

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
UNIVERSITY MOHAMED BOUDIAF - M'SILA

FACULTY: Mathematics and Computer
Science
DEPARTEMENT: Computer
Science

N°:



DOMAIN: Mathematics and
Computer Science

FIELD: Computer Science

Speciality: Networks and TIC

**A Dissertation in Fulfillment
for the Requirement of the Degree of
MASTER**

By: Samiha Attaoua & Chaima Guesmia

TOPIC:

A multilingual chatbot for supporting mobile
companies complaints.

Case study: ATM Mobilis of Algeria.

Defended publicly on: 15/06/2022

Board of Jury Examiners

Aimad-Eddin Debbi

University of M'sila

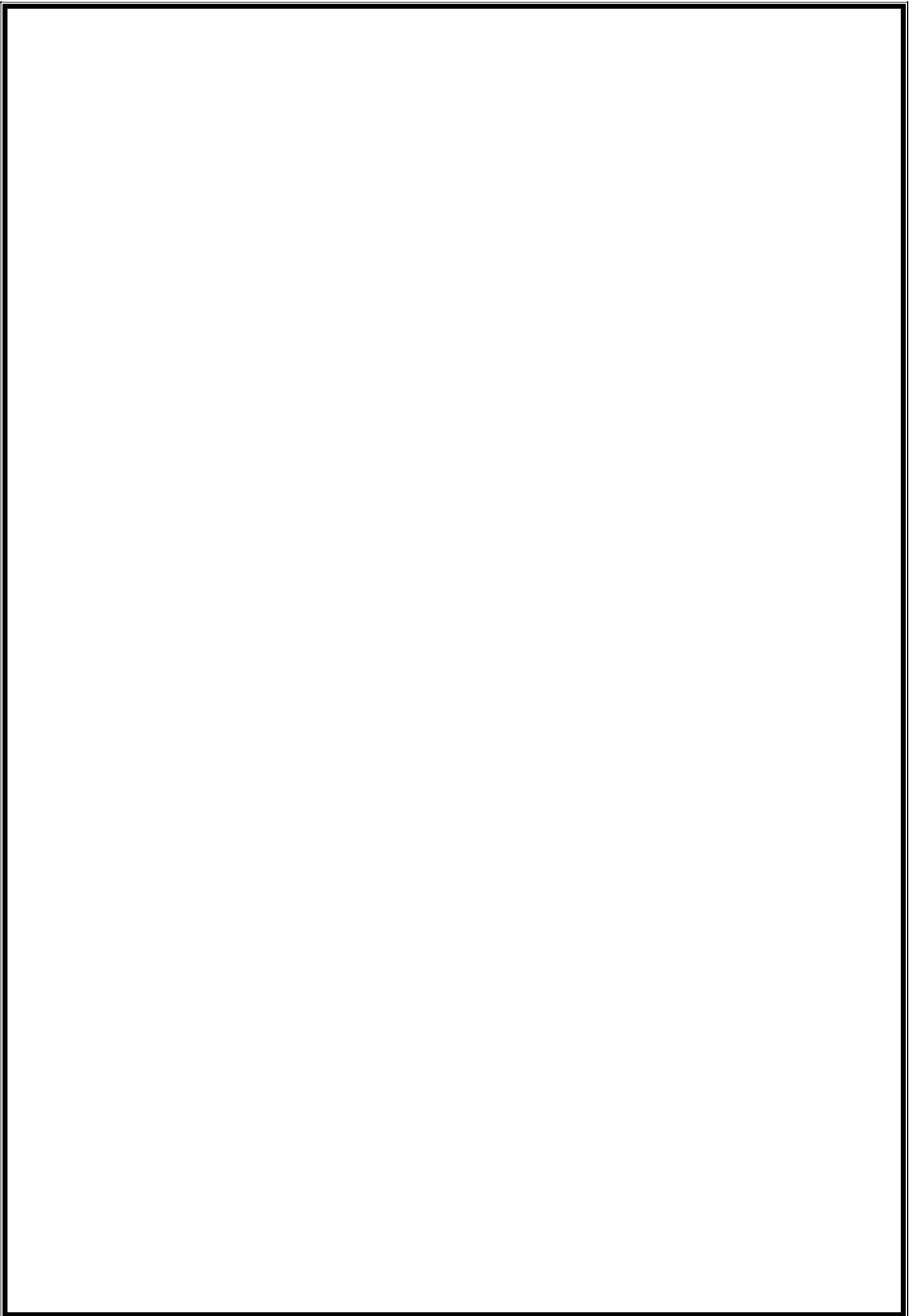
Tahar Mehenni

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Academic year: 2021/2022



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Dedication

Praise be to God, who has enabled us and given us the strength to complete this work

To the one who harvested the thorns from my path to pave the way for me to learn for you father and mother.

For those who were and still supported me, my family sisters, and brothers, from your eldest Kamal to your youngest Juhayna.

My supervisor who whenever we lost he was our guide

To the friends of the path, especially: Bassma, Nassima and Taima.

To everyone who accompanied me on my way, whether near or far.

for you ...

Samaha Attaoua

Dedication

In the name of Allah, Most Merciful

First of all, we thank Allah the Almighty for giving us the blessings and the strength to do this work.

I Would love to dedicate this modest work to my dearest mom who has not stopped encouraging me since my first school year.

To my dear dad for his sacrifices as a testimony of all my affection throughout my studies. To my brothers Firas, Abd Alwhab and Mouhamed.

To all my extended family especially my uncle Djaloul.

To All my friends especially: Halima, Boutheyne, Wissame, Ilhame, Samiha.

Cheyma Guesmia

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Introduction

Artificial intelligence (AI) is increasingly integrating our daily lives with the creation and analysis of smart software and devices, called intelligent agents. Intelligent agents can perform a variety of tasks ranging from laboratory work to complex operations. A chatbot is a typical example of an artificial intelligence system and one of the primary and most widespread examples of intelligent human-computer interaction (HCI). It is a computer program that responds like a smart entity when spoken to through text or voice and understands one or more human languages through Natural Language Processing (NLP). in the lexicon. Chatbots can also play the role of interactive agents, digital assistants, or artificial conversational entities rather than the human element.

Chatbots can simulate human conversation and amuse users but they are not just designed for this purpose. They are useful in applications such as education, information retrieval, business, and e-commerce. Chatbots integrate with group conversations or are shared just like any other contact, while multiple conversations can be transferred in parallel.

The implementation of chatbot technology in telecom companies is changing the nature of interactions with customers. It is now possible to automate repetitive and regular work, increasing productivity, creativity and efficiency in organizations. However, there must be a preoccupation with understanding the importance of the customer experience with the introduction of these innovations, not only because people react differently to technology, but also to ensure that the overall impact of the brand is positive.

The aim of this study is to propose a solution to overcome the problems of Mobilis Telecom, and the customers alike, and live up to their aspirations. It is represented in a chatbot that works on:

- Respond quickly to customer complaints in a more relevant and confidential manner
- Allow customers to voice their complaints and work to find solutions as quickly as possible or establish guidelines for resolving them.
- Providing company services in addition to new offers.

In the first chapter, we will talk about complaint support in mobile phone companies, the most important terms to understand the importance of the customer to the company, complaints, their types and importance, mobiles case study, and a chatbot proposal. solution to support its customers.

In the next chapter, we'll look at artificial intelligence, chatbots, machine learning, deep learning, natural language processing, natural language neural networks, and chatbots.

Then in the next chapter we will talk about chatbot architecture, the work of the chatbot system and an overview of our project. In the last chapter, we will show the implementation and results of two types of chatbots that we have created.

Chapter 1

Support Complaints in Mobile Phone Companies

1. Introduction

Every business must be customer centric to keep it going in the competitive market. Investing in customer support will help companies understand their complaints and improve their services and experiences.

