LET'S GET PLANTING!

SUMMARY

Good morning Greenthumb, I hope you've put on sunscreen and brought your hat. Today we're spending the whole day in the garden!

The goal of today's hackathon is to optimise the **growth rate** of your entire garden to rake in the most profits and walk away the winner!

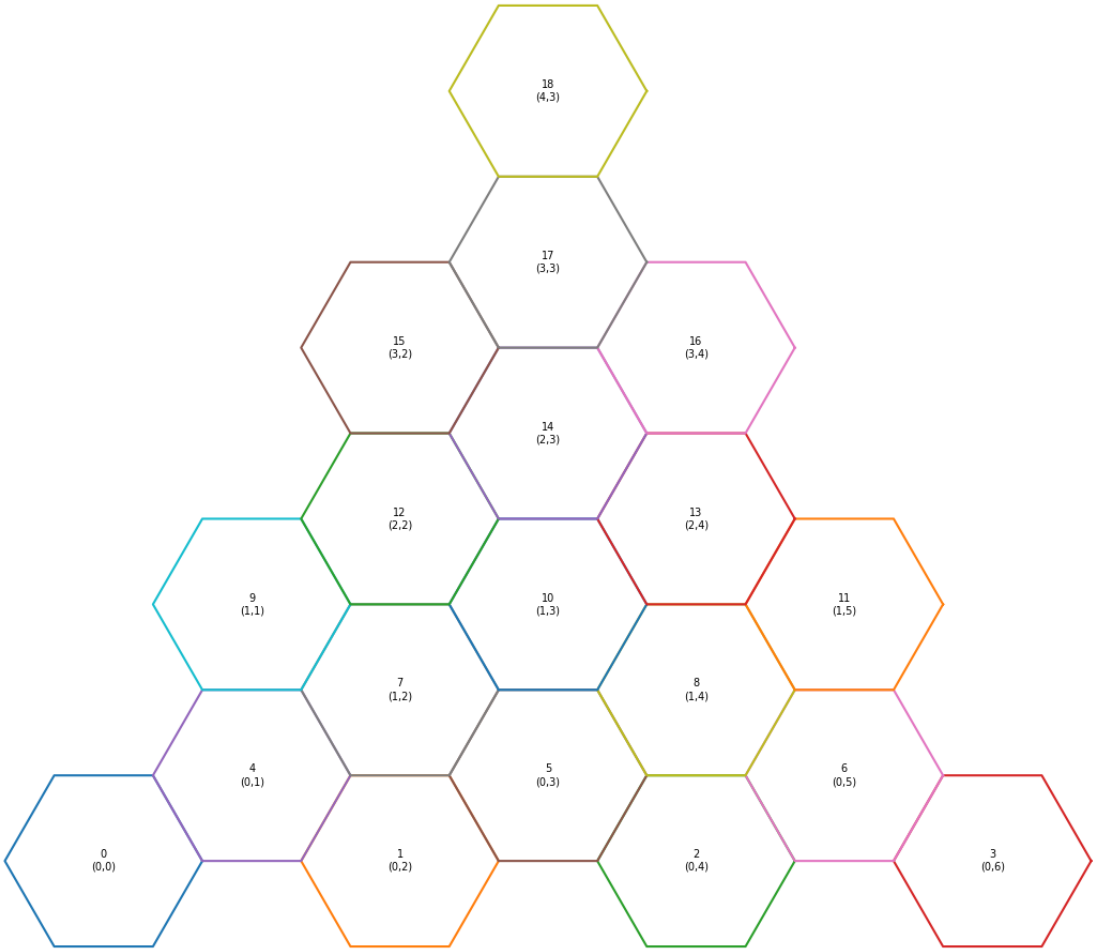
There are ten herbs at your disposal today namely **Rosemary, Basil, Mint, Lavender, Cilantro, Ginseng, Angelica, Patchouli, Valerian,** and **Rue**. Each herb has its own set of requirements to optimise growth. Some herbs are also more valuable than others.

Herbs require unobstructed sunlight as well as water coverage to optimise growth. You must determine the optimum placement of herbs and water sprinklers to maximise the profits you gain from selling your herbs.

GARDEN

Each level has a different garden shape. The following information about each garden will be provided.

Firstly, an image of the garden is provided showing the index of each hexagon and its offset coordinates from the bottom left corner. The offset is denoted as (x, y) or (row, column) i.e. (0, 1) is the 0^{th} row and the 1^{st} column. The index of each hexagon will be used to indicate herb and sprinkler locations. More on that later.



