BTC Trading with Q-Learning and Sentiment Analysis

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Motivation/Introduction

Over the last couple of decades investing has become more accessible and simpler than ever. Cryptocurrency has been a hot topic for the last decade facilitating over $1.8 trillion in trading volume in 2021. This increased interest in crypto paired with the increased use and influence of social media has peaked attention to the influence of social media sentiment on trading. As seen anecdotally over the last year, in events such as the price squeeze of common stocks such as GameStop and cryptocurrencies such as Dogecoin, social media sentiment typically has a positive correlation with the price action of a given stock or cryptocurrency. Financial institutions, such as hedge funds, are known for using machine learning models for high frequency trading that use multiple indicators, including social media sentiment among others, to beat the market. These models and data, however, are not readily available to retail investors in a way that can be used to improve their portfolio. This project aims to create such a tool that retail investors can use and seeks to achieve three main objectives:

1) Analyze and quantify Bitcoin Twitter sentiment
2) Combine the quantified Twitter sentiment with other commonly used financial indicators that can be used to train a machine learning trading algorithm
3) Provide an interactive user interface that allows retail investors to train and test a trading model that will provide them with a recommendation on when to buy, sell, or hold Bitcoin.

Data

The data preparation was performed using Pyspark/Spark SQL as it allows us to use a transformation framework that can easily be scaled when using larger datasets. The following two datasets were downloaded from the web in CSV format:

- Rraw Bitcoin Tweets (4 GB of data spanning 5 years from May 2014 to November 2019)
- Bitcoin price data (218 KB of data spanning 7 years from May 2014 – February 2022)

The data was transformed to add the following indicators:

- Average Twitter Sentiment
- Price to Price Simple Moving Average (SMA) Ratio
- Bollinger Bands
- Bollinger Band Percentage
- Moving Average Convergence Divergence (MACD)
- Stochastic Oscillator (SO)
- On Balance Volume (OBV)
- Momentum

The pipeline accepts user inputs to calculate the above indicators. The pretrained NLTK Vader tool was used for sentiment analysis on the raw Twitter data. The average sentiment was aggregated to a daily granularity and joined to the daily Bitcoin price.

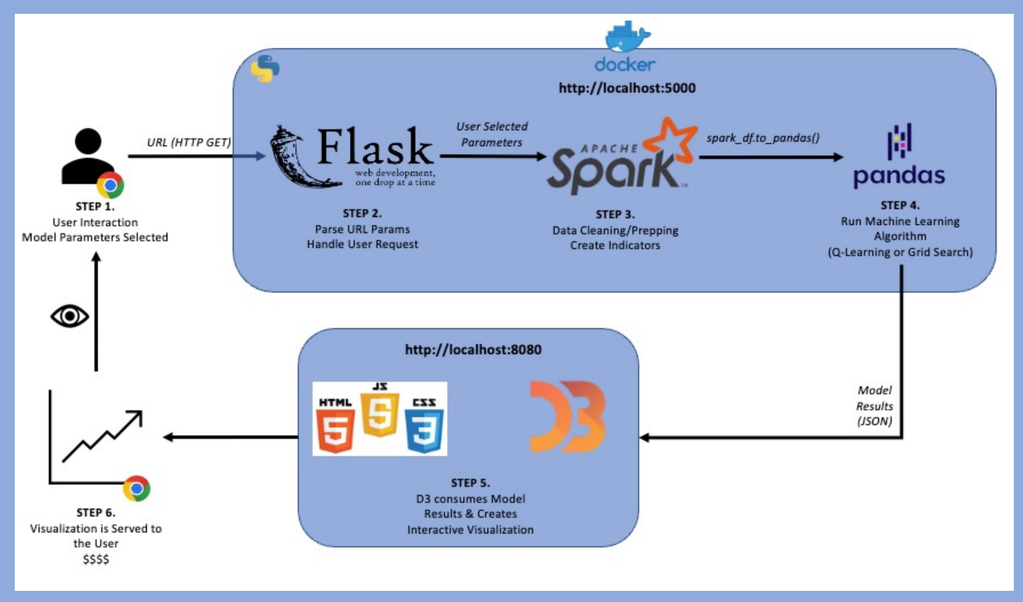

Figure 1. Application Flow

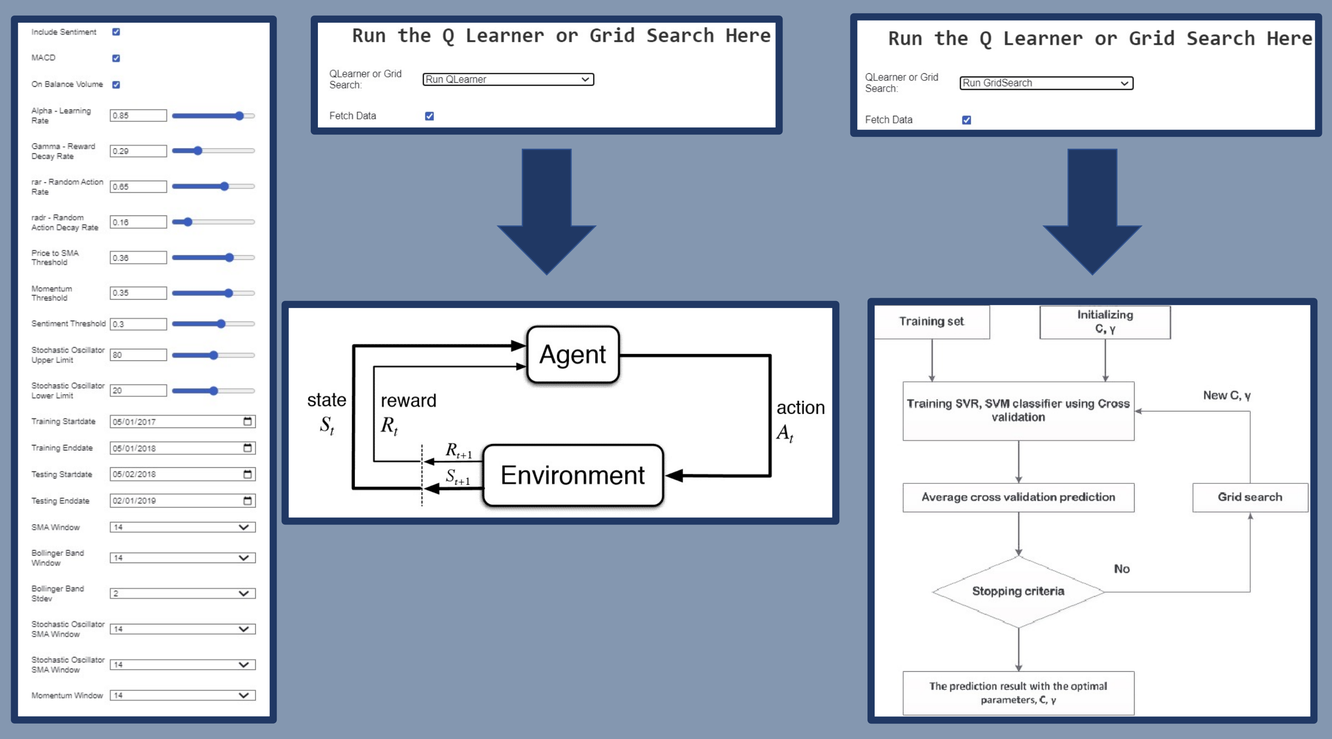

Figure 2. Q-Learner or Grid Search Algorithm

Our Approaches

Q-Learning

Q-learner is a reinforcement learning method where an agent takes actions in an environment to maximize the reward. The Q-Learning technique is used to predict the stocks over a Partially Observable Markov at each of the three possible actions: Hold, Buy, or Sell to maximize the reward. We decided to use Q-learner because it does not require labeled data, and agents can learn and improve in real time. The Q-learner agents are trained on the portfolio value. After Q-agent is trained, we can use the Q-learner table by sending price and sentiment data to the Q-agent, and Q-agent will pick action with highest Q value. All the training process, selected indicators by users, and portfolio results will be displayed to make it easy for user to select and visualize.

Grid Search

Grid Search Technical Indicator Analysis is a type of Optimization-based learner method that often combines with machine learning methods to predict future stock market prices. Those technical indicators reflect the market's behavior. Thus, by studying those indicators, we can develop a scan-based strategy using a set of rules and thresholds to decide when to Buy or Sell. The main goal is to determine the set of thresholds that optimized the portfolio return.

Experimentation and Results

Our experiment revolves around the use of the visualization to run the chosen Q-Learning or Grid Search algorithm. The user picked the Twitter Sentiment indicator along with their choice of several financial indicators (Simple Moving Average (SMA), Bollinger Bands/Bollinger Bands Percentage, Moving Average Convergence Divergence (MACD), Stochastic Oscillator, On Balance Volume, Momentum) to train and test the model and produce optimal signals to buy and sell BTC.

With varied combinations of indicators and hyperparameters, both the Q-learning and Grid Search models outperformed the benchmark scenario of buying an initial position and holding Bitcoin for most training and testing periods.

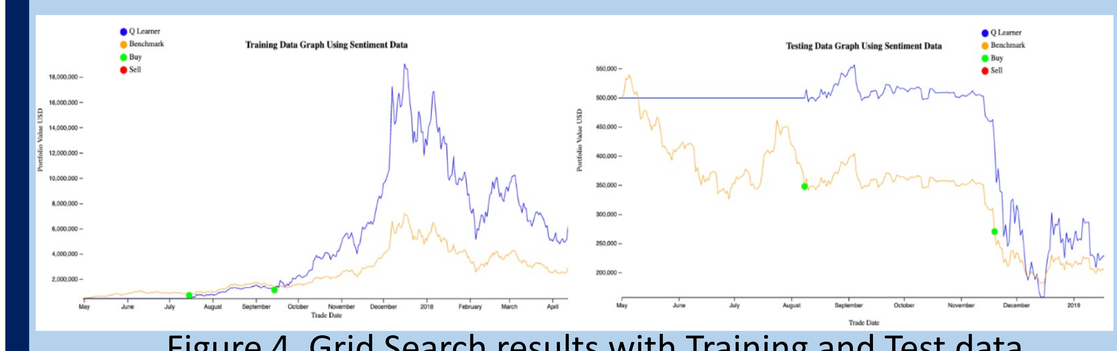

Figure 4. Grid Search results with Training and Test data

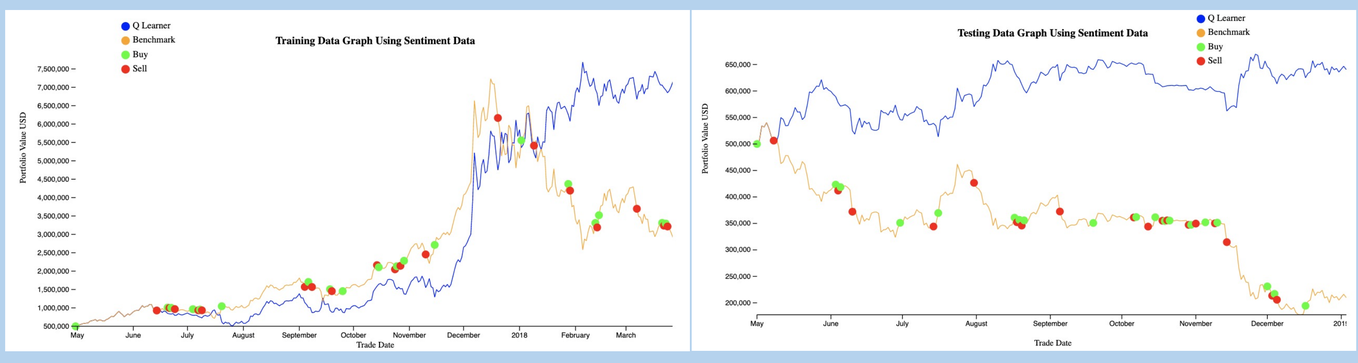

Figure 3. Q-Learner results with Training and Test data