



IIT Madras

ONLINE DEGREE

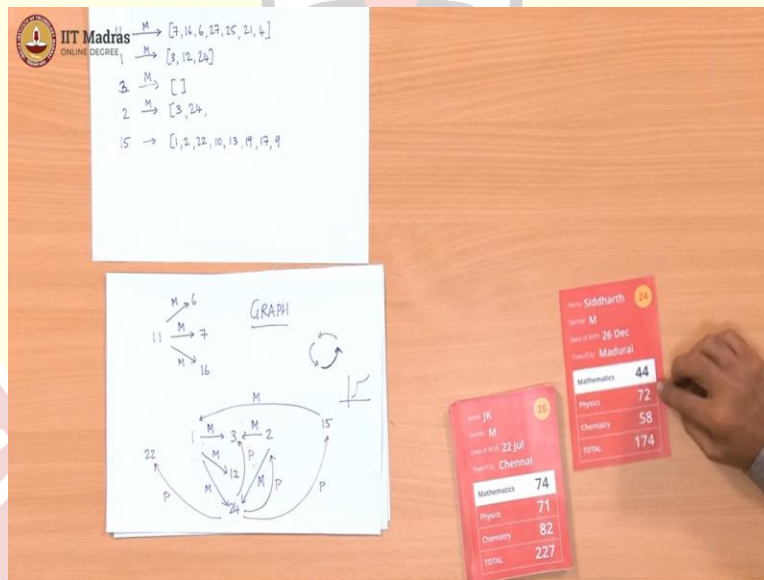
Computational Thinking
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Concept of Popular Students using Graph

Professor Madhvan Mukund: So, so we have been building these relationships based on different things. So, we look for instance for this mentoring relationship, which said one student can help another student if there is a big separation but not too big separation. Then we also said...

Professor G Venkatesh: In a subject, one subject.

Professor Madhvan Mukund: Yeah, one subject. And then we also looked at the other way around saying that students are similar, if they are very close in all subjects and so on.

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So, then we drew these things as graphs, sometimes directed, sometimes undirected; and then we said we were looking for patterns in these graphs. So, by looking at the graph structure we can understand something about the relationships between the cards.

Professor G Venkatesh: Looks like that.

Professor Madhvan Mukund: So, so one thing I was wondering is that supposing you look at somebody like this card number 24; so, it looks like this card number 24, for instance, at least from whatever cards we have already looked at in this earlier calculation, that this person can be mentored by two people in maths; and can mentor some four people in physics.

Professor G Venkatesh: Oh really?

Professor Madhvan Mukund: So, this card number 24 has two maths edges coming in; so you can see that they have two maths edges coming in and if you can find the physics.

Professor G Venkatesh: I see.

Professor Madhvan Mukund: So, so we can find these kind of interesting students, now students who are kind of...

Professor G Venkatesh: Somewhere in middle.

Professor Madhvan Mukund: Somewhere in the middle, who can be mentored by a lot of people and who can also mentor...

Professor G Venkatesh: Very likely that, you know these students are likely to be the more liked students in the class.

Professor Madhvan Mukund: Because it many people can sort of relate to them somehow.

Professor G Venkatesh: Because they neither too good nor too bad.

Professor Madhvan Mukund: So, everybody has some feeling either they can help them or they can be helped.

Professor G Venkatesh: They can be helped or they help something, 24.

Professor Madhvan Mukund: So, basically you can see that people who do well in maths can help him, whereas he has reasonable physics marks so, he is able to help people who do poorly in physics. So, he can form a lot of friendships or connections this way. So, this could be one thing that we can identify if you draw...

Professor G Venkatesh: So, what you call him? What you call people like this?

Professor Madhvan Mukund: Well, guess...

