Evaluation of Investment Strategies for Cryptocurrencies

How to get Rich Quick with this one Weird Trick (?)

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Introduction

Problem: Given the price history of Bitcoin, decide whether to

- Buy
- Sell
- Do nothing

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Objective: Maximum profit

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Percentage of funds gained/lost

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$$\Rightarrow \text{ROI} = \frac{\frac{F_b}{p_b} p_s - F_b}{F_b} = \frac{p_s}{p_b} - 1$$

Formal Problem Definition

Given:

- Current point in time t
- Prices $p = p_0, p_1, p_2, \ldots, p_t$
- Trades $T = \{(b_1, s_1), (b_2, s_2), \ldots\}$

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The strategy which generated T is called optimal,
if there exists no set T', such that:

$$\left(\prod_{(b,s)\in T} \frac{p_s}{p_b}\right) - 1 < \left(\prod_{(b',s')\in T'} \frac{p_{s'}}{p_{b'}}\right) - 1$$

(Without cost)

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$$\left(\prod_{(b,s) \in T} \frac{p_s \cdot (1 - c)}{p_b \cdot (1 + c)} \right) - 1 < \left(\prod_{(b',s') \in T'} \frac{p_{s'} \cdot (1 - c)}{p_{b'} \cdot (1 + c)} \right) - 1$$

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Why the brackets?

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Can we do better?

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The Basic Idea

- Deploy a bot that can buy/sell when signal is given
- The signal is produced by another popular strategy:

The SMAC

The SMA: Simple Moving Average

- For each data point, calculate the average of last n data points

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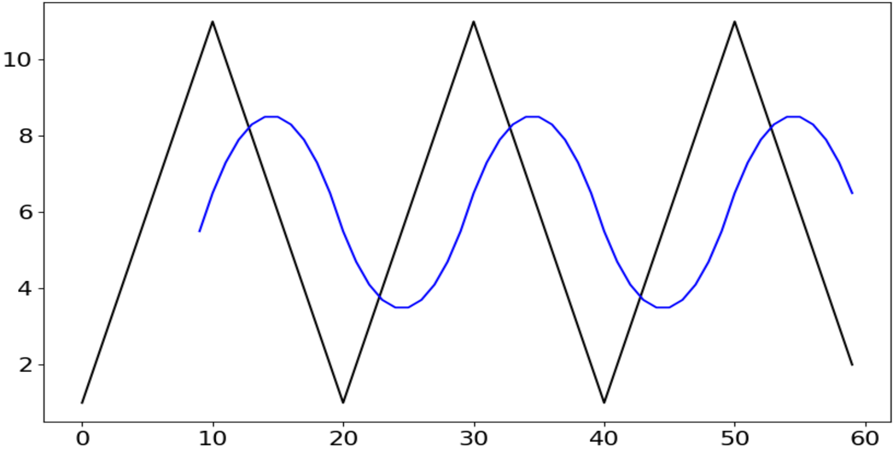

Figure: Black line: Price over Time, Blue Line: SMA with a window of 10

The SMA

Formula for SMA s_t with window n:

$$s_t = \frac{1}{n} \cdot \sum_{i=0}^{n-1} p_{t-i}$$

The SMAC Strategy

SMAC Simple Moving Average Crossover

- For each data point, calculate two SMAs with different windows
- If the difference between the SMAs changes sign, buy/sell

