

Exercise & Sports Biomechanics
Dr. Rahul Tiwari
High performance Analyst – Biomechanics, SAI
Netaji Subhas National Institute of Sports, Patiala (PB)
Week 09
Lecture 44
Demonstration of CoG Measurement

[Hello, friends! welcome to this course exercise and sports biomechanics].

The measurement of the estimation of center of gravity:

In this particular section, we are going to discuss regarding the estimation or the measurement of the estimation of center of gravity. So, I am going to demonstrate the same. We are using the segmental method that we have discussed in the previous video. So, for that, we will be requiring some graph paper.

I am using this graph paper. You can use it with the biggest square or the smallest square, whatever you feel right. Even you can do this on the plain paper as well, but I always prefer to do it on the graph paper in order to have the more accurate measurement, right? So, apart from that you require some of the pictures as mentioned in the video that this is the method in which there is not requirement of a particular person to be present at the time of measurement, but we can measure the center of gravity of the particular picture or the particular film as well, right? The frame as well.

Demonstration for the joint point method:

I will be having some anatomical position picture, some dynamic positions like this[see video]. I will be requiring a ruler and the pencil, some glue in order to stick the particular picture on the graph paper some pen. And apart from that it is always suggested to have the table ready with you the table which I have given in the previous section, so the first we are going to discuss the joint point method. So, in the **joint point method**, the table which we are needing is, this is always suggested to have the table ready with you.

You can have it on your screen, or you can have the manual thing. So, the first thing I am going to demonstrate is the joint point method. So, for the joint point method, I have a table which includes the body parts, the segmental parts we are analyzing, the right and left sides, and the segmental weight we have obtained. From the cadaver studies done by Dempster in 1995, we have the x-coordinate, y-coordinate, and the moments of x and y. We are clicking this alongside with us and aligning the paper along the line of the graph. So, make sure this has a straight margin so that the measurement will be much easier, and align it with one of the major lines of the graph. This will look something like this, right? Make a vertical axis—this is our y-axis.

The vertical axis and make a horizontal axis as well. So, this is our y-axis, and this is our x-axis, Remember in the joint point method, I told you that we need to mark the anatomical positions, like the segments. So, the segment would be the head. So, the head will be marked somewhere here, like this—shoulder like this, both the shoulders, right and left elbow, wrist, and the knuckle or the hand. The knuckle position will be used, then the hip—

the hip will be around the greater trochanter, knee joint line, ankle, and the foot is again along the toes, right. Then, it is necessary to measure the distance from the particular axis to get our coordinates.

Just measure the distance of the head position from the axis, something like this, and this comes up as 5.4 cm. So, have the paper ready with you, and this is the y-axis. So, on the y-axis, just write 5.4 straight away. And the vertical distance will again be measured along the line. This is the vertical distance, and that is coming around 14.3 cm. So, on the x-coordinate, just write 14.3. In a similar way, I have to do this for all the joints. So, this is the left shoulder, so the left shoulder is coming around 6.6 cm, and the right shoulder is coming around 4. So, the right shoulder Y-axis is 4, and this is 6.6. So, I will just finish the Y-axis first, and then I will go for the X-axis. So, the left elbow is 6.8, and the right elbow is 3.8. This is the other way around and this is wrong. So, this is, the right one is 3.8, and this is 6.8 for the wrist joint. For the right, it is 3.6, and for the left, it is 7. So, it is 3.6 and 7 for the hand. Same thing, it is coming as 3.5 and 7, so 3.5 and 7 for the hip joint. It is coming as 4.6 and 6 for the knee joint. It is coming as 4.8 and 5.9 for the ankle joint. For the ankle, it is coming like 5 and 5.7, and for the foot, it is coming like again 5 and 5.7. In a similar way, 5 and 5.7. So, this is the Y-axis.

You can have a line and then measure or whatever way you feel like right, so if we are having the lines there are too many lines and it create a confusion. So, for the sake of not creating the confusion i will basically just measure the distance and draw that in the in the table form, so similar way for the shoulder x-axis distance. So, for the right it is coming around 12.2 and for the left it is coming around the same 12.2. 12.2 and 12.2 as the person is standing in the lateral position so almost this will be the same position only. For the elbow, it is coming around 10.6 and 10.6, 10.6 10.6. For the wrist this is like the 8.7 and the 8.7. 8.7, 8.7 for the hand it is like 8.2 both the side 8.2, 8.2 For the hip joint, it is coming like the 8.8, both the sides. The knee joint, it is like 6 cm, both the sides, 6. For the ankle, it is like 3.8 and 3.8. 3.8, 3.8 and the foot is coming something like 2.8 and 2.8. So, this way we will be having all the coordinates ready with us. Right?

Now we know to identify **the moments** here, and we know the moment is what? Moment is basically the segmental weight multiplied by the distance. So, the segmental weight for the head is 0.07 that we have already discussed and the moment for axis, the length for axis is this. So, this will be coming something like 14.3 multiplied by 0.07. Whatever its answer is coming, that will be the moment for the particular axis. And for this, it will be like 5.4 multiplied by 0.07. [Something like this. Right?]

Similar way for this, will be 12.2 multiplied by the segment here, that is 0.136 and for this it will be the y is 4. So, 4 multiplied by 0.136. So, the answer will be coming as in moment. Moment of the particular x coordinate and the y coordinate. So, for the left it is the weight will be same. For the elbow it will be 10.6 multiplied by 0.026. Similar way, here it will be 3.8 multiplied by 0.026. For the wrist, you can see the weight is 0.008. So, it will be 8.7 multiplied by 0.008. And 3.6 multiplied by 0.008.

Likewise, we will fill everything here. And whatever value we are getting, whatever answer we are getting, in the end, we need to do a summation for all. Summation for all, so whatever value we are getting, that is the value for the x-coordinate, and here we are getting

the value for the y-coordinate. So, for example, if I am getting the value somewhere here, like for the x-coordinate, I am getting the value somewhere around here, and the y-coordinate, if I am getting the value somewhere around here, so you can see the point where these two lines are intersecting, right? The point where these two lines are intersecting is basically the point, where the center of gravity is located. This is the center of gravity of the particular person.

Let us have another demonstration for the joint point method only, where I am using this particular picture to identify the center of gravity. So again, stick the figure. Like this, have the axis drawn. So, the mistake here I did is basically I have taken the other part as well, so in order to avoid the chaos and all, just remove this thing. This is our vertical axis, that is the y-axis, and this is our horizontal axis, that is the x-axis. This is our y, and this is our x-axis. So again, we all know what to do now. So just mark the body segments, something like this. So, this is my shoulder. This is my elbow, wrist, hand like this. My hip joint, knee joint, ankle, and toe. So, have a table ready. So, I am doing the x-axis first. This is 7.2, this is 7.2 for the shoulder. It is 5.9, this is the right shoulder, 5.9 for the left shoulder. It is 8.3. 8.3 for the elbow. It is like 4.6, sorry, this is this, not this, 4.6, 4.6. And for the left side, it is 9.5. For the wrist, it is 2.8, and the left wrist is a bit far, that is 11.4. The right hand is 2.7. The left hand is 12. The right hip is 5, the left hip is 6.3. The right knee is 3.9, the left one is 4.7. 2.9, the ankle, right ankle. And the right one is 3.3, and the foot is the right one is again 2.4, and the left one is 2.6. And for the y-coordinates, if I have the value for the head, it is 6. For the right shoulder, it is 7.4. For the left side, it is 8. The elbow is 6.9 and 8.5. The wrist is 6.5 and 8.7, and it is 6.6 and it is 8.7. The hip joint is 9.9, and the left side is 10.4. The knee joint is like around 11.8, the left side is 12.5. The ankle is 14.1, and the left one is 14.5. The last one is the foot, so the foot is 14.6, the right one, and the left one is 14.9.

You can see that we are having all the distances from the x and y coordinates. In order to find out the movement for the head, it will be like the x-coordinate is 7.2 multiplied by the weight, that is 0.07. So, that is coming somewhere like, so if I calculate the things, it will be like 7.2 multiplied by 0.07. So, that is coming like 0.504. Similar way for the y, it is coming like 6. multiplied by 0.07 it is like 0.42 so same I will be doing it for all So, likewise, we calculate all the things here. So, the moment of X will be the distance multiplied by the segmental mass for Y will be the distance multiplied by the mass.

The value will be coming something like this for all the joints for head, shoulder, elbow, wrist, hand, hip, knee, ankle, and foot for both right and left side. And in the end, we have done a summation for all the things. The value of x is coming like 5.75 and for this line, it is coming like 9.6. So, on the x coordinate if I measure 5.75. So, let us begin with this first. It is 9.6. So, it is coming somewhere around here and for this. [It is coming somewhere around here]. These are the two coordinates. So, just make a line where these two are getting intersect and this is the point where the center of mass is basically located for the particular position.

Demonstration for the main point method:

Demonstrate another method that is called main point method. So, in the main point method, the basic difference was that we need to identify the center mass of the particular

segment, right? So, that and we are basically making the distance of X and Y coordinate from that particular center. So, the first step is similar as of the previous one. Just make a coordinate the y coordinate and the x coordinate, and in this you need to mark the segment the whole segment length, so for that for the head it will be like on the vertex and the down the chin where the chin and the neck is intersecting. So the head vertex is basically the vertex point like this and the down will be something like this for the shoulder it is from the shoulder till elbow and for the forearm it is from elbow till the wrist and for the hand it is from the wrist till the tip of the finger, so something like we will be marking on both the sides like this because we need to identify the segment length first, so that is why we need to mark the end point of that particular segment, right. So, the neck will be coming into the trunk here till the hip joint line and the hip will be from the GT till knee, knee till ankle and ankle till hip of the toe. [Similar way something like this].

Now, measure the length of this particular segment. If you can see the head is basically coming around 1.8 cm. As previous just keep the table ready. So this table is basically having the body parts. and the ratio of the proximal and the distal segment at which the center of mass could be located. And this ratio is based on that study that has been done on the cadaver by the Dempster in 1995. So, here we need to write down the length of the particular segment and then the distance with respect to the actual length.

The distance, for example, for the head, it is 3 to 1. So, the simplest method is basically 3 plus 1 is 4. So, divide the whole length into 4 parts. The three parts from the proximal will be coming here, and the one will be coming here. It is as simple as that.

And then, the relative weight we know from the previous table that we can mention up here, and the distance we need to measure from the center and the moment, right? So, the head length is coming up like 1.8. So, the length I am writing here as 1.8, right? For the trunk,

You can do it either two ways: either the neck can be included in the trunk, or you can mark the separate part just below the neck in order to get the trunk also. The trunk is coming something like 4.4, so this will be like 4.4, and the upper arm will be from the shoulder till the elbow, so it is 2. The lower arm will be So, this is the right upper arm, and the left upper arm will be again it is 2, so again this is 2.2. The right forearm, 2.2 left would be approximately the same, yeah, it is the same, and no need to go for the hand here. And in a similar way, we can go for the For the thigh length, so the right upper leg will be 3.5. The left is almost the same. The lower leg is 3.3. The foot is one. I am sorry, the hand needs to be taken here. The hand is in the last. This is 1.5. 1.5 and 1.5. So, the simplest way is basically we just identified the length here.

Now we need to identify the proximal and distal length as per this particular ratio. So, you can see this ratio is 3 and 1. 3 proximal and 1 distal. So, the simplest way is to add them. So, this comes to 4. So divide the whole part 1.8 into 4 different segments. 4 parts. So, 1.8 divided by 4. How much does it come to? So, it will be coming like 1.8 divided by 4, so it is coming like 0.45. So, 0.45 multiplied by 3 will be coming up here, and 0.45 will be coming up here—0.45, right? And 0.45 multiplied by 3 is 1.35. So, from this, it means the whole segment, which is of 1.8 centimeter length. So, the proximal part—one proximal

three part—will be at 1.35. So, you can see the proximal three part is 1.35. So, it is roughly here.

The center of mass for the head will be somewhere around here. It is like this, and for the trunk, it is like 3 to 2—3 to 2 means 5 parts. So, I need to divide this: 4.4 divided by 5. So, this is coming at 0.88. So, 0.88 multiplied by 3 will be the proximal part. 2.64, and 0.88 multiplied by 2 will be the distal part: 1.76. So, it means the total length, which is of 4.4 centimeters of the trunk—out of that, if I go towards around 2.65 like here. So, this will be basically the center of rotation for the trunk. Similarly, for the upper arm length, it is basically of 2, right? So, I need to divide it into 4 plus 5 into 9 parts. So, 2 divided by 9, which comes out to divided by 9, which comes out to 0.22, right? So, 0.22 multiplied by 4 will be the proximal part. Multiplied by 4, it is 0.88, yeah. And 0.22 multiplied by 5 is 1.1. So, you can see towards the proximal, from the proximal, 0.88, it means roughly nine. So, this will be the center or the moment of inertia for the particular segment.

[And for this part again], the right forearm, it is 2.2. And the division will be four plus five. So, it will be nine, so it is 2.2 divided by nine. Now, 0.24 multiplied by four. 0.96, and 0.24 multiplied by 5. So, from the proximal end, 0.96, roughly around 1 centimeter. This is basically the center of rotation for the particular segment, or this is the center of mass for the forearm, right? So, this way we can basically identify all the centers of mass. So, I am just roughly putting it down everywhere now. And so, this value will come up here. All the values, the distal and the proximal, will come up here. The relative mass we already know from the previous table. So, these are the relative masses that we have. For example, for the head, it is 0.07. For the shoulder, we know that it is 0.136. For the trunk and all, I have already given you the details in the previous slides.

Now, we need to measure the distance from the x and y coordinates of this moment. So, for the head, you can see the distance to the y-coordinate is somewhere around 10.9. So, it will come up to 10.9 here, and for the x, it will appear like this here. 15.3. Similarly, for the trunk, the x-coordinate is 10.3, and the y-coordinate from the center of the moment—the moment of inertia—from the center of the segment is 11. So, in the same way, we will get all the values here, all the values here.

We need to find out the moment. So, the moment is again the distance multiplied by the weight. So, this distance multiplied by this weight will appear here. This distance multiplied by the same weight will appear here. So, this will be the moment for the x and y coordinates for the head. Similarly, for the trunk, upper arm, lower arm, and so on, all the values will fill up here. In the end, we need to have a summation, and we will get the coordinate for x here and the coordinate for y here.

Similarly, if the coordinates are somewhere around here, just mark the intersection of the two coordinates, and this will be the center of gravity for the particular picture. Right? So, this way, just practice the task, have a picture uploaded, or test it on graph paper. You can even do this on white paper, but I always suggest using graph paper for accurate measurements.

Demonstrate the software-based measurement of the center of gravity:

[So, let us demonstrate the software-based measurement of the center of gravity].

Kinovea:

We will be talking about Kinovea first and then about the tracker software, which we discussed in the previous section. Right? So, just go to your browser, any browser, and type 'Kinovea.' You will see the first website as **kinovea.org**. Just go to that website, and you will find a link to download the software. This is called kinovea.org.

This is an open-source software that is freely available for your setup. You can see the most recent version of Kinovea here. This is the latest one: **Kinovea 2023.1.2**. We have an EXE file as well as a ZIP file for laptops and desktops that do not support the latest version or are a bit outdated. They can try this older version of Kinovea as well. They all work fine, right? Okay. I have already downloaded it on my laptop.

[I am jumping straight way to the Kinovea software].

This is the interface of Kinovea, where you can see the library. The library will display your whole desktop or laptop here. Just go to the specific folder or section where your videos are stored. The best part of Kinovea is that you can analyze an image as well.

In terms of the center of gravity. So, I am having certain videos here. But before that, I would like to have a demonstration on the one image as well. So, to bring that simply go to your image, which is wherever your images and simply drag that video to the software. So let us say this is the image. I am just dragging it. And as soon as you drag, it is basically opening up an interface where you can do a lot of analysis. Right. So, in the software, you can see there are some some options which are given up giving up on the upper side, upper left. So, this is the file that you can open. This is the to save the annotations and all, and you can explore the panel. Right. You can have a single image or a single screen analysis, a multiple screen analysis. You can even directly capture and do analysis here with the two screen as well and with one screen and the one live tagging analysis.

These are some of the options which basically help you to do the analysis part. The first option is basically the cursor. This is a move option, the cursor option. So, this is just a hand tool and this is just a cursor.

Then the second option is you can add a key image. So let us example, let us have an example. Like you are working for certain organization and you want to have that organization logo along with your analysis. So, you can add from here. Then, this is like, if you press this, you can have all the comments that you have already mentioned here, during your analysis.

One by one, all the comments will be coming straight away here. sorry. Yeah. Then ABC, AB tool is a text tool. So just select the tool, go anywhere, double click and you can type whatever you want. So let us say whatever you want, you can type straight away here and it will be coming and you can move it anywhere, wherever you want.

Then the pencil tool, pencil tool can straight away write or draw anything, whatever you want with the pencil tool. Just simply work like a pencil. Then we are having a human

model human model. We will be using to estimate the center of gravity. So, I will be coming to this in the last line tool. You can simply draw a line anywhere. The simplest method to have a straight line is just press the shift button of your keyboard and draw a line.

You can see this line with straight line like this, and the arrow is just to demonstrate something function like a normal arrow. Then we are having a marker. So, marker is if I want to mark something, some point like this, some point like this. So, this is a marker and an angle tool.

Here, angle means, for example, I want to track this angle. What is the angle here? So simply click the angle and click it here. So, bring this point to the joint, which angle you want, and these are the two sides of the angle. Again, if you press the shift button, the line will be coming as a straight line. So, this is an image so that it is not moving, but we can track the angle as well when we are analyzing a video. Simply just need to go to the angle, just bring the angle here, right click and track the angle.

Stopwatch is to measure the timing for certain things. Perspective grid is a part of calibration that I think you must have studied during the previous section and all. The spotlight, just to magnify the thing or to have a spot on a particular point, magnifier and the color combination, color profile. So, the particular, the main agenda of this section is to have, to identify the center of gravity of this particular image.

As told in the in the slides that this the center of gravity can be identified for a particular image as well as particular frame of the video. So, let us try with the image first. So let us have this human model. Click on the human model and click it here. You can say the human model is straight away coming here. And now this human model is you can say these are the multi segmented. So just drag all this segment to the particular point like this is shoulder. This is the head. Just drag all the particular bony landmarks like this. This is elbow. This is wrist and this is hand. So this is elbow. This is wrist and this is hand this is hip joint coming somewhere around here hip joint coming somewhere around here knee joint the ankle and the toes ankle heel and the toes kind of thing similar with the other side as well.

[This is the ankle, the heel and the toe. So, you can see a point is coming here]. This point is basically the center of gravity. This estimation is basically based on the segmental length. The software basically calculates the length and based on that, it is giving you the estimated point where the center of gravity is located.

[You can see this point; this point I am talking about, at this particular point. Or you can see this point. Yeah, this point I am talking about. So, this is the normal level of center of gravity].

You can right click this here, right click here and there are various options. So, if you go to the options and write display coordinates of center of mass. So these are the coordinates which are coming. So, this is the gravitational value which is coming up here. And this is the position of the center of gravity from this is the vertical position.

Since we have not calibrated the video, so this is coming into the pixel. The values are coming into the pixel here. If you calibrate the video like with certain known value, known reference values and all, so this all value will be coming up as in the meters or centimeter, whatever calibration we are using. So, let us take an example of some other images as well. So let us take an example of this image first [Yeah, this image].

Again, I am taking example of image only, for example, let us have a length of this will be around two meter. Okay. I am not sure. I am not, uh, I have not measured it, but just for an example, just take a link. So take a line tool. Okay. Drag it down like this, right click calibrate the video and make it around two meter.

So now the software knows the length of the human model. Apply the human model here and just drag the body segments likewise. Yeah, like this, like this, like this, like this, and like this. So, you can see the center of gravity is somewhere here. So when you right-click this and display, now it shows the true value, the real value, which is 0.73 meters. So, this is basically from the ground because you can double-check this. So, I go to the line tool, and if I drag this towards this, you see this is around 0.73 only. So, this is the distance from the calibration unit. So I am considering this as the ground.

If the calibration unit is at the ground, that will be the real position of the center of gravity from the ground. So, let us have another image. So, another image would be Let us have a video now. So, this is a video of a discus thrower. Okay. And I am moving to a certain position here. So, let us say, okay, one more. Let us say this is a position here and I want to estimate the center of gravity of this particular position to have a So, I know here the diameter of this circle that discus circle.

The diameter is basically 2.5 meter. That is a constant value, right? So let us have it along with the body position only, so that we can have a right click calibrate, and this is 2.5 meter.

[Now, if I am having a human model here and I am applying it here].

Let us just drag the thing as we were doing earlier. There are all the segments. Shoulder, this is wrist, this is hand, hip joint is coming something like this, this is hip joint, and this is a knee joint, which is something like this which is here this is a knee joint right and this is something like this and done. So, you know there is a point which is coming like as a measure of the center of gravity. Right click, option and display. So, this is coming like 0.89 meter from the ground. So, because we have calibrated like this.

This is the 0.89 meter vertically positioned the center of gravity. So, this is the simplest way to measure the center of gravity. Rather, you can use it for the various other position like for example, if you are taking some position like this, okay, so here the weight will be coming under concentration, but this is the note that note this as well that the weight is symmetrically distributed both the ways. So it will not affect the center of gravity much, but definitely the body position is lower.

The center of gravity will be coming a bit down. Just quickly do this. like this, like this and like this, like this. And it is coming here, it is coming there and it is coming here. Like this and like this.

You can see the center of gravity is coming somewhere here, right? So although it is not calibrated properly, but you can do this and you can see the center of gravity is coming over here. Right? So this way, I mean, this is left. So this way we can basically estimate the center of gravity of a particular body position. Right?

Tracker:

[Now let us move to the other software].

Now let us move to the other software and that is called tracker. So go to your browser and type the tracker video analysis and modeling tool and search it. And the first website will be getting you to a software called **Tracker**. So, this is basically by the open source **physics.github.io**. So, you can straight away download it for the Mac window as well as for the Mac OS. The limitation of kinovea is that it is only for the window, but tracker is available for both the things. But the other limitation of tracker is you can only track the point, but not you can do a much thing there. I have already downloaded it here. So, the video is something like this. And from here, we can play the video. And, for example, if I want to have this as a starting frame, I can just mark it as a starting frame and make it as the last frame. So, just right-click and make it as an end frame.

Again, I need to calibrate it first. So, the calibration would be done from the measurement scale here. You can see there are various points appearing. So, if you go to this particular section, new, this will be like the blue portion. If you go here, this will be the new calibration stick. So, your calibration stick is appearing here. Just drag the calibration stick to the pre-measured distance. I know this distance is one meter. This is one meter. So, I am not changing it. Otherwise, you can change this as well. Right. And if you again, if you click it again, so this will be hide now. And I need to have a coordinate here first.

Let us have a coordinate first because I need to track the movement in certain direction. So, I want to have a movement from here. So let us have, let us think that this is the point from where I want to track. So, the limitation in this particular section is that you need to first estimate the center and then you can track that center only.

If you already know where the center of gravity is, so roughly we know that thing and from there where we can basically track it down. Okay, so this is our estimation. This is our center zero, our coordinates and again hide it here. So go to the track here, go to the new track, point mass and you can rename this point mass as whatever point you want and you will be having a plot here. So, there are various plots which are coming to the plot against the time against the X coordinate times against the Y coordinate.

There are various things that are coming, so if I simply, click it, and there is a thing called auto mark or the auto tracker. So if I enable the auto tracker, if I play the auto tracker, the particular point which I will be marking will be auto-tracked, and the things will appear. But the limitation of that is, for that, you need to have a uniform background.

But on the ground, we cannot have such a thing. So, we are basically going for manual tracking first. For manual tracking, press the Shift button on your keyboard and mark it anywhere. So as soon as you press it, just look at this arrow. So as soon as I press the Shift button, the arrow is changing into a certain mark.

If I mark the thing, this will be the thing which I just marked. Again, and immediately the frame will move. Like the video will move one frame ahead. So again, I am marking the things. I am marking the things.

I just press the shift button and every time I am marking the point, which I basically estimated as a, as a center, like this, like this, like this. So with the manual tracking, it is a time consuming thing. Obviously for the auto tracking, we need to have a uniform background. Otherwise the software will get confused with the varieties of colors available in the background. So, you can do until the frame you want like this, like this, like this.

You can see some graph is coming here. So this graph is basically, X coordinate is the, so it is the basically X coordinate times Y and the Y time and the Y coordinate, and the time curve. And you can click it here and you can change it like the Y position to the position magnitude, position angle, velocity. There are many things which are coming up here.

If I move the video back also, And if I play the video frame by frame like this, you can see here. So it is object. So this is an instantaneous position of the particular marker like this.

This way you can track it to the, to the portion or to the position wherever you want, and you can save it. So, you can see the coordinates are coming here as well. So, this will be, you can save it as an XLS file or the CSV file, and you can have it for plotting of the graph and all. So, here we are coming up, we are getting two graphs. So, we can reduce it to one. We can get it to three also. So whatever things we want, we can do a many things here. So, the only key for the software is we need to explore it down. So, explore the things down and we can definitely have the question and the session. So, we can solve your doubts as well.

[Thank you. And thank you for watching the videos].

[Thank you and see you in the next video].