Assignment 3

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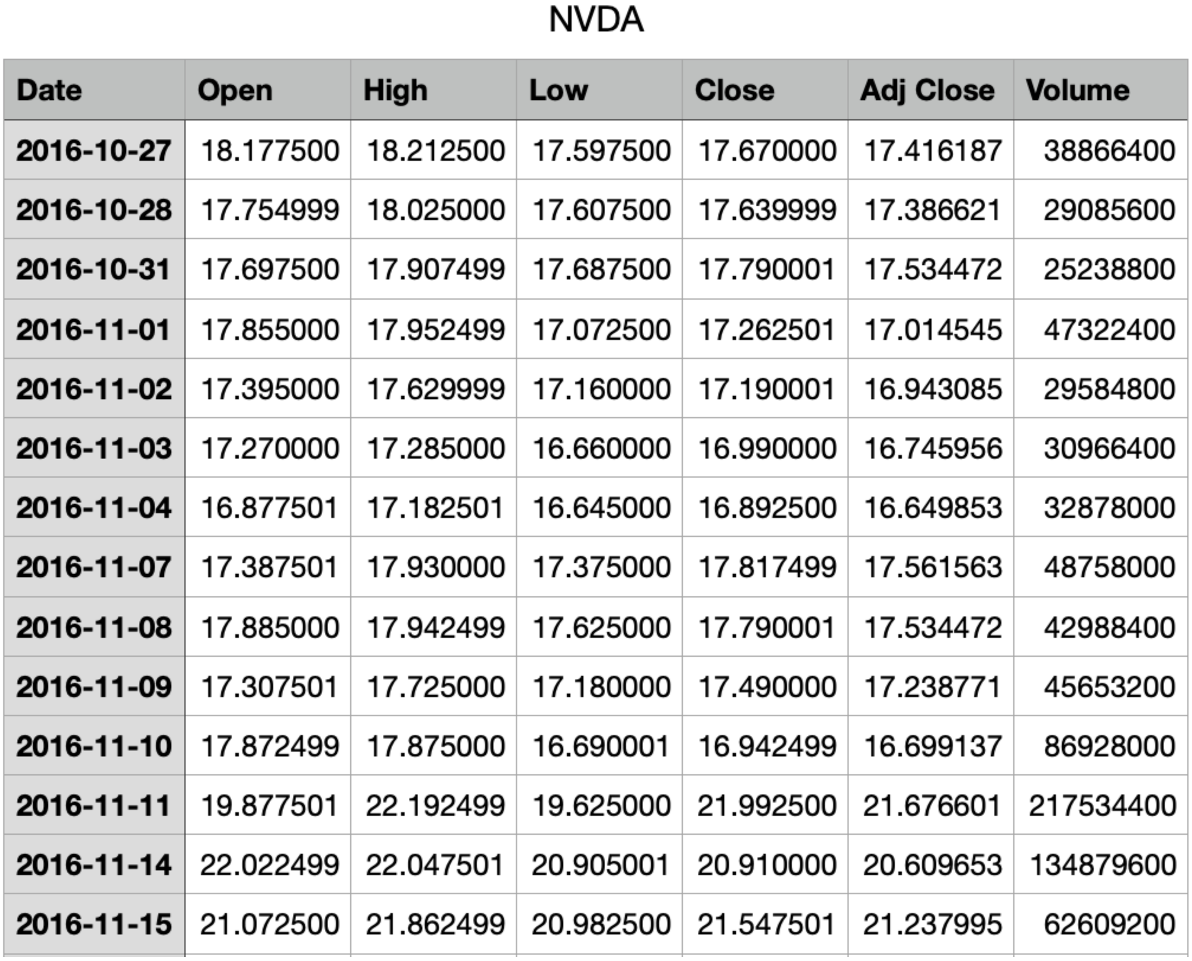
Dec 10 2021

1. Overview

The goal here is to use Reinforcement learning to learn trends in the stock market. After the agent has learnt, use it to perform a series of trades. Q learning is used here for Reinforcement learning.

2. Dataset

The dataset has stock information for NVDA stock price from 10/27/2016 to 10/26/2021.



