1. **Describe the Observations: What measurable data would the model use?**

In this project, the model would be working with data that we can directly measure from the movement of animals. For example, GPS trackers give us precise locations of an animal at different times. From the locations, we can derive how fast the animal is moving, in which direction it's going, and when these movements occur. Time of day matters since animals behave differently in daylight and at night. We can also give information regarding the habitat, like whether the animal is under forest cover, grassland, or near human settlement. Camera traps can also give more information by confirming the presence of the animal in certain areas. All these observations tell us what the animal did, but not why it did it. The hidden Markov model uses these visible data points to infer the internal actions — the hidden states — that produced these movements.

2. **Type of HMM Problem: If you don't know the hidden states in advance, what kind of HMM task is this?**

Because we never actually know what the animal is doing at any one time, this is known as an unsupervised problem. The model is not told if the animal was resting, foraging, or moving at any point. It simply looks at movement patterns and tries to group them into useful hidden states on its own. This is the kind of problem that just works with real wildlife data, as we usually only have the movement observations and not the actual behavior labels. The model learns to identify underlying behaviors from the statistical structure in the data, without having access to human-labeled examples.

3. **Training Algorithm:**

   a. What values are known at the start?

We have the whole collection of observations before training the model — all the GPS locations, speeds, directions, and times whenever the animal moved. These are known; they don't change. We also decide beforehand how many hidden states the model should try to find. For example, we can instruct the model to discover three hidden behaviors, but we don't specify what these behaviors are. The choice of the number of states is up to us and can either be based on ecological insight or experimenting with different options to see what fits best.

   b. What values are unknown and need to be learned?

What the model has to figure out is how the rules between the underlying states and what we see in the data relate. That is, it has to figure out how likely it is that the animal will move from one behavior to another, for example, how often it will move from rest to moving or from foraging to rest. It also has to learn what movement patterns are characteristic of each hidden state, like low speed and little direction change, which can mean resting. And it has to make an educated guess about the chance that the animal started in each type of state when the tracking commenced. None of these are known initially and have to be acquired by training.

4. **Parameter Updates: Which HMM parameters will your training algorithm update?**

The training process (usually the Baum-Welch process) will be constantly updating three sets of values. One is the transition probabilities — this is the matrix showing how likely it is that the animal will switch from one behavior to another. The second is the emission probabilities — these are the associations between hidden states and observations (e.g., GPS speed or direction of travel). The third one is the initial state probabilities — in other words, the chance that the animal started moving in a certain behavioral state. These three sets of values are repeatedly updated until the model settles on the most likely explanation for the observed movement data.