
# IIT Madras

## ONLINE DEGREE

**Computational Thinking**
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**Procedure to find relations among customers based on their spending patterns**

Professor. Madhavan Mukund: So, we were looking at this idea of a procedure when we were trying to find the maximum marks. So, now let us look at how that would work. For instance, in our shopping data set. If you remember, we had tried to find out whether two customers were similar to each other and finding out how many items they had bought of different categories.

Professor. G. Venkatesh: Correct.

Professor. Madhavan Mukund: And in order to do that, we had to actually look at each card and summarize the category in each card, we had to say how many entries are there for say household, how many are for food, and then update for each card. So, same thing we have to do for every card.

Professor. G. Venkatesh: Every card.

Professor. Madhavan Mukund: So, that would be a natural thing to delegate to somebody that you say, give me back.

Professor. G. Venkatesh: So, there is a work to be done for each card. And there is a work to be done across all card. So, what you are saying is that one percent the contractor is doing across all card, and the subcontractor is working on one card.

Professor. Madhavan Mukund: So I will keep the total overall so far for every customer. But for each new bill, I will ask the subcontractor to tell me what this bill contains for that customer. And then those totals I will update. And if it is a new customer, I will create a new way.

Professor. G. Venkatesh: Okay, so here is the data set.

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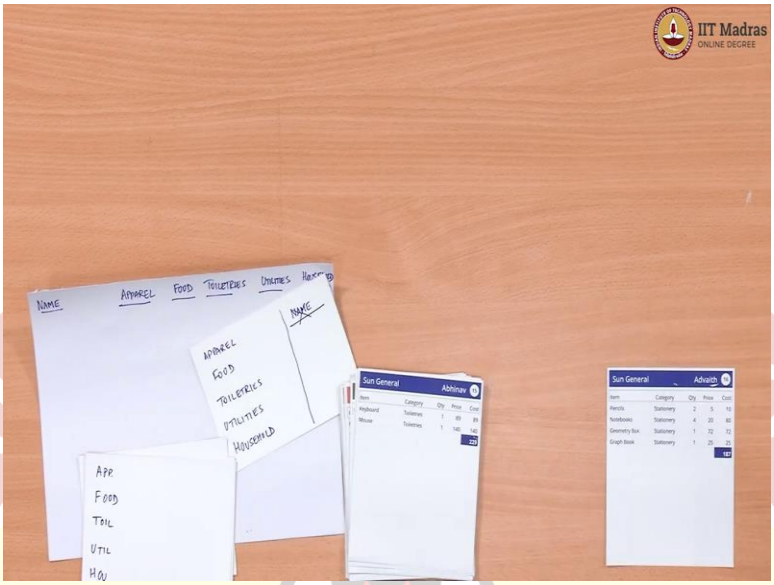


Professor. G. Venkatesh: So, let us say I am the subcontractor, you are the contractor.

Professor. Madhavan Mukund: So, what are we agreeing?

Professor. G. Venkatesh: What I agree you will give me what?

Professor. Madhavan Mukund: So, I will tell you that

Professor. G. Venkatesh: You will give me this bunch of cards.

Professor. Madhavan Mukund: I will give you this cards and I will tell you that I want you to tell me for this bill,…Professor. G. Venkatesh: For a given bill.

Professor. Madhavan Mukund: For a given bill, how many…

Professor. G. Venkatesh: So, the procedure is to find to find out these value for each category.

Professor. Madhavan Mukund: So, how many items are there for apparel?

Professor. G. Venkatesh: How many apparel food so I have written many things? I have not written one thing.

Professor. Madhavan Mukund: You have to give me back…

Professor. G. Venkatesh: I have to give back…

Professor. Madhavan Mukund: A list of values.

Professor. G. Venkatesh: For each of these apparel, food, toiletries, utilities household, how many items? How many rows are there? For apparel? How many rows are there for food? How many rows are there for toiletry utilities household?

Professor. Madhavan Mukund: And where we have also made and is that is like stationary comes under utility?

Professor. G. Venkatesh: That is okay. But is this for? What is it? Is it for a person or it is for a card?

Professor. Madhavan Mukund: I guess we are doing it for one card. So, or a person and for that one card, but I also need to know who whose card it is.

Professor. G. Venkatesh: Because you are doing it for a person, right?

Professor. Madhavan Mukund: So, maybe I should also tell you to tell me back because you are reading this card for me. So, you should also tell me back the name of the person.

Professor. G. Venkatesh: You can note the name of the person and give me.

Professor. Madhavan Mukund: I could note the name of the person and give you also.

Professor. G. Venkatesh: So, if you just give me one card? I do not need this deck actually, what do I need the deck for? If you just give me one card,…

Professor. Madhavan Mukund: And then you just tell me these things. So, then I do not,

You give me one card.

And I keep track of which card whose name it is?

Professor. G. Venkatesh: I do not want to know the name. You just give me the card. And I will I am not looking at name and all that. I am just looking at the items rows, I have all other fields ignored. I will go down the rows and look at the category. And I will keep track of how many line items I am seeing how many lines, rows I am seeing of each category.

Professor. Madhavan Mukund: And then you…

Professor. G. Venkatesh: And I will add it up. And I will put it in this and it will give it back to you.

Professor. Madhavan Mukund: So, let us try that.

Professor. G. Venkatesh: So, I do not need the deck. So, this is quite different from what we saw earlier, where you gave me the deck. And then you told me whether I can mess around with it or not.

Professor. Madhavan Mukund: Because here I just give you…

Professor. G. Venkatesh: Here, you give me one card.

Professor. Madhavan Mukund: And obviously you are not allowed to mess around with.

Professor. G. Venkatesh: I cannot do anything with your deck now. So, slightly different. But I have to do a lot of work on one card.

Professor. Madhavan Mukund: And in fact, it is something that in principle, I did not even give it to you, I could show it to you from through a window or something.

Professor. G. Venkatesh: Like you do not have to give me the card.

Professor. Madhavan Mukund: I do not have to physically give you the card because you do not need to operate on the card. You just need to read the…

Professor. G. Venkatesh: Read the values.

Professor. Madhavan Mukund: So, first I have to tell, but as we said, I have to remember who it is.

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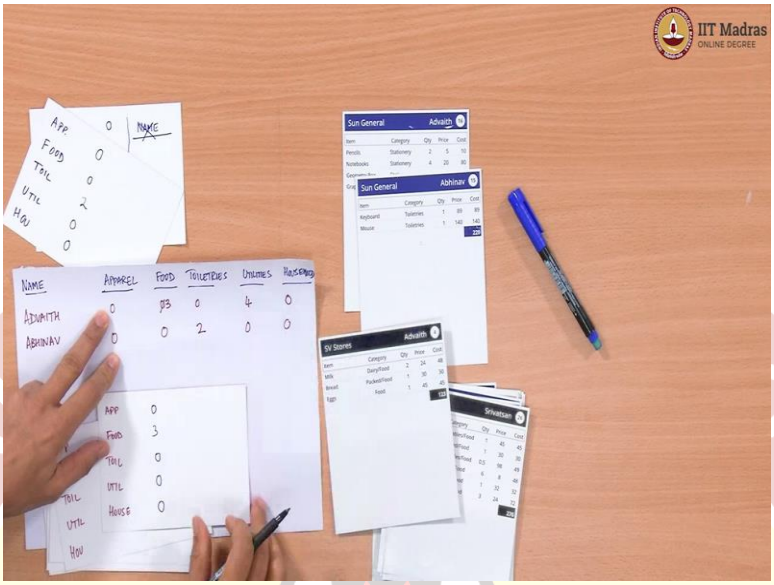


Professor. Madhavan Mukund: So, supposing I look at that card and I said this is the first time I am seeing Advaith and now I have given you a card for Advaith. So, whatever answers you So, I have to give you this card to write down what you report.

Professor. G. Venkatesh: So, what do I report on this? I have to report the number of so how many apparels are there? So, we know basically that there are no apparels so I put 0 here. Food items none. So, I put 0 here.

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: Toiletries again none stationary, we called a utility. So, there are 4 of them. And again household there are none. So, 0. So, this is what I give back.

Professor. Madhavan Mukund: So, now you give…

Professor. G. Venkatesh: And I give back your card.

Professor. Madhavan Mukund: The card is back with me. So, I will move it to that side since we have seen it. So, what I will do is I will go down this list I will not write 0 because we do not want to just unnecessarily write 0, we will always put or we could write so we could say that currently, Advaith has 0 for all these, 4 for utilities, and 0 for.

Professor. G. Venkatesh: So, what are you doing? You are taking whatever I gave you and right now, we are making an entry?

Professor. Madhavan Mukund: Making an entry but now if we see one more Advaith bill,…

Professor. G. Venkatesh: We may have to add, but you trust my reading, you are not just last time, you assume that what I am doing is correct. You trust me, as a subcontractor I give you.

Professor. Madhavan Mukund: So, now I give you so, first I note down that this is Abhinav. So, this is a different person. And I give you that thing again. And now again, you have to do the same procedure.

Professor. G. Venkatesh: Same procedure, right? I ignore everything. I am just looking down this line and seeing row by row. So, there are 2 toiletries here, right?

Professor. Madhavan Mukund: Yes.

Professor. G. Venkatesh: And there is nothing else. So, 0 everywhere else. So I give you back, I give you back this card, and I give you the result.

Professor. Madhavan Mukund: So, now I note down for Abhinav there were 2 toiletries, and 0 everywhere else. So, this is. So now, we have done that. So, now I have an interesting case, because now I have Advaith again.

Professor. G. Venkatesh: Advait has been…

Professor. Madhavan Mukund: So, Advaith has already been done once.

Professor. G. Venkatesh: I do not need to know about.

Professor. Madhavan Mukund: You do not know about it. But I need to keep track.

Professor. G. Venkatesh: You keep track.

Professor. Madhavan Mukund: So, I give you this card.

Professor. G. Venkatesh: And as far as I am concerned, as a subcontractor, I do not even know the name. I do not care actually.

Professor. Madhavan Mukund: You are not looking at the name, actually.

Professor. G. Venkatesh: I do not know anything. However I know basically, is that you have given me a card on this card, there are 3 lines, I have to just basically return to you. This category totals, so apparel in this is 0. Food is, all our food in fact, 3. And there are no toiletries, there is no utilities, there is no household. So, this is what I got. So here, I give you back the card.

Professor. Madhavan Mukund: Now I will take this information and I will look at the fact that it is Advaith, and go and update. So, now I see that apparel remains 0. But food has now become 3, which was earlier 0, toiletries is 0 and nothing else changes. So, I have updated 0 plus 3 is 3 and left the others column. So now, we are done with this card. Now there is a new card, which I give you, which is Srivatsan.

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Professor. G. Venkatesh: So, and again, I do not know whether it is Srivatsan, Advaith, I do not know anything.

Professor. Madhavan Mukund: It could have been…

Professor. G. Venkatesh: Does not matter to me, it does not matter to me. For me, all it matters, basically, is that I have this many rows here, and I have to look at the rows. So, there is 1, 2, 3, 4,

5, 6 food items here. And there are no apparel, there are no toiletries, there are no utilities. There are no household, Okay, so here, I give you back the card.

Professor. Madhavan Mukund: So, I take it back. So, I look at the name Srivatsan and I update the row for Srivatsan was nothing there so there was nothing there. So, I just put 0 6 0 0 0.

Professor. G. Venkatesh: This kind of makes it a little modular, easier, right? Modular? Because see, I do not need to know name.

Professor. Madhavan Mukund: Correct.

Professor. G. Venkatesh: And you do not need to know how to total.

Professor. Madhavan Mukund: Exactly. I also do not need to know how you are deciding the stationeries utility and

Professor. G. Venkatesh: All that decision I am making, you do not need to know. Right?

Professor. Madhavan Mukund: Correct.

Professor. G. Venkatesh: So, we have separated the decision making nicely into two buckets modular way of separating the thing.

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Professor. Madhavan Mukund: So, let us do one last one, maybe. So again, just to illustrate maybe this time, I do not even, even I do not know the name until you give it back to me. Because I just give it to you and say give me the total. And I get it back, I can look up, okay.

Professor. G. Venkatesh: And I also do not care about the name. But here there are many lines, 1, 2, 3, 4, 5, 6, 7, 8, 9 out of 9. 1 is household, 1 is household. And all others are food as far as I can make it 1, 2, 3, 4, 5, 6, 7, 8 foods. There are 8 food, no apparel, no toiletry, no utility. So, here you go.

Professor. Madhavan Mukund: So, now after you give it back to me, I checked that this Abhinav. So, I go back to the Abhinav row, because I have an Abhinav row here, and I have to now update the rows which change. So, food has become 8 and household has now gone from 0 to 1, and this is done. So in this way, basically, we could keep doing it for every card. So, at every card, I give you the card with the categories that I want you to total up, you give it back to me with those totals, I note down the name and either create a new row or update that row.

Professor. G. Venkatesh: So, they mean fundamentally there are some differences between what we saw for that Max, what we did for max with the and what we are seeing here, one thing I noticed basically is there, you gave me the entire deck of cards. And I had to operate on the entire deck to find the max each time and then return the max to you. Here, I have nothing I do not need the deck. I have only one card I am working at a time.

So, this looks this this case the parameter is the card is coming in, in some sense, right?

Professor. Madhavan Mukund: The parameter is the card here. And the function that we are calling is to return these anyways.

Professor. G. Venkatesh: But there the return was very simple.

Professor. Madhavan Mukund: One number.

Professor. G. Venkatesh: One number I have return.

Professor. Madhavan Mukund: Yeah.

Professor. G. Venkatesh: Whereas, here I am returning some more complicated thing. I am returning one value for each category.

Professor. Madhavan Mukund: So, let us call this function say category total. So, this is a function that we are doing. So, I give you a card, a bill say and what you return to me is a list of, or a table like this.

Professor. G. Venkatesh: A list of, a table of or whatever.

Professor. Madhavan Mukund: Yeah, so where we have apparel, food. So, the first column is known. So, these these are the 5 categories and you have to fill in these, these numbers, right? So, these numbers is what you have to fill and return.

Professor. G. Venkatesh: Fill and return. So, whereas the first one, the input was complicated, because we had a whole deck to work on, output was simple. Here, the input is simple. The output is complicated.

Professor. Madhavan Mukund: Complicated, but the other thing is, in this case, the input really, there is only a single object.

Professor. G. Venkatesh: A single value.

Professor. Madhavan Mukund: And you do not change anything.

Professor. G. Venkatesh: And I do not change anything.

Professor. Madhavan Mukund: There is no question of shuffling, no shuffling the cards, you cannot rearrange.

Professor. G. Venkatesh: Is there a name for this in programming this business that when we, when I return, I might also change the order of the card, something like that is that is there name for that? What is it called?

Professor. Madhavan Mukund: Well, sometimes we call it a side effect.

Professor. G. Venkatesh: Side effect.

Professor. Madhavan Mukund: So, I asked you to do something and in the process of doing that, you have changed something else which was not necessary to change, or I did not have to expect you to change. And so this happens, for instance, you call somebody to, for instance, you call somebody to fix your plug, electrician, and then he ends up messing up the wall. So, you have to call a painter. I mean, this happens actually quite a lot when you are building a house.

Professor. G. Venkatesh: Yeah.

Professor. Madhavan Mukund: So, if you have to call the fellow to make the tiles and then the fellow to make the lights and then the fellow to paint the walls, it is very difficult to figure out whom to call first, because each one will mess up the other person.

Professor. G. Venkatesh: The side effects.

Professor. Madhavan Mukund: So, the side effects can be very problematic subcontractors…

Professor. G. Venkatesh: So good idea to tell the subcontractor what he should, what state he should leave the thing when he finishes.

Professor. Madhavan Mukund: So, we should be able to anticipate the side effects and take care of that. If I assume that I give you that marks cards, and I get it back in the same order and it does not happen, then it will be a big problematic for me, because the next step might depend on the order and if you have messed it up, so I need to know whether the procedure is got side effects or not.

Professor. G. Venkatesh: Okay.

Professor. Madhavan Mukund: And take action according to that. Or I have to make you promise that you do not,..

Professor. G. Venkatesh: I would not do I would not have any say.

Professor. Madhavan Mukund: So, like in this case where I give you a card and there is no…

Professor. G. Venkatesh: There is no possibility of making side effects.