### algorithm\_week2\_2-20240909

说话人1 00:00  
The same as the data. This is one, right? The value corresponds to one. Please. Divide the counter. So advanced, divide those into that, the right. So you are already in our last. That's the matter, but they work, but it may be too fast, probably compared to the same thread. All right, it's good try. But for now, we are trying to be a bit slow, so we are trying to see whether we can see some property or find some property which help us to reduce the running time.

Here's the one. So starting from one, there are many lines, for example, this line and this line probably some other lines.

Now, let me just ask you a question for all the pairs, starting from one, which pair can be a potential candidate of this final. That's okay, neighbor. It's neighbor. You are also very fast. We already had our on that's it. Very good. Again, you have a slower. All right. I really, very nice direction.

Among all these tests. Actually, this neighbor may not be good, because you see this neighbor is this one, right? Negative, or that's not the best one. So the candidate for the best good pair, can you suggest in another candidate? Which one or the one with what kind of problem?

说话人2 02:00  
That is bigger than this .,

说话人1 02:04  
very bigger than the first one. But there could be many that is bigger than the first one, right? Which one do you pick? Biggest. It's the one biggest value or biggest one. It's a tricky question, right? It's the biggest, valuable, biggest. What? Because we are doing. So what is the final goal? Is the best goal there, which means the largest slope here, very good, a slope, right? Not biggest slope. So in other words, you have many such connections here, and then you will pick the one who's slope is largest.

Slope largest does not mean that value is largest. The slope is largest. It can guarantee that all the points in between, they are below this pair, right? Because nobody can be above. If it's above, that's will be even higher. It's even larger. That's not possible. It's like that. They say this is the largest slope one. This is the largest slope one.

And then you say, I have another point here. That's not good. That's not possible, because then this one will be even bigger, right? The largest soul, starting from one, that pair must be a very good candidate for prepare, right? For the final repair. That means for all these in pairs, I want to focus on one.

说话人2 03:30  
Right?

说话人1 03:32  
Now, similarly, for all the pairs, starting from two, you also need to only focus on the pair which who sold these lives, right? Okay. Now, in your mind, you have the picture ok . 1, compare n numbers, find the largest, right? . 2, compare n numbers, find the largest, and . 3, and numbers, find the largest. So altogether, is it an aspect? Yes, right? And square, you find every candidate starting from any ., right? And then among these n candidates, you find the best one and their best one must be your best one, right? This is the n squared error.

Now, but as I mentioned earlier, we have the final improvement, on this on we need some analysis. What's analysis? Let me draw. These are 2 points. These are 2 points. Now, let me ask you, if this is your final solution, can you have any . below this line? No, right. Why? Because if they have below, this is even higher, right? Okay. But can you have anyone above this? This is also no and the reason. Now you have two reasons, right? One reason, then you have an even bigger slope, right? Another reason, then this pair is not good, right? Good pair cannot have any point above it, right? You see, if some pair is your final, the largest, so good pair, there should be no points about it or build it, right?

说话人2 05:25  
Right?

说话人1 05:27  
Nobody about. What does it mean? It means that if you have some points in between, they must be, they must be here.

说话人2 05:38  
Right?

说话人1 05:39  
And then we come to that observation of adjacent pair neighbor. But what does it mean? Because you see, if somebody these points are in between these 2 points, then I don't need to care about this large segment. I don't need care about these. I only need to care about this. Because it's the same slope, right? Same slope, also a good path. Why bother going to that long run? Right? You need. So that tells us, actually, you only need to find the best repair among neighboring right neighbor that gives us this final on just check all the neighboring can find which one has a large slope done.

说话人2 06:25  
Right?

说话人1 06:25  
Okay. So next, this one is much easier than the first question, I believe, right? But still we need some structural insight of the problem. Right? Now, we come to the second approach called greedy error. Right? Now, you see, I don't like the copy and paste from the textbook. This is the only one, the only one I copy paste from the classic books, official site, right? Probably. You see, this is a bit cigarettes. It's not the tax tight words in this book introduction to the algorithms. They use this gas station. Example to explain what is reading of. Okay. So what's the scenario here?

