MATH 3310 Mathematical Modeling
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Homework 3
April 11 2022

Question 1.)

If first assuming that E, F, G, H all have the same probability of occurring and the goal is to maximize the expected value, you can just add up all of the expected values from each nature to get an estimate on which decision will be the best. For A, B, C, and D the results would all be 12, which doesn't help in determining a choice at all.

We can look at this in a different way. What if 3 out of the 4 natures did not occur? Which decision on average would be the best option then? Going in order, if E was the only activation:

A = 7	B = 3	C = 2	D = 6

If only F:

A = 10	B = 3	C = 2	D = 9

If only G:

A = -30	B = 3	C = 10	D = 10

If only H:

A = 25	B = 3	C = -2	D = -13

Because of the criteria we put in place for nature occurring, the decision is more obvious on the optimal solution. A is the most optimal outcome 3 out of 4 times, while C and D share a spot and B is never the most optimal outcome. The reason A is such a good decision is because of the 25% chance of G being picked. The higher the chance G is going to be picked, the much worse A becomes. For example, if instead a nature had a 75% chance of activating, A quickly becomes the WORST option to choose by far, where C would easily become the best.

D is just a less extreme version of A. Both choices have a ¼ chance losing value, a 2/4 chance of decent growth, and ¼ chance of large growth. So it could be argued D is a better choice because it is safer and you will lose less, but you will also gain less, so it's up for debate. B is consistent and a safe choice where you will never fail, and C seems to be around the same path for amount of gain.

Overall, my choice for optimal decisions would be A -> D -> C -> B where A is the best decision if the goal is to get the most points by the end.

Question 2)

I performed 2 separate methods in order to calculate the final results for each decision (described in code as well). I realized that my way of rationalizing the problem was technically incorrect. I assumed simply choosing 1 out of 4 of the natures was equivalent to a 25% chance (because 1 out of 4) and based the calculations off that. Of course this is not how real random probabilities work. Sometimes the 25% can happen 3 out of 4 times and sometimes it won't happen at all. So because of this, I made 2 methods to test my choice.

The first method simply uses my original thought process. 1 random choice is chosen for each decision each time, essentially a "1 in 4 chance".

The second method actually determines each nature's chance of happening with a probability of 25% every time. This is how it would more realistically happen.

Funnily enough, the end result didn't actually change much, sort of supporting the idea that choosing 1 out of the 4 is equivalent to an actual 25% chance. For the first method:

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===== METHOD 1 =====

After 12 iterations, the results for each choice are:
A: 72
B: 36
C: 20
D: 43
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And after the second method:

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===== METHOD 2 =====

After 12 iterations, the results for each choice are:
A: 47
B: 27
C: 22
D: 25
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So my original thought process of going with A seems to have been correct (at least for this random seed). Therefore, there is no regret criteria for my choice and I still believe A is the best choice, so I would not change it.

However I would change my order for best decisions. I ranked B and C around the same, but seeing B with a substantial lead over C both times makes me reconsider C being the worst decision. Also D is still the second best decision, but not by as much as I thought it was, as a few unlucky odds put it below B.