There is always a positive side to customer complaints. Smart companies understand the importance of customer complaints and consider it a golden business opportunity. However, complaints are inevitable, no matter how hard you work or how good your products are, no company can satisfy their customers all the time.

According to new research from Newvoicemedia, “US companies lose an estimated \$62 billion each year after bad customer experiences.”

The best way to ensure the growth of your business is to know customer complaints and treat them as valuable feedback to inculcate in your customer service strategy to improve your brand experience.

In this chapter, we will first talk about telecommunications companies in general, and the basic concepts that make us understand the importance of maintaining a good relationship with customers and satisfying them, and then we will specialize in studying Mobiles and trying to know the challenges they face. What are the most important problems faced by its customers and what are the solutions that it seeks to achieve in order to achieve their satisfaction

2. The most important concepts of the chapter :

2.1 Mobile Phone Companies

A mobile phone operator, wireless provider, or carrier is a mobile telecommunications company that provides mobile telephony or mobile Internet access services. The operator provides a SIM card to the customer who inserts it into their mobile phone or tablet to gain access to the operator's cellular network.

2.1 Customer (client)

A customer is an individual or business that purchases another company's goods or services. Customers are important because they drive revenues; without them, businesses cannot continue to exist. All businesses compete with other companies to attract customers, either by aggressively advertising their products, by lowering prices to expand their customer bases, or by developing unique products and experiences that customers love. [1]

2.3 Concept of customer loyalty

Customer loyalty is a measure of a customer's likeliness to do repeat business with a company or brand. It is the result of customer satisfaction, positive customer experiences, and the overall value of the goods or services a customer receives from a business so that Oliver (1997) defined customer loyalty as "a firm commitment to repeatedly buy back a preferred product/service in the future, thus allowing the same brand to be bought back, despite the impact of market conditions, and marketing efforts that may induce a change in behaviour and transfer to other companies'. [2]

2.4 Customer satisfaction

Customer satisfaction (often abbreviated as CSAT) is a measurement of how happy (or unhappy) customers are with a company's products, services or experience. Customer satisfaction consists of a customer's perceived quality, value and expectations of your company and what you offer. This data can reveal major insights into how customers relate to your brand and how they will interact with your brand in the future.[3]

American Satisfaction Measurement Model (ACSI) - such as the shows Figure 1



FIGURE 1.1; Customer Satisfaction (ACSI) [4]

2.5 Definition of customers' complaints

Customer complaints refer to when a business does not deliver on its commitment and does not meet customer expectations in terms of the product or services. The vital aspect of every business is its clients. For greater success, businesses need more satisfied clients. And the best way to obtain new clients and maintain the existing ones is by providing them with satisfactory service. But how to understand whether your customers are happy or unhappy? A customer complaint emphasizes a problem that might be related to an organization's product, employees or internal processes, and by hearing these problems directly from customers, an organization can investigate and improve to avoid additional complaints in the future.[5]

3. Types of Customer Complaints

Complaints are inevitable in every business. As customers have become aware of their rights than ever before. A large segment of customers is tech savvy and they are aware of the platform available to express their discontentment. Therefore, companies spend millions to provide services to customers. However, no matter how hard you try but you can never satisfy 100% customers 100% times. A company's reputation is decided from the way it addresses its customer's problems.

Clearly, failing to address or intentionally ignoring customer's complaints can cause bad consequences such as losing customers, negative reputation. Therefore, a company should never neglect their customer service segment and set up an efficient customer care unit. There are various ways through which a company can provide a platform for customers to reach them and get the solution for the problems they face

If the customer's issues are addressed properly and they are provided with proper solutions and they feel satisfied and happy with your service, there are up to 99% chances that they will do business with you again. With the internet becoming omnipotent, people prefer to complain about their issues publicly.

Therefore, it is advisable for companies to pay proper attention to the customers' complaints. To do this, it is important to understand different types of customers complaints and how to address them to not lose business.

