



Artificial Intelligence

Jude kuipo Kibinde, MSc

Lecture Plan in this Semester

Lecture-1: Introduction of Artificial Intelligence

Definitions and Goals of AI, AI Approaches and Techniques, Branches of AI, and Applications of AI.

Lecture-2: Problem Solving (Search and Control approaches)

General problem solving, Search and control strategies, Exhaustive searches, Heuristic search techniques, Constraint satisfaction problems (CSPs).

Lecture-3: Knowledge Representation

Knowledge representation, KR using predicate logic, KR using rules.

Lecture-4: Reasoning System

Reasoning, Symbolic reasoning, Statistical reasoning.

Lecture-5: Game Theory

Overview, Mini-Max search procedure, Game playing with Mini-Max, Alpha-Beta pruning.

Lecture-6: Learning

What is learning, Rote learning, Learning from example: Induction, Explanation Based Learning (EBL), Discovery, Clustering, Analogy, Neural net and genetic learning, Reinforcement learning.

Lecture-7: Decision Tree learning

Basic introduction of decision tree, Building of decision tree, Examples of decision tree, and significance of decision tree classifier.

Lecture-8: Neural Network

Introduction of neural network, Model of artificial neuron, Neural network characteristics, Learning methods, Single layer, two layer and multi-layer neural network system, Applications.

Lecture-09: Statistical Learning (Support Vector Machine)

Introduction of support vector machine (SVM), Linear and nonlinear SVMs, Mathematical details of SVM, SVM Characteristics, and Applications of SVM.

Lecture-10: Evolutionary Learning (Genetic Algorithm)

Introduction, Encoding, Operators of genetic algorithm, Basic genetic algorithm.

Lecture-11: Natural Language Processing

Introduction, Syntactic processing, Semantic and pragmatic analysis.

Lecture-12: Common Sense

Introduction, Physical world, Common sense Ontologies, Memory organization



11. Natural Language Processing

Introduction, Syntactic processing, Semantic and pragmatic analysis.

Natural Language

A natural language (or ordinary language) is a language that is spoken, written by humans for general-purpose communication.

Example: Macedonian, Hindi, English, French, and Chinese, etc.

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.

Natural Language Processing

- ▶ Natural Language Processing (NPL)
 - ▶ Process information contained in natural language text.
 - ▶ Also known as Computational Linguistics (CL), Human Language Technology (HLT), Natural Language Engineering (NLE).
 - ▶ Analyze, understand and generate human languages just like humans do.
 - ▶ Borrows from Linguistics, Psycholinguistics, Cognitive Science & Statistics.
 - ▶ Make computers learn our language rather than we learn theirs.

Natural Language Processing

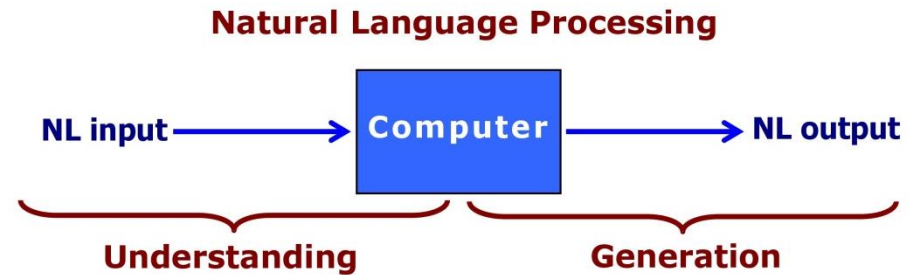
NLP includes anything a computer needs to understand natural language (typed or spoken) and also generate the natural language.

‡ Natural Language

Understanding (NLU) : The NLU task is understanding and reasoning while the input is a natural language.

‡ Natural Language Generation

(NLG) : NLG is a subfield of natural language processing NLP. NLG is also referred to text generation.



NLP Applications

I. Machine Translation

II. Database Access

III. Information Retrieval

- Selecting from a set of documents the ones that are relevant to a query.

IV. Text Categorization

- Sorting text into fixed topic categories, classify documents by topics, language, author, spam filtering.

V. Extracting data from text

- Converting unstructured text into structure data.

VI. Spoken language control systems

VII. Spelling and grammar checkers

VIII. Summarization

IX. Machine Translation

X. Question Answering

XI. Dialog Systems

- Language generation.

Example: Machine Translation

3/17/2015

Google Translate

Translate



A natural language (or ordinary language) is a language that is spoken, written by humans for general-purpose communication.



Природниот јазик (или обичен јазик) е јазик кој се зборува, напишана од страна на луѓето за општа намена комуникација.

Prirodniot Jazik (ili običen Jazik) e Jazik koj se zboruva, napisana od strana na lugeto za opšta namena komunikaciJa.

Dream Applications of NLP

- ❖ Show me Star Trek..?? (Talk to your TV set).
- ❖ Will my computer talk to me like another human ??
- ❖ Will the search engine get me exactly what I am looking for??
- ❖ Can my PC read the whole newspaper and tell me the important news only..??
- ❖ Can my palmtop translate what that Japanese lady is telling me.. ??
- ❖ Can my PC do my English homework ??
- ❖ Do you know how our brain processes language ??

Dream Applications of NLP



Difficulties in NLP

A NLP system needs to answer the question “who did what to whom”

- **Language is ambiguous**

- At all levels: lexical, phrase, semantic
- Iraqi Head Seeks Arms
 - Word sense is ambiguous (head, arms)
- Stolen Painting Found by Tree
 - Thematic role is ambiguous: tree is agent or location?
- Ban on Nude Dancing on Governor’s Desk
 - Syntactic structure (attachment) is ambiguous: is the ban or the dancing on the desk?
- Hospitals Are Sued by 7 Foot Doctors
 - Semantics is ambiguous : what is 7 foot?

Difficulties in NPL

- Language is flexible
 - New words, new meanings
 - Different meanings in different contexts
- Language is complex!
- Many hidden variables
 - Knowledge about the world
 - Knowledge about the context
 - Knowledge about human communication techniques
 - *Can you tell me the time?*
- Problem of scale
 - Many (infinite?) possible words, meanings, context
- Problem of sparsity
 - Very difficult to do statistical analysis, most things (words, concepts) are never seen before

I. Natural Language Understanding (NLU)

Raw speech signal



▶ **Speech recognition**

Sequence of words spoken



▶ **Syntactic analysis** using knowledge of the grammar.

Structure of the sentence



▶ **Semantic analysis** using info. about meaning of words.

Partial representation of meaning of sentence



▶ **Pragmatic analysis** using info. about context.

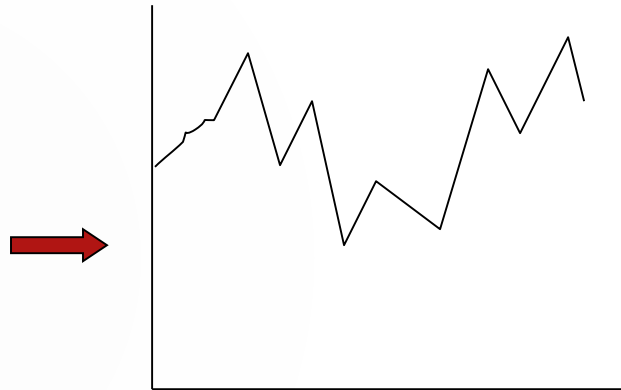
Final representation of meaning of sentence

1. Speech Recognition

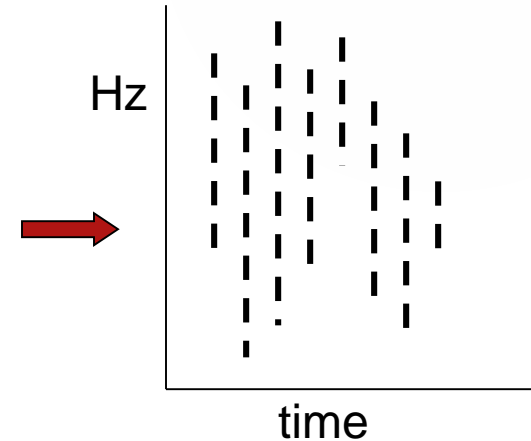
Input
(microphone records voice)



Analog Signal



Freq. spectrogram
(e.g. Fourier transform)



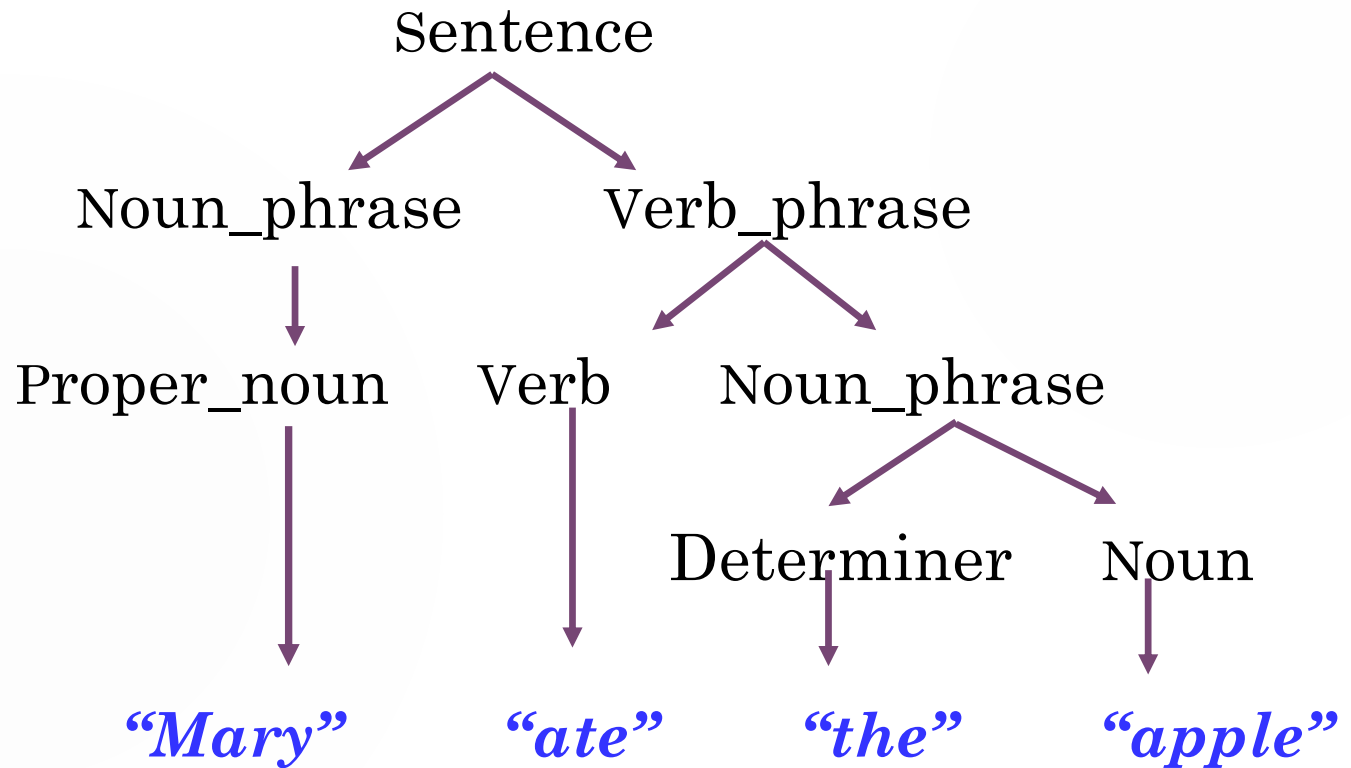
2. Syntactic Analysis

Syntactic analysis involves isolating phrases and sentences into a hierarchical structure, allowing the study of its constituents

