

CS 462 : Intro to AI

Assignment 5

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Rocky terrain 2 km/hr

Sandy terrain 3 km/hr

Smooth terrain 5 km/hr

BAYES' RULE

$$P(b|a) = \frac{P(a|b)P(b)}{P(a)}$$

- ① 2 km 20% sandy, 30% smooth, 50% rocky
- ② 1.8 km 40% sandy, 20% smooth, 40% rocky
- ③ 3.1 km 50% sandy, 40% smooth, 10% rocky

a) Route 1

$$\begin{aligned} & \frac{(0.2 \times 2 \text{ km})}{3 \text{ km/hr}} + \frac{(0.3 \times 2 \text{ km})}{5 \text{ km/hr}} + \frac{(0.5 \times 2 \text{ km})}{2 \text{ km/hr}} \\ &= 0.133 + 0.12 + 0.5 \\ &= 0.75 \text{ hours} \end{aligned}$$

Route 2

$$\begin{aligned} & \frac{(0.4 \times 1.8 \text{ km})}{3 \text{ km/hr}} + \frac{(0.2 \times 1.8 \text{ km})}{5 \text{ km/hr}} + \frac{(0.4 \times 1.8 \text{ km})}{2 \text{ km/hr}} \\ &= 0.24 + 0.072 + 0.36 \\ &= 0.672 \text{ hours} \end{aligned}$$

Route 3

$$\begin{aligned} & \frac{(0.5 \times 3.1 \text{ km})}{3 \text{ km/hr}} + \frac{(0.4 \times 3.1 \text{ km})}{5 \text{ km/hr}} + \frac{(0.1 \times 3.1 \text{ km})}{2 \text{ km/hr}} \\ &= 0.51666 + 0.248 + 0.155 \\ &= 0.9196 \approx 0.92 \text{ hours} \end{aligned}$$

ANS: Route 2 is the best / fastest. We should pick Route 2.

b) Route 1 contains a crater. If the wall of the crater is intact, we can go through it. If the wall has been damaged, we will need to go around, which will add 45 minutes to our journey. There is a 30% chance that the wall is damaged.

Route 2 contains a bridge. If that bridge is damaged, we will need to repair it, which will add 1 hour to our time. There is a 60% chance that the bridge is out.

Route 1

$$\begin{aligned} & \text{Route 1 time (from part a)} + (P(\text{wall damaged}) \times 45 \text{ mins}) \\ &= 0.75 \text{ hrs} + (0.3 \times 0.75 \text{ hr}) \\ &= 0.975 \text{ hrs} \end{aligned}$$

Route 2

$$\begin{aligned} & \text{Route 2 time (from part a)} + (P(\text{bridge damaged}) \times 1 \text{ hr}) \\ &= 0.672 \text{ hrs} + (0.6 \times 1 \text{ hr}) \\ &= 1.272 \text{ hrs} \end{aligned}$$

ANS: We should take Route 1.

c) Now suppose that we can use a satellite to find out whether the terrain in route 3 is smooth. Is this helpful? What is the value of this information? Expressed differently, how long are we willing to wait for this information from the satellite?

$$\begin{aligned} & \text{Route 3} \quad 100\% \text{ smooth} \\ & \frac{(1 \times 3.1 \text{ km})}{5 \text{ km/hr}} = 0.62 \text{ hrs} \end{aligned}$$

From Part b), Route 1 is the faster route between Route 1 & 2.

$$0.975 \text{ hrs} - 0.62 \text{ hrs} = 0.355 \text{ hrs} \approx 21.3 \text{ mins}$$

(Route 1 from part b)

ANS: This information is helpful. It helps us determine the time Route 3 will take then compare with Route 1 & 2. We are willing to wait 21.3 mins (0.355 hrs).

d) For part a) Route 1 & Route 3

↳ it is mostly correct in terms of showing the work except the addition of 1.00 at the end. The calculation and the result is incorrect.

For part a) Route 2

↳ it was correctly calculated and the work is correct as well

For part b) Route 1

because they calculated part a) incorrectly for Route 1, the part where they have to use the answer from part a) is incorrect. Calculating the time if the wall is damaged is correct.

For part b) Route 2 is correct.

For part c) Route 3 is incorrect.

↳ When calculating 100% smooth for Route 3, it included 50% rocky as well. Therefore, the result is incorrect.

In short, for the most part it didn't calculate correctly but Route 2 calculation was correct. The results are attached below. I think chatGPT struggles with understanding the problem accurately.

PART A)



To determine which route the Mars rover should pick to return to the charging station as quickly as possible, we need to calculate the expected time it will take for each route, taking into account the different terrains and their associated speeds. We will use the expected value (or mean) of the time it takes for each route as the basis for our decision.



Let's calculate the expected time for each route:

Route 1:

- Length: 2 km
- Terrain probabilities: Sandy (20%), Smooth (30%), Rocky (50%)
- Speeds: Sandy (3 km/h), Smooth (5 km/h), Rocky (2 km/h)

Expected time for Route 1:

$$(0.20 * 2 \text{ km} / 3 \text{ km/h}) + (0.30 * 2 \text{ km} / 5 \text{ km/h}) + (0.50 * 2 \text{ km} / 2 \text{ km/h}) = (0.40/3) + (0.60/5) + (1.00) = 0.1333 \text{ hours}$$

Route 2:

- Length: 1.8 km
- Terrain probabilities: Sandy (40%), Smooth (20%), Rocky (40%)
- Speeds: Sandy (3 km/h), Smooth (5 km/h), Rocky (2 km/h)

Expected time for Route 2:

$$(0.40 * 1.8 \text{ km} / 3 \text{ km/h}) + (0.20 * 1.8 \text{ km} / 5 \text{ km/h}) + (0.40 * 1.8 \text{ km} / 2 \text{ km/h}) = (0.24) + (0.072) + (0.36) = 0.672 \text{ hours}$$

Route 3:

- Length: 3.1 km
- Terrain probabilities: Sandy (50%), Smooth (40%), Rocky (10%)
- Speeds: Sandy (3 km/h), Smooth (5 km/h), Rocky (2 km/h)

Expected time for Route 3:

$$(0.50 * 3.1 \text{ km} / 3 \text{ km/h}) + (0.40 * 3.1 \text{ km} / 5 \text{ km/h}) + (0.10 * 3.1 \text{ km} / 2 \text{ km/h}) = (1.55) + (0.62) + (1.55) = 3.72 \text{ hours}$$

Now that we have calculated the expected times for each route, we can see that:

- Route 1 has an expected time of approximately 0.1333 hours.
- Route 2 has an expected time of approximately 0.672 hours.
- Route 3 has an expected time of approximately 3.72 hours.

So, the rover should pick Route 1 as it has the shortest expected time, which is approximately 0.1333 hours. This route minimizes the time required for the rover to return to the charging station.

PART B)



Now that we have additional information about obstacles on each route, we need to calculate the expected time for each route while considering the probability of encountering these obstacles. We'll also factor in the original terrain information.



Route 1:

- Length: 2 km
- Terrain probabilities: Sandy (20%), Smooth (30%), Rocky (50%)
- Speeds: Sandy (3 km/h), Smooth (5 km/h), Rocky (2 km/h)
- Crater wall damage probability: 30%
- Additional time for going around the damaged wall: 45 minutes (0.75 hours)

Expected time for Route 1:

Considering terrain and crater wall damage:

$$(0.20 * 2 \text{ km} / 3 \text{ km/h}) + (0.30 * 2 \text{ km} / 5 \text{ km/h}) + (0.50 * 2 \text{ km} / 2 \text{ km/h}) = 0.1333 \text{ hours}$$

Considering the probability of damaged wall:

$$0.1333 \text{ hours} + (0.30 * 0.75 \text{ hours}) = 0.1333 \text{ hours} + 0.225 \text{ hours} = 0.3583 \text{ hours}$$

Route 2:

- Length: 1.8 km
- Terrain probabilities: Sandy (40%), Smooth (20%), Rocky (40%)
- Speeds: Sandy (3 km/h), Smooth (5 km/h), Rocky (2 km/h)
- Bridge damage probability: 60%
- Additional time for repairing the bridge: 1 hour

Expected time for Route 2:

Considering terrain and bridge damage:

$$(0.40 * 1.8 \text{ km} / 3 \text{ km/h}) + (0.20 * 1.8 \text{ km} / 5 \text{ km/h}) + (0.40 * 1.8 \text{ km} / 2 \text{ km/h}) = 0.672 \text{ hours}$$

Considering the probability of damaged bridge:

$$0.672 \text{ hours} + (0.60 * 1 \text{ hour}) = 0.672 \text{ hours} + 0.60 \text{ hours} = 1.272 \text{ hours}$$

PART C)



Using a satellite to determine whether the terrain in route 3 is smooth can be helpful, but its value depends on the amount of time the rover is willing to wait for this information and the potential time savings that could result from this knowledge. The value of this information can be expressed as the trade-off between the time saved by having this information and the time spent waiting for it.



Let's break down the decision-making process:

1. **Without Satellite Information:**

- Expected time for Route 3: 3.72 hours (as calculated previously).

2. **With Satellite Information:**

- If the satellite information confirms that Route 3 is smooth:
 - Expected time for Route 3 (smooth): $(0.50 * 3.1 \text{ km} / 5 \text{ km/h}) + (0.50 * 3.1 \text{ km} / 2 \text{ km/h}) = 1.55 \text{ hours}$
- If the satellite information indicates that Route 3 is not smooth:
 - Expected time for Route 3 (not smooth): 3.72 hours (as previously calculated).

To determine the value of the satellite information, we need to calculate the time savings by waiting for the satellite data and compare it to the time spent waiting. The time savings is the difference between the expected times with and without the satellite information.

Time Savings = Expected time without satellite information - Expected time with satellite information

Time Savings = 3.72 hours - $(0.5 * 1.55 \text{ hours} + 0.5 * 3.72 \text{ hours}) = 3.72 \text{ hours} - 2.135 \text{ hours} = 1.585 \text{ hours}$