Business Analytics for Management Decision
Prof. Rudra P Pradhan
Vinod Gupta School of Management
Indian Institute of Technology, Kharagpur

Lecture – 37
Predictive Analytics: Machine Learning

Hello everybody, this is Rudra Pradhan here. Welcome to BMD lecture series. Today, we will continue with predictive analytics and that too coverage on machine learning.

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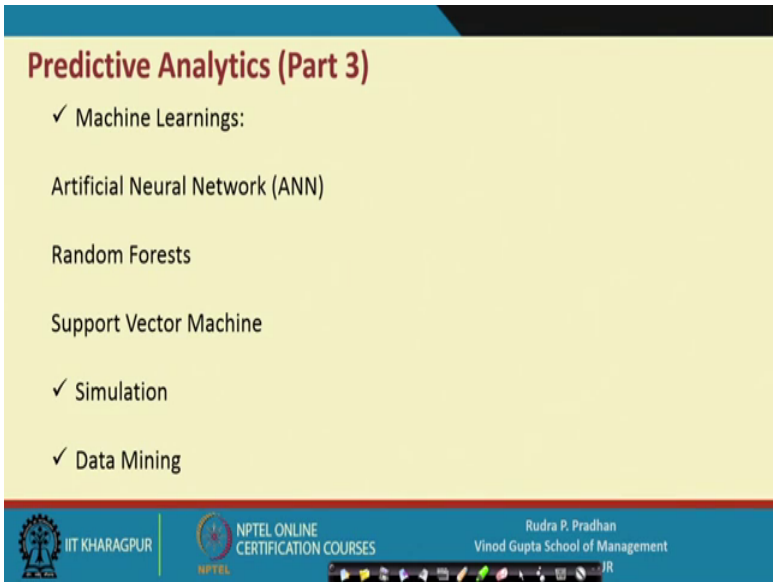

In fact, it is also one of the kind of you know fore casting technique through which you do the kind of you know forecasting as per the a management requirement. In fact, in the kind of in a forecastings, we have a two different structure linear structure and non-linear structure. And we can have a different kind of you know situations in a particular situation, we may have a single variable through which you will do the predictions for that variables by using different techniques. And in fact, we have discussed so many you know time series techniques through which you will do the similar kind of you know predictions with respect to information of a particular variables and the requirement you know futures.

And again in the other case we can have a multiple number variables through which we can do the similar kind of you know forecastings that too dependent variable with the many independent variables. And we can have a you know time series data that is

historical data. And again use the historical data for the future predictions. So, in the machine learning, we have a similar kind of you know structure, but here we can follow two different set offs altogether.

Having a first of all a you have to see how many variables are there in the systems, and how many observations are there in the system corresponding to all these variables. Let us let us start with a simple structure that is a part with a respective of particular variable. And then we have to check how many data points are there. And in the time series set setup technically we may have actually more number of data points so that prediction and forecasting you know can be very perfect as per the particular you know management requirement.

So, having actually more number of observation in a particular you know setup so the time series forecasting typically in the machine learning process. So, we divide the entire set data into two parts. So, first part you know around 70 to 80 percent, we keep it for you know model development. And then remaining data points we will keep for you know you know testings, model testings. Then finally, so the you know develop models and the kind of you know testings, so we can finally, come with a particular you know structure that that you know a model is a perfect already for the future forecasting or you know future prediction.

So, that means, you know whatever we have discussed in the previous lecture with respect to time series, you know time series forecasting, and that too we used the total number of you data points for the you know forecasted model. And then we get the you know forecasted figures then the then the particular you know you know obtain of you know particular error terms with respect to you know actual values and the kind of you know estimated value.

So, obtaining the error component with respect to actual value and estimated value, so we will give you the kind of you know model accuracy. Then through the indicators like you know mean square or means absolute deviations, means percentage error, we can we can finally, check the validations and then we can go for the kind of you know predictions and forecasting.

So, a here in this particular you know lecture, so we will go for you know similar kind of you know you know similar kind of you know framework. And then we will develop a

particular you know modelling framework through which we will do the you know forecasting of a particular variable with respect to you know time series data that too historical data. So, in the machine learnings, we have a couple of techniques; starting with a artificial neural network, random forest, support vector machines, and then we will follow a structure called as simulations and the kind of you know data mining.

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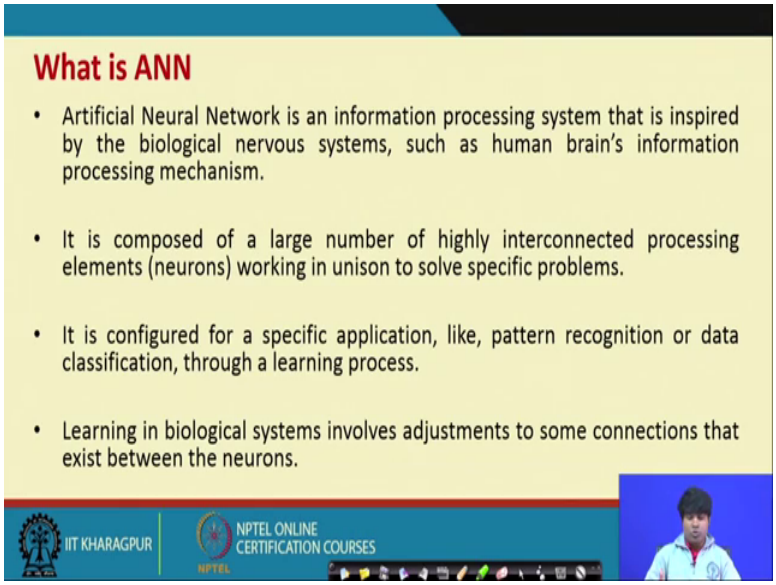

But in this in this particular you know lectures, we try to you know cover neural network. And then we look we will we will follow up with you know random forest and support vector machines. These are all you know interesting machine learning techniques through which you do the a you know time series forecastings or you know similar kind of you know forecasting as per the you know business requirement.

It is actually similar kind of you know times series models, but little bit you know you know structural difference is there to do the kind of you know forecasting. So, here in the artificial neural networks, the whole idea or the basic approach is the we have actually input clusters and these input cluster will be connected to particular you know output forecasting.

So, we can start with the one input with you know one output or we can start with the many inputs you know one particular output. Then you know how these inputs are you know connected properly with respect to time series data. And then we will go for the output prediction and output forecasting that too with you know the training and you

know the testing so that you know the model accuracy will be perfect for before you start the prediction and the forecasting.

So, this is one of the a you know interesting technique that is you know ANN artificial neural network. It is it is an information processing system and usually inspired by the biological nervous system such as human brains informations processing mechanism. It is a composed of large number of you know highly interconnected processing elements that is technically called as you know neurons. And the neurons are you know technically clusters and classified a and then a it they can be learned properly to develop a particular you know structure through which you can you know do the kind of you know output forecasting.

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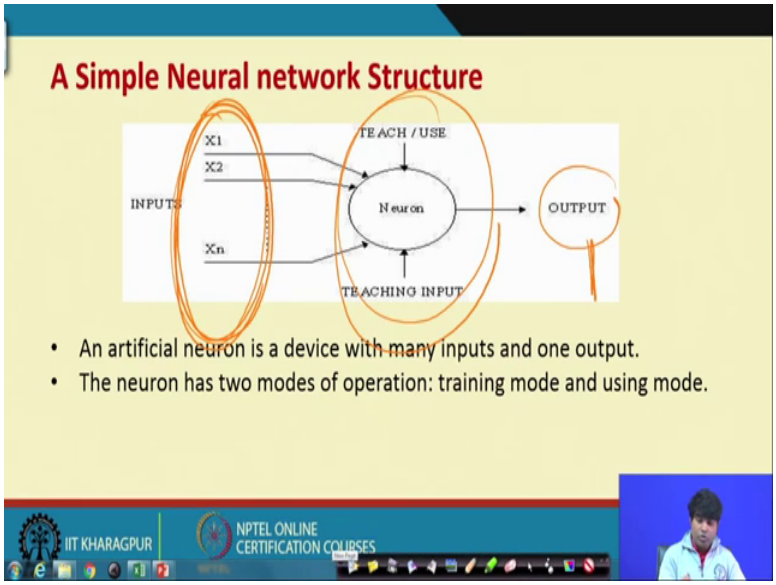

So, this is actually typical framework through which actually you can go the you know output forecasting with respect to the kind of you know input availability. And the usual structure of you know neural network is like this. So, what I have already mentioned so we can actually input clusters and our job is to predict the output.

And when we have actually input structure and the kind of you know the prediction of you know output, so what will we you what will we have here, so we can start with you know one particular input with one particular output. Then you will do the you know structuring to do the a kind of you know forecasting. But in the in the other sides, we can

have a multiple number of you know inputs through which you do the similar kind of you know output forecasting.

So, compared one input with one output it is not so challenging, but when you have a more number of inputs we the through which you can actually predict the particular output, it will be very challenging. So, the how these inputs can be actually combined in a what way in what you know kind of you know in a structure through which you know the output will be perfect for the kind of you know prediction requirement.

So, this you know simple diagram can narrate the particular structure. So, this is the input structure. So, this is first hand you know availability. And our target variable is output which is also you know available. And then a this is the mechanism in neural network mechanism through which it can a it will help you to process to you know predict the particular you know output.

An artificial neuron is a device you know with many inputs and one output. So, this is a you know simple structure altogether in a kind of you know artificial neural network framework. The neural has a two you know modes of you know operations what I have already mentioned that is the training mode and the using mode. So, first we know we use some data to create a kind of you know training structure then we use this training data for you know you know usable way to predict the output row you know the kind of you know the kind of you know requirement.

So, what we will do technically. So, the structure is like this. So, with this help of you know input and you know the particular structure we will go for the output and that too in a kind of you know modes like you know training modes and using mode.

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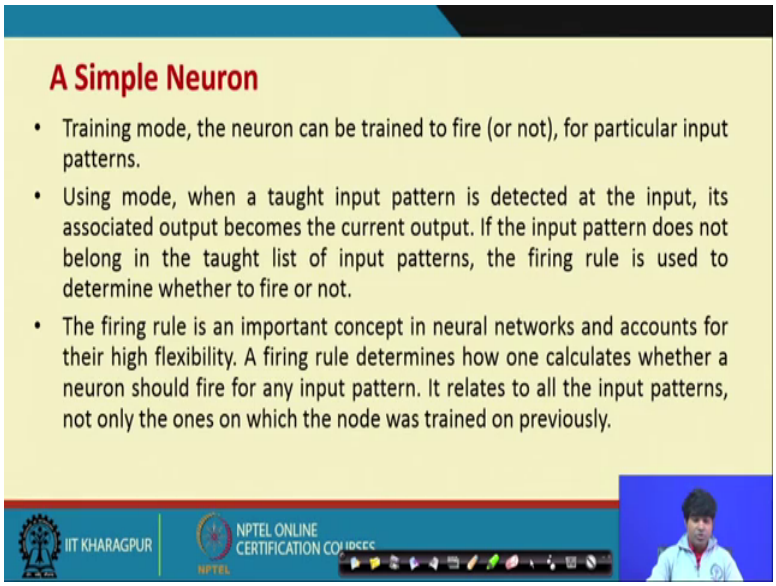

So, let us see how is the particular you know structure. So, in the kind of you know training mode, so the inputs are you know trained properly to predict the output, but in the using mode so the input pattern can be detected through the training modes, then it will be finally connected with the output forecasting. So, it is a kind of you know simple framework through which actually you can do the typical you know neural network forecasting.

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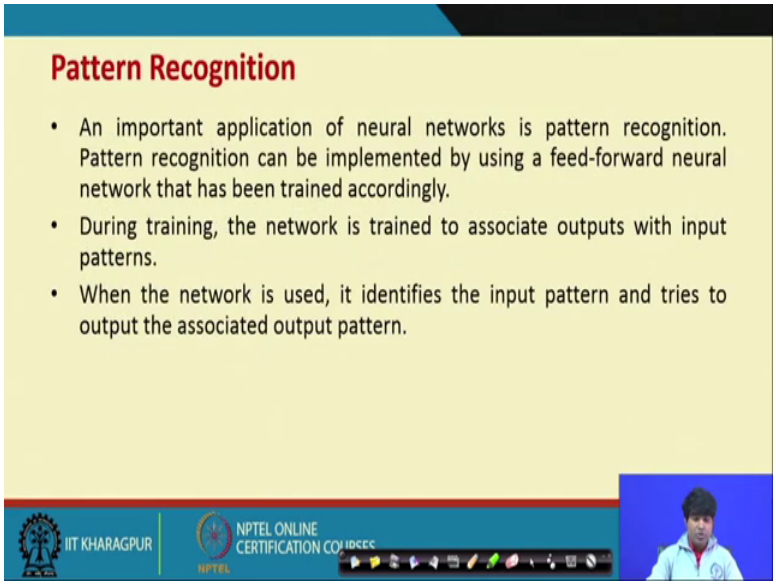

And in the in the particular you know neural network structure, so the typical understanding is you know it is the pattern recognition and this is the one of the important application you know neural network. So, how to actually recognise the particular you know structure that is through you know training. And then once you recognise properly the kind of you know arrangements, the kind of you know combinations, so that will be a properly you know indentified and connected then the output need to be forecasted as per the requirement.

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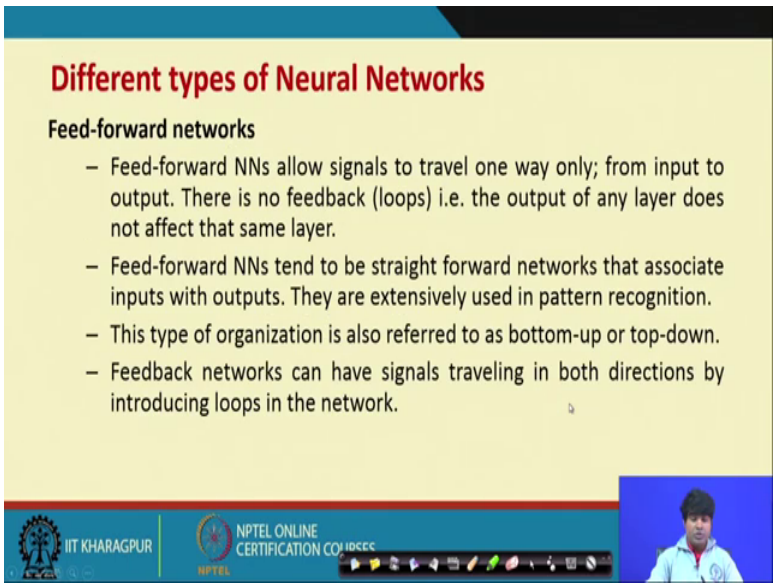

So, now in the kind of you know neural networks, we have a different you know types. So, in one of the interesting structure is called as you know feed forward networks. And in the feed forward networks, it is a it allows signals to travel one way only from input to output; and there is no feedbacks you know that feedback mechanism through which the output of a particular you know any layer does not affect the same layer.

So, that means, actually we have a kind of you know simple structure and you know complex structure and this is a kind of you know mechanism through which you know the connection will be one way, but sometimes we have multiple layers through which you can do the similar kind of you know forecasting.

All depends upon how you have to train the particular you know you know you know structure and then we will connect with a kind of you know forecasting structure through which you will do the forecasting as per the particular requirement. That means, actually

in the training process we have to develop the neural network structure that will be you know what we call as you know training structure through which you can recognise a particular signal and that signal will give you the some kind of you know predictions as per the future requirement.

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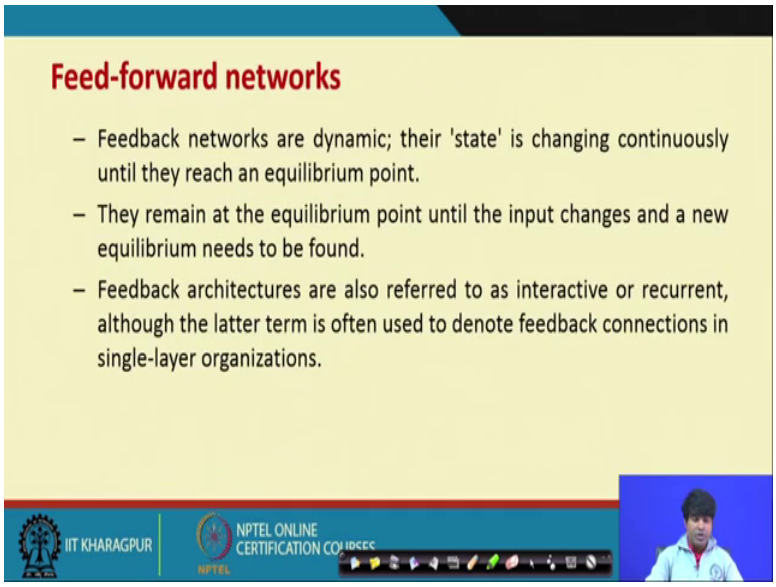

And in the you know feed forward you know networks, so the we have a kind of you know flexibility, we can change every times the kind of you know the kind of you know structure which is actually a you know one of the you know backbone for the neural network forecastings. And that is how training stage is very important because we have to train properly, so we have lots of flexibility different ways you have to you know train.

So, that you know this will give you a perfect path for which we can do the similar kind of you know forecasting ok.

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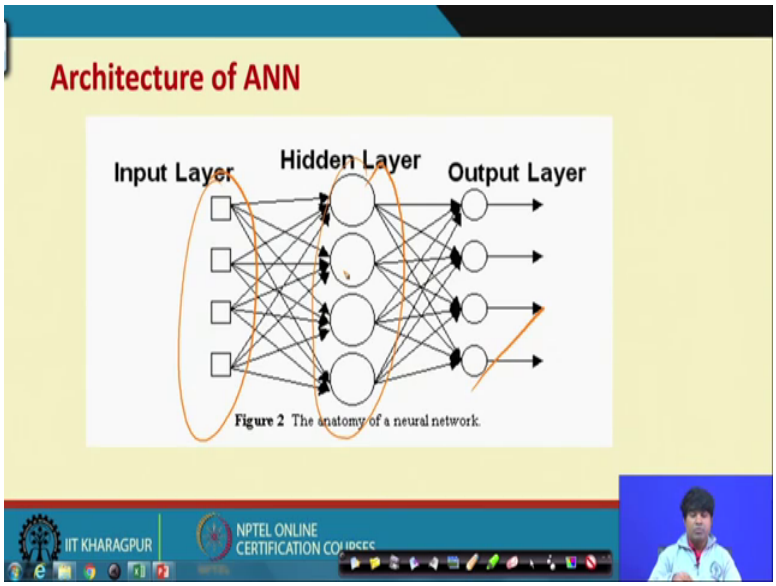

So, the neural network architecture usually like this. We have actually three different structure altogether input layers hidden layers and output layers. So, the interesting part of this particular you know neural network is the hidden layer, so which is not actually a manually visible, but what is actually visible in our structure is the input layer and the output layer. And in the input layers, so a in the in the process through which you can actually develop a structure, all these inputs can be linearly combined and you know then that that particular combination will be help you to predict the kind of you know output layer.

So, in this case you know we have actually multiple output layer, but usually we can go within a single output layer, but here we have actually series of you know input layers. And these are the typical structures through which actually you will do similar kind of you know forecasting. We have actually a component called as you know factor analysis.

In neural network structure is a similar kind of you know factor analysis structure through which you know the input transfer into a particular you know factor combination and that factor combination will help you to do the kind of you know output predictions. But how these inputs are you know connected with a particular you know hidden layer that is the factor through which the a output can be predicted that is very interesting in the neural network.

So, that means, the you know hidden layer whatever you know layers are there these are you know weighted combination of the input layers. So, now, the a you may getting the weights to these hidden layers is a kind of you know interesting a kind of you know things in the neural network structure. So, once you develop the particular you know structure so by default so the neural network forecasting will be very effective as per the particular you know requirement right.

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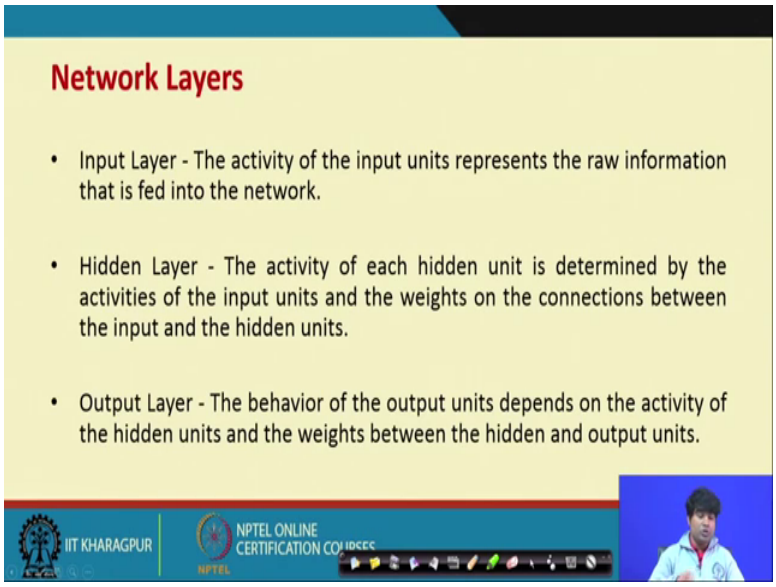

So, corresponding to this particular you know you know the structure of neural network so let us see how we can actually process through which you can you know you know do the forecasting. So, what have I mentioned, so there are three layers input layers hidden layers and output layers.

So, this is the first hand output and this is the process through which you can connect these input you know layers. And then finally, that will be connected to the output layer which is our actually core requirement for this prediction and you know the kind of you know management requirement.

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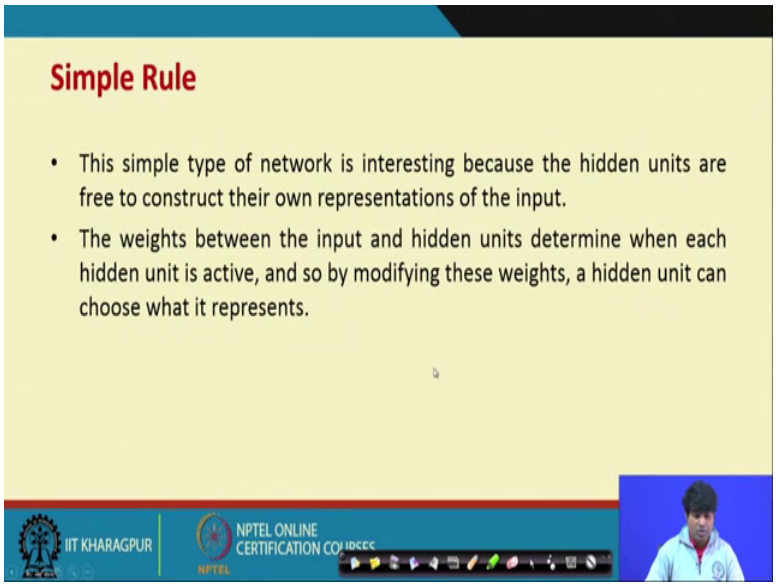

The simple the simple rule is actually how you have to actually you know how many hidden you know layers you can create and what are the weights you have to actually you know assign to these you know inputs. So, the training stage is that is why very important actually. So, because these weights can change as per the particular you know structure.

So, like you know previous you know the cases like you know moving average models, auto regression models, we have a plenty of you know flexibility before you fix a particular you know model for the forecasting. So, neural network also having more such flexibility because it will be continuously changing as per the particular you know structure you have to you know manually develop and through which actually it will finally, give you a perfect structure through which you can do the output forecasting.

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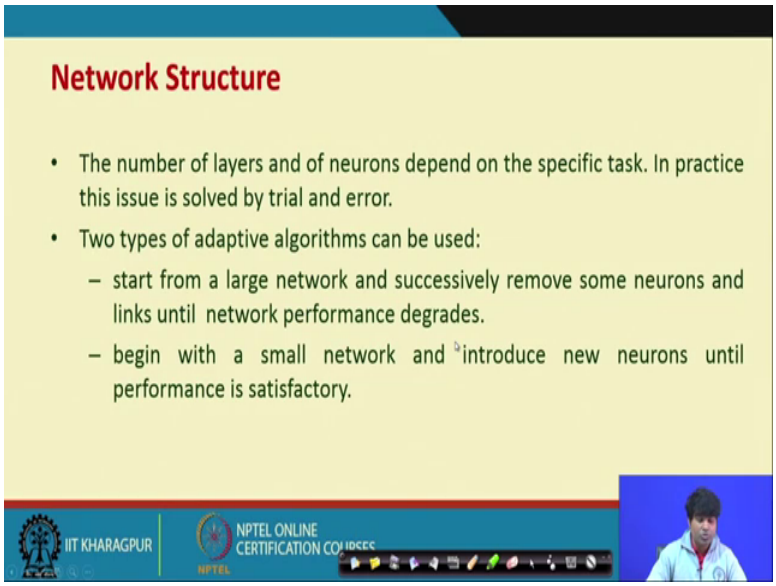

So, that is how you know it is a kind of you know challenging, and the most important challenge is you have to actually develop all these you know hidden layers and the kind of you know connections that to various weights to be assigned to these inputs before you go for the kind of you know output predictions.

