

ML Assignment Part-1

-2018101116

-Lakshmi Madhuri

My Roll Number: 2018101116

$$x = 1 - ((\text{last 3 digits}) \cdot 0.40 + 1) / 100$$

$$= 1 - ((116 \cdot 0.40) + 1) / 100$$

$$= 1 - (36 + 1) / 100$$

$$= 1 - (37 / 100) = 1 - 0.37$$

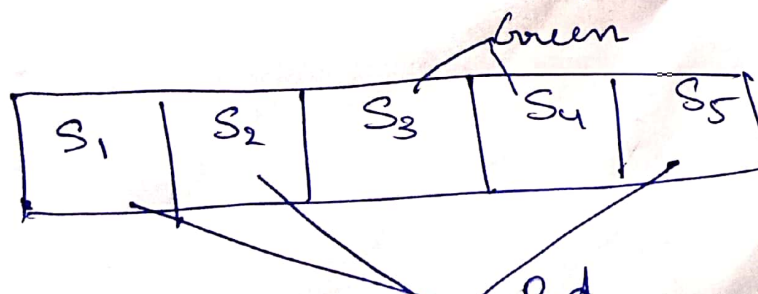
$$y = (\text{last two digits}) \cdot 0.3$$
$$= 16 \cdot 0.3$$

$$= 4.8$$

So, x, y values are 0.63 and 1

We are given five states S_1, S_2, S_3, S_4, S_5 .

in which S_3, S_4 are green, remaining Red



Actions : { left, Right }

Move Left :-

If agent goes left, probability = $x \geq 0$.

Right, Probability = $1-x$

Move Right :-

Over right with prob = x

Left with prob = $1-x$

Observation probabilities :-

$y=1$
So,

$P(\text{Observation} = \text{Red} \mid \text{state} = \text{Red})$	0.8
$P(\text{Observation} = \text{Green} \mid \text{state} = \text{Green})$	0.95

Initially, agent will be in one of Red states which are s_1, s_2, s_5 .

We have 3 actions in total

- 1) \hookrightarrow Action Right, Observation Red
- 2) \hookrightarrow Action Left, Observation Green
- 3) \hookrightarrow Action Left, Observation Green

Transition Probabilities for moving "Left" :-

To → From ↓	0	1	2	3	4
0	$\alpha = 0.63$	$\alpha = 0.63$	0	0	0
1	$\alpha = 0.63$	0	$1 - \alpha = 0.37$	0	0
2	0	$\alpha = 0.63$	0	$1 - \alpha = 0.37$	0
3	0	0	$\alpha = 0.63$	0	$1 - \alpha = 0.37$
4	0	0	0	$\alpha = 0.63$	$\alpha = 0.63$

Move Right :-

To → From ↓	0	1	2	3	4
0	0.63	0.63	0	0	0
1	0.37	0	0.63	0	0
2	0	0.37	0	0.63	0
3	0	0	0.37	0	0.63
4	0	0	0	0.37	0.37

Action 0

Belief State Previously

$$= [0.3333, 0.3333, 0, 0, 0.3333]$$

Action \rightarrow Right, Observation \rightarrow Red

States:-

$$\Rightarrow S_1 :-$$

$$\text{Sum} = 0.37 \times 0.3333 +$$

$$0.37 \times 0.3333 +$$

$$0.0 \times 0 + 0.0 \times 0 +$$

$$0.0 \times 0.3333$$

$$= 0.12333 + 0.12333 + 0 + 0 + 0$$

$$= 0.24667$$

So, new belief state $= 0.8 \times 0.24667$

$$= 0.19733$$

$$\Rightarrow \underline{S_2} :-$$

$$\text{Sum} = 0.63 \times 0.3333 + 0 \times 0.33 +$$

$$0.37 \times 0 + 0 \times 0 + 0 \times 0.33$$

$$= 0.21 + 0 + 0 + 0 + 0$$

$$= 0.21$$

$$\text{New belief state} = 0.8 \times 0.21$$

$$= 0.168$$

$$\Rightarrow \underline{S_3}$$

$$\text{Sum} = 0 \times 0.33 + 0.63 \times 0.33 + 0 \times 0 + 0.37 \times 0 + 0 \times 0.33$$

$$= 0 + 0.21 + 0 + 0 + 0$$

$$= 0.21$$

$$\text{New belief state} = 0.05 \times 0.21$$

$$= 0.0105$$

$$\Rightarrow \underline{S_4}$$

$$\text{Sum} = 0 \times 0.33 + 0 \times 0.33 + 0.63 \times 0 + 0 \times 0 + 0.37 \times 0.3333$$

$$= 0.123333$$

$$\text{New belief state} = 0.05 \times 0.12333 = 0.006167$$

$$\Rightarrow \underline{S_5}$$

$$\text{Sum} = 0 \times 0.33 + 0 \times 0.33 + 0 \times 0 + 0.63 \times 0 + 0.63 \times 0.3333 = 0.21$$

$$\text{New belief state} = 0.8 \times 0.21 = 0.168$$

All new belief states before Normalizing, -

$$= [0.19733, 0.168, 0.0105, 0.00616, 0.168]$$

For normalizing, dividing by 0.55 gives:-

$$= [0.358788, 0.305455, 0.019091, 0.011212, 0.305455] \rightarrow \textcircled{1}$$

$$\Rightarrow \text{Sum} = 0.999999999$$

Action 1:-

We know previous belief states are $\textcircled{1}$

Action \rightarrow Left, observation \rightarrow Green

State

$\Rightarrow \underline{S_1}$:-

$$\text{Sum} = 0.63 \times 0.358 + 0.63 \times 0.3054 +$$

$$0 \times 0.019 + 0 \times 0.0112 + 0 \times 0.305$$

$$= 0.2260 + 0.1924 + 0 + 0 + 0$$

$$= 0.418473$$

$$\text{New belief state} = 0.2 \times 0.418473$$

$$= 0.083695$$

$$\Rightarrow S_2 :-$$

$$\begin{aligned} \text{Sum} &= 0.37 \times 0.3587 + 0 \times 0.305 + \\ &\quad 0.63 \times 0.0190 + 0 \times 0.0112 + 0 \times 0.305 \\ &= 0.132752 + 0 + 0.012027 + 0 + 0 \\ &= 0.144779 \end{aligned}$$

