

МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ  
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Факультет «Информатика и системы управления»  
Кафедра «Систем обработки информации и управления»

## ОТЧЕТ

**Лабораторная работа № 6**  
по дисциплине «Методы машинного обучения в АСОИУ»

ИСПОЛНИТЕЛЬ:

группа ИУ5-22М

Воронцова А.В.

ФИО

подпись

" " 2024 г.

ПРЕПОДАВАТЕЛЬ:

Балашов А. М.

ФИО

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" " 2024 г.

Москва - 2024

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## Задание:

На основе рассмотренных на лекции примеров реализуйте алгоритм DQN. В качестве среды можно использовать классические среды (в этом случае используется полносвязная архитектура нейронной сети).

Для реализации алгоритма Deep Q-Network (DQN) на Python, я буду использовать библиотеку gym для симуляции среды и torch для создания и обучения нейронной сети. В качестве среды для DQN используем CartPole-v1 из библиотеки gym.

```
pip install gym[atari,accept-rom-license] torch torchvision

Requirement already satisfied: gym[atari,accept-rom-license] in
/usr/local/lib/python3.10/dist-packages (0.25.2)
Requirement already satisfied: torch in
/usr/local/lib/python3.10/dist-packages (2.3.0+cu121)
Requirement already satisfied: torchvision in
/usr/local/lib/python3.10/dist-packages (0.18.0+cu121)
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Requirement already satisfied: jinja2 in
/usr/local/lib/python3.10/dist-packages (from torch) (3.1.4)
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in /usr/local/lib/python3.10/dist-packages (from torch) (12.1.105)
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/usr/local/lib/python3.10/dist-packages (from torch) (12.1.105)
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(3.3.2)
Requirement already satisfied: idna<4,>=2.5 in
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(3.7)
Requirement already satisfied: urllib3<3,>=1.21.1 in
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(2.0.7)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.10/dist-packages (from requests-
>autorom[accept-rom-license]~=0.4.2->gym[accept-rom-license,atari])
(2024.6.2)
```

```
import gym
import random
import torch
import torch.nn as nn
import torch.optim as optim
import numpy as np
from collections import deque
import matplotlib.pyplot as plt

class DQN(nn.Module):
    def __init__(self, input_dim, output_dim):
        super(DQN, self).__init__()
        self.fc1 = nn.Linear(input_dim, 128)
        self.relu = nn.ReLU()
        self.fc2 = nn.Linear(128, 64)
        self.fc3 = nn.Linear(64, output_dim)

    def forward(self, x):
        x = self.relu(self.fc1(x))
        x = self.relu(self.fc2(x))
        return self.fc3(x)

class Agent:
    def __init__(self, state_space, action_space, lr=0.001,
gamma=0.99):
        self.state_space = state_space
        self.action_space = action_space
        self.gamma = gamma
        self.memory = deque(maxlen=10000)
        self.model = DQN(state_space, action_space)
        self.optimizer = optim.Adam(self.model.parameters(), lr=lr)
        self.criterion = nn.MSELoss()

    def update(self, batch_size):
        if len(self.memory) < batch_size:
            return
        batch = random.sample(self.memory, batch_size)
        states, actions, rewards, next_states, dones = zip(*batch)
```

```

        states = torch.FloatTensor(states)
        actions = torch.LongTensor(actions)
        rewards = torch.FloatTensor(rewards)
        next_states = torch.FloatTensor(next_states)
        dones = torch.FloatTensor(dones)

        q_values = self.model(states).gather(1,
actions.unsqueeze(1)).squeeze(1)
        next_q_values = self.model(next_states).max(1)[0]
        expected_q_values = rewards + self.gamma * next_q_values * (1
- dones)

        loss = self.criterion(q_values, expected_q_values.detach())
        self.optimizer.zero_grad()
        loss.backward()
        self.optimizer.step()

def act(self, state, epsilon):
    if random.random() > epsilon:
        state = torch.FloatTensor(state).unsqueeze(0)
        q_values = self.model(state)
        action = q_values.max(1)[1].item()
    else:
        action = random.randrange(self.action_space)
    return action

def remember(self, state, action, reward, next_state, done):
    self.memory.append((state, action, reward, next_state, done))

def train():
    env = gym.make('CartPole-v1')
    agent = Agent(env.observation_space.shape[0], env.action_space.n)
    episodes = 1000
    batch_size = 32
    epsilon_start = 1.0
    epsilon_end = 0.01
    epsilon_decay = 0.995
    epsilon = epsilon_start

    rewards = [] # Список для хранения вознаграждений

    for episode in range(episodes):
        state = env.reset()
        total_reward = 0
        done = False

        while not done:
            action = agent.act(state, epsilon)
            next_state, reward, done, _ = env.step(action)
            agent.remember(state, action, reward, next_state, done)

