Artificial Intelligence:

Understanding Language with the CD Theory

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Module – 05

Lecture - 03

So we are looking at classical dependency theory which is basically a small set of actions which they have chosen which contains actions like Ptrans Atrans Expel Ingest and so on and some sort of causal relationships between things that we are trying to see. So the last thing we saw was this sentence which says while going home I saw a frog and we modelled this by saying that there are two events that we happening that I am going home and I am seeing a frog. All these are happening in the past and I saw the frog while I was going home. So here are the conceptual tenses that you can talk about, the past future transition transition start transition finished. Notice that this transition finished tf is what we used for modeling that I stopped smoking in the past so P and tf together say that I stopped doing something.

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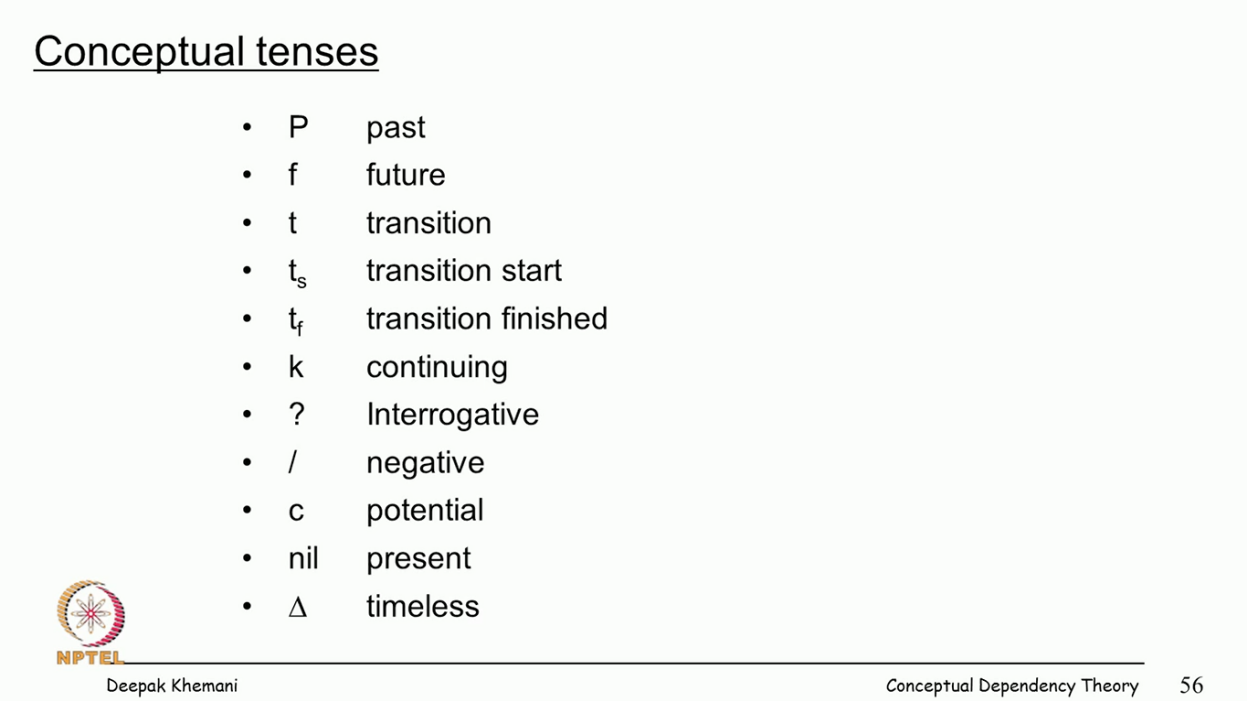

So k is continuing interrogative or negative or potential or even timeless. So if you wanted to model this.

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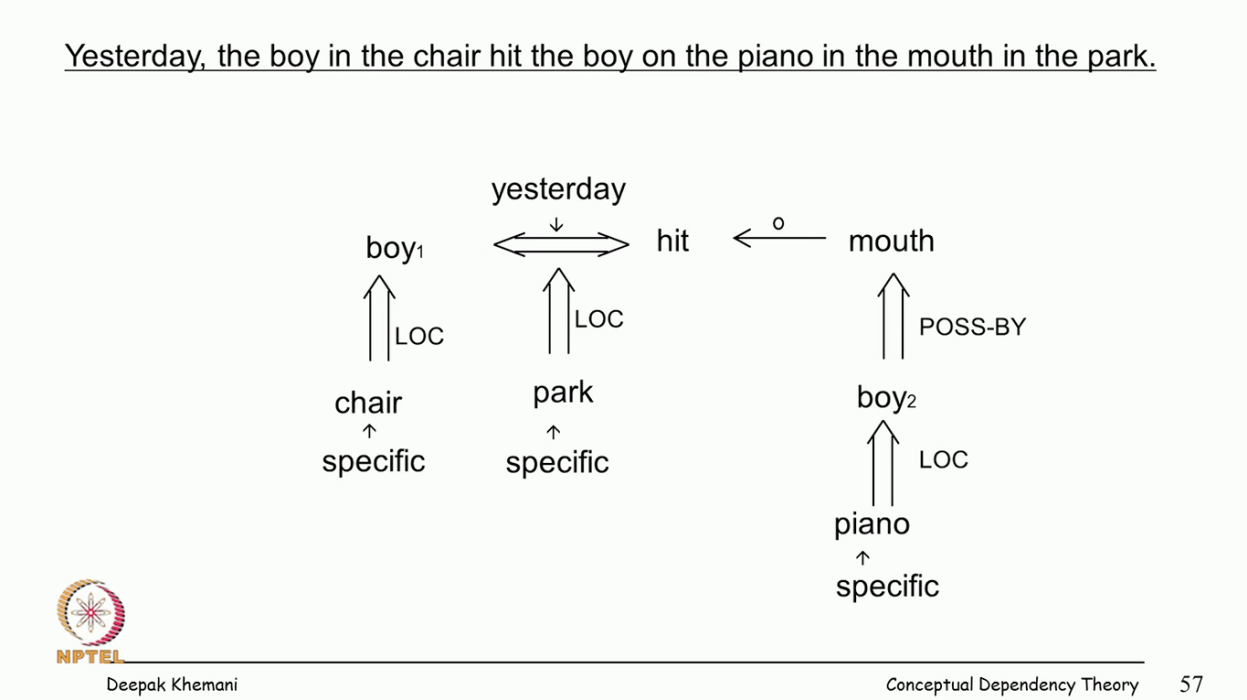

So if you wanted to model this yesterday the boy the chair hit the boy on the piano in the mouth in the park. So as you can see the basic high level conceptualization is the act of hitting which we have not yet we have said that it is not a basic CD act but know that we can model it we will see that little bit later using propel and move and things like that. So the high level act is that the boy hit the mouth. Whose mouth the mouth possessed by the other boy. And where was this boy the boy was sitting next to the piano. So that takes care of the which boy hit the other boy. The boy which was sitting on the specific chair. So because it says the chair and the piano we use the term specific. And this whole event happened the location of the event was in the park. So again specific the park and it all happened yesterday.

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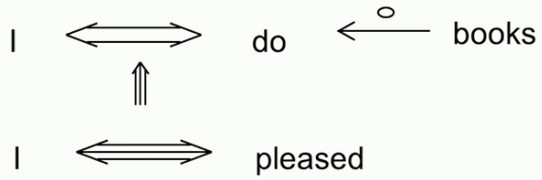
Separating Action and State

I like books

Books please me.



Like we said we want to separate action and state we want to distinguish between verbs which are verbs in the language and state change which happens in conceptual world essentially. So if you say something like you like books or books please me which we will treat as equivalent what you are saying is that when I do something with books and its not stated here what you do with books then as a result of that you become pleased essentially. Or you could model it as state change. Now this is not like a model of something which is physical which you can verify with ground truth in some sense. This is a kind of model which is an abstraction of how you represent and reason about things. So there is no way of verifying that this is indeed correct or meaningful. Except if you can use it in a meaningful fashion. If you can use to show that programs can now understand stories based on these kinds of representations. Then you have atleast some kind of justification for saying that okay this is a good way of doing things.

So we can have thinking actions. So preventing would basically mean that x does something as a result of which y cannot do something. So instigating is the opposite of preventing that you do something as a result of which y does something. So notice that some of these are states and some of these. These were one event resulting in another event and what we have here is the event resulting in a state.

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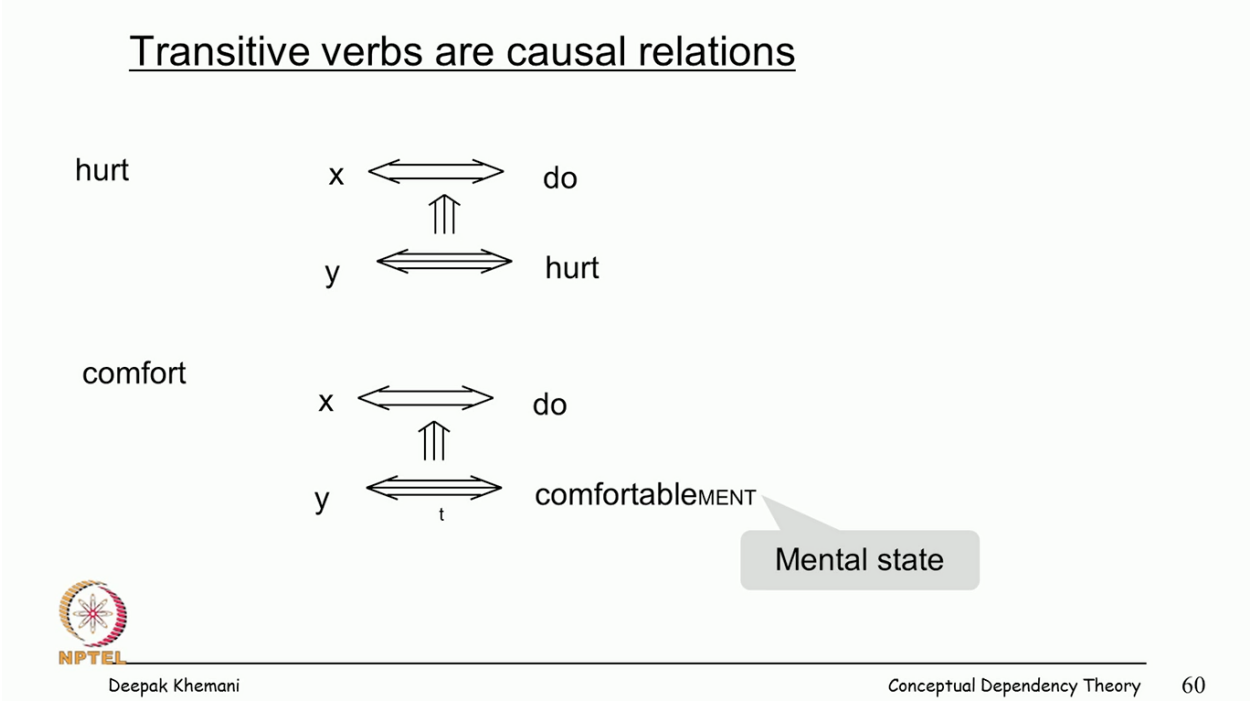

So hurting somebody means doing something as a result of which the other person is hurt. Comforting someone means doing something as a result of which the other person becomes comfortable. If you say I comforted John then I did something so that john went into a state of being comfortable. Or you might do something like I said something so we already have the word speak we could have used there or Mtrans with the instrument of speak.

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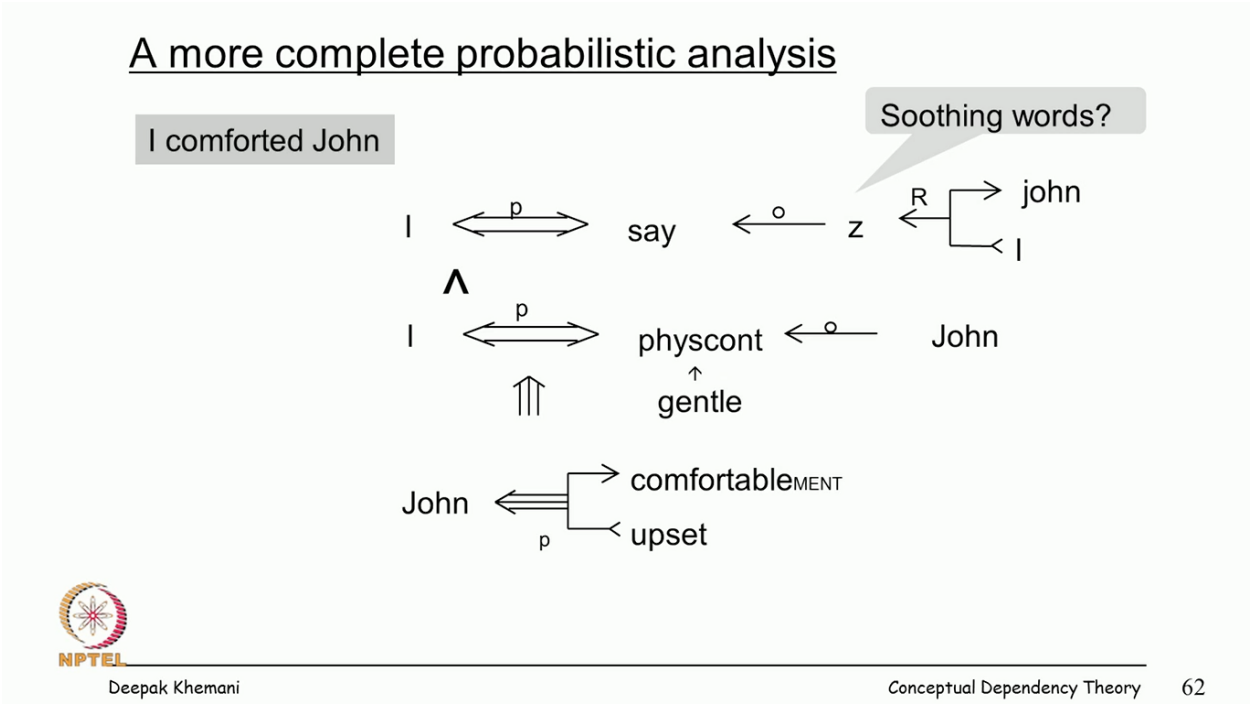

So I said some soothing words and I did some physical gentle contact you know kind of patting the person and this is what you might understand by how you comfort people. You know you say its fine tomorrow you will be well or something like that and then you know pat somebody. Trying to model something like that here as a result of which John went from a state of being upset to the state of being comfortable. Or you could say that I comforted John for feeding him then you transferred food towards John as a result of which John ate the food ingested the food as a result of which he became comfortable.

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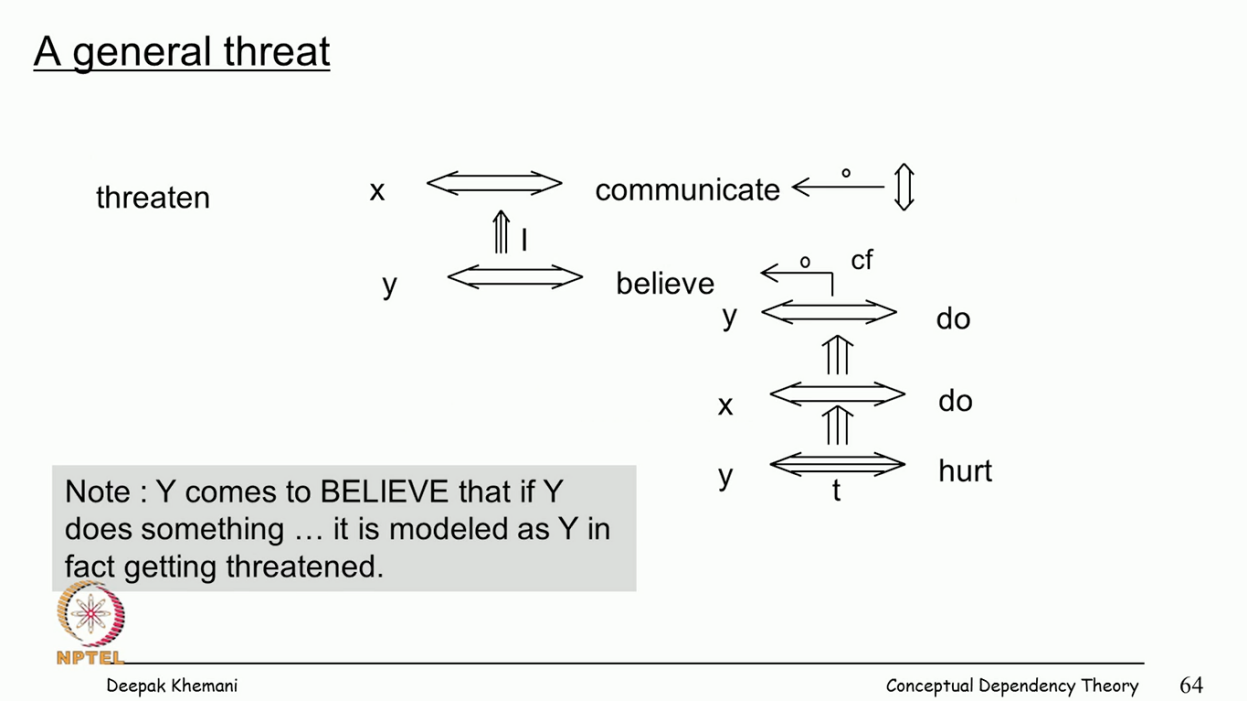

Now the word threaten can be represented as follows that x communicates something its not stated what that something is. Its some event as a result of which y comes to believe conditionally in the future cf stands for conditionally in the future if y does something x will do something as a result of which y will get hurt essentially. So what y comes to believe is this whole thing. The object of y's belief is that y does something as a result of which x will do something as a result of which y will be in a state of being hurt. And how did y believe this because x communicated that to him. We have not stated that he communicated to y but that may or may not be explicit. You could model it explicitly.

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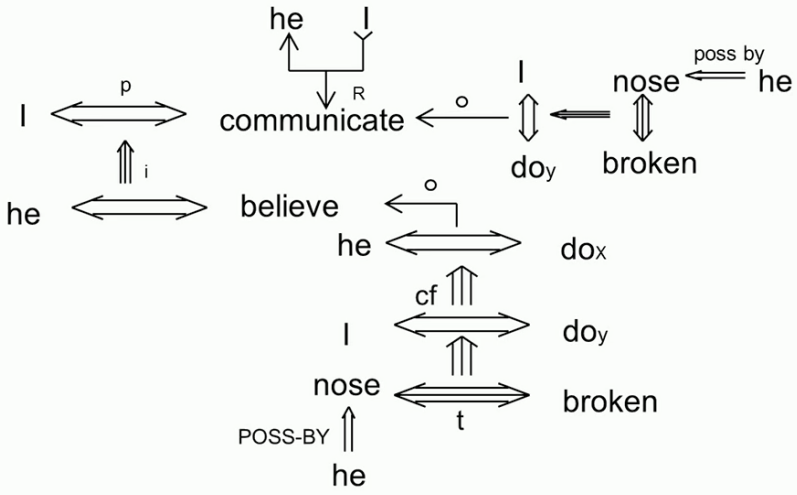
A specific threat

I threatened him with a broken nose



So here is a specific threat I communicated that I will do something. So I communicated this whole thing that I will so something which I will call as y as a result of which the nose which is possessed by him will go into a state of being broken. And this communication was from me to him as a result of which which is here he comes to believe it that if he does something which we will call as x then I will do this thing which I will call as y as a result of which his nose would be broken.

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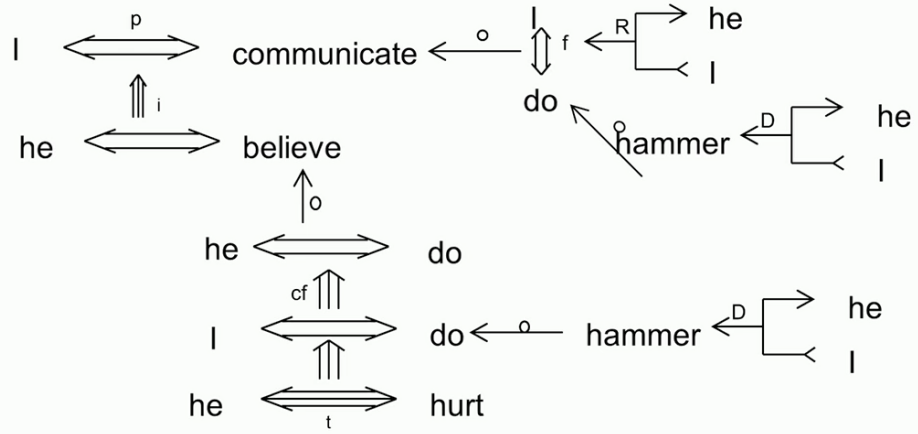
Another explicit threat

I threatened him with a hammer.



Or another explicit threat I communicated to him that I will do something with the hammer in his direction as a result of which he will get hurt. So the level of detail is changed as to what you will do essentially.

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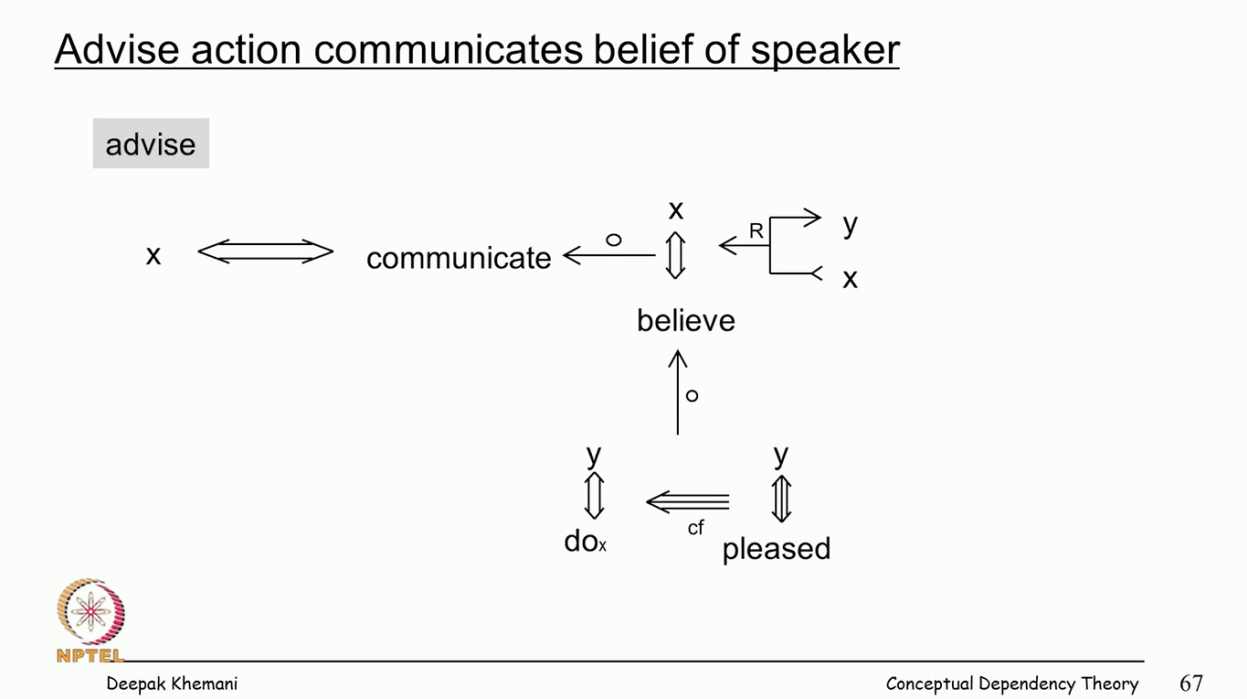

So advising we have talked about advising sometime John advised Mary to take aspirin or something like that. So this is the structure that one would create. If we say that john advised mary to take aspirin then essentially what you are saying is that is lets say this is john and he communicated to Mary that John believes this whole thing in red that if Mary were to do something in this case ingest an icecream sorry ingest a aspirin conditionally in the future then Mary would be in this case its pleased but in the case of advising for aspirin it could result in her getting into better health which would result in her getting pleased. So basically advising says that you tell somebody that if you do this you would be better off or happy or whatever. And you believe this thing essentially. So x believes that if y does this thing then y will be pleased.