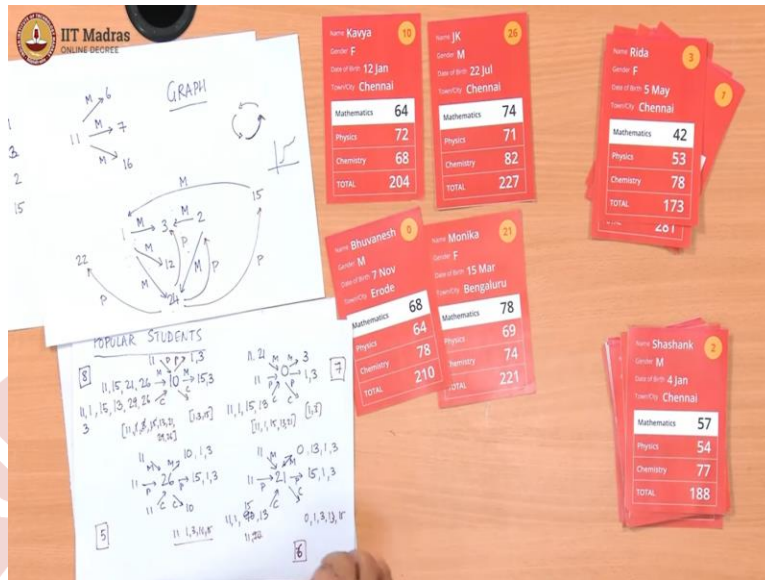
Professor G Venkatesh: Popular?

Professor Madhvan Mukund: Yes, popular, why not popular. So many people might be interested in knowing this person, because they can, they have some connection in subjects.

Professor G Venkatesh: So, I would suspect I mean even that the marks are running from 40 to 90, 80, 70...

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Professor Madhvan Mukund: So, somebody is in the middle will have some...

Professor G Venkatesh: Just like this guy 72, so 70 if you have 70 in all subjects basically I will say.

Professor Madhvan Mukund: So, there will be people who have in the 80s, who will be able to mentor...

Professor G Venkatesh: A lot of people have 90s who will be able to mentor him, many people have 60s, he can mentor.

Professor Madhvan Mukund: Correct.

Professor G Venkatesh: He should have many...

Professor Madhvan Mukund: Correct.

Professor G Venkatesh: What you call, what you call this? 24 has things coming in, name for that I mean?

Professor Madhvan Mukund: So, we have this incoming, how many incoming edges are there...

Professor G Venkatesh: In edges, incoming edges.

Professor Madhvan Mukund: So, sometimes it is called the degree, the degree of...

Professor G Venkatesh: In degree?

Professor Madhvan Mukund: Yeah, so the degree of a node is is how many edges are there around it. But, because we have directions, there is an incoming degree and an outgoing degree.

Professor G Venkatesh: So, in degree and out degree; so, they are looking for nodes which have a large degree.

Professor Madhvan Mukund: Degree, combination of in and out.

Professor G Venkatesh: Ideally good in degree and good out degree.

Professor Madhvan Mukund: So, for instance we can see that somebody like this number 11, who had very high marks in maths, will have a very high out degree, because they can mentor people who are below. But, because this is the highest mark in Maths, they will have no incoming edges, so the in degree will be 0.

Professor G Venkatesh: So not very popular.

Professor Madhvan Mukund: So, will not, cannot, it is more likely to be popular if you are in the middle range. People are above and below.

Professor G Venkatesh: Now, let us find somebody who is who is got 70 types marks.

Professor Madhvan Mukund: So, this is let us say this is one possibility.

Professor G Venkatesh: JK has 60s, all three 70 something like that we should see. We may not find anybody like that.

Professor Madhvan Mukund: Close to 70 at least if we find.

Professor G Venkatesh: No that is 51, 52, 64, 71, this 80 will be high, this is also high. This okay na?

Professor Madhvan Mukund: This is...

Professor G Venkatesh: Kavya 64, 72, 68.

Professor Madhvan Mukund: So, likely to get...

Professor G Venkatesh: This first one also seemed to be ok, JK also, this is 52, this is 56.

Professor Madhvan Mukund: 80s.

Professor G Venkatesh: 74.

Professor Madhvan Mukund: Bit on a higher side.

