Business Analytics for Management Decision
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Lecture – 53
Prescriptive Analytics 3 (Contd.)

Hello everybody, this is Rudra Pradhan here. Welcome to BMD lecture series. Today we will continue with prescriptive analytics, and that too coverage on goal programming. So, in the last couple of lectures, we have already discussed linear programming concept and we have discussed various types of, you know, problems various types of, you know, techniques various kind of, you know, requirements.

In the last couple of lectures, we have discussed a concept called as a integer programming, which is a special specialized case under the linear programming problem; where we look for the optimal solution corresponding to a business problem, where the values of the decision variable will be integer type. And we have also , you know, discussed a particular case where we look for the optimal solution corresponding to a business problem, and against we look for integer type solutions and that too again within the umbrella of, you know, binary numbers that is 0 1.

So, that is why the concept was 0 1 integer programming. So, the idea behind this particular, you know, discussion is like, you know, we are highlighting various special issues depending upon the particular, you know, business requirement. Or you know, problem requirement in fact, we have discussed the these problems in a solver package. And before we start the goal programming's, let me take you to the kind of, you know, structure where we have discussed the concept called as, you know, integer programming.

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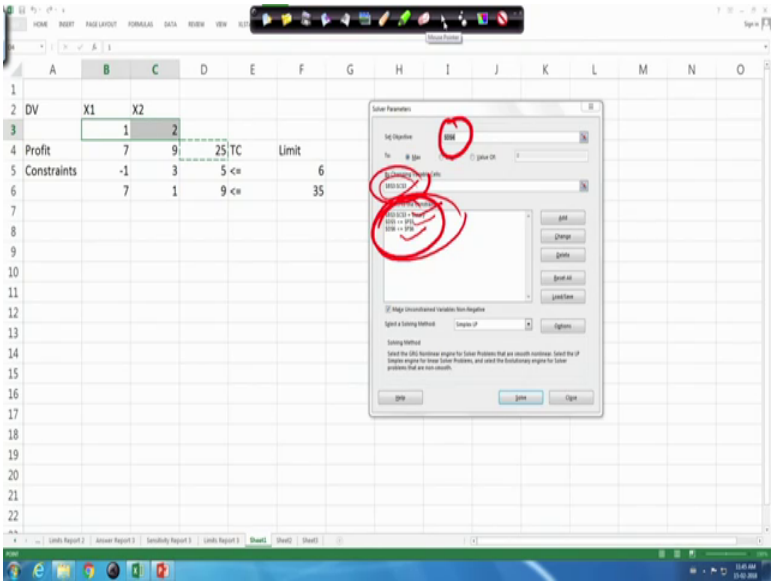

. So, in the case of, you know, integer programming's we have solve the kind of, you know, requirement here. And let us start with a simple problem here. So, we have a simple problem, and where we have 2 decision variables X 1 and X 2, and then we have a profit function corresponding to X 1 and X 2, that is 7 7. For X 1 and 9, for X 2 as a result profit function will be maximizing Z equal to 7 X 1s plus 9 X 2 and subject to 2 constraints minus 1 is for X 1s and 3 for X 2. So, as a result the first constraint will be a minus 1 plus 3 X 2, and that too limit is here 6 that is less than equal to 6. That is the maximum research availability and again second constraint is 7 X 1s and X 2 less than equal to 35 that is the research availability.

And we have already solved here the typical, you know, case. And this typical the solution which is nothing but actually called as, you know, integer type solutions. So, that means, the problem which we have solved earlier is a integer type of, you know, solutions. So, you see here we in the in the in the specific case here. So, this is the target of, you know, objective functions; that means, typically.

So, this is the objective function target, and this is the target of, you know, decision variables. And this is the target of, you know, constraints and which we have already actually a highlighted corresponding to this problem. And after the solutions uh, you know, uh, you know, without specific, you know, kind of, you know, requirement. So, we have X 1 equal to 1, and X 2 equal to 2 that too, you know, we have reached the

optimality and the we have received the values of the decision variables. however, the values of the decision variable, you know, are integer you know.

But , you know, they are not in a kind of, you know, 0 1 integer type a. So, we have a special case again. So, that means, technically if you if you go to this particular, you know, add ones. So, you if you put, you know, the kind of, you know, add ones here. So, you will find there is a restrictions.

So now, what will you do? So, the restriction will be with respect to X 1 X 2 because that is our decision variable, and the typical restriction about the integer or the kind of, you know, 0 1 integer. It is strictly with respect to values of the decision variable. So, that is why so, the in the solver package after putting all the entries with respect to objective function constraints that the kind of, you know, limit this a inequality equality constraints. So, after setting all this things, the last option we have to put, you know, in the solver is the kind of, you know, integer type of, you know, requirement. And agains if there is need of, you know, 0 1 a kind of, you knows, integer type. So, again you have to put the, we have to put that particular restriction again. So, that means, till now we have put the integer type requirement.

So now we will put the requirement of, you know binary type. So, here you will find in the , you know, solver mechanisms. So, we have a uh, you know, option (Refer Time: 05:07) So, that that by default will take you to the a, you know, the solution which is, you know, is a kind of, you know, 0 1 structure that is the binary structure. The way we have discussed in the last class corresponding to 4 different variables, where we have a 16 different cases and out of which a particular case to be finally, , you know, fixed and that will that will a help you to address the business problem as per the particular requirement. After putting the add ones.

So, put the so now, this screen will be appear like this. And then by default so, you can say this is all different case this is extra kind of, you know, options which you can also delete. So now, this is actually the kind of, you know, requirement. So, that means, what we have done till now? So, the requirement is here so, the uh, you know, the kind of, you know, what we can say. So, this is the restrictions and this is constrain 1 constraints 2 and this is the binary requirement, and this is how the decision variables a, you know, , you

know, entry. So now, after, you know, putting or setting all these things. So, what will you do? You just, you know, ask this solver to run the model.

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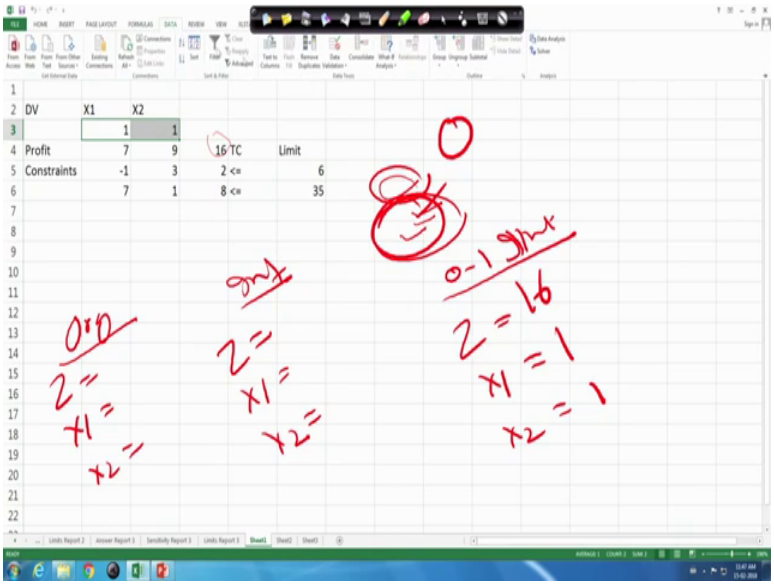

So now here you will find. So, solutions and X 1 is 1 and X 2 equal to 1. And that too so, you will find the value of the decision variable will be actually 16 so that means, see here is so now, the first option here, the first option is here. So now, optimize. So, the (Refer Time: 06:43) this is this is ok. So now, see here so, what will it do? So, that means, we have a 3 options this original problem, where we have a Z value X 1 and X 2 , and then we have a integer type a solutions where Z we have a Z value X x 1 value and X 2 value, and agains we have 0 1 integer type, you know, solutions, where Z Z we have a Z value we have X 1 value and we have X 2 value.

So now, we can have a we know more, you know, comparative kind of, you know, situations. So, you see here corresponding to uh, you know, since with respect to, you know, 2 variables X 1 and X 2. So, all together there are 4, you know, different cases 0 0 0 1 1 0 and 1 1. So, so, the solver gives, you know, the highest ones corresponding to the optimized value of the Z and which satisfy all the conditions.

Now, here in the case of, you know z. So, it is coming actually 16 so, that will be 16 here, and X 1 equal to 1 X 2 X 2 equal to 1. So now, agains what will you do? You go to the , you know, package and agains what will you do? So, we like to, you know, solve the problem. So now, you remove this particular, you know, this is the, this is what the

requirements. So, what you if you remove the binary requirement then that means, you put the delete options. So, if you put the delete options then binary restriction will be removed. So now, it is removed. So now, you put, you know, ask the solver to give the solution. So now, a, you know, now putting this particular, you know, structures.

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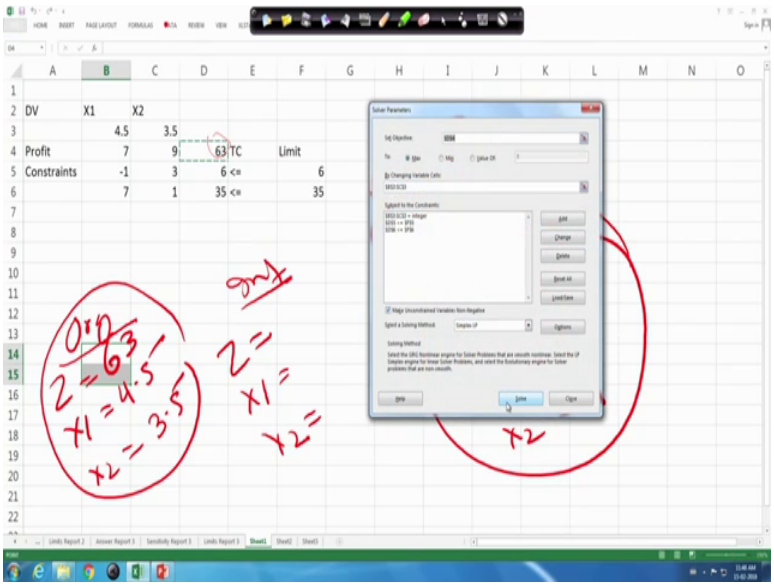

So, so, solve this case so now, this is coming actually here original solution. So, where Z equal to 63. So, here Z equal to 63 and X 1 equal to 4.5 and X 2 equal to 3.5. So, this is what the original solution, this is what 0 1 integer type solution. And agains so, go to the, this go to the solver, agains go to the solver and look for the solutions and that too integer type. So, for that again we have to add a restrictions. So, that means, we have to go to add options, and then you choose the values of the decision variable that is here X 1 and X 2.

And now you put instead of, you know, , you know, a binary you put the integer type, you know, requirement then you put ok. And then ask the solver to give the solutions.

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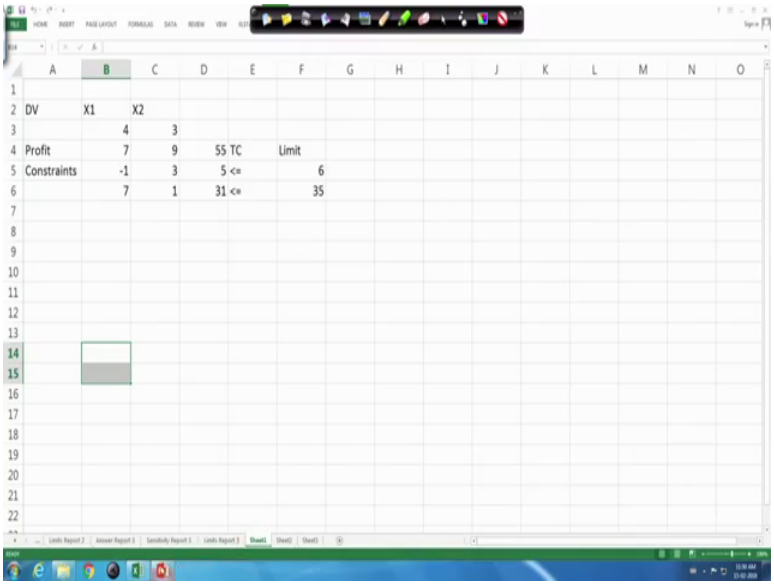

So now, here the solution is Z equal to 55 a Z equal to 55 and X 1 equal to 4 and X 2 equal to 3. So, this is what the integer type solution. So, that means, now you will find there are 3 different situation all together. A corresponding to original problem where optimize Z equal , you know, Z equal to 7 X 1 plus 7 X 9 X 2 subject to minus X 1 plus 3 X 2 less than equal to 6 , less than equal to 6 and then 7 X 1 plus X 2 less than equal to 35. So, the original solution is the Z equal to 63, X 1 equal to 4.5 and X 2 equal to 3.5.

Now if you put the integer requirement, then Z will be compromised to 55; that means, there is the , you know, reduction of, you know, profit level here and where X 1 equal to 4 and X 2 equal to 3. So, so we have now business about the values of the decision variables, since it is coming integer type. So now, we will if you will compare the Z value it has a it has a decreasing tendency. And again, so now, if you put 0 1 integer type solution.

So now, here Z is coming 16 so now if you will see originally Z, Z was 63, then 55 now it is come down to 16s, and where X 1 equal to 1 and X 2 equal to 1 only. So, this is actually very, very strict, you know, strict conditions for the kind of, you know, business requirement. And then you can apply this particular, you know, model if it is highly required for a business scenario or the management, you know, structure. Otherwise, you know, applying 0 1 integer programming to have the solutions, you know, may reduce your, you know, profit level if there is, you know, high such, you know, requirement in a

in a particular, you know, problem a. So, this is how the, you know, result are in front of you. So, you can compare and, you know, check how is this kind of, you know, structure yes (Refer Time: 11:28) they are very interesting and very useful, but it is very strictly problem specific.

So now coming with this kind of, you know discussions. So now, what will you do? So, we will go to the kind of, you know, , you know, structure now, where we have another kind of, you know, module that is called as, you know, goal programming. So, corresponding to integer programming goal programming is also very interesting, and it is also problem specific and it is a target-oriented game.