A list correlating the index and coordinates will also be provided:


```
{
  "0": [0, 0],
  "1": [0, 2],
  "2": [0, 4],
  "3": [0, 6],
  "4": [0, 1],
  "5": [0, 3],
  "6": [0, 5],
  "7": [1, 2],
  "8": [1, 4],
  "9": [1, 1],
  "10": [1, 3],
  "11": [1, 5],
  "12": [2, 2],
  "13": [2, 4],
  "14": [2, 3],
  "15": [3, 2],
  "16": [3, 4],
  "17": [3, 3],
  "18": [4, 3]
}
```

And finally, an adjacency list for the garden will also be provided:


```
{
  "0": [4],
  "1": [4, 5, 7],
  "2": [5, 6, 8],
  "3": [6],
  "4": [0, 1, 7, 9],
  "5": [1, 2, 7, 8, 10],
  "6": [2, 3, 8, 11],
  "7": [1, 4, 5, 9, 10, 12],
  "8": [2, 5, 6, 10, 11, 13],
  "9": [4, 7, 12],
  "10": [5, 7, 8, 12, 13, 14],
  "11": [6, 8, 13],
  "12": [7, 9, 10, 14, 15],
  "13": [8, 10, 11, 14, 16],
  "14": [10, 12, 13, 15, 16, 17],
  "15": [12, 14, 17],
  "16": [13, 14, 17],
  "17": [14, 15, 16, 18],
  "18": [17]
}
```

HERBS

There are 10 herbs that you can choose from to plant in your garden:

Herb	Growth conditions	Vertical Growth (mm per day)	Diameter	Selling Price (per mm)
Basil	40% sunlight, 60% water	2mm (Poor)	0.5	5
	60% sunlight, 70% water	5mm (Fair)		
	90% sunlight, 80% water	8mm (Excellent)		
Rosemary	60% sunlight, 50% water	4mm (Poor)	2	7
	70% sunlight, 60% water	7mm (Fair)		
	100% sunlight, 80% water	10mm (Excellent)		
Mint	30% sunlight, 80% water	1mm (Poor)	1	4
	50% sunlight, 70% water	4mm (Fair)		
	80% sunlight, 90% water	7mm (Excellent)		
Lavender	40% sunlight, 40% water	3mm (Poor)	2	8
	60% sunlight, 50% water	6mm (Fair)		
	80% sunlight, 60% water	9mm (Excellent)		
Cilantro	70% sunlight, 30% water	5mm (Poor)	0.75	6
	80% sunlight, 50% water	8mm (Fair)		
	100% sunlight, 70% water	11mm (Excellent)		
Ginseng	20% sunlight, 90% water	1mm (Poor)	1	10
	40% sunlight, 80% water	4mm (Fair)		
	70% sunlight, 100% water	7mm (Excellent)		
Angelica	10% sunlight, 85% water	1mm (Poor)	3	12
	30% sunlight, 75% water	3mm (Fair)		
	60% sunlight, 90% water	6mm (Excellent)		
Patchouli	40% sunlight, 70% water	3mm (Poor)	2	9
	60% sunlight, 80% water	6mm (Fair)		
	90% sunlight, 100% water	9mm (Excellent)		
Valerian	15% sunlight, 70% water	2mm (Poor)	1	11
	40% sunlight, 50% water	5mm (Fair)		
	80% sunlight, 90% water	8mm (Excellent)		
Rue	70% sunlight, 30% water	6mm (Poor)	1.75	7
	80% sunlight, 40% water	9mm (Fair)		
	100% sunlight, 60% water	12mm (Excellent)		

Herbs have different sunlight and water requirements. The condition is calculated by determining which requirements have been met the closest i.e. the nearest neighbour. This will be downgraded in the event of equal distance.

Each planted herb has at least the Poor condition even if none of its conditions are met.

Herb diameter is measured in hexagons. Therefore, a diameter of 1 means the herb diameter is equal to the long diagonal of the hexagon or twice the Circumradius of the hexagon.

For example, if you have a **Cilantro** plant that gets **53% sunlight** and 77**% water**, the nearest condition is calculated as follows:

Condition	Required	Achieved	Required	Achieved	Distance
Poor	70% sunlight	53%	30% water	77%	$abs(70-53)+abs(30-77)$ =64
Fair	80% sunlight		50% water		$abs(80-53)+abs(50-77)$ =54
Excellent	100% sunlight		70% water		$abs(100-53)+abs(70-77)$ =54

Thus, we can see that both the Fair and Excellent conditions have the lowest distance at 54. Since the condition is always downgraded, that means the Cilantro will have the **Fair** condition.

