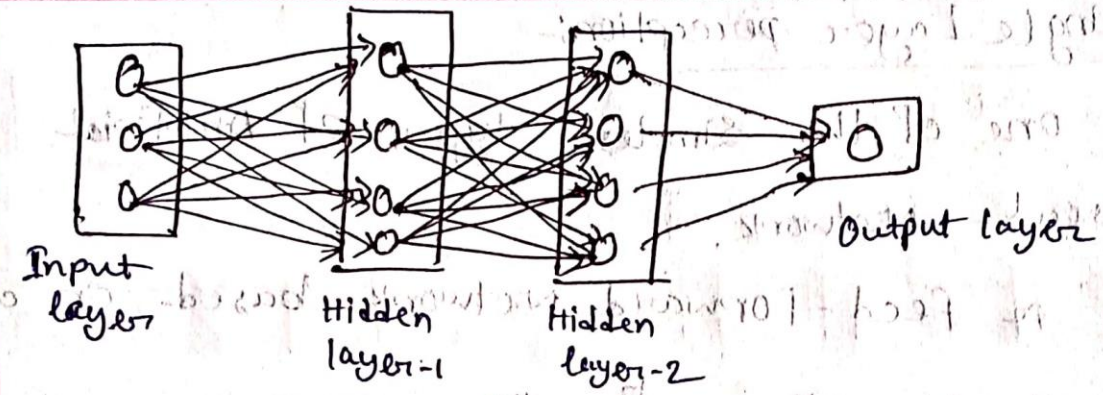


Fig:- Hidden Layer

Importance of Hidden layer:-

(1) Complexity & Representation:- Hidden layers allow neural networks to approximate functions & capture intricate patterns.

(2) Non-linearity:- These function helps enabling neural Networks.

(3) Feature Extraction:- Hidden layer performs it.

Impact of Hidden layers:-

(1) Complexity:- Makes suitable for complex tasks. like Image recognition, NLP etc.

(2) Depth vs width:- Deeper networks learns more complex representations but requires more data. width captures more input info. but may overfit.

(3) Regularization :- Techniques like dropout & early stopping help prevent overfitting.

Gradient Descent

=> Iterative optimization algorithm used to minimize the cost function by adjusting the parameters of a model.

How does the learning rate effect the gradient descent :-

The learning rate is very crucial part in gradient descent algorithms. It determines the size of the steps taken towards the minimum of the loss function during each iteration.

(i) Large learning rate :- Large learning rate can cause instability in the optimization process, resulting in erratic behavior & poor performance.

(ii) Small learning Rate :- Small learning rate slows down the convergence of the model.