3.1 Quality of service-related complaint:

Quality of service-related complaints are types of complaint that no business would want to have. Great investments in the quality of products and service do not guarantee zero quality of service related complaint.

Sometimes such complaints occur due to unrealistic expectations of a customer. such complaints play an important role to improve the quality of the product and service, which has

long term benefits. Information from such complaints should be collected, processed and analyzed, so that the company can take information-based decisions in the future.

This type of data is useful for the continuous improvement of the product and service. These types of customer complaint should be given the highest priority and great investment should be made to resolve such complaints.

3.2 Complaints because of misunderstanding:

Miscommunication is inevitable when dealing with people. A customer can misunderstand or misinterpret what you say. Sometimes they can get annoyed also and accuse you of lying. However, in such a scenario, one should not lose temper and take the matter to the experienced executive and settle the matter.

It is suggested that you should treat the customer with respect even when he is clearly misunderstood. To avoid such complaints requires knowledgeable and experienced staff and precise advertising material.

3.3 Personnel Complaint :

These types of complaints made by the customers when executives behave rudely or inappropriately with them. Few of the most common personnel complaints made by customers are “you don’t seem to care.” Or “Nobody bothers to solve my issue.” These complaints should be dealt with utmost care because customers who have made such complaint already feel offended and we are well-versed with human nature.

A human takes an extreme decision when angry or hurt. These customers can make a resolution to never buy anything from you which is very bad for the company. It is advisable to deal with these types of customers with empathy and provide them with better services.

3.4 First-time complaint :

Usually, customer care providers tend to ignore the complaints of a new customer or a customer who is complaining for the first time. If they do so, they make a big mistake and increase the chances of losing a loyal customer. On the contrary, such customers such be paid

extra attention and helped to fix their problem instantly. In the scenarios where there is actually a fault in the product.

3.5 Serial Complaint :

There is something wrong if a customer complains about something again and again or many customers complain about the same thing. Management should take effective actions to address such complaints before they go out of hand.

A customer loses his trust in the company if his complaint is not addressed when asked repeatedly. Therefore, serial complaints must be handled quickly. Fixing such problems reduces the work for the future altogether. However, working on such complaints is good for the company because these complaints help to make the service better and also gives room to the management for introspection and improvement.

On the other hand, a company should narrow down customers who complain frequently about every other thing and find smart ways to deal with them, because there are always some mischievous people who just want to create a nuisance. [6]

4. Reasons to take care of customers' complaints

One of the reasons is:

- Unsatisfied customer will not always become a customer of the enterprise as encouraging other customers to leave the enterprise.
- The unsatisfied customer will mention this to at least 14 individuals on the problem
- The cost of solving the problem is between 10-25% and the cost of finding a new customer.
- The customer who makes the complaint and whose problem is solved will nominate the institution to deal with it to at least 10 new individuals.
- The complainant customers clarify the existing problems and also send early warning signs that help the enterprise to overcome the problems it does not know, wasting the opportunity for its competitors to acquire the enterprise's permanent customers.
- Complaints help customers develop the enterprise's products and increase their sales.

5. Outcomes of customer complaints

The most important results of the Foundation are:

- Customer' transformation into competitors
- Reduced enterprise income
- Increasing Competition Power
- Low loyalty of employees
- Employers' desire to work for competitors

6. Case Study: ATM Mobilis of Algeria

Today, digital represents a very big challenge for economic institutions in Algeria. Is it thanks to its importance in the facilitation of work, the performance it provides, and the improvement of its economic growth, but above all it adds competitiveness. In addition, it brings these companies closer to people and consumers, who multiply daily interactions, communicating using digital tools, such as the mobile phone more specifically. Algeria is a very large, or almost new market in the use of digital services of several types.

But in this competitive market, telecom companies do not enjoy full customer loyalty, so they are always looking to think about how to create loyal customer base, providing better services to gain a competitive advantage that ensures their continuity in the market.

