Exercise Sheet 1 – Uninformed Search

Define each of the following problem as a *weighted state space problem*: a set of states S, an initial state s, a set of goal states T, a set of actions A and a cost function w. You do *not* need to enumerate all states of the set S, but you must provide an exact (and possibly formal) definition of each state and the successor function *succ(s_i)*.

EX1, Alphabetic Dice Puzzle: Given four dice and every dice has a single letter of the English alphabet on each of its six sides. In all, the four dice contain every letter of the English alphabet except Q and Z. By arranging the dice in various ways, you can spell all of the words listed below. Find the assignment of letters to the four dice for these words:
BAKE ONYX ECHO OVAL
GIRD SMUG JUMP TORN
LUCK VINY LUSH WRAP

EX2, Coins Problem: Given a bag of Euro cent coins of various denominations: 1, 2, 5, 10, 20, 50. Find the minimum number of coins contained in the bag such that by selecting only coins contained in the bag every Euro amount smaller than one Euro can be paid.
Example: if you put three coins with denominations of 1, 2, and 2 in the bag then you can pay exactly the amounts of 1, 2, 3, 4, and 5 cents.

EX3, Magic Square: "A magic square is a $n \times n$ square grid, where n is the number of cells on each side, filled with distinct positive integers in the range $1,2,\ldots,n^2$ such that each cell contains a different integer and the sum of the integers in each row, column and diagonal is equal. The sum is called the magic constant or magic sum of the magic square and calculated by the formula $M = n(n^2+1)/2$".
Problem: Given a number n, find the corresponding magic square.
Example: if $n = 3$ the magic constant is 15 and one of the possible magic squares is shown below

2	7	6
9	5	1
4	3	8

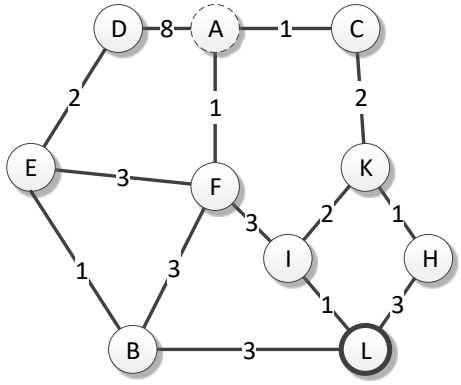
Produce the search trees for the state space below given *A* as a start node and a goal node *L* using each of the following search strategies:

EX4: breadth-first search,

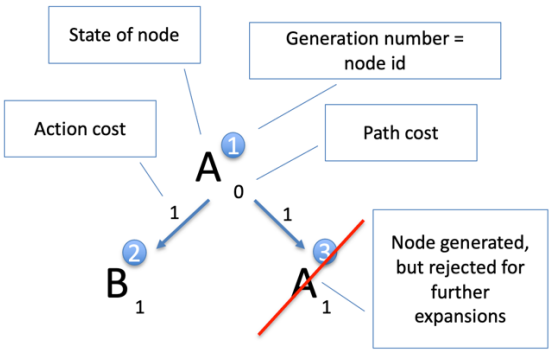
EX5: depth-first search,

EX6: uniform-cost search (The fringe is sorted by costs. Equal cost nodes are sorted by alphabetic order.),

EX7: iterative-deepening search



Input state space



Recommended notation for a search tree

For each search problem consider the following properties and answer the questions:

a) Which search variant – tree-search, graph-search, or another variant – would you prefer for every of the four search strategies above? Explain why? You are free to choose.

b) Nodes are generated in alphabetical order. E.g. expand(X) and problem.Actions return an ordered sequence in alphabetic order, smallest element first.
Indicate by a generation number the order of node generation. expand(X) generates all successor nodes of X at once.

c) Provide the solution path and its cost.

d) How many nodes have been generated?

e) What is the time complexity of the search algorithm?

f) What is the space complexity of the search algorithm?

EX8: Compare depth-limited search (i) with limit 2 and (ii) with limit 6. Assume that depth-limited search employs modified depth-first search.

- Does (i) or (ii) find a solution? If yes which solution is found?
- Does (i) or (ii) find an optimal solution?

Introduction to Artificial Intelligence I

Model and solve the following problem.

Provide:

a) a definition of the weighted state space problem
b) its graph representation
c) a choice of a search algorithm
d) a search tree.

Your search algorithm should find an optimal solution w.r.t. the number of actions.

EX9: *The towers of Hanoi with two disks*: Given are three rods (left, middle, right) and two disks of different size (1, 2). Initially, all disks are stapled on the left rod. The objective of the puzzle is to move all disks from the left rod to the right rod, whereby only one disk can be moved at a time. Furthermore, no disk may be placed on top of a smaller disk in all states.