# BUILDING A CHATBOT USING DIALOGFLOW

A proof-of-concept demonstration

Lappeenranta-Lahti University of Technology LUT

LUT School of Engineering Sciences

Bachelor's Programme in Software and System Engineering

2023

Ajay Sah

Examiner: Professor Jussi Kasurinen

# ABSTRACT

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Your school: LUT School of Engineering Science

Your degree programme: Software and Systems Engineering

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**Building a chatbot using Dialogflow - A proof-of-concept demonstration**

Bachelor's thesis

2023

37 pages, 12 figures and 3 tables

Examiner: Professor Jussi Kasurinen

Keywords: Dialogflow, Chatbot, NLU, AI, NLP

This thesis explores the dynamic field of chatbots with a particular emphasis on creating a proof-of-concept chatbot using Dialogflow. It provides a thorough overview of chatbot development, natural language understanding (NLU), natural language processing (NLP), artificial intelligence (AI), and their combined influence on changing traditional customer service practices. The main objective of this thesis is to acquire profound insights into the world of chatbots, delving into their historical roots, theoretical underpinnings, and the instrumental role of chatbot frameworks such as Dialogflow.

A proof-of-concept chatbot was developed with Dialogflow integrated, showcasing its ability to produce engaging, contextually aware interactions. While a proof-of-concept chatbot was developed, its main purpose was as a useful teaching tool. No extensive testing or usability approaches were used. Instead, this thesis provides a basic analysis of the architecture, design, and implementation of the chatbot. As a result, no rigorous testing was done; instead, the chatbot's

performance was evaluated informally by the author. Subsequent rigorous testing and validation are reserved for the forthcoming master's thesis.

The findings of this study support chatbot's positive potential for providing efficient and engaging customer assistance. It underscores the crucial role of platforms like Dialogflow in shaping the future of customer service, with its versatile and user-centric capabilities. In conclusion, this thesis explores the world of chatbots and Dialogflow while highlighting their profound impact on customer service. It opens the door to a future in which artificial intelligence and technology continue to drive superior customer service.

# ACKNOWLEDGMENTS

I would like to express my sincere gratitude to Professor Jussi Kasurinen for his assistance and direction throughout the writing of this thesis. Professor Kasurinen's expertise and encouragement played a crucial role in shaping the direction of my research work. He provided insightful guidance and support that helped this work's structure and substance improve. I sincerely appreciate his mentoring and patience he provided via his wealth of knowledge and experience.

# ABBREVIATIONS

**AI** Artificial Intelligence

**API** Application Programming Interface

**COVID-2019** Coronavirus Disease 2019

**FAQ** Frequently Asked Question

**GUI** Graphical User Interface

**LUT** Lappeenranta-Lahti University of Technology

**NLP** Natural Language Processing

**NLU** Natural Language Understanding

**UX** User Experience

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# 1 INTRODUCTION

Customer service is an essential component of every organization since it has a direct influence on client retention, brand loyalty, and general impression. Long waiting times, repeated questions, and restricted availability are common problems with traditional customer service techniques including phone calls and email correspondence. Intelligent chatbots offer quick replies, 24/7 accessibility, and the capacity to manage several consumer contacts at once, making them a scalable and effective solution to these problems. (Misischia et al. ,2022.)

In light of this transformative potential, communication between organizations and people has changed substantially in an age marked by technical developments and digital revolutions. Nowadays, universities continually deal with a wide range of questions and concerns from students. These inquiries frequently centre on Frequently Asked Questions (FAQs) about enrollment, degree programmes, timetables, and other university services. For the university, responding to these recurrent questions can be time-consuming and resource-intensive. This insight serves as the cornerstone of this bachelor thesis, which seeks to investigate the creation of an innovative solution utilizing modern conversational AI technology. The main objective is to build a proof-of-concept chatbot using Dialogflow, a popular natural language processing tool made by Google.

It is possible to construct a custom chatbot framework with natural language understanding and conversation capabilities. Although building a chatbot from scratch has its advantages, there are situations and scopes where using readily available intent classification and conversation management frameworks could be a more convenient, quicker, and cost-effective approach to building a chatbot (Singh et al. , 2019). A chatbot is a software program that can be used on websites, messaging platforms, mobile apps, or other platforms to provide users with information using various formats such as text, images, video, audio, and links. Its purpose is to perform a range of tasks, including answering frequently asked questions, automating reservations, handling service inquiries, collecting customer information, conducting surveys, and more, The specific functionalities of a chatbot depend on the requirements of the business, the platform where it will be deployed, and the intended audience, whether it’s clients, partners, or employees. (Stoilova, 2021.)

Furthermore, businesses and organizations in the modern digital world are continuously looking for novel methods to improve client experiences and optimize their client experiences and optimize their processes. Integration of intelligent chatbots, which may offer immediate assistance and individualized interactions, is one of the most well-known developments in customer service. These chatbots have completely changed how companies interact with their customers. They are driven by AI and NLP technology (Wang et al. ,2022). By automating communication and implementing an AI chatbot, businesses can enjoy several recognized benefits. These include generating more local business, enhancing business promotion efforts, reducing efforts, reducing costs and resource requirements, improving customer engagement, attracting new markets through a digital experience, gathering data for better planning, and more. In essence, deploying a chatbot enables businesses to leverage technology to streamline operations, enhance customer interactions, and achieve various business goals. (Stoilova, 2021.)

The scalability and efficiency that intelligent chatbots offer to customer service operations also contribute to the significance of this topic. During busy times or events, this scalability enables firms to effectively manage a large number of client contacts. By reducing the need for a big support team, chatbots can also save operating expenses while still delivering effective and efficient customer care. Businesses may leave a good impression on their clients and forge stronger bonds by providing prompt help and individualized experiences. Additionally, chatbots may act as a continuous and dependable source of information, ensuring that clients receive precise and current replies and building trustworthiness. (Adamopoulou & Moussiades, 2020.)

Moreover, this thesis will address various research topics related to the deployment of an intelligent chatbot for university customer assistance. It will examine how an intelligent chatbot can manage and address a range of student inquiries in the context of university customer assistance. This will entail looking at the capabilities of NLP and AI technologies to comprehend and interpret the wide range of student inquiries. The thesis will also look at the challenges and constraints involved in creating an intelligent chatbot for customer care service. This will include taking into account elements including the intricacy of the customer' questions, potential ethical and privacy concerns, and the requirement for precise and context-sensitive solutions.

The research work seeks to further knowledge and comprehension of intelligent chatbots in the context of university customer assistance. The research results and conclusions will be useful not just to the university, but also other businesses looking to integrate intelligent chatbots into their customer support procedures. Studying this topic offers insightful knowledge about the use of chatbot and AI technologies in the context of customer service. Businesses may explore new options for providing individualized and successful support experiences by looking at how intelligent chatbots can handle and respond to client inquiries.

In conclusion, this bachelor thesis establishes the foundation for the ultimate creation of a fully functional chatbot devoted to the university's services, a project that will be taken on in the Master's thesis. It serves as the first step in a larger academic journey. The main goal is to show how the chatbot might potentially relieve pressure on employees by responding to common questions. It is anticipated that the chatbot's skill at handling a variety of inquiries would increase operational effectiveness and improve user experience. Thus, this bachelor's thesis acts as the cornerstone for the bigger goal that lies ahead.

# 2 LITERATURE REVIEW

This chapter provides an overview of the existing knowledge on chatbots. It discusses chatbots' historical evolution, different development approaches, architectures, applications and more. This review of the literature prepares the groundwork for the development of a chatbot using Dialogflow, which is covered in the following chapters.

## 2.1 Historical development of chatbots

In 1950, Alan Turing addressed a basic question regarding the logical reasoning and thinking abilities of machines in his paper "Computing Machinery and Intelligence". To determine if a machine can converse indistinguishably from a human, he developed the Turing test. Turing foresaw a day when computers will be so adept at playing the imitation game that a typical interrogator would have difficulty properly identifying them as artificial beings in the course of a brief engagement. This revolutionary concept paved the way for the creation of chatbots, which are computer programmes created to converse with people and mimic human dialogue.The idea was to develop a software which would react to user communications by choosing the right phrases from preprogrammed schemas or using machine learning methods. (Zemčík, 2019.)

