Machine Learning for Trading
Project 6 Indicator Evaluation

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***Abstract*—** 2 trading strategies and 5 technical indicators are evaluated to serve as trading signals as a preparation for project 8.

1 INDICATORS

1.1 Price / Simple Moving Average (SMA)

SMA is the average closing price of a stock over a desired window. A 14 day window is used here to generate Figure 1. It is a helpful indicator to identify trends in stock prices. In general SMA can be used as a signal line and here it's selected as a signal for stock price.

By dividing stock price by SMA, result > 1.05 (overbought) indicates a sell and result < 0.95 (oversold) indicates a buy.

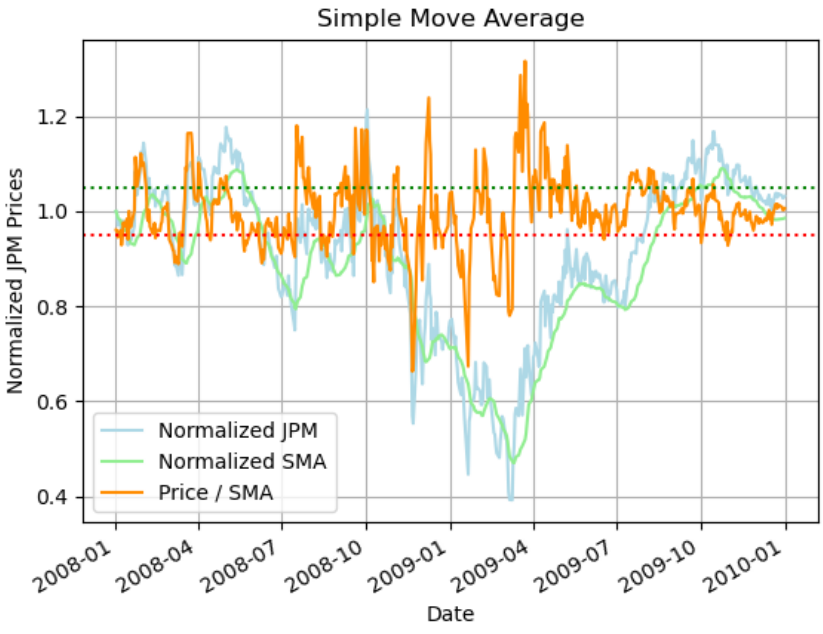

***Figure 1*—**Simple Move Average

1.2 Percent B (%B)

Bollinger Bands are great metrics that help determine whether price is high or low on a relative basis. Price fluctuation relative to SMA, upper band and lower band can lead to trading signals. To further investigate the relationship among prices, upper band and lower band, %B is calculate as such

$$[(price \ - \ lowe\_band) \ / \ (upper\_band \ - \ lower\_band)] \ * \ 100$$

It is a helpful indicator to identify overbought and oversold situations. In Figure 2, there is an up trend from 2009-04 to 2010-01 shown, and in Figure 3, within the same time range, there is indication of oversold where %B crosses below 0 which are buy signals. %B can be combined with momentum to generate trading signals.

During an up trend (positive momentum), %B < 0 indicates a strong buy signal. During a down trend (negative momentum), %B > 0 indicates a strong sell signal.

