Marathwada Shikshan Prasarak Mandal’s

**Deogiri Institute of Engineering and Management Studies,**

**Aurangabad**

**Seminar Report**

**On**

**Natural Language Processing Used in Amazon Alexa**

Submitted By

**Nemade Ashwini Anil (36157)**

**Dr. Babasaheb Ambedkar Technological University**

**Lonere (M.S.)**



Department of Computer Science and Engineering

**Deogiri Institute of Engineering and Management Studies,**

**Aurangabad**

(2019- 2020)

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Submitted By

**Nemade Ashwini Anil (36157)**

**In partial fulfillment of**

**Bachelor of Technology**

**(Computer Science & Engineering)**

Guided By

**Prof. Poonam Borase**

Department of Computer Science & Engineering

**Deogiri Institute of Engineering and Management Studies,**

**Aurangabad**

(2019- 2020)

**CERTIFICATE**

This is to certify that, the Seminar entitled “**Natural Language Processing Used in Amazon Alexa**” submitted by **Nemade Ashwini Anil** is a bonafide work completed under my supervision and guidance in partial fulfillment for award of Bachelor of Technology (Computer Science and Engineering) Degree of Dr. BabasahebAmbedkar Technological University, Lonere.

Place: Aurangabad

Date:

**Mrs Poonam Borase Mr. S.B. Kalyankar**

**Guide Head**

**Dr. Ulhas D. Shiurkar**

**Director,**

**Deogiri Institute of Engineering and Management Studies,**

**Aurangabad**

**Abstract**

Natural Language Processing is the technology used to aid computers to understand the human’s natural language. Natural Language Processing, usually shortened as NLP, is a branch of artificial intelligence that deals with the interaction between computers and humans using the natural language. The ultimate objective of NLP is to read, decipher, understand, and make sense of the human languages in a manner that is valuable. NLP entails applying algorithms to identify and extract the natural language rules such that the unstructured [language data](https://blog.liveedu.tv/a-quick-introduction-to-text-summarization-in-machine-learning/) is converted into a form that computers can understand. Syntactic analysis and semantic analysis are the main techniques used to complete Natural Language Processing tasks.

Amazon Alexa is a virtual assistant developed by amazon; it is used in Amazon smart speakers. Alexa is capable of voice interaction, music playback, making to-do lists, [setting alarms](https://en.wikipedia.org/wiki/Alarm_clock), streaming podcasts, playing audiobooks, and providing weather, traffic, sports, and other real-time information, such as [news](https://en.wikipedia.org/wiki/News). Alexa can also control several [smart devices](https://en.wikipedia.org/wiki/Smart_device) using itself as a [home automation](https://en.wikipedia.org/wiki/Home_automation) system. To do all this kind of task natural language processing is the main technique is used in this.

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**List of Abbreviation**

|  |  |  |
| --- | --- | --- |
| **Sr.No** | **Acronym** | **Abbreviation** |
| 1 | NLP | Natural Language Processing |
| 2 | AI | Artificial Intelligence |
| 3 | NLTK | Natural Language Toolkit |
| 4 | ASR | Automatic Speech Recognition |
| 5 | NLU | Natural Language Understanding |

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**1.Introduction**

* 1. **What is an Amazon Alexa?**

Amazon Alexa, known simply as Alexa, is a [virtual assistant](https://en.wikipedia.org/wiki/Virtual_assistant) developed by [Amazon](https://en.wikipedia.org/wiki/Amazon_(company)), first used in the [Amazon Echo](https://en.wikipedia.org/wiki/Amazon_Echo) and the Amazon Echo Dot [smart speakers](https://en.wikipedia.org/wiki/Smart_speaker) developed by [Amazon Lab126](https://en.wikipedia.org/wiki/Amazon_Lab126). It is capable of voice interaction, music playback, making to-do lists, [setting alarms](https://en.wikipedia.org/wiki/Alarm_clock), streaming podcasts, playing audiobooks, and providing weather, traffic, sports, and other real-time information, such as [news](https://en.wikipedia.org/wiki/News). Alexa can also control several [smart devices](https://en.wikipedia.org/wiki/Smart_device) using itself as a [home automation](https://en.wikipedia.org/wiki/Home_automation) system. Users are able to extend the Alexa capabilities by installing "skills" (additional functionality developed by third-party vendors, in other settings more commonly called [apps](https://en.wikipedia.org/wiki/Mobile_app) such as weather programs and audio features).

Most devices with Alexa allow users to activate the device using a wake-word (such as Alexa); other devices (such as the Amazon [mobile app](https://en.wikipedia.org/wiki/Mobile_app) on [iOS](https://en.wikipedia.org/wiki/IOS) or [Android](https://en.wikipedia.org/wiki/Android_(operating_system)) and Amazon Dash Wand) require the user to push a button to activate Alexa's listening mode. Currently, interaction and communication with Alexa are available only in English, German, French, Italian, Spanish, Portuguese, Japanese, and Hindi. In Canada, Alexa is available in English and in French.

As of September 2017, Amazon had more than 5,000 employees working on Alexa and related products. In January 2019, Amazon's devices team announced that they had sold over 100 million Alexa-enabled devices.

In September, 2019 Amazon launched many new devices achieving many records while competing with the world's smart home industry. The new Echo Studio became the first smart speaker with 360 sound and Dolby sound. Other new devices included an Echo dot with a clock behind the fabric, a new third-generation Amazon Echo, Echo Show 8, a plug-in Echo device, Echo Flex, Alexa built-in wireless earphones, Echo buds, Alexa built-in spectacles, Echo frames, an Alexa built-in Ring, and Echo Loop.

Amazon’s Alexa is a device that strictly revolves around WiFi to access everything from Google to various music-streaming services. Without WiFi it is simply impossible to connect to these applications and features. In order to make the most out of your Amazon Alexa investment, a Wi-Fi connection or hotspot must be available to get started and to take advantage of all that the device has to offer.

Alexa supports a growing number of free and subscription-based streaming services on Amazon devices. To see which services are available, in the Alexa app, select **menu, Settings**, and **TV & Video.** You can ask Alexa to stream music and media through one or more of your Alexa devices. After you register an Alexa device to your Amazon account, you automatically have access to your Amazon Music library.Some services require you to link an existing account or subscription to your Amazon account in the Alexa app.

