

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()
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[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))
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seaborn==0.9.0
pandas==0.23.4
numpy==1.14.5
matplotlib==3.0.2
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[3]: def get_state(data, t, n):
    d = t - n + 1
    block = data[d : t + 1] if d >= 0 else -d * [data[0]] + data[0 : t + 1]
    res = []
    for i in range(n - 1):
        res.append(block[i + 1] - block[i])
    return np.array([res])
```

TSLA Time Period: Mar 23, 2018 - Mar 23, 2019

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[6]: df = pd.read_csv('../dataset/TSLA.csv')
df.head()
```

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[6]:
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	Date	Open	High	Low	Close	Adj Close	\
0	2018-03-23	311.250000	311.250000	300.450012	301.540009	301.540009	
1	2018-03-26	307.339996	307.589996	291.359985	304.179993	304.179993	
2	2018-03-27	304.000000	304.269989	277.179993	279.179993	279.179993	
3	2018-03-28	264.579987	268.679993	252.100006	257.779999	257.779999	
4	2018-03-29	256.489990	270.959991	248.210007	266.130005	266.130005	


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    Volume
0    6654900
1    8375200
2   13872000
3   21001400
4   15170700
```

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[7]: close = df.Close.values.tolist()
window_size = 30
skip = 1
l = len(close) - 1
```

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[8]: 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 = []
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        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)
            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)
            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(layer_size, 1),
            np.random.randn(1, layer_size),

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    ]

    def predict(self, inputs):
        feed = np.dot(inputs, self.weights[0]) + self.weights[-1]
        decision = np.dot(feed, self.weights[1])
        buy = np.dot(feed, self.weights[2])
        return decision, buy

    def get_weights(self):
        return self.weights

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

```

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[9]: class Agent:

    POPULATION_SIZE = 15
    SIGMA = 0.1
    LEARNING_RATE = 0.03

    def __init__(self, model, money, max_buy, max_sell):
        self.model = model
        self.initial_money = money
        self.max_buy = max_buy
        self.max_sell = max_sell
        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, buy = self.model.predict(np.array(sequence))
        return np.argmax(decision[0]), int(buy[0])

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

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        if action == 1 and initial_money >= close[t]:
            if buy < 0:
                buy = 1
            if buy > self.max_buy:
                buy_units = self.max_buy
            else:
                buy_units = buy
            total_buy = buy_units * close[t]
            initial_money -= total_buy
            inventory.append(total_buy)
            quantity += buy_units
        elif action == 2 and len(inventory) > 0:
            if quantity > self.max_sell:
                sell_units = self.max_sell
            else:
                sell_units = quantity
            quantity -= sell_units
            total_sell = sell_units * close[t]
            initial_money += total_sell

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

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

def buy(self):
    initial_money = self.initial_money
    state = get_state(close, 0, window_size + 1)
    starting_money = initial_money
    states_sell = []
    states_buy = []
    inventory = []
    quantity = 0
    for t in range(0, 1, skip):
        action, buy = self.act(state)
        next_state = get_state(close, t + 1, window_size + 1)
        if action == 1 and initial_money >= close[t]:
            if buy < 0:
                buy = 1
            if buy > self.max_buy:
                buy_units = self.max_buy
            else:
                buy_units = buy
            total_buy = buy_units * close[t]
            initial_money -= total_buy
            inventory.append(total_buy)

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        quantity += buy_units
        states_buy.append(t)
        print(
            'day %d: buy %d units at price %f, total balance %f'
            % (t, buy_units, total_buy, initial_money)
        )
    elif action == 2 and len(inventory) > 0:
        bought_price = inventory.pop(0)
        if quantity > self.max_sell:
            sell_units = self.max_sell
        else:
            sell_units = quantity
        if sell_units < 1:
            continue
        quantity -= sell_units
        total_sell = sell_units * close[t]
        initial_money += total_sell
        states_sell.append(t)
        try:
            invest = ((total_sell - bought_price) / bought_price) * 100
        except:
            invest = 0
        print(
            'day %d, sell %d units at price %f, investment %f %, total_
→balance %f,'
            % (t, sell_units, total_sell, invest, initial_money)
        )
        state = next_state

invest = ((initial_money - starting_money) / starting_money) * 100
print(
    '\ntotal gained %f, total investment %f %%'
    % (initial_money - starting_money, invest)
)
plt.figure(figsize = (20, 10))
plt.plot(close, label = 'true close', c = 'g')
plt.plot(
    close, 'X', label = 'predict buy', markevery = states_buy, c = 'b'
)
plt.plot(
    close, 'o', label = 'predict sell', markevery = states_sell, c = 'r'
)
plt.legend()
plt.show()

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[10]: model = Model(window_size, 500, 3)
      agent = Agent(model, 10000, 5, 5)