So here is some advising on eating so this is an example from their book.

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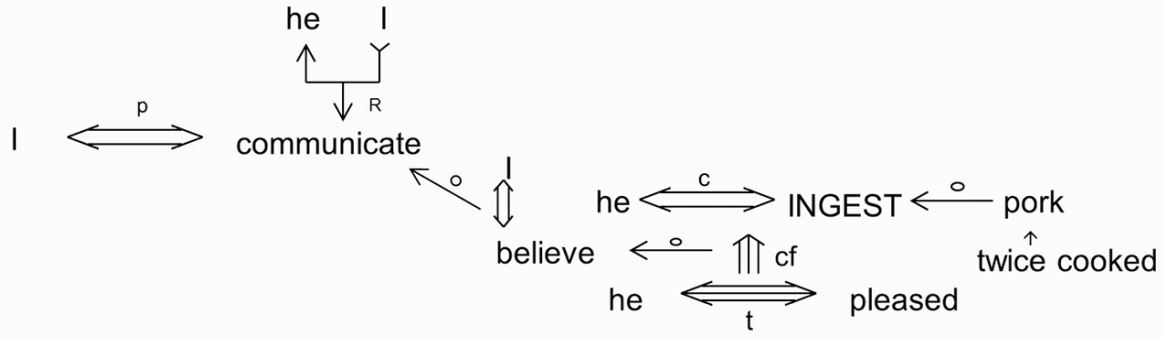
Some eating advise

I advised him to try the twice cooked pork



I advised him to try the twice cooked pork. So I communicated to him that I believe that if you ingest pork which is twice cooked then he would be happy. Just filling in some detail here. Ingesting is the instead of do we are saying ingest and we have given an object which is a twice cooked pork.

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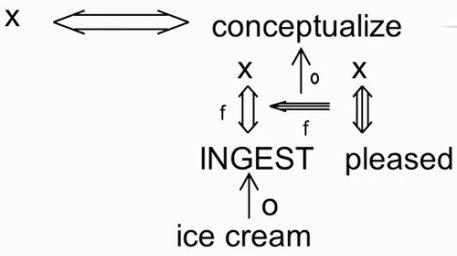
Liking ice cream

No thought component!



X thinks that X will be pleased if X eats ice cream

Now when you talk about liking something so when you say I like ice cream there are two different levels at which you can try to model this. The first one on the top says that if x ingests ice cream then in the future x becomes pleased. So eating ice cream makes x happy or pleased. The second one is that x thinks about it so that's the different between this sentence. He conceptualizes. The same thing that we have here that if x eats ice cream then x will be happy the same thing is here that if x eats ice cream then x will be happy but now this whole conceptual structure or conceptualization is an object of x's thinking. So when I say conceptualization you can say thinking. So the first one is capturing the fact that whenever x eats ice cream x is happy. The second one captures that x knows that in some sense thinking about of conceptualizes that if x eats ice cream then x will be happy. And you can see that there is a subtle difference between the two.

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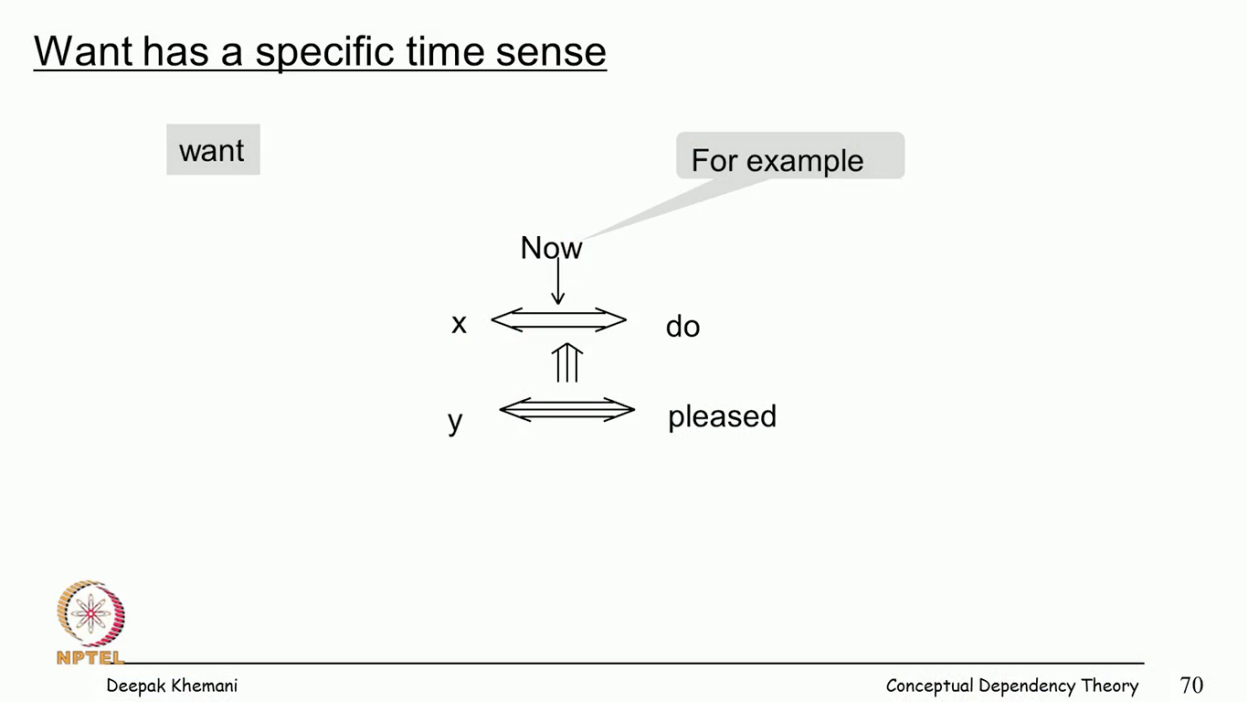

Now if you look at the English word want it has some two or three different senses we will see as we go along. One of them is that if x does something for example now then y will be pleased. I want you to sing a song or something like that if I say then this is the sense that I would be using in this. If you want to say that I wanted it then the same thing that if x does something I will be pleased I thought about that in the past so I conceptualize in the past that if with respect to the past if in future x does something that I would be pleased.

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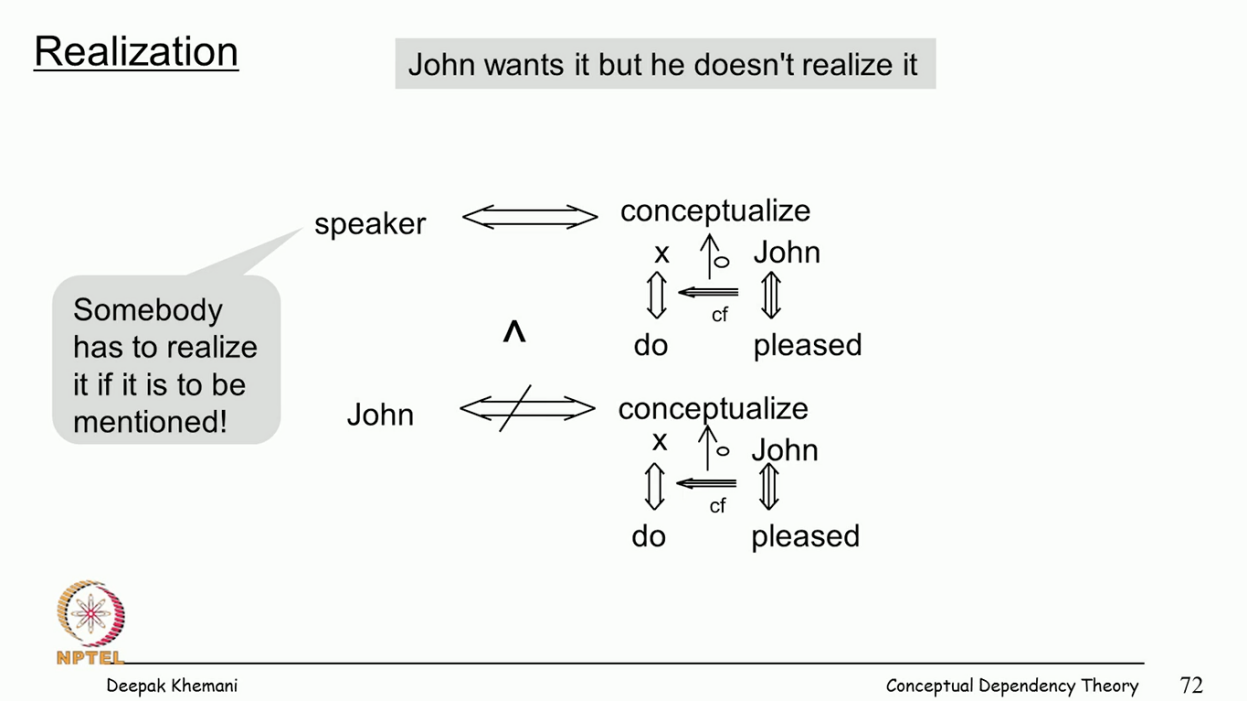

So if you want to say something like John wants it but he doesn't realize it then you can say that it is really the case that if John gets something he will be happy but he cannot conceptualize the fact that he will get that he will be happy. So both are true at the same time that in some sense the speaker who is uttering the sentence that John wants it but doesn't realize it the speaker realizes that John wants it which is the first part of this thing. And is connected using the logical and. The second part of the and is John does not conceptualize that he would be happy if that were to happen whatever.

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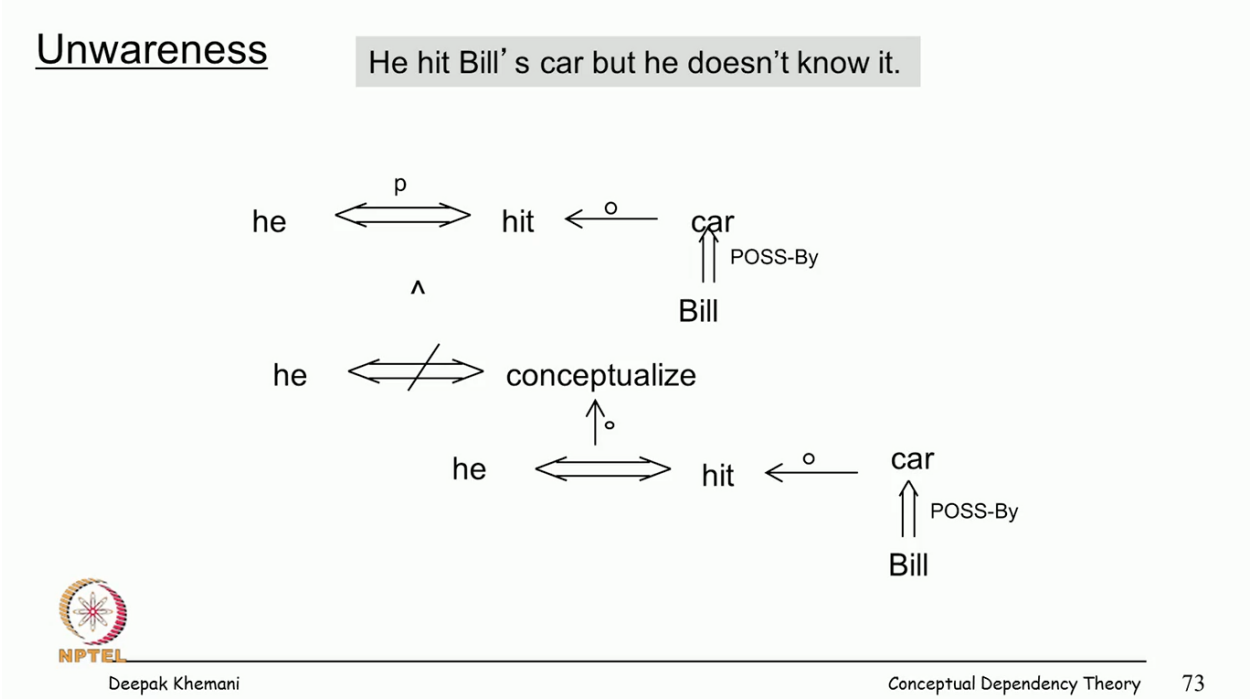

So if he said something like he hit Bill's car but he doesn't know it then the first part of the conceptualization is saying that he in the past hit the car which was possessed by Bill. The second part says that he doesn't know he hit the car possessed by Bill.

