Business Analytics for Management Decision
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Lecture – 41
Prescriptive Analytics

Hello everybody, this is Rudra Pradhan here welcome to BMD lecture series, and today we will start with Prescriptive Analytics, and that too coverage on linear programming problems.

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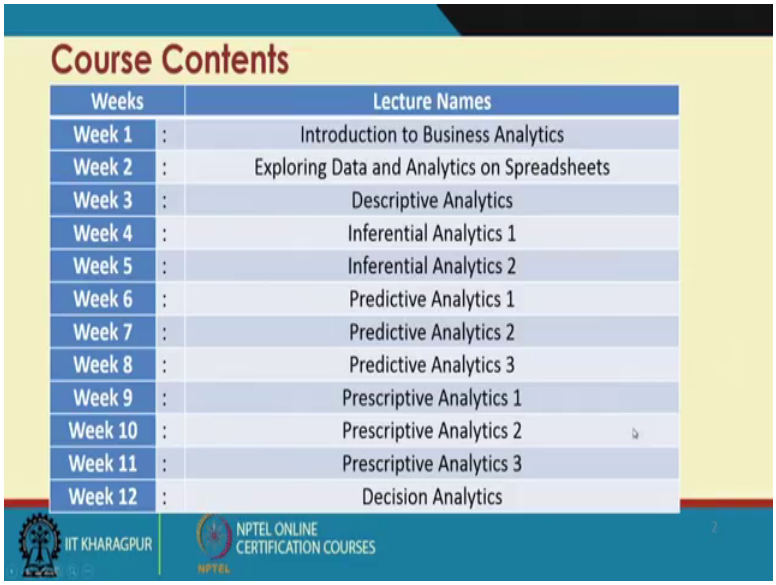

So, let us we start with the kind of you know structures, and we have already discussed the descriptive analytics inferential analytics, and predictive analytics, and that too we have already discussed details about the business structure, and to solve some of the business problems by using the descriptive analytic tools, and the inferential analytics tools, and the predictive analytic tools.

And as a result we have discussed so, many techniques you know inferential analytics structures, and the kind of you know predictive analytics techniques through which we have solved some of the problems, and accordingly we have already highlighted how what extent or you know how many you know different ways we can analyze a particular you know problems, and come with a kind of you know solution, through which we can

actually generalize the you know business problems, and accordingly we can take a kind of you know management decisions.

So, continuing with you know descriptive analytics inferential analytics, and predictive analytics. So, the new structure which we start with the is a concept called as you know prescriptive analytics.

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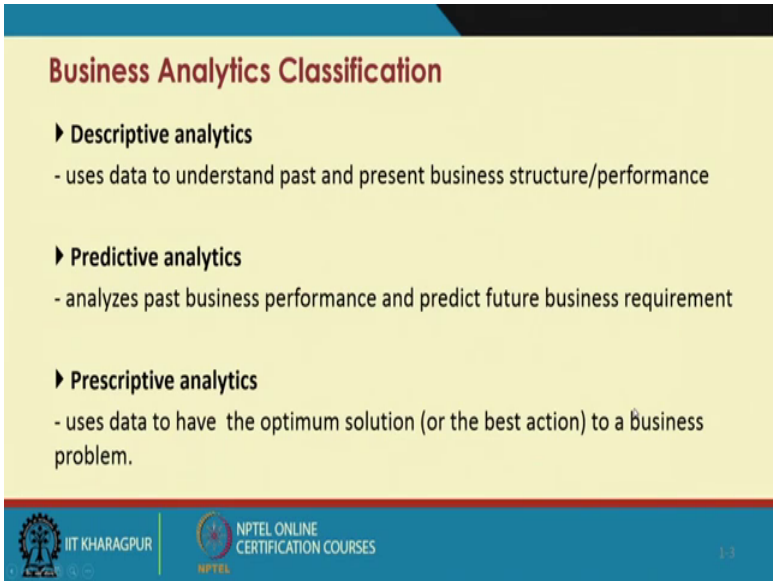

And let me little bit you know highlight about the particular you know structure that is the business analytics classification, and we have a three different structures which we have already highlighted, and that is the descriptive analytics predictive analytics, and prescriptive analytics. And in the descriptive analytics what we have already dones it is the use of data to understand the past and present business structure or business performance, and in the case of predictive analytics it is to analyze the past business performance and predict futures business requirement.

And the topic which we like to discuss today is the prescriptive analytics, and here we like to use the data to have the optimum solution that to the best action to a business problems so; that means, knowing the past, and then you know using the past structure through which you can predict the future kind of you know requirement, and within the particular you know past and you know future requirement.

So, we like to find a kind of you know optimality or optimal structure that is the best action through which the particular problem can be addressed in a much better way, and then management decision can be taken into considerations.

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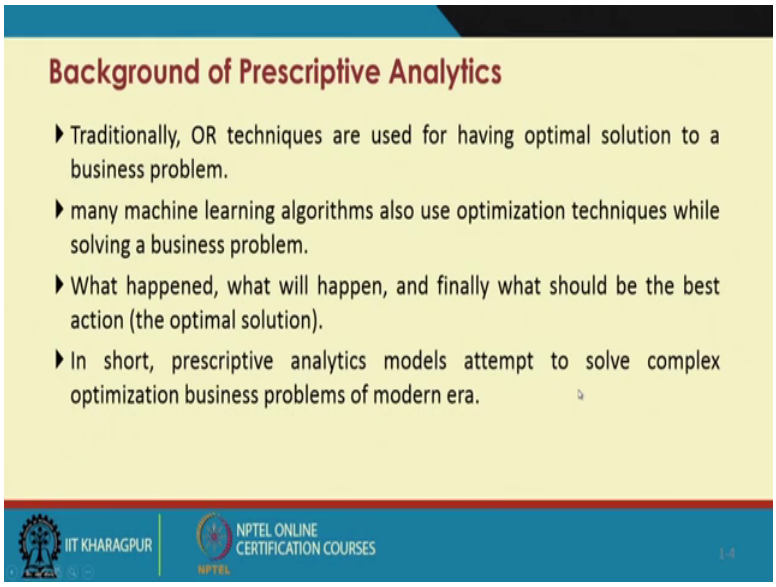

So, we are here to highlight the prescriptive analytics, and let us start with the little bit background about the prescriptive analytics, and it is a part of you know kind of you know structure called as you know operation research techniques, traditionally work techniques are used for having optimal solution to a kind of you know problems whether, it is a kind of you know business, or is a kind of you know defense, or any kind of you know (Refer Time: 03:30) problem and a corresponding to work techniques. In fact, many machine learning algorithms are also used in the kind of you know optimization techniques, a while solving a you know business problems.

So now, the typical structure is you know starting with descriptive predictive, and you know prescriptive. So, the questions we the question which will like to address is like you know what happened that is what we know the answer is through descriptive analytics, and what will happen that is the answer through which you we use predictive analytics and finally, what should be the best action that is the optimal solution which is the actually going to address through you know prescriptive analytics.

In some prescriptive analytics models attempt to solve complex optimization business problems in the kind of you know you know modern era, or the you know kind of you know dynamic business environment.

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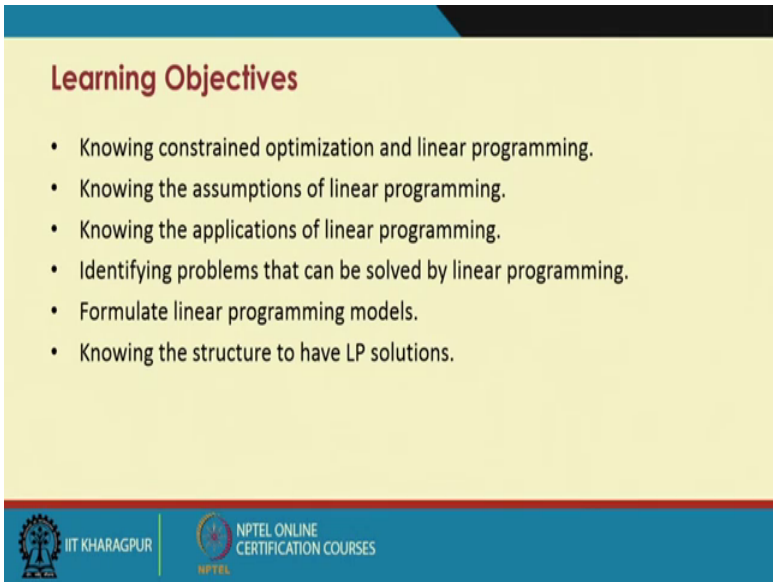

So, now, you know the these thing is that you know we like to know how this particular you know prescriptive analytics can be used frequently in the contest of you know management, and that to some of the business problem through which we can actually get the optimum solution that to values of the decision variable through, which you can address the business problem in more attractive way, and then we can come with a particular you know strategy or you know decision, through which you can actually a highlight the issue as per the business requirement. And a so far as this particular you know you know topic is concerned.

So, we have the following objectives. A knowing the constrained optimization, and linear programming then knowing the assumptions behind this particular you know predictive analytics prescriptive analytics tools through that is you know through linear programming.

And a we like to highlight some of the application through which prescriptive analytics can be connected, and can be a you know used to you know address the business problem. And identifying problems that can be solved by linear programming, and

formulate linear programming models, and knowing the structure to have the linear programming solutions.

In fact, the whole idea is actually the optimization structure, and so for optimization structure is concerned. So, we can divide the entire structure into 2 parts one is called as a constrained optimization, and unconstrained optimization, and most of the instances particularly in the business framework or business related problems you know we like to analyze the objective, or we like to analyze the problem with you know few or you know more constraints, without typical you know constraints, we can actually a cannot generalize the business problems.

So; that means, in real life scenario or in the kind of you know business environment. So, most of the objectives and most of the problems can be addressed through, you know particular constraint, or you know a few constraints. So, now how we can actually address the particular you know business problem with you know few, or you know several constraints. So, that we have to discuss here, and then we can you know address with address with you know business problems or you connect with a particular business problems, and then finding out a kind of you know solution through which you know decision can be taken into considerations.

