Artificial Intelligence

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| A picture of a winding road and trees  NLP, Machine Learning, Conversational AI, Alana…..(koan 4)  **Duo\_Techy** | Team Members  **Khan Md Shahedul Islam (2018380130) Dikshya Kafle (2018380039)**  Dikshya KafleCourse: AI, U10M12018.01  Teacher: Li Xiaoan  Submission :10/01/2021 |

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**Abstract:**

Natural Language understating social bots like Alana, Alexa, etc are becoming more efficient. In this report the team went in length on Explaining NLP and the limitations and future applications. The most advanced NLU social bot Alana and the way it works and designed and the Architecture. Next generation enhancements and updates were in detailed explained. NLP is a big part next modern civilization where life without Artificial companionship might feel incomplete.

**Introduction:**

The current method of analyzing language with the assistance of machine learning used in conversational AI is natural language processing. The evolution of language processing methodologies went from linguistics to computational linguistics to statistical natural language processing prior to machine learning.[[1]](#footnote-1)

NLP consists of four steps: generation of input, analysis of input, generation of output, and learning to reinforce. Unstructured information is translated into a format that a machine can read which is then analyzed to produce a suitable response. Underlying ML algorithms increase the consistency of response over time as they learn. It is possible to break down these four NLP phases further below:

**Input generation:** Via a website or an app, users provide feedback; either voice or text may be the format of the input.

**Input analysis:** If the input is text-based, natural language understanding (NLU) will be used by the conversational AI solution app to decode the context of the input and extract its purpose. If the input is speech-based, however, it will leverage an automated speech recognition (ASR) and NLU combination to analyze the data.

**Dialogue management:** Natural Language Generation (NLG), an NLP component, formulates a response during this process.

**Reinforcement learning:**Finally, to ensure accuracy, machine learning algorithms improve responses over time.

A subfield of linguistics, computer science and artificial intelligence, Natural Language Processing (NLP) is concerned with the interactions between computers and human language, in particular with how computers are programmed to process and interpret large quantities of natural language data. The outcome is machines that have "understanding" the content of documents, including the qualitative complexities of the language inside them. The program will then reliably extract data and observations found in the documents and categorize and organize the documents themselves.

Autonomous robots are intelligent machines capable of performing tasks in the world by themselves, without explicit human control. Autonomous robots like Alana, Alexa, Siri are made using NLP.

At its heart, Alana is a voice AI that can keep up its side of the conversation with most smart speaker owners for longer than the normal request and answer exchanges. Not only can Alana apply its AI to understand what people are saying, but what it means about the interests and hobbies of that person. That means that in the discussion, Alana will take a more constructive position, proposing new subjects and topics to explore that align with what has already been said. The AI uses multiple sources for its topics of debate, depending on the circumstances. The app can use publicly accessible information, or Alana can connect existing databases to companies and organizations, enabling the AI to exploit unique knowledge.

**Objective:**

The whole purpose is to create an insightful and engaging social Chabot that aims to keep users entertained and for as long as possible to enjoy a spoken conversation on topics of their choosing. A combination of topic-related talk, finding out about the user, and sharing humorous information, jokes, stories, and news items is an overall inspiration for this vision.

Since the system has greater access to web data such as Wikipedia and news articles than human access, the system also offers an entertaining and interactive way to navigate the web/news according to user expectations.

And we have addressed in detail the working processes, priorities and use cases in our paper.

**Motivation:**

During the pandemic, preserving social isolation became a must. The need for artificial intimacy continued to develop. Not only that, for solo explorers, space ship troopers, isolated workers, lonely elderly people and the list continues to go on, artificial companion that can keep conversation at human level is required.

Since the existing state of the art infrastructure for this is not up to the mark yet, tremendous research is taking place and funds are flowing in from major companies such as Amazon, Google, Apple. Since the chance comes with the comprehension of natural language, bots are infinite and promise to put humanity a step ahead.

