UNIVERSITY CUP

University Cup

Problem Description

Space station Nova is well known throughout the universe as the front runners in quantum material processing and logistics. Through years of arduous work and consistent efforts, the space station has created an infrastructure capable of supplying the entire human race with an abundance of rare metals and substances. These revolutionary substances jumped human technology forward millennia. The station is also equipped with humanity's latest Ultra Range Light Scanners, URLS, meaning the exact location and density of all resource clusters in your galaxy are known.

You are Nova's new Admiral, meaning you are the big boss that calls the shots around here. It is up to you to manage the station as well as your flotilla of space faring ships. Thanks to your predecessor, station Nova is running smoothly and requires no further adjusting and is operating at maximum efficiency and capacity.
However, the flotilla could use a bit of attention as their collection and delivery protocols are outdated and inefficient.

Your task is to create a new algorithm for your unmanned RC&D, Resource Collection & Delivery, vessels that will collect the resources and deliver it to station Nova for processing. Due to your scientists' breakthrough, your flotilla makes use of a Quantum Tethered Energy Source, or QTES for short, meaning there is no worries about refueling as the energy is shared to all ships. Since space station nova is located right next to Sub-Sector Kriuel's Dyson Sphere, you have UNLIMITED POWER at your disposal, so keeping your flotilla running is no worry at all.

Your Goal

Write an algorithm to collect as many resources as possible and deliver them to space station Nova for processing without breaching the threshold too far. Some resource clusters might have more resources than others and some resources are more valuable than others but take longer to process, so weigh your options carefully.

You will have five galaxies to traverse through.
Keep in mind that some galaxies might have optional objectives to score some tasty bonus points.

Distance is calculated as a straight line (rounded up): Euclidean distance - Wikipedia

Note: Not all spaceships need to be used to get an optimal solution.

Galaxy Details

Space Station

The space station is responsible for storing processed and un-processed materials as well as processing the raw materials. The space station does not have any strict storage limitations; however, the space station has a free storage threshold for processed resources. Once the processed resource storage thresholds are reached, the space station incurs charges for storing too much, this in turn will negatively affect your score.

A space station is outfitted with a set of labs able to process materials in batches that they are dropped off in. The space station manages the processing of resources at the labs

Labs

When batches of resources are dropped off at the lab, each batch is added to a queue for processing. A lab will pick up a batch of resources to process when available, once a lab is done with processing and storing a batch, it will pick up the next one from the queue.

In the instance that a batch results in the capacity threshold of the outpost for processed materials being stored to be exceeded, no penalties will be imposed on that batch, however, every subsequent batch processed will have storage penalties imposed upon it.

The processing of materials is done automatically and is limited by the number of labs available at the outpost.

Ships

Space station Nova has a flotilla of ships available to gather resources from the surroundings. Due to the excess of available energy, there is a minimal cost incurred for travelling far distances and consuming energy. You are responsible for determining the flight paths for your flotilla's ships.

Ships automatically pick up all resources in a resource cluster. In the event that the number of resources picked up at a cluster exceeds the ship's capacity, the ship will still pick up and store all the resources, however it will not be able to pick up any more resources until they have been dropped off at the outpost.

Ships have limited storage and can store more than one type of resource. Resources gets grouped into batches by resource type when offloaded at the space station, which will be individually queued for processing.

All ships in the flotilla start at the outpost and must end return to the outpost by the end of its planned journey. If the final destination of a ship is not specified to be the space station, once its final command is given, it will automatically be sent to the space station to drop off whatever materials it has on hand.

Resources

There are 10 unique resources spread across the galaxy that needs to be collected. Resources are spread across the galaxy in clusters with the density of resources known.

There are points awarded for collected resources that have been dropped off at the space station and process. Points will be lost for resources stored that are above the outpost's threshold.

Each resource has a different worth, based on the below table.

- CM – Score modifier for every resource of that type collected
- PM – Score modifier for every resource of that type processed
- PT – How long it takes to process each resource of that type
- QB – The bonus multiplier for reaching a quota

Resource Name	ID	Points per unit Collected (CM)	Points per unit Processed (PM)	Processing Time (PT)	Quota Bonus Modifier (QB)
Adamantium	1	1	2	2	1.5
Madamantium	2	1	2	2	2
Sadamantium	3	1	2	3	2.5
Gladamantium	4	2	4	3	4
Radamantium	5	2	4	3	3
Badamantium	6	2	4	4	4
Chocolate	7	3	6	4	4.5
Antmanium	8	3	6	5	4.5
Vladamantium	9	4	8	6	6
Vibranium	10	5	10	8	5

Quotas

Above the space station's overall processed resources threshold, there are bonuses for collecting enormous amounts of specific types of resources. Not every galaxy will have the same quota bonus for different resources as each galaxy has different requirements, and not every resource available in the galaxy will have the same quota bonus for every resource.

The quotas are percentage based on the ratio of a resource type to the total number of resources collected.

