



IIT Madras

ONLINE DEGREE

Computational Thinkung
Professor. Madhavan Mukund
Department of Computer Science
Chennai Mathematical Institute
Professor. G Venkatesh
Indian Institute of Technology, Madras
Introduction to Dictionary Data Structure

Professor Madhavan Mukund: Let us return to our shopping bills. So, one thing which it might be interesting to find out is which shop is the most popular for a given type of item. So, we have this category which tells us...

Professor G Venkatesh: Like food for example.

Professor Madhavan Mukund: Food for example, so which shop sells most food?

Professor G Venkatesh: It is more bills.

Professor Madhavan Mukund: More bills, more items per bill; total number of items.

Professor G Venkatesh: Total number of items.

Professor Madhavan Mukund: Because some bills will be mixed like, you have household and you have...

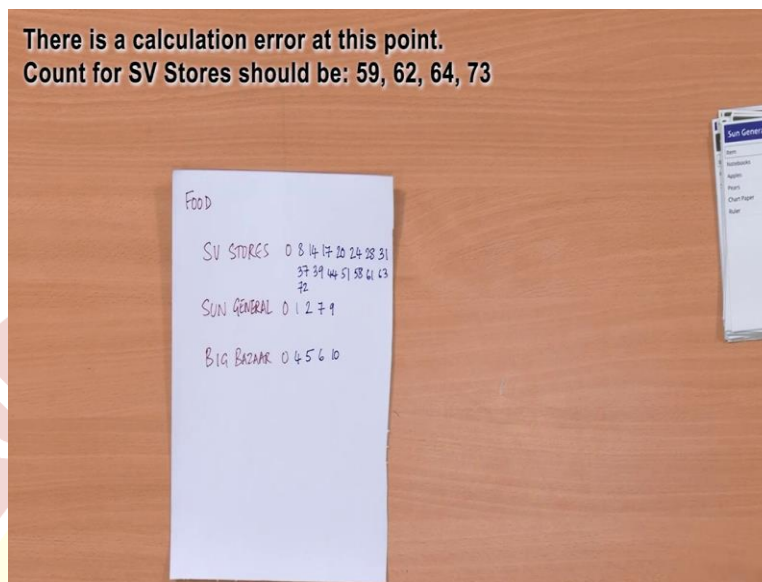
Professor G Venkatesh: Just count the number of items.

Professor Madhavan Mukund: Yes, so we will just count the number of food items...

Professor G Venkatesh: Food items...

Professor Madhavan Mukund: And we will across all the bills we want to know which shop is doing best in terms of food. Most popular for food.

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Professor Madhavan Mukund: So, we want to keep track of this number of items of food sold per shop. So there are only 3 shops.

Professor G Venkatesh: 3 shops...

Professor Madhavan Mukund: Right.

Professor G Venkatesh: Say 3 stores: SV stores, Sun General and Big Bazaar I think right?

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: So 3 variables. We start with 0 and count.

Professor Madhavan Mukund: We are keeping a count of the total number of items. So initially we will keep 0.

Professor G Venkatesh: 0 for everything. And we are doing iteration over the cards...

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: And each card will iterate over this list.

Professor Madhavan Mukund: Correct. So, in each card we will we have to go down the list...

Professor G Venkatesh: you have to go down the list...

Professor Madhavan Mukund: and wherever there is food, we have to add 1. So get a total for this card and then depending on which shop it is, we have to update that.

Professor G Venkatesh: Some procedure we have which basically is doing this is count tracing of this and...

Professor Madhavan Mukund: Yes, so we give it a card and it gives back to a number of item.

Professor G Venkatesh: Okay. Alright. Understand. Yes. So now that we know the procedure.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: So SV stores 1, 2, 3, 4, 5, 6, 7, 8, 8 items.

Professor Madhavan Mukund: Okay, so I update this 0 to 8.

Professor G Venkatesh: This is another SV stores 1, 2, 3, 4, 5, 6.

Professor Madhavan Mukund: Okay, that becomes 14 now.

Professor G Venkatesh: 1, 2, 3, SV stores again.

Professor Madhavan Mukund: Okay, 17.

Professor G Venkatesh: Sun general 0.

Professor Madhavan Mukund: Okay, so no change.

Professor G Venkatesh: 0.

Professor Madhavan Mukund: No change.

Professor G Venkatesh: So Sun General is not selling, 0, not selling...

