

# Natural Language Processing

# Course Objectives:

The course aims

- 1 To define natural language processing and to learn various stages of natural language processing.
- 2 To describe basic concepts and algorithmic description of the main language levels: Morphology, Syntax, Semantics, and Pragmatics & Discourse analysis.
- 3 To design and implement various language models and POS tagging techniques.
- 4 To design and learn NLP applications such as Information Extraction, Question answering.
- 5 To design and implement applications based on natural language processing.

# Course Outcomes

Students will be able

- 1 To describe the field of natural language processing.
- 2 To design language model for word level analysis for text processing.
- 3 To design various POS tagging techniques and parsers.
- 4 To design, implement and test algorithms for semantic and pragmatic analysis.
- 5 To formulate the discourse segmentation and anaphora resolution.
- 6 To apply NLP techniques to design real world NLP applications.

# Syllabus

1.1	<b>Introduction to NLP</b>
	Origin & History of NLP; Language, Knowledge and Grammar in language processing; Stages in NLP; Ambiguities and its types in English and Indian Regional Languages; Challenges of NLP; Applications of NLP
1.2	<b>Self-Learning topics:</b> Variety types of tools for regional languages pre-processing and other functionalities



2.1	<b>Word Level Analysis</b>
	<p>Basic Terms: Tokenization, Stemming, Lemmatization; Survey of English Morphology, Inflectional Morphology, Derivational Morphology; Regular expression with types;</p> <p>Morphological Models: Dictionary lookup, finite state morphology; Morphological parsing with FST (Finite State Transducer); Lexicon free FST Porter Stemmer algorithm; Grams and its variation: Bigram, Trigram; Simple (Unsmoothed) N-grams;</p> <p>N-gram Sensitivity to the Training Corpus; Unknown Words: Open versus closed vocabulary tasks; Evaluating N-grams: Perplexity;</p>
	Smoothing: Laplace Smoothing, Good-Turing Discounting;
2.2	<b>Self-Learning topics:</b> Noisy channel models, various edit distance, Advance Issues in Language Modelling

3.1	<b>Syntax analysis</b>
	<p>Part-Of-Speech tagging(POS); Tag set for English (Upenn Treebank); Difficulties /Challenges in POS tagging; Rule-based, Stochastic and Transformation-based tagging; Generative Model: Hidden Markov Model (HMM Viterbi) for POS tagging;</p> <p>Issues in HMM POS tagging; Discriminative Model: Maximum Entropy model, Conditional random Field (CRF);Parsers: Top down and Bottom up; Modelling constituency; Bottom Up Parser: CYK, PCFG (Probabilistic Context Free Grammar), Shift Reduce Parser; Top Down Parser: Early Parser, Predictive Parser</p>
3.2	<b>Self-Learning topics:</b> Evaluating parsers, Parsers based language modelling, Regional languages POS tree banks



4.1	<b>Semantic Analysis</b>
	Introduction, meaning representation; Lexical Semantics; Corpus study; Study of Various language dictionaries like WorldNet, Babelnet; Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy; Semantic Ambiguity; Word Sense Disambiguation (WSD); Knowledge based approach(Lesk's Algorithm), Supervised (Naïve Bayes, Decision List),Introduction to Semi-supervised method (Yarowsky) Unsupervised (Hyperlex)
4.2	<b>Self-Learning topics:</b> Dictionaries for regional languages, Distributional Semantics, Topic Models

5.1	<b>Pragmatic &amp; Discourse Processing</b>
	Discourse: Reference Resolution, Reference Phenomena, Syntactic & Semantic constraint on coherence; Anaphora Resolution using Hobbs and Canterling Algorithm
5.2	<b>Self-Learning topics:</b> Discourse segmentation, Conference resolution
6.1	<b>Applications of NLP</b>
	Case studies on (preferable in regional language):Machine translation; Text Summarization; Sentiment analysis; Information retrieval; Question Answering system
6.2	<b>Self-Learning topics:</b> Applications based on Deep Neural Network with NLP such as LSTM network, Recurrent Neural network etc.



<b>Textbooks:</b>	
1	Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
2	Christopher D.Manning and HinrichSchutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.
<b>References:</b>	
1	Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2	Daniel M Bikel and ImedZitouni — Multilingual natural language processing applications: from theory to practice, IBM Press, 2013.
3	Alexander Clark, Chris Fox, Shalom Lappin — The Handbook of Computational Linguistics and Natural Language Processing, John Wiley and Sons, 2012.
4	Nitin Indurkha and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.
5	Niel J le Roux and SugnetLubbe, A step by step tutorial: An introduction into R application and programming.
6	Steven Bird, Ewan Klein and Edward Loper, Natural language processing with Python: analyzing text with the natural language toolkit, O'Reilly Media, 2009.

## Digital References :

- |    |   |
|----|---|
| 1  | <a href="http://www.cse.iitb.ac.in/~cs626-449">http://www.cse.iitb.ac.in/~cs626-449</a>       |
| 2  | <a href="http://cse24-iiith.virtual-labs.ac.in/#">http://cse24-iiith.virtual-labs.ac.in/#</a> |
| 3. | <a href="https://nptel.ac.in/courses/106105158">https://nptel.ac.in/courses/106105158</a>     |

# NLP Lab

Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications:

[Machine Translation, Text Categorization, Text summarization, chat Bot, Plagarism, Spelling & Grammar checkers, Sentiment / opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]

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# Prerequisite



DATA STRUCTURE &  
ALGORITHMS



THEORY OF COMPUTER  
SCIENCE

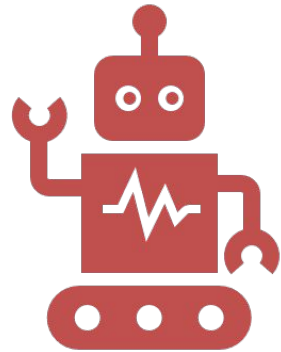


PROBABILITY THEORY.

# Syllabus

Topic	Topic	Discussion
1	Introduction	What, Why, How, Where
2	Word Level Analysis	Every word has a some meaning in language.
3	Syntax Level Analysis	I banana ate (मी केळी खाल्ले )
4	Semantic Analysis	नदीचे <u>पात्र</u> मोठे आहे तो या पदासाठी <u>पात्र</u> नाही
5	Pragmatics	Time to go to shop. Remember it is wet outside. <b>(We are going outside to the shop. You need to get ready. Make sure you put on a waterproof jacket or carry umbrella)</b>
6	Applications	Machine Translation, Information Retrieval, Question Answer System, etc.

# *Natural language processing (NLP)*



*-branch of Artificial Intelligence (AI)*



*-helps computers understand, interpret and manipulate human language.*



# What is NLP?

- *Natural Language Processing(NLP)is a field of research and application that determines the way computers can be used to understand and manage natural language text or speech to do useful things..*