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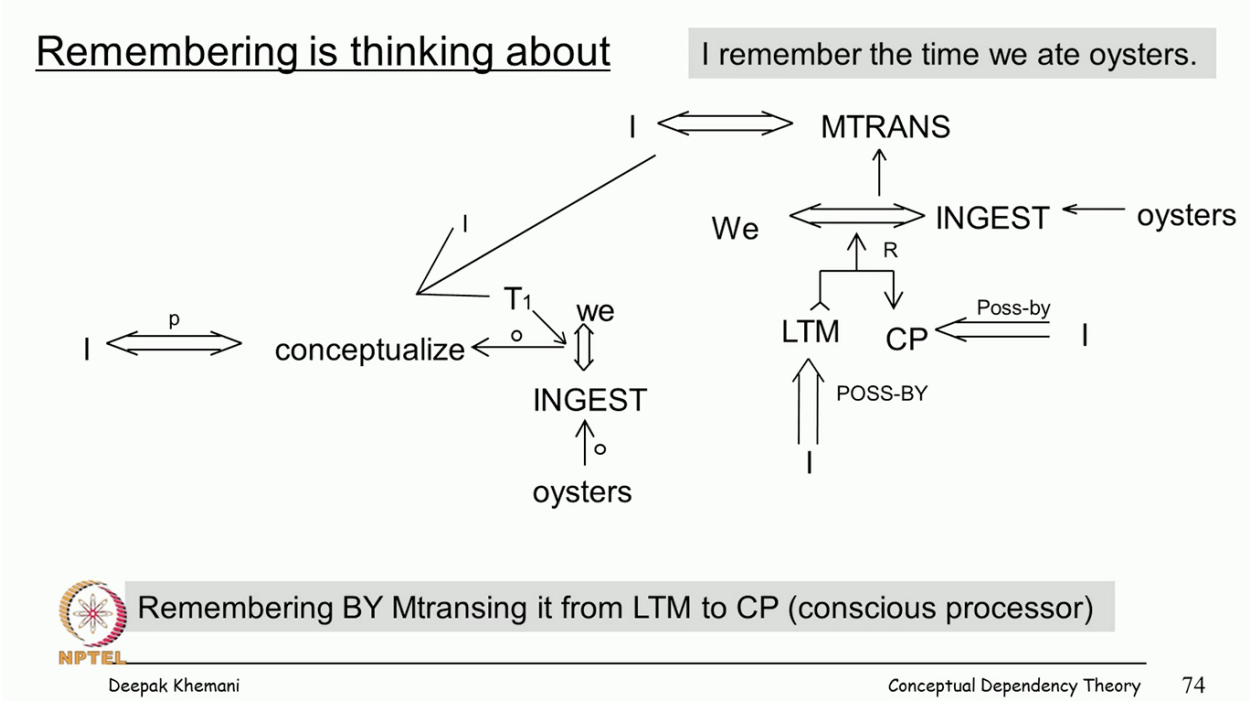

So when you talk about remembering I remember the time we ate oysters then you are conceptualizing about the event so you are conceptualizing the time that we ate oysters and an instrumental act for this is Mtrans mental transferring from the long term memory to the conscious processor. This fact which is residing in my long term memory I have brought it into my conscious processor and that is how I will model the term remember. That I bring if from my long term memory to my conscious processor. And the object of mtrans is this whole thing that we are eating oysters. And this was retrieved from the memory and brought into something a cache you might say or something like that.

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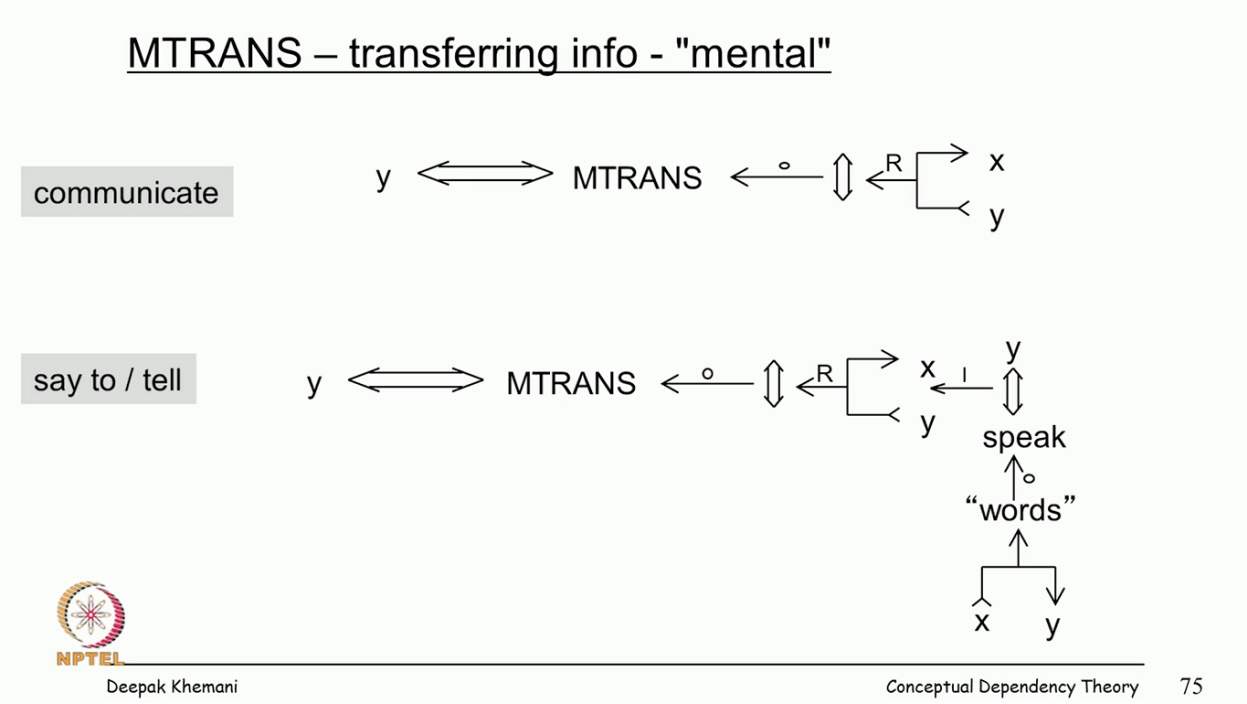

So many mental events would be captured using mtrans so communicate is simply mtrans. Saying or telling is mtrans with the instrumental act of speaking words in the direction of the person. Perceiving is mtrans with the or something from the sense organ to the conscious processor and there may be a corresponding instrumental attend act that we had seen earlier. Learning may be moving from conscious processor to immediate memory. This is just a way of modeling things essentially when you say what did you learn. Remembering as we have already seen is mtransing from long term memory to conscious processor. Forgetting is unable to bringing from long term memory to conscious processor. So this c with a slash across stands for you cannot mtrans it from your long term memory to your conscious processor.

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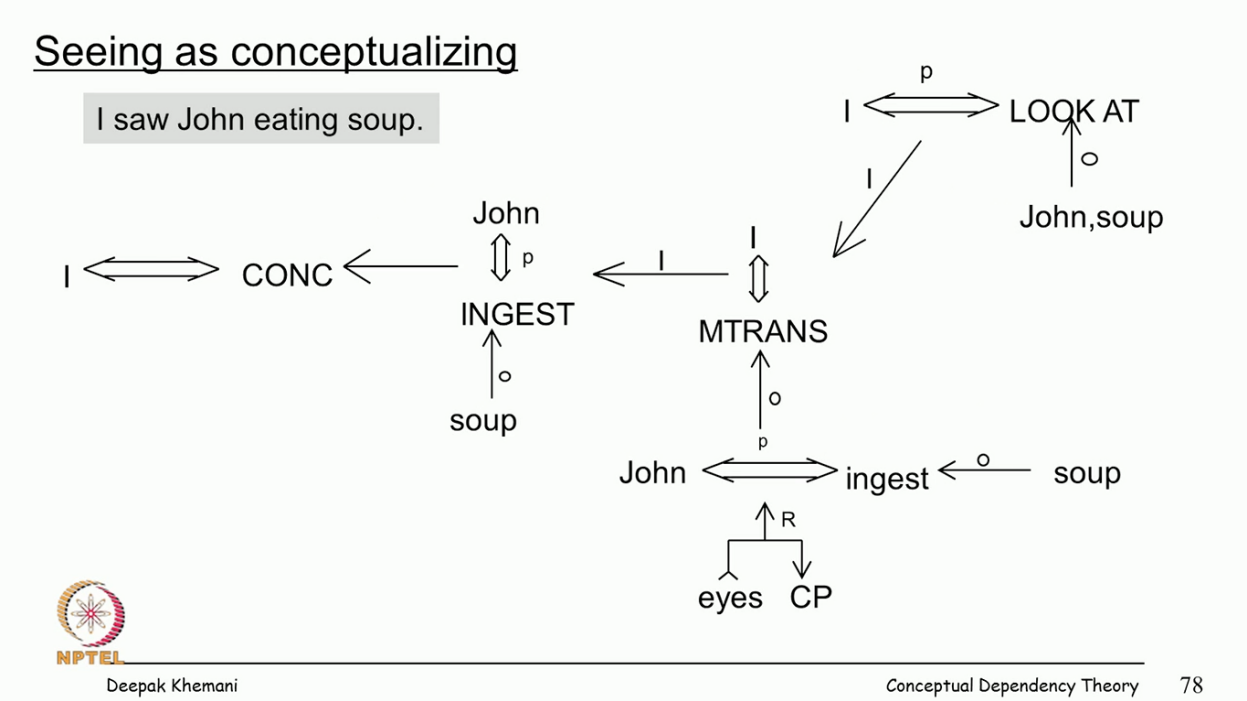

Seeing can also be thought of as conceptualization. When I say I saw John eating soup then I think about John eating soup by the instrumental act of mtransing this event of john eating soup from my eyes to my conscious processor and the instrumental act for that is that I attend or look at my eyes. So different versions I said there we were 11 or 14 basic this things. One of them had attend with different instruments other had look at, listen or something like that.