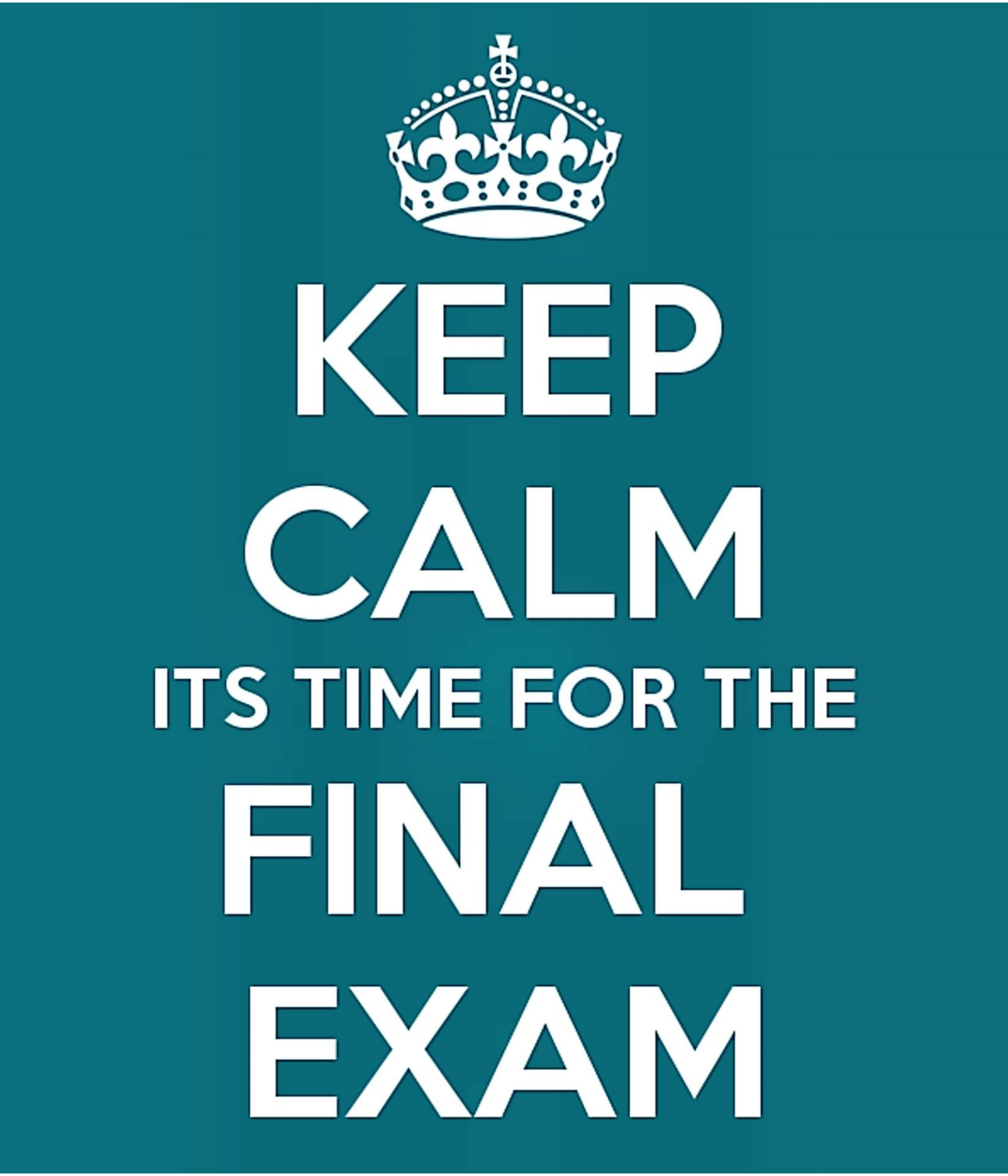
(iii) Optimal Learning rate :- It allows the model to converge efficiently. ~~without~~

(v) Impact on Gradient Descent:-

→ A higher learning rate means larger updates

↳ The learning rate acts as a scale factor.

(To be continued)


KEEP
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ITS TIME FOR THE
FINAL
EXAM

Artificial Intelligent (FINAL)

TOPIC:- Decision Making in AI

What is decision making in AI:-

→ Process of using AI techniques to make choices

→ Involves several steps:- Data collection, preprocessing, analysis, and prediction

→ Based on these, AI algorithms can generate recommendations & take actions autonomously.

Game Theory:-

→ Predefined rules & outcomes

→ Player or agent is a rational entity.

→ All players abide by certain rules.

→ Game theory has now become a describing factor for both ML algorithms & many daily life situations.

SVM & Game Theory :-

→ SVM is a game between 2 players where one player challenges the other to find the best hyper-plane after providing the most difficult points for classification.

→ Final playoff of this game is a solution that will be a trade-off between the strategic abilities of both players competing.

Nash Equilibrium :-

→ Consider as the essence of Game Theory.

→ A collaboration of multiple players in the game.

→ It guarantees max profits to each player.

