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For the employee basis. And then we are starting the one specific topic in of the same theory of the circle I am. Good. This feels at all. Corporate game theory is one big topic, and then we will use two lectures to cover it. And then actually, the slice here adapted from a very well known standard good scientist. It is airline was also a collaborator, and she gave the lecture in oxford. Okay. Now they have a book, actually, it's not necessary, but if you want, you can also try to have one. There will be more knowledge points in the book, competitive slides.

Now, it's a specific mission that is also available online, right? So there's an instruction. What is cooperative game? Now we first use some examples to explain the concept of cooperative game. And then we talk about two important concepts. One is called stability. So how would you consider some solution to be stable in a collaborative game? And the other one is fans. How do you consider the division of the money among the participants to be fair towards the first one stimulus? There is a related concept of core or about some further concept of like this, et cetera. Then for paris, there's a bigger company value, which we also mentioned in the last lecture. We have a simple example explaining what is shocking that, right?

Ok now, finally, we'll talk about the games with the non transferable utility, which means that you cannot give money to other groups, right? Non transferable other users, in the sense.

Ok now here, there's a very famous thing called he don't negate or give them or give sharply out of them for the matching problem. Now, here, transfer money. What does it mean? Actually, even if you can transfer money among users, we also talk about some limitations about this transfer. For example, if you have the groups, group one, group two, group three, and then move on to earn some money, and then this money can only be distributed among the group members. All right. So they cannot be given outside. And then the game is more like something without money issue. For example, everyone has some preference about which group you would like to be in. Right? For example, you say I would like to be the top preference is to be with my best friend. Second preference alone. All right. And the third preference is with somebody. I have not had another. You can specify an order of preference of the groups. And then he only gave basically says, what can you find some solution which everyone can be satisfied with? Because in this setting, there can be no money, right? You cannot say, because I assigned to a someone who we do not know that gives you the extra money to compensate, that cannot be, you cannot give money to compensate sooner or later, because it is not assigned to the ideal group.

Okay? Now, for low properties, usually detained and will choose their own action.

Now, the payoff in the setting will be given to that individual agent alone. This is no problem game, give the benefit to individual player. But for problem games, then it's like the agency for groups, and then every group can earn some money. Right? There are some profits, and then this profits will be, the group will take an action. Right? And then the profit will be given to the group, and then our group can divide the money among the group members. This is the difference between the non cooperative game and cooperative game. We start with a very simple example for happy farmer. Now you have an example, you have aaa group of farmers, so say, 100 farmers, then they can form smaller groups so that they do things together, right? What things do they do? They can grow some fruits. Oki either roll oranges or apples, the same.

Now suppose here cii the left, two people, two farmer rolled apple, and then the right, two raw oranges. Now, what's the benefit of growing fruits? You sell the fruit for money, right? So we suppose that if you have a group of size k they can grow k square, tons of re orange atoms, k squared up space, the k squared atoms. And then three k articles. So they can choose either one. Either they get taste the apples, or they get three k oranges. All right? And then for orange and apple, they have a price. What's the price? The price of apple is ￡200 per ton, and then the price for oranges are 300 pass return. Right? Ok in this case, you will consider then in what size the farmers small group, and then what do they grow? Right? So this is what you want to know.

Okay, now, actually, we what makes an assumption? What's the assumption? The assumption is? The actions of 1 group will not affect how much money the other group. Or what does it mean? It means that if my group raw oranges and the other proposal oranges, then the money they can earn will not be affected by my decision. I brought, they also earn this much. I wrote apple, they also earn this much. Then in other words, means what? It means that the market price of those groups are fixed. All right. It will not be because many people grow fruit, but grow oranges, and then orange becomes cheaper. That would happen, although in reality, it will happen, right? You have more oranges. Orange will be cheaper. But here we assume this will not have all the prices are fixed.

Now, the payoff of every group will be fully determined by its action. Right? For example, if I grow orange, I know exactly how much I will earn, right? If I grow, ii also know how to try to learn. Now, we we are left with the easier problem. So what is your problem? Easier problem is all those groups we have to possible actions grow through, grow apple or grow orange.

But now, if the group size is fixed, you will not only worry about what they grow. Why? Because for a group of size three, for example, if they grow apple, remember it's a square right place where so then they can generally 9 and ￡9 and then apple is ￡200 each, so it will be worth ￡1,800 if they grow orange. Because the three k so 3 times 3 equals 9 and 9 times 300, it's 2,700, right?