ELIZA, a chatbot created in 1966 with the intention of serving as a virtual psychotherapist, was the first known chatbot. It made use of a template-based response system and straightforward pattern matching. Although it had poor conversational skills, it was nonetheless able to perplex users at a period when they were not accustomed to talking with machines, which inspired developers to begin creating new chatbots. A chatbot with a personality dubbed PARRY was created in 1972 and was an upgrade over ELIZA. In 1995, the chatbot ALICE was created and won the Loebner prize, often known as the annual Turing test. It was the first machine to earn the title of "most human machine". Virtual personal assistants like Apple Siri, Microsoft Cortana, Amazon Alexa, Google Assistant, and IBM Watson were developed as the next step. (Adamopoulou & Moussiades, 2020.)

## 2.2 Chatbot development approaches

Chatbot development approaches are a collection of several techniques used to build conversational bots that communicate with people. Two well-known methods for development are the pattern matching approach and machine learning approach. Pattern

matching approach matches user input with appropriate replies based on pre-established rule and pattern, while machine learning approach uses sophisticated machine learning algorithms to allow chatbots to learn from data and enhance their responses over time.

### 2.2.1 Pattern matching approach

It is an artificial intelligence method that was utilized in the creation of a chatbot. The response is delivered once the input is compared to the inputs kept in the database (Dahiya, 2017). This is by far the most widely utilized strategy and method on chatbots. ELIZA and ALICE both used the pattern matching algorithm. Every chatbot system in use today uses a variation of a pattern matching algorithm. The sophistication of pattern matching techniques can vary, but the fundamental concept stays the same. (Bradeško & Mladenić, 2012.)

Since the knowledge employed is prewritten by the developer in the form of conversational patterns, these chatbots often do not provide new answers. The chatbot's capacity to answer user queries improves as the rule databases grow in size. Dealing with the grammatical and syntactic issues in user responses presents a formidable challenge as this type of chatbot demands the implementation of numerous rules for effective operation. The drawback of the pattern matching method is that the responses lack the originality and spontaneity of human responses and are automated and repeated.Nonetheless, due to the omission of more profound examination of the input text's syntax or meaning, the response time remains swift. (Adamopoulou & Moussiades, 2020.)

### 2.2.2 Machine learning approach

Machine learning is a dynamic field that focuses on creating computer systems capable of learning and improving autonomously. It sits at the intersection of computer science and statistics, forming the foundation of artificial intelligence and data science (Jordan & Mitchell, 2015). This dynamic field comprises evolving computational algorithms designed to mimic human intelligence by acquiring knowledge from their surroundings. It has become the driving force behind the era of big data, representing the essential workhorse that propels innovation in various industries and applications. (El Naqa & Murphy, 2015.)

In the field of chatbot creation, machine learning is a revolutionary force that goes beyond the constraints of hard-coded rules that are employed in traditional knowledge base techniques for AI. In contrast to rule-based systems, machine learning enables chatbots to

identify and extract useful patterns from data, which improves their comprehension and response times to customer enquiries (Bhagawat, 2018). By leveraging machine learning techniques, chatbots are able to deliver more intelligent and contextually relevant interactions with users by gaining a deeper awareness of the actual world. Machine learning has caused a paradigm change in chatbot technology, opening up new avenues for the development of intelligent conversational agents that can learn from their experiences and adapt accordingly. (Khan et al. ,2018.)

### 2.3 Chatbot's architecture and design

The first step in understanding and improving system designs is to distill the structure and architecture of a system. Usually, this architecture is shown by the components and relationships between them (Luo et al. ,2022). As detailed by Heikkilä (2022), the chatbot general architecture consists of the user interface, natural language processing, dialogue management and response generation, and knowledge management and training.

Table 1: Chatbot overall structure (Heikkilä, 2020)

| | |
|---|---|
| User interface | It is a medium through which users communicate with the chatbots. It can be anything from chat programmes to command line interpreters. |
| Natural Language Processing | It is responsible for message processing. There are several methods to accomplish this, but the key is to deliver the information to the chatbot in a machine understandable format. |
| Dialogue management and response generation | It plays a pivotal role in upholding a conversation resembling human interaction with the chatbot. This process can be achieved through a variety of techniques, spanning from straightforward rule-based categorizations to elaborate machine learning frameworks. |
| Knowledge management and training | It serves as the repository of information within the dialogue system. It holds data that can be expanded upon to enhance the chatbot's capabilities. |

In the domain of chatbot design, a customary approach involves a structured five-step process, as illustrated in Figure 1. Initially, the chatbot purpose is defined, aligning it with customer needs. Subsequently, a crucial decision emerges between a rule-based approach and a natural language processing (NLP) framework. Rule-based bots follow predefined decision trees akin to sequential diagrams. NLP-powered bots, on the other hand, excel in comprehending contextual cues, enhancing responsiveness through iterative learning. This process requires envisioning various scenarios and tasks for the chatbot, translating into tailored questions to fulfill these functions effectively. (Tamrakar & Wani, 2021.)

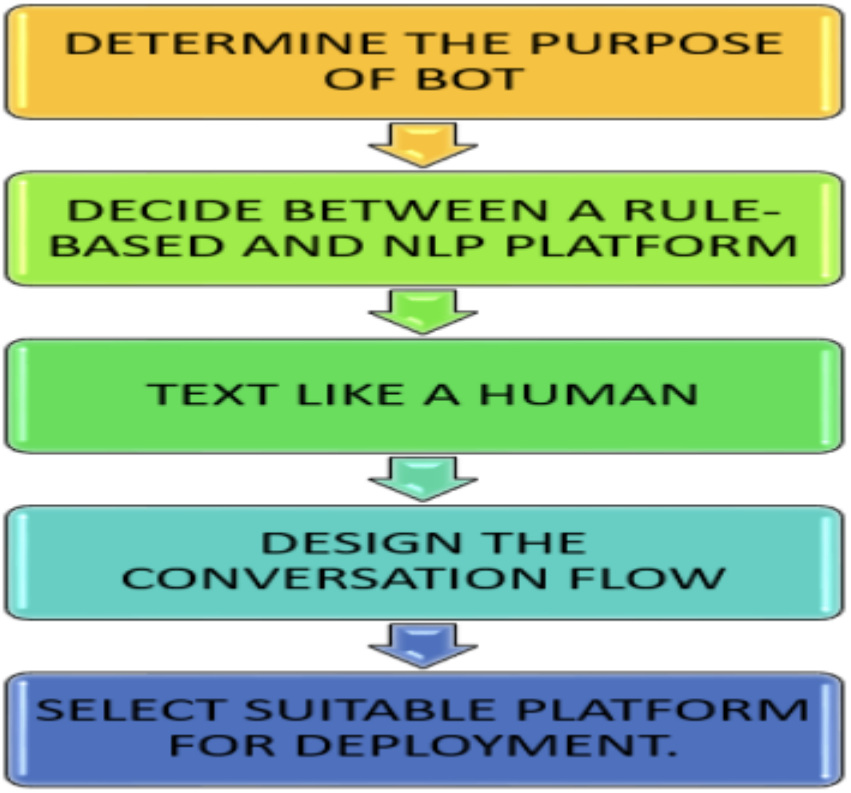


Figure 1: Basic chatbot design procedure (Tamrakar & Wani, 2021)

Underpinning this is the establishment of user-bot interaction, a pivotal aspect of chatbot design. This basically includes detailing the questions that may be asked by the user and possible answers. Therefore, the design process should initiate keeping users' requirements and inputs in mind. Workshops, use cases and soliciting feedback are some of the effective and useful approaches in achieving it (Merisalo, 2018). Moreover, engagement is an important factor in chatbot design. It includes all of the interactions users experience with

chatbot on an emotional, cognitive, and behavioral level across time. Chatbot designers and developers place a high priority on interactivity in order to increase engagement, allowing users to actively shape the content and structure of the interaction in real-time. (Fenie et al. ,2020.)

### 2.4 Overview of chatbot development platforms

Chatbots can be developed in two main ways: through programming languages like Java, Clojure, Python, C++, PHP, Ruby, or Lisp, or by utilizing cutting-edge platforms. Some of the well-known platforms are Google's Dialogflow, Facebook's wit.ai, Microsoft LUIS, IBM Watson Conversation, Amazon Lex, and SAP Conversation. All of them leverage machine learning and offer standard features, such as cloud-based services, support for various programming languages, and multilingual capabilities. However, they also exhibit significant differences in various aspects. Additionally, several other well-known development platforms are available, such as RASA, Botsify, Chatfuel, Manychat, Flow XO, Chatterboat, Pandoraboats, Botkit, and Botlytics (Adamopoulou & Moussiades, 2020).

