Date: 24-10-2023

Artificial Intelligence and Its Applications

3rd Semester

<u>Assignement-2</u>

Q1. What is constraint propagation? Give a suitable example.

Q2. What is Dempster-Shafer theory? Explain with suitable example.

Q3. Find the value of the function "maximum" in hill- climbing, assuming the function to be negative of the number of tiles "out of place" in the 8-puzzle problem, give the initial and goal states as shown:

Initial State

2	8	3
1	6	4
7	–	5

Goal State

1	2	3
8	–	4
7	6	5

Q4. Describe classical relations and fuzzy relations in detail?

Q5. Explain Neuro-fuzzy System its modelling and control in detail.

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AI Assignment - 2

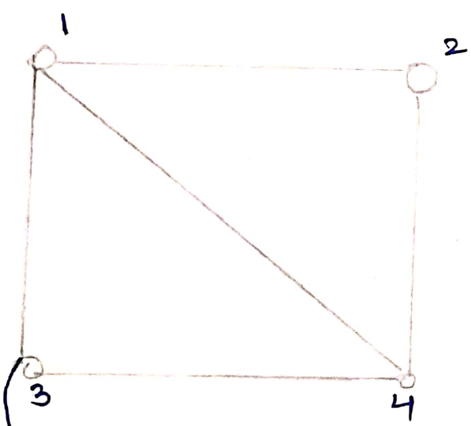
Q What is constraint Propagation? Give a suitable example?

ans) It is a technique used in constraint satisfaction problems (CSP) to reduce space of possible solutions by removing inconsistent values from the domain of variables

Example - Map Coloring Problem → Give color to vertices
constraint
⇒ Neighbours should not have same colour

Algorithm for CSP ⇒ Backtracking
↳ which is also used in Depth first Search

But in CSP we use Intelligent backtracking



4 nodes are to be colored

$V = \{1, 2, 3, 4\}$

$D = \{$ Red, Green, Blue $\}$

$C = \{1 \neq 2, 1 \neq 3, 1 \neq 4, 2 \neq 4, 3 \neq 4\}$

constraints while colouring

	1	2	3	4
Initial domain	R, G, B (i.e initially any colour may be given)	R, G, B	R, G, B	R, G, B
Let 1 = R	i.e. 1 = R	G, B (Possible domains) → called legals	G, B	G, B
2 = G	R	G	G, B	B
3 = B ↳ Backtrack Now	R	G	B	No legal value (No value satisfying constraint)
3 = G	R	G	G	B

Q What is Dampster Shafer Theory? Explain with suitable example?

ans) DST is an evidence theory, it combines all possible outcomes of the problem. Hence it is used to solve problems, where there may be a chance that a piece of different evidence that will lead to some different result.

The uncertainity in this model is given by-

① Consider all possible outcomes

② Evidence supports belief in some possibility, leading to a higher degree of belief in that specific possibility

③ Plausibility identifies the range of possible outcomes that are compatible with given evidence.

Example- In a room with A, B, C, D, B is found stabbed after lights go out. It is known B has not committed suicide. We have to find who the murderer is.

There are following possibilities:-

i) Either {A} or {C} or {D} has killed him

ii) Either {A, C} or {C, D} or {A, D} have killed him

iii) Or all three of them have killed i.e. {A, C, D}

iv) None of them have killed him {O} (let's say)

The power set of P (P is set of possible conclusions)

Power set contains 2^n elements whose n represents no. of elements in P

eg - If P={a, b, c} then power set is

{O, {a}, {b}, {c}, {a, d}, {d, c}, {a, c}

{a, c, d, y}} = 2^3 elements

The mass function m(K or B) represents evidence for {K or B}

The belief in K is sum of masses of the element which are subsets of K.

Example → Lets say K = {a, d, c}

Bel(K) = m(a) + m(d) + m(c) + m(a, d) + m(a, c) + m(d, c) + m(a, d, c)

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Plausibility in K: It is sum of masses of set that intersects with K

i.e. $Pl(K) = m(a) + m(d) + m(c) + m(a,d) + m(a,c) + m(a,d,c)$

Example ② A housewife finds a stain on her husband shirt. Her husband denies that it is a lipstick stain. She knows that applying a little C_2H_5OH to a stain & softening with washing up almost always removes lipstick stain. She also knows that this method hardly ever works on other stains. She applies this method to the shirt & finds that it removes the stains. As a result she concludes that it was almost certainly a lipstick stain.

