Analyzing Stocks Using the Moving Average Crossover Strategy

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1 Introduction

Moving averages are a common tool in stock analysis that help identify trends by smoothing out daily price changes. Instead of looking at how a stock jumps up and down every single day, moving averages calculate the average price over a set period, like 50 or 200 days, which makes it easier to see the overall direction a stock is heading. This helps filter out the "noise" of daily trading and shows whether a stock is generally trending upward, downward, or staying flat.

For this project, we're analyzing two major technology companies: NVIDIA Corporation (NVDA) and Sony Group Corporation (SONY). NVIDIA has become well-known for making graphics processing units (GPUs) that are now heavily used in artificial intelligence applications, while Sony operates across electronics, gaming, and entertainment. We're using two specific moving averages: the 50-day simple moving average (SMA) to track intermediate trends and the 200-day SMA to show longer-term patterns. When the 50-day average crosses above the 200-day average, it suggests the stock is gaining momentum. When it crosses below, it suggests momentum might be slowing down.

Our research question is: How do the 50-day and 200-day simple moving averages show the stock price trends for NVIDIA and Sony from 2020 to now, and what do these patterns tell us about how each company has been performing in the market?

2 Data Provenance

2.1 Data Source and Collection

Our data was obtained from Yahoo Finance (Yahoo! Inc., 2024) through the `quantmod` package in R (Ryan & Ulrich, 2023). Yahoo Finance aggregates stock market data from major exchanges and provides free access for research and analysis purposes.

Who: Yahoo Finance, collects and distributes financial market data from stock exchanges worldwide.

What: Daily stock price data for NVIDIA Corporation (NVDA) and Sony Group Corporation (SONY), including open, high, low, and close prices, as well as trading volume for each trading day.

When: Data spans from January 1, 2020 to December 17, 2025, covering 1,240 trading days over nearly five years.

Where: Data originates from the NASDAQ stock exchange where both NVIDIA and Sony are listed and actively traded.

Why: Yahoo Finance provides this data to enable transparent market information for investors, analysts, researchers, and the general public to make informed decisions.

How: Stock prices are recorded electronically during regular trading hours (9:30 AM - 4:00 PM EST) on each trading day. Exchange systems capture every transaction, and Yahoo Finance aggregates this data.

2.2 FAIR Principles Assessment

Findable: The data is highly findable through Yahoo Finance's public website (finance.yahoo.com) using standardized ticker symbols (NVDA for NVIDIA, SONY for Sony). The quantmod package provides a consistent programmatic method to retrieve the data.

Accessible: Data is freely accessible to anyone with internet access. No authentication, registration, or payment is required for historical stock data. Multiple access methods are available including the Yahoo Finance web interface, their API, and R packages like quantmod. The data format is standardized and machine-readable.

Interoperable: Data is provided in standard financial data formats compatible with multiple programming languages including R, Python, MATLAB, and Excel. The xts (extensible time series) format used by quantmod is widely supported across data analysis platforms. Standard date formats and numerical representations ensure compatibility.

Reusable: Data includes clear metadata describing each variable (Date, Open, High, Low, Close, Volume). The data can be freely used for research, educational purposes, and personal analysis with proper attribution to Yahoo Finance as the data source. Historical data remains consistent and can be retrieved repeatedly for reproducibility.

Overall Assessment: The dataset satisfies FAIR principles very well, making it highly suitable for reproducible research and educational analysis.

2.3 CARE Principles Assessment

The CARE principles (Collective Benefit, Authority to Control, Responsibility, Ethics) primarily apply to Indigenous data governance. Since this dataset consists of publicly-traded stock market information rather than personal or community data, CARE principles are not directly applicable. However, we acknowledge the importance of these principles for datasets involving human subjects, particularly Indigenous communities.

3 Variables and Attributes

3.1 Original Variables from Dataset

Our analysis uses the following original attributes from the Yahoo Finance dataset:

- **Date** (Date format): Trading date for each observation, representing when the market was open for trading. Excludes weekends and market holidays.
- **Close** (Numeric, USD): Closing price at the end of each trading day at 4:00 PM EST. This is our primary variable of interest as it represents the final price between buyers and sellers for that day.