~~New~~

~~New~~

$$\begin{aligned} \text{New belief state} &= 0.2 \times 0.144779 \\ &= 0.028956 \end{aligned}$$

$$\Rightarrow S_3 :-$$

$$\begin{aligned} \text{Sum} &= 0 \times 0.3587 + 0.37 \times 0.3054 + \\ &\quad 0 \times 0.019 + 0.63 \times 0.011 + 0 \times 0.305 \\ &= 0 + 0.1130 + 0 + 0.007 + 0 \\ &= 0.120082 \end{aligned}$$

$$\begin{aligned} \text{New belief state} &= 0.95 \times 0.120082 \\ &= 0.114078 \end{aligned}$$

$$\Rightarrow S_4 :-$$

$$\begin{aligned} \text{Sum} &= 0 \times 0.3587 + 0 \times 0.3054 + 0.37 \times 0.019 \\ &\quad + 0 \times 0.0112 + 0.63 \times 0.3054 \\ &= 0.1995 \end{aligned}$$

$$\text{New belief state} = 0.95 \times 0.1995 = 0.189525$$

⇒ S₅ :-

$$\begin{aligned} \text{Sum} &= 0 \times 0.358 + 0 \times 0.305 + 0 \times 0.019 \\ &\quad + 0.37 \times 0.0112 + 0.37 \times 0.205 \\ &= 0.117167 \end{aligned}$$

$$\begin{aligned} &= 0 + 0 + 0 + 0.004 + 0.113 \\ &= 0.117167 \end{aligned}$$

$$\begin{aligned} \text{New belief state} &= 0.2 \times 0.117167 \\ &= 0.023433 \end{aligned}$$

Values before Normalizing :-

$$= [0.083695, 0.028956, 0.114078, 0.189525, 0.023433]$$

dividing by 0.439686 gives :-

$$= [0.190351, 0.0658, 0.259453, 0.431046, 0.053296]$$

$$\text{Sum} = 1.0$$

Action 2:-

Previous belief states are ②

Action \rightarrow Left, Observation \rightarrow Green.

$\Rightarrow S_1$:-

$$\begin{aligned}\text{Sum} &= 0.63 \times 0.1903 + 0.63 \times 0.0658 + \\ &\quad 0 \times 0.259 + 0 \times 0.431 + 0 \times 0.053 \\ &= 0.16141\end{aligned}$$

$$\text{New belief state} = 0.2 \times 0.16141 = 0.0322$$

$\Rightarrow S_2$:-

$$\begin{aligned}\text{Sum} &= 0.37 \times 0.1903 + 0 \times 0.065 + 0.63 \times 0.25 \\ &\quad + 0 \times 0.431 + 0 \times 0.05 = 0.233885\end{aligned}$$

$$\text{New belief state} = 0.2 \times 0.233 = 0.04667$$

$\Rightarrow S_3$:-

$$\begin{aligned}\text{Sum} &= 0 \times 0.1903 + 0.37 \times 0.065 + 0 \times 0.259 + \\ &\quad 0.63 \times 0.431 + 0 \times 0.053 = 0.295925\end{aligned}$$

$$\text{New belief state} = 0.75 \times 0.2959 = 0.221925$$

$\Rightarrow S_4$:-

$$\begin{aligned}\text{Sum} &= 0 \times 0.1903 + \\ &\quad 0 \times 0.0658 + 0.37 \times 0.259 + \\ &\quad 0 \times 0.431 + 0.63 \times 0.0532 \\ &= 0.129574\end{aligned}$$

$$\text{New belief state} = 0.95 \times 0.1295 = 0.123095$$

$$\Rightarrow S_{52}$$

$$\begin{aligned} \text{Sum} &= 0 \times 0.1903 + 0 \times 0.065 + 0 \times 0.259 \\ &\quad 0.37 \times 0.4310 + 0.37 \times 0.053 \\ &= 0 + 0 + 0 + 0.1594 + 0.019219 \\ &= 0.179206 \end{aligned}$$

$$\begin{aligned} \text{New belief state} &= 0.2 \times 0.179206 \\ &= 0.035841 \end{aligned}$$

$$\text{Before Normalizing} = [0.03228, 0.0467, 0.2811, 0.123, 0.0358]$$

dividing by 0.519124 gives :-

$$= [0.0621, 0.090, 0.5415, 0.237, 0.06904]$$

$$\rightarrow \text{Sum} = 1.0000002$$

Beliefs After each Action :-

$$\begin{aligned} &= [0.35878, 0.3054, 0.01901, 0.01121, 0.3054] \\ &\quad [0.19035, 0.0658, 0.2594, 0.4310, 0.05329] \end{aligned}$$

$$[0.06218, 0.09010, 0.5415, 0.2371, 0.06904]$$