# 6.evolution-strategy-agent

September 29, 2021

```
[1]: import numpy as np
     import pandas as pd
     import time
     import matplotlib.pyplot as plt
     import seaborn as sns
     import random
     sns.set()
```

```
[2]: import pkg_resources
     import types


     def get_imports():
         for name, val in globals().items():
             if isinstance(val, types.ModuleType):
                 name = val.__name__.split('.')[0]
             elif isinstance(val, type):
                 name = val.__module__.split('.')[0]
             poorly_named_packages = {'PIL': 'Pillow', 'sklearn': 'scikit-learn'}
             if name in poorly_named_packages.keys():
                 name = poorly_named_packages[name]
             yield name


     imports = list(set(get_imports()))
     requirements = []
     for m in pkg_resources.working_set:
         if m.project_name in imports and m.project_name != 'pip':
             requirements.append((m.project_name, m.version))

     for r in requirements:
         print('{}=={}'.format(*r))
```

```
seaborn==0.9.0
pandas==0.23.4
numpy==1.14.5
matplotlib==3.0.2
```

```python
[3]: df = pd.read_csv('../dataset/GOOG-year.csv')
     df.head()
```

```
[3]:         Date        Open        High         Low       Close    Adj Close  \
     0  2016-11-02  778.200012  781.650024  763.450012  768.700012  768.700012
     1  2016-11-03  767.250000  769.950012  759.030029  762.130005  762.130005
     2  2016-11-04  750.659973  770.359985  750.560974  762.020020  762.020020
     3  2016-11-07  774.500000  785.190002  772.549988  782.520020  782.520020
     4  2016-11-08  783.400024  795.632996  780.190002  790.510010  790.510010

          Volume
     0  1872400
     1  1943200
     2  2134800
     3  1585100
     4  1350800
```

```python
[ ]:
```

```python
[4]: class Deep_Evolution_Strategy:

         inputs = None

         def __init__(
             self, weights, reward_function, population_size, sigma, learning_rate
         ):
             self.weights = weights
             self.reward_function = reward_function
             self.population_size = population_size
             self.sigma = sigma
             self.learning_rate = learning_rate

         def _get_weight_from_population(self, weights, population):
             weights_population = []
             for index, i in enumerate(population):
                 jittered = self.sigma * i
                 weights_population.append(weights[index] + jittered)
             return weights_population

         def get_weights(self):
             return self.weights

         def train(self, epoch = 100, print_every = 1):
             lasttime = time.time()
             for i in range(epoch):
                 population = []
                 rewards = np.zeros(self.population_size)
```

```python
        for k in range(self.population_size):
            x = []
            for w in self.weights:
                x.append(np.random.randn(*w.shape))
            population.append(x)
        for k in range(self.population_size):
            weights_population = self._get_weight_from_population(
                self.weights, population[k]
            )
            rewards[k] = self.reward_function(weights_population)
        rewards = (rewards - np.mean(rewards)) / (np.std(rewards) + 1e-7)
        for index, w in enumerate(self.weights):
            A = np.array([p[index] for p in population])
            self.weights[index] = (
                w
                + self.learning_rate
                / (self.population_size * self.sigma)
                * np.dot(A.T, rewards).T
            )
        if (i + 1) % print_every == 0:
            print(
                'iter %d. reward: %f'
                % (i + 1, self.reward_function(self.weights))
