Machine Learning For Engineering and Science Application
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Application 1 Description Fin Heat Transfer

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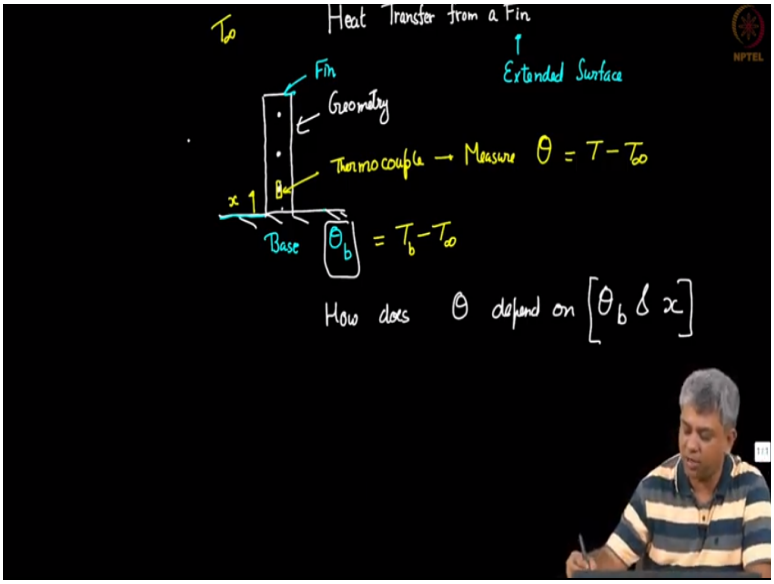

Welcome back we are going to start with a very-very simple problem almost a trivial problem and the solution as you will see later on as quite simple so this is the problem of so this is what discussed quite often in simple undergraduate heat transfer courses even if you do not know heat transfer the problem is something that you can understand quite simply from a physics perspective, so let us take what is known as a fin, a fin simply means an extended surface, why is it used most often you would have seen this is generator even at the bottom of your motor bike and several other places you will use notice this very-very commonly it is even used in electronic devices.

Now the reason this is order to extend heat transfer or in order for something to cool down little bit easily, so let us say this is the base it is at some temperature I am going to called temperature as theta, theta of the base now what happens is let us say this portion the base is really hot let us say it is you know the car radiator or it is an engine and it has brought an very hot and you have air or some other cooled fluid going passed it and you want to cool it and how would you do so.

Now all of us intuitively understand whether you know heat transfer whether you know fluid mechanics or not you intuitively understand that you have a few idea with which you can sort of

increase heat transfer which is if this is hot I make sure that I blow air pass you know suppose you get something hot you kind of blow in it intuitively it is built into the human system if you blow air pass it, it will become cooler and if you blow faster and faster and this is the reasons why fans are there this is called convective cooling.

So if you colder air pass it or the surrounding blow is colder then you will increase heat transfer or you will make it cool faster the other is actually to increase the surface area suppose you want to you at home if you are trying to cool milk or cool water you will put it in a white base so just exposer lots of surface area exposer actually causes cooling in fact it speculated that earlier dinosaurs had this large fin like structure I think stegosaurus or something it had large fin like structure in order to helped it kind of cooled down, so this kind of thing this is what is called a fin all it does is it increases the amount of surface area that is being exposed to air or whatever is this surrounding fluid.

Now you know trying to design this structure nicely etcetera is a very important problem within heat transfer especially when you are you know devices small etcetera-etcetera, so now in such cases we know that a few parameters determine what the temperature is at various places, so let us called this distance X and I have kept the temperature measuring device typically what is called the thermo couple hopefully we would have studied in this school, so I have kept a thermo couple at a particular place and I measure theta the temperature actually technically speaking this is you know theta B is temperature minus T on the outside but you do not need to remember this exactly.

So you keep a thermo couple you measure a temperature we want to find out our question is a very simple question with which we will start how does theta depend on theta B and X we can intuitively see that this is where inherent physical knowledge also comes sin that the farther away you are going to be away that the base the lesser the temperature will be this is R first intuition second intuition is the higher theta B is the higher your temperature that you measure here is going to be.

Now this is an example what I would called simply physics modeling you do not you know have you have some idea of what is the input and what is the output but you do not know what is the physic in this case of course we know the physics which is how we are going to generate the data

but in many cases like in whether you know what things affect what output but you do not actually know the physics in fin the question is can neural networks helps in such cases so now let me post the question little bit better will it depend only on this obviously not we know that it will depend on the geometry also in some way it will also depend on what kind of fluid you have outside is it air is it water etcetera.

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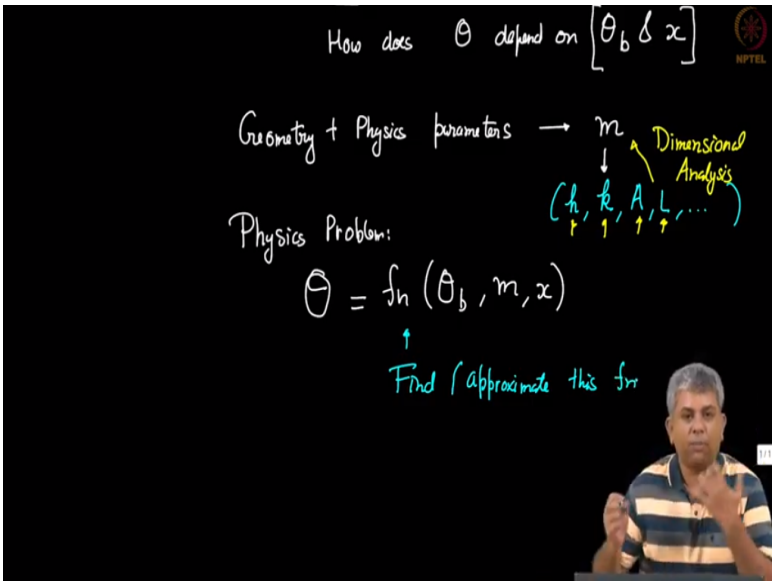

So all this parameters are abstracted into one single parameter M now what is this magical M I am not going to discuss this if you have done heat transfer you already know this but let me just mention what all it actually includes it includes H which decides whether this is water or not how fastest the fluid going etcetera all those are sitting in H this is called the convective coefficient another is K, K is K depend on the material of the solid itself you know obviously that if it is would temperature would drop in a certain way if it were let us say steel temperature would drop in another way.

So this depends on the solid other things are things like the cross sectional area how much area do you have across the cross section of this fame how long is this in etcetera, so all this parameters have somehow been combine in now how have they been combine them into M through dimensional analysis, so once again our knowledge of the physics of the problem goes into deciding this factors that this things are important and next step is to use dimensional

analysis also depends on physics knowledge in order to combine them and make the data a little bit compact.

So finally the problem in physics is as follows I want to find out how theta, theta S remember the temperature at a particular location depends on the based temperature this parameter M which includes all the physics of the problem and the location, so we want to find this function or let us say approximate this function, now to approximate this function what do you need you need data what kind of data you need.

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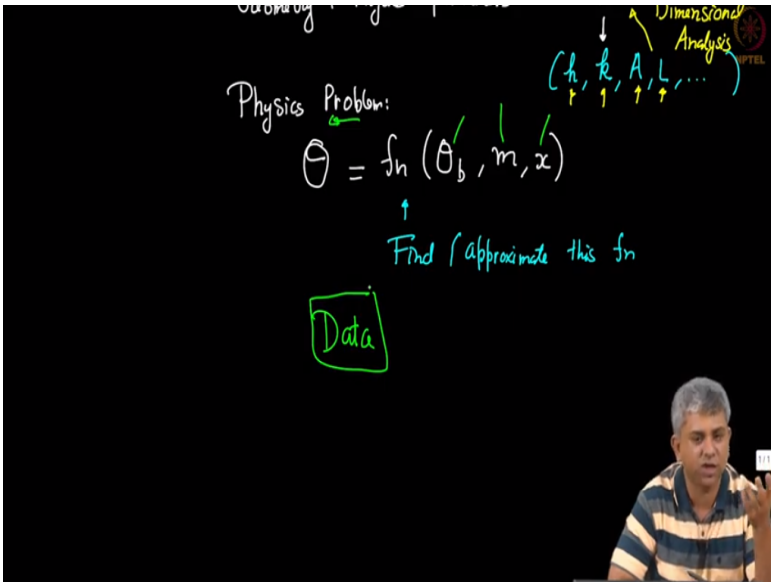

You need data of various theta this various M various X all put together along with what was the theta so let us say lot of people over lots years in a particular lab or all over the world somehow measure theta be MX but nobody had a clue what is the function was, so this is of course an artificial example but you can easily extend this to real life cases like if I said for the case weather or even in certain cases like you know what is the let us say temperature at this point in the room provided I keep my air conditioner some where you do not have good analytical expressions for some cases, so what we can make do is with data, so what we are going to do next in the next video I would like you to think about how you would do this actually let me show you the data.

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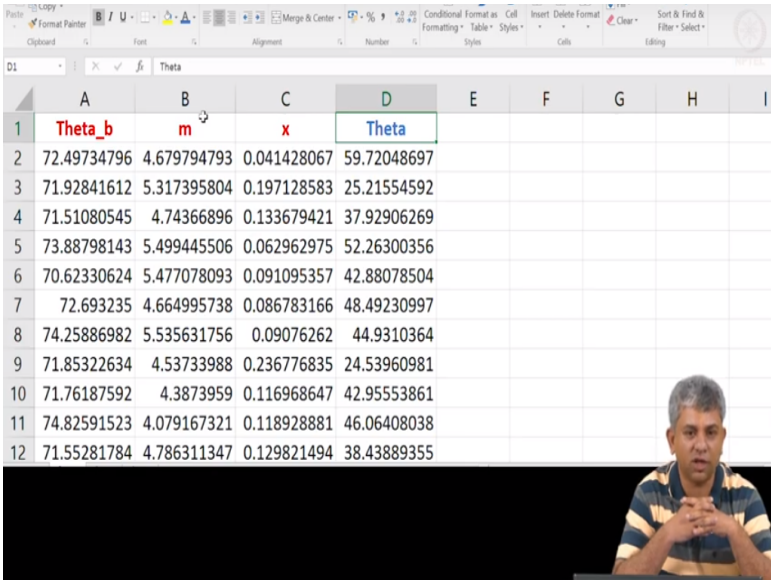

	A	B	C	D
1	Theta_b	m	x	Theta
2	72.49734796	4.679794793	0.041428067	59.72048697
3	71.92841612	5.317395804	0.197128583	25.21554592
4	71.51080545	4.74366896	0.133679421	37.92906269
5	73.88798143	5.499445506	0.062962975	52.26300356
6	70.62330624	5.477078093	0.091095357	42.88078504
7	72.693235	4.664995738	0.086783166	48.49230997
8	74.25886982	5.535631756	0.09076262	44.9310364
9	71.85322634	4.53733988	0.236776835	24.53960981
10	71.76187592	4.3873959	0.116968647	42.95553861
11	74.82591523	4.079167321	0.118928881	46.06408038
12	71.55281784	4.786311347	0.129821494	38.43889355

Here is one example of the data set that I will be using in order to build our model, so the data said is as follows for each points or there are lets us say thousand people I will show you I have about I have exactly thousand points or thousand points here and these thousand people or may be hundred experiments each of them took ten data sets each kind of measure various theta this various M's and X's and found out the actual output temperature measure by the thermo couple at that particular location X.

So once they have done that you know this historical data is now available to you now you wish to figure out how can I make theta function of theta B M and X and I would like you to think about what structure you would use etcetera you know the input and output are already kind of obvious in this problem what structure you would use how would you measure this etcetera I would like you to think about that before seen the next video, thank you.