# 2022 Problem C: Trading Strategies

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# Introduction

- best trading strategy based on past data for gold measured in troy ounces and bitcoins
- values from 9/11/2016 to 9/10/2021
- commission fee for each transaction, where we assume that gold = 1% and bitcoin = 2%


**Figure 1**: Gold daily prices, U.S. dollars per troy ounce. Source: London Bullion Market Association, 9/11/2021

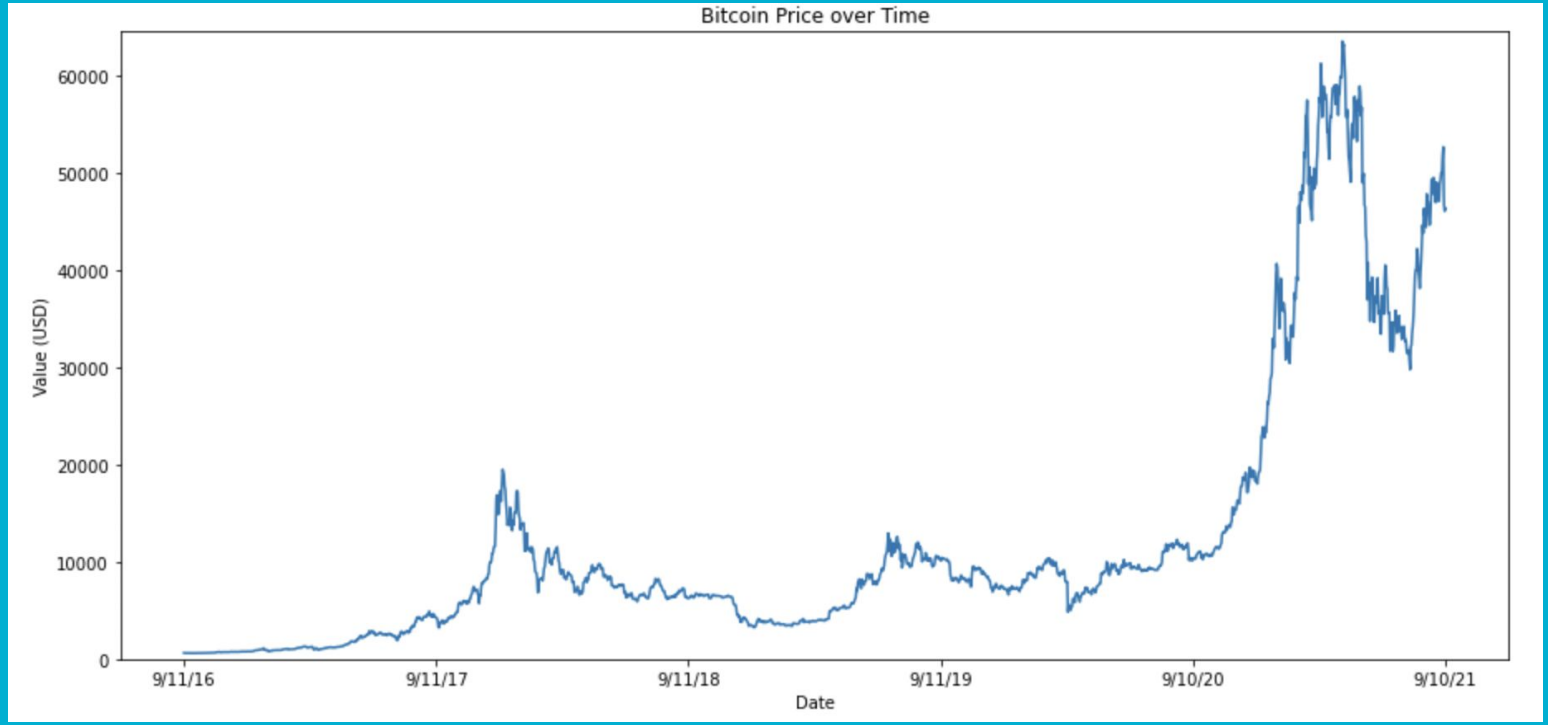



**Figure 2**: Bitcoin daily prices, U.S. dollars per bitcoin. Source: NASDAQ, 9/11/2021

# Assumptions

- There is only one fixed price for gold and bitcoins per day.
- The gold market is either fully open or closed, i.e. it is never partially open or closed early. It is not open on weekends and various US holidays. Our models will reflect this schedule.

# Assumptions (continued)

- The trader has no outside trading information and can only have their assets in either cash, gold, or bitcoin.
- The trader only uses the assets in their portfolio
- The trader cannot predict the future and thus cannot predict the decrease of value. They cannot sell before buying.

# Models

We tested the following models:

- Threshold
- Principle of Momentum Trading
- Simple Moving Average (SMA)
- Bitcoin Moving Average Prioritization (Bit MA Prioritization)

# Threshold

- prioritize(df, portfolio, max_threshold, min_threshold, length, prioritization)
- The investor should sell their shares whenever the stock's percent change rises above a maximum threshold, because their shares have surpassed the initial purchase value
- The investor should buy more shares when the stock's percent change drops below a minimum threshold in anticipation of rising value in future trading periods

# Threshold (continued)

- Assumption: Stock values tend to increase over time, this model keeps pace
- More conservative, tries to follow overall trend
- Thresholds must be set from the beginning
- Very sensitive; small percent changes in threshold can change total profit significantly

# Momentum Trading

- momentum_bitcoin(bitcoin, bail = -50, trade =  1, sell =  1)
- Market is most likely to follow its current trend
- The investor will buy shares no matter how high the stock grows and sell when the stock’s value enters a decline
- Only considers when to sell

# Momentum Trading (continued)

- If a stock's value continues to rise, we can monopolize on its success, and bail out if it eventually decreases
- Risky; although market trends should be stable, there can be fluctuations, so this method will either result in a high pay off or a heavy loss

# Simple Moving Average

- Simple Moving Average (SMA) is the arithmetic mean of a stock's value over a given time period

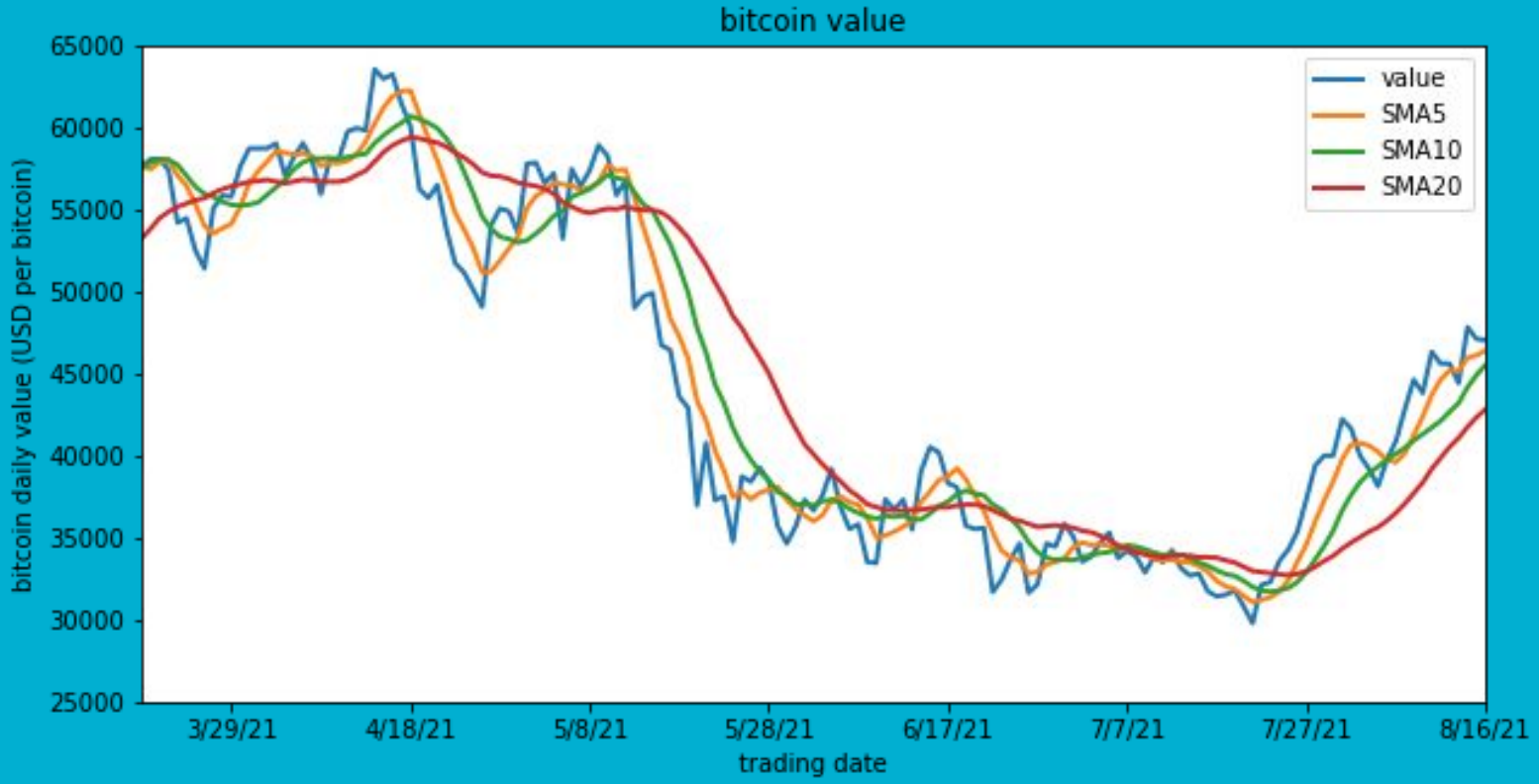
$$SMA = (A_1 + A_2 + \ldots + A_n) / n$$

$A_k$ : assets price on day $k$

$n$ : the total number of asset periods

- Critical points at intersection of SMA trajectories

# SMA bitcoin


bitcoin value
value
SMA5
SMA10
SMA20
bitcoin daily value (USD per bitcoin)
65000
60000
55000
50000
45000
40000
35000
30000
25000
3/29/21
4/18/21
5/8/21
5/28/21
6/17/21
7/7/21
7/27/21
8/16/21
trading date

# Bitcoin MA Prioritization

- bit_ma_prioritization(portfolio, bitcoin_df, max_threshold, min_threshold, length, types)
- max_threshold / min_threshold: forcing the model to sell / buy only after bitcoin has gone up / goes down to a certain %
- length: find the percent difference between the $i^{th}$ day and the i - length day
- Types:
  - .25, .75, .5, 1
  - Proportions allocated to SMA and threshold method

# Bitcoin MA Prioritization (continued)

- Combines the threshold and simple moving average (SMA) method
- Attempts to follow the trend (moving average), as well as keeping up the pace with the fast growth of Bitcoin (in the later part of the data set)
- Types specify the proportion of the initial money distributed into the threshold and the SMA method

# Initial Runs

- Testing our models, focus on bitcoin

- Simulations with ranging parameter for all of our models

# Analysis : Threshold

- maximum threshold : 60

  minimum threshold : -5

  trade every 3 days

- **$63,560.39**; commission fee **$436.46**

# Analysis : Momentum

- momentum_bitcoin(bitcoin, bail = -50, trade =  1, sell =  1)
- trade daily and sell 100% of our shares whenever the daily percent change significantly dropped
- **$55,582.92;** commission fee **$10,367.84** (16%)

# Analysis : SMA

- simple_moving_average_bitcoin(SMA_bitcoin, short = 'SMA5', long = 'SMA20', b = 1, s = 0.05)
- short-term average of 5 days compared to a long-term average of 20 days, trade daily

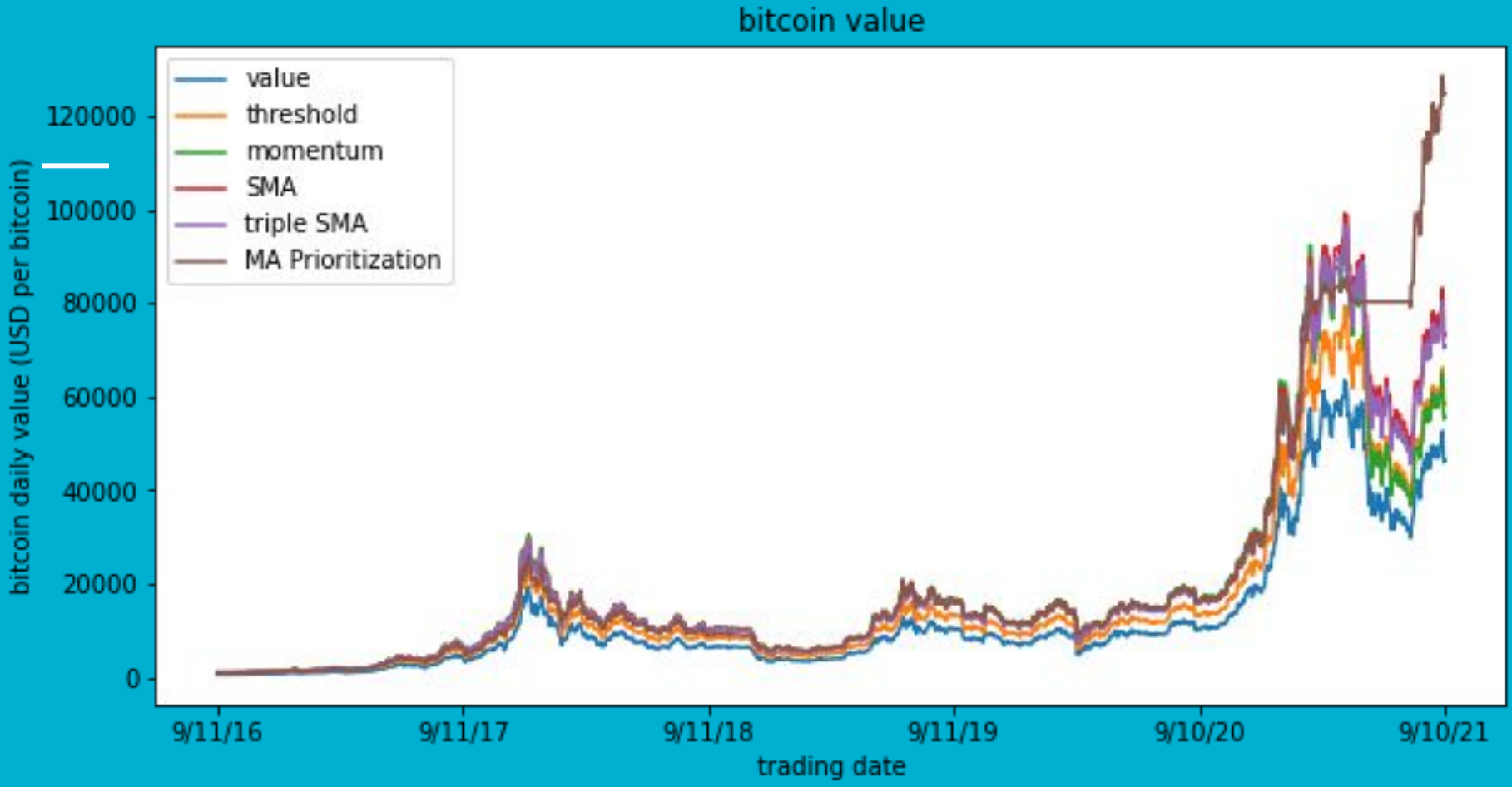
  buy for 100% of our worth, and sell shares at 5% of their value
- **$73,296.51**; commission fee **$417.42** (1% )

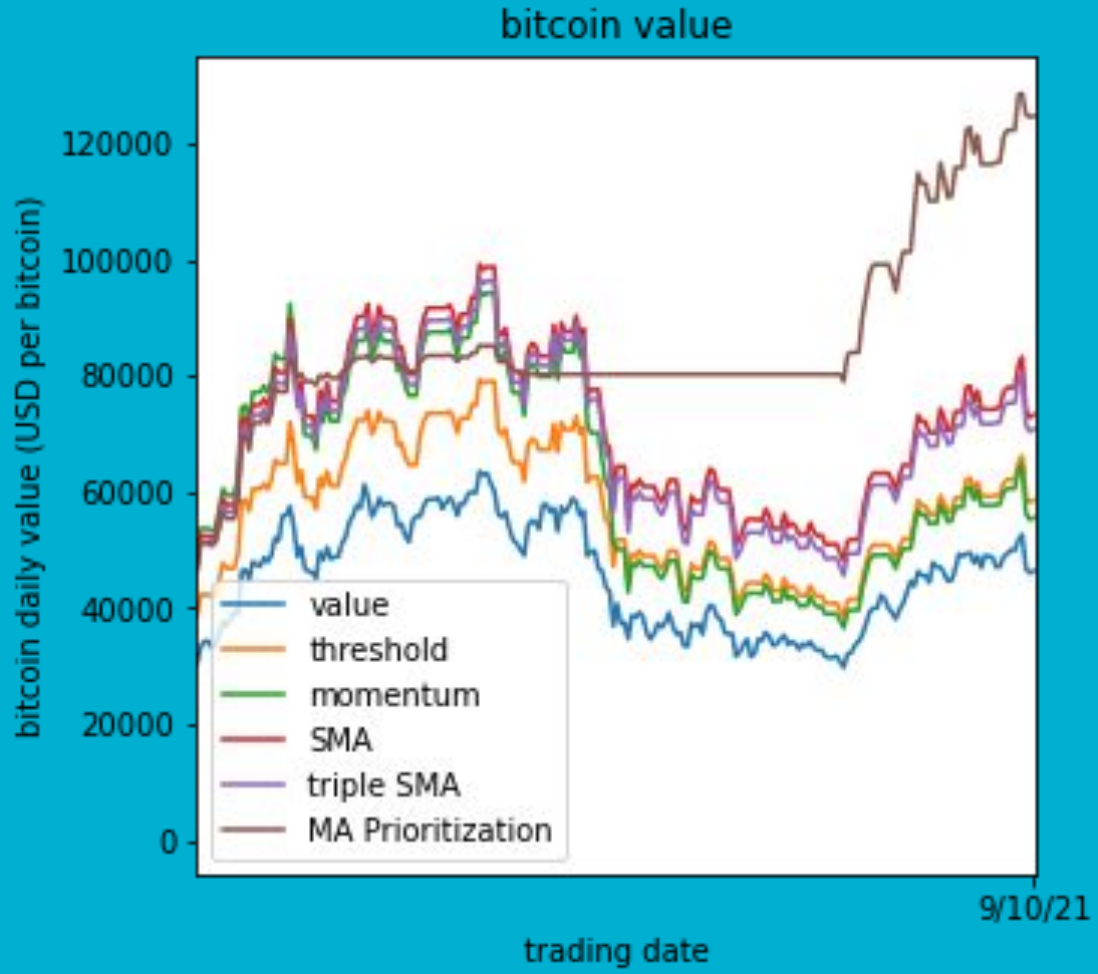
# Analysis : triple SMA

- SMA_triple_bit(SMA_bitcoin, 'SMA5', 'SMA10', 'SMA20', 1, 0.01)
- only buys or sells if 2 averages were changing at once
- small-term average of 5 days, a medium-term average of 10 days, and a long-term average of 20 days, buy at full price and sell shares at 1% of their value
- **$70,844.23**; commission fee **$343.31**

# Analysis : Bit MA Prioritization

- Type 2: 25% of initial money allocated to SMA method, 75% allocated to threshold method
- Utilizes both the threshold method and the SMA method
- **$124763.72**; commission fee **$7791.20** (5.88%)


bitcoin value
value
threshold
momentum
SMA
triple SMA
MA Prioritization
bitcoin daily value (USD per bitcoin)
120000
100000
80000
60000
40000
20000
0
9/11/16
9/11/17
9/11/18
9/11/19
9/10/20
9/10/21
trading date


bitcoin value
bitcoin daily value (USD per bitcoin)
120000
100000
80000
60000
40000
20000
0
value
threshold
momentum
SMA
triple SMA
MA Prioritization
9/10/21
trading date

# Conclusion

- Models did well; all of them generated profits
- However, MA prioritization model did way better
  - Only one to successfully predict the 2nd bitcoin crash
  - Diversified in a way that we have 2 methods working in the same model, in which we can control the proportion
- We recommend this to all other investors