            )
    print('time taken to train:', time.time() - lasttime, 'seconds')


class Model:
    def __init__(self, input_size, layer_size, output_size):
        self.weights = [
            np.random.randn(input_size, layer_size),
            np.random.randn(layer_size, output_size),
            np.random.randn(1, layer_size),
        ]

    def predict(self, inputs):
        feed = np.dot(inputs, self.weights[0]) + self.weights[-1]
        decision = np.dot(feed, self.weights[1])
        return decision

    def get_weights(self):
        return self.weights

    def set_weights(self, weights):
        self.weights = weights
```

```python
[5]: class Agent:

    POPULATION_SIZE = 15
    SIGMA = 0.1
    LEARNING_RATE = 0.03

    def __init__(self, model, window_size, trend, skip, initial_money):
        self.model = model
        self.window_size = window_size
        self.half_window = window_size // 2
        self.trend = trend
        self.skip = skip
        self.initial_money = initial_money
        self.es = Deep_Evolution_Strategy(
            self.model.get_weights(),
            self.get_reward,
            self.POPULATION_SIZE,
            self.SIGMA,
            self.LEARNING_RATE,
        )

    def act(self, sequence):
        decision = self.model.predict(np.array(sequence))
        return np.argmax(decision[0])

    def get_state(self, t):
        window_size = self.window_size + 1
        d = t - window_size + 1
        block = self.trend[d : t + 1] if d >= 0 else -d * [self.trend[0]] +␣
↪self.trend[0 : t + 1]
        res = []
        for i in range(window_size - 1):
            res.append(block[i + 1] - block[i])
        return np.array([res])

    def get_reward(self, weights):
        initial_money = self.initial_money
        starting_money = initial_money
        self.model.weights = weights
        state = self.get_state(0)
        inventory = []
        quantity = 0
        for t in range(0, len(self.trend) - 1, self.skip):
            action = self.act(state)
            next_state = self.get_state(t + 1)

            if action == 1 and starting_money >= self.trend[t]:
```

```python
                inventory.append(self.trend[t])
                starting_money -= close[t]

            elif action == 2 and len(inventory):
                bought_price = inventory.pop(0)
                starting_money += self.trend[t]

            state = next_state
        return ((starting_money - initial_money) / initial_money) * 100

    def fit(self, iterations, checkpoint):
        self.es.train(iterations, print_every = checkpoint)

    def buy(self):
        initial_money = self.initial_money
        state = self.get_state(0)
        starting_money = initial_money
        states_sell = []
        states_buy = []
        inventory = []
        for t in range(0, len(self.trend) - 1, self.skip):
            action = self.act(state)
            next_state = self.get_state(t + 1)

            if action == 1 and initial_money >= self.trend[t]:
                inventory.append(self.trend[t])
                initial_money -= self.trend[t]
                states_buy.append(t)
                print('day %d: buy 1 unit at price %f, total balance %f'% (t,
 →self.trend[t], initial_money))

            elif action == 2 and len(inventory):
                bought_price = inventory.pop(0)
                initial_money += self.trend[t]
                states_sell.append(t)
                try:
                    invest = ((close[t] - bought_price) / bought_price) * 100
                except:
                    invest = 0
                print(
                    'day %d, sell 1 unit at price %f, investment %f %%, total
 →balance %f,'
                    % (t, close[t], invest, initial_money)
