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Significance of Natural Language Processing in Language Based Automated Systems and Intelligent Agents

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ABSTRACT

Ability of computer program to understand human language as it is spoken is Natural Language Processing. This paper describes briefly about Processing, Generation and Understanding of Natural Language, the general working phases and also applications of NLP in the areas of Machine Translation, Natural Speech Understanding, Automatic Summarization, Text Analytics / Mining, Question Answering Systems and Chatbots. This paper also emphasizes on various aspects of automated systems and the significance of natural language processing for such applications. Also, the role of Natural Language Processing for intelligent agents with various features of those agents are presented.

Keywords : NLU, NLP, NLG, Automated Systems, Intelligent Agents

I. INTRODUCTION

Natural Language Processing is a field of computer science and linguistics concerned with interactions between computers and human language [5]. It is the machine handling of written and spoken human communication. It consists of different methods derived on linguistics and statistics coupled with machine learning to model the language of automation.

NLP is broken down to steps like morphological and syntactic analysis, semantic analysis, discourse integration and pragmatic analysis. It employs a variety of methodologies to solve the ambiguities in human language like automatic summarization, feature extraction as well as emotional detection.

NLP is widely classified in to Natural Language Understanding and Natural Language Generation [Fig 1]

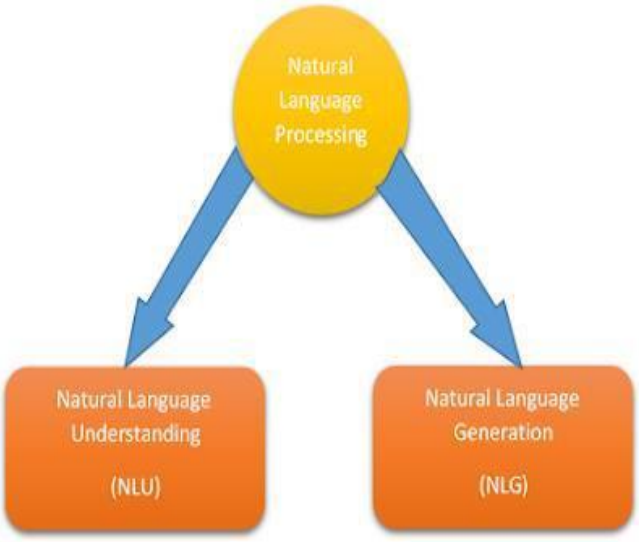

Fig 1: Classification of Natural Language Processing

Natural Language Understanding systems convert samples of human language into more formal representations such as parse trees or first order logic structures. NLU is basically a part of post processing of text after the use of NLP algorithms. It is involved in understanding grammar of text-Syntax, understanding the meaning of text-semantics and also what exactly the text is trying to achieve.

It is applied in real time for relatively simple to complex tasks like data collection and analysis ,short instructions for intelligent robots, automatic analysis of e-mails, human interacting bots and other applications that require conversion of speech to text and one language to another language.

Natural Language Generation systems convert samples of human language in to more formal representations such as parse trees or first order logic structures. NLG systems are also used as interactive explanation tools which convey information in an understandable way for the new users in engineering and medical fields. NLG systems performs Content Determination and Text Planning i.e., how information is structured and communicated to user simultaneously, Sentence Planning i.e., how information will be split into separate paragraphs and sentences with correct grammar, Realization i.e., to generate the sentences with proper grammar

In real-time NLG systems are used to generate textual weather forecasts from graphical weather maps, to summarize statistical data retrieved from database or spreadsheet, to explain medical information in a patient friendly way etc.