NVDA

Date	Open	High	Low	Close	Adj Close	Volume
2016-10-27	18.177500	18.212500	17.597500	17.670000	17.416187	38866400
2016-10-28	17.754999	18.025000	17.607500	17.639999	17.386621	29085600
2016-10-31	17.697500	17.907499	17.687500	17.790001	17.534472	25238800
2016-11-01	17.855000	17.952499	17.072500	17.262501	17.014545	47322400
2016-11-02	17.395000	17.629999	17.160000	17.190001	16.943085	29584800
2016-11-03	17.270000	17.285000	16.660000	16.990000	16.745956	30966400
2016-11-04	16.877501	17.182501	16.645000	16.892500	16.649853	32878000
2016-11-07	17.387501	17.930000	17.375000	17.817499	17.561563	48758000
2016-11-08	17.885000	17.942499	17.625000	17.790001	17.534472	42988400
2016-11-09	17.307501	17.725000	17.180000	17.490000	17.238771	45653200
2016-11-10	17.872499	17.875000	16.690001	16.942499	16.699137	86928000
2016-11-11	19.877501	22.192499	19.625000	21.992500	21.676601	217534400
2016-11-14	22.022499	22.047501	20.905001	20.910000	20.609653	134879600
2016-11-15	21.072500	21.862499	20.982500	21.547501	21.237995	62609200

Fig 1 - Sample images in dataset

The information in each column is :

- Open - the price at which the stock opened.
- High - the intraday high.
- Low - the intraday low.

- Close - the price at which the stock closed.
- Adj Close - the adjusted closing price.
- Volume - the volume of shares traded for the day.

3. Environment Details

Actions, states, rewards and Goal are a function of the environment.

- Actions - Can be 0, 1, 2. Representing Buy, Sell, Hold.
- States - Can be 0, 1, 2, 3. Which are encoding of the following arrays. Each entry at index is a boolean value i.e 0 - Price Increased , 1 - Price Decreased, 2 - Stock Held, 3 - Stock Not held
  - 0 - [1, 0, 0, 1]
  - 1 - [1, 0, 1, 0]
  - 2 - [0, 1, 0, 1]
  - 3 - [0, 1, 1, 0]
- Goal is a flag Done
- Reward is a return of an action taken corresponding to an observation.

