Git Clone Link - <https://github.com/ThenukaAnjala/lab8.git>

# Markov Decision Process and Q-Learning

In this lab, we explored two primary approaches to Reinforcement Learning: the Markov Decision Process and Q-Learning. Below are the tasks completed:

## Task 1: Iterative Policy Evaluation

The code for iterative policy evaluation was implemented to compute the utility values for each state based on a given policy. The following code was added:

def iterativePolicyEvaluation(mdp, policy, numIterations=10):  
 U = np.zeros(len(mdp.S))  
 U\_old = copy.copy(U)  
 for t in range(numIterations):  
 for s in range(len(mdp.S)):  
 U[s] = sum([p \* (r + mdp.discount \* U\_old[sp])   
 for p, sp, r in mdp.T(s, policy[s])])  
 U\_old = copy.copy(U)  
 return U

## Task 2: Value Iteration

Value Iteration was implemented to compute the optimal policy by updating the utility values for each state. The following code was added:

def valueIteration(mdp, numIterations=1):  
 U = np.zeros(len(mdp.S))  
 U\_old = copy.copy(U)  
 for t in range(numIterations):  
 for s in range(len(mdp.S)):  
 U[s] = max([sum([p \* (r + mdp.discount \* U\_old[sp])   
 for p, sp, r in mdp.T(s, a)])  
 for a in range(len(mdp.A))])  
 U\_old = copy.copy(U)  
 return U

## Task 3: Policy Extraction

The policy extraction method was implemented to derive the policy from the utility values. The following code was added:

def policyExtration(mdp, U):  
 policy = np.zeros(len(mdp.S))  
 for s in range(len(mdp.S)):  
 policy[s] = np.argmax([sum([p \* (r + mdp.discount \* U[sp])   
 for p, sp, r in mdp.T(s, a)])   
 for a in range(len(mdp.A))])  
 return policy

## Task 4: Policy Iteration

Policy Iteration was implemented to iteratively evaluate and improve the policy based on the utility values. The following code was added:

def policyIteration(mdp, numIterations=1):  
 U\_pi\_k = np.zeros(len(mdp.S)) #initial values  
 pi\_k = np.random.randint(low=0,high=4,size=len(mdp.S),dtype=int) #initial policy  
 pi\_kp1 = copy.copy(pi\_k)  
 for t in range(numIterations):  
 U\_pi\_k = iterativePolicyEvaluation(mdp, pi\_k, numIterations=10)  
 pi\_kp1 = policyExtration(mdp, U\_pi\_k)  
 if np.array\_equal(pi\_k, pi\_kp1):  
 break  
 pi\_k = copy.copy(pi\_kp1)  
 return U\_pi\_k, pi\_kp1