                )
            state = next_state

        invest = ((initial_money - starting_money) / starting_money) * 100
```

```
        total_gains = initial_money - starting_money
        return states_buy, states_sell, total_gains, invest
```

```
[6]: close = df.Close.values.tolist()
     window_size = 30
     skip = 1
     initial_money = 10000

     model = Model(input_size = window_size, layer_size = 500, output_size = 3)
     agent = Agent(model = model,
                   window_size = window_size,
                   trend = close,
                   skip = skip,
                   initial_money = initial_money)
     agent.fit(iterations = 500, checkpoint = 10)
```

```
iter 10. reward: 8.610248
iter 20. reward: 12.257399
iter 30. reward: 7.689600
iter 40. reward: 18.719300
iter 50. reward: 16.883897
iter 60. reward: 18.100399
iter 70. reward: 17.280399
iter 80. reward: 15.865947
iter 90. reward: 17.435298
iter 100. reward: 22.108749
iter 110. reward: 21.537897
iter 120. reward: 21.986898
iter 130. reward: 22.303096
iter 140. reward: 27.540547
iter 150. reward: 24.151497
iter 160. reward: 26.339196
iter 170. reward: 26.184596
iter 180. reward: 25.859546
iter 190. reward: 28.623797
iter 200. reward: 30.171547
iter 210. reward: 29.712899
iter 220. reward: 28.880399
iter 230. reward: 29.221448
iter 240. reward: 26.622551
iter 250. reward: 21.736548
iter 260. reward: 32.192049
iter 270. reward: 31.077749
iter 280. reward: 30.869947
iter 290. reward: 30.829648
iter 300. reward: 32.587899
iter 310. reward: 32.627998
```

```
iter 320. reward: 32.198498
iter 330. reward: 31.940298
iter 340. reward: 32.789998
iter 350. reward: 33.619697
iter 360. reward: 32.738196
iter 370. reward: 34.456997
iter 380. reward: 34.972598
iter 390. reward: 34.632198
iter 400. reward: 32.573597
iter 410. reward: 35.826097
iter 420. reward: 33.999698
iter 430. reward: 35.530297
iter 440. reward: 35.589196
iter 450. reward: 32.944796
iter 460. reward: 36.473798
iter 470. reward: 38.662997
iter 480. reward: 37.648599
iter 490. reward: 37.361099
iter 500. reward: 37.407198
time taken to train: 33.66626238822937 seconds
```

[7]: 
```
states_buy, states_sell, total_gains, invest = agent.buy()
```

```
day 1: buy 1 unit at price 762.130005, total balance 9237.869995
day 3: buy 1 unit at price 782.520020, total balance 8455.349975
day 4, sell 1 unit at price 790.510010, investment 3.723775 %, total balance
9245.859985,
day 5, sell 1 unit at price 785.309998, investment 0.356538 %, total balance
10031.169983,
day 6: buy 1 unit at price 762.559998, total balance 9268.609985
day 10: buy 1 unit at price 764.479980, total balance 8504.130005
day 11: buy 1 unit at price 771.229980, total balance 7732.900025
day 12: buy 1 unit at price 760.539978, total balance 6972.360047
day 17: buy 1 unit at price 768.239990, total balance 6204.120057
day 18: buy 1 unit at price 770.840027, total balance 5433.280030
day 19: buy 1 unit at price 758.039978, total balance 4675.240052
day 20: buy 1 unit at price 747.919983, total balance 3927.320069
day 21: buy 1 unit at price 750.500000, total balance 3176.820069
day 24, sell 1 unit at price 771.190002, investment 1.131715 %, total balance
3948.010071,
day 25: buy 1 unit at price 776.419983, total balance 3171.590088
day 26, sell 1 unit at price 789.289978, investment 3.245343 %, total balance
3960.880066,
day 27: buy 1 unit at price 789.270020, total balance 3171.610046
day 29, sell 1 unit at price 797.070007, investment 3.350496 %, total balance
3968.680053,
day 30, sell 1 unit at price 797.849976, investment 4.905725 %, total balance
4766.530029,
```

day 31, sell 1 unit at price 790.799988, investment 2.936582 %, total balance 5557.330017,
day 32: buy 1 unit at price 794.200012, total balance 4763.130005