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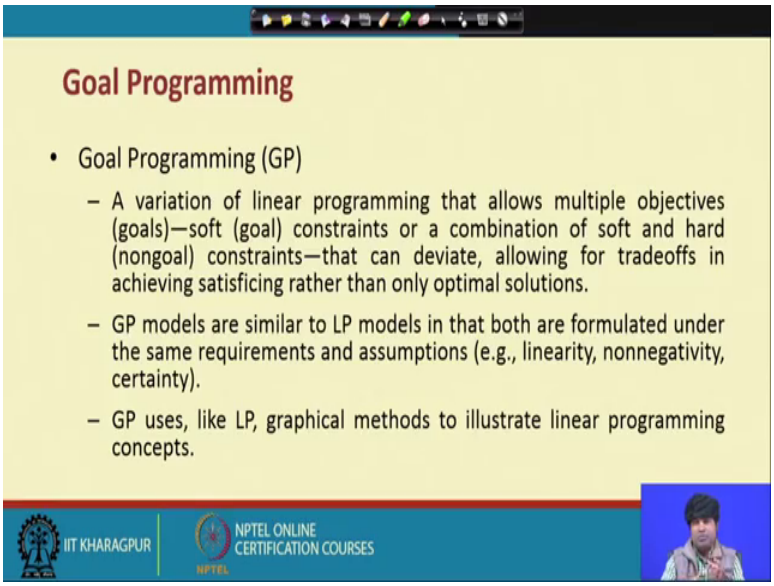

And we start with a simple structure of, you know, goal programming. It is not highly highly, you know, different from the uh, you know, items which we have discussed in the context of linear programming. And as it is somehow, you know, another kind of, you know, uh, you know, conditions or, you know, kind of, you know, restriction which will impose while solving the kind of, you know, business problem. So, means we start with a simple linear programming, then one after another we are, you know, discussing different kind of, you know, cases or the kind of, you know, special cases through which you can, you know, you know, revisit the business problems and then look for the solution optimal solutions as per the business requirement and as per the requirement of the management decision.

So now in the simple structure or simple understanding goal programming it is a variation of, you know, linear programming. That allows multiple objectives, and that is what goals sub goals constraints or the combination of, you know, soft and hard that is non-goal constraint that can be deviate allowing for tradeoffs in achieving satisfying rather than only optimal solutions. So, that means, you know, a it is typically multi objective kind of, you know, structures. Earlier we have discussed, you know, couple of problems and uh, you know, that too couple of business problem corresponding to a single objective with, you know, multiple constraints, and that too bivariate structure and multivariate structure.

But here it is a kind of, you know, very, very specialized case, and where we have a multiple objectives, right. And that too we have to fix the goals and then , you know, we look for the optimal solution which can address the business problem more accurately, more effectively and more efficiently.

So that means, you know, it is a very target oriented games or target oriented business uh, you know, and for future requirement that is how analytics plays very key role. And that too in the prescriptive kind of, you know, analytics. So, we typically have a kind of, you know, future requirement and that is how the goal programming has a kind of, you know, beautiful structure through which you can which through which you can, you know, get some kind of, you know, you know, output that will address the business problem more effectively as per the future requirement.

Or the as per the kind of, you know, present requirement so, goal programming models are similar to linear programming models in that case both are formulated under the same requirement and same assumptions that is the linearity, non-negativity and certainty and the kind of, you know, typical restriction. And goal programming uses like, you know, linear programming graphical method to, you know, highlight the particular, you know, concept. So, that means, you see whatever, you know, problems we have discussed uh, you know, whether it is a simple linear programming or it is a kind of, you know, integer type programming or it is a kind of, you know, goal programming. So, in the same times we can use actually either graphical structure or simplex structure to look for the optimal solution.

And that means technically, so, graphical methods and simplex methods that is the primal simplex or dual simplex these are the typical tools through which you can actually, you know, look for the optimal solution corresponding to a business problem. And that too we like to choose the technique depending upon the type of, you know, problems like bivariate and multivariate, and then the kind of, you know, constraints and the kind of, you know, requirement if the constraints, you know, having, you know, say supportive to the simplex uh, you know, simplex mechanism simple simplex mechanism you can apply the simple simplex mechanism.

Or else if the constraints are, you know, supporting the dual simplex process, then you can apply dual simplex methods to look for the optimal solution. And that means, these are all various options with you to solve a particular business problem as per the particular, you know, management requirement. So, that means, whatever special cases and, you know, different issues we are, you know, addressing. So, goal programming is also a typical case through which you can actually highlight some of the business problem more effectively and that too with a future requirement with, you know, , you know, more, you know, vision kind of, you know, scenario.

So, that means, it is a it is basically, you know, long term basis this will this particular tool will be very effective to address the business , you know, effectively. And so, far as goal programming models are concerned. So, we have strictly the following requirements.

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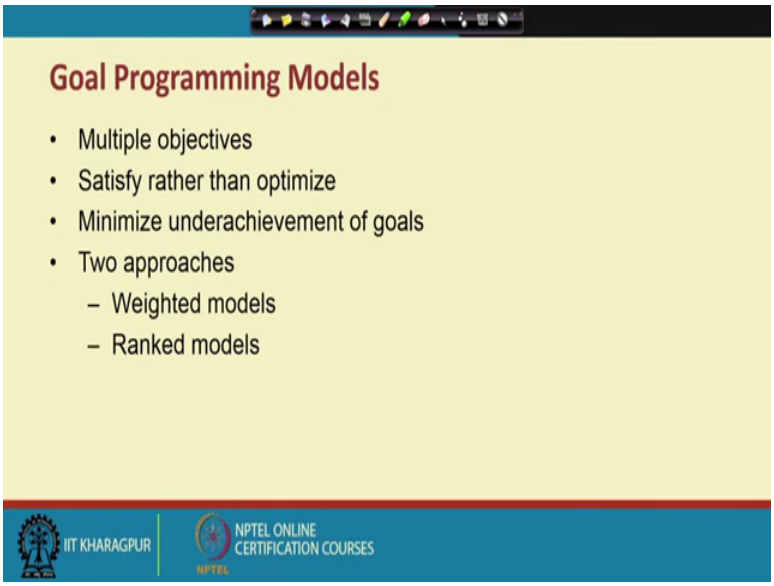

So, first requirement is the we must have multiple objectives, and satisfy rather than , you know, optimize. So, that means, we are not every time, you know, looking for the optimal solutions. But every times we are looking for optimal solution that is the first-hand requirement, but in the same times with respect to business requirement or the kind of, you know, management requirement or the kind of, you know, societal requirement we have to do lots of, you know, compromise. That is why the specific technique or, you know, specialized technique like integer programming goal programming's are very effective tools to, you know, bring the optimal solution as per the business requirement as per the kind of, you know, societal requirement.

So, here the, you know, our issue is to minimize under achievements of, you know, goals. And that means, technically we have actually discussed several issues in the kind of, you know, predictive analytics in the predictive analytics what we have discussed there are 3 different types of, you know, models or 3 different types of, you know, scenarios. So, the first one is the called as, you know, exactly identify models and if not then we have 2 different options.

One is called as under identified model another is called as, you know, over identified models. So, that means, so, this is this is like, you know, confidence intervals. So, corresponding to a particular objective, if it is exactly, you know, fitted as per the objective constraints conditions requirement specific goals or something like that. So,

then this particular structure or this particular model is called as, you know, exactly identified model. And if not then we have little bit, you know, plus minus that is what the confidence interval and the (Refer Time: 18:11) one is called as, you know, over identified case and the bottom one is called as, you know, under identified case.

