FaST

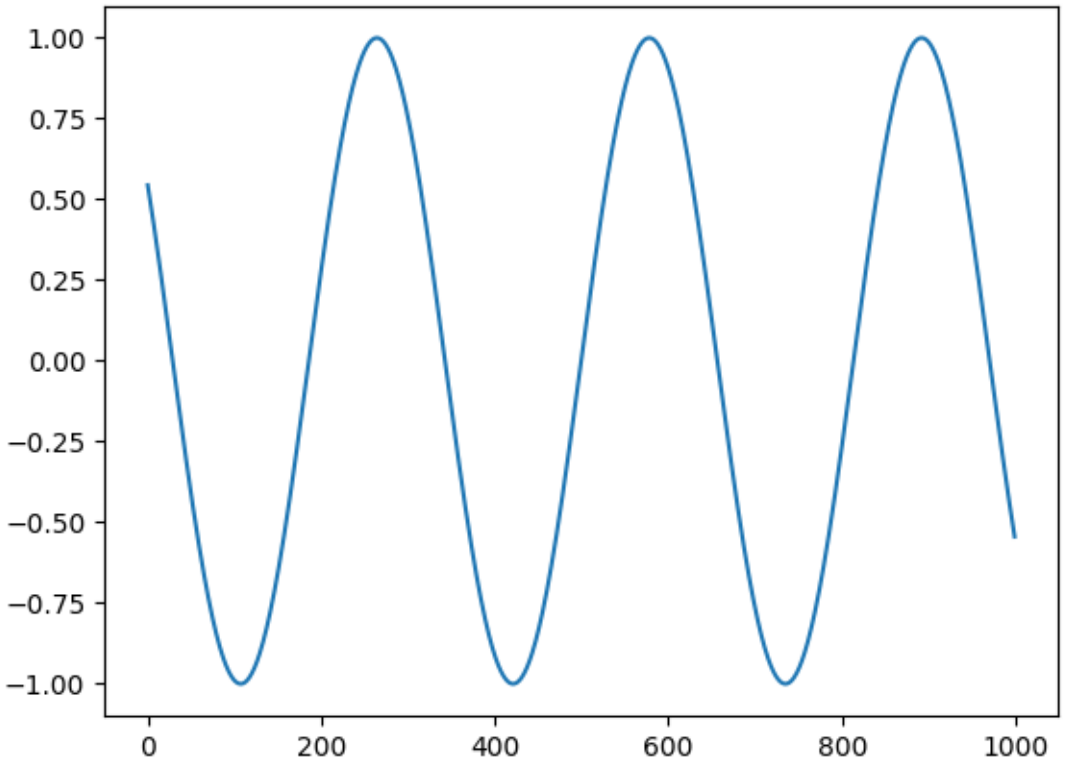
February 7, 2024

[434]:
```
import torch
import torch.nn as nn
import torch.nn.functional as F
import matplotlib.pyplot as plt
from torch.utils.data import TensorDataset, DataLoader
from torch import optim
```

[450]:
```
time = torch.linspace(-1, 1, 1000)
time_series = torch.sin(time*10)
```

[451]:
```
plt.plot(time_series)
```

[451]:
```
[<matplotlib.lines.Line2D at 0x2a0f69120>]
```



[17]:
```
import pandas as pd
# Available in the github repo : examples/data/BTC_USD-Hourly.csv
url = "https://raw.githubusercontent.com/ClementPerroud/Gym-Trading-Env/main/
 ↪examples/data/BTC_USD-Hourly.csv"
df = pd.read_csv(url, parse_dates=["date"], index_col= "date")
df.sort_index(inplace= True)
df.dropna(inplace= True)
df.drop_duplicates(inplace=True)
```

[18]:
```
import gymnasium as gym
import gym_trading_env

env = gym.make("TradingEnv",
        name= "BTCUSD",
        df = df, # Your dataset with your custom features
        positions = [ -1, 0, 1], # -1 (=SHORT), 0(=OUT), +1 (=LONG)
        trading_fees = 0.01/100, # 0.01% per stock buy / sell (Binance fees)
        borrow_interest_rate= 0.0003/100, # 0.0003% per timestep (one timestep␣
 ↪= 1h here)
    )
```

[19]:
```
# Run an episode until it ends :
done, truncated = False, False
observation, info = env.reset()
while not done and not truncated:
    # Pick a position by its index in your position list (=[-1, 0, 1])....
 ↪usually something like : position_index = your_policy(observation)
    position_index = env.action_space.sample() # At every timestep, pick a␣
 ↪random position index from your position list (=[-1, 0, 1])
    observation, reward, done, truncated, info = env.step(position_index)
```

```
Market Return : 395.51%   |   Portfolio Return : -99.45%   |
```

[20]:
```
import gymnasium as gym
from stable_baselines3 import PPO

# Parallel environments
model = PPO("MlpPolicy", env, verbose=1)
model.learn(total_timesteps=100_000)
```

```
Using cpu device
Wrapping the env with a `Monitor` wrapper
Wrapping the env in a DummyVecEnv.
