tay-cjqs-yfz - 2020-08-24

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Okay, so let's continue with where we were in terms of our discussion. We have been looking at time and space complexity analysis last name. So remember I went over the syllables first. And then I discussed basically how time complexities are actually notations. We go notation Omega. And I said, how big is a upper bound? Omega is a lower bound

and

Theta is the exact form and then we also you know saw the concept of this case average case and worst case time complexity. and I think I also mentioned that in practice We always look for worst case and average distance complexity. That is very important. to derive for every problem Okay, so now let's get started. We should start with our first problem. On which we will apply all these Concepts. Is called as table matching. So this problem is called as cable matching problem quite an interesting problem.

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And unique to delivery professor gets
unique so now what I assume so since in the first year of marches was all the professors know all the students. we have to assign the instructor instructor over the student to the instructor the professor and ta is the

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assistant. Let me open my whiteboard. And okay, so see this is the concept here. There are professors. the board

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Okay, so it's like this Okay, This is like this there are professors and there are students. So there are two groups of people. So let's say that is Professor number one. two three and four And there is student a b c and d. Now let's say professors once first choices student B. The professor one wants the student B. The student B. He doesn't get then he's okay with c and so on choices. Okay. And let us say let's take student C. Let's say students these first choices Professor 1. Missouri I'll go to So let's say student B's First Choice is Professor 1. Is not professor bandhan professor 4 and so on. So I hope you can see this choice. So what has happened is this is Professor. And this is truly. What You observe here is Professor 1 wants student p and if B is not available then he's okay with students C. And student B also wants Professor 1 only. And 1 is not available. Then he's okay with Professor 4. Now just try to imagine suppose somebody assigned. Professor 1 to student C And student be to let us say Professor 4. Well assume that Professor 4 also wanted student Beyond. first choice beginner so I Sagar assignment, who are So what will happen? Professor 1 and student B suppose if they meet somewhere Professor 1 and student be suppose they meet in the canteen or something. Even start discussing with each other. What will they discuss? They will discuss that see actually a professor one will say actually I wanted you only as my student, but I have got C. And student we will say that actually even I wanted you only as my professor. But I have been assigned student a teacher number four. So both Professor one and student be both are not happy. Okay, both are not happy with this arrangement. Are you getting it? So then what happens is this Arrangement will become unstable. Why is it unstable? Because Professor 1 is, you know Professor 1 and we both actually wanted each other. He's coming first choice beta is coming first one. but still somebody has matched one with c and four with so this matching which is this so This is the matching that we're talking about. This match is called unstable. It is unstable. Why does unstable so these two people are not happy one and we are not happy. And they will complain. And you understanding this. So the goal. Is to ensure that we have stable matching, so that is the problem. The goal is to ensure that we have. stable matching so I think so. So now what we will do is we will kind of little bit change the problem and we will talk about another problem which is kind of more interesting or more easy for all of you to understand. This i What is the stable marriage problem even managed problem means? There are men on one side. And there are women on the other. There are men three men And let's say there are. three women And let's say the three men have choices. Okay. So now what I will do is I have not called woman also one two, three. I'll call the woman as a b. So the men have choice for example Man one. Wants be as is a woman partner by for whatever you want to call it. If not B then C if not C. Now everybody will have their own choice because it's already personal. So let's say somebody else is some other choice. and let them s are you getting it? Okay. So what this means is the man number one wants women B First Choice LC for else a Okay, and two wants E A and B in this order? And three wants either B A or C. Now, let's come to the woman here. the woman also have choices So let's say a woman a wanted. A man one. Let us say it's not one then two if not two then. As far as women be concerned. She also had some choices. So let's say women we wanted man one. It's not three else two. And as far as women is concerned. Let us say, you know, she also wanted man. Let's say she wanted. Man 3. First is not man bun. So these are the choices now what is stable married? stable married means I should not have a situation where? X is married to y And what happens is? There is a conflict as in one second. So X is married to y. But X wanted said more than y so let's say that X got married to y. but X kaju preference listener in that said this before y and that is married to let us say some U. and instead Excuse before you prepare. I know it's a little difficult but let's say these two marriages have happened. Excess married to why and you is married to death. These are the men and these are the women. So that part I'm not writing. excess married to why and you is married to say and let's say in exactly wanted said more than by. And they had wanted X more than you. If such a marriage happens with such choices and what will happen if suppose extends dead will meet somewhere. Then it will be revealed that actually X wanted Dead more than the current partner y. And Z also wanted externally more than the current partner used. So what happened? Their current marriages will break. Current marriages will be destroyed, correct. So this marriage of x y and z? will become unstable means that they will eventually break off because they had a better choice. And they also want to determine. So now let's come back to the slide that I have. Come back to the side. So we want to arrange what is called a stable marriage. Okay, so I hope for the concept of stable marriage is clear. The stable marriage means no marriage should break later because we don't like diverse. So no marriage should break. I have a look at this problem that I put on the screen. That a is let us say the men and let us say that the woman. ABCD Okay, so set a each member instead as given his options and instead we each woman has also given her options. Now what I want is I want you to suggest to me a stable marriage. but since you have to tell me who should be married to who in such a way that the marriage will be. stable Okay, I want you to suggest to me. You can just write on the chat I want you to write on the chat. A particular marriage that means you have to tell me the marriage of ABCD to one two, three, four in such a way that the marriage will be people. that them Right. So what is given here are preferences, please note? Okay, so the choices are very clear. Is 2 4 1 3? You know, you can say that. Is 4 3 2 1 and D is 1 3 4 2 so I hope all of you are having some pen and you know some paper in front of you. You need to solve this. And you can put the answer in the chat. So then we will just discuss the answers. And then later come up with the algorithm. Okay. So everyone please use a pen and a paper. And you propose me some marriages. Which will be stable. Okay. So please not there can be multiple possibilities. Of marriages that actually will be stable. So look at the data that I've given