3.2 Derived Variables Created for Analysis

We created the following variables to support our moving average analysis:

- **SMA_50_day** (Numeric, USD): 50-day simple moving average of closing prices, calculated by summing the closing prices of the last 50 trading days and dividing by 50. This represents the intermediate-term trend and responds more quickly to recent price changes. The calculation uses the `SMA()` function from the TTR package.
- **SMA_200_day** (Numeric, USD): 200-day simple moving average of closing prices, calculated by summing the closing prices of the last 200 trading days and dividing by 200. This represents the long-term trend and provides a broader view of market direction. Because it uses more data points, it is slower to react to price changes but gives a more stable trend indicator.
- **Status** (Categorical: "Bullish" or "Bearish"): Market status indicator created by comparing the two moving averages at each point in time. When SMA_50_day $>$ SMA_200_day, the status is classified as "Bullish," indicating that short-term momentum exceeds long-term momentum and suggesting upward price pressure. When SMA_50_day $<$ SMA_200_day, the status is "Bearish," indicating that short-term momentum is below long-term momentum and suggesting downward pressure or weakening trends.

These derived attributes allow us to systematically identify trend direction, momentum changes, and potential turning points in the stock prices over time.

4 Analysis

4.1 NVIDIA Stock Analysis

```
[1] "NVDA"
```

4.1.1 Price Trend Visualization

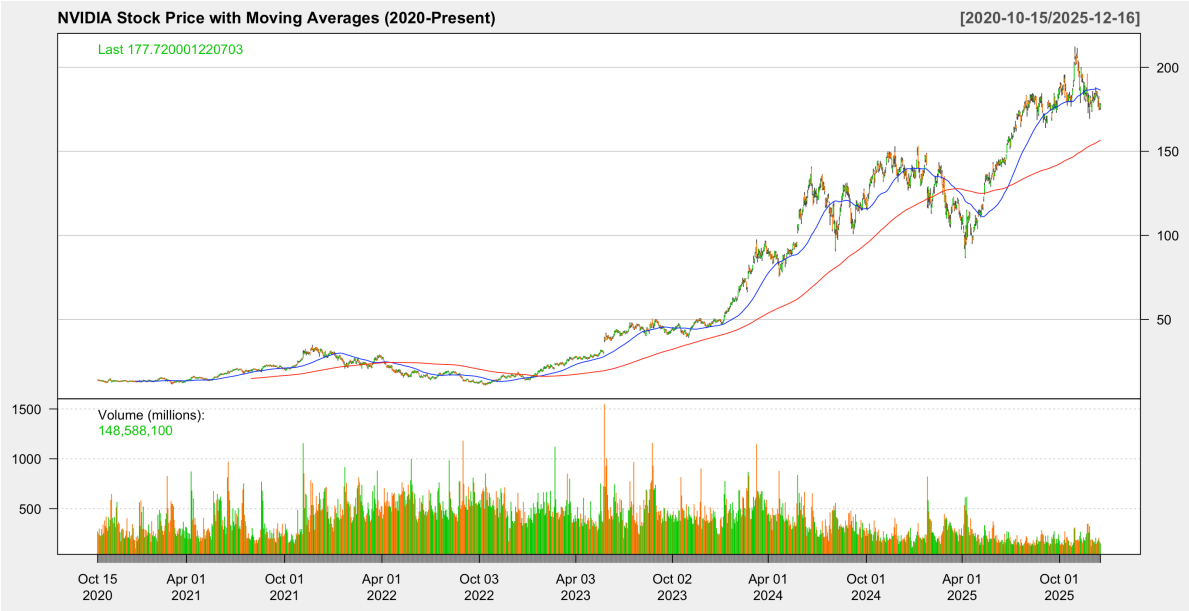

Figure 1: NVIDIA stock price from 2020 to present showing daily closing prices with 50-day simple moving average (blue line) and 200-day simple moving average (red line). The moving averages smooth out daily price fluctuations to reveal underlying trends. When the blue 50-day line is above the red 200-day line, it indicates bullish market momentum.

Figure Figure 1 shows NVIDIA's stock price from January 2020 through December 2025. The chart shows strong upward momentum, especially from 2023 onward, likely driven by increased demand for AI technology. For most of the period, the 50-day moving average (blue line) stays above the 200-day moving average (red line), indicating sustained bullish conditions. The steep rise in 2024 and 2025 shows the 50-day moving average pulling further away from the 200-day average, suggesting accelerating momentum.

4.1.2 Summary Tables

Table 1: NVIDIA stock prices and moving averages sampled every 50 trading days to show progression over time

Date	Close Price ()|50−$DaySMA$()	200-Day SMA ($)	Market Status	
2020-10-15	13.97	12.77	8.99	Bullish
2020-12-28	12.90	13.31	10.71	Bullish
2021-03-11	12.99	13.55	12.33	Bullish
2021-05-21	14.99	14.24	13.47	Bullish
2021-08-03	19.82	18.63	14.93	Bullish
2021-10-13	20.94	21.25	16.92	Bullish
2021-12-23	29.64	28.50	20.66	Bullish
2022-03-08	21.51	25.42	23.45	Bullish
2022-05-18	16.94	22.16	24.33	Bearish
2022-08-01	18.44	16.83	23.23	Bearish
2022-10-11	11.59	15.08	19.87	Bearish
2022-12-21	16.50	14.97	17.26	Bearish
2023-03-07	23.29	19.38	16.57	Bullish
2023-05-17	30.18	26.99	19.11	Bullish
2023-07-31	46.73	41.30	25.66	Bullish
2023-10-10	45.80	44.82	33.12	Bullish
2023-12-20	48.11	46.20	39.83	Bullish
2024-03-05	85.96	63.63	48.99	Bullish
2024-05-15	94.63	88.13	60.70	Bullish
2024-07-29	111.59	119.19	79.29	Bullish
2024-10-08	132.89	116.86	96.95	Bullish
2024-12-18	128.91	139.66	115.96	Bullish
2025-03-05	117.30	132.65	127.09	Bullish
2025-05-15	134.83	112.17	125.34	Bearish
2025-07-29	175.51	152.00	134.12	Bullish
2025-10-08	189.11	178.78	143.90	Bullish

Table 1 shows NVIDIA's stock data sampled every 50 trading days. The closing price increased from around $40-50 in early 2020 to over $100 by 2025, showing dramatic growth. The Status column is mostly "Bullish," meaning the 50-day moving average stayed above the 200-day for most of this period. This reflects strong investor confidence, especially as AI technology became more important. Both moving averages trend upward, though the 200-day SMA shows a smoother increase while the 50-day responds faster to price changes.

Table 2: NVIDIA's most recent 10 trading days showing current market conditions

Date	Close Price ()|50 − $DaySMA()$	200-Day SMA ($)	Market Status	
2025-12-03	179.59	186.88	154.31	Bullish
2025-12-04	183.38	187.00	154.53	Bullish
2025-12-05	182.41	187.10	154.74	Bullish
2025-12-08	185.55	187.24	154.99	Bullish
2025-12-09	184.97	187.31	155.27	Bullish
2025-12-10	183.78	187.25	155.55	Bullish
2025-12-11	180.93	187.13	155.80	Bullish
2025-12-12	175.02	186.85	156.07	Bullish
2025-12-15	176.29	186.62	156.33	Bullish
2025-12-16	177.72	186.46	156.65	Bullish

Table 2 displays NVIDIA's most recent 10 trading days as of December 2025. The stock continues trading in bullish territory with the 50-day moving average well above the 200-day. Recent prices around $170-180 show some volatility, which is normal after major price gains. The consistent "Bullish" status across recent days confirms NVIDIA maintains positive momentum.

4.2 Sony Stock Analysis

```
[1] "SONY"
```

4.2.1 Price Trend Visualization

Analyzing Sony's stock price and the 50 and 200-day SMAs from 2020 to present shows clear trending behavior. In 2020 and 2021, the stock followed an upward trend and the 50-day SMA was above the 200-day SMA, showing the market was bullish. This was a positive period as stock prices continued to rise and short-term momentum was stronger than long-term momentum.

However, in 2022 and parts of 2023, the market showed a sharp decrease in momentum with increased volatility and several bearish periods. This resulted in a declining trend and sideways price movement. During these phases, the 200-day SMA often acted as a resistance level that the price struggled to break through.

In late 2023, the stock shows renewed bullish strength as the 50-day SMA crossed back above the 200-day SMA. This is known as a bullish "golden cross" and typically signals improving momentum. As long as the stock price remains above both SMAs and both are trending upwards, it suggests strong momentum and improved long-term performance.

Figure 2: Sony stock price from 2020 to present with 50-day and 200-day moving averages. The chart shows periods of both bullish and bearish trends as the moving averages cross at various points throughout the analysis period.

4.2.2 Summary Tables

Table 3: Sony stock prices and moving averages sampled every 50 trading days to show progression over time

Date	Close Price ()|50 − $DaySMA$()	200-Day SMA ($)	Market Status	
2020-10-15	14.65	15.59	13.95	Bullish
2020-12-28	19.59	17.78	15.01	Bullish
2021-03-11	20.64	21.08	17.22	Bullish
2021-05-21	19.28	20.81	18.82	Bullish
2021-08-03	20.74	19.97	19.91	Bullish
2021-10-13	21.90	21.32	20.80	Bullish
2021-12-23	24.77	24.06	21.54	Bullish
2022-03-08	19.48	22.49	21.96	Bullish
2022-05-18	17.41	18.78	21.66	Bearish
2022-08-01	17.22	17.23	20.64	Bearish
2022-10-11	12.83	15.33	18.46	Bearish
2022-12-21	15.48	15.13	16.62	Bearish
2023-03-07	17.45	17.05	16.18	Bullish
2023-05-17	19.06	18.04	16.38	Bullish
2023-07-31	18.72	18.91	17.28	Bullish
2023-10-10	16.92	16.89	17.72	Bearish
2023-12-20	18.02	17.30	17.78	Bearish
2024-03-05	17.13	18.72	17.95	Bullish
2024-05-15	16.70	16.85	17.44	Bearish
2024-07-29	17.28	17.19	17.51	Bearish
2024-10-08	19.03	18.36	17.78	Bullish
2024-12-18	20.91	19.27	17.92	Bullish
2025-03-05	24.34	22.27	19.27	Bullish
2025-05-15	24.87	24.35	21.06	Bullish
2025-07-29	24.15	25.41	22.82	Bullish
2025-10-08	29.75	28.04	25.02	Bullish

Table 3 presents Sony's stock data sampled every 50 trading days, showing how prices evolved over the analysis period. The Status column alternates between "Bullish" and "Bearish" more frequently than NVIDIA, reflecting Sony's more cyclical performance with periods of both growth and consolidation.

Table 4: Sony's most recent 10 trading days showing current market conditions

Date	Close Price ()|50−$DaySMA$()	200-Day SMA ($)	Market Status	
2025-12-03	28.46	28.83	26.41	Bullish
2025-12-04	28.29	28.81	26.43	Bullish
2025-12-05	28.03	28.77	26.44	Bullish
2025-12-08	27.55	28.73	26.46	Bullish
2025-12-09	27.56	28.70	26.47	Bullish
2025-12-10	27.08	28.66	26.48	Bullish
2025-12-11	26.73	28.62	26.49	Bullish
2025-12-12	26.77	28.60	26.50	Bullish
2025-12-15	26.64	28.55	26.50	Bullish
2025-12-16	26.45	28.48	26.51	Bullish

Table 4 shows Sony's most recent 10 trading days as of December 2025. The recent data shows the current market status and how the moving averages are positioned relative to the stock price.

5 Discussion

5.1 Comparing NVIDIA and Sony Moving Average Patterns

Looking at NVIDIA and Sony's moving averages, the difference in their market behavior is quite clear. NVIDIA's stock is highly bullish with strong momentum. The 50-day SMA stays well above the 200-day SMA for long stretches, showing sustained investor confidence and strong upward momentum.

On the other hand, Sony's stock shows more cyclical behavior with alternating bullish and bearish phases. The market is more volatile with the moving averages crossing more frequently. This reflects Sony's more diversified business model across multiple industries compared to NVIDIA's focus on GPUs and AI technology.

5.2 Interpretation and Limitations

The moving average crossover strategy is effective for identifying long-term trends and changes in momentum. Bullish crossovers generally align with rising stock prices, while bearish crossovers often correspond to periods of decline or consolidation. This confirms that moving averages are helpful tools for summarizing whole market direction.

However, moving averages are lagging indicators and might signal trends only after significant price movements have occured. In addition, this analysis does not account for external factors such as economic conditions, company news, or earnings reports. Relying on historical price data may oversimplify complex market dynamics.

6 Conclusion

This project used 50-day and 200-day simple moving averages to analyze NVIDIA and Sony stock trends from 2020 to the present. NVIDIA demonstrated strong and sustained bullish momentum, while Sony exhibited more cyclical price movements. Overall, moving averages provide an effective way to visualize long-term trends, though they are most valuable when combined with more detailed analysis.

7 Author Contributions

Mohit Naveen: - Conducted NVIDIA stock analysis including data collection and processing - Created all NVIDIA visualizations (chart and tables) - Wrote NVIDIA analysis narrative and interpretation - Reviewed Sony analysis code

Kanon Tsuda: - Conducted Sony stock analysis including data collection and processing - Created all Sony visualizations (chart and tables) - Wrote Sony analysis narrative and interpretation - Reviewed NVIDIA analysis code

Joint Contributions: - Both team members collaborated on FAIR/CARE principles assessment - Both contributed to Discussion section comparing the two stocks - Both contributed to Conclusion section - Both participated in code review process - Both contributed to overall document structure and organization

8 References

Ryan, J. A., & Ulrich, J. M. (2023). *Quantmod: Quantitative financial modelling framework*. https://CRAN.R-project.org/package=quantmod

Yahoo! Inc. (2024). *Yahoo finance*. https://finance.yahoo.com

9 Code Appendix

```r
# tidyverse style
# nvidia graph for moving averages
# Primary Author: Mohit Naveen
# Reviewer: Kanon Tsuda

library(quantmod)
library(dplyr)
library(knitr)

# Get NVIDIA stock data
getSymbols("NVDA", from = "2020-01-01", to = Sys.Date())

# Calculate moving averages
NVDA$SMA50 <- SMA(Cl(NVDA), n = 50)
NVDA$SMA200 <- SMA(Cl(NVDA), n = 200)

# Create tidy data frame
nvda_df <- data.frame(
  Date = index(NVDA),
  Price = as.numeric(Cl(NVDA)),
  SMA_50_day = as.numeric(NVDA$SMA50),
  SMA_200_day = as.numeric(NVDA$SMA200)
) %>%
  na.omit() %>%
  mutate(Status = ifelse(SMA_50_day > SMA_200_day, "Bullish", "Bearish"))
# tidyverse style
# Nvidia sampled every 50 trading days
# Primary Author: Mohit Naveen
# Reviewer: Kanon Tsuda

sample_table <- nvda_df %>%
  slice(seq(1, n(), by = 50)) %>%
  mutate(
    Price = round(Price, 2),
    SMA_50_day = round(SMA_50_day, 2),
    SMA_200_day = round(SMA_200_day, 2)
  )

kable(sample_table,
      col.names = c("Date", "Close Price ($)", "50-Day SMA ($)",
                    "200-Day SMA ($)", "Market Status"),
      align = c("l", "r", "r", "r", "c"),
```

```
      row.names = FALSE)
# tidyverse style
# Nvidia most 10 recent trading days
# Primary Author: Mohit Naveen
# Reviewer: Kanon Tsuda

recent_table <- nvda_df %>%
  tail(10) %>%
  mutate(
    Price = round(Price, 2),
    SMA_50_day = round(SMA_50_day, 2),
    SMA_200_day = round(SMA_200_day, 2)
  )

kable(recent_table,
      col.names = c("Date", "Close Price ($)", "50-Day SMA ($)",
                    "200-Day SMA ($)", "Market Status"),
      align = c("l", "r", "r", "r", "c"),
      row.names = FALSE)
# tidyverse style
# Sony's moving day averages
# Primary Author: Kanon Tsuda
# Reviewer: Mohit Naveen

# Load libraries
library(quantmod)
library(dplyr)
library(knitr)

# Get Sony stock data (Sony Group Corporation ADR)
getSymbols("SONY", from = "2020-01-01", to = Sys.Date())

# Calculate 50-day and 200-day moving averages
SONY$SMA50 <- SMA(Cl(SONY), n = 50)
SONY$SMA200 <- SMA(Cl(SONY), n = 200)

# Create a tidy data frame for analysis
sony_df <- data.frame(
  Date = index(SONY),
  Price = as.numeric(Cl(SONY)),
  SMA_50_day = as.numeric(SONY$SMA50),
  SMA_200_day = as.numeric(SONY$SMA200)
```

```
) %>%
  na.omit() %>%
  mutate(Status = ifelse(SMA_50_day > SMA_200_day, "Bullish", "Bearish"))
# tidyverse style
# Sony sampled every 50 trading days
# Primary Author: Kanon Tsuda
# Reviewer: Mohit Naveen

sample_table <- sony_df %>%
  slice(seq(1, n(), by = 50)) %>%
  mutate(
    Price = round(Price, 2),
    SMA_50_day = round(SMA_50_day, 2),
    SMA_200_day = round(SMA_200_day, 2)
  )

kable(sample_table,
      col.names = c("Date", "Close Price ($)", "50-Day SMA ($)",
                    "200-Day SMA ($)", "Market Status"),
      align = c("l", "r", "r", "r", "c"),
      row.names = FALSE)
# tidyverse style
# Sony most recent 10 trading days
# Primary Author: Kanon Tsuda
# Reviewer: Mohit Naveen

recent_table <- sony_df %>%
  tail(10) %>%
  mutate(
    Price = round(Price, 2),
    SMA_50_day = round(SMA_50_day, 2),
    SMA_200_day = round(SMA_200_day, 2)
  )

kable(recent_table,
      col.names = c("Date", "Close Price ($)", "50-Day SMA ($)",
                    "200-Day SMA ($)", "Market Status"),
      align = c("l", "r", "r", "r", "c"),
      row.names = FALSE)
```