Professor Madhavan Mukund: Not selling food at all it looks like.

Professor G Venkatesh: Okay, here is 1.

Professor Madhavan Mukund: 1 Item. Occasionally people buy food there.

Professor G Venkatesh: It looks like that, yes. SV stores 3.

Professor Madhavan Mukund: So SV stores is only selling food more or less, yes. 20

Professor G Venkatesh: Big Bazaar, for the first time 1, 2, 3, 4.

Professor Madhavan Mukund: Okay, Big Bazaar has 4 items.of food.

Professor G Venkatesh: Sun General has 1.

Professor Madhavan Mukund: 2

Professor G Venkatesh: SV stores has 4.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Big Bazaar has 1.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Sun General 0.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: SV Stores 1, 2, 3, 4.

Professor Madhavan Mukund: Okay, so 28 now.

Professor G Venkatesh: 1, 2, 3

Professor Madhavan Mukund: 31.

Professor G Venkatesh: 1

Professor Madhavan Mukund: It is Big Bazaar. So 6 for Big Bazaar.

Professor G Venkatesh: SV Stores 1, 2, 3, 4, 5, 6

Professor Madhavan Mukund: So now 37.

Professor G Venkatesh: 2.

Professor Madhavan Mukund: 39.

Professor G Venkatesh: 1, 2, 3, 4, 5.

Professor Madhavan Mukund: 44.

Professor G Venkatesh: None in Sun General. So, Sun General is like a stationery type. 1, 2, 3, 4, 5, 6 SV stores, 7, 7 SV Stores.

Professor Madhavan Mukund: 51

Professor G Venkatesh: 1, 2, 3, 4, 5, 6, 7, 8

Professor Madhavan Mukund: 58

Professor G Venkatesh: Big Bazaar, 1, 2, 3, 4.

Professor Madhavan Mukund: Big Bazaar 10.

Professor G Venkatesh: 1, 2, 3 SV Stores.

Professor Madhavan Mukund: 61

Professor G Venkatesh: 1, 2, 3, 4, 5.

Professor Madhavan Mukund: Okay, Sun General so that is 7 now.

Professor G Venkatesh: 1, 2.

Professor Madhavan Mukund: 63.

Professor G Venkatesh: There is a big bill for SV stores. 1, 2, 3, 4, 5, 6, 7, 8, 9.

Professor Madhavan Mukund: 72.

Professor G Venkatesh: Big Bazaar, nothing and Sun general 2 foods.

Professor Madhavan Mukund: 9. So, it is very clear that...

Professor G Venkatesh: by a big margin...

Professor Madhavan Mukund: SV Stores is by far the most popular for food and Sun general and Big Bazaar are almost equal.

Professor G Venkatesh: 9 and 10

Professor Madhavan Mukund: 9 and 10, so here...

Professor G Venkatesh: but when we are looking at it, it looked like if we have asked, similarly some other category like...

Professor Madhavan Mukund: Stationery for example, then it would have been different. So obviously these are different types of shops.

Professor G Venkatesh: Different types of shops, so now I mean we did this by the shop, so 3 shops, but suppose we wanted to do by customer, I want to find out food, let us take food. Who is the customer that is buying most amount of food?

Professor Madhavan Mukund: So, then we would have to have the same thing. We would have to keep one variable for every customer.

Professor G Venkatesh: but there are lot of customers. So, there are too many customers.

Professor Madhavan Mukund: So, it would be nice to not have to keep a separate variable for each customer, you are saying.

Professor G Venkatesh: Yes. Somehow collect them because also we keep adding customers, no? Shops they do not, we do not add shops. Shops only in frequently...

Professor Madhavan Mukund: Correct. So as we collect bills for these same three shops over a period of time, there will be more customers...

Professor G Venkatesh: Many more customers will keep coming...

Professor Madhavan Mukund: So number of shops will remain 3....

Professor G Venkatesh: Yes, exactly it will keep fixed.

Professor Madhavan Mukund: So, if we look over 1 year, we might have the same three shops but...

Professor G Venkatesh: Many more customers.

Professor Madhavan Mukund: Hundreds of customers might come and we do not want to keep creating new...

Professor G Venkatesh: Variables.

Professor Madhavan Mukund: Variables for each one as...

Professor G Venkatesh: So, what do we do? Is there a way to...

Professor Madhavan Mukund: So, I think what we need is somehow of connecting a customer name, finally what we want to do is maintain a number for every customer but we do not want to give that new variable each time.