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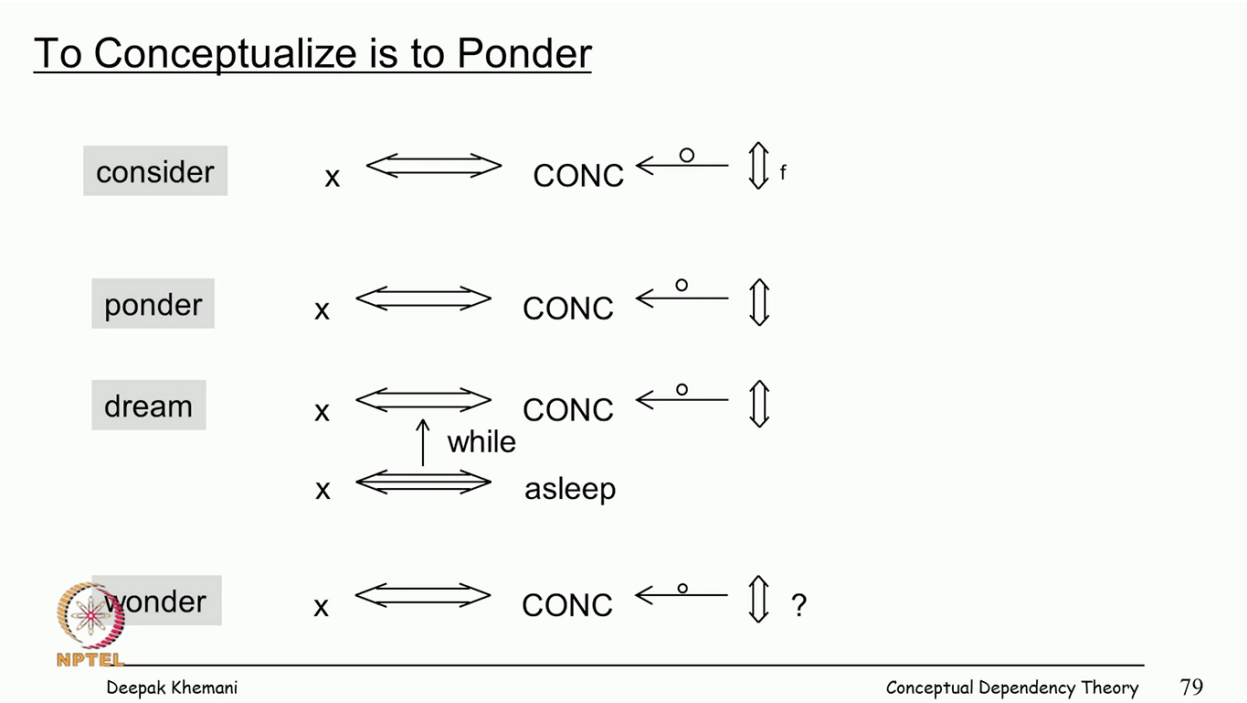

So the conceptualization basically is to ponder if x conceptualizes something then you can think of it as you are pondering about it essentially, with some small variations when you talk about consider then you bring some future with that. That in future you could be doing this. When you are talking about dreaming then again you are conceptualizing but while you are asleep and when you are wondering you are asking whether what you is thinking about whether I can be true or not. so there is a question mark at the end of that.

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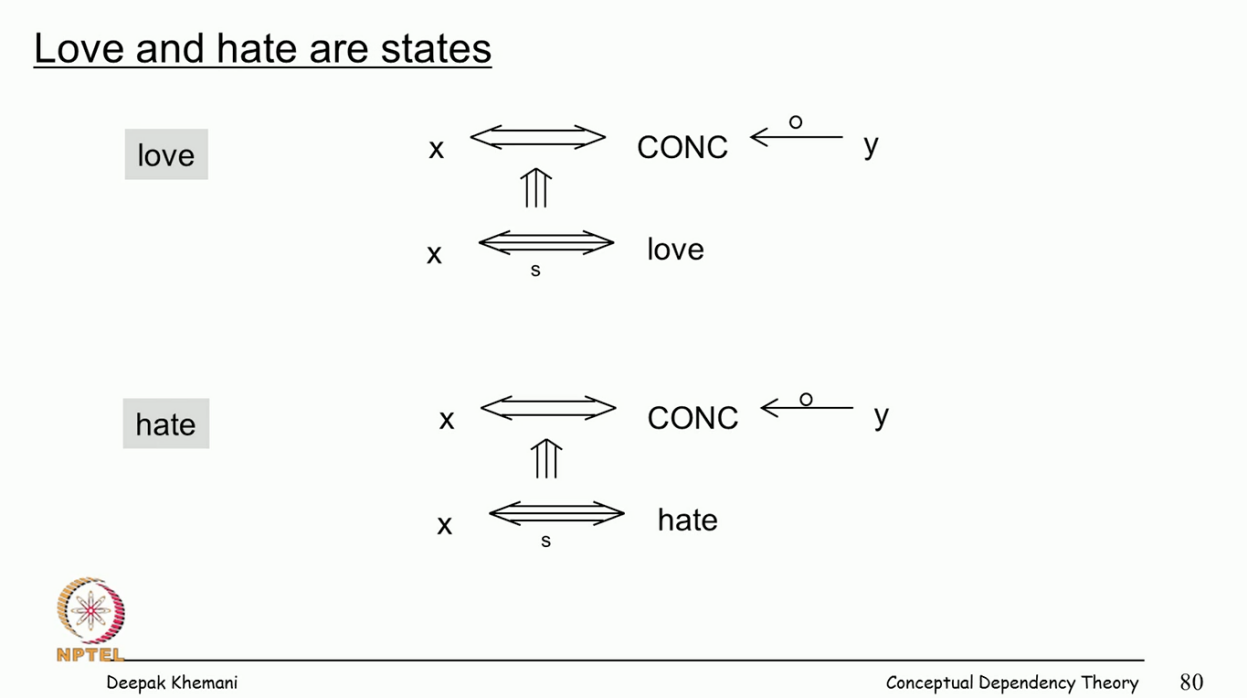

Love and hate are states so again in the English language love and hate are verbs but conceptually they are not verbs at all they are just states of being and you can model love as saying that when x thinks about y for example then x is in the state of being in love. So that's kind of a faithful representation of the word love. Likewise hate essentially the only difference is he is in a different state. So thinking has ofcourse different senses one way of thinking is when I say that I think that john is a fool then essentially I am saying that the conceptualization that john is a fool which is represented by this vertical set of arrows between john and fool. This conceptualization is lying in my memory the location is M which is possessed by me. So it's a memory possessed by me. So that thing is stored in my memory. So when I say that I believe that john is a fool or I think that john is a fool its like saying in my head that formula exists.

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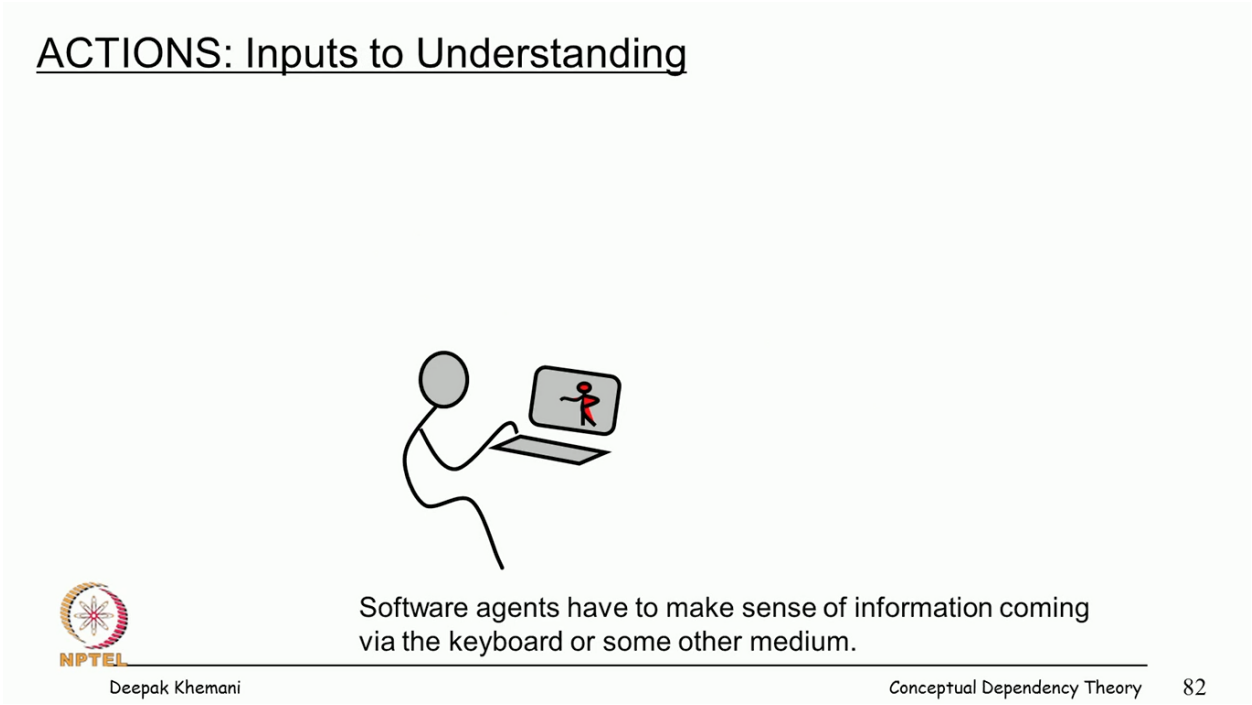

So actions are the inputs to understanding. If you were to develop a software agent if you were writing a game playing program for example what does a program have to do. The software agents have to make sense of the information coming via the keyboard assuming that you are the player is putting in information via the keyboard or a stick joystick or whatever. The agent has to make sense of those information. That information is basically in terms of actions. So goals and plans are not linguistic. We talk about goals and plans separately but whenever you are interacting with somebody you try to think about their goals and plans. He is doing this because he wants to come and hit me for example. He has a goal of hitting me that kind of thing.

And we will see that these are form of knowledge structures. They are not often stated explicitly. Its said that what we see is a sequence of actions. So if you are designing a game playing agent your keyboard strokes are the only actions the agent can see from that the agent has to figure out what are you trying to do. Ofcourse you may think that you are shooting a gun or something like that but that's only in your head. Luckily for you the agent is able to conform to your thoughts and produce visual images which correspond to that person dying or not dying or escaping or whatever is the case. But agent can only see action so what you see in the real world are actions. What you can think about are plans and goals but we will come to this a little bit later.

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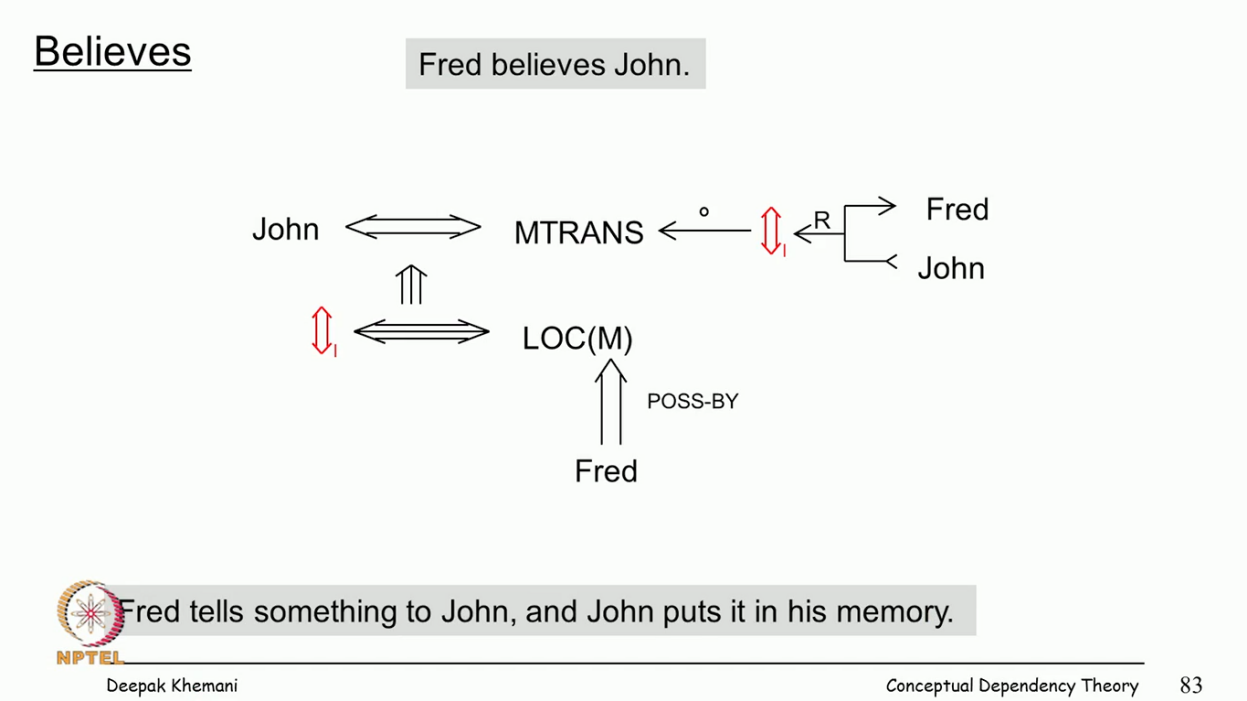

So another sense of the word believes. So Fred believes John. One sense of the word believe then you can say that John has said something to Fred which is the top half of this concept relation which says John mtranses something that red coloured whatever that thing is its some event. John told Fred that Mary ate the cake or something like that. So that whatever that event is so that has been told by John to Fred. This results in so there is a causal connection between John telling mtransing this to Fred and the causal connection of Fred believing it.

