Tutorial - 7

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1. Solve 8-Queen problem by Hill climbing & any one of its variants. Comment on the results of both.

→ - In 8-Queen problem, by moving a single queen to another square we have $8 \times 7 = 56$ possible states as we can move any queen in column. In this problem ~~In~~ we defines heuristic function, h as number of pair of queens that are attacking each other. Global minimum of this function is 0, which occurs only at perfect solution.

- Let's consider initial state as

18	12	14	13	13	12	14	14
14	16	13	15	12	14	12	16
14	12	18	13	15	12	14	14
15	14	14	Q	13	16	13	16
Q	14	17	15	Q	14	16	16
17	Q	16	18	15	Q	15	Q
18	14	Q	15	15	14	Q	16
14	14	13	17	12	14	12	18

- here currently $h = 17$.
- Queen can move columnwise
- Then each block represent possible heuristic value for column-wise movement
- Here best possible value of $h = 12$, so movement is done.

- Hill climbing is a greedy algorithm, it tries to minimize value of h.

						Q	
				Q			
	Q						
			Q				
					Q		
							Q
		Q					
Q							

- Here $h = 1$, now here value of h will increase by any movement.

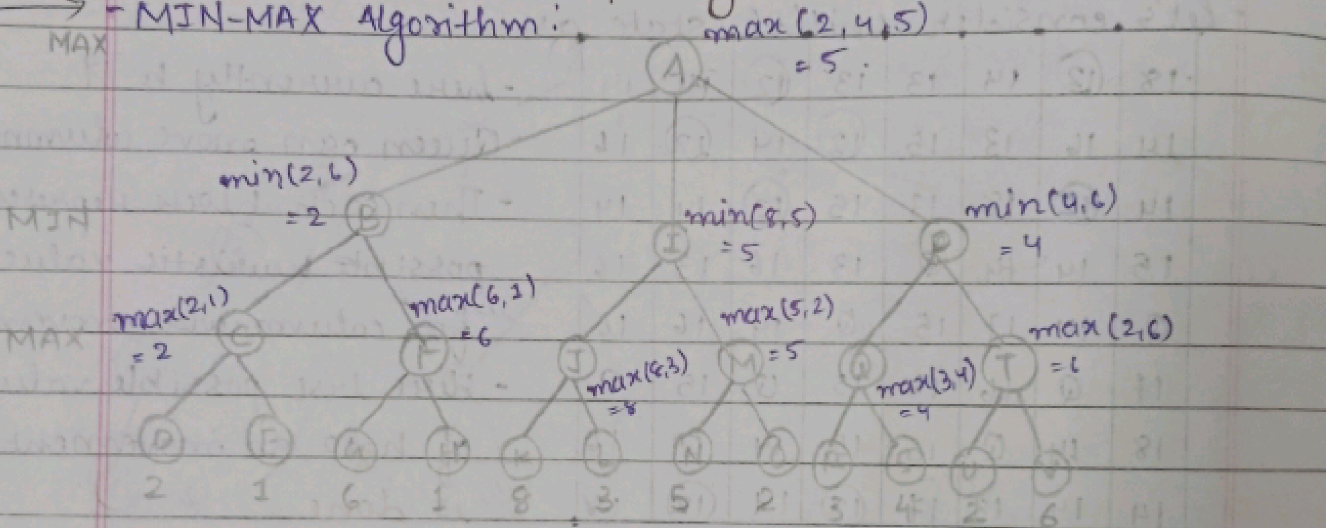
- Variant of hill climbing:
- Random restart hill climbing:
- If each hill climbing search has probability p ~~&~~ of success then expected number of restarts required is $1/p$.
- For 8 queen instance, with no-sideway moves allowes $p \approx 0.14$, $n = 7$, iteration to find a goal. Here coast will be 22 steps in all.
- For 8-queen problem, random restart hill climbing is

very effective as it can find solution for three million queen in a minute.

- Hill climbing is not optimal & complete whereas random restart hill climbing is complete as well as optimal.

2. Find the best path of tree by MIN-MAX algorithm. Also explain how α-β pruning helps in adversarial search? (Consider Node A as MAX, subsequent node as MIN then MAX-MIN ... subsequently).

→ - MIN-MAX Algorithm:



heuristic (h) of node C = max(h(D), h(E)) = max(2,1) = 2

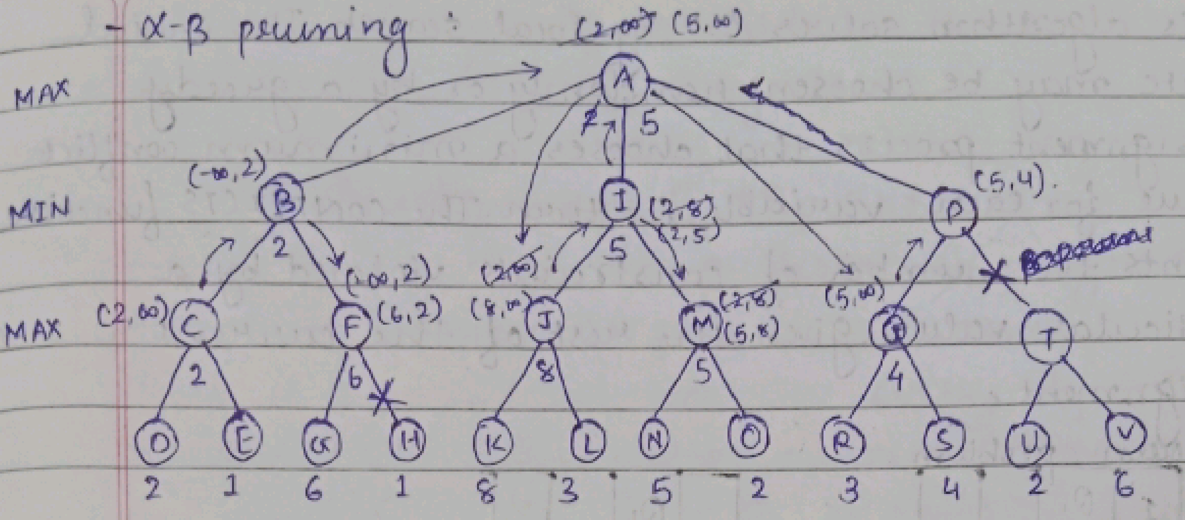
h of F = max(6,1) = 6
h(J) = max(8,3) = 8
h(M) = max(5,2) = 5
h(Q) = max(3,4) = 4
h(T) = max(2,6) = 6

h(B) = min(2,6) = 2
h(I) = min(8,5) = 5
h(O) = min(4,6) = 4.

h(A) = max(2,4,5) = 5

α-β pruning is a technique used to optimize the MIN-MAX algorithm by reducing the no. of nodes that needed to be evaluated. It works by pruning branches of the search tree that are guaranteed to lead to worse outcome than previously evaluated branch as shown in next figure

- α-β pruning :



3. Explain the following constraint in linear programming
(i) Unary (ii) Binary (iii) Global

→ (i) Unary constraints: It restricts the value of single variable.
(ii) Binary constraints: It relates two variables.
(iii) Global constraints: It involves an arbitrary number of variables.

4. Explain Minimum Arc Consistency (MAC) Algorithm. Solve 4 queen problem using same.

→ MAC Algorithm:

function: MIN-CONFLICT (csp, max-steps) returns a sol^n or failure
    inputs: csp, a constraint satisfaction problem
        max-steps, the no. of steps allowed before giving up.
    current ← an initial complete assignment for csp.
    for i=1 to max-steps do
        if current is a sol^n for csp then return current.
        var ← a randomly choosen conflicted variable from csp.VARIABLES
        value ← the value v for var that minimizes CONFLICTS(var, v, current, csp)
        set var = value in current.
    return failure.

This algorithm solves CSP by local search. The initial State may be choosen randomly or by a greedy assignment process that chooses a minimum conflict value for each variable in turn. The CONFLICTS function counts the number of constraints violated by a particular value, given the rest of the current assignment.

- 4-Queen problem.

1	Q_1		
Q_3			Q_2
0			
1		Q_4	

→

	Q_1		
			Q_2
Q_3			
		Q_4	

A one step solution using minimum conflicts. At each stage a queen is choosen for reassignment in its column. The no. of conflicts is shown in each square. The algorithm moves the queen to min-conflicts square, breaking ties randomly.

5. Solve the following using Constraint Satisfaction Problem: Class Scheduling: There is a fixed number of professors & classrooms, a list of classes to be offered, & a list of possible time slots for classes. Each professor has a set of classes that he or she can teach. Also explain cut-set conditioning & Sub-tree CSP.

→ - There are four variables in this problems ~~are~~, these are:
Professors, classrooms, list of classes to be offered i.e subjects and time slots.
- There are two contraint matrices P_{ij} & S_{ij}.
P_{ij} represents a professor in classroom i at time j & S_{ij} represents a subject being taught in classroom i at time j.

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- Domain of each P_{ij} variable is the set of professors & S_{ij} is the set of subjects.
- The constraints are:

$\cancel{P_{ij} \neq P_{kj}; k \neq i}$ $P_{ij} \neq P_{kj}$; $k \neq i$

which denotes that no professor is assigned to two classes which take place at the same time.
- There is a constraint between every P_{ij} & T_{ij}, denoted by $C_{ij}(p,s)$. that ensures that if professor p is assigned to P_{ij} then S_{ij} is assigned a value from $D(p)$ where $D(p)$ denotes the set of subjects that professor named p can teach.

$\therefore C(P_{ij}, S_{ij}) = \{(p,s) \mid$ professor p can teach subject s$\}$.

- Cut set conditioning is a technique used in CSPs to solve a problem by decomposing it into smaller subproblem. A cut set is a subset of variables that, when removed from the original CSP, results in a set of smaller, independent CSPs. Each smaller CSP can be solved independently & solutions can be combined to obtain solution for original problem.

- Sub-tree CSP is a technique used in CSPs to solve a problem by exploring only a subset of the search space. It involves selecting a subset of variables from the CSP & fixing their values, creating a sub-tree of the search space. This sub-tree is then explored to find solutions for the CSP.

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