-----------------------------
| time/              |      |
|    fps             | 4595 |
```

```
|    iterations      | 1    |
|    time_elapsed    | 0    |
|    total_timesteps | 2048 |
-----------------------------
-----------------------------------------
| time/                   |             |
|    fps                  | 3219        |
|    iterations           | 2           |
|    time_elapsed         | 1           |
|    total_timesteps      | 4096        |
| train/                  |             |
|    approx_kl            | 0.01757867  |
|    clip_fraction        | 0.159       |
|    clip_range           | 0.2         |
|    entropy_loss         | -1.09       |
|    explained_variance   | -41         |
|    learning_rate        | 0.0003      |
|    loss                 | -0.0181     |
|    n_updates            | 10          |
|    policy_gradient_loss | -0.00623    |
|    value_loss           | 0.00441     |
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| time/                   |             |
|    fps                  | 2936        |
|    iterations           | 3           |
|    time_elapsed         | 2           |
|    total_timesteps      | 6144        |
| train/                  |             |
|    approx_kl            | 0.0030630985 |
|    clip_fraction        | 0           |
|    clip_range           | 0.2         |
|    entropy_loss         | -1.08       |
|    explained_variance   | -0.081      |
|    learning_rate        | 0.0003      |
|    loss                 | 0.0157      |
|    n_updates            | 20          |
|    policy_gradient_loss | -0.000152   |
|    value_loss           | 0.000115    |
-----------------------------------------
-----------------------------------------
| time/                   |             |
|    fps                  | 2818        |
|    iterations           | 4           |
|    time_elapsed         | 2           |
|    total_timesteps      | 8192        |
| train/                  |             |
|    approx_kl            | 0.0073911143 |
```

```
|    clip_fraction        | 0.0259       |
|    clip_range           | 0.2          |
|    entropy_loss         | -1.05        |
|    explained_variance   | -0.025       |
|    learning_rate        | 0.0003       |
|    loss                 | 0.0139       |
|    n_updates            | 30           |
|    policy_gradient_loss | -0.00186     |
|    value_loss           | 0.000649     |
-----------------------------------------
-----------------------------------------
| time/                   |              |
|    fps                  | 2731         |
|    iterations           | 5            |
|    time_elapsed         | 3            |
|    total_timesteps      | 10240        |
| train/                  |              |
|    approx_kl            | 0.0072882143 |
|    clip_fraction        | 0.0154       |
|    clip_range           | 0.2          |
|    entropy_loss         | -1.06        |
|    explained_variance   | -0.0204      |
|    learning_rate        | 0.0003       |
|    loss                 | 0.000559     |
|    n_updates            | 40           |
|    policy_gradient_loss | -0.00206     |
|    value_loss           | 0.000162     |
-----------------------------------------
-----------------------------------------
| time/                   |              |
|    fps                  | 2677         |
|    iterations           | 6            |
|    time_elapsed         | 4            |
|    total_timesteps      | 12288        |
| train/                  |              |
|    approx_kl            | 0.0057591912 |
|    clip_fraction        | 0.0276       |
|    clip_range           | 0.2          |
|    entropy_loss         | -1.05        |
|    explained_variance   | -0.0128      |
|    learning_rate        | 0.0003       |
|    loss                 | 0.00566      |
|    n_updates            | 50           |
|    policy_gradient_loss | -0.00245     |
|    value_loss           | 0.000535     |
-----------------------------------------
-----------------------------------------
| time/                   |              |
```

```
|    fps                  | 2649         |
|    iterations           | 7            |
|    time_elapsed         | 5            |
|    total_timesteps      | 14336        |
| train/                  |              |
|    approx_kl            | 0.0065801544 |
|    clip_fraction        | 0.0285       |
|    clip_range           | 0.2          |
|    entropy_loss         | -1.03        |
|    explained_variance   | -0.0538      |
|    learning_rate        | 0.0003       |
|    loss                 | -0.00133     |
|    n_updates            | 60           |
|    policy_gradient_loss | -0.00296     |
|    value_loss           | 0.000249     |
-----------------------------------------
-----------------------------------------
| time/                   |              |
|    fps                  | 2624         |
|    iterations           | 8            |
|    time_elapsed         | 6            |
|    total_timesteps      | 16384        |
| train/                  |              |
|    approx_kl            | 0.0043677185 |
|    clip_fraction        | 0.011        |
|    clip_range           | 0.2          |
|    entropy_loss         | -1.04        |
|    explained_variance   | -0.00887     |
