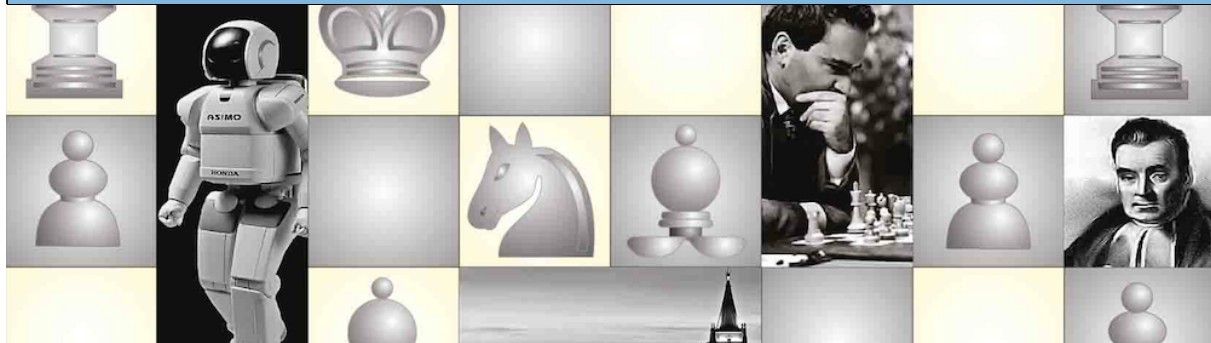


Fall 2024 - CSC545/645 Artificial Intelligence - Assignment 5



Due date: Thursday, October 3, 2024, 2:00 pm. Please create a folder called `assignment5` in your local working copy of the repository and place all files and folders necessary for the assignment in this folder. Once done with the assignment, add the files and folders to the repo with `svn add files,folders` and then commit with `svn ci -m "SOME USEFUL MESSAGE" files,folders`.

The Four Color problem is one of the most famous problems in Mathematics. The problem consists of the question of whether any map can be colored using four colors in such a way that adjacent regions (i.e. those sharing a common boundary segment, not just a point) receive different colors. This problem was formulated first by Francis Guthrie in 1852 (published in 1878) and was unsolved for roughly a century. Wolfgang Haken and Kenneth Appel could prove the four-color theorem with the help of a computer program in 1977 [Ken77].

Exercise 5.1 [20 points]

Read chapter 6 of the textbook. Consider the political map of the South-Eastern states of the USA (states North Carolina, South Carolina, Virginia, Tennessee, Kentucky, West Virginia, Georgia, Alabama, Mississippi, and Florida). How can we color this map with the four-color theorem using a CSP approach?

1. How is this problem represented in general (write in your own words). Define the variables, the value domain, and the constraints. [2 points]
2. Implement your algorithm using backtracking, backtracking with forward checking, backtracking with AC-3, and min-conflicts. Please run the algorithms with and without an initial assignment for one state. Construct a table of average run times for each algorithm for values and show the results. Comment on your results. [15 points]
3. You have implemented the same problem with different algorithms (assignment 4+5). What have you learned from the two exercises? Is there a preference for one algorithm over the other? If yes, please comment on that. If not, please do the same :-). [3 points]



Figure 1: South-Eastern states of the US

Exercise 5.2 *Mandatory for CSC645 students, optional for CSC545 students* [6 extra points]

In addition to the heuristics implemented in 5.1.2, implement the backtracking search with 1. degree-heuristic, 2. least-constraining-value, 3. minimum-remaining-values. Also, evaluate the different implementations with the map of the entire USA and the Sudoku puzzle (provided with the Java framework) to see the differences in the algorithm more apparent.

[6 points]

You may want to use the framework provided by Alexander Härtl (download [Java](#)).

References

[Ken77] Kenneth Appel and Wolfgang Haken. Every planar map is four colorable. Part I. Discharging. *Illinois Journal of Math*, 21:429–490, 1977.