you and propose

marriages that are stable. Again, let me just see if there is any trouble in that if anybody has any question or something. Okay, somebody written. Something so let's take some answers here. So we make testing that a gets married to one. He gets married before he gets married to three and he gets married. He just have a look at this. He gets married he He is married to four and he is married to one. This is married to one.

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And is looking at vivek's answer email the others can also. I just put the data back again. So others can just try to propose the marriage.

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Okay leaving I will look at your so this the marriage proposed by the week is actually unstable because not the correct answer. These are I'll tell you. With one now, please observe. that AP priority May so what can basically happen is one wanted CNB more than anything. And a also want shared two and four. more than one now if you look at two and four two and four if you look at four see, okay, so so just look at okay. Oh, yeah, I think this one. These four will work actually people will be happy. Yeah, okay.

think that this is correct. Sorry. Yeah. Okay. So this is fine. Okay. There are multiple possibilities. So that's why I was wondering. Well then. Yeah, okay. So it makes sense it is right. So let me just see if somebody else is giving someone their multiple answers possible here. So please try to understand when they can be a problem. So what I will do is I'll just take some example and tell you where we could actually have gone wrong. Let's say I married.

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Okay. Just imagine. I got a and three married. Has anybody written a getting married to me? Just imagine if a and three got married. What would have happened if a and three would have got married? What would have happened is? He wanted he had other preferences. He actually wanted two four one. and if you look at one four and two Okay, so let's say a got married. and let us take someone who's something who's proud

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O Okay have a look at this supposing a got married to 3 and Steve got married to 2 as anybody driven that. A3 C2 Okay, so somebody wants to see the slide again. Okay, so suppose if a got married to 3 and C got married to 2 just look at this. What would have happened is? Now. Suppose if a got married to 3 and 3 got married to 2. Then in A's priority who is higher than 3. Correct, because a Wanted 2 more than 3 and in two priority a is more than C. Are you having a look at this? So, please note what I'm saying suppose if a got married to 3 and 3 got married to 2. Then a would have because a wanted

two

more than three. And two wanted a more than C. So basically what would happen is a what I also broke his marriage and two would have also broke her marriage with c. Okay. So this marriage would have been unstable. So nobody has given such an option but it's possible right so you can come up with the wrong matching. Okay. I hope you understood what I'm saying. Right. So basically stable matching social when is the matching table? So please note?

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So it's not that stable matching. Please not doesn't mean that everybody should get their first priority.

will not happen like that. And let's imagine. There is some hypothetical Aishwarya Rai inside to be And everybody in statistics is that I want Aishwarya only. Okay that you may say but if I show you is happy with Abhishek Bachchan married, then the marriage will be stable because she's not want to break the marriage booty. Basically, you know that marriage will be stable. So I hope you're understanding what I say. So basically it's not necessary that you have to get your first choice.

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For to write an algorithm. Where we can accomplish this task. Okay, so actually honestly. The course is best. Taught face to face. So it's not the, you know, kind of I'm trying my best to do whatever I best way to teach course. can. So what I want you all to do is just speak two minutes. And try to write an algorithm. Obviously, I'm going to show my algorithm but what happens is, you know? Unless you try to write an algorithm yourself. You will not be able to appreciate why my algorithm is good.

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So I just give you two three minutes try to write something down. How you would now oppose many of you have done the matching by hand. That's okay. But you have to do it by an algorithm. So try to write a simple program. That does this message. I just wait for two minutes and then I will discuss my answer.

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Okay. So everyone please try to write. An algorithm take two minutes to do that. How would you arrange marriages between many? Of course, they are not taking the complicated case where the man wants to get married to the man and the woman that is too complicated. We will stick to the Simple Man wanting to bury the woman and by someone

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Okay, so I hope you all are trying something. I can't see everybody obviously. Okay, so basically see. What is the idea for my algorithm? So first observe that? The idea was algorithm is simple. So we will propose a two stage algorithm. Proposal the first stage that is proposal. And the second stage there is marriage. That's how

Look at this algorithm. The first thing that is proposing the first thing what happens? Every man will propose to the woman who is highest so that means the man he has woman one on His Highest he will propose to her. Under that woman doesn't have any other option. She'll accept it as it will be I only thank so far so good. but it's a woman is already matched to someone. Who another man into? And now M proposes to her. If she prefers him to M2, she will accept him. Which basically means that no m2k such a failure. And woman prefers M2 to him then she will reject basically M and be happy with him. Are you understanding? So basically the wage is algorithm will workers. In the first stage, there will be proposals.

in the and and that's proposals will keep happening repeatedly. Okay, that proposals will keep happening repeatedly. And in the second stage, they will be the marriage. Okay. So now I will run this algorithm that I'm saying on a sample data and then you will understand what's happening and then we will discuss. and because let's Okay, so let's take that data. Once again, unfortunately, I love to write it once again. a wanted that same data that I put on my slide just so that everything is in one place.


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These were
the choices of the men and


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Okay, so now we will start writing the algorithm. What is my algorithm the man starts proposing on the woman who is highest promise list? So a is the first man. in a will propose a of course is true. Okay. Now two does not have anybody right? So two will accept abito two k first two options. Together now our next chances for me. We will propose to force. We will propose. To looking like 13. Okay, we will propose happy 4K password. Okay. now third c will Propose now the matter is interesting. Now when C proposes to 4 4 already has one proposal from d. So now 4 now, let's look at 4. So 4 will consider whether she wants be more or symbol now if you look at 4. More case may be is higher priorities than correct. In force options he is higher priority than C. So 4 will reject the proposal of the a proposal project because what is happy with B. She doesn't want C.

But on the other hand suppose
him for in the option list of four. He was higher than the example I'm saying suppose in four C was higher than b then what would have happened? Four would have accepted C. And then in that case her Proposal with would be would have worked cancer. Are you getting it? So what has happened? Is this proposal got canceled? So for seek a chance tell again. Medieval proposal let's take these. We will propose to one because one is highest on this list and one will accepted one capacity.


