CS 830 Intro to AI, Spring 2025

Written Assignments, Sushma Akoju

Assignment 4

1. Describe any implementation choices you made that you felt were important. Clearly explain any aspects of your program that aren't working. Mention anything else that we should know when evaluating your work.

   DFS with backtracking, fc and mcv:
   Working fine. Runs on test*.col and queen*.col files. I did not get any error and all the datasets successfully ran on all of the examples on agate using color validator successfully.

   Mcv only seems space efficient if I used an object to store the domain, variables and neighbors.

   FC takes longer than 60 seconds with restarts on queen12_12.col and queen16_16.col

2. What is the size of the state space for this problem?

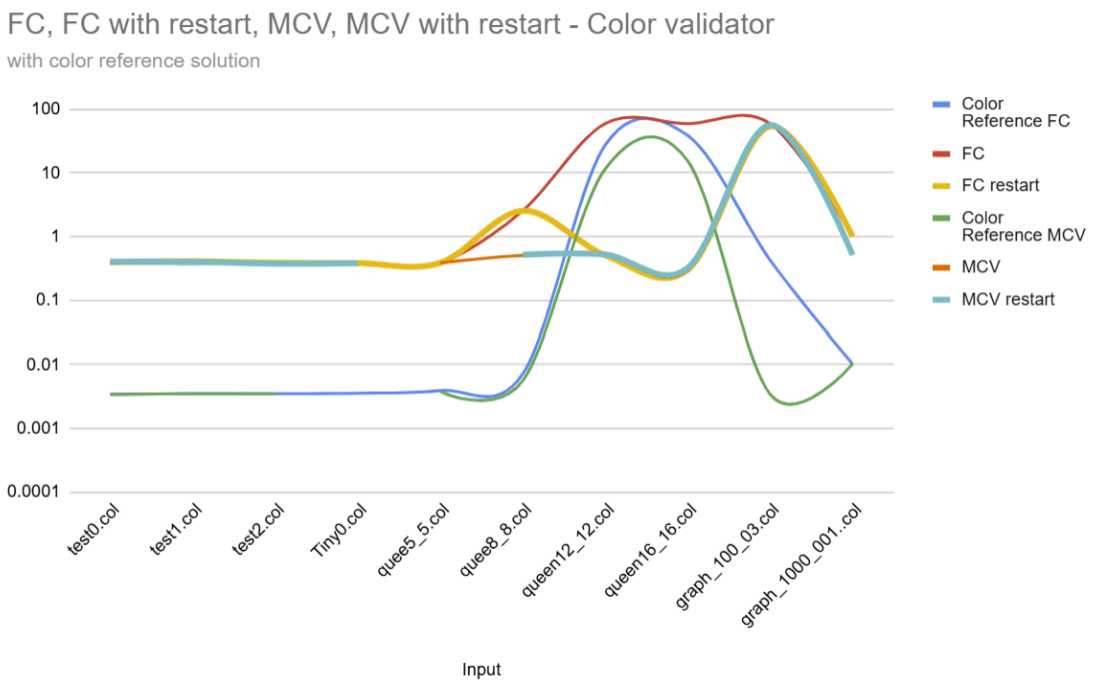
   FC - due to the use of inference to reduce the domain of unassigned variables and therefore search space is reduced. With MCV heuristic, search fails fast. by selecting the most constrained variable which selects the smallest domain first. MCV helps reduce the size of the search tree.

   State is the assignment of values to each variable.
   State space is set of all possible variations for variable assignments, each variable has a domain size of d_i. If number of colors = k, then if number of variables = n. State space would be n*k (for each variable (e), there are k possibilities). For this problem, k is finite.

3. What's the average speed-up you get for fc over dfs? For mcv over fc?

   For MCV over FC 12ms and number of nodes in the state space significantly reduces for mcv in comparison to fc.