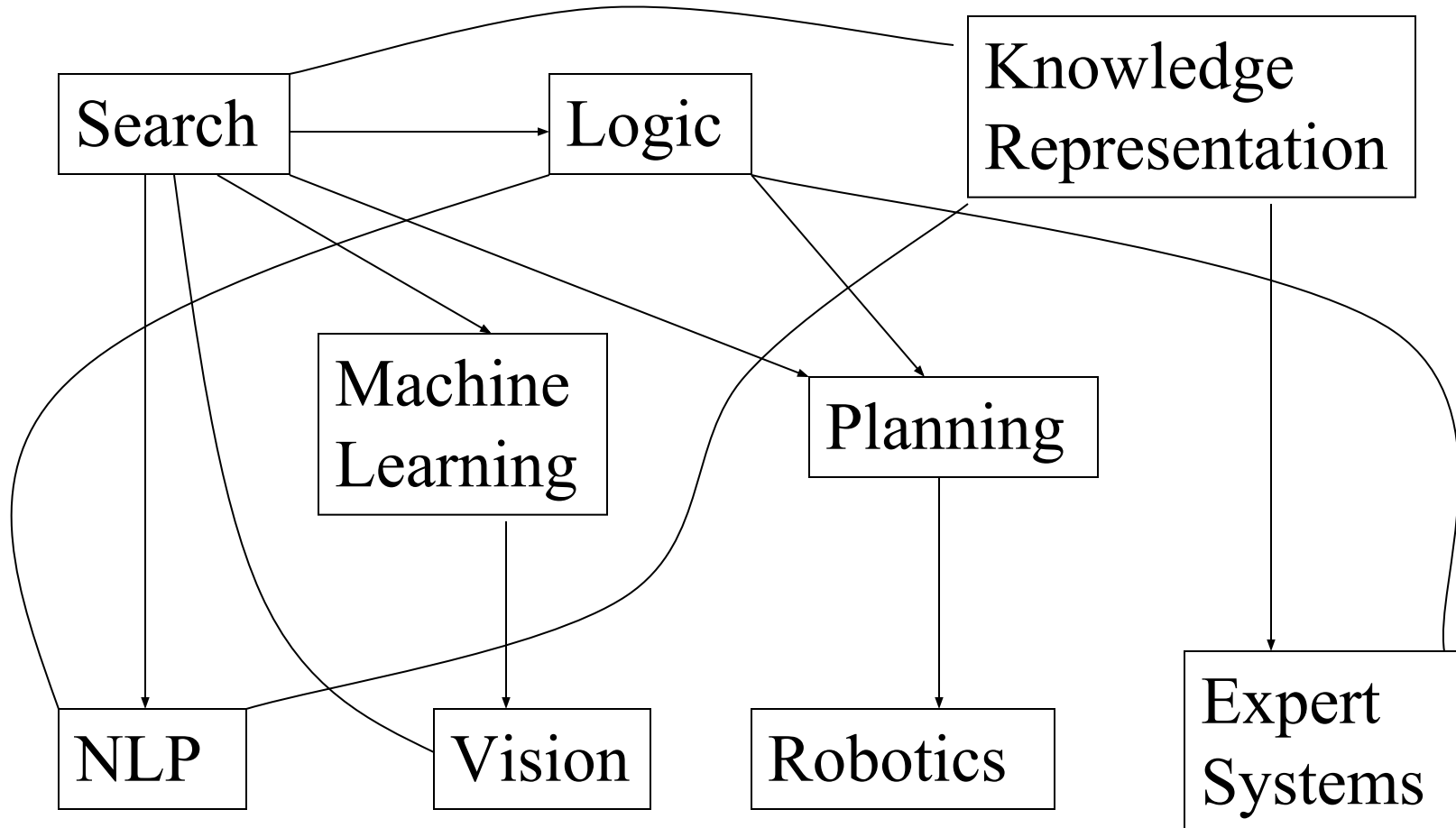
## **Background:**

- Humans are using language as a primary means of communication and by using this tool they are expressing their emotions and ideas.
- Language is used to shape the thoughts; it has structure and also it carries a meaning.
- By using our language, we naturally learn the new concepts and hardly realise how we process this natural language.
- Natural language processing is concerned with the development of computational models of aspects of human language processing.

# What is NLP?

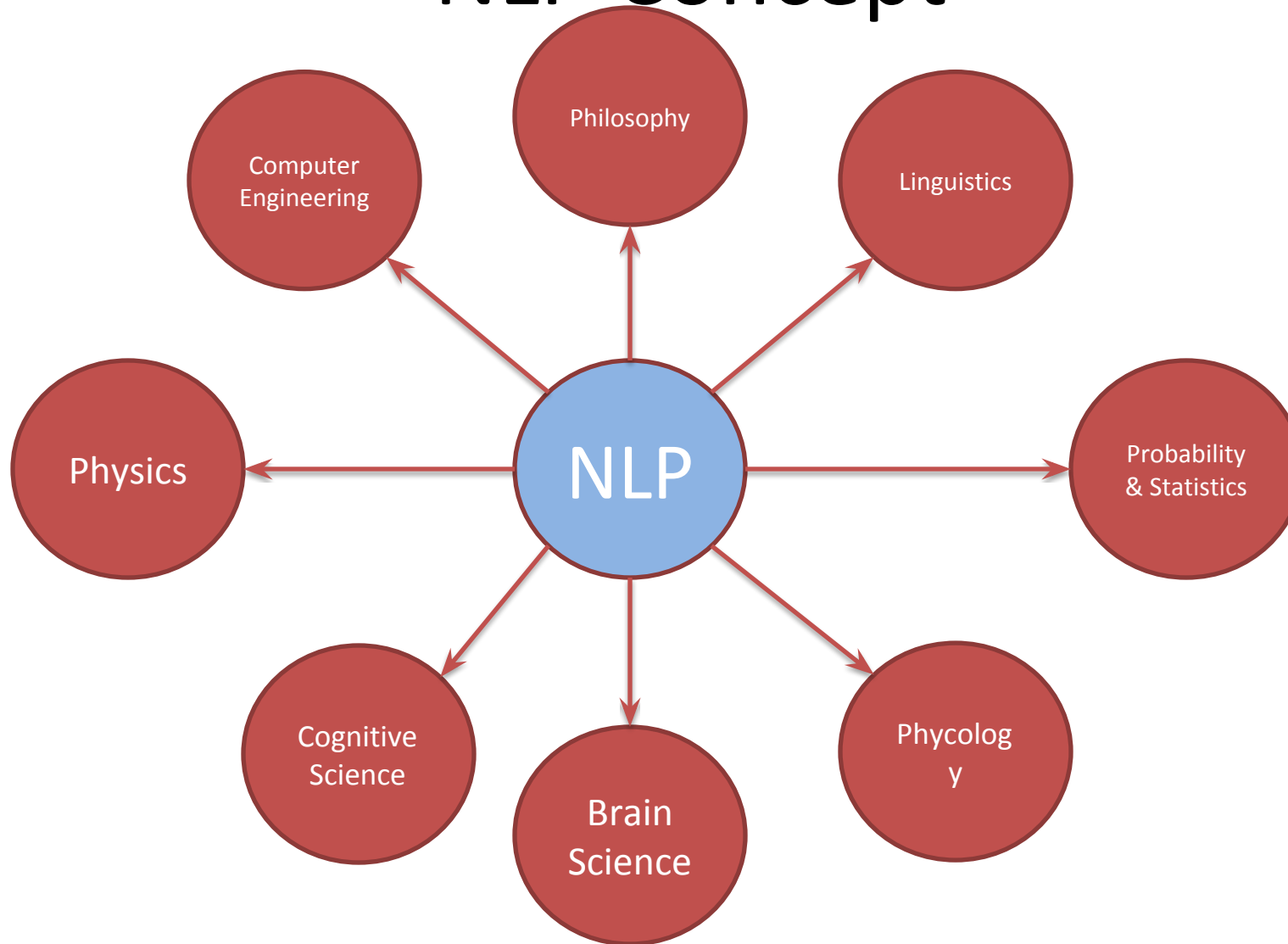
- The following are the two main reasons for such developments.
  - Develop automatic tool for natural language processing
  - Gain better understanding of human communication
- When we build computational models by using human language, we need processing abilities where this processing abilities incorporates how human collects, Store and process the language. It also needed a knowledge of the world and of language.
- The input and output of the NLP is text or speech.

# Relations of NLP





# NLP Concept

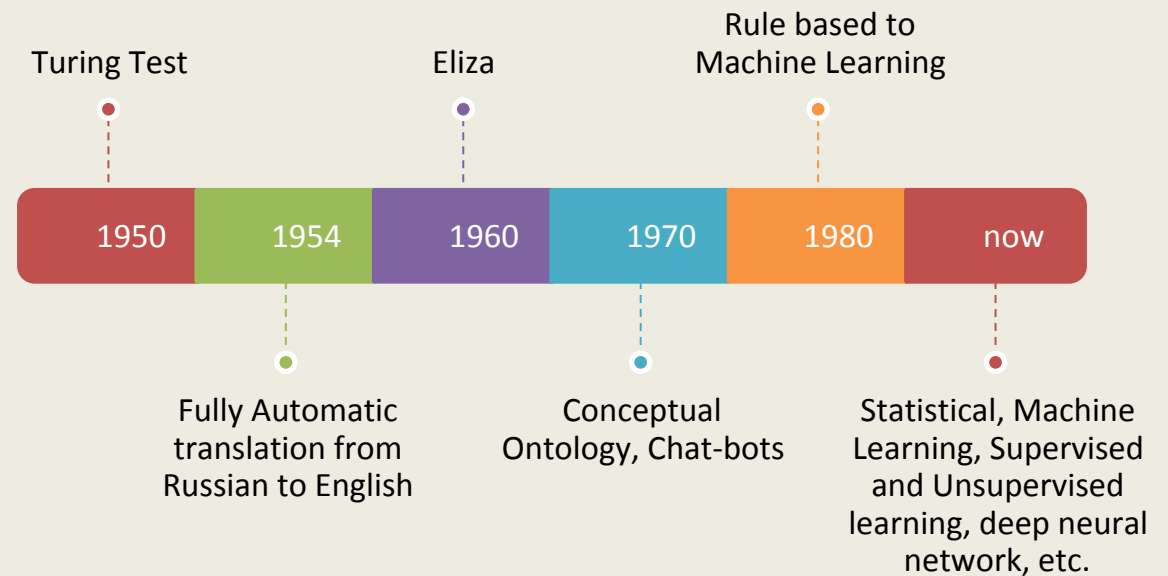


Philosophy	Semantics, Meaning of “meaning”, Logic (syllogism)
Linguistics	Study of Syntax, Lexicon, Lexical Semantics etc.
Probability and Statistics	Corpus Linguistics, Testing of Hypotheses, System Evaluation
Cognitive Science	Computational Models of Language Processing, Language Acquisition
Psychology	Behavioristic insights into Language Processing, Psychological Models
Brain Science	Language Processing Areas in Brain
Physics	Information Theory, Entropy, Random Fields
Computer Sc. & Engg.	Systems for NLP