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Again, you know, okay now let's second iteration. This is first preparation. What is the second iteration? What will happen a b copy see what will happen is see initially at 4 over here that now c will propose to c 3. Will propose 2 3 correct? Because 3 is the second option of C. To 3 K 1 to your proposal. Hey karna is not having any other proposal. So 3 will accept C. Now what has happened?


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Now everybody's matches. That means a b c d e f now all these proposals will become Finance. So basically they will become married. So when they become marriage then everybody has already proposed to someone. Then they will all become Finance. So our claim is is answer enough A to B for c one and d one and three. This is final abuse. It which videos?


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I understand this our claim is that this is a stable marriage. Okay, our claim is that this is a stable marriage. Now. What I will do is now I will take another example the same thing. Now we can have the proposal from the woman side also. So basically now what we will do is We will change the algorithm. That means that we have calculated. So first now let us see what happens. We will propose to see.


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I think capacity. Then next woman is to civil propose to be he kept us. the next woman to propose this three and she will also propose to see now what will happen. Is he capacity? originally one say I ever thought about so because of that. really value it you could point to yes does see what three more or one more now if you look at these options


OJAS NATU - 12:36

I mean it


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once again somebody asking some questions but somebody asking something Or is it some random noise that is? Okay. So I hope you understood what's happening. So please note. multiple answers and possible depending on who starts proposing


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to marriage

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the marriage is stable. Could you be

 ATHRVA MAMIDWAR - 12:40

in down

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Totally and men are proposing. You can assume that what can happen is in the worst case. proposal can keep getting broken. The worst is what can happen is every So what will happen is the second iteration again in men will propose the question is how long will it happen? It can happen only maximum n times remember it can happen only n times. Because each of the N men have only n choices. We also have four choices here in this code in our example n is equal to four so basically in the first reason The first situation there are four proposals made. The second iteration also worst case there can be four propos. ALS so particularly a total number of proposals in the worst case within Square. I hope you are getting by right then Square because there are n men and each man has n choices. So worst case every man will end up proposing to agree over on his list because all the proposals are getting canceled. I mean that can happen in a very complicated situation. When their options are completely opposite. Okay. So now please remember that is going to be ordering. I hope you understand why I mean, let's assume that all the men have unique choices among the women and let us say the woman also, I mean somehow so, let's assume that all the men have unique choices. That's them we ready and complexity and all the men will propose to the first one. They're listening. Everybody will get it. the choice in material because let's assume that a man wanted woman man be wanted woman to man. See wanted woman 3 Man 4 Wanted woman 4 first choice to step look up not the first choice for proposal. They will have to accept it. So basically a will get married to 1 b 2 2 c 2 3 and D 2 4 and it doesn't matter what the woman's Choice was you.

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So basically the best case time complexity is ordered and I hope you are understanding. and the average amount you see on an average on an average each man will propose to half the woman on his list. So suppose if there are men suppose if there are any each of them will propose to half of them. ending to n by 2 again and into That this is nothing but n Square by 2 and N Square by 2 is nothing but order n Square. I hope you remember this discussion that we've already had. right that either by 2 Hana So by 2 is a constitution we remember I had told you the time complexity that constants are going to be ignored. So basically because the constant will come in that's the G of n so average complexity N squared is complexity. every man ends up proposing to all the women on his visit Be directly in. Please note the average and worst case time complexity is in square and the best case time complexity is order it. So I hope this part is also understood as far as time complexity. You know. Now there is another point to be discussed the last Point as far as this algorithm is concerned. How is it that the algorithm is stable? basically so my question is What is the proof for stability remember I had told you the introduction itself that whenever we discuss this algorithm. Discussing what is called as table a proof of correctness. How is that correct? Why is it that this algorithm is correct that has to be discussed.