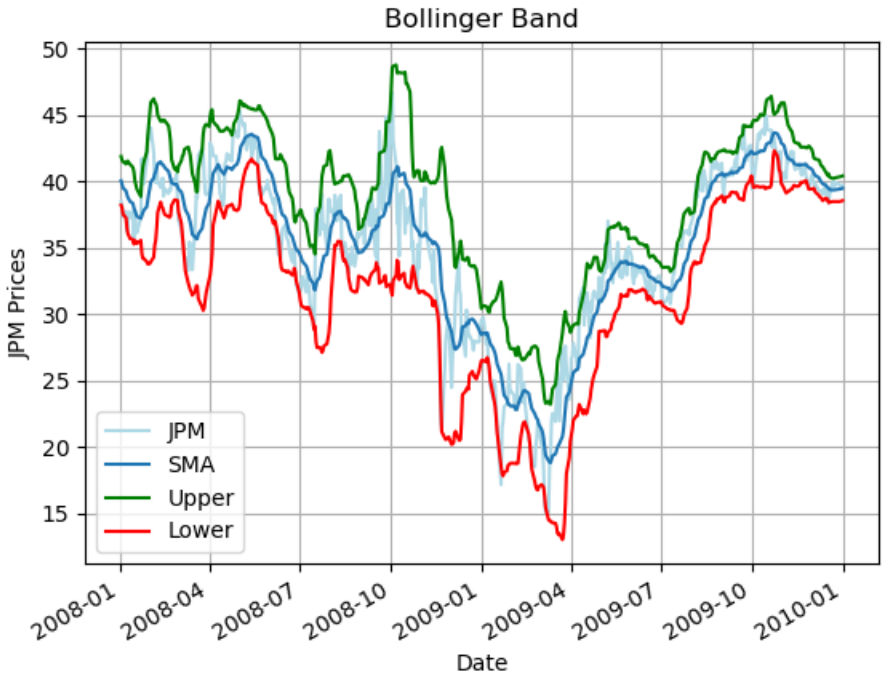

Figure 2—Bollinger Bands

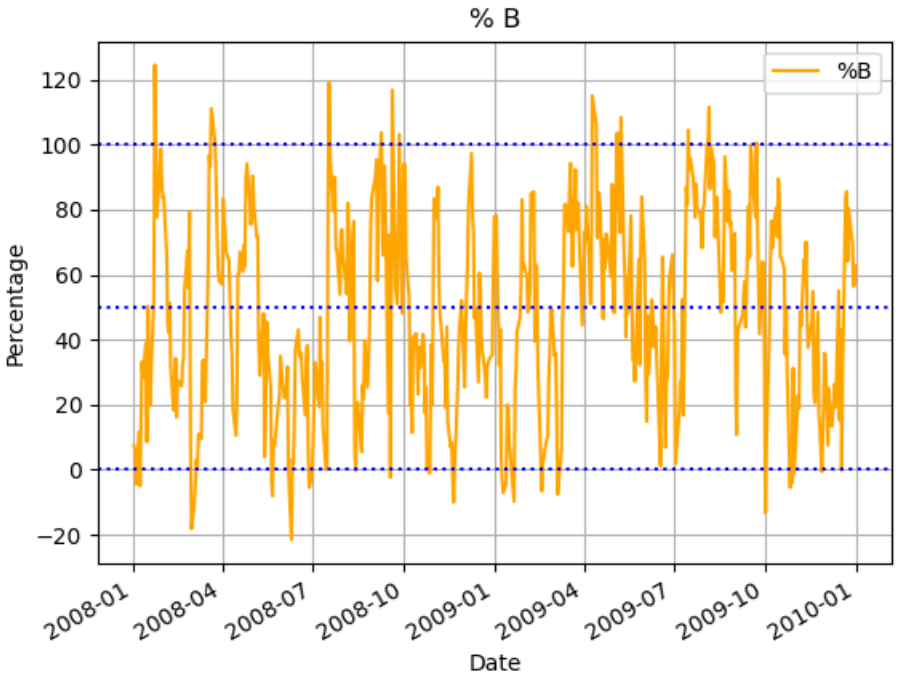

Figure 3—Percent B

1.3 Momentum

Momentum is calculated as the slope of stock prices, or rate of change over a period of time. Figure 4 is generated with a 14 day window. It is a good indicator to evaluate the strength of an up or down trend.

$$price[i] \,/\, price[i \;-\; 14] \;-\; 1$$

As shown in Figure 4, between 2009-04 and 2009-07, there was a strong up trend at the beginning and then turned into a more gradual price increase. This shows an exhaustion of momentum and potentially an indication for sell.

When momentum crosses over 0 from the negative side, it indicates a buy signal and when momentum crosses over 1 from the positive side, it indicates a sell signal. Momentum can also be combined with either price / SMA or %B (mentioned above) to generate trading signals.

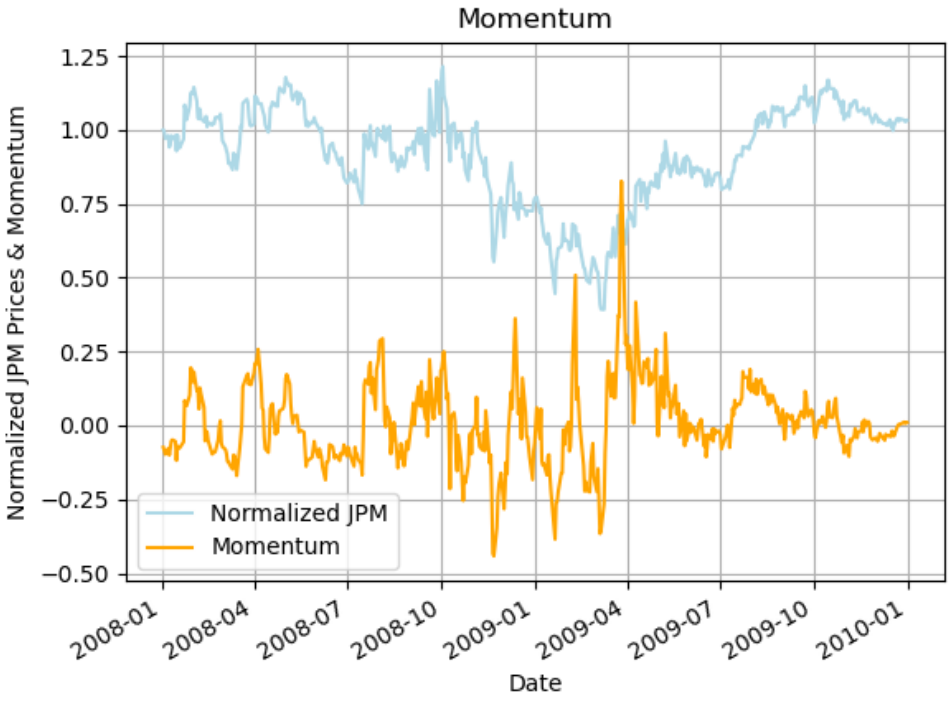

Figure 4—Momentum

1.4 Golden/Death Cross

Golden / Death Cross is an indicator calculated using two SMA with a 50 window and a 200 window. In general when a shorter term SMA lies above a longer term SMA, it is expected to be an up trend. In Figure 5, around 2009-05 SMA 50 crosses SMA 200 as an indication of buy. And from 2009-05 onward, we indeed see a strong up trend.

With this indicator, when the 50 SMA crosses above the 200 SMA, it indicates a buy signal and when 50 SMA crosses below the 200 SMA, it indicates a sell signal.

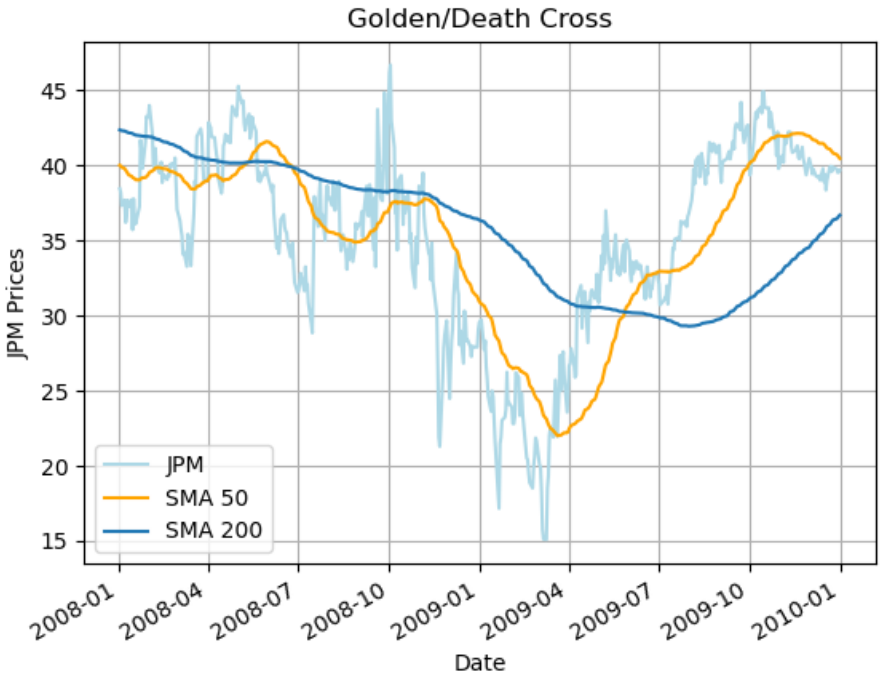

Figure 5—Golden/Death Cross

1.5 Moving Average Convergence Divergence (MACD)

MACD is a momentum indicator which compares long term moving average and short short term moving average to identify moving trends. It is built inherently using EMA to determine two factors, MACD and MACD signal. EMA is a weighted moving average that places more weight on most recent prices. It can be categorized into short-term or long-term EMAs which are determined by its window size. EMA is calculated using the panda function.

$$df.exponential\,weight(window,\ adjust)$$

In Figure 7, MACD is calculated as the difference between a 12 window EMA and a 26 window EMA. MACD signal is then determined as moving average of the MACD using window size of 9.

When MACD crosses above MACD signal, it indicates a buy signal and when MACD crosses below MACD signal, it indicates a sell signal

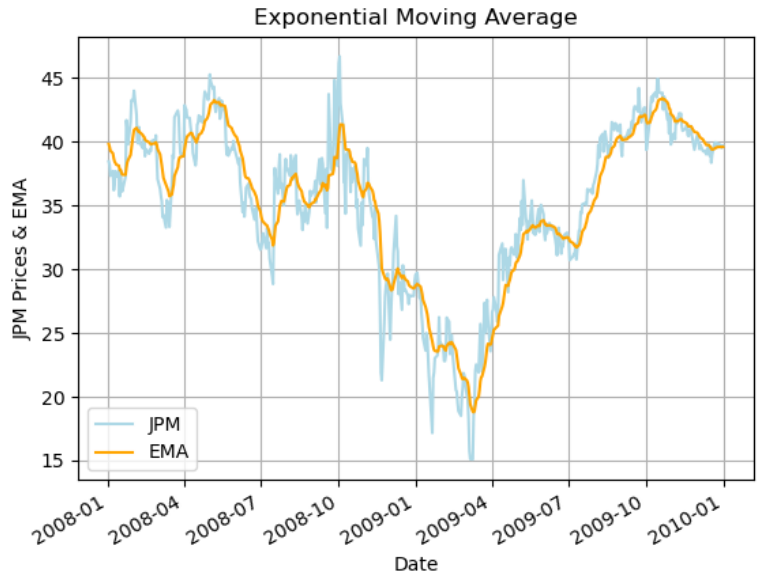

Figure 6—Exponential Moving Average

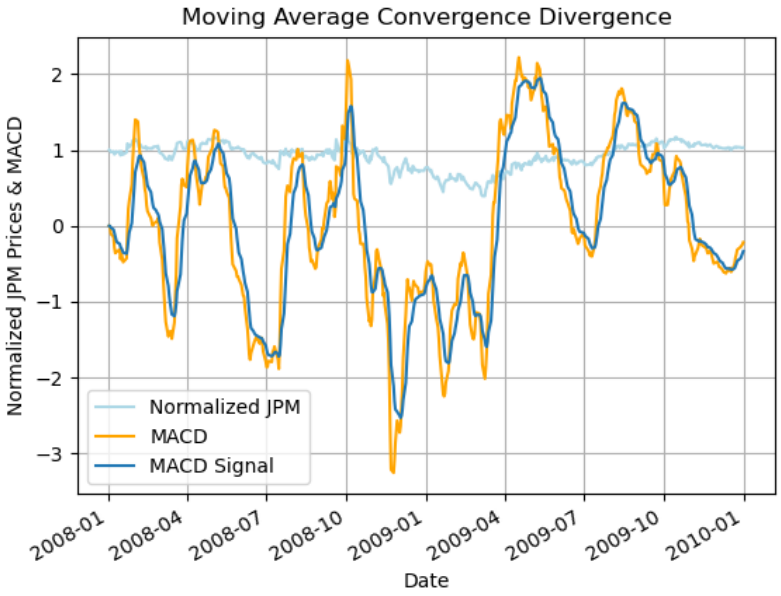

Figure 7— Moving Average Convergence Divergence

2 THEORETICALLY OPTIMAL STRATEGY (TOS)

In this problem, we are asked to provide an optimal strategy for trading JPM. Allowable positions are 1000 shares long, 1000 shares short, 0 shares. Assumption is that no commission or impact are considered.

The solution is implemented using a dynamic programming approach. By slicing a problem into smaller pieces and solving them individually, it helps solving the problem itself. In this problem, the intention is to maximize profit by trading a single stock within a date range. Therefore we can look at the stock prices daily and compare price[t] (current date) with price[t + 1] (next date). If price[t + 1] is greater, it means that the stock price is going up and it is guaranteed profit by making a buy order at the price[t]. In order to maximize this profit, the buy order should be in the amount 1000 shares if current position is 0 and 2000 shares if current position is -2000. However if price[t + 1] is smaller, we'd want to short the stock in order to make a profit. Therefore a sell order should be made and the amount is limited by the negative end. The shorted shares are bought back next time a price increase is observed.

This approach basically allows us to always long at a valley (lowest price) and short at a peak (highest price) and thus makes it an optimal strategy.

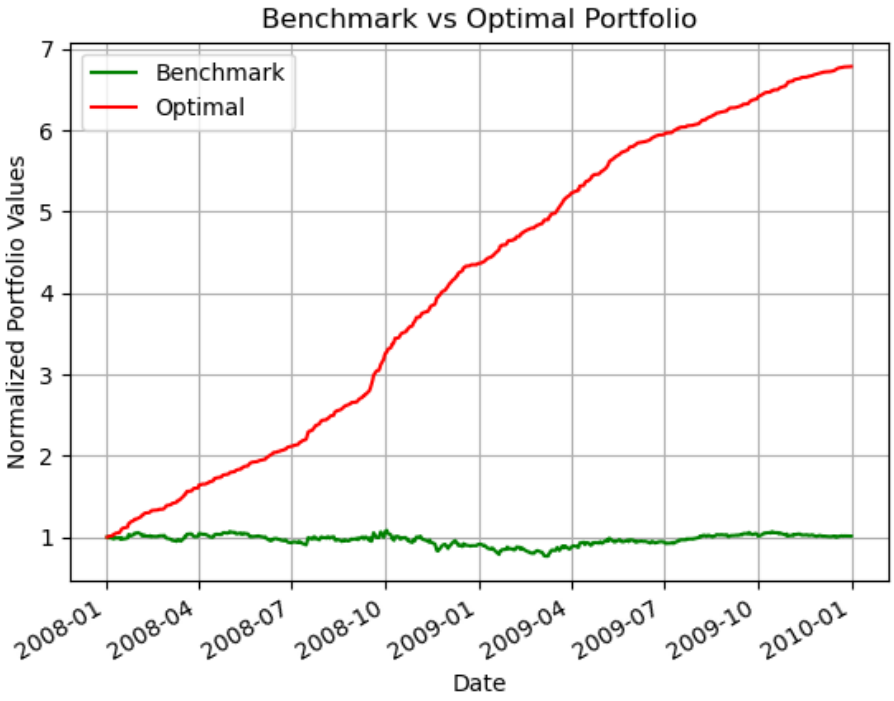

Figure 8—Theoretically Optimal Strategy

Table 1—TOS vs Benchmark Metrics

Name	**TOS**	**Benchmark**
Cumulative Returns	5.7861	0.0123
STD of Daily Returns	0.0045	0.0170
Avg of Daily Returns	0.0038	0.0002

3 References

1. https://matplotlib.org/stable/gallery/color/named_colors.html
2. https://towardsdatascience.com/implementing-macd-in-python-cc9b2280126a
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