```

```

        state = next_state
        total_reward += reward

        agent.update(batch_size)

        rewards.append(total_reward) # Добавляем вознаграждение за
эпизод
        epsilon = max(epsilon_end, epsilon_decay * epsilon)
        print(f"Episode: {episode}, Total reward: {total_reward},
Epsilon: {epsilon}")

        plt.plot(rewards)
        plt.title('Reward by Episode')
        plt.xlabel('Episode')
        plt.ylabel('Total Reward')
        plt.show()

if __name__ == "__main__":
    train()

```

```

Episode: 0, Total reward: 24.0, Epsilon: 0.995
Episode: 1, Total reward: 22.0, Epsilon: 0.990025
Episode: 2, Total reward: 17.0, Epsilon: 0.985074875
Episode: 3, Total reward: 29.0, Epsilon: 0.9801495006250001
Episode: 4, Total reward: 15.0, Epsilon: 0.9752487531218751
Episode: 5, Total reward: 21.0, Epsilon: 0.9703725093562657
Episode: 6, Total reward: 11.0, Epsilon: 0.9655206468094844
Episode: 7, Total reward: 23.0, Epsilon: 0.960693043575437
Episode: 8, Total reward: 22.0, Epsilon: 0.9558895783575597
Episode: 9, Total reward: 41.0, Epsilon: 0.9511101304657719
Episode: 10, Total reward: 47.0, Epsilon: 0.946354579813443
Episode: 11, Total reward: 24.0, Epsilon: 0.9416228069143757
Episode: 12, Total reward: 15.0, Epsilon: 0.9369146928798039
Episode: 13, Total reward: 29.0, Epsilon: 0.9322301194154049
Episode: 14, Total reward: 26.0, Epsilon: 0.9275689688183278
Episode: 15, Total reward: 13.0, Epsilon: 0.9229311239742362
Episode: 16, Total reward: 21.0, Epsilon: 0.918316468354365
Episode: 17, Total reward: 28.0, Epsilon: 0.9137248860125932
Episode: 18, Total reward: 20.0, Epsilon: 0.9091562615825302
Episode: 19, Total reward: 15.0, Epsilon: 0.9046104802746175
Episode: 20, Total reward: 17.0, Epsilon: 0.9000874278732445
Episode: 21, Total reward: 24.0, Epsilon: 0.8955869907338783
Episode: 22, Total reward: 16.0, Epsilon: 0.8911090557802088
Episode: 23, Total reward: 13.0, Epsilon: 0.8866535105013078
Episode: 24, Total reward: 13.0, Epsilon: 0.8822202429488013
Episode: 25, Total reward: 23.0, Epsilon: 0.8778091417340573
Episode: 26, Total reward: 23.0, Epsilon: 0.8734200960253871
Episode: 27, Total reward: 36.0, Epsilon: 0.8690529955452602
Episode: 28, Total reward: 26.0, Epsilon: 0.8647077305675338
Episode: 29, Total reward: 21.0, Epsilon: 0.8603841919146962

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Episode: 30, Total reward: 18.0, Epsilon: 0.8560822709551227  
Episode: 31, Total reward: 10.0, Epsilon: 0.851801859600347  
Episode: 32, Total reward: 16.0, Epsilon: 0.8475428503023453  
Episode: 33, Total reward: 29.0, Epsilon: 0.8433051360508336  
Episode: 34, Total reward: 14.0, Epsilon: 0.8390886103705794  
Episode: 35, Total reward: 32.0, Epsilon: 0.8348931673187264  
Episode: 36, Total reward: 21.0, Epsilon: 0.8307187014821328  
Episode: 37, Total reward: 36.0, Epsilon: 0.8265651079747222  
Episode: 38, Total reward: 22.0, Epsilon: 0.8224322824348486  
Episode: 39, Total reward: 35.0, Epsilon: 0.8183201210226743  
Episode: 40, Total reward: 43.0, Epsilon: 0.8142285204175609  
Episode: 41, Total reward: 17.0, Epsilon: 0.810157377815473  
Episode: 42, Total reward: 19.0, Epsilon: 0.8061065909263957  
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Episode: 66, Total reward: 36.0, Epsilon: 0.7147372386831305  
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