

## 3\_policy\_gradient\_mountain\_car

July 25, 2022

```
[1]: import gym
import torch.nn as nn
import torch
import torch.nn.functional as F
```

```
env = gym.make('MountainCarContinuous-v0')
```

```
[1]: 'https://medium.com/swlh/cartpole-with-policy-gradient-tensorflow-2-x-3a7a14b9cc03#:~:text=Policy%20gradient%20is%20a%20reinforcement,actions%20would%20be%20the%20best.'
```

### 0.0.1 Model Architecture

- 3 Linear layers
- ReLU Activation function
- Softmax Output function

Learning rate: 1e-3

Gamma: 0.95

```
[2]: class Model(nn.Module):
    def __init__(self, state_dim, num_actions):
        super().__init__()
        self.fc1 = nn.Linear(state_dim, 64)
        self.fc2 = nn.Linear(64, 64)
        self.action = nn.Linear(64, num_actions)

    def forward(self, x):
        x = self.fc1(x)
        x = F.relu(x)
        x = self.fc2(x)
        x = F.relu(x)
        x = self.action(x)
        mean = torch.tanh(x)
        return mean
```

/raid/home/kawinm/miniconda3/lib/python3.9/site-packages/tqdm/auto.py:22:  
TqdmWarning: IProgress not found. Please update jupyter and ipywidgets. See

```
https://ipywidgets.readthedocs.io/en/stable/user_install.html
from .autonotebook import tqdm as notebook_tqdm
```

```
[12]: class Agent:
    def __init__(self, gamma=0.95, lr=0.001, n_actions=2, state_dim =4):
        self.gamma = gamma
        self.lr = lr
        self.model = Model(state_dim, n_actions)
        self.opt = torch.optim.Adam(self.model.parameters(), lr=self.lr)
        self.action_memory = []
        self.reward_memory = []
        self.state_memory = []
        self.std = 1

    def choose_action(self, state):

        self.model.eval()
        state = torch.tensor(state)
        prob = self.model.forward(state)
        dist = torch.distributions.normal.Normal(prob, self.std)
        action = torch.tanh(dist.sample())
        self.action_memory.append(action.item())
        return action.item()

    def store_reward(self, reward):
        self.reward_memory.append(reward)

    def store_state(self, state):
        self.state_memory.append(state)

    def learn(self):
        sum_reward = 0
        discont_rewards = []
        self.reward_memory.reverse()
        for r in self.reward_memory:
            sum_reward = r + self.gamma*sum_reward
            discont_rewards.append(sum_reward)
        discont_rewards.reverse()

        self.model.train()

        for state, action, reward in zip(self.state_memory, self.
↪ action_memory, discont_rewards):
            state = torch.tensor(state)
            p = self.model.forward(state)
            #print(p)
            loss = self.calc_loss(p, action, reward)
```

```

        loss.backward()
        self.opt.step()
        self.opt.zero_grad()

        self.reward_memory = []
        self.action_memory = []
        self.state_memory = []

    def calc_loss(self, prob, action, reward):
        dist = torch.distributions.normal.Normal(prob, self.std)
        action = torch.tensor(action)
        log_prob = dist.log_prob(action)
        loss = -log_prob * reward
        return loss

```

Number of Actions: 1 State Dimension: 2

```

[15]: num_episodes = 1000
agent = Agent(n_actions=1, state_dim=2)

score_list = []
for i in range(num_episodes):
    state = env.reset()
    score = 0
    rewards = []
    states = []
    actions = []
    done = False
    if i % 200 == 0:
        agent.std -= agent.std / 1000
    while not done:
        action = [agent.choose_action(state)]
        state_, reward, done, _ = env.step(action)
        agent.store_reward(reward)
        agent.store_state(state)
        state = state_
        score += reward
        #env.render()
    if done:
        agent.learn()
        print(f'episode done: {i+1}\t score recieved: {score}')
        score_list.append(score)

```

```

episode done: 1  score recieved: -40.76378950888598
episode done: 2  score recieved: -54.70119132864172
episode done: 3  score recieved: -55.72568065016769
episode done: 4  score recieved: -54.92619175608551
episode done: 5  score recieved: 53.183042122297316

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episode done: 6 score recieved: -55.11291130012332  
 episode done: 7 score recieved: -52.67136191790513  
 episode done: 8 score recieved: -54.48115627584502  
 episode done: 9 score recieved: -55.792677177827294  
 episode done: 10 score recieved: -55.594431685462865  
 episode done: 11 score recieved: -55.39258843287286  
 episode done: 12 score recieved: -54.612417913112616  
 episode done: 13 score recieved: -56.08241620163895  
 episode done: 14 score recieved: -53.698048296118834  
 episode done: 15 score recieved: -54.46994114222948  
 episode done: 16 score recieved: -54.29339784513841  
 episode done: 17 score recieved: -53.81894364396893  
 episode done: 18 score recieved: -56.647262883359865  
 episode done: 19 score recieved: -56.1637304458377  
 episode done: 20 score recieved: -55.32470126406876  
 episode done: 21 score recieved: -54.079100566303566  
 episode done: 22 score recieved: -54.33467212301837  
 episode done: 23 score recieved: -53.94296970781327  
 episode done: 24 score recieved: -55.414727352154195  
 episode done: 25 score recieved: -56.70295218313537  
 episode done: 26 score recieved: 61.914928052735135  
 episode done: 27 score recieved: -53.99756215867722  
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 episode done: 42 score recieved: -54.31745413204091  
 episode done: 43 score recieved: -53.95823937582437  
 episode done: 44 score recieved: -55.21514006842489  
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 episode done: 46 score recieved: -54.99202262561096  
 episode done: 47 score recieved: -53.77384121179682  
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 episode done: 53 score recieved: -54.54034667675883

episode done: 54	score recieved: -53.99439806813014
episode done: 55	score recieved: -54.78687146970067
episode done: 56	score recieved: -52.90105025721194
episode done: 57	score recieved: -54.4696187438976
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episode done: 998	score recieved: -55.700097422655894
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episode done: 1000	score recieved: -55.48535220722701

```
[16]: epoch_x = [x for x in range(1, 1001)]

import matplotlib.pyplot as plt
%matplotlib inline

plt.plot(epoch_x, score_list, color = 'r')
plt.title("Scores vs Episodes")
plt.xlabel("Episodes")
plt.ylabel("Score")
plt.show()
```



