IIT Madras

ONLINE DEGREE

Computational Thinking
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Introduction to train dataset

Professor. Madhavan mukund: So, looks like we have a new data set now finally to look at, nice colorful one at all.

Professor. G. Venkatesh: Trains and Stations, right?

Professor. Madhavan Mukund: Yeah.

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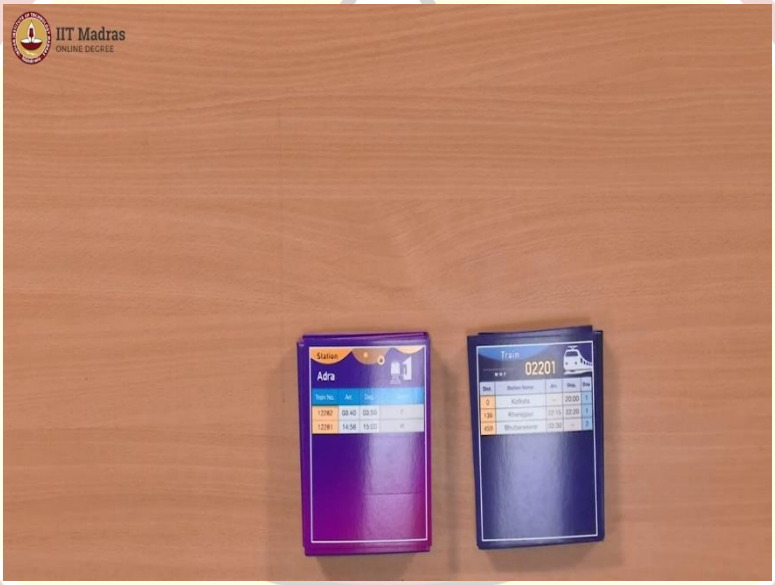

Professor. Madhavan Mukund: So, these are trains and there are two sets of two types of cards there are these dark blue cards which describe the trains and then there are these kinds of pinkish-purple cards, which talk about the stations which these trains go to. So, let us see what each train has to say. So, trains.

Professor. G. Venkatesh: we are trying to see how our train timetable is depicted typically,…

Professor. Madhavan Mukund: Yes. So, the kind of information that you would need if you wanted to book a ticket.

Professor. G. Venkatesh: Ticket.

Professor. Madhavan Mukund: And you wanted to decide on which train to choose from…

Professor. G. Venkatesh: Usually go to either a time table, our railway time table,

Professor. Madhavan Mukund: Yes or…

Professor. G. Venkatesh: Not as you go online and you see…

Professor. Madhavan Mukund: Yes, and if you go online, it will show you if you…

Professor. G. Venkatesh: Something like that…

Professor. Madhavan Mukund: Yeah, if you choose the train, it will show you that it stops or if you choose two destinations, it will try to find…

Professor. Madhavan Mukund: The possible trains are going from there to there.

Professor. G. Venkatesh: Okay.

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Professor. Madhavan Mukund: So, the train now basically the train card tells you what the train does. So, there are this. So, you start with.

Professor. G. Venkatesh: Next.

Professor. Madhavan Mukund: So, let us start with the obvious thing. So, every train has a number. So, train has a unique number. And let us just look at two cards, because it will clarify this point. So, this is these are two trains which actually go in opposite directions between the same. So, these are kind of a pair of trains.

Professor. G. Venkatesh: Alright, this is going from Kolkata-

Professor. Madhavan Mukund: Kolkata.

Professor. G. Venkatesh: To Bhubaneshwar, this is going from Bhubaneshwar to-

Professor. Madhavan Mukund: Kolkata.

Professor. G. Venkatesh: Kolkata.

Professor. Madhavan Mukund: So, they have different numbers, but usually these….

Professor. Madhavan Mukund: Trains are…

Professor. G. Venkatesh: Next to each other…

Professor. Madhavan Mukund: Next to each other and numbering.

Professor. G. Venkatesh: So, 2201 goes from Kolkata to Bhubaneshwar and the return train.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: There is a return train, right?

Professor. Madhavan Mukund: Return train

Professor. G. Venkatesh: Return train.

Professor. Madhavan Mukund: Yeah.

Professor. G. Venkatesh: 2202 returning.

Professor. Madhavan Mukund: Yeah.

Professor. G. Venkatesh: Bhubaneshwar to Kolkata.

Professor. Madhavan Mukund: So then obviously, within this now, this is the order in which the stations come.

Professor. G. Venkatesh: So, from Kolkata, it stops at Kharagpur.

Professor. Madhavan Mukund: Kharagpur and then it goes to…

Professor. G. Venkatesh: Then goes to Bhubaneshwar.

Professor. Madhavan mukund: Now, the first column tells you the distance in kilometers. So, Kolkata is where it starts. So, the distance from Kolkata 0, Kharagpur is 136 kilometers.

Professor. G. Venkatesh: It is far?

Professor. Madhavan Mukund: And then another 320, or 323 kilometers you reach Bhubaneshwar.

