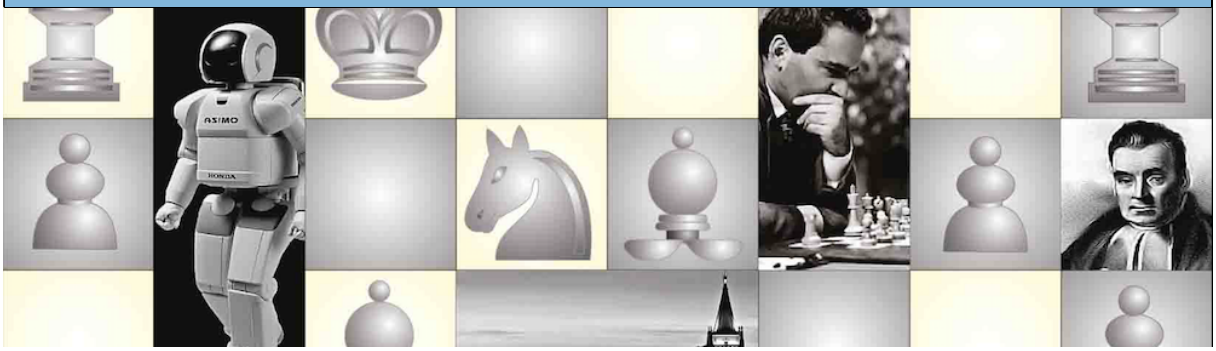
Fall 2024 - CSC545/645 Artificial Intelligence - Assignment 4



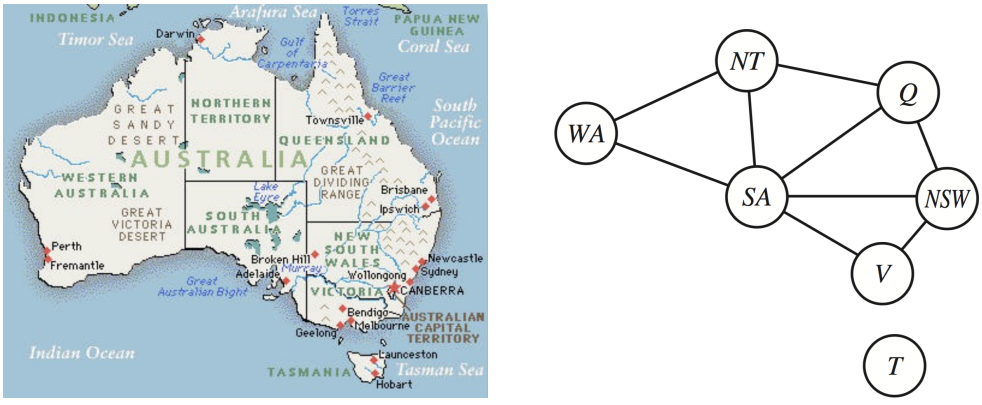
Due date: Thursday, September 26, 2024, 2:00 pm. Please create a folder called `assignment4` **in your local working copy of the repository and place all files and folders necessary for the assignment in this folder. Once done with the assignment, add the files and folders to the repo with** `svn add` *`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 4.1 [4 points]
Read chapters 4.1 – 4.2 and 6.1 – 6.2 of the textbook.

1. Define in your own words the terms constraint satisfaction problem, constraint, back-tracking search, back-jumping, and min-conflicts. [2.5 points]

2. How many solutions are there for the three-color map-coloring problem in Figure 1? Elaborate your answer.[1.5 points]



(a) States and Territories (b) Constraint-graph

Figure 1: a) The principal states and territories of Australia. b) The map-coloring problem represented as a constraint graph.

Exercise 4.2 [16 points]
Consider the political map of the South-Eastern states of the US (states North Carolina, South Carolina, Virginia, Tennessee, Kentucky, West Virginia, Georgia, Alabama, Mississippi, and Florida, see Figure 2). How can we color this map with the four-color theorem using a Genetic Algorithm? Use the same algorithm to color all 51 states of the USA (Washington DC is counted as a state in this case).

1. How is this problem represented in general (write in your own words). Define the states, the goal test, and the successor function of your problem.
   [2 points]

2. Implement your algorithm and show the results. You may want to use the framework provided by Alexander Härtl (download Java, C++, C). Fan Zhang has created a Python Framework which can be found here: Python). Neighboring states can be found in text files provided by Andreas Seekircher us_states_10_ij.txt and us_states_51_ij.txt
   [14 points]

Figure 2: South-Eastern states of the US

References

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