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Figure 1.1: Amazon Alexa

* 1. **History of Alexa**

In November 2014, Amazon announced Alexa alongside the [Echo](https://en.wikipedia.org/wiki/Amazon_Echo). Alexa was inspired by the [computer voice](https://en.wikipedia.org/wiki/Speech_synthesis) and [conversational system](https://en.wikipedia.org/wiki/Dialog_system) on board the [Starship Enterprise](https://en.wikipedia.org/wiki/Starship_Enterprise) in science fiction TV series and movies, beginning with [Star Trek: The Original Series](https://en.wikipedia.org/wiki/Star_Trek:_The_Original_Series) and [Star Trek: The Next Generation](https://en.wikipedia.org/wiki/Star_Trek:_The_Next_Generation).

Amazon developers chose the name Alexa because it has a hard consonant with the X, which helps it be recognized with higher precision. They have said the name is reminiscent of the [Library of Alexandria](https://en.wikipedia.org/wiki/Library_of_Alexandria), which is also used by Amazon [Alexa Internet](https://en.wikipedia.org/wiki/Alexa_Internet) for the same reason. In June 2015, Amazon announced Alexa Fund, a program that would invest in companies making voice control skills and technologies. The US$100 million in funds has invested in companies including [ecobee](https://en.wikipedia.org/wiki/Ecobee" \o "Ecobee), Orange Chef, Scout Alarm, [Garageio](https://en.wikipedia.org/wiki/Garageio" \o "Garageio), Toymail, MARA, and Mojio. In 2016, the [Alexa Prize](https://en.wikipedia.org/wiki/Amazon_Alexa#Alexa_Prize) was announced to advance the technology.

In January 2017, the first Alexa Conference took place in Nashville, Tennessee, an independent gathering of the worldwide community of Alexa developers and enthusiasts. The follow-up has been announced, to be keynoted by original Amazon Alexa / Connected Home product head Ahmed Bouzid.

At the Amazon Web Services Reinvent conference in Las Vegas, Amazon announced Alexa for Business and the ability for app developers to have paid add-ons to their skills.

In May 2018, Amazon announced they would include Alexa in 35,000 new [Lennar Corporation](https://en.wikipedia.org/wiki/Lennar_Corporation) homes built this year.

In November 2018, Amazon opened its first Alexa-themed pop-up shop inside of [Toronto](https://en.wikipedia.org/wiki/Toronto)'s [Eaton Centre](https://en.wikipedia.org/wiki/Toronto_Eaton_Centre), showcasing the use of home automation products with Amazon's smart speakers. Amazon also sells Alexa devices at [Amazon Books](https://en.wikipedia.org/wiki/Amazon_Books) and [Whole Foods Market](https://en.wikipedia.org/wiki/Whole_Foods_Market) locations, in addition to [mall-based pop-ups](https://en.wikipedia.org/wiki/List_of_Amazon_locations) throughout the United States.

In April 2019, Amazon announced the expansion of Alexa to Brazil, in [Portuguese](https://en.wikipedia.org/wiki/Portuguese_language), together with Bose, Intelbras, and [LG](https://en.wikipedia.org/wiki/LG). The company has since launched various products in India, including Alexa-enabled speakers, Bluetooth wireless speakers, [car chargers](https://www.gadgetssansar.in/2019/10/roav-viva-alexa-for-car-charger.html), power banks, robotic vacuum cleaner, USB cables, and wireless earphones under Anker, Eufy, and Soundcore.

* 1. **What is Natural Language Processing (NLP)?**

Natural language processing (NLP) is a subfield of [linguistics](https://en.wikipedia.org/wiki/Linguistics), [computer science](https://en.wikipedia.org/wiki/Computer_science), [information engineering](https://en.wikipedia.org/wiki/Information_engineering_(field)), and [artificial intelligence](https://en.wikipedia.org/wiki/Artificial_intelligence) concerned with the interactions between computers and human (natural) languages, in particular how to program computers to process and analyze large amounts of [natural language](https://en.wikipedia.org/wiki/Natural_language) data.

Challenges in natural language processing frequently involve [speech recognition](https://en.wikipedia.org/wiki/Speech_recognition), [natural language understanding](https://en.wikipedia.org/wiki/Natural_language_understanding), and [natural language generation](https://en.wikipedia.org/wiki/Natural_language_generation).

Natural language processing (NLP) is the ability of a computer program to understand human language as it is spoken. NLP is a component of artificial intelligence ([AI](https://searchenterpriseai.techtarget.com/definition/AI-Artificial-Intelligence)).

The development of NLP applications is challenging because computers traditionally require humans to "speak" to them in a programming language that is precise, unambiguous and highly structured, or through a limited number of clearly enunciated voice commands. Human speech, however, is not always precise -- it is often ambiguous and the linguistic structure can depend on many complex variables, including slang, regional dialects and social context.

Syntax and semantic analysis are two main techniques used with natural language processing. Syntax is the arrangement of words in a sentence to make grammatical sense. NLP uses syntax to assess meaning from a language based on grammatical rules. Syntax techniques used include parsing (grammatical analysis for a sentence), word segmentation (which divides a large piece of text to units), sentence breaking (which places sentence boundaries in large texts), morphological segmentation (which divides words into groups) and stemming (which divides words with inflection in them to root forms).

Semantics involves the use and meaning behind words. NLP applies algorithms to understand the meaning and structure of sentences. Techniques that NLP uses with semantics include word sense disambiguation (which derives meaning of a word based on context), [named entity recognition](https://whatis.techtarget.com/definition/named-entity-recognition-NER) (which determines words that can be categorized into groups), and [natural language generation](https://searchenterpriseai.techtarget.com/definition/natural-language-generation-NLG) (which will use a database to determine semantics behind words).

Current approaches to NLP are based on deep learning, a type of AI that examines and uses patterns in data to improve a program's understanding. Deep learning models require massive amounts of labeled data to train on and identify relevant correlations, and assembling this kind of [big data](https://searchdatamanagement.techtarget.com/definition/big-data) set is one of the main hurdles to NLP currently.

Earlier approaches to NLP involved a more rules-based approach, where simpler machine learning [algorithms](https://whatis.techtarget.com/definition/algorithm) were told what words and phrases to look for in text and given specific responses when those phrases appeared. But deep learning is a more flexible, intuitive approach in which algorithms learn to identify speakers' intent from many examples, almost like how a child would learn human language.

