Traditional and Non-Traditional Optimization Tools
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Lecture - 33
A Practical Optimization Problem (Contd.)

So, we have seen how to determine the children solution for the whole population, using the principle of your simulated binary crossover. Now, here if we see we have got for one solution we have got 2 numerical values like b and h and here we have got 6 such solution in the population. So, 6 multiplied by 2; that means, your there are 12 such numerical values.

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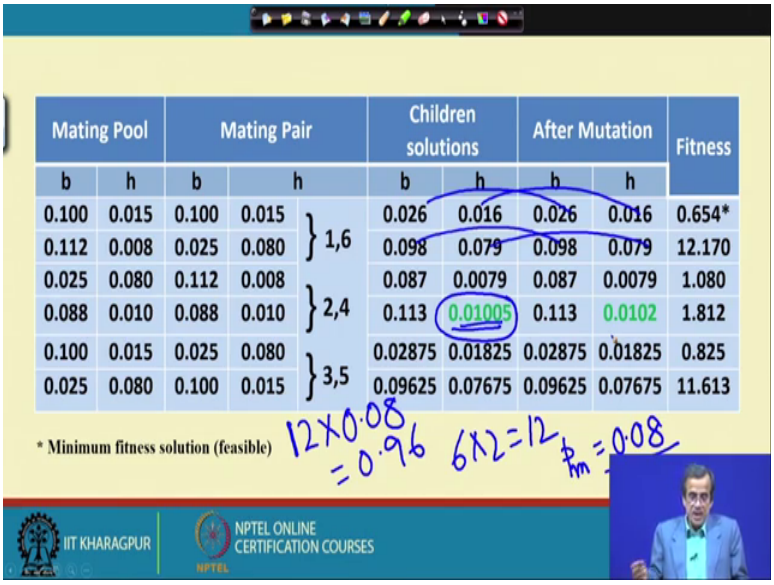

Now, what you will have to do is, we will have to concentrate on the probability of this particular the mutation, now here in this particular problem, the probability of mutation has been taken to be equal to 0.08, now what you will have to do is, we will have to take one decision, whether there will be any such mutation or not, out of these particular the 12 values numerical values. Whether there will be any such mutation, now to decide that actually what we do is. So, we try to find out one number that is 12 multiplied by 0.08. So, this is nothing but 0.96; that means, this is once again very near to 1; that means, your. So, if I just try this try, with these 12 numerical values there is a possibility probabilistically, that mutation will occur only on 1 numerical value.

So, once again to implement that; so, you will have to try with each of these particular numerical values, whether it is going to participate in mutation or not. So, what you can do I can use the random number generator, of generating that particular solution; that means, your if the random number generator, is going to generate a number lying between 0 and 0.08 it is a success; that means, that particular solution is going to participate in mutation, that testing has to be done at each of these particular the numerical values.

Now, supposing that it is found to be positive, that this particular numerical value is going to participate in mutation; that means, other values will remain the same, but this particular numerical value is going to be mutated, now what do you do is. So, here we directly copy the other solution, like 0.026 is copied here, 0.016 is copied here. So, this is copied here, this is copied here. So, this process will go on and go on, but corresponding to this, I will have to find out the mutated solution.

Now, let us see how to find out this particular the mutated solution and the purpose of mutation, as we know that just to give some local search to this particular GA, official local search to the GA we will take the help of the mutation.

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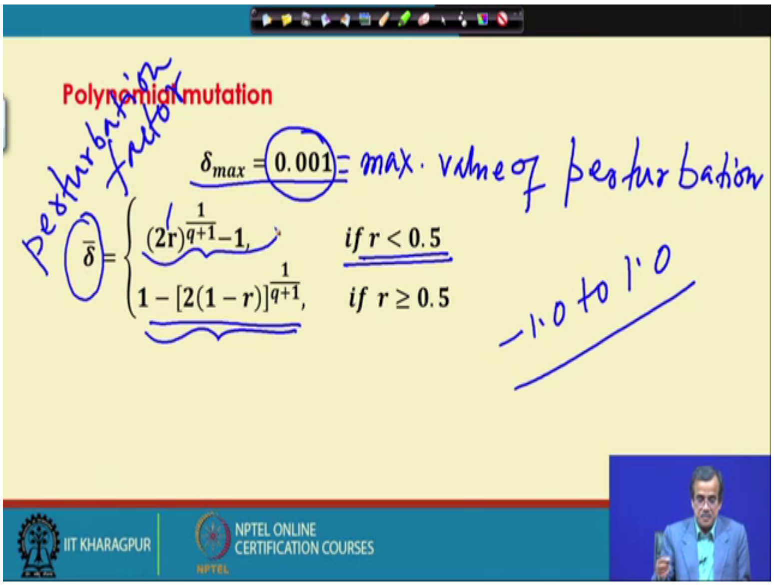

Now, let us see how to implement this particular the mutation. Now, if you see the literature, we have got a few mutation operators and here I am just going to discuss, the principle of a particular mutation operator that is called polynomial mutation.