The SMAC Strategy: Example

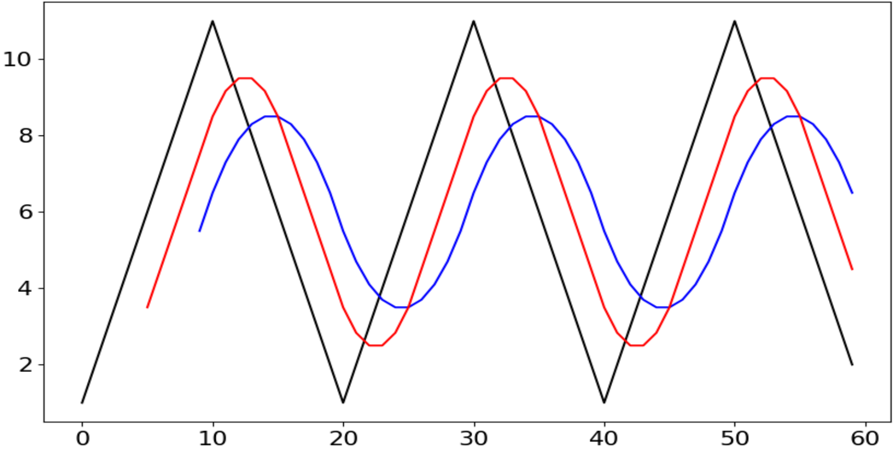

Figure: Red SMA window: 6, Blue SMA window: 10

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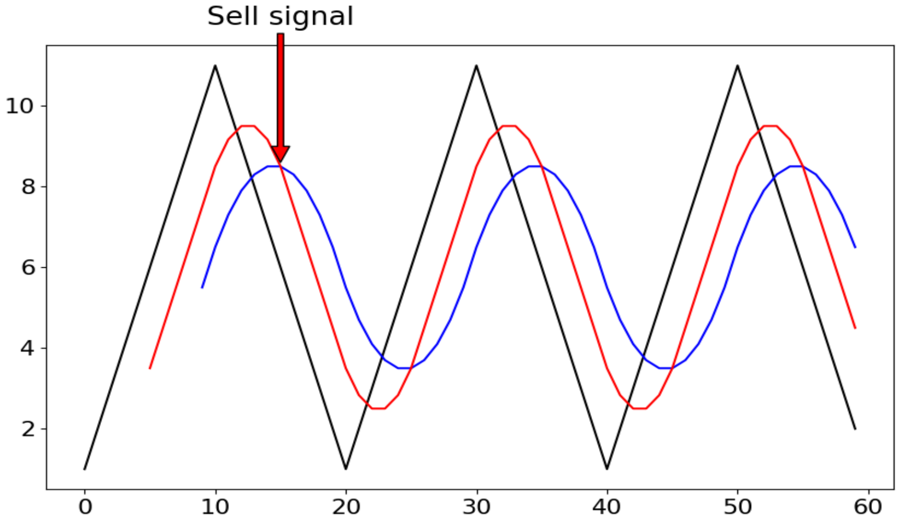

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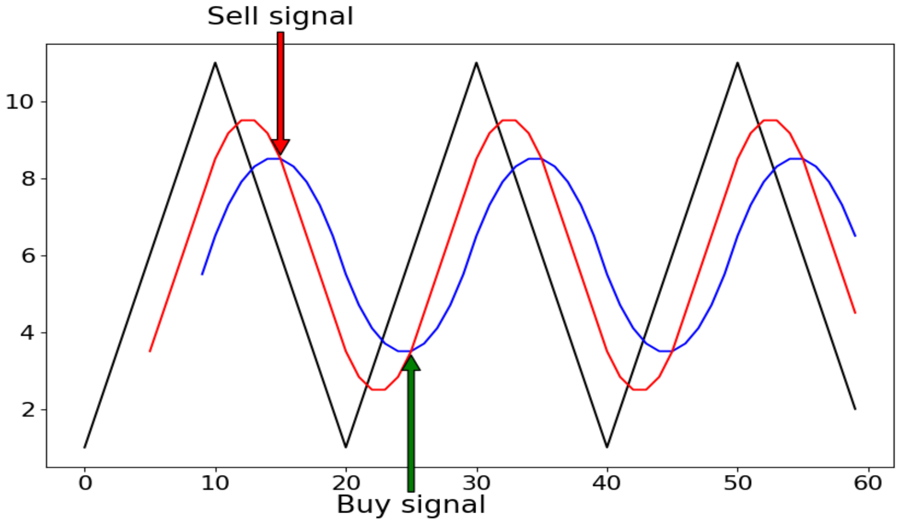

