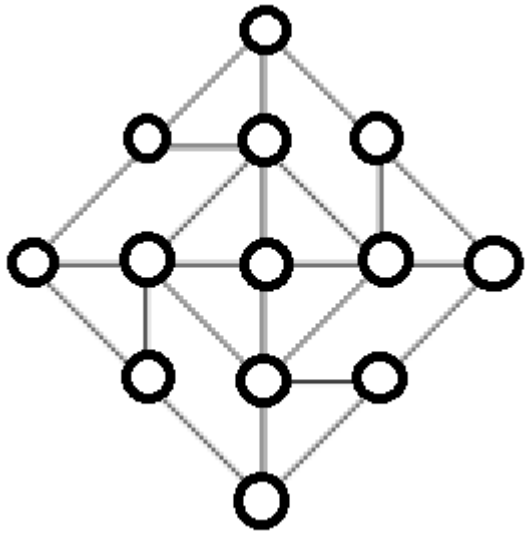
1. **Constraint Satisfaction Problems (4 parts, 50 points total).**

Consider the problem of coloring each node of this 13-node graph with one of three colors (**R**, **G**, **B**):



a) **(5 points) CSP Graph Representation.** Specify what the edges (links or neighborhood function) and vertices (nodes) in the above CSP mean.

In above CSP, edges mean binary constraints and nodes mean variables.

b) **(20 points) CSP Methods.** Suppose Node 1 (top) is colored **Blue**. Define **all** of the following and **choose one** to illustrate with an example using the above graph.

i) *Most constrained variable / Minimum remaining values (MRV) heuristic* for variable selection
ii) *Least constraining value* for value ordering
iii) *Forward checking* for speeding up constraint checking

i) Most constrained variable / MRV heuristic for variable selection :

The variable which is most likely to cause failure is assigned first. If the variable has higher chances of failure and we are supposed to assign variable then, it's better to assign early and find out failure earlier.

c) **(10 points) AC-3.** Explain in your own words how to use a table to store coloring constraints and show how it is updated using the AC-3 algorithm for the above graph. Give enough details to distinguish AC-3 from forward checking.

d) **(15 points) 3-Coloring.** Show that the graph **is** 3-colorable by finding a 3-coloring consistent with part (b). (Deciding 3-colorability, i.e., whether a graph is 3-colorable, is actually NP-complete.) You need not use any of the above heuristics, but they should help.