Now the two cities used there is from us but maybe we can use the cities here, right? So for example, from from shenzhen to dongguan, right? Easier. All right, you get a car, but this car, unfortunately, it's a tank. It's very small. Usually you don't need to refuse it, but it happens that you have to be doing this made not sufficient. Yes. Let's say along the way there are many gas stations, so the gas stations are here for the vertical, but their gas stations, right? Then you go with one, you go with, you try to stop as b small number as possible times. And then before you reach the final destination, if you can, if you can reach the final destination without any stop, please do that, right? If you have to stop once, then please just stop once, right? If you have to stop twice, because there's no solution which stops only once, then it's okay, stop twice. I want to stop as few times as possible.

And then what's the solution?

Now, here, we suppose that if your tank is refueled to full capacity, then you drive a distance of c this is ca. The sea here is a distance you can drive right now. I believe that many of you will have the a solution that come into your mind what's necessary solution is just like and keep driving and stop at the latest or farmers.

Gas station I can ever reach, because you see this is c right? This is c so if I drive on here, I cannot reach this one, because this one is too far away, right? This is too far. So the farthest one I can reach is this one. They're just not there. I just stopped at the farthest gas station and ever reached with my current guests.

Going beyond. You cannot reach, right? And if you saw earlier, it's not really because really says I want to make the some measure as high as possible. In my decision right here, the measure is I want to drive, but this is as far away as possible, right? From my starting point. Ok this is a really solution. Any questions about this really solution? It's okay. The resolution. Now this is the first step, right? First step drive until the farthest station I can ever reach. And then from a second moment on I use this one as a standpoint, and then again, drive to the farthest station I can ever reach.

This is a greedy search. Now the greedy algorithm, usually people will try to prove, it can give you investors.

So how to prove come back in the investors? Let me draw a line again. This is starting . zero. This is c I stopped at this place. This is my greedy solution. I stop here, right? My resolution is stop here, probably stop here, and then stop here, and then stop here and find out ok so this is my three research. Now, do you have an optimal solution? The optimal solution may not look like this. The optimal solution may say I will stop here and then here, here. So it can be some other thing, right? Optimal can be other things. So the red one is opc okay? Now our goal is, given this opt i'm going to change the solution to the previous solution without hurting the performance, without increasing the number of stops in the middle can do that.

This is a critical question. I already have an optimal solution, and I say i'm going to change the solution of it, such as you become a researcher. At the same time, I didn't increase the number of stocks.

说话人2 11:58  
Right?

说话人1 11:59  
So that means you're reading is very good, right? You saw this. It places the same number of people, same number of cells as the optimal solution. Right? So we started with this first ., this time.

Now, first of all, your optimal solutions first stop can never be on the right of the greedy solutions. First, stop.

Yes, right? Because you really already go to the extreme, right? Optimal cannot go beyond that, right? It's not possible. So the red circle has to be before

说话人2 12:32  
the white.

说话人1 12:33  
Okay. So now I say, good, now i'm going to change you. I change this place to this place, just move this red circle to this place. Okay? What happens if I move this recipe to this place? The new solution, ii I use another canada to present so new solution to this. I move this to the orange circle. This solution, is it still a feasible solution? Which means, can you guess still survive to every next step

说话人2 13:19  
or no?

说话人1 13:20  
Yes, right.

Now you need to look at two directions. One is, can you really reach this orange circle from the beginning? Here you go this way? Yes, right? Because you really can reach, I can also reach orange

说话人2 13:35  
place, right?

说话人1 13:36  
The second one is, can you go from this orange to the next red circle? Yeah, also, right? Because your first vessel can reach the second vessel, and then now you are closer to the second layer. You can still reach the second layer, right? Good. What does it mean? It means that your new solution is a feasible solution. Right? You can drop in the middle of stop in the middle and reach the destination. Right? You can still do that. At the same time. You see your solution. This solution matches with the greedy solution here, right?

Now, the first stop of the two solutions become the same.

说话人2 14:17  
Right? Okay.

说话人1 14:20  
Now what do we do next? I'm changing the optimal solution to be the same as three d solution in the first stop. Okay. What's the next step to do? Second one, very good. So now you have a second one, right? The second one, I can again move you to relieve solutions. Second one, this movement, again, will maintain the feasibility. You can still reach the second from the first. And then from the second, you can still reach the next red circle, right? Feasibility maintain, and then you have one more match, competitive the research. You just keep doing this until often becomes reading that. And then the number of sauce, did you ever increase it? No, right? Never increase the number of sauce. That means you're really, very good. The number of stocks in the middle is the same as optimal solutions. Number of stocks, right? So iii hope I also believe this one it should be okay directly. Of course, for other, for examples, it may be more challenging to prove that just don't worry.