day 33: buy 1 unit at price 796.419983, total balance 3966.710022
day 34: buy 1 unit at price 794.559998, total balance 3172.150024
day 36: buy 1 unit at price 789.909973, total balance 2382.240051
day 37, sell 1 unit at price 791.549988, investment 2.686674 %, total balance 3173.790039,
day 40: buy 1 unit at price 771.820007, total balance 2401.970032
day 41: buy 1 unit at price 786.140015, total balance 1615.830017
day 42: buy 1 unit at price 786.900024, total balance 828.929993
day 44: buy 1 unit at price 806.150024, total balance 22.779969
day 45, sell 1 unit at price 806.650024, investment 6.412597 %, total balance 829.429993,
day 48, sell 1 unit at price 806.359985, investment 7.813670 %, total balance 1635.789978,
day 49, sell 1 unit at price 807.880005, investment 7.645570 %, total balance 2443.669983,
day 50, sell 1 unit at price 804.609985, investment 3.630767 %, total balance 3248.279968,
day 51: buy 1 unit at price 806.070007, total balance 2442.209961
day 52: buy 1 unit at price 802.174988, total balance 1640.034973
day 53: buy 1 unit at price 805.020020, total balance 835.014953
day 56, sell 1 unit at price 835.669983, investment 5.878845 %, total balance 1670.684936,
day 57, sell 1 unit at price 832.150024, investment 4.778395 %, total balance 2502.834960,
day 59: buy 1 unit at price 802.320007, total balance 1700.514953
day 61: buy 1 unit at price 795.695007, total balance 904.819946
day 62: buy 1 unit at price 798.530029, total balance 106.289917
day 69, sell 1 unit at price 819.239990, investment 2.865323 %, total balance 925.529907,
day 70, sell 1 unit at price 820.450012, investment 3.258409 %, total balance 1745.979919,
day 71: buy 1 unit at price 818.979980, total balance 926.999939
day 72: buy 1 unit at price 824.159973, total balance 102.839966
day 74, sell 1 unit at price 831.659973, investment 5.285412 %, total balance 934.499939,
day 76, sell 1 unit at price 831.330017, investment 7.710348 %, total balance 1765.829956,
day 77, sell 1 unit at price 828.640015, investment 5.406162 %, total balance 2594.469971,
day 78, sell 1 unit at price 829.280029, investment 5.385691 %, total balance 3423.750000,
day 79: buy 1 unit at price 823.210022, total balance 2600.539978
day 80: buy 1 unit at price 835.239990, total balance 1765.299988
day 81: buy 1 unit at price 830.630005, total balance 934.669983
day 83: buy 1 unit at price 827.780029, total balance 106.889954

day 85, sell 1 unit at price 835.369995, investment 3.624632 %, total balance 942.259949,
day 88: buy 1 unit at price 845.539978, total balance 96.719971
day 89, sell 1 unit at price 845.619995, investment 4.906520 %, total balance 942.339966,
day 90, sell 1 unit at price 847.200012, investment 5.612868 %, total balance 1789.539978,
day 92, sell 1 unit at price 852.119995, investment 5.850783 %, total balance 2641.659973,
day 93, sell 1 unit at price 848.400024, investment 5.743346 %, total balance 3490.059997,
day 95: buy 1 unit at price 829.590027, total balance 2660.469970
day 96: buy 1 unit at price 817.580017, total balance 1842.889953
day 98: buy 1 unit at price 819.510010, total balance 1023.379943
day 99: buy 1 unit at price 820.919983, total balance 202.459960
day 105, sell 1 unit at price 831.409973, investment 4.488525 %, total balance 1033.869933,
day 107: buy 1 unit at price 824.669983, total balance 209.199950
day 113, sell 1 unit at price 836.820007, investment 4.795058 %, total balance 1046.019957,
day 115: buy 1 unit at price 841.650024, total balance 204.369933
day 116, sell 1 unit at price 843.190002, investment 2.956119 %, total balance 1047.559935,
day 118: buy 1 unit at price 872.299988, total balance 175.259947
day 119, sell 1 unit at price 871.729980, investment 5.771939 %, total balance 1046.989927,