Now, the principle of polynomial mutation I discuss little bit, now here actually what we will have to do is. So, we will have to find out. So, this particular delta bar, that is nothing but the perturbation factor, now this perturbation factor is actually perturbation is nothing but dissimilarity. So, I will have to find out the dissimilarity factor value and whose value will lie in the range of minus 1.0 to plus 1.0, in the normalized scale and this particular factor is going to tell us, how much dissimilar will be the mutated solution in comparison with the original parent solution. So, that I am going to discuss how to implement?

Now, here there is one that is called, delta max now this delta max is actually, the maximum value of perturbation or the maximum value of dissimilarity, which I am which I am going to tolerate, in the mutated solution and of course, this particular numerical value, depends on the range of this particular the variable.

Now, supposing that for this particular problem, I have decided delta max will be 0.001 and then how do determine the perturbation factor and how to proceed with determining the mutated solution, now this delta bar is nothing but 2 r raised to the power one divided by q plus 1 minus 1, if r is found to be less than 0.5, r is nothing but the random number lying between 0 and 1 and q is the exponent and here I will have to take a suitable value for this particular the q.

Now, this is the scenario if r is found to be greater than equals to 0.5; that means, I will have to use this particular expression, if r is found to be less than 0.5 this is the expression.

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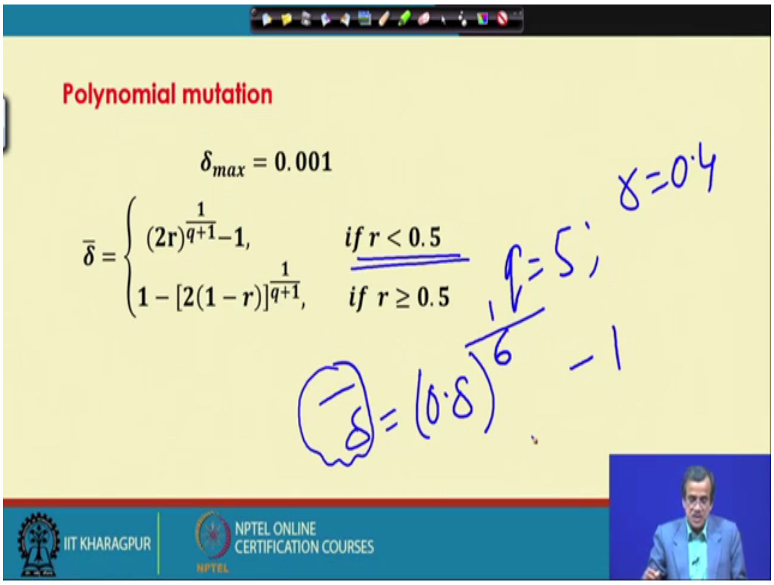

Now, let us see how to proceed with this. Now, using this particular actually what I will have to do is. So, I can do is like I will have to assign some value for this particular say q say, let me consider say q is equals to say 5, now if q is equals to 5. So, I can find out this particular the expression and supposing that say r is found to be less than 0.4 let us assume that.

Now, if that is the situation. So, your delta bar will be nothing but. So, r is say 0.4. So, this will become 0.8 raised to the power 1 divided by q equals to 5. So, 5 plus 1 that is 6. So, 1 divided by 6 minus 1. So, this is this is actually nothing but. So, this particular your delta bar. So, I will have to find out. So, this particular the value for the delta bar and once I have got this particular delta bar. So, very easily I can find out what should be the mutated solution.

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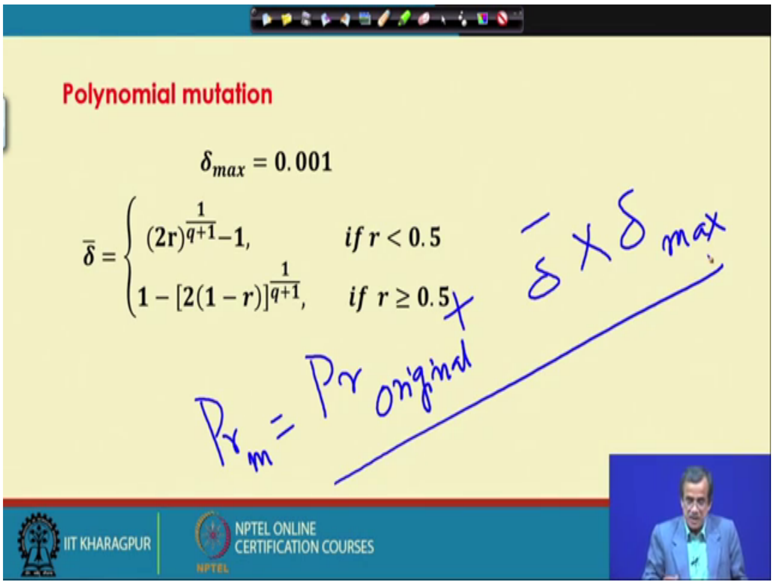

So, here I can find out let me just write it. I can find out this delta bar and delta max is given. So, if delta max is given. So, this will be your the mutated Pr mutated will be nothing but, Pr original plus delta bar multiplied by delta max, using this particular formula. So, I can find out what should be the mutated solution.

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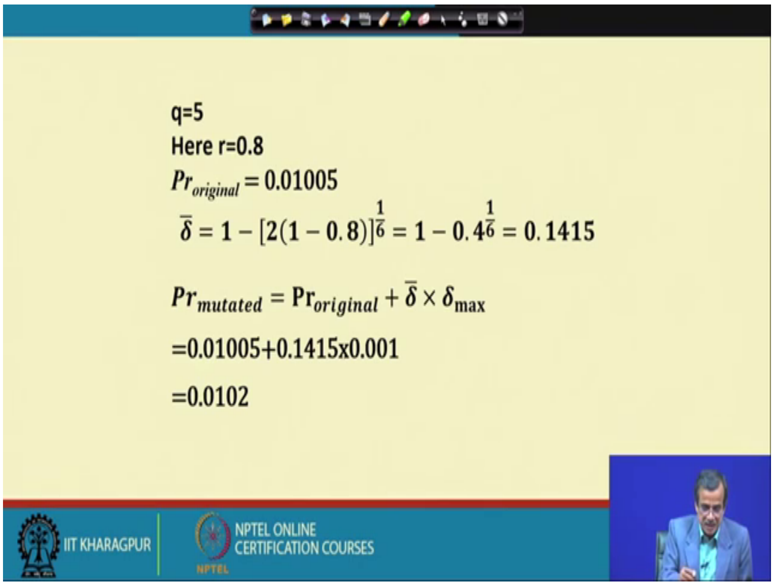

Now, using this particular principle actually here, that calculation shows here in fact. So, q equals to 5, r I have taken 0.8, Pr original is this. And so, this is nothing but the delta bar now. So, using this particular I can find out this particular your the mutated solution.

Now, if I go back to this particular table. So, other things we have directly copied, only thing this in place of this particular children solution, now I have got this particular you are the mutated solution, now corresponding to this particular the solution, I have got the this mutated solution.

So, after the mutation actually this is the scenario of the whole population and corresponding to this b and h, now I am just going to calculate the values of the fitness, corresponding to b and h. So, the fitness is found to be 0.654, corresponding to this the second set of b and h. So, this is the fitness for third set this is the fitness, 4th one this is the fitness, fifth one this is the fitness and the 6th one this is the fitness.

Now, if I compare; so, these fitness values, now if I compare these fitness values. So, this is found to be the minimum and this is a minimization problem and; that means, so, this is going to give the best solution, after the first generation of the GA is over and moreover we will have to check, whether all this particular solution is feasible or not. Now, feasibility of this particular solution has to be checked, using the principle of your that, whether it is going to violate that functional constraint or not and fortunately, this is not going to violate the functional constraint. So, this is a feasible and valid solution having the minimum fitness.

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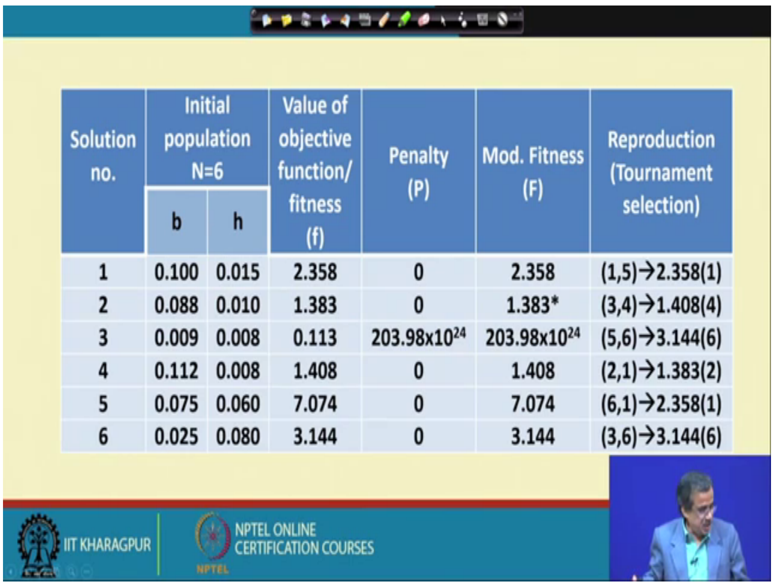

Solution no.	Initial population N=6		Value of objective function/ fitness (f)	Penalty (P)	Mod. Fitness (F)	Reproduction (Tournament selection)
	b	h				
1	0.100	0.015	2.358	0	2.358	(1,5)→2.358(1)
2	0.088	0.010	1.383	0	1.383*	(3,4)→1.408(4)
3	0.009	0.008	0.113	203.98×10^{24}	203.98×10^{24}	(5,6)→3.144(6)
4	0.112	0.008	1.408	0	1.408	(2,1)→1.383(2)
5	0.075	0.060	7.074	0	7.074	(6,1)→2.358(1)
6	0.025	0.080	3.144	0	3.144	(3,6)→3.144(6)

Now, this is whatever we are getting after the first iteration of this particular the GA. Now, let us see what was the situation in the initial population, now in the initial population. So, this was the best solution 1.383 the best feasible solution was this, now after the first generation.

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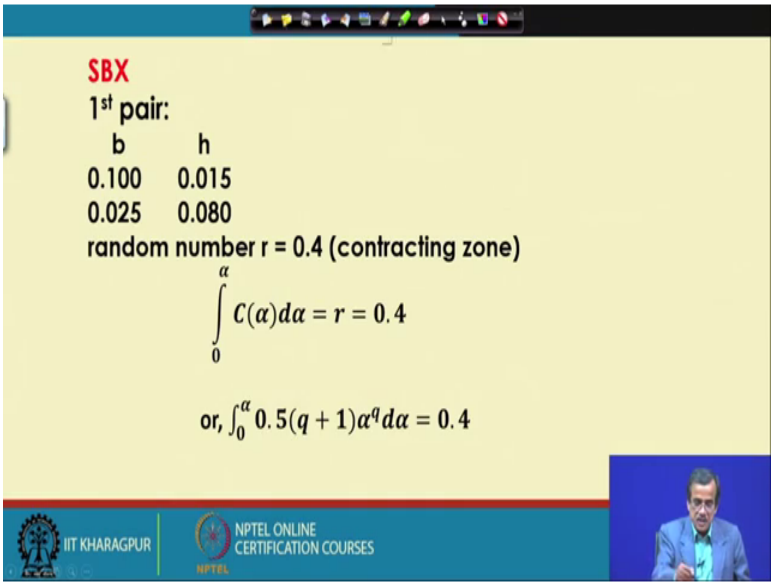

Let us see the optimal solution or the better solution that is 0.654. So, this particular solution is found to be better, compared to the best solution of the initial population. So, through this particular iteration GA is able to modify, this particular optimal solution or the. So, called optimal solution slightly.

Now, this process will go on and go on, through a large number of iteration, large number of generation and ultimately. So, this particular GA is going to are determine, what will be the globally optimal solution; that means, what should be the optimal design of this particular the single point cutting tool. So, that it can ensure the minimum weight of the cutting tool, after satisfying the condition of no mechanical breakage.

Now, this is the way actually we can use the principle of genetic algorithm, to find out the optimal the design of this particular the single point cutting tool, now as I told several times that these particular GA is having like each parson is having it is own plus and minus for example, a real coded GA, binary coded GA are having it is own merits and demerits, but we can we can also overcome some of the demerits and we can also make it more efficient. So, that it can find out the optimal solution.

Now, another thing actually I am just going to mention, that if I use this genetic algorithm, whether it is the real coded GA or the binary coded GA, there is a possibility that in the population particularly if the population size is a 100, 200 large population size, there is a possibility that you will be getting some multiple optimal solution, corresponding to the same value of the fitness.

So, you will be getting the numerically exactly the same value of the fitness, but there could be several possible combination of the design variables, at this particular the solution is going to give some advantage to the user, to select any one out of the feasible optimal solutions.

Thank you.