So basic philosophy of proving really being optimal, besides, You try to change your optimal solution, one by one to be matched to the greedy solution, right? Without hurting the performance. Okay? With this foundation, now we come to my favorite example of community solution. It's called golf fishing fish.

This one is very, very interesting. What does it mean? It means that you are living in the forest part ok and then you own a lot of things, including many days. So suppose that this is the whole range of your possible travel business, and my heart is here, ok my head is here. Then on one day, you say I want to go out fishing, right? What did I do? Well, on this straight road, along the way, there are some days.

Okay, I know how far away it is from my house to the first lady, from the first lady to the second lady, and then secondly to the very and all these sisters. All right? And they are the one same line and then you have 8 hours altogether in 1 day, and then you can travel from your heart to some lake and then fish for some time there, right?

And then you go to the second lake and fish for some time, and then go on and fish. And probably sometimes it's all I should go back to some place and fish. And then I want to go forward again up to you. Okay? Yeah. But remember you don't have 8 hours and the distance how long it takes from for you to reach from your heart to the first day, also from the first day, the second day, and so on. All these time business, I know it. Okay? And they also do the one more thing is what and now forget about this word, forget about this word. This sentence. This sentence is basically for each lake, the number of fish in the lake is fixed.

So you fish there for 5 minutes. You will get some number of fish, for example, first 5 minutes you get the ten fish quite productive. Okay? Anyway, 5 minutes, 10 fish. But if you keep fishing there for another 5 minutes, probably get fewer. You only get nine, right? And then another five, you only get six. And so on, this sequence is given. Basically, what you now have is the following. So they want me change the right one. So they want late two, late three, late four. I tell you for late one. If you fish the first 5 minutes, you get ten, the next 5 minutes you get 9. And then 65, play two. Maybe the first 5 minutes you get three, and then 211, and for three, you get 75, 42, 20,

说话人2 18:44  
10, 9,

说话人1 18:46  
ok so basically, every day, I tell you this data, ok the number of fish you can ever get after fishing 55 5 minutes 5. All right. So now the goal is to find out the best way you travel the fish such that you get most number of fish in 8 hours.

Now clear about the question. As clear. Again, 2 minutes, you can discuss more things. No t one need to be treated. Lets analyze it together, right? Definitely, this problem should be just reading because we have just finished reading explanation, right? There must be some reading what kind of reading can see it. You can say that you can explain the reading of the figure I draw this now, right?

What is reading element in this problem, which? Yeah, fish amount very good. So we are trying to do greedy on the fish amount of fish. Right? For example, the picture I show you here definitely will go to 21st, right? Then you go to ten, right? There are two tens of 2010 10, 9, et cetera, ok so this is a greedy element. But you cannot do this really directly because of some complication. Whats complication? Time, very good. You have a total amount of time, but this time needs to be split between traveling and fishing, right? You don't know how much time do you have sufficiency.

说话人2 23:16  
Right?

说话人1 23:18  
And you also don't know how much time for travel. But traveling part is a bit easier, because you can imagine, just now, I say you can go to make one fish for some time, go to make two fish for some time. You can go back to make one fish for some time and go back to make two.

But actually, this is not efficient, right? You will never do this. Right? Tracking forces does not help you. Basically, your travel pass will just be from your heart. You go to lake, one fish for some time, go to lake to fish for some time. So on, right? The uncertainty is just what? Your time, right? You can spend longer time traveling, shorter time traveling. It will affect one, sure. It will affect one, your vision and

说话人2 24:07  
wish

说话人1 24:08  
your share. The checking time effect what? Exactly. So how many you can play the role of the latest image? Very good. The travel time effect relates in the beach, which means it will affect the poor, right? Maybe you can only reach a one, then you can only do this, right? You can never go through the steps. Don't you? No way, right? Ok so only a certain thing, but a certain thing is, you don't know how many place you can reach. So whenever you don't know how many days you will reach, you will use one.

So now very soon you will know why I like this problem. You don't know how many exports in china. Is there any way to solve this issue?

说话人2 24:59  
Let's suppose we are in the eye, so and just draw a map in the with let's see the lake high as a pointing of the map and then we just draw other lakes in the map as points. We if you help it the distance and the can believe got 2 point I to other points. We need to pack them based on the plan. So we can say that in the kind of the help me, so we need to bank if we could pass this, just we can I

说话人1 25:56  
find more places.

So you see that you say that whether you go to further lake you, it would be dependent on whether you can get more fish. Right? If you can get more fish, you can go to further they. Right? You need some algorithm to decide whether you will reach certainly or not. Right? But remember, we don't have any errors yet, right?

So up to now, what errors we have, greedy and more information ok so we don't have sophisticated everything yet.

The best way to use here is to use what we have already known. And innovation. Really, we already see it. How do you agree? So then that means what? It means. I don't know how many days I will reach. And then it's very simple. I do what? Not very good immigration. I just try everyone. All right. If you have ten links, I could just divide it in ten cases. Case one, I will get go to make one, right? Then all the traveling time, right? And the remaining time are all fish time and just keep fishing in liquid.

说话人2 27:17  
Right?

说话人1 27:19  
Is it right? In case two, I just reached a one, a two. Then you have two ports, right? I just fished in these two legs and use what greedy right to pick.

For example, in this big two, what's the reading? Is 10, 965, and 3211, right? Then you have k three go to three legs, and then you just focus on these 3 columns, right? Then you do this 10, 97655, 43 2/3. Just pick numbers from largest to smallest. And even worried, no, you are going back and forth in place. Right? Am I really doing this? No, I don't know. I'm only picking numbers in this way, but when you fish, you just fish it up the right? Amount of time, each day, they'll be good enough.

说话人2 28:13  
Right?

说话人1 28:14  
We don't need to go back and forth. If you have 10 days, just ten cases, each case, the traveling time, deduct the traveling time, you have fishing time, and then fishing time will decide how many numbers they can pick, right in these things.

Well, done. This is a perfect example of enumeration plus three. Right? This is really too simple, not as typical as the gas station. This is too simple. It's just a big numbers from largest to smallest, right? So do you agree that this example is really, very interesting? My favorite example explained really and

说话人2 28:56  
generation to that. Right?

说话人1 28:59  
This is so much about reading. The next one is very any other factor. So the next one, it's still within the greedy category, but it's not a straightforward way.

This example says, as a landscape have a mountain, and then you want to put some light on the sky,

说话人2 29:35  
all right?

说话人1 29:36  
To make sure every point on the mountain can see, at least once one light effort on the sky, for example. So this point, right? This ., if you look this way, I can see that light, right? Okay. Then this ., again, I look that way. I can see that light. So you make sure that every point on the landscape can see one light to put on the on the side.

Now, what's your goal? Your goal is to use as few lines as possible to make sure this is true. If I can use one night to choose a goal, just use one night. Okay. All right. Now this one, and it's when you look at this, when you see this question, we'll never think about reading because it has nothing to do with video. For me, the same thing. I I when I learned my favorite, I can see the question. Just a it's just something impossible here, impossible to be related to breach.

So now, here, the most important thing is how to do the transformation. In other words, you want to make sure every point is visible. Right? And then you need to prove some property. What's the property? The property is? In order to make sure every point is, okay, you only need to make sure every turning point is okay. All right. As long as every turning point can see one, right? Then every point can see the one, see the light inside, see one light inside. This probably i'm not going to prove it. Here. It's not a little scope of reading,

说话人2 31:19  
right?

说话人1 31:20  
Now you can just believe me, every turning point, if they can see the light, then everyone can see the light, see one light. Now, because the reason we want to do this, the relationship is that turning points is fewer, right? If you see arbitrary points, infinite number of points, you cannot deal with it. We focus on turning points here. In this picture. You only have 1234567, 7, 10 months,

说话人2 31:49  
right?

说话人1 31:49  
Month, the peak and the back, something like that.

Now, for every point you see the lights, there is a very interesting property. For example, this one, this one, the light you can see is in a range. Now this time i'm using my mouth, not the ., this point, the range, you can see that if the lights, you can see this in this range. My drawing is not so good, but I think my intention, okay? As long as you have one light in this range, then the point here you can see it. Did we?

说话人2 32:38  
Right?

说话人1 32:39  
Now, similar thing happens for other points. For example, for this ., then the range is something like this. So this is the region, the regime that turning . to see, right? So now the problem becomes what? You have a bunch of so called intervals. You have a bunch of intervals. Now, this time I can draw here, you have a bunch of intervals, a bunch of intervals. I want to use the minimum number of lights to hit everything. They never finished problem called hitting set. Here is so many intervals.