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So let's go back to my slide. They're gonna this one algorithm. If M proposes to W M proposes to W W's and match the accepts if he's matched with someone else he will accept or reject. So basically the algorithm was like this unmatched template proposed to the highest woman on his preference list. He has not already proposed. to admit few redemptions

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Like so that is everything later. I mean I'm not talking. Practice what is stupid and I'm talking about what happened to this algorithm? So that proposes to the highest. performance that We have already. Done. Why is it that this algorithm produces? cable match okay here again.

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so what I have been do is and clear my canvas. dark ness I will do what is called as by contradiction. So very interesting by contradiction. Two by contradiction commitment is algorithm doesn't work. Well assume that is algorithm doesn't work. And then we will prove that while you cannot happen like that.

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So, let's assume that this is algorithm. So let us say that. Let's say that. m x let's say that there exists two matches. married to let us say and let us say another marriage is between

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Let's say x is married to Z and U is married through our algorithm. and let us say that this excellent B, they meet each other. and we actually wanted to marry more than you.

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more than humans Mysteries and X also says that I wanted to marry the only that said to a marriage today don't know marriage to me. So let us say it happens. Now the question is can such a scenario happen. So please note. suppose the excess married said Okay, and who has married me? so

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fell off years Okay, so suppose that us married. We know we are asking a question. I suppose that take X wants to be more than you and so basically somebody so what this means is that except X priority. B is somewhere before is that I don't understand. That's something that if exists wanting now to marry you we then what it means is it excess priority list.

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that I did was I took an algorithm called as table Matrix table matching. So what is table match is table matching is actually two applications one application is in the engineering field and one of the medical Fields engineering field. What happens is as I told you in Masters level professors and students are to be matched to each other. So suppose so every Professor has a priority of which student he wants and every student has a priority which professor she wants. That a stable matching means you are

stable magic

means a professor and a student is assigned and no professor and another student complained that we wanted each other more than our current student or professor. Which is similar even in medical education education, there was an application in my own hotel that right now but this is called stable I'm usually here how to do this. way. What did we do? We called a stable marriage problem. Stable management is the hypothetical problem where we have n men and women whose priorities are given.

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is isn't Square by 2 and best case time complexity is n why it isn't because if everybody has a unique Choice first choice and if the proposed to that person

who is uniquely First Choice then

Joba was accepted. So much time basically almost 1 hour is over now. 55 minutes I will not start another topic. Is there any question I mean anybody want to unmute and ask for asking to chat? Have you understood what? as you can ask the question the territory you're going to I mean is everybody there or am I audible? I don't know. It's a long time. Nobody said anything so in this somebody confirm or the child whether Well heard what I'm saying or just talking. Oh, yeah meal

A ASHWINI MAMULWAR - 12:55

Yes, so you would.

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people I think. Okay, thank you. Thank okay. So basically I hope you all have understood that okay. Now what I will do is now. My slides I will share it on the group.

Because

obviously sharing it on the group. And next time onwards we are going to start with sorting. With sort of homework tomorrow when we start with sorting not just have a look at bubble start selection start insertion sort and heat sort. Can the somebody unmute yourself? I want to know what your written second year. There are going can someone just unmute yourself. I want to know which sorting algorithms you will studied in data structures course in a

T TEJAS PRADHAN - 12:57

This stages here we have studied.
This stages here we have studied. So insertion selection bubble merge heat shell bucket. and these are the ones I can remember.

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And anyone just

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Who's that?

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Yeah, I understand.

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in point third option is left one point now. It depends on how you qualify. For example suppose you could say first option is 100 points. Second option is 50 third option is 25 or fourth option below satisfaction. So if we're subscribing algorithm that we wrote there was only one goal in it to ensure marriage is stable.

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Is stable means that it should not happen crisscross. They want to run away.

It didn't

mean that everybody is going to be satisfied told you suppose if in our algorithm a wants one D wants to see one three and d one four and even if the woman one two, three four don't want did not had ABCD last in their list. Another one case of say, you know, they wanted something else only but the way our algorithm is it will make the marriage and the marriage it is stable also because other person will not break it no.

