AI MID-2 SPRING 2023 SOLUTION

Q1: CSP

1) Enumerate the domains of each variable. (5 points, 1 point each)

T1 = { W2, W3}

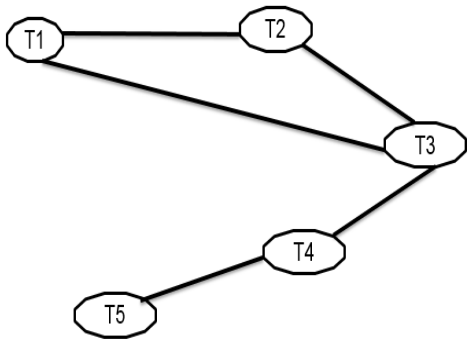
T2 = {W2}

T3 = {W1, W3}

T4 = {W1, W2}

T5 = {W1, W2, W3}

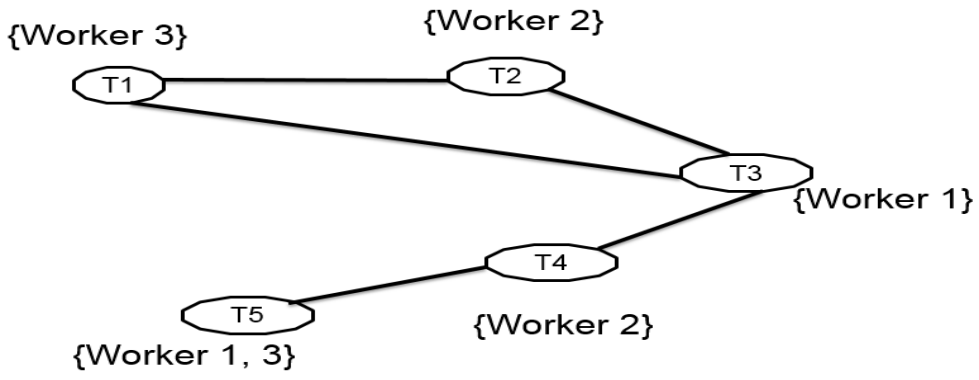
b) Draw the constraint graph for variables T1-T5. (2 points)



c) Assume that T2 is already assigned to its only domain value. What variables might be assigned by

the Minimum Remaining Values (MRV) heuristic? (3 points)

{T1, T3, T4} d) Show the domains of the variables after running arc-consistency on this initial graph. (5 points)