- ▶ Rules of syntax (grammar) specify the possible **organization of words in sentences** and determine sentence's structure(s)
 - ▶ “John saw Mary with a telescope”
 - ▶ John saw (Mary with a telescope)
 - ▶ John (saw Mary with a telescope)
- ▶ **Parsing:** given a sentence and a grammar
 - ▶ Checks that the sentence is correct according with the grammar and if so returns a **parse tree** representing the structure of the sentence

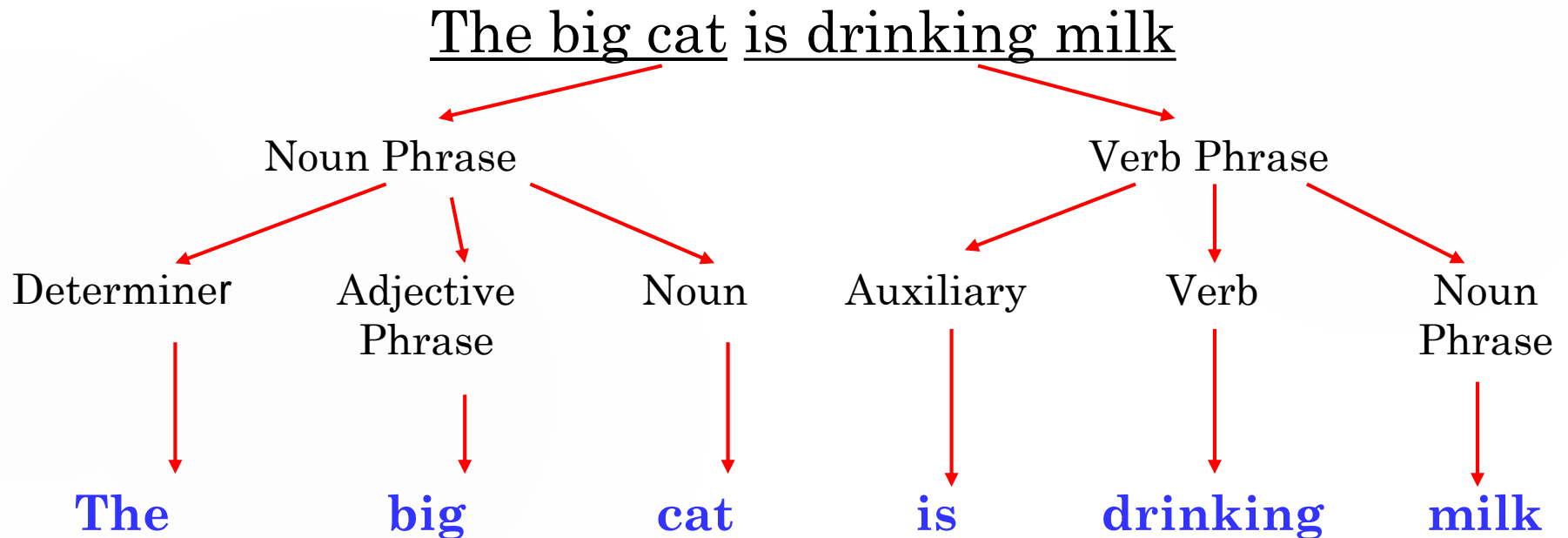
2. Syntactic Analysis

Parse Tree Example-1



2. Syntactic Analysis

Parse Tree Example-2





3. Semantic Analysis

- ❖ Generates (partial) meaning/representation of the sentence from its syntactic structure(s).
- ❖ Compositional semantics: meaning of the sentence from the meaning of its parts:
- ▶ **Grammar + Semantics**
 - ▶ Sentence (Smeaning)->
noun_phrase(NPmeaning),verb_phrase(VPmeaning),
combine(NPmeaning,VPmeaning,Smeaning)