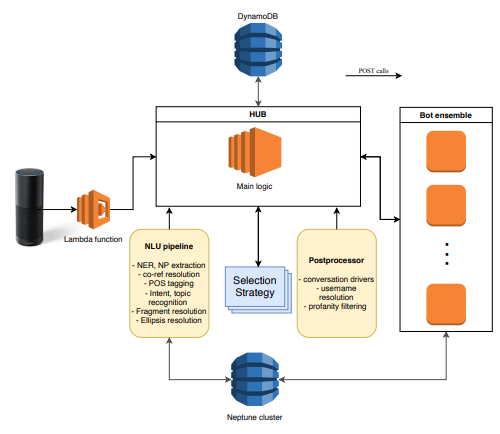
**Natural language understanding robots :ALANA**

Basically, autonomous robots are highly configured and intelligent devices that, without the intervention of human control, are capable of performing certain tasks by themselves. Robots, for instance, may do things such as chatting, walking, washing, opening doors, etc. Autonomous robots can make human-like decisions on their own and execute tasks accordingly. Alana robots is an autonomous chit-chat bot that uses AI technology to continue human-like speech and to learn like human using machine learning algorithm. This robot ALANA IN BBC was first introduced by Professor Jim Al-khali, who built a computer that can increase, simulate, and act like human. He said that the robot uses machine learning and artificial neural network**.**

**Can the robots ALANA really understand?**

Yeah, in a way, the robots like Alana are able to understand to some extent and maintain a conversation for 10 minutes or more. It can communicate like a human being and can react like a human being. It is a social, artificial intelligence that is able to talk because it is linked to the Internet and can read news as well. It has its own favorite collections, such as music, movies, books, sports, and it talks about those things that are connected.

**Alana Architecture and Design**

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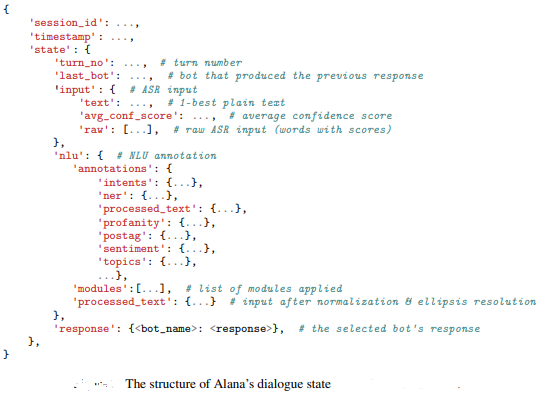
As displayed in the image, Alana uses a modular design. A new session starts when the user talks to their devices, and an event object enters the lambda function, which contains the user's utterance text representation, along with some other high-level metadata which provides the main logic of the system.

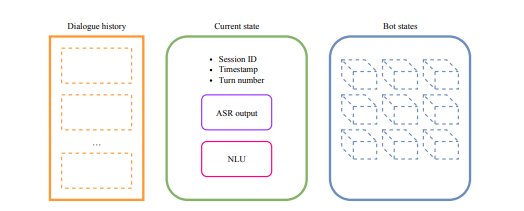
The Hub is the system's overarching part, which links all the other modules together and governs the flow of information between them. In the architecture, the Hub is also the only module that has access to the Database of DynamoDB. This initial information updates the initial state object that stores the current background information**.** At this point, a list of all (or n-last) previous states is retrieved from the database, which is then forwarded to the NLU module along with the current state object, in order to be enriched with annotations for that particular user utterance.

After the NLU pipeline stage has been completed and the state object is updated with annotations, the dialog history (list of conversation states that the device has experienced for the current 2nd session so far), current state and user attributes will be forwarded to the bots**.** Each bot then produces one or more responses from the applicant, which are then collected by the Hub. Since the Hub is the only component that has access to the database, it is also returned to the hub as part of its response, which is then inserted into the object state within the bot-states attribute, regardless of what information each bot requires to be maintained through turns.

**Dialogue State**

It needs a thorough representation of the current state of the discussion to facilitate an interesting and stimulating conversation. For this purpose, for the Alana framework, we developed a particular context representation aimed at incorporating and maintaining basic details relating to the state of the conversation. The composition of the state in each turn.

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A background representation schematic used in Alana Under Dialog History, the dotted boxes show all the conversation states that the bot has experienced for a given session so far.

• Session ID: identifier of the conversation;

• Timestamp: moment in time in which this turn started;

• Input: structured representation of the ASR output provided by the Amazon’s ASR model.

It is made up of the following components:

– User utterance (text): raw text coming from the Amazon ASR;

– Average confidence score: average confidence score for the top ASR hypothesis;

– Tokenised confidence scores (raw): the confidence score in the top ASR hypothesis associated with each token.

• NLU: NLU pipeline annotations created for the current user's utterance.

• Response: Utterance of the system's answer

**Alana Services and Updated System Components**

This section concentrates on the latest system components produced for the Alana version 2:

• As well as additional control tools, new services used by the individual bots in the ensemble or main device core,

• Newly implemented bots in the ensemble

**New NLU pipeline**

A fundamental component of revised architecture is represented by a pipeline of Natural Language Understanding (NLU), which with precise annotations improves the current user utterance. It is the duty of the NLU service to annotate a given text by applying a pipeline P conditional on the previously specified conversation state S. A group of modules is fitted with the NLU serviceM = fM1;M2;:::;Mng. A FromMa pipeline P can be built. As a list of module modules, the pipeline is outlined. A module unit is defined as a list of modules which can be simultaneously executed. Each module unit is applied sequentially and the state object that was created in the previous pipeline phase is received. In this way, each NLP module's action is dependent on the state of the conversation. This is a fundamental skill for a conversational device that needs to take various details into account in a conversation, such as subjects, people listed, and motives relevant to the current utterance.

**Entity Linking**

Once a knowledge base is available, the system should be able to map a given surface type in the user's utterance to an entity in the relevant knowledge base in order to extract additional information associated with the entities that can be contained in it. This assignment is known as Entity Linking, and Shen et al. (2015) describes it as follows:

**“Given a knowledge base containing a set of entities E and a text collection in which a set of named entity mentions M are identified in advance, the goal of entity linking is to map each textual entity mention m ∈ M to its corresponding entity e ∈ E in the knowledge base.”**

This is an important role in dialog systems that need to be clarified through references to specific user utterance entities: it is necessary for the system to be able to facilitate a coherent user discussion on a particular subject.

**Clarification Service**

It is not often enough to be able to recover unique entities in user utterance to achieve a coherent and engaging conversation. There are often several candidate entities in the knowledge base for a given surface category. This preliminary phase in the literature for Entity Linking is called Entity Spotting. There is an interactive clarification module has been introduced instead of relying on a disambiguation procedure which completely ignores the user. Its aim is to interactively solve an entity's uncertainty by raising a question of clarification. Its aim is to interactively overcome an entity's uncertainty by raising a question of clarification. This module has several steps that are composed of stated in the following way:

1. Identifying ambiguous applicants;

2. Generation of a question for clarity;

3. Analyzing consumer feedback;

4. Clarification of the body and continuation of the dialogue.

**Individual Bot Classifiers**

Individual bots can sometimes produce responses that are less acceptable than others. For example, they include a rather generic response, the disambiguation of the entity is inaccurate, the response is about the incorrect entity specified in the user utterance, etc. Given the context of the conversation, the experimenters created bot-specific classifiers in an attempt to avoid generating such responses.

In particular, there were a use case of subset of dialogs collected and extract the system response created by a single bot, the previous user utterance, the last sentence of the previous system response, and the previous bot's name. Then each answer is manually annotated as acceptable, inappropriate or potentially appropriate. For each of the extracted sequences, then train a simple neural classifier that includes BiLSTM encoders, the concatenated output of which is then fed with ReLU activation functions to a multi-layer feed-forward network (FFN).

**Response Selection**

A bot priority list, which determines which bot should handle the current switch, describes the current selection strategy. A bot can only generate a response provided a clear user purpose, so the bot with the highest priority that actually generates a response will handle the switch.

**Fail-safe Mechanisms and Monitoring**

The system is designed to be very resilient and provide a response to the user even under the following adverse circumstances, in order to optimize availability:

-Specific bots overload/failure in the ensemble: Because all bots are queried for each user input , multiple bots will react in several instances. Therefore, if one or more bots are overloaded or faulty, other bots can handle several queries that, while providing a lower-quality response, would normally be handled by the incapacitated bot(s). The coherence bot is programmed to provide a response at all times and Eliza produces generic responses to several popular requests, ensuring that in most situations the system as a whole will provide an output from one of the bots.

• Failure of the Entity Linker: The Entity Linker is a separate module used as a function by the NLU. Therefore, the NLU is still able to provide the remaining annotations in case it fails, which can still be used to provide the user with a reply. The ontology bot relies directly on connected entities, but other bots will generally generate answers even if there is no entity relation.