Quota bonuses are added at the end of the score calculation and is applied on the total number of resources collected for that resource type.

Map Constraints

The following are the minimum and maximum values you can expect for the different constraints on the map.

- UR - Unique Resource Types ($0 < UR <= 10$)
- RC - Number of Resource Clusters per Resource ($0 < RC <= 10000$)
- RA - Density of Resource Cluster ($0 < RA <= 200$)
- S - Number of Ships ($0 < S <= 200$)
- C - Ship Capacity ($0 < C <= 5000$)
- L - Number of Labs ($0 < L <= 20$)
- T - Outpost Processed Material Threshold ($0 < T <= 100000$)
- NQ - Number of Quotas ($0 < NQ <= 10$)
- RQ - Resource Quota percentage ($0 < RQ <= 100$)

Input File

Line		Example
First Line	UR|S|C|L|T|NQ	2|3|200|2|300|2
Second Line	Resource ID, Number of Resource Clusters	1,5|2,5
Next NQ Lines	Adamantium quota 50% |(RQ) Madamantium quota 50% | (RQ)	1|50 2|50
Next UR lines	Resource ID|Resource Cluster ID, coordinates, number of resources in cluster	1|a0,-3,-3,-4,12|a1,29,7,5,93|a2,27,0,-1,92|a3,26,-11,7,84|a4,8,-16,22,68 2|b0,-11,25,-33,1|b1,-30,-38,35,4|b2,-24,19,-34,9|b3,-39,15,48,3|b4,-24,48,13,1

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 for the leader board. You must complete as many maps as possible, to have the best chance at achieving a high score.

Solution files must be a '.txt' and your source code must be in a zip file '.zip'.

Once your submission has been scored, your score will be provided on the portal, as well as log files that could assist with understanding how your solution was scored.

Output file

You are responsible for the flotillas flight path to collect resources across the map. Your submission will be the desired flight paths per ship. The submission file should contain at most **S** lines, one for each ship used.

The path can be denoted by using the ID for the resource cluster.

The **outpost has an ID of '0'** for the flight path, and has coordinates of **[0,0,0]**.

Example Output file:

```
a1,a4,a2,0
b1,b4,0
a3,b2,0
```

For the submission to be valid, it must be in the above format (no spaces). If a ship's last command is not '0', it will be added as the final command to the ship. Excess ships in the submission file will be ignored.

Scoring Rules

You are scored based on the following metrics:

- Number of Resources in a Batch (NRB)
- Total number of resources collected of a specific type (TRC)
- Total Time taken to process all resources (TTP)
- Combined Total Distance travelled for all ships (TDT)

Scoring calculations are as follows:

- Gain points for resources collected
    - Before threshold is met: NRB * CM
    - After threshold is met: NRB * CM * 0.5
- Points gained or lost for processing of materials
    - Points Gained before threshold is met: NRB * PM
    - Points Lost after threshold is met: NRB * PM * 0.5
- Points lost for total distance travelled
    - TDT *0.5
- Points Lost for Total Time Taken to process all resources
    - TTP *0.1
- Bonus Points for Reaching quota
    - TRC * QB

Note:

- Scores will be **rounded up** once the individual additions and substructions have been applied.
- Distances are **rounded up** at time of calculation.

Scoring Example

Map Details

```
2|3|200|2|300|2
1,5|2,5
1|60
2|60
1|a0,-3,-3,-4,12|a1,29,7,5,93|a2,27,0,-1,92|a3,26,-11,7,84|a4,8,-16,22,68
2|b0,-11,25,-33,1|b1,-30,-38,35,4|b2,-24,19,-34,9|b3,-39,15,48,3|b4,-24,48,13,1
```

Submission file

```
a1,a4,a2,a0,0
b1,b4,0
b2,b3,a3,0
```

Ship 1

- Travels total distance of **138** units
- Collected the following resources
    - Batch 1 (Resource 1): 93 + 68 + 92 = 253 (When the ship reached cluster a0, it has already reached capacity so did not pick up any resources)

Ship 2

- Travels a total distance of **205** units
- Collected the following resources
    - Batch 2 (Resource 2): 4 + 1 = 5

Ship 3

- Travels a total distance of **242** units reaching the outpost last
- Collected the following resources
    - Batch 3 (Resource 2): 9 + 3 = 12
    - Batch 4 (Resource 1): 84

Total resources collected = 253 + 5 + 12 + 84 = 364

All batches were processed before the threshold was met, so no penalties.

Total time to processing all materials: **644** (Time not processing is also counted)

Quota met for Resource 1: Bonus Points = 337 * 1.5 = **505.5**

Total Batch Scores (Combined total of Collection + Processed)

- Batch 1: **759**
- Batch 2: **15**
- Batch 3: **36**
- Batch 4: **252**

Total Score = (759 + 15 + 36 +252) - (138 + 205 + 242) *0.5 - (644*0.1) + 505.5 = 1210.6

Final Score = 1211

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