GAN's

→ Generative Adversarial Networks

→ Combination of two Neural Network :- ① Discriminator
② Generator

→ Takes input images & then produce new sample images

→ Once produced they are sent to Descriminator. Neural Network. (DNN)

→ This NN judges the Images sent to it & classifies them as generated images & actual input images.

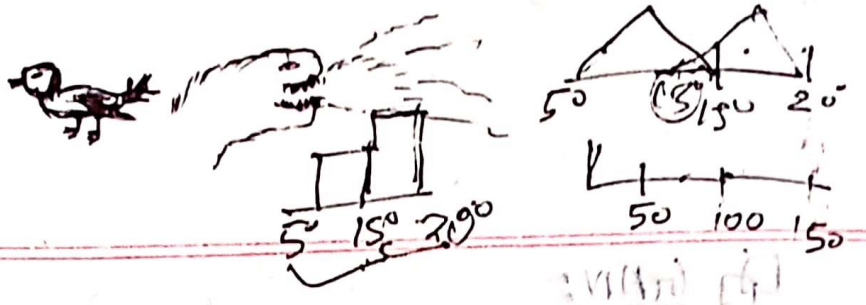
→ If the image is classified as original image, DNN changes its parameters of judging.

→ If the image = generated image, image is rejected & returned to GAN.

→ GNN then alters its parameters in order to improve the quality of the image produced

→ It continues, until both Neural Networks are satisfied.

→ GAN is a 2-player competitive game where both players are continuously optimizing to find Nash Eq.



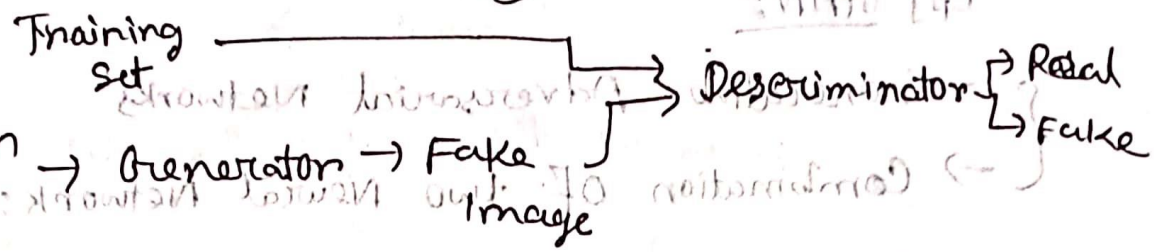


Fig:- GAN

TOPIC:- Fuzzy Logic

⇒ Complexity generally arises from Uncertainty.

⇒ Computer calculate more complex thing using its calculating skill.

Classical Set Theory:-

⇒ Based on the fundamental concept of a set in which individuals are either a member or not a member.

⇒ Ambiguous distinction exists between a member/non-member for any well defined set of entities.

→ In classical set theory an element is not allowed to be in a set of 1 or 0.

Sakur_E201037

Industrial Applications:-

- Mitsubishi (Fuzzy AC) First released 1989.
- Fisher, Sanyo, panasonic & canon (Fuzzy video Cameras)
- FUJtec & Toshiba have a fuzzy scheme that evaluates the passenger traffic & the elevator variables to determine car announcement & stopping time.
- Hitachi (subway system)
- Nissan (Anti lock breaking)

Uncertainty in Information:-

- Fuzzy sets provide similar to the human reasoning system.
- Student graduation এর পর আগের মতো স্কুলে যাওয়ার ভয় থাকে যা uncertainty. (example)
- All Info contains a certain degree of uncertainty.
- It can arise from factors like (Complexity, randomness, Ignorance, Imprecision).

Uncertainty & vagueness:-

→ Can also be called as fuziness.

→ Ex:- person's size, tall, their age is classified as young

→ If a person, tall / young it is impossible to decide if the person is in a set or not.