Professor. G. Venkatesh: Bhubaneshwar.

Professor. Madhavan Mukund: So, 459 the distance from Kolkata, not from the previous station,…

Professor. G. Venkatesh: Alright, I understand, yeah okay, 0 to 136. And then it is like a kilometer stone

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: You should actually when you are traveling by train those, they put the electric poles or whatever it is there but the kilometre.

Professor. Madhavan Mukund: Yeah.

Professor. G. Venkatesh: Indicator? So that is what it is 136 kilometer. This is 458 kilometer.

Professor. Madhavan Mukund: Yeah, and interestingly, in the return direction, the numbers are different.

Professor. G. Venkatesh: oh!

Professor. Madhavan Mukund: so, it seems to be following possibly a different route at some point. This is 459 kilometers in one direction. 522 kilometers going back.

Professor. G. Venkatesh: I see.

Professor. Madhavan Mukund: So, this first column is a distance. And then the third and fourth column gives you…

Professor. G. Venkatesh: It seems to be the same but…

Professor. Madhavan Mukund: No.

Professor. G. Venkatesh: Okay. Maybe not. I do not know.

Professor. Madhavan Mukund: It is a little bit more here is 320 something and there are 387. So that is really the difference. I think that comes between Bhubaneshwar and Kharagpur. It seems to be doing. This is 136. And that is roughly 135.

Professor. G. Venkatesh: 387 yeah.

Professor. Madhavan Mukund: 135. So this..

Professor. G. Venkatesh: This 60 kilometers more some other route.

Professor. Madhavan Mukund: Yeah.

Professor. G. Venkatesh: Alright. Okay. So, we do not know why. But this is what the data says.

Professor. Madhavan Mukund: And then we have the arrival and departure time at each station. So, because it starts from Kolkata, there is no arrival time, and it leaves at 8 pm

Professor. G. Venkatesh: 8 pm.

Professor. Madhavan Mukund: And then it reaches Kharagpur at 10:15.

Professor. G. Venkatesh: 10:15 and then leaves at

Professor. Madhavan Mukund: at night, 10:20 and reaches the next morning at 3:30.

Professor. G. Venkatesh: that is this

Professor. Madhavan Mukund: And that is why you have this last column, which tells you that this is a different day.

Professor. G. Venkatesh: Day.

Professor. Madhavan Mukund: So, if it starts on the day, so this is the day in terms of the journey time on Day 1, it starts then it reaches Bhubaneshwar and Day 2, the next day.

Professor. G. Venkatesh: Alright. So, there is a lot of very interesting information, that is encoded very nicely also, encoded nicely. I like this one too.

Professor. Madhavan Mukund: I think it is the same thing here. It leaves at night, fairly late at night from Bhubaneshwar 08:15.

Professor. G. Venkatesh: 08:15.

Professor. Madhavan Mukund: So, by the time it reaches Kharagpur, it is already past midnight. So Kharagpur is already in Day 2.

Professor. G. Venkatesh: Okay.

Professor. Madhavan Mukund: And then reaches early morning. So, it is an overnight train.

Professor. G. Venkatesh: Overnight train.

Professor. Madhavan Mukund: So, therefore it starts on 1 day and it reaches the next day, early morning.

Professor. G. Venkatesh: Right.

Professor. Madhavan Mukund: now the last thing which you had mentioned, which is what are these things?

Professor. G. Venkatesh: m w f,

Professor. Madhavan Mukund: so here it says m w f, and here it says tue, thr, sa. So, these are actually the days on which the train runs during the week.

Professor. G. Venkatesh: oh! I see.

Professor. Madhavan Mukund: So, this train will start on Monday, Wednesday, and Friday.

Professor. G. Venkatesh: So, it goes monday friday from kolkata to Bhubaneshwar.

Professor. Madhavan Mukund: So, it would reach on Tuesday, and then it comes back. Yeah. So essentially the same physical train.

Professor. G. Venkatesh: Train.

Professor. Madhavan Mukund: Is going back and forth.

Professor. G. Venkatesh: So, Kolkata it went from Kolkata to Bhubaneshwar reached Bhubaneshwar on-

Professor. Madhavan Mukund: Tuesday, early morning.

Professor. G. Venkatesh: tuesday. And then tuesday evening, 08:15 night.

Professor. Madhavan Mukund: Night it lefts.

Professor. G. Venkatesh: Left, then it will come back here…

Professor. Madhavan Mukund: on wednesday morning.

Professor. G. Venkatesh: on wednesday morning and then wednesday. Again, at 8 o'clock. It leaves like that, it does.

Professor. Madhavan Mukund: So, it spends the whole day.

Professor. Madhavan Mukund: Yeah, one physical train,

Professor. G. Venkatesh: Which changes the number

Professor. Madhavan Mukund: And they keep changing the number

Professor. G. Venkatesh: 2201 this way and then 2202 the other way.