So you see that for a group of three people, definitely better to roll on the side. Because i'm just giving more money, 2,700, right? Ok so that means what? That means. The first choice I don't need to care about that will never happen. In reality, right? As long as you have a blue books, size three, they always go out. And they can always earn 2,700 pass. Right? Now, you can just throw away all the actions. There are no actions. Right? Don't worry about action. You just say you have a group of size three, then you can earn so much money, right? The group size two, you can earn that much money. It's just a group size mapping to the money you can earn, right by the group. Okay. This is the whole thing, right story, whole story. You can just ignore it.

Now it's replace that one by this. The google site one will earn ￡900. The google section earned ￡1,800. It was a size 327, and so on. You see that at the very beginning, they always grow all of this, right? And everything is always for oranges because oranges seems better. Three k right? At the beginning is good, but later on apple will be better. Because this case where is it's a lot larger than ck when k is not, and then it will compensate for the cheaper price of the apple. So basically you have such a table from 1 to 2 and then so on. And then the price you have, the profit you can earn on the right hand side. Right? Now, this is the first example about the fund. Now, although probably will not go back to this example, again, this is only try to tell me about what is the so called cooperative game, right?

Now, let's look at the second example which will appear often in our future discussion. The second example is about the ice cream example. Buying ice creams. I don't know that our our subjects here will be children, right? So the children, they want to buy some ice cream. Every child has some money. Now here, it says that the ice child has the money, the idols, right? And then there are 3 types of ice cream you can buy. The first type is $7, which give you 500 grams. The second type is $9. It gives you 750 grams. The third one is $11, which gives you 1,000 grams. These are three types of ice to be divine.

Now, the children, they have activity about the ice cream, the more ice cream, the happier, right? But they do not care about something. They do not care about money. For example, you tell the child, you have so much money. Ii can give you two ice creams and spend all the money. Or I can do one ice cream. I will give back some money to you. That's how special I don't care. I just want to spend all my money. This is the money for today.

I think I need to spend. So I will take two questions, right? So basically in academic terms is called better feasible, which means as long as the child, the money, you get it over, you, somebody. That's okay. All right. But how much money is that it doesn't care? The child is not here? In this case, you see that what is the payoff for each group of children? If you just put the money, this group of children have into a big pool, for example, this child has $2 that $13, that $4 just for the together become $9. And let's say $9, how much ice cream? 95? Right? They buy the maximum amount of ice cream you can buy using $9 and then distribute the ice cream to the children. In some way, right? This is what we will do, right? The payoff of a group is just the maximum amount of ice cream. This set of children in the hole, combine, right?

Now, these are two examples. Now, later on, when we talk about how to design stable solutions, et cetera, we'll come back to that. I we could game again. But now this is just trying to formalize what is cooperative game and how it is played. All right. Okay. Now you see that in public games, although we say it's cooperative, people work together, but every individual is still somehow selfish. You cannot expect they all work for the global benefits about that. It's not this way. Everyone still wants itself to get sufficient share, right? Or enough money. Otherwise, they will still deviate from the current collaboration. Right? Okay, so that's why when you position the players into groups and divide the money, you need to guarantee something. You need to guarantee that no player is willing to deviate from your position.

Remember, for example, you have ten people. You say all these 31 group, this for 1 group and these 31 group, this kind of division will be stable only if nobody is willing to say I am not satisfied with this. I'm going out with some other of my friends and alone, right? If they can do along and they earn more, they will not care about the division, right?

So that's why I would say we should guarantee no single player or group of players. They have incentive to deviate from the current structure of the collaboration. Your division of structure and division of money should make sure this will not, they will have no incentive to details. Okay. So on the other hand, we say we also want to make sure that the outcome is fair, right? So remember, this one is very similar to our concept of stable, right? Stimulus, how to make decisions stable, and then how to make decisions fair. Now you need to give the important contributor more money compared to other people, right? For example, they are, I not a very good example. For example, we have a group project, three students in one group and you finish one task, they say now i'm going to give grade to the the group members. All right? And then ii hope you this whole project is a total worth, is a 90 points. Okay?