I want to select some points such that every interval contains any small point, or all the points they hit, all the influence ok No interval will be skipped in every interval. There is a point you choose to hit them. So in this example, one possible solution is you put something here. Then you can hit everything like this, right? And then you put into one point here. And then you can hit this remaining, right? Hit this remaining.

Now, the true last example of reading how to tell you something, that's something else. Greedy has different measures. For this example, I believe you can find out a different, at least two different ways to measure whether something is really okay, or which point is the greedy solutions,

说话人2 34:37  
first choice,

说话人1 34:39  
ok so now I will give you 1 minute to think about where do you put the first one? How many discussion if I look at the one of the record that one is not good? No problem.

So volunteer, what's your first or first version of degree? Anyone tell me? Remember, we want to use a small number of lights to hit every door, right? Okay. What's your first place to put the light first light? That is the red a is also the first nba segment, right? Red a right? Edge of the person in the second. Where is it? Specifically, let me draw some symbols here. So we called the a a one, b one, c one, d one, e one, a two, b two two, c two. Where is it? B two, a two, very good. This is one criteria, which is not so obvious. Basically, what's this point? This point is some ending point, right? This ending point is the left most ending point.

Basically, you can imagine that you have a line, you have aaa lines we get through, right? And then this line is a potential position of the lights. You move it to the right, you keep moving to the right until this point.

Now, the question is, why do you stop at this point in place of light there? Why? Remember, here we are placing light from left to right? So why do you put the light here? Why can I just keep going? Maybe a second keep going. Then a interval is wrong, right? You cannot get a interval, right? You keep moving the light to the right until you keep until further, right? Will miss my interval, right? And then just stop it, play somebody. So this is a two very good. So this is a bonus question. All right? Remember to write a bonus. Now, this algorithm it is correct by a proof similar as the gas station. Exactly.

说话人2 38:15  
If

说话人1 38:17  
the optimal solution does not choose this one, we always shifted to this place without hurting anyone. You only need one. Notice compared to that ok now, the proof i'm not going to explain it.

All right? Now, this time, we find the correct answer first. Sorry, my dad, we found one parameters. Are there a second parameters? All the second answers? Knock. Is there some other greedy measure? That is also very natural? Any other greedy measure? Yeah, because this really it's similar philosophy as gas station that it seems that the, although it's correct, right? The kind of really we learned here is still the same as the gas station, one, no big, no new insights, right?

Can we find another measure which is also really, but maybe improving is not so easy, or maybe it's wrong. That is came from d one, a

说话人2 39:41  
to d one, and

说话人1 39:45  
de one, d one, and two. They are saying, yes. Yes, you're right. But my question is, are there another measure of reading, which probably will make the wrong? What? Sorry? Make a different choice, but make a different choice compared to the region between d one and a two,

说话人2 40:08  
d two,

说话人1 40:09  
b two okb two. I purposely draw the line not in the real horizontal way. D two. Why did you okay? Now you see that this line touch finals are and this d two also touched on. Also five. So the intervals you can touch becomes a possible measure for me, right? If your first party can touch many peoples, then probably the solution is pretty good.

说话人2 40:53  
Right?

说话人1 40:55  
Ok now, for example, ok just, for example, if I have one more interval it, and then these two touches more intervals, either pitching more equals.

Now, but i'm not going to complete that. I'm just giving you an example where your first choice is not the same as issue. The first choice of constitution. Now, according to this new measure, so the new measure is, I choose that ., which can hit the largest number of interns, right? And then see at this ., remove all the related intervals, and then in the remaining goals that do the same thing. And again, pick the point which can touch multi molecules, this is also kind of reading.

You will exercise in the second grade is to find a counter example for this second grade. In other words, the second grade is not correct. If every time you pick the largest overlap place, you may not find the best solution.

Try to find the topic example in a way. I will not need to spend more time on this, because we already have the correct answer. Now, right? A two is the correct answer for sure, but the other one is a natural, greedy, but not correct.

So now we'll start the third method, third elements,

说话人2 42:31  
third types of everything.

说话人1 42:32  
It's called dynamic

说话人2 42:34  
program.