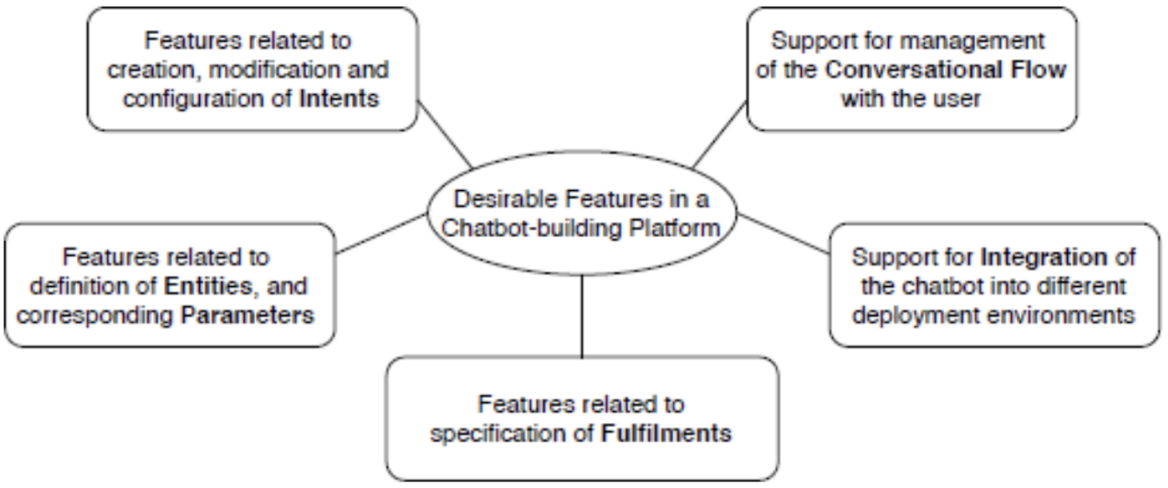


Figure 2: High-level overview of the desired characteristics (Srivastava & Prabhakar, 2020)

Dialogflow provides exceptional NLP capabilities for recognizing user intentions and entities. It includes options for both supervised training and manual correction of results. Developers can define intents and conversations using stateful contexts, making

Dialogflow a user-friendly platform which allows for the effortless creation of basic transactional chatbots (Kostelník et al. ,2019). Moreover, Dialogflow offers extensive language support, covering 30 languages. It leverages Google's advanced machine learning technology, enhancing its chatbots' ability to comprehend user input effectively. (Tavichaiyuth & Rattagan, 2021.)

Major organizations have created platforms for chatbot production in response to the spike in chatbot popularity. IBM, Amazon, Google, and Microsoft are key providers of frameworks for chatbot development. Microsoft possesses the Bot Framework, while Google employs Dialogflow. IBM holds Watson; Amazon Web Services (AWS) incorporates its independent bot framework, powered by AWS Lambda. The development of advanced chatbot frameworks and the rise of chatbots are closely related. (Biswas & Biswas, 2018.)

### 2.4 Use cases and applications of chatbots

Chatbots are employed in diverse sectors, including customer service, e-service, healthcare, finance, travel, education and more. Numerous educational chatbots are primarily designed to offer service assistance, mirroring the successful applications of chatbots in various sectors like healthcare, finance, and customer service. These educational chatbots excel in addressing frequently asked questions (FAQs) (Pérez et al. ,2020). Moreover, virtual agents are seen assisting hotel guests with check-in and check-out, patients with scheduling an appointment and general health inquiries.

The emergence of the COVID-19 pandemic directed business attention towards the necessity of digital transformation and the automation of customer support, service, and self-service choices. This shift aimed to align with the rapidly evolving business landscape and changing customer expectations. Chatbots, which were already gaining prominence as effective customer service agents, became imperative due to the pandemic and the widespread adoption of conversational AI (Stoilova, 2021). A global shortage of mental health professionals, with demand exceeding available services, has led to challenges in delivering one-on-one interventions. Developed nations have approximately 9 psychiatrists per 100,000 people, while low-income countries have as few as 0.1 per 1,000,000 people. To address this shortage, technology is being harnessed to aid those affected by mental

health issues. Chatbots have been emerging as a key technological solution in the mental healthcare industry. (Abd-Alrazaq et al. ,2019).

Utilizing AI plays a pivotal and essential role in driving economic progress. Moreover, AI advancements are progressively employed as digital aides, aiding enterprises within the hospitality sector across diverse aspects. These include enhancing customer support, broadening operations capacity, and reducing expenditures (Limna, 2022). Back in February 2017, the AccorHotels Group introduced the “BOT”, a tiny helper in the form of a messaging solution. This valuable asset enables both guests and locals to effortlessly explore the “local stories” around them by using location and authorized guidance. From the check-in process to in-room technological offerings, a swift evolution is underway in the hospitality and tourism sector. (Ristova & Dimitrov, 2019.)

### 2.5 Challenges with the use and development of chatbots

Communication stands as a cornerstone for human expression in social interactions. This significance is mirrored in the rising popularity of chatbots which offer convenient avenues for engagement. Businesses, aiming for product scalability and enhanced customer satisfaction, often opt for AI-driven solutions like chatbots.While meeting fundamental user needs, chatbots may also trigger ethical concerns (Srinivas et al. ,2022). Unethical chatbots could harm the reputation of those deploying them. Like other digital tools, chatbots raise unique ethical concerns, spanning privacy, transparency, accuracy, safety, and accountability. These ethical considerations will become more critical as chatbot technology advances. (Coghlan et al. ,2023.)

Developing an intelligent conversational agent that interacts with people in a humanlike manner presents a highly intricate and formidable endeavor (Chizhik & Zherebtsova, 2018). In the field of chatbot technology, there are certain limitations to consider. One major challenge is making sure that the chatbot can understand and respond well to different things users say. This needs a lot of data and training so that the chatbot can give the right answers to different user inputs. Furthermore, chatbots can have trouble understanding the specific details, likes, and needs of users. (El-Ansari & Beni-Hssane, 2023.)

Moreover, amidst the pursuit of effective communication, lack of personalization can be limiting for chatbots. This challenge is particularly pronounced when dealing with non-fact based queries, as different ways of defining concepts and explaining processes might not

be universally understood. Additionally, chatbots, designed to simulate human conversations, may struggle to discern the emotions underlying user messages, potentially impeding appropriate or effective responses. These systems must be capable of identifying the emotional tone- whether positive, negative, or neutral- of user messages and adjust replies accordingly. (El-Ansari & Beni-Hssane, 2023.)

In the context of delivering an effortless and seamless conversational, well-designed user interface emerges as pivotal. The conventional design patterns employed in graphical user interfaces (GUIs) are outdated and ill-suited for conversation-driven interfaces. User experience (UX) advocates often emphasize the importance of usability as a fundamental aspect of sound design and a positive UX. However, these approaches tend to focus primarily on usability, overlooking other crucial aspects. Designing UX for chatbots poses unique challenges, particularly concerning how information is presented and the means of interaction, be it through text, buttons, or speech. (Fadhil, 2018.)

# 3 THEORETICAL BACKGROUND

The major emphasis in the theoretical background is on three important subsections. The first subsection explores “Natural language processing in chatbot development”, examining the crucial role that NLP algorithms play in allowing chatbots to successfully understand and interpret human language. The second subsection then carefully investigates “Dialogflow’s architecture and core features” outlining Dialogflow’s essential features and outlining its core structure as a well-known chatbot creation platform. The final subsection “Dialogflow’s natural language understanding capabilities” goes into further detail on how Dialogflow uses NLP strategies to fully comprehend user inquiries and enable natural and fluid interactions between users and chatbot agents. Collectively, these subsections offer a solid framework for understanding chatbot development’s complexities and Dialogflow’s importance in obtaining human-like language understanding.

## 3.1 Natural language processing in chatbot development

Natural language processing, known as NLP in short, involves using computational techniques to analyze and represent texts in a way that mimics human language processing. Its goal is to achieve human-like language understanding and facilitate various tasks or applications involving natural language (Liddy, 2001). This encompasses performing various tasks, such as understanding and acquiring the meanings of words, phrases, and stories, making connections between different pieces of information, organizing and manipulating sentence structures, recognizing basic language elements like objects and actions, and representing complex ideas in a simpler form (Chowdhary, 2020). NLP is recognized as a field within Artificial Intelligence (AI) because it aims to achieve human-like language processing (Liddy, 2001). The goal of enabling computers to comprehend human language is to facilitate communication between humans and machines. (Fredriksson & Höppner, 2019.)