```

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agent.fit(500, 10)
```

```
iter 10. reward: 22.809600
iter 20. reward: 51.687003
iter 30. reward: 61.576206
iter 40. reward: 69.384603
iter 50. reward: 74.372100
iter 60. reward: 86.872802
iter 70. reward: 95.984703
iter 80. reward: 86.611603
iter 90. reward: 91.603299
iter 100. reward: 97.332000
iter 110. reward: 97.179203
iter 120. reward: 99.749703
iter 130. reward: 100.879403
iter 140. reward: 87.869305
iter 150. reward: 95.844503
iter 160. reward: 103.064303
iter 170. reward: 108.591401
iter 180. reward: 113.703303
iter 190. reward: 109.320401
iter 200. reward: 114.320704
iter 210. reward: 118.800302
iter 220. reward: 120.808302
iter 230. reward: 116.255301
iter 240. reward: 118.316202
iter 250. reward: 118.671802
iter 260. reward: 118.965402
iter 270. reward: 118.079800
iter 280. reward: 115.773998
iter 290. reward: 109.795800
iter 300. reward: 116.520801
iter 310. reward: 119.137195
iter 320. reward: 118.383199
iter 330. reward: 114.609903
iter 340. reward: 125.628802
iter 350. reward: 121.527300
iter 360. reward: 121.432399
iter 370. reward: 118.581801
iter 380. reward: 119.989300
iter 390. reward: 120.004502
iter 400. reward: 124.851201
iter 410. reward: 122.869297
iter 420. reward: 123.599999
iter 430. reward: 126.341600
iter 440. reward: 127.074699
iter 450. reward: 128.540102
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iter 460. reward: 126.781902
iter 470. reward: 128.691898
iter 480. reward: 127.336802
iter 490. reward: 127.829601
iter 500. reward: 129.304401
time taken to train: 36.91986346244812 seconds
```

