CS-171, Intro to A.I., Summer Session 1, 2018 — Quiz # 4 — 20 minutes

NAME:____

YOUR ID: ___________ ID TO RIGHT:____________ ROW:_________ SEAT:_________

1. (30 pts total, 10 pts each) 3x3 Checkerboard Constraints (adapted from Luis Ortiz, 2006). You are a robot assigned to color a 3x3 checkerboard. Squares that are adjacent vertically or horizontally may not have the same color. You need only two colors, red (R) and black (B). We limit discussion to these five squares:

X1	X2	X3
X4	X5	

Each variable Xi has domain Di = {R, B}. The constraints are X1 ≠ X2, X2 ≠ X3, X2 ≠ X5, X1 ≠ X4, X4 ≠ X5.
The initial state is: D1 = {R, B} D2 = {R, B} D3 = {R, B} D4 = {R, B} D5 = {R, B}

1.a. (10 pts total, -5 for each wrong answer, but not negative). Run arc consistency (AC-3 in R&N) on the initial state, which is shown below. Cross out all domain values that will be eliminated. Be neat; ambiguous answers are automatically wrong.

D1 = {R, B} D2 = {R, B} D3 = {R, B} D4 = {R, B} D5 = {R, B}

1.b. (10 pts total, -5 for each wrong answer, but not negative). Assign **B to X5,** and then run arc consistency (AC-3 in R&N) on the resulting state, which is shown below. Cross out all domain variables that will be eliminated. Be neat; ambiguous answers are automatically wrong.

D1 = {**X**, B} D2 = {R, **X**} D3 = {**X**, B} D4 = {R, **X**} **D5 = {B}**

1.c. (10 pts total, -5 for each wrong answer, but not negative). Assign **R to X1,** and then run Forward Checking (FC) on the resulting state, which is shown below. Cross out all domain variables that will be eliminated. Be neat; ambiguous answers are automatically wrong.

D1 = {R} D2 = {**X**, B} D3 = {R, B} D4 = {**X**, B} D5 = {R, B}

2. (20 pts total, 2 pts each) Constraint Satisfaction Problems.
Label the following statements as T (true) or F (false).

2.a. T_____A constraint satisfaction problem (CSP) consists of a set of variables, a set of domains (one for each variable), and a set of constraints that specify allowable combinations of values.
2.b. F_____A consistent assignment is one in which every variable is assigned.
2.c. F_____A complete assignment is one that does not violate any constraints.
2.d. F_____A partial assignment is one that violates only some of the constraints.
2.e. T_____The nodes of a constraint graph correspond to variables of the problem, and a link connects any two variables that participate in a constraint.
2.f. T_____A constraint consists of a pair <*scope, rel*>, where *scope* is a tuple of variables that participate and *rel* defines the values those variables can take on.
2.g. T_____Performing constraint propagation involves using the constraints to reduce the number of legal values for a variable, which in turn can reduce the legal values for another variable, and so on.
2.h. T_____A variable in a CSP is arc-consistent iff, for each value in its domain and each of its binary constraints, that constraint is satisfied by that domain value together with some value in the domain of the other variable in that constraint.
2.i. T_____The minimum-remaining-values (MRV) heuristic chooses the variable with the fewest remaining legal values to assign next.
2.j. T_____The least-constraining-value (LCV) heuristic prefers the value that rules out the fewest choices for the neighboring variables in the constraint graph.

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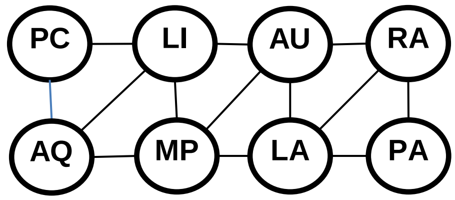
3. (50 points each, 10 pts each) Constraint Satisfaction Problems



AQ = Aquitaine
AU = Auvergne
LA = Languedoc
LI = Limousin
MP = Midi-Pyrenees
PA = Provence-Alpes-Cote d'Azur
PC = Poitu-Charentes
RA = Rhone-Alpes

You are a map-coloring robot assigned to color this map of the regions in southern France. Adjacent regions must be colored a different color (R=Red, G=Green, B=Blue). The constraint graph is shown.

3a. (10 pts total, -5 each wrong an See Section 6.3.2. **tive) FORWARD CHECKING.** AU has been assigned value B, as shown below. Cross out all values that would be eliminated by Forward Checking (FC):

AQ	AU	LA	LI	MP	PA	PC	RA
R G B	B	R G ~~B~~	R G ~~B~~	R G ~~B~~	R G B	R G B	R G ~~B~~

3b. (10 pts total, -5 each wrong an See Section 6.3.2. **tive) ARC CONSISTENCY.**
AU has been assigned B and MP has been assigned R, as shown below; but **no** constraint propagation has been done. Cross out all values that would be eliminated by Arc Consistency (AC-3 in your textbook).

AQ	AU	LA	LI	MP	PA	PC	RA
~~R~~ ~~G~~ B	B	~~R~~ G ~~B~~	~~R~~ G ~~B~~	R	~~R~~ ~~G~~ B	R ~~G~~ ~~B~~	R ~~G~~ ~~B~~

3c. (10 pts total, -5 each wrong an See Section 6.3.1. **tive) MINIMUM-REMAINING-VALUES HEURISTIC.**
Consider the assignment below. LI has been assigned B and constraint propagation **has** been done, as shown. List all unassigned variables (in any order) that might be selected now by the Minimum-Remaining-Values (MRV) Heuristic:

AQ, AU, MP, PC .

AQ	AU	LA	LI	MP	PA	PC	RA
R G	R G	R G B	B	R G	R G B	R G	R G B

3d. (10 pts total, -5 each wrong an See Section 6.3.1. **tive) DEGREE HEURISTIC.** Consider the assignment below. (It is the same assignment as in problem 3c above.) LI has been assigned B and constraint propagation **has** been done, as shown. **Ignoring the MRV heuristic,** list all unassigned variables (in any order) that might be selected now by the Degree Heuristic (DH):

LA .

AQ	AU	LA	LI	MP	PA	PC	RA
R G	R G	R G B	B	R G	R G B	R G	R G B

3e. (10 pts total, -5 each wrong an See Section 6.3.1. **tive) LEAST-CONSTRAINING-VALUE HEURISTIC.**
Consider the assignment below. (It is the same assignment as in problem 3c above.) LI has been assigned B and constraint propagation **has** been done, as shown. **LA is the variable that was chosen to explore next.** List all values for LA that might be explored first by the Least-Constraining-Value Heuristic (LCV):

B .

AQ	AU	LA	LI	MP	PA	PC	RA
R G	R G	R G B	B	R G	R G B	R G	R G B