One sense of believe is that it lies in your memory so that whatever the fact was told by Fred John has in some sense faithfully put it in his memory. So he believes it after that essentially.

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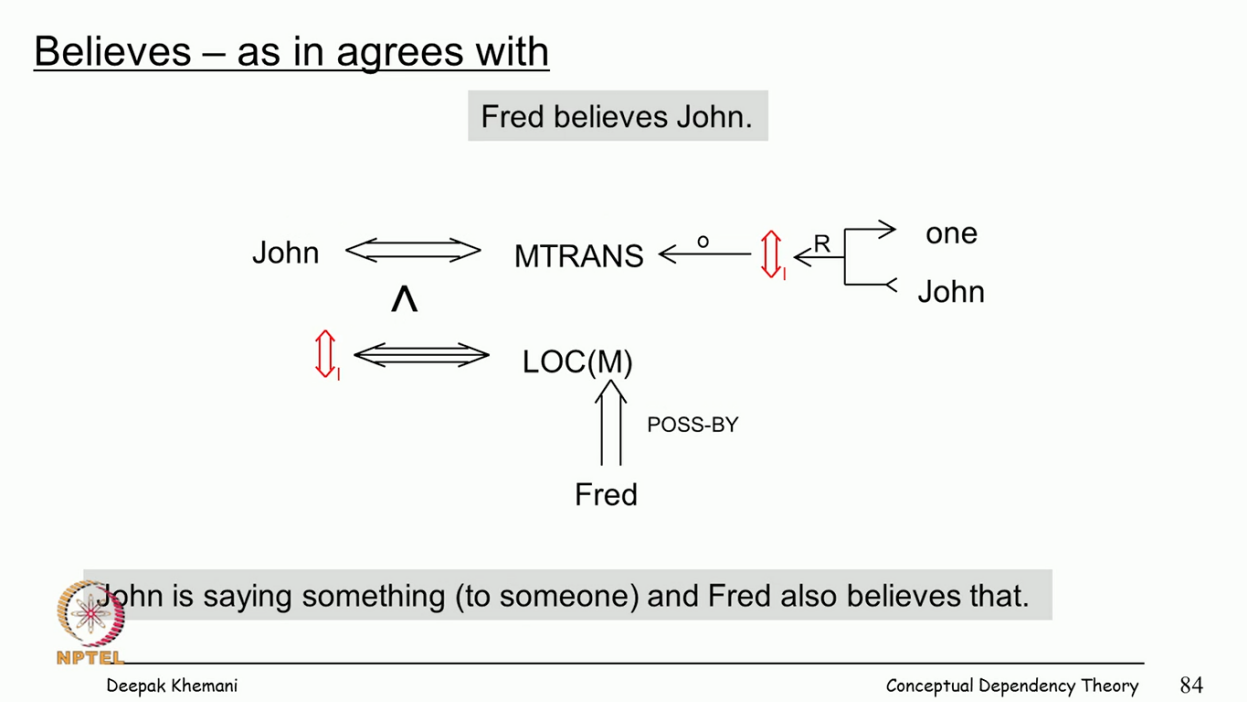

But it could also mean in the sense of agreeing with somebody. So john told fred for example as we saw in the last example that mary ate the cake and it already exists in Fred's head that Mary ate the cake. So John he believes it he believes what John is saying because he already knows that. So in that sense believes is in the sense of agreeing with somebody. So all these are issues which you have to tackle if you are dealing with natural language parsing.

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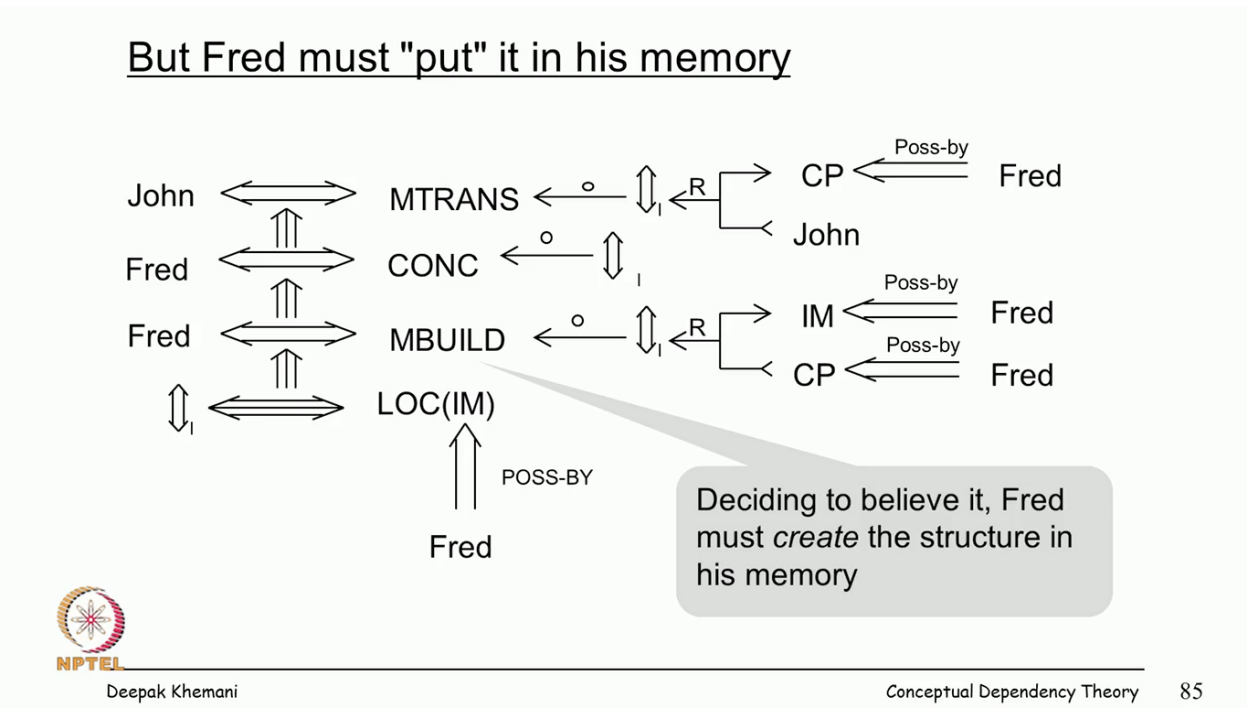

So in the first sense when he believes it in the sense that he learns it for the first time he must put it in his memory. So you can see that reading from top to bottom the topmost conceptualization says that John mtrans something to Fred as a result of which Fred started thinking about it as a result of which he built the formula which corresponded to that thing transferred it from his CP. So John had transferred that formula to his CP and Fred has taken it from his CP and put it into his immediate memory. As a result of which now it lies in his immediate memory. And in that sense Fred believes John.

So John said something which Fred actively put it in his memory.

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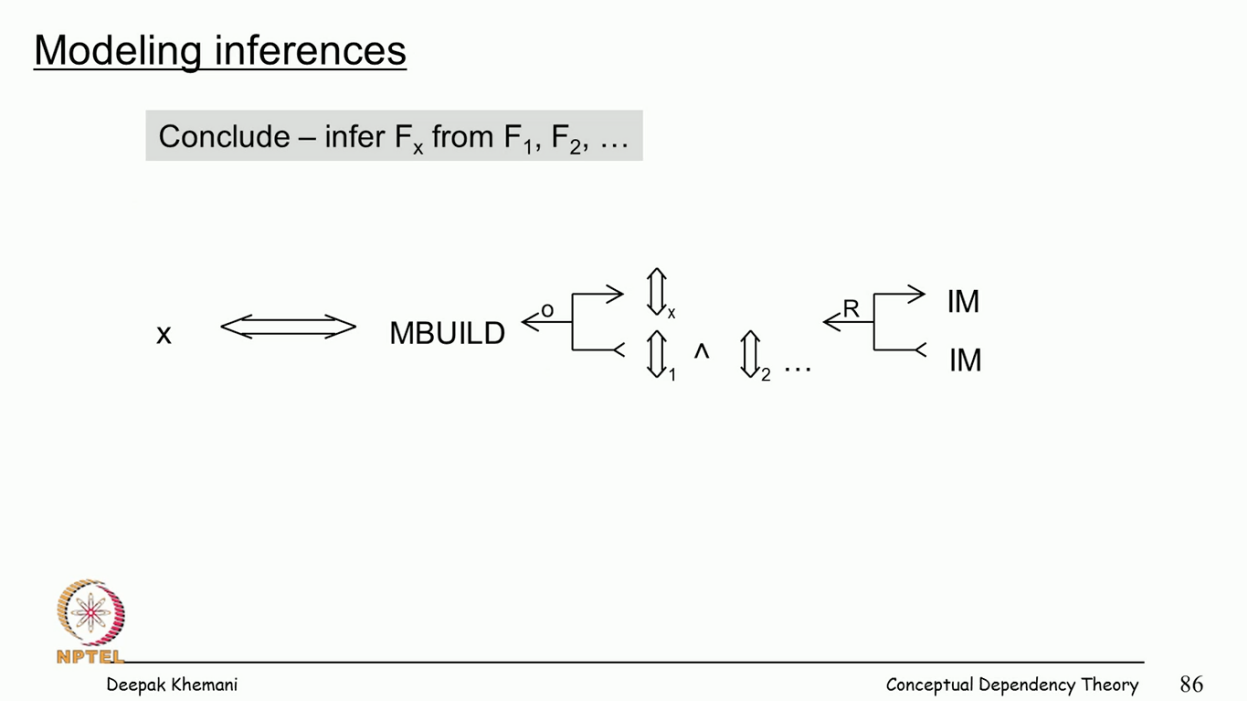

So if you want to model inferences then you can use mbuild where the input is a set of formulaes and the output is whatever you are inferring. And you can because he knows two facts lets say that all men are mortal and Socrates is a man. From this they infer that Socrates is mortal essentially. So those two facts will come in his memory and the new fact will be added to his memory.

