FAST NU National University
Of Computer & Emerging Sciences Faisalabad-Chiniot Campus

Artificial Intelligence Course Instructor Ms. Mahzaib Younas		
Time allowed = 30 min	Quiz 4	Total Marks = 30

BCS Section E

Roll No	Name	Signature

Question No 01: For each question statement below, choose the correct option. [6]

1. The term _____ is used for a depth-first search that chooses values for one variable at a time and returns when a variable has no legal values left to assign.	2. To overcome the need to backtrack in constraint satisfaction problem can be eliminated by _____
a) Forward search b) Backtrack search c) Hill algorithm d) Reverse-Down-Hill search	a) Forward Searching b) Constraint Propagation c) Backtrack after a forward search d) Omitting the constraints and focusing only on goals
3. Constraint satisfaction problems on finite domains are typically solved using a form of _____	**4. Which of the following algorithm is generally used CSP search algorithm?**
a) Search Algorithms b) Heuristic Search Algorithms c) None of these d) All of the mentioned	a) Breadth-first search algorithm b) Depth-first search algorithm c) Hill-climbing search algorithm d) None of the mentioned
5. What among the following constitutes to the incremental formulation of CSP?	6. Which of the following is an example of a unary constraint?
a) Path cost b) Goal cost c) Successor function d) All of the mentioned	a) $X \neq Y$ b) $X > 5$ c) $X + Y = Z$ d) $WA \neq NT$

Q2. Answer the following [5]

Statement	True/False
Every CSP can be solved in polynomial time if arc consistency is applied	False
A problem that is arc-consistent is always guaranteed to have a solution.	False
The Least Constraining Value (LCV) heuristic picks the value that eliminates the most choices for neighboring variables.	False.

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Solving a CSP using depth-first search is guaranteed to be more efficient than using breadth-first search.	
A CSP with a unique solution is guaranteed to have a strongly k-consistent structure.	

Question No 03: Consider a CSP with variables W, X, Y, Z each with domain {1, 2, 3, 4, 5} and the following constraints: [10]

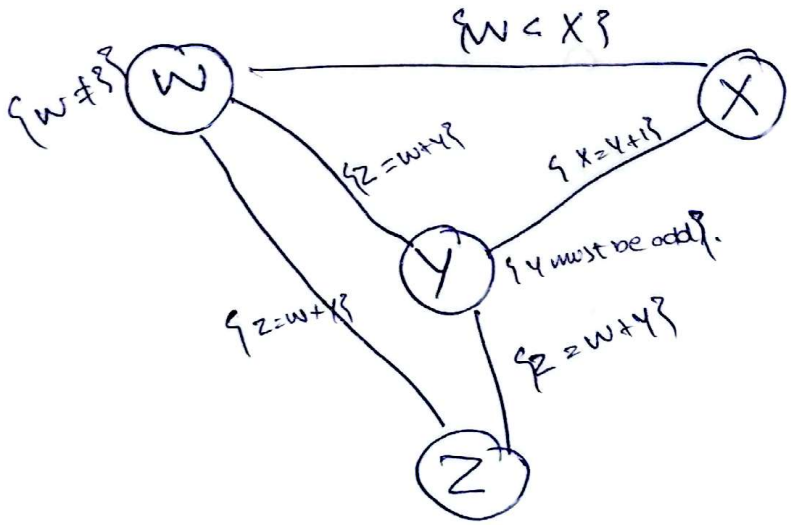
- W < X
- X = Y + 1
- Z = W + Y
- W ≠ 3
- Y must be odd

a) **Identify all unary and binary constraints.**

Unary :- → W ≠ 3
→ Y must be odd

Binary :- X = Y+1
W < X

a) **Draw the constraint graph.**



c) **Apply node consistency to remove invalid values from domains.**

W : {1, 2, 4, 5} (W ≠ 3)
X : {1, 2, 3, 4, 5} (no unary constraint)
Y : {1, 3, 5} (Y must be odd)
Z : {1, 2, 3, 4, 5} (no unary constraint).

d) Apply arc consistency and show the resulting domains for each variable.

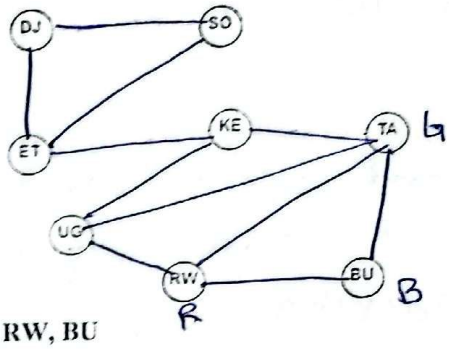
W : {1, 2, 4} (W < X, X ≤ 5)

X : {2, 3, 4, 5} (X = Y + 1, Y can be 1, 3, 5)

Y : {1, 3} (X = Y + 1, X ≤ 5, Y must be odd)

Z : {2, 3, 4, 5} (Z = W + Y)

Consider the constraint satisfaction problem of the following map coloring problem where the state space is represented as, [5]



Variables: DJ, SO, ET, KE, UG , TA, RW, BU
Domains: Di = red; green; blue
Part a: if RW is red

		DJ	ET	SO	KE	TA	UG	RW	BU
1	RW = red	R, G, B	R, G, B	R, G, B	R, G, B	G, B	G, B	R	G, B
2	BU = blue	R, G, B	R, G, B	R, G, B	R, G, B	G	G, B	R	B
3	DJ = red	R	G, B	G, B	R, G, B	G	G, B	R	B

Part b: If RW is red, Write NEXT TWO unassigned variables that might be selected by the Minimum-Remaining-Values (MRV) Heuristic:

Any with least domain (2 value) {TA, UG, BU}

Part c: f RW is red, write down NEXT TWO unassigned variables that might be selected by the Degree Heuristic?

TA : 3 {KE, UG, BU}
KE : 3 {ET, TA, UG}
ET : 3 {DJ, SO, KE}

— can choose any of 3 all have degree heuristic 3.

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Answer the below questions [4]

1. How does the **degree heuristic** assist in variable selection in CSPs, particularly when there are ties in MRV values?

It breaks ties in MRV by selecting the variable that constraint the most other variable. This helps reduce the branching factor for future variable assignment by prioritizing variables that affects many others.

2. What is the primary goal of the **Minimum Remaining Values (MRV) heuristic** when selecting the next variable to assign a value during a CSP search?

To identify and select variable that is most constrained. This implements fail first principle by tackling the hardest variables first, which helps to detect dead ends early.