PLANTING

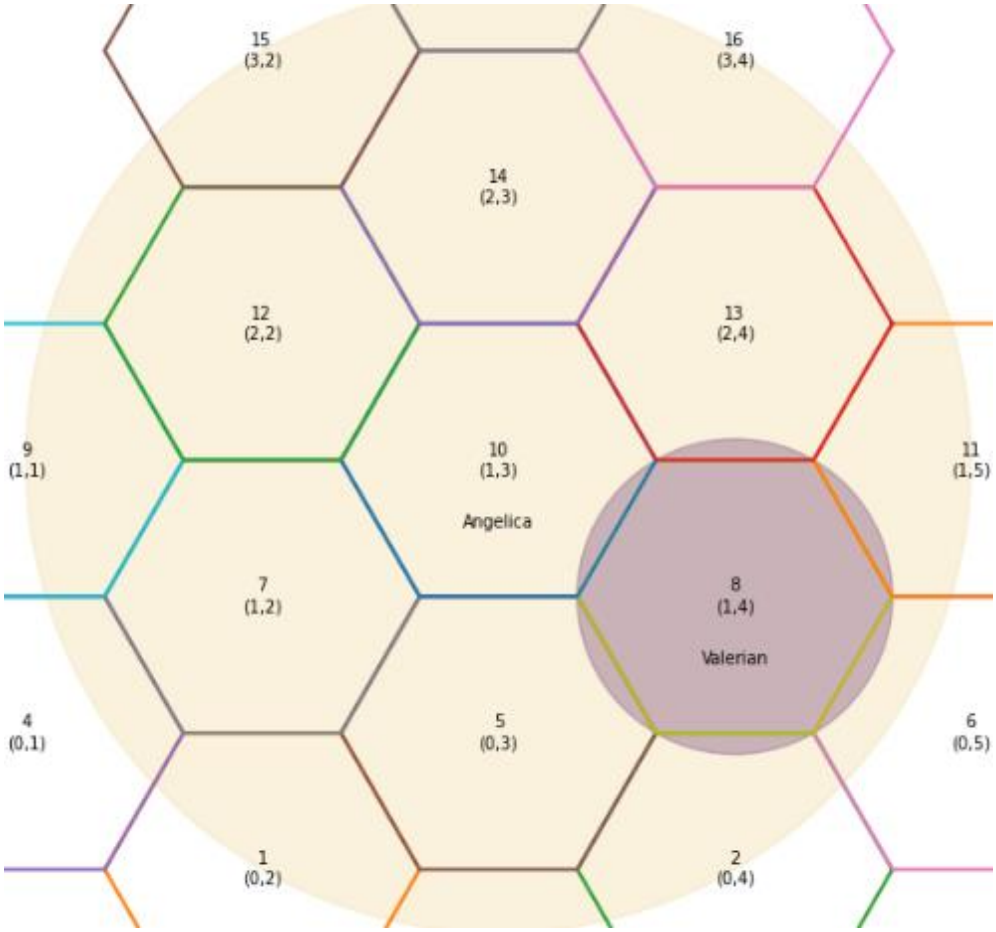
You can place as many herbs and sprinklers as possible in each garden. More than one herb or sprinkler cannot be placed at the same location.

Herbs are placed using the index of the hexagon.

Sprinklers are placed by triangulating three hexagon indices. The sprinkler will be placed at the intersection between the three hexagons.

Herbs overshadow each other. Bigger radius herbs will always overshadow smaller radius herbs regardless of the herb's growth. The percentage of overshadowing influences the sunlight that the overshadowed herb receives therefore altering its condition.