So, in the linear programming problem corresponding to, you know predictive analytics. So, we have the typical, you know, strictly optimizing output, then corresponding to strictly optimizing output. We have our kind of, you know achievement in goals and under achievement of, you know goals. So, in the dull in the goal programming so, we have a 2 different approaches to address the problems as per the business requirement or look for the solution as per the business requirement setting more number of goals corresponding to a particular, you know, models that too with, you know, giving resources with, you know, giving the requirement of, you know, revenue profit and something like that.

And then we look for the optimal solutions. So, there are 2 approaches to solve the goal programming like in the case of, you know, integer programming, we have already discussed cutting plane mechanism and, you know, branch and bound mechanism. So, the first approach in the goal programming to look for the optimal solutions to achieve the particular, you know, target or the goal. So, that is the weighted models and then the rank-based models.

So, we have to assign, you know, first of all, you know, we must have a, you know, more number of objectives, that is that is typically called as, you know, multi criterion decision making, you know, process. So, multi criterion decision making process means, means all these models which is nothing but, you know, helpful for, you know, decision making process that is why management decision is very, you know, effective in these kind of, you know, scenario, when we will look for the optimal solutions, and getting the optimal solution as per the business requirement then management decision by default will be very effective.

But here is, you know, there are scenarios where, you know, we have multiple objectives. So, when there are multiple objectives then some complexity by default will be there for instance if it is a single objectives. So, there is no point to compromise anything ok. So, of course, you know, the kind of, you know, integer or 0 1 integer these are all, you

know, specific requirement business requirement. But it is not the kind of, you know, target or, you know, goal specific kind of, you know, approach. But in real life scenario a having, you know, big business or, you know, dealing with, you know, big problems so, then, you know, there are, you know, , you know, more number of, you know, objectives simultaneously. So, it is not just to, you know, achieve a single target or single objective you have multiple target and multiple objectives.

So, when your business is very big then by default, you know, goals and objectives will be also very high. So, so when you have more number like, you know, what we have discussed with a single objective, if you have a more number of constraints and condition you will find, you know, the kind of, you know, optimality and the value of the objective function, you know, strictly a restricting accordingly means according to the restriction and condition and what we the way we are, you know, imposing.

That is what we know we have already highlighted the original problem the optimal solution the solution with respective integer type then solution with respect to 0 1 integer type. So now, here the special cases, you know, since corresponding to a particular, you know model case with respect to 2 variables or, you know, more than 2 variables. So now, we are adding another, you know, or, you know, few more constraints corresponding to the objective functions. So, that means, we have multiple objectives and multiple targets. And in that case so, the complexity of the problem will be more, you know, high.

And then within the complexity with within the kind of, you know, business requirement with the kind of, you know, business conditions agains we look for the optimal solution. And so, the first one is the weighted models so, here we have to first identify the number of objective or specify number of objectives, and every objective can be connected with a particular, you know, weight. So, we have a 2 different mechanisms all together, equal weightage principles and, you know, unequal weightage principles.

In fact, if you say equal weightage principle then, you know, then you go by simply actually simple approach. But when you will go for, you know, unweighted kind of, you know, approach. So, where let us say there are 3 objectives. So, ultimately how much weightage you will give into first objective how much weightage you will give into second objective and so on. So, assigning weight is a very typical issue. And so, that is,

you know, that you have to derive properly and then fix before you start the particular process. Then another is, you know, rank based, you know, approach so, you have to assign the rank then, you know, start the process, you know, derivations so, likewise you will find.

So, for example, we start with a simple example here. So, here, there are there are 3, you know, what will called as you know 3 constraints.

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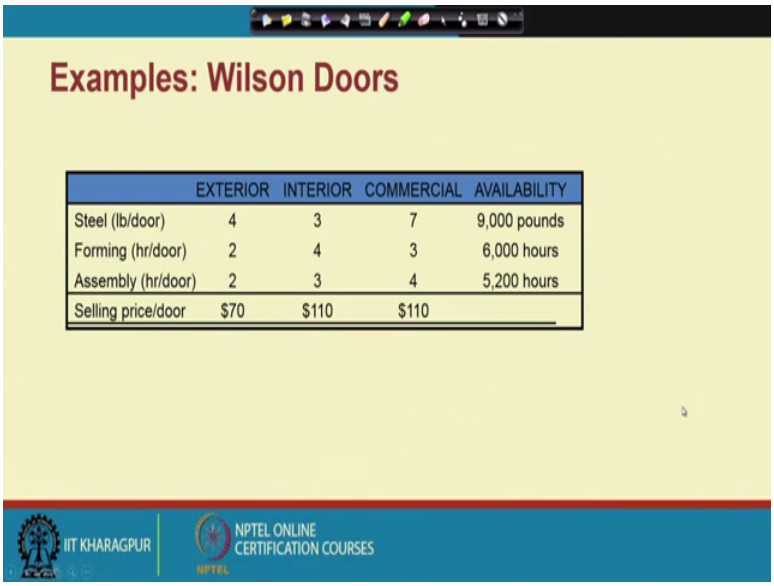

The constrain 1, constraint 2, constraints 3 and this is the objective functions and that too we have a 3 variables. So, this first variable second variable and third variable and corresponding this is a first constraint second constraint and third constraints and these are all restrictions corresponding to all these, you know, constraints and these are all, you know, objective functions value. That means, maxim the objective function will be maximized Z equal to 70 X 1s plus 110 X 2 and 110 X 3 subject to 4 X 1s plus 3 X 2 plus 7 X 1s less than equal to 9000 and then 2 X 1s 4 X 2 plus 3 X 3 less than equal to 6000. And 2 X 1s plus 3 X 2 plus 4 X 3 less than equal to 5200.

So, this is how the simple models, means, see whatever we have discussed you know. So, we always, you know, start with, you know, simple then we are putting restriction one after another. So, that means, you just imagine, you know, simple linear programming then the kind of, you know, cases special cases the way we are discussing. So, you will find, you know, very interesting and that too how that is how the prescriptive analytics

very interesting for addressing the business problem as per the particular, you know, business requirements.

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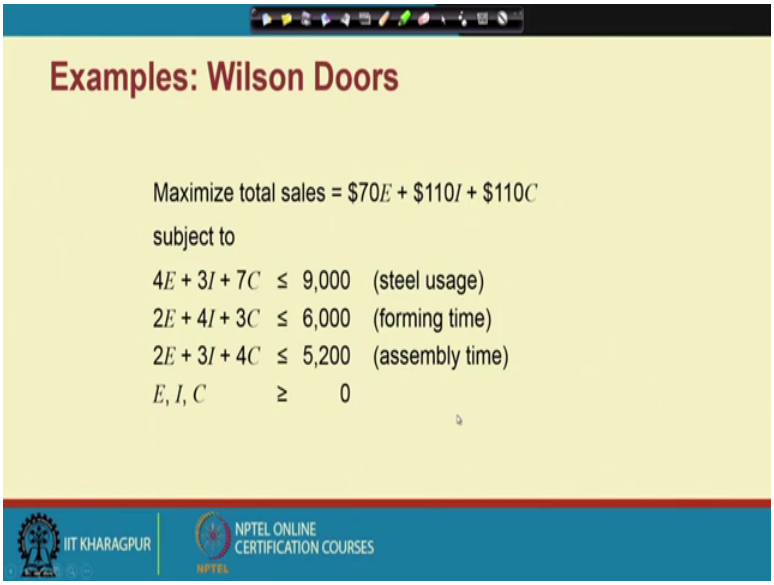

Now to transfer this particular case into models we will have what i have already mentioned. So, this is how the objective functions and these are the 3 conditions, and this is how the non-negativity restrictions. So, this is how we have transferred the particular, you know, information into a model format. And we like to now optimize this model. And since it is a linear programming and all are, you know, linearly related. So, you can easily actually start the process.

But the complexity will be, you know, complexity will start manually, you know, connect with, you know, different objectives.

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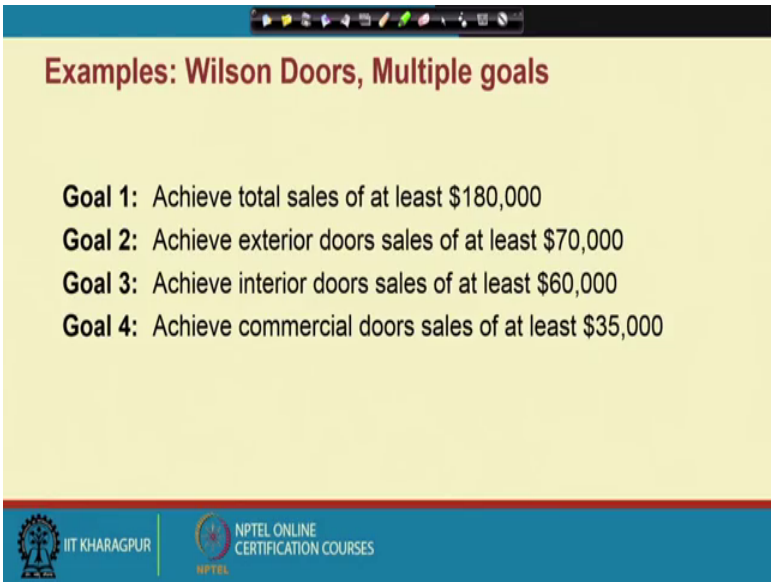

So now, in this particular, you know, problems so, 3 a 3 variables with 3 constraints. So, we are actually fixing here 4 different goals. So, the first that is why it is called as, you know, goal programming. So, we must have, you know, different goals then we will look for the goal programming. So, it is again very, very specialized, you know, kind of, you know, situations.

And that too, you know, to address the, you know, business problem. So, the first goal is the, you know, with respect to, you know, objective function achieve total sales of, you know, (Refer Time: 25:30) 1 180000. And then the second goal is the to achieve a, you know, exterior door sales of at least, you know, 70000, then interior doors achieve of, you know, interior door sales of at least 60000, then the commercial door cells is at least, you know, 35000. So, all these are actually with respect to decision variables only; that means, strictly towards the objective functions. So, because the objective function is X 1 X 2 and X 3 so, that is with respect to a exterior X 1s interior X 2 and commercial X 3, and in total it is called as, you know, total sales.

That means X 1 plus X 2 plus X 3. So, this is how 4 goals simultaneously are there corresponding to our, you know, original problem. So, our original problem is here. Our original problem is here is this, this one is our original problem, now we have a 3 different, you know, specification corresponding to this 3 specification we specifying 4 different goals. So, as a result this is a additional kind of you know, targets or the kind of,

you know, conditions where imposing to a problem while highlighting the, you know, business issue or, you know, dealing with, you know, business problem. So now, as a result you have to refresh the particular, you know, structure. This is again similar kind of, you know, sensitivity structure where we are putting more restriction more, you know, kind of, you know, you know, kind of, you know, conditions again, you know, look for the optimal solution as per the particular, you know, business requirement.

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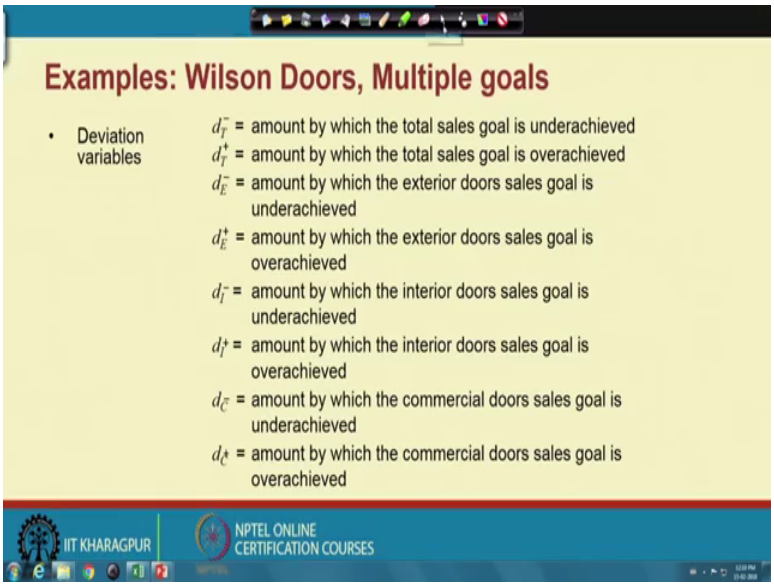

So now to set the business, you know, goal programming so, that means, the goal programming requirement is the original problem structures, and the targets that is the goals and now the original problems and the goals which we can combine. Then, you know, design a new models, and that models by default will be presented as a goal programming model, and then look for the optimal solutions which can address the business problem as per the particular, you know, requirement. So now, to design the, you know, goal programming corresponding to, you know, all these, you know, 4 objectives.

So, what I have mentioned earlier? So, we have a particular, you know, objectives, then by default for every objectives we have , you know, under achieved and over achieves like, you know, over identified and under identify model. So, that that a that is how so, we have actually 3 4 different, you know, targets uh, you know, goal 1 goal 2 goal 3 that too with total sales, then with respect to X 1 with respect to X 2 and with respect to X 3.

So, what will you do? So, we, you know, we define, you know, or, you know, we fix a kind of, you know, structure here, d T minus that is the amount by which the total, you know, total sales goal is under achieved. Then d T plus that is, you know, amount by which total assets goal of, you know, will be over achieved. So, this is with respect to total sales. And so, that means, if it this is the, you know, particular objective. So, we will go for, you know, over, you know, over achieved like this and under achieved like this. So, this is how the confident interval will.

So, that that is with respect to the first goal, and agains the amount by which the a exterior doors sales goal will be under achieved. So, this is with respect to X 1 and again d 1 minus 1 d 1 plus 1. So, this is with respect to X 2, and again d C minus 1 d C plus 1 this is again the commercial door sales goals is under achieved and over achieved and this is with respect to X 3. So, that means, corresponding to our, you know, objective functions. So now, we have a actually a, you know, designed a kind of, you know, structure or, you know, , you know, in such a way that, you know, the objective function has some kind of, you know, deviations.

That is how the goals we have achieved means, you know, see we are looking for the optimizations not only the existing resource need to be optimal, you know, connected and look for the a optimal solution where profit can be optimized or, you know, cost can be minimized and with respect to given, you know, resources and given, you know, , you know, constraints. But in the same times since it is a kind of, you know, business process so, every times we have a kind of, you know, targets we have a, you know, we have goals.

