**CMPE – 260 Assignment 2**

**Code:**

#!/usr/bin/env/ python

"""

SARSA.py

An easy-to-follow script to train, test and evaluate a Q-learning agent on the Mountain Car

problem using the OpenAI Gym. |Praveen Palanisamy

# Chapter 5, Hands-on Intelligent Agents with OpenAI Gym, 2018

"""

import gym

import numpy as np

MAX\_NUM\_EPISODES = 5000

# MAX\_NUM\_EPISODES = 50000

STEPS\_PER\_EPISODE = 200 # This is specific to MountainCar. May change with env

EPSILON\_MIN = 0.005

max\_num\_steps = MAX\_NUM\_EPISODES \* STEPS\_PER\_EPISODE

EPSILON\_DECAY = 500 \* EPSILON\_MIN / max\_num\_steps

ALPHA = 0.05 # Learning rate

GAMMA = 0.98 # Discount factor

NUM\_DISCRETE\_BINS = 30 # Number of bins to Discretize each observation dim

class SARSA(object):

def \_\_init\_\_(self, env):

self.obs\_shape = env.observation\_space.shape

self.obs\_high = env.observation\_space.high

self.obs\_low = env.observation\_space.low

self.obs\_bins = NUM\_DISCRETE\_BINS # Number of bins to Discretize each observation dim

self.bin\_width = (self.obs\_high - self.obs\_low) / self.obs\_bins

self.action\_shape = env.action\_space.n

# Create a multi-dimensional array (aka. Table) to represent the

# Q-values

self.Q = np.zeros((self.obs\_bins + 1, self.obs\_bins + 1,

self.action\_shape)) # (51 x 51 x 3)

self.alpha = ALPHA # Learning rate

self.gamma = GAMMA # Discount factor

self.epsilon = 1.0

def discretize(self, obs):

return tuple(((obs - self.obs\_low) / self.bin\_width).astype(int))

def get\_action(self, obs):

discretized\_obs = self.discretize(obs)

# Epsilon-Greedy action selection

if self.epsilon > EPSILON\_MIN:

self.epsilon -= EPSILON\_DECAY

if np.random.random() > self.epsilon:

return np.argmax(self.Q[discretized\_obs])

else: # Choose a random action

return np.random.choice([a for a in range(self.action\_shape)])

def learn(self, obs, action, reward, next\_obs, next\_action):

discretized\_obs = self.discretize(obs)

discretized\_next\_obs = self.discretize(next\_obs)

td\_target = reward + self.gamma \* self.Q[discretized\_next\_obs][next\_action]

td\_error = td\_target - self.Q[discretized\_obs][action]

self.Q[discretized\_obs][action] += self.alpha \* td\_error

def train(agent, env):

best\_reward = -float('inf')

for episode in range(MAX\_NUM\_EPISODES):

done = False

obs = env.reset()

total\_reward = 0.0

while not done:

action = agent.get\_action(obs)

next\_obs, reward, done, info = env.step(action)

next\_action = agent.get\_action(next\_obs)

agent.learn(obs, action, reward, next\_obs, next\_action)

obs = next\_obs

total\_reward += reward

if total\_reward > best\_reward:

best\_reward = total\_reward

print("Episode#:{} reward:{} best\_reward:{} eps:{}".format(episode,

total\_reward, best\_reward, agent.epsilon))

# Return the trained policy

return np.argmax(agent.Q, axis=2)

def test(agent, env, policy):

done = False

obs = env.reset()

total\_reward = 0.0

while not done:

action = policy[agent.discretize(obs)]

next\_obs, reward, done, info = env.step(action)

obs = next\_obs

total\_reward += reward

return total\_reward

if \_\_name\_\_ == "\_\_main\_\_":

env = gym.make('MountainCar-v0')

agent = SARSA(env)

learned\_policy = train(agent, env)

# Use the Gym Monitor wrapper to evalaute the agent and record video

gym\_monitor\_path = "./gym\_monitor\_output"

