2018 Main Problem

Elemental Mining

Introduction

A department at a specific military base that specializes in the mining and refining of the natural elements has approached you with a problem. They have sites where they have implemented automated worker drones to gather resources from mines and transport those resources to their factories for processing.

The problem they are currently facing is that the AI to control these drones are far from efficient, causing the worker drones to go to every single factory after picking up minerals instead of just going to the mine's assigned factory, which ends up costing them a lot of unnecessary money.

Problem Description

Your Goal

Your task is to minimize the cost of running these automated mining drones by finding the shortest route between all the mines and factories, whilst depleting all resources from each mine. You will need to mine all resources from every mine, and deliver them to the correct factories, while minimizing the total distance travelled, as the fuel cost to move the workers a single unit of distance costs R1. Each map will have an assigned budget to it, which you must try to lower as much as possible. These maps will also each have their own unique challenges to solve.

Distance is calculated using the Manhattan distance formula:
https://en.wikipedia.org/wiki/Taxicab_geometry

$$Given: A = [x_1, y_1] \; and \; B = [x_2, y_2]$$
$$Distance\ (A, B) = (\ abs(\ x_2 - \ x_1) + abs(\ y_2 - \ y_1\ )\ )$$

Scores will only be given to solutions where all resources have been deposited to factories. *Not all workers need to be used to get an optimal solution.*

Map

Your mining areas can be represented as a rectangular grid of height ***R*** and length ***C***. The mining area is covered with various mines and factories for different elements of the periodic table. The coordinates for the mines are $[r, c]$ (where $0 < \ r \leq \ R \; and \; 0 < c \leq C$).

Workers

You will have access to three types of workers with different inventory limits:

- Miners – Can carry a maximum of 1 resource.
- Excavators – Can carry a maximum of 3 resources.
- Haulers – Can carry a maximum of 5 resources.

You will have a miner count ***M***, excavator count ***E*** and hauler count ***H*** for each map, which will indicate the number of each type of worker you will have available to mine that area.
A worker can hold exactly one of any type of resource and can have a combination of different resources from different mines, given that it has the capacity. Each worker can only hold one of each type of resource, i.e. a worker will not be able to collect a resource from a mine that it already has a resource for in its inventory. It will need to deposit that resource at an associated factory before collecting the same resource from the same type of mine. Workers do not need to completely fill their inventory before visiting a factory or another mine.

Mines and Factories

There is a total of 118 unique elements on the periodic table, all of which will be available to be mined from the various maps provided. Mines will be denoted as the element's symbol in full uppercase, and the respective factory will be denoted as the element's symbol in full lowercase.

Each mine will hold a unique element within it, any resource mined from it will have to be delivered to the respective factory for it to be processed correctly. Example only resources collected from an Iron (FE) mine can be deposited to an Iron factory (fe) to be processed.

Each map will have a varying number of mines ***MN*** and factories ***F***. All mines and factories will be given a unique index, which you will use to identify every individual building (mine or factory).

Workers carrying multiple types of resources will only deposit the relevant resources to a factory and will deposit no resources if the worker does not have resources that the factory can process.

Resources

Each mine will hold varying amounts of resources that can be mined and will have to be delivered to their respective factories to be able to be processed. Visiting a factory without any resources that can be processed by that factory will be a wasted moved, so always ensure when visiting a factory, to have the correct resources in the worker.

Once a worker is at full capacity, that worker will not pick up any new resources when visiting new mines, until those resources have been delivered to the correct factory.

Map Input

The first line of the input file will contain the following information:

- R - Map Height $(0 < R \leq 1000)$
- C – Map Width $(0 < C \leq 1000)$
- M – Miner Count $(0 < M \leq 1000)$
- E – Excavator Count $(0 < E \leq 1000)$
- H – Hauler Count $(0 < H \leq 1000)$
- MN – Number of Mines $(0 < MN \leq 10000)$
- F – Number of Factories $(0 < F \leq 10000)$
- Budget – This is the maximum allowed distance to be travelled for each map as well as the distance to beat.

