TOPIC REPORT

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1 Introduction

A topic description of Team 17. List of members:

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2 Description of the problem

A extended 8-puzzle problem: 15-puzzle

A program to solve the extended 8-puzzle problem from the Chapter 3 's slides.
In this game, 15 tiles are arranged on a 4×4 grid with one vacant space. The tiles are numbered from 1 to 15. The state of the puzzle can be changed by sliding one of the numbered tiles – adjacent to the vacant space – into the vacant space. The action is denoted by the direction, in which the numbered tile is moved. For each state, the set of possible actions As is therefore a subset of $\{up, down, left, right\}$. The goal is to get the puzzle to the final state right by applying a sequence of actions. A puzzle configuration is considered as solvable, if there exists a sequence of actions which leads to the goal configuration.

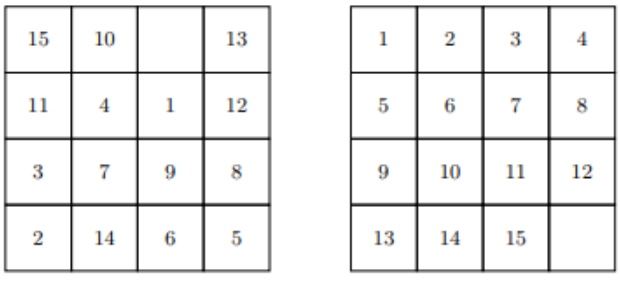

Fig. 1. A possible start state (left) and the goal state (right) of the 15-puzzle.

States: There are $16! = 2.092278989 \times 10^{13}$ possible states
(all permutations of $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15\}$ where 0 is the empty space).
Not all states are directly reachable from a given state. (In fact, exactly half of them are reachable from a given state.)

Each represented by a pair $(A, (i, j))$ where:
A is a 4×4 array of numbers in $[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15]$
(i, j) is the position of the empty space (0) in the array.

15	10		13
11	4	1	12
3	7	9	8
2	14	6	5

becomes $\left(\begin{vmatrix} 15 & 10 & 0 & 13 \\ 11 & 4 & 1 & 12 \\ 3 & 7 & 9 & 8 \\ 2 & 14 & 6 & 5 \end{vmatrix}, (1,3) \right)$

The initial state: randomly generated.

Actions: 4 operators of the form OPd where $d \in \{L, R, U, D\}$. OPd moves the empty space in the direction d.

The goal state: Pieces end up in the correct order

The path cost: Each move costs 1, so path cost = number of steps in path, performance measure is minimizing the total moves.

Each algorithm will has several outputs

- Time complexity (number of nodes expanded in order to solve the puzzle)
- Space complexity (number of nodes kept in memory)
- The sequence of moves from the blank tile to solve the puzzle (solution), or if there is no possible solution, print "Unsolvable".

Multiple puzzles (at least 50) will be generated and solved (or not, if they were not solvable) which will be aggregated before being analyzed in the report. This is the extended version of 8-puzzle problem so there will be comparison between 15-puzzle and 8-puzzle.

[0] https://mediatum.ub.tum.de/doc/1283911/1283911.pdf