```
[11]: agent.buy()
```

```
day 2: buy 5 units at price 1395.899965, total balance 8604.100035
day 3: buy 5 units at price 1288.899995, total balance 7315.200040
day 4: buy 5 units at price 1330.650025, total balance 5984.550015
day 5: buy 5 units at price 1262.399980, total balance 4722.150035
day 6: buy 5 units at price 1337.649995, total balance 3384.500040
day 8, sell 5 units at price 1528.600005, investment 9.506415 %, total balance
4913.100045,
day 11, sell 5 units at price 1523.500060, investment 18.201572 %, total balance
6436.600105,
day 12, sell 5 units at price 1504.649965, investment 13.076311 %, total balance
7941.250070,
day 13: buy 5 units at price 1470.399935, total balance 6470.850135
day 14, sell 5 units at price 1501.699980, investment 18.955957 %, total balance
7972.550115,
day 15: buy 5 units at price 1456.049955, total balance 6516.500160
day 16: buy 5 units at price 1438.450010, total balance 5078.050150
day 18, sell 5 units at price 1500.399935, investment 12.166855 %, total balance
6578.450085,
day 19: buy 5 units at price 1451.199950, total balance 5127.250135
day 22: buy 5 units at price 1403.450010, total balance 3723.800125
day 24, sell 5 units at price 1470.399935, investment 0.000000 %, total balance
5194.200060,
day 25: buy 5 units at price 1469.499970, total balance 3724.700090
day 26, sell 5 units at price 1499.600065, investment 2.990976 %, total balance
5224.300155,
day 27, sell 5 units at price 1505.749970, investment 4.678644 %, total balance
6730.050125,
day 28: buy 1 units at price 284.450012, total balance 6445.600113
day 29: buy 1 units at price 294.089996, total balance 6151.510117
day 30, sell 5 units at price 1513.849945, investment 4.317117 %, total balance
7665.360062,
day 31: buy 5 units at price 1509.850005, total balance 6155.510057
day 32, sell 5 units at price 1534.250030, investment 9.319892 %, total balance
7689.760087,
day 34, sell 5 units at price 1505.299990, investment 2.436204 %, total balance
9195.060077,
day 35: buy 5 units at price 1459.850005, total balance 7735.210072
day 36: buy 5 units at price 1420.899965, total balance 6314.310107
day 37, sell 5 units at price 1432.400055, investment 403.568288 %, total
```

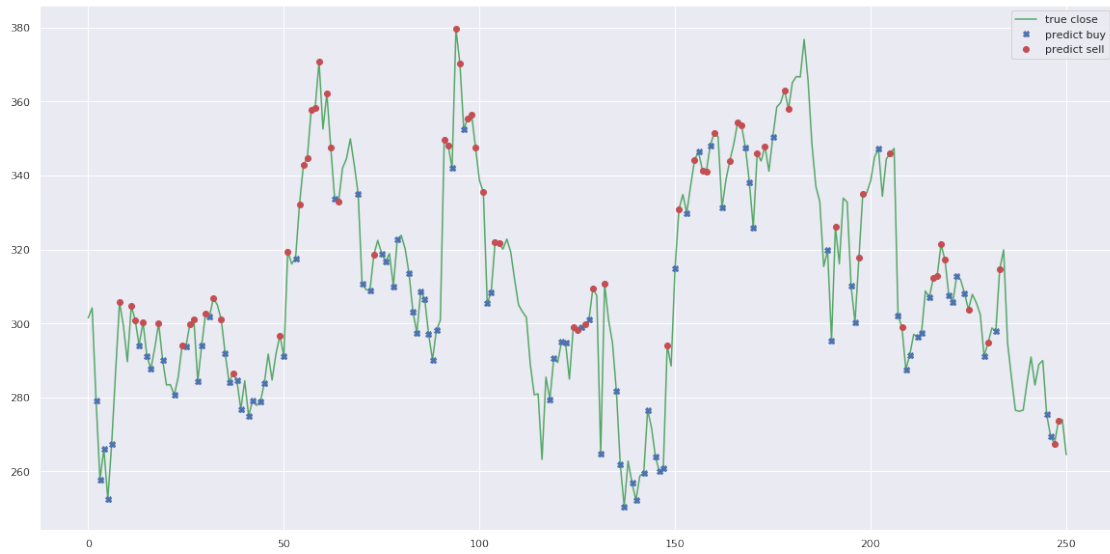

balance 7746.710162,
 day 38: buy 5 units at price 1422.700045, total balance 6324.010117
 day 39: buy 5 units at price 1384.100035, total balance 4939.910082
 day 41: buy 5 units at price 1375.050050, total balance 3564.860032
 day 42: buy 5 units at price 1395.350035, total balance 2169.509997
 day 44: buy 5 units at price 1394.250030, total balance 775.259967
 day 45: buy 5 units at price 1418.800050, total balance -643.540083
 day 49, sell 5 units at price 1483.699950, investment 404.505413 %, total
 balance 840.159867,
 day 50: buy 5 units at price 1455.650025, total balance -615.490158
 day 51, sell 5 units at price 1597.500000, investment 5.805212 %, total balance
 982.009842,
 day 53: buy 5 units at price 1588.300020, total balance -606.290178
 day 54, sell 5 units at price 1660.500030, investment 13.744564 %, total balance
 1054.209852,
 day 55, sell 5 units at price 1713.849945, investment 20.617214 %, total balance
 2768.059797,
 day 56, sell 5 units at price 1723.899995, investment 21.171009 %, total balance
 4491.959792,
 day 57, sell 5 units at price 1788.600005, investment 29.224764 %, total balance
 6280.559797,
 day 58, sell 5 units at price 1790.850065, investment 30.238900 %, total balance
 8071.409862,
 day 59, sell 5 units at price 1854.149935, investment 32.880631 %, total balance
 9925.559797,
 day 61, sell 5 units at price 1811.100005, investment 29.897792 %, total balance
 11736.659802,
 day 62, sell 5 units at price 1737.550050, investment 22.466168 %, total balance
 13474.209852,
 day 63: buy 1 units at price 333.630005, total balance 13140.579847
 day 64, sell 3 units at price 999.030030, investment -31.368803 %, total balance
 14139.609877,
 day 69: buy 1 units at price 335.070007, total balance 13804.539870
 day 70: buy 1 units at price 310.859985, total balance 13493.679885
 day 72: buy 5 units at price 1544.499970, total balance 11949.179915
 day 73, sell 5 units at price 1592.550050, investment 375.288751 %, total