Professor G Venkatesh: It is on a higher side, 71, 92, 84; 72, 92, 97.

Professor Madhvan Mukund: So, these are our two candidates; so we are trying to see whether these three have got high degree. So, let us try and compute their neighbors in this mentorship graph.

Professor G Venkatesh: We keep, we have four.

Professor Madhvan Mukund: We have four...

Professor G Venkatesh: Enough I think.

Professor Madhvan Mukund: Let see among these four who is the most popular. So, we have 10...

Professor G Venkatesh: So, we are saying that they have large degree, large in degree and out degree.

Professor Madhvan Mukund: So, we will have to go through and check for each subject, who are their neighbors, whom they can mentor and whom they can be mentored by. So, right here we can check for instance, so Kavya within this group; so 10 to 20, so 26 is an incoming so I will draw it like this, this list. So, this is the maths list, the maths list has 26 as an incoming thing; and it has 21 because it is between 10 and 20.

But, nobody in this group can be mentored by Kavya in maths; then we have to go to physics. But, physics they are all very similar, so they cannot mentor each other. Chemistry again 26 can mentor; 82 can mentor 68, but these two are, so it is between 10 and 20. So, 26 is also a chemistry neighbor of 10; so this is within this group, but we have to do it for all the...

Professor G Venkatesh: 26 can mentor 10...

Professor Madhvan Mukund: In physics; in chemistry and in maths.

Professor G Venkatesh: And in maths, JK, JK is like a good candidate too.

Professor Madhvan Mukund: So, we will have to do a similar thing for JK also; so we will have a 26 list. So, for each of these four what we will have to do is construct list, these in and out list for all degrees. And then see which one of them has the highest degree. So, we just start off by creating this space is 26 and 0 and 21; so these are four candidates and each of them has this maths, physics and chemistry, these three possible lists.

Professor G Venkatesh: Each has a list.

Professor Madhvan Mukund: So each is going to be a list; so we will fill them in as we see cards. But we can do it all in and in one shot, so for each card we can put them in all the list for all the four, we can compare then. So, we do not have to do it again and again. So, so let me just draw it for this person also.

Professor G Venkatesh: So, we have examined this; so we need not this cards, right?

Professor Madhvan Mukund: Well, we will have to because if we will show them, we will have to compare with this.

Professor G Venkatesh: But, this all four with each other have done?

Professor Madhvan Mukund: With each other I think there are no, no, 21 can mentor; no we have 10 only for 10, because we have to write down list explicitly for everybody.

Professor G Venkatesh: Let us do it systematically then.

Professor Madhvan Mukund: So we did it for 10, now let us do it for 26. So, 26 can mentor 10 in maths that we already said, 26 can mentor 10 in chemistry and 26 cannot mentor anybody else in anything.

Professor G Venkatesh: Who can who can mentor 26?

Professor Madhvan Mukund: Who can mentor 26, nobody I think is got more than 10 marks. Now, if we go to 0, then I think we are done, and I think 0 is, 21 can mentor 0 in maths. So, therefore, 21...

Professor G Venkatesh: 0 can be mentored by 21, you can enter in both places, that is about it. So, now we go, only we have to look at, we are cannot keeping this node, we are not looking at this as a node.

Professor Madhvan Mukund: We are just going to put it in one of these lists. So 72, so maths it does not go with anybody.

Professor G Venkatesh: 72, 66 again no; 68, 81 yes; so 10 can be mentored by 29 in chemistry.

Professor G Venkatesh: Let us look at this, now for 72, 71, 66, 82, 81. Let us look at this. Again 29 can mentor 0.

Professor Madhvan Mukund: 29 can mentor 0 in, no you cannot this only 4 marks. Again it is within 7 marks within...

Professor G Venkatesh: So we are done with this card?

Professor Madhvan Mukund: Yeah. So, this is done, we can put it aside, so let us keep some space here, so that we have space. So that is done, now we will do same thing.

Professor G Venkatesh: So 65, 73, 89.

Professor Madhvan Mukund: So that is again, so...

Professor G Venkatesh: Kavya can be mentored by 13 in chemistry. 74, 65, 71, 73, 82, 89, no. 68, 65, 64, 73, 78, 89.

Professor Madhvan Mukund: 89 yes, so 13 can mentor 0; 13 can mentor 0 in chemistry.

Professor G Venkatesh: 78, 65 yes; Monika can mentor Gopi, so 21 can mentor 13 in maths. 69, 73, 74, 89 here again.

Professor Madhvan Mukund: So, 13 can mentor 21 in chemistry, so actually they could form a study group in maths and chemistry.

Professor G Venkatesh: Actually. Goutami 76, 54.

Professor Madhvan Mukund: 15 so she can help in maths.

Professor G Venkatesh: 72, 58 so...

Professor Madhvan Mukund: Physics also, Goutami can go

Professor G Venkatesh: Again they can make a study pair.

Professor Madhvan Mukund: And Chemistry...

Professor G Venkatesh: Chemistry again, this is looking good. Then JK, Goutami 76, 74, 71, 58.

Professor Madhvan Mukund: So, 26 can help 15.

Professor G Venkatesh: 82, 90 no. 68, 76?

Professor Madhvan Mukund: No.

Professor G Venkatesh: 64, 58? Yes.

Professor Madhvan Mukund: No, okay sorry, no it is only 6 marks here, but this side so, 15 can mentor 0 in chemistry.

Professor G Venkatesh: 78, 76, 69, 58.

Professor Madhvan Mukund: So, Monika can mentor in physics.

Professor G Venkatesh: 90, 74.

Professor Madhvan Mukund: So, it is certainly looks like number 10; Kavya has got more neighbors in anybody so far at least.

Professor G Venkatesh: 64, 62, 72, 45.

Professor Madhvan Mukund: So, 1 can be mentored in physics and chemistry...

Professor G Venkatesh: Around 68. 74, 62, 71, 45

Professor Madhvan Mukund: So, 1 can be mentored in maths and physics and chemistry there is no mentor; so only 9 marks.

Professor G Venkatesh: Here also you cannot, 74, 62 is 12 marks.

Professor Madhvan Mukund: Okay, sorry, yeah.

Professor G Venkatesh: 68, 62, 64, 45.

Professor Madhvan Mukund: So, 0 can mentor 1 in physics.

Professor G Venkatesh: So, 91, 78.

Professor Madhvan Mukund: 1 can mentor 0 in chemistry.

Professor G Venkatesh: Physics?

Professor Madhvan Mukund: Maths the other way, so 21 can mentor 1 in maths.

Professor G Venkatesh: Physics also.

Professor Madhvan Mukund: And in physics and chemistry is here.

Professor G Venkatesh: Alright, this is a good pair. Rahul we will stop after some time ok, 97, 64.

Professor Madhvan Mukund: So, Rahul can obviously help in maths.

Professor G Venkatesh: 92, 72.

Professor Madhvan Mukund: And in physics.

Professor G Venkatesh: And in everything. So he can do for everybody I think all three, all of them. So that is easy. Rida.

Professor Madhvan Mukund: So, maths she is on the right side 3; physics also she is low, so 3; chemistry is 10 marks. So, chemistry we said 10 inclusive, so 3 comes here.

Professor G Venkatesh: JK.

Professor Madhvan Mukund: JK can help in maths and in Physics.

Professor G Venkatesh: But not chemistry.

Professor Madhvan Mukund: Not in chemistry; Bhuvanesh can help in maths and in physics and not in chemistry. And Monika can help in maths and in physics but not in chemistry.

Professor G Venkatesh: So, we stop and we will see what we get?

Professor Madhvan Mukund: So, we can stop and see what we get. So now we have to decide what the criterion is. Because we have some cases like you know 3 is a physics target and maths I mean this 10 can help in both. So, if we are doing popularity it does not matter which, so we have collapse I think these duplicates. So, we have to look at on the right hand side I would say that 10 can help...

Professor G Venkatesh: 1, 3 and 15.

Professor Madhvan Mukund: 1, 3 and 15.

Professor G Venkatesh: Three people.

Professor Madhvan Mukund: So, it is 3 people so 1, 3 and 15 so it is 3 people. And the inside, input side we have 11, 1, 3; so now again see 15 comes on both sides, because someone is this way, so we will see what to do. 15, 13 a lot of them 21, 29, 26. So now we will remove the duplicates from both sides, so you can say that 3 can be removed from here, 15 can be removed from here, 1 can be removed. So, 10 has 5 plus 3, 8 neighbors, 5 if we, if we count only the distinct one, so 10 has 8 neighbors.

Professor G Venkatesh: So, 5 it can help and 5 is basically something like that.

Professor Madhvan Mukund: Something like that.

Professor G Venkatesh: 8, 8 people they can, 8 people 10 can interact with.

Professor Madhvan Mukund: Yeah.

Professor G Venkatesh: There is a reason what 10, out of the card we have seen.

Professor Madhvan Mukund: Also the card we have seen. Look at 26 on the other hand, the right hand side we have 1, 3, 10 and 15, and on the inside we have 11. So, there are only 5 people that 26 can interact. And this is 1, 3 on the outside, and 11, 1, 15, 13, 21 so this is 7 and this is 0, 1, 3, 13, 15 on this side. And on this side it is 1 is already there so I will leave it out; 13 is already there so I will leave it out. That is why it is 11 and 90 so this is again 7.

Professor G Venkatesh: 90?

Professor Madhvan Mukund: 90, not, it cannot be 90 so what is that? I think 90 was the marks; I this I mixed up something. I do not know who was it maybe 15 look at the chemistry marks of 15, so this 15; so that is all read there, so this is actually only 6. So, what we have seen is by looking at...

Professor G Venkatesh: Out of so far it looks like Kavya has the most popularity.

Professor Madhvan Mukund: So, if you look at these four people and compare them amongst themselves and another however many five or six sample things, Kavya has a popularity of 8 and the next has popularity 7 is of 0 which is Bhuvanesh, then Monika is 6. And and you can also see in some sense that see JK is on the higher end of this spectrum, you know has so is more. So has fewer things. So, the ones who are more middlish, so again here the 78, 74 these are two higher scores. So, it looks like 60s is where the very popular people are, as you go to the 70s you have already an over achiever in this class. So, so we could do this now and we could so the point...

Professor G Venkatesh: So, again what we have done, we have taken, try to create a graph, try to take nodes and connect the nodes to each other...

Professor Madhvan Mukund: So, we are doing the same graph, same graph that we did it before; but we are just doing a different analysis with that. We are just trying to see for each node, what is the concentration of edges around that node.

Professor G Venkatesh: You are counting an in degree and out degree of that.

Professor Madhvan Mukund: And then we are doing a little bit more, because we are saying that...

Professor G Venkatesh: Duplicates?

Professor Madhvan Mukund: Yeah, like this 24 has an in 2 and then out 2, we would say that has only one neighbor, so we are not counting the neighbors. So, we are counting how many distinct neighbors it has across all the incoming and outgoing. And based on that we are assigning this notion of popularity, and we are trying to identify who is the most popular. But, in some sense if we had first constructed this graph properly, once you have constructed this graph, you do not have to go back...

Professor G Venkatesh: You do not have to go back to the cards.

Professor Madhvan Mukund: So this problem of...

Professor G Venkatesh: A lot of things like this, popularity, mentoring.

Professor Madhvan Mukund: So, all the details of those marks, everything is hidden inside this graph. We do not need to know anymore, what are the exact marks and do this recalculation every time. So, this graph is a nice way of capturing this...

Professor G Venkatesh: Essence of the relationships.

Professor Madhvan Mukund: Yeah, relationships ones and for all, and then we can do many, many different kind of things with that. So, that is that is a very useful data structure to capture this, summary of this information.

