



# IIT Madras

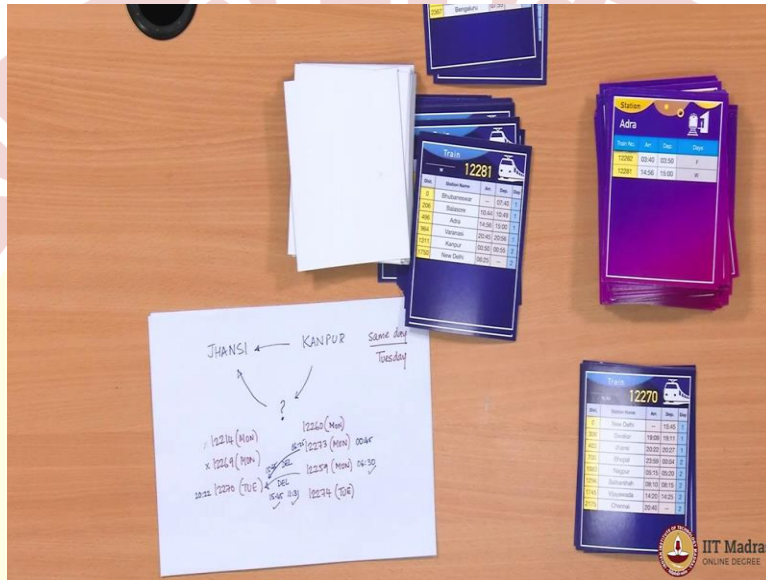
ONLINE DEGREE

**Computational Thinking**  
**Professor Madhavan Mukund**  
**Department of Computer Science**  
**Chennai Mathematical Institute**

**Professor G Venkatesh**  
**Indian Institute of Technology, Madras**

**Applications of encapsulation, abstraction, class and object (Part 1)**

(Refer Slide Time: 0:26)



Professor Madhavan Mukund: So, we were looking at these trains and thinking of them stations and trains and looking at them as objects.

Professor G. Venkatesh: Both station is 1 object. Station is actually an object. The train this thing was not an object.

Professor Madhavan Mukund: So, the train actually we said template as a class and each class we have to make an instance.

Professor G. Venkatesh: This is called instance. Instance of an...

Professor Madhavan Mukund: Yeah, it is an instance of that template. So, there is a Wednesday version of this train that is 1 object, there is a Friday version of this train that is another object.

Professor G. Venkatesh: But there is nothing like this here.

Professor Madhavan Mukund: Yeah.

Professor G. Venkatesh: This is instance of Agra station.

Professor Madhavan Mukund: Yeah, so, and then we said that we could ask some questions which could be answered on either side with more or less efficiency for instance this direct train.

Professor G. Venkatesh: We ask the station.

Professor Madhavan Mukund: Yeah, if we want to go from Bhubaneshwar...

Professor G. Venkatesh: We are looking at this entire thing as 1 object.

Professor Madhavan Mukund: Yes.

Professor G. Venkatesh: We ask this whole object, station's object.

Professor Madhavan Mukund: Can I go from Bhubaneshwar to Vijayawada we asked.

Professor G. Venkatesh: Then he took the Bhubaneshwar car, Vijayawada card did something and we have written the answer.

Professor Madhavan Mukund: Yeah, and then to do the same thing here we have to go through every train and check for a long time, but both these questions in principle were answered without referring to the other 1. So, the station could answer it on its own, the train could answer it on its own. So, of course the next thing after doing a direct train is can, I go if there is no direct train.

Professor G. Venkatesh: Means if I want to go from one place to another. There is no direct train.

Professor Madhavan Mukund: If there is no direct train then how would we find it, or how would that object find it. So, let us say for instance, so let us say for instance, so supposing we want to go from Jhansi to Kanpur.

Professor G. Venkatesh: Kanpur to Jhansi,

Professor Madhavan Mukund: Or Kanpur to Jhansi,

Professor G. Venkatesh: Let us go Kanpur to Jhansi.

Professor Madhavan Mukund: So, let us go from Kanpur to Jhansi. So, we would then...

Professor G. Venkatesh: It will be a direct train from Kanpur to Jhansi.

Professor Madhavan Mukund: So, that we can ask that to the station guy.

Professor G. Venkatesh: So, last time we asked this entire box.

Professor Madhavan Mukund: Yeah, same box.

Professor G. Venkatesh: So, we asked this guy, hey, tell me...

Professor Madhavan Mukund: Can I go from Kanpur to Jhansi?

Professor G. Venkatesh: I want to go in 1 day, I want to go today.

Professor Madhavan Mukund: Yeah, same day.

Professor G. Venkatesh: Now, today that is more specific.

Professor Madhavan Mukund: So, take out the Kanpur card.

Professor G. Venkatesh: So, you have to say which day. It can be any day. So, Kanpur to Jhansi.

Professor Madhavan Mukund: So, let us say it is a Tuesday.

Professor G. Venkatesh: Okay, let us see what happens. So, Kanpur to Jhansi on a Tuesday. So, this box I am asking this box.

Professor Madhavan Mukund: So, the first thing it will do is it will look...

Professor G. Venkatesh: See at the direct trains. So, we will first take out Kanpur and we will take out Jhansi.

Professor Madhavan Mukund: Just before that.

Professor G. Venkatesh: So, we took out Jhansi and he took out Kanpur, then what we do, he check whether it is a common train. So, we have to do 1 more thing, we have to check today. So, Tuesday only trains leaving Kanpur today that is Tuesday, so this train is leaving 12260, this is arriving there we have to check.

Professor Madhavan Mukund: No.

Professor G. Venkatesh: Then we take 12273, is it arriving there?

Professor Madhavan Mukund: No.

Professor G. Venkatesh: Then we take 12259.

Professor Madhavan Mukund: No.

Professor G. Venkatesh: 12274.

Professor Madhavan Mukund: No.

Professor G. Venkatesh: So, he cannot go from Kanpur to Jhansi by a single train. So, now if we were we could just reply by saying I cannot go with a single train. It is not a question I asked again. There I want to go today, I did not say you should go by single train. has to be little more intelligent.

Professor Madhavan Mukund: So, now it has to look for this intermediate point. Next option is to find the...

Professor G. Venkatesh: So, the object itself decides, it is its part object. It try to find, but it could not find. Now, it will say ok, I am going to try and find another station. So, what does it mean by another station? Look through all stations.

Professor Madhavan Mukund: Yeah, so it could take...

Professor G. Venkatesh: I can take one by one the cards and answer the same questions. Can I go from recursion.

Professor Madhavan Mukund: Yeah, so

Professor G. Venkatesh: So, I can say go, can I go from Kanpur to X, X is a card and then from X to Jhansi and on same day.

Professor Madhavan Mukund: So, do not take long time.

Professor G. Venkatesh: To find I have to do every pair X have to compare Kanpur with, then compare X with Jhansi, it is taking too long, that way we will do it.

Professor Madhavan Mukund: So, I think this is a good point where we can ask these things to cooperate.

Professor G. Venkatesh: Can ask the train.

Professor Madhavan Mukund: So, it could ask each of these trains that we have identified, it could ask the train box, to create a train box.

Professor G. Venkatesh: The train box for this guy. Which 1 do I ask? I know 12260, so I do not need to ask this entire... I can go to 12260 but that is not a box, that is not a object.

Professor Madhavan Mukund: That is a template, so you have to tell it I want 12260.

Professor G. Venkatesh: I have to go to the 12260 class.

Professor Madhavan Mukund: On a Tuesday. And tell me where all you go on a Tuesday something like that.

Professor G. Venkatesh: So, I have to go to 12260 class first and ask the fellow to generate a train.

Professor Madhavan Mukund: Generate a train for Tuesday and report back...

Professor G. Venkatesh: Let us say he does that, so we got 12260, so we got this class, we tell this class 12260 class generate me a train starting on Tuesday, we are looking at Tuesday.

Professor Madhavan Mukund: The day on which you passes through should be Tuesday, so here is Tuesday. So, it should actually be generated on Monday.

Professor G. Venkatesh: So, I am saying, I have to tell the station also that Kanpur 12260 I want to be in Kanpur on Tuesday.

Professor Madhavan Mukund: So, I will get a 12260.

Professor G. Venkatesh: So, that fellow even he looks at 12260 template basically looks at my requirement and finds out that he can get to Kanpur on Tuesday if we takes the Monday train, so he will return me a Monday train.



Professor Madhavan Mukund: So, this is 1 train which I can examine.

Professor G. Venkatesh: Like that I have to find more train.

Professor Madhavan Mukund: Yeah, I have to look at every one of those trains and ask.

Professor G. Venkatesh: So, I will take 12273 and then again, I have to figure out whether I want a Tuesday train or a Monday train by looking at. What about we will see. You are okay with the train?

Professor Madhavan Mukund: Yeah.

Professor G. Venkatesh: I do not do anything. We have to ask it sometimes. Here is 12273.

Professor Madhavan Mukund: So, at what days it pass through Kanpur, again day 2.

Professor G. Venkatesh: Kanpur day 2. So, again a Monday train.

Professor Madhavan Mukund: 12273 again I need a train that left originally on Monday.

Professor G. Venkatesh: I need the Monday train. Then I have 12281.

Professor Madhavan Mukund: 81 is not on Tuesday, I think.

Professor G. Venkatesh: It is not on Tuesday, so 12259. Here is 12259.

Professor Madhavan Mukund: So, 59 passes through again it leaves the previous day.

Professor G. Venkatesh: So, it leaves Kolkata at.

Professor Madhavan Mukund: So, again we need a Monday version.

Professor G. Venkatesh: We need a Monday version of 12259. So, I have 3 trains and I think there is 1 last 1.

Professor Madhavan Mukund: 12274.

Professor G. Venkatesh: My goodness a lot of trains, Kanpur has many trains, 12274. So, each of these I am actually asking the corresponding class to produce the trains for me. So, here 12274.

Professor Madhavan Mukund: It is actually a Tuesday train.

Professor G. Venkatesh: In this case same day it left at 12:30 and arrived. So, I got 4 trains objects now.

Professor Madhavan Mukund: Concrete train objects.

Professor G. Venkatesh: Concrete train objects for Kanpur.

Professor Madhavan Mukund: Rather you should keep it on that side, since it is Kanpur, you should keep it with Kanpur, that we have collected it.

Professor G. Venkatesh: So, I have got 4 cards for Kanpur. Now, what do I do?

Professor Madhavan Mukund: Something with Jhansi.

Professor G. Venkatesh: Jhansi arriving?

Professor Madhavan Mukund: Yeah, so we want to look at trains that arrive at Jhansi on a Tuesday. So, they have to pass through on a Tuesday. So, we have to look at the Jhansi trains on Tuesday...

Professor G. Venkatesh: So, anything that passes through Jhansi on a Tuesday.

Professor Madhavan Mukund: Yeah, again same thing.

Professor G. Venkatesh: So, I go and ask Tuesday, this one 12214. It is unlikely to be on the same day because 4:25 in the morning but anyway we will correct it. So, 12214, same train on both sides, that is what we want to find.

Professor Madhavan Mukund: It is not the same train because if it is the same train we could have a direct train. So, look for 2 trains which actually go through a common station. So, naturally because there is no direct train, these 2 sets will be separate. So, the same object will not be created over here and there.

So, 12214, Tuesday, so it leaves on a Monday from Delhi and then comes to Jhansi. And the other one is 12269, I will take both 69 and 70. So, 12269 actually left Chennai the previous day.



So, it is 12269 left on Monday and 70 is going to Chennai and left on the same day, so it is a Tuesday.

Professor G. Venkatesh: So, it is Tuesday train of 12270.

Professor Madhavan Mukund: So, we got 3 train objects for Jhansi and 4 for Kanpur.

Professor G. Venkatesh: 4 train objects for Kanpur. Who got?

Professor Madhavan Mukund: Jhansi and Kanpur have got, because they were the stations which requested this information from the train.

Professor G. Venkatesh: So, we ask the question to this stations box. The station box asked Jhansi to get its trains, Jhansi got its trains, in fact Kanpur got its trains.

Professor Madhavan Mukund: So, it has these 4 lists of stations.

Professor G. Venkatesh: has got 4, do something in these trains.

Professor Madhavan Mukund: So, now you have to start, this station.

Professor G. Venkatesh: This entire box we will have to do it. So, he is now got the result from Kanpur, so Kanpur is not required.

Professor Madhavan Mukund: Kanpur is not required, Jhansi is also not required.

Professor G. Venkatesh: So, Kanpur is not required, Jhansi is not required, because these fellows have done their job, this guy returned these trains and that guy returned these trains. So, now this object, so station's object has now 2 lists of trains, train objects, concrete objects he is got 2 lists. Now, what do you do with these 2 lists?

Professor Madhavan Mukund: Now, you are coming to Jhansi, so basically you go in this list, it take each train, it take 1227, so can I arrive in Jhansi on this train from Kanpur? So, we have to go and say if I am arriving on this train I would either come via Gwalior or come via Delhi because those are the 2 previous stations before I reach Jhansi. So, I have to look at that and check if there is any train which will take me from Kanpur to 1 of these 2, either Gwalior or Delhi at that right time on the same day.

Professor G. Venkatesh: I have to search all the cards.

Professor Madhavan Mukund: Yes.

Professor G. Venkatesh: I will do it this way.

Professor Madhavan Mukund: So, we will do this way. So, for these, each of these I have to check all of those whichever.

Professor G. Venkatesh: So, what you want me to check whether from Kanpur can you go to Gwalior or Delhi.

Professor Madhavan Mukund: Yeah, but this is going the other direction.

Professor G. Venkatesh: So, this train is ruled out from Kanpur to Delhi. So, here I leave at 6:30 from Kanpur, reach Delhi at 11:31, and then I can take 3:45 and reach here. So, we will try.

Professor Madhavan Mukund: So, we know 1 combination which is that 12:59 if I take.

Professor G. Venkatesh: 12259 I reach...

Professor Madhavan Mukund: Leave Kanpur you can write 6:30, so you know what this is, just because this is Tuesday, it left on a Monday from wherever it is, so on a Tuesday morning I left at 6:30 and I reach Delhi at 11:30 on Tuesday morning and then on Tuesday afternoon at 3:45 and then I reach Jhansi at 8:22.

Professor G. Venkatesh: So, it will spit out the entire route.

Professor Madhavan Mukund: At 6:30 take 12259.

Professor G. Venkatesh: Wow! This guy is really finding something for me. So, it says take 6:30 AM take the 12259 departing 1 day from whatever it is and arriving Kanpur on a Tuesday at whatever time, departing 6:30 from Kanpur you take that train, reach Delhi, get off at Delhi at 3:45, reach Delhi.

Professor Madhavan Mukund: Yeah, so get off at 11:30, take 3:45 and.

Professor G. Venkatesh: Get off at 11:31, have a lunch at all. And say around 3:45 you get into another train 12270 train departing on Tuesday and then you will reach 8:22 at Jhansi, so this is 1 solution, any other way of doing it?

Professor Madhavan Mukund: So, go to the next 1, because we still not finish this, so this one does not work, this one works, this one is going to Delhi, also works, leaving even earlier.

Professor G. Venkatesh: Kanpur at 00:45, so which is 12273.

Professor Madhavan Mukund: So, now here if I leave at.

Professor G. Venkatesh: It has the same connection.

Professor Madhavan Mukund: 00:45 and then I am going to come here, because that train is only 1 object. So, this is going to be again, this 15:45 departure but I have to sit in Delhi for a long time because I will reach by 6:25.

Professor G. Venkatesh: I will reach 6:25 and I will hang in Delhi now and I can have breakfast and Lunch in Delhi and then catch that fellow and go.

Professor Madhavan Mukund: Let us finish this. Then we have this train which is going the wrong way again, it is going away from Delhi. So, 12270 has give me 2 connections. Now, we have to look, I do not need to look at this again, for the next train I will have to look because it is another station. So, 12269 now I have to look at trains coming into Jhansi, we have to look at all these trains, whether this is Bhopal, Nagpur, Balharshah, Vijayawada, Chennai. So, let us go through it. So, again we look at this, so Kanpur is going towards Kolkata, so it is not going to any of these stations.

Professor G. Venkatesh: Kanpur Delhi?

Professor Madhavan Mukund: No, not there, and again it is going towards Rajasthan, so this is...

Professor G. Venkatesh: Delhi there...

Professor Madhavan Mukund: Yeah, but Delhi is, we are coming to Jhansi from Chennai sector. So, Delhi is not useful.

Professor G. Venkatesh: Kanpur, again it is Varanasi, Patna, Asansol, Kolkata.

Professor Madhavan Mukund: So, 629 is useless. So, basically this has no connections, so useless, we will discard it.

Professor G. Venkatesh: I will put it here. 12214.

Professor Madhavan Mukund: Now, this is again coming from Delhi, but now the problem is that as we said we are coming from Delhi but the previous station is actually, the previous day, so it does not work because we have to be on same day. So, this is ruled out. So, finally we have found...

Professor G. Venkatesh: This is only 1.

Professor Madhavan Mukund: Yeah.

Professor G. Venkatesh: So, all of them we have found. So, there are 2 ways, 1 is to depart at 12:45 early morning and reach Delhi at... Visit somebody in Delhi and then go through out, ok that is fine. Otherwise we want to save time, we recommend they will take 6:30 train, you will get a full night sleep also. 6:45 comfortably catch 6:30 train.

Professor Madhavan Mukund: Reach at 11:30.

Professor G. Venkatesh: Have your lunch and all 3:45.

Professor Madhavan Mukund: And land in Jhansi at 8:22. So this is interesting.

Professor G. Venkatesh: Because here what we do, we ask the station's dabba 'box', tell me to go from Kanpur to Jhansi. We try to find out a direct way. We could not find. Then he said Kanpur guy, he call the Kanpur object and he said Kanpur object get me all the trains that pass through you today. Kanpur date and it puts the trains. For that it had to do work, it had to go to the train.

Professor Madhavan Mukund: And create objects on that day and correct day, not today, sometimes it is yesterday.

Professor G. Venkatesh: Yeah, so very interesting thing he did, then it got a list of trains he kept it. Jhansi also similarly go get me all the trains that goes through you, he also found the trains and he gave, these are list concrete objects, train objects. Then this guy said you give me the trains, so he took the trains and he dismissed that Kanpur and Jhansi. We had the trains and then he took the trains one by one.

Professor Madhavan Mukund: And he looked at all the stations which could have been junctions and check whether the other guy was able to reach that junction at the right time.

Professor G. Venkatesh: He did that comparison of trains, all the train data is there, so he compared train by train by train and he found 2 solutions. Then he pick the better one, then he gave us the better one.

Professor Madhavan Mukund: So, this is the better one, very interesting.

Professor G. Venkatesh: This is a beautiful way of doing things, intuitive also, I mean this is very natural for us, this way of doing things, asking somebody to do something, that guy does something, he asked somebody else, they returned something then he looks at something, then he returns something else.

Professor Madhavan Mukund: And from our perspective when we asked the trains, stations is it possible, we do not need to bother whether we have got a list of trains, did not get a list of trains, that is none of our business.

Professor G. Venkatesh: He in fact collected trains, we do not even know.

Professor Madhavan Mukund: Yeah, we do not even know how we did it, so for all we know it could have actually done this tedious thing of checking every possible junction.

Professor G. Venkatesh: In fact actually we have done that, then somebody may have told him, look this is not a good way of doing, there is a better way. So, inside he changed his way of doing, but outside we do not know. You have no idea what he has done, he may have changed, he may have become better, improved.

Professor Madhavan Mukund: So, we have a new version of the software which new release. But it works the same way as far as we are concerned, it works the same.

Professor G. Venkatesh: This is really superb, this is very nice.