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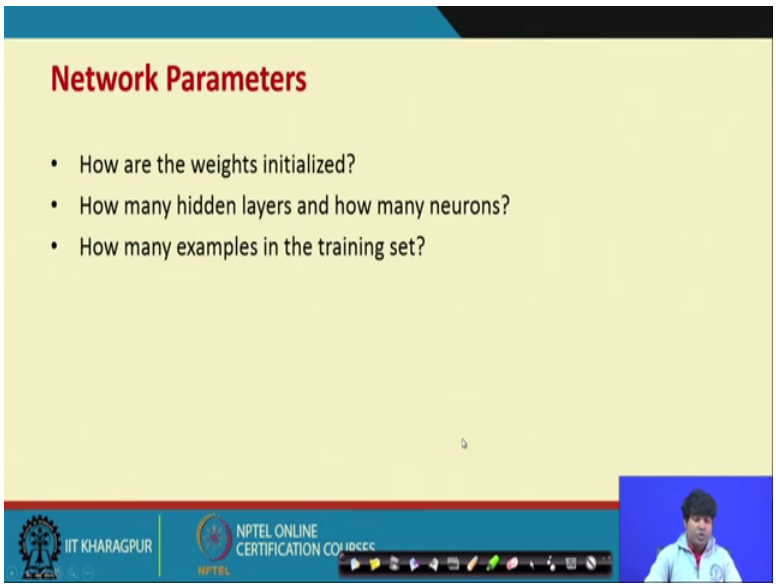

And. So, what is important in the neural network is the parameters. So, first one the first issue is a how to fix these you know weights, and how many hidden layers and how many neurons, and finally, how many examples in the training set. So, that means, what I

have to mentioned earlier that we have actually the entire data can be divided into two parts something for you know training and something you know for testing. And how what should be the kind of you know proper combinations or you know breakups, so that is very important.

And again so what is the particular you know weights structure and the kind of you know hidden layer structures and the kind of you know neurons. So, these are actually important challenge you know important challenges in the kind of you know neural network architecture. So, once you are familiar with all these things and the kind of you know changes, so then you are in a position to pick up a particular models and develop a particular models so that the forecasting will be very effective and very efficient as per the management requirement.

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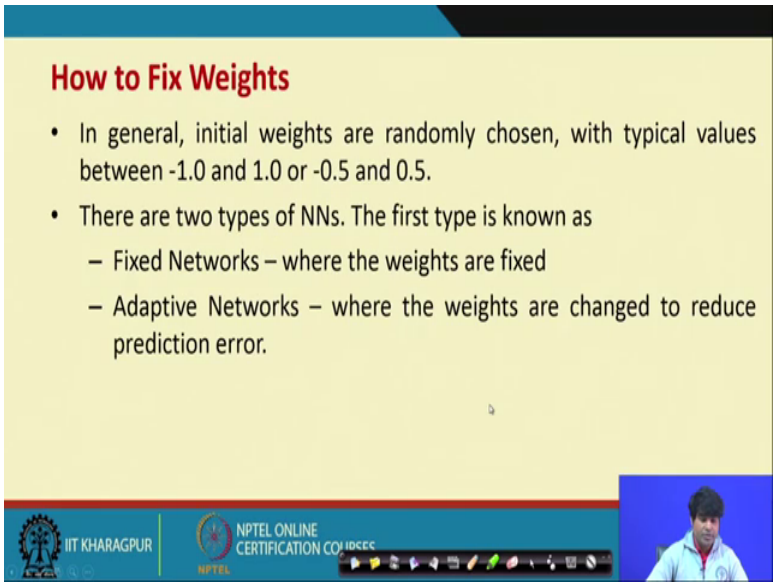

And so obviously, they there are standard you know thumb rules or you know general rules how you have to fix up all these things. Once you start you know processing so then automatically it is a kind of you continuous stress structure or you know iterative structure through which actually every time you have to learn and develop, develop, develop and finally, you have to actually fix as per the particular you know requirement and as per the best rights.

So, it is a kind of you know flexible structure through which every times we can change till you get the best results or the best requirement for these kind of you know forecasting.

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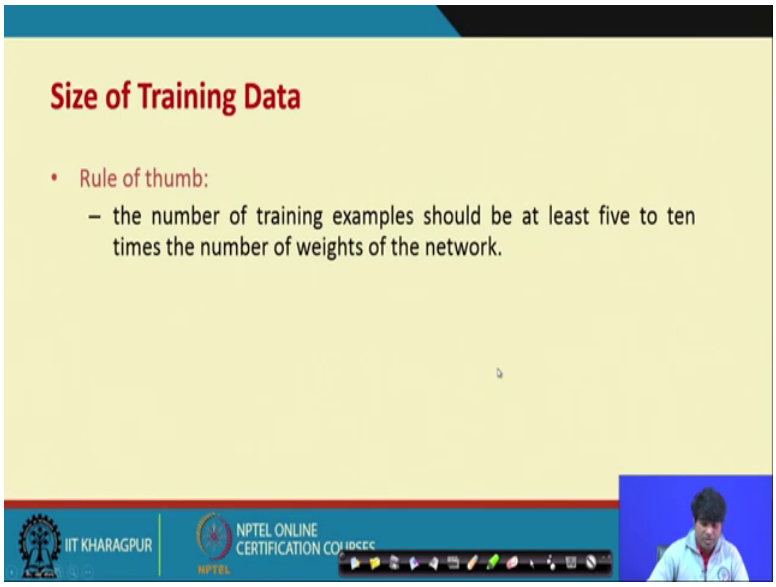

And the rule of thumb says that you know at least five to ten times the number of weights or the networks should be fixed during the training times.

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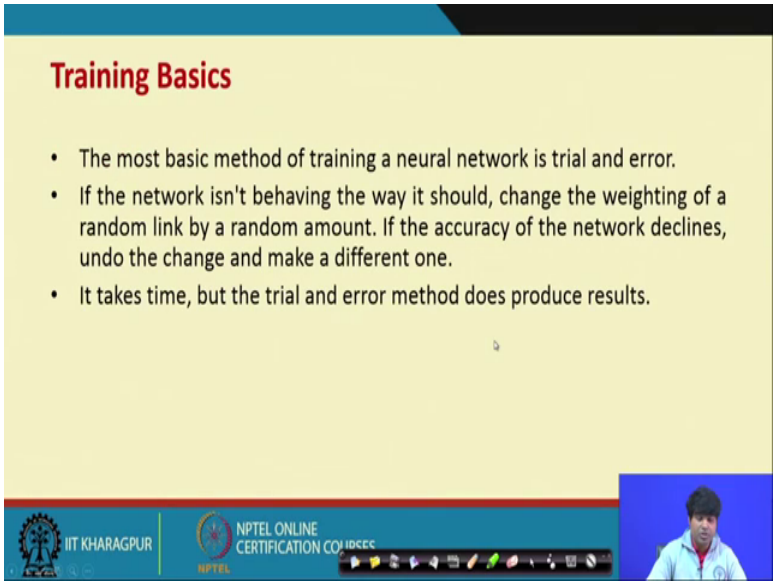

And the break up should be what I mentioned actually you must have a kind of you know structure through which you know you have enough data through which you can do the

you know testing so that you know the prediction can be accurate as per the particular you know requirement.

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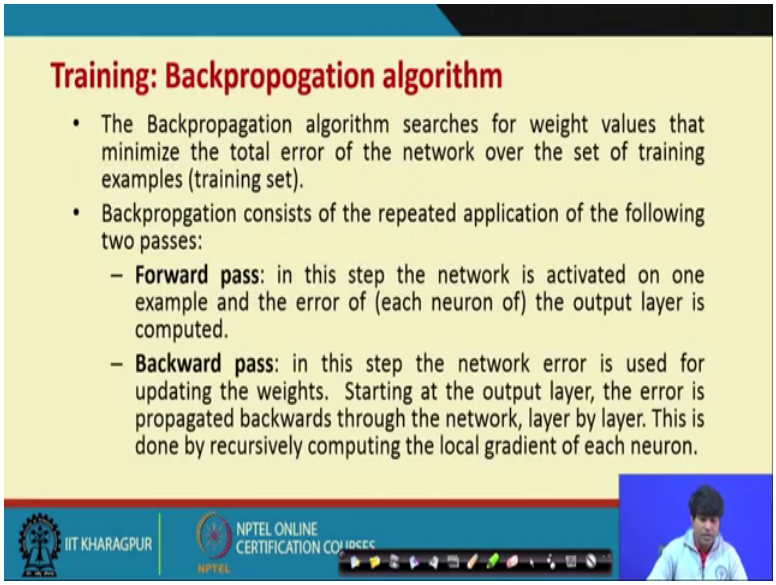

And so in the training so the structure which like to develop is called as you know back propagation you know algorithm and it has actually forward structure and backward structure. And then you can actually connect accordingly the input layer and the hidden layer through which you can you know do the kind of you know output forecasting.

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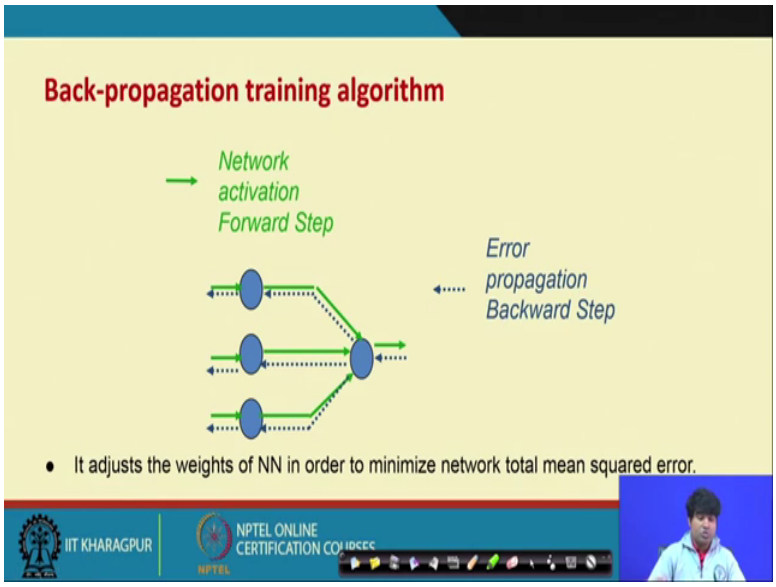

So, the particular you know structure is like this. So, in this case you see here. So, the green one it is kind of you know forward structuring and the kind of you know the blue is the kind of you know backward structuring. That means, it is a kind of you know iterative process through which actually you can continuously work and develop that is in the training stage before you fix a particular models or the particular structure through which you will do the best predictions as per the particular you know requirement.

So, again the same actually the indicators you know error indicators we like to use every times that is actually mean square errors and then you have to see the you know declare that the model is best fit for the requirement. So, accordingly so the kind of you know structure is a to how to proceed actually and how to develop the particular you know requirement that is very interesting in the neural network structure.

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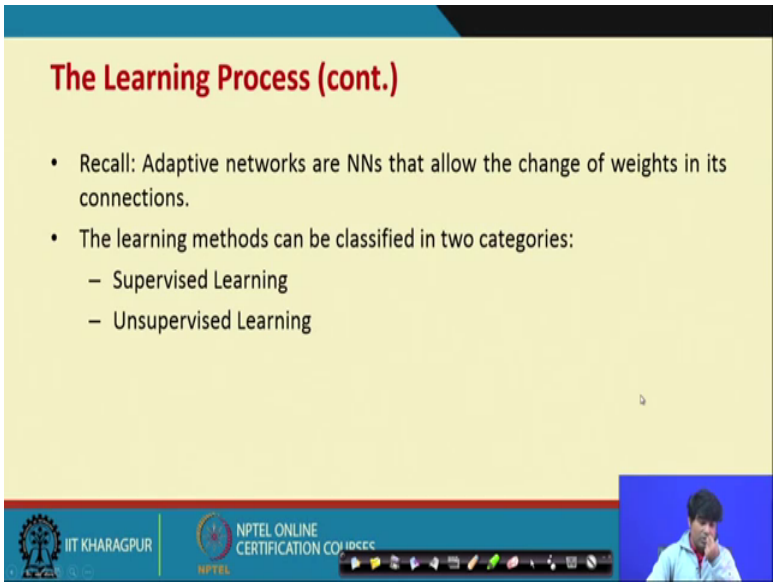

And in fact, in the in the learning stage or you know training stage, so we usually follow two different kind of you know structure one is called as a supervised learning and unsupervised learning. So, that means, actually like you know what I mentioned like you know factor analysis we have explanatory factor analysis, and complementary factor analysis, here also similar kind of you know structure called as you know supervised learning and unsupervised learning.

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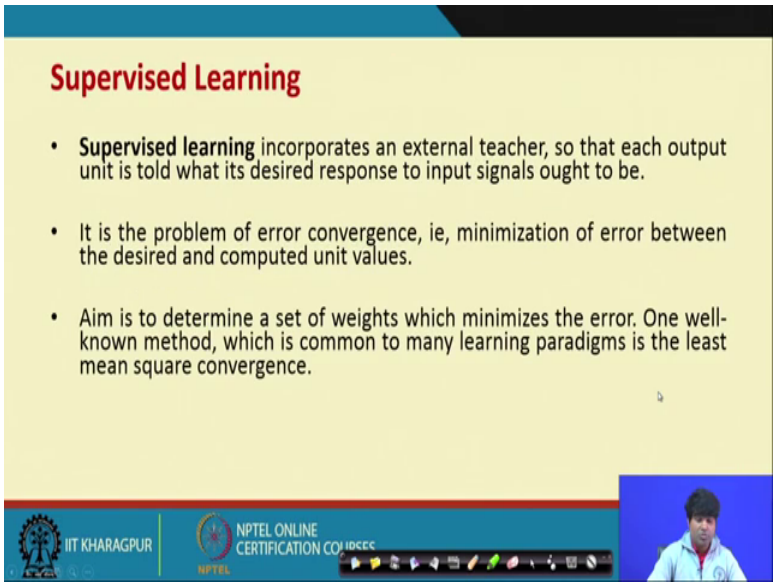

But in the supervised learning so we have to give proper kind of you know commands and you know structure through which you have to develop the particular you know linkage the kind of you know layers through which you can you will do the you know output forecasting.

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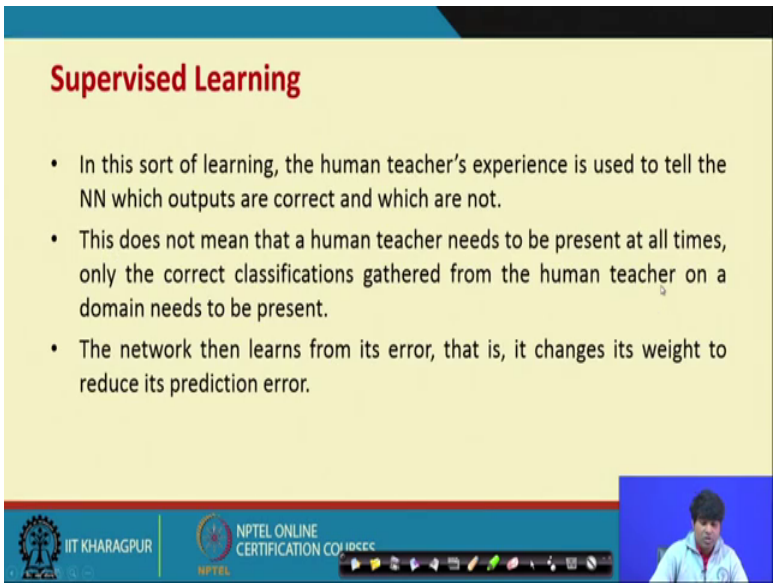

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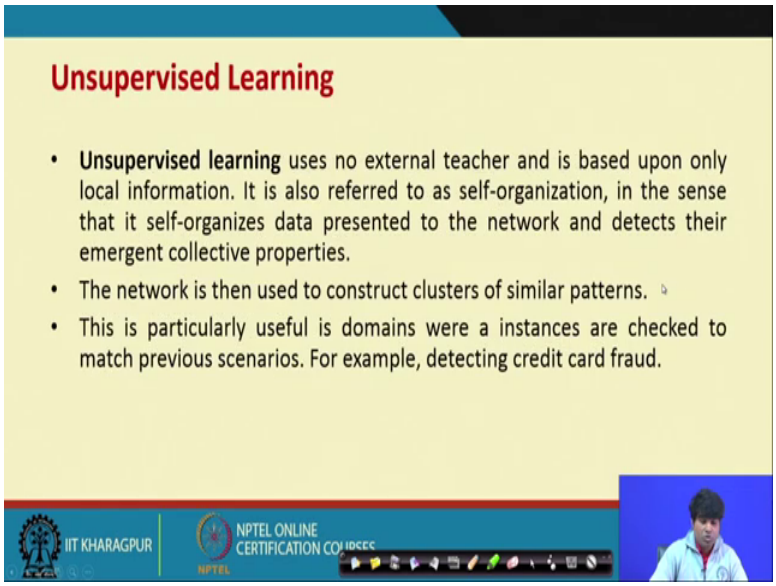

But in the kind of you know unsupervised learning it is not actually the kind of you know structure like you know supervised where you know no proper guidance is required. So, you know it depends exclusively on a self actualisation process through which is actually to develop a particular structure through which that is in the kind of training stage to get the particular you know you know models through which you can do the kind of you know forecasting.

So, it is depends upon you know particular you know you know structure through which whether you go for you know supervised or you know unsupervised. But ultimately we need actually particular you know structure or you know best structure through which you will do the kind of you know forecasting.

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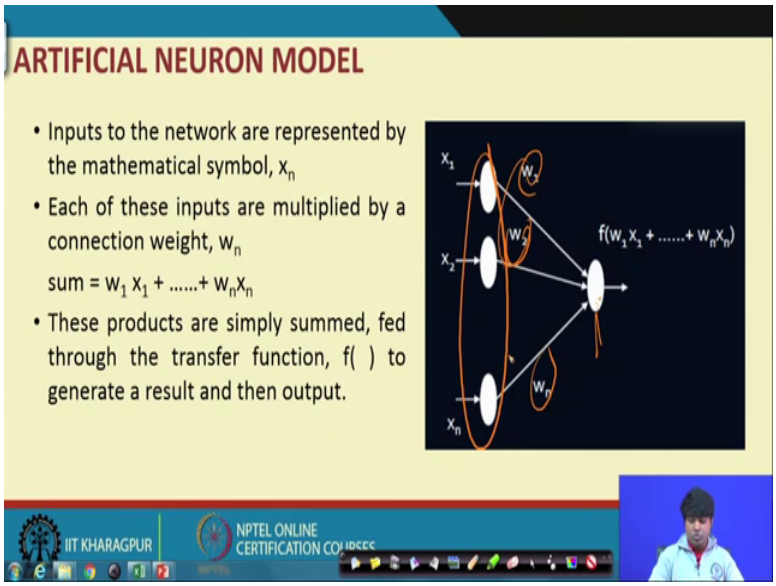

The usual structure of you know neural network is like this, you see here. And what I have mentioned. So, we actually input combinations and these are all you know layers hidden layers, so that is actually kind of you know you can have more number of layers like this and all inputs are you know connected with a particular layer with different weights.

And the assign of a weight or you know change of weights for a particular layer is a very interesting. So, how these inputs are combined with you know layers hidden layers and that too you know many layers, and these layers finally, will be connected with the output of kind of you know.

So, it is a kind of you know weighted kind of you know linear combination of all these inputs to develop some factors or layers through which you can actually predict the output. This is actually you know very simple structure through which you can do the kind of you know prediction means you know similar like you know what I mentioned kind of you know factor analysis through which you will do the kind of you know forecasting. So, the challenge is actually the weights and the number of you know which you have developed for you know the at the particular you know training stage.

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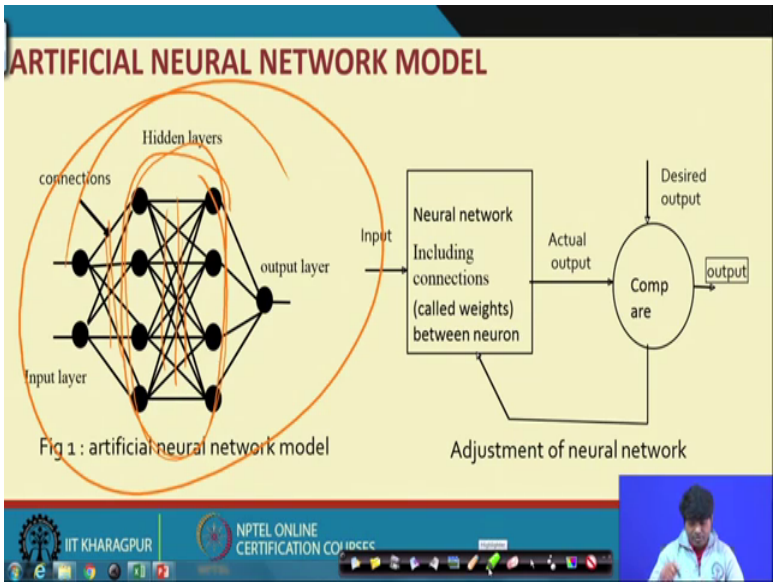

So, accordingly the particular you know structure will be like this. And because it it gives you know with respect to a single layers and that is how the inputs a connected with a particular you know weight structure. And these weights can be changed when you will change the particular you know you know setups. And the final look will be like this. So, this the kind of you know complete neural network structure where we have actually plenty of you know inputs and different layers. So, we develop one particular structure, but it can have a multi layers and through which output can be connected. So, the this is what the actually challenging part.

And these are all connected with you know different weights altogether ok. So, once you know develop the layers and the kind of you know weights and that will give you the kind of you know output layers through which you will do the you know forecasting. So, initial inputs then the kind of you know hidden layers we have to create for the you know output forecastings, so that is the most important challenge or most important you know task in the artificial neural network model.

And the weight adjustment and the kind of you know number of layers for the output is actually a very important a particularly at the training kind of you know situations. Once it will be trained properly and fix the particular structure, then the prediction will be very perfect. Otherwise it will be you know will be kind of you know you know complicated structure or you know they may be you know not good for the kind of you know best

prediction or you know best requirement. It is a similar kind of you know time series model, but the thing is you know we just you know the challenge part is you know fix how what is the kind of you know weight structure, what is the kind of you know linear combination or what is the kind of you know hidden layers through which you will do the kind of you know forecastings.

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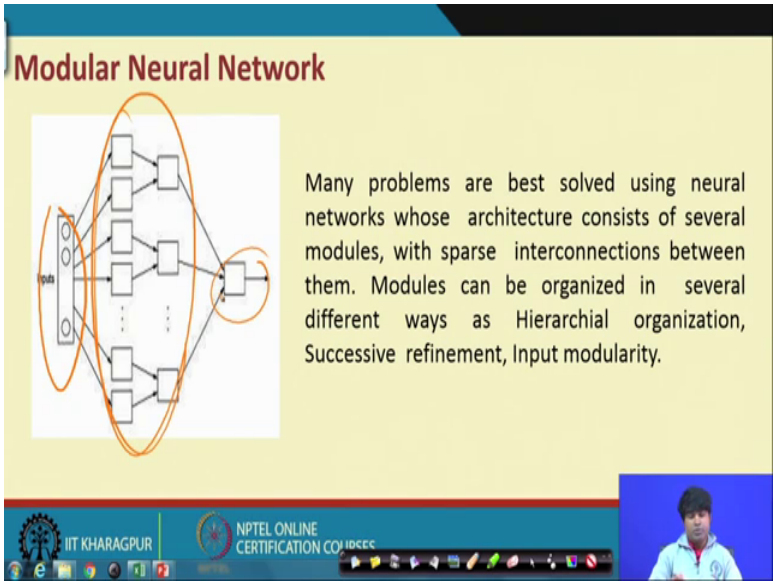

So, likewise we can actually you know proceed for this particular you know structure. This is another you know visualisation process through which you know because here the structure is actually starts with you know input layers. And these are all actually various hidden layers and connected with a simple structure. And then finally, output will be connected.

It is as usual actually you know you know structure of you know neural network through which you will do the output forecastings that means, it is typically the game between input to output. And how these inputs are you know connected you know through their you know particular structure to predict the a you know business output.

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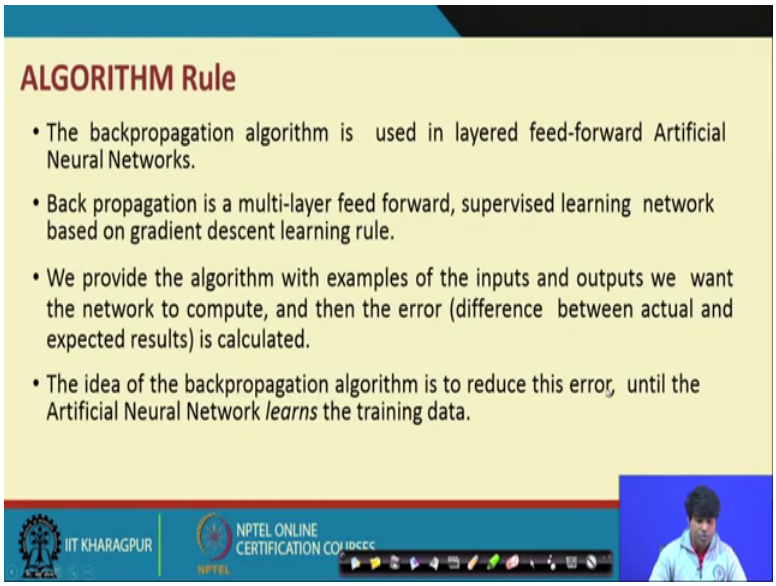

Accordingly a so what I will do I will give you some of the issues here you know various issues through which you know what I have already mentioned. So, you know the algorithm we usually follow the back propagation algorithm that you know multi-layer feed forward you know and supervised learning through which actually to develop the models or you know the kind of you know structure through which you will do the a forecasting.

