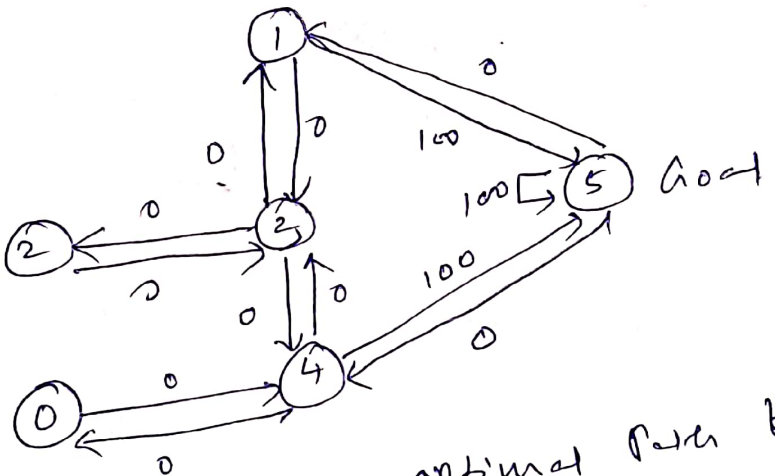
What is Q-Learning

Q-Learn is a reinforcement learning that will find the next best action, it is a model free RL reinforcement learning. The objective of this model is to find the best course of action given its current state.

Example:- Advertisement recommendation system.

In a usual ad recomendation system, the ads you get are based on your previous purchases. using Q-learning we can optimize the ad ~~recomendation~~ recomendation system to recommend products that are frequently brought together.



We need to find an optimal path from each state to goal state 5 where 5 is considered as goal state.

The actions which are leading to goal state are rewarded with 100. all the other actions are rewarded with 0.

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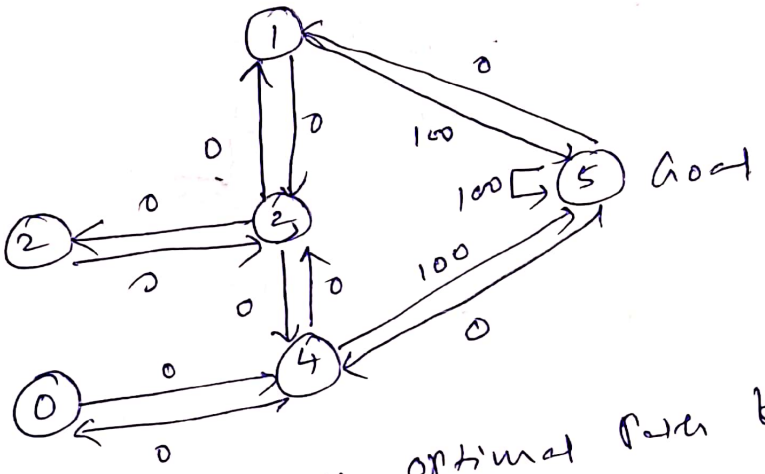

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Q. Learning algorithm is applied to get optimal Q matrix.

Reward matrix:

State \ Action	0	1	2	3	4	5
0	-1	-1	-1	-1	0	-1
1	-1	-1	-1	0	-1	100
2	-1	-1	-1	0	-1	-1
3	-1	0	0	-1	0	-1
4	0	-1	-1	0	-1	100
5	-1	0	-1	-1	0	100

$R =$

when you are in state 1 you can perform actions 3 & 5 (0) (100). -1 indicates there is no direct edge.

Learning rate = 0.8, Initial State = 1

Now initialize Q Matrix

	0	1	2	3	4	5
0	0	0	0	0	0	0
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0

$Q =$

Initial state is 1 there are two actions for this state 3 & 5 with 0 & 100 rewards. So I will select my next state as 5. immediate reward 5. from next state 5 you can perform an action 1, 4, & 5 with rewards 0, 0, & 100.

Q. Learning algorithm is applied to get optimal ②
path.

Reward matrix:

State \ Action	0	1	2	3	4	5
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1	-1	-1	-1	0	-1	100
2	-1	-1	-1	0	-1	-1
3	-1	0	0	-1	0	-1
4	0	-1	-1	0	-1	100
5	-1	0	-1	-1	0	100

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1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0

$Q =$

Initial state is 1 there are two actions for this state 3 & 5 with 0 & 100 rewards. So I will select my next state as 5. immediate reward 5. from next state 5 you can perform an action 1, 4, & 5 with rewards 0, 0, & 100.