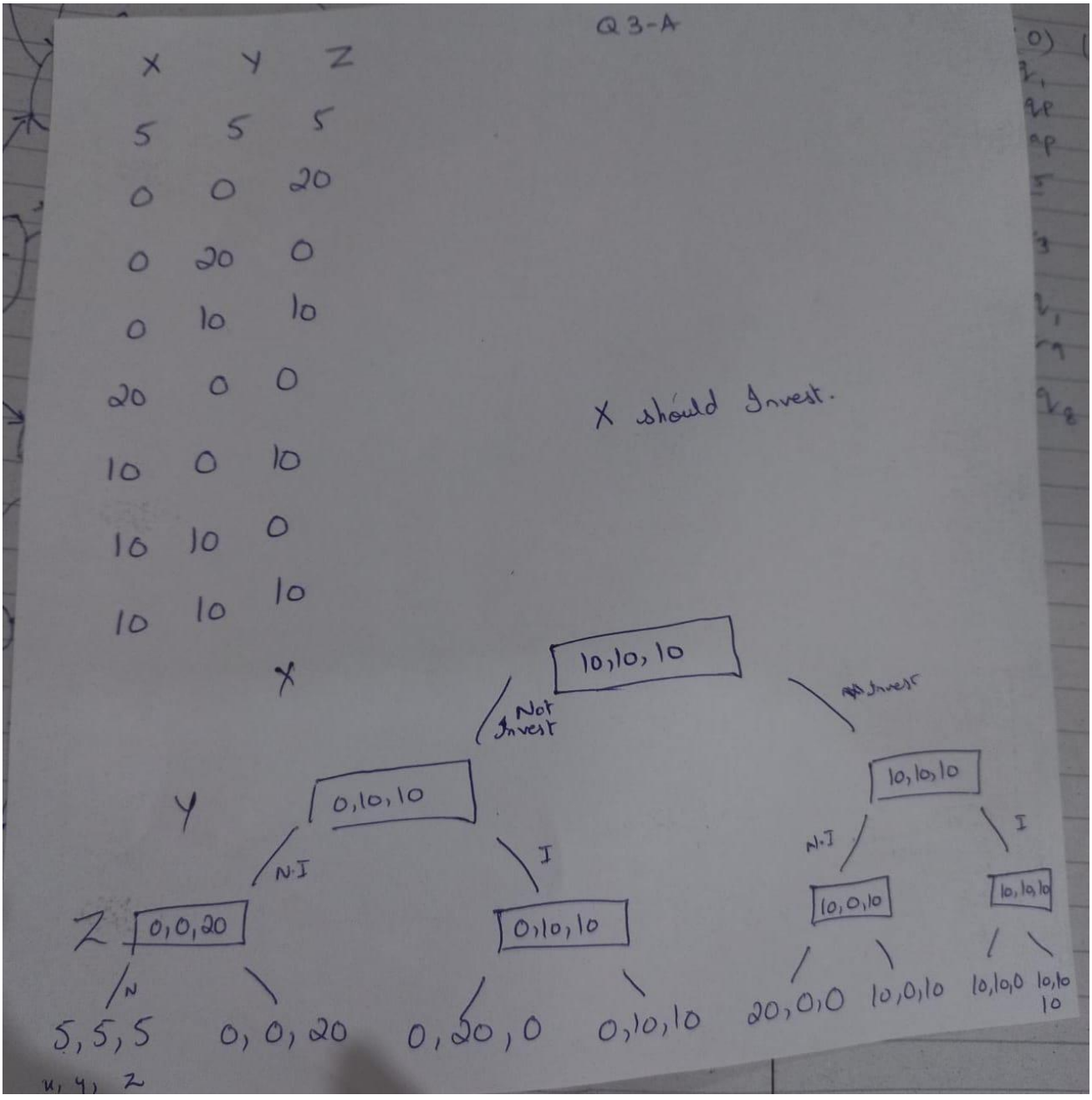


Q 2

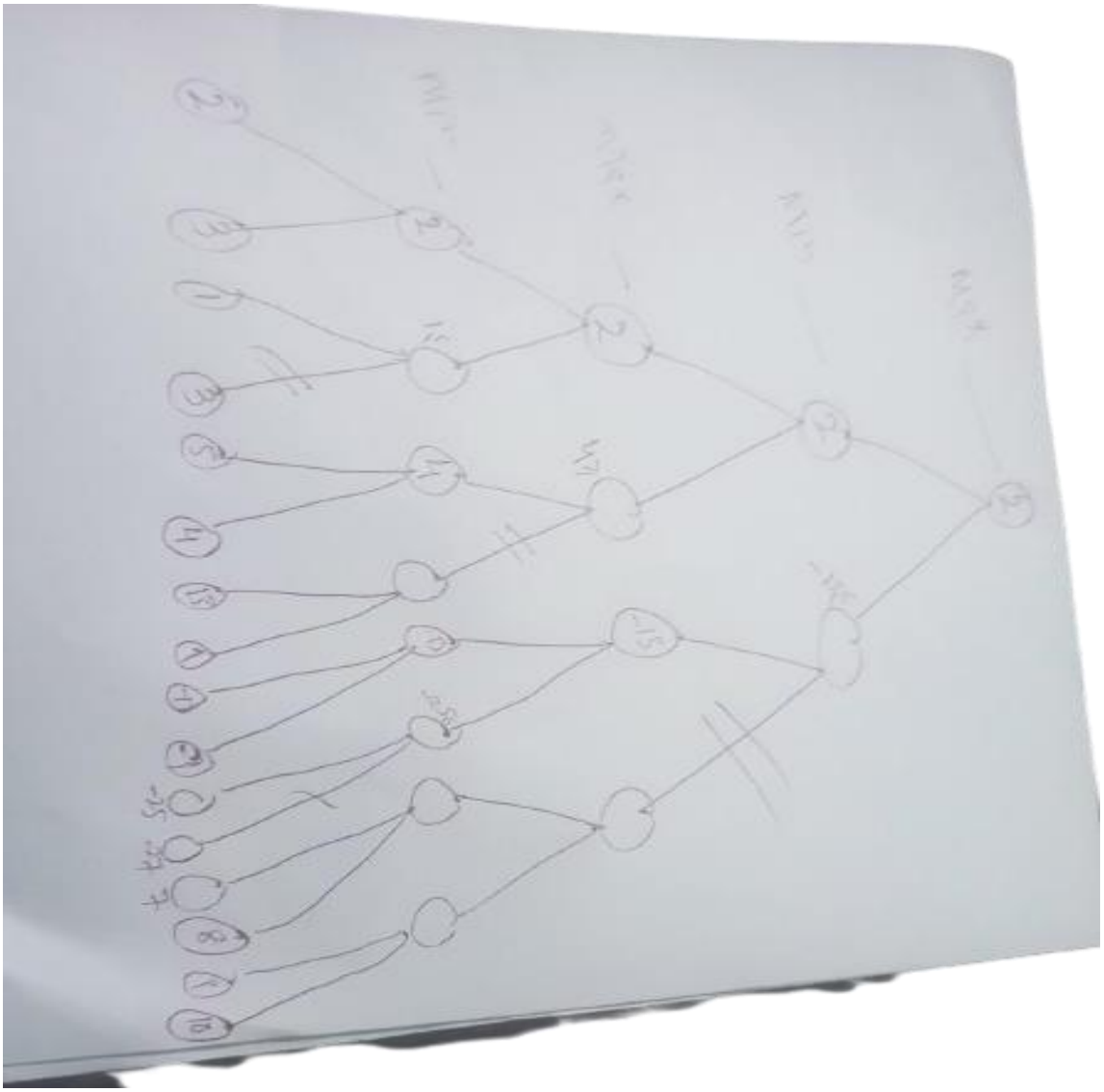
A: Suppose that three companies, Company X, Company Y, and Company Z, are competing in the market for a new product. Each company can choose to invest in research and development (R&D) or not invest in R&D. The offer is:

A. If all companies invest in R&D, they will all develop a high-quality product and receive a benefit of $10 million each.
B. If two companies invest in R&D, they will all develop a high-quality product and receive a benefit of $10 million each and the other companies receive nothing.
C. If only one company invests in R&D, that company will develop a superior product and receive a benefit of $20 million while the other companies receive nothing.
D. d)If no company invests in R&D, they will all develop a mediocre product and receive a benefit of $5 million each.

Now choose the best strategy for Company X using Min-Max concept and provide reasoning for your choice. Define properly how you generated utility values based on which the result/ strategy has been figured.



B.



Q3:

