National University of Computer & Emerging Sciences, Karachi
Spring -2024
AI-2002 Artificial Intelligence
Assignment# 02

Due Date: 19th April 2024 **Max Marks**:10 points

Constraint Satisfaction Problem

Q-01: Solve the following problems using the Constraint Satisfaction Approach by providing Variable, Domain, and Constraint Sets for each problem:

I. Find the value of:

a. B + A + D if each alphabet represents a unique single digit from 0 - 9

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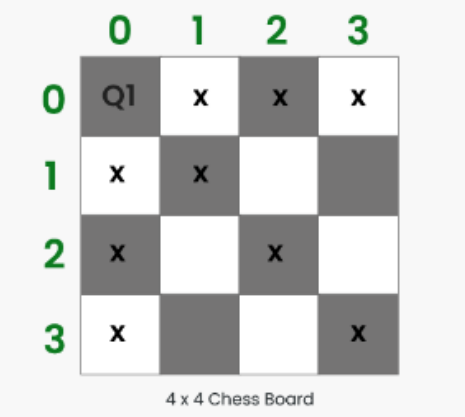
  A B C D
+ E B C B
---------
A F G A G
```

a. R * I * M if each alphabet represents a unique single digit from 0 - 9

```
  W I R E
+ M O R E
---------
M O N E Y
```

II. Considering the below-given scenario, find out at least two sets of combinations in which 4 Queens can be placed on a 4 x 4 Chess Board with no attacks. Show all the steps including backtracking, if needed.



Local and Adversial Search:

Question#1: Suppose a genetic algorithm uses chromosomes of the form x = abcdefgh with a fixed length of eight genes. Each gene can be any digit between 0 and 9. Let the fitness of individual x be calculated as:

$$f(x) = (a + b) - (c + d) + (e + f) - (g + h),$$

and let the initial population consist of four individuals with the following chromosomes:

x1 = 6 5 4 1 3 5 3 2

x2 = 8 7 1 2 6 6 0 1

x3 = 2 3 9 2 1 2 8 5

x4 = 4 1 8 5 2 0 9 4

a) Evaluate the fitness of each individual, showing all your workings, and arrange them in order with the fittest first and the least fit last.

b) Perform the following crossover operations:
   i) Cross the fittest two individuals using one–point crossover at the middle point.
   ii) Cross the second and third fittest individuals using a two–point crossover (points b and f).
   iii) Cross the first and third fittest individuals (ranked 1st and 3rd) using a uniform crossover.

c) Suppose the new population consists of the six offspring individuals received by the crossover operations in the above question. Evaluate the fitness of the new population, showing all your workings. Has the overall fitness improved?

d) By looking at the initial population of the algorithm can you say whether it will be able to reach the optimal solution without the mutation operator?

Question#2: Consider the following two-player zero-sum game. The game begins with a pile of seven bricks. On your move, you must split one pile of bricks into two piles. You may not split a pile of bricks into two equal piles. If it is your turn and all the piles of bricks have either one or two bricks, you have lost the game.

1. Apply the minimax algorithm to find the best action for the max player at the root.

2. Apply the minimax algorithm with alpha-beta pruning to find the best action for the max player at the root.

Here, you can find the minmax tree of the game: