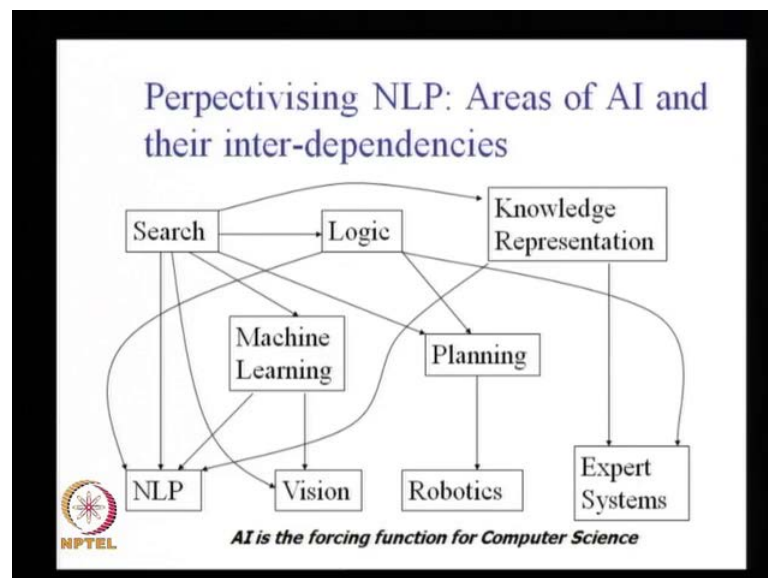**Natural Language Processing**
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Lecture - 2
Stages of NLP

We begin lecture 2 natural language processing, in lecture 1 we gave an introduction to the course and also define the subject. We proceed with stages of natural language processing, which would form the content of lecture two.

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Let us continue on the slide as I had mentioned before the faculty instructor is myself and my area of research is natural language processing, machine learning and course home page will be soon created. Proceeding further I would like to remind the once again the areas of artificial intelligence and their inter dependents, we find here that natural language processing comes on the left bottom corner, which is dependent on machine learning, knowledge representation logic and such. There are many other areas of artificial intelligence and they have this inter dependents, these us explain last time and we also say that A I is the forcing function for the computer science and natural language processing happens to be the forcing function for A I itself.
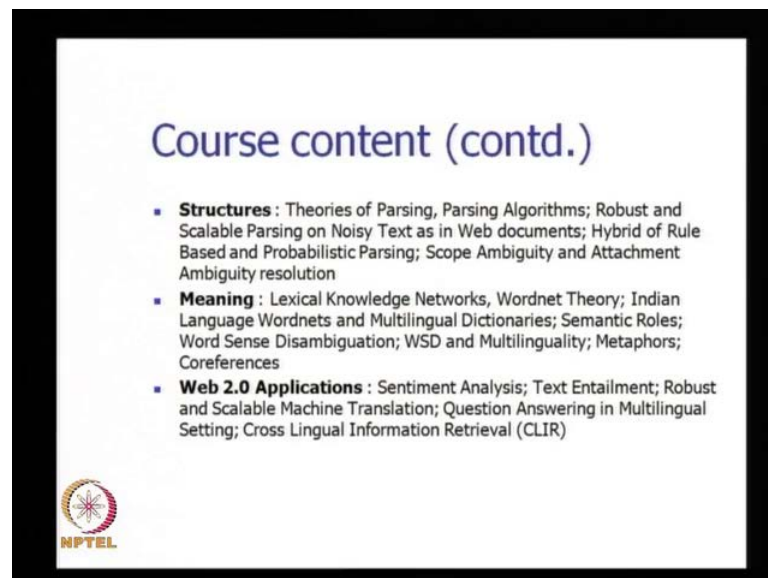
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We once again mention the course content, will cover sound that means speech processing, word and word forms morphological processing.
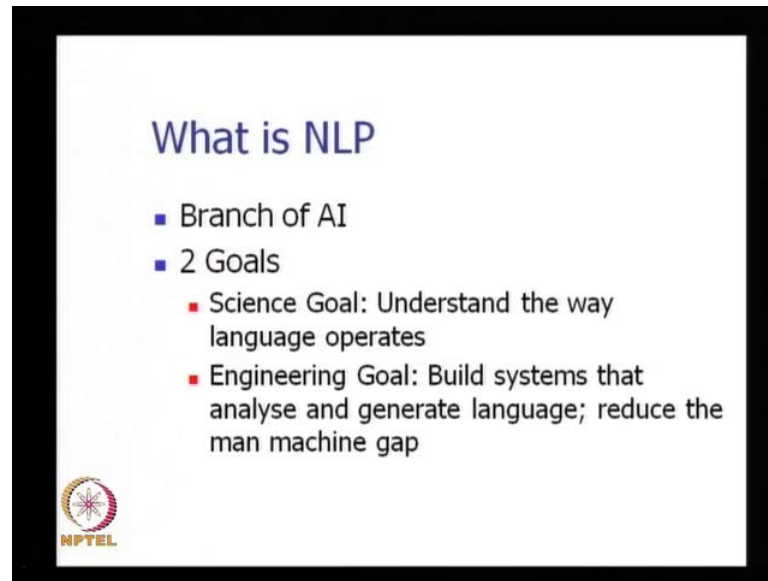
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Structures which means sync acting processing passing, meaning representation means semantics and we have to conserve applications. This is a plan for the whole course and these are the topics to be covered.

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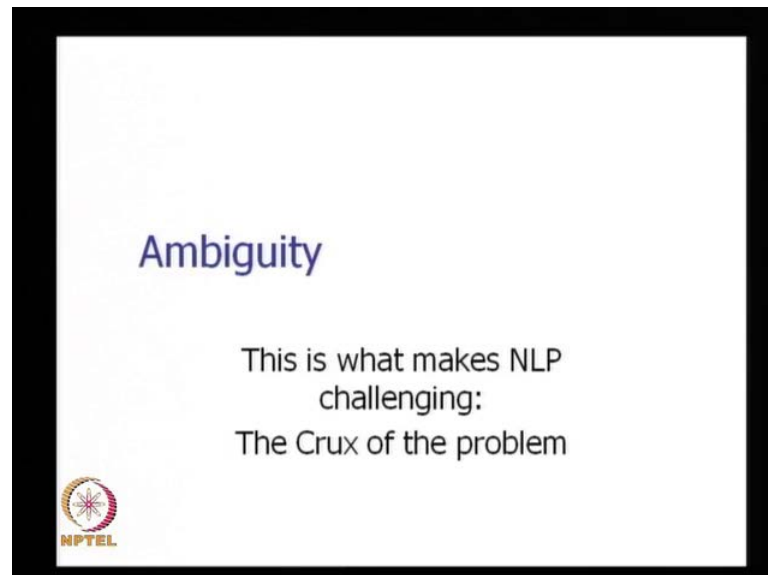
Natural language processing was defined as a branch of artificial intelligence with 2 goals. The science goal is to understand the way the language operates and engineering goal is to build systems that analyze and generate language; and reduce the man machine gap.

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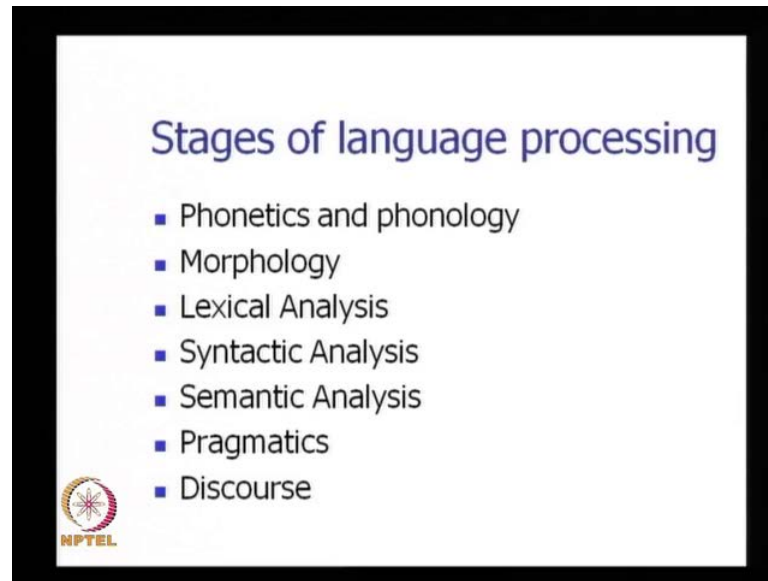
We also mention that, ambiguity is the cracks of the problem in natural language processing. And resolving ambiguity is the main concern of language processing.

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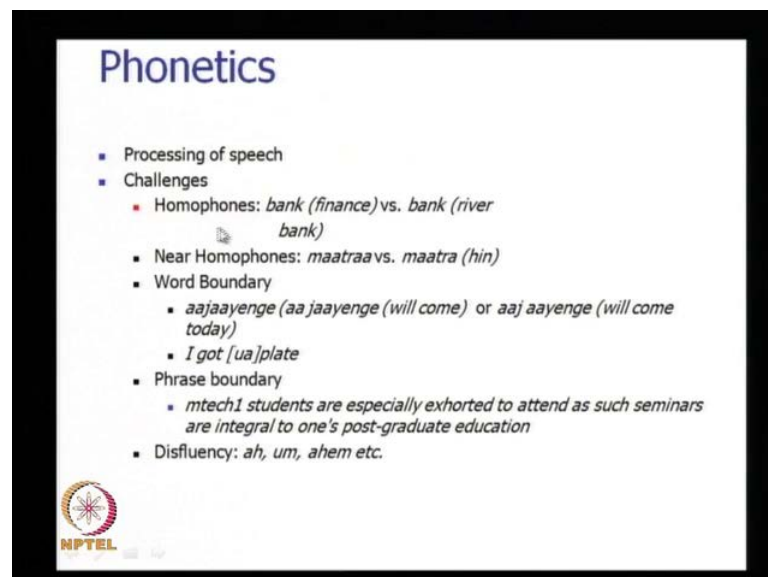
We then, introduce the stages of language processing and the phonetic and phonology, which is concerned with the sound morphology concerned with words, lexical analyses, how make the dictionaries? And how to store words in them? Syntactic analysis parsing of sentences, Symmetric analyses is concerned with meaning representation, pragmatics means how a sentence is used? And discourse is a processing of connected of sentences.

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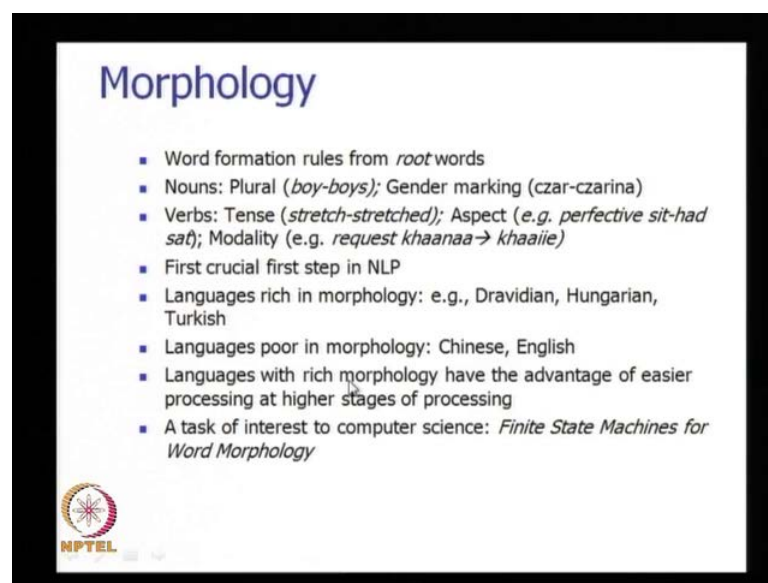
We proceed it further and understood that, there are something called homophones, which are words which sound similar near homophones, which are words which are

nearly identical in the pronunciation. In speech processing word boundary processing is very important problem, the example which was given was ((Refer Time: 03:32)) can we broken up into ((Refer Time: 03:35)) will come or ((Refer Time: 03:37)) will come tomorrow, or the sentence I got a plate which can broken in two different ways, either to mean I got up late, which means I woke up late or I got a plate, I have a plate with me. Similarly, phase boundary detection is a problem and disfluency is concerned with how a speaker inters fares as sentences, with meaningless sound just to be able to organize is thought.

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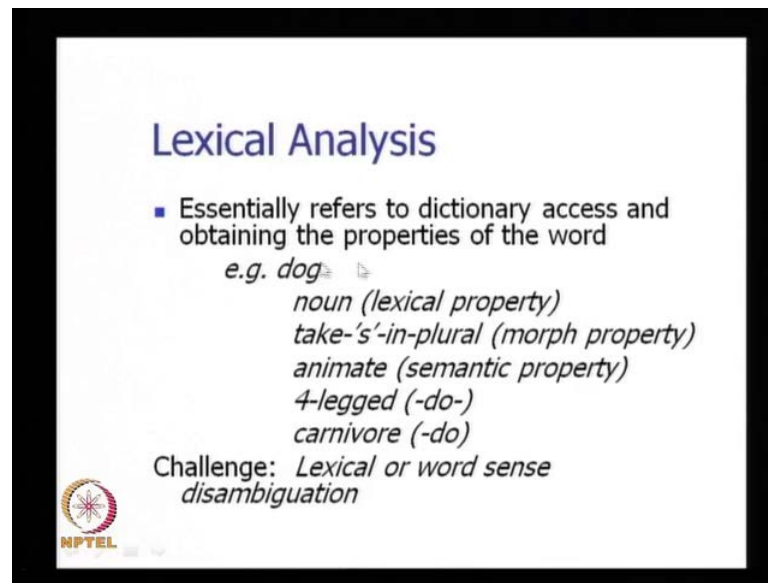
The last topic we discussed, in the last lecture was morphology or the word formation rules, how plurals influence a noun forms? Of all forms influence aspect modality and so on. We also mention that, by using finites machine, one can produce morphology analyses and this is a very important problem in computer science. Language defer in the regions of morphology for example, Dravidian, Hungarian, and Turkish, language are rich in morphology Chinese an English or poor in morphology. So, this is where we stopped in the last class. Now, we proceed with the further discussion name with the stage of natural language processing.

Now, comes lexical analysis, which is the dictionary making, if you look at the example given in the slide it refers to dictionary axis and obtaining the properties of the word. For example, the word dog, this is noun, which correspond to the lexical property, it takes s in plural, which is the morphological property, it is animate which is the semantic property, it is the 4 legged animal, which is again the semantic property, its carnivore that means it is the meat again a semantic property. So, one might wonder why we need to store all this information on to the dictionary so, when we produce the dictionary entries in a lexicon, one of our main concern is how to research in this whole detail structure?

Dictionary indeed forms a part of the natural language processing, just like morphology processing is concern with breaking up a word and the obtaining a suffix, obtaining the features which are contained on the world. Dictionary on the other hand is concerned with how to store the root words after morphological processing one obtains a root words and how this words are stored in the dictionary, what kind of the information do we have t imbed in the dictionary. For example, the example which was given was the dog in the dictionary.

Dog takes s inverse so, many dogs are barking, here dog has become down after morphological analyses s is the plop and the root words is dog, at the point of time when the processing has to go further, it needs to know, what are the properties of the word

dog? So, at that point of the time, the dictionary comes handy and it tells us that, dog is a noun, it takes s in the plural its semantic property at that it is animal, it is animate it has 4 legs and so on. So, who uses this kind of information? There is the field of research called question answering, which is a very upcoming field in today is world of internet and in question answering a machine is made to answer uses question.

So, this is a field of information extraction, information retrieval it is a branch of those field and it gets it support from information. When the documents are obtained from the internet the document are proceed to manufacture in answer so to say. So, if we ask a question, how many years does a dog live? This question please supposes that, dog is the animate entity it has a stage of being bound then, there is the period of being alive, which finally, terminates in the dog being dead. So, how many years does a dog live? That this pre support all these intricate and small were curtail pieces of knowledge, it is many times requiring internecine. So, this kind of processing is assisted by a rich dictionary without a rich lexical knowledge, this kind of processing is not possible.

So, here is the important of lexical analysis. If you look at the bottom of the slide the main challenge in lexical analysis is lexical or word sense disambiguation, which indeed is one of the most challenging problem of natural language processing. We would like to dwell on disambiguation through a set of examples.

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So, these transference lexical disambiguation, shows the steps involved in the disambiguating process. The 1st step is part of speech disambiguation, look at the example here, the dog as a noun is a animal and dog as a verb means to pursue, to run after, to go after so, one could for example, say an sentence wherever, ram went miss fortune dog came, that means wherever, ram went means fortune went after him. So, this is the part of speech of dog as a verb and the 1st part of speech in 1st line dog is a noun here dog is an animal. The words and disambiguation problem comes in, after parts of speech is ambulation is over. So, for example, when you decide the dog is a noun the next question we ask, is dog and animal or is the particular sense of dog a very detachable person, one of the sense of the dog is this very detachable person.

So, from the context one you have to make out whether dog is to being used as an animal or dog is used as a detestable person. So, we must mention here that, when a word is used many meanings of the word come into play depending on the context. Typically in a document what operates is called one sense per discourse assumption, typically a word used in only a single sense.

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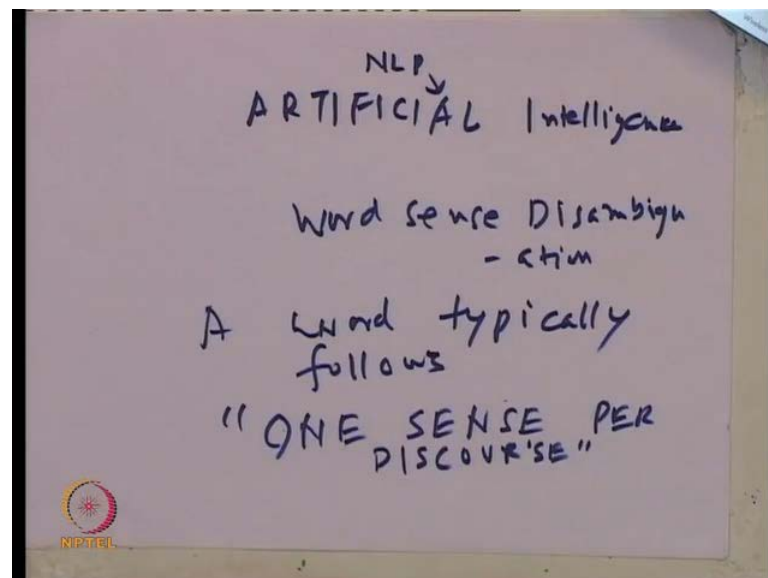
Let me write down these particular hypothesis, we are discussing, the branch of natural language processing, as a branch of artificial intelligence and we are also discussing, word sense disambiguation, digestion in this context. And we are saying that a word typically follows one sense per discourse. So, this is the statement one sense per

discourse so, this is very important assumption it says that when a word appears in the document, it does not have the multiple senses, it has typically one sense ok. So, let us proceed lets proceed with the discussion, look at the transference once again, dog has this to senses as an even and as a detestable person. Now, when we see dog in the text, what do we make out from the context? Do you mean animal? Or do you mean a detestable person?

Now it is so happens that, dog the predominate sense of dog is animal, the sense of detestable person is very low and these are typical phenomenon in most of the languages, for most of the words, each word has a very predominant meaning, other meanings are more or other meanings are less frequency compared to this particular meaning. So, the animal sense of dog is more frequent detestable person sense of dog is less frequent. Now, it to disambiguate a word, we need word relationship in a context for example, look at this sentence the chair emphasis the need for adult education, the chair emphases the need for the adult education.

The word which is being disambiguated here is chair. Now, chair can be either piece of furniture or the person holding the chair right so, when we look at this sentence what is the meaning of the chair? From the context it is clear that, we mean a person here the, chair emphasized the need for adult education presumably the furniture cannot talk emphasizing is a kind of talking and therefore, emphasizing is the clues to disambiguation. So, let us remember this very important point mean words in disambiguation, namely: when we find out the sense of a word from its context, the context provides clues critical clues with respect to the since.

And when we design a computer algorithm for version disambiguation we have to see how to obtain that, clue from the sentence so, for example, in this sentence the chair embassies the need for adult education the clue word is emphasize. Now, when we create the automatic system for disambiguation it has to identify that emphasis is an activity which can be done by animate being and therefore, chair is not furniture, this is the way the alga rhythm is proceed, there are lots of interceding case involving words and disambiguation in the course will cover words and disambiguation algorithms in lot of detail quite a few lecture, we divided towards a disambiguation.

So, at this point we just mark this particular fact that, from the context a clue will come in and disambiguate the word. Now, this is an this particular sentence which I showed as on elastration is constructed by me but, watson disambiguation is not really an artificial problem it appears day to day at all the time, it is very common in day to day communication, look at these particular advertisement in satellite channel one of the satellite channel, which I have seen on t v. Look at this sentence watch what you want, when you want, this particular sentence if you think carefully has two meanings, watch what you want when you want. The word watch as two meanings one meaning is look intimately look carefully and the other meaning of watch is be careful.

Now, one meaning of this sentence will be careful what you want, when you want so, just be watchful what is that you desire? And what is the time when you desiring? There is always a right time for desiring anything and also that, things should appropriate, this is the meaning of that sentence one meaning 1st meaning. The 2nd meaning of watch is look carefully so, watch what you want, when you want here watch means the act of watching something, act of looking at something. So, watch you what you want, when you want so, this is the satellite channel add a add advertisement for a satellite channel.

So, this advertisement is sort of giving propaganda for the satellite channel, it is saying watch what you want, when you want you have this kind of the freedom on this satellite channel it is scaring there are two meanings of this sentence coming from two different senses of this word, not only words but, phases also have a multiple meaning for example, the phase here ground breaking ceremony versus ground breaking research, ground making ceremony means the starting reach well some kind of worship, some kind of pooja done for starting and activity, or starting an organization or even you know starting a building, starting the activity of constructing a building, that is ground breaking ceremony. And ground breaking research is something which is a par nearing kind of work is starts a line of research.

So, here the phrase ground breaking has two meaning ok. So, may be through this particular slide, we have made this very important part that words have multiple meanings whenever, we have to phrase a sentences, we have to 1st solve this difficulty that words a multiple meanings and in this particular context which meaning of the word is being talked about ok. So, that is the meaning which with you proceeds further for the next stage phrasing of the sentence.

Next proceed to the next slide, it is also a very common observation that, technological developments bring a new terms additional meanings and nuance for existing terms. For example, let us look at the 1st line the word justify, the words justify as the its own original meaning justifying something, that means validating something, where as in this particular sentence justify the right margin, this means aligning the words of sentences with the right margined this meaning of justify is align and this meaning came because of what processing, when what processing came ok.

So, software assisted word processing at the time the word justify also came into our parleys and this means aligning the sentence with the right margin. So, justify came because a word processing. The word xerox is a new word which came because, the xerox machine where brought into play copy our machines. So, the word xerox we came new verb digital trace, these are new expression and a very interesting expression. Digital trace acutely describes, the trace of the individual as he or she navigate the words or the internet all the your else that we visit, all the pages that is we browse they form what is called our digital trace.

So, in this sense you can imagine that, Google as such engine is the extreme powerful entity, influencing all rights. Every click of hours every u r l that, we have visited every page that we have browsed everything has a record with ok. So, Google as a complete digital trace of our activities on the internet so, this particular expression digital trace it

came, because of search engine and also because, of the internet. A clear indication the technology brings new phrases a new words, into our day to day life. The next word is also an interesting word this is the expression, which came as the combination of two words communication and faking, communicating and faking.

The word is communifaking this means pretending to talk on a mobile, when you are actually not talking ok so, that is a very interesting situation somebody he has taken up the mobile and he is talking in to the mobile but, actually this person is not talking with anybody. So, he is faking communication that, is why it is called communifaking, what would be the use of this? The use of communifaking could be for example, humorously speaking a giving a way of disappear for a boring meeting, suppose you are sitting in the meeting and you do not like the way things are presiding it is very boring discussion and you would like to excuse yourself from the meeting, then you can communicate into a mobile, while acutely you are not communicating you are faking communication and this is called a situation of communifaking ok.

So, communifaking could be useful in disappearing from a boring meeting. The next word is also a very new expression it is called this discomgooglation, discomgooglation this is anxiety or discomfort at not being able to access internet, this is a very modern phenomena a very resent phenomenon in our life more many of our young people are glue to the computer searching the web, searching for the information, looking at different web pages, looking at pictures, browsing pages and so on. So, all this is the goggling activity, you are very active on the internet searching for information and browsing.

If this individual is not able to use the search engine, not able to axis the internet, then he or she suffers from anxiety syndrome, this particular syndrome is called discomgooglation, this is discomfort at not being able to do goggling not be able to do google. So, this is the discomgooglation it is a new word. The next phrase which is the phrase helicopter parenting, this is phrase and it means over parenting just like a helicopter goes over a terrine, it keeps on moving over a terrine seeing what is below it?. Similarly, there is some over bearing parents who are extra careful what the children are doing and in their extra care they are doing what is called helicopter parenting.

So, all this words you can see came from technological advancements, justify because of what processing xerox because, of the xerox machine digital phrase, because of the internet, communicating because of mobile, technology, discomgooglation because of goggling, helicopter parenting it has a metaphorical association with helicopter.

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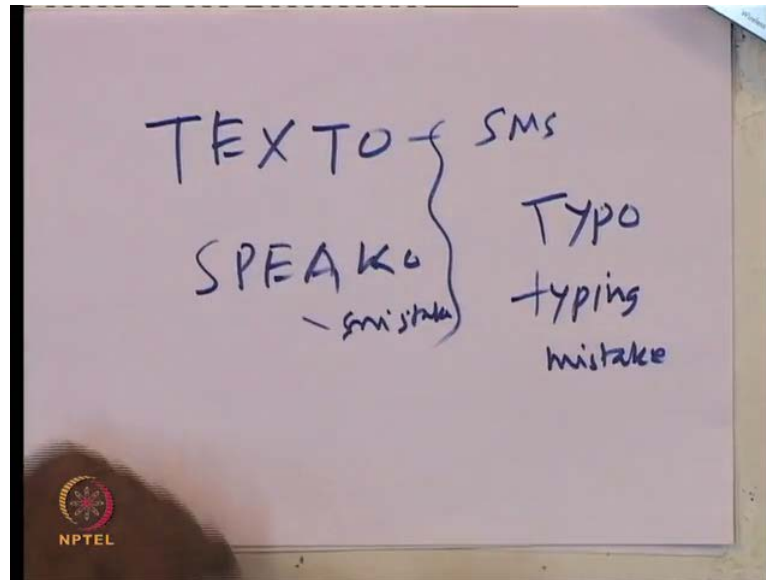
Let me give you one more word which is also very interesting I came to know about this yesterday from the newspaper this word is called texto and there is aligned word speako. So, they came from the word typo, what is the word typo mean? The typo means a typing mistake so, texto is a texting mistake that means you are trying to send on S M S so, trying to send the S M S over the mobile and if you make a mistake then, this is known as texto. And from that, change the expression speko you are trying to speak something and make a mistake while speaking this is called as speko ok.

So the word typo instead of two more words texto this came in the context of mobile technology, speko came in the context of speaking. So, again we can see that new technology name the technology of the mobile, had to be when you came it introduce this new term called texto ok. So, let us proceed and this particular transparency showed that we create new words in our language or an existing word gets a new meaning let say just justify, new word come because of the technology and we have to deal with the meaning of these words.
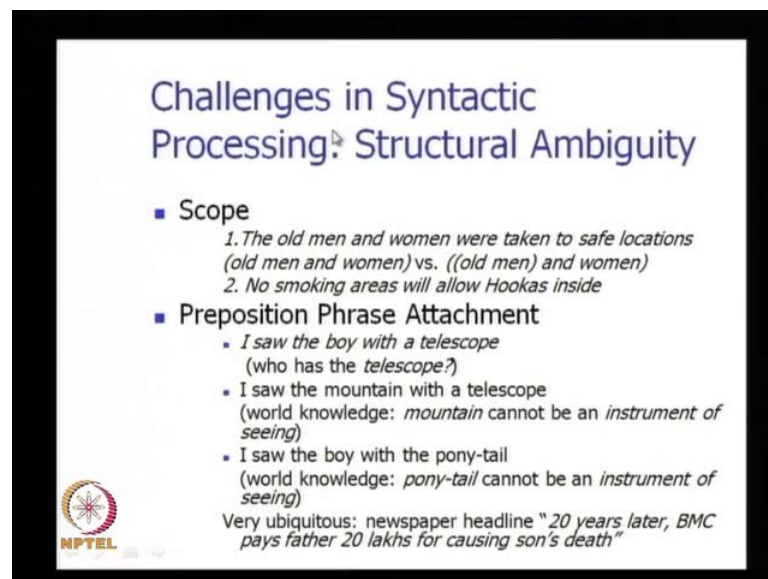
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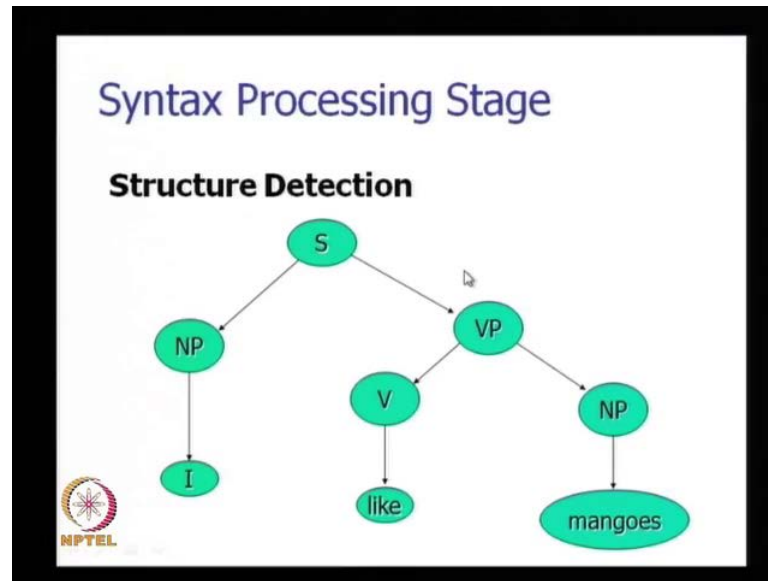
Next we come to a very important stage, where we have graduated from the processing of words ok. So, we have processed the words now we come to the structure of the sentence, the phrases. So, here S is the sentence and this is a tree structure which computer scientist a very familiar with the sentence has two phrases, noun phrase and the verb phrases under the noun phrases you have the noun in this particular case it is the word I which pronoun, under the word phrases you have a word and noun phrase, the particular verb in this case is like and the noun phrases goes to noun, namely a mangoes.

This whole sentence is I like mangoes ((Refer Time: 26:01)) so, I like mangoes these as this structure, it is a noun phrases and the verb phrase, the word phrases is again broken into two entities for an noun phrases ok. This is known as structure detection and the whole problem of converting a sentence in a tree like structure like this, is called the problem parsing the parsing technical analyses. And we will look many algorithm for parsing as a the course process. We again mention here, the problems which in natural language processing system encounters while parsing.

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Look at the next transferring the challengers which come in syntactic processing, are known as structural ambiguities. The 1st challenge which I show here, is a scope challenge it is called the scope ambiguity. If you see the sentence the old men and women we are taken into safe locations, the old men and women were take into safe locations. The question in this sentence is who is old? Are both men and women old or only the men that are old ok. Because, there is a adjective here, old how much of the text does the adjective qualify? There is the question. Both men and women are old or only men are old. This is known as the scope ambiguity that means, what is the reason of influence or scope of the adjective here in this sentence the word old, how much text does it qualify?

Look at the next sentence here, this ambiguity is an extremely on interesting ambiguity because, it completely reverses the meaning of the sentence, here what we have is an

adjective like entity no smoking areas will allow hook as inside So, when you look at the sentence what meaning does it convey to you, the word no is the quantifier not any the meaning of no is not any. Now, what is the scope of no? Because, it is it acts like an attitude quantifier acts like an entity.

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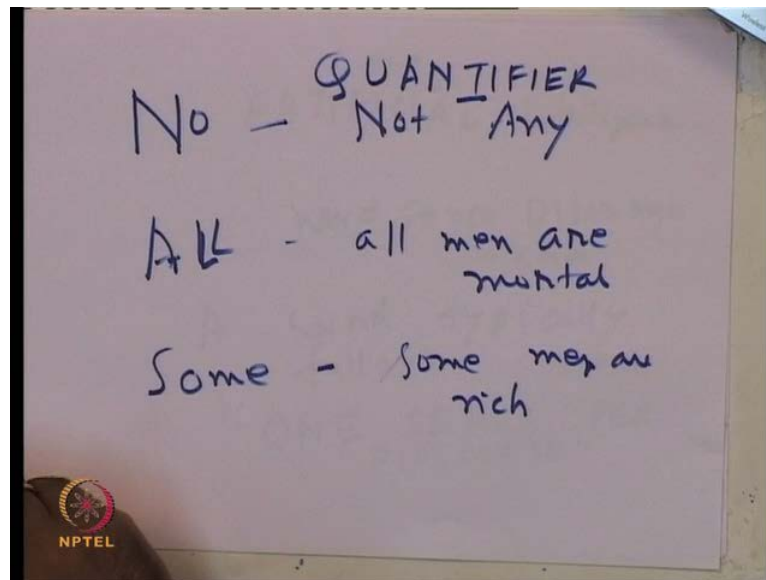
Let me write down the term for no and this star is called quantifier, just look at the word here No, the meaning of the no is not any ok. So, this is a quantifier I write here the term for such entities linguistic units quantifier ok. There are other quantifiers also no is not only quantifier, all is a very important quantifier all, all men are mortal so, this is the quantifier application over men, all men this is all, another quantifier is some. So, some men are rich these also quantifier so, no, all, some these things are known as quantifiers. Let me also mention, that all and some have a special place in logic and artificial intelligent.
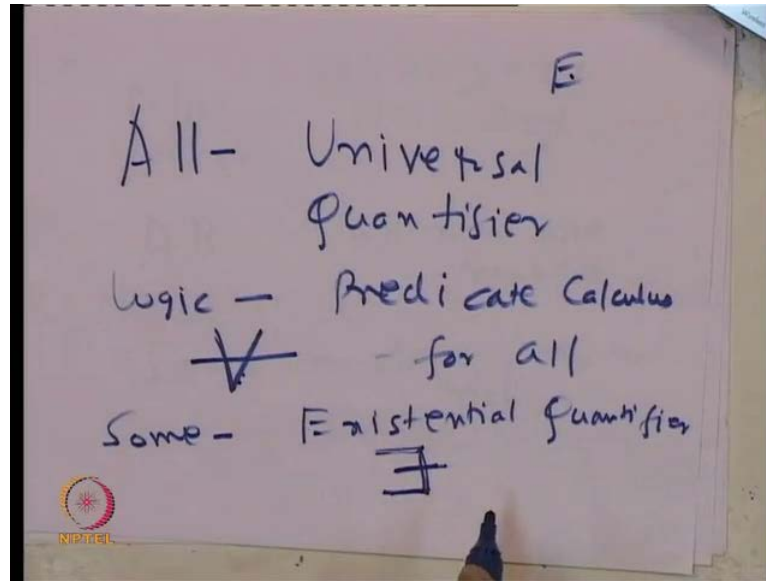
Let me write it down for you, all is called a universal quantifier, universal quantifier and in logic when you go to predicate calculus, the quantifier all is expressed by a special symbol this is the symbol, this is known as the power all quantification symbol. This is a V ups and down, with a bar passing through the center of the V. So, it is almost like upside down a except that both its end are extended in both directions. So, this is called a universal quantifier standing for, for all. And some as a quantifier is called existential quantifier ok and the symbol for that, is a reverse E a E is written this way instead of that, you turn it other way a mirror image and this becomes the existential quantifier.

So, quantifier are very important linguistic particles in natural language processing. And they their processing is also a very important job should be carefully done, otherwise we can have ambiguity. So, let us look at the sentence which we are discussing at some time back, before the discussion on universal and existential quantifier. These sentence no smoking areas will hook as inside the question was, what is the scope of qualification of no? We say the depending on the scope of no the sentences has one or the other meaning. one meaning of the sentence is that you cannot find any smoking area which will allow Hookas inside so, this is the sense of not any. Not that does not exist a smoking area, which will allow hook as inside.

So, here no smoking areas the scope of no is, smoking areas this qualified smoking areas qualifying the whole sentences, the smoking areas will allow Hookas inside, this whole

sentence is being negative by the presence of no. The scope of the no is complete sentence therefore; no smoking areas will allow Hookas inside. The other meaning of the sentence is there are certain area special areas called smoking areas ok, the special areas called the no smoking areas and these no smoking areas is such that, they allow Hookas inside, they may not allow other think they may not other thinks, they may not allow segregates and signers but, they will allow Hookas inside.

So, you can possibly see that depending on what is the scope of no? Whether it is the complete sentence after these or just this compound ward smoking area depending on that, the meaning takes completely reversal ok. The one meaning of the sentence is that, there are certain designated areas called smoking areas, none of them allow Hookas and there are also some areas called no smoking areas they are however, allows Hookas so, this the meaning. Now, these two examples will be sufficient to tell us that, adjectives and quantifier unless there scope is completely precise the determine, they can lip the ambiguity confusion of weakling. Next kind of synthetic ambiguity which we move on two now, is called the preposition phrase ambiguity and this comes from the multiple possibilities of attachment of the preposition phrase in the sentence.

We have in front of us a very classical sentence I saw the boy with the telescope I saw the boy with the telescope, this sentence is ambiguous because, with the telescope is attach to what why or saw. One meaning of the sentence is I saw a boy and the boy had a telescope that means I saw the boy with the telescope. The other meaning is I saw the boy and I saw the boy with the telescope using a teleshop. So, you can see that, if we was substituted by using, then there is no ambiguity apparently I saw the boy using a telescope now, even then there is an ambiguity because, again the word using does not clarify who is that in the telescope I saw the boy using the telescope, the boy might be using the telescope or I might be using the telescope.

So, you can see the difficulty of the sentence whether with remains or does not and if it is substituted by a financial verb using, even then the ambiguity does not go so, the question is who has the telescope a boy or I? And this is arising because, with the telescope is a qualified for boy or not. Next sentence I saw the mountain with a telescope in this case there is no ambiguity apparently ok, I saw the mountain with the telescope why should they have an ambiguity in this because, with the telescope is definitely the instrument of seeing I am performing the same action with the telescope and therefore,

the meaning, that the mountain has the telescope does not arise here that possibility does not arise so, it is an ambiguity in the sense.

But, it is not a such a simple case it is country specific, domine specific, there is a state in united states called Arizona. The state of Arizona is famous for its space research program and the program is an extremely thrilling program in the state so, much so that, most of the mountains in Arizona are fitted with a telescope, which are used for the absorbing the planet and the star. So, if these sentence are attired in Arizona it continuous to be on ambiguity sentence because, in Arizona you have mountains with telescope, you have mountains which have telescope in there.

So, again the question that will arise, where is the telescope is the telescope with me or is it with a mountain? So, we are invoking the word knowledge here something called the word noise, the mountain connect their instrument of telescope instrument of seeing which is fine the mountain is not instrument of seeing and therefore, the mountain cannot has the telescope but, we are did not take in to account the possibility, that a mountain will be fitted with the telescope for making observation of the celestial figures, in which case this whole sentence is ambiguous fine.
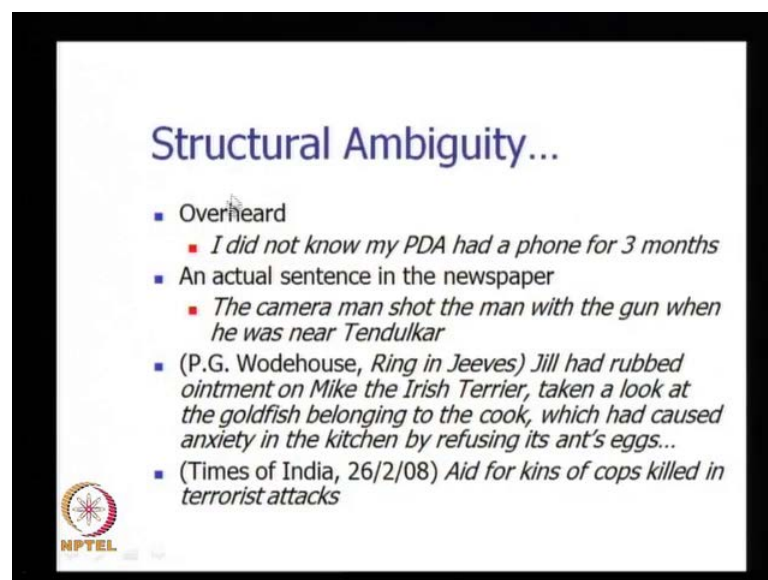
So, I think this point is well understood, that ambiguity is a settled and certain feature it is situation dependent time dependent, country dependent, region dependent, Next sentence I saw the boy with the pony tail here at last we can heap a sigh of relief, this sentence is definitely not ambiguous the pony tail is with the boy, I cannot see anybody with the pony tail, pony tail is not an instrument of seeing, this is the crucial piece of world knowledge which is being used and that ambiguity is reserved now. However, the word knowledge is a situation dependent, region dependent, the in the previous case the world knowledge did not come handy when the sentenced was been uttered in Arizona.

Now, this kind of sentence is once sees in text book and one wonders whether a structural ambiguity is indeed a real life problem, does it indeed arise in day to day communication. Here I say that structural ambiguity like word sense ambiguity is a very ubiquitous problem, it is all for wearing I saw a news paper headline in times of India, 20 years later B M C pays further 2000000 for causing sons death. 20 years later Bombay municipality cooperation pays further 2000000 rupees for causing sons death. Now, in this case who is a causing the son's death? Who is responsible for sons death?

It is something to do with the Bombay municipality corporation, may be some vehicle which the municipality cooperation was using was responsible for sons death but, if the phrase for causing sons death is not correctly attached, it can lead to a completely different meaning and completely unacceptable meaning may be comical meaning. So, read it this way 20 years later B M C pays father 2000000 for causing sons death, these might be to the B M C is paying father 2000000 for causing sons death. It is might be contrive to read B M C is paying further 2000000 rupees as a reward because, the father has caused the son's death.

So, by causing the son's death the father is able to get rupees 2000000 rupees so, these are completely unacceptable meaning we know it from our real day to day experience and it is very carpenter that, unless the attachment problem is properly solved, the there is meaning discussion complete discussion meaning in the sentence. So, let me just summarize what we say in this slide? We discussed, the scope ambiguity which is the region of influence of quantifiers an adjectives how much of text the qualify? And we discuss the very classical problem natural language processing, preposition phrase ambiguity were we are concerned with how the preposition is attaching to the particular word in the sentence.

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Let us specify other, there are other structural ambiguity examples here all of them are actual examples, which occurred, when I was in a confidence or I was in the discussion

with somebody for example, this I heard this particular sentence I heard in a particular conference. I did not know my P D A, P D A is a hand held device, had a phone for 3 months, I did not know my P D A had phone for 3 months. The question is this for 3 months which is the duration; it is a diuretic phase for 3 months it refers to which event. So, one of the possibilities that, here is it reference to this knowing event, I did not know for 3 months that my P D A had phone.

So, this is one reading I did not know my P D A had phone for 3 months and other reading is for 3 months is attached to the noun phone so it is the qualified for phone so, the since of the sentence will be I did not know my P D A had a phone and this phone was therefore, 3 months this is one meaning. There is another attachment point for 3 months, may be you can guess which is the certain point, for 3 months can also be attach to P D A a very interesting rule of thumb is to see that, preposition phrases in a sentence can be attached potentially to any noun that comes before it ok.

So, it can be attached to I it can be attached to P D A it can be attached to phone and it can also attached to the main part of the sentence. So, all this attachments all the 3 different, 4 different attachment, they will give you rights to 4 meaning. So, one meaning was I did not know for 3 months that my instrument had a phone, another meaning is I did not know that my P D A for 3 months that means this P D A was which me for 3 month, maybe it was loaned for 3 month had a phone and finally, I did not my P D A had a phone for 3 months, that means the phone itself was called 3 months.

Now, depending on the naturalness of the situation depending on our life experience we can exclude some meanings for example, phone for 3 months is a strain construction in this particular sentence so, most likely the actual reading of this sentence is I did not know from 3 months in my, this was over heart by me in a conference, there is an actual sentences in the newspaper which do my attention, these are also very famous sentence in the sense that, similar kind of construction abounds in news paper, story newspaper writing, the camera man short the man with the gun, when he was near Tendulkar. I will read this sentence once again the camera man short the man with the gun when he was near Tendulkar.

The different meanings of the sentence arise from a complex interaction or many different factors ok, one of the factor is in fact that, the camera man short the man with

the gun when he was Tendulkar the 1st fact is that short has 2 meanings ok. This is the act of shooting the shooting can be by a camera which camera man does, or a shooting can be done by the gun which can be by a terrorist for example, or by a murderer so, the camera man short the man with the gun when he was near Tendulkar.

If somebody comes back and says that, no the word camera man makes the meaning very clear for the works out, makes it very clear the camera man short the man because, of this phrases the phrases of the word camera the meaning of shoots becomes very clear, this is not the case. There is nothing which prevents the camera man from carrying an actual gun I will doing the shooting activity. Therefore, it is possible that the camera man is shooting with the gun. Now, the camera man shot the man with the gun, when he was near Tendulkar again there is this complex interaction of the preposition phrase with an house the camera man shot the man with the gun that means, he shot he took a picture of the man who had a man with the gun is a complete noun phrase, in this case with the gun is attached to man ok, or the camera man actually fired a shot with the man with his own gun.

In this case the gun is with camera man. So, this is the 1st develop ambiguity for actual 2nd level of ambiguity, 1st level of ambiguity was two meanings of shots, the 2nd level of ambiguity is with the gun being attach to the man, or being attach to shoot ok. So, this gun was used as an instrument for suiting or it is qualified for men. The next level of ambiguity comes from close attachment here, when he was near Tendulkar the ambiguity here is who is who was near Tendulkar, The camera man or the man ok. So, there are these 2 possibility camera man or the man and depending on that ok depending on that, there are more meanings of the sentences ok. So, this sentence really can have really can have a very large number of meanings depending on combinations of multiple possibilities of attachment, multiple meanings of the words sort and multiple attachments coming from the clause ok.
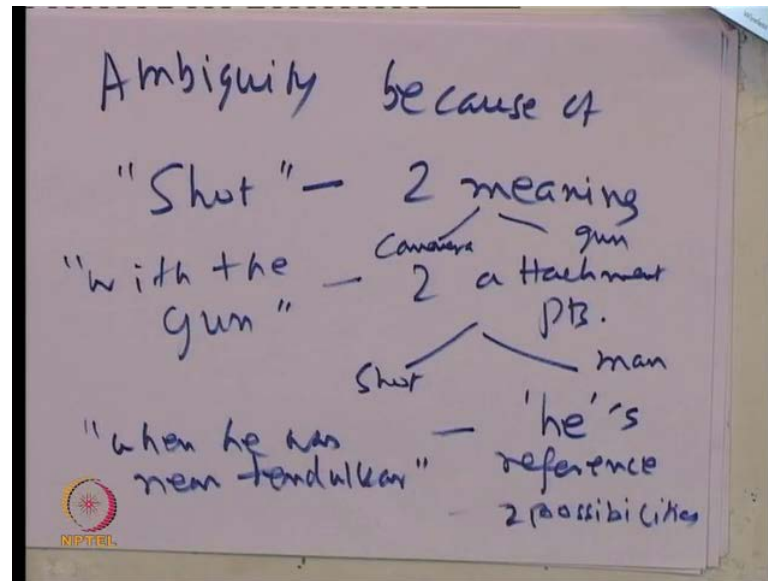
So, let me just write down where this ambiguity comes from this is an interesting point and it clarifies our notion of how ambiguity arises. So, the sentence is the camera man sort the man with the gun when he was Tendulkar so, ambiguity because, of shot 2 meanings ok, with the gun this is the preposition phase, 2 attachment points, means shot or man 2 meanings of shot camera or gun. So, 2 meanings here 2 attachment points, another possibility is the clause, when he was near Tendulkar ok. So, this is the clause when you was near Tendulkar is a clause. The question is he is reference, what is he refer to? This he refers to the man or the cameraman so, again 2 possibilities ok.

So, 2 meanings of sort 2 attachment points for with the gun and 2 references point for he, camera man or man ok. So, when we multiply all this possibilities 2 into 2 into 2 we find that it there are 8 different meanings of this sentence ok. So, this particular sentence the cameraman shot the man with the gun when he was Tendulkar has 8 meanings on the 1st level of analysis. Where it is differently to that this particular sentence, which is very complex sentence and it has many more meanings apparently there are 14 meanings of this, many of quite of them are actually nonsense ok. But, this 8 meanings that, we discussed about they are extremely real, they are very much real and this meanings are all possible and they are competing meanings.

Now, this meanings becomes apparent I definitely heartily to do this exercise, this meanings become apparent, when you translate the sentence, according to this meanings

in to your own mother tongue. Translate this for example, into Tamil or Hindi or Marathi so, this will show you that there are different meanings of the sentence ok. Now, we have understood that, ambiguity can come from the reference of a pronoun to a particular noun that there are different possibility, 2 different meaning of the word lexical ambiguity and 2 different attachment points of preposition phase. I have given more examples; one example is from P G woodhouse ring in Jeeves a very famous novel.

Here this sentence is very instructive in terms of the ambiguity produces, when we analyze its phrases and clauses, Jill had rubbed ointment on mike. The Irish Terrier taken a look at gold fish belonging to the cook, which had caused anxiety in the kitchen while refusing its ants eggs.

Your exercise would be to find out what this which refers to and depending on that how the meaning changes. And the final sentence here is the a times of India click 26-th February 2008 aid for kins of cops, killed in terrorist attacks. So, here killed in terrorist attacks is clause the question is it modifies, what the cops or kins ok, from that ambiguity arises. So, let me summaries the structural ambiguity point, let us first go back to the previous slide, where we have seen the scope ambiguity namely the region of influence of adjectives and quantifier, preposition phrase attachment ambiguity, where does the preposition phase attach.

And then we proceeded at to show that, the combination of this ambiguities, words senses different senses of the word, the preposition phase attachment points and the clause attachments. The interaction of all this different point kinds of ambiguity can give rise to a very large number of meanings of a sentence. So, with this we finish lecture number 2. We will proceed to other kinds of other stages of natural language processing, in a next lecture.