说话人1 42:35  
Now, I need to do a brief survey. How many of you have learned recursion? Raise your hand. Recursion? No, why? So few. Two, I guess we nervous, because that's supposed to be the most basic programming cost to do. Maybe you just forgot about the name. Yeah, it's good. Sorry, I cannot say chinese speak chinese.

Yes, you are right. That's the reason you didn't raise your hand. Okay? Anyway, it's good. It's okay. No, but I can write chinese right.

Now, regression, I want to solve a problem, fm for example, I am from fn and then inside the function and probability for fn minus one, that will cause smaller problem to solve it, right? Recursion. And what is the dynamic programming? You can consider dynamic programming as a smart, recursion, smart depression. Why smart? When you solve fm you will call fm plus minus one. Then within fn minus one, probably you will call fn minus two. But this fn minus two may also be called from fn so basically, fn will call m minus one, ms two. And within ms one, you call fms one. You call m minus two.

Again. This is the same sub problem, can be called multiple times. This is what is wasted in recursion. Same problem could be called many times. And you have to, we do a lot of repetitive work. You just to use it, right? Because you already solved one problem. You call it again, you solve it again, call again. That's just a waste, right? So then it would avoid this situation. And they don't even know. We have two different ways of that. For me, one of them will use this kind of simplification on the question. Okay. Now, because the question, now I ii draw some formula here. You will, you know what I mean? I want to solve fn plus. Let me see, maybe n plus one. I want to solve n plus one, but there are many choices to give you the answer for n plus one. I need to try each of them to see which is the best. And then I will use that solution to to make up the solution for fn plus.

Now, here, this b here is a number of combinations. When you decide the value of fn plus one, how many different branches need to choose? I will let you know the meaning of branches very soon. Then c the c here is what? The c here is the cost. When you calculate the value of each branch, you have ten branches for each branch. Maybe you need a certain time to calculate it. You need to multiply the time together.

That's the overall time to evaluate the right time a for a single problem, for a single problem, like this, for a single problem, fn plus one. Notice a it is. How many single problems do n you have? Nn plus one. You have nfn minus one. You have nn minus two. You have many such problems, right? How many of them do you need to solve this a if you multiply ab and c together, that becomes the overall running time of your dynamic program. This is the overall feature.

Now, it's time to talk about the two different ways for that dynamic programming. One of this top down approach. This word is the word. I hate it most. Anyone remember anyone know this word? The first one m the one starting with m when you see the word, what do you want to and ask? This one is very special. Originally, I thought it should be memorized. Remember something, right? But there is no r here.

说话人2 47:27  
Right?

说话人1 47:28  
And then they know I check the dictionary. I found. Indeed, there is a word without r probably the same meaning. Okay, same meaning. It means that the meaning i'm going to tell you very soon. Okay? What's that meaning? The meaning is very simple. And then the programming usually you will need to use a table to store entries. This is a state, the table. What's the table? Recall the solution for every single sub problem?

For example, here is two dimensional table. And you have a problem of, for example, bij there's a solution for bij what's ij for example, I is two, j is three. Then it just means here I is two, j is three. This is the answer for the ip two three. This is just two d array. The answer for d two three is stored in the second row, third column, ok the answer for d 34 is the third row, 4th column.

Now, if this is clear, then what is sorry that memorizing? Okay? What's that means? For example, if you want to do d 2 three, you say I need this the answer for d one three. I need the answer for d one three. Where is d one three? It's here, right? Ok dining room says ok before you call d 13, please go to the table to see whether the value is already there. If it's already there, just take it out. If it's not there to be called the 13. Is it simple? This is true. Is this problem already calculated? If the answer is, then no need to compute again, right? It just takes a very out, right? If not everything, then please calculate it. After calculation, please fill in that engine. This is a top down approach. It's called remember and remember either clear about this top down.

Now the second one is, what is the one? All of this table. I do not feel it in an arbitrary order. I feel in a certain order that will make sure every time I compute the solution for the new problem, all it needs are already in the table. I don't need to do that. So it's basically excessive. I have a certain way to fill in the table such that whenever I fill in a new entry, the knowledge I need for this new entry, they have already done in the table. So I just copy, I just take existing value from table to calculation and fill in the dimension. All right. And you will see the example very soon in our first example of the network. Now take a 10 minutes break. We'll come back to the longest common subsequence. Free time.

说话人2 50:35  
Yeah, that's right.