Table 2: NLP functionalities in Dialogflow

| NLP Functionality | Description |
|---|---|
| Automatic Summarization | An innovative capability that condenses textual data into concise and relevant summaries of user input. |
| Named Entity Recognition | The function that identifies and classifies named entities within unstructured natural language, including organizations, person names, age, status, immunity, and location. |
| Relationship Extraction | The process of identifying semantic connections between entities present in natural language text or speech, facilitating comprehensive data understanding. |
| Sentiment Analysis | The ability to determine the emotional tone, such as positive, negative, or neutral, in user text or speech, valuable for gathering feedback and conducting sentiment analysis surveys. |

Table 2 illustrates the functionalities of prebuilt NLP algorithms in the Dialogflow framework, which efficiently organize and structure the unstructured data received from users (Daniel et al. ,2021). The NLP capabilities enable the system to perform diverse tasks.The service Dialogflow was utilized to enable the chatbot to communicate in natural language. It played a role in both analyzing the user's message and generating the response. The user's message, which can be single or multiple sentences, are processed by Dialogflow using NLP to extract keywords (Fredriksson & Höppner, 2019). The concept of Dialogflow is explained in depth in the next subsection.

## 3.2 Dialogfow's architecture and core features

Dialogflow, owned by Google, is a platform that enables developers to create conversational interfaces and seamlessly integrate them into their applications. It supports integration with various cognitive services, including sentiment analysis and knowledge base services. Additionally, Dialogflow allows the utilization of cognitive, AI, and other services from different cloud providers through API integration. It also offers pre-built

integrations for widely used messaging platforms like Facebook Messenger and Slack, empowering developers to quickly develop chatbots that can operate within these platforms. (Sabharwal & Agrawal, 2020.)

### 3.2.1 Dialogflow console

The Dialogflow console, a web user interface, allows users to create, build, and test agents.

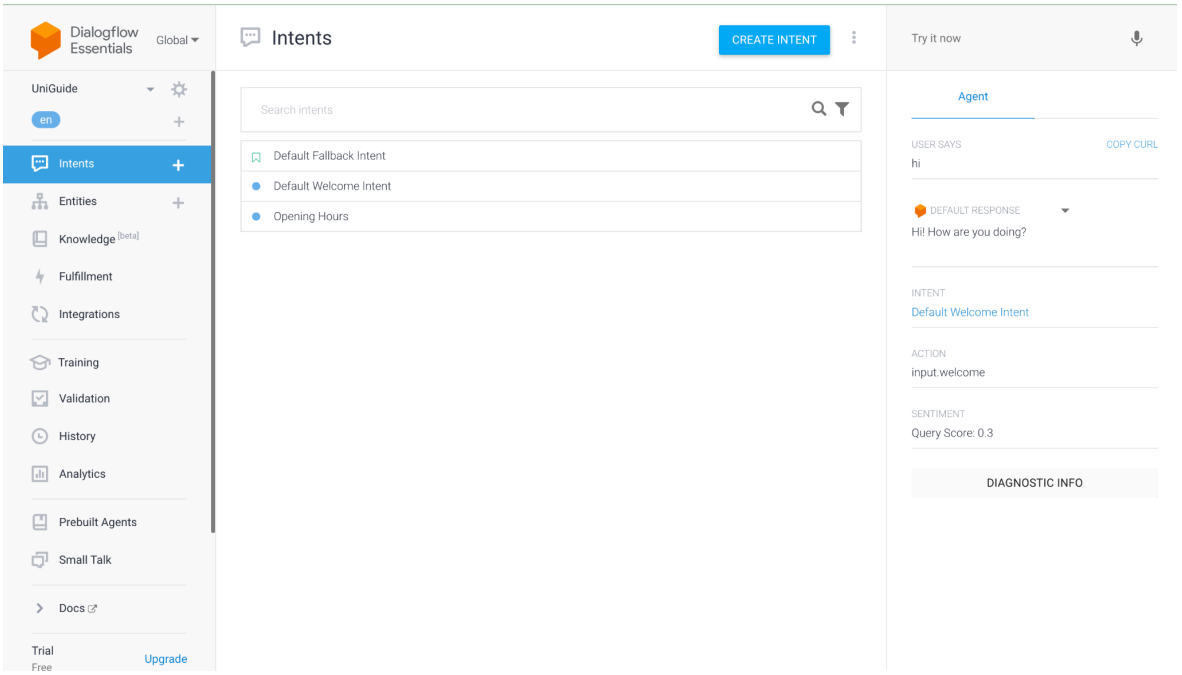


Figure 3: Dialogflow console (Google Cloud, 2023)

Developers may create the conversational flow, provide intents, and set up responses for the chatbots using this interface. It provides a visible and interactive interface, making the setup and management of the chatbot features simpler.

### 3.2.2 Agents

A Dialogflow agent functions as a virtual agent, capable of managing multiple conversations with end-users simultaneously. It is designed to understand human language nuances and translates text or audio from users into structured data, making it easier for applications and services to comprehend. Building a Dialogflow agent involves designing it to handle various conversation types needed for the system's requirements. In analogy, a Dialogflow agent can be compared to a human call center agent, as both are trained to

handle anticipated conversation scenarios without requiring overly explicit training. (Google Cloud, 2023.)

### 3.2.3 Intents

An intent represents an end-user's purpose or intention for a specific part of a conversation. Agents have multiple intents, collectively enabling them to handle complete conversations. When an end-user expresses something, known as end-user expression, Dialogflow identifies the most suitable intent within the agent through intent classification. Let's consider a weather agent as an example. It recognizes and responds to weather related queries from users. To achieve this, an intent specifically tailored for forecast questions is created. Additionally, intents can be configured to extract important details from the end-user's input, like the time or location for the desired weather forecast. (Google Cloud, 2023.)

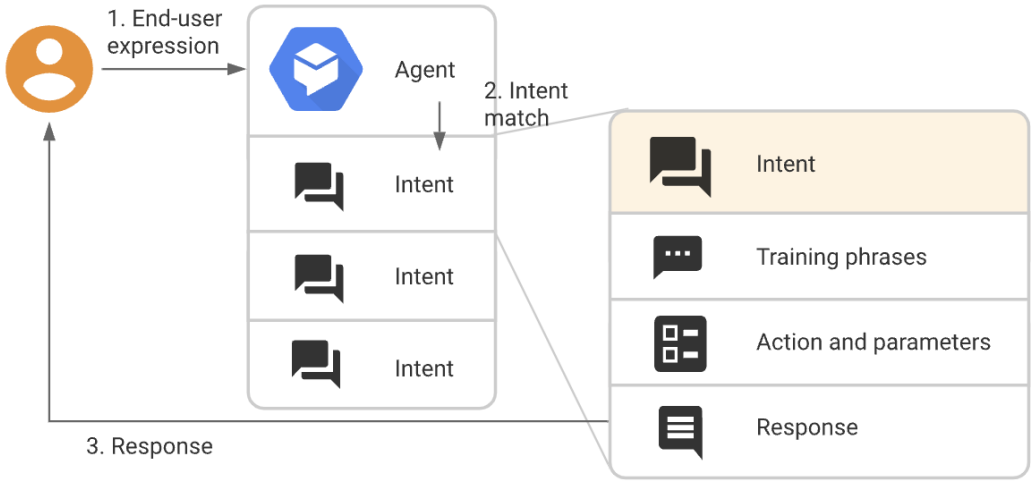


Figure 4: Basic flow for intent matching and responding to the user (Google Cloud, 2023)

As shown in Figure 4, in the context of a basic intent in Dialogflow, the primary constituents encompass Training phrases, Actions, Parameters, and Responses. Training phrases consist of exemplar user utterances, facilitating the model's understanding of potential input variations. The Action element dictates the specific actions to be executed when the intent is triggered. Parameters play a vital role, as they involve extracting essential values from the user's expressions during runtime. Lastly, the Responses entails the chatbot's generated replies, thereby establishing a seamless and coherent experience between users and the system. (Patil et al. ,2021.)

### 3.2.4 Entities

Entities are nouns that work together with intents to pinpoint a specific action. They also determine how parameter values are extracted from user inputs (Sabharwal & Agrawal, 2020). When Dialogflow matches an intent during runtime, it retrieves extracted values from the end-user's expression as parameters (Google Cloud, 2023). Each parameter has an entity type that defines the type of data to be extracted and stored. Dialogflow comes with predefined system entities like @sys.email, @sys.number, @sys.phone-number, etc. When a training phrase contains any of these entities, Dialogflow automatically enables system entities (Sabharwal & Agrawal, 2020). In figure 5, there is an example containing multiple entities, which helps to illustrate the concept more effectively.