 balance 13541.729965,
 day 75: buy 1 units at price 318.959991, total balance 13222.769974
 day 76: buy 5 units at price 1583.549955, total balance 11639.220019
 day 78: buy 5 units at price 1550.500030, total balance 10088.719989
 day 79: buy 1 units at price 322.690002, total balance 9766.029987
 day 82: buy 5 units at price 1567.899935, total balance 8198.130052
 day 83: buy 1 units at price 303.200012, total balance 7894.930040
 day 84: buy 5 units at price 1487.149965, total balance 6407.780075
 day 85: buy 1 units at price 308.739990, total balance 6099.040085
 day 86: buy 5 units at price 1533.249970, total balance 4565.790115
 day 87: buy 1 units at price 297.179993, total balance 4268.610122
 day 88: buy 5 units at price 1450.850065, total balance 2817.760057

day 89: buy 5 units at price 1490.700075, total balance 1327.059982
 day 91, sell 5 units at price 1747.700045, investment 462.214543 %, total
 balance 3074.760027,
 day 92, sell 5 units at price 1740.850065, investment 12.712858 %, total balance
 4815.610092,
 day 93: buy 1 units at price 341.989990, total balance 4473.620102
 day 94, sell 5 units at price 1897.850035, investment 495.011941 %, total
 balance 6371.470137,
 day 95, sell 5 units at price 1851.699980, investment 16.933474 %, total balance
 8223.170117,
 day 96: buy 1 units at price 352.450012, total balance 7870.720105
 day 97, sell 5 units at price 1777.449950, investment 14.637208 %, total balance
 9648.170055,
 day 98, sell 5 units at price 1782.050020, investment 452.248291 %, total
 balance 11430.220075,
 day 99, sell 5 units at price 1738.200075, investment 10.861671 %, total balance
 13168.420150,
 day 101, sell 5 units at price 1677.250060, investment 453.182716 %, total
 balance 14845.670210,
 day 102: buy 5 units at price 1527.500000, total balance 13318.170210
 day 103: buy 1 units at price 308.440002, total balance 13009.730208
 day 104, sell 5 units at price 1609.499970, investment 8.227146 %, total balance
 14619.230178,
 day 105, sell 5 units at price 1608.200075, investment 420.891406 %, total
 balance 16227.430253,
 day 118: buy 5 units at price 1397.200010, total balance 14830.230243
 day 119: buy 5 units at price 1452.700045, total balance 13377.530198
 day 121: buy 5 units at price 1476.000060, total balance 11901.530138
 day 122: buy 5 units at price 1474.199980, total balance 10427.330158
 day 124, sell 5 units at price 1495.099945, investment 7.006866 %, total balance
 11922.430103,
 day 125, sell 5 units at price 1491.649935, investment 2.681207 %, total balance
 13414.080038,
 day 126: buy 1 units at price 299.100006, total balance 13114.980032
 day 127, sell 5 units at price 1498.399965, investment 1.517609 %, total balance
 14613.379997,
 day 128: buy 5 units at price 1504.949950, total balance 13108.430047
 day 129, sell 5 units at price 1547.899935, investment 4.999319 %, total balance
 14656.329982,
 day 131: buy 5 units at price 1323.849945, total balance 13332.480037
 day 132, sell 5 units at price 1553.500060, investment 419.391517 %, total
 balance 14885.980097,
 day 135: buy 1 units at price 281.829987, total balance 14604.150110
 day 136: buy 5 units at price 1309.750060, total balance 13294.400050
 day 137: buy 5 units at price 1252.799990, total balance 12041.600060
 day 139: buy 5 units at price 1284.400025, total balance 10757.200035
 day 140: buy 5 units at price 1261.149980, total balance 9496.050055
 day 142: buy 5 units at price 1297.949980, total balance 8198.100075

day 143: buy 1 units at price 276.589996, total balance 7921.510079
 day 145: buy 5 units at price 1319.550020, total balance 6601.960059
 day 146: buy 1 units at price 260.000000, total balance 6341.960059
 day 147: buy 5 units at price 1304.750060, total balance 5037.209999
 day 148, sell 5 units at price 1470.700075, investment -2.275815 %, total balance 6507.910074,
 day 150: buy 5 units at price 1574.299925, total balance 4933.610149
 day 151, sell 5 units at price 1654.499970, investment 24.976398 %, total balance 6588.110119,
 day 153: buy 5 units at price 1649.499970, total balance 4938.610149
 day 155, sell 5 units at price 1721.399995, investment 510.793767 %, total balance 6660.010144,