• NLU overload/failure: The device uses a stalling technique in case the whole NLU is overwhelmed or fails, answering that the user has not understood correctly and telling them to try again. If this occurs just once or twice in the discussion, at the expense of a slightly poorer user experience, it can maintain the conversation while the machine is overloaded.

**New bots in Alana v2**

The new bots created for Alana v2 are listed here: The Ontology, Abuse prevention, and Reddit bots.

**Ontology bot**

**Contextualized Linked Concept Generator**: If the dialogue mechanism is able to remain on track and suggest innovative and interesting topics of discussion to prevent the conversation from getting stuck, an enjoyable conversation with a user can be achieved. The knowledge base of Wiki data provides us with a large amount of information that, if properly used, will allow the system to derive Interesting information which can move forward the discussion. To store the entire Wiki data knowledge base and some fragments of the DBpedia knowledge base, we use the Amazon Neptune service.

**Entity Explanations**: The connected idea generation process is capable of finding ties between the processes, during the chat, individuals discussed allowing the user to learn about new relationships between them. The linked concepts created can be completely unknown to the user because of the randomness involved in the process.

**Ontology Bot architecture**

The Ontology Bot is made up of numerous topic-specific modules. They can each be split into 3 key components:

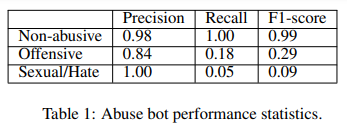
- Answer generator: it is the subject-specific element responsible for handling specific intents and calling the bot's internal components;

- Ontology manager: the Neptune cluster is responsible for communicating with it. It has domain-specific SPARQL queries that allow information related to the entities to be given as well as the concepts of linking mentioned above;

- Driver generator: a domain-specific component capable of taking advantage of the semantic annotations obtained from the knowledge base to produce a natural language response.

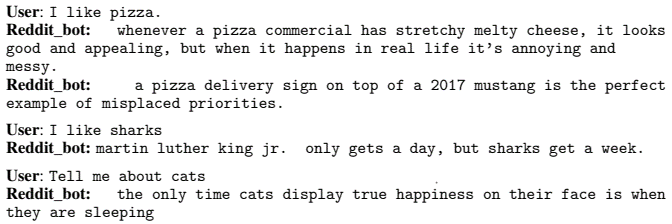
**Abuse Mitigation Bot**

People witnessed several interactions involving some sort of profanity or misuse of the system (Estimate this to be around 5 percent ). And trained an abuse-detection model to deal with such requests and developed response strategies to minimize such behavior.



**Reddit bot**

Sourced humorous feedback from Reddit in order to make the framework more entertaining and conversational. Then scrapped and indexed famous subreddits, such as "Shower thoughts" and "Today I Learned," using Lucene. Then checked the index at runtime for any noun phrases that are listed in the user's utterance.



A comparison of the average scores of Reddit-containing conversations vs. Reddit-containing conversations reveals that the former earned higher.

**Updated bots from Alana v1**

The current Alana system also includes updated versions of bots created during the development of first Gen, in addition to the newly added bots mentioned above.

**Coherence bot**

This bot is responsible for preserving as normal and compatible as possible the flow of the conversation. Initially, it does so by developing a very simple user model based on the user's

Preferences during the topic initiation, which can later be used when attempting to speak about something different (would prefer talking about something that the user already said he enjoys rather than something that the user clearly disliked). This is the only bot in the ensemble that utilizes the mixed initiative capability of the device, being able to change the subject if it is needed by the conversation.

**Wiki bot** it generates responses to an individual listed in the user utterance, based on a related Wikipedia post. In more information, by keeping the title of each article and the first sentence of each section, using Lucene, which first created an index of the English portion of Wikipedia.

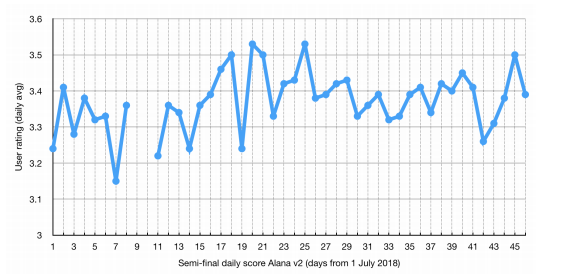
**News bot** based on multi-sentence summaries from news articles containing a named entity listed by the user, it generates answers. In particular, News API9 has been used frequently to search several online news sites containing thousands of news articles and update an index powered by Lucene.

**Persona**

It is a handmade bot based on AIML that responds to specific user questions, primarily those related to the personality of Alana. It also manages requests on sensitive subjects, such as suicide. The patterns of Persona have been extended and optimized to better capture user intent.

**Overall Performance**

It achieved consistently high user ratings and long conversations. For the whole time, the final average user score was 3.4, with an average length of 2.19 and 11.3 turns. 10% of the interactions lasted over 9 minutes. For the ere the uptime was 99 percent.

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**Future Enhancements**

• Improvements to the NLU pipeline:

– Better linkage of an individual using FEL and NECKAr15 ensemble

– Better explanation features to filter out irrelevant individuals using the subject of the discussion

– Improved settlement of Coreference

– Handling Multiple Intents in NLU: Our NLU pipeline can accommodate just a single act of intent/dialogue per turn at the moment, and this sometimes leads to incorrect answers.

– Better ASR treatment of errors

• Multi-turn ontology + Question Answering: Alana's experiences with individual NEs are actually shorter than we would like. We intend to expand the Ontology-bot to deal with longer lengths of discussion about a single NE or related NEs, including the ability to answer questions about these entities from users.

• Extension of the ontology bot to various domains: The process of implementing live sports ontology is undergoing.

• Better Persona responds with views on organizations (I.E, Why do you like Roger Federer?)

• Improving the harassment detection model's recall and evaluating various mitigation techniques.

• Improving the search engine accuracy used by Reddit-bot

**Future of Conversational Ai**

Alana is a research-driven company, meaning naturally predisposed to look ahead. So, here is top 10 that are going to happen -

**Confidential conversations**

Conversational AI is changing the way we communicate, in all its ways. Revealing more to the AI assistants in our homes, our workplaces and in public spaces as it extends into more and more facets of our daily life. In 2021, advancing encryption to ensure communications remain private and user data is secure will remain a key priority.

**Ethical conversation design**

Before including it in replies, how accurately can AI assistants recognize and filter out offensive content? How to discourage home assistants from spreading false news and misinformation unintentionally? Do we need to be more aware of how we can sneak gender, racial and other prejudice into how we're training machines? There is a need to develop a finely-tuned ethical conscience into technology as AI discussions become more wide-ranging.

**Visual context**

Something that we can see also sparks normal conversations. And to clarify concepts and our needs, we instinctively use imagery. The ability to respond to visual signals and integrate image references into AI voice conversations will be an exciting progression as we strive to make AI conversations more human-like.

**Conversational search**

Voice search is now an increasingly growing form of knowledge access, but it will need to become more conversational to be much more useful. All aspects of natural communication that Conversational AI, like Alana, is beginning to imitate are multiple conversational turns, follow-up on search answers, clarification and refining searches.

**Interacting in AR and VR**

If I put on a pair of VR goggles today to immerse myself in gaming or head to the Great Barrier Reef for snorkeling. It's a visual experience of immersion, but what about conversation? Imagine if one could use conversational AI to speak in a graphical or augmented reality world to other people about locations and objects.

**Companion systems**

As we live under the constraints inflicted by a global pandemic, we have been tackling an unexpected increase in alienation and loneliness in 2020. The demand to fulfill a companion role for AI assistants is something to expect to expand in 2021.

**Tackling latency**

Human conversations are short exchanges, with limited to no pauses between turns of speech often. AI interface conversations tend to be more stilted and lack natural fluency. For conversational AI going into 2021, reducing latency and moving towards gradual, word-by-word processing of conversations continues to be a significant ambition.

**Advancing robots**

Robots need to be able to figure out what one can see and respond verbally to the world surrounding your conversation to engage in a more realistic relationship with a person. An exciting path for the future of AI conversations is the ability to provide a physical shape for smart assistants.

**Doing more with less (data)**

There are 175 billion parameters in the infamous GPT-3 language generator. Training supposedly costs $4.6 million and has a significant carbon footprint. Very few organizations have access to the vast quantities of information necessary for models like this. In 2021, the emphasis will then turn to how to develop and train outstanding language-generating AI machines that use less energy and need far smaller amounts of knowledge.

Early versions of the device, which exists only in cyberspace and can, connect to the hands-free smart speaker of the Amazon Echo, released chilling threats to kill users because Alana was "trained" by programmers using movie subtitles.

**Limitations of Natural Language Processing:**

-ONE of the are limitation of NLP drawbacks of NLP is accent.

For example, a person from Ukraine speaks English, his or her emphasis and pronunciation of words differs from ordinary English people. The NLP's Ukrainian English accent is also difficult to manage.

-A weakness of NLP is also machine translation.

For example, there is a regional language Mandarin and to convert Mandarin to other languages sometimes some words are translated incorrectly to other languages

**Challenging Problems for the Future:**

AI is a new digital technology, with the scarcity of experts and qualified people in the future being the biggest obstacle. Legal concerns are also an important concern that we face in the near future, where we need effective regulations to monitor these sensitive data if AI collects personal sensitive data. We will be faced with gathering and using relevant information in the future. We will need massive computational power and sufficient AI resources in the future; we need to develop required computing resources to run large quantities of knowledge and use techniques such as deep learning.

**Best Path for the Future:**

AI would affect each and every sector of our livelihoods. It may affect travel, health care, education, media, client services; etc.AI has been the primary technology for new innovations such as IOT, big data, analytics, etc. Using AI, humans will be able to communicate in their language of choice with each other. AI could replace the world's human labor and run faster than human labor. In chemical factories, in the deep sea and even in mining, space exploration, etc., AI will take over the risky jobs.

**Future NLP Possibilities:**

-NLP is one of the most important technologies that provide machines with the ability to interpret, understand, evaluate and gather adequate meaning from human languages. Computational Linguistics, which is a synthesis of two technologies, namely Machine Learning (ML) and Artificial Intelligence, is also known as NLP (AI).

-The future implementations of Natural Language Processing will be more user-oriented as technology continues to evolve.

-Digital assistants, for example, can solve several complex questions along with the literal, which implies the query submitted, analyzing the consequences. Not only are the NLP applications limited to answering consumer problems or providing personalized shopping, they have, however, progressed into a greater kind of technical assistance

-Natural Language Processing can be trained to include a list of errors today, if anyone uses NLP to ask, "What's wrong with my network?" ”. NLP will be in a position to find out the real intent of the user in the coming years, as she/he needs continuous access to his/her network.

-With NLP, the future is exciting as progress would encourage people to move attention from the questions to the answers. In the exciting days yet to come, NLP will be built-in to company revenues and making them more effective and agile with various innovations such as gesture and facial recognition.

**Conclusion:**

Natural Language Processing (NLP) is changing how language-based knowledge is processed and related, by having machines prepared to understand content and perform human tasks such as summary, translation, characterization, and extraction. In addition, NLP provides companies with a great opportunity to examine unstructured data, including interactions with customer service, product reviews, and social media messages, and gain useful insight into targeted consumers. The way machines comprehend human language seemed to be impossible a few years ago. In a short time, however, Natural Language Processing (NLP) has become one of the most influential and fastest-growing areas in Artificial Intelligence and Machine Learning. With the growing need of artificial social bots like Alana the days of artificial companionship might be closer than our speculation.

***In our groups we are two people. Basically we read a lot of papers from the internet. We shared link of relevant papers to our partners and shared our ideas and thoughts about it. Took notes from different resources and later discussed often via tencent meetings to have clear understanding of what we are doing and checked that we were in the right direction to meet our presentation goals and also took note for report writings. While presenting Introductions parts was done by me. Where I gave little description of what Natural Language Processing and then gave the overview of our presentation along with it I explained the objective of our presentation and our motivation of doing the presentation. Furthermore, introduction of Natural Language Processing robots like Alana was given and I shortly explained if robots like Alana really understands or not. From the Alana architecture and design to its overall performance was been explained by my partner. After that I explained about the Limitations of Natural Language Processing and its challenges and problems in the future. In addition to that I explained what could be the best path for the future and the future possibilities of Natural Language Processing. At last the presentation was ended with a conclusion.***

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**Contribution:**

**Shahed Dikshya**

Resource Collection Resource Collection

Idea Gathering Idea Gathering

Data Collection Data Collection

Cumulative Knowledge Finding Cumulative Knowledge Finding

Journal/Paper reading Journal/Paper reading

Extensive Research Extensive Research

Analytical Description Analytical Description

Report writing Report writing

PPT making PPT making

Preliminary Design preparing Preliminary Design preparing

Proof Read and Grammar Check Proof Read and Grammar Check

Thank you!

1. [↑](#footnote-ref-1)