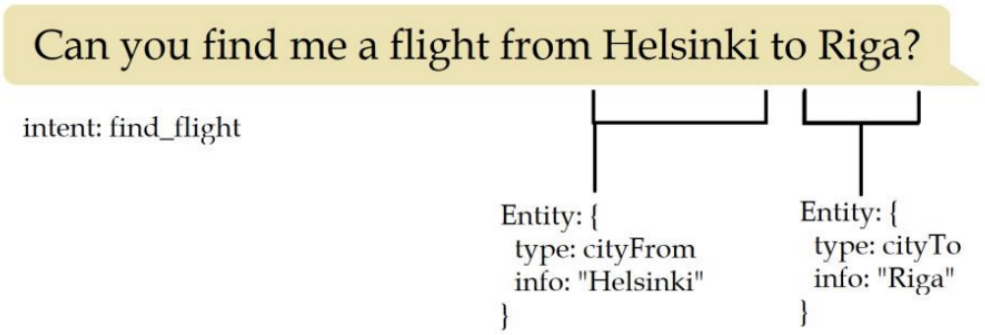


Figure 5: Example showing entities and intents within user input (Heikkilä, 2020)

In this instance, the user requests flight related information. While the intent could be labeled as "find_flight", the entities provide supplementary details about the departure destination and the arrival destination (Heikkilä, 2020). These entities are called custom entities and unlike system entities, they are added manually by the creator.

### 3.2.5 Contexts

Context plays a vital role in the success of the chatbot, particularly in Dialogflow. By utilizing contexts, the agent can communicate more naturally, retaining relevant information from previous interactions to steer the conversation effectively based on the user's intent and responses (Ranavare & Kamath, 2020). Contexts are applied to intents and can be reused in subsequent intents. When creating an intent, two choices are presented: input and output contexts. To link one intent to another, the output context of

the first intent should be set as the input context of the second intent. By configuring multiple input and output contexts, more intricate use cases can be handled. (Sabharwal & Agrawal, 2020.)

### 3.2.5 Fulfillment

Fulfillment is the last piece in the puzzle. It's the code that developers write to interface with the backend services to respond to a dynamic request. Dialogflow has inbuilt integrations with Google cloud functions to interface with backend. Figure 6 illustrates the processing flow during such interactions.

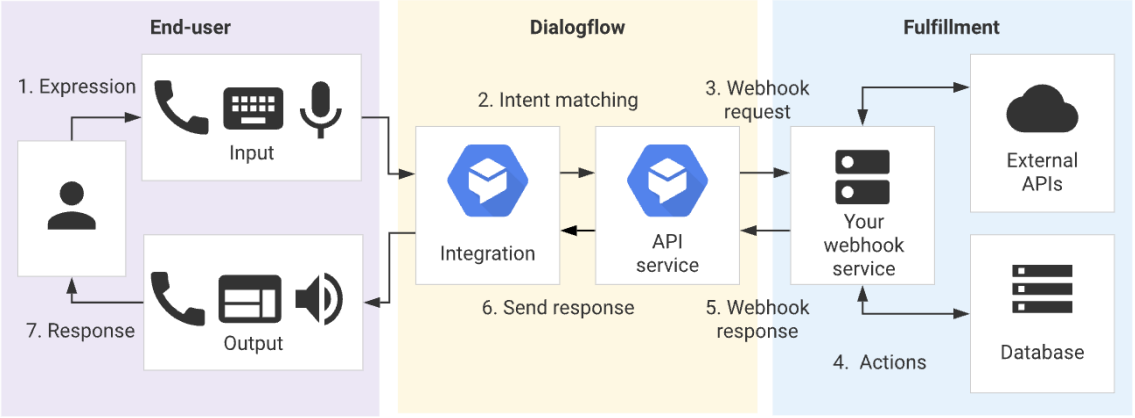


Figure 6: Processing flow for fulfillment (Google Cloud, 2023)

Firstly, the end-user provides an expression through text input. Subsequently, this expression is forwarded to Dialogflow in the form of a detect intent request message. Dialogflow then responds with a detect intent response message, furnishing pertinent details like the matched intent, action, parameter, and the defined response for the intent. To meet specific requirements, the custom service may execute diverse actions, such as conducting database queries or invoking external API calls. Following the necessary computations, the service sends a response back to the end-user, which is then presented as output, enabling a seamless and dynamic conversational experience for the user. (Patil et al. ,2021.)

## 3.3 Dialogflow's natural language understanding capabilities

Chatbots rely on Natural Language Understanding platforms, known as NLU, to understand and respond to user inputs effectively. These NLUs utilize machine-learning

and natural language processing (NLP) techniques to extract meaningful information, such as the user's intent and relevant entities, from unstructured text provided by the user. Creating an NLU from scratch is a highly challenging task that requires specialized expertise in NLP. As a result, chatbot developers often opt for widely-used and established NLUs to integrate into the chabots. By doing so, chatbots can leverage the capabilities of these existing NLUs to enhance understanding and responsiveness to user queries. (Abdellatif et al. ,2021.)

Dialogflow is a powerful NLU platform that supports various languages and offers seamless integration with different chatbot-based platforms, such as Telegram, Google Assistant, and Amazon Alexa. The platform features a user-friendly web-based interface with forms representing different parts of a conversation, where developers can input example sentences and corresponding NLU-generated answers. Responses can be added directly within the interface or obtained from a dedicated server application through Dialogflow's webhook mechanism, enabled by its APIs. (Canonico & De Russis, 2018.)

Dialogflow incorporates essential NLP and NLU algorithms, which are crucial for comprehending the user's natural language input. When a text input is received, it undergoes processing within the NLP module, where it is transformed into structured data for further analysis and understanding. One of the significant advantages of using Dialogflow is its integration with Google and the utilization of its built-in Machine Learning Algorithms, which enhances its ability to understand natural language expressed by users through agents. These agents comprise intents that are matched with user expressions, enabling appropriate actions as responses to queries. Beyond merely providing answers to customers. Dialogflow allows agents to engage in casual conversations with users. (Patil et al. ,2021.)

# 4 METHODOLOGY

The methodology section outlines the steps used to create a proof-of-concept conversational interface that makes use of Dialogflow. This methodology's main goal is to provide an example of how Dialogflow's essential elements, including agent, intents, entities, context, parameters, actions, training phrases, and events may be used effectively. Together, these components help to create a dynamic and engaging user engagement. It includes setting up Dialoflow, defining user intentions using training phrases and examples, configuring entities and parameters, creating and managing context. Collectively, this section aims to provide a thorough overview of the steps necessary to build a dynamic conversational interface. Through this demonstrative process, the versatility of Dialogflow as a tool for creating interesting and contextually aware user interactions is highlighted.

## 4.1 Setting up the Dialogflow

Google Dialogflow consists of two editions, namely the ES edition and CX edition. Both editions possess functionalities that aid in the management and construction of application systems (Patil et al. 2021, 6-17). Dialogflow ES edition was used for the purpose of this thesis.

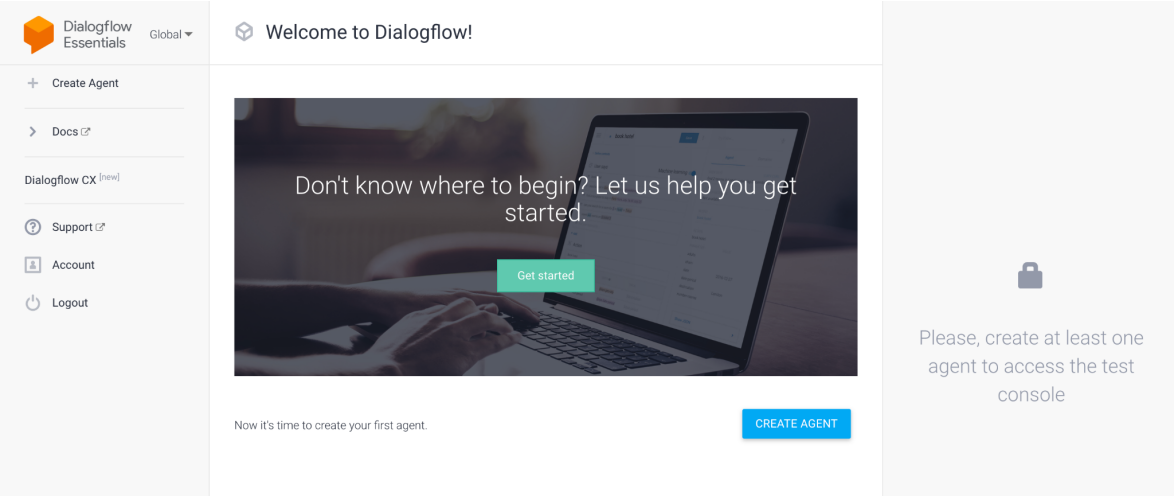


Figure 7: Dialogflow's main page (Google Cloud, 2023)

### 4.2 Creating an agent

The process of creating an agent on Dialogflow consists of a series of steps. After setting up and logging into Dialogflow, the main dashboard acts as the starting point. On this page, clicking on 'Create new agent' serves as the first step. This leads to a page where the user needs to assign a unique name for the agent.