Professor G Venkatesh: Yeah.

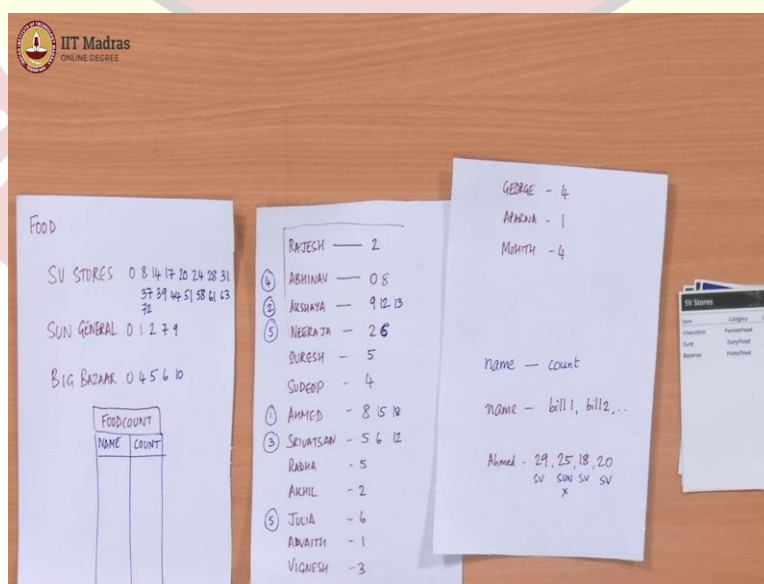
Professor Madhavan Mukund: So we have to have a variable which has 2 parts in some sense. It has a name and for each name it has a customer. So it has, kind of it is like a table in a sense.

Professor G Venkatesh: Table? Where rows are names...

Professor Madhavan Mukund: Which has, so the rows

Professor G Venkatesh: Then we can keep adding more rows.

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Professor Madhavan Mukund: Yes, we can keep adding rows, so we would have a name here and for that name we have a count.

Professor G Venkatesh: When I give you a name we will check whether it is there already on the list.

Professor Madhavan Mukund: Yes, I will check if it is already I will update the count...

Professor G Venkatesh: Not there...

Professor Madhavan Mukund: if it is not there, I will start a new count with the value that you give me. So every name which I have not seen before is...

Professor G Venkatesh: What it means that it will be more convenient if I do not have to keep searching to find the name.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: in a way, directly to go and check whether the name is there in the table otherwise...

Professor Madhavan Mukund: so let us assume that we can do that. So like an

Professor G Venkatesh: Is there...

Professor Madhavan Mukund: index

Professor G Venkatesh: Index?

Professor Madhavan Mukund: Index. So we call...

Professor G Venkatesh: Like an index, like what we have this bookmark.

Professor Madhavan Mukund: Yes, a bookmark thing. So, we will call this whole thing for instance, we give it a name, like food...

Professor G Venkatesh: You know, I mean...

Professor Madhavan Mukund: Food count.

Professor G Venkatesh: You know I can think something which is basically, it happens right?

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: It is a dictionary, if you look at the English...

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: Words, the dictionary

Professor Madhavan Mukund: So if you have a word, I can just go where usually there is a way of...

Professor G Venkatesh: correct.

Professor Madhavan Mukund: Quickly getting to that word?

Professor G Venkatesh: Right.

Professor Madhavan Mukund: Quickly get to that word in the dictionary.

Professor G Venkatesh: Right.

Professor Madhavan Mukund: So, we have a basically this whole thing we can think of it like a dictionary...

Professor G Venkatesh: Dictionary.

Professor Madhavan Mukund: So the names we can always assume are in some particular convenient to find order, so I can easily find...

Professor G Venkatesh: You can quickly get to that word...

Professor Madhavan Mukund: Yeah.

Professor G Venkatesh: With out having to search.

Professor Madhavan Mukund: And then the word will tell me what is associated value and if the word is not there, I will insert the word in the right place so that I can proceed with that.

Professor G Venkatesh: So, this is a dictionary. So, dictionary for food count.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: Okay, so we are, what do you want to do? So each time we will go through this bills...

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Professor Madhavan Mukund: And each time now we look at, earlier we were counting the food items and assigning it to the name of the shop, instead we will now assign it to the person who is shopping and...

