LECTURE 9 – COMMON SENSE

What is Common Sense ?

• Common sense is the mental skills that most people share.

• Common Sense is ability to analyze a situation based on its context, using millions of integrated pieces of common knowledge.

• John McCarthy was the first to talk about commonsense reasoning in his paper in 1959, explains that a program has commonsense if it automatically deduces for itself sufficiently wide class of immediate consequences of any thing it is told and what it already knows.

• Common sense is what people come to know in the process of growing and living in the world (R.Elio, 2002).

• Common sense knowledge includes the basic facts about events and their effects, facts about knowledge and how it is obtained, facts about beliefs and desires. It includes the basic facts about material objects and their properties (John McCarthy, 1990).

• Currently, computers lack common sense.

Commonsense is ability to analyze a situation based on its context using millions of integrated pieces of common knowledge. Ability to use common sense knowledge depends on being able to do *commonsense reasoning.*

Commonsense Reasoning is a central part of intelligent behavior.

Example :

Everyone knows that dropping a glass of water, the glass will break and water will spill on podium. However, this information is not obtained by formula or equation for a falling body or equations governing fluid flow.

The goal of the formal commonsense reasoning community is to encode this implicit knowledge using formal logic.

Why computers can not think about the world as any person can ?

Where the problem lies ?

There are two basic types of knowledge. One is the **specialist's** which mathematicians, scientists knowledge and engineers possess. The other type is the **commonsense knowledge** which every one has. The need is to teach the computer to reason about the world (commonsense knowledge).

Common sense knowledge - what every one knows.

Common sense reasoning - ability to use common sense knowledge.

Common Sense Knowledge

What one can express as a fact using a richer ontology.

Examples

‡ Every person is younger than the person's mother

‡ People do not like being repeatedly interrupted

‡ If you hold a knife by its blade then the blade may cut you

‡ If you drop paper into a flame then the paper will burn

Here the problem is , how to give computers these millions of ordinary pieces of knowledge that every person learns by adulthood.

What one builds as a reasoning method into his program.

Examples

‡ If you have a problem, think of a past situation where you solved a similar problem.

‡ If you take an action, anticipate what might happen next

‡ If you fail at something, imagine how you might have done things differently .

Here the problem is, how to give computers the capacity for commonsense reasoning, the ways to use

the commonsense knowledge to solve the various problems we encounter every day.
Presently, there is no program that can match the common sense reasoning powers of a 5 year old child. We do not yet have enough ideas about how to represent, organize, and use much of commonsense knowledge, let alone build a machine that could learn automatically on its own

Building Human Commonsense Knowledge Base
The two ongoing projects for AI assembling comprehensive ontology and knowledge base of everyday common sense knowledge with the goal of enabling AI applications to perform human-like reasoning.

- The commonsense knowledge problem is a current project in the sphere of artificial intelligence to create a database that contains the general knowledge most individuals are expected to have, represented in an accessible way to artificial intelligence programs that use natural language.
- Due to the broad scope of the commonsense knowledge this issue is considered to be among the most difficult ones in the AI research sphere.
- In order for any task to be done as a human mind would manage it, the machine is required to appear as intelligent as a human being.
  Such tasks include :
    - object recognition,
    - machine translation and
    - text mining.

To perform them, the machine has to be aware of the same concepts that an individual, who possess commonsense knowledge, recognizes.

Next comes the Common Sense Reasoning :
It is what one builds as a reasoning method into his program, which is a very complex task. We want computer to do reasoning as human does.

Logic Reasoning (deductive, inductive, abductive), is of main concern in AI reasoning system.
The logic reasoning can accomplish the of common sense reasoning. For instance :
‡ Predicate logic can represent knowledge about objects, facts, rules,
‡ Frames can describe everyday objects
‡ Scripts can describe typical sequences of events
‡ Non-monotonic logics can support default reasoning,

Logic Programming
Most People, have no notion of the "laws of physics" that govern this world, yet they
- can predict that a falling ball will bounce many times before come to halt.
- can predict the projection of cricket ball and even catch it.
• know a pendulum swings back and fore finally coming to rest in the middle.

How can we build a computer program to do such reasoning ?
One answer is to program the equations governing the physical motion of the objects. But most people do not know these equations and also do not have exact numerical measures, yet they can predict what will happen in physical situations.

Researchers are therefore motivated towards :
- Modeling the qualitative World and
- Reasoning with qualitative information

Reasoning with Qualitative Information

Reasoning with qualitative information is often called qualitative simulation. The basic idea is:

‡ Construct a sequence of discrete episodes that occur as qualitative variable.

‡ States are linked by qualitative rules that may be general.

‡ Rules may be applied to many objects simultaneously as they may all influence each other.

‡ Ambiguity may arise so split outcomes into different paths.

A network of all possible states and transitions for a qualitative system is called an envisionment (mental images).

There are often many paths through an envisionment. Each path is called history. Programs must know how to represent the behavior of many kinds of processes, materials and the world in which they act.

Common Sense Ontologies

Some concepts are fundamental to common sense reasoning. A computer program that interacts with the real world must be able to reason about things like time, space and materials. On each of these, here some thought is presented.

Time The most basic notion of time is events. Events occur during intervals over continuous spaces of time. An interval has a start and end point and a duration between them.

Intervals can be related to one another as : is-before, during, is-after, contains, meets, is-met-by, starts, is-started-by, ends, is-ended-by and equals.

We can build a axioms with intervals to describe events in time.

Space

The Blocks World is a simple example of what we can model and describe space. However common sense notions such as: place object X near object Y are not accommodated.

Material

Describe the properties of materials as :

‡ You cannot walk on water.

‡ If you knock a cup of coffee over what happens?

‡ If you pour a full kettle into a cup what happens?

‡ You can squeeze a sponge but not a brick.

The Liquids provide many interesting points, such as, the space occupied by them. Thus we can define their properties such as:

‡ Capacity - a bound to an amount of liquid.

‡ Amount - volume occupied by a liquid.

‡ Full - if amount equals capacity.

Other properties that materials can posses include:

‡ Free - if a space is not wholly contained inside another object.

Memory Organization

Memory is central to common sense behavior and also the basis for learning.

Human memory is still not fully understood psychologists have proposed several ideas.

■ Short term memory (STM) : Only a few items at a time can be held here; perceptual information are stored directly here.

■ Long term memory (LTM) : Capacity for storage is very large and fairly permanent;

LTM is often divided further as : **Episodic memory** : Contains information about personal experiences.

‡ Semantic memory : General facts with no personal meaning, e.g. Birds fly; useful in natural language

understanding.

Lecture 10 - Natural Language Processing

NLP is Natural Language Processing.
Natural languages are those spoken by people.
NLP encompasses anything a computer needs to understand natural language (typed or spoken) and also generate the natural language.
Natural Language Processing (NLP) is a subfield of Artificial intelligence and linguistic, devoted to make computers "understand" statements written in human languages.

A **language** is a system, a set of symbols and a set of rules (or grammar).

- The Symbols are combined to convey new information.
- The Rules govern the manipulation of symbols.

NLP encompasses anything a computer needs to understand natural language (typed or spoken) and also generate the natural language.
‡ **Natural Language Understanding (NLU) :** The NLU task is understanding and reasoning while the input is a natural language. Here we ignore the issues of natural language generation.
‡ **Natural Language Generation (NLG) :** NLG is a subfield of natural language processing NLP. NLG is also referred to text generation.

NL INPUT ------COMPUTER ------ NL OUTPUT
----understanding-------------generation-------------

Formal Language
Before defining formal language Language, we need to define symbols, alphabets, strings and words.
Symbol is a character, an abstract entity that has no meaning by itself. e.g., Letters, digits and special characters
Alphabet is finite set of symbols; an alphabet is often denoted by Σ (sigma)
e.g., B = {0, 1} says B is an alphabet of two symbols, 0 and 1.
C = {a, b, c} says C is an alphabet of three symbols, a, b and c.
String or a word is a finite sequence of symbols from an alphabet.
e.g., 01110 and 111 are strings from the alphabet B above.
b and aaabccc are strings from the alphabet C above.
Language is a set of strings from an alphabet . **Formal language** (or simply language) is a set L of strings finite alphabet ∑ .
Formal language is described using *formal grammars.*

Linguistic and Language Processing
Linguistics is the science of language. Its study includes : sounds (phonology), word formation (morphology), sentence structure (syntax), meaning (semantics), and understanding (pragmatics) etc.

Steps of Natural Language Processing (NLP)
Natural Language Processing is done at 5 levels. These levels are briefly stated below.
■ **Morphological and Lexical Analysis** : The lexicon of a language is its vocabulary, that include its words and expressions.
Morphology is the identification, analysis and description of structure of words. The words are generally accepted as being the smallest units of syntax. The syntax refers to the rules and principles

that govern the sentence structure of any individual language.
Lexical analysis: The aim is to divide the text into paragraphs, sentences and words. the lexical analysis can not be performed in isolation from morphological and syntactic analysis
Syntactic Analysis : Here the analysis is of words in a sentence to know the grammatical structure of the sentence. The words are transformed into structures that show how the words relate to each others. Some word sequences may be rejected if they violate the rules of the language for how words may be combined.
Example : An English syntactic analyzer would reject the sentence say : " Boy the go the to store ".
Semantic Analysis : It derives an absolute (dictionary definition) meaning from context; it determines the possible meanings of a sentence in a context.
The structures created by the syntactic analyzer are assigned meaning. Thus, a mapping is made between the syntactic structures and objects in the task domain. The structures for which no such mapping is possible are rejected.
Example : the sentence "Colorless green ideas . . . " would be rejected as semantically anomalous because colorless and green make no sense.
■ **Discourse Integration :** The meaning of an individual sentence may depend on the sentences that precede it and may influence the meaning of the sentences that follow it.
Example : the word " it " in the sentence, "you wanted it" depends on the prior discourse context.
■ **Pragmatic analysis** : It derives knowledge from external commonsense information; it means understanding the purposeful use of language in situations, particularly those aspects of language which require world knowledge;
The idea is, what was said is reinterpreted to determine what was actually meant. Example : the sentence "Do you know what time it is ?" should be interpreted as a request.

Defining Terms related to Linguistic Analysis

Phones The Phones are acoustic patterns that are significant and distinguishable in some human language.
Example : In English, the L - sounds at the beginning and end of the word "loyal", are termed "light L" and "dark L" by linguists.
■ **Phonetics**:Tells how acoustic signals are classified into phones.
■ **Phonology**: Tells how phones are grouped together to form phonemes in particular human languages.
An **alphabet** is a finite set of symbols.
Example : English alphabets { a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z }
A **String** is a sequence of symbols taken from an alphabet.
■ **Lexicon** Lexicon is collection of information about words of a language.
The information is about the lexical categories to which words belong.
Example : "pig" is usually a noun (N), but also occurs as a verb(V) and an adjective(ADJ).
Lexicon structure : as collection of lexical entries.
Example : ("pig" N, V, ADJ)

Words : Word is a unit of language that carries meaning.
Determiner: Determiners occur before nouns and indicate the kind of reference which the noun has.
Morphology Morphology is the analysis of words into morphemes, and conversely the synthesis of words from morphemes.
■ **Morphemes**
A smallest meaningful unit in the grammar of a language.
A smallest linguistic unit that has semantic meaning.
A unit of language immediately below the ‘word level’.

A smallest part of a word that can carry a discrete meaning.
Example : the word "unbreakable" has morphemes:
1 "un-" a bound morpheme;
2 "-break-" a free morpheme; and "-able" a bound morpheme;
Also "un-" is also a prefix; "-able" is a suffix; Both are affixes.

Pragmatics

Pragmatics tell how language is used; that is ‘meaning in context’. Example: if someone says "the door is open" then it is necessary to know which door "the door" refers to; Need to know what the intention of the speaker : could be a pure statement of fact, could be an explanation of how the cat got in, or could be a request to the person addressed to close the door.

Syntactic Processing converts a flat input sentence into a hierarchical structure that corresponds to the units of meaning in the sentence.
The Syntactic processing has two main components : one is called grammar, and other is called parser.
Grammar : It is a declarative representation of syntactic facts about the language. It is the specification of the legal structures of a language. It has three basic components : terminal symbols, non-terminal symbols, and rules (productions) .

Parser : It is a procedure that compares the grammar against input sentences to produce a parsed structures called parse tree.
Modeling a Sentence using Phase Structure Every sentence consists of an internal structure which could be modeled with the phrase structure.
Algorithm : **Steps**
‡ Apply rules on an proposition
‡ The base proposition would be : S (the root, ie the sentence).
‡ The first production rule would be : (NP = noun phrase, VP = verb phrase)
S -> (NP, VP)
‡ Apply rules for the 'branches'
NP -> noun
VP -> verb, NP
The verb and noun have terminal nodes which could be any word in the lexicon for the appropriate category.
‡ The end is a tree with the words as terminal nodes, which is referred as the sentence.
Example : Parse tree – sentence "He ate the pizza", - apply the grammar with rules
S -> NP VP, NP -> PRO, NP -> ART N, VP -> V NP, - the lexicon structure is ("ate" V) ("he" PRO) ("pizza" N) ("the" ART)
The parse tree is

```
                    S
                 NP    VP
      PRO              V          NP

                          ART         N

         He          ate   the         pizza
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