

Creating an Automated Stock Trading System in Excel

Automated Stock Trading System

<http://spreadsheetml.com/automatedstocktradingsystem>

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1. Introduction

The aim of this course is to allow you to use the various Stock Technical Indicators and create an Automated Stock Trading System using Microsoft Excel. We assume that you have some basic knowledge of Excel and is interested in putting into practice the financial concepts of a technical stock trading system.

We will start from downloading Stock data and move into the calculation of the different Technical Indicators. The Technical Indicators include Moving Average, Directional Movement, Directional Movement Indicator, Average Directional Movement Index and Average True Range. The focus is on two aspects. The first is the understanding of the specific Technical Indicators and the second is the implementation of the indicators in Excel.

We do not guarantee that you will get rich by going through these materials but we are confident that you will become a better technical trader as you will be able to apply many of these Technical Indicators to analyse your portfolio.

2. Download Stock Trading Prices

2.1 Download Data from Yahoo Finance

Launch your browser and navigate to <http://finance.yahoo.com>. Search for the stock you require by entering the stock quote, such as “BAC”, into the search bar. Click on the “Historical Data” link and then the “Download Data” link as shown.

 Download Data

When prompted, click on “Open” to download the data to Excel.

What do you want to do with BAC.csv?
From: query1.finance.yahoo.com

Open

Save

Cancel

You should see the following stock data in Excel.

	A	B	C	D	E	F	G
1	Date	Open	High	Low	Close	Adj Close	Volume
2	5/30/2017	23.13	23.21	22.88	22.91	22.835	61307900
3	5/31/2017	22.78	22.8	22.09	22.41	22.41	1.39E+08
4	6/1/2017	22.48	22.64	22.3	22.63	22.63	69725100
5	6/2/2017	22.27	22.59	22.16	22.45	22.45	79722300
6	6/5/2017	22.44	22.7	22.39	22.41	22.41	51590300
7	6/6/2017	22.2	22.41	22.07	22.23	22.23	71735600
8	6/7/2017	22.3	22.62	22.27	22.6	22.6	66429700
9	6/8/2017	22.62	23.21	22.6	22.97	22.97	93069800
10	6/9/2017	23.22	23.67	23.21	23.67	23.67	1.08E+08
11	6/12/2017	23.82	24.04	23.73	23.78	23.78	85829900
12	6/13/2017	23.95	24.11	23.66	23.77	23.77	68047300
13	6/14/2017	23.55	23.81	23.2	23.76	23.76	1.02E+08
14	6/15/2017	23.55	23.95	23.47	23.54	23.54	69707500
15	6/16/2017	23.56	23.62	23.37	23.43	23.43	57745800
16	6/19/2017	23.61	24	23.6	23.91	23.91	58587800
17	6/20/2017	23.91	23.99	23.48	23.49	23.49	59693500
18	6/21/2017	23.5	23.57	23.07	23.13	23.13	72432800
19	6/22/2017	23.12	23.2	22.9	22.93	22.93	64763300
20	6/23/2017	23.11	23.11	22.74	22.82	22.82	85399600
21	6/26/2017	22.91	23.14	22.73	22.89	22.89	60851100
22							

2.2 Automating the download of Stock Prices

The methods above are useful when you are exploring what kind of data to download to Excel. However, it will be laborious to go through all the steps to download the price of a specific Stock symbol. This section will show you how to automate the download of the Stock Prices. We will be using a simple programming language called Visual Basic for Applications (VBA). If you will like to find out more about VBA, you will be interested to know that spreadsheetml.com offers a VBA course on our website. Otherwise, please be assured that we will be going through the steps, one at a time to allow you to construct the models without prior knowledge of VBA.

Launch Excel and create a new workbook. Call this workbook AutomatedDownloadData.xls.

In Microsoft Excel 2003: Go to Tools->Macro->Visual Basic Editor

In Microsoft Excel 2007: Go to Developer->Visual Basic

Right click on VBAProject (your Excel Filename) and select Insert->Module. A default "Module1" will be inserted. Click on Module1 and paste the VBA code below on the right-hand side of the Visual Basic Editor. The following VBA codes allow you to download data from Yahoo Finance based on a specified Stock symbol, Start Date and End Date.

```
Sub GetStock(ByVal stockSymbol As String, ByVal StartDate As Date, ByVal EndDate As Date)

    On Error GoTo ErrHandler:
    Dim freq As String
    Dim crumb          As String
    Dim cookie         As String
    Dim response       As String
    Dim strUrl As String
    Dim DownloadURL As String
    Dim period1, period2 As String
    Dim httpReq As WinHttp.WinHttpRequest
    Set httpReq = New WinHttp.WinHttpRequest
    freq = "1d"

    DownloadURL = "https://finance.yahoo.com/lookup?s=" & stockSymbol
    With httpReq
        .Open "GET", DownloadURL, False
        .setRequestHeader "Content-Type", "application/x-www-form-urlencoded; charset=UTF-8"
        .send
        .waitForResponse
        response = .responseText
        cookie = Split(.getResponseHeader("Set-Cookie"), ";")(0)
    End With

    period1 = (StartDate - DateValue("January 1, 1970")) * 86400
    period2 = (EndDate - DateValue("January 1, 1970")) * 86400
    Dim counter As Long
    Dim startCounter As Long
    Dim result As String
    Dim dataResult As String
    Dim startResult As String
```

```

    crumb = Chr(34) & "CrumbStore" & Chr(34) & ":{" & Chr(34) & "crumb" & Chr(34) & ":" &
Chr(34)
    startCounter = InStr(response, crumb) + Len(crumb)
    While Mid(response, startCounter, 1) <> Chr(34)
        result = result & Mid(response, startCounter, 1)
        startCounter = startCounter + 1
    Wend
    crumb = result
    DownloadURL = "https://query1.finance.yahoo.com/v7/finance/download/" & stockSymbol &
"?period1=" & period1 & "&period2=" & period2 & "&interval=" + freq +
"&events=history&crumb=" & crumb

    startResult = ""
    startCounter = 0
    While (startResult <> "Date" And startCounter < 8)
        With httpReq
            .Open "GET", DownloadURL, False
            .setRequestHeader "Cookie", cookie
            .send
            .waitForResponse
            dataResult = .responseText
        End With
        startResult = Mid(dataResult, 1, 4)
        startCounter = startCounter + 1
    Wend
    If (startResult <> "Date") Then
        noErrorFound = 0
        GoTo ErrHandler
    End If
    dataResult = Replace(dataResult, ",", vbTab)
    Dim dataObj As New DataObject
    dataObj.SetText dataResult
    dataObj.PutInClipboard
    Set currentWorksheet = ThisWorkbook.ActiveSheet
    Set currentRange = currentWorksheet.Range("A1")
    dataObj.GetFromClipboard
    currentRange.PasteSpecial
    Columns("F").Select
    Selection.EntireColumn.Insert , CopyOrigin:=xlFormatFromLeftOrAbove
    ActiveSheet.Columns("H:H").Cut Destination:=Columns("F:F")
    Range("A1").Select
    noErrorFound = 1

ErrHandler:
    If noErrorFound = 0 Then
        Application.ScreenUpdating = True
        MsgBox ("Stock " + stockSymbol + " cannot be found.")
    End If
    'Resume Next
End Sub

Sub Download()
    Call GetStock("BAC", "02/01/2017", "09/05/2017")
End Sub

```

Click on Save and then File->Close to return to Microsoft Excel. In Excel, try out the downloading of data by going to

Excel 2003: Go to Tools->Macro->Macros..., select the Download macro and click run
Excel 2007-2016: Go to Developer->Macros, select the Download macro and click run.

and press the Enter key. This will initiate a download of Stock Prices from Yahoo! Finance.

In the whole block of code above, the most important part is the following.

```
DownloadURL = "https://query1.finance.yahoo.com/v7/finance/download/" & stockSymbol &
"?period1=" & period1 & "&period2=" & period2 & "&interval=" + freq +
"&events=history&crumb=" & crumb
```

```
With httpReq
.Open "GET", DownloadURL, False
.setRequestHeader "Cookie", cookie
.send
.waitForResponse
dataResult = .responseText
End With
```

It basically says that we will be downloading data from DownloadURL:

```
https://query1.finance.yahoo.com/v7/finance/download/" & stockSymbol & "?period1=" & period1
& "&period2=" & period2 & "&interval=1d&events=history&crumb=" & crumb
```

- stockSymbol is the variable containing a stock symbol such as "BAC".
- period1 and period2 specifies the start date and end date to download data.
- The "cookie" and "crumb" (extracted from response) required is extracted with the following VBA codes.

```
DownloadURL = "https://finance.yahoo.com/lookup?s=" & stockSymbol
With httpReq
.Open "GET", DownloadURL, False
.setRequestHeader "Content-Type", "application/x-www-form-urlencoded; charset=UTF-8"
.send
.waitForResponse
response = .responseText
cookie = Split(.getResponseHeader("Set-Cookie"), ";")(0)
End With
```

Save this workbook as we will be using it for our next section.

3. Moving Average Trends

Many successful investors and traders make use of trends to profit from the market, and Moving Average is one of the most important methods for identifying market trends. The stock prices for successive periods are used for the calculation of a moving average. Moving average reduces the effects of short term volatility and allows the investors or traders to see the underlying trends of a market.

The aim of this section is to allow you to calculate simple moving average using Excel and make use of Moving Average Crossover to determine buy / sell signal and resistance level in a stock. After that, the simple moving average will be expanded with Welles Wilder method of moving average, Directional Movement and Average Directional Movement Indicators. Welles Wilder is the founding father who had introduced many of the modern trend concepts in his book *New Concepts in Technical Trading System*.

3.1 Simple Moving Average

A moving average reduces the effect short term price volatility. For example, a 10 day simple moving average of the closing price is calculated by averaging the closing price of the last 10 days.

$$\text{Simple Moving Average} = \text{Sum}(\text{Closing Price of Last 10 Days})/10$$

Applying this simple concept, let's go to our Excel file to calculate the following

- 10 Day Moving Average
- 14 Day Moving Average
- 20 Day Moving Average
- 30 Day Moving Average

3.1.1 10 Days Moving Average

Open the *AutomatedDownloadData.xls* in Excel. Save it as a new workbook call it *MovingAverage.xls*. Run the Download macro if the data has not yet been downloaded. Remember to sort the data based on Date from Oldest to Newest (or in Ascending order for Excel 2003).

Next, we are going to calculate a 10 Day Moving Average. Follow the steps below:

1. Click on the Cell H11.
2. Type in “=ROUND(AVERAGE(E2:E11),2)”. This will calculate the average (of ten values of the closing price) from row 2 to row 11 of column E and round them to 2 decimal places.
3. Drag this cell downwards to the end of the Stock Prices. For Excel 2003, copy this cell (we are actually copying the formula of this cell) drag a range downwards to the last value of the Stock Prices, and paste it.
4. Go to Cell H1, and type in “10 Day SMA”

3.1.2 14 Days Moving Average

Next, we are going to calculate the 14 Day Moving Average. Follow the steps below:

1. Click on the Cell I15.
2. Type in “=ROUND(AVERAGE(E2:E15),2)”. This will calculate the average (of fourteen values of the closing price) from row 2 to row 15 of column E and round them to 2 decimal places.
3. Drag this cell downwards to the end of the Stock Prices. For Excel 2003, copy this cell (we are actually copying the formula of this cell), drag a range downwards to the last value of the Stock Prices, and paste it.
4. Go to Cell I1, and type in “14 Day SMA”

3.1.3 20/30 Days Moving Average

Repeat the above steps for column J and column K for the 20 days/30 days moving average.

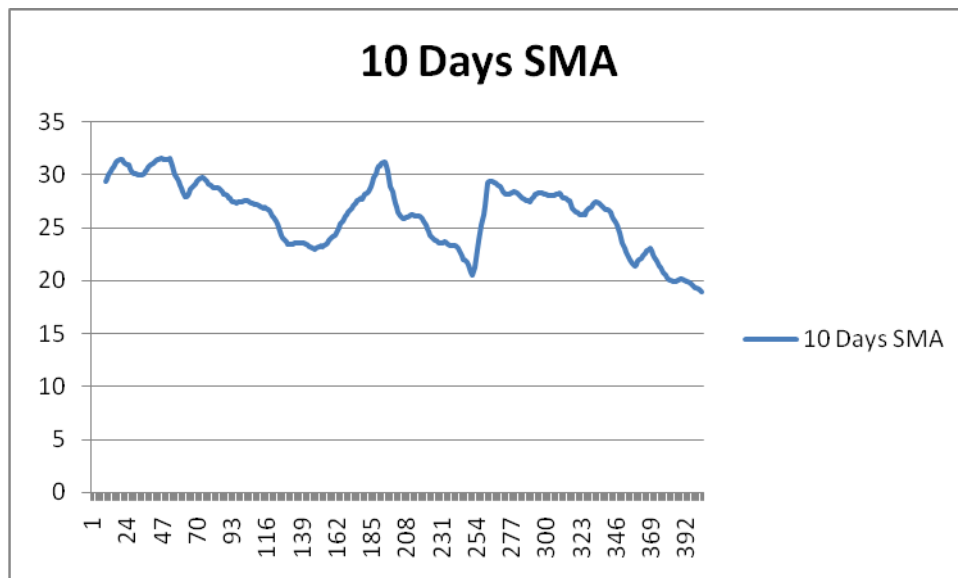
3.1.4 Charting the Moving Average

Select the 10 Days SMA column and

Excel 2003: Go to Insert->Chart, and select Line as the Standard Types, and click the Next button repeatedly until the dialog closes.

Excel 2007-2016: Go to Insert->Line. Choose the first line graph. You will be getting a graph like below.

You will be able to change the X-Axis to date. We will leave that as an Exercise for you.



Repeat the above steps for the 14 / 20 / 30 Days SMA. Alternatively, you may create a chart to display the moving average together with the actual closing price, in a single graph in order to compare them. At this point, you will be able to apply the concepts of the Moving Average trends mentioned in the various Financial Technical Indicators papers.

3.2 Using the Moving Average

Compare a 10 day versus a 20-day moving average. One uses 10 values to compute the average while the other uses 20 values.

A 20-day moving average gives you less fluctuation and sees the underlying trend more clearly. However, it does not mean that the 20-day average is better. Imagine that you are going to calculate the moving average for a new day, the 20-day moving average includes more values in its averaging, and thus, might be slower to respond to changes compared to the 10 day one. So if a trend is reversing, you will be able to see it faster in the 10 day moving average. However, sometimes, the reverse trends in the 10 days moving average might be a false signal.

If you overlap the different moving averages in a single graph, notice

- A support level usually occurs when two moving averages cross / intersects each other.
- When the shorter (faster changing) moving average crosses above the longer (slower changing) one, it usually means a rising trend of the prices.
- When the shorter (faster changing) moving average crosses below the longer (slower changing) one, it usually means a declining trend of the prices.
- Moving average is actually a mean of the price, thus when the actual price deviates too far from its moving average, it will typically start moving back (tends) towards the moving average.

3.3 Wilders Moving Average

A new trading day simple moving average is calculated by dropping off the earliest trading day's price. This can cause a problem if the recent price data shows little changes. This is not acceptable to some traders or analysts. On the other hand, it is also often argued that the recent prices are often the most important in identifying trends.

Wilders devised a simple mechanism to overcome the above problem. This is done by taking into account previous days moving average and also placing more weight on the recent prices.

Launch Excel and load the MovingAverage.xls workbook. Remove the charts and save the workbook as Wilders.xls.

Wilder's Current Day Moving Average = (Previous Day Wilder's Moving Average * (n-1) + Current Day Price)/n

We are going to calculate a 14 Days Wilder's Moving Average.

1. Copy the value from Cell I15 to the Cell L15. We are initializing the first Wilder's Moving Average with the value of a Simple Moving Average.
2. Click on Cell L16. Type in `"=ROUND((L15*13+E15)/14,2)"`.
3. Drag Cell L16 downwards to the end of the Stock Prices. For Excel 2003, copy this cell (we are actually copying the formula of this cell), drag a range downwards to the last value of the Stock Prices, and paste it.
4. Go to Cell L1, type in "Wilder's MA"

3.4 True Range

If in a new trading day, a stock starts its trading at a higher or lower price than the previous day's closing price, then a gap is said to have occurred. Welles Wilder feels that this gap needs to be taken into account when measuring fluctuations.

The True Range of a stock price (as defined by Wilder) will need to take into account the gaps. He thus suggests True Range to be calculated as the Greatest number among the following values:

- Difference between the current High and the current Low
- Absolute difference between the current High with the previous Close □ Absolute difference between the current Low with the previous Close

Open the Wilders.xls file, launch the Visual Basic Editor, and key in the following into Module1.

```
Function TrueRange(ByVal high As Double, ByVal low As Double, ByVal previousclose As Double)
As Double

Dim returnValue As Double diffHighLow1 =
Math.Abs(high - low) diffHighLow2 =
Math.Abs(high - previousclose) diffHighLow3 =
Math.Abs(previousclose - low)

If (diffHighLow1 > diffHighLow2) Then
    returnValue = diffHighLow1 Else
    returnValue = diffHighLow2
End If

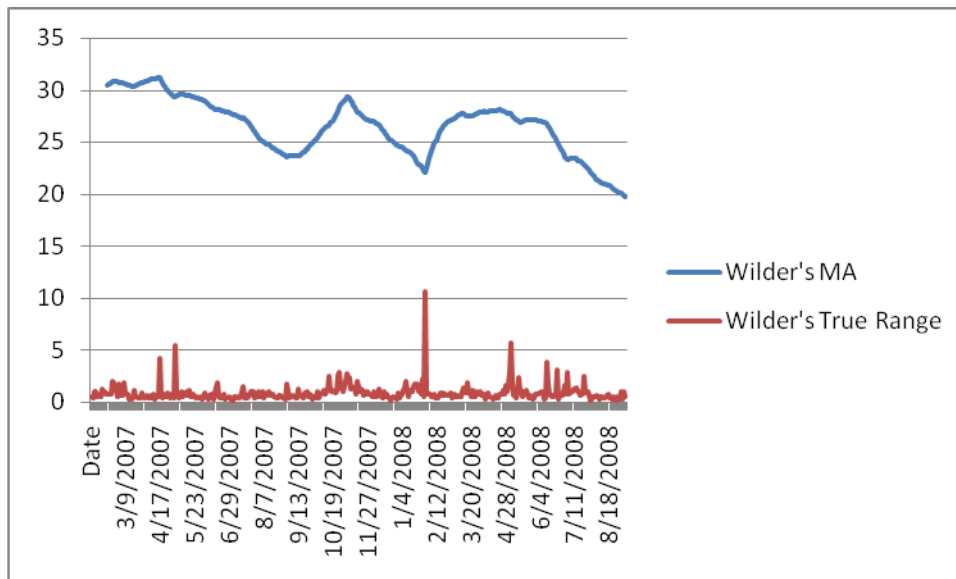
If (diffHighLow3 > returnValue) Then
    returnValue = diffHighLow3
End If

TrueRange = returnValue

End Function
```

1. Click on the Cell M3.
2. Key in “=TrueRange(C3,D3,E2)”.
3. Drag this cell downwards to the end of the Stock Prices.
4. Click on Cell M1 and type in “Wilder’s True Range”

If you chart the Wilder’s Moving Average and Wilder’s True Range, the following is what you will be getting.

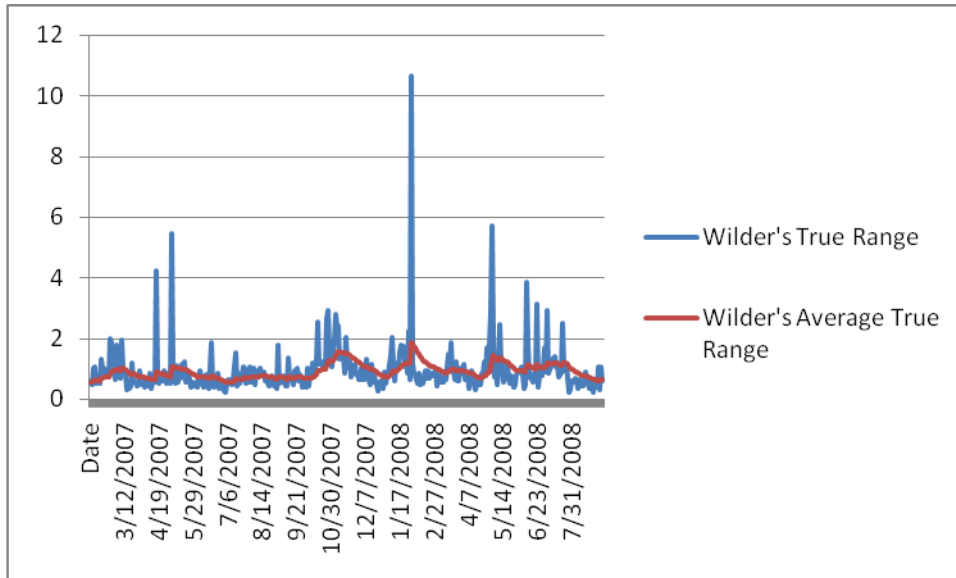


3.5 Average True Range

The Average True Range is calculated as the average of the True Ranges using Wilder's method of moving average. The Average True Range is not used to predict prices but for determining the daily activity level of a stock. Low Average True Range indicates a stock is trading within narrow ranges without much swing while High Average True Range indicates period with sharp swings of prices.

1. Click on the Cell N3.
2. Key in “=TrueRange(C3,D3,E2)”. We initialize the first True Range to be our first Average True Range. **Some technical analysts will initialize the first value with a 14 Day Simple Moving Average of the True Range.**
3. Click on the Cell N4. 4. Type in “=ROUND((N3*13+M4)/14,2)”.
5. Drag this cell downwards to the end of the Stock Prices.
6. Click on Cell N1 and type in “Wilder’s Average True Range”

You can proceed to chart out the Average True Range versus the True Range.



3.6 Directional Movement

Wilder compares the stock trading range of the current day and previous day, and use them to measure trend. If the current High is higher then the previous day High then a Positive Directional Movement is said to have occurred. If the current Low is lower then the previous day Low then a Negative Directional Movement is said to have occurred. If both Positive and Negative Directional Movement occurred, then the bigger of the two is taken. During days when the trading range is within the previous day range, it is considered to have no Directional Movement.

Using the Wilders.xls file, launch the Visual Basic Editor. Key in the following into Module1. PDM stands for Positive Directional Movement while NDM stands for Negative Directional Movement.

```
Function PDM(ByVal high As Double, ByVal low As Double, ByVal previousHigh As Double, ByVal
previousLow As Double) As Double
Dim highdifference As Double
Dim lowdifference As Double

highdifference = 0
lowdifference = 0

If (high > previousHigh) Then    highdifference = high - previousHigh
End If

If (low < previousLow) Then    lowdifference = previousLow - low
End If

If (highdifference > lowdifference) Then
    PDM = highdifference
Else
    PDM = 0
End If

End Function
```

```

Function NDM(ByVal high As Double, ByVal low As Double, ByVal previousHigh As Double, ByVal
previousLow As Double) As Double
Dim highdifference As Double
Dim lowdifference As Double

highdifference = 0
lowdifference = 0

If (high > previousHigh) Then    highdifference = high - previousHigh
End If

If (low < previousLow) Then    lowdifference = previousLow - low
End If

If (lowdifference > highdifference) Then
    NDM = lowdifference
Else
    NDM = 0
End If

End Function

```

Click on Save and then File->Close and Return to Microsoft Excel.

1. Click on the Cell O3.
2. Key in "=PDM(C3,D3,C2,D2)".
3. Drag this cell downwards to the end of the Stock Prices. This will give us the Positive Directional Movement. For Excel 2003, copy this cell (we are actually copying the formula of this cell), drag a range downwards to the last value of the Stock Prices, and paste it.
4. Click on Cell O1 and type in "Wilder's PDM"
5. Click on the Cell P3.
6. Key in "=NDM(C3,D3,C2,D2)".
7. Drag this cell downwards to the end of the Stock Prices. This will give us the Positive Directional Movement. For Excel 2003, copy this cell (we are actually copying the formula of this cell), drag a range downwards to the last value of the Stock Prices, and paste it.
8. Click on Cell P1 and type in "Wilder's NDM"

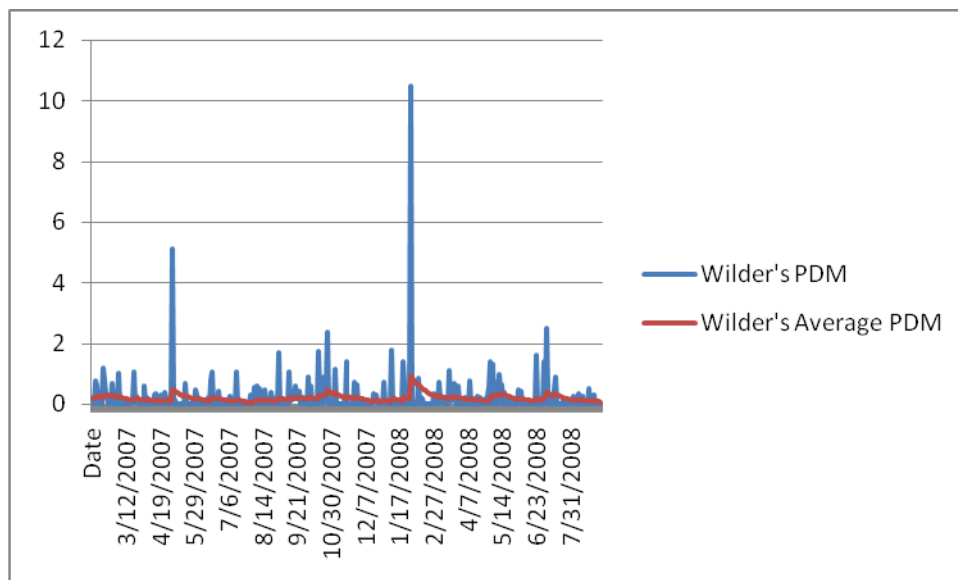
3.7 Directional Movement Indicator

Positive Directional Movement Indicator is the ratio of the Average Positive Directional Movement to the Average True Range. Negative Directional Movement Indicator is the ratio of the Average Negative Directional Movement to the Average True Range. Thus whichever Directional Movement Indicator is larger; it will mean that the trend of the price is in the direction.

First we must calculate the Wilder's Average for both the PDM and NDM.

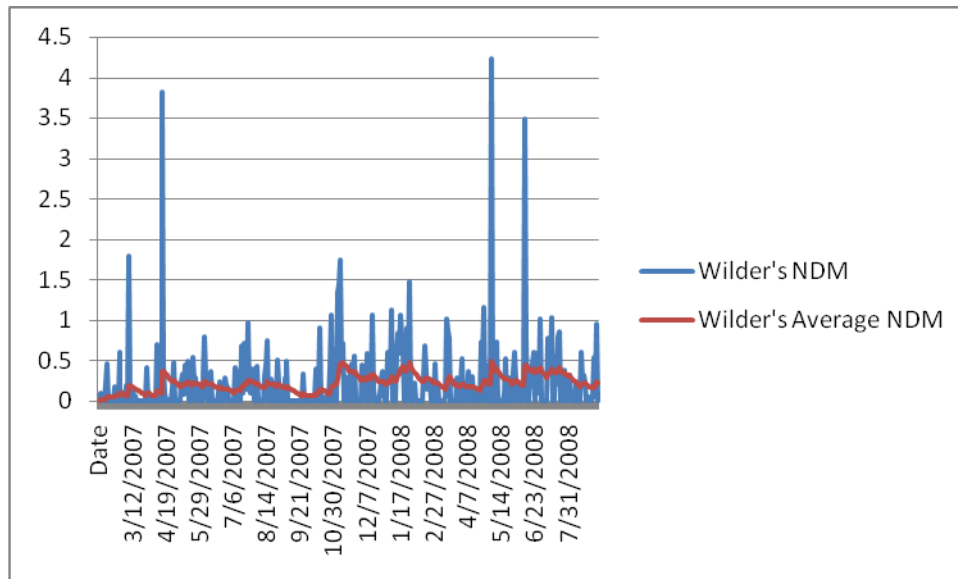
1. Copy the value in the Cell O3 to Cell Q3. This is the first value we used for initializing the Wilder's Average. **Some technical analysts will initialize the first value with a 14 Day Simple Moving Average of the PDM.**
2. Select Cell Q4. Key in `"=ROUND((Q3*13+O4)/14,2)"`.
3. Drag this cell downwards to the end of the Stock Prices. This will give us the Wilder's Average
Positive Directional Movement. For Excel 2003, copy this cell (we are actually copying the formula of this cell), drag a range downwards to the last value of the Stock Prices, and paste it.
4. Click on Cell Q1 and type in "Wilder's Average PDM"

If you chart the Wilder's PDM with Wilder's Average PDM, the following is what you will get.



1. Copy the value in the Cell P3 to Cell R3. This is the first value we used for initializing the Wilder's Average. **Some technical analysts will initialize the first value with a 14 Day Simple Moving Average of the NDM.**
2. Select Cell R4. Key in `"=ROUND((R3*13+P4)/14,2)"`.
3. Drag this cell downwards to the end of the Stock Prices. This will give us the Wilder's Average Positive Directional Movement. For Excel 2003, copy this cell (we are actually copying the formula of this cell), drag a range downwards to the last value of the Stock Prices, and paste it.
4. Click on Cell R1 and type in "Wilder's Average NDM"

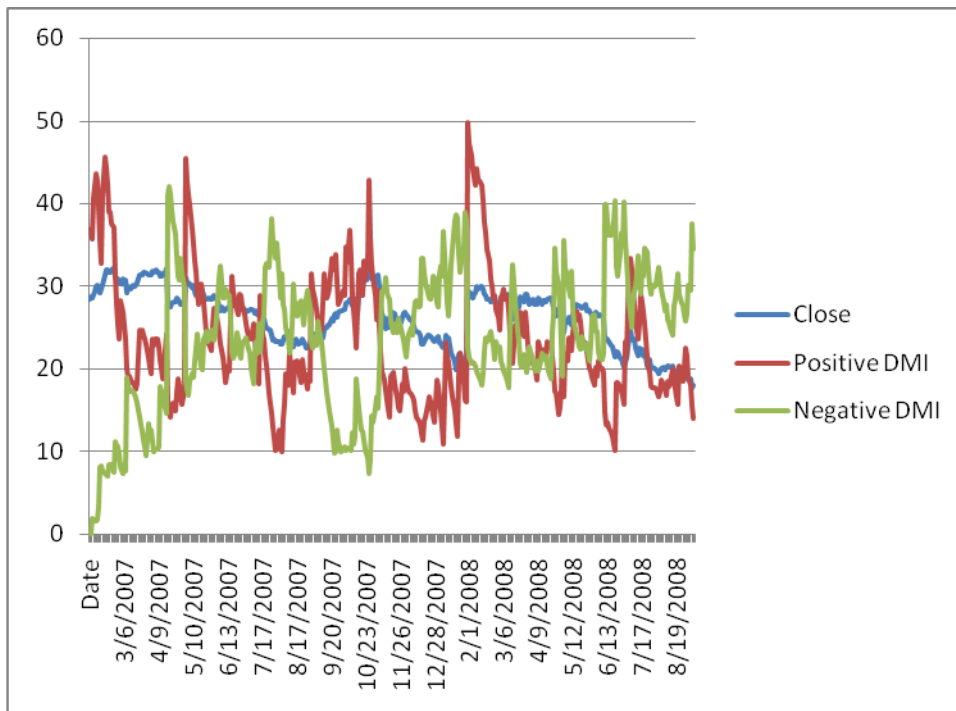
If you chart the Wilder's NDM with Wilder's Average NDM, the following is what you will get.



3.7.1 Positive/Negative Directional Movement Indicator

1. Click on the Cell S3.
2. Key in “=ROUND((Q3/N3)*100,2)”.
3. Drag this cell downwards to the end of the Stock Prices. This will give us the **Positive Directional Movement Indicator**. For Excel 2003, copy this cell (we are actually copying the formula of this cell), drag a range downwards to the last value of the Stock Prices, and paste it.
4. Click on Cell S1 and type in “Positive DMI”
5. Click on the Cell T3.
6. Key in “=ROUND((R3/N3)*100,2)”.
7. Drag this cell downwards to the end of the Stock Prices. This will give us the **Negative Directional Movement Indicator**. For Excel 2003, copy this cell (we are actually copying the formula of this cell), drag a range downwards to the last value of the Stock Prices, and paste it.
8. Click on Cell T1 and type in “Negative DMI”

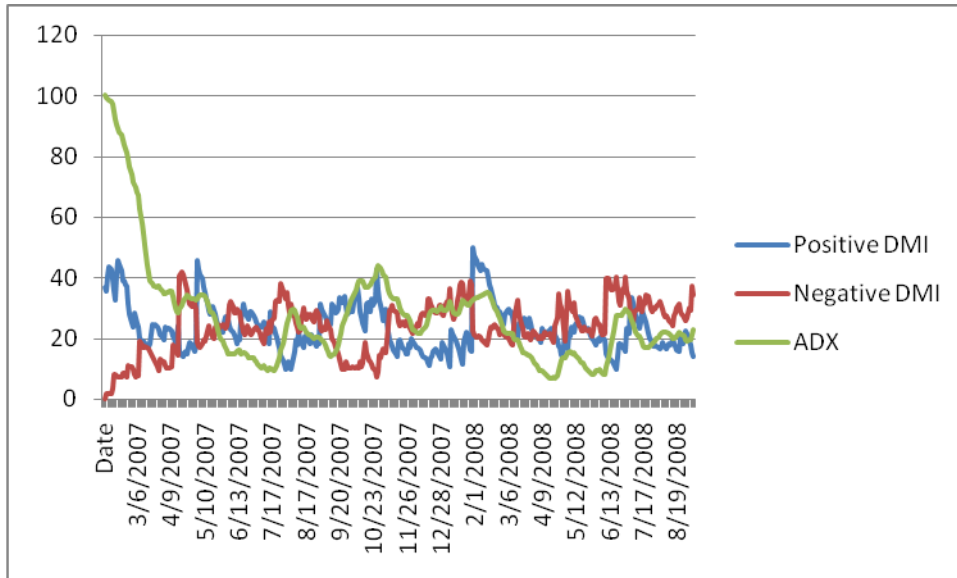
Chart out the Positive DMI, Negative DMI and the Closing Price. Use it to analyze trends observed and published by the different Technical Traders or by Wilder himself. Or refer to Section 3.9 for an analysis of the trends.



3.8 Average Directional Movement Index

Directional Index (DX) is calculated as the ratio of the absolute *difference* between the values of the two Directional Movement Indicators to the *sum* of the two Directional Movement Indicators. This allows us to measure the strength of a trend. The DX will be a larger value when the price is moving towards one direction. The Average DX can be calculated using Wilder's Moving Average. This allows the fluctuations in the Directional Index to be reduced.

1. Click on the Cell U3.
2. Key in “=ROUND((ABS(S3-T3)/(S3+T3))*100,2)”.
3. Drag this cell downwards to the end of the Stock Prices. This will give us the **Directional Movement Index**. For Excel 2003, copy this cell (we are actually copying the formula of this cell), drag a range downwards to the last value of the Stock Prices, and paste it.
4. Click on Cell U1 and type in “DX”
5. Copy the value on Cell U3 to the Cell V3. This value is used to initialize our Wilder's Average. **Some technical analysts will initialize the first value with a 14 Day Simple Moving Average of the Directional Movement Index.**
6. Click on Cell V4 and key in “=ROUND((V3*13+U4)/14,2)”. This will give us the Wilder's Average of DX. For Excel 2003 (or Excel 2007-2016), copy this cell (we are actually copying the formula of this cell), drag a range downwards to the last value of the Stock Prices, and paste it.
7. Drag this cell downwards to the end of the Stock Prices. This will give us the **Average Directional Movement Index**.
8. Click on Cell V1 and type in “ADX”



3.9 Using the Indicators

We now have three very useful indicators, the Positive DMI, Negative DMI and Average Directional Index (ADX). If the Positive Directional Movement Indicator crossover above the Negative Directional Movement Indicator, it meant that the price is on the upward trend, whereas when the Positive Directional Movement Indicator crossover below the Negative Directional Movement Indicator, it meant the price is on the downward trend. The Average Directional Index is used to indicate how strongly the price is moving towards one direction. So, if the chart shows Average Directional Index increasing, it means the price is increasing in trend in a particular direction indicated by the Positive Directional Movement Indicator or Negative Directional Movement Indicator (whichever is larger).

4. What Next?

We hope you have enjoyed the training so far and have gained a better understanding of several useful Technical Indicators. These Technical Indicators are definitely useful in the creation of an Automated Stock Trading System. Please also be assured that we are in the process of adding new materials to our website at <http://www.spreadsheetml.com>.

If you have any comments or suggestions to help improve this document, please contact us at info@spreadsheetml.com.