Professor. Madhavan Mukund: So, this is one…

Professor. G. Venkatesh: And then sunday. There is nothing, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and then Sunday?

Professor. Madhavan Mukund: Sunday, there is no train

Professor. G. Venkatesh: No train at all.

Professor. Madhavan Mukund: Yeah.

Professor. G. Venkatesh: Okay.

Professor. Madhavan Mukund: that is because if they ran a train on sunday, then the next week, it will…

Professor. G. Venkatesh: it will go get some other…

Professor. Madhavan Mukund: Yeah, then it will read monday and we will get jumbled up. So, we probably have to keep it on weekly schedule. Otherwise, every other week, they will be a different.

Professor. G. Venkatesh: But you know sometimes the train runs over multiple days, but there are trains running every day.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: In case, I guess there are more trains,

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: One train going like this,

Professor. Madhavan Mukund: and there will be another train coming back and then they go back and they will keep crossing. And of course, if the journey is more than two days, then you might even have two trains.

Professor. G. Venkatesh: more than one train

Professor. Madhavan Mukund: more than one train. The train that left yesterday would still be on its way

Professor. G. Venkatesh: on the way.

Professor. Madhavan Mukund: the train that leaves today will be a different one.

Professor. G. Venkatesh: Okay.

Professor. Madhavan Mukund: and so on. So, depending on the frequency.

Professor. G. Venkatesh: but the number of days are same.

Professor. Madhavan Mukund: yeah.

Professor. G. Venkatesh: Okay, number will be the same, you have to figure it out.

Professor. Madhavan Mukund: yes

Professor. G. Venkatesh: so number starting on monday, number starting on tuesday,

Professor. Madhavan Mukund: yeah.

Professor. G. Venkatesh: like that, you have to figure out.

Professor. Madhavan Mukund: yeah,

Professor. G. Venkatesh: this is interesting. I mean, this data set is going to give us a lot of interesting problems.

Professor. Madhavan Mukund: Yeah, and there are some trains for instance, which have a lot more stops. So here is one.

Professor. G. Venkatesh: okay.

Professor. Madhavan Mukund: So, this is a long journey,

Professor. G. Venkatesh: Pune to Kolkata.

Professor. Madhavan Mukund: Pune to Kolkata.

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Professor. Madhavan Mukund: so you can see that it stops at a lot more places. And here fortunately, the distance is the same in both directions. So, this is not doing anything funny. But this only operates twice a week.

Professor. G. Venkatesh: It leaves from Pune on Monday. And then second day it is reaching. So, Tuesday it is reaching Kolkata.

Professor. Madhavan Mukund: yeah.

Professor. G. Venkatesh: it reaches at 7:50.

Professor. Madhavan Mukund: In Wednesday, it does not do anything. Because Thursday is when it leaves.

Professor. G. Venkatesh: Thursday is leaving it morning again.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: So, Thursday morning, it leaves from Kolkata. And the second day, so Friday, it will reach.

Professor. Madhavan Mukund: Yeah.

Professor. G. Venkatesh: And then Saturday, Sunday. Again, do not do anything. Again, monday leaves.

Professor. Madhavan Mukund: yeah, no Saturday it leaves.

Professor. G. Venkatesh: oh! It leaves at Saturday.

Professor. Madhavan Mukund: Yeah. But then here also it leaves on Saturday. So, there must be to train. So, there must be some other combination of trains going on here.

Professor. G. Venkatesh: Okay.

Professor. Madhavan Mukund: Because it is Monday, Saturday here and Thursday, Saturday there. So obviously on saturday, there is a train starting in both directions.

Professor. G. Venkatesh: Both directions

Professor. Madhavan Bukund: So, there must be at least two trains on this.

Professor. G. Venkatesh: Some other train is going.

Professor. Madhavan Mukund: yeah, so some other train might be coming to Kolkata and then leaving as this train. Sometimes they change the board on the

Professor. G. Venkatesh: board on the train, okay, so that. All right. So, this is a great data set, which is telling us about the stations in that are visited by a train.

Professor. Madhavan Mukund: yeah,

Professor. G. Venkatesh: So, this train starts from someplace goes someplace, visit some stations in the middle, where it stop for some period of time and distance.

Professor. Madhavan Mukund: yeah

Professor. G. Venkatesh: distance, all right.

Professor. Madhavan Mukund: yeah, so this is one part of the data.

Professor. G. Venkatesh: so, one part of the data

Professor. Madhavan Mukund: and the other part of the data set refers to these places where it stops. So we have two

Professor. G. Venkatesh: stations

Professor. Madhavan Mukund: look at the stations themselves. So, if you look at a station, so Let us look at say a station like

Professor. G. Venkatesh: Bhopal

Professor. Madhavan Mukund: Bhopal. So, what this card now tells us is all the trains that pass-through Bhopal in the set,

Professor. G. Venkatesh: I see.