Professor G Venkatesh: First you have to check whether...

Professor Madhavan Mukund: Yes if it is in a dictionary we will add, if it is not in the dictionary we will create a new entry

Professor G Venkatesh: New dictionary element.

Professor Madhavan Mukund: Okay, let us do that.

Professor G Venkatesh: Yeah.

Professor Madhavan Mukund: So this is the first one, so clearly there is...

Professor G Venkatesh: Rajesh, nobody before, so you are starting the dictionary. First element of the dictionary and putting to in it.

Professor Madhavan Mukund: So I will just draw a line to indicate this connection which here is 2.

Professor G Venkatesh: Okay, 2. then there is Abhinav, so again this is...

Professor Madhavan Mukund: So, here we can read it off but normally it will be a lot of things, so there has to be an efficient way of checking whether this name is already been seen or not. But now this is a new thing.

Professor G Venkatesh: If only the computer can do this, right? I mean...

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: You can take a name and check whether it is in the list or not quickly?

Professor Madhavan Mukund: Yes

Professor G Venkatesh: You should have do it without searching. So Abhinav has 0.

Professor Madhavan Mukund: So this is, we have actually seen a customer called Abhinav but he has not bought any food.

Professor G Venkatesh: Now this is Akshaya who has bought a lot of things 1, 2, 3, 4, 5, 6, 7, 8, 9; 9 food items.

Professor Madhavan Mukund: Okay

Professor G Venkatesh: There is Neeraja bought 2 food items.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: There is Suresh, who bought Now this is Akshaya who has bought a lot of things 1, 2, 3, 4, 5 food items.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: And there is Akshaya again...

Professor Madhavan Mukund: So, now we will quickly find out Akshaya...

Professor G Venkatesh: Akshaya is quickly found, you straight away went to Akshaya and there are 3 food items.

Professor Madhavan Mukund: Okay, so that 9 becomes 12.

Professor G Venkatesh: So useful, this thing, because without variables now, this is not a variable?

Professor Madhavan Mukund: So I have, I have one single, I believe that this like a single table...

Professor G Venkatesh: Table.

Professor Madhavan Mukund: And I am looking at the first column using the name and then the second column I am updating.

Professor G Venkatesh: Alright, Okay. So Sudeep, 1, 2, 3, 4 . 4.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Ahmed, 1, 2, 3, 4, 5, 6, 7, 8.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Again Ahmed.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: 1, 2, 3, 4, 5, 6, 7.

Professor Madhavan Mukund: Okay, so that becomes 15.

Professor G Venkatesh: Then there is Ahmed again, but 0.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Shrivatsan, new name 1, 2, 3, 4, 5.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Shrivatsan 5.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Radha. We have not seen Radha before?

Professor Madhavan Mukund: No.

Professor G Venkatesh: 1, 2, 3, 4, 5.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Akhil, again new 1, 2.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Julia.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: 1, 2, 3, 4, 5, 6.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Advait

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: 1.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Vignesh 1, 2, 3, Neeraja we have seen before.

Professor Madhavan Mukund: We have seen before?

Professor G Venkatesh: Yes, 1, 2, 3.

Professor Madhavan Mukund: Neeraja is now 5, she was 2.

Professor G Venkatesh: 4, 4 actually, sorry 1, 2, 3, 4.

Professor Madhavan Mukund: Okay, 6.

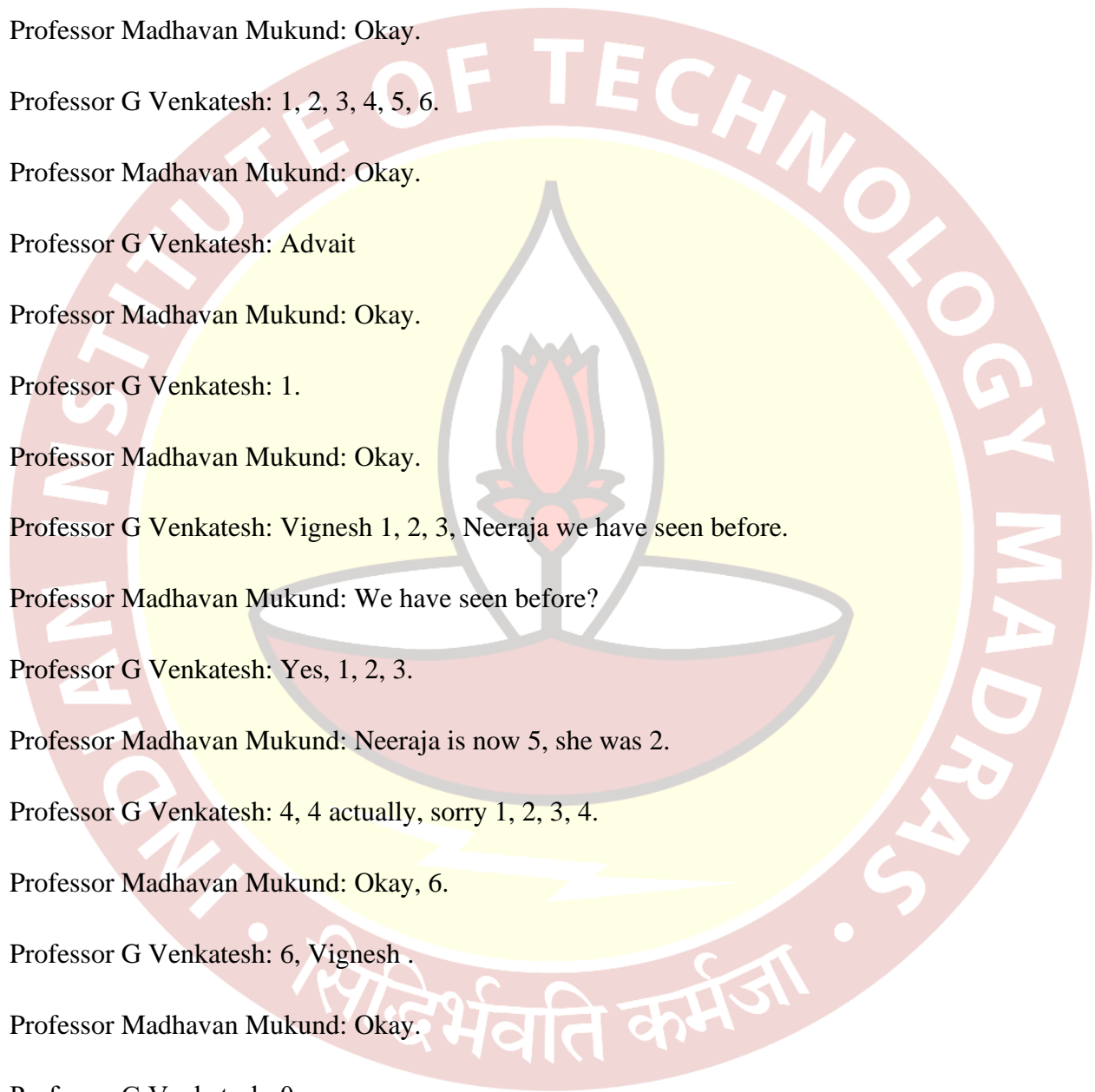
Professor G Venkatesh: 6, Vignesh .

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: 0 so no...

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Ahshaya, you have seen.



Professor Madhavan Mukund: Yes.

Professor G Venkatesh: 1.

Professor Madhavan Mukund: So now, this is 13.

Professor G Venkatesh: George, you have seen George?

Professor Madhavan Mukund: George is new.

Professor G Venkatesh: Okay.

Professor Madhavan Mukund: So we will have to make some more space. So George...

Professor G Venkatesh: 4, 4 food items.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Aparna.

Professor Madhavan Mukund: Also new.

Professor G Venkatesh: Aparna, we have seen?

Professor Madhavan Mukund: No. Okay.

Professor G Venkatesh: 1.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Mohit.

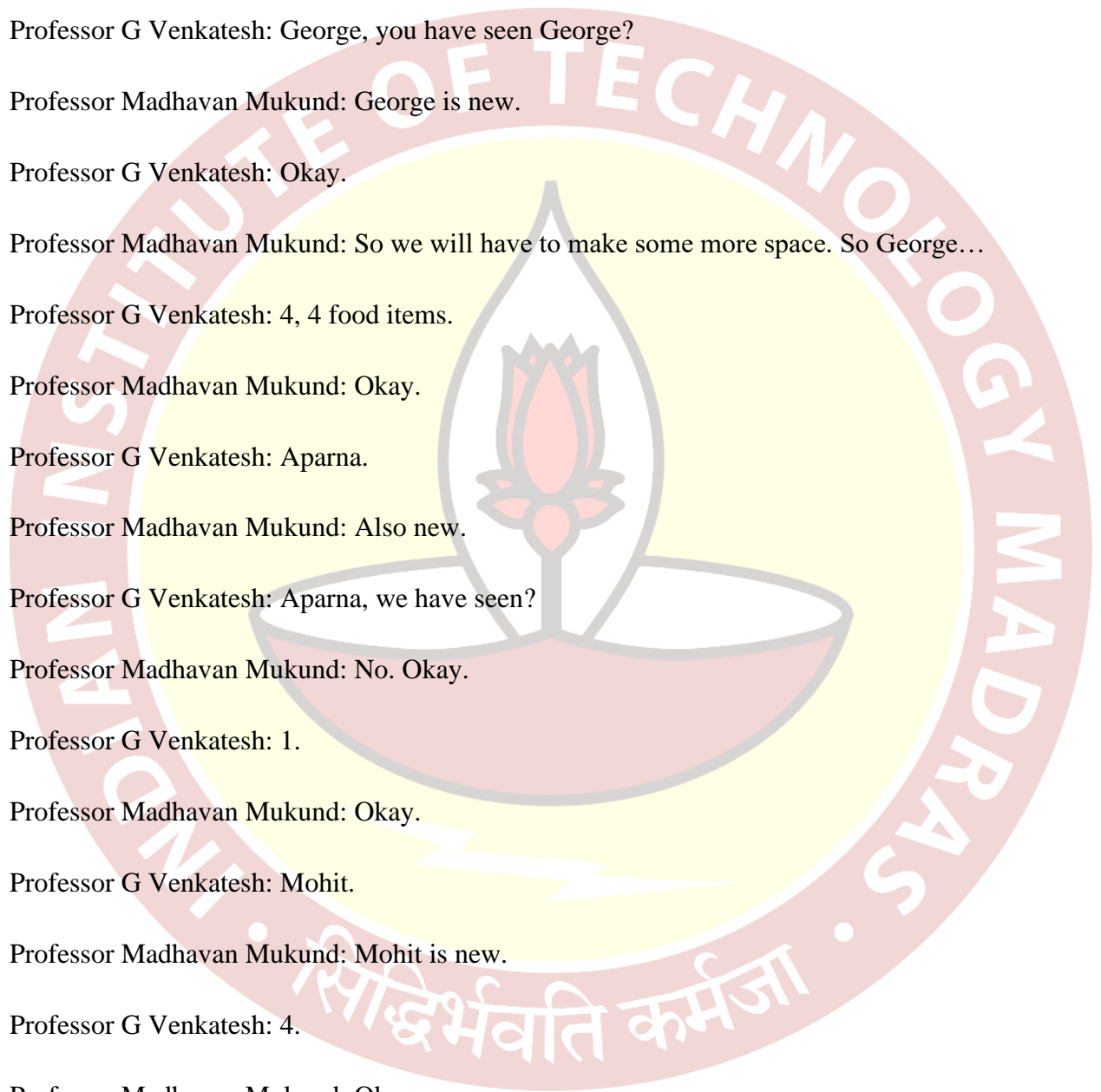
Professor Madhavan Mukund: Mohit is new.

Professor G Venkatesh: 4.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Ahmed, Ahmed should...

Professor Madhavan Mukund: Yes,



Professor G Venkatesh: 3, we have seen.

Professor Madhavan Mukund: yes 18.

Professor G Venkatesh: Shrivatsan have also seen it.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: 1.

Professor Madhavan Mukund: 6.

Professor G Venkatesh: Another Shrivatsan.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: 0

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Advait, 0.

Professor Madhavan Mukund: Advait, okay

Professor G Venkatesh: Abhinav, 0.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Shrivatsan,

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: 1, 2, 3, 4, 5, 6.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Abhinav.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: It is there?



Professor Madhavan Mukund: Abhinav is right at the beginning we saw his name.

Professor G Venkatesh: 1, 2, 3, 4, 5, 6, 7, 8.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: We are done.

Professor Madhavan Mukund: Okay. So, now we have this dictionary.

Professor G Venkatesh: We have a dictionary with all the names of all the customers...

Professor Madhavan Mukund: Customers who appear in this list of bills.

Professor G Venkatesh: And then have the count of...

Professor Madhavan Mukund: Yes and for each of them...

Professor G Venkatesh: Food items.

Professor Madhavan Mukund: We have the count of food items.

Professor G Venkatesh: Food items.

Professor Madhavan Mukund: Rajesh has bought 2 totally, Abhinav has bought 8, Akshaya has bought 13, Ahmed is I think the winner with 18. So there Akshaya is second with 13, Shrivatsan is third with 12. So...

Professor G Venkatesh: It is kind of obvious relationship one can draw, I can try and say with the people buying the most amount of food are likely to be buying from the shop that sells the most amount of food.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: Seems intuitive.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: Should be?

Professor Madhavan Mukund: Should be. So we will have to see now...

Professor G Venkatesh: How do I verify that?

Professor Madhavan Mukund: We will have to now ask...

Professor G Venkatesh: You have this list; you have the list of all the people.

Professor Madhavan Mukund: Yes and we have the list previously that we...

Professor G Venkatesh: You can sort this maybe.

Professor Madhavan Mukund: I sort it now? Yes we could sort it, so we could get...

Professor G Venkatesh: Sort it by...

Professor Madhavan Mukund: So we could get 18 as the maximum...

Professor G Venkatesh: sort it by...

Professor Madhavan Mukund: then 13 and then 12. So we are sorting by the total number of...

Professor G Venkatesh: Total number of food items.

Professor Madhavan Mukund: Right. And then we want to see whether that person actually buys these food items...

Professor G Venkatesh: These here right here are sorted number 1, 2, 3 I mean we have just...

Professor Madhavan Mukund: Yes, so let us do 1, 2...

Professor G Venkatesh: Who is third?

Professor Madhavan Mukund: This is 3.

Professor G Venkatesh: 3.

Professor Madhavan Mukund: Upto 12, I think the next is 8.

Professor G Venkatesh: 4.

Professor Madhavan Mukund: 4 and then...

Professor G Venkatesh: Next is 6.

Professor Madhavan Mukund: Let us stop at that, yes?

Professor G Venkatesh: We will stop.

Professor Madhavan Mukund: So these are...

Professor G Venkatesh: This is 5 or 6? 6.

Professor Madhavan Mukund: That is also 6.

Professor G Venkatesh: Okay we have got, it is enough. I think we will take this 5.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: What do you want to verify? You want to check that these 5, these 6 people...

Professor Madhavan Mukund: Generally buy their, this is all food, buy from the top ranked food shop which is SV Stores.

Professor G Venkatesh: It is SV Stores. How do you do that?

Professor Madhavan Mukund: So we will have to go through and find the bills for these guys and see which shops, so we have to do 1 iteration through this whole thing and see if every bill in which they have food because for instance Abhinav had a bill in which he had no food. So that bill, we do not care. We are only interested in the...

Professor G Venkatesh: So, instead of keeping the count, so it means that instead of keeping the count if I have kept the bill numbers here...

Professor Madhavan Mukund: Yes, then you would have that directly...

Professor G Venkatesh: Directly possible.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: Here I kept the count.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: Suppose I had kept the bill number.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: Then what I could do is, I could go down these bill numbers...

Professor Madhavan Mukund: And just check which shop they correspond to.

Professor G Venkatesh: Which shop they correspond to. How do I find out, which shop they correspond to? I will have to keep the shop...

Professor Madhavan Mukund: Well...

Professor G Venkatesh: From the bill number.

Professor Madhavan Mukund: From the bill number, assuming that we can look up the bill number easily from the, from bill from the bill number. Then you can always look up the shop and hear the details if you want.

Professor G Venkatesh: Yes.

Professor Madhavan Mukund: But as of now we do not have any idea where the bills came from. So we have to go back and look through all the bills again to make sure that...

Professor G Venkatesh: So for, I have to take all the bills of Abhinav?

Professor Madhavan Mukund: Yeah.

Professor G Venkatesh: If I had kept all the bills of Abhinav separately, this would be much easier then.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: So instead of just keeping the count, the dictionary I had kept the list of all the bills of Abhinav...

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: I can do many things with it.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: It is interesting.

Professor Madhavan Mukund: Correct. Kind of a representation

Professor G Venkatesh: Yes.

Professor Madhavan Mukund: We could have a name...

Professor G Venkatesh: Instead of keeping just the count because count is already digested like data.

Professor Madhavan Mukund: Yes, so name, what we had now is a single number.

Professor G Venkatesh: Number.

Professor Madhavan Mukund: Digit count. And instead what we are saying is that we will keep a name...

Professor G Venkatesh: And keep the bills.

Professor Madhavan Mukund: And then we will keep a list of bills

Professor G Venkatesh: Let us just do it for Abhinav, I mean it is useful? I want to check Abhinav because he is highest, who is highest?

Professor Madhavan Mukund: Ahmed is the highest.

Professor G Venkatesh: Okay. Let us do Ahmed.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Suppose I want to find out all the bills of Ahmed?

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: So I am going through all the bills of, bills like this, so this is Ahmed.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: so it is 29.

Professor Madhavan Mukund: So, this is now 29.

Professor G Venkatesh: Neeraja, Vignesh, Advait, Julia, Akhil, Radha, Shrivatsan, Ahmed okay.
There is one more?

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: 25.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: 18.

Professor Madhavan Mukund: Okay.

Professor G Venkatesh: Akshaya, Suresh, Neeraja, Akshaya, Abhinav, Rajesh.

Professor Madhavan Mukund: So these are 3 bills of Ahmed.

Professor G Venkatesh: We have missed something. We have missed something.

Professor Madhavan Mukund: It is alright.

Professor G Venkatesh: Are there 18 in that?

Professor Madhavan Mukund: No, so there should be 1 more food bill because there is one bill where I did not go to...

Professor G Venkatesh: Did not go to?

Professor Madhavan Mukund: I did not buy any food at all. So, I think there should be a fourth bill for Ahmed which has some food on it.

Professor G Venkatesh: Here that is, alright.

Professor Madhavan Mukund: So that is 20.

Professor G Venkatesh: Alright.

Professor Madhavan Mukund: So. we have these bills of which, one of these bills...

Professor G Venkatesh: So, if we had instead of counting we had put this bill numbers there.

Professor Madhavan Mukund: Yes then we could say that bill number 20 for instance, we could look up quickly and say that it is SV and then we could...

Professor G Venkatesh: This is SV.

Professor Madhavan Mukund: Then 18 is also SV..

Professor G Venkatesh: 18 is also SV. 25 is Sun but...

Professor Madhavan Mukund: And Sun is no food. So...

Professor G Venkatesh: Does not count.

Professor Madhavan Mukund: It actually does not count for a hypothesis.

Professor G Venkatesh: 29 is...

Professor Madhavan Mukund: SV.

Professor G Venkatesh: It is also SV.

Professor Madhavan Mukund: So, on the 3 bills where we actually consolidated...

Professor G Venkatesh: They were all from SV.

Professor Madhavan Mukund: which is what are hypothesis was...

Professor G Venkatesh: So at least for Ahmed it confirms.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: Now we have to do the same for Abhinav...

Professor Madhavan Mukund: Akshaya for example.

Professor G Venkatesh: Akshaya we have to do. But we can do that.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: If we do that then we should be able to confirm our hypothesis?

Professor Madhavan Mukund: Right.

Professor G Venkatesh: So, what we have seen basically is that when the number of, in the case shops, number is small and is fixed.

Professor Madhavan Mukund: Fixed, likely to be fixed. It is easy to keep track of one variable...

Professor G Venkatesh: Variables.

Professor Madhavan Mukund: per shop.

Professor G Venkatesh: One variable per shop. So it makes sense to keep it as a variable.

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: But when the number is larger like this...

Professor Madhavan Mukund: Then we...

Professor G Venkatesh: And also it keeps changing, it may increase also then...

Professor Madhavan Mukund: Instead of keeping separate variables for all of these and confusing ourselves because we have so many variables in our thing we can think of this whole thing as 1 variable.

Professor G Venkatesh: 1 variable, 1 thing, 1 entity.

Professor Madhavan Mukund: 1 entity, 1 structure which has a way of indexing through the name to a value.

Professor G Venkatesh: And the value itself could be a list...

Professor Madhavan Mukund: Yes.

Professor G Venkatesh: As we saw here.

Professor Madhavan Mukund: Could be a list.

Professor G Venkatesh: So initially we kept the count but it was more useful basically to keep the list.

Professor Madhavan Mukund: Yes. So this is a kind of dictionary as we called it where the index is Ahmed and the value is...

Professor G Venkatesh: Value is a list.

Professor Madhavan Mukund: this list of shopping bill data, shopping bill numbers.

Professor G Venkatesh: Bill integers, index integers.

Professor Madhavan Mukund: Okay.