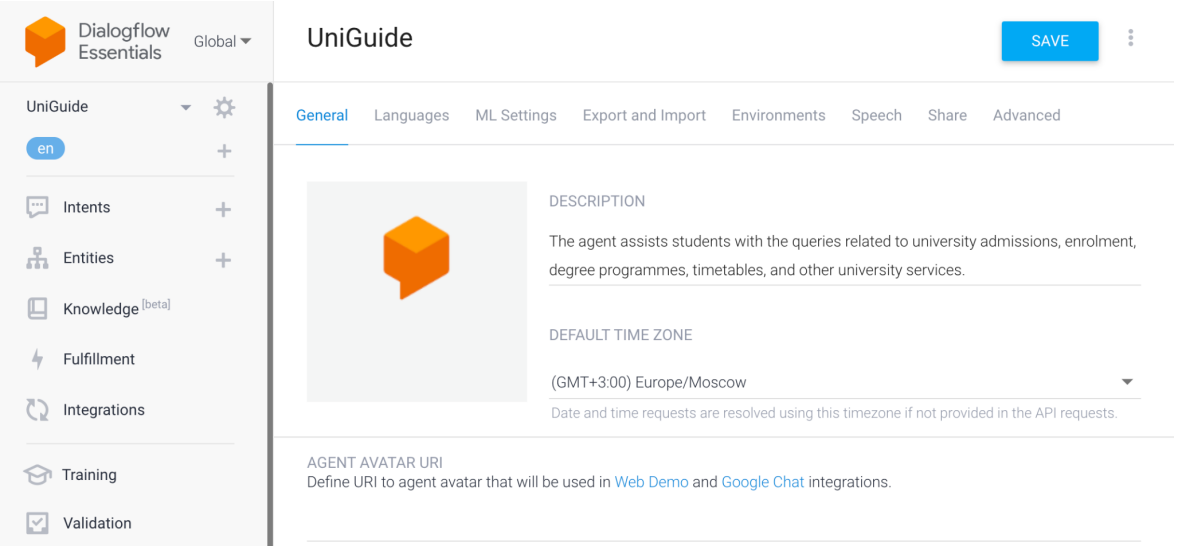


Figure 8: Agent Information - UniGuide

The name should reflect the function of the chatbot. It must be concise and accurate in describing the purpose and function of the chatbot. The agent was thus named 'UniGuide' as the name perfectly reflects the chatbot's intended use, which is to offer guidance and support within the framework of a university.

### 4.3 Creating intents

Google's Dialogflow provides two default intents namely 'Default Welcome Intent' and 'Default Fallback Intent'. The fallback intent serves as a type of catch-all for any unrecognized and unknown user input when the user's input does not fit any intent. Default fallback intent has a variety of static text responses such as 'I didn't get that. Can you say it again?', 'I missed what you said. What was that?', and 'Sorry, could you say that again?' (Ranavare & Kamath 2020, 4806-4814). Additionally, developers can add more fallback responses. Similarly, default welcome intent is used to greet users at the beginning of a conversation when the user's input matches the default welcome intent. The default

welcome intent contains text phrases such as ‘hello’, ‘hi’, ‘hey there’, ‘greetings’ and all. Like default fallback intent, developers can add more phrases manually to the welcome intent. Table 3 shows the intents and their purpose that was created for the proof-of-concept chatbot.

Table 3: Intent’s description and purpose

| Intents | Purpose |
|---|---|
| Assistance and Queries | It is created to understand user inputs including requests for assistance or information. It includes training phrases such as ‘Can you help me?’, ‘Help me, please?’. |
| Greetings and Well-Being | It is designed to understand user inputs which includes greetings phrases such as ‘Hi there, how are you?’,’Greetings! How’s your day?’. |
| Opening Hours | It recognizes user input looking for details about the business hours of a service. The services can be campus, libraries, restaurants/cafeteria or other campus facilities. Phrases like ‘When is it open for the day?’,’Give me the opening hours’ activate this intent. |
| Opening Hours Campus | It is tailored to assist users looking for information about the opening hours of campus. Some common training phrases triggering this intent are ‘Can I visit the campus today?’ ‘It's the weekend. Is the campus open?’ ‘Is the campus operating today?’ |
| Opening Hours Libraries | It identifies user input asking for the hours when library facilities are open. Phrases like ‘Is the library open today?’,‘When does the library open tomorrow?’ trigger this intent. |
| Opening Hours Restaurant/Cafeteria | It is designed to respond to user questions regarding the opening times of cafeterias and restaurants. Some training phrases include ‘Restaurant opening hours?’,‘Cafe |

| | |
|---|---|
| | opening hours?','Can we eat lunch at the campus?'. |
| Orientation Schedule Energy Technology | It recognizes user input that requests details on the schedule and content of orientation events for programmes in Energy Technology. Training phrases include 'Give me the orientation schedule','What's the orientation schedule for Energy Technology?','Tell me the orientation schedule for BSc. in Energy Technology'. |
| Orientation Schedule Industrial Engineering | It recognizes user input that requests details on the schedule and content of orientation events for programmes in Industrial Engineering. Training phrases include 'Give me the orientation schedule','What's the orientation schedule for Industrial Engineering?','Tell me the orientation schedule for BSc. in Industrial Engineering'. |
| Orientation Schedule Software Engineer | It recognizes user input that requests details on the schedule and content of orientation events for programmes in Software Engineering. Training phrases include 'Give me the orientation schedule','What's the orientation schedule for Software Engineering?','Tell me the orientation schedule for BSc. in Software Engineering'. |
| Thank you | It recognizes user input expressing gratitude for assistance or information provided. Some training phrases are 'Thank you for answering my question. ','Thanks a lot.','Thank you for answering all my questions.'. |

Dialogflow enables to add follow-up intent which allows for logical and well-structured conversation. The 'Opening hours' intent is followed by follow-up intents such as 'opening hours - restaurant/cafeteria','opening hours - library','opening hours - campus'.

These follow-up intents were purposefully created to highlight the Dialogflow's features and how it can help create better conversation flow. It successfully demonstrates the ability to precisely guide user interactions by defining distinct areas such as campus, library, and restaurants.

