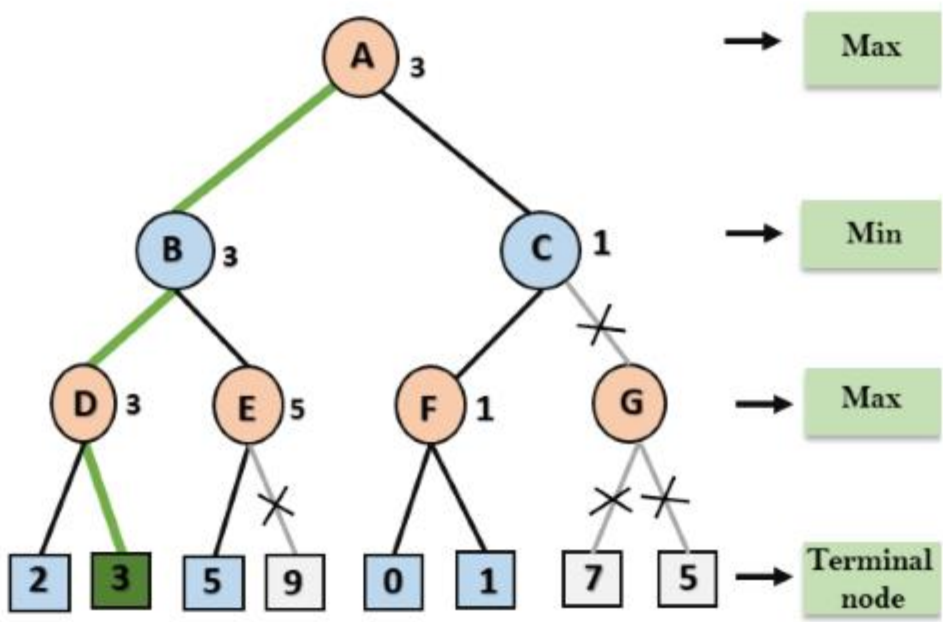
E/15/366

S.THINESH

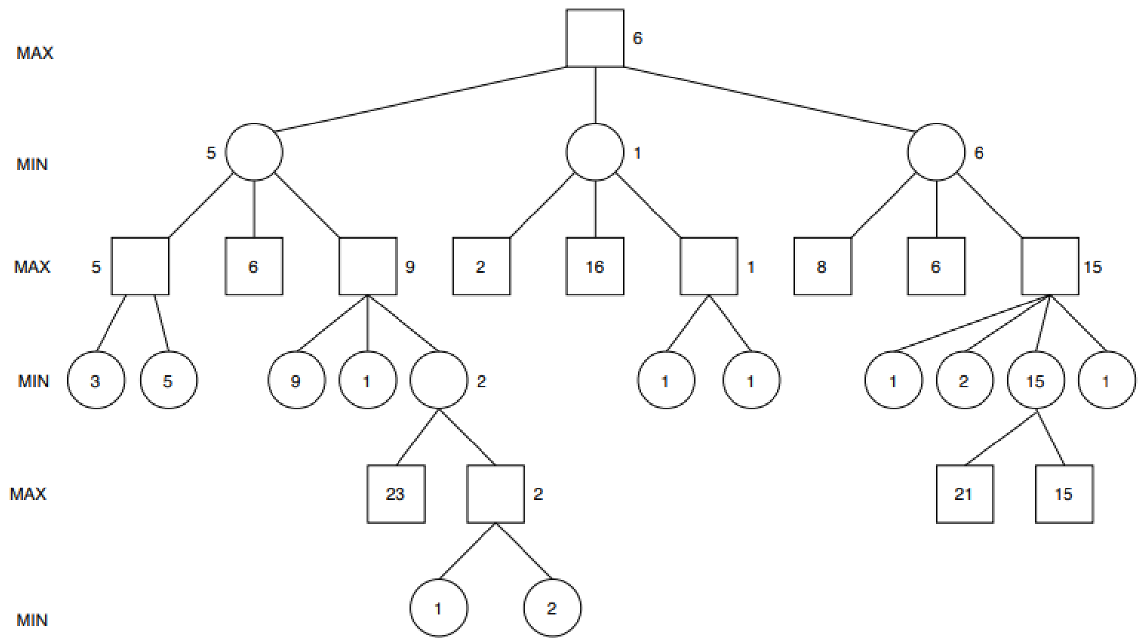
CO541: Artificial Intelligence

Assignment 4

1.