# Why NLP?

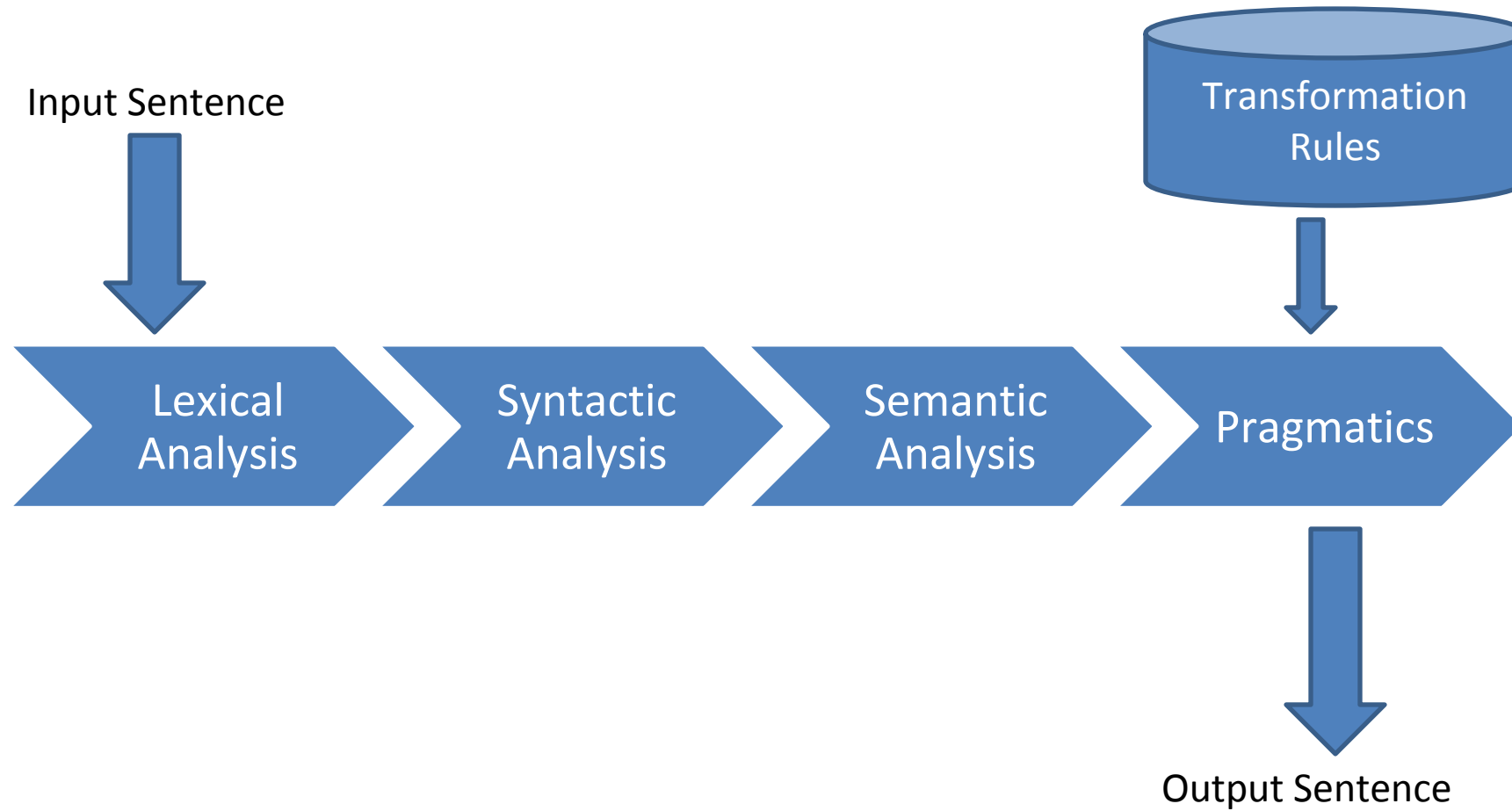
- Large volumes of Textual Data
- Structuring a Highly Unstructured Data Source
- To reduce Digital Poverty

# History of NLP

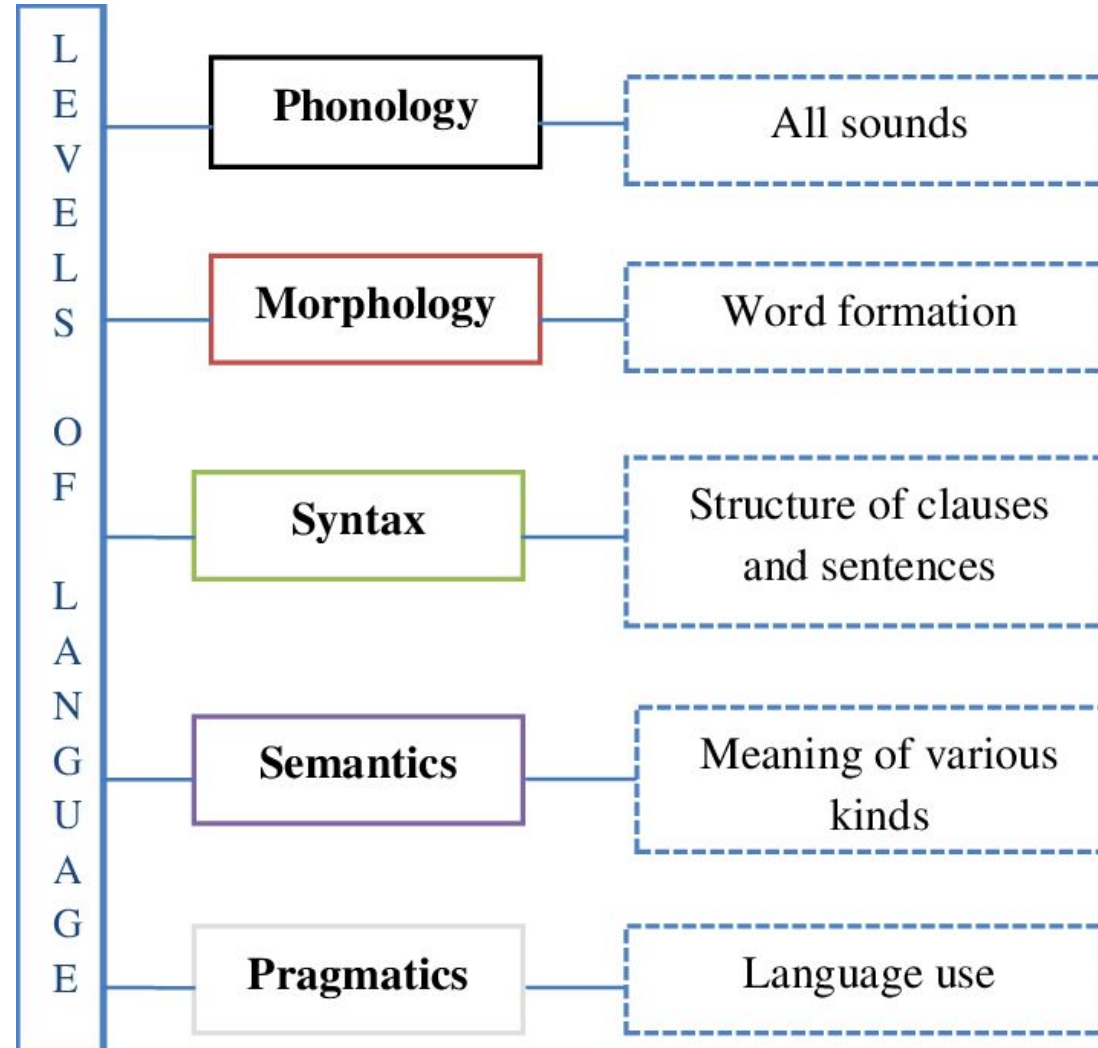




# How NLP works?



# Levels of NLP



# Levels of NLP

**1. Phonology level :** This level basically deals with the *interpretation of speech sound within and across words*.. As English spelling is especially only partially phonemic, *John inputs the data* does not show these very clearly; for example, the *h* in *John* is silent.

**2. Morphological level :** Morphology deals with the smallest parts of words that convey meaning, and suffixes and prefixes. Morphemes means studying how the words are built from smaller meaning. For example, the word 'dog' has single morpheme while the word 'rats' have two morphemes 'rat' and morpheme 's' denotes singular and plural concepts. It also considers how words can be grouped into parts of speech.

**3. Lexical level :** The lexical level deals with the study at the level of words with respect to their lexical meaning and Part-Of-Speech (POS). This level uses lexicon that is a collection of individual lexemes. A lexeme is a basic unit of lexical meaning; which is an abstract unit of morphological analysis that represents the set of forms or "senses" taken by a single morpheme. For example, "*Duck*", can take the form of a noun or a verb but its POS and lexical meaning can only be derived in context with other words used in the phrase/sentence.

**4. Syntactic level :** Syntactic level deals with grammar and structure of sentences. It studies the proper relationships between words. The POS tagging output of the lexical analysis can be used at the syntactic level of two group words into the phrase and clause brackets. Syntactic Analysis also referred to as "*parsing*", allows the extraction of phrases which convey more meaning than just the individual words by themselves, such as in a noun phrase.

# Levels of NLP

## 5. Semantics level

- This level deals with the meaning of words and sentences. There are two approaches of semantic level:
  1. Syntax-driven semantic analysis,
  2. Semantic grammar
- It is a study of the meaning of words that are associated with grammatical structure. For example, *John inputs the data* from this statement we can understand that John is an *Agent*.

## 6. Discourse level

- This level deals with the structure of different kinds of text. There are two types of discourse:
  - 1. Anaphora resolution,
  - 2. Discourse / text structure recognition.
- The words are replaced in Anaphora resolution, for example pronouns.
- Discourse structure recognition determines the purpose of sentences in the text which enhances meaningful illustration of the text.

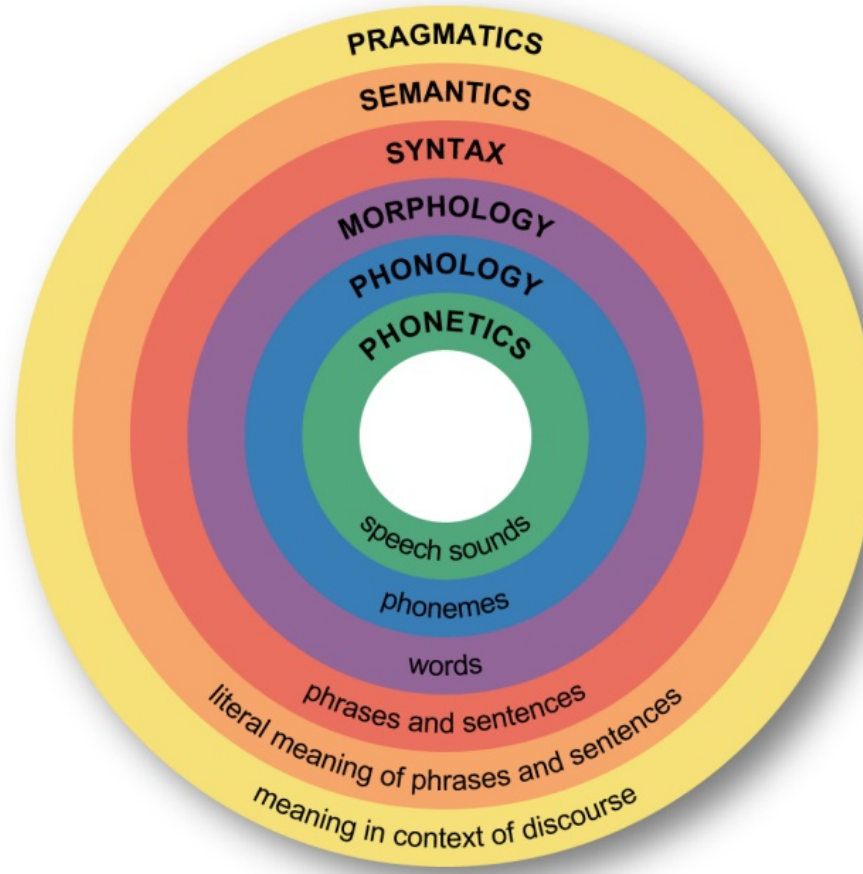


# Levels of NLP

## **7. Pragmatic level**

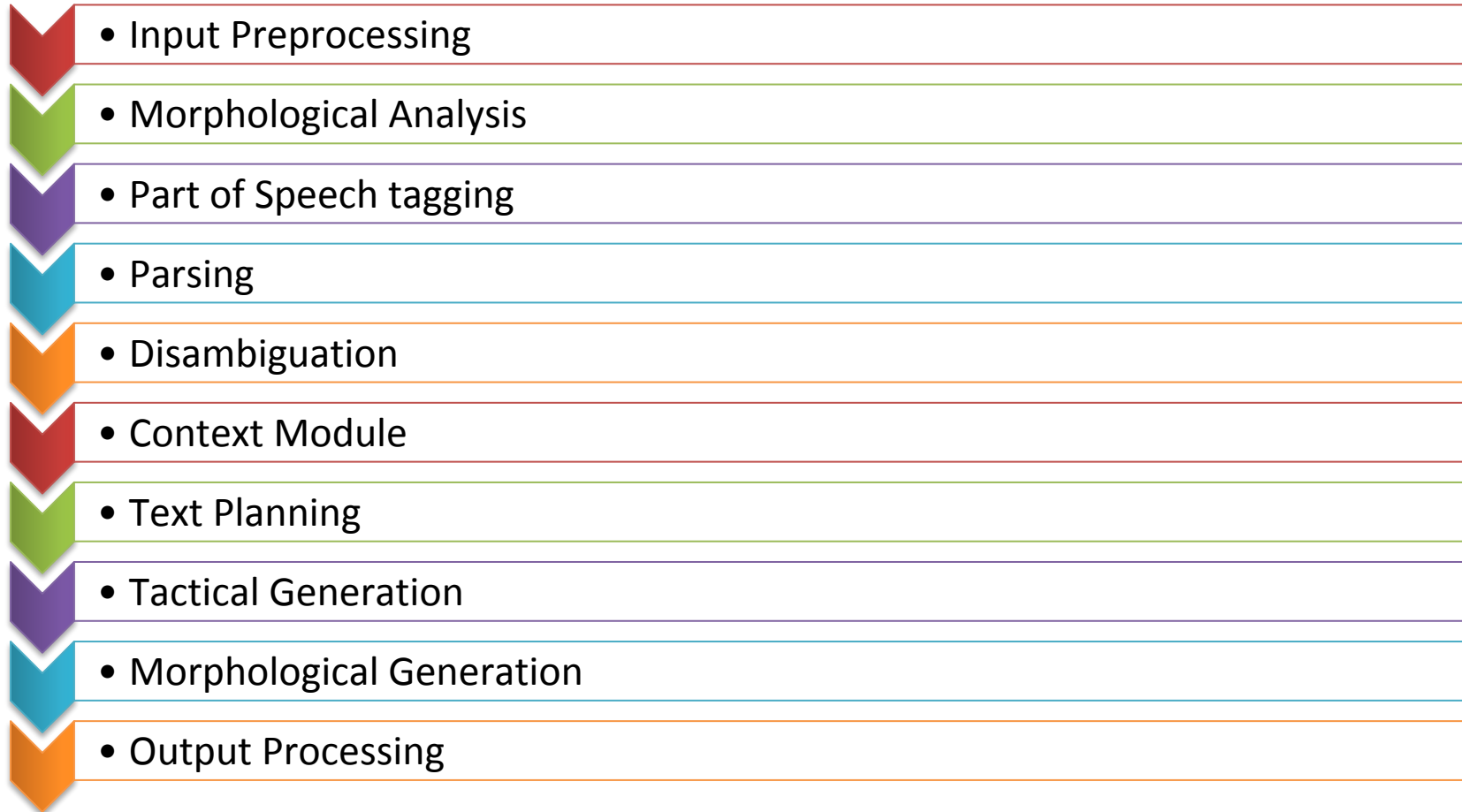
This level deals with the use of real world knowledge and understanding of how this influences the meaning of what is being communicated. By analysing the appropriate dimension of the documents and queries, a more detailed representation is derived.

