

Language and Mind
Prof. Rajesh Kumar
Department of Humanities and Social Sciences
Indian Institute of Technology, Madras

Module - 08
Lecture - 39
Language and Computers
Resolving Ambiguity: A Challenge

Having looked at the relationship between language and mind, and the relationship between language and cognition, we have started looking at language and computers. We are looking at language and computers as one of the applications of the understanding about underlying patterns of language has implications for studies in the domains of computer science. We looked at the relationship between language and cognition in the sense that cognition in simplest term means understanding, and one of the significant things for us to understand is the relationship between language and cognition. And while looking at that, we moved towards looking at connections between language and computers.

Artificial intelligence was argued to have... in the domains of cognitive science, one of the approaches was to come up with computational algorithm - mathematical algorithms for understanding cognition, and the approach that was taken for this was artificial intelligence. The goal of artificial intelligence was to give models which will unify all kinds of learnings. With the emergence of mentalism in the theory of language learning, the difficulties surfaced, and then it came up with a sufficient acknowledgement that learning of language has to be a special kind of learning for human mind, because it was becoming increasingly difficult to unify the models for natural language processing with other kinds of learning.

(Refer Slide Time: 02:23)

ARTIFICIAL INTELLIGENCE

- Artificial Intelligence (AI) programs and computer algorithms can combine general problem solving and aspects of language acquisition and processing.

This was difficult for artificial intelligence. And it was difficult to come up with computer algorithms that could combine general problem solving and the aspects of language acquisition and processing.

(Refer Slide Time: 02:40)

Computational Linguistics

- Computational linguistics studies natural language. It studies languages such as English and Hindi, rather than computer languages, such as Fortran, C+, C++, or Java.

Then we started looking at computational linguistics, because when artificial intelligence did not work or the concepts of artificial intelligence were not really significantly used to combine language learning with other kinds of learning, a whole new domain of

discussions started. And then, we looked at some of the developments in the field of computational linguistics where the study of natural language got several different edges.

(Refer Slide Time: 03:32)

Goals of Computational Linguistics

- Makes computers usable as tools in analyzing and processing natural language.
- Helps us understand, by analogy with computers, more about how people process natural language.

It became lot easier to study natural languages where computers can be used as tools; it became much easier to analyze processing of natural language definitely, even though unification in the domain of cognitive science was difficult; that is, unification of different kinds of learning with learning of language.

(Refer Slide Time: 03:52)

Some Breakthroughs

- Natural language interfaces to software
- Information Extraction and Data Mining
- Machine Translations

We have seen some of the breakthroughs in the field of computer science and computational linguistics, where natural language interfaces with software was very significant. Information extraction and data mining were other domains where we have achieved huge success; and machine translation has brought revolutions to human life. These things are the success stories of computational linguistics and computer science, which came up with the... the success story of computational linguistics is together with the story from computer science and understanding of patterns underlying language. (Refer Slide Time: 04:49)

Some Challenges

- Developing a set of rules and procedures, e.g. to recognize the syntactic structure of sentences or to resolve the references of pronouns.
- Resolving ambiguity.
- Most ambiguities escape our notice because we are very good at resolving them using our knowledge of the world and of the context. But computer systems do not have much knowledge of the world and do not do a good job of making use of the context.

This is why it is significant for us to understand the combination of the two in order to understand patterns in human mind, and in particular some of the difficulties that might be difficult and at least we wanted to understand those difficulties in terms of the nature of difficulties for finding models for computer science, for computational linguists.

We have looked at one of the... we have identified one of the difficulty zones as resolving ambiguity. In human cognition, when we are looking at human mind, human mind uses so many types of information to process natural language that the knowledge of the context, that is also knowledge of the world, becomes... makes things very easy for human mind to figure out. Human mind in short has got no difficulty in resolving ambiguities intended in sentences; however, these things become a big time challenge for machines.

We will look at some of these examples why... We will also look at some of the examples and we will look at why some of these difficulties in resolving ambiguities is not such a big problem for human mind, but they become problematic for machines. And this is where we find one of the challenges in the fields of computational linguistics, where probably understanding more from language learning patterns and patterns underlying languages will probably help model resolving ambiguities through machines as well.

(Refer Slide Time: 06:56)

Imperatives

- Imperatives are sentences used to ask someone to do or not to do something and that do not denote truth value. [Miguel Perez-Ramirez and Chirs Fox 2004]
- Imperatives are prescriptions without truth value.

We want to give you one example where you can see how human mind resolves ambiguities in a simple way, and it becomes difficult for machines to resolve such ambiguities as precisely as human mind does.

We want to come up with sentences from a particular type of sentences; they are called imperative sentences. Imperatives are sentences that are used to ask someone to do or not to do something and that do not denote truth value in it. Imperatives are prescriptions without truth value, in other words.

(Refer Slide Time: 07:41)

Ambiguities

Imperatives

- (1) ghar aa-o
home come-imp
'Come home.' [informal]
- (2) ghar aa-iye
home come-imp
'Please come home.' [formal]

Let us look at an example of an imperative sentence. It will make us... make lives easier to see what we mean by ambiguities, and why we are taking examples from imperatives. Simpler sentences - these are also called non-finite sentences. Again non-finite sentences mean tense-less sentences; these sentences do not have tense in-built in them. These sentences are full sentences; they fulfill all the requirements of sentences that you have seen before and we will look at the ambiguity part of this in a moment.

So the two examples that you see on your screen - ghar aao and ghar aaiye; both of them in English means - come home. The difference is these are the sentences from Hindi, and the difference between these two Hindi sentences is, one is informal, where the other is formal. For our understanding, we can translate it in English with 'Come home' or 'Please come home'; however, we will look at that translation part in a moment.

The precise way to make distinction between these two sentences will be to translate both of them as 'come home' where as... where one is informal and the other is formal. How does human mind figure out the context in which we need to use informal sentences, and where we need to use formal sentences? We can look at more sentences and look at some generalizations as well.

(Refer Slide Time: 09:35)

- (3) mujhse kal milo
I-Dat tomorrow meet-imp
'See me tomorrow.' (Lit: Informal)
- (4) mujhse kal miliye
I-Dat tomorrow meet-imp
'Please see me tomorrow.' (formal)

Let us look at one more set of sentences to understand imperatives in a better way – mujhse kal milo - this is another imperative sentence – 'see me tomorrow'. A similar type of sentence, that is similar to number two in the previous screen of this type like ghar aaiye, we can have a sentence like - mujhse kal miliye - which also means 'see me tomorrow' with... which is more formal; such sentences are used in more formal contexts.

So, we can look at the verbs and predict subjects of these sentences, where we see.. Let us see the example from the previous slide. When we have the ending like 'o' like on the verb 'aa', which makes the verb complete as 'aa-o', where 'o' is an imperative marker, we can say this is informal imperative marker. And here, the subject of the sentence is probably going to be second person pronoun 'Thum' and it is not difficult to disambiguate, because we use these types of sentences in informal contexts.

Whereas the marker on the verb 'iye' or 'ye' in the verb 'aa-iye' is the marker of formality and the subject of the sentence will be 'Aap'. Now the... it is not difficult for human mind to figure it out at all. Probably with this much of information, even machines could figure out the distinction between these two sentences; that is, if we look at the verb morphology and probably train machines with these types of information, probably machines will figure out these two sentences and will give adequate interpretations to them.

However if we look at, like I mentioned before about translations, look at the contexts; 'Please come home' in English is considered to be a very formal kind of request or a very very good kind of request. Now, look at the next set of sentences where in an informal sentence, if you use this sentence in the real world talking to your friends saying 'Mujhse kal milo' – is this not a request to a friend or do I need to use the sentence 'Mujhse kal miliye' to mean request with a friend. I want your attention here carefully. What we have looked at as the distinction between these two sentences can easily be taught to machines and then probably machines will give intended interpretations of these two sentences.

However the question comes up as: human mind does not see the distinction between these two sentences and figures it out as a proper normal kind of request even when we use number three; this is interpreted as request in informal situations like friends. So, now we see an overlap; the overlap is - what is considered literally informal, looking at the form of the sentence, can also be formal request given a proper context. However, what is formal can mean much more than that given the context, where what I mean by much more than that is very simple; it is not just number four which is a formal sentence means a request does not necessarily mean request alone; it could mean an order, given the context.

Now we only need to put these things in a proper context to understand that. Like I said, the context of a friend; in such a context, sentence number three 'Mujhse kal milo' in Hindi is a perfectly normal request as well; this does not intend anything more. In short 'Mujhse kal milo' - if I tell a friend, I do not mean to command the friend. At the same time if we construct a context with a sentence 'Mujhse kal miliye' - 'Please see me tomorrow', does not necessarily have to mean a request alone.

Imagine a situation where we have the Commander-in-chief of Army talking to an Army General and saying this sentence: 'Please see me tomorrow'. As we know the context of armed forces, anything that comes from a senior person becomes an order. So, even though the sentence intends request, it can be interpreted as an order and human mind makes no mistake with this. Therefore, it becomes difficult for a machine to give exact interpretation of these two sentences. In other words, looking at the verbal morphology and the form of the sentence is not enough for a machine to give an interpretation, given adequate interpretation for understanding these two sentences.

(Refer Slide Time: 16:43)

Negation

(5) lanc ke liye caleN
lunch for come-subj
'Let's us go for lunch.'

(6) abhii to mujhe bahut kaam hai
at this time emph I-dat a lot of work is
'I have a lot of work.'

Imp: No. I cannot go.

Before I summarize I want to give you examples from one more domain, which is the use of negation in again a language like Hindi. We can say... please look at these sentences carefully. If you are not a Hindi speaker, look at the gloss; that is, word by word meaning of every segment of a sentence in the second line, and at the end of this and in the third line we have English translation given in quotes. So, Hindi sentence is 'lunch keliye caleN' - it could be a question as a request 'Let us go for lunch'. If the answer to this question is 'abhii to mujhe bahut kaam hai' - like 'I have a lot of work'.

Now look at the request or the question and the response, together; in number 5 - request, number 6 - response. When you put the two things together, it is not very difficult for human mind to figure out that the answer is actually 'No, I cannot go'. So, the total meaning for human mind that comes out of the sentence 'abhii to mujhe bahut kaam hai' has almost nothing to do with the literal meaning of the sentence. In such a context 'lunch keliye caleN', that is in the context of the question 'lunch keliye caleN', in the context of this request, this answer means 'No, I cannot go'. This is pretty simple for human mind to figure out, but pretty difficult for machines to be trained with. This is the question of ambiguity resolution which is hard for machines.

We can look at more and more examples to come up with these things to see that such things do exist in languages.

(Refer Slide Time: 19:01)

- (7) aap-ne kahaa aap aais-kriim khariidenge
you-erg said you ice-cream buy-fut
'You said you will buy ice-cream.'
- (8) maiN-ne kab kahaa
I-erg when said
'When did I say?'
Imp: I did not say so.
- (9) maiN-ne kahaaN kahaa
I-erg where said
'Where did I say?'
Imp: I did not say so.

Let us look at one more set of sentences for us to look at this context in a more precise way. Another Hindi sentence 'aap-ne kahaa aap aais-kriim khariidenge' - 'You said you will buy ice cream'; the answer is 'maiN-ne kab kahaa?'; this is a sentence which means - 'When did I say?' Now in the context of the previous sentence 'aap-ne kahaa aap aais-kriim khariidenge', this sentence has a meaning which is 'I did not say so'; the sentence 'maiN-ne kab kahaa?' gives the meaning 'I did not say so' to human mind, and it is not at all difficult for human mind to get this meaning.

One can also say 'maiN-ne kahaaN kahaa?' which literally means, 'Where did I say'; but the implied meaning is 'I did not say so'. Such contexts are not difficult for human mind to figure out; human mind which you heard yesterday is like a biological computer; has got no difficulty interpreting these things; whereas machines have got difficulty with these situations. Now, what is the problem, what is the precise problem, and what do we need to do to train machines to get these interpretations?

(Refer Slide Time: 20:50)

Resolving Ambiguity

- Human cognition uses inbuilt socio cultural context.
- Missing link is culturally grounded social context.
- A context is a consistent collection of propositions that reflects a relevant subset of agents' beliefs. [Miguel Perez-Ramirez and Chirs Fox 2004]

See, there is one thing which is loaded and human mind is loaded with this that human cognition uses inbuilt socio-cultural context; that is, these sentences have got context with them and these interpretations human mind arrives at in these contexts; whereas the missing link for machines is these culturally grounded social contexts. Sometimes these contexts are probably culturally grounded; sometimes they are plain social context.

Now first we need to model social context and train machines with them; that will give us a breakthrough for modeling culturally grounded social context as well. That will establish the link between structure of sentence and the context, and then probably machines will be able to figure out these ambiguities.

You can see, a context is a consistent collection of possibilities that reflects relevant subset of agents' belief. Now this is just a definition. I have given you sufficient examples to see what we mean by contexts. And we want you to understand that the context is the keyword that is the missing link between machines and sentences that is, the structure of the sentence, for which machines do not get in correct interpretations, and therefore does not give, does not resolve ambiguities in the intended way.

Thank you.