Given the above configuration of a limited version of the Wumpus world with only Wumpus and its accompanying stench. W_x,y is true if there is a Wumpus in [x,y]. S_x,y is true if agent perceives a stench in [x,y]. Now do the following:

1,2	2,2	3,2
1,1 Agent	2,1 Stench	3,1 Wumpus

i. Create a Knowledge Base using predicate logic given the above configuration. Observations should be named as obs_1, obs_2….obs_n.

ii. Suppose a1= {No Wumpus in 2,2}

Prove whether the Knowledge-Base entails a1 or not, using enumeration of all states.

Answer: Solution of wumpus world is very similar to scenerio given in the slides. Instead of Pit and Breeze here we have Wumpus and stench. The KB did not entail if agent observe stench at [2, 1]. If the student has made it graphically or through truth table, both are correct.

5 marks for creating knowledge base:

5 marks for model checking (enumeration algo)

For example: Observation 1 Agent can move to 2,1 then KB will have following data

1,2	2,2 Wumpus	3,2
1,1	2,1 Agent Stench	3,1 Wumpus

1,2	2,2 Wumpus	3,2
1,1	2,1 Agent Stench	3,1

1,2	2,2	3,2
1,1	2,1 Agent Stench	3,1 Wumpus

Now apply model-checking algo then a1 not entail.