|    learning_rate        | 0.0003       |
|    loss                 | 0.000583     |
|    n_updates            | 70           |
|    policy_gradient_loss | -0.000592    |
|    value_loss           | 0.000278     |
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-----------------------------------------
| time/                   |              |
|    fps                  | 2608         |
|    iterations           | 9            |
|    time_elapsed         | 7            |
|    total_timesteps      | 18432        |
| train/                  |              |
|    approx_kl            | 0.0059102587 |
|    clip_fraction        | 0.0312       |
|    clip_range           | 0.2          |
|    entropy_loss         | -1.05        |
|    explained_variance   | 0.00344      |
|    learning_rate        | 0.0003       |
|    loss                 | -0.0193      |
```

```
|    n_updates            | 80           |
|    policy_gradient_loss | -0.00246     |
|    value_loss           | 0.0011       |
-----------------------------------------
-----------------------------------------
| time/                   |              |
|    fps                  | 2577         |
|    iterations           | 10           |
|    time_elapsed         | 7            |
|    total_timesteps      | 20480        |
| train/                  |              |
|    approx_kl            | 0.00784404   |
|    clip_fraction        | 0.0615       |
|    clip_range           | 0.2          |
|    entropy_loss         | -1.04        |
|    explained_variance   | -0.173       |
|    learning_rate        | 0.0003       |
|    loss                 | -0.00421     |
|    n_updates            | 90           |
|    policy_gradient_loss | -0.00458     |
|    value_loss           | 0.000395     |
-----------------------------------------
-----------------------------------------
| time/                   |              |
|    fps                  | 2567         |
|    iterations           | 11           |
|    time_elapsed         | 8            |
|    total_timesteps      | 22528        |
| train/                  |              |
|    approx_kl            | 0.008025686  |
|    clip_fraction        | 0.0491       |
|    clip_range           | 0.2          |
|    entropy_loss         | -1.01        |
|    explained_variance   | -0.132       |
|    learning_rate        | 0.0003       |
|    loss                 | -0.0235      |
|    n_updates            | 100          |
|    policy_gradient_loss | -0.00381     |
|    value_loss           | 0.000127     |
-----------------------------------------
-----------------------------------------
| time/                   |              |
|    fps                  | 2559         |
|    iterations           | 12           |
|    time_elapsed         | 9            |
|    total_timesteps      | 24576        |
| train/                  |              |
|    approx_kl            | 0.005523345  |
```

```
|    clip_fraction        | 0.0392      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.997      |
|    explained_variance   | -0.00646    |
|    learning_rate        | 0.0003      |
|    loss                 | 0.00826     |
|    n_updates            | 110         |
|    policy_gradient_loss | -0.00282    |
|    value_loss           | 0.000206    |
-----------------------------------------
-----------------------------------------
| time/                   |             |
|    fps                  | 2554        |
|    iterations           | 13          |
|    time_elapsed         | 10          |
|    total_timesteps      | 26624       |
| train/                  |             |
|    approx_kl            | 0.0068858266 |
|    clip_fraction        | 0.0293      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.95       |
|    explained_variance   | -0.00137    |
|    learning_rate        | 0.0003      |
|    loss                 | 0.0165      |
|    n_updates            | 120         |
|    policy_gradient_loss | -0.00229    |
|    value_loss           | 0.000686    |
-----------------------------------------
-----------------------------------------
| time/                   |             |
|    fps                  | 2548        |
|    iterations           | 14          |
|    time_elapsed         | 11          |
|    total_timesteps      | 28672       |
| train/                  |             |
|    approx_kl            | 0.010913776 |
|    clip_fraction        | 0.0257      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.911      |
|    explained_variance   | -0.00619    |
|    learning_rate        | 0.0003      |
|    loss                 | -0.029      |
|    n_updates            | 130         |
|    policy_gradient_loss | -0.00236    |
|    value_loss           | 0.000524    |
-----------------------------------------
-----------------------------------------
| time/                   |             |
```

```
|    fps                  | 2533        |
|    iterations           | 15          |
|    time_elapsed         | 12          |
|    total_timesteps      | 30720       |
| train/                  |             |
|    approx_kl            | 0.014860675 |
|    clip_fraction        | 0.0859      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.832      |
|    explained_variance   | -0.122      |