Now I need to make sure the average rate of these three members should be 90. Now I have to say, do you think some of you deserve more, deserve less, et cetera? So you need to divide the money, divide the total money among group members, so that they will feel their contribution is a suitably rewarded. Right? Now, this is about the fairness, but in reality, group project, usually the same mark, right? For all the members. Otherwise, you'll fight for each other anyway, unless all right, you have some agreement among yourselves. So ii hope for. So please give me more credit. They are right in the division of the the points. Okay. Now let's see how to formalize these ideas. Right now. Today, all we can do this is to discuss about this stable issue. The stable issue, whether people will not have incentive to deviate from certain structure.

Then this will be the next lecture, ok now let's say I what is the former game? We have two barrels. One is n the other is b what is n and the is the set of players. For example, you have 100 players, then, and just consist of these 100 players. What does it mean? Piece of that for the money making generates by grouping somebody together, right? Ok as players b is that, and also for its characteristics function. Characteristic function means you take an arbitrary subset of players. I I tell you what damage they can generate. Give me a set of three people. I said these three people, they can generate $1,000. It no matter which subset to give me, I tell you this stuff. So that's the very comfortable characteristic function.

Now, for each subset of players, we've already said, right? So this is the amount of money, right? You see the amount of money that the the members of c can earn. I'm working together right now. We assume be satisfied some good property. What's the property? First of all, if nobody in the set, right? Give me the one that was to be, these are surprise. You give me no way. I can do nothing. So he said it should be zero, right? Okay? But there is a second requirement, which is also very natural. It says, if I give you a subset a sense, now, you have somebody, right? Then the vector generator will never be negative. Its always either zero or positive, right? So this is a most of the time assumption. Sometimes maybe you will argue with me that's not true. Sometimes, if you put some people together with their enemies, right? They will only destroy something. They will not produce something. Right? If they have a bad relationship, they will fight each other.

And then probably by accident broke some table or something like that, it will cause negative, bad. But here we are not dealing with this kind of issue. We are saying these people right, as well as they work together, they will always generate non negative utility of that. Right?

Now, the final thing is also very natural, and also we need that assumption that these people they are among the enemies. What does it mean? So this one says, if you put in one more people, one of us or more people into my group, then you will only generate more value, all the same value as before. So it's called monotone property, right? More people, more problems. So we are dealing with the ideal world, right? There are no enemies among the group members. Now we define a so called coalition to be a subset of the group grant. For a great player set, coalition is any subset of n in itself, this one, the big hand is all the people together. We call it grant coalition, which is means the biggest coalition, right? Everyone together. Now we come back and ask me again to see, but how to formalize those concepts, we just have.

Suppose we have three people, three children, $6, $4, and $3. Then ice cream we already know, right? $7, $9, and $11. And related grams are also keep are also here. Then we know that the value of empty sets or value of c or value of n value of p all of them are zero because they can find nothing. Only $7 by asking. So not a single child has enough money to buy ice cream. So they have to collaborate, right? But when they collaborate cnm together $10, they can buy this time. So they have 750 graphs, right? And then if it is acnb $9, also, they can buy this 750. And if it's mnp they can buy $7 here, 500 grams, right? Then if all the children pull their money together, what do they have? They have $13, right? 13 $50, then they can buy together, right? For the loan. That's the best you can buy.

So you get 1,000 grass, ok this is how you define the value function, the characteristic function, ok now, I believe that now everything looks very easy. It's even easier than you have the present. Right? I'm very sure.

Now, let's look at how to define so called outcome of this game. All right. Now, we are talking about this transferable utility game. So the transferability game means you can give the money generated by 1 group to its group members, right? You can transfer the money to group members. All right? Now, so what is the outcome here? Outcome of the game is also a pair. Now, this pair is called cs and xok now, cs here does not mean to do the science. That's not possible. Okay? What does it mean? Actually, iii all right. There are some of the real obligations, very, very interesting. Now cs most available is to do the science. And then sometimes you also hear about data science, but you if you talk about data science, if you talk about subjects, there are some relations which says ds so what subjects can you remain? You can recall, if I tell you ds it's a sad question, unrelated to the game theory course. That was, for many years, have been teaching many ds courses.

So what is ds data structure over the data structures? Anything else? There's a lot of time to take anything else. There are data, what? Data base systems, very good, the database systems, right? There's also another possible distributed systems. Basically, I found everything. And other than data science, I I don't teach data science, but I don't teach memory, data structure a little bit and the distributed to this, et cetera.