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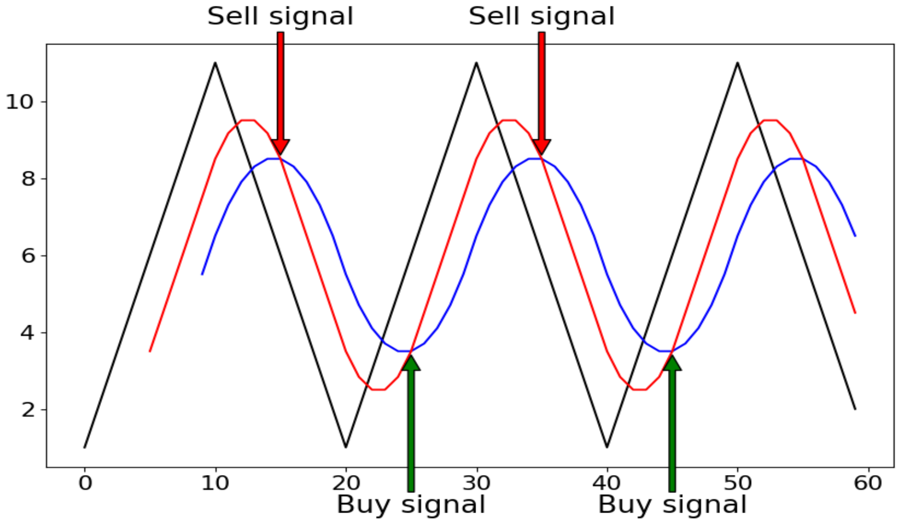

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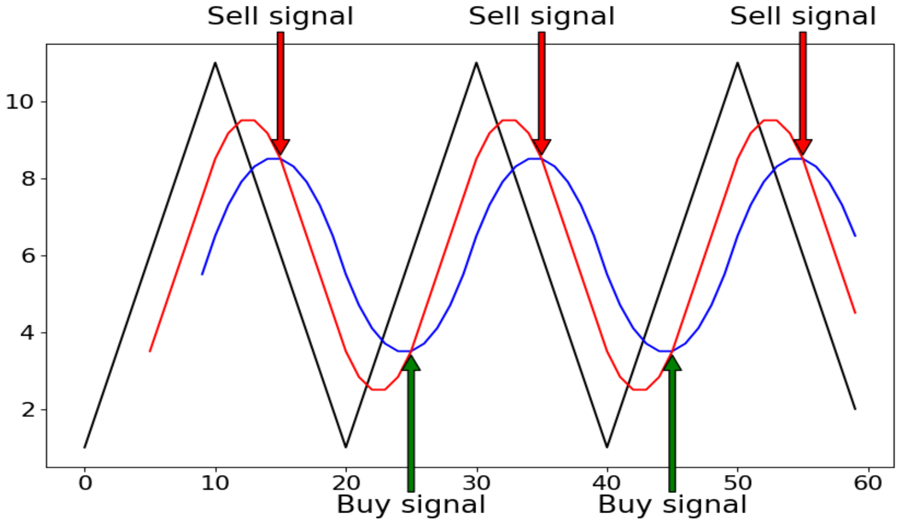

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The SMAC Strategy

- Let the window values be m, n with $m < n$
- Fast SMA: $f_t = \frac{1}{m} \cdot \sum_{i=0}^{m-1} p_{t-i}$
- Slow SMA: $s_t = \frac{1}{n} \cdot \sum_{i=0}^{n-1} p_{t-i}$
- Difference: $d_t = f_t - s_t$
- Strategy:

$$d_{t-1} < 0 \text{ and } d_t \geq 0 \Rightarrow \text{Buy}$$

$$d_{t-1} > 0 \text{ and } d_t \leq 0 \Rightarrow \text{Sell}$$

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Theory: An Optimal Model

- Assume price decreases linearly $p_t = p_0 - t \cdot k$

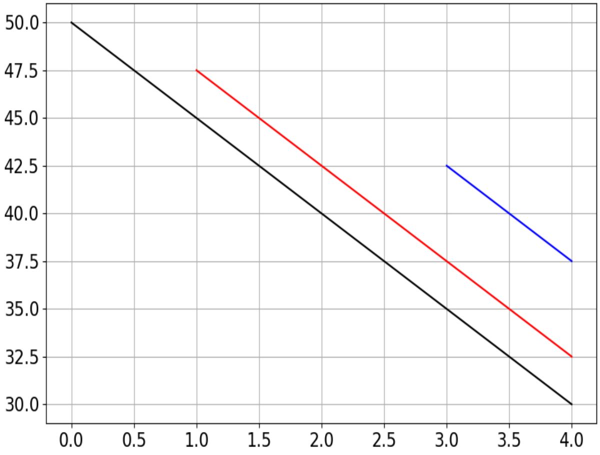
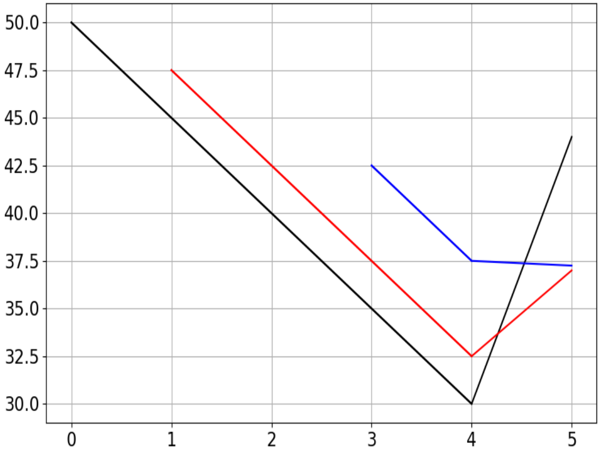