 day 156: buy 1 units at price 346.410004, total balance 6313.600140
 day 157, sell 5 units at price 1706.999970, investment 30.330207 %, total balance 8020.600110,
 day 158, sell 5 units at price 1705.299990, investment 36.119094 %, total balance 9725.900100,
 day 159: buy 1 units at price 348.160004, total balance 9377.740096
 day 160, sell 5 units at price 1756.999970, investment 36.795386 %, total balance 11134.740066,
 day 162: buy 1 units at price 331.279999, total balance 10803.460067
 day 164, sell 5 units at price 1720.000000, investment 36.383462 %, total balance 12523.460067,
 day 166, sell 5 units at price 1771.549990, investment 36.488310 %, total balance 14295.010057,
 day 167, sell 5 units at price 1767.350005, investment 538.978282 %, total balance 16062.360062,
 day 168: buy 1 units at price 347.489990, total balance 15714.870072
 day 169: buy 1 units at price 338.190002, total balance 15376.680070
 day 170: buy 1 units at price 325.829987, total balance 15050.850083
 day 171, sell 5 units at price 1730.000000, investment 31.105299 %, total balance 16780.850083,
 day 173, sell 5 units at price 1739.349975, investment 568.980760 %, total balance 18520.200058,
 day 175: buy 5 units at price 1752.400055, total balance 16767.800003
 day 178, sell 5 units at price 1815.299990, investment 39.130094 %, total balance 18583.099993,
 day 179, sell 5 units at price 1789.850005, investment 13.691805 %, total balance 20372.949998,
 day 189: buy 1 units at price 319.769989, total balance 20053.180009
 day 190: buy 5 units at price 1476.950075, total balance 18576.229934
 day 191, sell 5 units at price 1630.449980, investment 409.882114 %, total balance 20206.679914,
 day 195: buy 1 units at price 310.119995, total balance 19896.559919
 day 196: buy 5 units at price 1501.799925, total balance 18394.759994
 day 197, sell 5 units at price 1588.450010, investment 7.549337 %, total balance 19983.210004,
 day 198, sell 2 units at price 669.919982, investment 116.019603 %, total

balance 20653.129986,
 day 202: buy 1 units at price 347.260010, total balance 20305.869976
 day 205, sell 1 units at price 346.049988, investment -0.348448 %, total balance
 20651.919964,
 day 207: buy 1 units at price 302.260010, total balance 20349.659954
 day 208, sell 1 units at price 298.920013, investment -1.105008 %, total balance
 20648.579967,
 day 209: buy 5 units at price 1437.949980, total balance 19210.629987
 day 210: buy 5 units at price 1457.550050, total balance 17753.079937
 day 212: buy 5 units at price 1481.900025, total balance 16271.179912
 day 213: buy 1 units at price 297.459991, total balance 15973.719921
 day 215: buy 1 units at price 307.019989, total balance 15666.699932
 day 216, sell 5 units at price 1561.049955, investment 8.560797 %, total balance
 17227.749887,
 day 217, sell 5 units at price 1564.450075, investment 7.334227 %, total balance
 18792.199962,
 day 218, sell 5 units at price 1606.750030, investment 8.424995 %, total balance
 20398.949992,
 day 219, sell 2 units at price 634.440002, investment 113.285827 %, total
 balance 21033.389994,
 day 220: buy 1 units at price 307.510010, total balance 20725.879984
 day 221: buy 5 units at price 1528.999940, total balance 19196.880044
 day 222: buy 1 units at price 312.839996, total balance 18884.040048
 day 224: buy 1 units at price 308.170013, total balance 18575.870035
 day 225, sell 5 units at price 1518.849945, investment 394.707185 %, total
 balance 20094.719980,
 day 229: buy 5 units at price 1456.150055, total balance 18638.569925
 day 230, sell 5 units at price 1473.549955, investment 379.187638 %, total
 balance 20112.119880,
 day 232: buy 1 units at price 297.859985, total balance 19814.259895
 day 233, sell 4 units at price 1258.959960, investment -17.661216 %, total
 balance 21073.219855,
 day 245: buy 5 units at price 1377.149965, total balance 19696.069890
 day 246: buy 1 units at price 269.489990, total balance 19426.579900
 day 247, sell 5 units at price 1337.350005, investment -2.890024 %, total
 balance 20763.929905,
 day 248, sell 1 units at price 273.600006, investment 1.525109 %, total balance
 21037.529911,

 total gained 11037.529911, total investment 110.375299 %



[]: