Introduction to Soft Computing
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Lecture – 40
Soft computing tools

Yes we are almost at the end of this online NPTEL course on introduction to sub computing this is the final lectures, in this final lecture. We will learn about the different tools which are available to solve, the problem using the different sub computing techniques that we have learn in the course, in this course we have covered mainly 3 sub computing paradigms, 1 is fuzzy logic, another it is genetic algorithm, and the neural network. Now so, plan of this lecture is basically to cover the different tools which are available in the market, and then it is application how those tool can be used.

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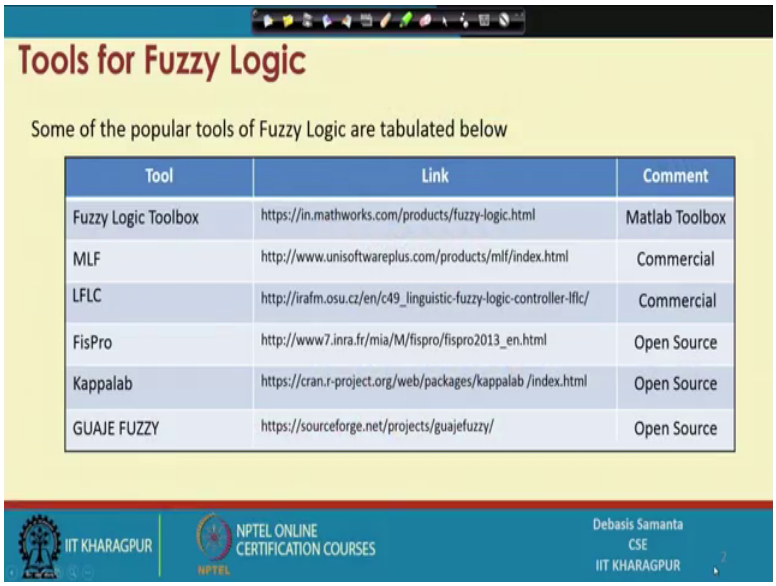

I will give an idea about it and finally, I will discuss about some hybridization approach. Now, let us first discuss about the different tools which are available to solve some problem using fuzzy logic. Now there are many tools of course, the some tools are available as a open source so, you can just simply download the source code, and then use it as a open source the tools which are available in the market, we have discussed here

So, these are the last three tools are open source is called the FisPro, then Kappalab and another is that GUAJE fuzzy. So, GUAJE fuzzy is developed for Japanese scientist Kappalab is also from Chinese scientist, and FisPro is a open source is a fuzzy group. So, these are the different open source tool that is available there, other than the open source there are many sophisticated tools are available in the market to use the fuzzy logic concepts. So, these tools are called the MLF and LFLC. Now these are the commercial tools a lot of features are there, and it is very useful now other than this another commercial tool, another one commercial tool is also available which is very popular it is called the fuzzy logic toolbox.

The fuzzy logic toolbox is available in matlab software. So, this is the fuzzy logic toolbox is popular, and I will discuss about the fuzzy logic toolbox how this can be used to solve some problem using fuzzy logic. So, so, this is the fuzzy logic toolbox that is available in the matlab toolbox we will discuss about it.

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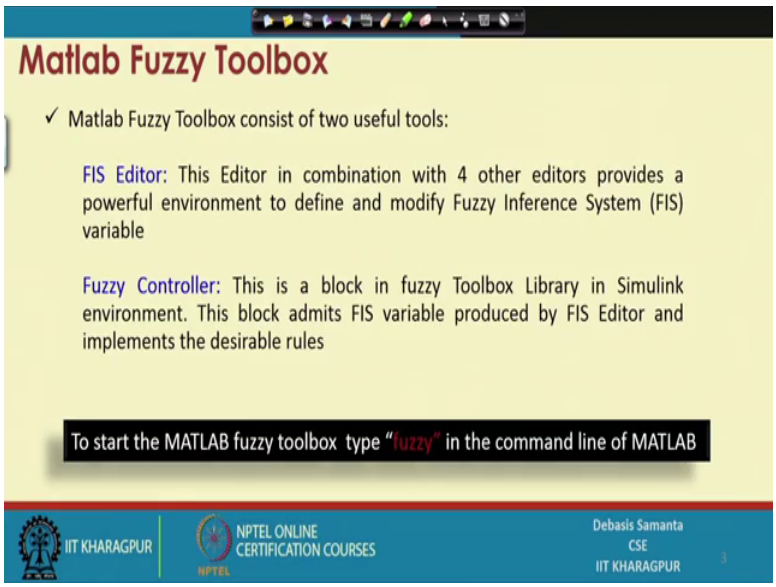

Now, so it is called the matlab fuzzy toolbox. So, if you know matlab then you just in the matlab if you type the command fuzzy, then this toolbox will be invoked. So, it basically have very good editor it is called the fuzzy inferencing system editor FIS editor, this editor basically in combination with 4 other editors which provides a very powerful environment to define and modify your fuzzy system or it is called the fuzzy inference system.

Now, you can recall at defining a fuzzy system is basically in terms of fuzzy sets, fuzzy rules, fuzzy membership functions, fuzzy inference, rule and finally, the inference engine. So, the FIS can allow you to define all these things according to your own problem or application, then it also has a very good tool set it is called a fuzzy controller.

So, this is basically is a fuzzy toolbox is a block block in the fuzzy toolbox in the library called Simulink environment this block allows FIS variable produced by the FIS editor, and then implements the many rules base system, and then controller that controller you can define either using mamdani approach or using takako sugan approach.

So, these are the toolbox if you know the concept, and then toolbox are available to you, then we will be easily able to use the toolbox to solve your problem. Now solving your solving a problem means you have to decide the fuzzy membership functions for the different fuzzy element, then fuzzy rule base matrix, then fuzzy inferences all these things. So, they will allow you to enter all these things in a user friendly manner using graphical user interface in the matlab toolbox.

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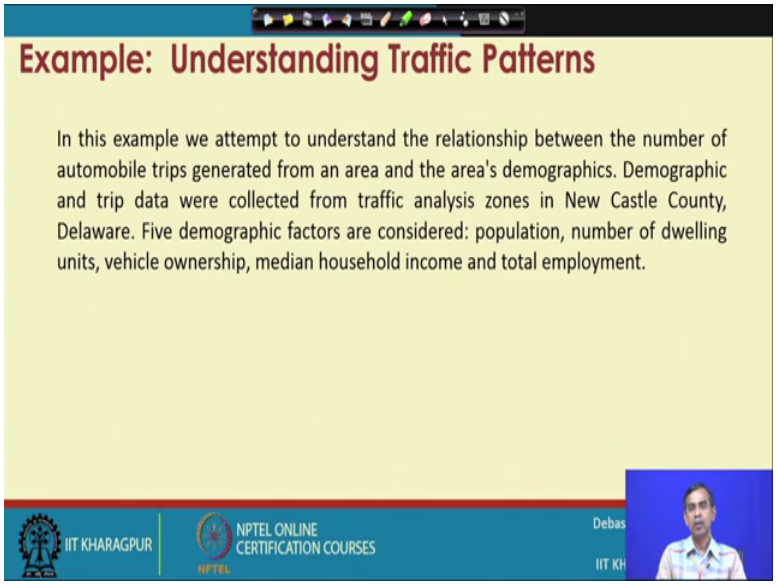

Now, so this is the toolbox it is called the matlab fuzzy toolbox. That is there in matlab right. So, just it is very difficult to include the solution, because I want to give an introduction to all the toolboxes or all the tools that is available to solve the sub computing problems. So, it is one problem and this problem you can see it is basically traffic pattern recognition problem using the fuzzy system.

