

Lab Assignment 5 : Map Coloring Problem

Problem Statement

In this assignment, you are required to implement the Map Coloring Problem on the map of India(29 States) using Backtracking along with the AC-3 algorithm for early failure detection. The goal is to compare the efficiency (in terms of the number of steps explored) between plain backtracking, backtracking with heuristics (MRV + LCV), and backtracking enhanced with AC-3.

Variables/ States in India = [List of states in India (Abbreviations)]

Colors/Values = ['Red', 'Green', 'Blue', 'Yellow']

Constraints :

1. No two adjacent regions should have the same color.
2. The number of available colors is limited (4).

Note : MRV (Minimum Remaining Values), LCV (Least Constraining Value), AC-3 (Arc Consistency Algorithm)

Algorithms to be Used

- Plain Backtracking
- Backtracking with MRV + LCV (Heuristics)
- Backtracking with MRV + LCV + AC-3

Detailed Explanation

1. Start with the plain backtracking implementation (Discussed in the class). Run it on the India map and record the number of steps taken to reach a solution.
2. Extend your backtracking solver with the MRV (Minimum Remaining Values) and LCV (Least Constraining Value) heuristics. While running your program, print which variable was selected using MRV and the order of colors chosen using LCV at each decision step. This will help in understanding how heuristics guide the search.
3. Implement the AC-3 algorithm for early failure detection. Combine AC-3 with backtracking and heuristics (MRV + LCV). Run your solver and record the steps.
4. Compare the step counts for all three approaches. Analyze and explain why AC-3 helps in reducing the number of explored states in comparison to plain backtracking and heuristic backtracking.

5. Submit your code along with the output comparison table showing the step counts for all three methods, along with the printed MRV and LCV choices during execution.

India Map Description

We will use the following abbreviations and adjacency list for the states and union territory in India (simplified map for CSP representation):

Abbreviations

AP – Andhra Pradesh
AR – Arunachal Pradesh
AS – Assam
BR – Bihar
CG – Chhattisgarh
GA – Goa
GJ – Gujarat
HR – Haryana
HP – Himachal Pradesh
JH – Jharkhand
KA – Karnataka
KL – Kerala

MP – Madhya Pradesh
MH – Maharashtra
MN – Manipur
ML – Meghalaya
MZ – Mizoram
NL – Nagaland
OD – Odisha
PB – Punjab
RJ – Rajasthan
SK – Sikkim
TN – Tamil Nadu
TS – Telangana
TR – Tripura
UP – Uttar Pradesh
UK – Uttarakhand
WB – West Bengal
JK – Jammu & Kashmir

Adjacency List

AP: TS, OD, TN, KA
AR: AS, NL
AS: AR, NL, ML, TR, MZ, MN, WB
BR: UP, JH, WB
CG: UP, JH, OD, MH
GA: MH, KA
GJ: MH, RJ
HR: PB, HP, UK, RJ
HP: JK, PB, HR, UK
JH: BR, UP, CG, OD, WB
KA: MH, AP, TS, TN, KL, GA
KL: KA, TN
MP: RJ, UP, CG, MH, GJ
MH: GJ, MP, CG, TS, KA, GA

MN: AS, MZ, NL
ML: AS, TR
MZ: AS, MN, TR
NL: AR, AS, MN
OD: WB, JH, CG, AP, TS
PB: JK, HP, HR, RJ
RJ: PB, HR, MP, GJ, UP
SK: WB
TN: AP, KA, KL
TS: MH, KA, AP, OD
TR: AS, ML, MZ
UP: UK, HR, RJ, MP, CG, JH, BR
UK: HP, HR, UP
WB: BR, JH, OD, AS, SK

Expected Output:

- Output a text list like {'MH': 'Red', 'KA': 'Blue',} or Graphical visualization of graph with colored nodes/vertices.
- The output should also display MRV variable selections and LCV color orders for each decision step.
- A table showing the number of steps for each algorithm.

All the best!