Three tools used commonly for NLP include NLTK, Gensim, and Intel NLP Architect. NTLK, Natural Language Toolkit, is an open source [python](https://whatis.techtarget.com/definition/Python) modules with data sets and tutorials. Gensim is a Python library for topic modeling and document indexing. Intel NLP Architect is also another Python library for deep learning topologies and techniques.

NLP has not yet been wholly perfected. For example, semantic analysis can still be a challenge for NLP. Other difficulties include the fact that abstract use of language is typically tricky for programs to understand. For instance, NLP does not pick up sarcasm easily. These topics usually require the understanding of the words being used and the context in which the way they are being used. As another example, a sentence can change meaning depending on which word the speaker puts stress on. NLP is also challenged by the fact that language, and the way people use it, is continually changing.

**1.4 Rule-based verses statistical NLP**

In the early days, many language-processing systems were designed by hand-coding a set of rules: such as by writing grammars or devising heuristic rules for [stemming](https://en.wikipedia.org/wiki/Stemming).

Since the so-called "statistical revolution" in the late 1980s and mid1990s, much natural language processing research has relied heavily on [machine learning](https://en.wikipedia.org/wiki/Machine_learning). The machine-learning paradigm calls instead for using [statistical inference](https://en.wikipedia.org/wiki/Statistical_inference) to automatically learn such rules through the analysis of large [corpora](https://en.wikipedia.org/wiki/Text_corpus) (the plural form of corpus, is a set of documents, possibly with human or computer annotations) of typical real-world examples.

Many different classes of machine-learning algorithms have been applied to natural-language-processing tasks. These algorithms take as input a large set of "features" that are generated from the input data. Some of the earliest-used algorithms, such as [decision trees](https://en.wikipedia.org/wiki/Decision_tree), produced systems of hard if-then rules similar to the systems of handwritten rules that were then common. Increasingly, however, research has focused on [statistical models](https://en.wikipedia.org/wiki/Statistical_models), which make soft, [probabilistic](https://en.wikipedia.org/wiki/Probabilistic) decisions based on attaching [real-valued](https://en.wikipedia.org/wiki/Real-valued) weights to each input feature. Such models have the advantage that they can express the relative certainty of many different possible answers rather than only one, producing more reliable results when such a model is included as a component of a larger system.

Systems based on machine-learning algorithms have many advantages over hand produced rules:

* The learning procedures used during machine learning automatically focus on the most common cases, whereas when writing rules by hand it is often not at all obvious where the effort should be directed.
* Automatic learning procedures can make use of statistical-inference algorithms to produce models that are robust to unfamiliar input (e.g. containing words or structures that have not been seen before) and to erroneous input (e.g. with misspelled words or words accidentally omitted). Generally, handling such input gracefully with handwritten rules, or, more generally, creating systems of handwritten rules that make soft decisions, is extremely difficult, error-prone and time-consuming.
* Systems based on automatically learning the rules can be made more accurate simply by supplying more input data. However, systems based on handwritten rules can only be made more accurate by increasing the complexity of the rules, which is a much more difficult task. In particular, there is a limit to the complexity of systems based on handcrafted rules, beyond which the systems become more and more unmanageable. However, creating more data to input to machine-learning systems simply requires a corresponding increase in the number of man-hours worked, generally without significant increases in the complexity of the annotation process.

**2.LITERATURE SURVEY**

**2.1 Review of Research Work in NLP**

Natural Language Processing (NLP) is that field of computer science which consists of interfacing computer representations of information with natural languages used by humans. It examines the use of computers in understanding and manipulating the natural language text and speech. Over the past years, a lot of research has been done in the field of NLP. Some of the recent works have been discussed here. Kumarana et al. have developed a multilingual content creation tool for Wikipedia. Optimal Search for Minimum Error Rate Training has been discussed by Michel and Chris. Associating Web Queries with Strongly-Typed Entities, Linguistic Style Accommodation in Social Media, Predicting the Importance of Newsfeed Posts and Social Network Friends, Wiki BABEL: A System for Multilingual Wikipedia Content, The utility of article and preposition error correction systems for English language learners: Feedback and Assessment. The work presented in this Section has been previously published.

**2.1.1**. **Theoretical developments in NLP**

Theoretical developments in NLP can be grouped into following classes: (i) statistical and corpus-based methods in NLP, (ii) use of WordNet for NLP research, (iii) use of finite-state methods in NLP.

**2.1.1.1. Statistical Methods**

The models and methods used in solving NLP problems are broadly classified into two types: deterministic and stochastic. A mathematical model is called deterministic if it does not involve the concept of probability; otherwise it is said to be stochastic. A stochastic model can be probabilistic or statistical, if its representation is from the theories of probability or statistics, respectively. Statistical methods are used in NLP for a number of purposes, e.g., speech recognition, part-of-speech tagging, for generating grammars and parsing, word sense disambiguation, and so on. There has been a lot of research in these areas. Geoffrey Zweig and Patrick Nguyen have proposed a segmental conditional random field framework for large vocabulary continuous speech recognition. Gerasimos Potamianos, Chalapathy Neti, Ashutosh Garg, Guillaume Gravier and Andrew W. Senior have reviewed Advances in the Automatic Recognition of Audio-Visual Speech and have presented the algorithms demonstrating that the visual modality improves automatic speech recognition over all conditions and data considered. Raymond J. Mooney has developed a number of machine learning methods for introducing semantic parsers byc training on a corpus of sentences paired with their meaning representations in a specified formal language. Marine CARPUAT and Dekai WU have shown that statistical machine translation can be improved by using word sense disambiguation. They have shown that if the predictions of the word sense disambiguation system are incorporated within a statistical machine translation model then the translation quality is consistently improved.

