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Курс «Методы машинного обучения»

Отчет по лабораторной работе 7

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Лабораторная работа 7. Реализовать алгоритм Actor-Critic для любой среды

In [1]:

```
import torch import torch.nn as
nn import torch.optim as optim
import torch.nn.functional as F
import torch.distributions as distributions

import matplotlib.pyplot as plt import
numpy as np
import gym import
tqdm
```

In [2]:

```
train_env = gym.make('CartPole-v1') test_env
= gym.make('CartPole-v1')
```

In [3]:

```
SEED = 1234

train_env.seed(SEED); test_env.seed(SEED+1);
np.random.seed(SEED);
torch.manual_seed(SEED);
```

In [4]:

```
class MLP(nn.Module):     def __init__(self, input_dim,
hidden_dim, output_dim):         super().__init__()

        self.fc_1 = nn.Linear(input_dim, hidden_dim)
self.fc_2 = nn.Linear(hidden_dim, output_dim)
     def forward(self,
x):          x =
self.fc_1(x)         x =
F.relu(x)         x =
self.fc_2(x)
return x
```

```
input_dim = train_env.observation_space.shape[0]
hidden_dim = 32
```

In [5]:

```
class ActorCritic(nn.Module):     def
__init__(self, actor, critic):
super().__init__()

        self.actor = actor
self.critic = critic
             def
forward(self, state):

        action_pred = self.actor(state)
value_pred = self.critic(state)

        return action_pred, value_pred
```

In [6]:

In [7]:

```
def init_weights(m):      if type(m) ==
nn.Linear:
torch.nn.init.kaiming_normal_(m.weight)
        m.bias.data.fill_(0)
```

In [8]:

```
device = torch.device('cuda')
```

```
output_dim = train_env.action_space.n
```

```
def calculate_returns(rewards, discount_factor, device, normalize = True):

    returns = []
```

In [9]:

op

```
def train(env, policy, optimizer, discount_factor, device):

    policy.train()

In  log_prob_actions = []
[10]: entropies = []
value_preds = []
In  rewards = []      done =
[11]: False     episode_reward
= 0

    state = env.reset()
     while not
done:

        state = torch.FloatTensor(state).unsqueeze(0).to(device)

        action_pred, value_pred = policy(state)

        action_prob = F.softmax(action_pred, dim = -1)

        dist = distributions.Categorical(action_prob)

        action = dist.sample()
        log_prob_action = dist.log_prob(action)

        entropy = dist.entropy()

        state, reward, done, _ = env.step(action.item())

        log_prob_actions.append(log_prob_action)
entropies.append(entropy)
        value_preds.append(value_pred.squeeze(0))
rewards.append(reward)

        episode_reward += reward

    log_prob_actions = torch.cat(log_prob_actions)
entropies = torch.cat(entropies)      value_preds =
torch.cat(value_preds)

    returns = calculate_returns(rewards, discount_factor, device)
advantages = calculate_advantages(returns, value_preds)

    loss = update_policy(advantages, log_prob_actions, returns, value_preds, entropies,

    return loss, episode_reward
```

```
def calculate_advantages(returns, pred_values, normalize = True):

    advantages = returns - pred_values
         if
normalize:

        advantages = (advantages - advantages.mean()) / advantages.std()

    return advantages
```

In [12]:

```
def evaluate(env, policy, device):

    policy.eval()

    done = False
episode_reward = 0

    state = env.reset()
     while not
done:

        state = torch.FloatTensor(state).unsqueeze(0).to(device)
                 with
torch.no_grad():

            action_pred, _ = policy(state)

            action_prob = F.softmax(action_pred, dim = -1)
```

In [13]:

```
        action = torch.argmax(action_prob, dim = -1)



    R = 0          for r in
reversed(rewards):        R = r
+ R * discount_factor
returns.insert(0, R)

    returns = torch.tensor(returns).to(device)
         if normalize:        returns = (returns -
returns.mean()) / returns.std()

return returns
```

In [14]:

```
def update_policy(advantages, log_prob_actions, returns, value_preds, entropies, optimizer

    returns = returns.detach()

    policy_loss = -(advantages * log_prob_actions).mean()
value_loss = F.smooth_l1_loss(returns, value_preds)
        state, reward, done, _ = env.step(action.item())
    optimizer.zero_grad()
        episode_reward += reward
    loss = policy_loss + value_loss * 0.5 - entropies.mean() * 0.01
      return episode_reward
    loss.backward()

    optimizer.step()

    return loss.item()
```

de

```
n_runs = 5
max_episodes = 300
discount_factor = 0.99

train_rewards = torch.zeros(n_runs, max_episodes)
test_rewards = torch.zeros(n_runs, max_episodes)
device = torch.device('cpu')

for run in range(n_runs):

    actor = MLP(input_dim, hidden_dim, output_dim)
    critic = MLP(input_dim, hidden_dim, 1)
    actor_critic = ActorCritic(actor, critic)
    actor_critic = actor_critic.to(device)
    actor_critic.apply(init_weights)
    optimizer = optim.Adam(actor_critic.parameters(), lr=1e-2)
        for episode in tqdm.tqdm(range(max_episodes), desc=f'Run: {run}'):

            loss, train_reward = train(train_env, actor_critic, optimizer, discount_factor,

            test_reward = evaluate(test_env, actor_critic, device)

            train_rewards[run][episode] = train_reward
            test_rewards[run][episode] = test_reward
```

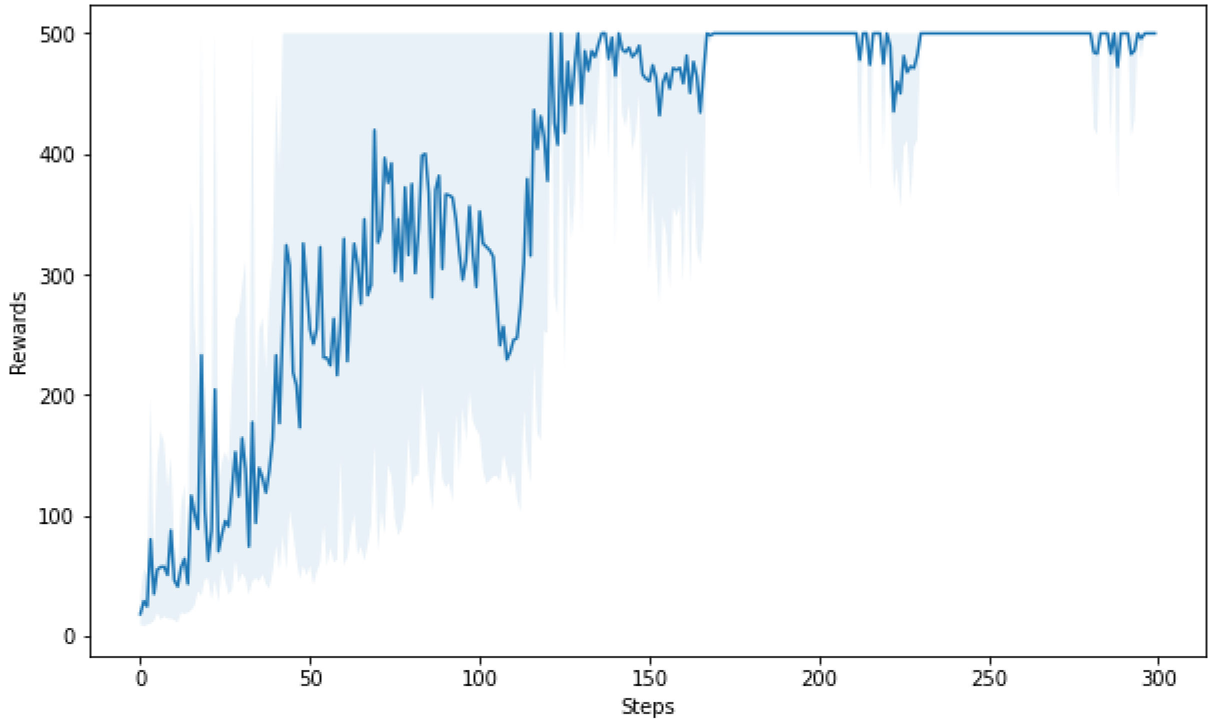
```
Run: 0: 100%|██████████| 300/300 [01:33<00:00,  3.21it/s]
Run: 1: 100%|██████████| 300/300 [01:40<00:00,  2.99it/s]
Run: 2: 100%|██████████| 300/300 [01:29<00:00,  3.35it/s]
Run: 3: 100%|██████████| 300/300 [01:23<00:00,  3.60it/s]
Run: 4: 100%|██████████| 300/300 [01:23<00:00,  3.59it/s]
```

```
idxs = range(max_episodes)
fig, ax = plt.subplots(1, figsize=(10,6))
ax.plot(idxs, test_rewards.mean(0))
ax.fill_between(idxs, test_rewards.min(0).values, test_rewards.max(0).values, alpha=0.1)
ax.set_xlabel('Steps')
ax.set_ylabel('Rewards');
```

In [15]:

In [16]:

```
x = torch.randn(2, 10)
y = torch.randn(2, 10)
print(F.smooth_l1_loss(x, y))
print(F.mse_loss(x, y))
```




```
tensor(0.5806) tensor(1.4047)
```

```
# This is formatted as code
```

```
# This is formatted as code
```