SC1003: Introduction to Computational Thinking and Programming

Assignment 2

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MACD Trend Reversal Model Design

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1: Brief Introduction of MACD Trading

What is MACD?

It stands for Moving Average Convergence Divergence, consisting of 2 lines and histograms.

Such two lines are the MACD line and the signal line.

Below are the properties of the lines and histograms:

**MACD Line:**

It is the moving averages of a security’s price.

It uses recent price movement to plot a line and it is the result of a calculation between 2 different moving averages:

* MACD= 26 period EMA -12 period EMA
* EMA stands for exponential moving average

One more point to note is that the MACD line responds faster compared to the signal line towards price changes.

**Signal Line:**

The signal line is plotted alongside the MACD line.

It is the 9 period EMA of the MACD line.

In terms of price changes, the signal line responds slower compared to the MACD line.

Hence, we usually refer to the signal line as a slightly slower and more smoothed out version of the MACD line.

**Histogram:**

Essentially, it serves to plot the difference between the MACD line and the Signal line.

There are two types of histograms in the chart:

* Positive histogram
* Negative histogram

A positive histogram occurs when the MACD line crosses the signal line from bottom to top. This represents a trend reversal turning bullish.

A negative histogram, conversely, occurs when the MACD line crosses the signal line from top to bottom. This represents a trend reversal turning bearish.

An interesting relationship between the two lines and histogram is that:

* the wider the distance between the MACD line and the signal line, the larger the bars of the histogram
* vice versa

**Definition of a moving average:**

It is the average of a time series over a specific window size that slides along as we move along the time series.

Long Moving Average (LMA) is considered as 26 days whereas,

a short Moving Average (SMA) is regarded as 1 day.

**MACD Model:**

Trend reversal:

Each pair forms a BUY-HOLD-SELL action and with each BUY and SELL position there is a commission loss incurred.

MACD line= SMA – LMA (MA can be either SMA or EMA of the time series)

MACD histogram= MACD – 9-MACD-MA

Assume all the holdings are bought or sold with all the accumulated funds.

Usage of the simple moving average with past data is restricted due to the inability to have future data values in the time series.

An exponential moving average helps to mitigate the issue with the lack of future data by utilising more recent data.

Calculation of Exponential moving average (EMA) is as of below:

EMA = (today’s closing price \*K) + (Previous EMA \* (1 – K))

N = number of days in EMA

K (Smoothing Factor) = 2/(N+1)

LEMA: N=26 days

SEMA: N=12 days

2. Computerisation of the MACD trend reversal system: depicted by Flowchart and Pseudo Code

**Pseudo Code:**

READ excel sheet data

DISPLAY data plots between dates and close price

INITIATE Balance of BUY and SELL pair to be equal to BUY-SELL -1/8(commission)

INITIATE BUY to be an empty array of prices.

INITIATE SELL to be an empty array of prices.

INITIATE tradecounter to be zero.

INITIATE SUM to be zero.

#Sum is the balance between BUY and SELL signals

READ user input to choose between using SSMA or EMA to calculate MACD signals

#choice 1 to use EMA, choice 2 to use SSMA

**#USE EMA**

CALCULATE SEMA

#every 12 days worth of closing price divide by 12 (Short Exponential Moving #Average, 12 days)

CALCULATE LEMA

#every 26 days worth of closing price divide by 12 (Long Exponential Moving #Average, 26 days)

CALCULATE MACD line by subtracting LEMA from SEMA

CALCULATE SIGNAL line by dividing 9 from 9 consecutive values of MACD

SHOW MACD line (green colour) and SIGNAL line (yellow colour) in a graph

FOR first close price to last close price

IF MACD line goes over Signal line

ASSIGN null to SELL

INITIATE a BUY Signal with the current close price # Buy Signal is given

CALCULATE net gain by SUM-1.125 of current close price

#inclusive of 1/8 for commission

INCREMENT tradecounter by 1

ENDIF

ELSE MACD line goes under Signal line

ASSIGN null to BUY

INITIATE a SELL Signal with the current close price # Buy Signal is given

CALCULATE net gain by SUM+0.875 of current close price

#inclusive of 1/8 for commission

INCREMENT tradecounter by 1

ENDELSE

ENDFOR

SHOW Buy and Sell signals in plot #with blue triangle for buy signals and red triangle for sell signals

WRITE BUY\_Signal\_Price, SELL\_Signal\_Price and NetGain to excel sheet

2. Computerisation of the MACD trend reversal system: depicted by Flowchart and Pseudo Code (continued)

PRINT summary of code run

PRINT tradecounter #total number of trades done

PRINT total NetGain #overall net earnings (profit or loss)

CALCULATE avgReturn

PRINT avgReturn

#average returns per trade by calculating total NetGain divided by total number of #trades done

CALCULATE relativeGainLoss

PRINT relativeGainLoss

#relative gain/loss against the long term Buy-Hold-Sell Strategy

#long term Buy-Hold-Sell Strategy = highest close price – lowest close price

**#USE SSMA (Standard Simple Moving Average)**

#INITIATE a counter i

INITIATE i to be zero

#LENGTH is 12 for SSMA, 26 for LSMA and 9 for SIGNAL line

#Calculation for SMA, LMA, SIGNAL line

WHILE counter i is less than total number of close prices subtracted by LENGTH +1

STORE elements from i to i+LENGTH

CALCULATE the average of current window

STORE the average of current window in movingAvg

RETURN movingAvg

ENDWHILE

CALCULATE MACD line by subtracting LEMA from SEMA

SHOW MACD line (green colour) and SIGNAL line (yellow colour) in a graph

FOR first close price to last close price

IF MACD line goes over Signal line

ASSIGN null to SELL

INITIATE a BUY Signal with the current close price

# Buy Signal is given

CALCULATE net gain by SUM-1.125 of current close price

#inclusive of 1/8 for commission

INCREMENT tradecounter by 1

ENDIF

ELSE MACD line goes under Signal line

ASSIGN null to BUY

INITIATE a SELL Signal with the current close price

# Buy Signal is given

2. Computerisation of the MACD trend reversal system: depicted by Flowchart and Pseudo Code (continued)

CALCULATE net gain by SUM+0.875 of current close price

#inclusive of 1/8 for commission

INCREMENT tradecounter by 1

ENDELSE

ENDFOR

SHOW Buy and Sell signals in plot #with blue triangle for buy signals and red triangle for sell signals

WRITE BUY\_Signal\_Price, SELL\_Signal\_Price and NetGain to excel sheet

PRINT summary of code run

PRINT tradecounter #total number of trades done

PRINT total NetGain #overall net earnings (profit or loss)

CALCULATE avgReturn

PRINT avgReturn

#average returns per trade by calculating total NetGain divided by total number of #trades done

CALCULATE relativeGainLoss

PRINT relativeGainLoss

#relative gain/loss against the long term Buy-Hold-Sell Strategy

#long term Buy-Hold-Sell Strategy = highest close price – lowest close price

3. Computerisation of the MACD trend reversal system: Flowchart

START

**Flowchart:**

READ excel sheet data

DISPLAY data plots between dates and close price

INITIATE Balance of BUY and SELL pair to be equal to BUY-SELL -1/8(commission)

INITIATE BUY to be an empty array of prices.

INITIATE SELL to be an empty array of prices.

INITIATE tradecounter to be zero.

INITIATE SUM to be zero.

INITIATE BUY AND SELL TO BE ZERO

INPUT USE SMA OR EMA

USE EMA

USE SSMA

CALCULATE SEMA AND LEMA

CALCULATE MACD LINE AND SIGNAL LINE

CALCULATE SSMA AND SLMA

CALCULATE MACD LINE AND SIGNAL LINE

FOR first close price to last close price

TRUE

TRUE

IF MACD line goes over Signal Line

IF MACD line goes over Signal Line0

FALSE

FALSE

TRUE

BUY signal given (Bullish)

INITIATE a BUY with current close price

BUY signal given (Bullish)

INITIATE a BUY with current close price

SELL signal given (Bearish)

INITIATE a SELL with current close price

SELL signal given (Bearish)

INITIATE a SELL with current close price

Calculate net gain by SUM-1.125 of current close price

Increment tradecounter by 1

Calculate net gain by SUM-1.125 of current close price

Increment tradecounter by 1

Calculate net gain by SUM +0.85 of current close price

Increment tradecounter by 1

Calculate net gain by SUM +0.85 of current close price

Increment tradecounter by 1

ENDIF

ENDFOR

ENDIF

ENDFOR

3. Computerisation of the MACD trend reversal system: FlowChart (continued)

ENDIF

ENDFOR

ENDIF

ENDFOR

SHOW BUY and SELL signals

WRITE BUY\_SIGNAL\_Price, SELL\_Signal\_Price and NetGain to excel sheet

PRINT summary of code run

PRINT tradecounter

PRINT total NetGain

Calculate avgReturn

Print avgReturn

Calculate relativeGainLoss

Print relativeGainLoss

END

1. Key Functions and Data Structure

Key functions:

One of the key functions is **buySell(signal)** which allows the user to append buy and sell signals to the excel sheet through the columns.

It also calculates the number of trades completed after each iteration of the for loop.

Furthermore, we have the net profit/loss labelled as netGain in the function which calculates after each buy or sell signal is initiatilised (inclusive of the 1/8 commission of each trade).

These data are useful for calculating average return per trade from the MACD trading in the end.

Secondly, is the **plotbuySell()** function.

This function returns a plot showing trend reversals with buy signals (marked as blue triangles) and sell signals (marked as red triangles).

This way we can see a visual view of an approximate number of trend reversals and the proximity of time (days) between each trend reversals.

Thirdly, another key function is the SMA(inputted, length) function. Parameter inputted refers to the data file (i.e. df[‘Close’] for calculating SSMA and LSMA and MACD for calculating signal line) and parameter length refers to the number of days (9 for signal line, 12 for SSMA and 26 for LSMA).

It starts with initialising movingAvg to be zero.

Then the control goes to the while loop where loop control variable i starts with zero and ends when all the close prices are inputted into the loop body.

During each iteration, the close prices in the window of length are summed and the average is calculated then stored in the list movingAvg=[ ].

For those rows vs columns that do not have a value, nan is assigned to prevent any errors from occurring during runtime.

In the end, SSMA, LSMA and the signal line is calculated.

MACD line is calculated before the signal line with MACD= SSMA- LSMA.