So, that is how there is a kind of there is possibility of, you know, deviations. So, that means, with respect to a specific objective uh, you know, when you are, you know, putting a target and, you know, goals. Then obviously, we have to actually work or we have to reorient the resource resources to, you know, achieve the particular, you know, target. So, while doing this one so, we are putting lots of, you know, risk a, you know. So, we may achieve we may not achieve.

So, as a result if we achieve how much, you know, average, you know, kind of, you know, our the particular, you know, target. Then if not then it is a kind of, you know, under achieved. So, that means, there is a little bit, you know, deviations corresponding

to a particular, you know, requirement. So, we like to know if there is a kind of, you know, deviation with respect to a particular requirement then what is the optimality structure all together. So, that means, corresponding to 4 different, you know, goals. So, we define, you know, 4 different, you know, new variables, and corresponding to under achieved and over achieved of a particular, you know, goals.

So, all together we have a now 8 new variables, which you can introduce in the set up and then redesign the models. Again, it is what I mentioned earlier any condition any restrictions whether it is with respect to constraints or with respect to variable or with respect to objective function it is nothing but, you know, sensitivity analysis structure. So now, after, you know, doing all these things. So, we look for the kind of, you know, structure.

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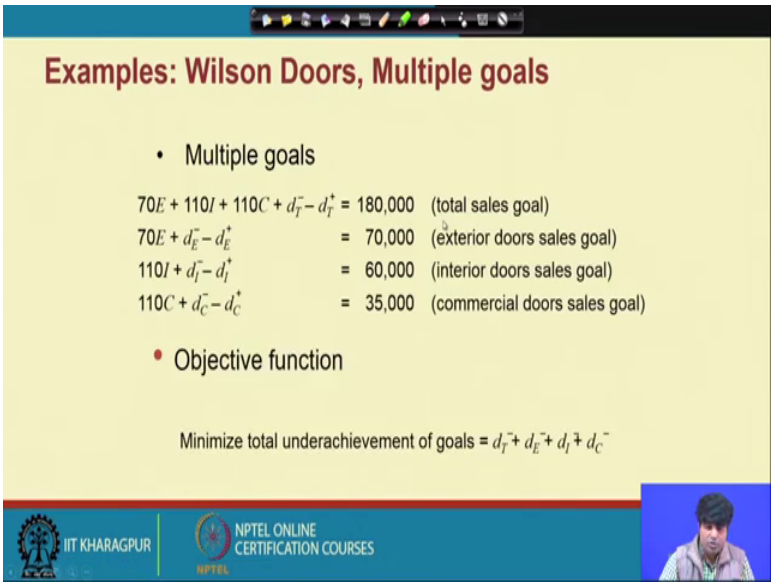

So now, so, the particular model can be a redefined again. So, so the particular, you know, multiple goals should be like this corresponding to the total sales. So, the corresponding to the total sales, this is what the particular item under achieve and over achieve.

So, this will be equal to, you know, 180000, and then with respect to the X 1s. So, this is with respect X 1s. So, 70 and this is with respect to second and this is with respect to third. So, as a result and these are the under achieved and over achieved targets and with respect to the kind of, you know, requirements we have fixed; that means, technically

these are 4 different constraints now to be added into the process. So, the objective function will be (Refer Time: 32:12) now. So now, minimize the total under achievement of goals , you know, that is how here is d T minus and d minus d 1 minus and d i minus and d C minus. So, that means, these are all actually under achievement goals. So, we like to minimize the under achievement of goals. So, that, you know, it will satisfy the business requirement and thee conditions and the kind of, you know, constraints. Then corresponding to these objective functions and the kind of, you know, constraints will be now the kind of, you know, constraint will be now like this.

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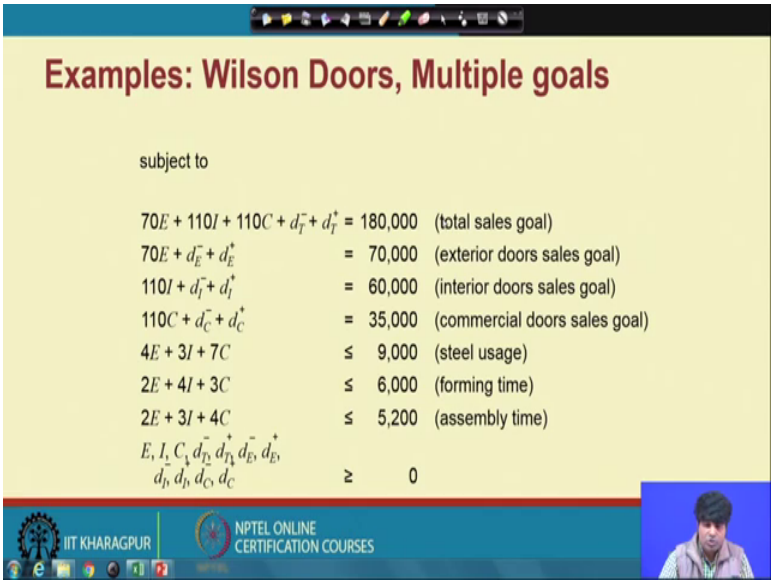

So, earlier we have we have this constraint, we have this constraint, we have this constraint. So now we have a new objective function now corresponding to this, you know, , you know, goals. And then so, these goals with respect to, you know, under achieved and over achieved. So, we have actually 4 different new constraints. So, the equality constraint that will be added into the process and then we look for the optimal solution; that means, now the original problem corresponding to this is this is what the original problem.

This is what the original problem now after the, you know, targets after the, you know, targets or, you know, goals. So, the model is now redesigned, and then the final model will be here is minimizing the objective functions is the total under achievement of goals subject to all this restrictions. Corresponding to our original problem we have 3

restrictions or 3 constraints. So now, we have actually 7 different constraints and while, you know, the objective function is with respect to 4 variables that too (Refer Time: 33:59) in the earlier case we have a 3 variables that is with respect to E i and C.

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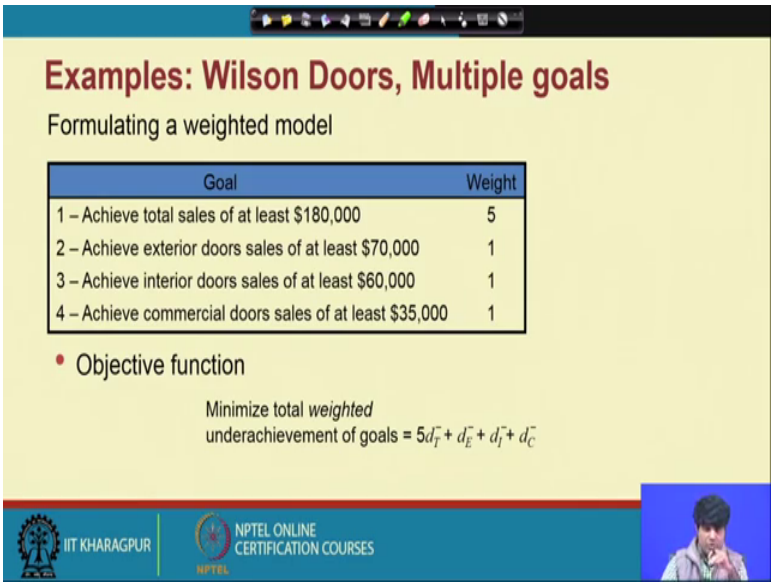

So now let us see how is the kind of, you know, structure and this is how uh, you know, after doing this ones then we can, you know, connect with, you know, either weighted kind of, you know, models or you know, rank based models.

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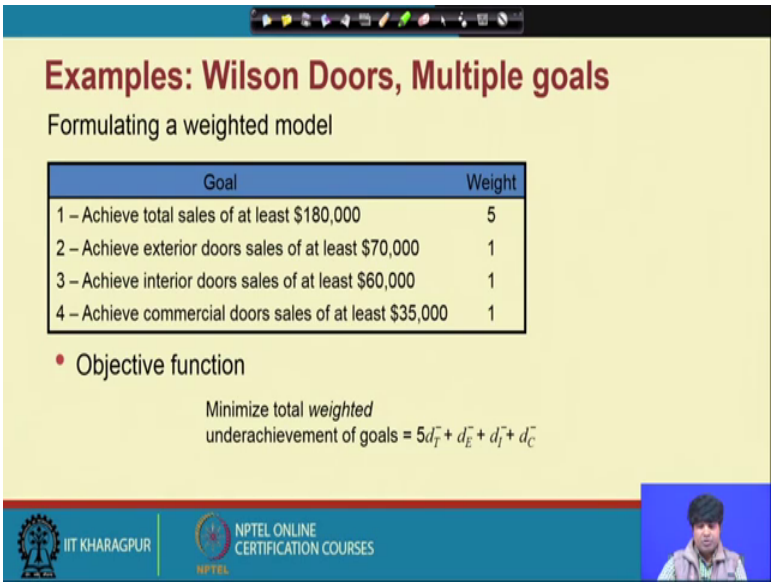

So now, if you go by weighted kind of, you know models. So, we are putting actually in the case of, you know, goal ones we are putting 5 and in the case of, you know, second, we are putting one third case we are putting one and 4th case we are putting one. So, then the new the typical objective function will be minimize the total under achievement of, you know, weighted under achievement of, you know, goals. So, that means, earlier the kind of, you know, structure was earlier structure was so; this is what the simple objective function. Now we like to actually optimize with weighted, weighted objective functions that is weighted under achievement of, you know, goals that to the minimization process.

So, just, you know, connect the weight with the corresponding variables like here is earlier it is here d T d E d i d C. So now, you have to just connect with, you know, weights corresponding to all these, you know, variables right corresponding to all these variable then, you know, refresh the particular, you know, objective functions. Now after doing this so, let us see the kind of, you know, structures.

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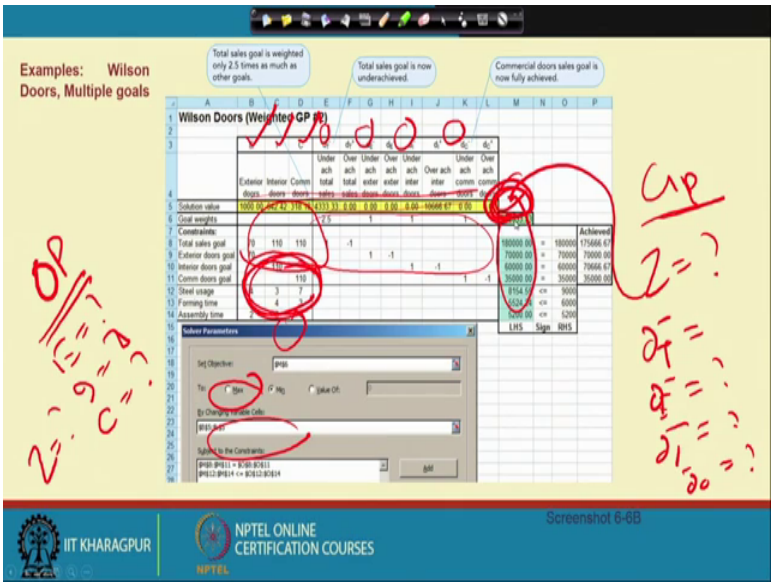

In fact, while doing this, you know, weight or, you know, rank you constraint structure will not change. So, these are all the constraints only we have to give (Refer Time: 35:33) the weight to the corresponding objective function, and then look for the optimal solution. So now, again you go to this solvers, and then these are these are the kind of, you know, structures through which you can. So, original problem is here 4 3 7 2 4 3 2 3

4 that is with respect to the variables E i C. And then is these are all actually the kind of, you know, targets or, you know, goals corresponding to the corresponding to a particular, you know, I targets that is means total sales goals that is the 70, 110, 110. So, that is means it is typically we derive from here only. So, this is what, you know, 70 110 110 and this by default will be 1 1.

And this is what the, you know, upper upper limit. So, just, you know, we, you know, (Refer Time: 36:35) the, you know, derive this variables, you know, inputs then putting the kind of, you know, extra solvers and these are the variable indications. Uh this is what the first variable second variable third variable and this is under achieved total sales; that means, technically a so, this is what the first variable second variable third third variable and this is what the original constraints.

And these are all called as, you know, these are all called as, you know, later constraints with respect to we know specification of the goals. And these are all the requirements of, you know, under achievement and over achievement targets. And then these are the limits with respect to the constraints. And then we look for the optimal solution it is a same process. So, this is what the values of the objective functions, and this is what the targets of the decision variables. And these are all weights and it is a simple kind of, you know, structure again then just, you know, operate the process same things here is like, you know, you have a objective function here and this is what the decision variables.

And these are all, you know, constraint, the way we have solved in the case of, you know, integer programming. So, that means, we can actually solve solve these , you know, the objective initial objective functions and these 3 constraint we can actually solve then look for the solutions. Now ah; that means, we have original problems, and then where we have actually E i's you have to find out E you have to find out i and you have to find out C. And then we can look for the optimum value.

So now, we have a goal programming here where we have actually 4 different goals, and then there is kind of, you know, targets and as a result. So, we have agians Z value. So, which is actually appearing here, and corresponding to, you know, new objective functions where we are targeting d T minus n then d minus n d i minus n and d C minus. So, that means, here we like to find out d T minus that is the under achievement targets

then d d minus d i minus and d C minus these are the these are the requirement which you like to report now.

So now with respect to, you know, setting just, you know, add on the all these constraints one after another. And since it there is no requirement of, you know, integer type of, you know, target then you just put ok. And then, you know, you look for the optimal solutions. So now, the typical optimal solution will be like this. So now, this is how the particular, you know, structures, and then this is what the solutions.

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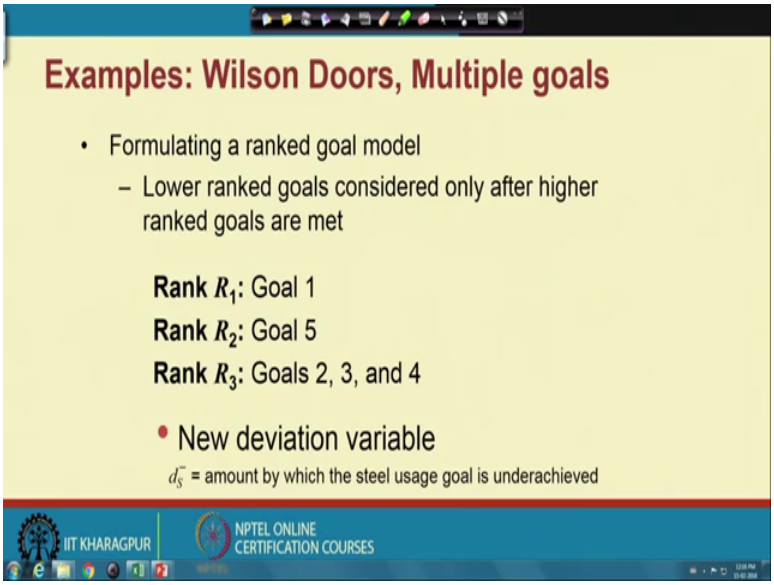

And then that solution will help you to achieve this particular, you know, target ok. So, that means, technically a the way the way we have actually uh, you know, set the goals. So, the results are here so, that means, technically the objective function will be 10833.33 corresponding to the values of the d. Means, we have actually values for, you know, decision variables, you know, for all the variables, but our target is the only d d T minus and d i minus d C minus and d minus. So, that that we have to actually target and then we have to, you know, find out the objective function value.

So, this is how the final output under this, you know, objectives.

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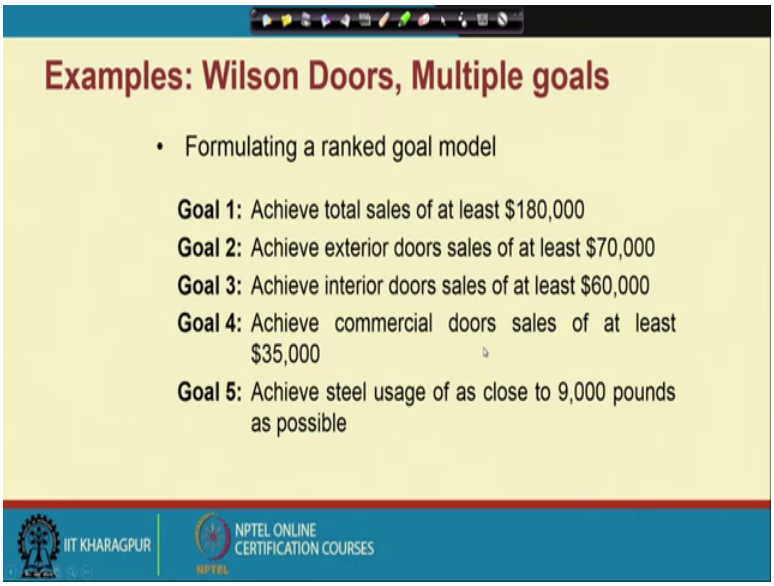

And formulating; that means, second task is the, you know, rank based goals where, you know, this same targets are there. And then we like to actually uh, you know, fix up the models and then this is what, you know, we are putting actually rank 1, rank 2, rank 3 and that to goal one, you know, goes to rank 1 goal 5 goes to rank 2 and then rank 3 is a, you know, in the case of, you know, goals 2 3 and 4s. So now, the new deviation variable will be d S minus and then accordingly.

So, the problem will be agains minimize the rank deviation; that means, in the weighted case weighted, you know, weighted model case. So, we like to assign where to corresponding, you know, under achievement targets. And then here in the case of, you know, rank base we are just assigning rank that is again similar kind of, you know, weights, but the rank will be connected with all the decision variables. And the constraints are, you know, more or less same. So, see here is in the earlier case here there are there is weight factor w 1 w 2 w 3 w 4. Now since we are putting actually 3 ranks corresponding to total sales then the kind of, you know d S. And then this is a second goal, and then the other goals which we have actually equal ranks.

So, as a result so, we have actually a 3 different, you know, rank requirements corresponding to the particular, you know, problems and that too the given, you know, constraints. So, same, you know, original constraints, and then we have here, you know,

the targeted constraints. So now, agains you look for the solutions now corresponding to this, you know, new objective functions and these constraint.

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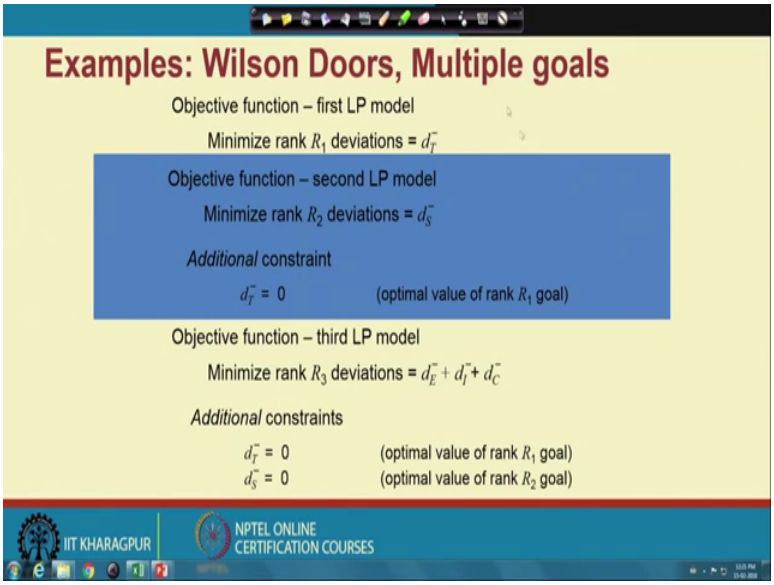

So, we will again go to the kind of, you know, solutions. So, the objective function the first l p model and minimizing rank 1 deviation d T minus 1 so, that means, technically the objective function minus second l p models. So, this how the then there is a additional constraint here. Then finally, a the objective functions minus third l p and minimize the rank 3 a deviation. So now, the total structure will be like this, and then finally, you look for the kind of, you know, solutions, the final solution will be like this. So, agains it is more or less, you know, same like the weighted case.

So, this these are all actually original variables, and these are all after targeted variables, and this is how the kind of, you know, constraint set ups. And thens agains you this is what the objectives and this is what the decision variables and these are all constraints. Now allow to solver to give the output then finally, the output is will be here. So, the these are all actually the kind of, you know, targets, and this is how the a rank base methods will help you to solve the business problem under the goal programming scenario.

So, as usual so, this is what the uh, you know, final the rank 2 goal only and this is what the kind of, you know, rank 3 goals only. So, that means, there are, you know, different cases all together. And so, this is what actually rank 1 case and this is this is what rank 2

case, and this a rank 3 case, because we have a 3 different ranks. So, that means, 3 sets of, you know, outputs now and corresponding to this particular, you know, rank assignment and that too with respect to 5 different a 4 different goals. So, we have actually different kind of, you know, structure through which you are looking for the optimal solution which can address the business problem more effectively.

So that means, typically in this particular, you know, structures we have discussed several kind of, you know, business problem dealing with various methods and there are within the particular, you know, structures we have discussed various specialized cases starting with, you know, integer programming 0 1 integer programming, goal programming and that too within goal programming weighted weighted based, you know, structure then rank based structure.

So, ultimately so, this will give you what we can say that, you know, more flexibility and, you know, more kind of, you know, (Refer Time: 44:24) kind of, you know, search process through which you can, you know, address the business problem more effectively and look for the optimal solution the values of the decision variables the kind of, you know, targets to be achieved. And then a we you may be in a position to address the business problem more effectively more efficiently then come with a kind of, you know, management decision as per the particular, you know, business requirement. With this we will stop here.

Thank you very much, have a nice day.