**2.1.1.2. Use of WordNet for NLP** **research**

Mihalcea & Moldovan have proposed the use of WordNet to make the outcome of statistical analysis of natural language texts better. WordNet or the electronic dictionary is developed at Princeton University. It is a large database that serves as an important NLP tool consisting of nouns, verbs, adjectives and adverbs. These are arranged in the form of synonym sets (synsets).Each set represents one underlying lexical concept. These sets are linked with each other by means of conceptual-semantic and lexical relations. There are different wordnets for about 50 different languages, but they are not complete like the original English WordNet. WordNet is now used in a number of NLP research and applications. One of the most important applications of WordNet in NLP is EuroWordNet developed in Europe. EuroWordNet is a multilingual database which consists of WordNets for the European languages. It has been structured in the same way as the WordNet for English. A methodology for the automatic construction of a large-scale multilingual lexical database has been proposed where words of many languages are hierarchically organized in terms of their meanings and their semantic relations to other words. This database is capable of organizing over 800,000 words from over 200 languages, providing over 1.5 million links from words to word meanings. This universal wordnet has been derived from the Princeton WordNet. Lars Borin and Markus Forsberg have given a comparison between WordNet and SALDO. SALDO is a Swedish lexical resource which has been developed for language technology applications. Japanese WordNet currently has 51,000 synsets with Japanese entries. Methods for enhancing or extending the Japanese Wordnet have been discussed. These include: increasing the cover, linking it to examples in corpora and linking it to other resources. In addition various plans have been outlined to make it more useful by adding Japanese definition sentences to each synset. The use of WordNet in multimedia information retrieval has also been discussed and the use of external knowledge in a corpus with minimal textual information has been investigated. The original collection has been expanded with WordNet terms in order to enrich the information included in the corpus and the experiments have been carried out with original as well as expanded topics. A Standardized Format for Wordnet Interoperability has been given i.e., WordNet- LMF. The main aim of this format is to provide the WordNet with a format representation that will allow easier integration among resources sharing the same structure (i.e. other wordnets) and, more importantly, across resources with different theoretical and implementation approaches.

**2.1.1.3. Use of finite state methods in NLP**

The finite-state automation is the mathematical tool used to implement regular expressions – the standard notation for characterizing text sequences. Different applications of the Finite State methods in NLP have been discussed. From past many years the finite state methods have been used in presenting various research studies on NLP. The FSMNLP workshops are the main forum of the Association for Computational Linguistics‟ (ACL) Special Interest Group on Finite-State Methods (SIGFSM).

**2.2 NLP Software**

A number of NLP software packages and tools have been developed, some of which are available for free, while others are available commercially. These tools have been broadly classified into different types some of which are mentioned here. General Information Tools( e.g. Sourcebank – a search engine for programming resources., The Natural Language Software Registry), Taggers and Morphological Analyzers( e.g. A Perl/Tk text tagger, AUTASYS – which is a completely automatic English Wordclass analysis system, TreeTagger – a language independent part-of-speech tagger, Morphy – which is a tool for German morphology and statistical part-of-speech tagging), Information Retrieval & Filtering Tools (e.g. Rubryx: Text Classification Program, seft – a Search Engine For Text, Isearch – software for indexing and searching text documents, ifile – A general mail filtering system, Bow: A Toolkit for Statistical Language Modeling, Text Retrieval, Classification and Clustering), Machine Learning Tools ( e.g. Machine Learning Toolbox (MLT), The Machine Learning Programs Repository), FSA Tools( e.g. FSA Utilities: A Toolbox to Manipulate Finite-state Automata), HMM Tools (e.g. Hidden Markov Model (HMM) Toolbox, Discrete HMM Toolkit, A HMM mini-toolkit), Language Modeling Tools( e.g. Maximum Entropy Modeling Toolkit, Trigger Toolkit, Language modeling tools), Corpus Tools ( e.g. WebCorp, Multext: i.e. Multilingual Text Tools and Corpora, TACT- i.e. Text Analysis Computing Tools, Textual Corpora and Tools for their Exploration). Some more tools include DR-LINK (Document Retrieval using LINguistic Knowledge) system demonstrating the capabilities of NLP for Information Retrieval, NLPWin: an NLP system from Microsoft that accepts sentences and delivers detailed syntactic analysis, together with a logical form representing an abstraction of the meaning. Waldrop has described the features of three NLP software packages, viz. Jupiter: a product of the MIT research Lab that works in the field of weather forecast, Movieline: a product of Carnegie Mellon that talks about local movie schedules, and MindNet from Microsoft Research, a system for automatically extracting a massively hyperlinked web of concepts.

**3.Brief on System**

**3.1 How Does Alexa Works?**

According to [Adi Agashe](https://www.quora.com/profile/Adi-Agashe), Program Manager at Microsoft, Alexa is built based on natural language processing (NLP), a procedure of converting speech into words, sounds, and ideas.

* Amazon records your words. Indeed, interpreting sounds takes up a lot of computational power, **the recording of your speech is sent to Amazon’s servers to be analyzed** more efficiently.
* Amazon breaks down your “orders” into individual sounds. It then consults a database containing various words’ pronunciations to **find which words most closely correspond to the combination of individual sounds**.
* It then**identifies important words to make sense of the tasks** and carry out corresponding functions. For instance, if Alexa notices words like “sport” or “basketball”, it would open the sports app.
* **Amazon’s servers send the information back to your device and Alexa may speak**. If Alexa needs to say anything back, it would go through the same process described above, but in reverse order

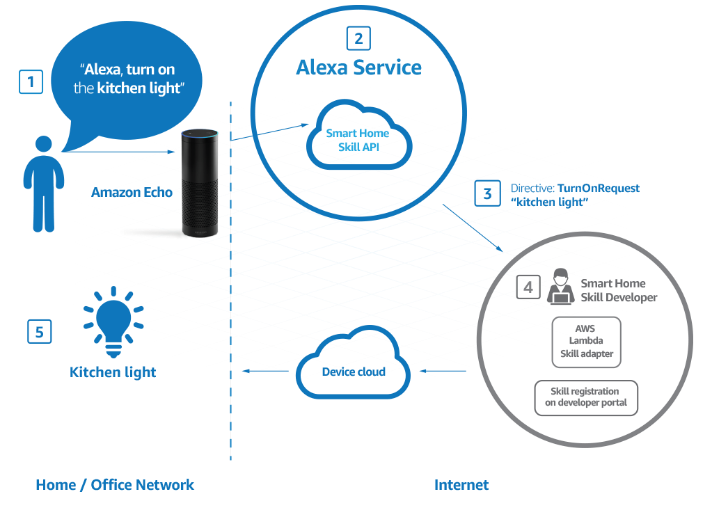


Figure 3.1: Working of Alexa

According to [Trupti Behera](https://www.quora.com/profile/Trupti-Behera-6), “It starts with signal processing, which gives Alexa as many chances as possible to make sense of the audio by cleaning the signal. Signal processing is one of the most important challenges in far-field audio.