$$P(X/Y) = \frac{P(X) \cdot P(Y/X)}{P(Y)}$$

$P(\text{lipstick}) = 0.25$

$P(\text{works}/\text{lipstick}) = 0.9$

$P(\text{works}) = 0.3$

$$P(\text{lipstick}/\text{works}) = \frac{P(\text{works}) \cdot P(\text{works}/\text{lipstick})}{P(\text{lipstick})}$$

$$= \frac{0.3(0.9)}{0.25} = 0.75 \rightarrow$$ one piece of evidence

$P(\text{late from office}/\text{lip}) = 0.6$

$P(\text{late}) = 0.5$

$$P(\text{lipstick}/\text{late}) = \frac{P(\text{lipstick}) * P(\text{late}/\text{lipstick})}{P(\text{late})}$$

$$= \frac{0.25(0.6)}{0.5} = 0.3 \rightarrow$$ 2nd piece of evidence

Then we measure plausibility

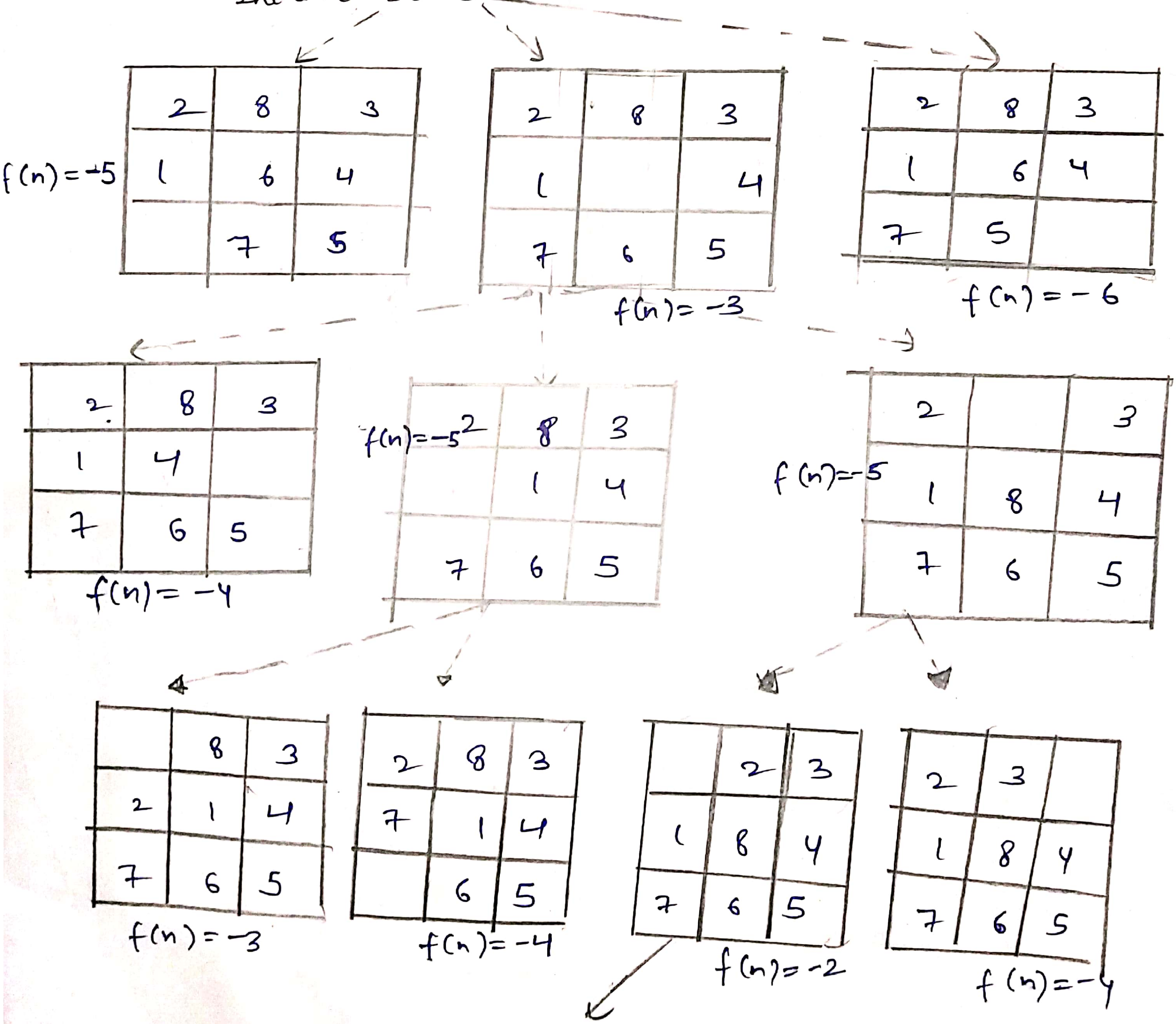
Q3 Find the value of function "maximum" in hill climbing, assuming the function to be negative of the number of tiles "out of place" in the the 8 puzzle problem given the initial & goal states as shown:-

