Project 2 Report CSP Graph Coloring

Weigeng Li G44406413

Graph Coloring

In this problem, we are going to color nodes in a graph. This is a Constraint satisfaction problem (CSPs) with these constraints.

Each node is assigned a color.

Adjust node cannot have the same color.

A simple approach is trying every combination of colors which can be done by backtracking. In these projects, we use two ways to speed up searching in backtracking.

1. Heuristics for variable choosing and value choosing (min remaining values, least constraining value)
2. Constraint propagation using AC3.
3. least constraining value

Heuristics

The Heuristics Functions are.

$$h(n) = RV - \frac{IC}{Max(Degree) + 1}$$

For a node n, Let RV be the remaining values of that node. IC is the involved constraint, which is equal to the number of neighbors that have not to be colored. $Max(\#Neighbour)$ the maximum degree (number of neighbors) among all nodes. Therefore

$$\frac{IC}{Max(Degree) + 1} \in [0,1)$$

In conclusion, $\min(h(n))$ have minimum remaining values, then maximum involving constraints.

Constraint propagation

For each choice of variable and value, there is a constraint propagation for this variable and its neighbor. The constraints are:

The neighbor can't have 0 remaining value.

If the neighbor only has one value in its remaining value, its neighbor can have the same remaining value.

If this expansion can't pass the constrain propagation, backtrack to its parent.

Choosing of value

Given a choice of variable, choose the least constraining value that rules out the fewest values of the remaining value of its neighbors.

Code Link

https://github.com/WeigengLi/GWU_Course/tree/master/6582AI/Project2

Result:

```
---------- Testing file test1.txt ----------
Time cost  0.59853 s
Answer:  {30: 4, 31: 3, 28: 3, 29: 4, 27: 4, 35: 3, 33: 4, 37: 3, 40: 2, 36: 4, 39: 3, 41: 4, 34: 3, 32: 2, 44: 4, 43: 3, 38: 2, 47: 4, 46: 2, 49: 3, 50:
4, 51: 4, 48: 3, 53: 4, 45: 3, 55: 3, 57: 2, 54: 4, 58: 4, 59: 3, 56: 2, 26: 4, 25: 3, 24: 2, 13: 4, 22: 4, 42: 2, 10: 3, 16: 3, 17: 4, 11: 2, 19: 3, 15:
4, 14: 2, 21: 3, 20: 2, 6: 4, 12: 2, 7: 4, 3: 2, 8: 4, 1: 3, 0: 4, 5: 4, 9: 2, 18: 3, 23: 4, 52: 3, 4: 3, 2: 3}
Answer passed the constrain examination. Number of color have: 4  Number of color used: 3
---------- Testing file test2.txt ----------
Time cost  0.08589 s
Answer:  {14: 4, 5: 3, 15: 2, 16: 4, 6: 2, 19: 3, 17: 1, 22: 1, 0: 4, 1: 3, 9: 4, 18: 2, 7: 1, 8: 2, 2: 1, 20: 4, 21: 3, 13: 2, 4: 1, 11: 4, 10: 3, 12: 1,
 3: 2}
Answer passed the constrain examination. Number of color have: 4  Number of color used: 4
---------- Testing file test3.txt ----------
Time cost  0.034 s
Answer:  {6: 4, 7: 3, 8: 2, 12: 4, 16: 2, 13: 3, 11: 1, 10: 3, 9: 2, 14: 4, 15: 1, 5: 4, 2: 3, 1: 2, 0: 1, 4: 4, 3: 3}
Answer passed the constrain examination. Number of color have: 4  Number of color used: 4
---------- Testing file test4.txt ----------
Answer:  {13: 4, 6: 3, 9: 2, 10: 3, 14: 2, 2: 3, 3: 4, 11: 1, 12: 4, 8: 1, 5: 2, 4: 1, 0: 4, 7: 3, 1: 2}
Answer passed the constrain examination. Number of color have: 4  Number of color used: 4
```