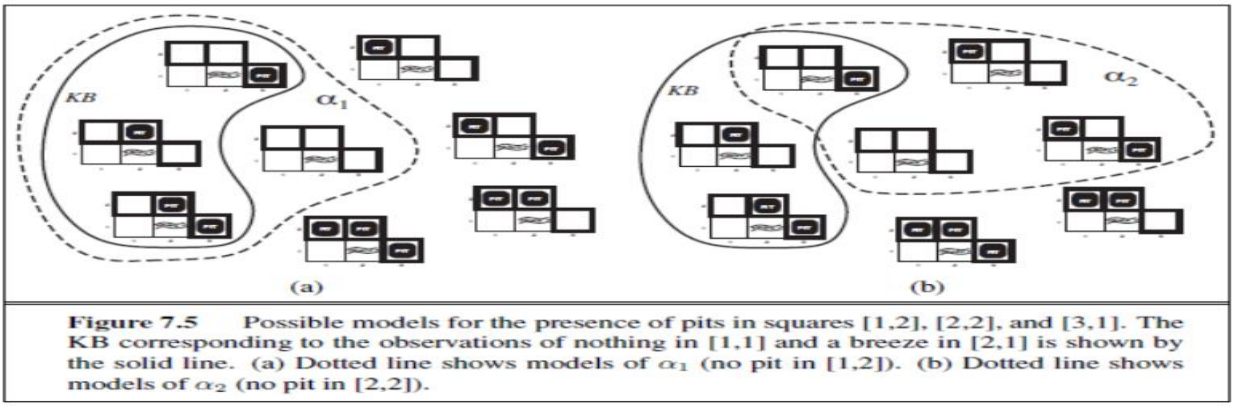


Figure 7.5 Possible models for the presence of pits in squares [1,2], [2,2], and [3,1]. The KB corresponding to the observations of nothing in [1,1] and a breeze in [2,1] is shown by the solid line. (a) Dotted line shows models of α_1 (no pit in [1,2]). (b) Dotted line shows models of α_2 (no pit in [2,2]).

$S_{2,1} = W_{2,2} \vee W_{3,1}$

If Agent can move to 2,1 and feel stench then KB = 1 for 3 cases ($W_{2,2}$ = true and $W_{3,1}$ = true or $W_{2,2}$ = true and $W_{3,1}$ = False or $W_{2,2}$ = false and $W_{3,1}$ = true) for all other cases KB = 0

$S_{2,1}$	$W_{1,2}$	$W_{2,2}$	$W_{3,1}$	KB
True	Flase	True	True	True
True	False	True	False	True
True	False	False	True	True
True	Flase	False	False	False
True	True	Flase	False	False
True	True	False	True	False
True	True	True	True	False

Qno 04 Solution:

A) Explain the following in one or two statements.

1) **Zero-Sum game**: Agents have opposite utilities (values on outcomes), single value that one maximizes and the other minimizes
2) **Successor function** in min-max game: It defines what the legal moves a player can make are.
3) **Significance of game tree**: Game tree shows the best possible move of max and min player at each level.
4) **Types of constraints:** Unary Constraint and binary constraint.
5) **backtracking search** is used for a depth-first search that chooses values for one variable at a time and backtracks when a variable has no legal values left to assign.
6) **Binary CSP:** each constraint relates (at most) two variables
7) **Logic:** Logic is a formal system for manipulating facts so that true conclusions may be drawn
8) **Propositional Logic:** concrete statements that are either true or false and **Predicate Logic:** allows statements to contain variables, functions, and quantifiers
9) **Knowledge Base:** A set of sentences that encodes assertions about the world in a formal knowledge representation language.
10) Game theory is powerful tool for modeling cooperative behavior in many wireless networking applications such as cognitive radio networks, wireless system, physical layer security, virtual MIMO, among others.