Machine Learning for Engineering and Science Applications
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Application 3 description Topology Optimization

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Welcome back, I would now like to describe the third problem which is topology optimization, I will spend only a brief time describing it. This work was done by what I will show you in the next video was work done by a couple of students at IIT-M Harish and Sai Kumar, I will show you the results shortly, but I once again in the spirit of these lectures I would like you to think about how to post this problem.

Ideally you will see that there are a lot of similarities within this problem and the CFD problem that I discussed earlier which is why the students did it, okay. So in this case what we are trying to do is what is called a topology optimization that is you try to redistribute material of a structure by giving certain design constraints, design constraints could be I want to use only so much material, okay.

So suppose you have a particular shape and a particular loading condition. For example you know you have a building and you have certain beams that are supporting it and you want to use as minimal material as possible and that is your constraint, so you want to use this. And obviously you will have constraints such as it should not break, so you do not put such weak material or such sparse material that it actually breaks.

So in case you know the solid mechanics of the problem, you can use it and redistribute the material I will not get into the detail, nor will I get into the equations in this case that is too much beyond the requisite amount of knowledge that you require for this course. So what we will be doing is you take a shape of this sort and kind of remove material and redistribute it optimally, okay and the usual method for doing it is using some Eigen frequency, maximization, etc.

So we will look at one very very simple problem and I would like you to think about how you would do this?

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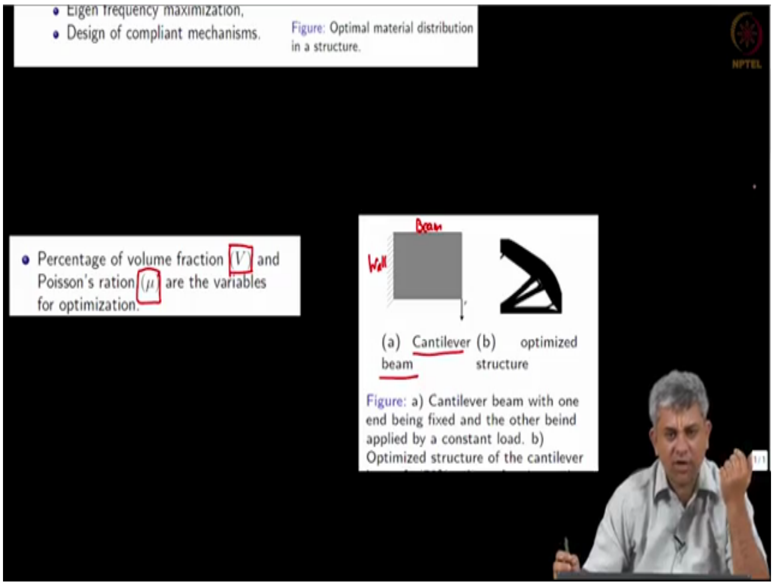

So the problem is as follow, the problem is we have something called a cantilever beam, okay. A cantilever beam in case you do not know is simply a beam that is fixed at the wall at one end and it is free at the other end and people are able to force it down. So you can see that structure here, here is a wall, here is the beam and you are pushing it down. Now what you would like to know is you know given that I am able to use only a certain percentage of this mass, what is the optimal way for me to distribute this mass so that this thing does not break. So that is the problem that we are going to consider, okay.

Now our constraints are as follows, our constraints are I am going to give you what volume fraction, what percentage of volume fraction you can use, okay. So if I give you 10 kg of material and I will say that 70 percent is what you can use, you will have to make do through a way 3 kg of material in some way so that it still does not break, okay. Another variable here is something called Poisson's ratio, Poisson's ratio is I will describe it again very very simply in that if I squeeze something in one direction, you know that it will move in the other direction also.

So the amount that it moves in the other direction in some sense very very (())(3:40) is Poisson's ratio it will not just come out, it will actually move in other directions also. So strain in one direction versus strain in the other direction is Poisson's ratio, okay. Given these constraints, how would you pose this problem? What would be the input for this problem? What would be the appropriate output for this problem? And what would be the network architecture for this problem? Please think about it and I will show what Harish and Sai did in the next video, thank you.