For example, say you plant an Angelica at index 10 and a Valerian at index 8 like so:



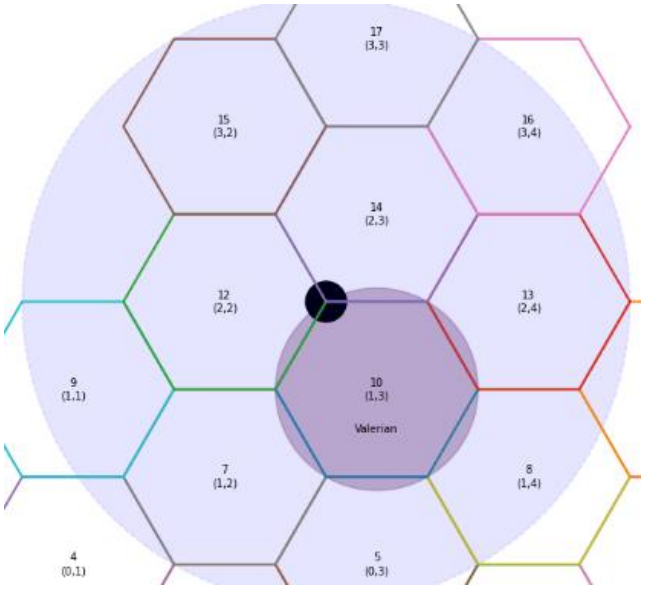
In this example, the Angelica is completely overshadowing the Valerian, therefore the Valerian will receive 0% sunlight and will thus have a Poor condition resulting in only 2mm of growth per day.

Herbs that have the same radius also influence each other and the percentage of overshadowing is halved and subtracted from each herb. For example, say you plant two Angelica herbs, one at index 7 and another at index 8 like so:

In this configuration, the two herbs overlap for 40% of their total area. Thus, each herb receives 20% less sunlight.

Sprinklers provide the water requirement for each herb and is based on the percentage that a sprinkler covers an herb. Beware, herbs can be over watered, if they are too densely covered by multiple sprinklers. This will negatively impact the condition of the herb. The sprinkler radii are fixed at three times the Circumradius of the hexagons.

For example, let's say you have a sprinkler at indices 10, 12 and 14 and a Valerian at index 10 like so:



The Valerian is fully covered by the sprinkler thus it provides 100% water to the Valerian.

Water coverage is not influenced by other herbs.

Sprinklers need 3 hexagon indices to be placed, thus, sprinklers cannot be placed on the periphery of the garden.

PROFIT

Your profit is calculated by selling all your herbs at the end of a **10-day** period. Your herb conditions will affect the growth rate of your herbs.

The unpenalized profit for each herb is calculated at the end of the growth period.

$$P_c = gr \times gp$$

where:

gr is the growth rate of the herb at its calculated growth condition.	gp is the growth period in days.

Biodiversity and market saturation play a role in your herb selling though therefore, any herb that accounts for more than 50% of all herbs will have its profit penalized.

The penalty is applied as:

$$P_p = \frac{P_c}{2 + p}$$

where:

P_p is the penalised profit	P_c is the current profit
p is the percentage of herb in relation to all the herbs in the garden.	

For example, let's say you plant 12 Ginseng and 6 Valerian herbs in your garden. That is a total of 18 herbs meaning that Ginseng makes up 66.67% of all herbs in your garden and Valerian makes up 33.33% of all herbs in your garden. Therefore, if the profit calculated for Ginseng was 1000, the penalised profit would be ≈ 375.

GOAL

Write an algorithm to optimally place herbs and sprinklers to optimise your garden's growth.

Your submission must be a list of herbs and their planting positions as well as sprinkler positions.

There will be **four** gardens of different shapes, in today's hackathon.

SUBMISSION

NB: Your submission must be a .txt in valid JSON format. Use https://jsonlint.com/ to verify.

```
{
  "Herbs": [
    [13, "Rosemary"],
    [5, "Basil"]
    ...
  ],
  "Sprinklers": [
    [7, 13, 18],
    [31, 36, 40]
    ...
  ]
}
```