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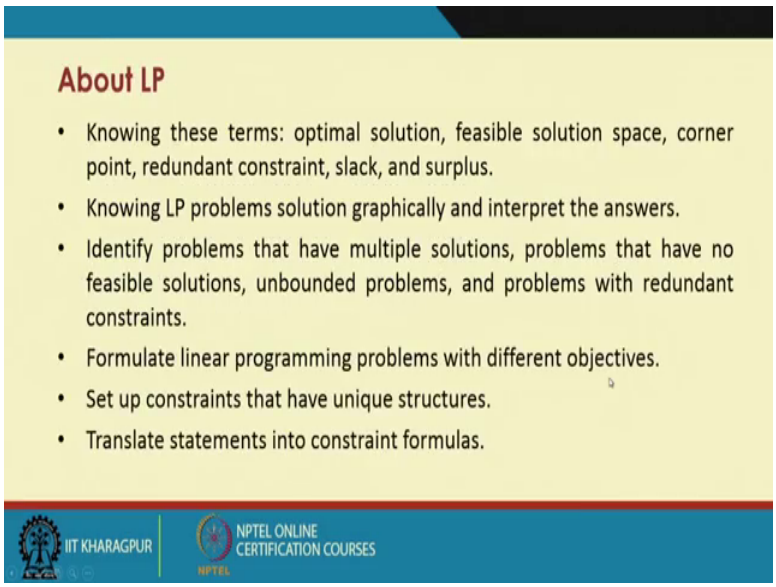

Let us start with the particular you know structure, and so the particular structure is you know we can start with the linear programming in fact, the optimization what I what I

have already mentioned is called as you know constraint optimization, and or unconstraint optimization, and against the particular you know optimization structure can be analyzed against or can be evaluated with the with the structure of you know linear programming for format, and non-linear programming format.

So, we first start with the linear programming structure, and the particular structure is like you know we have a business problem, and the business problem can be converted into a kind of you know models, where we can have the kind of you know objective functions, and then with respect to constraints and the kind of you know condition through which we like to know the values of the decision variables, or you know optimality of the particular you know structure, through which you know the you know the business problem can be addressed more accurately, more effectively and more efficiently.

So, without knowing the particular you know structure we are not in a position to say the you know optimality of a particular you know requirement, and a accordingly we are not in a position you know to address the problem. So, the thing is that you know starting with you know you know kind of you know descriptive analytics to predictive analytics, we can get to know the a kind of you know past structure, then the kind of you know present structure, and the kind of you know future requirement.

So that means, all together for a particular business problems corresponding to objectives, and the kind of you know constraint; that means, may be with respect to few or you know more kind of you know variables or the kind of requirements, and then we like to know what is the a exact you know values of the decision variables through which we can actually address the problem more effectively, and more accurately.

So, that is how linear programming can help us to know the particular situation, and then address the problem as per the particular you know requirement. So, starting with the linear programming so, some of the terms we like to you know first address, then we like to connect with you know prescriptive analytics structures. So, the requirements are you know knowing the optimal solution, feasible solutions, space corner point, then redundant constraints, slack variables, surplus variables. So, these are the things which we you know frequently use to get the values of the decision variables.

So, now the so far as you know linear program is concerned. So, there are you know 3 different steps all together, we start with the problem structure, then with the problem structure, we can transfer into a model formulations. And a once we get the model formulations, then we like to apply some kind of you know optimization tool through which you we can get the kind of you know solution.

So, the solution here is to know the values of the decision variables. So, now in the kind of you know linear programming formatal non-linear programming format. So, basic structure is the objective function, and the constants and the kind of you know condition. So, now since it is a kind of you know decision making process so; obviously, a problem problems will start with you know at least 2 variables so, that we can have a kind of you know decisions.

So, when the system will be more and more number of variables, and more number of you know constraints, then it will be a it will be a complex process, and it will be a challenging process, and then we like to have some kind of you know third process through which we can find out the optimality structures, where the values of the decision variables can be obtained, and that too we can you know in a position to address the business problem. And so the here is the idea is to identify the problems that I have actually multiple solutions, and problem that have not feasible solutions, and then the kind of you know unbounded structures, and problem with redundant constraints; that means, typically what is actually happening in the kind of you know optimization structures.

So, corresponding to a particular problems and that too with objectives and constraints, and conditions we may have the solutions that is the optimal solution or sometimes we may not have a kind of you know optimal solution. So, it depends upon the kind of you know structure, the kind of you know requirement ultimately a if you know if you can get the kind of you know solution with respect to objective function in constraints that is fine.

In case if we are not in a position to get the optimum solution that is the case where you know that is there may be chance of you know unbounded solutions there is the chance of you know infeasible solutions. So, where the solution is not coming, because of you know certain issues, but here in the kind of you know analytic structures we like to we

like to find out a situation, or we like to bring a particular situation through which you know the unbounded problems, or you know infeasible solution can have some kind of you know optimum solution. So, first of all you know corresponding to original problem the original requirement, we try to build the models, and solve the models, and get the look for the optima optimality or optimal solutions.

One once we get the optimal solution it is fine; that means, in the first end if you will get the optimal solution corresponding to the particular model that is with respect to objective functions, and constraints and the conditions it is its fine. If not then you know we like to you know bring some kind of you know, feasibles kind of you know structure where we can have the some we can have some kind of you know optimality, for instant means in the in the simple structure corresponding to objective function if the constraints are not consistent then by default we may not get the optimal solutions.

So, one way to address a or you know to bring the optimal solution is the make the constraint you know consistent as per the particular you know objective. So heres we know in the kind of you know prescriptive analytic structures, we like to address all the these issues, and come to a kind of you know structure, where we can have the kind of you know optimal solutions, and that too values of the decision variable, through which we can actually address the business problem as per the particular requirement, and then we can take the management decision more effectively.

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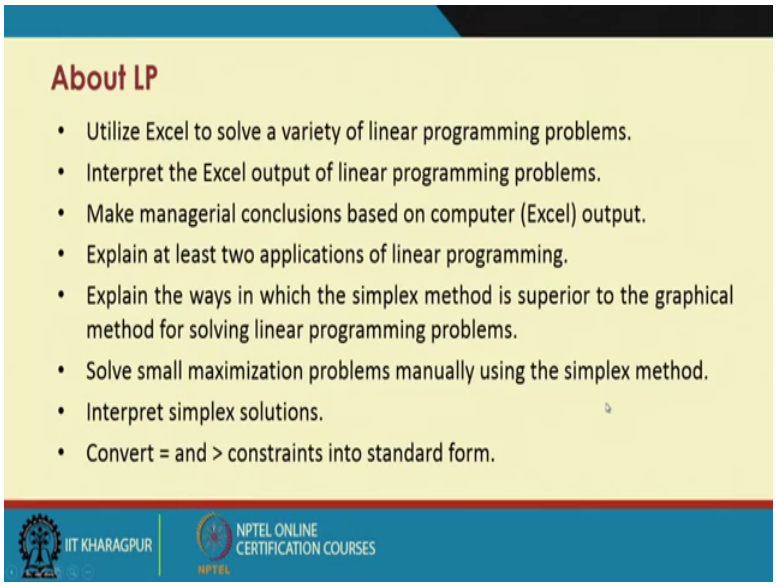

So, that is how we like to know some of these using the contest of you know linear programming, and so, far as you know linear programming is concerned you know, if the problem is very complicated, and very complex against like you know predictive analytics, and inferential analytics, manually we may not actually understand or we may not in a position to get the optimum optimality or optimum values of the decision you know kind of you know situation.

So, in that case we need actually a typical you know software's may be are software's may be kind of you know you know excels of solvers, through which we can actually address the problem, and then we can actually come with a kind of you know solution which we can address the business problems more effectively. And a in the contest of you know linear programming.

So, utilize the excel to solve a variety of linear programming problems is the kind of you know key agenda in this particular you know structure. So, the you know the way we have already you know solved some of the problems that too you know you know contest of you know predictive analytics. So, excels you know in the in the excel software's so we have used some kind of you know data analytic structures, but here so, for as prescriptive analytics you know is concerned.

So, we have a solver package in the excel, and through which we can actually analyze the kind of you know optimization problems, and come with a kind of you know solution through which we can address the business problem more you know effectively. And a then after you know getting the kind of you know output optimality, then we can think about the kind of you know managerial interpretation, the kind of you know business interpretation the business strategy.

So that means, technically we like to you know have the kind of you know situation, the input kind of you know situations, and the actual kind of you know scenario, and then with the help of you know problem the kind of you know model, and the kind of you know software, will come with a kind of you know solutions. Now we have the problem you know initial structure, then the you know the kind of you know model, the kind of you know inputs, and then finally we have the kind of you know outputs.

Now, looking the problem inputs and output, we think you know which one is the best and how we can address, and analyze and then come with a kind of you know structure

through which you know, we can address the problems as per the particular you know requirement. And that is how we are here to know the kind of you know structure about the linear programming, and so, far as the solution is concerned and what I have already mentioned.

So, the particular problem will start with the 2 variables or more than 2 variables so; that means, the entire structure can be divided into two different you know ways, and first way is a you know with a with a particular you know objective or with a particular problems, we must have a constraint and that too at least you know we have 2 variables, and with you know 2 constraints, then we may be in a position to address the problem more effectively.

Or we if we in case the problem is the more number of variable with more number of constraint, then it is you know kind of you know solute kind of you know structure through which you can think about the kind of you know solution, think about the optimality and; that means, technically it is a kind of you know challenging process, and where the analytics will play kind of you know excellent role.

But a if the problem is actually smaller one, and the decision the number of decision variable is a less enough, then you know it will not be you know interesting or challenging where the role of analytics may not be so, interesting; that means, we are here to address you know you know bigger problems, and wheres you know analytics can play you know kind of you know better roles to think about the solution towards the particular you know business problem.

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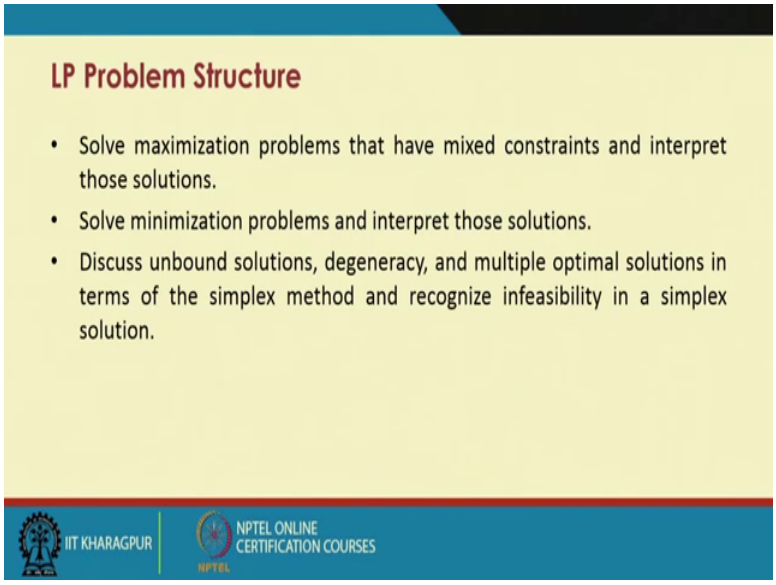

So, now so how we have to you know start with this particular problems, understand the problems, and how to come with you know kind of you know optimality. So, that is again the agenda of the you know discussions. So, heres so far as you know prescriptive analytics a analytics is concerned, what we have already mentioned that you know it is a kind of you know optimization structure.

And so, far as optimization structure is concerned, again you know what I like to highlight we have already you know mentioned constraint optimization unconstraint optimization linear programming, non-linear programming, then you know in the case of you know optimization the another way to you know divide the particular structure, you know you know is like this the maximization kind of you know problem, and the kind of you know minimization kind of you know problem.

That means, once you say that you know there is a optimality then; obviously, there is a kind of you know objective function with respect to certain constraints, and then some of the conditions may be there is or may not be there, but you know the basic requirement is the objective function with the constraints, and that too the that too when we talk about the optimizations, either it will be the maximization structure or the minimization structure how the you know the maximization structure, and how is the minimization structure that we can address here, in a kind of you know you know kind of you know LP structure.

So, how you have to means the thing is that you know when we have a maximization type of you know problems. So, the kind of you know we like to you know discuss how is the kind of you know solution, again when there is a kind of you know minimization kind of you know objective, then we again think what should be the kind of you know solution, and what should be the you know kind of interpretation and the kind of you know structuring.

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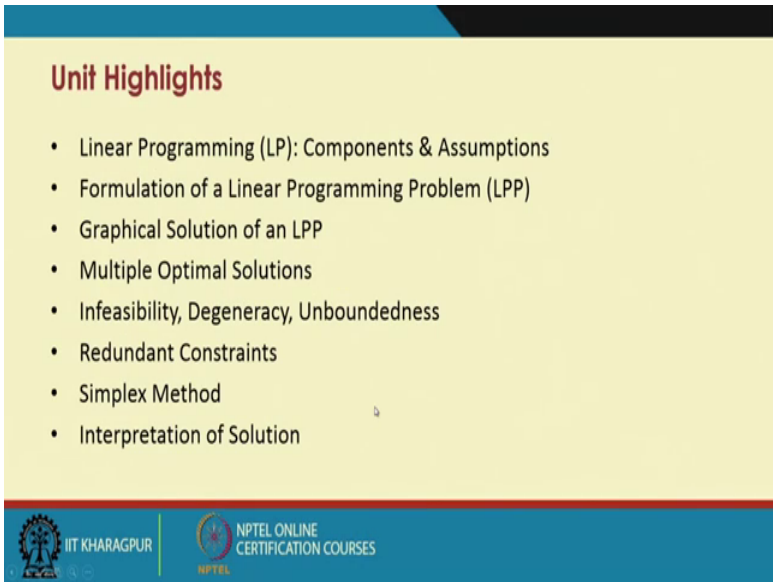

So these are all things you know we like to address here, and in a the a typical structure is like this, and means a if you talk about the linear programming, that is you know some of the assumption is also, there to address the particular you know situation. In fact, you know when you were you know analyzing a complex business problems or dynamic business problems and; obviously, some of the assumption you know very much required.

So, it is not in the case of you know predictive prescriptive analytics, it is also true equally true, in the case of you know predictive analytics or the kind of you know inferential analytics. So, it is also here and the first part of this particular you know structure is the formulation of you know linear programming problem that too with respect to a particular problem, then think about the kind of you know solutions. And since suppose I have already highlighted that you know it can be with respect to 2 variables or with respect to more than 2 variables.

So, accordingly we have a two different structure of the solution, and one particular structure of the solution is called as a graphical solutions, and another particular structure is called as a you know algebraic solution, that is in the context of you know linear programming it is called as simplex method procedure. In fact, whether you like to use graphical structure or you know algebraic structures that is not our actually main agenda our main agenda is the we have a kind of you know problem, business problems, and we like to you know have some kind of you know optimality, or optimum kind of you know requirement through which you can actually take a management decision more effectively.

So, accordingly so whether it is a you know graphical kind of you know structure through which you get the solution or algebraic kind of you know solution through which you get the solution that is not actually the kind of you know requirement, but the requirement is the solutions. In fact, you know most of the business problem is very complicated, and by the way it is you know there is high chance that you know it consist of you know more number of variables.

As a result in reality we like to address or we look for the optimality, or you know search for the kind of you know values of decision variable, in that for that actually simplex procedure is the more attractive way to get the kind of you know optimum solution. So, these are things actually we like to highlight here.

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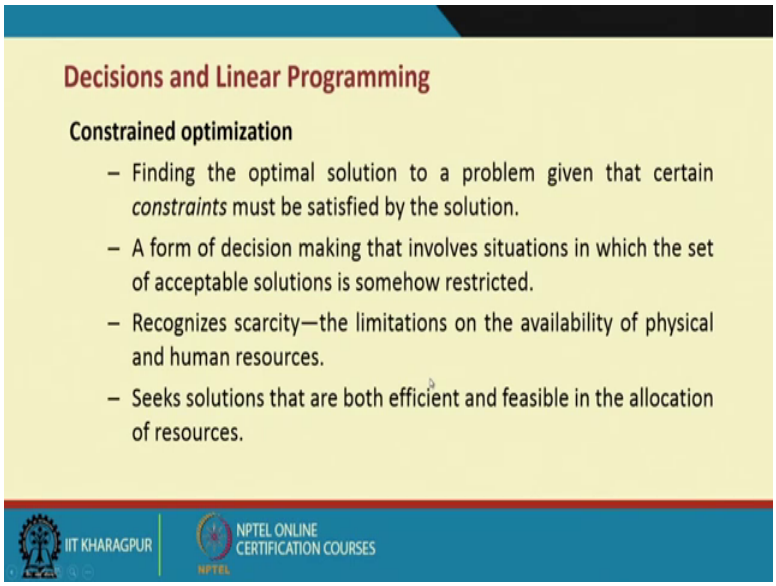

And by the way the LP structure is the a you know is the means the LP structure is the like this, you know we must have objective functions and the constrains.

What I have mentioned actually since it is a kind of you know decision making process so, at least you know 2 variables must be there in the system to address the kind of you know situation, then you know the structure is you know objective function with constraints, and again so, the objective function can be single objective it can have a multiple objective. So, accordingly we have two different structure of you know linear programming. So, linear programming structure one that is which is single objective, and a linear programming structure 2 with you know multi objective, that is sometimes called as multi criterion decision making process.

So, now, how we have to address a you know all this kind of you know situation, and again how to get the kind of you know optimum solution that is actually the kind of you know agenda here to discuss. So, now the discussion you know so, far as you know linear program is concerned and that too constraint optimization. So, looking for the optimal solution to a problem giving that you know certain constraint must be satisfied by the solution.

And it is a kind of you know decision making that involves situation in which the set of you know acceptable solution is somehow restricted, and understand the scarcity the limitations on the availability of you know resources, the kind of you know for the particular you know business a requirement or the kind of you know business investigation, and looking for the solution the that have actually very efficient and feasible with respect to all the constraints, and conditions and that to the with the kind of you know allocation of you know resources. So, these are the you know major things or you know through which we have to highlight.

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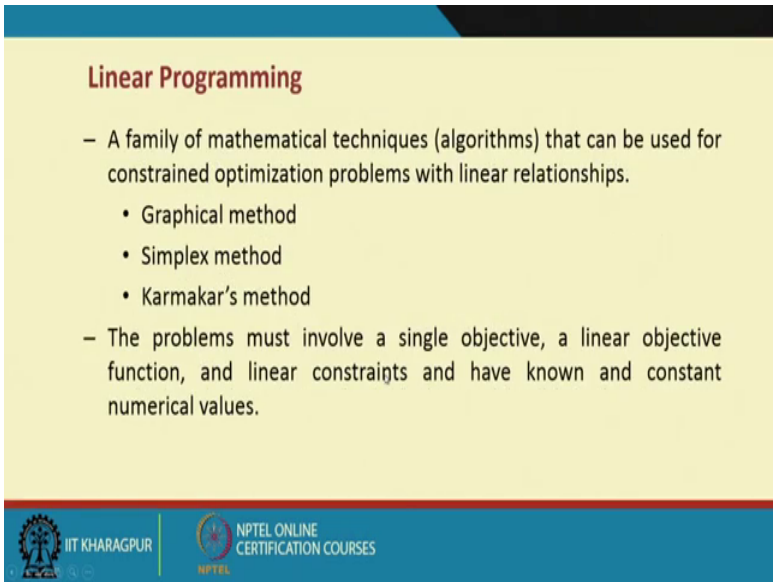

And then so far as you know solution is concerned that to linear programming it is a kind of you know familiar mathematical techniques, and a that is you know called as you know algorithm that can be used for constrained optimization problem with linear relationships.

Since it is starts with a linear programming so, whether it is an objective functions or constraints. So, the expressions will be you know in the form of linear. So, we have a kind of you know structure called as a linear combination and; obviously so the linear combination will be applied to both objective function, and constraints so; that means, you know the problem will be more interesting with you know at least 2 variable.

So that means, when you say that you know objective function, then the linear combination of both the variables will give you the objective function structure for instance, let us say x 1 is the variable, and x 2 is the variable, then the objective function will be like you know c 1 x 1 plus c 2 x 2. So, that is how the you know the kind of you know coefficient to x 1, and the coefficient to x 2.

That is what the decision variables right. So, means x 1 is the decision variable, and x 2 is the decision variable, but now when we put you know say w you know z equal to c 1 x 1 plus c 2 x 2; that means, c 1 is the kind of you know item corresponding to x 1 and c 2 is the kind of you know item corresponding to the x 2. So, now, we like means these are c 1 c 2 are the kind of you know parameters, and a then accordingly we like to you know

think about the kind of you know calculation of you know c 1 and c 2 through which you actually you have to address the particular you know problem so; that means, technically what I have already mentioned.

So, we have actually graphical structures or we have a simplex structure through which you can actually get the kind of you know solutions, and a the problem must involve a single objective, a you know a linear objective function a linear constraints, and you know kind of you know some kind of you know non or you know constant numerical values.

Like in the case of you know predictive analytics, which we have already discussed, there itself also corresponding to a problems we have to develop a models and the model will be this model usually like you know the kind of you know variables with you know parameters, and the kind of you know linkage, or the kind of you know relationship.

And we frequently use the data to get the values of the parameters corresponding to the kind of you know variables through which you can actually analyze the problem more effectively, and in the kind of you know prescriptive analytics structure the idea is also more or less same, and a here the idea is you know against we have a kind of you know objective function corresponding to problem, and then constraints, and the conditions, and every times whether it is objective function or constraints. So, the decision variable will be there and then corresponding to the decision variables.

So, we have a kind of you know constraints or kind of you know parameters, and the whole idea of you know optimization or the kind of you know structuring is the you know find out this parameters through which actually we can address the business problem more effectively, and then come with a kind of you know optimum solution, or the kind of you know optimality through which the you we can actually generalize the problem.

And that is the kind of you know basic requirement of you know prescriptive analytics so; that means, the whole objective of prescriptive analytics is you know to find out the values of the decision variable that is that is actually the optimal values of the decision variable through which you can analyze the particular you know business problem.

For instance you know let us say there are 2 variables x 1 and x 2, and a a x 1 and x 2 having actually a so many data points that is through you know let us say past data points, and then with the help of you know predictive analytics develop the model, and you generalize or you know a generate some you know future uh kind of you know requirement for both x 1 and x 2.

So, now, all together starting with the you know you know actual information that is the past information, then with the predictive analytics, we have actually future information; that means, we have a big pool of you know data for both x 1 and x 2, and the kind of you know combination for every x 1s you know there must be x 2 value. So, that is the kind of you know structure through which you know descriptive analytics predictive analytics just can work together.

And then in the prescriptive analytics, since x 1 x 1 and x 2 for each items whether with a particular you know cross sectional structure, or time structure for each cross sectional unit, or each time series unit, we have values of the a variable for x 1 and x 2 so; that means, x 1 you know set of you know in you know more number of variables, and x 2 is also set of you know more number of variable.

Now so far as the optimality is concerned which specific combination is the you know perfectly a you know required for the particular you know business problem. So, that you know the business can be address more effectively as per the particular you know business objective, or the particular you know business requirement, and that is what the kind of you know main agenda, and through which you can actually look for the kind of you know structure.

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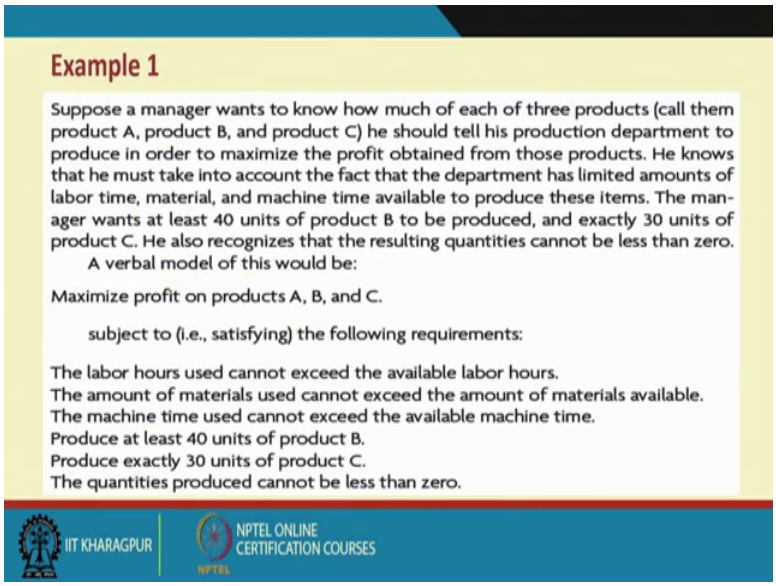

And a in fact, this is the kind of you know simple example, and through which you can actually understand the linear programming structure, and the idea about the linear programming structure is actually you have a problem, and the means that is the kind of you know theoretical background or the kind of you know structure of the kind of you know business.

And since we are in the kind of you know analytics game, and a we cannot or we are not in a position to you know solve the problems or the kind of you know we cannot reach the kind of you know requirement, until unless you transfer the theoretical structure into a kind of you know model format, again whether it is a kind of you know prescriptive structure, or predictive structure, or the kind of you know inferential structures.

So, we need a know kind of you know model through which you can use the data, and then use the kind of you know technique, then we can we can create we can create a kind of you know flexibility environment, or you know flexibility structures, and within the flexibility structures we like to you know find out the kind of you know best, you know choice through which you can address the you know business problem more effectively.

And that is what the main agenda of this particular you know you know unit. And let us start with a simple game here, and our simple problem business problem. Suppose a manager wants to know how much of each of the a 3 products, you know call them product A, product B, and product C. He should you know tell his production department

to produce in order to maximize the profit, obtained from those products so; that means, technically so, it is the kind of you know 3 products game. And a so the this is actually production and operation kind of you know environment.

So, when we are talk about a kind of you know business you know structure, or you know business problem the a ultimate time is you know to obtain profit, and the kind of you know revenue maximization, profit maximization, cost minimization. So, all these things are you know usually in the kind of you know those steps, in the in the structure of you know any kind of you know business.

And here also same thing say in the kind of you know a production game. So, we have a kind of you know 3 products. So, we are interested to know. So, what should be the volume of these 3 production? So, that you know profit can be optimized and; obviously, if in there are 3 production you know production case in we need a kind of you know combination, linear combination of these 3 products a b c through which actually the business problem can be at the you know optimum levels that is the you know to have you know optimum profit.

And obviously, a so it is actually under the particular you know couple of constants, and in this particular you know case we have actually the structure is you know all these 3 products will be through you know different departments, and accordingly we have a labor time, material time, and machine time, to produce this you know kind of you know products.

So, the manager wants at least you know 40 units of product B to be produced, and exactly 30 units of product C to be produced, and a he also recognize that the resulting quantities cannot be less than 0 so; that means,; obviously, since it is a kind of you know production process. So, the output cannot be you know 0 if output will be 0, then the entire game is over there, and again output cannot be negative. So, that is how in the linear programming format. So, we put the restriction you know with respect to let us say A B C. So, we can you know transfer into or you know we can you actually symbolize x 1 x 2 x 3 so; that means, x 1 x 2 x 3 are decision variables.

So, now a whatever may be the shape of problem, whatever may be the structure of the problem, the values of the decision variables in this case here x 1 and x 2 x 3 cannot you know cannot you know negative yes of course, a sometimes it can 0 or sometimes you

know it can be more than 0 so; that means, you know when we are looking for a kind of you know combination, and looking for the kind of you know optimality where profit can be a the a high level.

So, that times so, there is high chance that you know the particular you know you know values of the variables you know 0 will be 0, and a obviously, if particular variable will be 0 the other case it will be very high, but to the more you know feasible structure will be all these items will be there in the system, and all will be in a kind of you know positive structure.

So; that means, we need to connect with you know kind of you know structure, where all the production can you know take place, and then the you know the optimization structure can happen. So, that you know it will be (Refer Time: 03:35) kind of you know situation. So, that you know a particular product cannot be discarded, and then we will look for the optimum solution.

So, a it is not so easy to find out the kind of you know structure, but still we are looking that is how analytics are you know the kind of you know business analytics will help you to understand the particular you know requirement, and the kind of you know need. So, now in this contests. So, our objective is to maximize profit on products A and B, A B C and subject to the following kind of you know requirement.

So, the labors labor hours used cannot exceed the a available labors that is what you know we have here, and then the machine time used cannot exceed the available machine time, and produce at least 40 units of you know product b produce exactly thirty units of you know product C, then the quantity produced cannot be less than 0. So, these are the kind of you know condition so; that means, you know a from these particular you know problems.

So, it is very much clear that you know. So, in real life scenario particularly in the kind of you know business, kind of you know scenario. So, we have lots of you know conditionality right. So, that is how prescriptive analytics and the kind of you know optimization tools like linear programming a problem is a having actually key requirement.

And because when there is a kind of you know conditionality, and the kind of you know restrictions, and this a this a this tools are you know very effective to address the a problems, and come with a kind of you know solutions as per the you know as per the particular you know business requirement, and the kind of you know management requirement.

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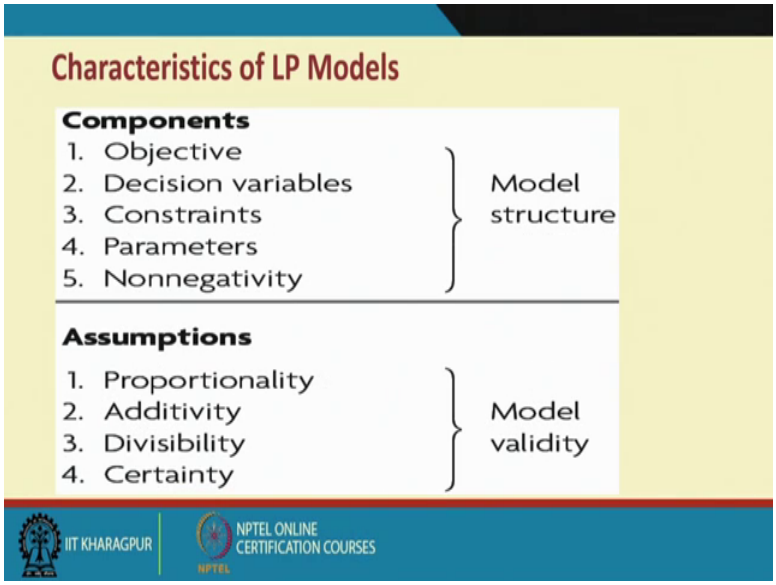

So, now corresponding to this you know simple structures. So, the linear programming can be you know linear programming model can be you know analyzed, and that is with respect to objective function values of the decision variables, constraints, parameters, non-negativity, and some kind of you know assumptions.

So, you know with this we will stop here, and in the next class we will continue with this particular you know discussion, and then we will address the particular business problems with you know linear programming format.

Thank you very much have a nice time.