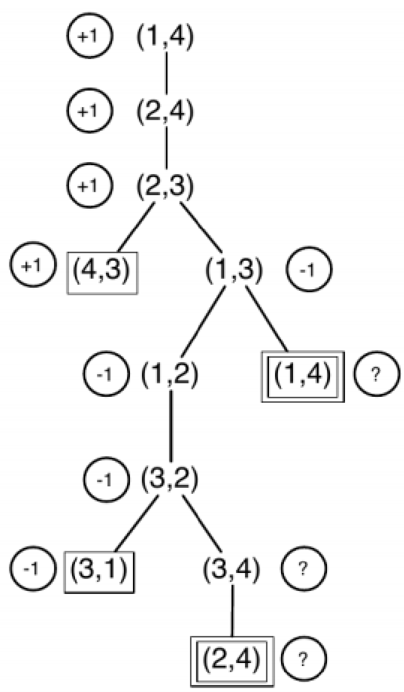
2.



MAX
MIN
MAX
MIN
MAX
MIN
6
5
1
6
5
6
9
2
16
1
8
6
15
3
5
9
1
2
1
1
1
2
15
1
23
2
21
15
1
2

3.

a.



+1 (1,4)
+1 (2,4)
+1 (2,3)
+1 (4,3)
(1,3) -1
-1 (1,2)
(1,4) ?
-1 (3,2)
-1 (3,1)
(3,4) ?
(2,4) ?

b.

The “?” nodes can be assigned a value of 0, so choosing the loop state will not benefit either player. If there is a win for a player from a loop state then they will chose the moves that lead to the win, rather than end up in the loop state.

c.

Standard minimax is depth-first and would go into an infinite loop. It can be fixed by comparing the current state against the stack; and if the state is repeated, then return a “?” value. Propagation of “?” is handled as above. Although it works in this case, it does not always work. For example, it is not clear how to compare “?” with a drawn position: a drawn position is not better or worse for either player, but might at least bring an end to the game, so assigning 0 to “?” states will not work there.

4.

CSP :

A constraint satisfaction problem (CSP) is a problem that requires its solution within some limitations/conditions also known as constraints. It consists of the following:

- A finite set of variables which stores the solution. (V = {V1, V2, V3,....., Vn})
- A set of discrete values known as domain from which the solution is picked. (D = {D1, D2, D3,.....,Dn})
- A finite set of constraints. (C = {C1, C2, C3,......, Cn})

Please note that the elements in the domain can be both continuous and discrete but in AI, we generally only deal with discrete values.

Also, note that all these sets should be finite except for the domain set. Each variable in the variable set can have different domains.

Backtracking

• Backtracking search, a form of depth-first search, is commonly used for solving CSPs. Backtracking occurs when no legal assignment can be found for a variable. Conflict directed backjumping backtracks directly to the source of the problem.

• The minimum remaining values and degree heuristics are domain-independent methods for deciding which variable to choose next in a backtracking search. The leastconstraining-value heuristic helps in ordering the variable values.

• By propagating the consequences of the partial assignments that it constructs, the backtracking algorithm can reduce greatly the branching factor of the problem. Forward checking is the simplest method for doing this. Arc consistency enforcement is a more powerful technique, but can be more expensive to run.

• Localsearch using the min-conflicts heuristic has been applied to constraintsatisfaction problems with great success.