So, so you can decide what are the inputs to this system, and then all for all the inputs you have to fozify it and then for the all fozified inputs fozify means you have to decide the different membership function, and then all the membership functions once it is defined, then you can discuss the rule based system; that means, if then else rule that basically you have to decide that if this is happen you can recall what is the rule based system that we have discussed, and all those rule base you can define using these toolbox.

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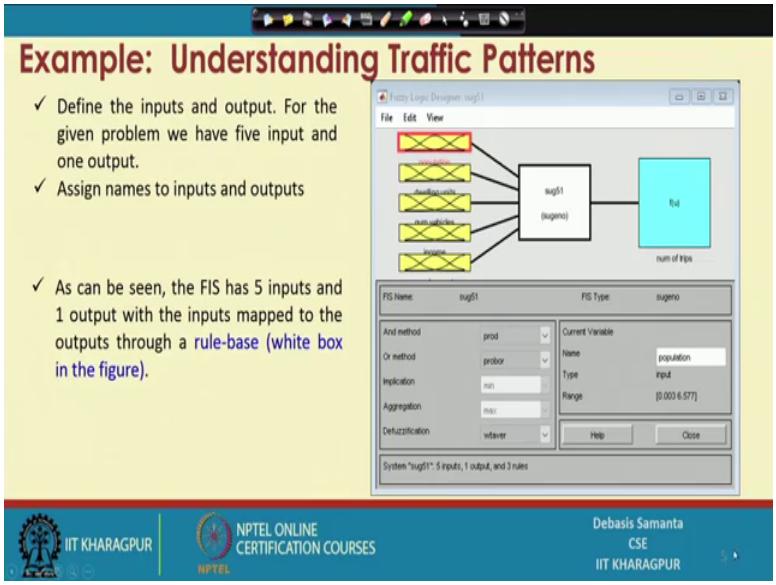

So, here is basically I mean view of the editors, where the different interfacing function can be there, and you can just simply using plotter, and plane we can discuss a different membership function for the different fuzzy elements, and then the different the fuzzy rule base can be entered, and then we can decide the fuzzy systems or fuzzy controller.

And here the menu it is there which menu you can decide you to finally, adjust your membership function, and this menu also can give you the link of menus of the different membership function you can select one for example, you can select bell shape function, or trapezoidal function, or triangular membership function, and then different parameters in these membership functions by setting the different value here and then all the functions can be there.

So, basically this tool will allow you to decide or define all your fuzzy members, or fuzzy elements for your application. Now so, so this way you can enter every fuzzy members or fuzzy elements.

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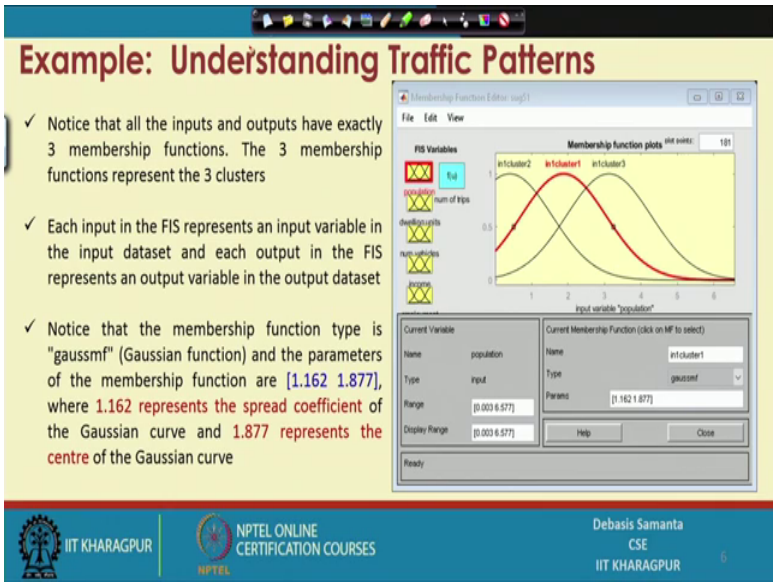

And then the fuzzy membership functions, and the fuzzy rule base and others. Now once it is there then you can also know exactly what is the output that the system can be a given to you it is in the form of fuzzy output. So, for example, for certain input the fuzzy output which can look like this one.

So, this fuzzy output again can be converted to the creeps output by using some fuzzification method. So, in the tool based method it will allow you to decide which fuzzification method that you want to follow, and then after your decision the toolbox will give the creeps output for the fuzzy values the fuzified values. So, this is a tool that is there.

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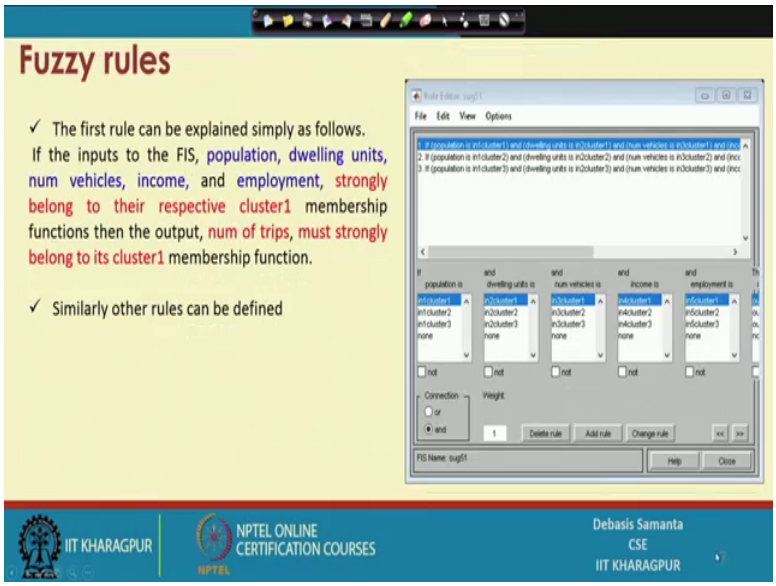

So, it is basically fuzzy tools that is there in the fuzzy toolbox system, now here also one example how the fuzzy rule based can be entered into there. So, this basically allow a graphical user interface to enter the different rules are there.

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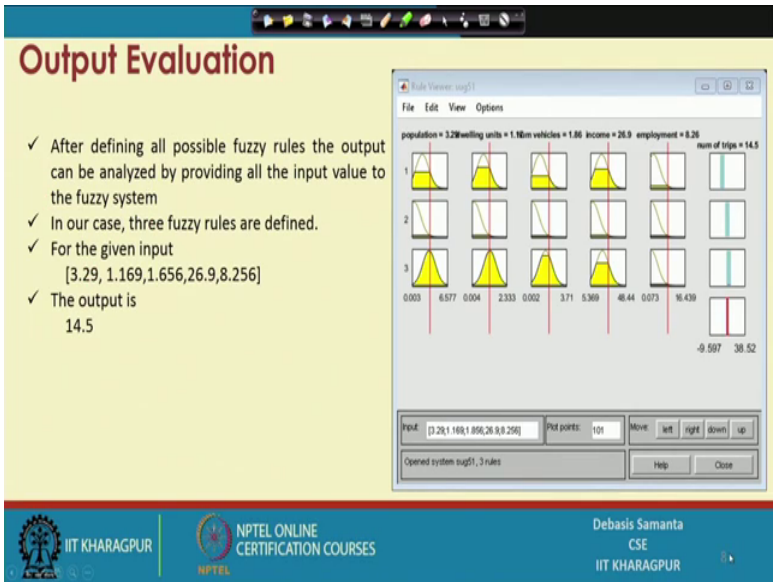

So, you can apply it and then the fuzzy rule based system can be developed, and then fuzzy controller can be implemented. So, so this is the tool that is the there for the fuzzy logic controller in case of fuzzy tool base, and this basically shows how the output fuzzification method it is basically how the output can be decided.

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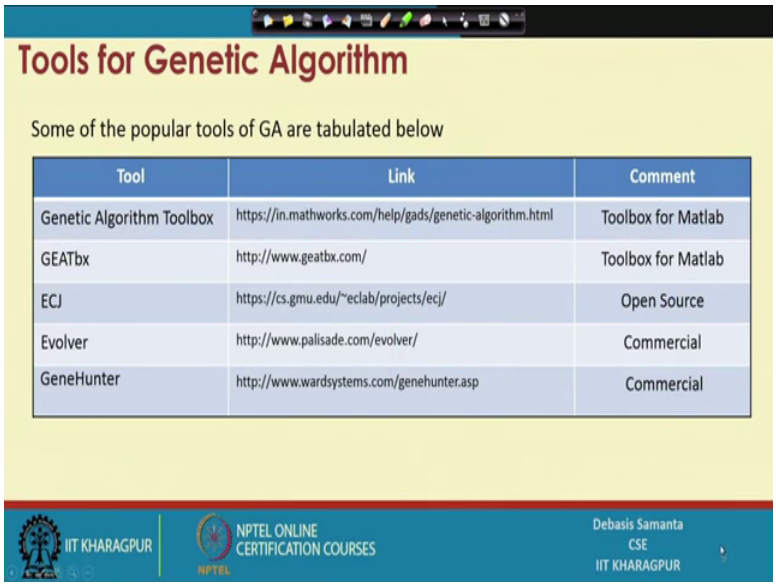

Now, so there is a tool and I have just given an idea about the glimpse of the idea about the fuzzy toolbox that is there in matlab other toolbox is likewise right. So, once you have the idea about that fuzzy concept then handling these toolbox will not take much time, but it is a matter of practice. So, basic idea of the practice is that you decide 1 program to be solved, and then decide the different elements that is there then different rules, and then the inference engine, and then you can allow the tools, then all the steps that is there in the fuzzy computing can be carried out, and your problem will be solved.

Now, now next let us discuss about the tools for genetic algorithm like the open source tool there is also an open source tool is available, this one is called the ECJ, this is the tool is developed by GMU that is a good software or program repository a lot of programs will be there, and this is an as open source other than the open source there is there are 2 commercial softwares for the genetic algorithm solving, they are called evolver, and another is gene hunter.

So, these are the 2 commercial source. Now in the toolbox for matlab again the 2 toolbox are there 1 toolbox is called the GA toolbox it is called a genetic algorithm toolbox that is there, and another is also this is for the multi objective optimization solving toolbox GEAT box. So, it is basically GEAT box is there. So, we will discuss about genetic algorithm toolbox to solve the optimization problem a single objective optimization

problem, using multi using matlab toolbox. Now, again you have to consider one application so, that you can practice the toolbox.

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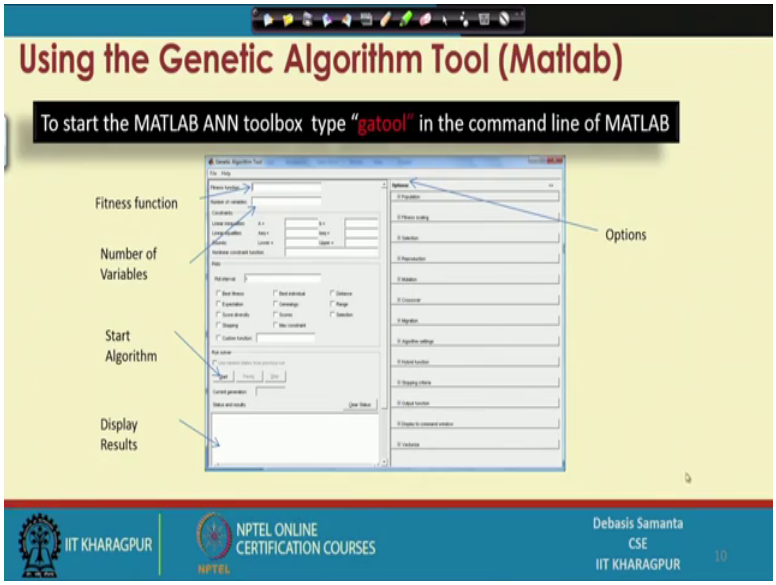

Now, it is basically a give an idea about the interface, or editor interface of the toolbox this toolbox can be invoked by using the command GA tool in the matlab commands, and then it basically defined many ideas for example, using this interface you can define what is the fitness function, what are the different constants are there, then what are the different what is called the interval that you have to discussed, the different parameters that can be considered, and once you enter all the values that mean constant then objective functions, different parameters the phenotype genotype everything, then once it is declared then you can start running the genetic algorithm.

And once the genetic algorithm runs it will give the output from each iteration, you can check it and then you can stop the running, if you see that output is not changing; that means, termination condition, and there are many other things that also can be set here which crossover technique you can use which mutation can be what are the different selection strategy that you can follow, you can take it there is a top down menu is there, if you select it. The different fitness assignment method will be there, different selection techniques also will be there, different crossover techniques are there, you can select some crossover technique use it, and then run your program to see the output.

So, this is very user friendly one toolbox which we can use it without knowing much details about, how they are basically working, but what they are supposed to do if you know and why they are doing like this if you it is known to you then you can use this tool, and then solve your problem very easily, without any burden without any programming headache, and even without knowing any programming also, you can use this tool to solve your problem using genetic algorithm. So, this way this tool is very handy and very popular among the different students and researchers.

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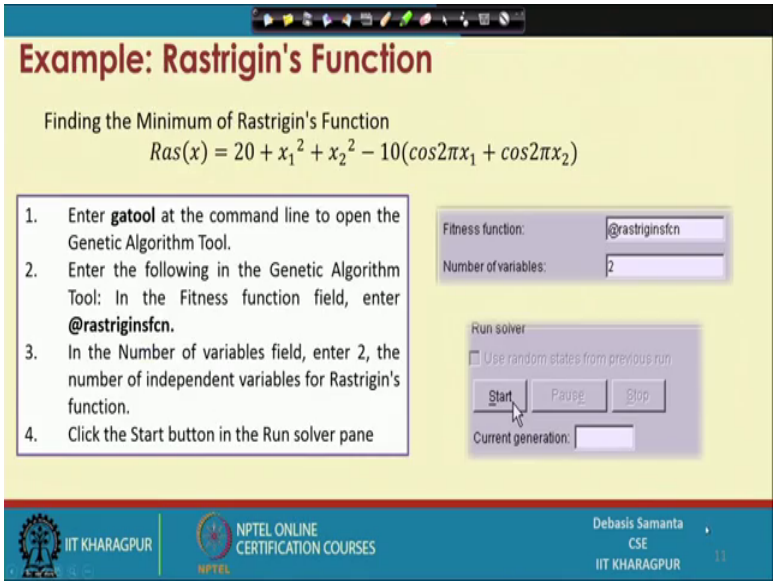

Now, here for example, you can try this GA toolbox to optimize this function this one. So, here basically what you have to do is that you have to enter this is the objective function, and then parameters that you have to discussed about x 1 and x 2 are the 2 parameters, and then in this case there is no constant mention, you can follow certain constant about that what is the range of the values of x 1 and x 2 from the link that is there in the things.

And then once the crossover technique whether it is a binary genetic algorithm or real value coded genetic algorithm all these things you specify, it will run this and then ultimately give the solution for this for this of for this problem. Now, if you run this particularly if you try with these tools, because matlab tool is readily available in everywhere right. So, you can use this tool and they learn it.

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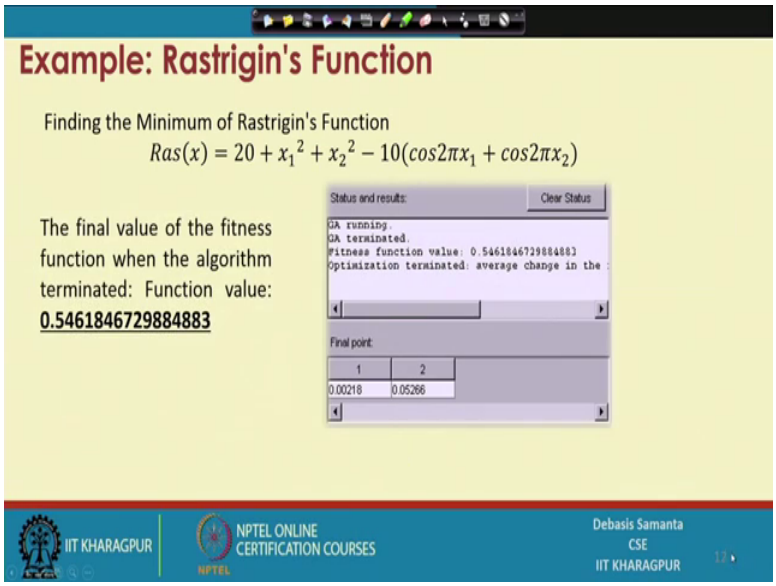

It will give you finally, the output result like this a this output result for this; that means, this is the values of our x 1, and some other values of x 2 by this is a values of x 1 and values x 2 for each this gives you the minimum value, and the minimum value of this is this one. So, so far the accuracy is concerned it is very highly accurates, and then it will give it will solve your problem in a real time, and it is very effective and useful, and you can try solving the same problem once it is using binary GA, then using the real coded GA then using other GA techniques also, and then you can get the result and which GA technique gives a better result that you can use it and then finally, solve your problem. So, these are toolbox is basically there.

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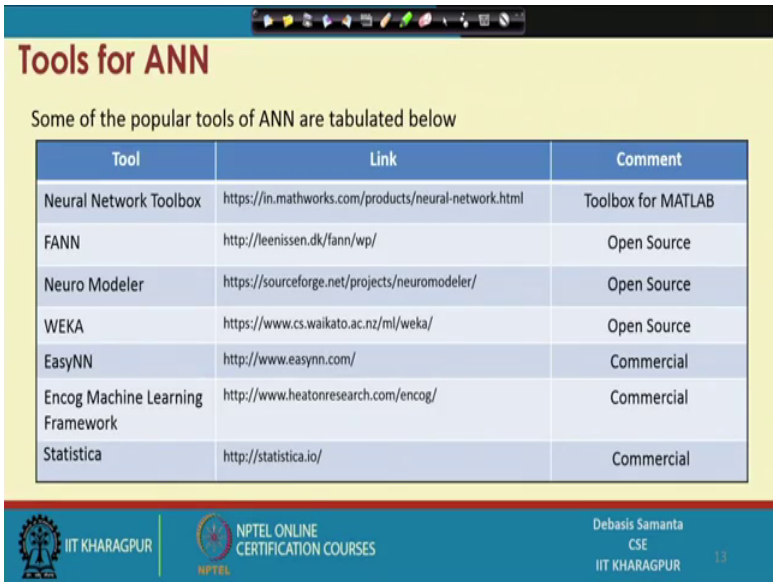

So, far genetic algorithm is concerned. Now we will quickly come to the ANN toolbox there are many ANN toolbox is available some are open source some are the commercial toolbox. So, these are the open source tool box namely FANN FANN, then Neuro modeler, and then WEKA. WEKA is very 1 sophisticated and very powerful 1 toolbox to solve the neural network related problem. And there is also some commercial toolboxes which are here these are the commercial toolbox, like easy NN then in Encog machine learning framework, and another is statistica.

So, these are the toolbox, and I have given the link from where all the tool box can be accessible, those are the open source toolbox can be accessed from this link, and the commercial toolbox also can be obtained, I advise you to try or practice yourself with a WEKA tool which is very powerful.

Now, like the GA tools and then fuzzy logic tools, for the ANN also matlab has a very good tool box, it is called the ANN tool box or neural net network toolbox. So, this is the link that you can use to access this tool box, if you have the matlab from the matlab you can just give a command you can give a command.

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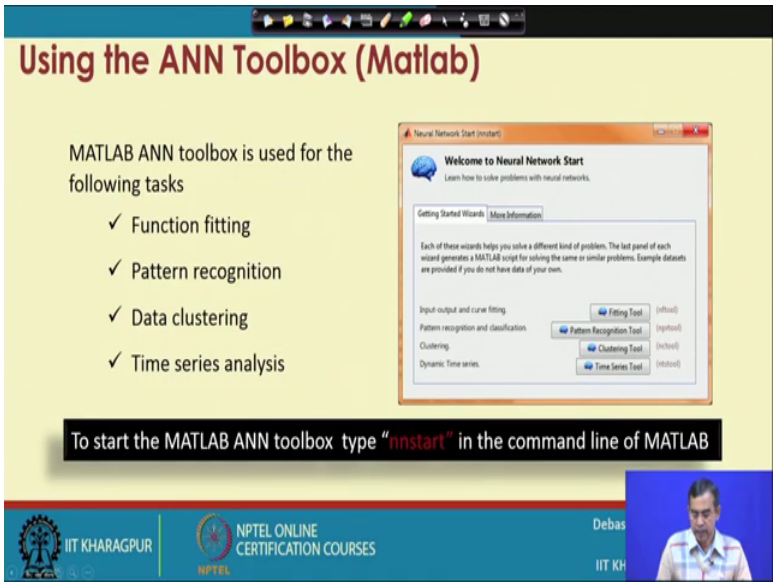

So, that you can it is NN start command NN start command if you type it, then it will invoke the neural network toolbox in matlab, and using this toolbox lot of problems you can solve, I have mentioned the many problems for example, it is basically program related to the regression analysis, these are the program related to the pattern recognition or classification, and these are the relation regration this is the method for clustering technique, and this is basically time series analysis.

So, I have mentioned many problems, where the ANN can be used can be applied to solve all the problem. Now, this toolbox is also very similar to the other toolbox that we have discussed, in the context of this it is just like a simple user interface by which we can define.

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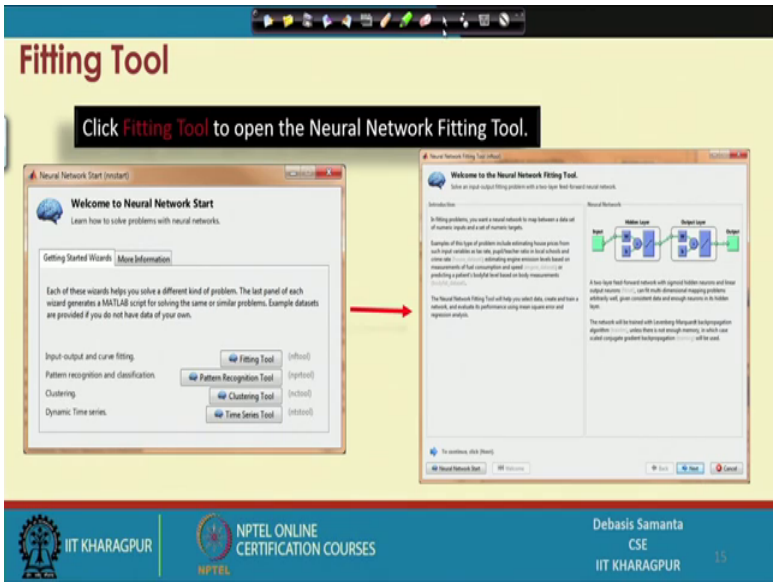

The input size the output size, and we can give an input as the training data set to the net. So, it will take it and then finally, it will model it will learn the neural network, and for the learning neural network, again you can follow any technique that we have discussed either supervised or unsupervised or Hevian or Computive learning or any other Turk. So, toolbox have the all implementation of all the concept it is there, we have discussed for example, back proportion algorithm for as a Stephen descent method to learn to tell a neural network.

So, likewise back proportion there are many other training method, also known and then you can select from the toolbox apply it, and then it will solve for you. So, again like the other there is no headache for the programmer. So, for the coding effort is concern coding is by the coding is behind the tool you can use these toolbox as the white box like; that means, give whatever the specification according to your own judgment give it to it.

And then system will take it and then system will solve the problem for you will get ultimately the final result that this is an neual network has been model, and this is the output. So, for any unknown data if you give this data to the model, it will give you the result like this one, just like a pattern recognition or classification or clustering this kind of problems are there. So, only one thing that is very much essential is that you have to know exactly what is your application, what is the specification of your problem and

how you can use this problem, and then using this problem how you can solve it, and how the different things can be achieved.

So, this is the different tools related to the fuzzy logic, related to the genetic algorithm, related to neural network computing, we have discussed. So, it is just introduction and then ultimately it is it depends on your own practice, and then effort that you can spend to learn it more effectively, but for learning it requires how you have to decide some objective problems. So, if the problem is known to you, then you will try all these tools to solve your problem, and then you can have the idea about that these tools how it works to solve the problem.

Now, we will discuss about the concept of hybrid computing, we have discussed three computing paradigms mainly the fuzzy logic genetic algorithm, and then artificial neural network. Now in case of hybrid computing it is very interesting to know, whether all the computing that we have learn can be applied to solve a particular problem, or say suppose both fuzzy logic and genetic algorithm can be applied to solve problem, or say GA ANN or fuzzy ANN it is the concept and this concept is called a hybrid computing.

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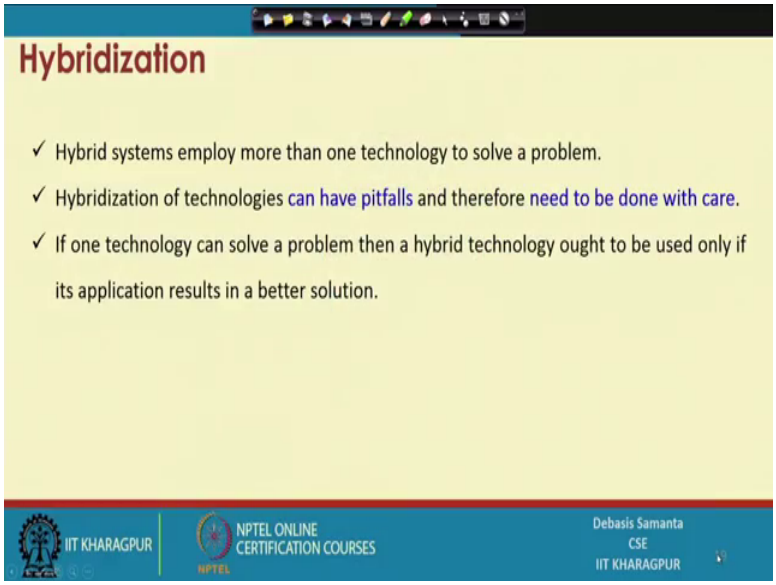

Now, for this hybrid computing so, here basic idea about is that you have to know exactly which program can be solved which computing better, for example if you do not know precisely about the input, then you should try to solve this problem using fuzzy

logic. If there is an optimization problem you can think about solving GA for example, GA ANN can be clubbed together. So, ANN can give you the model parameters.

Now GA can help you to decide. What is the optimum number of model parameters that is required for a particular problem? So in that case it is NN followed by the GA is useful to solve your program, and it is called the GA ANN techniques. So, like this GA ANN techniques, there is a GA FLL or GA FL ANN techniques are also there. So, we will quickly discuss about the different concept in this regard.

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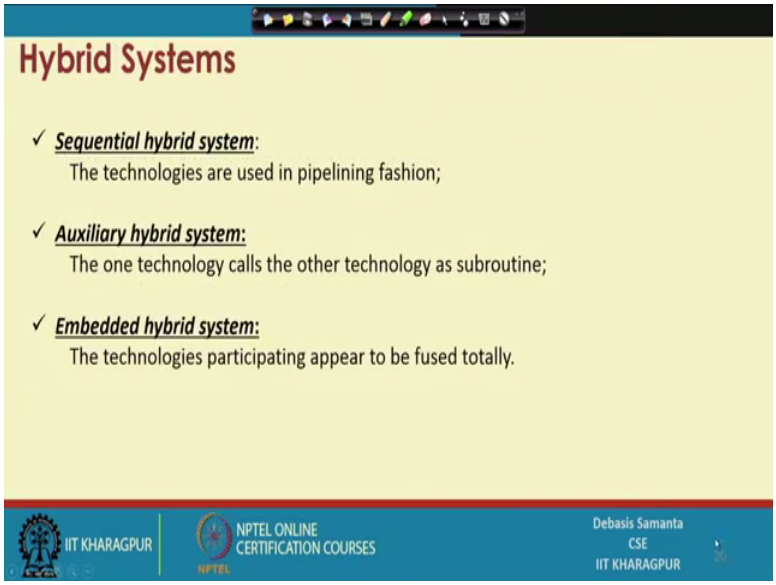

Now, any hybrid system which basically requires two or more that sub computing things and they can be classified into three broad category, one is called the sequential hybrid systems in case of sequential hybrid system, one technique will be used then followed by the next technique, it is a pipeline fashion. On the other hand auxiliary hybrid system is basically to solve one problem, we can follow say neural network, but neural network will call GA techniques as a subroutine.

So, it is called the auxiliary hybrid system, and embedded hybrid system is basically the different components of the problem can be solved with the different computing techniques like say GANN and the ANN fuzzy logic. So, it is basically so you have to know only, and this kind of systems is basically useful for if the system is very large and complex so that the embedded hybrid system can be used to solve the problem.

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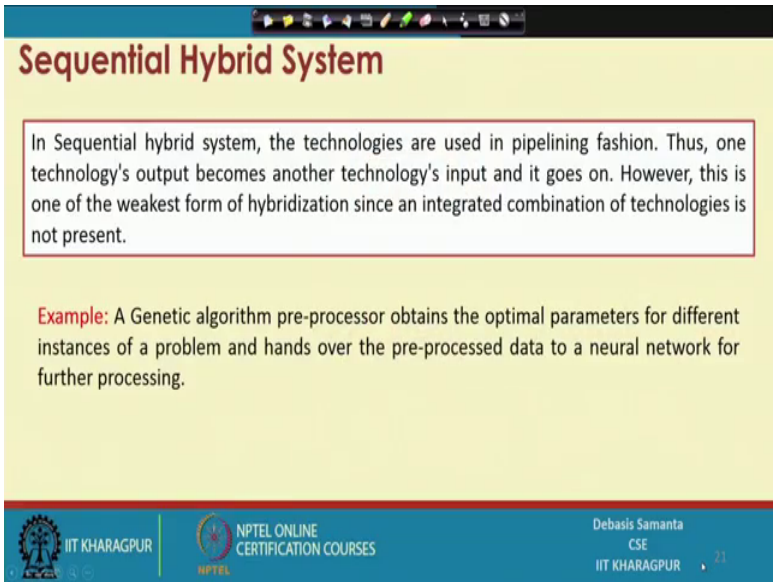

Now, sequential hybrid system that we have discussed about that here as, I told you the different computings are to be used in pipelining fashion. So, in other words, if there are different cascaded what is called the functions are there. So, it will basically take the one techno technology maybe say GA which will produce an output this becomes the input to the next stage and so on so on.

So, this is basically a sequential approach and gives rise to a sequential hybrid system as an example, I can say genetic algorithm can be considered as a preprocessor which basically gives you the optimal parameters for different instance of a problem, and it basically give the preprocessed data to a neural network, and the neural network use it. So, the problem can be solved not only accurately, but it is also solved in a more faster way than any other method. So, it is most the quality as well as the speed can be enjoyed, if we use the hybrid system.

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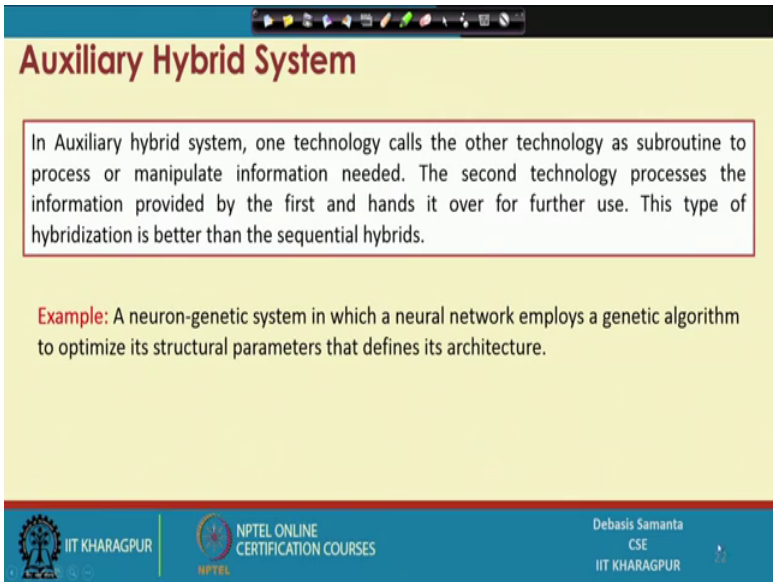

So, this is the sequential hybrid system, likewise the auxiliary hybrid system is basically the as I told you is basically one technology can be used as a subroutine, or it is a function to solve the other technology. So, it is for an example a neuro neural genetic system; that means ANN GA combination, in which neural network can be employed a genetic algorithm to optimize the different structural parameter, and then the optimum architecture can be obtained. So, this is the auxiliary hybrid system that can be considered as an hybrid system.

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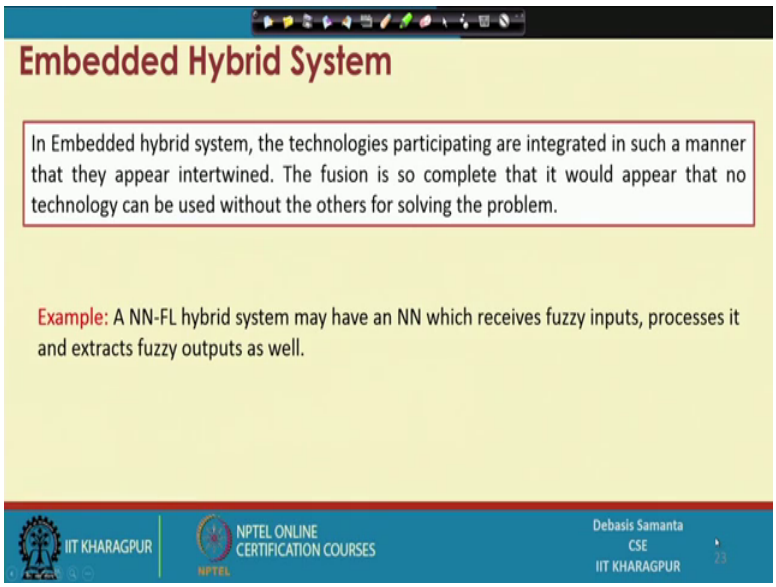

And then embedded hybrid system, as I told you there here the different technology can be used to solve the different parts of a very complex problem for example, here neural network, and fuzzy logic, can be embedded together to solve where the ANN which receives the fuzzy input, and process it and it will extract the fuzzy output, and then finally, the result can be obtained.

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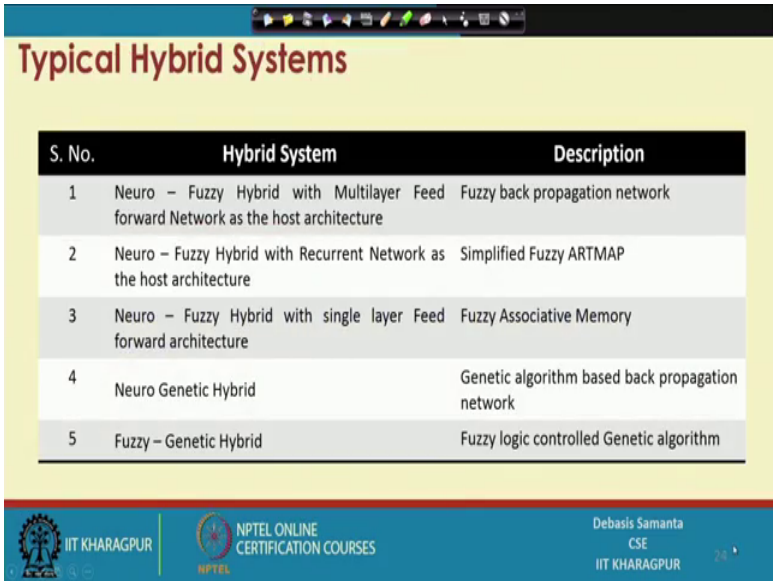

Now, as an illustration I can give an example ok, there are few hybrid system therefore, we can have it is also some tool box also available for the different fuzzy systems are there, one hybrid system is called neuro fuzzy hybrid with multi layer feed forward neural network as the host architecture, it basically used fuzzy back propagation network.

Likewise neuro fuzzy hybrid with recurrent network as the host architecture is basically called art map the simplified fuzzy some fuzzy problem, and then neuro fuzzy hybrid with single layer feed forward architecture is also known; it is called the fuzzy associative memory architecture or tools. The neuro genetic hybrid system is also known it is basically the genetic algorithm based back propagation network. Similarly fuzzy genetic hybrid system is also known, here basically fuzzy logic control the genetic algorithm has been proposed. So, these are the different what is called a hybrid system is known at present, and it can be used to solve many problems for our problem solving a domain.

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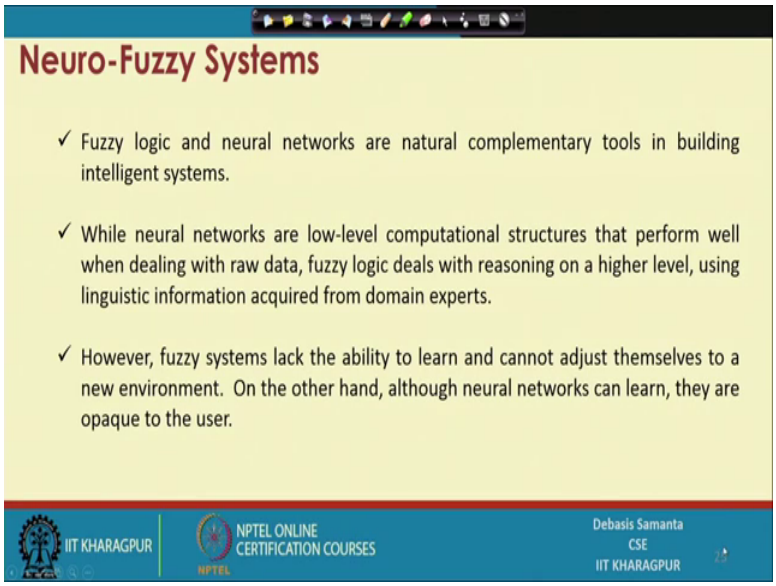

Now, so neuro fuzzy systems what we have discussed about it.

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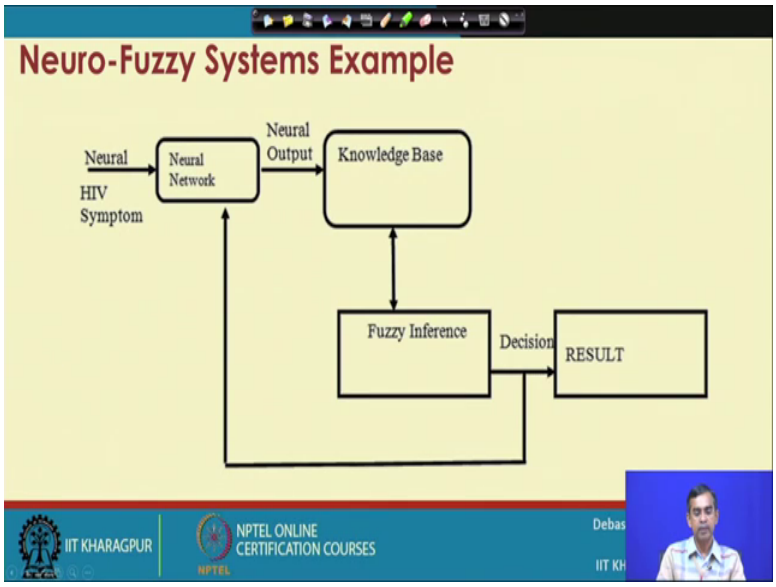

Now, here the idea about how the neuro fuzzy system works for you it basically take the input, as a training data, and this training data is basically for example, some disease symptoms, then it gives you the neural network, neural network will be trained, and the trained network will give output for an input, and this output will be used to develop the knowledge base.

And using this knowledge base the fuzzy inference will be here, now here the neural output is basically in terms of fuzzy fuzzy input like, and then fuzzy inference give you the decision this is ultimately result, but it can be feedback to this one so, that it can be repeat, and the system can be fine tuned and finally, the hybrid system can be decided. So, this is the idea about that, how the fuzzy how the hybrid system works, and it is for the neuro fuzzy system that we have discussed.

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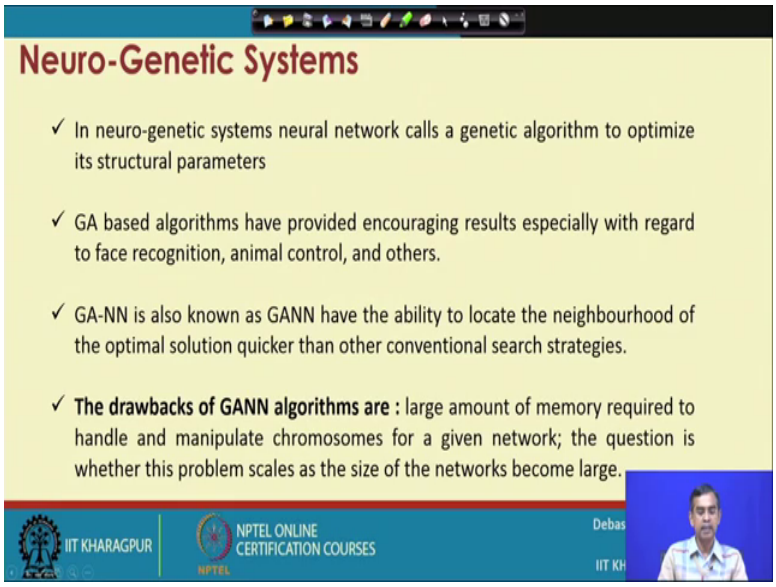

Similarly, neuro genetic system also can be obtained, and here is idea about how the neuro genetic algorithm is there.

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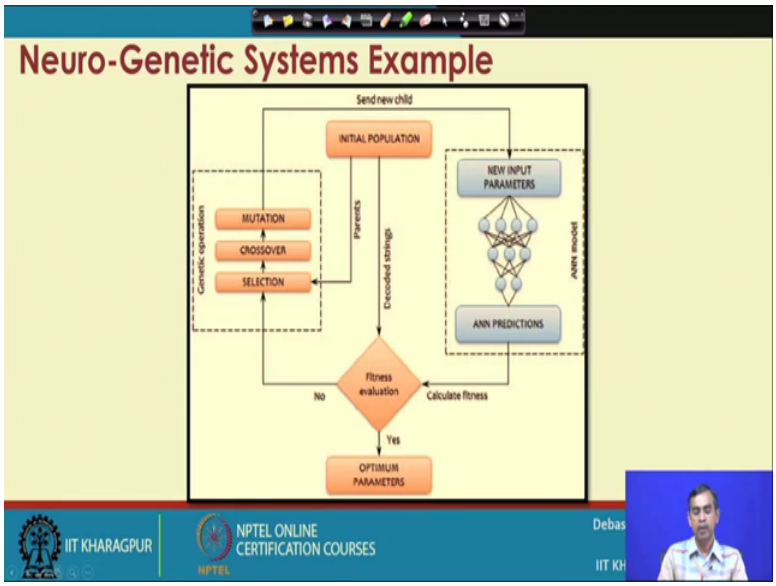

So, it basically the neuro neural network it is there, and all these things are basically embedded system that we are discussing about; that means, the problem can be solved using the different components in the different parts here.

Now, it is basically the genetic algorithm we approach, suppose GA and then NN can be clubbed together to solve the problem like, here the idea about is that so far the genetic algorithm is concerned, it will start with the initial population, and then so these are all populations are used to generate the new population.

And this new population will go here, and then it train the network and that the network once trained it will check that fitness value, if the fitness value satisfy the optimum criteria it will give the result if not so, again GA then ANN. So, it is basically GANN one what is called the loop system, and that can be used to solve the problem. So, this is a concept of neuro genetic algorithm as the hybrid system to solve many problem.

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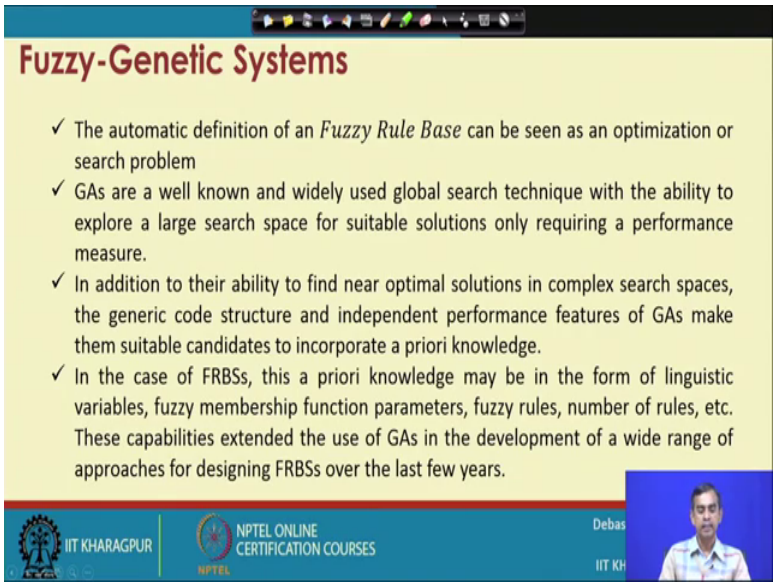

Likewise there is a fuzzy genetic system also can be considered here, basically the idea about fuzzy genetic neural system.

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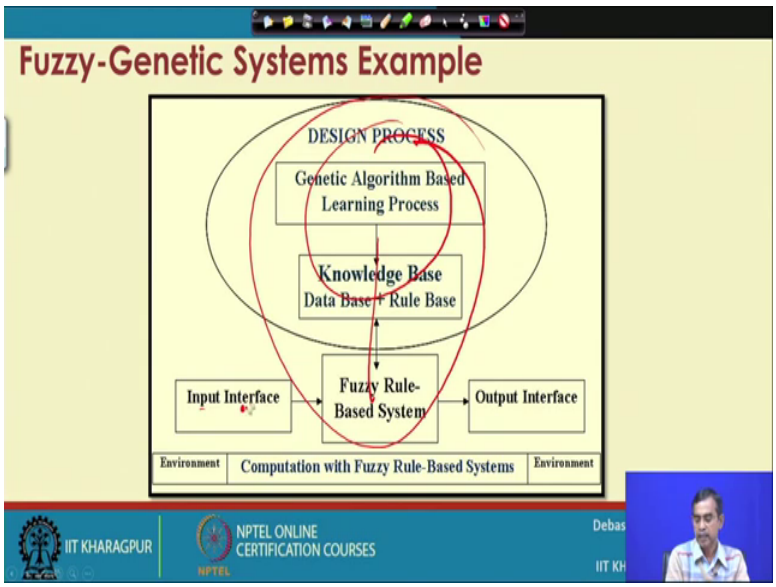

So, it is basically genetic algorithm based learning process it is called, and here the input inference will given fuzzy rule base system will be developed, but fuzzy rule base system will be develop in terms of the consolation of GA approaches which is an optimization of the number of rules that needs to be considered to solve your problem and finally, other output will be there.

So, in this concept there is basically GA, and then fuzzy are embedded together to solve for certain input to get certain output. So, it is basically the computation system using fuzzy genetic hybrid approach. So, we have discussed about the tools and applications, which we can consider to solve our problem, and finally, the most advanced concept of computing it is called the hybrid computing, where all fuzzy GA neural network can be clubbed together to solve your problem most effectively, and more accurately. So, with these things are you want to stop it here, I hope you have understood the basic concept the course wise in an introductory level. So, the introduction to the different concepts have been given, and you have enjoyed this class.

Thank you very much.