day 120: buy 1 unit at price 874.250000, total balance 172.739927
day 121, sell 1 unit at price 905.960022, investment 10.052113 %, total balance 1078.699949,
day 122, sell 1 unit at price 912.570007, investment 9.258419 %, total balance 1991.269956,
day 123, sell 1 unit at price 916.440002, investment 10.330712 %, total balance 2907.709958,
day 124, sell 1 unit at price 927.039978, investment 11.991102 %, total balance 3834.749936,
day 125, sell 1 unit at price 931.659973, investment 10.185207 %, total balance 4766.409909,
day 126, sell 1 unit at price 927.130005, investment 11.757612 %, total balance 5693.539914,
day 127, sell 1 unit at price 934.299988, investment 14.276275 %, total balance 6627.839902,
day 128, sell 1 unit at price 932.169983, investment 13.747236 %, total balance 7560.009885,
day 129: buy 1 unit at price 928.780029, total balance 6631.229856
day 130: buy 1 unit at price 930.599976, total balance 5700.629880
day 132: buy 1 unit at price 937.080017, total balance 4763.549863
day 133: buy 1 unit at price 943.000000, total balance 3820.549863
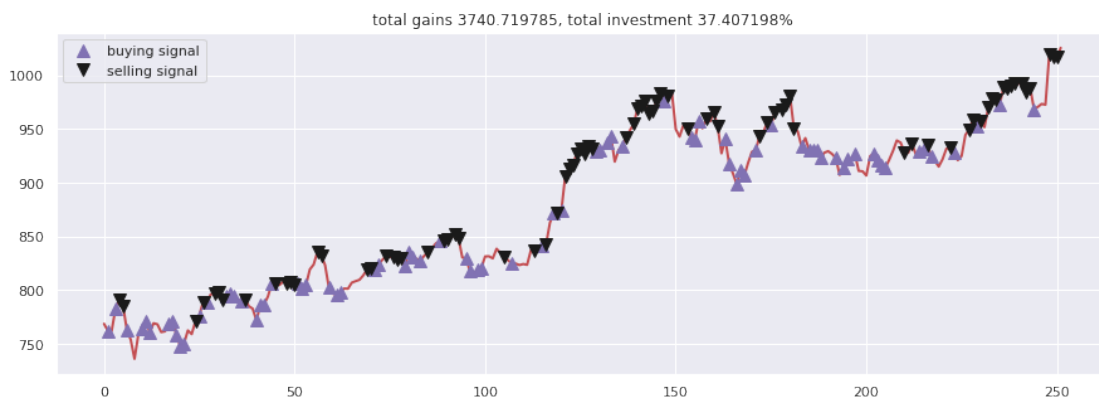day 136: buy 1 unit at price 934.010010, total balance 2886.539853

day 137, sell 1 unit at price 941.859985, investment 14.732252 %, total balance 3828.399838,
day 139, sell 1 unit at price 954.960022, investment 15.799052 %, total balance 4783.359860,
day 140, sell 1 unit at price 969.539978, investment 15.195146 %, total balance 5752.899838,
day 141, sell 1 unit at price 971.469971, investment 11.368793 %, total balance 6724.369809,
day 142, sell 1 unit at price 975.880005, investment 11.624822 %, total balance 7700.249814,
day 143, sell 1 unit at price 964.859985, investment 3.884661 %, total balance 8665.109799,
day 144, sell 1 unit at price 966.950012, investment 3.906086 %, total balance 9632.059811,
day 145, sell 1 unit at price 975.599976, investment 4.110637 %, total balance 10607.659787,
day 146, sell 1 unit at price 983.679993, investment 4.313891 %, total balance 11591.339780,
day 147: buy 1 unit at price 976.570007, total balance 10614.769773
day 148, sell 1 unit at price 980.940002, investment 5.024571 %, total balance 11595.709775,
day 153, sell 1 unit at price 950.760010, investment -2.642923 %, total balance 12546.469785,
day 154: buy 1 unit at price 942.309998, total balance 11604.159787
day 155: buy 1 unit at price 939.780029, total balance 10664.379758
day 156: buy 1 unit at price 957.369995, total balance 9707.009763
day 158, sell 1 unit at price 959.450012, investment 1.818936 %, total balance 10666.459775,
day 160, sell 1 unit at price 965.590027, investment 2.746387 %, total balance 11632.049802,
day 161, sell 1 unit at price 952.270020, investment -0.532707 %, total balance 12584.319822,
day 163: buy 1 unit at price 940.489990, total balance 11643.829832
day 164: buy 1 unit at price 917.789978, total balance 10726.039854
day 166: buy 1 unit at price 898.700012, total balance 9827.339842
day 167: buy 1 unit at price 911.710022, total balance 8915.629820
day 168: buy 1 unit at price 906.690002, total balance 8008.939818
day 171: buy 1 unit at price 930.090027, total balance 7078.849791
day 172, sell 1 unit at price 943.830017, investment 0.355137 %, total balance 8022.679808,
day 174, sell 1 unit at price 955.989990, investment 4.162174 %, total balance 8978.669798,
day 175: buy 1 unit at price 953.419983, total balance 8025.249815
day 176, sell 1 unit at price 965.400024, investment 7.421833 %, total balance 8990.649839,
day 178, sell 1 unit at price 968.150024, investment 6.190565 %, total balance 9958.799863,
day 179, sell 1 unit at price 972.919983, investment 7.304589 %, total balance

10931.719846,
day 180, sell 1 unit at price 980.340027, investment 5.402703 %, total balance