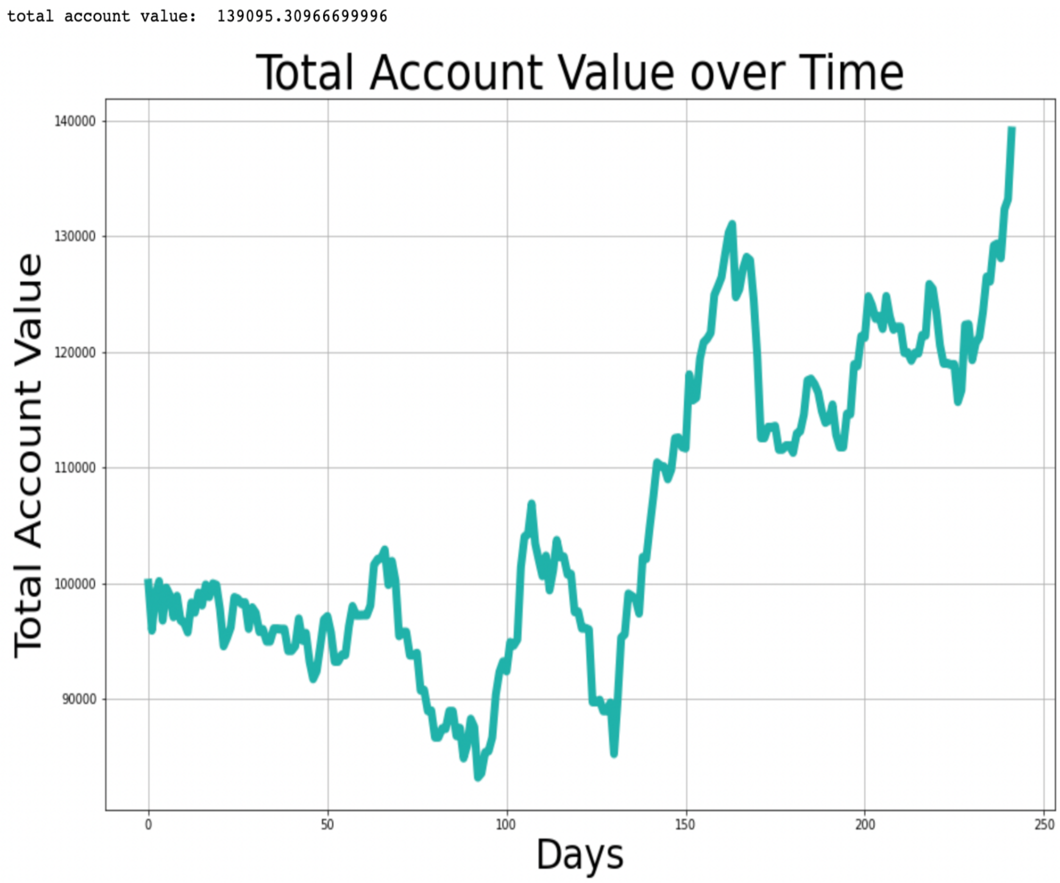
4. Q learning

4.1 Training and Testing the model

Deterministic Q learning algorithm is implemented from scratch and used as an RL algorithm. The Qtable is a 3 x 4 table. Where 3 is number of actions and 4 is number of observations. ε greedy selection method is used to decide which action to choose. During the training phase this value favours exploration during initial episodes and exploitation during later episodes. However, during testing a greedy selection method is used which always exploits.

4.2. Outcome

Starting from an account value of $100000 the trained agent increases the total value to **$139095.30**.



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total account value:  139095.30966699996
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Fig 2 - Model Performance

Explanation -

The graph value depicts account values over time. While selecting action we choose the most optimal action i.e the most greedy action at a state.