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So I do understanding so like I give a simple example because there are 10 men and everyone wants to get married to Australia. So then you know, but she's not want to break her current marriage. So then basically the marriages are stable the Scooby store. Nobody will be answering. So so the problem that we discussed was stable message the problem that Jeremy meta has put up on the interesting point. She has put up on the chat. This is a different problem for today. Yeah, that problem is this all canopy is for dynamic programming application will have to put function we have to quantify things or technical satisfaction.

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Everyone and then we have to also ask the question whether you want stability. Also you want only this. Maximum satisfaction I said, thank you. Mama, so is it at the cost of stability or is it assuming stability to stop say the problem will change the algorithm building? That's what I see. Okay, good. Good question. Any other question or comment maybe before we just qualitative? I think anyway is already one o'clock. So I think so. Maybe just one. Okay, so and finding all possible stable matches is also different question. Well, no all possible stable matching is no so for that simple thing. What you can do is

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One run the proposal from the main side and one from a woman's side because the base is algorithm works as I told you. This is biased towards who proposes first. So the man proposes first. Then they you know, their successive woman option keeps reducing but eventually, you know, they have a more satisfaction and the woman proposed first, then their satisfaction level is higher. Okay. I'm the solutions. They're completely different. I already showed you how depending on who proposes first. Our algorithm will give you multiple

now another way to find all possible. People my business you can start proposing. Okay, I think. Okay, so I'm just trying to think well algorithm is only two answers or can give more two answers. It's shortly used depending on who proposed this was. otherwise won't we also have to consider proposing from every possible man? Yeah, that's what I'm thinking cases what he's saying. I'm the same thing. That means you run proposal list from a different man starting point.

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And the question is would that give you necessarily a different answer? Maybe one second.

me also just look at that. So for example If e proposes can be used something like backtracking and we can use backtracking. Well, that's more expensive. I mean Raj is asking the question of marketing backtracking mechanology the time complexity becomes exponential in backtracking. I'll talk of that when I come to backtracking backtracking. Yeah, actually backtracking will give all possible solutions. So that part what he's saying is correct.

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Backtracking. I mean, I'm not sure whether everybody here understands backtracking. What are you seeing? but attracting basically Is a three leg solution? Where you know you find all possibilities? So checking will indeed find all possibilities Titania saying won't some matches be more stable than others. No, absolutely not because there's nothing like more stable. Please try to understand. What do you mean more stable less stable? The stability definition was solid. Over this it is a definition of stability wasn't too culture. It was a solid definition. What was that definition of stability that the opposite partner that means, you know, M1 is married to W1 and M2 is married to W2 M1 and W2 should not run away with each other. Now. The question is if either of them are happy with their current spouse, then it is stable. There is nothing like more stable. So I think Titan is going towards what semi had us in terms of more satisfaction, but that doesn't make it more stable. Please remember that. So it's either stable or it is not stable when you say more stable maximum satisfaction. We are actually qualitatively speaking. Now what happens when we write algorithms. We want quantification. Okay, so our algorithm Quantified and it observed the answer correctly. So there is nothing like it. Okay, so I think I'll just end with this note that backtracking would find all solutions. We will be looking into it for all solutions what we have to take into account all possible permutations for one side. Will that make time complexity and Factor area? Of course when you go into backtracking then the time complexity is in factorial and it is basically exponential. So basically n factorial is exponential so I will be talking about that later currently, but as everybody may not understand that so but backtracking will give an exponential answer. But anyway, the if you see this problems, you know what happens now, every problem is written for a particular purpose. This problem was actually originally devised for this American University problem of you know, assigning a student to Professor. So any answer would have done so it's not that you know, you wanted something most people or anything. Like that. So our n Square solution was actually decent at least it was Finding two answers different thing on how you started you started from the menu. condition maximum