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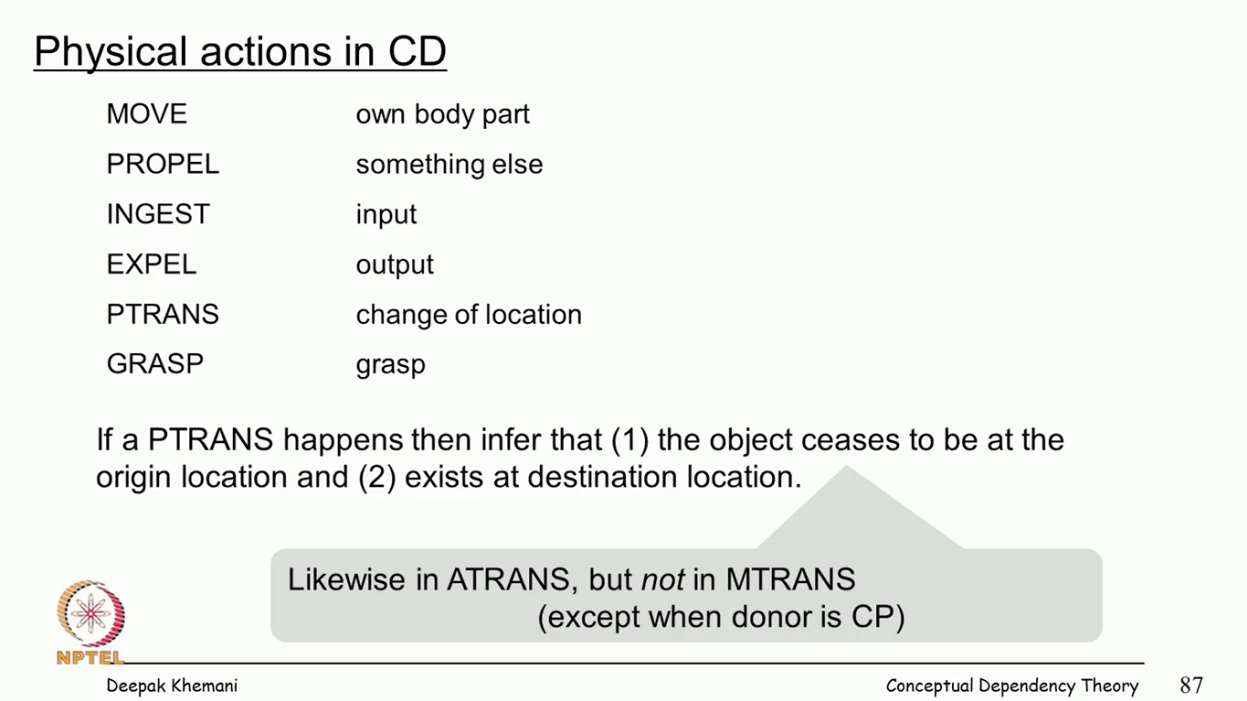

So the physical actions that we are talking about in conceptual dependency are move own body part, propel something else, ingest expel ptrans and grasp these are physical actions. They will have their own set of inferences that you can make with physical actions because they are talking of physical things essentially. So if ptrans happens for example you can infer that the object used to be at the original location and exist at the destination location. So John went to the canteen then John is no longer here and also John is in the canteen.

Likewise in atrans if I give you the book then I don't have the book anymore but you have it. but not in the case of mtrans essentially. So if I tell you something then I still have the formula and you also have the formula. Except we sometime model it that in the CP this doesn't hold true. Once CP transfers to immediate memory then it loses it automatically.

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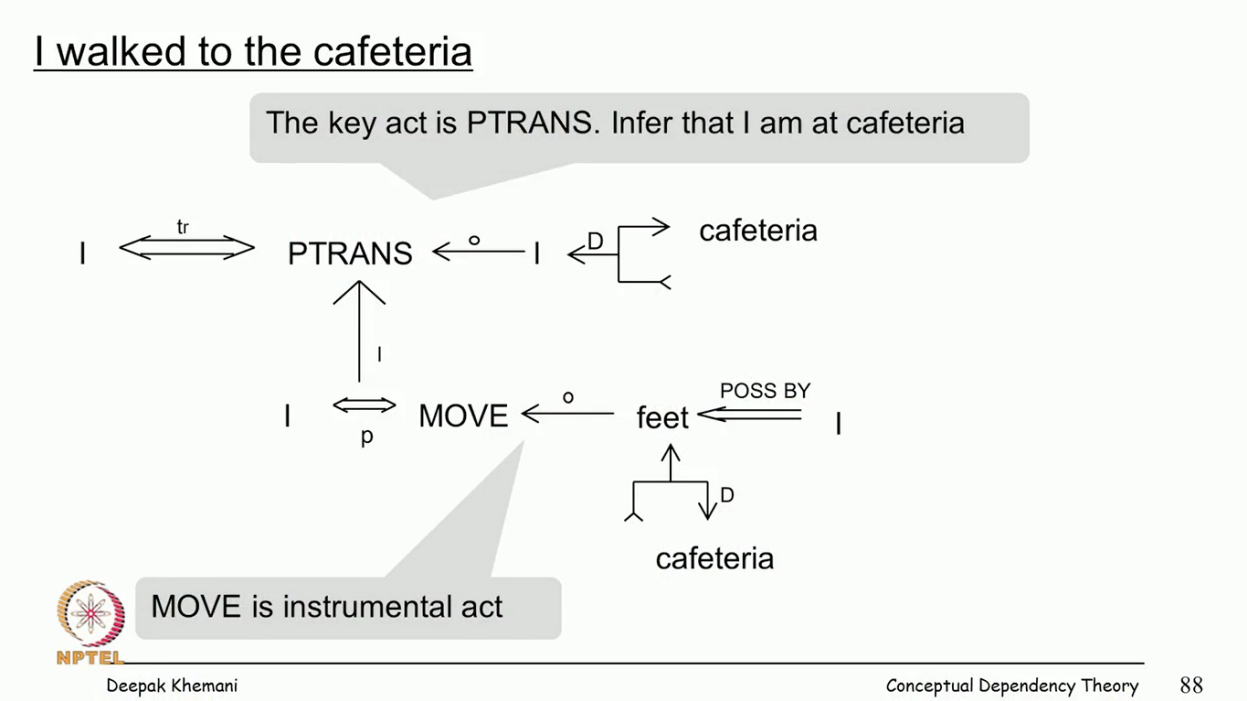

So if you want to say I walked to the cafeteria then key act is ptrans that I ptransed myself towards the cafeteria which is at the top of this thing. For this there was an instrumental act of moving and the object of moving was my feet which are possessed by me and I model it by saying I am moving my feet in the direction of the cafeteria. So walked is ptransing high level thing is ptransing but the instrumental act is move.

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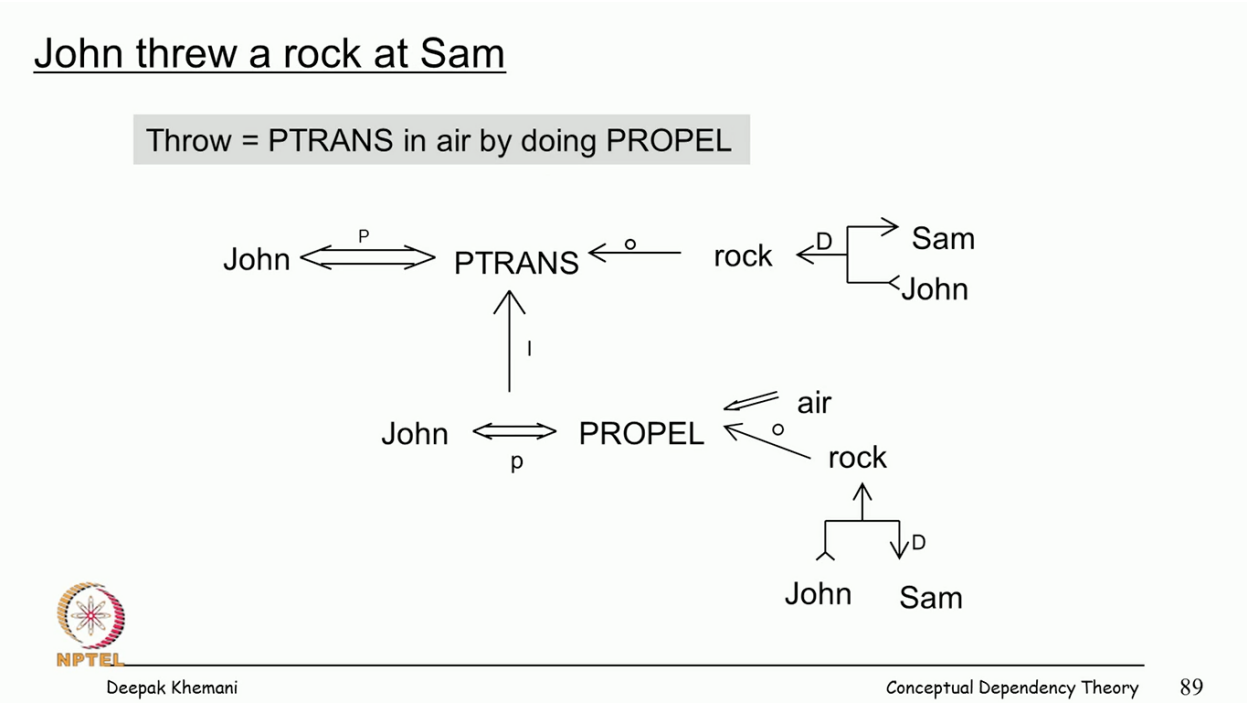

If you say that John threw a rock at Sam so again throw can modeled as ptrans in the air by doing propel. So John ptransed a rock towards Sam and the propel action was on rock and in the air again towards Sam. So here we use a word at John threw a rock at Sam. But if we had something like John threw the pencil to Sam then we should model it as abstract transfer of possession. So if we are giving pencil to somebody so at the top level action is atrans.John atransed the pencil to Sam and instrumental act is ptrans which is that he moved the pencil from him to Sam. And the further instrumental act to ptrans is propel that he propel he pushed the pencil in the air towards Sam.

So this John hit Mary we have been talking about this for a while. When you say hit you really want to say that you are doing an act of propel which is a CD theory act towards the direction of Mary. And you are propelling something its not been said as to what is that you are propelling. We just marked it with a x so you are propelling x towards Mary. And that x and Mary came into physical contact as a result.

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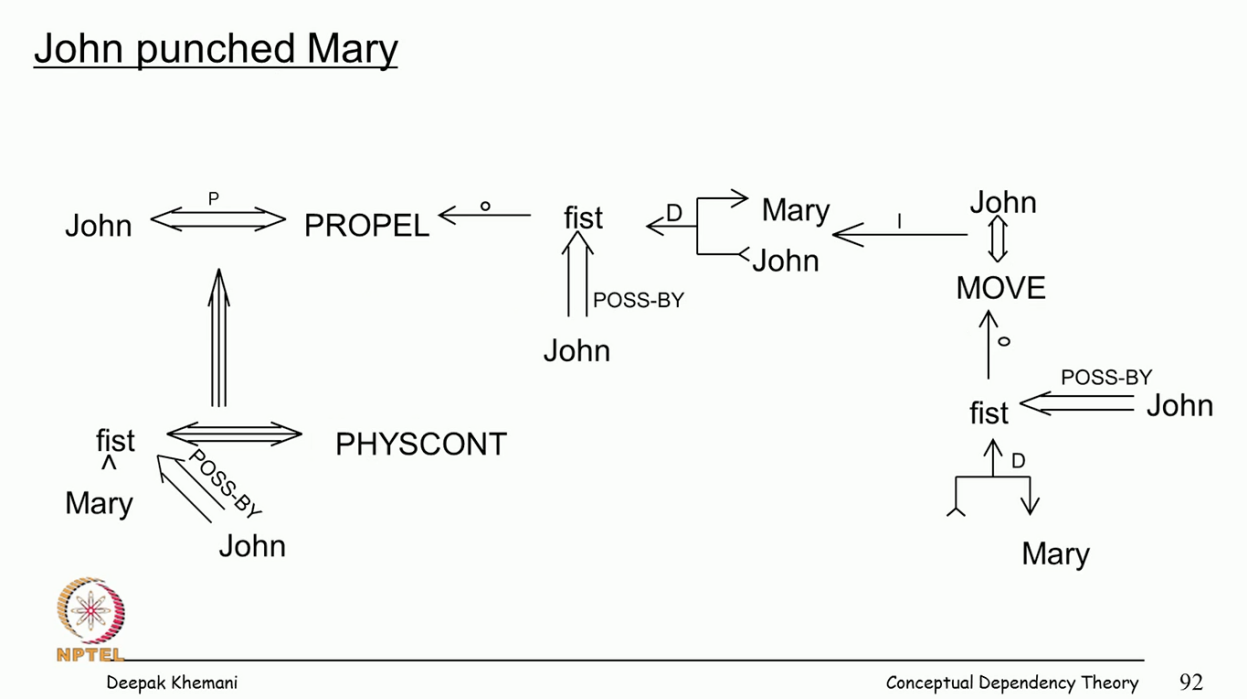

If we had said John punched Mary then we could have said he propelled his fist which is the fist possessed by John as you can see towards the direction of Mary and an instrumental act to propel was to move his fist towards Mary and as a result of this propelling action the fist which was John’s fist and Mary came into physical contact.

