Stock Market Round-Off Error Analysis

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During a lecture on scientific computation, it was mentioned how round-off errors can drastically impact the final answer. In 1982 round-off errors caused a decline in the Vancouver Stock Exchange. The index was set to 1,000 points initially and was updated after each transaction. Over 22 months the index fell to 520 during a bull market. This was due to rounding errors where the final value was truncated to only two decimal places (ie 599.245 rounds to 599.24). When this was fixed the index was 1098.892.

The following is the impact of rounding errors on the 2009-2020 bull market run using the S&P 500 index. **Python** and its various libraries were used to test out the impact of rounding errors. Past data was acquired using the **"yfinance"** open-source library to access the financial data available on Yahoo Finance. The estimated beginning of the bull market was noted to be on March 9, 2009, and the end was around February 2020 during the COVID-19 pandemic. **Pandas,** an open-source Python library**,** was used for data manipulation and **Matplotlib** was used to create static visualizations of the index performance as well as the relative error.

Method

The true value was plotted along with the truncated value with a round-off to two decimal places. The rounded values were truncated or "chopped" simply by removing the remaining values after the second decimal value. Using the stock index value the calculation was performed by also chopping the percent change from the day before. The percent change from the true values was taken and truncated and then multiplied by the previous day's truncated values and the result was then truncated again to be appended to the results array.

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The relative error was calculated using the following formula:

$$relative\ error\ =\ |true\ value\ -\ truncated\ value|\ \div\ true\ value$$

Results

It was noted that over time the error increases and causes a drastic change in the overall index value over time as observed in the Vancouver Stock Exchange. Through the 10-year period, the relative error grew to over 2.0%. The following were the results:
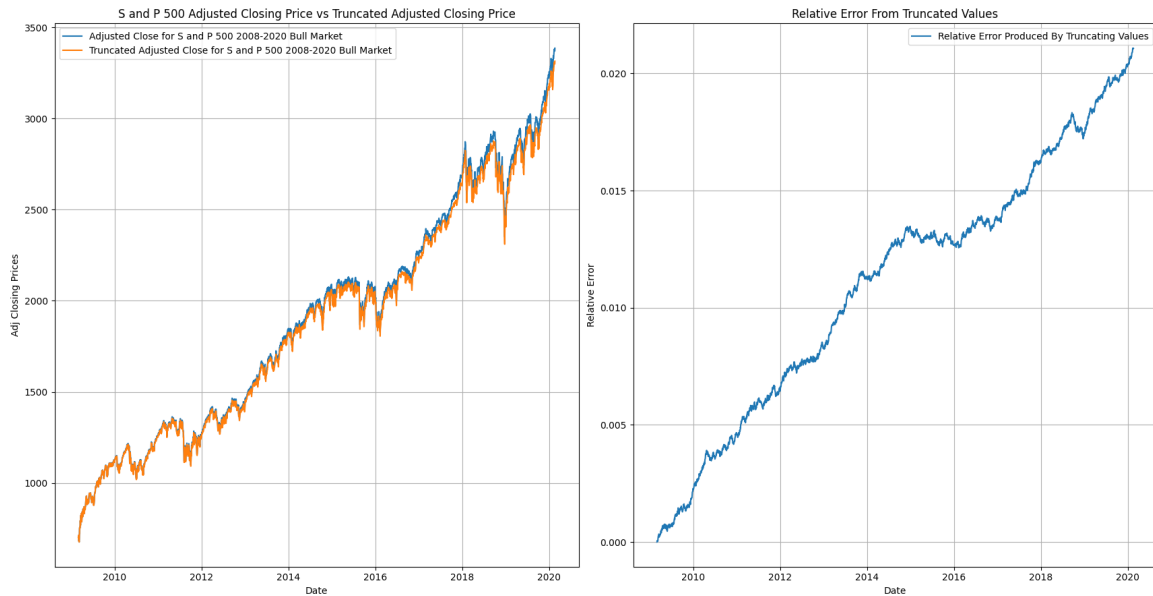

Figure 1: Graph to S&P and Relative Error

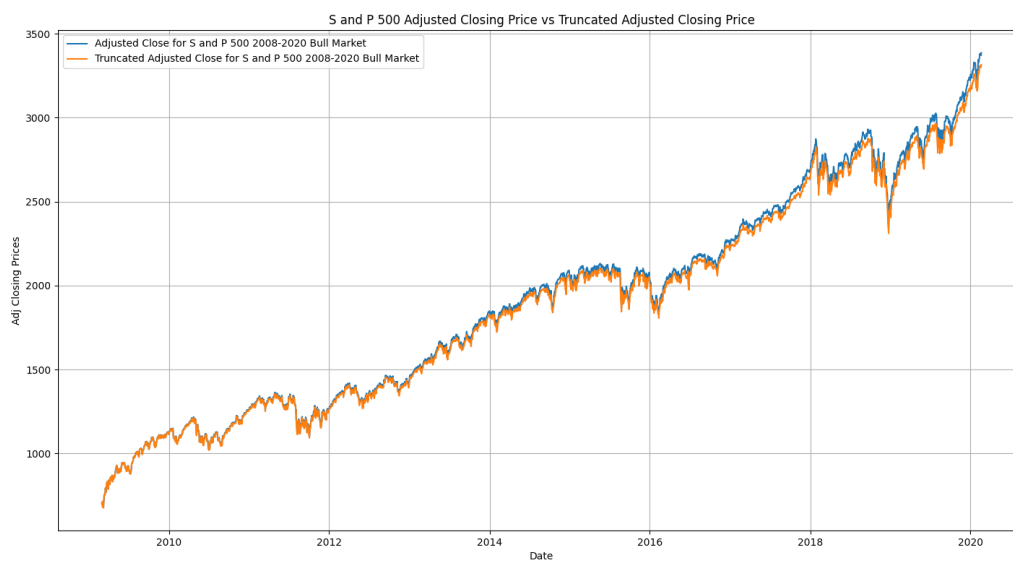# Stock Market Round Off Error Analysis
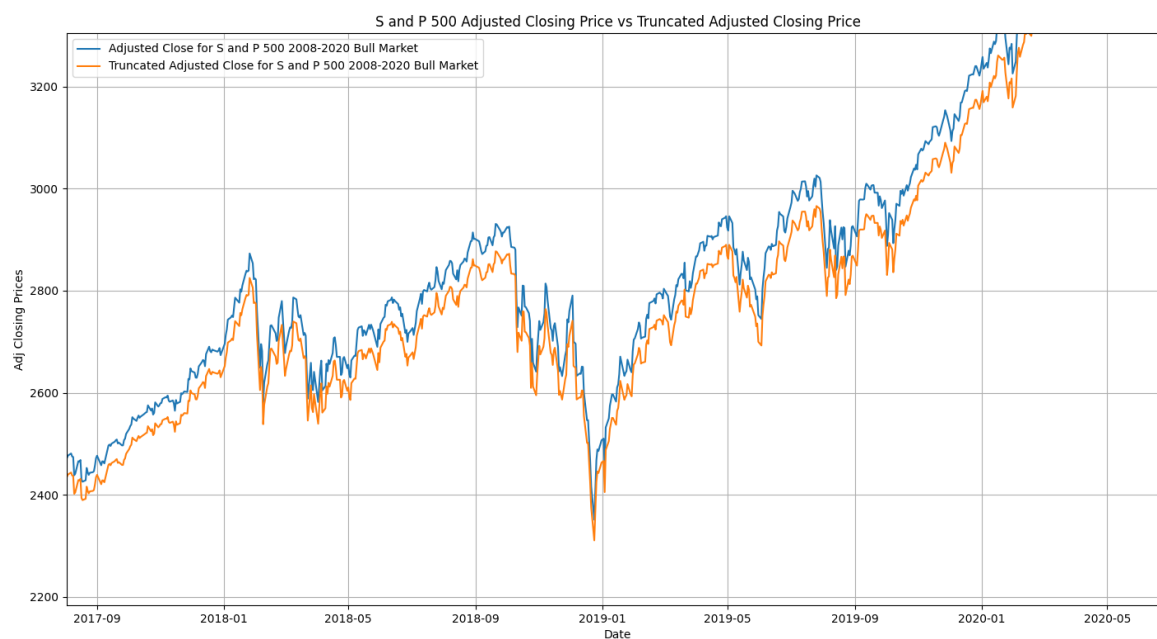

Figure 2: S&P 500 Index 2009-2020

Figure 3: Zoomed-in portion of the graph showing true values and truncated values for S&P 500
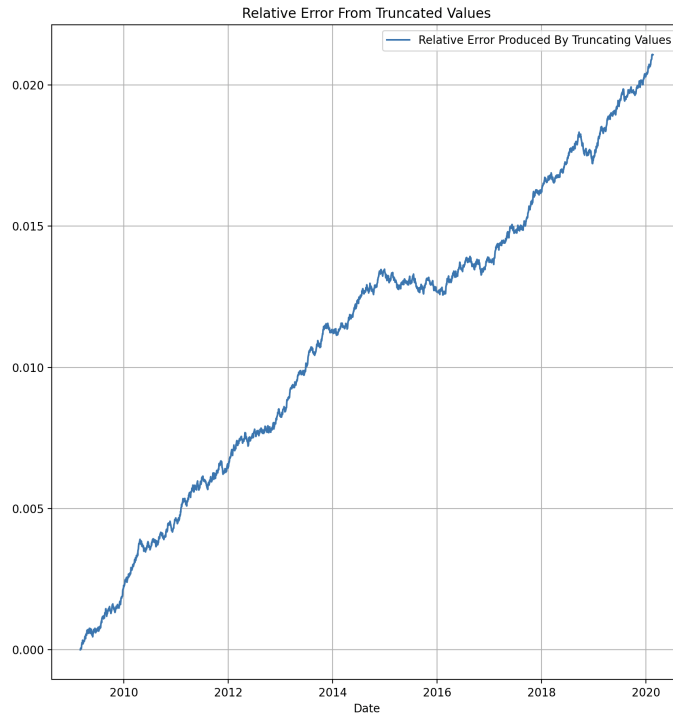
Figure 4: Relative Error From Truncated Values

Discussion

In conclusion, the results show the importance of rounding and how important it is to keep rounded values to the correct precision. In Python the data from the yFinance was stored in float values in Python are represented as 64-bit double-precision values. Chopping causes drastic changes to the overall results. This is why measures are taken in order to prevent this from happening.

References

The Wall Street Journal November 8, 1983, p.37.

The Toronto Star, November 19, 1983.

B.D. McCullough and H.D. Vinod Journal of Economic Literature Vol XXXVII (June 1999), pp. 633-665. (References communicated by Valerie Fraysse)