Exercise 3.1 (Hillclimbing search)
Consider the Traveling Salesman Problem on the cities \{a, b, c, d, e\} with the symmetric cost matrix

\[
\begin{array}{c|ccccc}
   & a & b & c & d & e \\
\hline
a & 0 & 2 & 7 & 3 & 6 \\
b & 2 & 0 & 3 & 12 & 10 \\
c & 7 & 3 & 0 & 2 & 8 \\
d & 3 & 12 & 2 & 0 & 5 \\
e & 6 & 10 & 8 & 5 & 0 \\
\end{array}
\]

A tour is a closed path that visits every city exactly once. The cost of a tour is the sum of the distances of the edges used. Perform a hillclimbing search for a tour with minimal cost starting with the tour \(t_0 = [a - c - b - d - e - a]\). The neighborhood of a tour \(t\) consists of all tours obtained from \(t\) by visiting a pair of cities visited consecutively in \(t\) in the reversed order (i.e. in this problem, each tour has exactly five neighbors). Draw the resulting search tree.

Exercise 3.2 (CSPs)
The \(SEND + MORE = MONEY\) problem consists in finding distinct digits for the letters \(D, E, M, N, O, R, S, Y\) such that \(S\) and \(M\) are different from zero, i.e. no leading zeroes, and the equation

\[SEND + MORE = MONEY\]

is satisfied.
Formulate the problem as a constraint satisfaction problem, i.e. give the variables, constraints, etc. Give a solution.

Exercise 3.3 (Sudoku)
Show how \(Sudoku\) puzzles can be represented as graph coloring problems in which fixed colors are already assigned to certain nodes at the beginning. Describe an algorithm transforming a given Sudoku into an equivalent graph coloring problem. (Give the nodes and edges of the graph, the set of possible colors and the initial colorings.)


The exercise sheets may and should be worked on in groups of three (3) students. Please write all your names and the number of your exercise group on your solution.