|    learning_rate        | 0.0003      |
|    loss                 | 0.0323      |
|    n_updates            | 140         |
|    policy_gradient_loss | -0.00422    |
|    value_loss           | 0.00034     |
-----------------------------------------
-----------------------------------------
| time/                   |             |
|    fps                  | 2527        |
|    iterations           | 16          |
|    time_elapsed         | 12          |
|    total_timesteps      | 32768       |
| train/                  |             |
|    approx_kl            | 0.002905743 |
|    clip_fraction        | 0.0261      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.82       |
|    explained_variance   | -0.0019     |
|    learning_rate        | 0.0003      |
|    loss                 | 0.0303      |
|    n_updates            | 150         |
|    policy_gradient_loss | -0.00146    |
|    value_loss           | 0.000206    |
-----------------------------------------
Market Return : 395.51%   |   Portfolio Return : -96.68%   |
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2517        |
|    iterations           | 17          |
|    time_elapsed         | 13          |
|    total_timesteps      | 34816       |
| train/                  |             |
|    approx_kl            | 0.007132735 |
|    clip_fraction        | 0.0511      |
|    clip_range           | 0.2         |
```

```
|    entropy_loss         | -0.793      |
|    explained_variance   | -0.000227   |
|    learning_rate        | 0.0003      |
|    loss                 | -0.00919    |
|    n_updates            | 160         |
|    policy_gradient_loss | -0.00387    |
|    value_loss           | 0.000216    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2513        |
|    iterations           | 18          |
|    time_elapsed         | 14          |
|    total_timesteps      | 36864       |
| train/                  |             |
|    approx_kl            | 0.004511296 |
|    clip_fraction        | 0.0509      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.836      |
|    explained_variance   | -0.0106     |
|    learning_rate        | 0.0003      |
|    loss                 | -0.0127     |
|    n_updates            | 170         |
|    policy_gradient_loss | -0.00353    |
|    value_loss           | 0.000268    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2509        |
|    iterations           | 19          |
|    time_elapsed         | 15          |
|    total_timesteps      | 38912       |
| train/                  |             |
|    approx_kl            | 0.003457654 |
|    clip_fraction        | 0.0331      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.847      |
|    explained_variance   | -0.0132     |
|    learning_rate        | 0.0003      |
|    loss                 | -0.00696    |
|    n_updates            | 180         |
|    policy_gradient_loss | -0.00225    |
```

```
|    value_loss           | 0.000173    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2509        |
|    iterations           | 20          |
|    time_elapsed         | 16          |
|    total_timesteps      | 40960       |
| train/                  |             |
|    approx_kl            | 0.005192832 |
|    clip_fraction        | 0.0356      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.867      |
|    explained_variance   | -0.00131    |
|    learning_rate        | 0.0003      |
|    loss                 | -0.0134     |
|    n_updates            | 190         |
|    policy_gradient_loss | -0.00214    |
|    value_loss           | 0.000462    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2507        |
|    iterations           | 21          |
|    time_elapsed         | 17          |
|    total_timesteps      | 43008       |
| train/                  |             |
|    approx_kl            | 0.009277115 |
|    clip_fraction        | 0.03        |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.835      |
|    explained_variance   | -0.00306    |
|    learning_rate        | 0.0003      |
|    loss                 | -0.00205    |
|    n_updates            | 200         |
|    policy_gradient_loss | -0.00221    |
|    value_loss           | 7.69e-05    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
```

```
| time/                   |             |
|    fps                  | 2506        |
|    iterations           | 22          |
|    time_elapsed         | 17          |
|    total_timesteps      | 45056       |
| train/                  |             |
|    approx_kl            | 0.008206483 |
|    clip_fraction        | 0.0886      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.859      |
|    explained_variance   | -0.00204    |
|    learning_rate        | 0.0003      |
|    loss                 | -0.0302     |
|    n_updates            | 210         |
|    policy_gradient_loss | -0.00716    |
|    value_loss           | 0.000363    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2505        |
|    iterations           | 23          |
|    time_elapsed         | 18          |
|    total_timesteps      | 47104       |
| train/                  |             |
|    approx_kl            | 0.011617135 |
|    clip_fraction        | 0.0416      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.887      |