11912.059873,
day 181, sell 1 unit at price 950.700012, investment -0.285286 %, total balance
12862.759885,
day 183: buy 1 unit at price 934.090027, total balance 11928.669858
day 185: buy 1 unit at price 930.500000, total balance 10998.169858
day 186: buy 1 unit at price 930.830017, total balance 10067.339841
day 187: buy 1 unit at price 930.390015, total balance 9136.949826
day 188: buy 1 unit at price 923.650024, total balance 8213.299802
day 192: buy 1 unit at price 922.900024, total balance 7290.399778
day 194: buy 1 unit at price 914.390015, total balance 6376.009763
day 195: buy 1 unit at price 922.669983, total balance 5453.339780
day 197: buy 1 unit at price 926.960022, total balance 4526.379758
day 202: buy 1 unit at price 927.000000, total balance 3599.379758
day 203: buy 1 unit at price 921.280029, total balance 2678.099729
day 204: buy 1 unit at price 915.890015, total balance 1762.209714
day 205: buy 1 unit at price 913.809998, total balance 848.399716
day 210, sell 1 unit at price 928.450012, investment -0.603798 %, total balance
1776.849728,
day 212, sell 1 unit at price 935.950012, investment 0.585708 %, total balance
2712.799740,
day 214: buy 1 unit at price 929.080017, total balance 1783.719723
day 215: buy 1 unit at price 932.070007, total balance 851.649716
day 216, sell 1 unit at price 935.090027, investment 0.457657 %, total balance
1786.739743,
day 217: buy 1 unit at price 925.109985, total balance 861.629758
day 222, sell 1 unit at price 932.450012, investment 0.221412 %, total balance
1794.079770,
day 223: buy 1 unit at price 928.530029, total balance 865.549741
day 227, sell 1 unit at price 949.500000, investment 2.798676 %, total balance
1815.049741,
day 228, sell 1 unit at price 959.109985, investment 3.923498 %, total balance
2774.159726,
day 229: buy 1 unit at price 953.270020, total balance 1820.889706
day 230, sell 1 unit at price 957.789978, investment 4.746329 %, total balance
2778.679684,
day 232, sell 1 unit at price 969.960022, investment 5.125347 %, total balance
3748.639706,
day 233, sell 1 unit at price 978.890015, investment 5.602183 %, total balance
4727.529721,
day 234, sell 1 unit at price 977.000000, investment 5.393743 %, total balance
5704.529721,
day 235: buy 1 unit at price 972.599976, total balance 4731.929745
day 236, sell 1 unit at price 989.250000, investment 7.377775 %, total balance
5721.179745,
day 237, sell 1 unit at price 987.830017, investment 7.854655 %, total balance
6709.009762,

```
day 238, sell 1 unit at price 989.679993, investment 8.302601 %, total balance
7698.689755,
day 239, sell 1 unit at price 992.000000, investment 6.772289 %, total balance
8690.689755,
day 241, sell 1 unit at price 992.809998, investment 6.516677 %, total balance
9683.499753,
day 242, sell 1 unit at price 984.450012, investment 6.414375 %, total balance
10667.949765,
day 243, sell 1 unit at price 988.200012, investment 6.426285 %, total balance
11656.149777,
day 244: buy 1 unit at price 968.450012, total balance 10687.699765
day 248, sell 1 unit at price 1019.270020, investment 6.923537 %, total balance
11706.969785,
day 249, sell 1 unit at price 1017.109985, investment 4.576394 %, total balance
12724.079770,
day 250, sell 1 unit at price 1016.640015, investment 4.975993 %, total balance
13740.719785,
```

[8]:
```python
fig = plt.figure(figsize = (15,5))
plt.plot(close, color='r', lw=2.)
plt.plot(close, '^', markersize=10, color='m', label = 'buying signal',
 ↪markevery = states_buy)
plt.plot(close, 'v', markersize=10, color='k', label = 'selling signal',
 ↪markevery = states_sell)
plt.title('total gains %f, total investment %f%%'%(total_gains, invest))
plt.legend()
plt.show()
```



total gains 3740.719785, total investment 37.407198%

[ ]: