Assignment 7

Subject

Topics of this session :

1. Decision making under uncertainty.
2. One-shot decisions.
3. Stochastic gradient optimisation.

This assignement is graded and must be submitted (individually) on Moodle before next week's class.

For each exercise, detail your reflexion steps :
- We are mostly interested in your actual thinking process.
- Even if you are unable to solve an exercise, write out what were you reflexion steps.
- For each attempted exercise, a written feedback will be provided (if time alllows it).

For coding :
- Noto (Online Jupyter NoteBook).
- Any other python coding environment you prefer using.

Exercise 1

You are planning a one-day hike and must make a **single decision before you leave**. However, you are **uncertain** about the weather conditions on the trail. The weather can either be sunny, rainy or windy.

Disrete Actions Before starting the hike, you must choose **one jacket** to wear :
- No jacket (lightweight, but bad if it rains).
- Windbreaker (good for wind but bad for rain).
- Rain jacket (protects from rain but is heavy).

Tasks :

1. Fill the utility table, such that is it representative of the utility of each jacket option :

	Sunny	Rainy	Windy
No jacket			
Windbreaker			
Rain jacket			

TABLE 1 – Empty utility table.

2. Given your defined utility table and a belief that the probability of the weather being rainy is 40%, wind is 35% and sunny is 25%, what is the optimal decision to make in terms of **Expected Utility** ?

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3. We will now assume that we do not know the true probabilities of rain, wind and sun. We will further assume that the weather is sampled independently from that unknown distribution each day. Complete the code in `hiking_discrete_stochastic_gradients` and estimate the optimal action using stochastic gradient optimisation.

Continuous Actions Now, instead of choosing a jacket to wear, we must pick the amount of water w to bring for the hike. Depending on the weather, we get thirsty quicker. But bringing water also makes our bag heavier. Here are the corresponding utility functions for each weather condition :

$$U_{\text{sunny}}(w) = 7 - (3 - w)^2 - w$$

$$U_{\text{windy}}(w) = 4 - (2 - w)^2 - w$$

$$U_{\text{rainy}}(w) = 3 - (1 - w)^2 - w$$

Tasks :

1. For each weather condition, what is the optimal water amount ?
2. What is the amount of water that yields maximum expected utility, knowing that the weather distribution is 10% rainy, 45% sunny and 45% windy ?
3. Similarly to the discrete case, we will now assume that we do not know the true weather distribution. Complete the code in `hiking_continuous_stochastic_gradients` and estimate the optimal action using stochastic gradient optimisation.