

For each question on Quiz #1, “Zero” gives the percentage of students who received zero, “Partial” gives the percentage who received partial credit, and “Perfect” gives the percentage who received 100%. (Due to rounding, numbers shown below are only an approximate estimate.)

**We will fill in these numbers as they become available to us.**

**Problem 1**

Zero: ~0% (~0 students), Partial: ~34% (~44 students), Perfect: ~66% (~86 students)

**Problem 2**

Zero: ~0% (~0 students), Partial: ~58% (~75 students), Perfect: ~42% (~55 students)

**Problem 3**

Zero: ~0% (~0 students), Partial: ~72% (~94 students), Perfect: ~28% (~36 student)

# CS-171, Intro to A.I., Winter Quarter, 2016 — Quiz # 1 — 20 minutes

NAME: \_\_\_\_\_

YOUR ID: \_\_\_\_\_ ID TO RIGHT: \_\_\_\_\_ ROW: \_\_\_\_\_ NO. FROM RIGHT: \_\_\_\_\_

**1. (32 pts total, 4 pts each) Constraint Satisfaction Problem Concepts.** For each of the following terms on the left, write in the letter corresponding to the best answer or the correct definition on the right. The first one is done for you as an example.

A	Solution to a CSP	A	A complete and consistent assignment
D	Complete Assignment	B	Specifies an allowable combination of variable values
G	Constraint Graph	C	Associates values with some or all variables
H	Arc Consistency	D	Every variable is associated with a value
I	Forward Checking	E	The values assigned to variables do not violate any constraints
C	Assignment	F	Set of allowed values for some variable
F	Domain	G	Nodes correspond to variables, links connect variables that participate in a constraint
B	Constraint	H	All values in a variable's domain satisfy its binary constraints
E	Consistent Assignment	I	When variable X is assigned, delete any value of constraint-graph neighbor variables inconsistent with the assigned value of X.

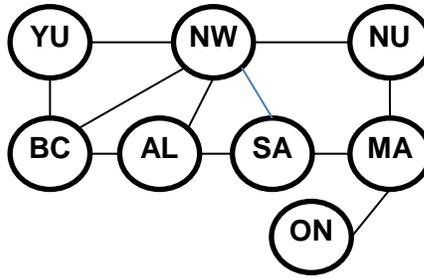
**2. (18 pts total, 2 pts each) Constraint Satisfaction Problems.**

Label the statements as T (true) or F (false). The first one is done for you as an example.

- 2a. 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.
- 2b. F A consistent assignment is one in which every variable is assigned.
- 2c. F A complete assignment is one that does not violate any constraints.
- 2d. F A partial assignment is one that violates only some of the constraints.
- 2e. 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.
- 2f. T A constraint consists of a pair  $\langle \text{scope}, \text{rel} \rangle$ , where *scope* is a tuple of variables that participate and *rel* defines the values those variables can take on.
- 2g. 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.
- 2h. 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.
- 2i. T The minimum-remaining-values (MRV) heuristic chooses the variable with the fewest remaining legal values to assign next.
- 2j. T The least-constraining-value 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



AL = Alberta  
 BC = British Columbia  
 MA = Manitoba  
 NW = Northwest Territories  
 NU = Nunavut  
 ON = Ontario  
 SA = Saskatchewan  
 YU = Yukon Territory

You are a map-coloring robot assigned to color this map of western Canada territories. 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 answer, but not negative) FORWARD CHECKING

See Section 6.3.2.

NW has been assigned value B, as shown. Cross out all values that would be eliminated by Forward Checking (FC):

YU	NW	NU	BC	AL	SA	MA	ON
R G <del>X</del>	B	R G <del>X</del>	R G <del>X</del>	R G <del>X</del>	R G <del>X</del>	R G B	R G B

#### 3b. (10 pts total, -5 each wrong answer, but not negative) ARC CONSISTENCY

See Section 6.3.2.

NW has been assigned B and AL has been assigned R, as shown; but no constraint propagation has been done. Cross out all values that would be eliminated by Arc Consistency (AC-3 in your book).

YU	NW	NU	BC	AL	SA	MA	ON
R <del>XX</del>	B	R G <del>X</del>	<del>X</del> G <del>X</del>	R	<del>X</del> G <del>X</del>	R <del>X</del> B	R G B

3c. (10 pts total, -5 each wrong answer, but not negative) MINIMUM-REMAINING-VALUES HEURISTIC. Consider the assignment below. AL 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:

NW, BC, SA

See Section 6.3.1.

YU	NW	NU	BC	AL	SA	MA	ON
R G B	R G	R G B	R G	B	R G	R G B	R G B

#### 3d. (10 pts total, -5 each wrong answer, but not negative) DEGREE HEURISTIC.

Consider the assignment below. (It is the same assignment as in problem 3c above.) AL 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): NW

See Section 6.3.1.

YU	NW	NU	BC	AL	SA	MA	ON
R G B	R G	R G B	R G	B	R G	R G B	R G B

#### 3e. (10 pts total, -5 each wrong answer, but not negative) LEAST-CONSTRAINING-VALUE HEURISTIC.

See Section 6.3.1.

Consider the assignment below. (It is the same assignment as in problem 3c above.) AL has been assigned B and constraint propagation has been done, as shown. MA has been chosen as the next variable to explore. List the values for MA that would be explored first by the Least-Constraining-Value Heuristic (LCV): B

YU	NW	NU	BC	AL	SA	MA	ON
R G B	R G	R G B	R G	B	R G	R G B	R G B