Arc-consistency :

Arc-consistency algorithms are widely used to prune the search space of Constraint Satisfaction Problems (CSPs). One of the most well-known arc-consistency algorithms for filtering CSPs is AC3. This algorithm repeatedly carries out revisions and requires support checks for identifying and deleting all unsupported values from the domains. Nevertheless, many revisions are ineffective, that is, they cannot delete any value and they require a lot of checks and are time-consuming. We present AC3-OP, an optimized and reformulated version of AC3 that reduces the number of constraint checks and prunes the same CSP search space with arithmetic constraints. In inequality constraints, AC3-OP, checks the binary constraints in both directions (full arc-consistency), but it only propagates new constraints in one direction. Thus, it avoids checking redundant constraints that do not filter any value of the variable's domain. The evaluation section shows the improvement of AC3-OP over AC3 in random instances.

Min conflicts

The min conflicts algorithm is a search algorithm to solve constraint satisfaction problems (CSP problems).
It assigns random values to all the variables of a CSP. Then it selects randomly a variable, whose value conflicts with any constraint of the CSP. Then it assigns to this variable the value with the minimum conflicts. If there are more than one minimum, it chooses one among them randomly. After that, a new iteration starts again until a solution is found or a preselected maximum number of iterations is reached.

5.

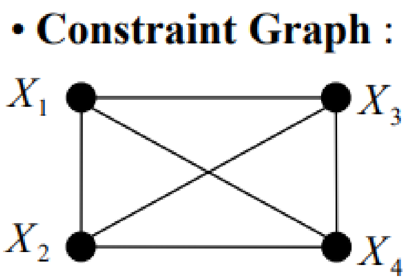
18

6.

It is a good heuristic to choose the variables that are the most constrained but the value that is least constrained in a constraint satisfaction problem. This is because by choosing the variable that is most constrained, there is a possibility that the variable will cause a failure and it is most efficient to as early as possible. If a value is chosen that is least constrained in CSP, there will be a possibility that more number of future assignments will take place that avoid conflict.

8.

a.



b.

D_i = {1,2,3,4}

R_{12} ={(1,3)(1,4)(2,4)(3,1)(4,1)(4,2)}

R_{13} ={(1,2)(1,4)(2,1)(2,3)(3,2)(3,4)(4,1)(4,3)}

R_{14} ={(1,2)(1,3)(2,1)(2,3)(2,4)(3,1)(3,2)(3,4)(4,2)(4,3)}

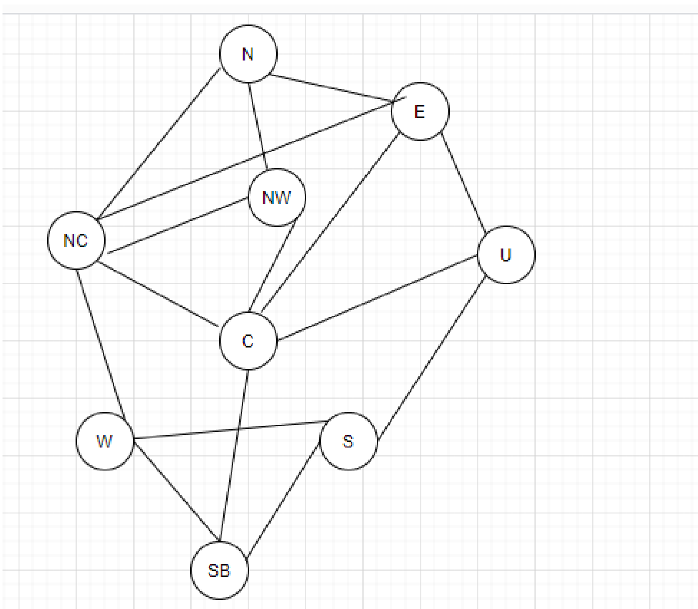
R_{23} ={(1,2)(1,4)(2,4)(3,1)(4,2)(4,1)}

R_{24} ={(1,2)(1,4)(2,1)(2,3)(2,4)(3,2)(3,4)(4,1)(4,3)}

R_{34} ={(1,3)(1,4)(2,4)(3,1)(4,1)(4,2)}

9.

a.



b.

N	NW	NC	E	W	SB	C	U	S
RGB	RGB	RGB	RGB	RGB	RGB	RGB	RGB	RGB
GB	R	GB	GB	GB	RGB	GB	GB	RGB
GB	R	B	R	GB	B	G	RB	RGB