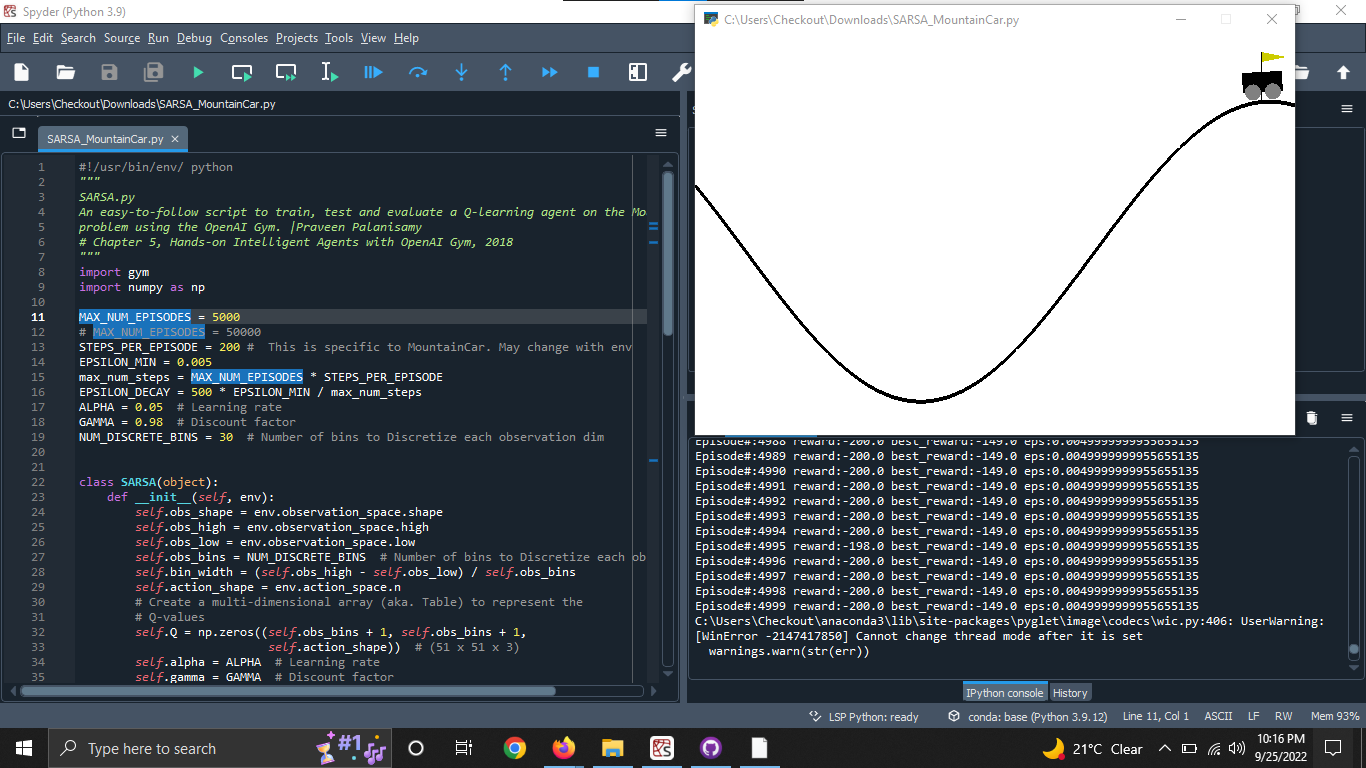
env = gym.wrappers.Monitor(env, gym\_monitor\_path, force=True)

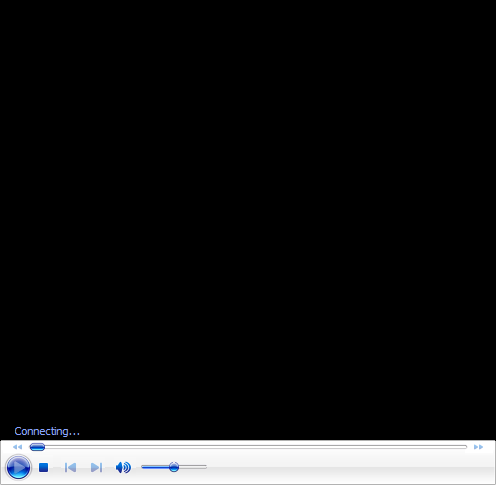
for \_ in range(1000):

test(agent, env, learned\_policy)

env.close()

**Output:**

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