Why fuzzy sets:-

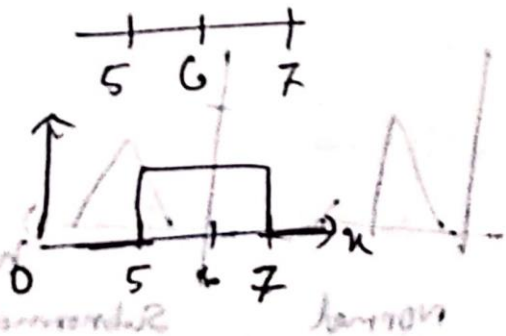
→ works in uncertain & ambigious situations & solve ill-posed problems.

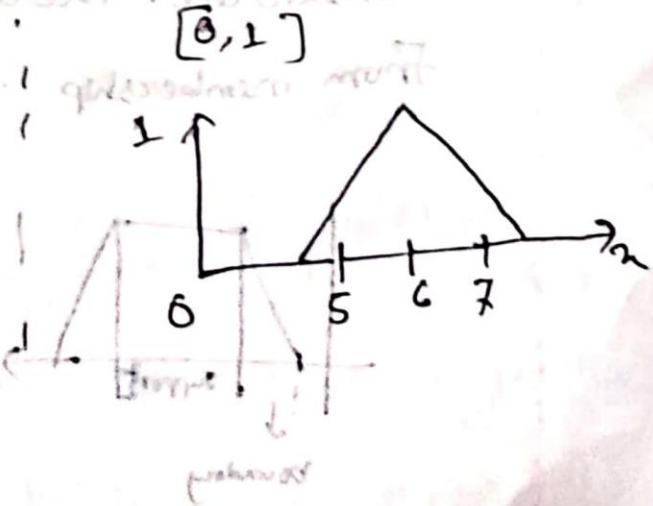
Comparison between Fuzzy & Classical Set Theory :-

Classical Set Theory	Fuzzy set Theory
① Object with sharp boundaries.	① Objects with unsharp boundaries.
② Is defined with Crisp. No certainty about the location of the set boundaries	② Its ambiguay boundary.
③ used in digital system	⑤ used in Fuzzy Controllers

Crisp Set vs Fuzz set

$$\mu_A = \begin{cases} 1 \\ 0 \end{cases}$$





Membership Function:-

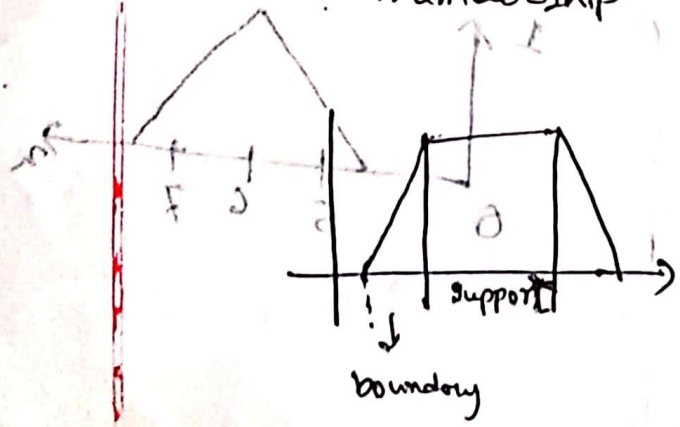
→ A curve that defines how each point in the input space is mapped to a membership value.

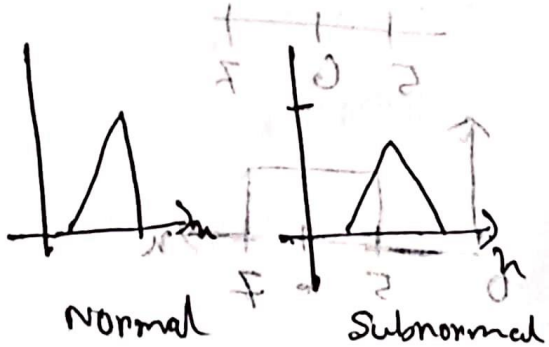
→ Input space is referred to as the universe of discourse

→ classifies the element in the set, whether it is discrete or continuous.

