Additional Material for Module 5 (Discrete Models): Some Standard Problems

SP (Shortest Path Problem):
Given a weighted graph, find a shortest path from node a to node b.

MST (Minimum Spanning Tree):
Given a weighted graph, find the MST, i.e. a set of edges such that all nodes are connected at minimum cost.

Knapsack Problem:
Given n objects and a size s_j and a value v_j for each of them, find a subset of objects such that the sum of s_j does not exceed S and the sum of values v_j is maximized.

Graph Coloring Problem:
Given a graph, find the minimum number of colors such that two nodes that are connected with an edge have different colors.

TSP (Travelling Salesperson Problem):
Given a set of cities and distances for each pair of cities, find the shortest round tour.

Set Packing:
Given n objects $a_1 \dots a_n$ and a value v_j for each object. Given further a set of subsets A_i over objects a_j. Maximize the total value of the selected objects without selecting more than one object from every subset.

SAT (Satisfiability):
Given a set of boolean variables $x_1 \dots x_n$ and a set of clauses C over those variables (a clause is a boolean expression with AND,OR and NOT). Does there exist a satisfying truth assignment for C?

There often exist several versions of a standard problem, e.g. an *optimization version* or a *decision version*, in the latter version the answer to the question in the problem is either 'Yes' or 'No'. In some books, e.g. in [1], problems are formulated as as *decision problems* for theoretical reasons. In this course we mainly work with the *optimization version* of the respective standard problem since we are interested in not only in the theoretical difficulty of the problem but also the (optimal) solution of a problem.

[1] Garey, Johnson (1979). Computers and Intractability.