The following is the time in seconds for each algorithm in comparison to that of color reference solution:



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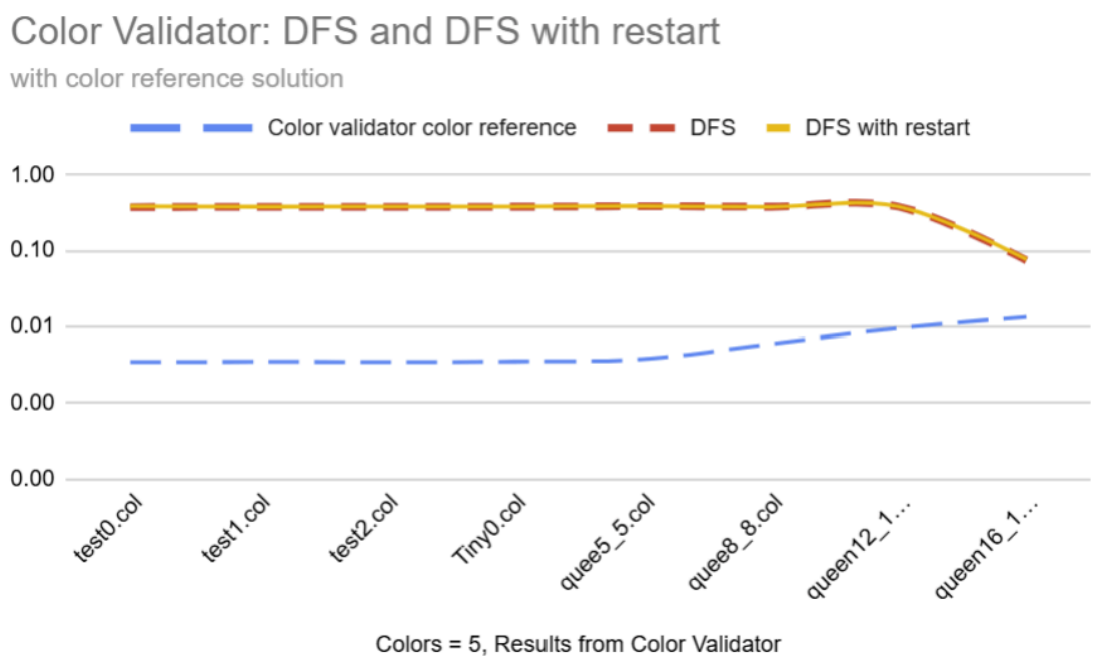

Colors = 5, Results from Color Validator	Colors = 5, Results from Color Validator	Colors = 5, Results from Color Validator	Colors = 5, Results from Color Validator
Input	Color Reference DFS	DFS	DFS with restart
test0.col	0.00345396995544 seconds 326 nodes	0.374341964722 seconds 2 nodes	0.384522914886 seconds and 2 nodes
test1.col	0.00348687171936 seconds 4 nodes	0.378524065018 seconds 4 nodes	0.3796210289 seconds and 4 nodes
test2.col	0.00347304344177 seconds 0 nodes	0.377842903137 seconds 0 nodes	0.381197929382 seconds and 5 nodes
Tiny0.col (example from assignment)	0.00351500511169 seconds 4 nodes	0.37916302681 seconds 4 nodes	0.382825136185 seconds and 4 nodes
quee5_5.c	0.00377106666565	0.385175943375 seconds	0.386924982071

ol	seconds 29 nodes	29 nodes	seconds and 29 nodes
quee8_8.col	0.0059859752655 seconds 326 nodes	0.379633188248 seconds 326 nodes	0.378844022751 seconds and 326 nodes
queen12_12.col	0.0095329284668 seconds 326 nodes	0.379698991776 seconds 326 nodes	0.380620002747 seconds and 325 nodes
queen16_16.col	0.0133719444275 seconds 326 nodes	0.0743238925934 seconds 325 nodes	0.0765061378479 seconds and 326 nodes
graph_100_03.col			

Colors = 5, Results from Color Validator	Color validator color reference	DFS	DFS with restart
test0.col	0.00	0.37	0.38
test1.col	0.00	0.38	0.38
test2.col	0.00	0.38	0.38
Tiny0.col (example from assignment)	0.00	0.38	0.38
quee5_5.col	0.00	0.39	0.39
quee8_8.col	0.01	0.38	0.38
queen12_12.col	0.01	0.38	0.38
queen16_16.col	0.01	0.07	0.08

