



Introduction

The year is 2894. Your mission, should you choose to accept it, is to undertake the monumental task of terraforming four currently uninhabitable planets for the benefit of the United Alliance. These planets, once transformed into life-supporting environments, will serve a crucial role in sustaining our civilization by being utilized in growing crops for our colonies.

Your mission, however, comes with a challenge. The planets that have been selected are beyond treacherous, and their surfaces consist of a variety of dire biomes. A probe has identified the following biomes: **Sizzling Sahara, Violent Volcanoes, Shocking Storms, Curious Caves, Blazing Badlands, Perilous Peaks, Radiant Ravines, and Windy Wallows.**

Each day, you will have a limited distance that you can travel, since your rover battery needs to recharge. Starting at the North Pole of the planet, and ending at the South Pole, you will traverse nodes, placing an Automatic Universal Resource Extraction Machine (AUREM) on each that have been visited.

Your terraforming score will be evaluated based on the number of terraforming points that the AUREMs can gather throughout a set number of days. Beware, some biomes are sparser than others.

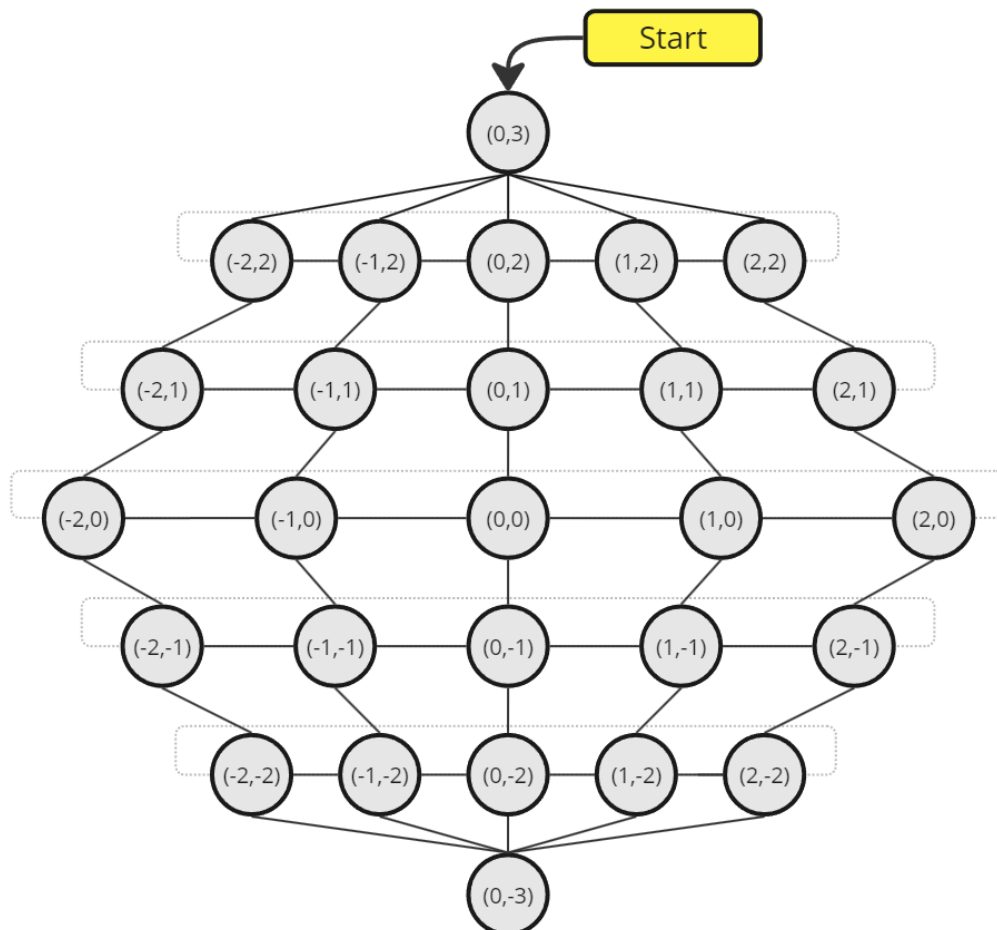
Goal

Your goal is to write an algorithm that finds an optimal path that will result in the maximum amount of terraforming points that you can gather within the given number of days. Your submission must be a list of coordinates that you visit in your rover.

Planets

The planets are circular, with a coordinate system that is very similar to that of Earth. The centre point is $(0,0)$ and represents the centre of the planet (like where the Equator crosses with the Prime meridian). Each level has a different planet size, denoted by a radius.

Below is an example of a planet with a radius of 2. The nodes are connected to each other in a grid format and wrap around at the ends. The physical distance between nodes can be ignored and instead regarded as 1 unit of travel.



Planet representation

The planet is represented by a text file containing lines, that include the coordinate of the node, the index of its biome, as well as its quality. The North and South Pole are included and can be found on the **first** and **last** line of the file. The coordinates start from the top left to the bottom right.

$$\{(x_i, y_i); p_j; q_i\}$$

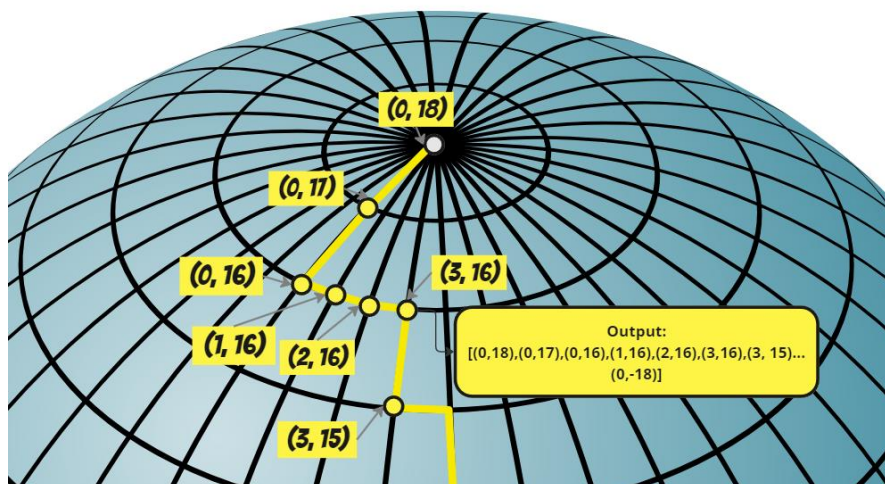
Example:

```
{(0,11)}  
{(-10,10);0;1.84}  
{(-9,10);2;2.19}  
{(-8,10);2;0.53}  
{(-7,10);2;0.53}  
...  
{(10,-10);0;1.46}  
{(0,-11)}
```

Movement

Every planet has an allocated number of days in which you must complete your terraforming. You have a maximum of **three** units of movement each day meaning, you can only traverse **three** nodes. Your submission will be split into days accordingly.

Movement is limited to **up, down, left and right**. You are not allowed to move diagonally to other nodes. You may only move one node at a time, and **visiting the same node twice is not allowed**. Wraparound occurs when moving from $(-2,2)$ to $(2,2)$, for example, and the north and south pole can be visited by any of the nodes on the top and bottom rows of the grid respectively.



Automatic Universal Resource Extraction Machine (AUREMS)

The AUREM is placed automatically on each node visited and will start earning terraforming points the day after it was placed. For example, when there are 10 days to complete the path, and an AUREM was placed on day 6, it will earn points for day 7, 8, 9 and 10.

Biomes

Each node on the planet, except the North and South Pole, represent an area of terrain (biome) on which an AUREM can be placed when visited. Each node has a specific quality value multiplier which determines how “good” that node is for terraforming yields. This quality value is normally distributed around 1.0, so some nodes have a quality of 0.2, and others can have a quality of 2.5.



Index	Biome	Terraforming points generated per day
0	Sizzling Sahara	1
1	Violent Volcanoes	14
2	Shocking Storms	28
3	Curious Caves	42
4	Blazing Badlands	57
5	Perilous Peaks	71
6	Radiant Ravines	85
7	Windy Wallows	100

Levels

Level	Radius	Days	Biomes included	North and South pole
1	10	37	1 - 3	N: (0, 11) S: (0, -11)
2	30	310	1 - 4	N: (0, 31) S: (0, -31)
3	100	3367	1 - 6	N: (0, 101) S: (0, -101)
4	210	14770	All	N: (0, 211) S: (0, -211)

Submission



Your submission is a list of coordinates of the nodes visited. Your submission **MUST** start at the North Pole and end at the South Pole. This needs to be a .txt file, and must adhere to the following format:

$$[(x_0, y_0), (x_1, y_2), \dots, (x_n, y_n)]$$

In this case (x_0, y_0) is the North Pole, and (x_n, y_n) is the South pole. You do not need to worry about whitespace. Below is an example of a submission on a planet with radius 3, where the path leads straight down to the South Pole:

```
[(0,4),(0,3),(0,2),(0,1),(0,0),(0,-1),(0,-2),(0,-3),(0,-4)]
```

Scoring

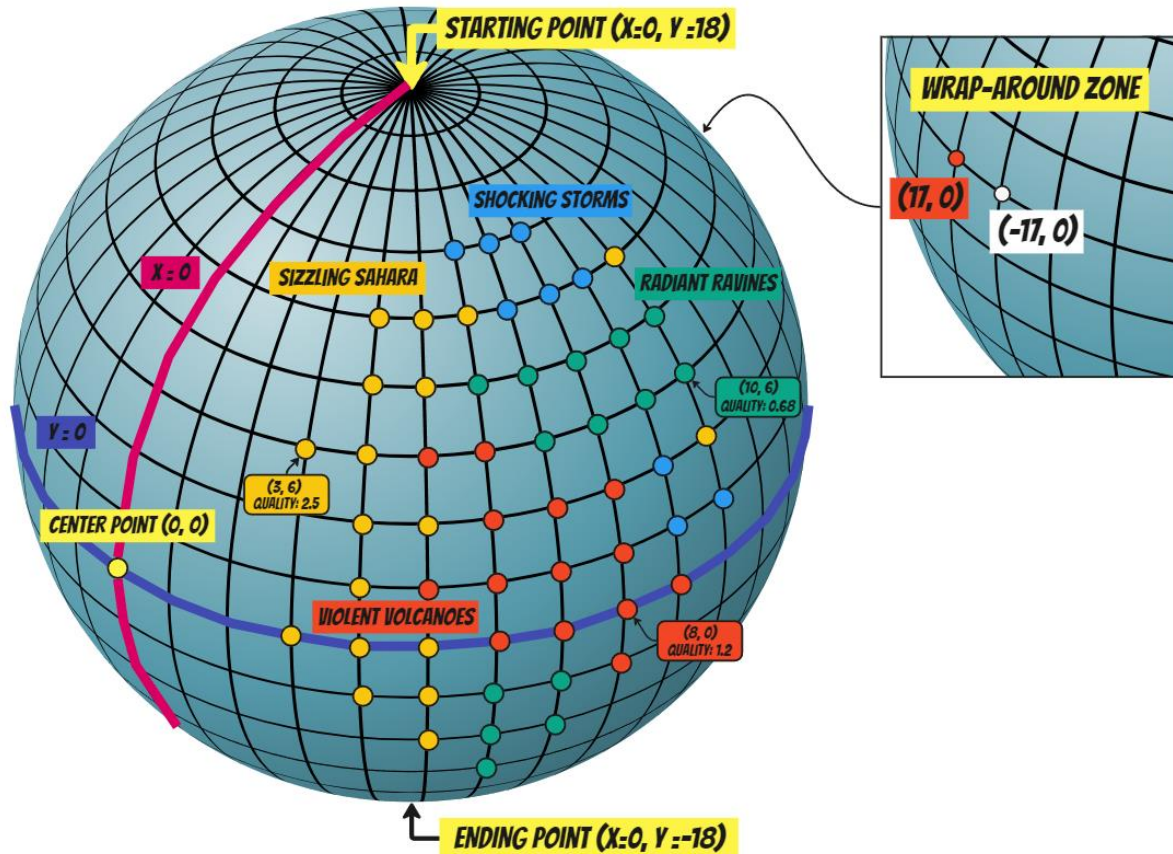
The score of your terraforming path will be determined at the end of the run, and is calculated as follows:

$$\text{score} = \sum_{i=0}^n p_j \cdot q_i \cdot d_i$$

n is the total number of nodes visited.	p_j is the terraforming points of the node's biome per day.
q_i is the quality value multiplier of the resources at the node.	d_i is the number of days that the AUREM was operational in the node area.

Visual Guide

Below is a visual representation of a planet. It has a radius of 17, with the North Pole at (0, 18), and the South Pole at (0, -18). The Centre Point (0,0) is right at the intersection between the Equator and the Prime Meridian. A section of the planet shows the biomes in various colours, and the coordinates and quality of some of the nodes are highlighted.



Example:

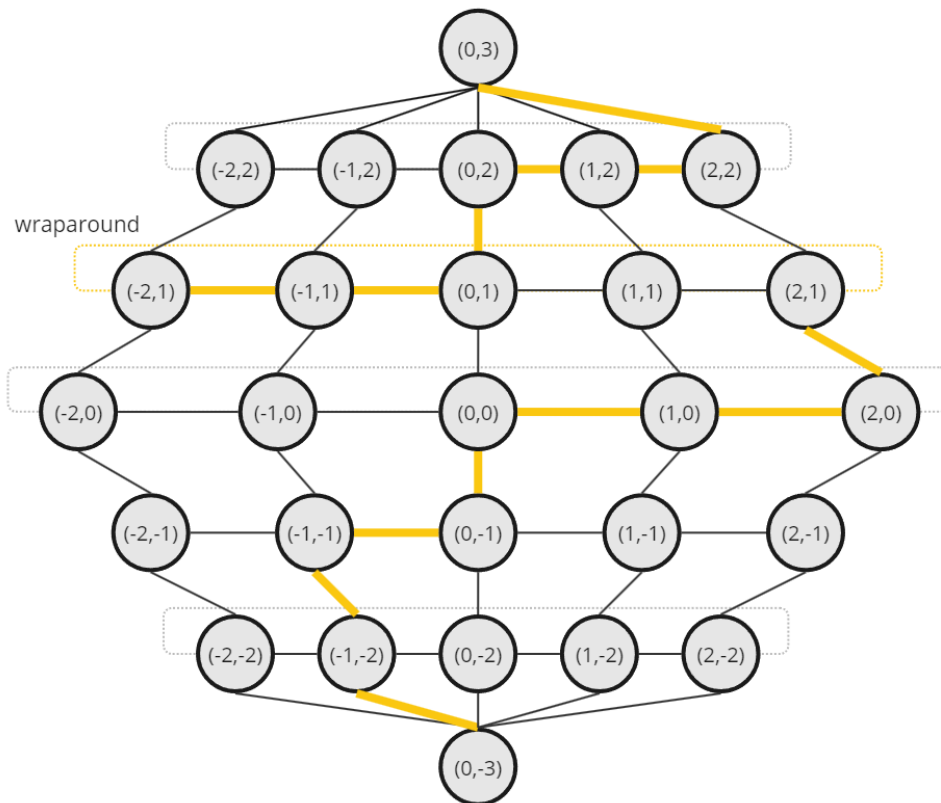
Give the following planet with radius **two** and **four** days of terraforming time:

```
{(0,3)}
{(-2,2);0;2.43}
{(-1,2);1;0.4}
{(0,2);2;1.02}
{(1,2);2;0.73}
{(2,2);0;3.36}
{(-2,1);2;0.09}
{(-1,1);2;0.14}
{(0,1);0;1.98}
{(1,1);0;0.44}
{(2,1);0;0.1}
{(-2,0);2;0.62}
{(-1,0);0;2.8}
{(0,0);1;1.8}
{(1,0);1;0.21}
{(2,0);1;2.05}
{(-2,-1);2;2.94}
{(-1,-1);2;0.27}
{(0,-1);2;1.23}
{(1,-1);1;0.12}
{(2,-1);0;0.21}
{(-2,-2);0;1.49}
{(-1,-2);0;1.5}
{(0,-2);0;1.49}
{(1,-2);1;0.62}
{(2,-2);2;1.97}
{(0,-3)}
```

And the following submission:

```
[(0,3),(2,2),(1,2),(0,2),(0,1),(-1,1),(-2,1),(2,1),(2,0),(1,0),(0,0),(0,-1),
(-1,-1),(-1,2),(0,-3)]
```


Which can be visualized as:



The evaluation function for this submission will be as follows:

Node	Biome points	Quality	Days active	Subtotal
(0,3)	0	N/A	4	0
(2,2)	1	3.36	4	13
(1,2)	28	0.73	4	82
(0,2)	28	1.02	4	114
(0,1)	1	1.98	3	6
(-1,1)	28	0.14	3	12
(-2,1)	28	0.09	3	8
(2,1)	1	0.1	2	0
(2,0)	14	2.05	2	57
(1,0)	14	0.21	2	6
(0,0)	14	1.8	1	25
(0,-1)	28	1.23	1	34
(-1,-1)	28	0.27	1	8
(-1,2)	1	0.4	0	0
(0,-3)	0	N/A	0	0
Total				365

And thus, the score for this submission will be **365**.