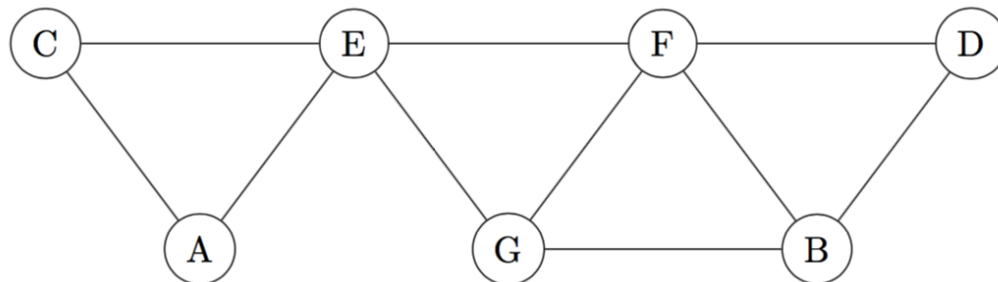


Problem 2. Constraint Satisfaction Problems [20 points]

Consider the following graph representing 7 countries on a map that needs to be colored using three different colors, 1, 2 and 3, so that no adjacent countries have the same color.

Adjacencies are represented by edges in the graph. We can represent this problem as a CSP where the variables are the countries and the values are the colors.



- (a) [5] What are the domains of all the variables after applying Forward Checking inference with variables ordered alphabetically (from A to G) and values ordered increasingly (from 1 to 3), assuming you start with each variable having all possible values except it is known that A has value 1 and E has value 2?

- (b) [10] Apply the Backtracking Search algorithm (Figure 6.5 in the textbook) with Forward Checking inference (Section 6.3.2), assuming you start with each variable having *all* possible values. Variables and values are chosen following alphabetical ordering of the variables (A to G) and increasing order of the values (1 to 3), respectively. Show your result as a search tree where each node in the tree shows each variable with its set of possible values. Arcs in the search tree should be labeled with an assignment of a selected value to a selected variable. If a solution is found, show the final coloring of the map. The search tree only needs to show nodes and arcs until a single solution is found.

- (c) [5] What are the domains of all the variables after applying Arc-Consistency (AC-3) inference (Figure 6.3) with variables ordered alphabetically and values ordered increasingly, assuming you start with each variable having all possible values except it is known that A has value 1, B has value 1, and C has value 2? List all the possible outcomes.

