

## Homework 4

Feb 23, 2021

In this homework assignment you are going to implement the forward algorithm in the forward-backward algorithm and write a unit test for your function.

### Task 1 - Forward model

The formula is

$$P(X_{t+1}|e_{1:t+1}) = \alpha P(e_{t+1}|X_{t+1}) \sum_{x_t} P(X_{t+1}|x_t) P(x_t|e_{1:t})$$

You are supposed to complete the **forward** function in the *forward.py* file. In this function you calculate the probability distribution of the belief states ( $X_t$ ) given the evidence ( $e_t$ ) and the probability distribution of the belief states ( $X_{t-1}$ ).

There are four input parameters of the function **forward**.

- (1) `xT_1Distribution` - A dictionary representing the distribution of the random variable. The keys of dictionary are the possible values of random variable  $X_{t-1}$  and the values of the dictionary are the corresponding probability  $P(x_{t-1}|e_{1:t-1})$ .
- (2) `eT` - a scalar representing  $e_t$ .
- (3) `transitionFunction` - `transitionTable` - A dictionary whose keys are belief states ( $X_{t-1}$ ) and values are dictionaries whose keys are the next belief states ( $X_t$ ) and values are the probabilities of transitioning from  $X_{t-1}$  to  $X_t$  ( $P(X_t|x_{t-1})$ ).
- (4) `sensorTable` - A dictionary whose keys are belief states ( $X$ ) and values are dictionaries whose keys are observations ( $e$ ) and values are the probabilities of getting the observation from the belief state ( $P(e_t|X_t)$ ).

The return value of the function **forward** is a dictionary. It represents probability distribution of the belief states ( $X_t$ ) given one step forward information.

In the main function, these pieces of information are provided:

- (1) `e` - A list containing  $e_{1:t}$ . The first element of the list
- (2) `pX0` - A dictionary containing prior distribution of belief states ( $P(X_{t-1}|e_{1:t-1})$ ).
- (3) `transitionTable` - A dictionary whose keys are belief states ( $X_{t-1}$ ) and values are dictionaries whose keys are the next belief states ( $X_t$ ) and values are the probabilities of transitioning from  $X_{t-1}$  to  $X_t$  ( $P(X_t|x_{t-1})$ ).
- (4) `sensorTable` - A dictionary whose keys are belief states ( $X$ ) and values are dictionaries whose keys are observations ( $e$ ) and values are the probabilities of getting the observation from the belief state ( $P(e|x)$ ).

### Task 2 - Unit test

You are supposed to complete the **TestForward** object in the *testForward.py* file. In this object you can perform a unit test on your **forward** function in the *forward.py*.

Fill in at least two set of data and complete the **test\_forward** function. You have to calculate what result your function should return and see if it passes the test. **Do not use the set of data provided in *forward.py*.**

## Submission

Please submit a completed *forward\_YourLastName\_YourFirstName.py* file and a completed *testForward\_YourLastName\_YourFirstName.py* on CCLE before due. **Please submit two separate files. Do not zip them!** The due date and time of this homework assignment is Monday, 03/01/2021 11:59pm.