2	8	3
1	6	4
7	–	5

Initial State

1	2	3
8	–	4
7	6	5

Goal State



1	2	3
	8	4
7	6	5

f(n) = -1

1	2	3
8		4
7	6	5

f(n) = 0

GOAL STATE

1	2	3
7	8	4
	6	5

f(n) = -2

Hence the value of function maximum in hill climbing is <u>0</u>

Q4 Describe classical relationship & fuzzy relations in detail

Fuzzy Relation :- Fuzzy relation relates element of one Universe (X) to those of another universe (Y) through the cartesian product of two universe.

$A \in X$, $B \in Y$, $R = A \times B \subset X \times Y$

if $A = \{(a, 0.2), (b, 0.7), (c, 0.4)\}$

& $B = \{(a, 0.5), (b, 0.6)\}$

$$\mu_R(X, Y) = \mu_{A \times B}(X, Y)$$
$$= \min[\mu_A(X), \mu_B(Y)]$$

$$\mu_R(X, Y) = \begin{array}{c c} & \begin{array}{cc} a & b \end{array} \\ \begin{array}{c} a \\ b \\ c \end{array} & \begin{bmatrix} 0.2 & 0.2 \\ 0.5 & 0.6 \\ 0.4 & 0.4 \end{bmatrix} \end{array}$$

The matrix representating a fuzzy is called "Fuzzy Matrix"

Operation on fuzzy Relation :-

(a) Union :- $\mu_{R \cup S}(x, y) = \max(\mu_R(x, y), \mu_S(x, y))$

Let $\mu_R(x, y) = \begin{array}{c c} & \begin{array}{cc} a & b \end{array} \\ \begin{array}{c} a \\ b \\ c \end{array} & \begin{bmatrix} 0.2 & 0.2 \\ 0.5 & 0.6 \\ 0.4 & 0.4 \end{bmatrix} \end{array}$

$\mu_S(x, y) = \begin{array}{c c} & \begin{array}{cc} a & b \end{array} \\ \begin{array}{c} a \\ b \\ c \end{array} & \begin{bmatrix} 0.3 & 0.5 \\ 0.1 & 0.4 \\ 0.3 & 0.6 \end{bmatrix} \end{array}$

$\mu_{R \cup S}(x, y) = \begin{array}{c c} & \begin{array}{cc} a & b \end{array} \\ \begin{array}{c} a \\ b \\ c \end{array} & \begin{bmatrix} 0.3 & 0.5 \\ 0.5 & 0.6 \\ 0.4 & 0.6 \end{bmatrix} \end{array}$

(b) Intersection :-

$$\mu_{R\cap S}(x,y) = \min(\mu_R(x,y), \mu_S(x,y))$$

$$\mu_{R\cap S}(x,y) = \begin{array}{c|cc} & a & b \\ \hline a & 0.2 & 0.2 \\ b & 0.1 & 0.4 \\ c & 0.3 & 0.4 \end{array}$$

(c) Complement :-

$$\mu_R(x,y) = \begin{array}{c|cc} a & 0.2 & 0.2 \\ b & 0.1 & 0.4 \\ c & 0.3 & 0.4 \end{array}$$

$$\overline{\mu_R(x,y)} = \begin{array}{c|cc} & a & b \\ \hline a & 0.8 & 0.8 \\ b & 0.5 & 0.4 \\ c & 0.6 & 0.6 \end{array}$$

Classical Relationship :

Relations are mapping b/w 2 sets - Presence or Absence of a connection or association b/w elements of 2 sets.