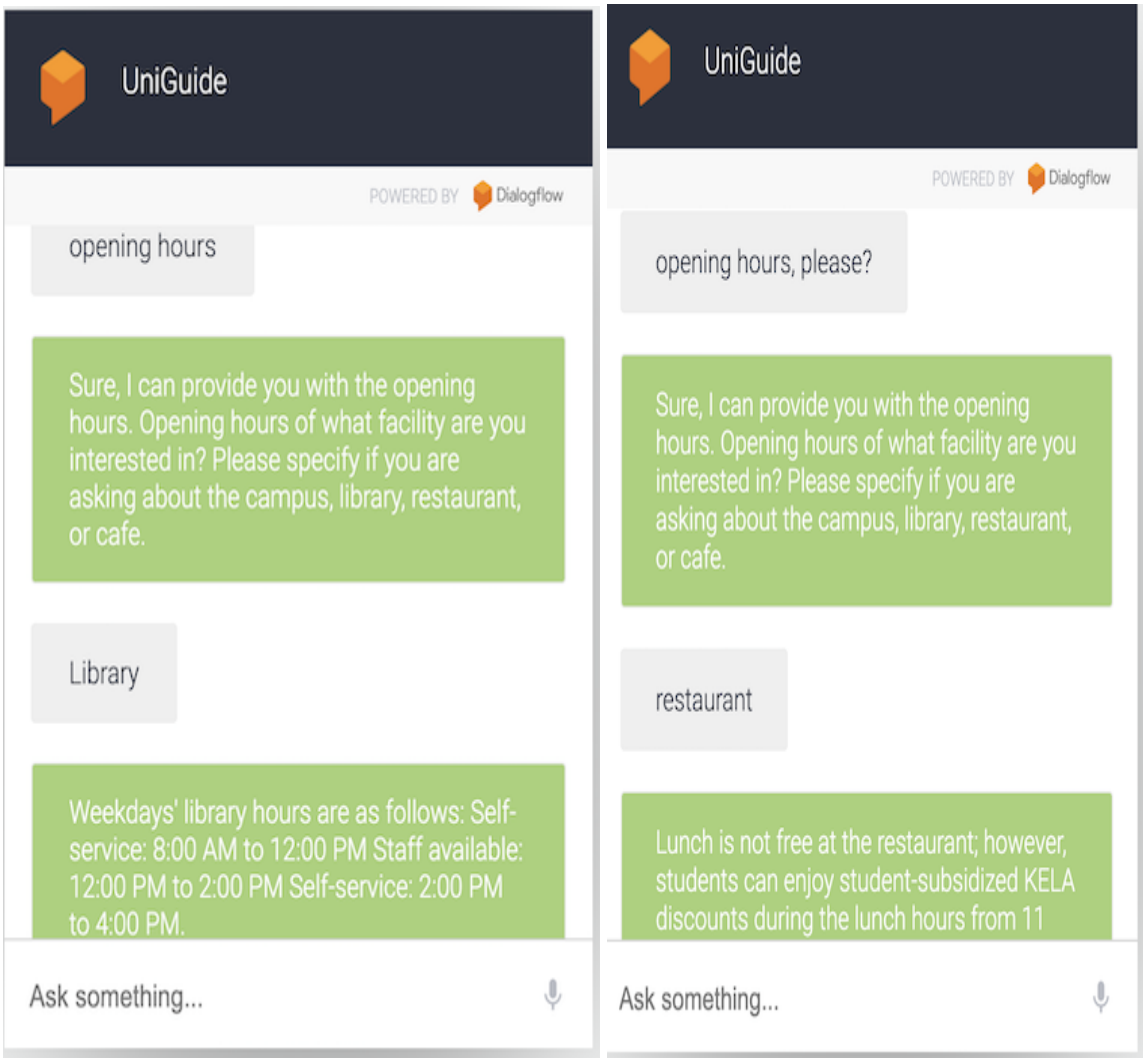


Figure 9: Demonstration of follow-up intent

### 4.4 Creating entities

There are three orientation schedule intents for three different study programs. The 'StudyProgram' entity is purposefully paired with these intents to provide a more seamless and context-aware conversation flow. This feature in Dialogflow enables the chatbot to respond to questions about orientation schedules for various programmes in a thorough

manner. By ensuring that the chatbot not only recognizes the user's interest but also customizes its replies appropriately, this feature maximizes the user experience and creates a more personalized conversation interaction.

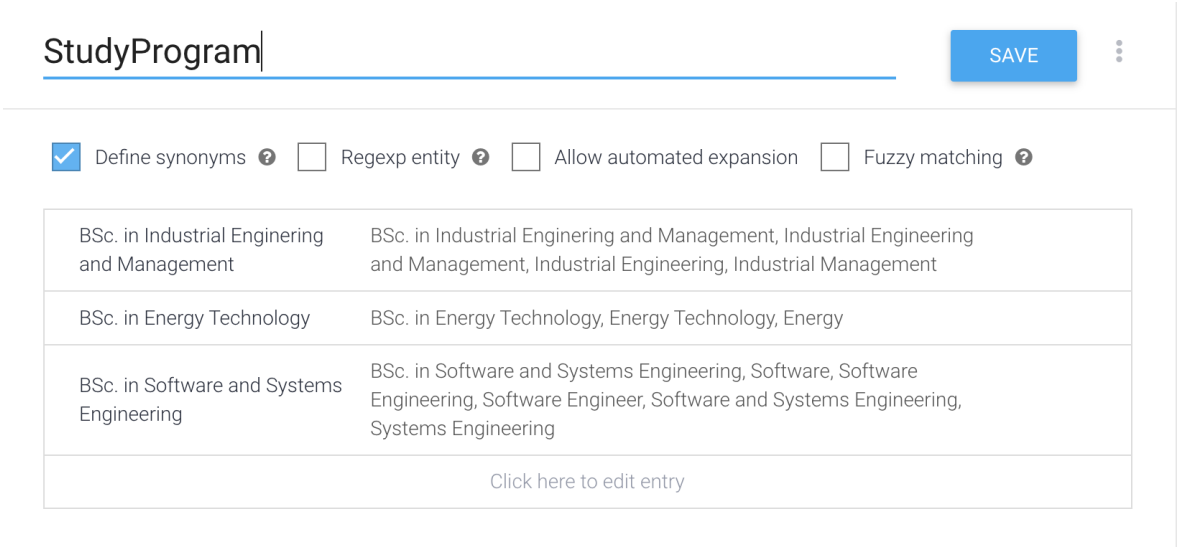


Figure 10: StudyProgram entity and its entries

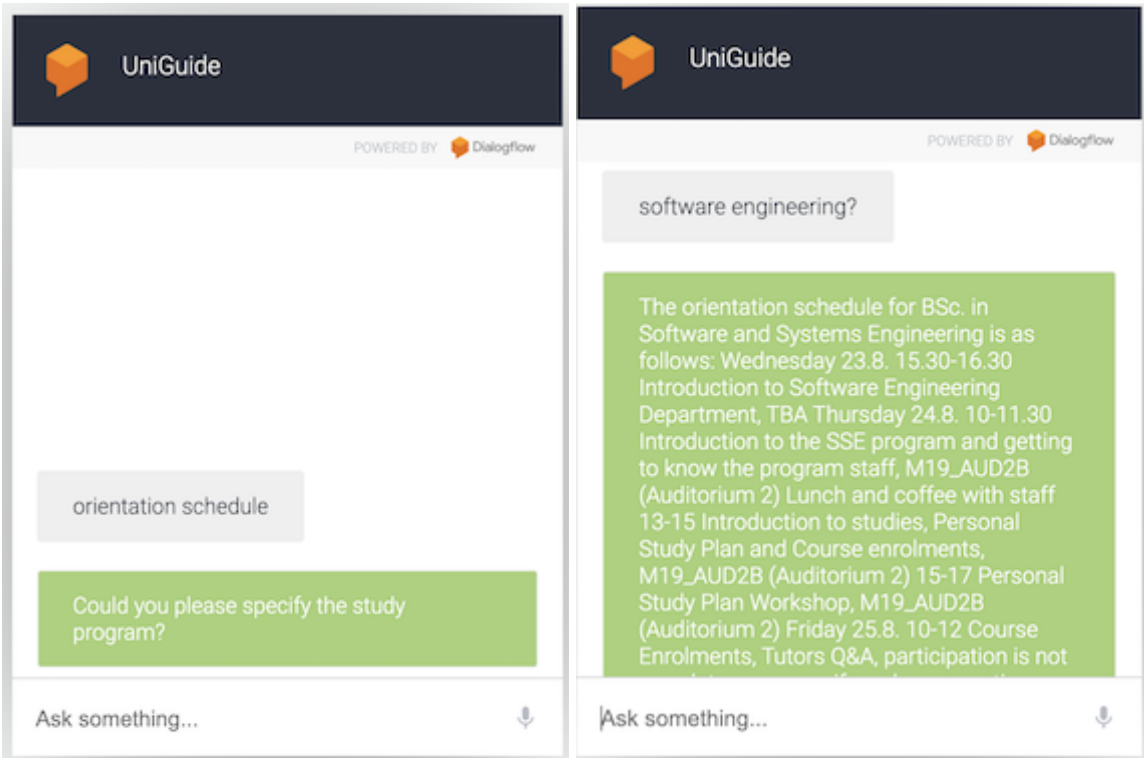


Figure 11: Enhanced chatbot interaction with entity and prompt message feature

Moreover, by making the 'StudyProgram' entity in Dialogflow required and using parameters effectively, the chatbot's conversation flow is enhanced. For example, when a user starts a query with only 'orientation schedule', the chatbot prompts with a message 'Please, specify which study program?'. This proactive approach means that the user provides necessary information before continuing, which makes the conversation more accurate and user friendly.

### 4.5 Integrations

Using Dialogflow's online demo integration capability, a detailed testing strategy was used to verify the chatbot's functioning. Direct user engagement was made possible by the chatbot's flawless integration into the specific web application. Although formal user testing was not carried out, the author methodically recreated a wide range of test situations. A number of user queries and interactions were simulated using the online demo integration to evaluate the chatbot's response and accuracy.