# Summary



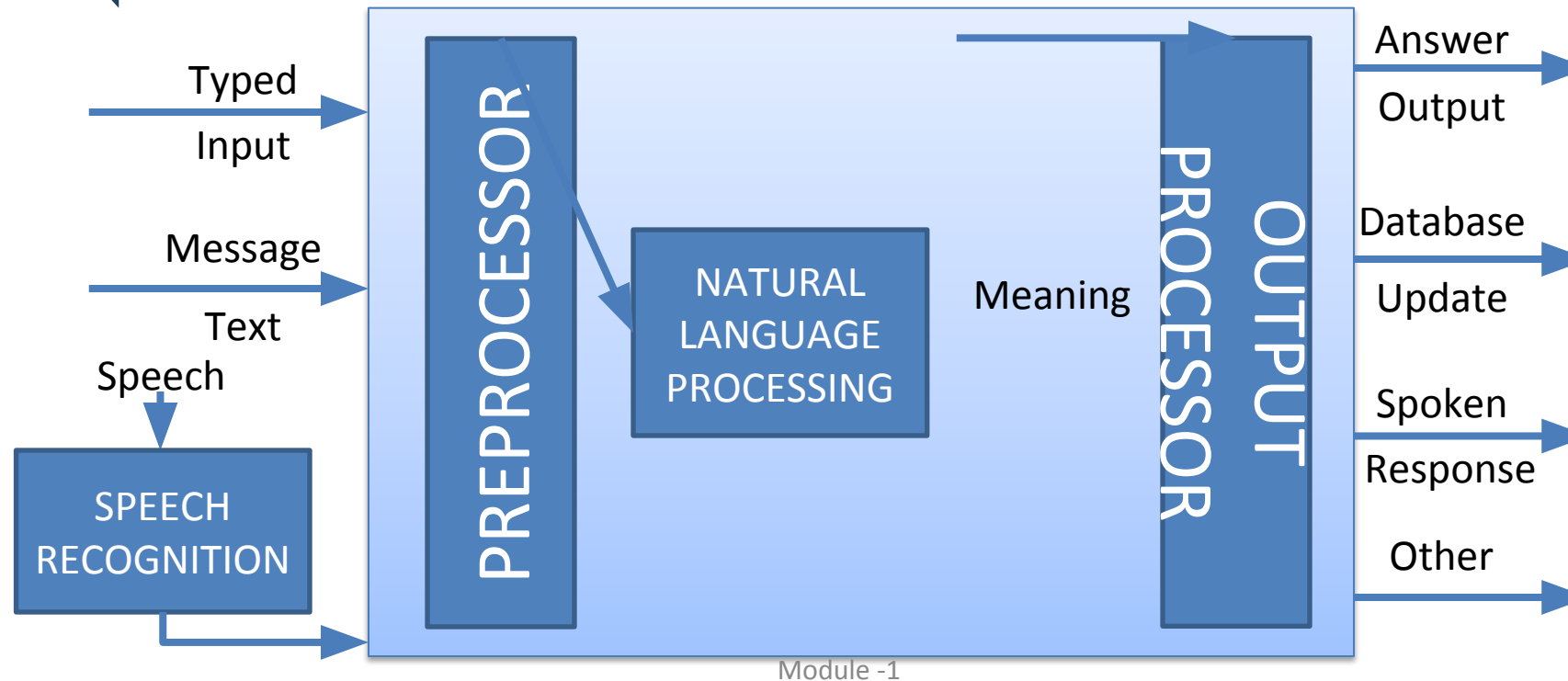
- *To summarize, the knowledge of language needed to engage in complex language behavior can be separated into six distinct categories.*
- ***Phonetics and Phonology*** – *The study of linguistic sounds.*
- ***Morphology*** – *The study of the meaningful components of words.*
- ***Syntax*** – *The study of the structural relationships between words.*
- ***Semantics*** – *The study of meaning.* \_ ***Pragmatics*** – *The study of how language is used to accomplish goals.*
- ***Discourse*** – *The study of linguistic units larger than a single utterance.*

# Components of NLP





# Generic NLP

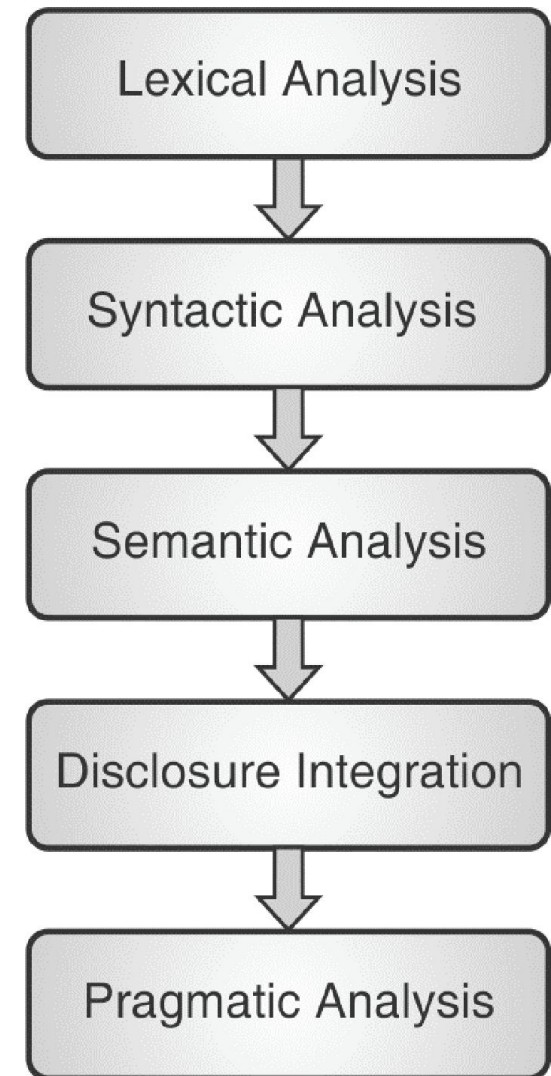


# Stages in Building NLP system

There are five stages in natural language processing.

## 1. Lexical Analysis

- Lexical Analysis is the first stage in NLP.
- It is also known as morphological analysis.
- At this stage the structure of the words is identified and analysed.
- Lexicon of a language means the collection of words and phrases in a language.
- Lexical analysis is dividing the whole portion of text into paragraphs, sentences, and words



# Stages in Building NLP system

## Syntactic Analysis (Parsing)

- It involves analysis of words in the sentence for grammar and ordering words in a way that shows the relationship among the words.
- The sentence such as *The school goes to girl* or *“Ravi apple eats”* is rejected by English syntactic analyser.

## Semantic Analysis

- *Semantics concerns the (literal) meaning of words, phrases, and sentences*
- *This abstracts the dictionary meaning or the exact meaning from context*
- The text is checked for meaningfulness. It is done by mapping syntactic structures and objects in the task domain.
- The semantic analyser neglects sentence such as *“hot ice-cream”* or *“colorless blue idea”*.

# Stages in Building NLP system

## 4. Discourse Integration

- This deals with the sense of context.
- *The meaning of any single sentence depends upon the sentences that precedes it and also invokes the meaning of the sentences that follow it*
- Furthermore, it also brings about the meaning of immediately following sentence.
- For example: *Meena is a girl, she goes to school*” here “she” is a dependency pointing to Meena.