Consider two crisp sets A and B, the cartesian product of two crisp sets $A \times B$ is denoted by

$$A \times B = \{(a,b) \mid a \in A, b \in B\}$$

Properties :- (1) $A \times B \neq B \times A$

(2) $|A \times A| = |A| \times |B|$

(3) Cartesian product of 2 sets is not same as the arithmetic product of two or more sets

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Consider the elements A and B

$A = \{2, 4, 6, 8\}$

$B = \{3, 7, 8, 9\}$

Cartesian product of 2 sets

$A \times B = \{(2,3), (2,7), (2,8), (2,9), (4,3), (4,7), (4,8), (4,9), (6,3), (6,7), (6,8), (6,9), (8,3), (8,7), (8,8), (8,9)\}$

A particular mapping is done from $a \in A$ to $b \in B$ which is denoted by R (relation).

Let us define a relation:

$R = \{(a,b) \mid a = b-1;\ (a,b) \in A \times B\}$

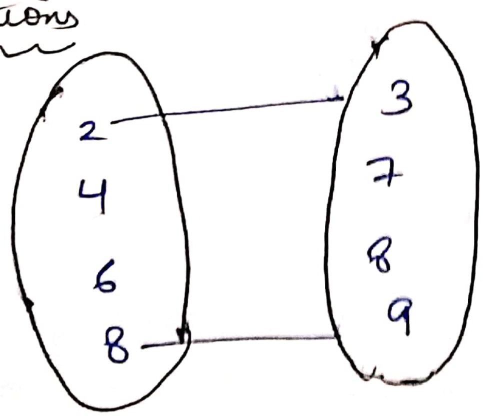
then $R = \{(2,3), (8,9)\}$

Crisp Relations

We can represent R in matrix form

$$R = \begin{array}{c} \\ 2 \\ 4 \\ 6 \\ 8 \end{array} \begin{array}{c} \begin{array}{cccc} 3 & 7 & 8 & 9 \end{array} \\ \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \end{array}$$

Mapping Representations



Operations on Crisp Relations :-

Let R & S be two separate relations on cartesian A × B defined over two crisp set S $a \in A$ and $b \in B$

(i) <u>Union</u> :- $R(a,b) \cup S(a,b) = \max(R(a,b), S(a,b))$

(ii) <u>Intersection</u> :-

$R(a,b) \cap S(a,b) = \min(R(a,b), S(a,b))$

(iii) Complement :- $R(a,b) = 1 - R(a,b)$

(iv) Containment :- $R \subset S \longrightarrow R(a,b) \le S(a,b)$

Q5 ~~Exd~~ Explain Neuro-Fuzzy System its modelling and control in detail

Soln A neural network in general, is highly interconnected network of large processing elements called neurons in an architecture inspired by human brain

- The objective of neural network is to transform input meaningful output
- Neural networks by examples

<u>Fuzzy Logic</u>

- Fuzzy means not clear, distinct, precise or blurred (with unclear outline)
- It is flexible machine learning technique
- Fuzzy logic deals with uncertainity and vagueness existing in a system and formulating fuzzy rules to find a solution to problems.

Imprecise & Vague value $\longrightarrow$ $\boxed{\text{Fuzzy Logic System}}$ $\longrightarrow$ Decision

→ Fuzzy logic use values b/w 0 & 1

→ Fuzzy set also consist of fuzzy rule base to perform approximate reasoning somewhat similar to human brain

Traditional Logic

True False

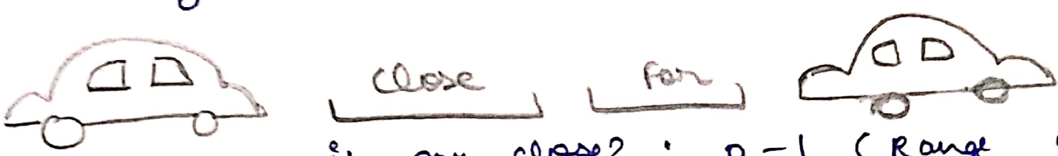
1 0

Fuzzy Logic

True False

0.8 0.4

eg



is car close? : 0-1 (Range of No to Yes)

Brakes? 0-1 (Range of OFF to ON)

→ Central Driving force for the creation of Hybrid Soft Commuting System

i) Every soft computing technique has particular computational parameters which make them suited for a particular problem and not for others

↳ Ability to learn & decision making

→ Neural networks are good at recognising patterns but they are not good at explaining how they reach their decisions

→ fuzzy logic is good at explaining the decisions but cannot automatically acquire the rules used for making the decision

→ These limitations acts as a central driving force for creation of hybrid soft computing systems where 2 or more techniques are combined in a suitable manner that overcomes the limitation of individual activities

→ The aim is to build highly automated, intelligent machines for the future generations using all of these techniques