4. Pragmatic Analysis

- ❑ Sentence standing alone may not mean so much. It may be ambiguous.
 - ❑ What information is contained in the contextual sentences that is not conveyed in the actual sentence.
 - ▶ **Handling Pronouns**
 - ▶ “Mary eats apples. She likes them.”
 - ▶ She=“Mary”, them=“apples”.
 - ▶ **Handling ambiguity**
 - ▶ Pragmatic ambiguity: “you’re late”: What’s the speaker’s intention: informing or criticizing?
 - ▶ **Ellipsis – Incomplete sentences**
 - ▶ “What’s your name?”
 - ▶ “Srini, and yours?”
- The second sentence is not complete, but what it means can be inferred from the first one.

QUESTIONS

1. Define natural language?
2. What do you mean by natural language processing?
3. Name the two parts of natural language processing?
4. List five applications of natural language processing?
5. What are the dream applications of natural language processing?
6. Mention some difficulties in natural language processing?
7. What are the basic steps of natural language understanding?
8. Define Syntactic Analysis?
9. What is the meaning of Symantic analysis?
10. Define role of Pragmatics?

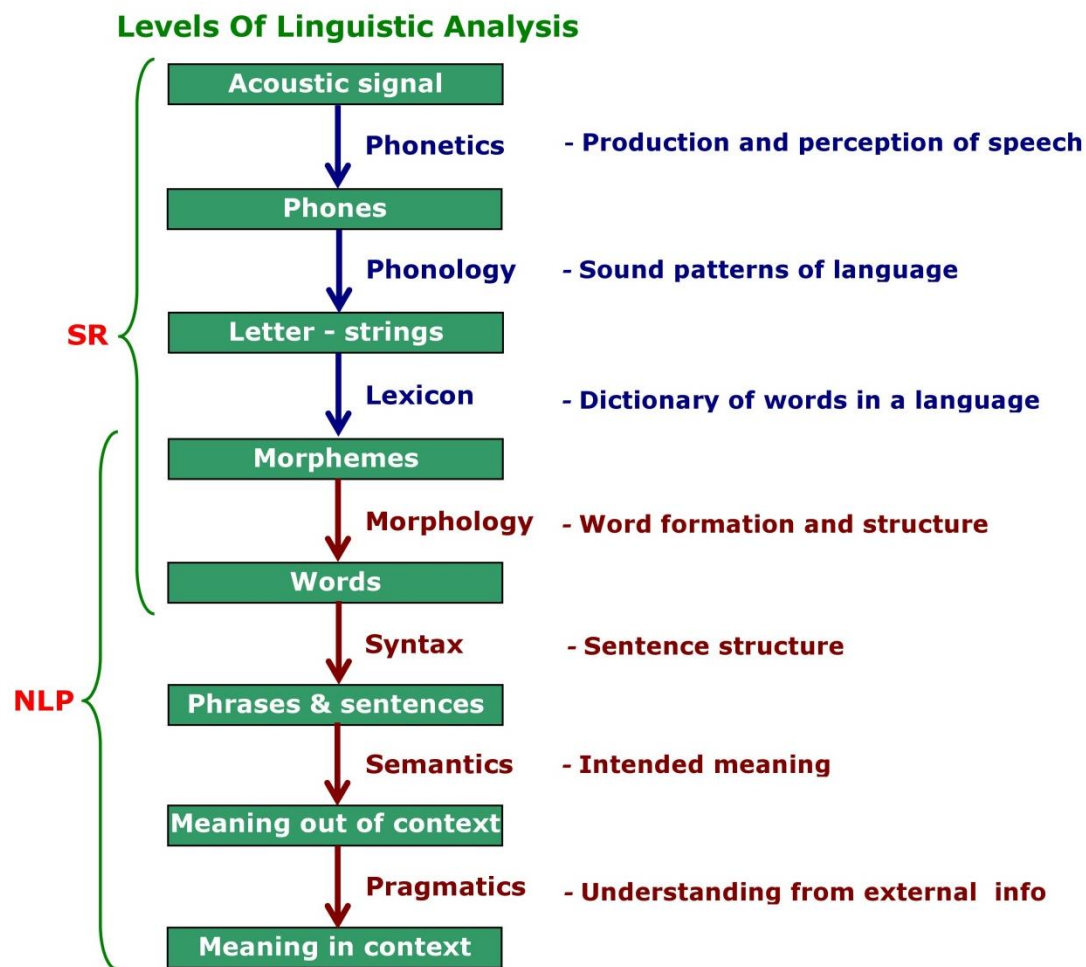
Linguistic and Language Processing

Linguistics is the science of language. Its study includes :

- sounds (phonology),
- word formation (morphology),
- sentence structure (syntax),
- meaning (semantics), and
- understanding (pragmatics) etc.

The levels of linguistic analysis are shown in figure.

higher level corresponds to Speech Recognition (SR)
lower levels corresponds to Natural Language Processing (NLP).





Discourse Integration: An Intermediate Step Between Symantic Analysis and Pragmatic Analysis of Natural Language

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.

Defining Terms Related to Linguistic Analysis:

The following terms are commonly used in linguistic analysis:

Phones, Phonetics, Phonology, Strings, Lexicon, Words, Determiner, Morphology, Morphemes, Syntax, Semantics, Pragmatics, Phrase, and Sentence.

■ 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.

Defining Terms Related to Linguistic Analysis:

■ Strings

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.

Example : words like bear, car, house are very different from words like run, sleep, think, and are different from words like in, under, about.

These and other categories of words have names :

