

a2-full-rl-return-cartpole-acrobot

March 29, 2023

```
[ ]: import numpy as np
import random
import torch
import torch.nn as nn
import torch.nn.functional as F
from collections import namedtuple, deque
import torch.optim as optim
import datetime
import gym
from gym.wrappers.record_video import RecordVideo
import glob
import io
import base64
import matplotlib.pyplot as plt
from IPython.display import HTML
import tensorflow as tf
from IPython import display as ipythondisplay
from PIL import Image
import tensorflow_probability as tfp
```

```
[ ]: class ActorCriticModel(tf.keras.Model):
    """
    Defining policy and value networkss
    """
    def __init__(self,
        ↪action_size,num_layers=2,num_neurons_each_layer=[1024,512]):
        super(ActorCriticModel, self).__init__()
        self.num_layers = num_layers
        self.neurons_each_layer = num_neurons_each_layer
        self.linears = [tf.keras.layers.Dense(self.neurons_each_layer[0],
        ↪activation=tf.nn.relu)]
        self.linears.extend([tf.keras.layers.Dense(self.neurons_each_layer[i],
        ↪activation=tf.nn.relu) for i in range(1, self.num_layers)])

        #Output Layer for policy
        self.pi_out = tf.keras.layers.Dense(action_size, activation=tf.nn.
        ↪softmax)
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#Output Layer for state-value
self.v_out = tf.keras.layers.Dense(1)

def call(self, state):
    """
    Computes policy distribution and state-value for a given state
    """
    h = None
    for i in range(self.num_layers+1):
        if i == 0:
            h = tf.nn.relu(self.linear[0](state))
        elif i < self.num_layers:
            h = tf.nn.relu(self.linear[i](h))
        else:
            return self.pi_out(h), self.v_out(h)

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[ ]: class Agent:
    """Agent( action_size=env.action_space.n, num_layers=num_layers,
    ↪ num_neurons_each_layer=num_neurons_each_layer, lr=LR, seed = seed)
    Agent class
    """
    def __init__(self, action_size, num_layers, num_neurons_each_layer, lr=0.
    ↪ 001, gamma=0.99, seed = 85):
        self.gamma = gamma
        self.ac_model =
    ↪ ActorCriticModel(action_size=action_size,num_layers=num_layers,num_neurons_each_layer=num_n
        self.ac_model.compile(tf.keras.optimizers.Adam(learning_rate=lr))
        np.random.seed(seed)

    def sample_action(self, state):
        """
        Given a state, compute the policy distribution over all actions and
    ↪ sample one action
        """
        pi,_ = self.ac_model(state)

        action_probabilities = tfp.distributions.Categorical(probs=pi)
        sample = action_probabilities.sample()

        return int(sample.numpy()[0])

    def actor_loss(self, action, pi, delta):
        """
        Compute Actor Loss
        """
        return -tf.math.log(pi[0,action]) * delta

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def critic_loss(self,delta):
    """
    Critic loss aims to minimize TD error
    """
    return delta**2

@tf.function
def learn(self, state, action, reward, next_state, done):
    """
    For a given transition (s,a,s',r) update the paramters by computing the
    gradient of the total loss
    """
    with tf.GradientTape(persistent=True) as tape:
        pi, V_s = self.ac_model(state)
        _, V_s_next = self.ac_model(next_state)

        V_s = tf.squeeze(V_s)
        V_s_next = tf.squeeze(V_s_next)

        ##### TO DO: Write the equation for delta (TD error)
        ## Write code below
        delta = reward+((self.gamma)*V_s_next) - V_s
        loss_a = self.actor_loss(action, pi, delta)
        loss_c = self.critic_loss(delta)
        loss_total = loss_a + loss_c

        gradient = tape.gradient(loss_total, self.ac_model.trainable_variables)
        self.ac_model.optimizer.apply_gradients(zip(gradient, self.ac_model.
↪ trainable_variables))

def learn_full_return(self, states, actions, rewards, next_states, dones,T):
    with tf.GradientTape(persistent=True) as tape:
        delta_ts = np.empty(T)
        pis = []
        for t in range(0,T):
            delta_t = 0
            for t_ in range(t,T):
                delta_t += (((self.gamma)**(t_-t))*rewards[t_+1] if t_+1<↪
↪ len(rewards) else 0)

            pi, V_s = self.ac_model(states[t])
            V_s = tf.squeeze(V_s)
            pi, V_s = self.ac_model(states[t])
            delta_t = delta_t - V_s
            delta_ts[t] = (delta_t)
            pis.append(pi)

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        loss_a = 0
        loss_c = 0
        for i in range(T):
            loss_a += self.actor_loss(actions[i], pis[i], delta_ts[i])
            loss_c += self.critic_loss(delta_ts[i])
        loss_total = loss_a + loss_c

        gradient = tape.gradient(loss_total, self.ac_model.trainable_variables,
        ↪unconnected_gradients=tf.UnconnectedGradients.ZERO)
        self.ac_model.optimizer.apply_gradients(zip(gradient, self.ac_model.
        ↪trainable_variables))

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[ ]: import warnings
warnings.filterwarnings("ignore", category=FutureWarning)

def Actor_critic_full_return(num_layers, num_neurons_each_layer,
    ↪LR,num_episodes,seed):
    env = gym.make('Acrobot-v1')

    #Initializing Agent
    agent = Agent( action_size=env.action_space.n, num_layers=num_layers,
    ↪num_neurons_each_layer=num_neurons_each_layer, lr=LR,seed = seed)
    #Number of episodes
    episodes = num_episodes
    tf.compat.v1.reset_default_graph()

    reward_list = []
    average_reward_list = []
    steps = []
    begin_time = datetime.datetime.now()
    ep_solved = num_episodes
    for ep in range(1, episodes + 1):
        state = env.reset().reshape(1,-1)
        done = False
        ep_rew = 0
        T = 0
        states,actions,next_states,rewards,dones = [],[],[],[0],[None]
        while not done:
            T+=1
            action = agent.sample_action(state) ##Sample Action
            next_state, reward, done, info = env.step(action) ##Take action
            next_state = next_state.reshape(1,-1)
            ep_rew += reward ##Updating episode reward
            states.append(state)
            actions.append(action)

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        next_states.append(next_state)
        rewards.append(reward)
        dones.append(done)
        state = next_state ##Updating State
    agent.learn_full_return(states, actions, rewards, next_states, dones,T)
    reward_list.append(ep_rew)
    steps.append(T)
    if ep % 10 == 0:
        avg_rew = np.mean(reward_list[-10:])
        average_reward_list.append(avg_rew)
        print('Episode ', ep, 'Reward %f' % ep_rew, 'Average Reward %f' %
↪avg_rew)

    if ep>1000 and np.std(reward_list[-500:])*100/np.mean(reward_list[-500:]))
↪< 5:
        ep_solved = num_episodes
        break

    if ep % 100:
        avg_100 = np.mean(reward_list[-100:])
        if avg_100 > -100.0:
            print('Stopped at Episode ',ep-100)
            ep_solved = ep-100
            break
time_taken = datetime.datetime.now() - begin_time
print(time_taken)
return [reward_list,steps,ep_solved]

```

```

[ ]: LR = 1e-5
NUM_NEURONS_EACH_LAYER = [18,36,18]
NUM_LAYERS = 3
NUM_EPISODES = 1800
rew,ste,eps = Actor_critic_full_return(NUM_LAYERS, NUM_NEURONS_EACH_LAYER,
↪LR,NUM_EPISODES,np.random.randint(1,200))

```

C:\Users\CFI Workstation\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.10_qbz5n2kfra8p0\LocalCache\local-packages\Python310\site-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(
C:\Users\CFI Workstation\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.10_qbz5n2kfra8p0\LocalCache\local-packages\Python310\site-packages\gym\wrappers\step_api_compatibility.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(

| | | | | | |
|---------|-----|--------|-------------|----------------|-------------|
| Episode | 10 | Reward | -331.000000 | Average Reward | -432.800000 |
| Episode | 20 | Reward | -305.000000 | Average Reward | -457.300000 |
| Episode | 30 | Reward | -366.000000 | Average Reward | -404.400000 |
| Episode | 40 | Reward | -444.000000 | Average Reward | -448.600000 |
| Episode | 50 | Reward | -500.000000 | Average Reward | -433.300000 |
| Episode | 60 | Reward | -377.000000 | Average Reward | -446.200000 |
| Episode | 70 | Reward | -339.000000 | Average Reward | -447.900000 |
| Episode | 80 | Reward | -500.000000 | Average Reward | -406.500000 |
| Episode | 90 | Reward | -500.000000 | Average Reward | -458.700000 |
| Episode | 100 | Reward | -405.000000 | Average Reward | -474.200000 |
| Episode | 110 | Reward | -478.000000 | Average Reward | -379.600000 |
| Episode | 120 | Reward | -488.000000 | Average Reward | -419.500000 |
| Episode | 130 | Reward | -500.000000 | Average Reward | -444.500000 |
| Episode | 140 | Reward | -500.000000 | Average Reward | -441.000000 |
| Episode | 150 | Reward | -500.000000 | Average Reward | -425.200000 |
| Episode | 160 | Reward | -500.000000 | Average Reward | -450.100000 |
| Episode | 170 | Reward | -322.000000 | Average Reward | -430.600000 |
| Episode | 180 | Reward | -476.000000 | Average Reward | -395.400000 |
| Episode | 190 | Reward | -357.000000 | Average Reward | -378.500000 |
| Episode | 200 | Reward | -500.000000 | Average Reward | -498.400000 |
| Episode | 210 | Reward | -499.000000 | Average Reward | -416.600000 |
| Episode | 220 | Reward | -348.000000 | Average Reward | -404.500000 |
| Episode | 230 | Reward | -500.000000 | Average Reward | -377.000000 |
| Episode | 240 | Reward | -500.000000 | Average Reward | -414.000000 |
| Episode | 250 | Reward | -470.000000 | Average Reward | -418.900000 |
| Episode | 260 | Reward | -478.000000 | Average Reward | -405.900000 |
| Episode | 270 | Reward | -307.000000 | Average Reward | -430.600000 |
| Episode | 280 | Reward | -490.000000 | Average Reward | -431.100000 |
| Episode | 290 | Reward | -413.000000 | Average Reward | -450.700000 |
| Episode | 300 | Reward | -500.000000 | Average Reward | -408.500000 |
| Episode | 310 | Reward | -407.000000 | Average Reward | -408.000000 |
| Episode | 320 | Reward | -282.000000 | Average Reward | -419.800000 |
| Episode | 330 | Reward | -500.000000 | Average Reward | -412.100000 |
| Episode | 340 | Reward | -500.000000 | Average Reward | -400.800000 |
| Episode | 350 | Reward | -500.000000 | Average Reward | -415.600000 |
| Episode | 360 | Reward | -314.000000 | Average Reward | -417.400000 |
| Episode | 370 | Reward | -500.000000 | Average Reward | -445.000000 |
| Episode | 380 | Reward | -399.000000 | Average Reward | -417.000000 |
| Episode | 390 | Reward | -500.000000 | Average Reward | -424.800000 |
| Episode | 400 | Reward | -500.000000 | Average Reward | -455.200000 |
| Episode | 410 | Reward | -326.000000 | Average Reward | -445.800000 |
| Episode | 420 | Reward | -297.000000 | Average Reward | -416.800000 |

| | | | | | | |
|---------|-----|--------|-------------|---------|--------|-------------|
| Episode | 430 | Reward | -500.000000 | Average | Reward | -422.000000 |
| Episode | 440 | Reward | -346.000000 | Average | Reward | -453.100000 |
| Episode | 450 | Reward | -313.000000 | Average | Reward | -405.000000 |
| Episode | 460 | Reward | -340.000000 | Average | Reward | -398.400000 |
| Episode | 470 | Reward | -413.000000 | Average | Reward | -430.400000 |
| Episode | 480 | Reward | -500.000000 | Average | Reward | -431.800000 |
| Episode | 490 | Reward | -500.000000 | Average | Reward | -426.000000 |
| Episode | 500 | Reward | -421.000000 | Average | Reward | -398.100000 |
| Episode | 510 | Reward | -431.000000 | Average | Reward | -416.800000 |
| Episode | 520 | Reward | -500.000000 | Average | Reward | -416.800000 |
| Episode | 530 | Reward | -316.000000 | Average | Reward | -413.300000 |
| Episode | 540 | Reward | -500.000000 | Average | Reward | -429.100000 |
| Episode | 550 | Reward | -405.000000 | Average | Reward | -428.700000 |
| Episode | 560 | Reward | -458.000000 | Average | Reward | -442.100000 |
| Episode | 570 | Reward | -482.000000 | Average | Reward | -456.200000 |
| Episode | 580 | Reward | -500.000000 | Average | Reward | -408.900000 |
| Episode | 590 | Reward | -421.000000 | Average | Reward | -405.700000 |
| Episode | 600 | Reward | -271.000000 | Average | Reward | -424.800000 |
| Episode | 610 | Reward | -500.000000 | Average | Reward | -393.500000 |
| Episode | 620 | Reward | -350.000000 | Average | Reward | -406.500000 |
| Episode | 630 | Reward | -500.000000 | Average | Reward | -405.300000 |
| Episode | 640 | Reward | -345.000000 | Average | Reward | -452.900000 |
| Episode | 650 | Reward | -388.000000 | Average | Reward | -462.500000 |
| Episode | 660 | Reward | -500.000000 | Average | Reward | -438.900000 |
| Episode | 670 | Reward | -500.000000 | Average | Reward | -438.100000 |
| Episode | 680 | Reward | -467.000000 | Average | Reward | -415.800000 |
| Episode | 690 | Reward | -315.000000 | Average | Reward | -455.500000 |
| Episode | 700 | Reward | -359.000000 | Average | Reward | -436.100000 |
| Episode | 710 | Reward | -383.000000 | Average | Reward | -406.400000 |
| Episode | 720 | Reward | -327.000000 | Average | Reward | -417.600000 |
| Episode | 730 | Reward | -423.000000 | Average | Reward | -402.700000 |
| Episode | 740 | Reward | -300.000000 | Average | Reward | -405.100000 |
| Episode | 750 | Reward | -500.000000 | Average | Reward | -418.400000 |
| Episode | 760 | Reward | -277.000000 | Average | Reward | -334.100000 |
| Episode | 770 | Reward | -300.000000 | Average | Reward | -422.600000 |
| Episode | 780 | Reward | -500.000000 | Average | Reward | -445.600000 |
| Episode | 790 | Reward | -500.000000 | Average | Reward | -427.800000 |
| Episode | 800 | Reward | -379.000000 | Average | Reward | -432.500000 |
| Episode | 810 | Reward | -500.000000 | Average | Reward | -450.100000 |
| Episode | 820 | Reward | -480.000000 | Average | Reward | -417.800000 |
| Episode | 830 | Reward | -500.000000 | Average | Reward | -446.200000 |
| Episode | 840 | Reward | -498.000000 | Average | Reward | -437.500000 |
| Episode | 850 | Reward | -273.000000 | Average | Reward | -390.500000 |
| Episode | 860 | Reward | -453.000000 | Average | Reward | -448.200000 |
| Episode | 870 | Reward | -326.000000 | Average | Reward | -389.800000 |
| Episode | 880 | Reward | -409.000000 | Average | Reward | -392.200000 |
| Episode | 890 | Reward | -414.000000 | Average | Reward | -379.700000 |
| Episode | 900 | Reward | -489.000000 | Average | Reward | -446.400000 |

```
Episode 910 Reward -454.000000 Average Reward -390.100000
Episode 920 Reward -464.000000 Average Reward -474.400000
Episode 930 Reward -500.000000 Average Reward -445.000000
Episode 940 Reward -318.000000 Average Reward -378.900000
Episode 950 Reward -500.000000 Average Reward -421.600000
Episode 960 Reward -360.000000 Average Reward -400.900000
Episode 970 Reward -389.000000 Average Reward -427.400000
Episode 980 Reward -464.000000 Average Reward -428.900000
Episode 990 Reward -277.000000 Average Reward -390.600000
Episode 1000 Reward -500.000000 Average Reward -387.900000
1:14:07.949448
```

```
[ ]: average_reward = [-432.800000,
-457.300000,
-404.400000,
-448.600000,
-433.300000,
-446.200000,
-447.900000,
-406.500000,
-458.700000,
-474.200000,
-379.600000,
-419.500000,
-444.500000,
-441.000000,
-425.200000,
-450.100000,
-430.600000,
-395.400000,
-378.500000,
-498.400000,
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-404.500000,
-377.000000,
-414.000000,
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-431.100000,
-450.700000,
-408.500000,
-408.000000,
-419.800000,
-412.100000,
-400.800000,
-415.600000,
```


-417.400000,
-445.000000,
-417.000000,
-424.800000,
-455.200000,
-445.800000,
-416.800000,
-422.000000,
-453.100000,
-405.000000,
-398.400000,
-430.400000,
-431.800000,
-426.000000,
-398.100000,
-416.800000,
-416.800000,
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-436.100000,
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-417.600000,
-402.700000,
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-418.400000,
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-422.600000,
-445.600000,
-427.800000,
-432.500000,
-450.100000,
-417.800000,

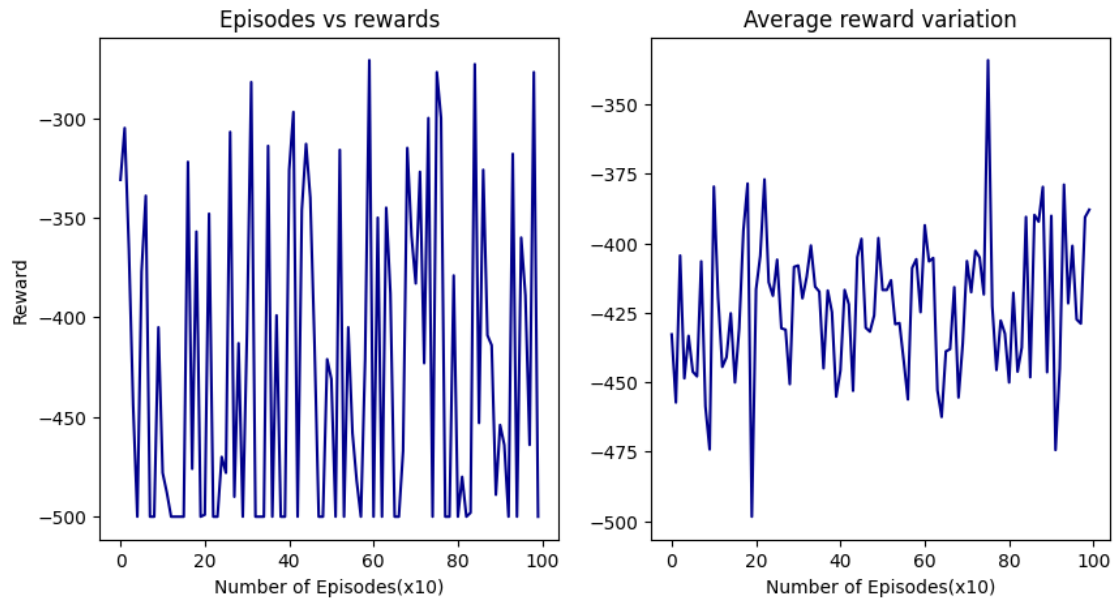
```
-446.200000,  
-437.500000,  
-390.500000,  
-448.200000,  
-389.800000,  
-392.200000,  
-379.700000,  
-446.400000,  
-390.100000,  
-474.400000,  
-445.000000,  
-378.900000,  
-421.600000,  
-400.900000,  
-427.400000,  
-428.900000,  
-390.600000,  
-387.900000]
```

```
[ ]: reward = [ -331.000000 ,  
-305.000000 ,  
-366.000000 ,  
-444.000000 ,  
-500.000000 ,  
-377.000000 ,  
-339.000000 ,  
-500.000000 ,  
-500.000000 ,  
-405.000000 ,  
-478.000000 ,  
-488.000000 ,  
-500.000000 ,  
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-499.000000 ,  
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-500.000000 ,  
-500.000000 ,  
-470.000000 ,  
-478.000000 ,  
-307.000000 ,  
-490.000000 ,
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-413.000000,
-500.000000,
-407.000000,
-282.000000,
-500.000000,
-500.000000,
-500.000000,
-314.000000,
-500.000000,
-399.000000,
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-383.000000,
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-423.000000,
-300.000000,
-500.000000,

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-277.000000,  
-300.000000,  
-500.000000,  
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-318.000000,  
-500.000000,  
-360.000000,  
-389.000000,  
-464.000000,  
-277.000000,  
-500.000000]
```

```
[ ]: import matplotlib.pyplot as plt  
import numpy as np  
plt.figure(figsize = (10,5))  
plt.subplot(121)  
plt.plot(np.arange(len(reward)),reward, color = 'darkblue')  
plt.title("Episodes vs rewards")  
plt.xlabel("Number of Episodes(x10)")  
plt.ylabel('Reward')  
plt.subplot(122)  
plt.plot(np.arange(len(average_reward)), average_reward, color = 'darkblue')  
plt.title("Average reward variation")  
plt.xlabel("Number of Episodes(x10)")  
plt.show()
```



```
[ ]: import wandb
      !wandb login --relogin

import pprint
import numpy as np

sweep_config = {
    'method': 'bayes'
}

metric = {
    'name' : 'num_episodes_tosolve_acrobot_full_ac',
    'goal' : 'minimize'
}
sweep_config['metric'] = metric

'''BATCH_SIZE= 64
EPS_DECAY= 0.995
GAMMA= 0.99
LR= 5e-4
MAX_TRUNCATION= 1
NUM_LAYERS= 2
NUM_NEURONS_EACH_LAYER= 90
UPDATE_EVERY= 20
a_TUNE= 0.7
'''
parameters_dict = {
```

```

    'NUM_NEURONS_EACH_LAYER' : {
        'values': [512,1024,724]
    },
    'NUM_LAYERS' : {
        'values': [2,4,8]
    },
    'NUM_EPISODES': {
        'values': [1800,2000,2500,3000]
    }
}

sweep_config['parameters'] = parameters_dict

import math
parameters_dict.update({
    'LR': {

        'distribution': 'uniform',
        'min': (0.00001),
        'max': (0.0001)
    }

})

pprint.pprint(sweep_config)

sweep_id = wandb.sweep(sweep_config, project="Hyper parameter tuning RL full_
↳return - v1")

def train(config = None):
    with wandb.init(config = config):
        config = wandb.config
        LR = config.LR                ## learning rate
        NUM_NEURONS_EACH_LAYER = config.NUM_NEURONS_EACH_LAYER  ##number of neurons_
↳in each hidden layer
        NUM_LAYERS = config.NUM_LAYERS                ##number of layers for the_
↳neural network
        NUM_EPISODES = config.NUM_EPISODES
        steps_over_10_runs = []
        rewards_over_10_runs = []
        episodes = []
        min_len = np.inf
        for run in range(10):
            print("Run: ",run+1,"_
↳-----")
            env = gym.make('Cartpole-v1')

```

```

seed = np.random.randint(low=0, high = 100)
env.seed(seed)
state_shape = env.observation_space.shape[0]
action_shape = env.action_space.n

begin_time = datetime.datetime.now()    #(num_layers,
↳ num_neurons_each_layer, LR, num_episodes, seed):
    rewards_each_ep, steps_each_ep, episodes_solved =
↳ Actor_critic_full_return(NUM_LAYERS, [NUM_NEURONS_EACH_LAYER]*NUM_LAYERS,
↳ LR, NUM_EPISODES, seed)
    steps_over_10_runs.append(steps_each_ep)
    rewards_over_10_runs.append(rewards_each_ep)
    episodes.append(episodes_solved)

    if len(rewards_each_ep) < min_len:
        min_len = len(rewards_each_ep)
    time_taken = datetime.datetime.now() - begin_time

    print(time_taken)

rewards = np.array(rewards_over_10_runs)
avg_episodes = int(np.array(episodes).mean())
steps = np.array(steps_over_10_runs)

y, error_reward = calculate_mean(rewards)
plt.figure(figsize = (15,8))
plt.subplot(131)
# for i in range(len(rewards_over_10_runs)):
#     plt.plot(np.
↳ arange(len(rewards_over_10_runs[i])),rewards_over_10_runs[i],label='run
↳ '+str(i))
    plt.plot(np.arange(len(y))+1, y, color='darkblue',label='average')
    plt.title("Episodes vs rewards")
    plt.xlabel("Number of episodes")
    plt.ylabel("Reward per episode")
    plt.legend()
    plt.subplot(132)
    y, error = calculate_mean(steps)
    plt.plot(np.arange(len(y))+1, y, color='darkblue',label='average')
    plt.title("Episodes vs steps ")
    plt.xlabel("Number of episodes")
    plt.ylabel("Steps taken per episode")
    plt.legend()
    plt.subplot(133)

```

```

plt.plot(np.arange(len(error_reward))+1, error_reward , color='darkblue',
label = 'Deviation of reward per episode') #plotting the variance = std
squared
plt.title("Episodes vs Variance ")
plt.xlabel("Number of episodes")
plt.ylabel("Observed Variance")
plt.legend()
plt.savefig('hyp_acrobot_ac_full'+str(NUM_EPISODES)+str(LR)+'.jpg', dpi =
250)
plt.show()

for i in range(avg_episodes):
    print("Episode: ",i+1, 'Number of steps: ',round(y[i]))
wandb.log({"num_episodes_tosolve_acrobot_full_ac":avg_episodes})

```

wandb: ERROR Find detailed error logs at: c:\Users\CFI
Workstation\Documents\RL\wandb\debug-cli.CFI Workstation.log
Error: api_key not configured (no-tty). call wandb login [your_api_key]

```

{'method': 'bayes',
 'metric': {'goal': 'minimize',
            'name': 'num_episodes_tosolve_cartpole_full_ac'},
 'parameters': {'LR': {'distribution': 'uniform', 'max': 0.0001, 'min': 1e-05},
                 'NUM_EPISODES': {'values': [1800, 2000, 2500, 3000]},
                 'NUM_LAYERS': {'values': [2, 4, 8, 10]},
                 'NUM_NEURONS_EACH_LAYER': {'values': [64, 90, 128]}}}

```

Create sweep with ID: s8rh75ci

Sweep URL: <https://wandb.ai/me19b190/Hyper%20parameter%20tuning%20RL%20full%20return%20-%20v1/sweeps/s8rh75ci>

```
[ ]: wandb.agent(sweep_id, train, count=6)
```

wandb: Agent Starting Run: 1la41d9f with config:

wandb: LR: 8.481392602516921e-05

wandb: NUM_EPISODES: 2000

wandb: NUM_LAYERS: 2

wandb: NUM_NEURONS_EACH_LAYER: 128

Failed to detect the name of this notebook, you can set it manually with the WANDB_NOTEBOOK_NAME environment variable to enable code saving.

C:\Users\CFI Workstation\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.10_qbz5n2kfra8p0\LocalCache\local-packages\Python310\site-

packages\wandb\sdk\lib\ipython.py:47: DeprecationWarning: Importing display from IPython.core.display is deprecated since IPython 7.14, please import from IPython display

```
from IPython.core.display import HTML, display # type: ignore
```

<IPython.core.display.HTML object>


```

<IPython.core.display.HTML object>
<IPython.core.display.HTML object>
<IPython.core.display.HTML object>
<IPython.core.display.HTML object>
<IPython.core.display.HTML object>

C:\Users\CFI Workstation\AppData\Local\Packages\PythonSoftwareFoundation.Python.
3.10_qbz5n2kfra8p0\LocalCache\local-packages\Python310\site-
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(
C:\Users\CFI Workstation\AppData\Local\Packages\PythonSoftwareFoundation.Python.
3.10_qbz5n2kfra8p0\LocalCache\local-packages\Python310\site-
packages\gym\wrappers\step_api_compatibility.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(
C:\Users\CFI Workstation\AppData\Local\Packages\PythonSoftwareFoundation.Python.
3.10_qbz5n2kfra8p0\LocalCache\local-packages\Python310\site-
packages\gym\core.py:256: DeprecationWarning: WARN: Function
`env.seed(seed)` is marked as deprecated and will be removed in the future.
Please use `env.reset(seed=seed)` instead.
    deprecation(

Run: 1 -----
Episode 10 Reward 26.000000 Average Reward 23.300000
Episode 20 Reward 67.000000 Average Reward 29.300000
Episode 30 Reward 14.000000 Average Reward 20.500000
Episode 40 Reward 13.000000 Average Reward 24.900000
Episode 50 Reward 17.000000 Average Reward 25.800000
Episode 60 Reward 34.000000 Average Reward 25.700000
Episode 70 Reward 36.000000 Average Reward 29.600000
Episode 80 Reward 25.000000 Average Reward 33.600000
Episode 90 Reward 29.000000 Average Reward 29.600000
Episode 100 Reward 30.000000 Average Reward 30.200000
Episode 110 Reward 57.000000 Average Reward 33.100000
Episode 120 Reward 24.000000 Average Reward 36.700000
Episode 130 Reward 25.000000 Average Reward 34.000000
Episode 140 Reward 37.000000 Average Reward 30.100000
Episode 150 Reward 11.000000 Average Reward 26.500000

```

| | | | | | |
|---------|-----|--------|------------|----------------|------------|
| Episode | 160 | Reward | 101.000000 | Average Reward | 43.200000 |
| Episode | 170 | Reward | 28.000000 | Average Reward | 34.700000 |
| Episode | 180 | Reward | 13.000000 | Average Reward | 28.600000 |
| Episode | 190 | Reward | 10.000000 | Average Reward | 32.800000 |
| Episode | 200 | Reward | 17.000000 | Average Reward | 28.200000 |
| Episode | 210 | Reward | 64.000000 | Average Reward | 36.400000 |
| Episode | 220 | Reward | 36.000000 | Average Reward | 40.000000 |
| Episode | 230 | Reward | 35.000000 | Average Reward | 30.800000 |
| Episode | 240 | Reward | 20.000000 | Average Reward | 36.800000 |
| Episode | 250 | Reward | 124.000000 | Average Reward | 38.300000 |
| Episode | 260 | Reward | 51.000000 | Average Reward | 49.300000 |
| Episode | 270 | Reward | 32.000000 | Average Reward | 27.900000 |
| Episode | 280 | Reward | 40.000000 | Average Reward | 62.600000 |
| Episode | 290 | Reward | 46.000000 | Average Reward | 40.400000 |
| Episode | 300 | Reward | 40.000000 | Average Reward | 48.200000 |
| Episode | 310 | Reward | 47.000000 | Average Reward | 69.100000 |
| Episode | 320 | Reward | 34.000000 | Average Reward | 32.500000 |
| Episode | 330 | Reward | 27.000000 | Average Reward | 48.100000 |
| Episode | 340 | Reward | 82.000000 | Average Reward | 43.800000 |
| Episode | 350 | Reward | 54.000000 | Average Reward | 45.700000 |
| Episode | 360 | Reward | 15.000000 | Average Reward | 50.100000 |
| Episode | 370 | Reward | 71.000000 | Average Reward | 56.800000 |
| Episode | 380 | Reward | 29.000000 | Average Reward | 46.800000 |
| Episode | 390 | Reward | 112.000000 | Average Reward | 69.400000 |
| Episode | 400 | Reward | 71.000000 | Average Reward | 54.500000 |
| Episode | 410 | Reward | 49.000000 | Average Reward | 84.000000 |
| Episode | 420 | Reward | 49.000000 | Average Reward | 78.300000 |
| Episode | 430 | Reward | 58.000000 | Average Reward | 73.100000 |
| Episode | 440 | Reward | 40.000000 | Average Reward | 66.600000 |
| Episode | 450 | Reward | 30.000000 | Average Reward | 71.300000 |
| Episode | 460 | Reward | 156.000000 | Average Reward | 73.800000 |
| Episode | 470 | Reward | 164.000000 | Average Reward | 80.400000 |
| Episode | 480 | Reward | 40.000000 | Average Reward | 77.900000 |
| Episode | 490 | Reward | 134.000000 | Average Reward | 84.400000 |
| Episode | 500 | Reward | 129.000000 | Average Reward | 101.600000 |
| Episode | 510 | Reward | 123.000000 | Average Reward | 116.200000 |
| Episode | 520 | Reward | 34.000000 | Average Reward | 120.400000 |
| Episode | 530 | Reward | 154.000000 | Average Reward | 128.300000 |
| Episode | 540 | Reward | 139.000000 | Average Reward | 134.000000 |
| Episode | 550 | Reward | 166.000000 | Average Reward | 123.200000 |
| Episode | 560 | Reward | 126.000000 | Average Reward | 137.200000 |
| Episode | 570 | Reward | 96.000000 | Average Reward | 98.800000 |
| Episode | 580 | Reward | 164.000000 | Average Reward | 129.500000 |
| Episode | 590 | Reward | 142.000000 | Average Reward | 134.900000 |
| Episode | 600 | Reward | 220.000000 | Average Reward | 129.000000 |
| Episode | 610 | Reward | 246.000000 | Average Reward | 154.900000 |
| Episode | 620 | Reward | 304.000000 | Average Reward | 165.500000 |
| Episode | 630 | Reward | 166.000000 | Average Reward | 144.400000 |

Episode 640 Reward 186.000000 Average Reward 140.000000
Episode 650 Reward 160.000000 Average Reward 164.000000
Episode 660 Reward 195.000000 Average Reward 168.800000
Episode 670 Reward 147.000000 Average Reward 178.600000
Episode 680 Reward 178.000000 Average Reward 170.100000
Episode 690 Reward 292.000000 Average Reward 170.700000
Episode 700 Reward 163.000000 Average Reward 159.100000
Episode 710 Reward 227.000000 Average Reward 168.900000
Episode 720 Reward 210.000000 Average Reward 214.300000
Episode 730 Reward 500.000000 Average Reward 306.900000

Stopped at Episode 638

0:09:05.486463

0:09:05.554479

Run: 2 -----

Episode 10 Reward 29.000000 Average Reward 23.900000
Episode 20 Reward 16.000000 Average Reward 20.600000
Episode 30 Reward 18.000000 Average Reward 25.600000
Episode 40 Reward 17.000000 Average Reward 19.400000
Episode 50 Reward 10.000000 Average Reward 15.900000
Episode 60 Reward 23.000000 Average Reward 22.200000
Episode 70 Reward 38.000000 Average Reward 25.000000
Episode 80 Reward 16.000000 Average Reward 22.300000
Episode 90 Reward 32.000000 Average Reward 30.300000
Episode 100 Reward 17.000000 Average Reward 21.500000
Episode 110 Reward 19.000000 Average Reward 24.500000
Episode 120 Reward 13.000000 Average Reward 18.900000
Episode 130 Reward 15.000000 Average Reward 26.100000
Episode 140 Reward 28.000000 Average Reward 22.100000
Episode 150 Reward 12.000000 Average Reward 18.200000
Episode 160 Reward 38.000000 Average Reward 30.100000
Episode 170 Reward 23.000000 Average Reward 34.000000
Episode 180 Reward 17.000000 Average Reward 28.400000
Episode 190 Reward 20.000000 Average Reward 30.000000
Episode 200 Reward 30.000000 Average Reward 53.000000
Episode 210 Reward 9.000000 Average Reward 27.900000
Episode 220 Reward 41.000000 Average Reward 30.900000
Episode 230 Reward 15.000000 Average Reward 41.100000
Episode 240 Reward 27.000000 Average Reward 23.200000
Episode 250 Reward 48.000000 Average Reward 45.600000
Episode 260 Reward 17.000000 Average Reward 35.500000
Episode 270 Reward 15.000000 Average Reward 38.800000
Episode 280 Reward 63.000000 Average Reward 49.600000
Episode 290 Reward 37.000000 Average Reward 37.100000
Episode 300 Reward 41.000000 Average Reward 52.000000
Episode 310 Reward 82.000000 Average Reward 51.700000
Episode 320 Reward 12.000000 Average Reward 31.500000
Episode 330 Reward 77.000000 Average Reward 50.400000
Episode 340 Reward 33.000000 Average Reward 53.800000

| | | | | | | |
|---------|-----|--------|------------|---------|--------|------------|
| Episode | 350 | Reward | 42.000000 | Average | Reward | 40.000000 |
| Episode | 360 | Reward | 34.000000 | Average | Reward | 37.000000 |
| Episode | 370 | Reward | 28.000000 | Average | Reward | 69.500000 |
| Episode | 380 | Reward | 79.000000 | Average | Reward | 43.100000 |
| Episode | 390 | Reward | 33.000000 | Average | Reward | 59.800000 |
| Episode | 400 | Reward | 37.000000 | Average | Reward | 46.100000 |
| Episode | 410 | Reward | 76.000000 | Average | Reward | 51.700000 |
| Episode | 420 | Reward | 32.000000 | Average | Reward | 39.600000 |
| Episode | 430 | Reward | 31.000000 | Average | Reward | 61.500000 |
| Episode | 440 | Reward | 44.000000 | Average | Reward | 67.400000 |
| Episode | 450 | Reward | 52.000000 | Average | Reward | 74.400000 |
| Episode | 460 | Reward | 107.000000 | Average | Reward | 58.600000 |
| Episode | 470 | Reward | 66.000000 | Average | Reward | 52.200000 |
| Episode | 480 | Reward | 59.000000 | Average | Reward | 62.000000 |
| Episode | 490 | Reward | 109.000000 | Average | Reward | 107.000000 |
| Episode | 500 | Reward | 133.000000 | Average | Reward | 79.000000 |
| Episode | 510 | Reward | 126.000000 | Average | Reward | 92.300000 |
| Episode | 520 | Reward | 69.000000 | Average | Reward | 80.900000 |
| Episode | 530 | Reward | 114.000000 | Average | Reward | 99.100000 |
| Episode | 540 | Reward | 108.000000 | Average | Reward | 100.100000 |
| Episode | 550 | Reward | 118.000000 | Average | Reward | 54.200000 |
| Episode | 560 | Reward | 131.000000 | Average | Reward | 91.800000 |
| Episode | 570 | Reward | 110.000000 | Average | Reward | 108.100000 |
| Episode | 580 | Reward | 30.000000 | Average | Reward | 83.000000 |
| Episode | 590 | Reward | 110.000000 | Average | Reward | 115.000000 |
| Episode | 600 | Reward | 55.000000 | Average | Reward | 105.200000 |
| Episode | 610 | Reward | 66.000000 | Average | Reward | 103.800000 |
| Episode | 620 | Reward | 152.000000 | Average | Reward | 103.100000 |
| Episode | 630 | Reward | 59.000000 | Average | Reward | 141.900000 |
| Episode | 640 | Reward | 30.000000 | Average | Reward | 91.400000 |
| Episode | 650 | Reward | 149.000000 | Average | Reward | 111.700000 |
| Episode | 660 | Reward | 133.000000 | Average | Reward | 182.900000 |
| Episode | 670 | Reward | 178.000000 | Average | Reward | 201.900000 |
| Episode | 680 | Reward | 315.000000 | Average | Reward | 168.000000 |
| Episode | 690 | Reward | 280.000000 | Average | Reward | 202.900000 |
| Episode | 700 | Reward | 155.000000 | Average | Reward | 135.700000 |
| Episode | 710 | Reward | 116.000000 | Average | Reward | 134.500000 |
| Episode | 720 | Reward | 318.000000 | Average | Reward | 233.600000 |
| Episode | 730 | Reward | 224.000000 | Average | Reward | 205.000000 |
| Episode | 740 | Reward | 147.000000 | Average | Reward | 165.800000 |
| Episode | 750 | Reward | 41.000000 | Average | Reward | 140.300000 |
| Episode | 760 | Reward | 151.000000 | Average | Reward | 156.800000 |
| Episode | 770 | Reward | 176.000000 | Average | Reward | 165.500000 |
| Episode | 780 | Reward | 128.000000 | Average | Reward | 138.700000 |
| Episode | 790 | Reward | 180.000000 | Average | Reward | 210.200000 |
| Episode | 800 | Reward | 157.000000 | Average | Reward | 175.100000 |
| Episode | 810 | Reward | 159.000000 | Average | Reward | 230.900000 |
| Episode | 820 | Reward | 400.000000 | Average | Reward | 295.600000 |

Episode 830 Reward 276.000000 Average Reward 184.200000
Episode 840 Reward 168.000000 Average Reward 222.800000
Stopped at Episode 745
0:10:41.465945
0:10:41.473948

Run: 3 -----
Episode 10 Reward 56.000000 Average Reward 37.000000
Episode 20 Reward 22.000000 Average Reward 26.800000
Episode 30 Reward 16.000000 Average Reward 28.400000
Episode 40 Reward 12.000000 Average Reward 31.100000
Episode 50 Reward 18.000000 Average Reward 22.300000
Episode 60 Reward 22.000000 Average Reward 27.600000
Episode 70 Reward 44.000000 Average Reward 35.300000
Episode 80 Reward 23.000000 Average Reward 29.600000
Episode 90 Reward 32.000000 Average Reward 19.800000
Episode 100 Reward 21.000000 Average Reward 27.900000
Episode 110 Reward 40.000000 Average Reward 31.100000
Episode 120 Reward 32.000000 Average Reward 30.400000
Episode 130 Reward 22.000000 Average Reward 23.400000
Episode 140 Reward 24.000000 Average Reward 29.800000
Episode 150 Reward 41.000000 Average Reward 32.600000
Episode 160 Reward 14.000000 Average Reward 25.500000
Episode 170 Reward 13.000000 Average Reward 22.700000
Episode 180 Reward 15.000000 Average Reward 21.900000
Episode 190 Reward 11.000000 Average Reward 30.300000
Episode 200 Reward 28.000000 Average Reward 28.600000
Episode 210 Reward 14.000000 Average Reward 26.900000
Episode 220 Reward 19.000000 Average Reward 23.600000
Episode 230 Reward 24.000000 Average Reward 21.800000
Episode 240 Reward 22.000000 Average Reward 24.700000
Episode 250 Reward 17.000000 Average Reward 26.700000
Episode 260 Reward 16.000000 Average Reward 29.000000
Episode 270 Reward 55.000000 Average Reward 40.600000
Episode 280 Reward 39.000000 Average Reward 41.100000
Episode 290 Reward 22.000000 Average Reward 22.000000
Episode 300 Reward 51.000000 Average Reward 22.700000
Episode 310 Reward 33.000000 Average Reward 36.000000
Episode 320 Reward 17.000000 Average Reward 34.900000
Episode 330 Reward 28.000000 Average Reward 43.500000
Episode 340 Reward 28.000000 Average Reward 53.500000
Episode 350 Reward 38.000000 Average Reward 44.500000
Episode 360 Reward 20.000000 Average Reward 49.600000
Episode 370 Reward 33.000000 Average Reward 27.100000
Episode 380 Reward 23.000000 Average Reward 43.400000
Episode 390 Reward 50.000000 Average Reward 41.000000
Episode 400 Reward 62.000000 Average Reward 38.800000
Episode 410 Reward 54.000000 Average Reward 59.500000
Episode 420 Reward 40.000000 Average Reward 41.300000

Episode 430 Reward 38.000000 Average Reward 38.200000
Episode 440 Reward 59.000000 Average Reward 61.900000
Episode 450 Reward 33.000000 Average Reward 56.200000
Episode 460 Reward 20.000000 Average Reward 48.100000
Episode 470 Reward 58.000000 Average Reward 59.200000
Episode 480 Reward 38.000000 Average Reward 74.700000
Episode 490 Reward 25.000000 Average Reward 40.000000
Episode 500 Reward 46.000000 Average Reward 72.000000
Episode 510 Reward 49.000000 Average Reward 53.100000
Episode 520 Reward 111.000000 Average Reward 85.100000
Episode 530 Reward 97.000000 Average Reward 71.300000
Episode 540 Reward 59.000000 Average Reward 61.900000
Episode 550 Reward 26.000000 Average Reward 58.700000
Episode 560 Reward 25.000000 Average Reward 49.200000
Episode 570 Reward 44.000000 Average Reward 73.300000
Episode 580 Reward 43.000000 Average Reward 63.800000
Episode 590 Reward 27.000000 Average Reward 56.400000
Episode 600 Reward 83.000000 Average Reward 44.100000
Episode 610 Reward 175.000000 Average Reward 72.200000
Episode 620 Reward 71.000000 Average Reward 88.500000
Episode 630 Reward 69.000000 Average Reward 61.900000
Episode 640 Reward 34.000000 Average Reward 83.000000
Episode 650 Reward 135.000000 Average Reward 125.700000
Episode 660 Reward 25.000000 Average Reward 107.800000
Episode 670 Reward 50.000000 Average Reward 84.600000
Episode 680 Reward 116.000000 Average Reward 133.200000
Episode 690 Reward 147.000000 Average Reward 109.000000
Episode 700 Reward 19.000000 Average Reward 66.600000
Episode 710 Reward 144.000000 Average Reward 117.500000
Episode 720 Reward 107.000000 Average Reward 116.700000
Episode 730 Reward 175.000000 Average Reward 120.100000
Episode 740 Reward 97.000000 Average Reward 108.400000
Episode 750 Reward 131.000000 Average Reward 115.100000
Episode 760 Reward 118.000000 Average Reward 134.800000
Episode 770 Reward 16.000000 Average Reward 105.600000
Episode 780 Reward 227.000000 Average Reward 191.700000
Episode 790 Reward 230.000000 Average Reward 129.000000
Episode 800 Reward 202.000000 Average Reward 166.100000
Episode 810 Reward 366.000000 Average Reward 170.900000
Episode 820 Reward 52.000000 Average Reward 186.800000
Episode 830 Reward 323.000000 Average Reward 160.600000
Episode 840 Reward 152.000000 Average Reward 198.000000
Episode 850 Reward 226.000000 Average Reward 204.300000
Episode 860 Reward 74.000000 Average Reward 229.300000
Episode 870 Reward 207.000000 Average Reward 236.000000
Episode 880 Reward 324.000000 Average Reward 241.700000
Stopped at Episode 783
0:09:27.283496

0:09:27.292499

```
Run: 4 -----
Episode 10 Reward 15.000000 Average Reward 40.600000
Episode 20 Reward 19.000000 Average Reward 32.300000
Episode 30 Reward 30.000000 Average Reward 21.900000
Episode 40 Reward 31.000000 Average Reward 27.000000
Episode 50 Reward 24.000000 Average Reward 28.600000
Episode 60 Reward 20.000000 Average Reward 32.400000
Episode 70 Reward 41.000000 Average Reward 24.200000
Episode 80 Reward 24.000000 Average Reward 27.200000
Episode 90 Reward 24.000000 Average Reward 20.700000
Episode 100 Reward 17.000000 Average Reward 33.300000
Episode 110 Reward 41.000000 Average Reward 23.200000
Episode 120 Reward 22.000000 Average Reward 26.600000
Episode 130 Reward 16.000000 Average Reward 37.600000
Episode 140 Reward 24.000000 Average Reward 26.500000
Episode 150 Reward 61.000000 Average Reward 25.900000
Episode 160 Reward 50.000000 Average Reward 29.400000
Episode 170 Reward 21.000000 Average Reward 29.300000
Episode 180 Reward 37.000000 Average Reward 30.200000
Episode 190 Reward 16.000000 Average Reward 27.900000
Episode 200 Reward 35.000000 Average Reward 34.700000
Episode 210 Reward 60.000000 Average Reward 37.800000
Episode 220 Reward 24.000000 Average Reward 34.500000
Episode 230 Reward 83.000000 Average Reward 37.000000
Episode 240 Reward 44.000000 Average Reward 35.400000
Episode 250 Reward 14.000000 Average Reward 27.000000
Episode 260 Reward 56.000000 Average Reward 37.300000
Episode 270 Reward 19.000000 Average Reward 34.100000
Episode 280 Reward 23.000000 Average Reward 26.900000
Episode 290 Reward 37.000000 Average Reward 44.000000
Episode 300 Reward 60.000000 Average Reward 40.600000
Episode 310 Reward 16.000000 Average Reward 46.600000
Episode 320 Reward 41.000000 Average Reward 44.900000
Episode 330 Reward 42.000000 Average Reward 37.500000
Episode 340 Reward 18.000000 Average Reward 35.600000
Episode 350 Reward 53.000000 Average Reward 44.400000
Episode 360 Reward 59.000000 Average Reward 47.800000
Episode 370 Reward 26.000000 Average Reward 42.900000
Episode 380 Reward 25.000000 Average Reward 47.400000
Episode 390 Reward 34.000000 Average Reward 77.300000
Episode 400 Reward 25.000000 Average Reward 46.400000
Episode 410 Reward 62.000000 Average Reward 50.600000
Episode 420 Reward 181.000000 Average Reward 57.100000
Episode 430 Reward 82.000000 Average Reward 53.700000
Episode 440 Reward 27.000000 Average Reward 45.600000
Episode 450 Reward 36.000000 Average Reward 52.400000
Episode 460 Reward 59.000000 Average Reward 48.000000
```

| | | | | | | |
|------------------------|-----|--------|------------|---------|--------|------------|
| Episode | 470 | Reward | 60.000000 | Average | Reward | 45.000000 |
| Episode | 480 | Reward | 56.000000 | Average | Reward | 57.700000 |
| Episode | 490 | Reward | 74.000000 | Average | Reward | 58.200000 |
| Episode | 500 | Reward | 50.000000 | Average | Reward | 109.100000 |
| Episode | 510 | Reward | 42.000000 | Average | Reward | 54.600000 |
| Episode | 520 | Reward | 42.000000 | Average | Reward | 63.000000 |
| Episode | 530 | Reward | 55.000000 | Average | Reward | 56.500000 |
| Episode | 540 | Reward | 119.000000 | Average | Reward | 82.500000 |
| Episode | 550 | Reward | 78.000000 | Average | Reward | 69.000000 |
| Episode | 560 | Reward | 45.000000 | Average | Reward | 79.700000 |
| Episode | 570 | Reward | 128.000000 | Average | Reward | 72.700000 |
| Episode | 580 | Reward | 37.000000 | Average | Reward | 66.300000 |
| Episode | 590 | Reward | 149.000000 | Average | Reward | 139.500000 |
| Episode | 600 | Reward | 27.000000 | Average | Reward | 83.000000 |
| Episode | 610 | Reward | 77.000000 | Average | Reward | 58.500000 |
| Episode | 620 | Reward | 23.000000 | Average | Reward | 62.800000 |
| Episode | 630 | Reward | 65.000000 | Average | Reward | 99.400000 |
| Episode | 640 | Reward | 127.000000 | Average | Reward | 91.400000 |
| Episode | 650 | Reward | 139.000000 | Average | Reward | 105.700000 |
| Episode | 660 | Reward | 22.000000 | Average | Reward | 104.700000 |
| Episode | 670 | Reward | 89.000000 | Average | Reward | 107.800000 |
| Episode | 680 | Reward | 119.000000 | Average | Reward | 106.300000 |
| Episode | 690 | Reward | 143.000000 | Average | Reward | 94.500000 |
| Episode | 700 | Reward | 131.000000 | Average | Reward | 105.800000 |
| Episode | 710 | Reward | 52.000000 | Average | Reward | 117.800000 |
| Episode | 720 | Reward | 160.000000 | Average | Reward | 141.100000 |
| Episode | 730 | Reward | 406.000000 | Average | Reward | 139.500000 |
| Episode | 740 | Reward | 53.000000 | Average | Reward | 131.000000 |
| Episode | 750 | Reward | 180.000000 | Average | Reward | 119.100000 |
| Episode | 760 | Reward | 103.000000 | Average | Reward | 112.000000 |
| Episode | 770 | Reward | 195.000000 | Average | Reward | 138.600000 |
| Episode | 780 | Reward | 208.000000 | Average | Reward | 97.700000 |
| Episode | 790 | Reward | 217.000000 | Average | Reward | 146.200000 |
| Episode | 800 | Reward | 176.000000 | Average | Reward | 150.000000 |
| Episode | 810 | Reward | 17.000000 | Average | Reward | 138.300000 |
| Episode | 820 | Reward | 189.000000 | Average | Reward | 167.500000 |
| Episode | 830 | Reward | 121.000000 | Average | Reward | 114.200000 |
| Episode | 840 | Reward | 126.000000 | Average | Reward | 137.900000 |
| Episode | 850 | Reward | 242.000000 | Average | Reward | 174.400000 |
| Episode | 860 | Reward | 139.000000 | Average | Reward | 149.000000 |
| Episode | 870 | Reward | 144.000000 | Average | Reward | 174.700000 |
| Episode | 880 | Reward | 360.000000 | Average | Reward | 232.100000 |
| Episode | 890 | Reward | 228.000000 | Average | Reward | 182.800000 |
| Episode | 900 | Reward | 198.000000 | Average | Reward | 200.000000 |
| Episode | 910 | Reward | 390.000000 | Average | Reward | 198.600000 |
| Episode | 920 | Reward | 469.000000 | Average | Reward | 217.000000 |
| Episode | 930 | Reward | 145.000000 | Average | Reward | 261.600000 |
| Stopped at Episode 833 | | | | | | |

0:11:02.717026

0:11:02.724028

```
Run: 5 -----
Episode 10 Reward 19.000000 Average Reward 19.000000
Episode 20 Reward 32.000000 Average Reward 29.800000
Episode 30 Reward 16.000000 Average Reward 22.000000
Episode 40 Reward 14.000000 Average Reward 18.000000
Episode 50 Reward 26.000000 Average Reward 22.600000
Episode 60 Reward 16.000000 Average Reward 26.400000
Episode 70 Reward 13.000000 Average Reward 20.800000
Episode 80 Reward 15.000000 Average Reward 30.500000
Episode 90 Reward 26.000000 Average Reward 25.800000
Episode 100 Reward 25.000000 Average Reward 22.900000
Episode 110 Reward 42.000000 Average Reward 22.100000
Episode 120 Reward 36.000000 Average Reward 27.500000
Episode 130 Reward 31.000000 Average Reward 27.300000
Episode 140 Reward 18.000000 Average Reward 27.900000
Episode 150 Reward 14.000000 Average Reward 27.500000
Episode 160 Reward 21.000000 Average Reward 29.600000
Episode 170 Reward 52.000000 Average Reward 27.300000
Episode 180 Reward 19.000000 Average Reward 33.200000
Episode 190 Reward 27.000000 Average Reward 22.800000
Episode 200 Reward 22.000000 Average Reward 38.900000
Episode 210 Reward 25.000000 Average Reward 38.500000
Episode 220 Reward 22.000000 Average Reward 27.700000
Episode 230 Reward 11.000000 Average Reward 29.700000
Episode 240 Reward 38.000000 Average Reward 39.700000
Episode 250 Reward 15.000000 Average Reward 23.900000
Episode 260 Reward 14.000000 Average Reward 33.800000
Episode 270 Reward 21.000000 Average Reward 33.400000
Episode 280 Reward 54.000000 Average Reward 40.200000
Episode 290 Reward 14.000000 Average Reward 35.100000
Episode 300 Reward 10.000000 Average Reward 33.800000
Episode 310 Reward 20.000000 Average Reward 29.000000
Episode 320 Reward 76.000000 Average Reward 39.900000
Episode 330 Reward 27.000000 Average Reward 34.600000
Episode 340 Reward 13.000000 Average Reward 40.900000
Episode 350 Reward 28.000000 Average Reward 31.700000
Episode 360 Reward 35.000000 Average Reward 56.600000
Episode 370 Reward 42.000000 Average Reward 41.300000
Episode 380 Reward 13.000000 Average Reward 39.000000
Episode 390 Reward 94.000000 Average Reward 46.500000
Episode 400 Reward 22.000000 Average Reward 51.500000
Episode 410 Reward 35.000000 Average Reward 43.800000
Episode 420 Reward 28.000000 Average Reward 44.500000
Episode 430 Reward 58.000000 Average Reward 43.100000
Episode 440 Reward 29.000000 Average Reward 34.400000
Episode 450 Reward 73.000000 Average Reward 54.200000
```

| | | | | | | |
|---------|-----|--------|------------|---------|--------|------------|
| Episode | 460 | Reward | 21.000000 | Average | Reward | 45.700000 |
| Episode | 470 | Reward | 23.000000 | Average | Reward | 35.600000 |
| Episode | 480 | Reward | 57.000000 | Average | Reward | 55.700000 |
| Episode | 490 | Reward | 25.000000 | Average | Reward | 46.900000 |
| Episode | 500 | Reward | 33.000000 | Average | Reward | 53.000000 |
| Episode | 510 | Reward | 61.000000 | Average | Reward | 50.100000 |
| Episode | 520 | Reward | 64.000000 | Average | Reward | 43.800000 |
| Episode | 530 | Reward | 56.000000 | Average | Reward | 61.400000 |
| Episode | 540 | Reward | 56.000000 | Average | Reward | 64.600000 |
| Episode | 550 | Reward | 48.000000 | Average | Reward | 44.200000 |
| Episode | 560 | Reward | 22.000000 | Average | Reward | 48.300000 |
| Episode | 570 | Reward | 64.000000 | Average | Reward | 61.100000 |
| Episode | 580 | Reward | 31.000000 | Average | Reward | 59.800000 |
| Episode | 590 | Reward | 92.000000 | Average | Reward | 59.200000 |
| Episode | 600 | Reward | 96.000000 | Average | Reward | 72.700000 |
| Episode | 610 | Reward | 73.000000 | Average | Reward | 69.500000 |
| Episode | 620 | Reward | 120.000000 | Average | Reward | 69.100000 |
| Episode | 630 | Reward | 56.000000 | Average | Reward | 40.900000 |
| Episode | 640 | Reward | 72.000000 | Average | Reward | 76.600000 |
| Episode | 650 | Reward | 58.000000 | Average | Reward | 56.500000 |
| Episode | 660 | Reward | 30.000000 | Average | Reward | 71.600000 |
| Episode | 670 | Reward | 91.000000 | Average | Reward | 65.000000 |
| Episode | 680 | Reward | 29.000000 | Average | Reward | 77.400000 |
| Episode | 690 | Reward | 238.000000 | Average | Reward | 80.300000 |
| Episode | 700 | Reward | 70.000000 | Average | Reward | 97.800000 |
| Episode | 710 | Reward | 16.000000 | Average | Reward | 86.600000 |
| Episode | 720 | Reward | 134.000000 | Average | Reward | 105.400000 |
| Episode | 730 | Reward | 136.000000 | Average | Reward | 131.900000 |
| Episode | 740 | Reward | 44.000000 | Average | Reward | 102.100000 |
| Episode | 750 | Reward | 68.000000 | Average | Reward | 85.500000 |
| Episode | 760 | Reward | 87.000000 | Average | Reward | 117.400000 |
| Episode | 770 | Reward | 173.000000 | Average | Reward | 135.400000 |
| Episode | 780 | Reward | 77.000000 | Average | Reward | 98.700000 |
| Episode | 790 | Reward | 58.000000 | Average | Reward | 121.800000 |
| Episode | 800 | Reward | 66.000000 | Average | Reward | 125.800000 |
| Episode | 810 | Reward | 22.000000 | Average | Reward | 142.500000 |
| Episode | 820 | Reward | 101.000000 | Average | Reward | 155.900000 |
| Episode | 830 | Reward | 334.000000 | Average | Reward | 186.100000 |
| Episode | 840 | Reward | 165.000000 | Average | Reward | 155.100000 |
| Episode | 850 | Reward | 154.000000 | Average | Reward | 159.500000 |
| Episode | 860 | Reward | 210.000000 | Average | Reward | 169.600000 |
| Episode | 870 | Reward | 317.000000 | Average | Reward | 167.400000 |
| Episode | 880 | Reward | 252.000000 | Average | Reward | 190.900000 |
| Episode | 890 | Reward | 143.000000 | Average | Reward | 206.000000 |
| Episode | 900 | Reward | 349.000000 | Average | Reward | 219.500000 |
| Episode | 910 | Reward | 320.000000 | Average | Reward | 178.600000 |
| Episode | 920 | Reward | 191.000000 | Average | Reward | 141.300000 |
| Episode | 930 | Reward | 141.000000 | Average | Reward | 199.600000 |

Episode 940 Reward 259.000000 Average Reward 249.600000
Episode 950 Reward 156.000000 Average Reward 212.600000
Stopped at Episode 852
0:10:17.424302
0:10:17.432304

Run: 6 -----
Episode 10 Reward 21.000000 Average Reward 25.500000
Episode 20 Reward 17.000000 Average Reward 19.600000
Episode 30 Reward 53.000000 Average Reward 27.900000
Episode 40 Reward 14.000000 Average Reward 18.000000
Episode 50 Reward 26.000000 Average Reward 27.900000
Episode 60 Reward 16.000000 Average Reward 16.900000
Episode 70 Reward 14.000000 Average Reward 24.400000
Episode 80 Reward 23.000000 Average Reward 26.200000
Episode 90 Reward 19.000000 Average Reward 26.800000
Episode 100 Reward 26.000000 Average Reward 23.000000
Episode 110 Reward 30.000000 Average Reward 28.500000
Episode 120 Reward 32.000000 Average Reward 22.500000
Episode 130 Reward 25.000000 Average Reward 24.800000
Episode 140 Reward 22.000000 Average Reward 26.500000
Episode 150 Reward 12.000000 Average Reward 26.500000
Episode 160 Reward 18.000000 Average Reward 31.700000
Episode 170 Reward 22.000000 Average Reward 24.500000
Episode 180 Reward 21.000000 Average Reward 25.600000
Episode 190 Reward 77.000000 Average Reward 35.600000
Episode 200 Reward 17.000000 Average Reward 30.500000
Episode 210 Reward 12.000000 Average Reward 17.900000
Episode 220 Reward 72.000000 Average Reward 31.500000
Episode 230 Reward 31.000000 Average Reward 24.700000
Episode 240 Reward 13.000000 Average Reward 37.200000
Episode 250 Reward 45.000000 Average Reward 29.100000
Episode 260 Reward 52.000000 Average Reward 24.400000
Episode 270 Reward 13.000000 Average Reward 35.600000
Episode 280 Reward 75.000000 Average Reward 31.900000
Episode 290 Reward 60.000000 Average Reward 25.700000
Episode 300 Reward 44.000000 Average Reward 33.900000
Episode 310 Reward 62.000000 Average Reward 41.700000
Episode 320 Reward 201.000000 Average Reward 43.900000
Episode 330 Reward 41.000000 Average Reward 37.300000
Episode 340 Reward 38.000000 Average Reward 42.300000
Episode 350 Reward 22.000000 Average Reward 39.200000
Episode 360 Reward 41.000000 Average Reward 42.300000
Episode 370 Reward 63.000000 Average Reward 34.400000
Episode 380 Reward 40.000000 Average Reward 37.600000
Episode 390 Reward 18.000000 Average Reward 44.100000
Episode 400 Reward 40.000000 Average Reward 46.100000
Episode 410 Reward 36.000000 Average Reward 42.800000
Episode 420 Reward 106.000000 Average Reward 62.800000

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Episode 430 Reward 36.000000 Average Reward 51.600000
Episode 440 Reward 104.000000 Average Reward 50.200000
Episode 450 Reward 131.000000 Average Reward 72.800000
Episode 460 Reward 18.000000 Average Reward 57.200000
Episode 470 Reward 59.000000 Average Reward 56.500000
Episode 480 Reward 22.000000 Average Reward 45.800000
Episode 490 Reward 42.000000 Average Reward 81.600000
Episode 500 Reward 67.000000 Average Reward 44.700000
Episode 510 Reward 24.000000 Average Reward 58.000000
Episode 520 Reward 30.000000 Average Reward 48.700000
Episode 530 Reward 81.000000 Average Reward 58.300000
Episode 540 Reward 51.000000 Average Reward 42.300000
Episode 550 Reward 20.000000 Average Reward 66.600000
Episode 560 Reward 46.000000 Average Reward 56.100000
Episode 570 Reward 130.000000 Average Reward 76.300000
Episode 580 Reward 49.000000 Average Reward 69.100000
Episode 590 Reward 28.000000 Average Reward 73.400000
Episode 600 Reward 63.000000 Average Reward 50.500000
Episode 610 Reward 44.000000 Average Reward 67.400000
Episode 620 Reward 113.000000 Average Reward 93.500000
Episode 630 Reward 31.000000 Average Reward 104.800000
Episode 640 Reward 48.000000 Average Reward 63.900000
Episode 650 Reward 25.000000 Average Reward 119.000000
Episode 660 Reward 139.000000 Average Reward 103.800000
Episode 670 Reward 100.000000 Average Reward 127.700000
Episode 680 Reward 125.000000 Average Reward 100.200000
Episode 690 Reward 103.000000 Average Reward 90.300000
Episode 700 Reward 180.000000 Average Reward 143.300000
Episode 710 Reward 78.000000 Average Reward 134.700000
Episode 720 Reward 255.000000 Average Reward 117.600000
Episode 730 Reward 75.000000 Average Reward 186.600000
Episode 740 Reward 63.000000 Average Reward 174.400000
Episode 750 Reward 230.000000 Average Reward 253.200000
Episode 760 Reward 29.000000 Average Reward 128.100000
Episode 770 Reward 123.000000 Average Reward 197.000000
Episode 780 Reward 245.000000 Average Reward 268.500000
Episode 790 Reward 341.000000 Average Reward 253.300000
Episode 800 Reward 264.000000 Average Reward 228.500000
Stopped at Episode 706

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0:08:07.579006

0:08:07.586008

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Run: 7 -----
Episode 10 Reward 28.000000 Average Reward 23.200000
Episode 20 Reward 13.000000 Average Reward 17.900000
Episode 30 Reward 14.000000 Average Reward 27.900000
Episode 40 Reward 31.000000 Average Reward 27.100000
Episode 50 Reward 14.000000 Average Reward 21.700000
Episode 60 Reward 17.000000 Average Reward 25.400000

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| | | | | | | |
|---------|-----|--------|------------|---------|--------|-----------|
| Episode | 70 | Reward | 9.000000 | Average | Reward | 23.900000 |
| Episode | 80 | Reward | 34.000000 | Average | Reward | 28.300000 |
| Episode | 90 | Reward | 29.000000 | Average | Reward | 23.700000 |
| Episode | 100 | Reward | 16.000000 | Average | Reward | 23.900000 |
| Episode | 110 | Reward | 22.000000 | Average | Reward | 25.400000 |
| Episode | 120 | Reward | 21.000000 | Average | Reward | 26.400000 |
| Episode | 130 | Reward | 34.000000 | Average | Reward | 20.000000 |
| Episode | 140 | Reward | 19.000000 | Average | Reward | 22.100000 |
| Episode | 150 | Reward | 11.000000 | Average | Reward | 21.400000 |
| Episode | 160 | Reward | 35.000000 | Average | Reward | 25.300000 |
| Episode | 170 | Reward | 13.000000 | Average | Reward | 25.800000 |
| Episode | 180 | Reward | 39.000000 | Average | Reward | 28.600000 |
| Episode | 190 | Reward | 13.000000 | Average | Reward | 28.800000 |
| Episode | 200 | Reward | 19.000000 | Average | Reward | 22.900000 |
| Episode | 210 | Reward | 24.000000 | Average | Reward | 22.400000 |
| Episode | 220 | Reward | 10.000000 | Average | Reward | 34.900000 |
| Episode | 230 | Reward | 43.000000 | Average | Reward | 34.200000 |
| Episode | 240 | Reward | 26.000000 | Average | Reward | 28.300000 |
| Episode | 250 | Reward | 20.000000 | Average | Reward | 27.100000 |
| Episode | 260 | Reward | 19.000000 | Average | Reward | 34.700000 |
| Episode | 270 | Reward | 41.000000 | Average | Reward | 38.900000 |
| Episode | 280 | Reward | 54.000000 | Average | Reward | 35.200000 |
| Episode | 290 | Reward | 17.000000 | Average | Reward | 40.800000 |
| Episode | 300 | Reward | 54.000000 | Average | Reward | 51.200000 |
| Episode | 310 | Reward | 62.000000 | Average | Reward | 45.000000 |
| Episode | 320 | Reward | 43.000000 | Average | Reward | 41.200000 |
| Episode | 330 | Reward | 76.000000 | Average | Reward | 51.500000 |
| Episode | 340 | Reward | 61.000000 | Average | Reward | 59.900000 |
| Episode | 350 | Reward | 61.000000 | Average | Reward | 60.200000 |
| Episode | 360 | Reward | 15.000000 | Average | Reward | 34.300000 |
| Episode | 370 | Reward | 55.000000 | Average | Reward | 39.500000 |
| Episode | 380 | Reward | 21.000000 | Average | Reward | 38.100000 |
| Episode | 390 | Reward | 49.000000 | Average | Reward | 49.400000 |
| Episode | 400 | Reward | 103.000000 | Average | Reward | 46.800000 |
| Episode | 410 | Reward | 69.000000 | Average | Reward | 55.200000 |
| Episode | 420 | Reward | 16.000000 | Average | Reward | 52.900000 |
| Episode | 430 | Reward | 16.000000 | Average | Reward | 39.200000 |
| Episode | 440 | Reward | 40.000000 | Average | Reward | 52.800000 |
| Episode | 450 | Reward | 28.000000 | Average | Reward | 60.500000 |
| Episode | 460 | Reward | 81.000000 | Average | Reward | 56.800000 |
| Episode | 470 | Reward | 63.000000 | Average | Reward | 56.700000 |
| Episode | 480 | Reward | 30.000000 | Average | Reward | 52.100000 |
| Episode | 490 | Reward | 50.000000 | Average | Reward | 48.700000 |
| Episode | 500 | Reward | 60.000000 | Average | Reward | 65.300000 |
| Episode | 510 | Reward | 76.000000 | Average | Reward | 64.600000 |
| Episode | 520 | Reward | 25.000000 | Average | Reward | 46.000000 |
| Episode | 530 | Reward | 16.000000 | Average | Reward | 42.500000 |
| Episode | 540 | Reward | 69.000000 | Average | Reward | 66.700000 |

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Episode 550 Reward 203.000000 Average Reward 70.900000
Episode 560 Reward 76.000000 Average Reward 75.700000
Episode 570 Reward 55.000000 Average Reward 76.100000
Episode 580 Reward 33.000000 Average Reward 51.200000
Episode 590 Reward 14.000000 Average Reward 56.500000
Episode 600 Reward 180.000000 Average Reward 93.400000
Episode 610 Reward 57.000000 Average Reward 99.700000
Episode 620 Reward 80.000000 Average Reward 79.800000
Episode 630 Reward 278.000000 Average Reward 88.600000
Episode 640 Reward 37.000000 Average Reward 91.000000
Episode 650 Reward 60.000000 Average Reward 93.200000
Episode 660 Reward 104.000000 Average Reward 55.300000
Episode 670 Reward 232.000000 Average Reward 111.900000
Episode 680 Reward 138.000000 Average Reward 116.800000
Episode 690 Reward 208.000000 Average Reward 102.500000
Episode 700 Reward 102.000000 Average Reward 129.700000
Episode 710 Reward 121.000000 Average Reward 88.200000
Episode 720 Reward 57.000000 Average Reward 113.000000
Episode 730 Reward 124.000000 Average Reward 106.600000
Episode 740 Reward 173.000000 Average Reward 144.800000
Episode 750 Reward 210.000000 Average Reward 146.800000
Episode 760 Reward 69.000000 Average Reward 121.300000
Episode 770 Reward 154.000000 Average Reward 133.700000
Episode 780 Reward 148.000000 Average Reward 131.100000
Episode 790 Reward 150.000000 Average Reward 162.400000
Episode 800 Reward 211.000000 Average Reward 180.100000
Episode 810 Reward 167.000000 Average Reward 129.800000
Episode 820 Reward 167.000000 Average Reward 192.200000
Episode 830 Reward 23.000000 Average Reward 108.900000
Episode 840 Reward 146.000000 Average Reward 162.000000
Episode 850 Reward 185.000000 Average Reward 170.400000
Episode 860 Reward 171.000000 Average Reward 140.800000
Episode 870 Reward 188.000000 Average Reward 194.300000
Episode 880 Reward 129.000000 Average Reward 216.900000
Episode 890 Reward 304.000000 Average Reward 214.900000
Episode 900 Reward 460.000000 Average Reward 251.900000
Episode 910 Reward 170.000000 Average Reward 188.500000
Episode 920 Reward 327.000000 Average Reward 181.800000
Episode 930 Reward 202.000000 Average Reward 217.700000

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Stopped at Episode 831

0:10:43.014582

0:10:43.022584

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Run: 8 -----
Episode 10 Reward 26.000000 Average Reward 15.600000
Episode 20 Reward 26.000000 Average Reward 18.500000
Episode 30 Reward 14.000000 Average Reward 23.900000
Episode 40 Reward 11.000000 Average Reward 16.600000
Episode 50 Reward 21.000000 Average Reward 22.400000

```

| | | | | | | |
|---------|-----|--------|------------|---------|--------|------------|
| Episode | 60 | Reward | 10.000000 | Average | Reward | 21.300000 |
| Episode | 70 | Reward | 13.000000 | Average | Reward | 27.600000 |
| Episode | 80 | Reward | 21.000000 | Average | Reward | 35.900000 |
| Episode | 90 | Reward | 48.000000 | Average | Reward | 32.400000 |
| Episode | 100 | Reward | 14.000000 | Average | Reward | 30.400000 |
| Episode | 110 | Reward | 64.000000 | Average | Reward | 31.700000 |
| Episode | 120 | Reward | 40.000000 | Average | Reward | 28.500000 |
| Episode | 130 | Reward | 16.000000 | Average | Reward | 27.000000 |
| Episode | 140 | Reward | 60.000000 | Average | Reward | 33.400000 |
| Episode | 150 | Reward | 13.000000 | Average | Reward | 22.200000 |
| Episode | 160 | Reward | 20.000000 | Average | Reward | 31.300000 |
| Episode | 170 | Reward | 26.000000 | Average | Reward | 23.300000 |
| Episode | 180 | Reward | 23.000000 | Average | Reward | 34.400000 |
| Episode | 190 | Reward | 45.000000 | Average | Reward | 24.900000 |
| Episode | 200 | Reward | 33.000000 | Average | Reward | 25.400000 |
| Episode | 210 | Reward | 16.000000 | Average | Reward | 38.700000 |
| Episode | 220 | Reward | 16.000000 | Average | Reward | 33.800000 |
| Episode | 230 | Reward | 72.000000 | Average | Reward | 34.300000 |
| Episode | 240 | Reward | 20.000000 | Average | Reward | 39.100000 |
| Episode | 250 | Reward | 100.000000 | Average | Reward | 34.800000 |
| Episode | 260 | Reward | 40.000000 | Average | Reward | 36.600000 |
| Episode | 270 | Reward | 57.000000 | Average | Reward | 50.700000 |
| Episode | 280 | Reward | 31.000000 | Average | Reward | 37.100000 |
| Episode | 290 | Reward | 58.000000 | Average | Reward | 47.800000 |
| Episode | 300 | Reward | 48.000000 | Average | Reward | 42.000000 |
| Episode | 310 | Reward | 63.000000 | Average | Reward | 51.500000 |
| Episode | 320 | Reward | 115.000000 | Average | Reward | 40.000000 |
| Episode | 330 | Reward | 29.000000 | Average | Reward | 41.800000 |
| Episode | 340 | Reward | 33.000000 | Average | Reward | 37.500000 |
| Episode | 350 | Reward | 16.000000 | Average | Reward | 42.200000 |
| Episode | 360 | Reward | 47.000000 | Average | Reward | 47.300000 |
| Episode | 370 | Reward | 52.000000 | Average | Reward | 65.600000 |
| Episode | 380 | Reward | 55.000000 | Average | Reward | 50.000000 |
| Episode | 390 | Reward | 70.000000 | Average | Reward | 66.400000 |
| Episode | 400 | Reward | 88.000000 | Average | Reward | 62.700000 |
| Episode | 410 | Reward | 29.000000 | Average | Reward | 55.100000 |
| Episode | 420 | Reward | 74.000000 | Average | Reward | 53.100000 |
| Episode | 430 | Reward | 39.000000 | Average | Reward | 56.600000 |
| Episode | 440 | Reward | 22.000000 | Average | Reward | 62.500000 |
| Episode | 450 | Reward | 75.000000 | Average | Reward | 57.600000 |
| Episode | 460 | Reward | 125.000000 | Average | Reward | 75.000000 |
| Episode | 470 | Reward | 16.000000 | Average | Reward | 62.600000 |
| Episode | 480 | Reward | 31.000000 | Average | Reward | 92.400000 |
| Episode | 490 | Reward | 53.000000 | Average | Reward | 90.500000 |
| Episode | 500 | Reward | 66.000000 | Average | Reward | 70.500000 |
| Episode | 510 | Reward | 185.000000 | Average | Reward | 139.400000 |
| Episode | 520 | Reward | 47.000000 | Average | Reward | 79.800000 |
| Episode | 530 | Reward | 20.000000 | Average | Reward | 76.300000 |

Episode 540 Reward 125.000000 Average Reward 115.600000
 Episode 550 Reward 45.000000 Average Reward 105.500000
 Episode 560 Reward 126.000000 Average Reward 113.000000
 Episode 570 Reward 345.000000 Average Reward 124.800000
 Episode 580 Reward 125.000000 Average Reward 97.200000
 Episode 590 Reward 197.000000 Average Reward 152.200000
 Episode 600 Reward 78.000000 Average Reward 144.100000
 Episode 610 Reward 44.000000 Average Reward 132.600000
 Episode 620 Reward 51.000000 Average Reward 131.700000
 Episode 630 Reward 95.000000 Average Reward 139.500000
 Episode 640 Reward 138.000000 Average Reward 188.900000
 Episode 650 Reward 133.000000 Average Reward 148.900000
 Episode 660 Reward 149.000000 Average Reward 158.400000
 Episode 670 Reward 111.000000 Average Reward 179.800000
 Episode 680 Reward 103.000000 Average Reward 186.700000
 Episode 690 Reward 197.000000 Average Reward 202.300000
 Episode 700 Reward 210.000000 Average Reward 165.200000
 Episode 710 Reward 254.000000 Average Reward 219.100000
 Episode 720 Reward 205.000000 Average Reward 187.400000
 Episode 730 Reward 161.000000 Average Reward 158.700000
 Episode 740 Reward 357.000000 Average Reward 228.300000
 Episode 750 Reward 321.000000 Average Reward 179.300000
 Episode 760 Reward 56.000000 Average Reward 202.700000
 Episode 770 Reward 117.000000 Average Reward 137.400000
 Episode 780 Reward 237.000000 Average Reward 218.600000
 Episode 790 Reward 134.000000 Average Reward 226.100000

Stopped at Episode 694

0:09:57.709854

0:09:57.717856

Run: 9 -----

Episode 10 Reward 15.000000 Average Reward 23.800000
 Episode 20 Reward 32.000000 Average Reward 29.300000
 Episode 30 Reward 10.000000 Average Reward 18.700000
 Episode 40 Reward 30.000000 Average Reward 24.000000
 Episode 50 Reward 40.000000 Average Reward 23.100000
 Episode 60 Reward 14.000000 Average Reward 22.000000
 Episode 70 Reward 13.000000 Average Reward 23.000000
 Episode 80 Reward 11.000000 Average Reward 24.500000
 Episode 90 Reward 21.000000 Average Reward 22.500000
 Episode 100 Reward 20.000000 Average Reward 27.500000
 Episode 110 Reward 31.000000 Average Reward 25.800000
 Episode 120 Reward 27.000000 Average Reward 33.800000
 Episode 130 Reward 25.000000 Average Reward 29.700000
 Episode 140 Reward 20.000000 Average Reward 38.200000
 Episode 150 Reward 15.000000 Average Reward 33.600000
 Episode 160 Reward 13.000000 Average Reward 34.300000
 Episode 170 Reward 28.000000 Average Reward 42.900000
 Episode 180 Reward 45.000000 Average Reward 39.500000

| | | | | | | |
|---------|-----|--------|------------|---------|--------|------------|
| Episode | 190 | Reward | 15.000000 | Average | Reward | 30.900000 |
| Episode | 200 | Reward | 22.000000 | Average | Reward | 26.500000 |
| Episode | 210 | Reward | 23.000000 | Average | Reward | 28.300000 |
| Episode | 220 | Reward | 16.000000 | Average | Reward | 38.700000 |
| Episode | 230 | Reward | 47.000000 | Average | Reward | 43.200000 |
| Episode | 240 | Reward | 13.000000 | Average | Reward | 41.400000 |
| Episode | 250 | Reward | 24.000000 | Average | Reward | 37.800000 |
| Episode | 260 | Reward | 43.000000 | Average | Reward | 32.200000 |
| Episode | 270 | Reward | 44.000000 | Average | Reward | 38.400000 |
| Episode | 280 | Reward | 57.000000 | Average | Reward | 33.800000 |
| Episode | 290 | Reward | 81.000000 | Average | Reward | 34.800000 |
| Episode | 300 | Reward | 52.000000 | Average | Reward | 37.800000 |
| Episode | 310 | Reward | 41.000000 | Average | Reward | 36.000000 |
| Episode | 320 | Reward | 51.000000 | Average | Reward | 39.900000 |
| Episode | 330 | Reward | 62.000000 | Average | Reward | 47.200000 |
| Episode | 340 | Reward | 26.000000 | Average | Reward | 38.800000 |
| Episode | 350 | Reward | 26.000000 | Average | Reward | 41.900000 |
| Episode | 360 | Reward | 22.000000 | Average | Reward | 46.800000 |
| Episode | 370 | Reward | 91.000000 | Average | Reward | 57.500000 |
| Episode | 380 | Reward | 69.000000 | Average | Reward | 40.900000 |
| Episode | 390 | Reward | 23.000000 | Average | Reward | 52.000000 |
| Episode | 400 | Reward | 48.000000 | Average | Reward | 51.200000 |
| Episode | 410 | Reward | 49.000000 | Average | Reward | 45.300000 |
| Episode | 420 | Reward | 19.000000 | Average | Reward | 38.800000 |
| Episode | 430 | Reward | 69.000000 | Average | Reward | 50.800000 |
| Episode | 440 | Reward | 52.000000 | Average | Reward | 50.600000 |
| Episode | 450 | Reward | 61.000000 | Average | Reward | 62.400000 |
| Episode | 460 | Reward | 32.000000 | Average | Reward | 45.700000 |
| Episode | 470 | Reward | 55.000000 | Average | Reward | 71.600000 |
| Episode | 480 | Reward | 31.000000 | Average | Reward | 40.800000 |
| Episode | 490 | Reward | 50.000000 | Average | Reward | 63.300000 |
| Episode | 500 | Reward | 94.000000 | Average | Reward | 65.200000 |
| Episode | 510 | Reward | 43.000000 | Average | Reward | 70.700000 |
| Episode | 520 | Reward | 22.000000 | Average | Reward | 38.800000 |
| Episode | 530 | Reward | 169.000000 | Average | Reward | 70.600000 |
| Episode | 540 | Reward | 45.000000 | Average | Reward | 52.700000 |
| Episode | 550 | Reward | 28.000000 | Average | Reward | 78.900000 |
| Episode | 560 | Reward | 83.000000 | Average | Reward | 93.700000 |
| Episode | 570 | Reward | 101.000000 | Average | Reward | 73.400000 |
| Episode | 580 | Reward | 13.000000 | Average | Reward | 57.000000 |
| Episode | 590 | Reward | 32.000000 | Average | Reward | 76.300000 |
| Episode | 600 | Reward | 131.000000 | Average | Reward | 92.800000 |
| Episode | 610 | Reward | 142.000000 | Average | Reward | 87.100000 |
| Episode | 620 | Reward | 129.000000 | Average | Reward | 96.200000 |
| Episode | 630 | Reward | 19.000000 | Average | Reward | 88.900000 |
| Episode | 640 | Reward | 173.000000 | Average | Reward | 87.900000 |
| Episode | 650 | Reward | 177.000000 | Average | Reward | 90.000000 |
| Episode | 660 | Reward | 105.000000 | Average | Reward | 136.600000 |

Episode 670 Reward 136.000000 Average Reward 132.600000
 Episode 680 Reward 142.000000 Average Reward 100.000000
 Episode 690 Reward 239.000000 Average Reward 121.500000
 Episode 700 Reward 32.000000 Average Reward 135.800000
 Episode 710 Reward 211.000000 Average Reward 101.400000
 Episode 720 Reward 105.000000 Average Reward 139.200000
 Episode 730 Reward 149.000000 Average Reward 139.500000
 Episode 740 Reward 153.000000 Average Reward 148.100000
 Episode 750 Reward 48.000000 Average Reward 185.500000
 Episode 760 Reward 19.000000 Average Reward 130.600000
 Episode 770 Reward 147.000000 Average Reward 188.600000
 Episode 780 Reward 234.000000 Average Reward 144.000000
 Episode 790 Reward 148.000000 Average Reward 127.100000
 Episode 800 Reward 64.000000 Average Reward 147.100000
 Episode 810 Reward 159.000000 Average Reward 211.400000
 Episode 820 Reward 61.000000 Average Reward 168.900000
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 Episode 870 Reward 214.000000 Average Reward 185.600000
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 Episode 900 Reward 150.000000 Average Reward 197.700000
 Episode 910 Reward 77.000000 Average Reward 170.900000
 Episode 920 Reward 108.000000 Average Reward 212.700000
 Episode 930 Reward 168.000000 Average Reward 188.400000
 Episode 940 Reward 159.000000 Average Reward 214.000000

Stopped at Episode 846

0:11:54.707250

0:11:54.715252

Run: 10 -----

Episode 10 Reward 13.000000 Average Reward 23.800000
 Episode 20 Reward 33.000000 Average Reward 21.100000
 Episode 30 Reward 28.000000 Average Reward 18.300000
 Episode 40 Reward 15.000000 Average Reward 23.800000
 Episode 50 Reward 31.000000 Average Reward 23.600000
 Episode 60 Reward 23.000000 Average Reward 16.100000
 Episode 70 Reward 21.000000 Average Reward 26.800000
 Episode 80 Reward 16.000000 Average Reward 16.200000
 Episode 90 Reward 18.000000 Average Reward 23.100000
 Episode 100 Reward 17.000000 Average Reward 26.100000
 Episode 110 Reward 12.000000 Average Reward 19.100000
 Episode 120 Reward 13.000000 Average Reward 22.100000
 Episode 130 Reward 39.000000 Average Reward 25.800000
 Episode 140 Reward 43.000000 Average Reward 23.600000
 Episode 150 Reward 57.000000 Average Reward 22.700000
 Episode 160 Reward 23.000000 Average Reward 27.000000

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|---------|-----|--------|------------|---------|--------|-----------|
| Episode | 170 | Reward | 19.000000 | Average | Reward | 25.000000 |
| Episode | 180 | Reward | 29.000000 | Average | Reward | 23.600000 |
| Episode | 190 | Reward | 29.000000 | Average | Reward | 32.300000 |
| Episode | 200 | Reward | 12.000000 | Average | Reward | 22.800000 |
| Episode | 210 | Reward | 22.000000 | Average | Reward | 27.200000 |
| Episode | 220 | Reward | 20.000000 | Average | Reward | 33.300000 |
| Episode | 230 | Reward | 42.000000 | Average | Reward | 23.800000 |
| Episode | 240 | Reward | 26.000000 | Average | Reward | 28.000000 |
| Episode | 250 | Reward | 28.000000 | Average | Reward | 29.800000 |
| Episode | 260 | Reward | 30.000000 | Average | Reward | 26.800000 |
| Episode | 270 | Reward | 77.000000 | Average | Reward | 34.600000 |
| Episode | 280 | Reward | 11.000000 | Average | Reward | 29.200000 |
| Episode | 290 | Reward | 23.000000 | Average | Reward | 29.300000 |
| Episode | 300 | Reward | 28.000000 | Average | Reward | 26.500000 |
| Episode | 310 | Reward | 73.000000 | Average | Reward | 31.400000 |
| Episode | 320 | Reward | 30.000000 | Average | Reward | 20.700000 |
| Episode | 330 | Reward | 46.000000 | Average | Reward | 36.100000 |
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| Episode | 350 | Reward | 23.000000 | Average | Reward | 43.000000 |
| Episode | 360 | Reward | 29.000000 | Average | Reward | 40.700000 |
| Episode | 370 | Reward | 44.000000 | Average | Reward | 41.600000 |
| Episode | 380 | Reward | 53.000000 | Average | Reward | 35.100000 |
| Episode | 390 | Reward | 38.000000 | Average | Reward | 39.500000 |
| Episode | 400 | Reward | 49.000000 | Average | Reward | 48.600000 |
| Episode | 410 | Reward | 83.000000 | Average | Reward | 51.300000 |
| Episode | 420 | Reward | 30.000000 | Average | Reward | 27.100000 |
| Episode | 430 | Reward | 21.000000 | Average | Reward | 50.400000 |
| Episode | 440 | Reward | 54.000000 | Average | Reward | 37.800000 |
| Episode | 450 | Reward | 25.000000 | Average | Reward | 50.800000 |
| Episode | 460 | Reward | 23.000000 | Average | Reward | 50.900000 |
| Episode | 470 | Reward | 114.000000 | Average | Reward | 61.300000 |
| Episode | 480 | Reward | 27.000000 | Average | Reward | 52.000000 |
| Episode | 490 | Reward | 38.000000 | Average | Reward | 55.300000 |
| Episode | 500 | Reward | 11.000000 | Average | Reward | 55.500000 |
| Episode | 510 | Reward | 38.000000 | Average | Reward | 55.500000 |
| Episode | 520 | Reward | 27.000000 | Average | Reward | 52.500000 |
| Episode | 530 | Reward | 11.000000 | Average | Reward | 61.500000 |
| Episode | 540 | Reward | 46.000000 | Average | Reward | 59.400000 |
| Episode | 550 | Reward | 38.000000 | Average | Reward | 60.100000 |
| Episode | 560 | Reward | 90.000000 | Average | Reward | 70.700000 |
| Episode | 570 | Reward | 93.000000 | Average | Reward | 77.600000 |
| Episode | 580 | Reward | 48.000000 | Average | Reward | 53.100000 |
| Episode | 590 | Reward | 160.000000 | Average | Reward | 88.300000 |
| Episode | 600 | Reward | 48.000000 | Average | Reward | 84.000000 |
| Episode | 610 | Reward | 75.000000 | Average | Reward | 68.800000 |
| Episode | 620 | Reward | 17.000000 | Average | Reward | 87.000000 |
| Episode | 630 | Reward | 282.000000 | Average | Reward | 88.600000 |
| Episode | 640 | Reward | 55.000000 | Average | Reward | 87.100000 |

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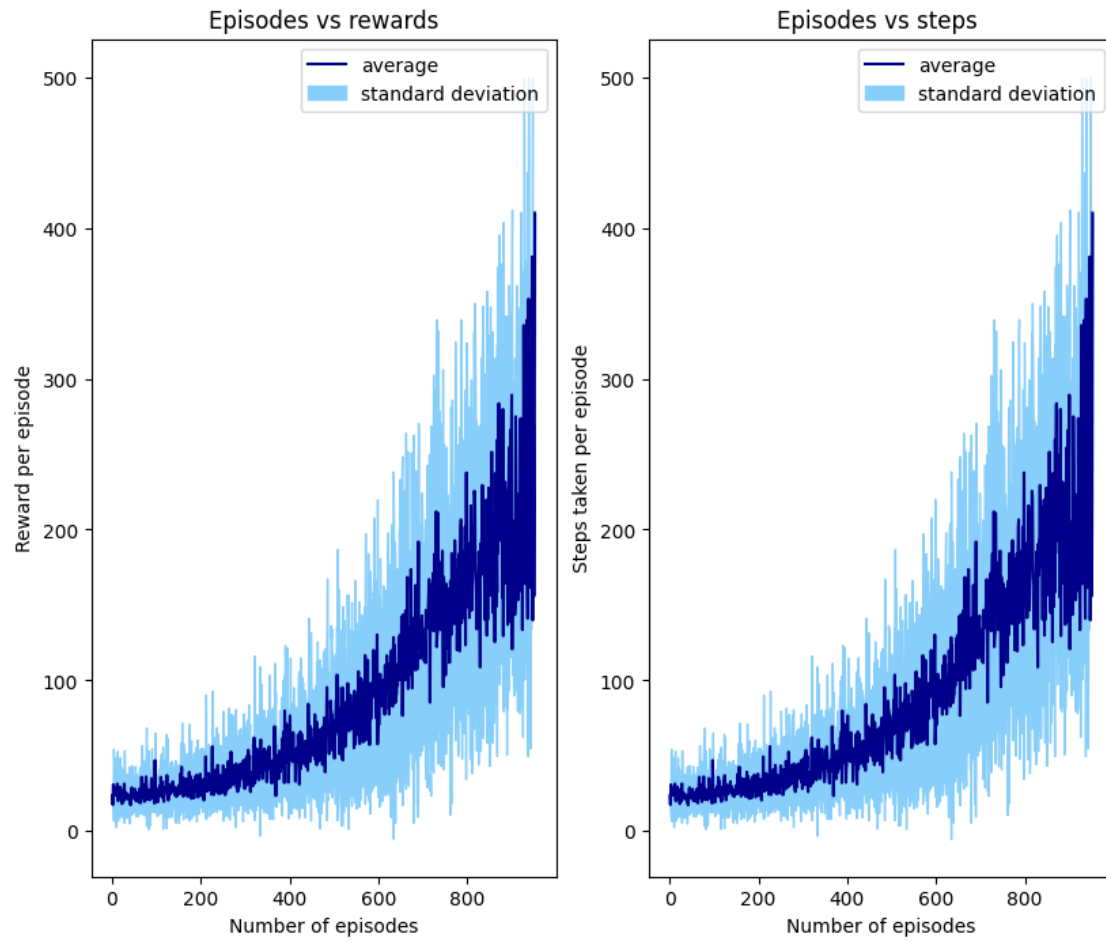
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Episode 660 Reward 100.000000 Average Reward 84.000000
Episode 670 Reward 125.000000 Average Reward 107.000000
Episode 680 Reward 149.000000 Average Reward 101.400000
Episode 690 Reward 72.000000 Average Reward 131.500000
Episode 700 Reward 112.000000 Average Reward 139.400000
Episode 710 Reward 206.000000 Average Reward 119.900000
Episode 720 Reward 81.000000 Average Reward 95.200000
Episode 730 Reward 169.000000 Average Reward 106.600000
Episode 740 Reward 114.000000 Average Reward 88.600000
Episode 750 Reward 68.000000 Average Reward 167.400000
Episode 760 Reward 374.000000 Average Reward 141.900000
Episode 770 Reward 144.000000 Average Reward 148.200000
Episode 780 Reward 121.000000 Average Reward 143.200000
Episode 790 Reward 211.000000 Average Reward 145.500000
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Episode 860 Reward 215.000000 Average Reward 230.800000
Episode 870 Reward 449.000000 Average Reward 192.800000
Episode 880 Reward 135.000000 Average Reward 192.100000
Stopped at Episode 788
0:09:28.263552
0:09:28.271555

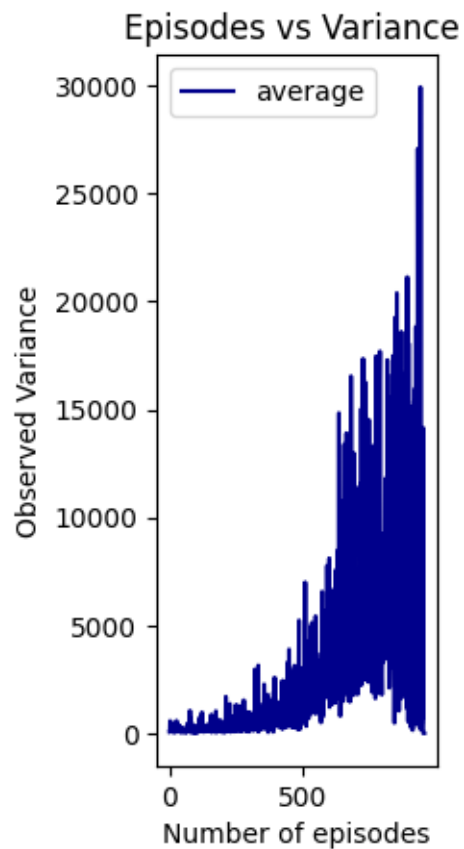
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C:\Users\CFI Workstation\AppData\Local\Temp\ipykernel_37432\416375277.py:88:
VisibleDeprecationWarning: Creating an ndarray from ragged nested sequences
(which is a list-or-tuple of lists-or-tuples-or ndarrays with different lengths
or shapes) is deprecated. If you meant to do this, you must specify
'dtype=object' when creating the ndarray.
    rewards = np.array(rewards_over_10_runs)
C:\Users\CFI Workstation\AppData\Local\Temp\ipykernel_37432\416375277.py:90:
VisibleDeprecationWarning: Creating an ndarray from ragged nested sequences
(which is a list-or-tuple of lists-or-tuples-or ndarrays with different lengths
or shapes) is deprecated. If you meant to do this, you must specify
'dtype=object' when creating the ndarray.
    steps = np.array(steps_over_10_runs)

```





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Episode: 1 Number of steps: 24
Episode: 2 Number of steps: 18
Episode: 3 Number of steps: 31
Episode: 4 Number of steps: 29
Episode: 5 Number of steps: 29
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```
C:\Users\CFI Workstation\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.10_qbz5n2kfra8p0\LocalCache\local-packages\Python310\site-packages\wandb\sdk\lib\ipython.py:47: DeprecationWarning: Importing display from IPython.core.display is deprecated since IPython 7.14, please import from IPython display
```

```
    from IPython.core.display import HTML, display # type: ignore
```

```
<IPython.core.display.HTML object>
```

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<IPython.core.display.HTML object>
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<IPython.core.display.HTML object>
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<IPython.core.display.HTML object>
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