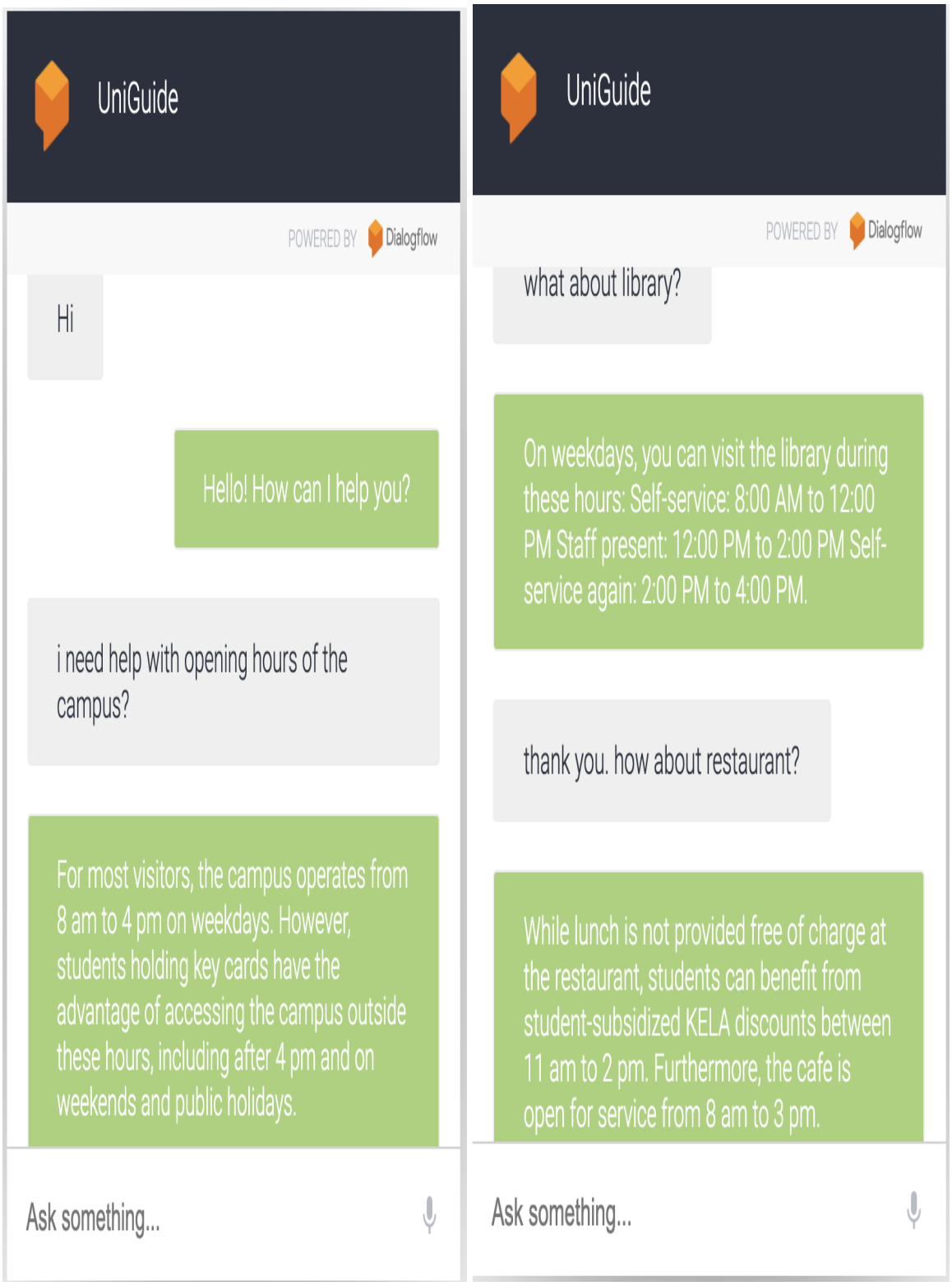


Figure 12: Opening hours conversation flow

Through these testing, it was confirmed that the chatbot accurately acknowledged and processed user inputs, providing appropriate and relevant responses. The web demo integration helped in understanding the chatbot's performance within a suitable environment.

# 5 Results and Analysis

The proof-of-concept study's use of the Dialogflow-based chatbot gave useful insights into its capabilities and drawbacks. The chatbot's occasional difficulty in comprehending and preserving context consistently emerged as a crucial issue during the testing. This outcome raises crucial questions about the usefulness of the chatbot and the requirement for additional improvement.

The chatbot proved adept at understanding and answering user inquiries on a variety of subjects, from basic questions to specific requests for information regarding opening hours and orientation programmes. The chatbot was typically responsive and helpful which emphasizes the chatbot's capacity to deliver pertinent and helpful answers to user queries. The construction of intents, entities, and follow-up intents showcased Dialogflow's flexibility and adaptability and enabled the building of a dynamic conversational interface.

However, even though Dialogflow has strong natural understanding skills, the chatbot occasionally had trouble grasping the context of the user's requests. For example, when asked, "Opening hours of a cafe?" the chatbot sometimes responded with "Opening hours of what facility are you interested in?". This clearly highlighted an issue where despite training, the chatbot did not always accurately infer the user's intent. It is important to note, nevertheless, that the chatbot showed the capacity to respond correctly after asking for clarification. The chatbot successfully delivered the precise opening hours in the identical circumstance as above when the user confirmed that they were referring to the cafe. This indicates that the chatbot's training and configuration were effective in addressing the user's query once the context was clarified.

Despite some issues, Dialogflow's features offer a quick and straightforward method for developing chatbots for conversational user interfaces for a variety of applications. It is a great starting point for companies looking to create conversation-based interactions for customer satisfaction and several other use cases because of its accessibility and versatility. Dialogflow's learning capabilities make it a viable tool for developers and organizations looking to increase user engagement and satisfaction, especially when combined with efficient training and configuration.

The study also emphasizes the importance of efficient training and configuration for developing a chatbot that is more context-aware. The likelihood of accurate responses can be greatly boosted by giving the chatbot well-crafted training phrases and examples. This emphasizes the value of solid training data that can help the chatbot understand a wider range of customer inquiries.

# 6 Conclusion and Future Work

The primary motivation for undertaking this thesis was to create a fully functional chatbot which would enhance student services at LUT university. The objective was to build a chatbot that would not only address routine queries but also free up manpower for other important services. However, due to the limitations of a bachelor's thesis, the emphasis moved to creating a proof-of-concept. Although it was not feasible to fully develop a comprehensive chatbot within the parameters of this study, the proof-of-concept offered insightful information about the potential advantages of utilizing chatbot technology to enhance student services at LUT university.

In this proof-of-concept study, the implementation of a Dialogflow-based chatbot served as a significant exploration of its capabilities and limitations. The broader landscape of technological advancements, including machine learning and AI, has reshaped the way people interact with information and services. Chatbots have quickly evolved from being business web assistants to being essential elements in a variety of sectors, including higher education. They have developed into essential tools for addressing the needs of a generation that is focused on mobile and ravenous for instant messaging. It goes without saying that chatbots have the ability to reduce administrative tasks, increase engagement, and give quick answers.

From a learning perspective, this topic presented an excellent opportunity. It offered an exploration of the realm of conversational AI, dialog management, and natural language understanding. Moreover, the bachelor thesis helped in understanding the practical aspects of developing an AI-driven solution, emphasizing the critical role of considering the user's intention and perspective. Writing this thesis was an enlightening journey that highlighted the growing importance of AI and chatbots in the realm of customer service. It is evident that these technologies are the future, revolutionizing the way organizations interact with their customers. This understanding broadened the horizon of possibilities for transforming customer service and meeting the instant-response expectations of modern customers.

Future work will entail developing this proof-of-concept into a fully operational chatbot for the LUT university. The development of the chatbot will involve an integration of data from the university's website and the use of backend API such as Dialogflow. The chatbot will be trained with information from the LUT university website. Information regarding courses, degree programs, opening hours, campus facilities, and other relevant details will be retrieved and updated from the website. This knowledge base of the chatbot will be kept up to date and comprehensive using web scraping. The fulfillment aspect will involve setting up replies to user queries, which includes information from the website, providing links to certain pages, or even transferring complex and sensitive questions to the relevant university departments when necessary. The dynamic conversation flow will be handled by Dialogflow, which will give users timely, context-aware replies.

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