1a). $A = 1$

$B = 1, 2, 3$

$C = 3$

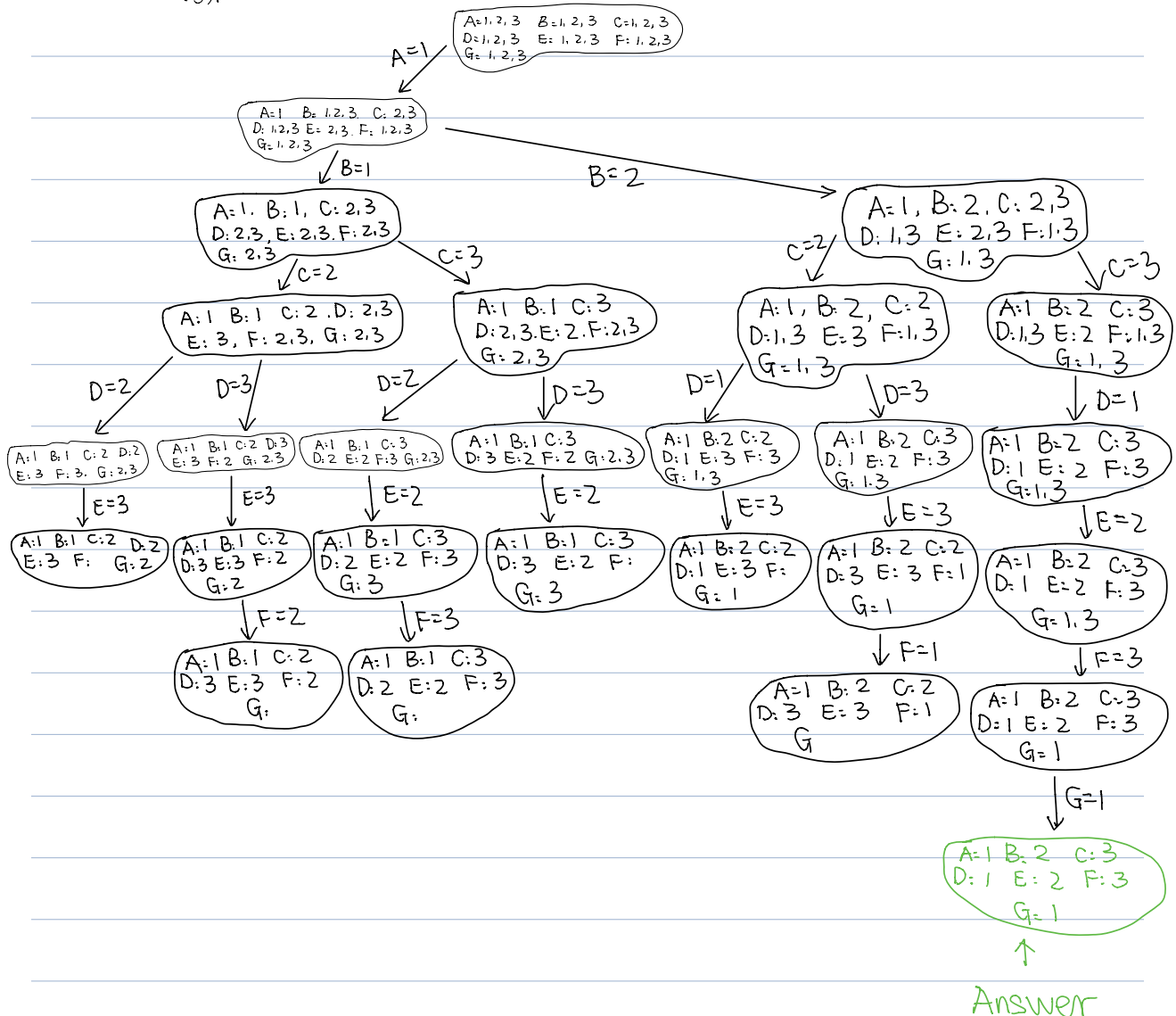
$D = 1, 2, 3$

$E = 2$

$F = 1, 3$

$G = 1, 3$

1b).



(c). $A: 1, 2, 3$ $B: 1, 2, 3$ $C: 1, 2, 3$ $D: 1, 2, 3$ $E: 1, 2, 3$ $F: 1, 2, 3$ $G: 1, 2, 3$
 $A=1$ \downarrow
 $A: 1$ $B: 1, 2, 3$ $C: 2, 3$ $D: 1, 2, 3$ $E: 2, 3$ $F: 1, 2, 3$ $G: 1, 2, 3$

propagate $A: 1$ $B: 1, 2, 3$ $C: 2, 3$ $D: 1, 2, 3$ $E: 2, 3$ $F: 1, 2, 3$ $G: 1, 2, 3$
 $B=1$ \downarrow
 $A: 1$ $B: 1$ $C: 2, 3$ $D: 2, 3$ $E: 2, 3$ $F: 2, 3$ $G: 2, 3$

propagate $A: 1$ $B: 1$ $C: 2, 3$ $D: 2, 3$ $E: 2, 3$ $F: 2, 3$ $G: 2, 3$
 $C=2$ \downarrow
 $A: 1$ $B: 1$ $C: 2$ $D: 2, 3$ $E: 3$ $F: 2, 3$ $G: 2, 3$

propagate ① $A: 1$ $B: 1$ $C: 2$ $D: 2, 3$ $E: 3$ $F: 2$ $G:$

② $A: 1$ $B: 1$ $C: 2$ $D: 2, 3$ $E: 3$ $F:$ $G: 2$

③ $A: 1$ $B: 1$ $C: 2$ $D: 3$ $E: 3$ $F: 2$ $G:$

④ $A: 1$ $B: 1$ $C: 2$ $D: 2$ $E: 3$ $F:$ $G: 2$

⑤ $A: 1$ $B: 1$ $C: 2$ $D: 2, 3$ $E:$ $F: 3$ $G: 2$

Answer \uparrow