Anyway, let's come back to the ccs this cs the full name is coalition structure because we defined coalition earlier, right? A group of people, right? The coalition structure here means that you divide into c one group, c two group, c three group, and so on, right? Divide all the people into groups. Ok this is the first one cs how do you divide this? This is the first thing. And what is x now c is this division need to satisfy the property that there is not. You cannot assign one person in two divisions, right? It's not. Okay, right? Everyone we don't want to. Now what is xx is called payoff vector? What is the offer? It means how much money each individual each player received. From the scheme, x one means the money player one receives, right? Xm means the money player m receives, right? Okay. Now, you need to guarantee this money, every individual player sees, cannot be negative. That means you cannot take money from play around. You can only give money to them. You cannot take money from them. Ok this is prostate.

Second thing, the money you give to players should come from the group, give it awesome. For example, these three people, they work together, generate $100. It's okay, I think this person 50, this person 30, this person 20 or less of paper, because you divide $100, but then it's okay that I think the one 50 and by borrowing some money from other groups. This is not enough. All right. I'm sorry. This is the requirements. You guarantee that the edge for each coalition, right? For each corner to see the solution of the xi is equal to the value of this collision can generate ok the money goes inside of it does not go outside. All right. Okay. But still, I think that this is very easy to understand. Right? Now, let me know if you feel some confusion or difficulty, you raise your hand. All right? Now let's give you one example. In this example, we have 123 one coalition, right? And then 45, the other coalition. I tell you the value of 123 is 9, the value of 45 is 4.

Now i'm going to divide the money into them, right? I say now the coalition is 12345. These 2 groups. I give money, $3, $3, $3 to 123, and then $3 ~ four $1 ~ 5. This one is an outcome because you only give the three players, the money they get right by working together.

Now this one is good, but this one is not good. Why? These three people, they got $6, right? 33, but they only generate four. They are borrowing money. I said, cannot borrow money back. Okay? Yeah. This is not an outcome. The next one is another terminology that they usually call it. This one individual restaurants. So you say the outcome is an imputation. It's a very complicated word. I also know the meaning, not implying you go to sites that even now I don't know how to translate it in chinese, because the more important key word is here, individual rationality, what does it mean? It means that the money you get, right? So I get will not be less than if player I works alone.

Basically, it says you should give incentive to each individual to join your game. Because if you give player I less than I that I will not run again that I would just do the work by himself, right? Because we work by himself and give him more money, but then why does he join big? Right? You never. That's so called individual rationality. And later on, other subjects, like option, et cetera, you should also guarantee individual rationality in order to persuade the or incentive eyes that agents or players to join game. Right?

So this is a very important property in any game.

And then for the summation of value for money, you get within the origin c we use xc to represent it. Xc basically is a summation of or the xi or ki in the coalition c now, again, that's a good action game, right? The ascii game. One is the outcome, $6, $4, and $3. And these 3 kinds of in high streets, right? And then we know that if you ask the children to buy asking by themselves individually, then nobody can get anything. Right? The 000. This is one possible outcome. This is one possible outcome. You also say, please, mnp you two are ice cream together. C you buy them, right? And then seek again, nothing happened. Then because they can buy 500 grams of last week, they can divide money, sorry, I have no money. They might ask me about these two children, right? So 100 grams and 400 grams.

Now how to divide? I don't care for a moment. We are just looking at possible outcome for this ice cream game, right? Ok now, if you say all three children, please buy the oxygen together, and they can buy this right by 1,000. And then this line tells you I can divide the 1,000 grams into three set, which is roughly the same, right? 3343, right? This is also impossible. Right? Now, this one, this one is also one outcome. They say I give c zero, a second, and then ma hundred, p 200. But this one, everyone will agree that it's extremely unfair because c has the most amount of money. He's done nothing, right? What will the person think?

But then The bad guy also has an army. He says this one is okay. Why? Because he tells c if you are not satisfied, you leave, then after cdc can get up, right? So not better. I thought this is the viewpoint of the bad direct. We are not bad. We are not having this kind of situation. Okay? So much about the easy steps. Now we are going to some, it's easy to medium level materials. So when we find some other games, for example, the first one is defined as super additive games. So what is super additive game? The concept is very easy. It tells you, super entity means you merge groups together. They can generate more money competitive working by themselves.

Ok what do you think of? Group one? Can generate $100. Group two can generate $100. If I put group one and group two together, I can generate $300. This is good, right? That's why it's called super, super editor. It means not only you add the benefit of 2 groups together. There may be some extra game, right? The bigger the group, it could be better. So this is the official definition. It's very easy, right? Now this definition works for the destroyed coalition, cnd because we emerge into groups. If you have common member, then I do not guarantee anything. If you don't have all number you merge. I promise you you can strictly more than you simply add them together, right? One example here, if your value c is the size of the group, this is easy because b of c union d is equal to the size of c plus the size of dok this is equal to bc plus b it's equal. You assign, right? Because that it says I allow people to assure, right? I love you.

