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

ОТЧЕТ

Лабораторная работа №__7__
по дисциплине «Методы машинного обучения в АСОИУ»

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Москва - 2024

Задание:

Реализуйте любой алгоритм семейства Actor-Critic для произвольной среды.

```
pip install gym torch numpy matplotlib
```

```
Requirement already satisfied: gym 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: numpy in
/usr/local/lib/python3.10/dist-packages (1.25.2)
Requirement already satisfied: matplotlib in
/usr/local/lib/python3.10/dist-packages (3.7.1)
Requirement already satisfied: cloudpickle>=1.2.0 in
/usr/local/lib/python3.10/dist-packages (from gym) (2.2.1)
Requirement already satisfied: gym-notices>=0.0.4 in
/usr/local/lib/python3.10/dist-packages (from gym) (0.0.8)
Requirement already satisfied: filelock in
/usr/local/lib/python3.10/dist-packages (from torch) (3.14.0)
Requirement already satisfied: typing-extensions>=4.8.0 in
/usr/local/lib/python3.10/dist-packages (from torch) (4.12.1)
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/usr/local/lib/python3.10/dist-packages (from torch) (1.12.1)
Requirement already satisfied: networkx in
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Requirement already satisfied: jinja2 in
/usr/local/lib/python3.10/dist-packages (from torch) (3.1.4)
Requirement already satisfied: fsspec in
/usr/local/lib/python3.10/dist-packages (from torch) (2023.6.0)
Collecting nvidia-cuda-nvrtc-cu12==12.1.105 (from torch)
  Using cached nvidia_cuda_nvrtc_cu12-12.1.105-py3-none-
manylinux1_x86_64.whl (23.7 MB)
Collecting nvidia-cuda-runtime-cu12==12.1.105 (from torch)
  Using cached nvidia_cuda_runtime_cu12-12.1.105-py3-none-
manylinux1_x86_64.whl (823 kB)
Collecting nvidia-cuda-cupti-cu12==12.1.105 (from torch)
  Using cached nvidia_cuda_cupti_cu12-12.1.105-py3-none-
manylinux1_x86_64.whl (14.1 MB)
Collecting nvidia-cudnn-cu12==8.9.2.26 (from torch)
  Using cached nvidia_cudnn_cu12-8.9.2.26-py3-none-
manylinux1_x86_64.whl (731.7 MB)
Collecting nvidia-cublas-cu12==12.1.3.1 (from torch)
  Using cached nvidia_cublas_cu12-12.1.3.1-py3-none-
manylinux1_x86_64.whl (410.6 MB)
Collecting nvidia-cufft-cu12==11.0.2.54 (from torch)
  Using cached nvidia_cufft_cu12-11.0.2.54-py3-none-
manylinux1_x86_64.whl (121.6 MB)
Collecting nvidia-curand-cu12==10.3.2.106 (from torch)
  Using cached nvidia_curand_cu12-10.3.2.106-py3-none-
```

```
manylinux1_x86_64.whl (56.5 MB)
Collecting nvidia-cusolver-cu12==11.4.5.107 (from torch)
  Using cached nvidia_cusolver_cu12-11.4.5.107-py3-none-
manylinux1_x86_64.whl (124.2 MB)
Collecting nvidia-cusparse-cu12==12.1.0.106 (from torch)
  Using cached nvidia_cusparse_cu12-12.1.0.106-py3-none-
manylinux1_x86_64.whl (196.0 MB)
Collecting nvidia-nccl-cu12==2.20.5 (from torch)
  Using cached nvidia_nccl_cu12-2.20.5-py3-none-
manylinux2014_x86_64.whl (176.2 MB)
Collecting nvidia-nvtx-cu12==12.1.105 (from torch)
  Using cached nvidia_nvtx_cu12-12.1.105-py3-none-
manylinux1_x86_64.whl (99 kB)
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/usr/local/lib/python3.10/dist-packages (from torch) (2.3.0)
Collecting nvidia-nvjitlink-cu12 (from nvidia-cusolver-
cu12==11.4.5.107->torch)
  Downloading nvidia_nvjitlink_cu12-12.5.40-py3-none-
manylinux2014_x86_64.whl (21.3 MB)
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Requirement already satisfied: packaging>=20.0 in
/usr/local/lib/python3.10/dist-packages (from matplotlib) (24.0)
Requirement already satisfied: pillow>=6.2.0 in
/usr/local/lib/python3.10/dist-packages (from matplotlib) (9.4.0)
Requirement already satisfied: pyparsing>=2.3.1 in
/usr/local/lib/python3.10/dist-packages (from matplotlib) (3.1.2)
Requirement already satisfied: python-dateutil>=2.7 in
/usr/local/lib/python3.10/dist-packages (from matplotlib) (2.8.2)
Requirement already satisfied: six>=1.5 in
/usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.7-
>matplotlib) (1.16.0)
Requirement already satisfied: MarkupSafe>=2.0 in
/usr/local/lib/python3.10/dist-packages (from jinja2->torch) (2.1.5)
Requirement already satisfied: mpmath<1.4.0,>=1.1.0 in
/usr/local/lib/python3.10/dist-packages (from sympy->torch) (1.3.0)
Installing collected packages: nvidia-nvtx-cu12, nvidia-nvjitlink-
cu12, nvidia-nccl-cu12, nvidia-curand-cu12, nvidia-cufft-cu12, nvidia-
cuda-runtime-cu12, nvidia-cuda-nvrtc-cu12, nvidia-cuda-cupti-cu12,
nvidia-cublas-cu12, nvidia-cusparse-cu12, nvidia-cudnn-cu12, nvidia-
cusolver-cu12
```

```
Successfully installed nvidia-cublas-cu12-12.1.3.1 nvidia-cuda-cupti-cu12-12.1.105 nvidia-cuda-nvrtc-cu12-12.1.105 nvidia-cuda-runtime-cu12-12.1.105 nvidia-cudnn-cu12-8.9.2.26 nvidia-cufft-cu12-11.0.2.54 nvidia-curand-cu12-10.3.2.106 nvidia-cusolver-cu12-11.4.5.107 nvidia-cusparse-cu12-12.1.0.106 nvidia-nccl-cu12-2.20.5 nvidia-nvjitlink-cu12-12.5.40 nvidia-nvtx-cu12-12.1.105
```

```
import gym
import numpy as np
import torch
import torch.nn as nn
import torch.optim as optim
from torch.distributions import Categorical
import matplotlib.pyplot as plt
```

Определение модели Actor-Critic

```
class ActorCritic(nn.Module):
    def __init__(self, state_space, action_space):
        super(ActorCritic, self).__init__()
        self.fc1 = nn.Linear(state_space, 128)
        self.actor = nn.Linear(128, action_space)
        self.critic = nn.Linear(128, 1)

    def forward(self, x):
        x = torch.relu(self.fc1(x))
        action_probs = torch.softmax(self.actor(x), dim=-1)
        state_values = self.critic(x)
        return action_probs, state_values
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `should_run_async` will not call `transform_cell` automatically in the future. Please pass the result to `transformed_cell` argument and any exception that happen during thetransform in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Обучение модели

```
def train(env, policy, optimizer, episodes):
    episode_rewards = []

    for episode in range(episodes):
        state = env.reset()
        log_probs = []
        values = []
        rewards = []
        masks = []
        entropy = 0
```

```
        while True:
            state = torch.FloatTensor(state).unsqueeze(0)
            probs, value = policy(state)
            m = Categorical(probs)
            action = m.sample()
            next_state, reward, done, _ = env.step(action.item())

            log_prob = m.log_prob(action)
            entropy += m.entropy().mean()

            log_probs.append(log_prob)
            values.append(value)
            rewards.append(torch.tensor([reward],
dtype=torch.float32))
            masks.append(torch.tensor([1-done], dtype=torch.float32))

            state = next_state

            if done:
                break

        next_state = torch.FloatTensor(next_state).unsqueeze(0)
        _, next_value = policy(next_state)
        returns = compute_returns(next_value, rewards, masks)

        log_probs = torch.cat(log_probs)
        returns = torch.cat(returns).detach()
        values = torch.cat(values)

        advantage = returns - values

        actor_loss = -(log_probs * advantage.detach()).mean()
        critic_loss = advantage.pow(2).mean()

        loss = actor_loss + 0.5 * critic_loss - 0.001 * entropy

        optimizer.zero_grad()
        loss.backward()
        optimizer.step()

        total_reward = sum(rewards)
        episode_rewards.append(total_reward)

    return episode_rewards

def compute_returns(next_value, rewards, masks, gamma=0.99):
    R = next_value
    returns = []
    for step in reversed(range(len(rewards))):
        R = rewards[step] + gamma * R * masks[step]
```

```
        returns.insert(0, R)
    return returns
```

Запуск обучения

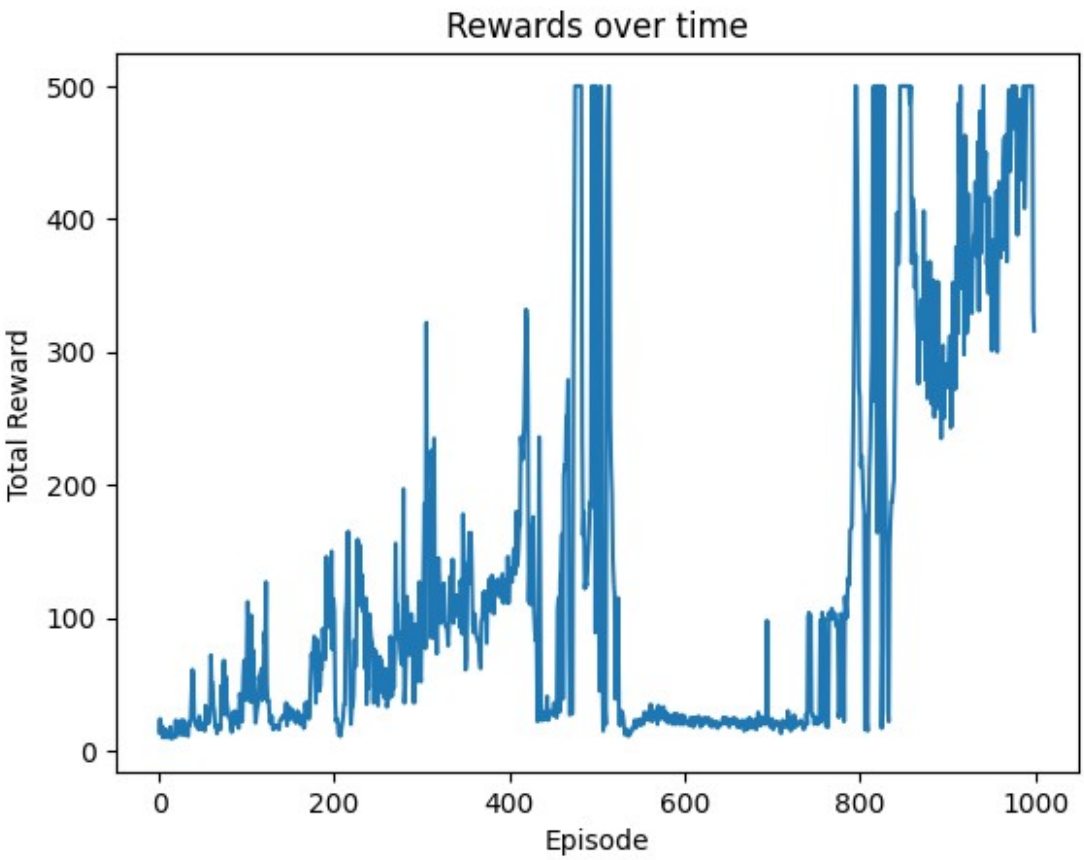
```
env = gym.make('CartPole-v1')
state_dim = env.observation_space.shape[0]
action_dim = env.action_space.n

policy = ActorCritic(state_dim, action_dim)
optimizer = optim.Adam(policy.parameters(), lr=0.01)

episodes = 1000
rewards = train(env, policy, optimizer, episodes)

plt.plot(rewards)
plt.title('Rewards over time')
plt.xlabel('Episode')
plt.ylabel('Total Reward')
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/gym/core.py:317:
DeprecationWarning: WARN: Initializing wrapper in old step API which
returns one bool instead of two. It is recommended to set
`new_step_api=True` to use new step API. This will be the default
behaviour in future.
  deprecation(
/usr/local/lib/python3.10/dist-packages/gym/wrappers/step_api_compatib
ility.py:39: DeprecationWarning: WARN: Initializing environment in old
step API which returns one bool instead of two. It is recommended to
set `new_step_api=True` to use new step API. This will be the default
behaviour in future.
  deprecation(
/usr/local/lib/python3.10/dist-packages/gym/utils/passive_env_checker.
py:241: DeprecationWarning: `np.bool8` is a deprecated alias for
`np.bool_`.  (Deprecated NumPy 1.24)
  if not isinstance(terminated, (bool, np.bool8)):
```


Rewards over time
Total Reward
Episode
0
100
200
300
400
500
0
200
400
600
800
1000