## 5. Pragmatic Analysis

- During this, what was said is re-interpreted on what it truly meant. It contains deriving those aspects of language which necessitate real world knowledge.
- *It means abstracting or deriving the purposeful use of the language in situations.*
- For example, “John saw *Mary in a garden with a cat*”, here we can't say that John is with cat or mary is with cat
- *E.g. “close the window?” should have been interpreted as a request rather than an order*



# Challenges and ambiguity in NLP

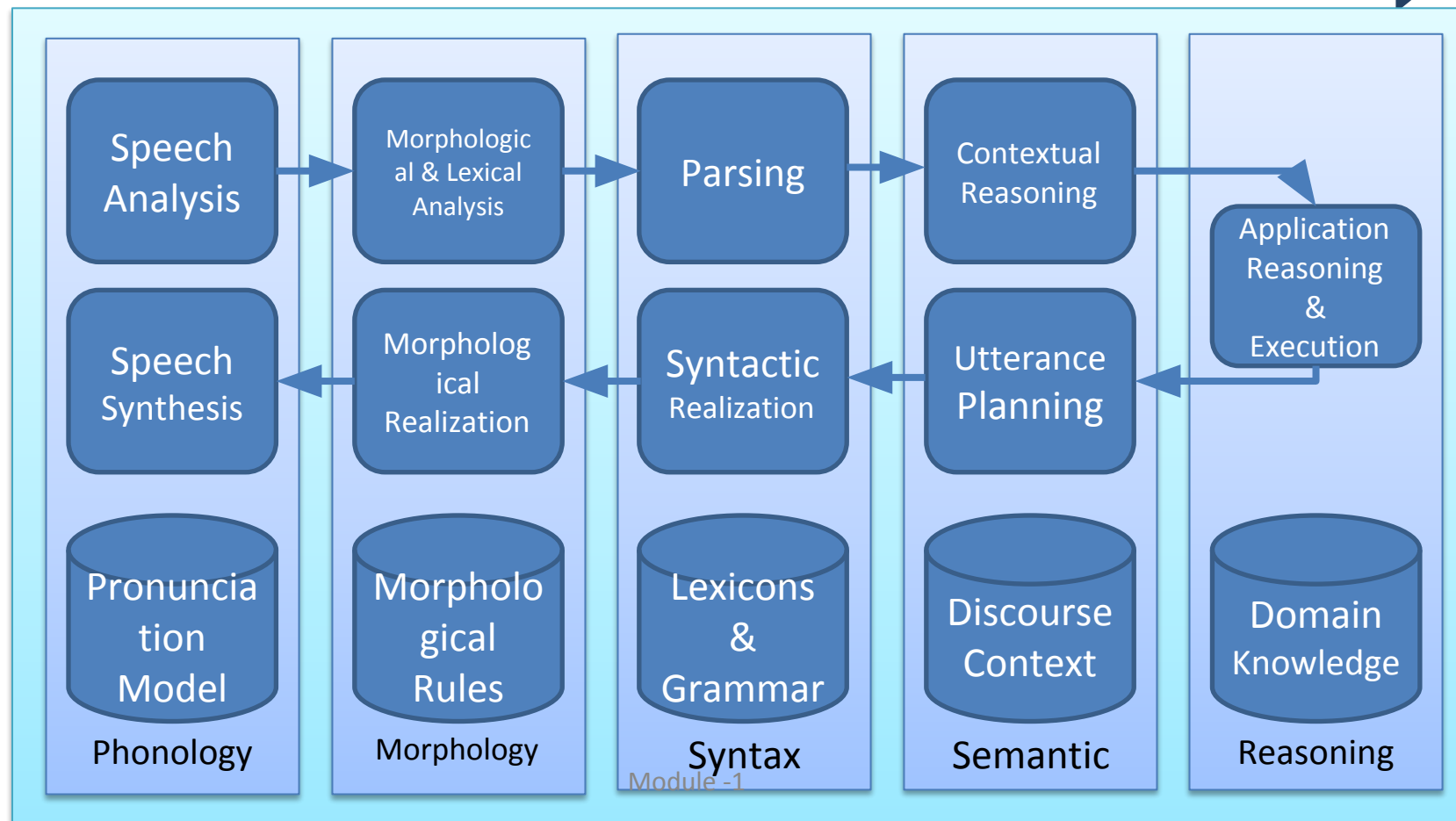
What is ambiguity?

- Natural language has a very rich form and structure. It is very ambiguous.
- Ambiguity means not having well defined solution.
- Any sentence in a language with a large-enough grammar can have another interpretation.

# Challenges and ambiguity in NLP

- There are various forms of ambiguity related to natural language and they are..
  1. Lexical Ambiguity
  2. Syntactic Ambiguity
  3. Semantic Ambiguity
  4. Pragmatic Ambiguity

# Levels of NLP





# Stages of NLP

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Morphological Analysis

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Lexical Analysis

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Syntax Analysis

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Semantic Analysis

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Discourse

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Pragmatics

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# Issues in NLP



AMBIGUITY



CO-REFERENCE  
RESOLUTION



ELLIPSIS



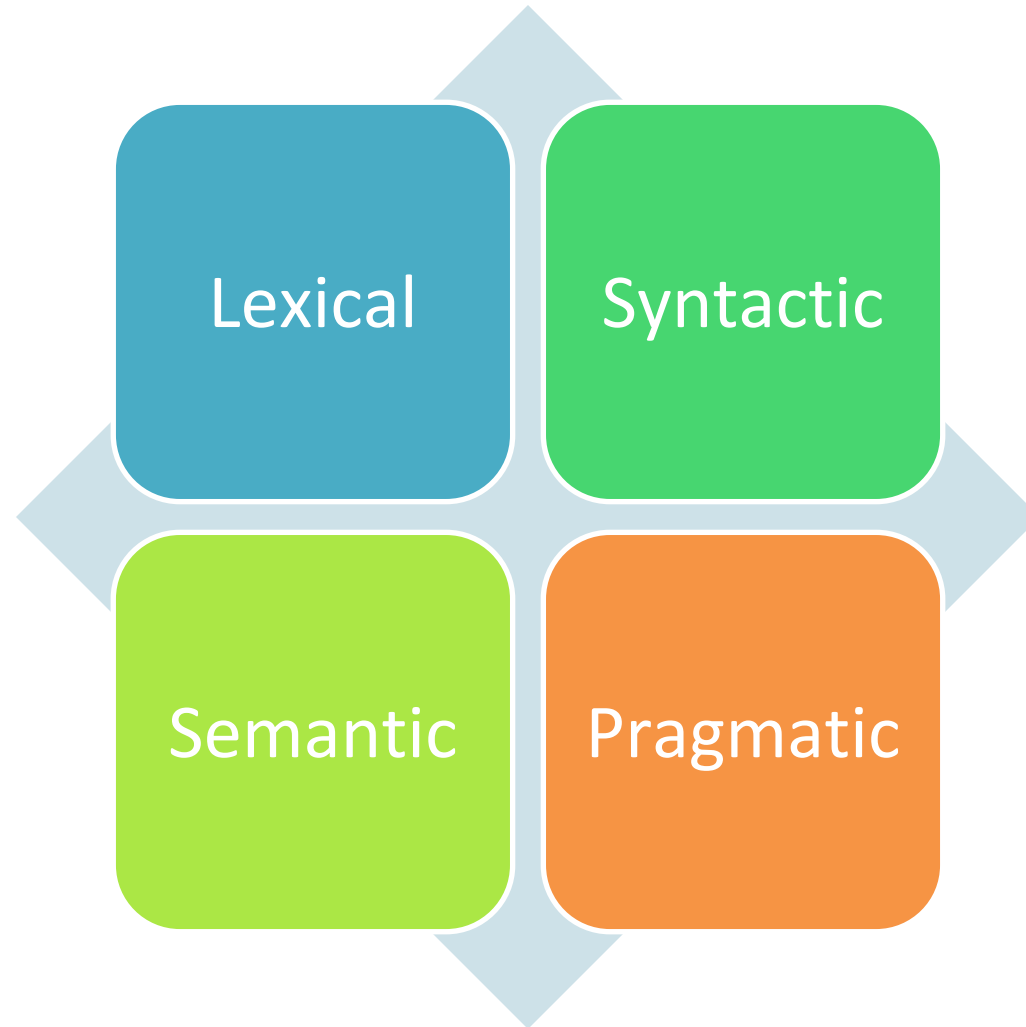
# Ambiguity

I went to the bank



- A good life depends on a liver

# Types of Ambiguity



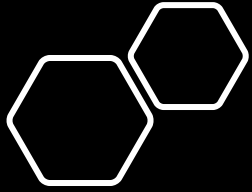
# Lexical Ambiguity



WORDS HAVE MULTIPLE MEANINGS.



"I SAW A BAT."  
BAT = FLYING MAMMAL / WOODEN CLUB?  
SAW = PAST TENSE OF "SEE" / PRESENT TENSE OF  
"SAW" (TO CUT WITH A SAW.)



# Lexical Ambiguity

- Polysemy: a word has two or more related meanings.
  - Example
    - Bright : shining, intelligent
    - To glare : to shine intensely, to stare angrily
    - A deposit : minerals in the earth, money in the bank
- Homophony: a single form has two or more entirely distinct meanings.
  - Example
    - Atmosphere - the gases surrounding the earth / the mood of a situation
    - Employ - to put into use / to hire someone for a job
    - Grave - something very serious / a place to bury the dead

# Syntactical Ambiguity

A sentence has multiple parse trees.

**I saw the man with the binoculars** – Did I have the binoculars or did he?

**Look at that dog with one eye** – Am I to close an eye and look at the dog or does the dog have one eye?



# Syntactical Ambiguity



**Syntactical ambiguity happens if there is a sentence which is ambiguous because its words relate each other in different ways, even though none words are ambiguous.**

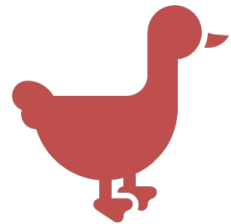


**Syntactic ambiguity arises when a sentence can have two (or more) different meanings because of the structure of the sentence—its syntax.**

# Semantic Ambiguity

- "The dog is chasing the cat." vs. "The dog has been domesticated for 10,000 years." In the first sentence, "The dog" means to a particular dog; in the second, it means the species "dog".
- "John and Mary are married." (To each other? or separately?)

# Semantic Ambiguity



Semantic ambiguity occurs when a word, phrase or sentence, taken out of context, has more than one interpretation.

# Pragmatic Ambiguity

Intention or hidden context

Speech Act

- The cops are coming ( Warning / Relief)
- I'm sorry you were raised so badly ( Insult / Apology)
- Can you pick me up later? ( Request / Question)
- Can you pass the salt? & Are you able to pass the salt?

# Pragmatic Ambiguity

- Pragmatic ambiguity arises when the statement is not specific, and the context does not provide the information needed to clarify the statement. Information is missing and must be inferred.
- Example: The story of King Croesus and the Oracle of Delphi.
- “Lydia King Croesus consulted the Oracle of Delphi before warring with Cyrus of Persia. The Oracle replied that, "If Croesus went to war with Cyrus, he would destroy a mighty kingdom".
- Delighted, Croesus attacked Persia, and Croesus’ army and kingdom were crushed. Croesus complained bitterly to the Oracle’s priests, who replied that the Oracle had been entirely right. By going to war with Persia, Croesus had destroyed a mighty kingdom – his own."

# Co-reference Resolution

A phrase or word refers to something previously mentioned, but there is more than one possibility.

- *Place the wrench on the table. Then paint it. (What does **it** mean?)*
- I went to the hospital, and they told me to go home and rest.
- The White House announced today that ...



# Ellipsis

The omission of words that are needed for grammatical completion and are "understood".

- Move the table to the corner. Also, the chair.
- I went to market on Sunday, she on Monday.
- I am allergic to tomatoes. Also, fish.
- Mozart was born in Salzburg and Beethoven, in Bonn

# Challenges in NLP

- NLP is a powerful tool with enormous benefits; nonetheless there are still numerous Natural Language Processing challenges :

# Challenges in NLP

## 1. Contextual words and phrases and homonyms

- The same words and phrases can have diverse meanings according to the context of a sentence and many words have the exact same pronunciation but completely different meanings.
- For example :
  - o I ran to the store because we ran out of milk.
  - o Can I run something past you really quick?
  - o The house is looking really run down.
- In the above three sentences the meaning of the *run* is different according to the context
- Homonyms means the pronunciation of two or more words is same but have different meaning. For example, their and there, right and write.
- This will create **problem in question answering and speech-to-text applications.**

# Challenges in NLP

## 2. Synonyms

- Synonyms can cause issues like contextual understanding since we use many different words to express the identical idea.
- Additionally, some of these words may convey exactly the same meaning, while some may be levels of complexity and different people use synonyms to denote slightly different meanings within their personal vocabulary.
- For example, small, little, tiny, minute have same meaning.

# Challenges in NLP

## 3. Irony and sarcasm

- Irony and sarcasm present problems for machine learning models since they usually use words and phrases that, strictly by definition, may be positive or negative, but truly mean the opposite.
- Models can be trained with certain indications that frequently accompany ironic or sarcastic phrases, like yeah right, whatever, etc., and word embeddings (where words that have the same meaning have a similar representation), but it's still a complicated process.

# Challenges in NLP

## 4. Ambiguity

- Ambiguity in NLP refers to sentences and phrases that potentially have two or more possible interpretations.
- There is lexical, syntactic and semantic ambiguity.



# Challenges in NLP

## 5. Errors in text or speech

- Misspelled or misused words can generate problems for text analysis.
- **Autocorrect and grammar correction applications can handle common mistakes, but do not at all times understand the writer's intention.**
- With spoken language it is difficult for the machine to understand mispronunciations, different accents, stammers, etc

# Challenges in NLP

## 6. Idioms and slang

- Informal phrases, expressions, idioms, and culture-specific lingo present a number of problems for NLP, especially for models intended for comprehensive use.
- Because as formal language, idioms may have no dictionary definition at all, and these expressions may even have different meanings in different geographic areas.
- Furthermore, cultural slang is continuously morphing and increasing, so new words arise every day.
- Examples of idioms are:  
“Up in the air” , “Kill two birds with one stone.”

# Challenges in NLP

## **7. Domain specific language**

- Different businesses and industries often use very different language.
- An NLP processing model needed for healthcare would be very different than one used to process legal documents.

# Challenges in NLP

## 8. Low-resource languages

- Artificial Intelligence, machine learning NLP applications have been mostly built for the most common, widely used languages.
- It is absolutely incredible at how precise translation systems have become. However, many languages, especially those spoken by people with less access to technology often go overlooked and under processed.
- For example, there are over 3,000 languages in Africa, alone. There simply isn't ample data on many of these languages

# Applications of NLP

- Machine translation
- Question answering
- Sentiment analysis
- Text summarization
- Text categorization
- Spelling and grammar checker

# Applications of NLP

- The first application area of Natural Language Processing is machine translation.
- Machine translation is considered to be a complete linguistic analysis of the natural language sentences as well as linguistic generation of output sentence.
- There is vast progress happened in NLP field. Some
- applications of NLP are as follows:

# Applications of NLP

## 1. Machine translation

- In machine translation, the translation of the text in one human language to another human language is performed automatically.
- For performing the translation, it is important to have the knowledge of the words and phrases, grammar of two languages that are involved in Translation, semantics of the languages and the Knowledge of the word.



# Applications of NLP

## 2. Speech recognition

- Speech recognition is the process where the acoustic speech signals are mapped to the set of words.
- As there is wide variation in the pronunciation of the word, homonym for example, sea and see, acoustic ambiguities like in the rest and interest

# Applications of NLP

## 3. Speech synthesis

- Automatic production of speech is known as speech synthesis.
- It means speaking a sentence in natural language.
- The speech synthesis system reads mails on your telephone or reads storybooks for you.
- For generating the utterances text processing is required, so, NLP is an important component in speech synthesis system

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Added security | https://www.google.com/search?q=utterances&ei=oOPAY-akFryUseMP58eLoA4&ved=0ahUKEwj9LaK4MP8AhU8SmwGHefjAuQQ4dUDCA8&uact=5&oq=utter...

Googleutterances

AllImagesNewsVideosBooksMoreTools

About 5,19,00,000 results (0.32 seconds)

Dictionary

Definitions from Oxford Languages · Learn more

English

Search for a word

utterance

/ˈʌt(ə)rəns/

Learn to pronounce

noun

plural noun: utterances

a spoken word, statement, or vocal sound.  
"he whispered, as if to lend his utterances an added confidentiality"

Similar: remarkcommentwordexpressionstatementobservation

the action of saying or expressing something aloud.  
"the simple utterance of a few platitudes"

Similar: voicingsayingspeakingspeakingexpressiondeliverysounding

LINGUISTICS

an uninterrupted chain of spoken or written language.

Feedback

Translations and more definitions

See results about

Utterance

In spoken language analysis, an utterance is a continuous ...

77°FSmoke

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# Applications of NLP

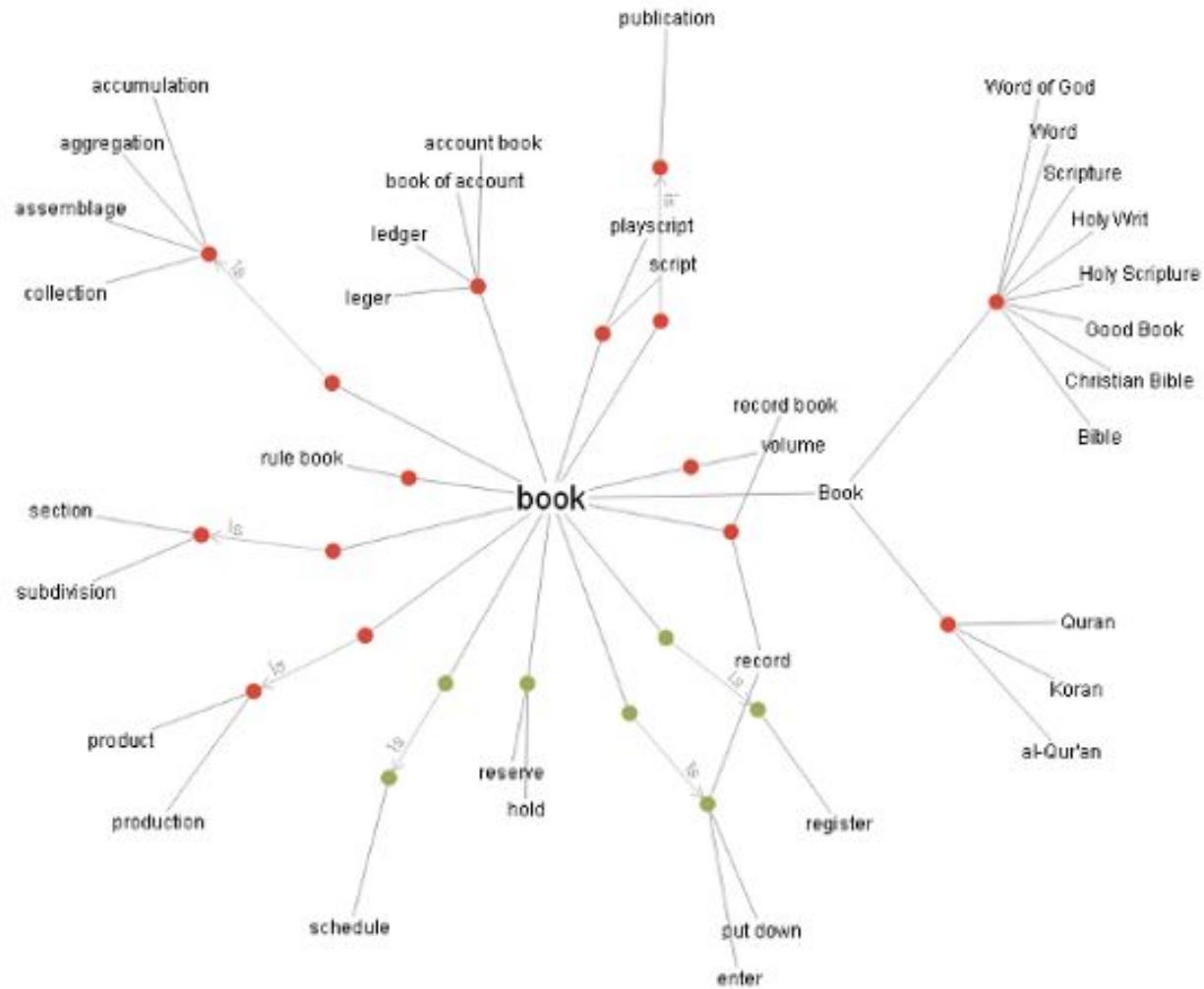
## 4. Information retrieval

- In Information retrieval the relevant documents related to the user's queries are identified.
- In Information retrieval indexing, query modification, word sense disambiguation, and knowledge bases are used for enhancing the performance.
- For example, wordnet, and Longman Dictionary of Contemporary English (LDOCE) are some useful lexical resources for Information retrieval research.

# Applications of NLP

- WordNet® is a large lexical database of English. Nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms (synsets), each expressing a distinct concept.
- Synsets are interlinked by means of conceptual-semantic and lexical relations. The resulting network of meaningfully related words

# Example of WordNet



# Applications of NLP

## 5. Information extraction

- Information extraction is one of the most significant applications of NLP.
- Information extraction (IE) is the task of automatically extracting structured information from unstructured and/or semi-structured machine-readable documents, while information retrieval (IR) is finding material (usually documents) of an unstructured nature (usually text) that satisfies an information need from within .
- For example extraction of NER (**Named Entity Recognition**) ((person names, location names, etc.) from a te4xt.
- Relation Extraction: Dedetermining meaningful relationships between different entities.



# Applications of NLP

## 6. Question answering

- The question answers system tries to find out the correct answer or part of the text where the answer appears for the given question and a set of documents.
- The question answers system returns a full document that is relevant to the user's query.
- The question answer system uses an information extraction system for identifying the entities in the text.
- A question answering system needed more NLP than an Information retrieval system or an information extraction system.
- It needed process analysis of question and portions of text and also semantic as well as background knowledge to answer certain type of questions.

# Applications of NLP

## 7. Text summarization

- Text summarization means creating short, correct summary of longer text documents.
- Automatic text summarization will assist us with appropriate information in less time.
- NLP has an important role in developing an automatic text summarization.
- Text summarisation involves syntactic, semantics, and discourse level processing of text

# Applications of NLP

## 8. Sentiment Analysis

- Sentiment Analysis is also referred as opinion mining. It is used on the web to analyse the attitude, behaviour, and emotional state of the sender.
- This application is implemented through a combination of NLP and statistics by assigning the values to the text such as positive, negative, or neutral and then recognize the mood of the context for example, happy, sad, angry, etc.

# Applications

Spelling and grammar checking	Optical character recognition (OCR)	Screen readers for blind and partially sighted users	Augmentative and alternative communication	Machine Translation
Information Retrieval	Text Categorization	Text Summarization	Question Answer System	Sentiment Analysis
Information Extraction	Document Clustering	Report Generation	Fake news detection	... and many more

# Futures of NLP

## Healthcare

- Information discovery and retrieval
- Diagnostic assistance
- Virtual healthcare assistant
- Image classification and report generation

## Personal Virtual Assistance

- “Hey, I want to go out to dinner with my friend after my last meeting on Thursday. Take care of it.”

## Automotive

- the user could tell the car to stop at a flower shop on the way home, and the car will have to figure out how to do that.

## Customer Service

- analyze voice calls and emails in terms of customer happiness quotient, prevalent problem topics, sentiment analysis, etc.

# Advantages of NLP

- Once implemented, NLP is less expensive and more time efficient than employing a human resource.
- It can help business grow. It offers faster customer service response times.
- Pre-trained learning models are available for developers to facilitate different applications of NLP.
- NLP can be used to establish communication channels between humans and machines.
- For blind people NLP is a boon in their day-to-day life.

# Disadvantages of NLP

- Training can be time consuming. Without the use of pre-trained model (i.e. training from scratch) can take hours or weeks based on the amount of training data.,
- There is always a possibility of errors in predictions and results.
- Sometimes NLP failed to show context.
- Difficulty in generalizing NLP app. Building one-for –all NLP all is not possible therefore most of the NLP applications are for a specific task.

# Important Questions

1. What is Natural language processing ( NLP) ? Discuss various stages involved in NLP process with suitable examples.
2. Differentiate between Syntactic ambiguity and Lexical ambiguity.
3. What do you mean by ambiguity in Natural language? Explain with suitable examples. Discuss various ways to resolve ambiguity in NL. Explain different stages of NLP.
4. Discuss various challenges in processing natural language.
5. List various applications of NLP and discuss any 2 applications in detail.