Now. Next one is realistic gravity. Really? It's a real one. This one says, if my value is the size of c squared, then what is the, therefore, c union b c union d becomes size of c plus size of d squared. And I take two squares out. There is a another term there, right? Two cd but two cd is a positive or zero. Right? Anyway, it's not elegant. So I can remove it. Is that, okay? This is not an angle to this, right? But this is vc plus vt right? By definition, definition, is squared this vc plus vt therefore, vc union d is larger than equal to vc plus vd again, it is a super additive game right?

Now, actually, no question. High speed game. Is it super additive? It's not quite a question. It's just a fact, right? It should be used to get it. Why? Is it? Because for the time, the basic you get, specific example is zero, right? But sometimes it may not be zero. For example, the first trial is $10, second is also $10, right? Each of them can buy something. But if you put the money together, you can also buy something. But is it true that if you put them together, they can buy even more compared to the individual buyer? When you see this kind of question, you need to follow some logic, right?

For example, they are like a they have the two child, right? But there are 2 groups of children. Group one has so much money, group two has so much money, okay? They say this much money you can buy us from here. So pretend that you see some iphone here, right? And then you see so much from here. So this is what they can buy right now. If you put the money together, can they still buy this much? Right? Because I can split and buy, and then we'll try ok so the early solution is still a solution for your merge group, right? Is that right? Your earlier seven buying solution is still a solution when you put the money together. That's true, right? So definitely you will not buy less. You can only buy more, but sometimes can you really buy more? The answer is right. Because remember this one after buying this group of this, actually you have $3 left, right? This one have to buy this. Actually, you have $4 there, and then you put this three and four together. This $7 can buy another ice cream.

Okay, so sometimes you can buy some extra ice cream compared to your earlier individual buy and search. Right? Ok so you see last weekend, it's a super additive game. Nice. Okay, so you see that again, right? So you will see us engage for at least 5 times. So you familiar with the setting, okay?

Now, because it's too bad to gain, you can always merge 2 groups, right? Merge two groups never merge you, because they generate more money compared to adding 2 groups money together. Right? So then that means usually it's relatively, you are very safe to adopt grand coalition. Maybe this grand coalition can give you the most amount of money. So you have a very safe way to give money to people so that they are happy. Right? If sitting make them happy, then virgin make them also happy because they will not get less.

Okay. This is super advocate. Now, it's time to introduce the third game for the induced subgraph game. So what's this in this game? Players are vertices in the graph. Then now this graph is weighted. The weights are on the edges. Now, what's the value of the coalition groups and people together? What's their value? The value is the summation of weights of their internal entrance. What does it mean? For example, t this is one coalition inside t there are three players, 123. And what's the internal edges? This? One is internal edge. This one is interaction, right? Because internet just means the two end points are both in my group. You see that the x plus y vt is x plus y vsvs the s is bigger, is is this, so vs is the summation of these collections, right?

Okay? This kind of game. They can model social network. So very useful and questions? How induce a rocking super editor? Additive means you combine ruins two things together. They will not become, the value will not become less, they will become more. So is this one super added? No. Why not? Which one? You put these two together, you put this one, you merge this one with this one. But this one also has no value if you don't have one note. Right? For those who say no. Tell me the reason why do not supervise it? Then there is also a follow up question. He wants to make his strategy. What what assumption do you need to add every time you at that? Coming at the . to your collision, it needs to connect to your point at home. I am answering my first question or second question.

Second, we first figure out the first question. Is this a benefit? And do it can be equal? Is this superlative? You say, yes. Yeah, usually proving is more difficult, but whether it can weight or edge, whether they can add weight. So there is a weight for every edge. There is a weight, right? An edge. When you work very good, when you have more edges sometimes, right? Because they have 2 groups, right? They have those 2 groups. Then every edge connecting this group to that group, they become internal edges, and their value. Their weights will be added into the value. You can only what is about it. Okay, so you put a very good point. Yeah, so this is a one bonus point. Okay? The last part is the weight possible. I never tell you anything about that. Weight can be positive, can be zero, can be negative.