The idea is to improve the target signal, which means being able to identify ambient noise like the TV and minimize them. To resolve these issues, seven microphones are used to identify roughly where the signal is coming from so the device can focus on it. Acoustic echo cancellation can subtract that signal so only the remaining important signal remains.

The next task is “Wake Word Detection”. It determines whether the user says one of the words the device is programmed to need to turn on, such as “Alexa”. This is needed to minimize false positives and false negatives, which could lead to accidental purchases and angry customers. This is really complicated as it needs to identify pronunciation differences, and it needs to do so on the device, which has limited CPU power.

If the wake word is detected, the signal is then sent to the speech recognition software in the cloud, which takes the audio and converts it to text format. The output space here is huge as it looks at all the words in the English language, and the cloud is the only technology capable of scaling sufficiently. This is further complicated by the number of people who use the Echo for music — many artists use different spellings for their names than there are words.

To convert the audio into text, Alexa will analyze characteristics of the user’s speech such as frequency and pitch to give you feature values.

A decoder will determine what the most likely sequence of words is, given the input features and the model, which is split into two pieces. The first of these pieces is the prior, which gives you the most likely sequence based on a huge amount of existing text, without looking at the features, the other is the acoustic model, which is trained with deep learning by looking at pairings of audio and transcripts. These are combined and dynamic coding is applied, which has to happen in real time.”

**3.2. Analysis of Order**



Figure 3.2: Analysis of order

The above command has 3 main parts: Wake word, Invocation name, Utterance.

* **Wake word:** When users say ‘Alexa’ which wakes up the device. The wake word put the Alexa into the listening mode and ready to take instructions from users.
* **Invocation name:** Invocation name is the keyword used to trigger a specific “skill”. Users can combine the invocation name with an action, command or question. All the custom skills must have an invocation name to start it.
* **Utterance:** ‘Taurus’ is an utterance. Utterances are phrases the users will use when making a request to Alexa. Alexa identifies the user’s intent from the given utterance and responds accordingly. So basically, the utterance decides what user want Alexa to perform.

After, Alexa enabled devices sends the user’s instruction to a cloud-based service called Alexa Voice Service (AVS).

Think the Alexa Voice Service as the brain of Alexa enabled devices and perform all the complex operations such as Automatic Speech Recognition (ASR) and Natural Language Understanding (NLU).

Alexa Voice Service process the response and identify the user’s intent, then it makes the web service request to third party server if needed.

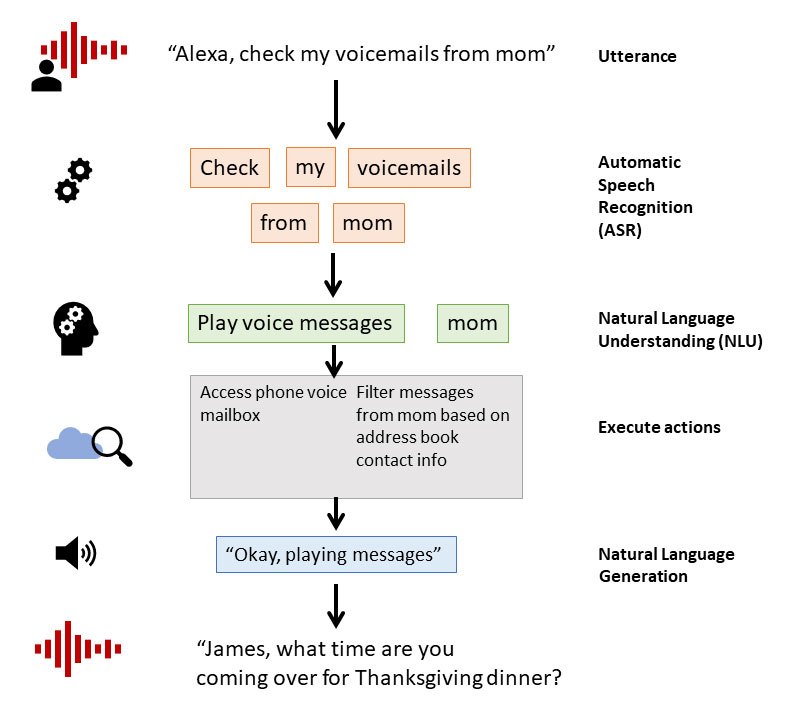


Figure 3.3: Processing in Alexa

**3.3 Major evaluations and tasks of NLP**

The following is a list of some of the most commonly researched tasks in natural language processing. Some of these tasks have direct real-world applications, while others more commonly serve as subtasks that are used to aid in solving larger tasks.

Though natural language processing tasks are closely intertwined, they are frequently subdivided into categories for convenience. A coarse division is given below.

**3.3.1. Syntax**

[**Grammar induction**](https://en.wikipedia.org/wiki/Grammar_induction)**:** Generate a [formal grammar](https://en.wikipedia.org/wiki/Formal_grammar) that describes a language's syntax.

[**Lemmatization**](https://en.wikipedia.org/wiki/Lemmatisation)**:** The task of removing inflectional endings only and to return the base dictionary form of a word which is also known as a lemma.

[**Morphological segmentation**](https://en.wikipedia.org/wiki/Morphology_(linguistics))**:** Separate words into individual [morphemes](https://en.wikipedia.org/wiki/Morpheme) and identify the class of the morphemes. The difficulty of this task depends greatly on the complexity of the [morphology](https://en.wikipedia.org/wiki/Morphology_(linguistics)) (i.e. the structure of words) of the language being considered. [English](https://en.wikipedia.org/wiki/English_language) has fairly simple morphology, especially [inflectional morphology](https://en.wikipedia.org/wiki/Inflectional_morphology), and thus it is often possible to ignore this task entirely and simply model all possible forms of a word (e.g. "open, opens, opened, opening") as separate words. In languages such as [Turkish](https://en.wikipedia.org/wiki/Turkish_language) or [Meitei](https://en.wikipedia.org/wiki/Meitei_language), a highly [agglutinated](https://en.wikipedia.org/wiki/Agglutination) Indian language, however, such an approach is not possible, as each dictionary entry has thousands of possible word forms.