II. DIFFERENT PHASES IN NLP

Following are the different phases of Natural Language Processing[Fig 2]

A. Morphological Analysis and Syntactic Analysis

In linguistics, individual words from sentences are analyzed into their nonword tokens and components known as Morphological Analysis which is commonly known as study of structure and formation of words Syntactical Analysis/Parsing is a process of analyzing text made of sequence of tokens to determine its grammatical structure with respect to a given formal grammar. Syntactic analysis builds structural description of the sentence involves determining the subject and predicate and the place of nouns, verbs, pronouns, etc. The System is enabled to read through the input sentence word by word and produce a structural description at the end. Syntactic analysis includes consideration of morphological and syntactic knowledge on the part of the natural language processor.

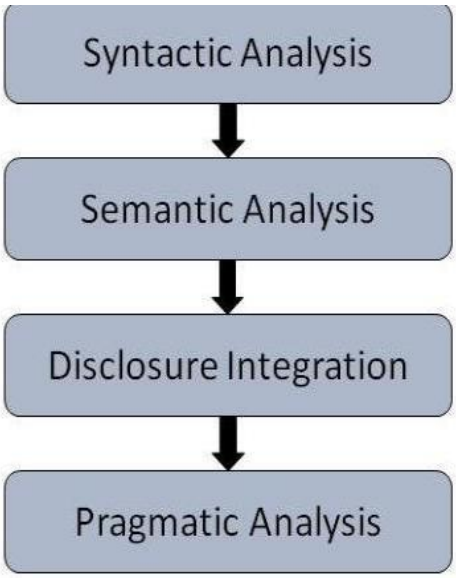

Fig 2: Different Phases of Natural Language Processing

B. Semantic Analysis

Semantic Analysis is carried out based on the knowledge about the structure and meaning of sentences, words and phrases. It is a form of representing context independent meaning of the sentence. It involves some of the stages like dependency parsing which identifies how the words of a sentence relate to each other, finding the noun phrases, named entity recognition which identifies the named entities that are the main designators of a sentence like the person names, organization names, locations etc. as a part of semantic analysis.

C. Pragmatic Analysis

Pragmatic Analysis considers the context in which a particular word or text is used. It considers the

intentions behind using the text. It deals with the usage of sentences or words in different situations. In this phase the differentiation of "what was said" and "what is actually meant" will be made. The main challenge of natural language understanding is the ambiguity. Pragmatic analysis helps to reduce the ambiguity by understanding the context and meaning of usage.

D. Discourse Integration

Discourse Integration is usually carried out by considering the preceding sentences of words and succeeding sentences of words. It may also consider the meaning conveyed by the whole paragraph. Usually the sentences of a paragraph go in a flow and this phase tries to utilize this feature to understand natural language meaning.

III. ROLE OF NLP IN AUTOMATED SYSTEMS AND INTELLIGENT AGENTS

A. Significance of NLP for Automated Systems

Automated systems are developed to make human life simpler and easier by making a set of tasks programmed. NLP plays a significant role in building automated systems in major fields such as production and engineering, home automation systems, evaluation systems, robotic processes automation etc.

Major benefits of automated systems are:

- Better utilization of time, money and resources.
- Reduce human errors and biases.
- Ease of management.

Main challenges while using automated systems are:

- Security.
- Complexity.
- Accuracy.

Language based automated systems are developed for question answering, summarization, handwritten character recognition, evaluations, speech interactions and for many other applications. They should be able to understand the language of communication and to generate the natural language. Language based automated systems are implemented in the following four NLP and NLG phases.

Analysis: The system must be capable of understanding the syntax, morphology and semantics of a particular text under consideration.

Recognition: Based on the analysis performed it must be capable of identifying the context in which the particular text appears. Also, it should be capable of predicting the part of speech features, word features and other lexicalized features of the given text.

Classification: For the purpose of understanding the natural language text, they must be classified based on the recognized contextual, part of speech, word and other lexicalized features.

Interpretation: The classified text is interpreted by the system using efficient algorithms and other learning techniques depending on the application which is used. In this phase many resources like the word nets, dictionaries, language specific word lists etc. are used. Interpretation phase is the most important phase as it determines the accuracy of the predicted output.

Output Generation: Based on the application under consideration, the output is generated which can be in the form of natural language or digitized form.

B. Significance of NLP for Intelligent Agents

Intelligent agents are entities that perform activities autonomously to achieve specific goals. Intelligent agents map its perceptional input at a particular instant to an action. Logical agents decide on its action based on logical deduction. Reactive agents map the current situation to an action directly. Belief desire intention agents uses beliefs which is acquired from past actions, desires which depends on the output expected and intentions which are the desires which the agent is more committed as parameters to decide on the actions.

Intelligent agents can be classified into the following classes:

Simple Reflex Agents: uses only current perceptions and does not depend on history of perceptions.

Model Based Reflex Agents: uses current perceptions and also history of perceptions to decide on the actions.

Goal Based Reflex Agents: uses the goal information also together with current perceptions and history of perceptions to select a desired action among multiple possibilities.

Utility Based Reflex Agent: uses an utility function to maximize the utility of the action chosen.

Learning Agents: works initially in an unknown environment but improves its actions through learning.

Intelligent agents must be capable of understanding and generating natural language. With the advent of keyboard less devices, autonomous vehicles etc. the importance of natural language processing for intelligent agents has increased significantly. The autonomous agents are enabled with listening, speaking, explaining, adapting and understanding the context of the language.

The below features emphasizes the importance of natural language understanding and natural language generation for intelligent agents.

Conversational: Intelligent agents must be able to understand what is the task assigned to it or it is instructed to do. It cannot clear its ambiguity by itself as it does not have a pre-defined script.

Explanatory: Agents must be capable of explaining the reason for selecting a particular action in a given situation.

Sociable: Agents must be having an awareness of the environment in which it is present and should be capable of interacting with human counterpart.

Context Aware: Contextual intelligence is a must as the agent must be capable of pro-actively selecting a service based on the behavior by its human counterpart in a similar context.

Engaging: Agents must be capable of understanding the importance of a request from the natural language spoken. Based on the priority or urgency of a particular request the agent must behave in a desired way.

IV. APPLICATIONS OF NLP

Below are the broader areas where NLP is widely used [Fig 3]. The key component in all the applications is text and speech processing[4]

Fig 3: Various applications of NLP

1. Text Mining/ Text Analytics

Text Mining key technology in NLP. It is carried out by examining large collections of written resources to generate new information, and to transform the unstructured text into structured data for use in further analysis using NLU methods[3]

2. Machine Translation

Machine translation helps to overcome natural language barriers by converting information from one language to another. Different levels of NLP Machine translation approaches are implemented such as direct translation, rule based translation, corpus based translation and knowledge based translation to undergo high level analysis and translation [6].

3. Speech Understanding

Speech is provided as input to the Speech Recognition system which results in retrieving all the information specific to particular task. Also, another form is programmed production of speech by generating the utterances by processing the text [9].

4. Automated questions and Answering/ Chatbots

NLP has also evolved in Questions and Answering sections, Chatbots and voice activated technologies

which have renewed interest in natural NLU and NLP.

Researchers forged ahead with reinforcement learning to teach to agents to design their own language by dropping them into set of simple words and giving them goals that can best achieved by communicating with other agents [4].

5. Automatic Summarization

Internet is an aggregate of enormous information and its challenging to the web user to verve through the information on web. So, NLU- Statistical Machine Learning methods filters out summaries of significant facts from the large text document [7]. Different Automatic Summarization of NLP like Abstract vs. Exact Summary Single vs. Multidocument Summary are existing to reduce bigger text in to smaller abbreviated representation [8].

V. CONCLUSION

Natural Language Processing is widely blended with the extensive number of educational connections pertaining to science and research fields, linguistics, web-learning, automatic evaluations systems, training artificial intelligent agents etc. This paper is an attempt to look through the significance of natural language processing for all these applications emphasizing on automated systems and intelligent agents.

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