Professor. Madhavan Mukund: So, the first column tells us this train number. So, it tells us the train number 2286 goes through Bhopal

Professor. G. Venkatesh: find out what 2286 is by looking at this side. So, if you look at ordered, so if I get 2286 is here, okay? This is 2286, this is New Delhi to Secundrabad train.

Professor. Madhavan Mukund: And there you can see that it passes through Bhopal,

Professor. G. Venkatesh: it is passing through Bhopal.

Professor. Madhavan Mukund: And here, the same information should be there. It says that it arrives at 001 and leaves at 006. So, this should be consistent with that. What you can see here, for instance, is that it does this on a Tuesday and a Saturday.

Professor. G. Venkatesh: What is Tuesday, Tuesday and Saturday is the time

Professor. Madhavan Mukund: On Tuesdays and Saturdays the strain will pass through at this

Professor. G. Venkatesh: Pass through at this time,

Professor. Madhavan Mukund: But that means it should also be their

Professor. G. Venkatesh: on Monday.

Professor. Madhavan Mukund: But they left on Monday, Monday was Day 1, and reached Bhopal on Day 2.

Professor. G. Venkatesh: Day 2, So that, was Tuesday.

Professor. Madhavan Mukund: so that. So, there has to be some consistency

Professor. G. Venkatesh: some consistency between them.

Professor. Madhavan Mukund: So here if Day 2, Monday is Day 1, Tuesday is Day 2. So here it is Tuesday.

Professor. G. Venkatesh: I see.

Professor. Madhavan Mukund: here Friday is Day 1. So, Saturday is Day 2, so here it is Saturday. So, this train actually reaches Bhopal on Tuesdays and Saturdays at the same time.

Professor. G. Venkatesh: 01 at least comes leaves at six.

Professor. Madhavan Mukund: and, for instance, the

Professor. G. Venkatesh: you can pay 852022

Professor. Madhavan Mukund: 85

Professor. G. Venkatesh: that is a return train.

Professor. Madhavan Mukund: that is actually the return train.

Professor. G. Venkatesh: okay. This train?

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: Which is Secundrabad to New Delhi,

Professor. Madhavan Mukund: yes

Professor. G. Venkatesh: This is New Delhi to Secundrabad.

Professor. Madhavan Mukund: yeah.

Professor. G. Venkatesh: And what are we saying about Secundrabad but it is also going through Bhopal?

Professor. Madhavan mukund: yeah.

Professor. G. Venkatesh: 215

Professor. Madhavan Mukund: 215 220. And it leaves there on Thursday, Sunday, and it reaches on the second day. So, it should be Friday and Monday. So, this is written as Monday and Friday because it is always arranged from Monday to Sunday.

Professor. G. Venkatesh: I see. So that you do not get confused.

Professor. Madhavan Mukund: Yeah.

Professor. G. Venkatesh: it is an order.

Professor. Madhavan Mukund: So, this is arranged in order of days. So, Monday to Friday, but actually, this Monday corresponds to the train that left on

Professor. G. Venkatesh: Sunday

Professor. Madhavan Mukund: Sunday. This Friday is a train that left thereon

Professor. G. Venkatesh: Thursday. All right. So, there is a lot of elements in this right.

Professor. Madhavan Mukund: yeah.

Professor. G. Venkatesh: so, we have the days

Professor. Madhavan Mukund: yeah, and another thing is, why is it in this order? So, there are 6 trains.

Professor. G. Venkatesh: in ordered.

Professor. Madhavan Mukund: But if you look at the train number, it looks odd, because 86 before 85. And these are the pairs

Professor. G. Venkatesh: yeah.

Professor. Madhavan Mukund: And similarly, this 22,

Professor. G. Venkatesh: you know, this is,

Professor. Madhavan Mukund: so, this is an order,

Professor. G. Venkatesh: that is an all right,

Professor. Madhavan Mukund: so, it is ordered by the time at which it passes through the station on a given day. So, the first train passes through, it just

Professor. G. Venkatesh: it could be more than one platform. So, there it could be more than the train, right?

Professor. Madhavan Mukund: it could be more than one train. But this, this is just telling you, in what order these trains go through

Professor. G. Venkatesh: departure, I guess probably order but departure.

Professor. Madhavan Mukund: because they so they also stopped for different times like this train stops only 2 minutes, the train stops 5 minutes, and they both leave at the same time.

Professor. G. Venkatesh: oh! I see so that they are ordered on arrival.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: It might be ordered on arrival.

Professor. Madhavan mukund: Yeah. But notice, of course, that they do not ever do that because they are on different days.

Professor. G. Venkatesh: that is another thing.

Professor. Madhavan Mukund: so, this, the fact that they have this order does not mean that on a given day, we will actually see them. So, some you will seem like these last two trains both come on a sunday. So, you will actually see this train followed by this train. Similarly, these 3 trains come on tuesday, the first third and the fourth

Professor. G. Venkatesh: So, it stands in the station.

Professor. Madhavan Mukund: so, you will see those three…

Professor. G. Venkatesh: date for the whole day.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: you are likely to see 3 training,

Professor. Madhavan Mukund: you will see three trains.

Professor. G. Venkatesh: yeah.

Professor. Madhavan Mukund: so, on some days, you will see 3 trains some days, you will see none. So, for example,…

Professor. G. Venkatesh: Is there a day when you see none?

Professor. Madhavan Mukund: Monday, you see this Tuesday, Wednesday, Thursday. Thursday is the no train and Bhopal

Professor. G. Venkatesh: Bhopal

Professor. Madhavan Mukund: among this.

Professor. G. Venkatesh: I see, you can stand at the station, you will see nothing.

Professor. Madhavan Mukund: see nothing.

Professor. G. Venkatesh: So, do not go to the station. You are not getting any train. Yeah, I see.

Professor. Madhavan mukund: So, we have our train data set. And we have trains and we have the station

Professor. G. Venkatesh: Stations.

Professor. Madhavan Mukund: And you can either look at the stations or look at the trains.

Professor. G. Venkatesh: yeah.

Professor. Madhavan Mukund: and it looks to be that they are sorted. Both within each card.

Professor. G. Venkatesh: Naturally sorted.

Professor. Madhavan Mukund: So, within each card, there is an order which is given in terms of…

Professor. G. Venkatesh: So, this is sorted by arrival time or something.

Professor. Madhavan mukund: Yes.

Professor. G. Venkatesh: And this one seems to be ordered by…

Professor. Madhavan Mukund: the journey. So, it is by the distance and also therefore by the time at which it reaches each direction.

Professor. G. Venkatesh: I see. Okay.

Professor. Madhavan Mukund: so, I mean, there are typically if you take train data set, and the trains

Professor. G. Venkatesh: Standard questions they asked like example. I'm in Chennai, can I go to Ahmedabad? For example, if I want to know

Professor. Madhavan Mukund: yes. So, then you

Professor. G. Venkatesh: There is a train which takes me to Ahmedabad, How to find out?

Professor. Madhavan Mukund: so, we can, of course, go through all the trains. But that is not very efficient, because it will be trains, which have nothing to do with Chennai and Ahmdabad. But we do have these station cards.

Professor. G. Venkatesh: So, should I start with Chennai

Professor. Madhavan Mukund: So, maybe we should start with either Ahmedabad or Chennai here

Professor. G. Venkatesh: Chennai to Ahmedabad

Professor. Madhavan Mukund: Let us switch Chennai to Ahmedabad. So, if we look at the card for Chennai, for instance, Let us find the card for Chennai. Hopefully, it has some information about Chennai trains. So, only one train in this set that actually passes through Chennai. So now if we were to go from Chennai to Ahmedabad, it must be on one of these trains.

Professor. G. Venkatesh: 12269 or 12270.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: So, let me pull out so okay, so let me pull out 12269 269 61, 12269, and 12270. Okay, I got these two cards.

Professor. Madhavan Mukund: yeah.

Professor. G. Venkatesh: So, these are the two trains which go through Chennai,

Professor. Madhavan Mukund: So, they actually go from Chennai to Delhi. And if you go through all the stations, unfortunately, it does not go anywhere near Ahmedabad, but because it goes up the center of the country through Nagpur and so, there is apparently

Professor. G. Venkatesh: So, there is no way to go from Chennai to Ahmedabad, at least there is no direct way of going, no one train.

Professor. Madhavan Mukund: yes.

Professor. G. Venkatesh: And you check some other things like Bangalore to Bhubaneshwar, let us see.

Professor. Madhavan Mukund: Let us see Bangalore to Bhubaneshwar. So now let us see Bangalore.

Professor. G. Venkatesh: Bhubaneshwar may not be there in Bangalore

Professor. Madhavan Mukund: Bhubaneshwar, there is no reason why there should be a direct train. So, now we have four choices.

Professor. G. Venkatesh: so, I need to extract 12214.

Professor. Madhavan Mukund: Let us do 12214, 12214 is actually from okay. So, it is actually arriving in Bangalore. So, this is the train to Bangalore. So, you want actually the pair 12213, which is from Bangalore,

Professor. G. Venkatesh: this is 12213.

Professor. Madhavan Mukund: So, Bangalore, Guntakal, Secundrabad, Balarshah, Bhopal, Jhansi, New Delhi. So, this is not going is again going up the center. So this is not a good thing. So it must, if there is anything, it must be the other one

Professor. G. Venkatesh: which is 02245. He is got a pair. It is 46. This is the one that goes

Professor. Madhavan Mukund: this is Bangalore to Kolkata, look at 46 because that is the one that leaves so you can see here that 45 and 14 arrive in Bengaluru and they do not leave and 46. So this is actually indicating that for these trains, Bangalore is one endpoint.

Professor. G. Venkatesh: it is a terminal?

Professor. Madhavan mukund: it is a terminus.

Professor. G. Venkatesh: Okay, so Bangalore here so what you want to fit here? Bengaluru, Rediganta, Vijayawada, Vijayanagaram. Which is Vijayawada I guess, Vijayawada, Vijayanagaram

Professor. Madhavan Mukund: I think so

Professor. G. Venkatesh: Bhubaneswar and then Kolkata

Professor. Madhavan Mukund: So you can go from Bengaluru

Professor. G. Venkatesh: So, you can go from Bengaluru to Bhubaneswar,

Professor. Madhavan Mukund: and going to take you how long? It is going to take you.

Professor. G. Venkatesh: If you leave at 11 o clock in the morning. Then I reach Bhubaneshwar at 9:50 the next morning because it is very fast.

Professor. Madhavan Mukund: Alright. So, this is the kind of so you can

Professor. G. Venkatesh: What are we doing here? I mean, how do we describe this? If you want to find out whether there is a way to go, it is a single train you take me from one city to another. What will I do?

Professor. Madhavan Mukund: So, you want to go from one city it says is the starting city to the ending city. So, you have a source and a destination. So, you take this card for the source first of all, it must be there this is not a station that you are on and does not make any sense,

Professor. G. Venkatesh: Assume that we are starting

Professor. Madhavan Mukund: there is and then you have to look at all the trains, which are listed here. And for each of these, this train number gives you an index into the into that set

Professor. G. Venkatesh: into the train set.

Professor. Madhavan Mukund: so you pull out that particular card for that train set.

Professor. G. Venkatesh: Okay.

Professor. Madhavan Mukund: and then once again, you go down the list of stations

Professor. G. Venkatesh: list of stations

Professor. Madhavan Mukund: and look for the destination.

Professor. G. Venkatesh: so, it is a list. This also lists you first start with a list of trains

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: for each of the trains. Look at the list of stations,

Professor. Madhavan Mukund: yes. And then look for a match.

Professor. G. Venkatesh: I mean, a nested loop is one list. The outer loop is listing is itrating over. All the trains of the agent that stay in that station. the notation and then in the rope is iterating over the stations that that translate visits.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: so outer loop is trains and the station inner loop is the stations that that train is visiting.

Professor. Madhavan Mukund: yeah. And you want to find the destination in that list

Professor. G. Venkatesh: It has that destination and you know that

Professor. Madhavan Mukund: It does not have it, then you go to the next train and the next train and so on. And finally, you know whether

Professor. G. Venkatesh: in this case actually there is nothing return here,

Professor. Madhavan Mukund: so, I think if you does not think, no, so mw is written only for translate. So here the mw is written here.

Professor. G. Venkatesh: yeah. So specifically, if I leave so what did I say if I leave on 11 o'clock, I will reach at 950. But that is only for Monday, Tuesday, Thursday, Friday. So, for example, if I want to leave on Wednesday

Professor. Madhavan Mukund: then you have to wait for a day

Professor. G. Venkatesh: because you have to wait for one day.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: Or you have to from some other city.

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Professor. Madhavan Mukund: So, that you can also check from here because if you are going to take this train, which is 2246 then it tells you that you can only leave on these five days. So Wednesday is not possible

Professor. G. Venkatesh: not possible.

Professor. Madhavan Mukund: Saturday is also not possible

Professor. G. Venkatesh: Saturdays is also not possible.

Professor. Madhavan Mukund: so those two days if you have to leave, then you have to find some other ways

Professor. G. Venkatesh: otherwise, I can go in less than 24 hours.

Professor. Madhavan Mukund: Yes, on five days of the week who can reach. So, you can also ask the following question on which days if I want to reach one Bhubaneshwar on say, Thursday,

Professor. G. Venkatesh: Thursday,

Professor. Madhavan Mukund: If I want to reach Bhubaneshwar on Thursday, then that is Day 2.

Professor. G. Venkatesh: so, day 1

Professor. Madhavan Mukund: I should have left on Wednesday

Professor. G. Venkatesh: Wednesday.

Professor. Madhavan Mukund: But there is no Wednesday

Professor. G. Venkatesh: there is no Wednesday. So, there is no way to reach on Thursday.

Professor. Madhavan Mukund: So, there is no way to reach on Thursday. So, depending on your constraint could be, either way, supposing you have to appear for an interview on Friday, and you want to reach one day before on Thursday, then you cannot do it.

Professor. G. Venkatesh: So, I have to leave on Wednesday, I have to leave on Tuesday,

Professor. Madhavan Mukund: Tuesday

Professor. G. Venkatesh: and reach on Wednesday and stay.

Professor. Madhavan Mukund: or you to risk reaching the morning of the interview at 9:15 and rushing to the 9:15,

Professor. G. Venkatesh: I do not know okay

Professor. Madhavan Mukund: have a bath and get ready quickly

Professor. G. Venkatesh: As I have reached on Tuesday and spend two nights and enjoy the Bhubaneshwar

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: All right. So, I think this makes this interesting. Now, you know while you were doing this, you pointed out that this is a

Professor. Madhavan Mukund: terminus.

Professor. G. Venkatesh: terminus you call it yes because…

Professor. Madhavan Mukund: Because it only comes in it does not leave…

Professor. G. Venkatesh: it does not leave. So, you can easily find out whether a particular station is a Terminus or not for some train Yeah, by just looking at whether it has whether it has this entry.

Professor. Madhavan Mukund: for instance, if you look at Bhopal which is the next station here every train that reaches Bhopal also leaves within a few minutes…

Professor. G. Venkatesh: so it is not a terminus…

Professor. Madhavan Mukund: so it is not a Terminus it is on the way from somewhere to somewhere.

Professor. G. Venkatesh: So, Bhopal is not Terminus for any station.

Professor. Madhavan Mukund: it is not for any of the trains it is not Terminus where is this is a Terminus now maybe there are rains look at this one Bhubaneshwar is again a good example which we come up with so Bhubaneshwar for example, there are two trains we were just looking which passed through an issue because they arrive when they depart,

Professor. G. Venkatesh: I go to Kolkata.

Professor. Madhavan Mukund: Yeah, but look at these other 4 trains. For other 4 trains, they either arrive or depart so it is a Terminus for 4 trains. And it is on the way waystation for 2 trains.

Professor. G. Venkatesh: I see.

Professor. Madhavan Mukund: So, 2 trains pass through it and 4 trains either start.

Professor. G. Venkatesh: because you can see it, that is a Terminus though you know some stations Do you think to pass through and all that some stations act like Junction, right?

Professor. Madhavan Mukund: Yes. Where you can switch from one?

Professor. G. Venkatesh: Where you can switch from one train to another. How do you find out if something is a junction?

Professor. Madhavan Mukund: So, I guess one has to…

Professor. G. Venkatesh: Junction means that it means that there are two tracks.

Professor. Madhavan Mukund: yes.

Professor. G. Venkatesh: like this?

Professor. Madhavan Mukund: going in different directions. Yes,

Professor. G. Venkatesh: It is the same direction. So, I have two trains going through that station. That is not going to tell me it is a junction right. If both those two trains are going to the station have the same station before and after whatever I mean,..

Professor. Madhavan Mukund: So at least on one side, in one side, there must be going in different directions. Right. So, it could be that because for a junction it could be like, why this part is like a y. So, you want to come from there and go there. So, you come here and then leave in that direction. That is also…

Professor. G. Venkatesh: y, or can be cross like this….

Professor. Madhavan Mukund: Yeah. So, either the x or y. So, what you would need to do is check for So, first of all, there has been multiple trains, not just these pairs, which are going back and forth in the same direction these adjacent pairs.

Professor. G. Venkatesh: should be multiple trains.

Professor. Madhavan Mukund: multiple trains and they should be two of those trains on which on at least before or after the station must be different.

Professor. G. Venkatesh: before or after?

Professor. Madhavan Mukund: the current station. So, suppose you want to ask whether Bhubaneshwar station is a junction, then we have to look at these two of these trains.

Professor. G. Venkatesh: and then check, let us check.

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Professor. Madhavan Mukund: let us check

Professor. G. Venkatesh: let me put this back. So these are Bhubaneshwar trains. So, we can keep that we can keep it what are the other trains.

Professor. Madhavan Mukund: 2201.

Professor. G. Venkatesh: 2201, Okay.

Professor. Madhavan Mukund: So, here for instance,…

Professor. G. Venkatesh: another?

Professor. Madhavan Mukund: and 2202 which is its pair. So, these do not help you because the next station out of Bhubaneshwar here is Kharagpur but actually is going towards Kolkata. So, in principle, it is a junction because if you are coming from Bangalore for example, which you want to go to Kharagpur, then you could come up to Bhubaneshwar on this train come down up to Bhubaneshwar and then take this train and switch over to Kharagpur. So, it is a junction.

Professor. G. Venkatesh: So, Bhubaneshwar is a junction because…

Professor. Madhavan Mukund: because the next station after Bhubaneshwar

Professor. G. Venkatesh: after Bhubaneshwar….

Professor. Madhavan Mukund: towards Kolkata for example, the next station in one direction one train is Kolkata and the next train it is Kharagpur. So, therefore, by getting off at Bhubaneshwar you could go to a different station by changing the train compared to not getting off Bhubaneshwar.

Professor. G. Venkatesh: okay.

Professor. Madhavan Mukund: And one could also look at the other train

Professor. G. Venkatesh: in this train changes the direction was the same.

Professor. Madhavan Mukund: Yes, this is the same because this is also going to Kolkata, this are going to Kolkata.

Professor. G. Venkatesh: So, directions that I can say look,

Professor. Madhavan Mukund: it is only a junction in the sense that this has one more stop

Professor. G. Venkatesh: one more stop.

Professor. Madhavan Mukund: Let us look at this other trade that might be different 12281

Professor. G. Venkatesh: Okay, 12281

Professor. Madhavan Mukund: that might be going somewhat interesting junction, if it is going in some other direction. Again, 12281 that will 282. Okay, so this 12281 and 12282. So, this is a more interesting thing. So, you see this is going from Bhalasore going to Delhi, but it is so this is going along the coast as you can see from Bhubaneshwar to Kolkata and this is cutting in going in the northwest.

professor. g. venkatesh: Kanpur and all.

Professor. Madhavan Mukund: So here it is actually going from Bhubaneshwar to Bhalasore which is quite different from going from Bhubaneshwar to Kharagpur. So, this actually is a more genuine so if you are going to for instance from Kolkata to say Varanasi, then you could come down this train

Professor. G. Venkatesh: direct route from Kolkata.

Professor. Madhavan Mukund: It might be, But you could also

Professor. G. Venkatesh: Kharagpur

Professor. Madhavan Mukund: Kolkata to Balasore. So, for example, you can come down to Bhubaneshwar and then switch over to this train and then go to Balasore.

Professor. G. Venkatesh: Balasore. I see. So, the way to find out so can you describe the seminar. Let us see what we have done here. If you want to find out if a train station is a junction.

Professor. Madhavan Mukund: Then you must first look at all the trains.

Professor. G. Venkatesh: all the trains, so, iterate over all the trains that are passing through the

Professor. Madhavan Mukund: all pairs of trains actually,

Professor. G. Venkatesh: All pair.

Professor. Madhavan Mukund: So, for every train and every other train every two trains that you get for every train, you have to see if there is another train, which becomes a nested iteration says that in the second train the station after Bhubaneshwar is different from the station after Bhubaneshwar,

Professor. G. Venkatesh: so you are taking all the trains all pairs of train.

Professor. Madhavan Mukund: all pairs of trains and checking whether…

Professor. G. Venkatesh: again these are pairs which are not yes pair pairs which are not coupled

Professor. Madhavan Mukund: coupled.

Professor. G. Venkatesh: So, it is the opposite with your layout that…

Professor. Madhavan Mukund: Yeah.

Professor. G. Venkatesh: So, trains which appear to be going in different ways.

Professor. Madhavan Mukund: Yes,

Professor. G. Venkatesh: or not, return train.

Professor. Madhavan Mukund: Okay.

Professor. G. Venkatesh: So, trains that appear to be going so take all such pairs. And for all such pairs, what we are doing,

Professor. Madhavan Mukund: checking whether the next station.

Professor. G. Venkatesh: next station,

Professor. Madhavan Mukund: after Bhubaneshwar is different.

Professor. G. Venkatesh: At least in one direction.

Professor. Madhavan Mukund: Yeah. But it will happen the other way also.

Professor. G. Venkatesh: Yeah.

Professor. Madhavan Mukund: So, one of them will check stations going from Bhubaneshwar in one direction the other one will check in the other direction. So, it is enough to check on the next.

Professor. G. Venkatesh: Okay.

Professor. Madhavan Mukund: You do not have to check the previous because the previous will be in the opposite direction will be the next.

Professor. G. Venkatesh: Correct.

Professor. Madhavan Mukund: So, you just have to check the next. So, for every train, you check for every

Professor. G. Venkatesh: Bhalasore we found here

Professor. Madhavan Mukund: Yeah,

Professor. G. Venkatesh: What is this, Kharagpur?

Professor. Madhavan Mukund: Kharagpur.

Professor. G. Venkatesh: or Kolkata in one of them, it is Kolkata.

Professor. Madhavan Mukund: Yes, actually, we look at the Bhubaneshwar, so, next is Kharagpur, Bhubaneshwar next is Bhalasore and it was one

Professor. G. Venkatesh: Kolkata

Professor. Madhavan Mukund: Bhubaneswar, so, the next is Kolkata. So, these are all going in one direction. The other direction you have Vijayawada here you have nothing so the other two trains Bhubaneshwar is actually Terminus.

Professor. G. Venkatesh: Correct.

Professor. Madhavan Mukund: That way even to go for example, from Balasore to Vijayawada. This is a junction and then you have to come up to Bhubaneshwar your train will terminate there then you get down get onto this other train and then go to.

Professor. G. Venkatesh: Yeah, something interesting is building up here. I think I can see that. There are stations that are trains and somehow there is a relationship between trains and stations.

Professor. Madhavan Mukund: Yeah.

Professor. G. Venkatesh: and the train is going from one station to another so it is trying to establish a relationship as is doing some dynamic relationship is getting formed here.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: Right now, all we did this, we're doing things with lists, whatever we did so far.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: find out whether I can go from one city to another city. Just find out

Professor. Madhavan Mukund: Yeah,

Professor. G. Venkatesh: we just go to the list of trains, whether it is a Terminus.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: find out whether it is a junction is that three things we have done today. All of them require only for you to examine this, nothing else. Maybe you will do the nested iterations.

Professor. Madhavan Mukund: Yeah, nested iterations two or less.

Professor. G. Venkatesh: Yes, okay.