Colors = 5, Results from	Colors = 10, Results from Color Validator	Colors = 10, Result	Colors = 10, Results from Color	Colors = 10, Results from Color Validator	Colors = 10, Results from Color Validator	Colors = 10, Results from Color Validator

Color Validator		s from Color Validator	Validator			
Input	Color Reference FC	FC	FC restart	Color Reference MCV	MCV	MCV restart
test0.col	0.00343108177185 seconds and 2 nodes	0.395381927 49 seconds and 2 nodes	0.396310091019 seconds and 2 nodes	0.00343298912048 seconds and 2 nodes	0.386655092239 seconds and 11 nodes	0.405215978622 seconds and 2 nodes
test1.col	0.00352811813354 seconds and 4 nodes	0.376301050186 seconds and 4 nodes	0.410300970078 seconds and 4 nodes	0.003509998322153 and 4 nodes	0.391717910767 seconds and 47 nodes	0.401384115219 seconds and 2 nodes
test2.col	0.003522157766907 seconds and 0 nodes	0.393320798874 seconds and 0 nodes	0.389028072357 seconds and 0 nodes	0.003494977955105 seconds and 0 nodes	0.391717910767 seconds and 0 nodes	0.375793933868 seconds and 0 nodes
Tiny0.col (example from assignment)	0.00358080863953 seconds and 4 nodes	0.394713878632 seconds and 4 nodes	0.38329410553 seconds and 4 nodes	0.00561189651489 seconds and 4 nodes	0.381789922714 seconds and 4 nodes	0.381531953812 seconds and 4 nodes
quee5_5.col	0.00394105911255 seconds and 26 nodes	0.394298076 63 seconds and 26 nodes	0.386795043945 seconds and 26 nodes	0.003813982009989 seconds and 25 nodes	0.387121915817 seconds and 25 nodes	0.397708892822 seconds and 25 nodes

quee8_8.col	0.00714612007141 seconds and 90045 nodes	2.554301023 48 secondseconds and 133887 nodes	2.556411981 58 seconds and 133887 nodes	0.00561189651489 seconds and 68 nodes	0.50656914711 seconds and 594 nodes	0.520363092422 seconds and 594 nodes
queen12_12.col	27.6374540329 seconds and 6235301 nodes	59.976763963 7 seconds and terminated by color validator	0.510385990143 seconds and 1023 nodes	11.6062989235 seconds and 6235301 nodes	0.509354829788 seconds and 177 nodes	0.524905920029 seconds and 177 nodes
queen16_16.col	39.0409810543 seconds and 6235301 nodes	59.625509023 7 seconds and 6235 nodes	0.299053907394 seconds and 176 nodes	15.624669075 seconds and 6235301 nodes	0.300813913345 and 176 nodes	0.320758104324 seconds
graph_100_03.col	0.428736209869 seconds and 659005 nodes	59.865955114 4 seconds and 668139 nodes	54.2476820946 seconds and 668139 nodes	0.00343298912048 seconds and 659005 nodes	57.2554368973 seconds and 668139 nodes	57.3343610764 seconds and 668139 nodes
graph_1000_001..col	0.0102920532227 seconds and 1000 nodes	1.021561861044 seconds and 1000 nodes	1.008960962323 seconds and 1000 nodes	0.0102920532227 seconds and 1000 nodes	0.523256778717 seconds and 1000 nodes	0.517082929611 seconds and 1000 nodes

graph_1000_01..col	Agate - time out for color reference solution	Agate - time out for color reference solution	Agate - time out for color reference solution	Agate - time out for color reference solution	59.5555489063 seconds and	Agate - time out for color reference solution
le450_15b.col	Agate - time out for color reference solution					

4. (830 only) Discuss the effectiveness of randomized restarting.

There is a chance that the right assignment is chosen by random tie breaking and with restart, there is a cutoff on the number of nodes in the state space. It esp. seems to be beneficial as the number of search steps before a restart occurs, increases geometrically at each restart. This controls longer searches which helps to exit the local minima.

5. What suggestions do you have for improving this assignment in the future?

Textbook is helpful, but it would help if more edge cases were discussed.