→ Can also be formed by graphical representation

→ The shape of the membership function is an important criterion that has to be considered. There are different methods from membership functions.





(a)

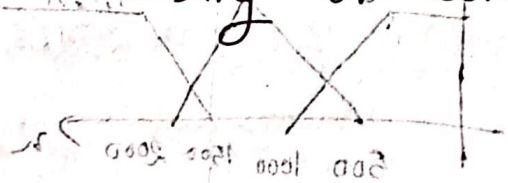
Fuzzy sets based on membership functions:-

Normal Fuzzyset:- At least one element in the universe. whole value = 1

Subnormal Fuzzyset:- Membership value < 1

Conver Fuzzyset:- Membership values monotonically increasing or decreasing.

Nonconver:- Membership values which are not strictly monotonically decreasing or both monotonically increasing.



⇒ Membership function can have different shapes triangle, Trapezoidal, Gaussian.

Fuzzification:-

→ Crisp quantities are converted to Fuzzy.

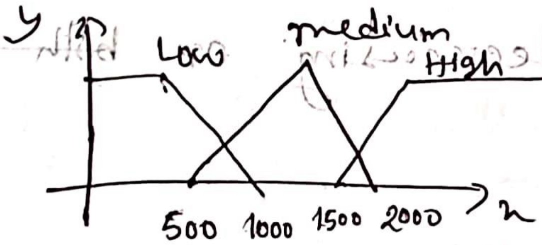
→ By identifying uncertainties we form the Fuzzy values.

Q) ⇒ Fuzzification is the process of changing a real scalar value into a fuzzy value. Achived by different types of Fuzzifiers.

[1] Membership value Assignments:-

(1) Intuition:- Based on the Human's own intelligence & understanding to develop membership functions.

Ex:- Speed of DC motor



(2) Inference

(3) Rank ordering

(4) Angular Fuzzy sets

(5) Neural Networks

(6) Genetic Algorithm.

(7) Inductive reasoning.

Defuzzification:-

→ Fuzzy to Crisp Conversions.

→ Fuzzy results generated can't be used in application.

→ So ~~daff~~ defuzzification is needed.

Fuzzy Rule based system

(*) Formation of Rules:-

(1) Assignment statements

(2) Conditional statements.

(3) Unconditional statements.

(1) Assignment Statements:-

→ variable is assigned with the value. Equal is used. Assigned in linguistic term.

→ y = low

climate = hot

a = 5.

② Conditional Statement:-

→ If conditions are satisfied then it enters into the following statement.

Ex:- If x=y then both are equal

③ Unconditional:-

→ No specific condition

Ex:- Go to F10
Push the value
Stop

④ Aggregation of Fuzzy rules:-

→ may involve more than one rule.

→ process of obtaining the overall conclusion.

Two methods:-

(i) Conjunctive System of rules

(ii) Disjunctive " " "

properties of set of rules:-

→ **Completeness:-** For a input there has to be output.

→ **Consistency:-** If-then inconsistent, if there are two rules with the same rule.

→ **Continuity:-** If-then rules is continuous if it does not have neighbouring rules

→ **Interaction:-** If x is A, then y is B.

Fuzzy Inference System:-

→ Also known as Fuzzy rule based system, Fuzzy model, Fuzzy expert system.

→ Major unit

→ Formulate suitable rules & based upon the rules the decision is made.

→ If-Then -- used to take necessary decision.

Construction & working of inference System

→ Consists of a fuzzification interface, a rule base, a database, a decision making unit. & finally a defuzzication interface.

Fuzzy interface System:-

→ A rules ~~database~~ contain IF-Then rules

→ Database defines Fuzzy sets

→ A decision-making unit (performs Inference operation on the rules).

→ Fuzzification interface transform crisp into degree.