The next ***MN*** number of lines will contain information regarding the mines where each line will contain the following information:

- I – Unit Index (Used for commands) $(0 \leq I < MN)$
- T – Tag, uppercase element symbol
- x – X coordinate for mine $(0 \leq x < R)$
- y – Y coordinate for mine $(0 \leq y < C)$
- R – Number of resources for that mine $(1 \leq R \leq 50)$

The next ***F*** number of lines will contain information regarding the factories where each line will contain the following information:

- I – Unit Index (Used for commands) $(MN \leq I < MN + F)$
- T – Tag, lowercase element symbol
- x – X coordinate for mine $(0 \leq x < R)$
- y – Y coordinate for mine $(0 \leq y < C)$

All workers always start at position [0,0] and all coordinates are referenced from this point.

Example

6 6 2 2 0 4 5 100	6x6 map, 2 miners, 2 excavators, 0 haulers, 4 mines, 5 factories, budget R100
0 FE 1 4 2	Index 0, Tag FE, coordinates [1,4], 2 resources
1 AG 4 1 1	Index 1, Tag AG, coordinates [4,1], 1 resources
2 S 3 2 3	Index 2, Tag S, coordinates [3,2], 3 resources
3 B 2 0 2	Index 3, Tag B, coordinates [2,0], 2 resources
4 fe 2 3	Index 4, Tag fe, coordinates [2,3]
5 ag 4 4	Index 5, Tag ag, coordinates [4,4]
6 s 5 3	Index 6, Tag s, coordinates [5,3]
7 s 1 2	Index 7, Tag s, coordinates [1,2]
8 b 0 2	Index 8, Tag b, coordinates [0,2]

Submissions

Submissions will need to be made on the Entelect Challenge portal. Each submission will need to consist of a solution output file containing information described below as well as a zipped filed containing your source code used to generate your solution.

You may upload multiple submissions per map, the best scoring submission will be used. You must complete as many maps as possible, to have the best chance at achieving a high score.

Output File Format

Each line in the submission file must contain ***F*** lines, one for each worker.

Each line describing the worker's actions will contain the worker type separated from the series of movement commands for that worker separated by a pipe '|'. The commands thereafter will need to be comma separated. The commands of which mines or factories to visit must be denoted by the index provided for that respective mine or factory.

Worker tags are as follows:

- M – for Miners
- E – for Excavators
- H – for Haulers

Be sure not to exceed the number of miners, excavators and haulers available for each area map (each area will have a different number of each worker type available).

Example Output File:

```
M|0,4,1,5
M|2,6,2,7
E|3,2,6,8
E|3,0,4,8
```

For a submission to be valid, the contents of the file should be in the above format. All resources must be delivered, and all mines must be empty. If any resources remain on any workers or in any mines, the submission will be treated as unsuccessful.

Simulation and Scoring

Only the solution file submitted will be processed and scored once submitted. The source code provided will be required for verification purposes and will not be run during the duration of the challenge.

Each team's goal is to get the highest *Overall Score* possible. For each map, the *Map Score* is calculated by the *Map Total Distance* travelled by all workers, including miners, excavators, and haulers (this is the result of your submission), subtracted from a predefined *Map Budget Distance* (provided) for that map which results in the *Total Score* for that map. The sum of *Total Scores* for each map is the team's *Overall Score*.

Example

Map 1 Budget Distance = 30
Map 1 Total Distance = 5
Map 1 Total Score = Map 1 Budget - Map 1 Total Distance
Map 1 Total Score = 25

Map 2 Budget Distance = 50
Map 2 Total Distance = 45
Map 2 Total Score = Map 2 Budget - Map 2 Total Distance
Map 2 Total Score = 5

Overall Score = Map 1 Total Score + Map 2 Total Score
Overall Score = 30

If you have any questions or comments, please ask the team via email or the forum:

challenge@entelect.co.za
https://forum.entelect.co.za