Now, if it can be a positive, zero, negative, then is this game super additive? No, right? Because especially when it is negative, right? If it's negative, you have more edges. It does not mean you have more right. You decrease the value. That's not good, ok so when you have negative edge, it's not super additive.

But on the other hand, now we come to the second question, right? On the other hand, if you want to make it relative, you need to add an assumption. What's that assumption? No negative edges, no negative weight edges, then it is really, super additive. You are clear. Good. Okay. Now, for super additive games, usually we can identify the outcomes with payout better for the grand coalition. This will be only said, right? Because eventually, merging everything together is best, right? So you consume, we are doing brand coalition. Right? I think super additive games. Now, the outcome is a vector x where x one plus x two plus xn then equal to the value of the grand coalition. Right? The interesting thing is, for non super edited game, you can transform it into a super edited game in some way.

What can you do here? For example, the same. I these 2 groups, right? When you emerge these 2 groups, I found that the value increases, right? Less than the summation of these two values. That's not good. Then you should have some way to define the value of the big group. You cannot define it as a summation of these two, right? Or you cannot define it as a summation of these two plus something in between, right? You cannot do this because this will not be good.

Now, how do you define the value of a certain coalition? Usually say all the coalition? If I spit in this way, it's larger than some. It's very good, right? But how about if you split its left hand? Then how do you define the balance of a difficulty? Now, one hint is the following. You say. Suppose I have five people to do so. I can divide the five people into two subjects in a many different way, right? One, one specific person over here. And then this way, I got another one here for here. Anyway, I have many conditions, 1414, right? And there are many conditions. 2323, right? This is what I can do, right? 32. Anyway, I can divide.

Now, among all the division, you can check which kind of division will generate the most profits or most money. I just define the value of the big group to be that best position. Ok so see, this is the definition of use. We define the value of coalition c special value, ok as the maximum of all the position of your current coalition and the value of these positions together. Just says, okay, try to divide your members in the best way such that their value, right? Add up to the maximum possible value. I use this maximum possibility to define the value of my big group. Okay? By this definition, you see it is always relative, why? Because I already enumerated all the possible division, no matter which two subset you give me, there then added together will not be better than mine, right? Because I already considered that option.

My new value must the dominating all the other positions back. Right? So this way you can guarantee, based on this new definition of values, this one is a super additive game. We call this gsaok the new values, the super additive cover of g elevates the value of different groups such that it becomes reality. Right? And then this new valuation motion, the new value based game is a super additive cover of the game g now, this is only a concept, probably would never use it at this time, right? But you can know that we have some way to transform the game into a super additive game where the value of each group becomes higher. Right? You take the best of it, all the condition below it. All right. Okay. Now, everything up. Now, then I will use the remaining 2 minutes to explain the way to vote again, and then we will go on to analyze this the property. So what is vote which is voting game? Actually, the way the voting game is a very interesting concept.

They said, now there are ten parties in the castle in the committee, okay? Then every party has certain number of representatives, the party. I has AA couple of I representatives, okay? Then what is the collision? Collision is formed by some parties, right? Some. And so the party, you can just consider it as some kind of people that's a person. All right. Now, coercion party, they can get enough support if their total size is at least q what does it mean? See here? Usually, for example, when you are deciding where to go camping in the weekend, all right? There are many different locations, right? The location of camping. And they say we fall study group. You have to have some normal study groups. You have group, this group of four people, this group. You have five people, and every group their target location is the same. Okay? And then you will discuss it on yourself. You say where do we go? And let's choose, okay.

Now suppose there is a lot famous person, maybe the sunshine lake around the sunshine, so that's a good place. Then you say who will be supporting that patient? Raise your hand. Now, if you have a majority of people raise your hand, and then you win, right? That's the destination. All right? Maybe next time we'll listen to the other groups, ok all right? For this time, majority means. So this is a strict majority, so usually it would be a strict majority.

Now, the weight of the coalition, actually, we define it as the weight sum of all the copyright right in the coalition. Then this setting can be described our game. And this game you have a set of players hand and the value function b then here, the value function of a coalition is one. If the w the weight is added speed, which means your total weight, the total number of supports, right? Exceeds the threshold, or the whole time we call you the whole time. If the total weight exceeds the quarter, then value is one. Otherwise, the value is zero. Okay. Then the notation of the game just looks like it's a focus followed by many ways from different parties, right? Okay? This is the game. And then the next hour, we'll talk about the how to analyze this game. 10 minutes straight.