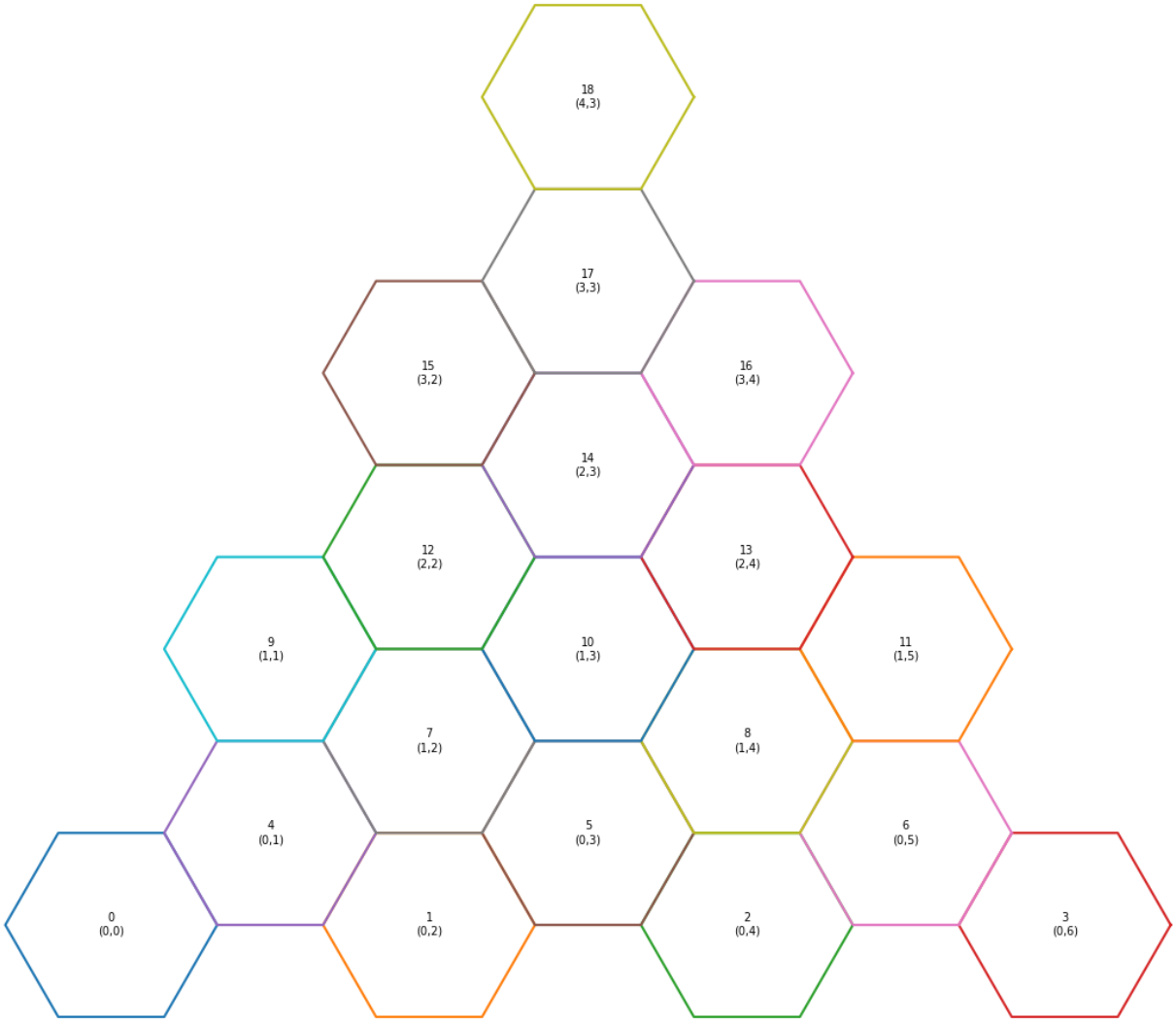
SCORING

Your final score is the sum of all herb profits, penalised or otherwise.

Your final score is rounded to the nearest 2 decimals.