Figure: $k = 5$, Red SMA window: 2, Blue SMA window: 4

Theory: An Optimal Model

- Assume price decreases linearly $p_t = p_0 - t \cdot k$
- Buy signal is only triggered by a change $\geq k(\frac{n \cdot m}{2} - 1)$



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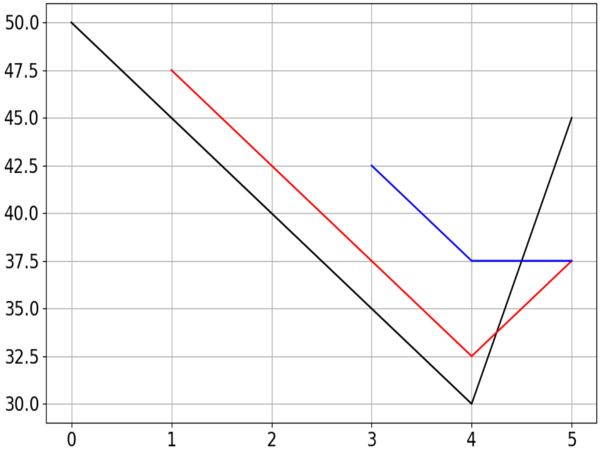

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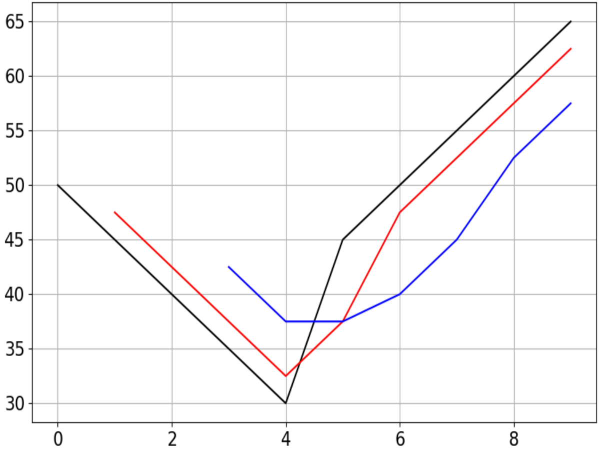

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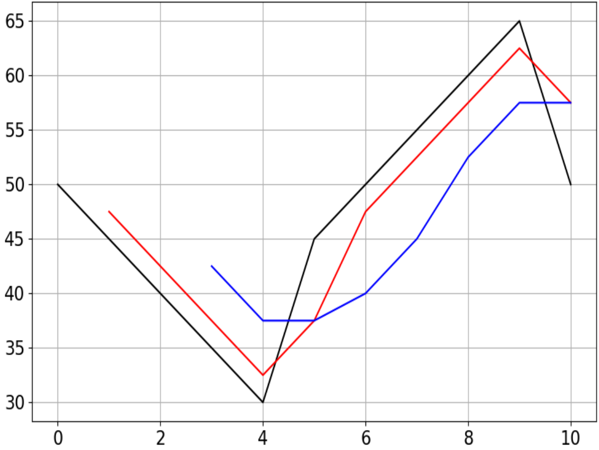
Theory: An Optimal Model

- We can trigger a sell signal in a similar fashion
- Here: change $\leq -k(\frac{n \cdot m}{2} - 1)$



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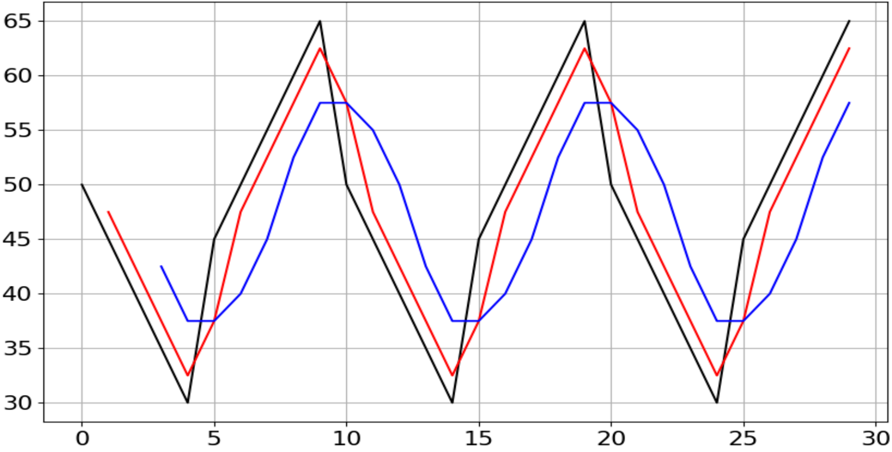
Theory: An Optimal Model

And so on. . .



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Bitcoins Next Top Model?

- $p_0 \geq \frac{n \cdot m}{2} \cdot k$
- ROI: $\frac{p_0}{p_0 - k} - 1$
- Length: $n \cdot m + 2$

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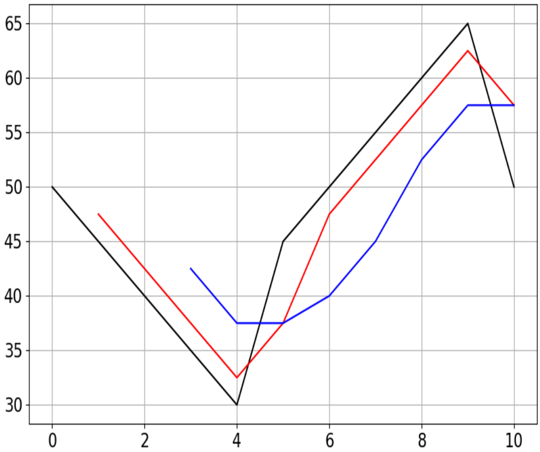
- For $k = 5, m = 2, n = 4$:
- $p_0 = 50 \geq 20$



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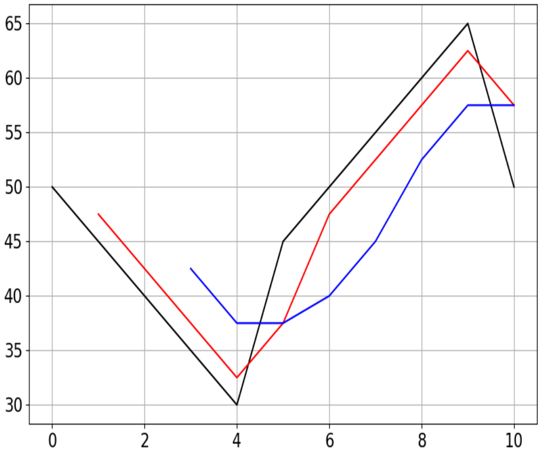
- For $k = 5, m = 2, n = 4$:
- $p_0 = 50 \geq 20$
- ROI: $\frac{50}{50-5} - 1 = +11.1111\%$



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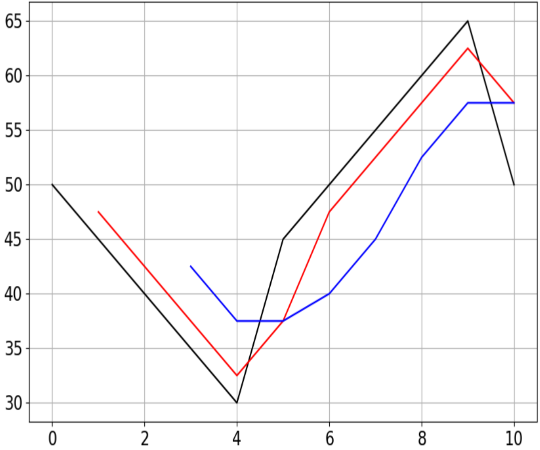
- Length: $2 \cdot 4 + 2 = 10$

- Seems reasonable



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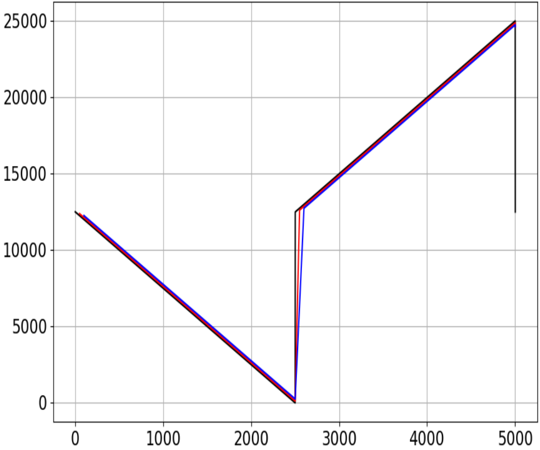
- For a realistic setting: $k = 5, m = 50, n = 100$:
- $p_0 \geq 12500$



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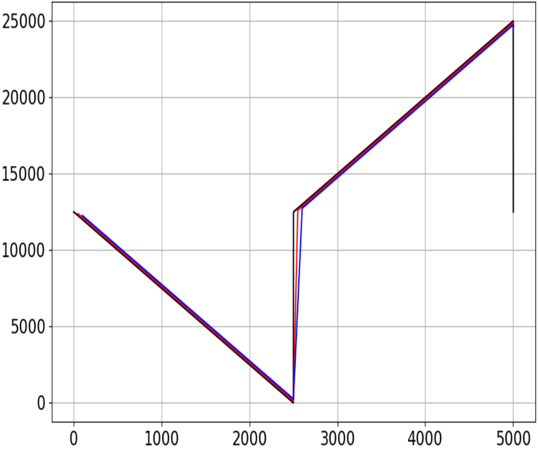
- For a realistic setting: $k = 5, m = 50, n = 100$:
- $p_0 \geq 12500$
- ROI: $\frac{12500}{12500-5} - 1 = +0.04\%$



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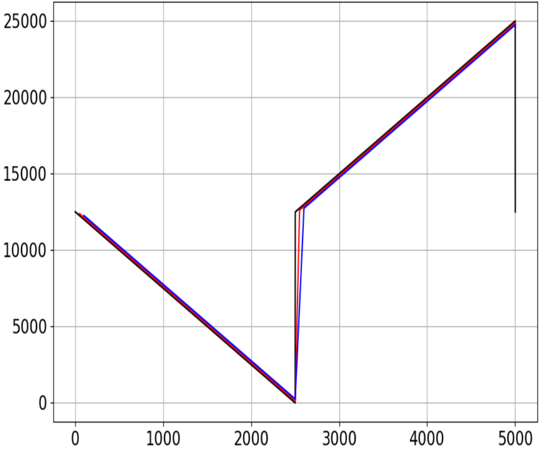

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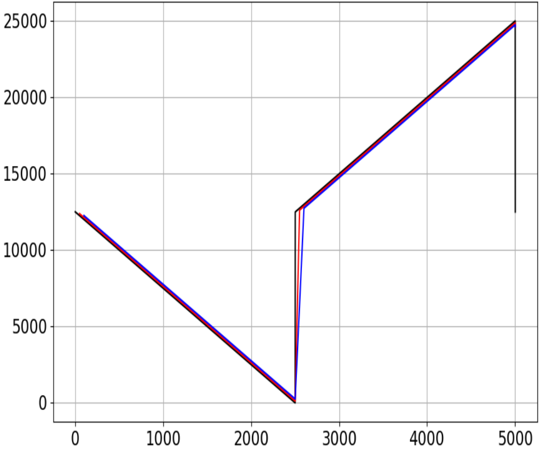
- Length: $50 \cdot 100 + 2 = 5002$
- **Does not seem reasonable**



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- And if it is the SMAC: For what window setting?

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- Time period $\geq$ 3 months
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Optional: Formal definition of the binomial test setting

SMAC: The Strategy Settings

- If we consider window sizes up to 300 reasonable:
- **44850** possible settings (Proof)

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- What gives a higher chance of success:
  Choosing a recommended setting or one at random?

Test Results

Dataset	Recommended settings (11)	All settings (44850)

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Bitcoin (daily)	0	0.033% (15)

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Euro (in USD)	18.18% (2)	20.43% (9165)

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The recommended settings do not give a higher chance for profit!

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- Most other day trading strategies lack a mathematical justification

Day trading strategies are basically astrology for Millenials

Thank you!

Cost

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- With the **spread**
- **Spread**: Difference between buying and selling price

- Example, where spread is 2%:
- "Regular" BTC price is 100$
- Exchange will sell BTC for 101$
- Exchange will buy BTC for 99$

- Note: This is more complex in a real setting
- (Based on price movement, amount of customers, trading volume, etc.)

Return

Compounded ROI

- For $T = \{(b_1, s_1), \ldots, (b_n, s_n)\}$

Compounded ROI

- For $T = \{(b_1, s_1), \ldots, (b_n, s_n)\}$
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- Null hypothesis: SMAC has a greater ROI than the BnH with probability at most $\frac{1}{2}$
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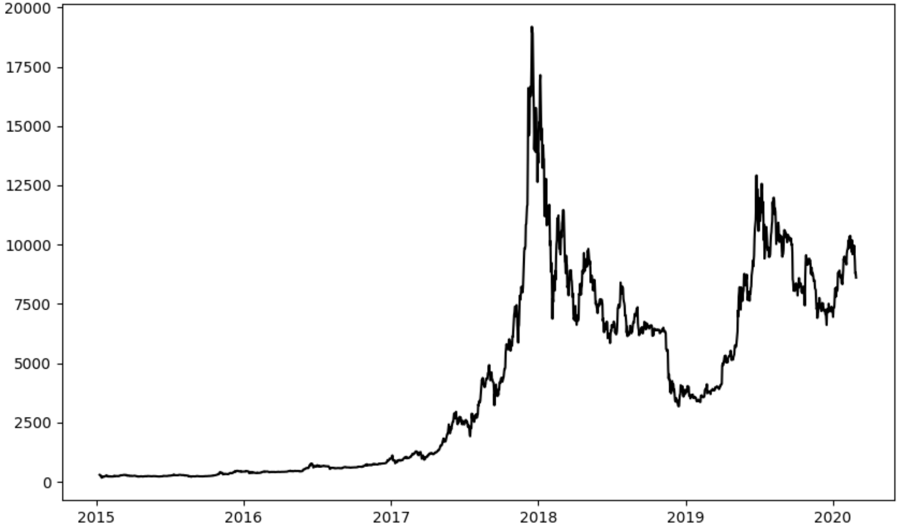
- Then we get type II error probability $\beta = 0.053$
- And power $(1 - \beta) = 0.947$

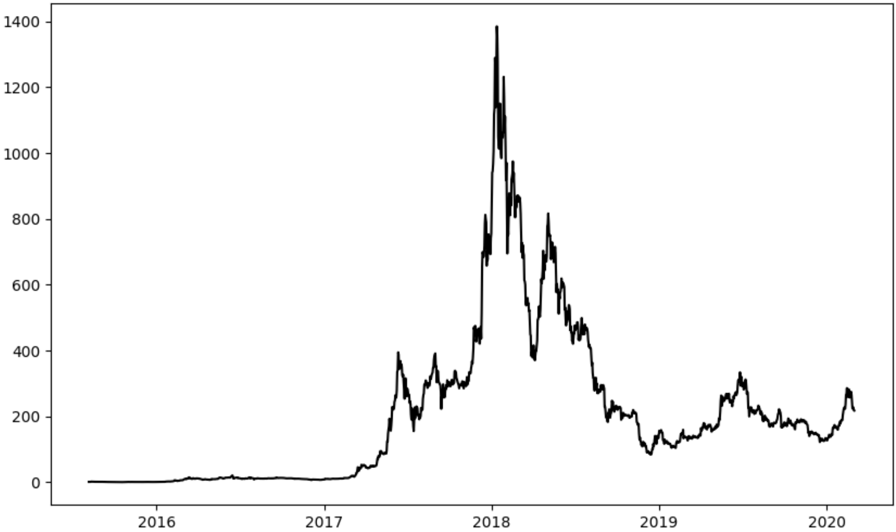
Return

Bitcoin Price Data



Return

Ethereum Price Data



Return

Dow Jones Price Data

Return

Microsoft Price Data

Return

EUR/USD Price Data

Return

Notes