|    explained_variance   | -0.00289    |
|    learning_rate        | 0.0003      |
|    loss                 | 0.0133      |
|    n_updates            | 220         |
|    policy_gradient_loss | -0.00308    |
|    value_loss           | 0.000533    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2506        |
|    iterations           | 24          |
|    time_elapsed         | 19          |
|    total_timesteps      | 49152       |
| train/                  |             |
```

```
|    approx_kl            | 0.009045278 |
|    clip_fraction        | 0.065       |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.903      |
|    explained_variance   | -0.13       |
|    learning_rate        | 0.0003      |
|    loss                 | -0.0149     |
|    n_updates            | 230         |
|    policy_gradient_loss | -0.00313    |
|    value_loss           | 0.00017     |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2505        |
|    iterations           | 25          |
|    time_elapsed         | 20          |
|    total_timesteps      | 51200       |
| train/                  |             |
|    approx_kl            | 0.011044464 |
|    clip_fraction        | 0.0738      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.879      |
|    explained_variance   | -0.16       |
|    learning_rate        | 0.0003      |
|    loss                 | -0.0147     |
|    n_updates            | 240         |
|    policy_gradient_loss | -0.00407    |
|    value_loss           | 0.000145    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2505        |
|    iterations           | 26          |
|    time_elapsed         | 21          |
|    total_timesteps      | 53248       |
| train/                  |             |
|    approx_kl            | 0.009289868 |
|    clip_fraction        | 0.0429      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.846      |
|    explained_variance   | 0.00788     |
|    learning_rate        | 0.0003      |
```

```
|    loss                 | -0.0149     |
|    n_updates            | 250         |
|    policy_gradient_loss | -0.00309    |
|    value_loss           | 0.00125     |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2503        |
|    iterations           | 27          |
|    time_elapsed         | 22          |
|    total_timesteps      | 55296       |
| train/                  |             |
|    approx_kl            | 0.0074337786 |
|    clip_fraction        | 0.0216      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.833      |
|    explained_variance   | 0.000378    |
|    learning_rate        | 0.0003      |
|    loss                 | 0.00558     |
|    n_updates            | 260         |
|    policy_gradient_loss | -0.00124    |
|    value_loss           | 8.04e-05    |
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-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2503        |
|    iterations           | 28          |
|    time_elapsed         | 22          |
|    total_timesteps      | 57344       |
| train/                  |             |
|    approx_kl            | 0.012326394 |
|    clip_fraction        | 0.0548      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.836      |
|    explained_variance   | -0.00731    |
|    learning_rate        | 0.0003      |
|    loss                 | -0.0128     |
|    n_updates            | 270         |
|    policy_gradient_loss | -0.00454    |
|    value_loss           | 0.00013     |
-----------------------------------------
-----------------------------------------
```

```
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2502        |
|    iterations           | 29          |
|    time_elapsed         | 23          |
|    total_timesteps      | 59392       |
| train/                  |             |
|    approx_kl            | 0.011439586 |
|    clip_fraction        | 0.0561      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.877      |
|    explained_variance   | -0.0174     |
|    learning_rate        | 0.0003      |
|    loss                 | -0.0192     |
|    n_updates            | 280         |
|    policy_gradient_loss | -0.00497    |
|    value_loss           | 0.000404    |
-------------------------------------
-------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -3.41       |
| time/                   |             |
|    fps                  | 2502        |
|    iterations           | 30          |
|    time_elapsed         | 24          |
|    total_timesteps      | 61440       |
| train/                  |             |
|    approx_kl            | 0.003075521 |
|    clip_fraction        | 0.00566     |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.857      |
|    explained_variance   | -0.0119     |
|    learning_rate        | 0.0003      |
|    loss                 | 0.0226      |
|    n_updates            | 290         |
|    policy_gradient_loss | -0.000288   |
|    value_loss           | 0.000306    |
-------------------------------------
-------------------------------------
| rollout/                |            |
|    ep_len_mean          | 3.33e+04   |
|    ep_rew_mean          | -3.41      |
| time/                   |            |
|    fps                  | 2504       |
|    iterations           | 31         |