EXAMPLE

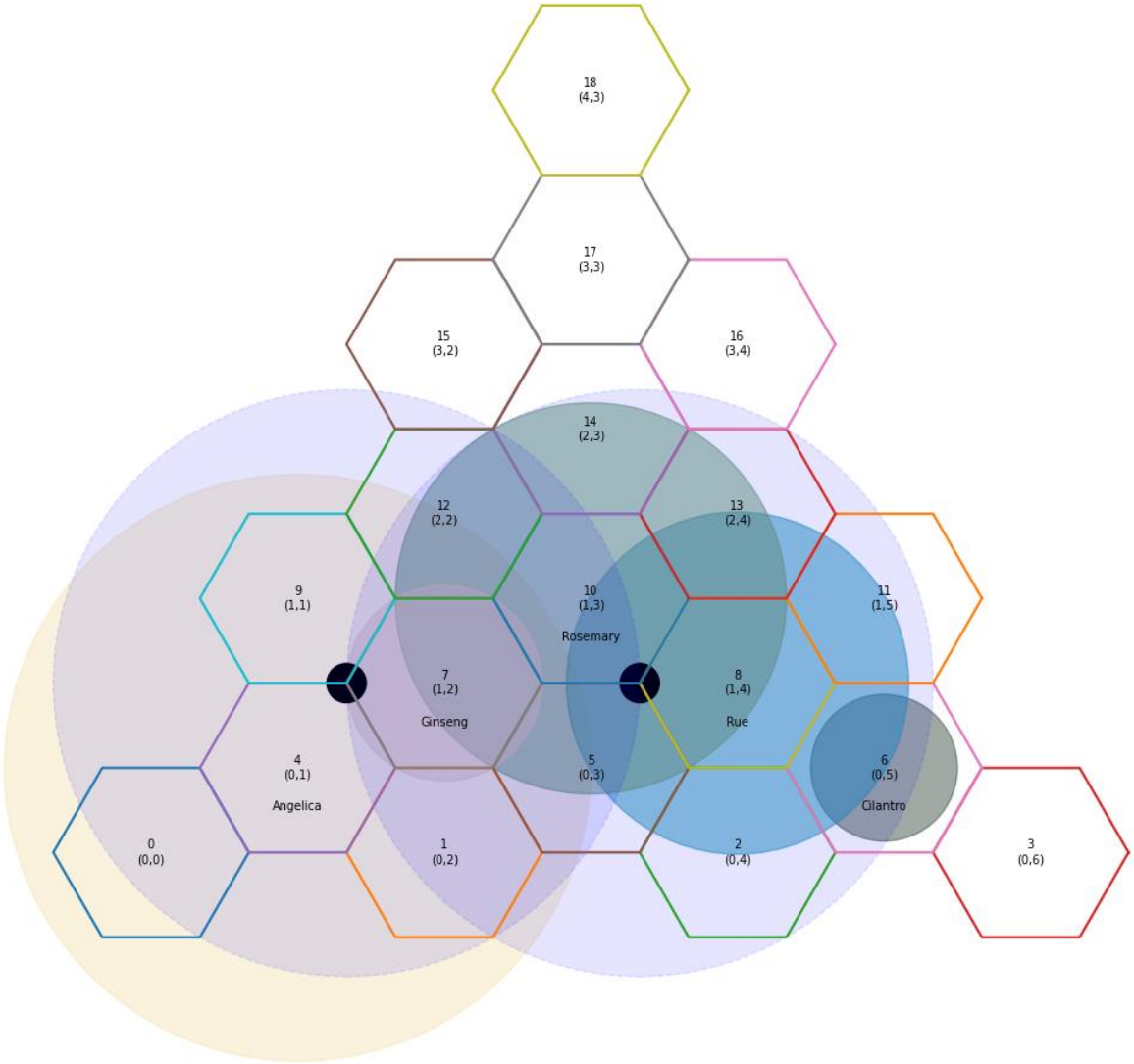
Given the following triangular garden with a 10-day growth period:



And the following submission:

```
Herbs:
4, Angelica
6, Cilantro
7, Ginseng
8, Rue
10, Rosemary
Sprinklers:
4, 7, 9
5, 8, 10
```

The resulting garden would look like this:



And the profit would be calculated as follows:

The Angelica herb at position 4 covers **1%** of the **Rue** herb at position 8, **28.9%** of the **Rosemary** herb at position 10 and **100%** of the **Ginseng** herb at position 4.

The Rosemary herb at position 10 covers **49%** of the **Rue** herb at position 8 and **64%** of the **Ginseng** herb at position 7 although it is already fully covered so there is no additional affect.

The Rue herb at position 8 covers **47%** of the **Cilantro** herb at position 6.

The sprinkler at (4, 7, 9) wets **79%** of the **Angelica** herb at position 4, **13%** of **Rue** herb at position 8, **54%** of **Rosemary** herb at position 10 and **100%** of **Ginseng** herb at position 7.

The sprinkler at (5, 8, 10) wets **77%** of **Cilantro** herb at position 6, **28%** of **Angelica** herb at position 4, **100%** of **Ginseng** herb at position 7, **100%** of **Rue** herb at position 8 and **100.0%** of **Rosemary** herb at position 10.

Therefore, each herb has the following conditions:

Herb	Index	Sunlight	Water	Condition	Growth Rate	Total growth	Total profit
Angelica	4	100%	107%	Excellent	6	60	R 720
Cilantro	6	53%	77%	Fair	8	80	R 480
Ginseng	7	0%	200%	Poor	1	10	R 100
Rue	8	50%	113%	Poor	6	60	R 420
Rosemary	10	71%	154%	Excellent	8	80	R 400

Thus, the submission would get a total profit of **R 2120**.

Try manually placing some herbs for your first submission!