It has 3 possible actions 1, 4 & 5

Q-learning equation

$Q(state, action) = R(state, action) + Gamma * max(Q(next\ state, all\ actions))$

$Q(1,5) = R(1,5) + 0.8 \max(Q(5, (1,4,5)))$

$= 100 + 0.8 * 0 = 100.$

	0	1	2	3	4	5
0	0	0	0	0	80	0
1	0	0	0	64	0	100
2	0	0	0	64	0	0
3	0	80	51	0	80	0
4	64	0	0	64	0	100
5	0	80	0	0	80	100

for the next episode I will consider 3 as initial state.

3 it can go to 1, 2, 4.

So will select the next state as 1

$Q(3,1) = R(3,1) + 0.8 Q(\max(1, (3,5)))$

$= 0 + 0.8 \times 100 = 80$ ✓

Next I will select 0 as initial state

0, 4.

$Q(0,4) = R(0,4) + (0.8) \times \max(4, (0,3,5))$

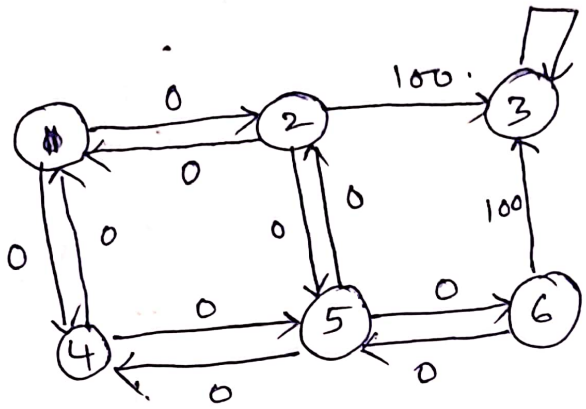
$= 0 + 0.8 \times \max = 0 + 0.8 \times 100$

$= 80$

Next I will select 1 as my initial state

$Q(1,3) = R(1,3) + 0.8 * (3, \max(1,5,4))$

Q-Learning Example. Example - 2



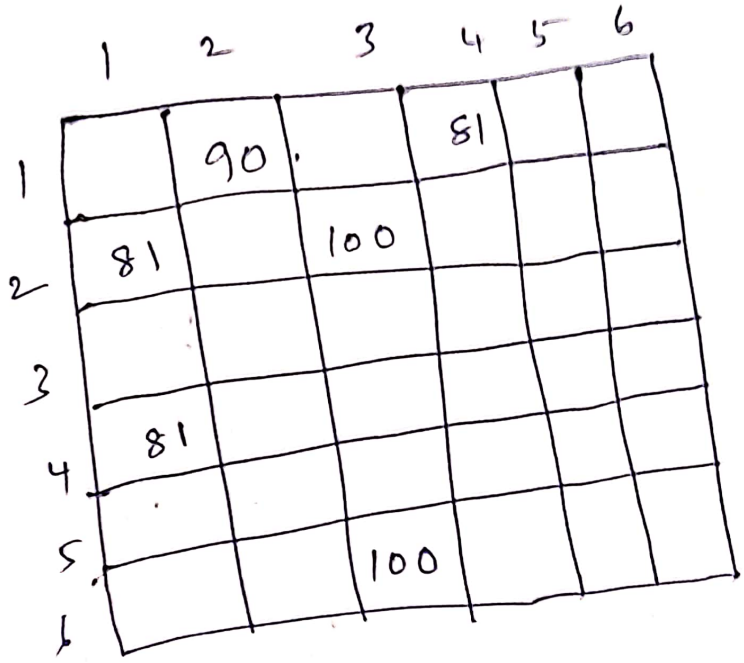
R

	1	2	3	4	5	6
1	-1	0	-1	0	-1	-1
2	0	-1	+100	-1	0	-1
3	-1	-1	100	-1	-1	-1
4	0	-1	-1	-1	0	-1
5	-1	0	-1	0	-1	0
6	-1	-1	+100	-1	0	-1

Q =

	1	2	3	4	5	6
1	0	0	0	0 81	0	0
2	0 81	0	0 100	0	72 0	0
3	0	0	0 100	0	0	0
4	0 81	0	0	0 72	0	0 90
5	0	0 90	0	0 100	0	0 90
6	0	0	0	0	0	0

Q(State, action) = R(State, action) + γ * max(Q(NextState, action))



(1,2)

$$Q(1,2) = R(1,2) + 0.9 * (\max[(2,1)(2,3)(2,5)]$$

$$= 0 + 0.9 * (\max[0, 100, 0]$$

$$= 0.9 \times 100 = 90.$$

(2,1)

$$Q(2,1) = R(2,1) + 0.9 (\max[(1,2)(1,4)]$$

$$= 0 + 0.9 (\max(90, 0)]$$

$$= 81.$$

(4,1)

$$Q(4,1) = R(4,1) + 0.9(\max(1,2)(1,4)]$$

$$= 0 + 0.9 \times (\max(81, 90)$$

$$= \underline{81} \checkmark.$$