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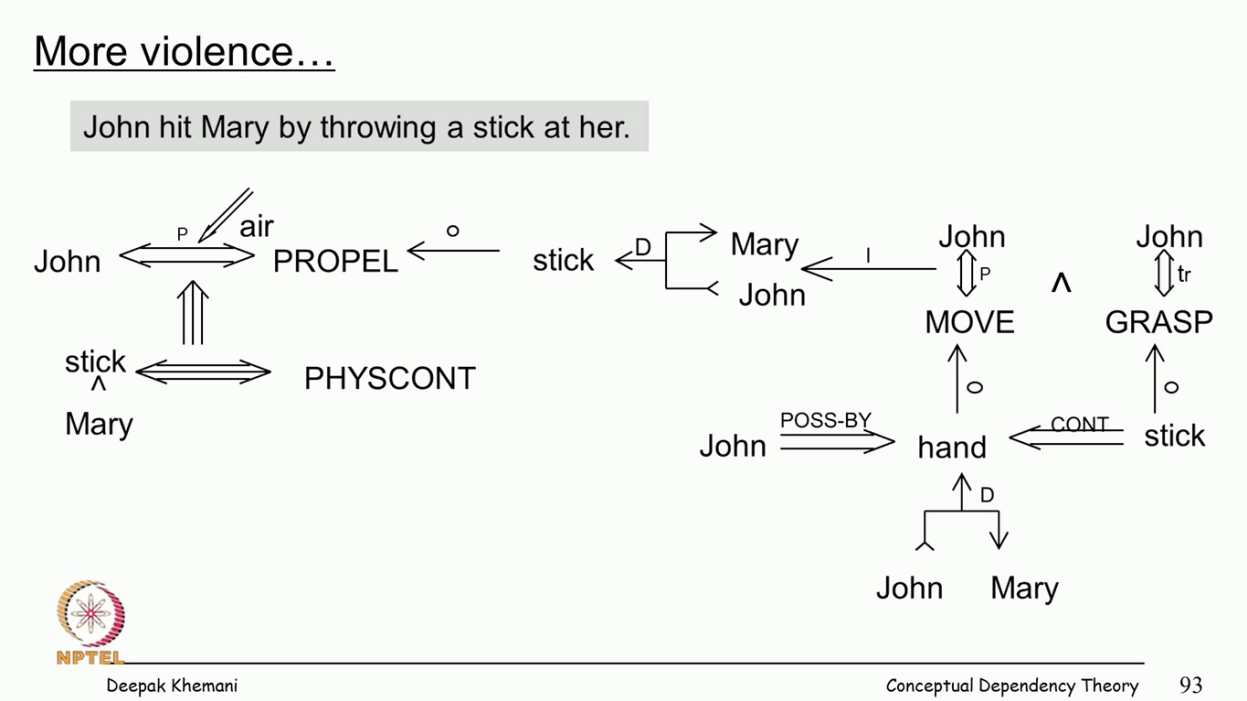

So there is some more violence between them. So John hit Mary by throwing stick at her. Its very similar you can see that John propelled something as a result of which stick and Mary came into physical contact. Except that when you talk about stick now we are propelling the object stick and then we know how to throw a stick. You move your hand and then you grasp it and then I will grasp it and then leave. So all that has been modeled on the right hands side.

A car hit Mary. So Mary its not Mary's good day today. We can say that somebody was propelling the car we don't know who and the car and Mary came into physical contact. We don't know who of agent of this is, who is the actor in this we don't want to model car as actor most of the times unless it's a movie. so when you say I moved the table to the corner. Now linguistically move sounds like the physical move the CD act move are talking about. But that is not necessarily the case so when you say I moved the table to the corner its not necessary that I physically moved it. I mean I could have said that okay there were whole set of people working helping me arrange my room or something you know we are going to have a party or something and I told the workers just to move it here and I would still say it by saying that I moved the table even though I physically may not have moved. So a sentence that I moved the table to the corner should be mapped as state transition event that I did something I don't know what I may have just spoken some words but as a result of that the table went ended up in a corner.

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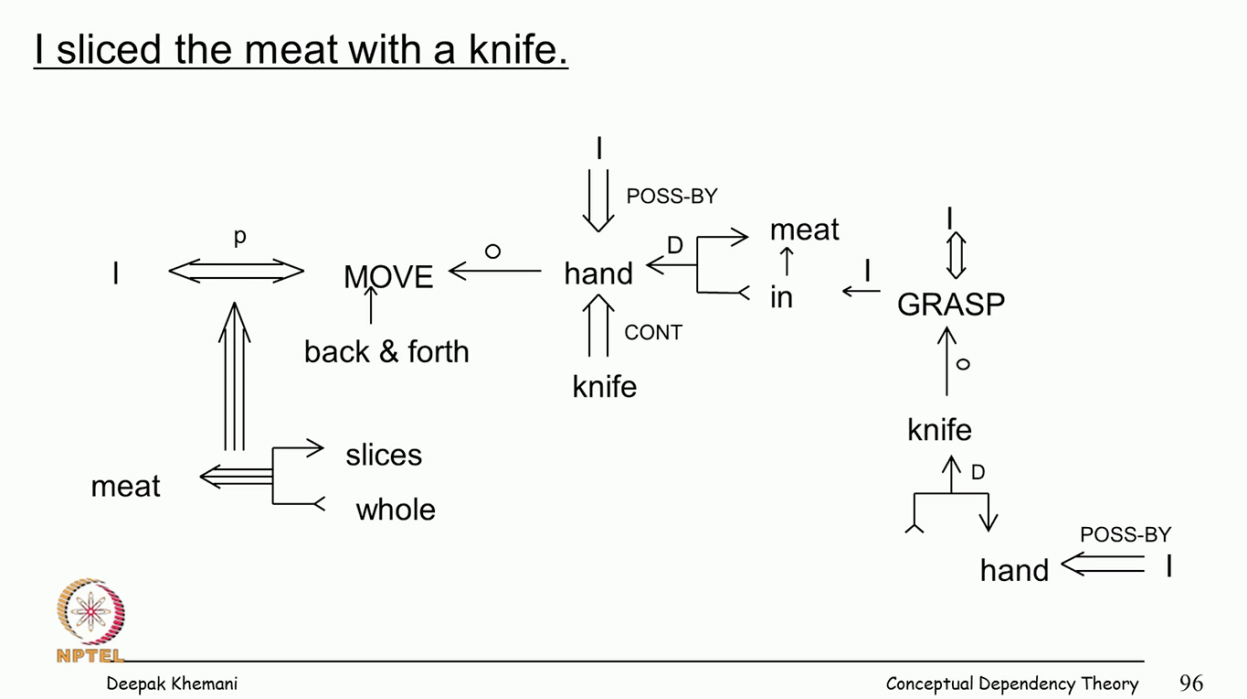

Here is some more complicated thing. I sliced a meat with a knife so let me try and separate these parts here. So what you are saying is that I did something which is a move action as a result of which the meat went from a state of being whole to the state of being sliced. The rest of the CD structure is trying to describe what do you mean by the world sliced. So the first thing to say is that you move your hands back and forth this should come with the meaning of the word sliced. So when you look at this you can imagine that you are constructing a dictionary of in a given language where for every word so we saw advise threaten and all these words those words a conceptual structure should be stored a framework should be stored with empty slots. So your task is to retrieve the appropriate structure and fill in the slots. So sliced when you talk about slice then this whole structure will come into play because of sliced.

So you move back and forth and your hand should contain a knife because it says here and you move it towards the direction of the meat. And the instrumental act for that is that you grasp the knife in your hand.

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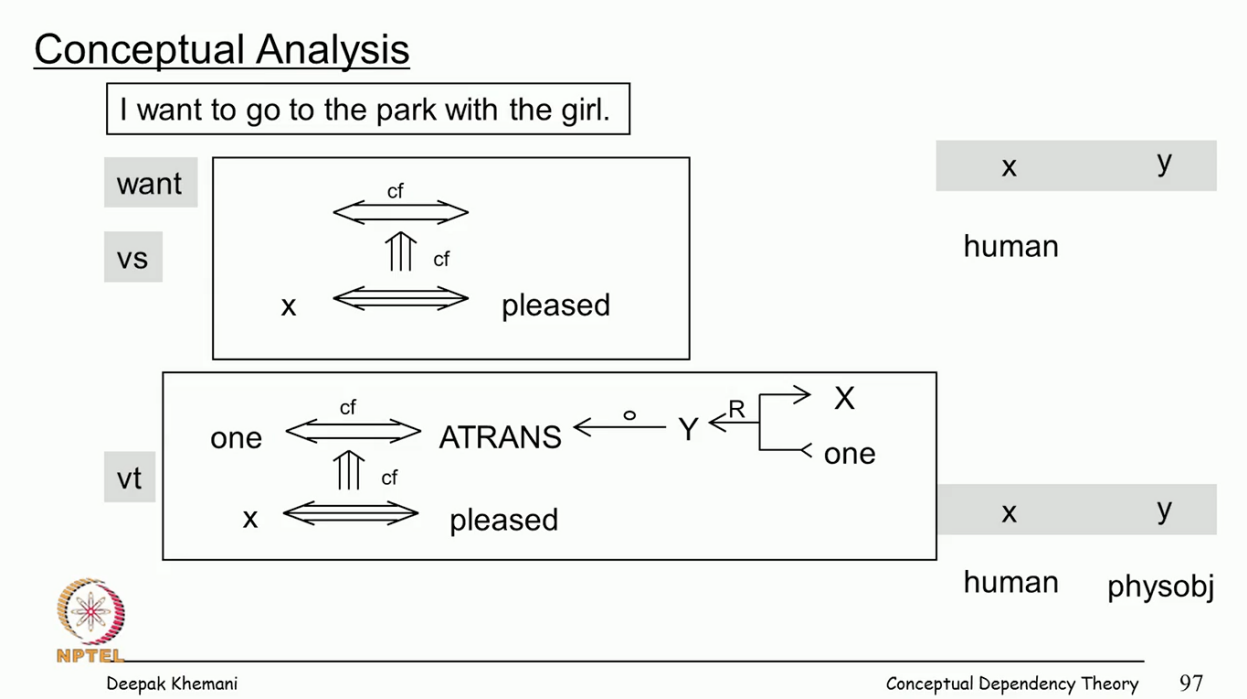

Okay I think I will not do this today. The word conceptual analysis that you see here is their word for parsing so how do you parse sentences and this is a I mean some people would call it semantic parsing that how do you generate a semantic representation that underlie a given natural language set. So we will do that in the next class. But you can try to imagine that if you were to parse this sentence I want to go to the park with a girl we already know what we want you know we know how to model to go we can model and so on and so forth. But as we will see in the next class that with is a very ambiguous kind of a this thing so it can mean different things at different times so handling something like with is not such a straight forward this thing. So first of all what do you mean by this sentence I Want to go to a pack with a girl. Is it that you want to go with the girl to the park or does it mean that you want to go to the park where that girl is. They are two different meanings and the whole idea of semantic parsing or conceptual analysis is to arrive at a meaning essentially.

We will see that it is there are times when you don't have enough information for example of the two meanings that I gave to you for this sentence either one could be true but a program which is processing if it can keep both in contention and resolve ambiguity when some more information comes in then that would be a good program. So in the next class we will see how this analysis is done what is the process of creating the conceptual dependency representation for a given sentence