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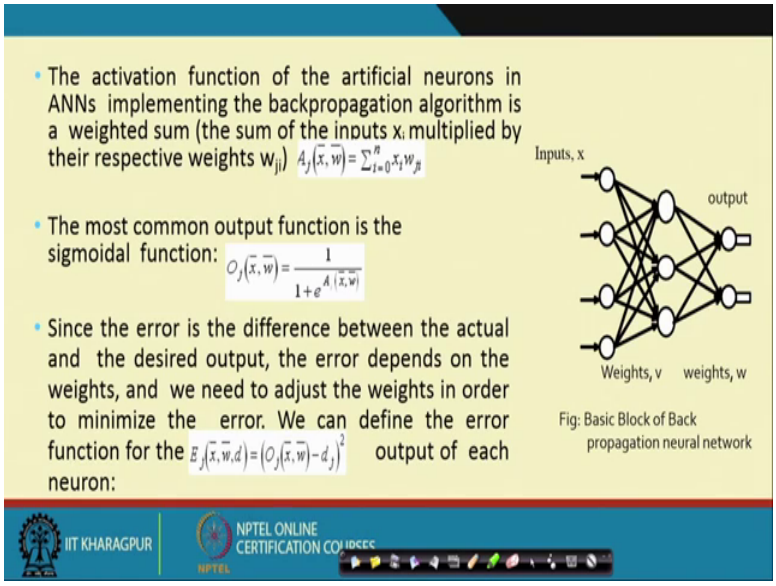

Every time we have to check the error and you know the model final model will be based on the kind of you know minimum of all these error indicators root mean squared error, mean squared errors. And the particular you know structure of neural network actually it is followed by a function called as you know sigmoid functions. And the mathematics behind this particular you know structure is like this.

And these are all you know various mathematics through which you can means whatever we have actually architecture here it is not actually just causally developed , but is you know mechanism mathematical mechanism through which it is connected and like you know every models we have a kind of you know functional forum.

So, in the neural networks with the typical functional for neural is actually sigmoid and that is that is what actually the kind of you know sigmoid function is all about. And this through which you know the weights and the kind of you know structure developed through which you can do the output forecasting.

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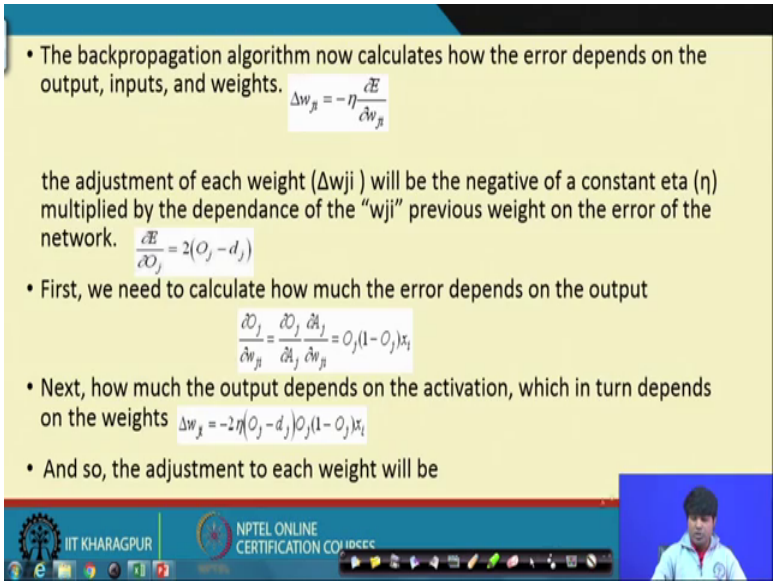

And with this actually I what I can do these are all you know corresponding mathematics behind this neural network model.

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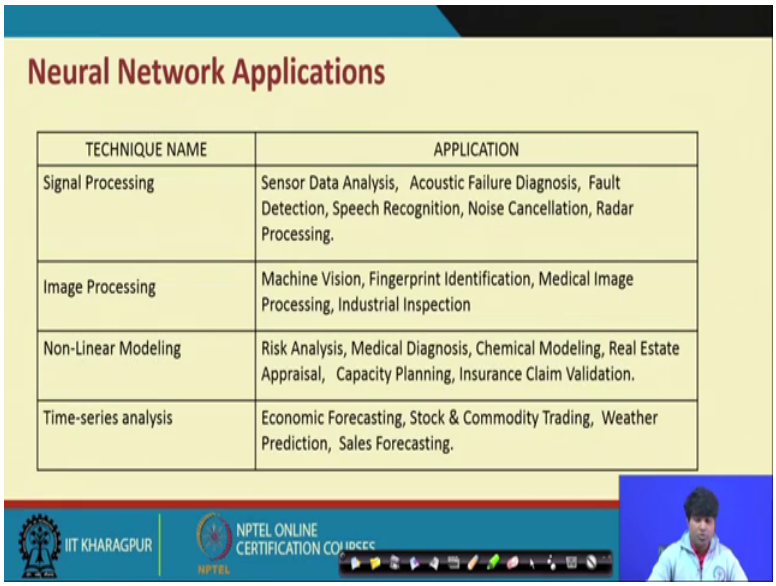

And accordingly a we can proceed. And these are the various neural networks you know applications signal processing, image processing, and non-linear modelling, time series structure and the application wise. So, we can have actually couple of areas through which apply this particular models starting with you know operation you know environment or financial environment, marketing environment supply chain environment, medical environment. So, a you know it is a very interesting kind of you know technique through which you can apply a you know.

But the most important requirement is you know you should have a series of input combination and the kind of you know theoretical structure or understanding through which the input and output can be connected. And the most important challenge is the kind of you know the weight assigned and the kind of you know the kind of you know hidden layer or kind of you know structures. So, neural network will give you the particular you know signal through which the inputs can be connected to the particular you know the output or particular you know requirement.

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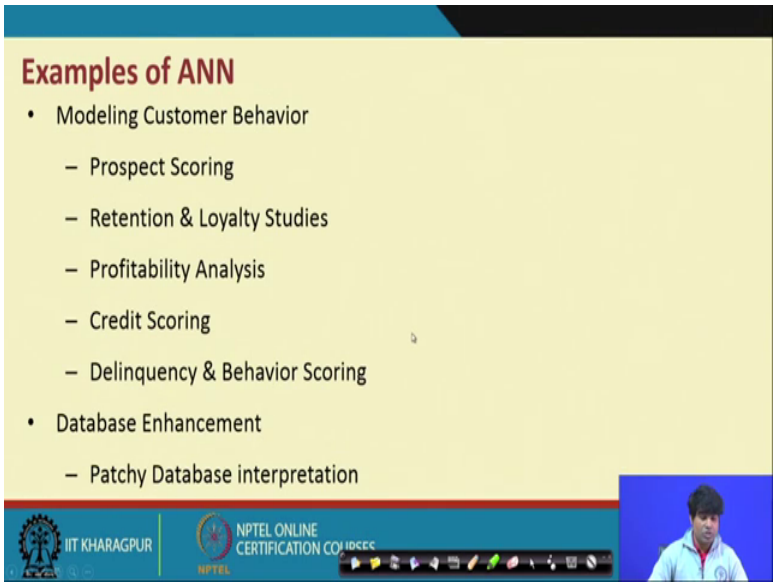

So, these are the various examples of you know neural network modelling and you know we have actually plenty of you know you know case studies through which you can do the apply this particular technique and do the forecasting as per the management requirement.

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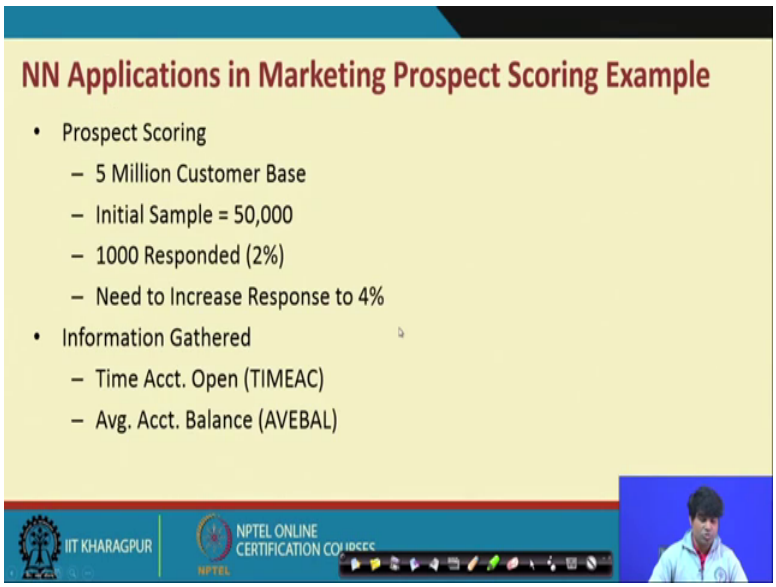

So, to you know highlight this particular problem. So, I will take a particular you know you know case and then I will discuss how these neural network actually working.

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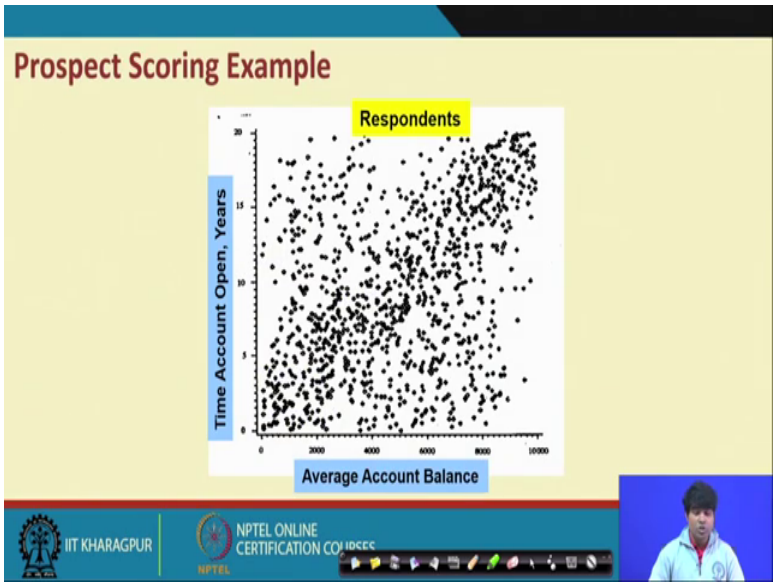

So, usually you know these are all these are all you know firsthand inputs and squaring examples it is with respect to average account balance and time account opening with respect to years.

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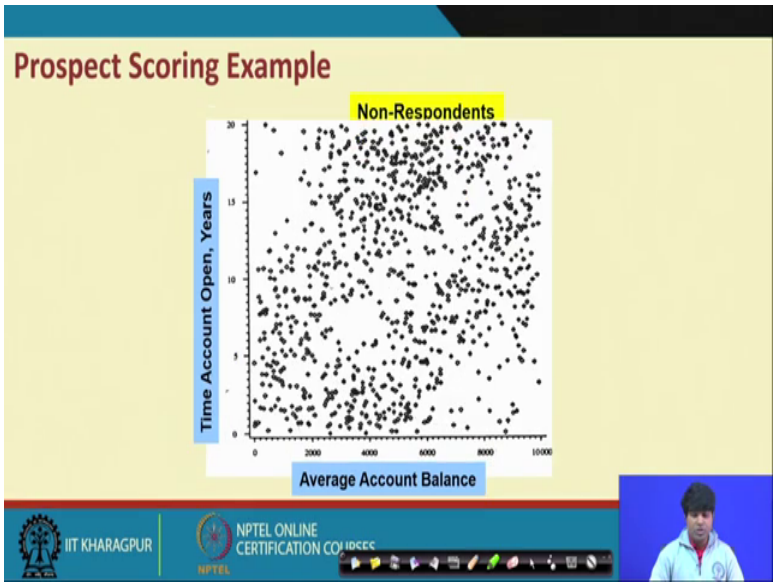

And then these are all non-respondents that means, two different classification all together, so all the respondents and non-respondents.

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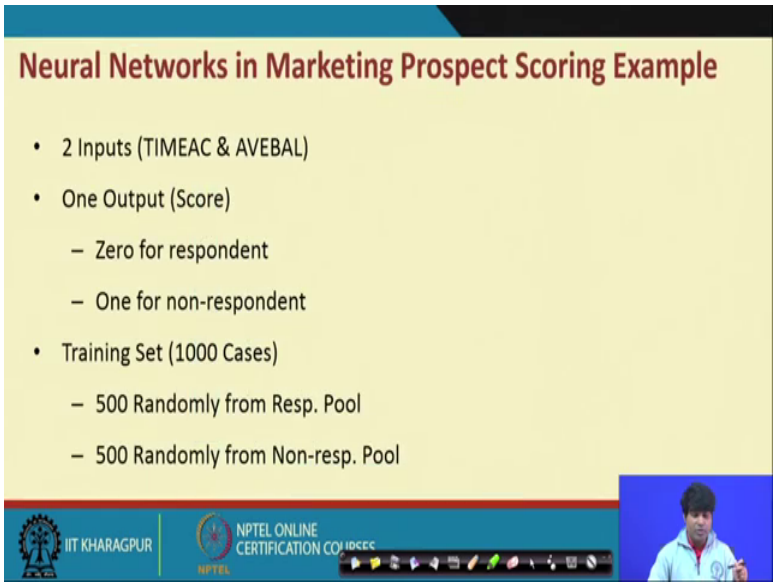

And then finally with the process so we can have here two inputs and one output that is the score. And the training set is a 1000 cases and 500 randomly a for you know the kind of you know response pool and 500 for non-response pool.

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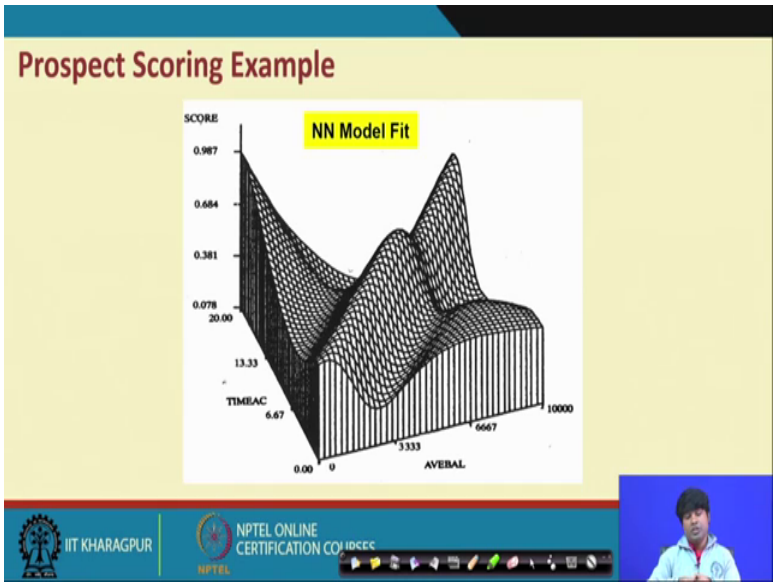

And finally, with the help of you know training and the kind of you structuring the entire structure will be developed a model like this. So, this is actually a interesting model which can be actually developed through these data and that too through neural network you know structure. So, that means, you just you know see here how the firsthand look

and then how it actually transport to a particular you know setup and that is how the neural network challenge, and that is how the neural network you know technique all about.

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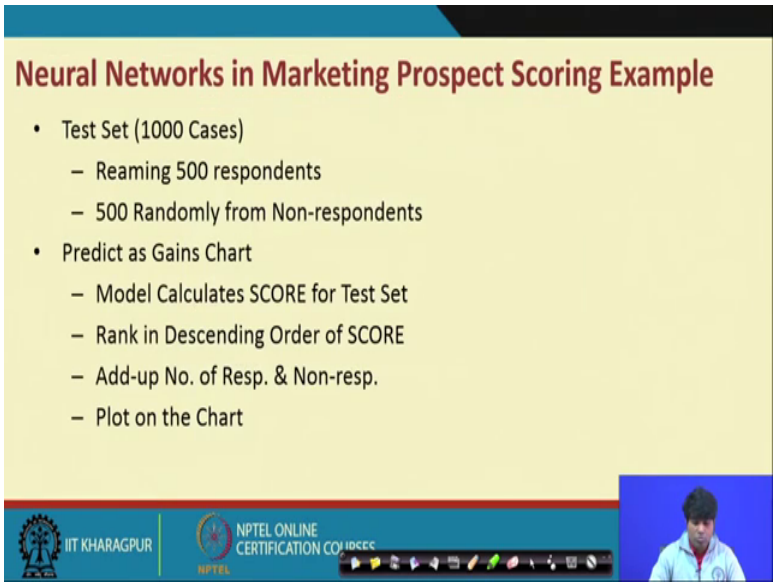

So, now, in order to you know respond more details, so what I will do I will take a particular problem and then I will connect with a you know describe how it will work in a real life scenario.

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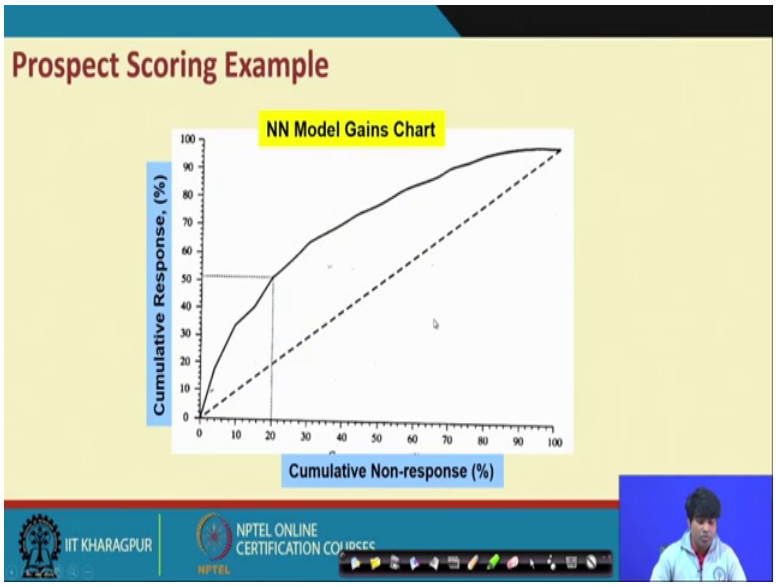

So, this is actually similar kind of you know structure and every times we have the actual information and the kind of you know predicted information. And then once the model is developed, then the developed model will give you the forecasted figures. So, we have actually information and the forecasted information. And by default you will get the error component and that error component need to be evaluated and validated before you go for the final prediction and find out for forecasting.

It is actually a in the forecasting structure the you know final structure will be always in the wishes of you know validation. And the these are all same whether it is a simple you know forecasting structures or you know through artificial neural network, but almost all a rule is same. Before you do the prediction, you should have actually similar kind of you know framework through which you develop the particular you know process.

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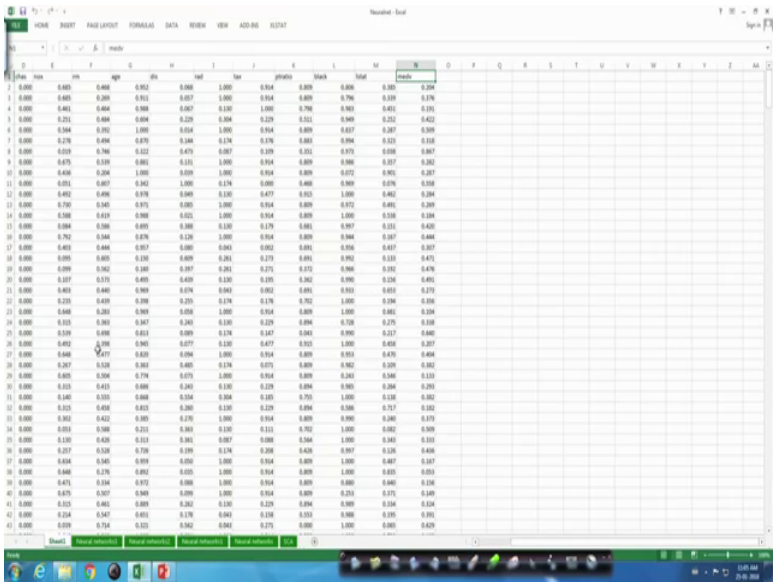

So, let us you know you know go with your particular examples and I will take you to this particular you know spreadsheet. And see here. So, this is actually a kind of you know big problem. So, we have you know you know more number of you know variables. And starting with you know we have around you know couple of independent variables; And these independent variables starting from this time through this much. And then this is the median value and this median value need to be actually forecasted. So, that means, this is the output variable and that need to be forecasted.

We have actually plenty of data and that is one of the requirement you know biggest requirement of the neural network. So, that means, actually the entire data what I have you know done here, so I have classified into two parts and this is what actually the it test for testing. And it is starts with you know 383 data points; that means, technically. So, 381 data points we have actually kept for training in this problem. And that too oh predict this output median value and subject to with respect to all these independent variables.

So, now, what we will do, so this will be our dependent variable and that will be connected with a all these inputs, these are all you know inputs. And then so we develop a particular you know model artificial neural network model so that will give you the better forecasting about this you know dependent variable. And then finally, once the model will be developed and that will be connected with you know testing data and this will be a same data is actually reserved for you know testing. So, once will it you know connect with you know all these you know testing data, then it will give you the model accuracy.

So, that means technically so this is the prediction of this dependent variables subject to these independent variables. And for these independent variables, some data you know we use that is around 80 percent of the data we are using for the training and to develop the particular you know structure. And whatever structure we develop that need to be tested. And for that we have actually kept some reserved data. And then finally, we will check whether the particular neural network is fit for this you know dependent variable prediction.

So, what will what we do. So, we can have actually n number of software through which you will do this neural networks. So, R is the best softwares and you can also do the through MATLAB. And it is also available in start you know s b s s. And what I am doing here, so I will I will solve this problem with the excel start and to run this neural networking excel start, so r package must be installed. And then accordingly so you just go to this you know neural network structure. So, here is if you click here so there is a particular you know framework.

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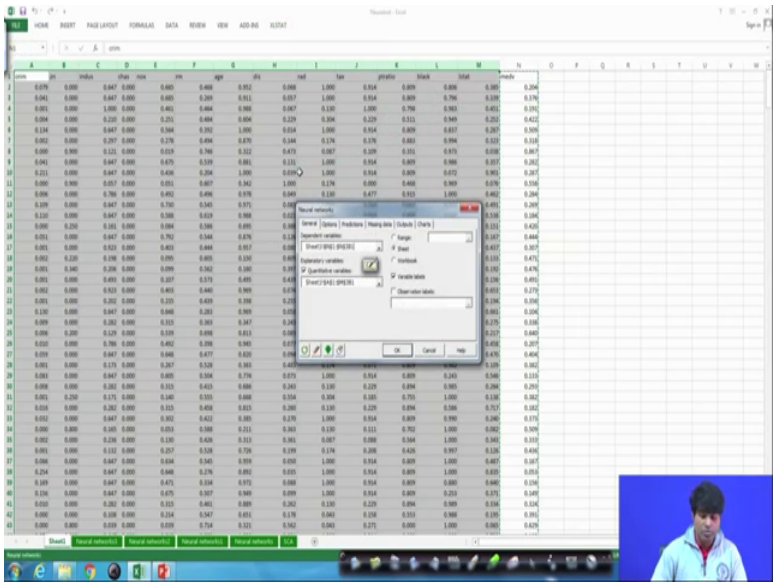

So, the excel you know soft softwares so the neural net you know item is there just you click there click this particular you know neural network framework. So, the output you know the particular input box will be coming like and then what it will do. So, we have already connected. So, the firsthand requirement is the dependent variable. So, this is the dependent variable which is connected with the a which is connected with this particular you know requirement that is the median value.

And then we have actually here the independent variable. So, this is actually the dependent variable, and then it is connected with all these independent variables. And these independent variables are recognised here. And so this is the indication about the dependent variable from median value starting with you know unit you know unit one, and then it will continue with a 381 data points. Then independent variables starting with you know you know a column to m column so that is how 1 a to m thirty eighty ones. Then what will go for you know check the options.

And here the interesting part is actually neurons for layers. So, we put actually here 5 and 3 that can be actually changed. So, you can put 4, 3 then; obviously, you can you know get the particular neurons and threshold value we put actually 0.01. And maximum step of this you have to repetitions you put a one. And what we have done here actually so once you put the neurons then the a particular you know functions you have to indicate and finally, you go to the output and these are the output requirement you can as

per your requirement. But we need actually residuals that is through which you have to check the particular you know structure. And after knowing all these things so you just you know put ok, so then continue and by default so the particular you now structure will be you know yes.

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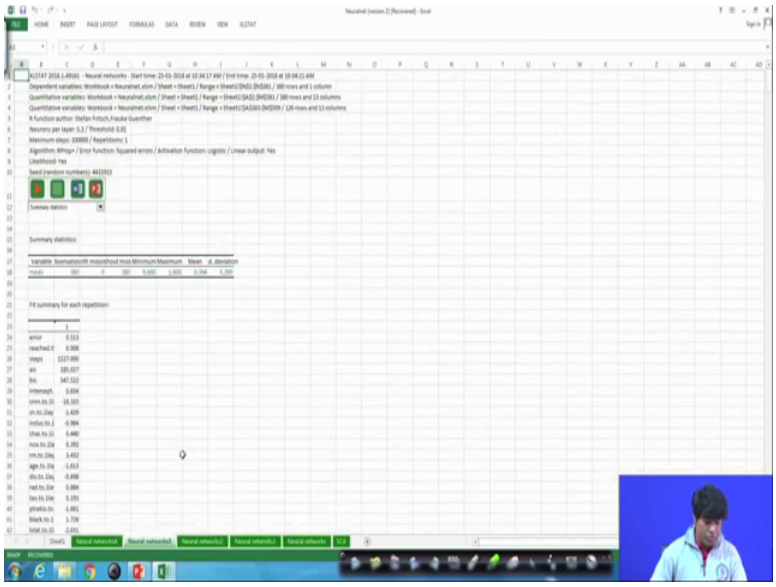

So, this is what the a particular you know output and then so the output structure will be output structure will be coming like this. And this is what the neural network output. And this is what the error component. And these are the following steps which you have actually have in this particular you know process.

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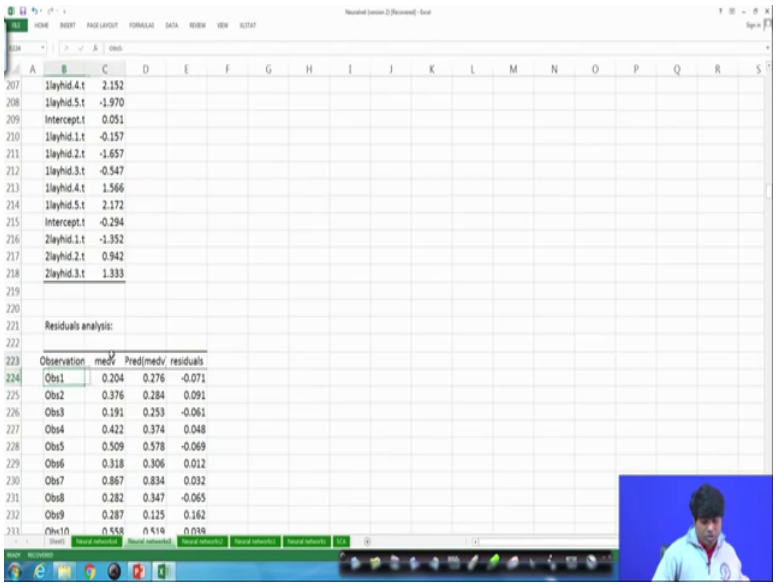

So, now the entire output will be a developed like this. So, these are all you know observations and this is what the a median value a actual, and this is what the you know predicted. And finally, the median value and the predicted value will get the residuals. So, this is what actually the kind of you know requirement and this is what the residuals output and this is what actually we have done in the kind of you know time series forecasting.

So, the actual observations and the kind of you know this is actual observation and the predicted observation. And then finally, the residuals so that means, the particular model which you have actually observed through neural network.

And then the actual of the observation of the dependent variable and the predicted observation of this you know dependent variable will give you the residuals. Then finally so this is actually available for you know all the data points. And whatever we have actually a kept for you know trending and the kind of you know testing, then finally, all these data points we have actually figures so that means technically we have 603, you know observations and through which you know these are actually error component, these are all predicted figures. And these are all you know actual figures.

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Then the residuals will be you know looking like this. And this is game between the actual structures and the kind of you know predicted structure and through which actually you do the kind of you know predictions.

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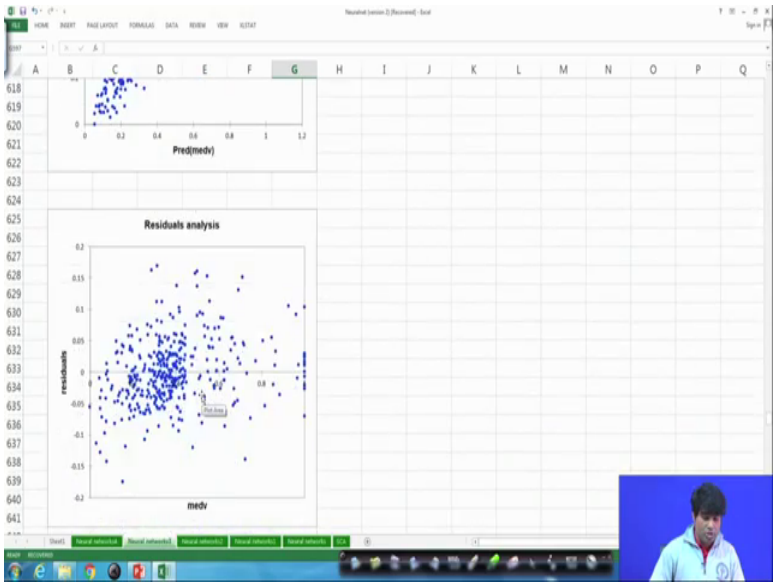

And so the you know it is a more you know you know elaborative where the you know residuals or you know plotting here and; that means, it gives you the kind of you now standard structure. So; that means, as usual actually when we have a kind of you know

predicted structure with respect to the actual. So, some of the error point will be above and some of the error point will be below.

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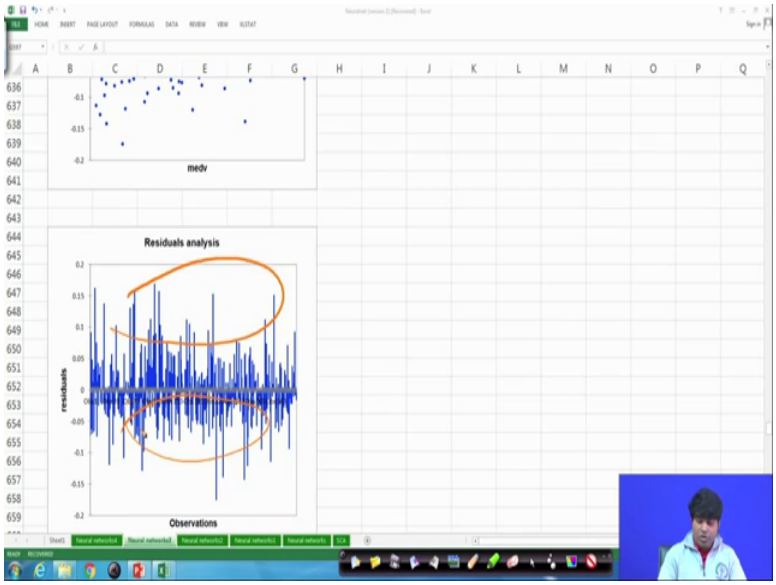

So, this figure by default is actually giving the kind of you know signal about this you see here. So, these are all actually above to this particular you know predicted line and this is what the kind of you know below the kind of you know predicted line. So, that means, the particular you know structure neural network structure for this prediction is very kind of you know effective. And let us see how is the kind of you know network structure through which actually we have developed this model.

So, if you go down then you can get to know the kind of you know structure see here is. And this is what actually prediction for a new data set because your the actual actually the actual structure in this kind of you know prediction is you have historical data that too kind the of you know actual informations. And what we have done actually on the basis of actual information, we keep you know 80 percent of data for you know developing the model and for you know training the kind of you neural network structure and then remaining points we have kept for testing.

And once it is final the models then we extend this particular you know future requirement. So, this is what the future requirement and this is beyond the particular you know data points. So, it will be start with you know up to 603 that is the actual data availability.

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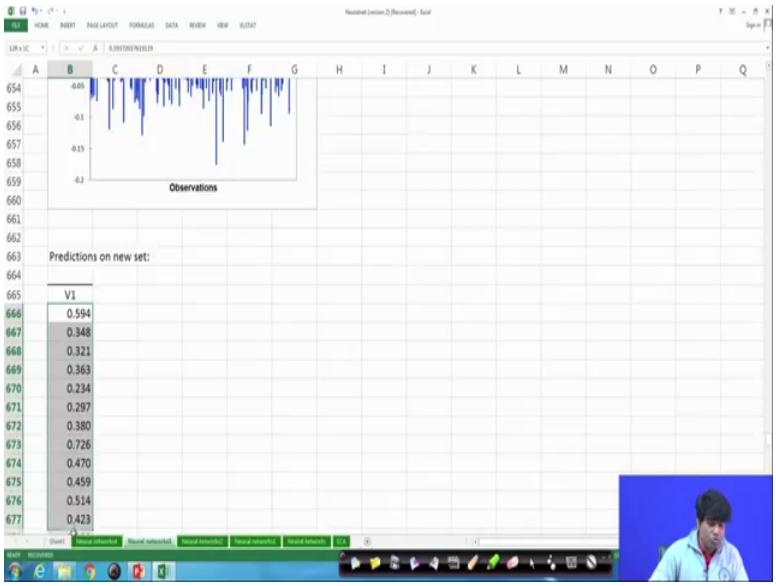

And now it would be the predicted figures would be forecasted accordingly. So, here for next you know requirement as per the particular. So, it will be you know giving you the kind of you know forecasted output.

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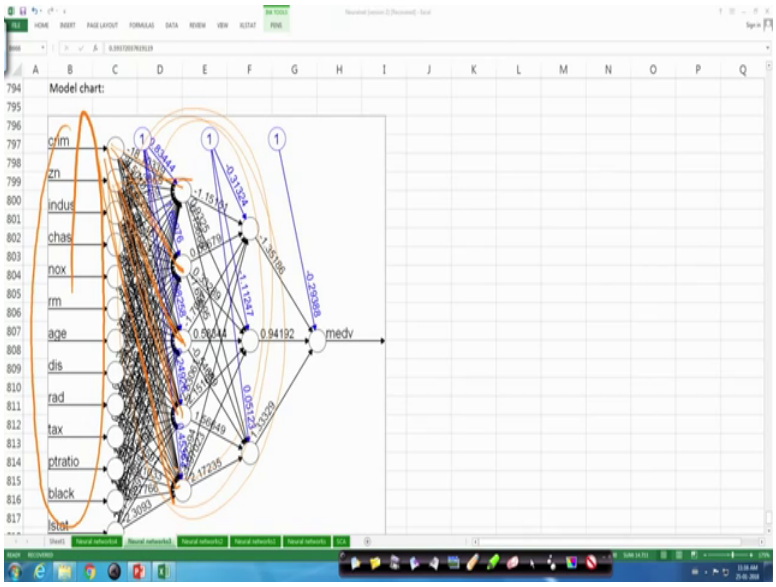

So, you see here. The software has given you now the particular you know neural network architecture. And this is what actually the input combinations. So, we have already we have already taken actually number of you know inputs and these are all inputs which you have connected. Of course, we have actually given the kind of you

know structure about the training and testing so that is the part of the game of the neural network. But ultimately the entire model depends upon the architecture of you know inputs and the kind of you know hidden structure and through which the output will be predicted.

So, what I have already mentioned you know you see similar kind of you know factor analysis framework through which you start with you know input combinations. Then you know develop some kind of you know factors or layers through which these layers can be interconnected. And then finally, allowed to the kind of you know output to the actually predicted right. So, this is actually this is how the interesting part of this neural network architecture.

And the idea is actually here see here. So, this is what the interesting part. So, this is input and these are all actually the kind of you know the kind of you know you know structure hidden structures or you know layers or the kind of you know neurons through which we connect and then finally, the output. So, you see here. So, these inputs are you know how they are you know connected. So, the particular input with the connected with every layers like this ok.

Similarly, the second input can be connected with each layers like ok. So, this is actually you know mathematically or you know kind of you know structure, it will be a very interesting. So, it is very you know what we call as you know technically call as you know path structures ok. So, you we have a technique called as you know structural equation modelling, where you know we can develop the particular you know path then you connect and then that will help you to predict the output variable.

But the beauty of the neural network is you know it is actually the means the machine learning process is that you know it automatically you know just you know develop a kind of you know frame. And of course, you can change the kind of you know layers and the kind of you know weights and through which you can do the kind of you know predictions. So, that means, technically it is a very interesting through which you have to develop the particular you know structure through which output can be predicted with you know series of you know inputs.

What is the main structure of this you know forecasting is the to predict the output with you know more number of you know independent variables. It is actually done through

simple regression structures or simple kind of you know time series structure, but this is another kind of you know you know technique predictive analytic techniques that is the machine learning techniques through which you can do this similar kind of you know forecasting.

But interesting thing is that you know means if you if you look the a look into the particular you know problem. Here the problem objective is to predict the output with respect to series of you know inputs so that means, till now whatever techniques we have already discussed so starting with you know simple regression multiple regression and so many you know time series techniques and against we can you know discuss some other techniques, and every time the structure is like this you know we have to you know set with you know dependent variable with you know independent variable. So, dependent variable with one independent variable or dependent variable with a series of you know independent variable.

So, these techniques are you know can be you know what we can say that you know we have a two different kind of you know clusters, one particular clusters see you know directly you can connect with the particular you know structure. So, independent variable to dependent variable, and develop the model and then get the estimated model with the with the help of you know the data. And then you can go for the kind of you know prediction.

But in the second structures like you know this particular model neural network model where you know seems same you know structure we used to follow that too you know connect dependent variable with the independent variable. But the connection between a dependent variable and independent variables in between so there is a different kind of you know a kind of you know structuring and the kind of restructuring. Because it is a kind of you know continuous process through which you can develop the particular you know layers and that is how the inputs can be actually connected properly through which the output can be you know processed and the predicted.

It is like you know kind of you know input output analysis. The inputs you know connected with different you know departments through which you know that will be finally, coming within output them that need to be predicted.

So, that means, you know a neural network is a very interesting machine learning process through which a input can be connected properly to predict the output that is the simple you know kind of you know message through which we can get from the neural network structure. And that too for the predictive analytic structure and the that too for the kind of you know business requirement and the kind of you know management requirement.

So, obviously, so the kind of you know structure which you have already discussed here. So, the neural network so. So, like you know what I have last slides which you have already highlighted. So, this is the every times the game is to check the kind of you know actual structure and the kind of you know predicted structure and find out the error component. And that error component need to be evaluated again by the by the kind of inner indicators like mean squared error, root mean squared error and check whether the particular you know structure or the particular model is appropriate for the a future forecasting or you know future requirement.

So, once it is a and the model is validate then obviously, you can go for the prediction and the kind of you know forecasting.

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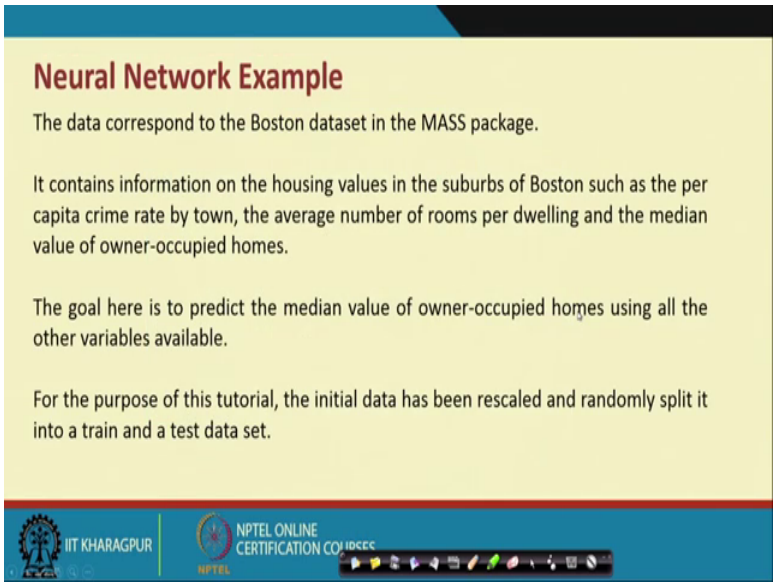

So, this is how the kind of you know structures.

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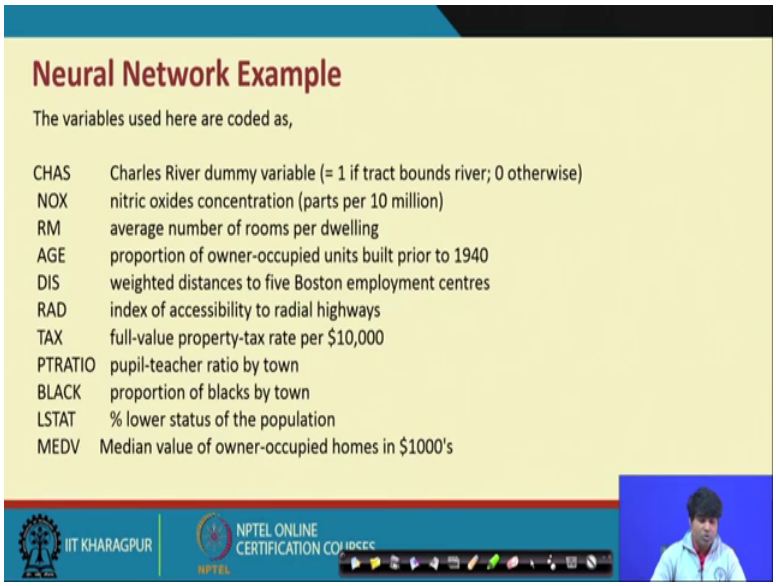

And likewise you we means what whatever examples which I have shown so these are all you know similarity. And this is how the actually the variable description through which you have actually shown these particular you know examples. So, the median value of you know owner occupied sums that is you know the actually real estate problems and so, the kind of you know structure is connected with you know more number of you know independent variables and that is how the results which you have obtained.

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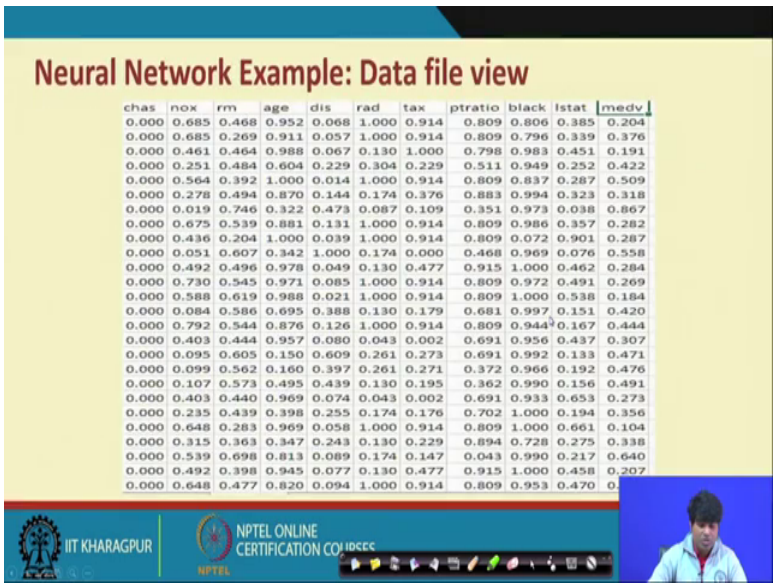

And these results this is how the input base which have already gone through it.

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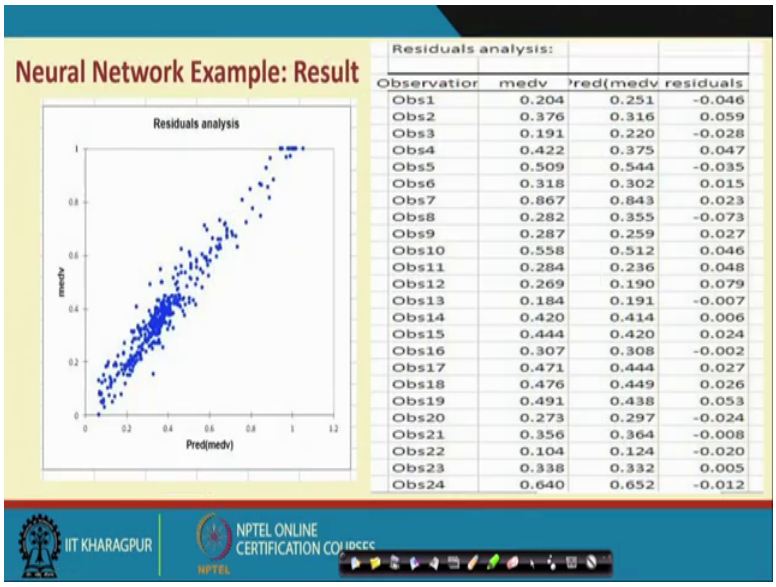

And this is how the residual plot team and that is how the differences.

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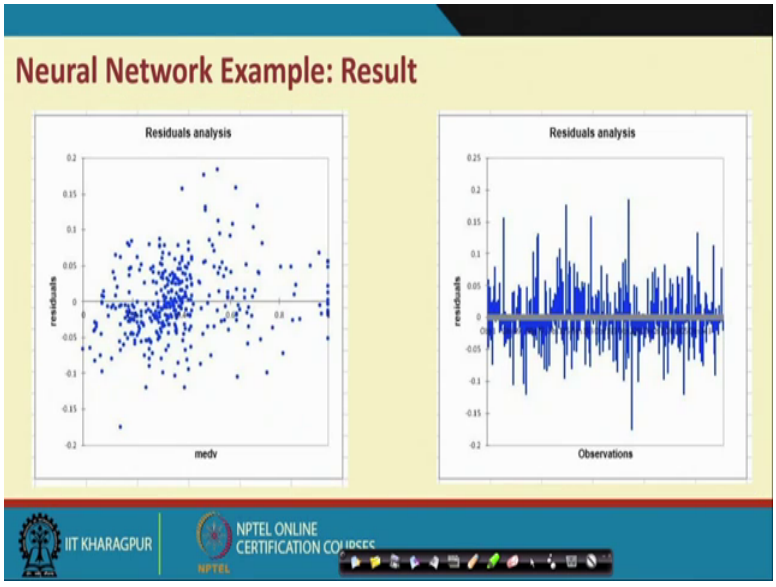

So, the you know residual plotting are you know giving the kind of you know clue that you know the model is perfectly for the kind of you know you know this particular you know housing predictions so that is about the median value of you know owner occupied predictions.

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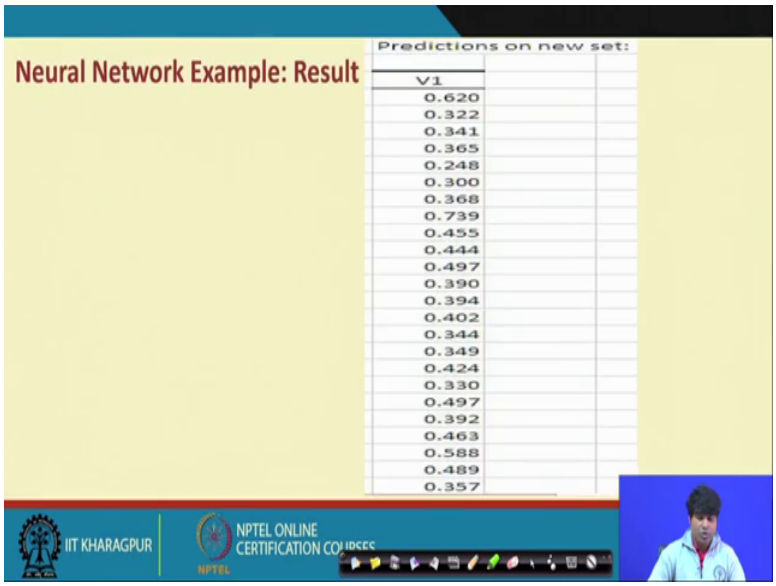

So, this is how the neural network you know is for the these are all you know predicted structure through which you know we started.

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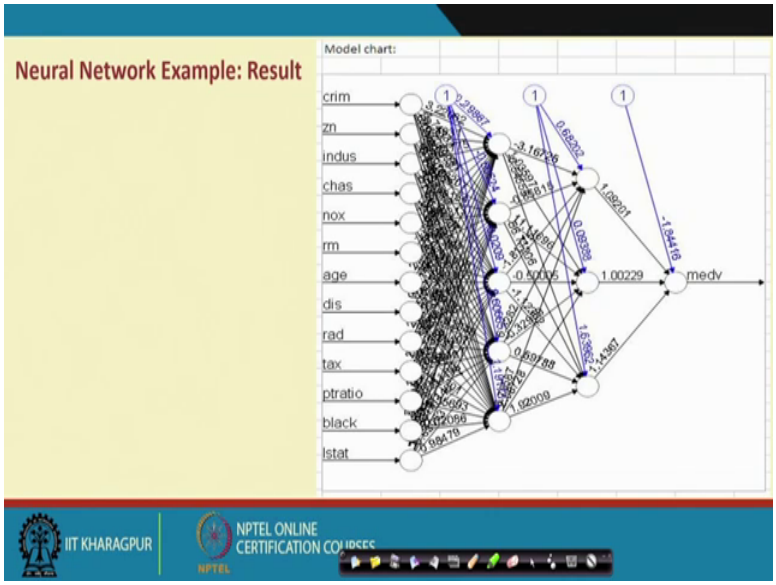

And this is what we have already seen and this is the beauty of this you know neural network that means the architect and the kind of you know structure itself is a kind of you know hike itching and that itself is a challenging for the kind of you know output prediction. Otherwise the same structure you can do in a simple regression structure or simple time series structure, but the beauty of this particular you know how to develop

the kind of you know layers and the kind of number of layers. And that too how how interestingly you can develop so that you know the output can be predicted more efficiently you know more attractive way.

And in fact, you know it is not the kind of you know beauty it is a kind of you know kind of you know comparison. The same output and input can be tested with you know simple regression and through artificial neural network. And then finally, through the kind of you know prediction indicators like you know mean square error, root mean squared error etcetera you have to check and then fine the neural network results are you know coming as per the best then you can finally, predict the particular you know output with you know neural network only. Otherwise, you can go with you know simple regressions where the predicted model gives you know better result compared to neural networks.

It is not necessarily that you know the problem can be solved through neural network only this same problem can be solved through other techniques. But now through neutral network we have a more number of flexibility to check the particular you know structure and come out with a particular you know model which can give you the best predictions as per the best requirement and the kind of you know management decision. With this, we will stop here.

Thank you very much, have a nice time.