COMP 4106 - Artificial Intelligence
Fall 2017

Assignment #1

Due date: February 15, 2017

1 Overview

In this assignment you will use AI techniques to solve two problems. The first will be a transportation problem couched in terms of a "riddle". The second will be a space allocation problem phrased in the setting of a puzzle. Good Luck and hope you enjoy doing them. Once you do them, you will be able to solve a host of other similar real-life problems.

2 Commodity Transportation Problem: Bridge and Torch

2.1 Problem Statement

The classic version of this problem concerns scheduling the movement of N, say four people. This is a typical problem in transportation, especially for the real-life transportation of material and personnel. In the traditional classical problem, you have to move these four people, over a narrow bridge at night. The bridge can only hold two people at a time and thus the torch has to be used to cross the bridge. It takes person A one minute, B two, C five, and D eight minutes, respectively, to cross the bridge. When two persons are crossing the bridge together, they both move at the pace dictated by the slower person. The task is get the group across the bridge in the minimum time.

Your task is to solve the above problem for the case of 6 persons $\mathcal{P} = \{p_1, p_2, \cdots, p_6\}$, with specified crossing times for each person, for example, $\mathcal{T} = \{1, 2, 3, 5, 8, 13\}$. Your UI must prompt the user for the corresponding times, specified in an increasing order.

3 Space Management Problem

3.1 Problem Statement

In this problem, you will be implementing a typical problem in space management. The problem is interesting if you recognize that politicians like to be in prominent places, and the place where they sit is often a cause for being offended and strife.

We shall model this using an enhanced variation of the "age-old" *8-puzzle* or *tile-puzzle*.

The game is played on a 3x3 board with 8 of the tiles having the numbers '1' through '8' on them. Initially these tiles are in a random order. One space is left blank. The goal is to arrange the tiles in the correct order. The figure below illustrates the game, where the left side is the starting state, and the right side is the goal state.

3.2 Game Definition

We generalize the traditional game by permitting the following moves:

1. Any tile that is adjacent to the blank-space can slide into the blank space, thus essentially swapping positions with the blank-space.

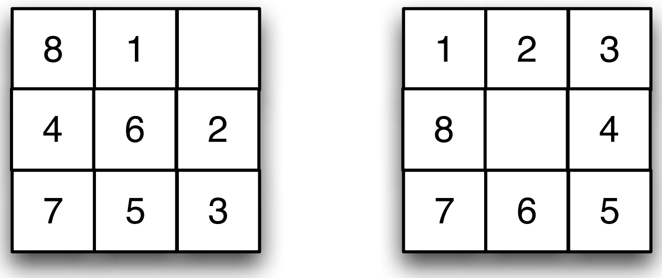

Figure 1: 8-Puzzle Illustration

2. The move for the blank-space can be in all eight directions. Thus, in the figure on the left, the tile '6' can be moved diagonally to the top-right, essentially swapping places with the blank-space.

3. Two non-blank tiles can be swapped as per the "Chess Horse" move. Thus, in the figure on the left, the tiles '8' and '2' can swap places. Similarly the tiles '7' and '2', and '8' and '5', can also swap places.

Your task is to solve the problem for 2×4, 3×3 and 2×5 squares.

Your program should read a comma delimited file that represents the starting configuration, or have some other way of configuring the initial board. Also, if the problem is unsolvable, you may choose to terminate the search after a reasonable number of nodes are processed.

4 Assignment Objectives

4.1 Tasks

In this assignment you are to:

- Implement the *Commodity Transportation* and *Space Management* problems with interactive front-ends.
- Implement a *Breadth_ First Search* for solving the problems.
- Implement a *Depth_ First search* for solving the problems.
- Implement the *A* search* for the problems.
  - Implement two (2) different heuristics for solving the problems.
  - Implement a third heuristic which takes the average of the first two heuristics.
- Write a short report (no more than 1 (one) page for each problem) about the state space of the problems, and about the choice of your heuristics.

4.2 Questions

During the demo you should be prepared to discuss, for each problem, the following questions:

- Which search worked best?
- Which heuristics did you use?
- Why did you choose these heuristics?
- Does the combination of the two heuristics work better or worse than they do individually?
- How well do the searches work if you increased the number of commodities for the *Commodity Transportation* problem, and the size of the board in the *Space Management* problem (to, for example, 9x9 or 11x11).

4.3 Bonus Tasks

The following items are considered as bonus. You should work on these if you have completed the required objectives.

- **Commodity Transportation Problem**: Allow for an increased number of "commodities" with specified constraints. Thus, in the general scenario, find the solution for the case when we have N persons, $\mathcal{P} = \{p_1, p_2, \cdots, p_N\}$, whose crossing times are $0 < t_1 \leq t_2 \leq \cdots \leq t_n$, respectively.
- **Space Management Problem**: Allow for variable-sized boards and multiple blank spaces.

4.4 Tips

The search maybe slow. In this case, think about how you can optimize it. However, one of the first steps is to make sure that the search actually works.