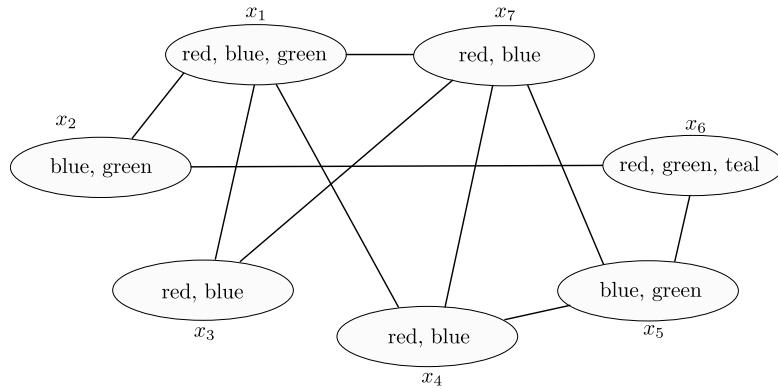


## 16.410-13 Recitation 4 Problems

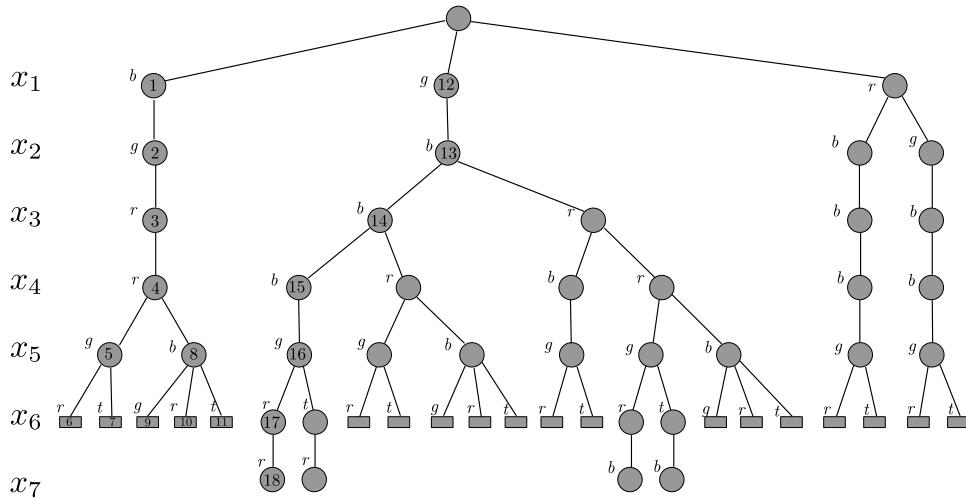
### Problem 1: Backtracking and Forward-checking

Consider the following coloring problem.



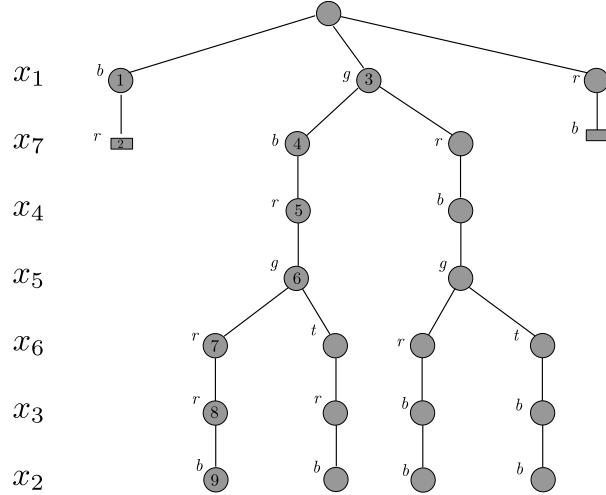
Draw the search tree of the backtracking algorithm and number the nodes according to their order of expansion until the algorithm finds a feasible assignment that solves the constraint satisfaction problem. The algorithm picks the colors according to the following order: blue, green, red, teal. Assume that the algorithm traces the variables according to the following order:  $x_1, x_2, x_3, x_4, x_5, x_6, x_7$ .

**Solution:** The tree that backtracking would explore is given in the following figure. The tracing order until a solution is found is indicated with numbers on the nodes. The square nodes indicate the case when the algorithm gets stuck, circle nodes indicate the cases when the algorithm can continue search or has found a solution (the leaves).



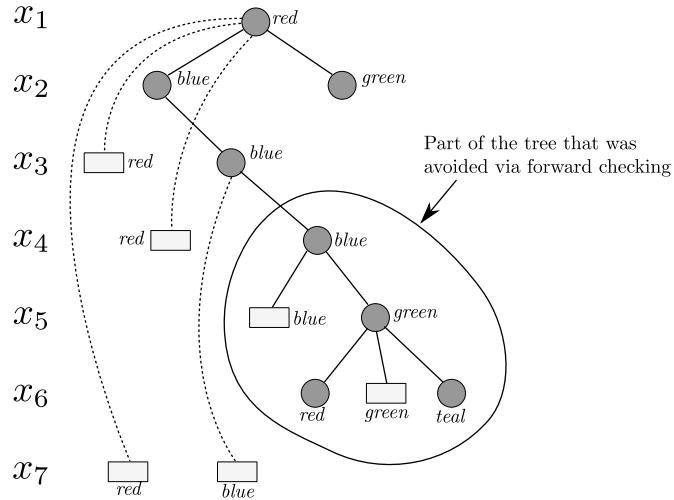
Assume that the algorithm uses the following order for picking variables:  $x_1, x_7, x_4, x_5, x_6, x_3, x_2$ . How would your answer change?

**Solution:** The solution for this case is provided in the following figure.



Consider the case when the algorithm also does forward checking and assume that the algorithm is tracing the variables according to the first order, i.e.,  $x_1, x_2, x_3, x_4, x_5, x_6, x_7$ . At some point during search, the algorithm assigns  $x_1 = \text{red}$ ,  $x_2 = \text{blue}$ , and  $x_3 = \text{blue}$ . How would the forward checking algorithm change the rest of the search? Indicate which values are eliminated from the domains of other variables in each step. Indicate the part of the rest of the tree that the algorithm does not have search due to forward checking.

**Solution:** The assignment is depicted in the following figure. The inconsistencies detected using forward-checking are indicated with white boxes. The part of the tree that is not explored due to forward-checking is also shown in the figure.



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