[**Part-of-speech tagging**](https://en.wikipedia.org/wiki/Part-of-speech_tagging)**:** Given a sentence, determine the [part of speech](https://en.wikipedia.org/wiki/Part_of_speech) (**POS**) for each word. Many words, especially common ones, can serve as multiple [parts of speech](https://en.wikipedia.org/wiki/Parts_of_speech). For example, "book" can be a [noun](https://en.wikipedia.org/wiki/Noun) ("the book on the table") or [verb](https://en.wikipedia.org/wiki/Verb) ("to book a flight"); "set" can be a [noun](https://en.wikipedia.org/wiki/Noun), [verb](https://en.wikipedia.org/wiki/Verb) or [adjective](https://en.wikipedia.org/wiki/Adjective); and "out" can be any of at least five different parts of speech. Some languages have more such ambiguity than others. Languages with little [inflectional morphology](https://en.wikipedia.org/wiki/Inflectional_morphology), such as [English](https://en.wikipedia.org/wiki/English_language), are particularly prone to such ambiguity. [Chinese](https://en.wikipedia.org/wiki/Chinese_language) is prone to such ambiguity because it is a [tonal language](https://en.wikipedia.org/wiki/Tonal_language) during verbalization. Such inflection is not readily conveyed via the entities employed within the orthography to convey intended meaning.

[**Parsing**](https://en.wikipedia.org/wiki/Parsing)**:** Determine the [parse tree](https://en.wikipedia.org/wiki/Parse_tree) (grammatical analysis) of a given sentence. The [grammar](https://en.wikipedia.org/wiki/Grammar) for [natural languages](https://en.wikipedia.org/wiki/Natural_language) is [ambiguous](https://en.wikipedia.org/wiki/Ambiguous) and typical sentences have multiple possible analyses. In fact, perhaps surprisingly, for a typical sentence there may be thousands of potential parses (most of which will seem completely nonsensical to a human). There are two primary types of parsing, Dependency Parsing and Constituency Parsing. Dependency Parsing focuses on the relationships between words in a sentence (marking things like Primary Objects and predicates), whereas Constituency Parsing focuses on building out the Parse Tree using a [Probabilistic Context-Free Grammar](https://en.wikipedia.org/wiki/Probabilistic_context-free_grammar) (PCFG). See also: [Stochastic grammar](https://en.wikipedia.org/wiki/Stochastic_grammar).

[**Sentence breaking**](https://en.wikipedia.org/wiki/Sentence_breaking)**:** Given a chunk of text, find the sentence boundaries. Sentence boundaries are often marked by [periods](https://en.wikipedia.org/wiki/Full_stop) or other [punctuation marks](https://en.wikipedia.org/wiki/Punctuation_mark), but these same characters can serve other purposes (e.g. marking [abbreviations](https://en.wikipedia.org/wiki/Abbreviation)).

[**Stemming**](https://en.wikipedia.org/wiki/Stemming)**:** The process of reducing inflected (or sometimes derived) words to their root form. (e.g. "close" will be the root for "closed", "closing", "close", "closer" etc.).

[**Word segmentation**](https://en.wikipedia.org/wiki/Word_segmentation)**:** Separate a chunk of continuous text into separate words. For a language like [English](https://en.wikipedia.org/wiki/English_language), this is fairly trivial, since words are usually separated by spaces. However, some written languages like [Chinese](https://en.wikipedia.org/wiki/Chinese_language), [Japanese](https://en.wikipedia.org/wiki/Japanese_language) and [Thai](https://en.wikipedia.org/wiki/Thai_language) do not mark word boundaries in such a fashion, and in those languages text segmentation is a significant task requiring knowledge of the [vocabulary](https://en.wikipedia.org/wiki/Vocabulary) and [morphology](https://en.wikipedia.org/wiki/Morphology_(linguistics)) of words in the language. Sometimes this process is also used in cases like Bag of Words (BOW) creation in data mining.

[**Terminology extraction**](https://en.wikipedia.org/wiki/Terminology_extraction)**:** The goal of terminology extraction is to automatically extract relevant terms from a given corpus.

**3.3.2. Semantics**

[**Lexical semantics**](https://en.wikipedia.org/wiki/Lexical_semantics)**:** What is the computational meaning of individual words in context?

[**Distributional semantics**](https://en.wikipedia.org/wiki/Distributional_semantics)**:** How can we learn semantic representations from data?

[**Machine translation**](https://en.wikipedia.org/wiki/Machine_translation)**:** Automatically translate text from one human language to another. This is one of the most difficult problems, and is a member of a class of problems colloquially termed "[AI-complete](https://en.wikipedia.org/wiki/AI-complete)", i.e. requiring all of the different types of knowledge that humans possess (grammar, semantics, facts about the real world, etc.) in order to solve properly.

[**Named entity recognition**](https://en.wikipedia.org/wiki/Named_entity_recognition)**(NER):** Given a stream of text, determine which items in the text map to proper names, such as people or places, and what the type of each such name is (e.g. person, location, organization). Although [capitalization](https://en.wikipedia.org/wiki/Capitalization) can aid in recognizing named entities in languages such as English, this information cannot aid in determining the type of named entity, and in any case is often inaccurate or insufficient. For example, the first letter of a sentence is also capitalized, and named entities often span several words, only some of which are capitalized. Furthermore, many other languages in non-Western scripts (e.g. [Chinese](https://en.wikipedia.org/wiki/Chinese_language) or [Arabic](https://en.wikipedia.org/wiki/Arabic_language)) do not have any capitalization at all, and even languages with capitalization may not consistently use it to distinguish names. For example, [German](https://en.wikipedia.org/wiki/German_language) capitalizes all [nouns](https://en.wikipedia.org/wiki/Noun), regardless of whether they are names, and [French](https://en.wikipedia.org/wiki/French_language) and [Spanish](https://en.wikipedia.org/wiki/Spanish_language) do not capitalize names that serve as [adjectives](https://en.wikipedia.org/wiki/Adjective).

[**Natural language generation**](https://en.wikipedia.org/wiki/Natural_language_generation)**:** Convert information from computer databases or semantic intents into readable human language.

[**Natural language understanding**](https://en.wikipedia.org/wiki/Natural_language_understanding)**:** Convert chunks of text into more formal representations such as [first-order logic](https://en.wikipedia.org/wiki/First-order_logic) structures that are easier for [computer](https://en.wikipedia.org/wiki/Computer) programs to manipulate. Natural language understanding involves the identification of the intended semantic from the multiple possible semantics which can be derived from a natural language expression which usually takes the form of organized notations of natural language concepts. Introduction and creation of language metamodel and ontology are efficient however empirical solutions. An explicit formalization of natural language semantics without confusions with implicit assumptions such as [closed-world assumption](https://en.wikipedia.org/wiki/Closed-world_assumption) (CWA) vs. [open-world assumption](https://en.wikipedia.org/wiki/Open-world_assumption), or subjective Yes/No vs. objective True/False is expected for the construction of a basis of semantics formalization.

[**Optical character recognition**](https://en.wikipedia.org/wiki/Optical_character_recognition)**(OCR):** Given an image representing printed text, determine the corresponding text.

[**Question answering**](https://en.wikipedia.org/wiki/Question_answering)**:** Given a human-language question, determine its answer. Typical questions have a specific right answer (such as "What is the capital of Canada?"), but sometimes open-ended questions are also considered (such as "What is the meaning of life?"). Recent works have looked at even more complex questions.

[**Recognizing Textual entailment**](https://en.wikipedia.org/wiki/Textual_entailment)**:** Given two text fragments, determine if one being true entails the other, entails the other's negation, or allows the other to be either true or false.

[**Relationship extraction**](https://en.wikipedia.org/wiki/Relationship_extraction)**:** Given a chunk of text, identify the relationships among named entities (e.g. who is married to whom).

[**Sentiment analysis**](https://en.wikipedia.org/wiki/Sentiment_analysis)**:** Extract subjective information usually from a set of documents, often using online reviews to determine "polarity" about specific objects. It is especially useful for identifying trends of public opinion in the social media, for the purpose of marketing.

[**Topic segmentation**](https://en.wikipedia.org/wiki/Topic_segmentation)**and recognition:** Given a chunk of text, separate it into segments each of which is devoted to a topic, and identify the topic of the segment.

[**Word sense disambiguation**](https://en.wikipedia.org/wiki/Word_sense_disambiguation)**:** Many words have more than one [meaning](https://en.wikipedia.org/wiki/Meaning_(linguistics)); we have to select the meaning which makes the most sense in context. For this problem, we are typically given a list of words and associated word senses, e.g. from a dictionary or from an online resource such as [WordNet](https://en.wikipedia.org/wiki/WordNet).

**3.3.3. Discourse**

[**Automatic summarization**](https://en.wikipedia.org/wiki/Automatic_summarization)**:** Produce a readable summary of a chunk of text. Often used to provide summaries of text of a known type, such as research papers, articles in the financial section of a newspaper.

[**Coreference resolution**](https://en.wikipedia.org/wiki/Coreference)**:** Given a sentence or larger chunk of text, determine which words ("mentions") refer to the same objects ("entities"). [Anaphora resolution](https://en.wikipedia.org/wiki/Anaphora_resolution) is a specific example of this task, and is specifically concerned with matching up [pronouns](https://en.wikipedia.org/wiki/Pronoun) with the nouns or names to which they refer. The more general task of coreference resolution also includes identifying so-called "bridging relationships" involving [referring expressions](https://en.wikipedia.org/wiki/Referring_expression). For example, in a sentence such as "He entered John's house through the front door", "the front door" is a referring expression and the bridging relationship to be identified is the fact that the door being referred to is the front door of John's house (rather than of some other structure that might also be referred to).

[**Discourse analysis**](https://en.wikipedia.org/wiki/Discourse_analysis)**:** This rubric includes a number of related tasks. One task is identifying the [discourse](https://en.wikipedia.org/wiki/Discourse) structure of connected text, i.e. the nature of the discourse relationships between sentences (e.g. elaboration, explanation, contrast). Another possible task is recognizing and classifying the [speech acts](https://en.wikipedia.org/wiki/Speech_act) in a chunk of text (e.g. yes-no question, content question, statement, assertion, etc.).

**3.3.4. Speech**

[**Speech recognition**](https://en.wikipedia.org/wiki/Speech_recognition)**:** Given a sound clip of a person or people speaking, determine the textual representation of the speech. This is the opposite of [text to speech](https://en.wikipedia.org/wiki/Text_to_speech) and is one of the extremely difficult problems colloquially termed "[AI-complete](https://en.wikipedia.org/wiki/AI-complete)" (see above). In [natural speech](https://en.wikipedia.org/wiki/Natural_speech) there are hardly any pauses between successive words, and thus [speech segmentation](https://en.wikipedia.org/wiki/Speech_segmentation) is a necessary subtask of speech recognition (see below). In most spoken languages, the sounds representing successive letters blend into each other in a process termed [coarticulation](https://en.wikipedia.org/wiki/Coarticulation), so the conversion of the [analog signal](https://en.wikipedia.org/wiki/Analog_signal) to discrete characters can be a very difficult process. Also, given that words in the same language are spoken by people with different accents, the speech recognition software must be able to recognize the wide variety of input as being identical to each other in terms of its textual equivalent.

[**Speech segmentation**](https://en.wikipedia.org/wiki/Speech_segmentation)**:** Given a sound clip of a person or people speaking, separate it into words. A subtask of [speech recognition](https://en.wikipedia.org/wiki/Speech_recognition) and typically grouped with it.

[**Text-to-speech**](https://en.wikipedia.org/wiki/Text-to-speech)**:** Given a text, transform those units and produce a spoken representation. Text-to-speech can be used to aid the visually impaired.

**4.CONCLUSIONS**

**4.1 Conclusion**

As a computerized approach of analyzing text, NLP is continually striving forward. Researchers are

continually trying to gather knowledge on how human beings understand and use various

languages. This aid in the development of appropriate tools and techniques which make computer

systems understand and manipulate natural languages to perform the various tasks. Technologies,

such as string matching, keyword search, glossary lookup are now on the past as, to more forward

looking technologies such as grammar checkers, conceptual search, event extraction, interlingual on

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The Natural language processing are designed to perform specific tasks. Some major tasks of NLP are automatic summarization, discourse analysis, machine translation, conference resolution, speech recognition, etc.

Automatic summarization helps the computer provide us with a summary for a specific text, article, journals, etc. Discourse analysis helps the computer to understand how the flow of sentence is supposed to maintain and go together. Machine translation or MT helps the computer to translate text or speech from one language to another. This is usually hard thing to achieve as the computer might have to know a great deal of grammar and language. These things make it hard for a computer understand and translate. Speech recognition is used to determine the textual representation of a sentence spoken out. Some famous applications like Siri and Cortana are great examples of speech recognition.

Natural language processing is also focused on machine learning algorithms. Automated learning processes are used to create a map with the large amount of input that it may receive. There are many advantages of using machine learning algorithms. Some include- these makes it easier for the computer to understand their mistakes and learn from them, etc. There are difficulties in developing human language translation softwares as languages change constantly. Natural language processing has close ties with Artificial intelligence. Some problems in NLP are solved by AI and vice-versa.

**4.2 Applications**

Alexa can perform a number of pre-set functions out-of-the-box such as set timers, share the current weather, create lists, access [Wikipedia](https://en.wikipedia.org/wiki/Wikipedia) articles, and many more things. Alexa-supported devices can stream music from the owner's [Amazon Music](https://en.wikipedia.org/wiki/Amazon_Music) accounts and have built-in support for [Pandora](https://en.wikipedia.org/wiki/Pandora_Radio) and [Spotify](https://en.wikipedia.org/wiki/Spotify) accounts. Alexa can play music from streaming services such as [Apple Music](https://en.wikipedia.org/wiki/Apple_Music) and [Google Play Music](https://en.wikipedia.org/wiki/Google_Play_Music) from a phone or tablet.

**4.2.1 Ordering**

Take-out food can be ordered using Alexa; as of May 2017 food ordering using Alexa is supported by [Domino's Pizza](https://en.wikipedia.org/wiki/Domino%27s_Pizza), [Grubhub](https://en.wikipedia.org/wiki/Grubhub" \o "Grubhub), [Pizza Hut](https://en.wikipedia.org/wiki/Pizza_Hut), [Seamless](https://en.wikipedia.org/wiki/Seamless_(company)), and [Wingstop](https://en.wikipedia.org/wiki/Wingstop" \o "Wingstop). Also, users of Alexa in the UK can order meals via [Just Eat](https://en.wikipedia.org/wiki/Just_Eat). In early 2017, [Starbucks](https://en.wikipedia.org/wiki/Starbucks) announced a private beta for placing pick-up orders using Alexa. In addition, users can order meals using [Amazon Prime Now](https://en.wikipedia.org/wiki/Amazon_Prime_Now) via Alexa in 20 major US cities. With the introduction of [Amazon Key](https://en.wikipedia.org/wiki/Amazon_Key) in November 2017, Alexa also works together with the smart lock and the Alexa Cloud Cam included in the service to allow Amazon couriers to unlock customers' front doors and deliver packages inside.

According to an August 2018 article by The Information, only 2 percent of Alexa owners have used the device to make a purchase during the first seven months of 2018 and of those who made an initial purchase, 90 percent did not make a second purchase.

**4.2.2 Music**

Alexa supports a multitude of subscription-based and free streaming services on Amazon devices. These streaming services include: Prime Music, Amazon Music, Amazon Music Unlimited, [Apple Music](https://en.wikipedia.org/wiki/Apple_Music), [TuneIn](https://en.wikipedia.org/wiki/TuneIn), [iHeartRadio](https://en.wikipedia.org/wiki/IHeartRadio), Audible, [Pandora](https://en.wikipedia.org/wiki/Pandora_Radio), and [Spotify](https://en.wikipedia.org/wiki/Spotify) Premium. However, some of these music services are not available on other Alexa-enabled products that are manufactured by companies external of its services. This unavailability also includes Amazon's own Fire TV devices or tablets.

Alexa is able to stream media and music directly. To do this, Alexa's device should be linked to the Amazon account, which enables access to one's Amazon Music library, in addition to any audiobooks available in one's Audible library. Amazon Prime members have an additional ability to access stations, playlists, and over two million songs free of charge. Amazon Music Unlimited subscribers also have access to a list of millions of songs.

Amazon Music for PC allows one to play personal music from Google Play, iTunes, and others on an Alexa device. This can be done by uploading one's collection to My Music on Amazon from a computer. Up to 250 songs can be uploaded free of charge. Once this is done, Alexa can play this music and control playback through voice command options.

**4.2.3. Sports**

Amazon Alexa allows the user to hear updates on supported sports teams. A way to do this is by adding the sports team to the list created under Alexa's Sports Update app section.

The user is able to hear updates on up to 15 supported teams:

* MLS - Major League Soccer
* EPL - English Premier League
* NBA - National Basketball Association
* NCAA men's basketball - National Collegiate Athletic Association
* UEFA Champions League - Union of European Football Association
* FA Cup - Football Association Challenge Cup
* MLB - Major League Baseball
* NHL - National Hockey League
* NCAA FBS football - National Collegiate Athletic Association: Football Bowl Subdivision
* NFL - National Football League
* German Bundesliga 2nd Division
* WNBA - Women's National Basketball Association
* German Bundesliga 1st Division

**4.2.4. Messaging and calls**

There are a number of ways messages can be sent from Alexa's application. Alexa can deliver messages to a recipient's Alexa application, as well as to all supported Echo devices associated with their Amazon account. Alexa can send typed messages only from Alexa's app. If one sends a message from an associated Echo device, it transmits as a voice message. Alexa cannot send attachments such as videos and photos.

For households with more than one member, one's Alexa contacts are pooled across all of the devices that are registered to its associated account. However, within Alexa's app one is only able to start conversations with its Alexa contacts. When accessed and supported by an Alexa app or Echo device, Alexa messaging is available to anyone in one's household. These messages can be heard by anyone with access in the household. This messaging feature does not yet contain a password protection or associated PIN. Anyone who has access to one's cell phone number is able to use this feature to contact them through their supported Alexa app or Echo device. The feature to block alerts for messages and calls is available temporarily by utilizing the Do Not Disturb feature.

**4.2.5. Business**

Alexa for Business is a paid subscription service allowing companies to use Alexa to join conference calls, schedule meeting rooms, and custom skills designed by 3rd-party vendors. At launch, notable skills are available from [SAP](https://en.wikipedia.org/wiki/SAP_SE), [Microsoft](https://en.wikipedia.org/wiki/Microsoft), and [Salesforce](https://en.wikipedia.org/wiki/Salesforce).

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**Signature of Student**

Nemade Ashwini Anil (36157)