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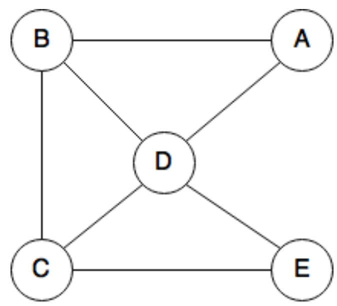
Part I: Constraint Satisfaction Problems

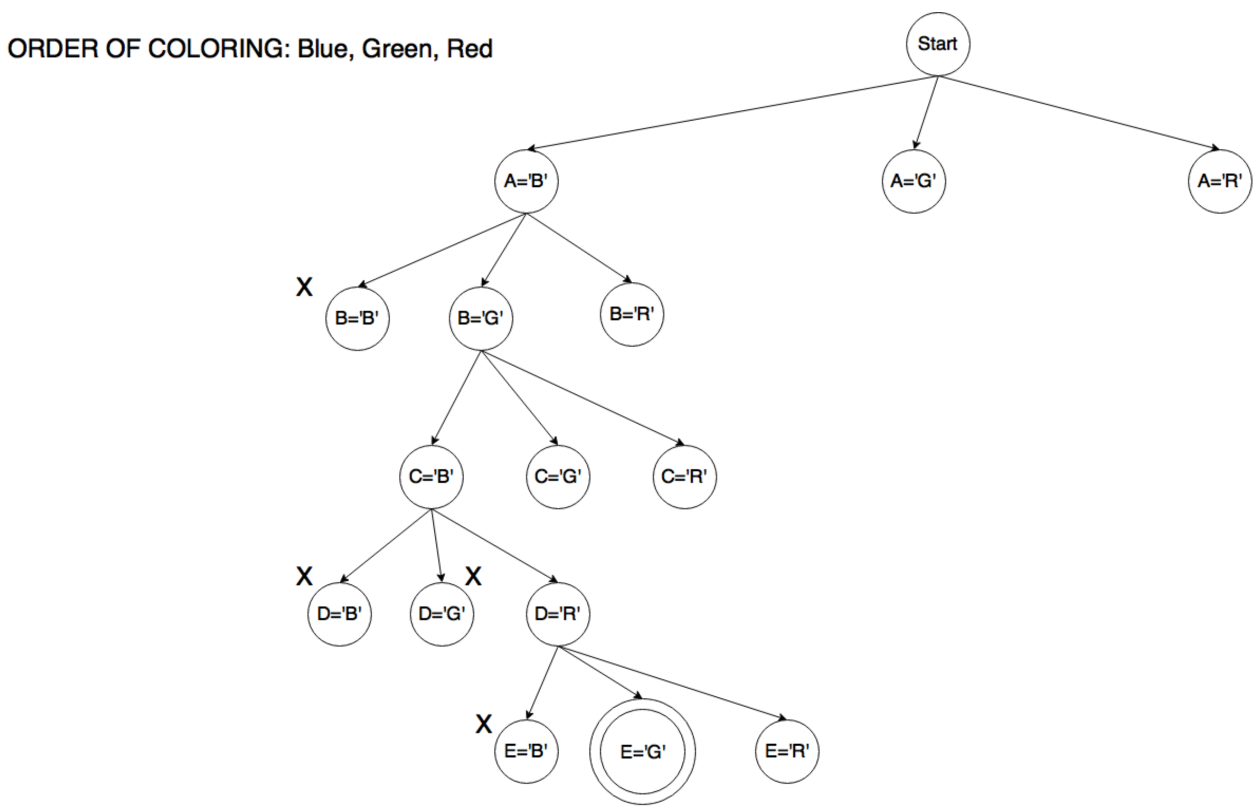
Part A: Backtracking Search

According to map given in the problem following graph can be created. Nodes of this graph represents regions and edge represent the regions which are connected to each other.

This problem can be further simplified by putting constraints on edge of graph, such that no two connected nodes are of same color.



1. Show the complete search tree and circle the solution node if there is one



2. Show the final coloring, if one is found
    - The final coloring is **Blue, Green, Blue, Red, Green** in order of nodes A, B, C, D, E

3. How many variable instantiations are tried by this search method?
    - According to above tree created by backtracking search, total of 15 variable instantiations are present in this search method

Part B: Solution Spaces

4. How large is search space for this problem? That is, how many different colorings, legal or illegal, are there for this map?
    - In this map, every node has three choices for coloring (legal or illegal)
    - There are in total 5 regions present in this map. Therefore, total number of coloring would be 3^5 = 243.

5. For this map, how many different solutions are there?
    - Total of 6 solutions are possible for this map.
    - Different solutions possible are:
    1. Blue, Green, Blue, Red, Green
    2. Blue, Red, Blue, Green, Red
    3. Green, Blue, Green, Red, Blue
    4. Green, Red, Green, Blue, Red
    5. Red, Blue, Red, Green, Blue
    6. Red, Green, Red, Blue, Green

Part II: Game Playing: Rolling Dice

6. Draw the 4-ply (two moves for each player) expecti-minimax tree for this problem

   Link to XML as well as PNG file of expecti-minimax tree
   XML Link:
   https://drive.google.com/file/d/0ByF5vXq2PL2waFZDQkc5OThIZm8/view?usp=sharing
   PNG Link:
   https://drive.google.com/file/d/0ByF5vXq2PL2weE54bDRpMnN3cUE/view?usp=sharing

7. Using the static evaluation function (score(player1) – score(player2)), back up the leaf values to root of the tree. Annotate each of the nodes in the tree with the backed-up values

   Link to XML and PNG file with annotated nodes
   XML Link:
   https://drive.google.com/file/d/0ByF5vXq2PL2wdUFEd20zY2Q0V2M/view?usp=sharing
   PNG Link:
   https://drive.google.com/file/d/0ByF5vXq2PL2waHo1cHlyaDA1WDQ/view?usp=sharing

8. Circle the nodes that would be pruned by alpha-beta pruning using depth-first (left to right) search.

   Link to XML and PNG file with pruned nodes denoted by coloring
   XML link:
   https://drive.google.com/file/d/0ByF5vXq2PL2wVlhBYkZkWXNVNm8/view?usp=sharing
   PNG link:
   https://drive.google.com/file/d/0ByF5vXq2PL2wazFJbFBlWktCc0k/view?usp=sharing

9. What is the best action for the first player to take? (play or stop?)

   It doesn't really matter what the first player does, because if he decides to stop the game then the game will draw. But if he plays then also the value iterated after drawing minimax tree is zero. Therefore, it doesn't really matter what action he does in the first take.

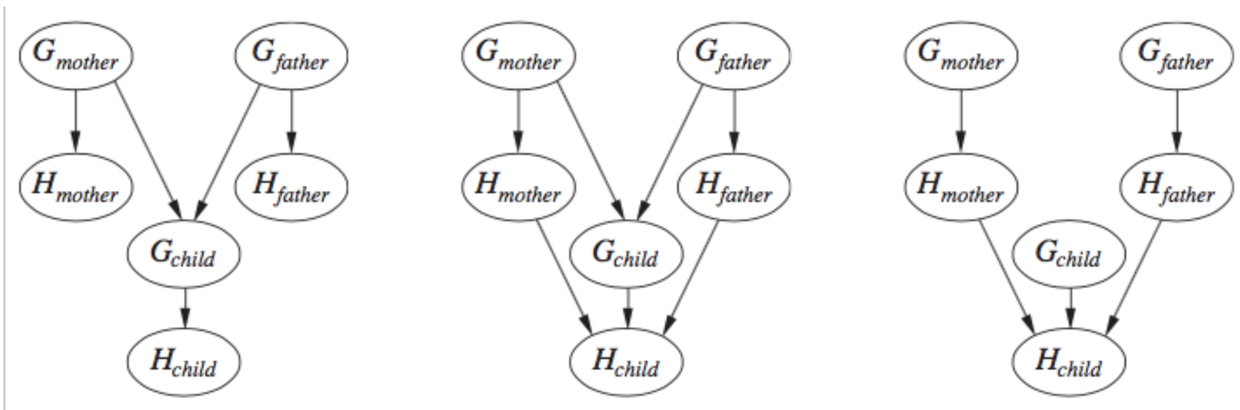
10. If player 1 rolls a five, what should player 2 do? Why?

    If player 1 gets a five, then **player 2 should continue playing the game**. Even if he stops then he will win, but every player's aim is to win by highest possible difference.
    There is a probability that he will get a node where he gains 1 point, which will further make the difference better than previous node.

11. Would you describe the game as fair? Why or why not?

I think the game is pretty fair because there is an equal chance of both the players to win. It is a zero sum game therefore, the chance of first player to win by maximum value is equal to chance of second player to loose.

Part III: Bayes' nets and probability



(a) (b) (c)

a) Which of the three figures claim $P\ (G_{father}\ , G_{mother}, G_{child})$ = $P\ (G_{father}).\ P\ (G_{mother})$ $P\ (G_{child})$
Figure (c) satisfy the above equation

b) Which of the three networks make independence claims that are consistent with the hypothesis about the inheritance of handedness?
The hypothesis made in the question is that gene of child are dependent on genes of father and mother.
This hypothesis is satisfied in **figure (a) and (b)**.
The independence of child's gene from its father and mother in figure (c) contradicts the questions arguments

c) Which of the three networks in best description of hypothesis?
Figure (a) has the best description of hypothesis. Hypothesis doesn't talk about any inference in handedness which is given in figure (b).

d) Write down CPT for the G_{child} node in network (a), in terms of s and m.

G_{mother}	G_{father}	$P(G_{child} = l \vert ..)$	$P(G_{child} = r \vert \ldots)$
L	L	1-m	m
L	R	0.5	0.5
R	L	0.5	0.5
R	R	m	1-m

e) Suppose that $P(G_{father} = l)$ = $P(G_{mother} = l)$ = q. In network (a), derive an expression for $P\ (G_{child} =\ l)$ in terms of *m* and *q* only, by conditioning at its parent nodes

$P(G_{child} =\ l)$ = $\sum_{gf,\ gm} P(G_{child}|gf, gm).P(gf).P(gm)$

= (1-m).q^2 (when f = l; m = l; c = l) + 0.5q(1-q) + 0.5q(1-q) + m$(1-q)^2$
= q + m – 2mq

f) Under the conditions of genetic equilibrium, we expect the distribution of genes to be the same across generations. Use this to calculate the value of q, and, given, what you know about handedness in humans, explain why the hypothesis described at the beginning of this question must be wrong.

Using the conditions of genetic equilibrium, we know that probability of left hand of child in its gene is equal in every generation
Therefore, $P(G_{child})$ = $P(G_{father})$ = $P(G_{mother})$
q + m – 2mq = q
q = 0.5

REFERENCES:
1. Artificial Intelligence: A Modern Approach by Stuart Russell, Peter Norvig
2. draw.io