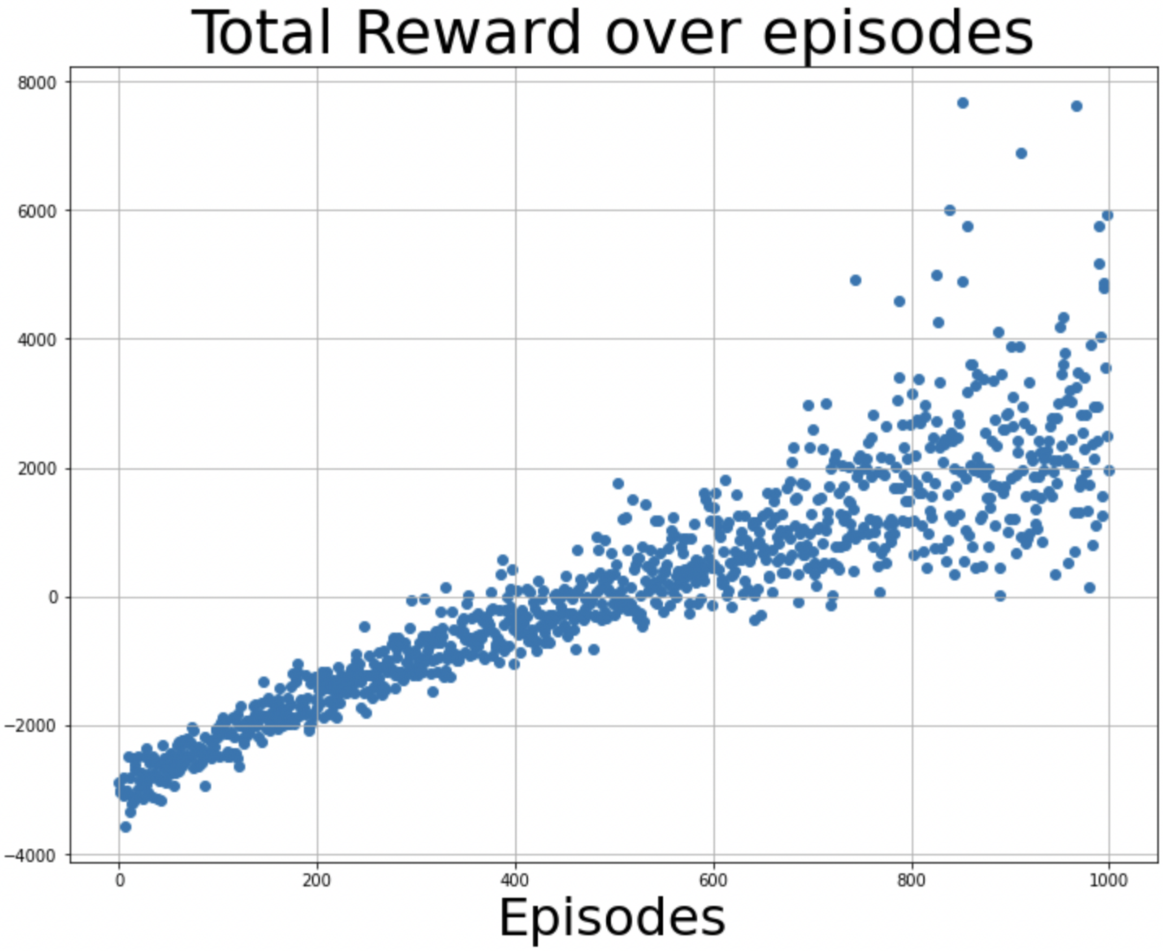

Fig 3 - Total rewards over Episodes

Explanation -
Since we start from all 0 values in Q tables. Rewards have large negative values in the initial phases. As the algorithm progresses the reward value becomes positive. Another factor contributing to large positive values is decrease in ε ε i.e we select more and more greedily as iterations increase.

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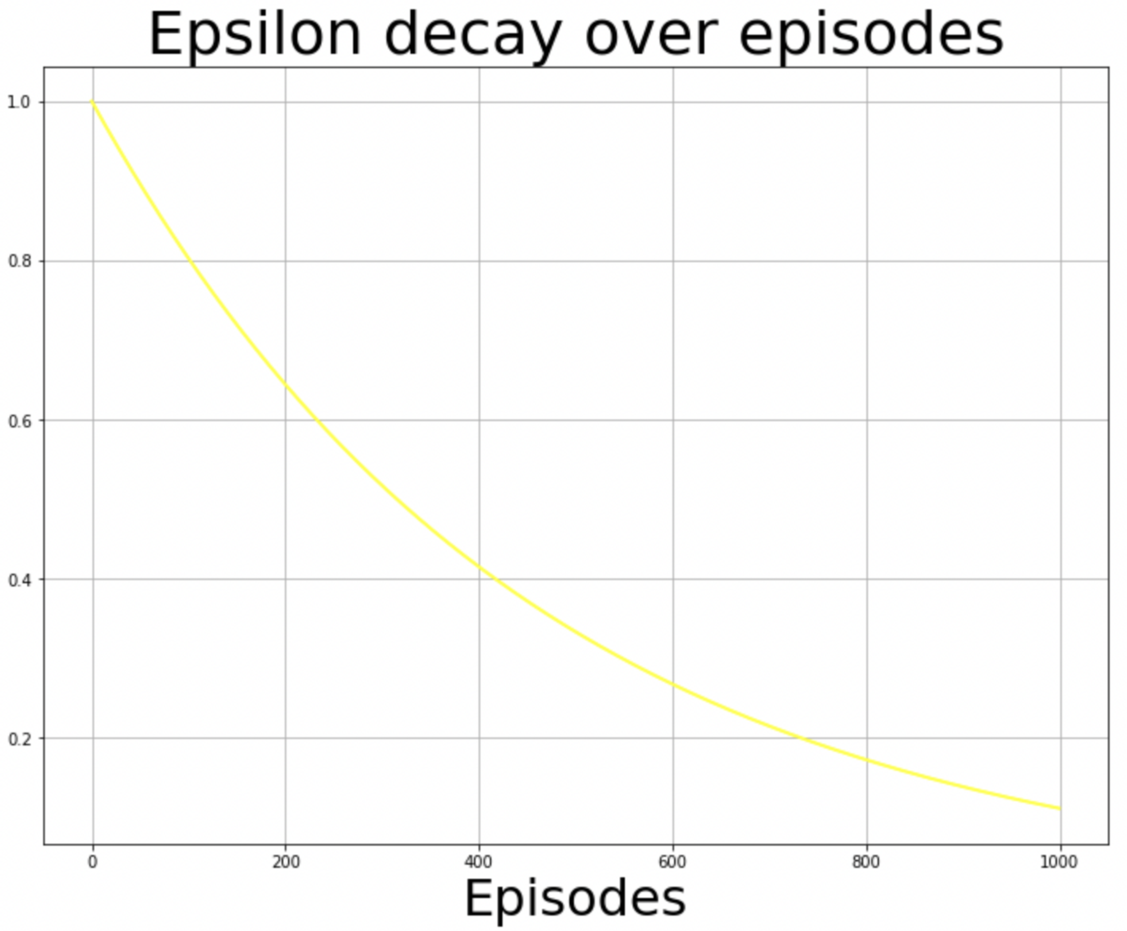

Fig 5 - Epsilon Decay over Episodes

Explanation -
We start with value of `ε = 1.` This value is updated as **epsilon = epsilon * decayRate.** Where Decay rate is 0.9978. Large epsilon values favour exploration and low epsilon values favour exploitation.