```

```
|    time_elapsed         | 25         |
|    total_timesteps      | 63488      |
| train/                  |            |
|    approx_kl            | 0.00841793 |
|    clip_fraction        | 0.0228     |
|    clip_range           | 0.2        |
|    entropy_loss         | -0.886     |
|    explained_variance   | -0.0125    |
|    learning_rate        | 0.0003     |
|    loss                 | 0.0209     |
|    n_updates            | 300        |
|    policy_gradient_loss | -0.0027    |
|    value_loss           | 0.000674   |
-----------------------------------------
-----------------------------------------
| rollout/                |            |
|    ep_len_mean          | 3.33e+04   |
|    ep_rew_mean          | -3.41      |
| time/                   |            |
|    fps                  | 2506       |
|    iterations           | 32         |
|    time_elapsed         | 26         |
|    total_timesteps      | 65536      |
| train/                  |            |
|    approx_kl            | 0.01248743 |
|    clip_fraction        | 0.0567     |
|    clip_range           | 0.2        |
|    entropy_loss         | -0.9       |
|    explained_variance   | -0.636     |
|    learning_rate        | 0.0003     |
|    loss                 | 0.0269     |
|    n_updates            | 310        |
|    policy_gradient_loss | -0.00557   |
|    value_loss           | 0.000168   |
-----------------------------------------
Market Return : 395.51%   |   Portfolio Return : -79.76%   |
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -2.5        |
| time/                   |             |
|    fps                  | 2504        |
|    iterations           | 33          |
|    time_elapsed         | 26          |
|    total_timesteps      | 67584       |
| train/                  |             |
|    approx_kl            | 0.004764275 |
|    clip_fraction        | 0.0464      |
```

```
|    clip_range           | 0.2         |
|    entropy_loss         | -0.875      |
|    explained_variance   | -0.00564    |
|    learning_rate        | 0.0003      |
|    loss                 | -0.0229     |
|    n_updates            | 320         |
|    policy_gradient_loss | -0.00408    |
|    value_loss           | 0.000232    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -2.5        |
| time/                   |             |
|    fps                  | 2506        |
|    iterations           | 34          |
|    time_elapsed         | 27          |
|    total_timesteps      | 69632       |
| train/                  |             |
|    approx_kl            | 0.0033423395 |
|    clip_fraction        | 0.0109      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.853      |
|    explained_variance   | 0.00178     |
|    learning_rate        | 0.0003      |
|    loss                 | -0.00208    |
|    n_updates            | 330         |
|    policy_gradient_loss | -0.00102    |
|    value_loss           | 0.000195    |
-----------------------------------------
-----------------------------------------
| rollout/                |           |
|    ep_len_mean          | 3.33e+04  |
|    ep_rew_mean          | -2.5      |
| time/                   |           |
|    fps                  | 2506      |
|    iterations           | 35        |
|    time_elapsed         | 28        |
|    total_timesteps      | 71680     |
| train/                  |           |
|    approx_kl            | 0.00402539 |
|    clip_fraction        | 0.0286    |
|    clip_range           | 0.2       |
|    entropy_loss         | -0.878    |
|    explained_variance   | -0.000996 |
|    learning_rate        | 0.0003    |
|    loss                 | 0.00629   |
|    n_updates            | 340       |
```

```
|    policy_gradient_loss | -0.00227   |
|    value_loss           | 0.000164   |
-----------------------------------------
-----------------------------------------
| rollout/                |              |
|    ep_len_mean          | 3.33e+04     |
|    ep_rew_mean          | -2.5         |
| time/                   |              |
|    fps                  | 2506         |
|    iterations           | 36           |
|    time_elapsed         | 29           |
|    total_timesteps      | 73728        |
| train/                  |              |
|    approx_kl            | 0.0055667525 |
|    clip_fraction        | 0.0164       |
|    clip_range           | 0.2          |
|    entropy_loss         | -0.901       |
|    explained_variance   | -0.00406     |
|    learning_rate        | 0.0003       |
|    loss                 | -0.0225      |
|    n_updates            | 350          |
|    policy_gradient_loss | -0.0012      |
|    value_loss           | 0.00032      |
-----------------------------------------
-----------------------------------------
| rollout/                |              |
|    ep_len_mean          | 3.33e+04     |
|    ep_rew_mean          | -2.5         |
| time/                   |              |
|    fps                  | 2507         |
|    iterations           | 37           |
|    time_elapsed         | 30           |
|    total_timesteps      | 75776        |
| train/                  |              |
|    approx_kl            | 0.016751437  |
|    clip_fraction        | 0.0923       |
|    clip_range           | 0.2          |
|    entropy_loss         | -0.897       |
|    explained_variance   | -0.00691     |
|    learning_rate        | 0.0003       |
|    loss                 | -0.00248     |
|    n_updates            | 360          |
|    policy_gradient_loss | -0.00708     |
|    value_loss           | 0.000211     |
-----------------------------------------
-----------------------------------------
| rollout/                |              |
|    ep_len_mean          | 3.33e+04     |
```

```
|    ep_rew_mean          | -2.5         |
| time/                   |              |
|    fps                  | 2507         |
|    iterations           | 38           |
|    time_elapsed         | 31           |
|    total_timesteps      | 77824        |
| train/                  |              |
|    approx_kl            | 0.0069012013 |
|    clip_fraction        | 0.0534       |
|    clip_range           | 0.2          |
|    entropy_loss         | -0.867       |
|    explained_variance   | -0.00473     |
|    learning_rate        | 0.0003       |
|    loss                 | -0.0242      |
|    n_updates            | 370          |
|    policy_gradient_loss | -0.00436     |
|    value_loss           | 0.000197     |
-----------------------------------------
-----------------------------------------
| rollout/                |            |
|    ep_len_mean          | 3.33e+04   |
|    ep_rew_mean          | -2.5       |
| time/                   |            |
|    fps                  | 2507       |
|    iterations           | 39         |
|    time_elapsed         | 31         |
|    total_timesteps      | 79872      |
| train/                  |            |
|    approx_kl            | 0.00948631 |
|    clip_fraction        | 0.0747     |
|    clip_range           | 0.2        |
|    entropy_loss         | -0.888     |
|    explained_variance   | -0.0465    |
|    learning_rate        | 0.0003     |
|    loss                 | -0.0204    |
|    n_updates            | 380        |
|    policy_gradient_loss | -0.00563   |
|    value_loss           | 0.000269   |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -2.5        |
| time/                   |             |
|    fps                  | 2508        |
|    iterations           | 40          |
|    time_elapsed         | 32          |
|    total_timesteps      | 81920       |
```

```
| train/                  |             |
|    approx_kl            | 0.006828591 |
|    clip_fraction        | 0.0774      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.898      |
|    explained_variance   | -0.176      |
|    learning_rate        | 0.0003      |
|    loss                 | -0.0123     |
|    n_updates            | 390         |
|    policy_gradient_loss | -0.00361    |
|    value_loss           | 0.000164    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -2.5        |
| time/                   |             |
|    fps                  | 2508        |
|    iterations           | 41          |
|    time_elapsed         | 33          |
|    total_timesteps      | 83968       |
| train/                  |             |
|    approx_kl            | 0.012665521 |
|    clip_fraction        | 0.072       |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.874      |
|    explained_variance   | -0.00278    |
|    learning_rate        | 0.0003      |
|    loss                 | 0.0198      |
|    n_updates            | 400         |
|    policy_gradient_loss | -0.00576    |
|    value_loss           | 0.000162    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -2.5        |
| time/                   |             |
|    fps                  | 2508        |
|    iterations           | 42          |
|    time_elapsed         | 34          |
|    total_timesteps      | 86016       |
| train/                  |             |
|    approx_kl            | 0.011862967 |
|    clip_fraction        | 0.0399      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.849      |
|    explained_variance   | -0.0151     |
```

```
|    learning_rate        | 0.0003      |
|    loss                 | -0.00422    |
|    n_updates            | 410         |
|    policy_gradient_loss | -0.00285    |
|    value_loss           | 0.000734    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -2.5        |
| time/                   |             |
|    fps                  | 2508        |
|    iterations           | 43          |
|    time_elapsed         | 35          |
|    total_timesteps      | 88064       |
| train/                  |             |
|    approx_kl            | 0.0030131377 |
|    clip_fraction        | 0.0215      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.836      |
|    explained_variance   | -0.122      |
|    learning_rate        | 0.0003      |
|    loss                 | 0.011       |
|    n_updates            | 420         |
|    policy_gradient_loss | -0.00139    |
|    value_loss           | 0.00016     |
-----------------------------------------
---------------------------------------
| rollout/                |           |
|    ep_len_mean          | 3.33e+04  |
|    ep_rew_mean          | -2.5      |
| time/                   |           |
|    fps                  | 2508      |
|    iterations           | 44        |
|    time_elapsed         | 35        |
|    total_timesteps      | 90112     |
| train/                  |           |
|    approx_kl            | 0.01052033 |
|    clip_fraction        | 0.0493    |
|    clip_range           | 0.2       |
|    entropy_loss         | -0.833    |
|    explained_variance   | 0.000372  |
|    learning_rate        | 0.0003    |
|    loss                 | -0.0175   |
|    n_updates            | 430       |
|    policy_gradient_loss | -0.0026   |
|    value_loss           | 0.000134  |
---------------------------------------
```

```
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -2.5        |
| time/                   |             |
|    fps                  | 2509        |
|    iterations           | 45          |
|    time_elapsed         | 36          |
|    total_timesteps      | 92160       |
| train/                  |             |
|    approx_kl            | 0.006371608 |
|    clip_fraction        | 0.0271      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.82       |
|    explained_variance   | -0.00798    |
|    learning_rate        | 0.0003      |
|    loss                 | -0.00766    |
|    n_updates            | 440         |
|    policy_gradient_loss | -0.00242    |
|    value_loss           | 0.000518    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -2.5        |
| time/                   |             |
|    fps                  | 2509        |
|    iterations           | 46          |
|    time_elapsed         | 37          |
|    total_timesteps      | 94208       |
| train/                  |             |
|    approx_kl            | 0.010200999 |
|    clip_fraction        | 0.0494      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.809      |
|    explained_variance   | -0.0145     |
|    learning_rate        | 0.0003      |
|    loss                 | 0.0259      |
|    n_updates            | 450         |
|    policy_gradient_loss | -0.00359    |
|    value_loss           | 0.000454    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -2.5        |
| time/                   |             |
|    fps                  | 2510        |
```

```
|    iterations           | 47          |
|    time_elapsed         | 38          |
|    total_timesteps      | 96256       |
| train/                  |             |
|    approx_kl            | 0.006765333 |
|    clip_fraction        | 0.0266      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.795      |
|    explained_variance   | -0.00444    |
|    learning_rate        | 0.0003      |
|    loss                 | 0.00442     |
|    n_updates            | 460         |
|    policy_gradient_loss | -0.00254    |
|    value_loss           | 0.000509    |
-----------------------------------------
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -2.5        |
| time/                   |             |
|    fps                  | 2510        |
|    iterations           | 48          |
|    time_elapsed         | 39          |
|    total_timesteps      | 98304       |
| train/                  |             |
|    approx_kl            | 0.003156825 |
|    clip_fraction        | 0.0111      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.766      |
|    explained_variance   | -0.00431    |
|    learning_rate        | 0.0003      |
|    loss                 | -0.00581    |
|    n_updates            | 470         |
|    policy_gradient_loss | -0.00052    |
|    value_loss           | 0.000305    |
-----------------------------------------
Market Return : 395.51%   |   Portfolio Return : -78.04%   |
-----------------------------------------
| rollout/                |             |
|    ep_len_mean          | 3.33e+04    |
|    ep_rew_mean          | -2.17       |
| time/                   |             |
|    fps                  | 2509        |
|    iterations           | 49          |
|    time_elapsed         | 39          |
|    total_timesteps      | 100352      |
| train/                  |             |
|    approx_kl            | 0.007867938 |
```

```
|    clip_fraction        | 0.0584      |
|    clip_range           | 0.2         |
|    entropy_loss         | -0.725      |
|    explained_variance   | -0.0501     |
|    learning_rate        | 0.0003      |
|    loss                 | 0.00152     |
|    n_updates            | 480         |
|    policy_gradient_loss | -0.00478    |
|    value_loss           | 0.000236    |
-----------------------------------------
```

[20]:
```
<stable_baselines3.ppo.ppo.PPO at 0x2a515fe50>
```

[21]:
```
from stable_baselines3.common.evaluation import evaluate_policy

mean_reward, std_reward = evaluate_policy(model, model.get_env(),␣
 ↪n_eval_episodes=10)
```

```
Market Return : 395.51%   |   Portfolio Return : 395.46%   |
Market Return : 395.51%   |   Portfolio Return : 395.51%   |
Market Return : 395.51%   |   Portfolio Return : 395.41%   |
Market Return : 395.51%   |   Portfolio Return : 395.46%   |
Market Return : 395.51%   |   Portfolio Return : 395.41%   |
Market Return : 395.51%   |   Portfolio Return : 395.51%   |
Market Return : 395.51%   |   Portfolio Return : 395.46%   |
Market Return : 395.51%   |   Portfolio Return : 395.51%   |
Market Return : 395.51%   |   Portfolio Return : 395.51%   |
Market Return : 395.51%   |   Portfolio Return : 395.51%   |
```