→ Defuzzification Fuzzy result into crisp.

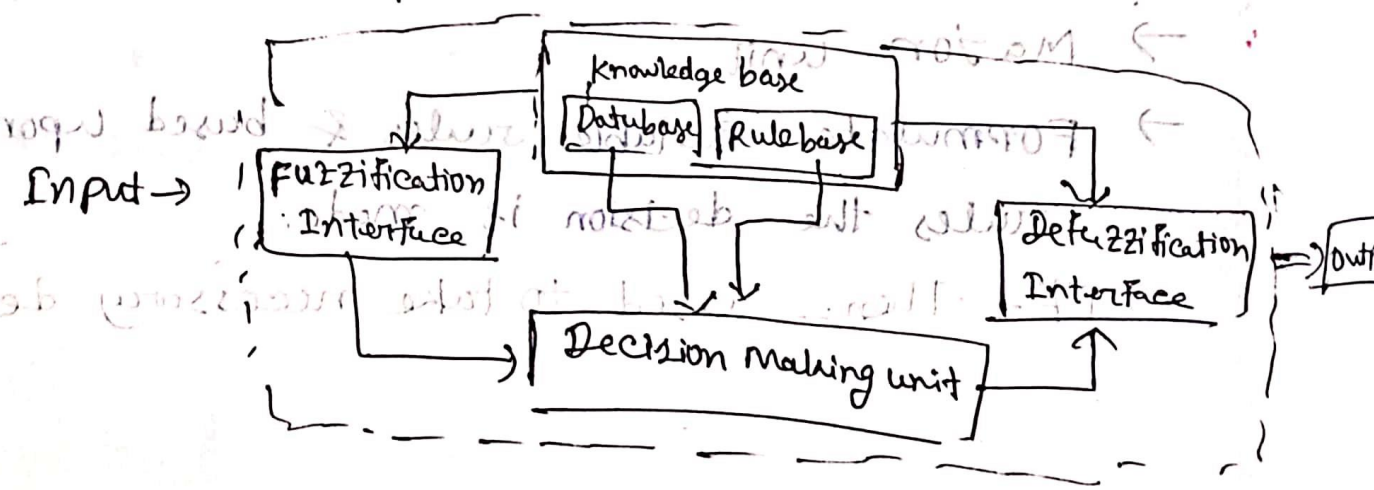


Fig:- Fuzzy Interface System.

FIS Method:-

(1) Mamdani Fuzzy Interface System (FIS) → To control steam engine & boiler combination

(2) Takagi-Sugeno " model TS method.

Computation of output of FIS:-

(1) Fuzzy rules to be determined

(2) Using input membership function, the input would be made Fuzzy.

(3) Establish the rule strength by combining Fuzzified inputs.

(4) Determine consequent rule (combine the rule strength & the output membership function).

(5) Output distribution (combine all)

(6) Defuzzified output.

Fuzzy Rules OF TSK!

→ IF x is A & y is B then, → Fuzzy sets

$z = f(x, y)$ → Crisp Function

example!-

1) IF x is small & y is small then, $z = -x+y+1$

2) if x is small & y is large, $z = -y+3$

3) " x " large & y " small " $z = -x+3$

4) " x " " & y " large " $z = x+y+2$

Takagi - Sugeno Fuzzy Model ~~as~~: TSM model:

IF x is A & y is B then z = f x,y

↓ Antecendents (A & B)

↓ Crisp

Works:-

(1) Inputs are made fuzzy

(2) Fuzzy operators are applied for output.

Comparison between Two Methods:-

(1) Output Membership Function:

→ The sugeno output membership func. are either linear or constant

(2) Aggregation & defuzzification:-

→ Difference available for this too.

(3) Mathematical Rules:

→ More mathematical Rules exist for Sugeno than Mamdani-

Sugeno

(4) Adjustable parameter: Sugeno Controller has more adjustable parameters than Mamdani: