

Advanced Algorithmic Trading and Portfolio Management
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In this video, we will start with the Bollinger Band Analysis. So, we will talk about Bollinger Bands. To construct the Bollinger Band variable, first we need a moving average variable. So, for this we will use maybe a 20-day frequency. So, we will create 20 day moving average data. Very easy, we have already seen it how to create it.

Roll mean and then closing. We will use Amazon close and then specify the period as 20. So, this is our rolling Amazon So, here we can see. Next, we also need to add standard deviation data.

So, we have the standard deviation, and we will use the roll apply. In the roll apply variable, we will use our Amazon close prices, but with this close prices, we will add the standard deviation and with a width of 20 days. So, we will use a width of 20 days. Function will be SD. Fill equal to NA.

So, if there are any unavailable values, we will use NA. So, we have our standard deviation ready. Now, we need to create our Amazon Bollinger Band variable, BB variable and we will use the cbind command. So, first series will be Amazon dot close which is Amazon closing price. So, I will use it directly.

The closing price series we have is the first data point, second data point is Amazon MA 20 and lastly, we have standard deviation data. So, we will combine all these series. Let us name them. So, call names, the very useful command call names where you can specify the and you can provide the names Amazon dot close. Next, you have Amazon underscore MA 20-day MA and lastly, we will add this standard deviation data.

So, we have given the names. Also, sometimes with this analysis, NA is not available, observations may crop up. So, you keep on adding this na.omit command so that there are no unavailable observations. Now, we will add the upper and lower bands and before that, let us check if there is any issue with our data. The heads and tails are properly appearing for the Bollinger Band data.

Yes, they are. So, we have the head and tail and standard deviation. So, all I need to do is add the upper and lower limits of the Bollinger Bands. If you would have seen Bollinger Bands, you would recognize that we need two standard deviation above and lower limits.

So, first we are using two standard deviation, but you can add a higher or lower value as well.

So, first is our Amazon Bollinger Band 20 moving average and, the upper limit will be summation of 2 into standard deviation. So, we will add the standard deviation. Similarly, the lower limit would be minus, that is the only difference. So, we have our Bollinger Band data ready. Now, we start with plotting the data.

So, to plot data, we will make use of this plot command. So, we will use this plot and again x is index. This BB data, the dates are indexed, we will add the x axis as date, y axis as close and y lab as price, that line type as l and maybe a line width of 2. Now, we will give the central heading which is main equal to Amazon Bollinger Bands for 20 days and two standard deviations.

The period is January 1st, 2013, to December 31st, 2013. Notice that I specified a particular period. So, how do I ensure that this period is followed? We will see that. So, for this I need to specify the range wherever I want to zoom in, I need to specify the x range variable. So, let's call it range dot x which is equal to as dot date c 2013 December 31st.

Similarly, for the other end is 2000, sorry it was January, so I will use 01 and the other range is December, so 12 and then 31. So, this is our range of x axis. Similarly, you can specify y axis also. So, for example, let's say I want to specify y ranges 60 to 100. We can adjust this later on as well if we find that details are not so proper.

So, this is my y and x ranges and in fact, I need to provide ranges here itself. So, I will add the range dot x and this is my x lim. So, I will specify that x lim equal to range dot x and y limb equal to range dot y. You can adjust these x and y ranges as per your requirement or your understanding of data so that your plot appears proper. So, this command will be used to draw the plots.

So, because there is no plot, I will change this window a little bit from 0 to 50. So, the plot appears proper. So, let me add the ranges now and also the y limb. In fact, let's first examine the plot before these limits to see what the range is. So, it seems that this particular range from 18 to 20 is more proper.

So, rather I will focus on the period 18 to 20. Let's see how it appears and also the prices in this range range from 50 to 200. So, I will use 50. So, this is more appropriate to just see the data how it appears and then plot it. So, now I will put x lim equal to range dot x and dot y.

So, again, it does misfit. So, let me rather just put the x axis focus on x axis. So, this is also nice. So, this is also fine. Also, I think I need to change the plot, the central heading as well.

The next thing would be to add the lines that are needed. So, I will add moving average lines. So, first using these lines command, let me add these lines command. So, I will add lines command to specify the x axis first. Then I need to specify the y axis which is Amazon underscore BB and I will use the first field plot the moving average plot with line type equal to two and maybe a color of blue.

So, we will add this and then the next thing that we need to add is upper band. So, we will add the upper band, upper band and maybe green. So, green for upper band and similarly red for the lower band. So, we will add the red color for the lower band.

So, these are the lines. So, let us start with the plot. See if our plot is appearing properly and robustly yes it does. Better let us add LWD, LWD equal to 2. So, probably it will appear more solid.

Let us see. Yes, now they are slightly more visible. The very last important thing you want is the legend here. So, you add legend it seems that maybe bottom right appears to have some extra space bottom right and then I need to specify the legend names which is Amazon closing price. So, we started with Amazon closing price. The next is 20-day MA and then we have the upper band and lastly, we have the lower band.

We need to specify the line type. So, although I will ignore the line type here. So, or maybe I will do so. So, line types are mostly 2 only so I will use 1, 2, 2, 2. Then I need to specify colors as black, blue, red and lastly green.

So, these are colors. I will also specify the fill here. For the fill the same parameters can be used. So, this is done. So, let us see if we are able to add the color.

So, let us plot the complete thing. So, we started from will not use this range window, only the x range is useful here. So, we will use the x range and add the legend. So, a nice very nice plot we can see how Bollinger bands are moving and we can zoom in on the plot. The way to interpret it look at the behavior of the black solid line which is the closing price vis-a-vis the green plot which is the upper band and lower band whenever the signal this is you can also call it a signal line when it just crosses over from the top for the green or crosses from bottom to the red and also you can interpret in conjunction with the blue line which is the 20 day MA and black line. So, you can combine them for interpretation you can refer to the theory videos discussed earlier.

In this video, we will start with a relative strength indicator, a very important measure. So, we will start with relative strength indicator. So, first we need to have a difference in

prices. So, we use the diff command to compute the differences in the first we will start with amazing closing prices and compute the difference. Now, as part of this RSI or relative strength measure, we need to compute up movement.

So, we will first create an up variable which is 1 if this delta is greater than 0 else 1 or 0. So, if delta is positive then it is 1 and 0. Similarly, we will create a down variable in a very opposite manner where if delta is less than 0 the value is 1 else 0. Now, we will combine these in the Amazon RSI which is equal to cbind dot close which is equal to closing price and then we have our delta variable up and down.

Let us give them some appropriate names. So, let us name this first as Amazon dot close, second variable as delta same, third as up and fourth as down. So, these are our relevant variables in the Amazon RSI variable. Let us see if the variable is created properly or something is meddled. So, we can see there are the variable is created. Since there are some NA observations, let us remove these NA for a clean operation with our good old na dot omit command.

Now, we will fill up the up and down value that is also easy. So, we use our Amazon RSI measure. We will create a new variable which is first we have up value, let us call this up value which is simply equal to Amazon closing price into the up value. In a very similar manner, we will create the down value, as well. As you would have guessed already, it is the closing price multiplied by down value.

So, now we have up and down values. In the next step, we will take the average of these values. Let us see how this is done. So, probably we will use a moving average of 14 days maybe. So, let us see how it is done. So, we will use, let us call it up average, which is simply the average of previous, let us say we use 14 days values.

So, we will use this role apply command. Through this role apply command, what we will do is, we will take this up value and select an interval of 14 days. So, the moving average of 14 day up value is created into supply the function mean, function is mean fill, so not available, so those will be filled with nas and na dot rm is equal to true. So, na observation should not affect our estimation. So, first in this manner, we will compute the up averages for 14 days. Similarly, and please note where the value is down, it is taken as 0.

Similarly, we will compute for down value. Not that difficult, again the same set of commands, only that instead of up we will use down. Now that our variable is created, let us clean it for any na observations. So, we will again go back to our good old na dot omit and run.

Let us see, let us check the head of the observations to see if some if the variables are created. Yes, they are up, and down averages are created. So, now as a last step, we need

to compute the relative strength, which will transform later into RSI measure. Let us see how it is done.

So, first we let us call it RS relative strength. And this is nothing but Amazon relative strength up averages divided by Amazon down average. So, this is our relative strength measure. Now very easily, we can compute the final relative strength variable, let us call it RSI relative strength indicator. And the formula is simple, it is 100 minus and because of this formula, if you recall from the discussion in the theoretical in the classes, the theoretical discussion we had, how this formula helps us in getting a very nicely behaving RSI measure.

We will discuss and see the sum of the property shortly. So, this was this measure created. Now, if I take the head, let us see the head if the measure is created. Yes, it is indeed created and let me show you something interesting. So, let me show you the summary of this RSI measure that we have created something interesting. So, if you notice, this measure moves between 0 to 100, a lower value and higher and lower limits are 0 to 100.

And therefore, as we can see this in this particular case, it moves from 14, the way it is constructed, it will move from 0 to 100. A value would indicate that RS, this RS relative strength was 0, when relative strength is 0, you will get a value of 0 and when this relative strength indicator is very high, tending to very large values, then you would get a value of 100. So, it varies between 0 to 100. A high value would indicate very high momentum like 86 would indicate a very high momentum on the very top of it and minimum values indicate low momentum. So, in this video, we saw how to construct RSI. In the next video, we will see how to visualize the RSI measure.

In this video, we will learn how to visualize the RSI indicator that we constructed earlier. So, we will learn how to visualize the RSI indicator. We use the title of the graph as title 1, let us call it Amazon RSI.

So, let us use this name. Next, we will create the plot with plot command. Let us create some space so that it will get visible. So, in the plot command, I will use, this is our index date. Next, we will give x-axis as date and I should specify y as this indicator we created earlier, this variable, RSI variable which hovers between somewhere around 15 to 85. Now, let us put the y-axis name as ylab as RSI, the name should be explanatory so that user can understand what exactly is being plotted, 14 day moving average.

So, the 14-day moving average RSI measure. Now, specify the y limit. So, as we already, we are aware that it moves from 0 to 100. So, we will specify 0 to 100 and it is a line plot. So, we will create a type equal to l. Now, please recall that you need to find some signal lines that when they are crossed, the signal is generated.

So, first main equal. So, what we will do is we will use this paste comma, paste title one. So, this paste title one will give us the title. Let us see what exactly it does. So, it will, I need to run this and then probably it will run better.

So, yes, you have a measure RSI. Either way, I could have given it directly as well. For example, I could have specified here the title as well, that is also fine. So, now, one important thing that we need to do here is, we need to add an abline command. The role of this abline command here is that I specify the upper and lower signal lines.

For example, here I am specifying the signal lines at 30 and 70. So, if the line moves, these will be horizontal lines specifically. And what will happen is, let me give it a line width of 2 and color equal to blue. So, what will happen is that when this plot is created, there will be a signal line on the up and down like this. Let me type, I put line type is 4. I wanted line width, I wanted line width to be slightly, now it is better.

So, I by mistake I have using lty, it should have been LWD. The way to interpret this chart is that when this signal line, the line which is fluctuating a lot, which is RSI line, when it crosses, it goes above, it is at a very high level, you expect it like a car rolling down the hill, you expect it to fall when it is crossing from above the upper line and when it is crossing from below the lower line, you would expect it to rise. So, when it is crossing the 30-line, line at 30 points from below to above, it is expected to rise and as we can see it is happening many times and when it is falling above, crossing from above to below the line at 70, it is expected to fall. Now, the upper and lower limits we should specify depending upon experience with the plot. For example, in this case, 30 and 70 seem to be a good fit, but depending upon your experience and frequency and the kind of average you have taken, you can change it to let us say 80, 20 as well. In this plot, what if we wanted to focus on a particular range of x, let us say we wanted to focus on the year 2020, then we would use the same set of commands, but we make some extra changes.

First and foremost, we specify the range that we want to use range of x which is equal to, let us put it as dot date and we will use the limit dates, our dates are 2020. So, first January 2020 and the closing limit of this range is 2020, but now it is December 31st. So, this is the range we will use and also, we have specified the title, and we will also specify a subtitle 2, which we will use as a next line kind of title, we will specify that we are using Jan 2020 to Dec 2020. Now, we will go back to our plot command and the only change now we are going to do, we need to add, so in this case, we will need to use the paste command to add our title. So, we will put it like this, so the title 1 first and then we will specify next line, which means that the next line of title should come in the next line and here after this we will put title 2.

So, one slight change, sometimes while plotting this you may not want the color, the color to be let us say blue only, you may want to change for lower line blue and then higher line will be red. So, for those kinds of changes, I specify that the other line should be red. So, now this vector command would specify the two lines as separate colors. Let us run this. So, first we have specified the range, we have given the title 1, title 2 and then we need to specify the plot command.

So, we will run the plot command and you can see now nicely plotted. One more, so it looks like this, you can zoom it out and you can see when it crosses the upper line and comes back that is a clear signal of falling prices, momentum is falling down like a car rolling down the hill and similarly when it crosses from below the 30 line, when it crosses from below 30 line to on the upside that means the car is now at the bottom and going to move up, there is lot of upside momentum in the car and when it is moving from above to below, crossing at 70 that means the car is falling now, so that is a downside momentum. So, this is how you understand this RSI plot. Till now we have been constructing these plots from brick by brick, piece by piece in a very lengthier manner. Next, we will use the functionalities of quant mode like chart series and some advanced plot to see how with a simple single line, one to line codes we can prepare these complex diagrams in a very aesthetic manner.

In this video, we will understand the advanced techniques using quant mode package. So, session 2, quant mode. So, what you need to do is, first you need to add this library, quant mode and now you are ready. So, we have already downloaded the apple data, if you recall we have already downloaded the apple data and this data basically this was downloaded from quant mode package get symbols only, so I will not repeat that. Let's start with some basic steps with some useful commands you can extract various columns, let's see how it is done. For example, you can extract the open prices using this op apple command, so you can check the head of open, so this is the open price. Similarly, you can extract the high price using Hi function Hi, so you can extract the high price, you can extract in a very similar manner you can extract, you can run the head of high, you can extract the low with this useful command Lo and you can see if you have extracted it properly, then you have closing, you can also extract the closing, using Cl and you can check if you have extracted it properly with this close function.

You can also extract volume, let's call it volume equal to Vo apl, you can extract that, you can check with head if you have extracted the volume correctly, yes you have done. Lastly, we have adjusted close, you can extract the adjusted close with this Ad function of AAPL head adjusted close, we have done that. Often you need to aggregate measures like volume, prices from weekly to yearly basis. So, let me show you how to aggregate starting with volume series, the procedure for price and other measures pretty similar, so I will show you how to aggregate series.

Currently, we have downloaded daily data for volume. So, let us say we want to aggregate it for monthly volume, then you use this command `apply.monthly` and you provide your volume measure that you have just computed, I will use the function `Vo AAPL`, `Vo` here you can use also and you wanted `sum`, so if you wanted `sum`, you can just put `sum` you could have put other functions like `mean` and so on, but we wanted `sum` to aggregate, so we run that. Then similarly, you wanted to `sum` for quarterly, so let us call it `quarter`, `qtr quarter volume` and now instead of `apply monthly`, I will use the `apply quarterly`. I can check the `apply quarterly`, I can do that. Similarly, I can `apply yearly`, let us call it `yearly` and I will use the `apply yearly` function, this will aggregate the series to `yearly` and this to that extent that your series is continuous without missing observations, your results will be fairly accurate.

You wanted to `apply weekly`, you have the option to `apply` it for let us call it `weekly`, so that is also available, you can aggregate it to `weekly` series and so on. You can see you can aggregate the series, similarly you can aggregate price series and so on. So, in this series we saw how to work around with different attributes of the share prices downloaded from Yahoo Finance with Quant mode package. In the next step, we will start with the advanced plotting using `chart series` function.

In this video, we will learn how to plot nice plots with price volume using `chart series` function. So, let us start with a simple `chart series` plot. So, you have `chart series` function where first you provide the price series that you want to use in virtual C form, then let us say you want a `line type` plot. So, let us start with a very simple `line type` plot. Also, you need to specify the period for which you want to plot. So, let us say you plot for a period of, you want to plot a particular period, let us say 2010, maybe May 2010 to 2020, maybe 2020, June, this is your plotting period.

Now you need to specify the theme. So, maybe I will use a `white` theme, we will see what are other options, theme equal to `white`, let us see what it gives us, a small adjustment. So, this is my period, let me see. So, this is a very nice plot that we have received here. Let us say you want to `zoom` on a particular period.

So, you can use this `zoom chart` and there you can specify a different period. So, then with `chart` it will provide you with the `zooming` functionality, let us say instead of that you wanted to `fix` it, be `fixed` on 2019 that also is possible here. So, you can `zoom` on a particular section. So, you can plot it and then you can `zoom` on it. Also, let us say, so this was `line plot`, `line plot`, let us see what other options do we have.

So, first also we can instead of `white` you can use the `black` theme. Let me see if `black` theme is available. Yep, so it appears like this, but we will stick to the `white` theme. And in the next, let us see what happens if we put `type` as by default.

Let us say what is the default plot. So, it seems the default is this kind of bar kind of plot. So, default is like bar. So, your bar is default. If you want to check what are other options available to you, so you can see this chart series command. And what are the options available to us? So, it is auto, auto is themed by default, bar, line, candlestick match.

So, let us instead of, let us try some other combinations. So, we will use maybe type as auto. Let us see what happens. What do we get here? So, it is, yep, so it seems let us zoom on the chart, kind of bars only, similar to bar theme. Let us see if I specifically put bar, then also very similar looking plot I get or something different. So, let me plot. So, this is a slightly different, if you recall that theoretical discussion these bars opening, closing bars and so on.

It is a nice plot. Then I can also there are some other versions let me show you. So, you have matchstick and candlestick. Candlestick is more famous. So, I will start with candlestick.

It is rather more famous and more a higher utility. You will see that when I plot it. So, see if when I zoom it, by default you have red and green colors, you can change it. So, the red bars are the falling prices and green bars are the rising one, you can see the volume and prices. Refer to the class discussions to make more sense of this candlestick plot.

Then lastly, we have matchstick plot. So, we will see. You have matchsticks. Let us see how it works. Matchstick. So, matchsticks are also very similar to bars, but they have the, you can see there. Again, the red ones are falling, and green ones are rising. So, it gives you some idea of how things work. So, in this video, we have plotted very nice plots with price volume data, which you will see and price volume data, some very nice plots using chart series function. In the next video, we will see how to add more complex technical indicators in the same chart series plot using the same chart series function.

In this video, we will see how to add technical trading indicators with the help of TTR package and we will also see how to visualize them in a simple manner. So, we will add technical indicators with TTR package. So, we need to add library TTR. Now, let us compute some of the technical trading indicators starting with simple moving average, simple MA, simple moving average, let us call it SMA and we will create simple moving average using the closing price series of Apple. And we need to give how many days of moving average we want. So, let us specify as 20. So, our indicator is created. Let us see how it appears.

So, let us use head sma. So, the indicator is there. Use tail sma, let us see if there are some items here. Yes, so I can use our na dot omit with sma and also, I can plot this.

And in the plot, I can specify that this is SMA plot. So, you can see the SMA plot, moving average plot.

Similarly, I can plot Bollinger Bands, and how to do it. Put simply, I can create this Bollinger Band series. B bands, again we will specify that we want to use closing prices on Apple, you can use Apple, Amazon, so any series. Next, I need to specify that we need a standard deviation of 2 and also you need to specify apart from standard deviation how many numbers you need series. So, let us, so we have computed the BB series.

And now, let us see if this is working. So, let us see if it is working. The next step is to plot BB and let us give the name as main equal to Bollinger Bands, let us see. So, we have a nice plot here, with nice colorful plot, you have Bollinger Bands on up and down. So, you can plot this graph and nicely see how it behaves. For theoretical discussion, you can go back to the PPT where we discussed in a more theoretical manner.

Now, let us see how to add momentum. So, we want to compute the momentum, let us use the momentum indicator. So, momentum indicator, so we will create let us say m equal to momentum and we will add again the closing price of Apple for n momentum for maybe 5 days kind of momentum we will use. Let us plot the momentum. So, this is the momentum plot, which reflects the momentum on the up or downside. Also, you can use as a momentum indicator ROC oscillator. So, ROC momentum indicator very easy, simply we use ROC equal to again the ROC function and use closing Apple series again maybe 5 days of ROC series.

Let us plot and let us give the name as ROC indicator. Let us see if it is just so this is ROC indicator. Similarly, we have moving average convergence divergence. For a real discussion, we can refer to the theoretical videos where we discuss the fundamentals to these. So, let us start with MACD indicator. Again, we will use MACD command in the TTR package.

We will specify, we need to specify the closing price series that we want to use. Also, you need to provide a fast and slow signal line. So, fast line for 12 days generally, so your fast line for 12 days and slow line, let us use the slow line for 26 days. Slow line supposed to be for higher day so that it is slower, the higher that period the slower it is. And then the signal generation line, let us use the signal generation line for maybe 9 days and we will add the maType as SMA simple moving average for MACD.

You can use exponential or any other variant. So, we are using this simple moving average. And then let us plot this MACD. So, we adjust the numbers a little bit, I use signal line as 100, slow line as 200, so to make the graph more visible. And when I plot the graph, let us just focus on this. The red line, the more fluctuating line is the black line, which is a MACD line, and the red line is a signal line. So, when this is crossed over, when the signal line is crossed over from above or below, you understand the signal is

generated. For example, when it is crossed from above towards the moving average line crosses from above to below that means now the momentum is falling.

Similarly, when it is crossing it from below to above that means momentum is rising. Lastly, let us also try RSI indicator rather than writing those lengthier codes. To plot RSI, we will simply use this RSI command and again supply the closing price and add it within 14, maybe 14 we will try some more if it does not work. So, we can then plot RSI, we will give the name as RSI indicator, we can plot it. Now this is the RSI plot, you can decide based on your comfort you can decide the crossing line. For example, here let us say I decide that 70, 30 is my crossing line. So, whenever the this RSI indicator goes crosses from above to below the 70 line that means momentum is falling and similarly when it crosses from below to above the 30 line that also means momentum is rising as we discussed earlier also.

So, here you can identify some of the signal generations, you can identify trend reversals, patterns and so on. So, in this video, we understood how to compute these indicators using TTR package. In the next video, we will make use of chart series plot to create some more complex plots with indicators.

In this video, we will combine our learnings of TTR package, technical trading package, TTR to compute the technical indicators as well as chart series package to create more complex plots of technical indicators. So, let us start with the charting exercise.

Let us start with simple SMA plot and then we will move on increase the complexity so to say. So, we will first compute, we have already seen that this is quite simple, we use this SMA function and CF and Apple and we specified that n should be may be equal to 20. Now with this, let us use our good old chart series plot. In the chart series plot, we specify Apple series, we specify the subset period as may be 2019 January up till 2019 December.

So, this is the period that we are using and let us add a theme as white. So, this is our plot, let us see if it is working. So, I should have put here chart series, chart series plot. Let us see if our plot is working.

Yes, so the plot is there. Now let us add one by one indicator. So, first let us add simple moving average and it is pretty simple. We just put n equal to 20 as we wanted, on equal to 1, call equal to blue. So, this will add first rather fast-moving average of smaller period. Similarly, we can add on another indicator with n equal to 200. So, this will be rather slower and probably we should change the color to red and you can see it is much more slow, it is almost. Now you can use these SMAs in conjunction, you can zoom the plot and for example, you can wait for the price to cross over one of the indicators.

And similarly, the blue ones or you can also compare between two SMAs, let us say blue versus red, the blue one is obviously faster because small period and when it crosses over, signal is generated, but the actual action appears from the price itself. So, now let us quickly look at some of the other indicators, charting other indicators. For example, instead of MA, in this plot we were focusing on SMA, let us do for EMA, the commands are rather simple. So, all I need to do, I need to just instead of add SMA, I should just add EMA and let me see how it works. So, I have made a small change instead of SMA, I have added EMA, so that you can add, you can see EMA slightly more capturing the upward movement because the name suggests exponential moving average, so it gives more weighted to recent changes.

Similarly, I can compute Bollinger Bands again for Bollinger Bands, we will use the same plot chart series plot, all we are doing instead of adding the one indicator, we are referring to another, so let us say add Bollinger Bands and I need to just specify the period and standard deviation of 2. Let us see, let us create the plot fresh, let me put the heading Bollinger Bands, let us see how to add them, simple plot and you can see the bands are added and you can see wherever, you can zoom the plot and see whenever the price is crossing the band, on the lower side when it is crossing over from above to below or fall signal is generated, when it is crossing from below to above and upside signal is generated.

Let us move to the next one which is momentum, so let us add the momentum plot, again same mold exercise, we copy the same codes, I do not rewrite the code, then rest of time I add momentum and let us say specify a period of 5, we will fit around the period to see how it works, so you can add the momentum, you can see the momentum is plotted below, when the momentum is falling or going above, you can see that very nicely. As you increase the period, you notice the momentum will come more, you can add more momentum, more and more plots, for example 10, 15, so you can keep on adding momentum plot to see the performance.

Next let us add ROC plot to our chart, again very simple, so I will add ROC plot, how to add it, same old plot, first we select the, we plot the fresh the chart and then we add ROC. In a very simple manner, I can specify maybe an equal to 5 or maybe I can specify an equal to 10, let us see if it adds there, so I can keep on adding, increasing the period higher and higher and find the plot, maybe let us say 15, add another layer, so we can do that. Next, we will add, the rules of interpretation remains the same of any momentum indicator, only that its construction varies according to our requirements. Let us plot MACD indicator, all we do, again we use the same chart command and then we will add the MACD line, in the MACD line, first we need to provide the faster one, let us start with 2012, we will change it later depending upon our requirements, then slow 126 and then the signal line maybe 9 days and let us keep the type as EMA to make it more fast. So, let us plot the plot fresh, let us change the indicators, so you can see it appearing at

the bottom, for example, you can see when the line cross, for example, you can see the signal line in red and MACD line in 2 point on slightly grey colour and you can see whenever the signal line crosses the MACD line, signal is generated, for example, here the MACD is crossing the signal line from below that means upside signal and price also shows upside movement similarly, whenever it crosses from above to below, a downside signal is generated like the one here. Let us try some other combinations, so maybe the fast one, let us keep the fast one as more fast and slow one as more slow maybe 60 and the signal line to at 30, so let us see what happens, yup we get another, so you can see now as we change the configuration at sort of different line, a slightly more different line is appearing, as we can see 12, 26, 9, 6, 60 and 30, you can see different line configuration, it generates more signals, it is a trade-off when your signal is, when you make your signal line more finicky for a larger period and your signal line, the MACD line to be more fluctuating, more signals are generated but some of these signals as we discussed in the theoretical lectures can be whipsaws, false signals.

So, depending up, there is a trade-off, when more signals are there, some of many of them can be whipsaws, when less signals are there, more when these less signals are more efficient but then you may miss out on profits many times.

Now, let us add another chart which is RSI chart, let us see how to do it, again very simple, we will add RSI chart, let us see how to do it. So for RSI chart, I will copy the same plot command, so I will create the plot afresh and then I need to add the RSI, all I need to specify the period maybe 14 days and the type, matype graph, what kind of MA I want to have, maybe EMA we will choose, we have seen SMA, let us choose the EMA and the plot is added, you can change the period, for example, you can add RSI for 28 days and you can see the comparison. Lastly, let me show you a more complex chart where we will add multiple indicators, so a complex chart, let us see how it is done. So again, let us have our original plot but this time around, after plotting the fresh plot, we will add number of indicators starting with Bollinger bands, so for Bollinger bands, we need the argument number of days and standard deviation, that is first addition, the second addition is RSI, so let us add RSI, what parameters do we need, again we will stick to n equal to 20 same and then I will add MA type as EMA, so we have added another EMA and then we will also add MACD to increase the complexity and signal generation.

So again, the fast one may be 12, the slow one maybe 26 and signal generation, signal generation maybe 30 and type as EMA, so let us see what has given us, so all a very complex chart with many indicators to help us with our technical analysis.

To summarize, in this lesson, we visualized the data and examined its various properties. For example, financial market returns do not follow normal distribution as often suggested in the theory. We also saw that its tails are fatter and more negatively skewed.

With the help of moving average plots, we saw how to generate trends and trend reversal signals. We saw how to use a system of moving averages, a short term and long-term moving average to generate signals. In addition, we also saw the application of momentum indicators to generate trend and trend reversal signals. Momentum indicators are very useful in generating reliable signals. We saw how these momentum indicators give us early warning signals before the actual price movement happens.

Lastly, with the Quant Mode and TTR package, we constructed complex momentum charts. These complex momentum charts are part of weight of evidence approach that is to which direction a higher weight of evidence points out. For example, whether considerable evidence points towards trend continuation or reversal. That is what we try to gauge examining all these indicators. Thank you.