nouns, verbs, prepositions, and so on.

Words build phrases, which in turn build sentences.

Defining Terms Related to Linguistic Analysis:

■ Determiner

Determiners occur before nouns and indicate the kind of reference which the noun has.

Example below shows determiners marked by "bold letters"
the boy **a** bus **our** car **these** children **both** hospitals.

■ 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 3 morphemes: 1 " **un-**" a bound morpheme;

2 " **-break-**" a free morpheme; and 3 " **-able**" a bound morpheme; Also "**un-**" is also a prefix; "**-able**" is a suffix; Both are affixes.

Defining Terms Related to Linguistic Analysis:

‡ **Free Morphemes** can appear stand alone, or "free" .

Example : "**town**", "**dog**" or with other lexemes

"**town hall**" , "**dog house**" .

‡ **Bound Morphemes** appear only together with other morphemes to form a lexeme. Example : "**un-**" ; in general it tend to be prefix and suffix.

‡ **Inflectional Morphemes**

modify a word's tense, number, aspect, etc. Example : **dog** morpheme with plural marker morpheme **s** becomes **dogs**.

‡ **Derivational Morphemes** can be added to a word to derive another word.

Example : addition of "**-ness**" to "**happy**" gives " **happiness**."

‡ **Root Morpheme** -It is the primary lexical unit of a word; roots can be either free or bound morphemes; sometimes "root" is used to describe word minus its inflectional endings, but with its lexical endings.

Example : word **chatters** has the inflectional root or lemma **chat**, but the lexical root **chat**.

QUESTIONS

1. What do you mean by Linguistics?
2. Differentiate between the speech recognition and natural language processing on the basis of Linguistics?
3. What is the meaning of Discourse Integration?
4. Define String?
5. What do you mean by Lexicon?
6. Define Determiner with an Example?
7. What do you mean by Morphemes?
8. List few types of Morphemes?
9. Give an example of free morphemes?
10. What do you mean by derivational morphemes?

WHAT WE DISCUSSED

In present lecture we discussed about the natural language processing.

IN NEXT LECTURE

In next lecture we will discuss in details about the Common Sense.

ACKNOWLEDGEMENTS

- ▶ I acknowledge all the authors of book and WebPages whose contents are being used in preparation of this lecture on concepts of project management.