ATM Mobilis, like all companies, since its launch in 2003 has made a name for itself in the digital world thanks to its usefulness as a company in terms of communication with its customers. . For this, the three operators are working hard to attract new customers and retain old customers at all levels.

On this basis, we will present in this section the company ATM MOBILIS, its historical evolution, its organization and its most important objectives, then we will talk about its

relationship with its customers and the most important complaints it receives from them and how to deal with them.

Next, we will propose a solution that helps strengthen the customer's relationship with the company, which is a chatbot that automatically responds to their complaints, thus ensuring its continuity in the competitive market.

6.1 Presentation of the company ATM MOBILIS

Mobilis has been positioned as a close operator for its partners and clients, supported by its institutional signature; "Everywhere with you." Her motto is a promise to listen.

Mobilis appeared in August 2003 as a company affiliated with the Algerian state in the field of mobile telecommunications, with shares with a capital estimated at 100 million DA. It is affiliated with Algeria Telecom, which offers its customers a wide range of services provided with high quality. The first dealer in the field of communication, as Mobilis is the new name for this company that was divided.

Algeria's communications have already entered the market since 1 January 2003 with the following objectives:

- Increase and facilitate access to communication services by as many users as possible
- Raise the quality of service offered and expand its configuration and work to make it more competitive
- Development of the national communications network

6.2 The Historical Development of Mobilis

- In 2002, Telecom Algeria benefited from a licence to organize its GSM mobile activities and entered the licence via the app starting from Al Fatih in Jan 2003
- In August 2003, the unloading of Algiers Telecom Company was carried out and ATMOBILIS mobile phone was set up in a shareholder company
- In May 2004 Mobilis inaugurates the Subscribers Center
- In August 2004, Mobilis offers a prepaid service

- December 2004 Mobilis launched the first experimental network for 3G mobile phone services UHTS in partnership with the Chinese Huawei Technology Corporation
- February 2005 Mobilis proposes two Internet service via the phone MMS/GPRS under the name MOBI+
- March 2005 Mobilis launches its first commercial agency
- March 2006 Mobilis achieves six million subscribers
- In the first months of 2006, Mobilis was able to cover more than 80% of the national territory
- In July 2016, the subscriber base of Mobilis (GSM and 3G) reached 16.5 million subscribers.
- In December 2019, Mobilis obtained a global telecommunications license (2G, 3G et 4G) for employment in Mali.

6.3 Objectives of the company:

Since its creation, Mobilis has set itself main objectives which are:

- Customer satisfaction.
- Customer loyalty.
- Innovation and technological progress.
- Mobilis is constantly working on its brand image and constantly strives to offer the best to its customers.
- A high quality network.
- Develop subscriber share and gain market share.

6.4 Geographical location

For the exercise of its activities, Mobilis is distributed throughout the national territory. It is represented by:

- A head office located in Algiers. It is located in the Business District, Bab Ezzouar, since November 2011.

- A distribution and sales network, made up of commercial agencies, distributors and points of sale.
- Eight Regional Directorates:
 - 1) The Algiers Regional Directorate: which covers the following wilayas: Algiers, Blida, Tipaza, Tizi Ouzou, Boumerdes and Bouira.
 - 2) The Oran Regional Directorate: which covers the following wilayas: Oran, Sidi Bel Abbas, Mostaganem, Tlemcen, Ain T'emouchent, Saida and Mascara.
 - 3) The Annaba Regional Directorate: which covers the following wilayas: Annaba, Tébessa, Guelma, Skikda, El Taref and Souk Ahras.
 - 4) The Constantine Regional Directorate: which covers the following wilayas: Constantine, Batna, Oum El Bouagui, Mila and Khenchela.
 - 5) The Chlef Regional Directorate: which covers the following wilayas: Chlef, Relizane, Tissemsilt, Tiaret, Medea, Djelfa and Ain Defla.
 - 6) The Sétif Regional Directorate: which covers the following wilayas: Sétif, Jijel, Bejaïa, M'sila and Bordj Bou Arreridj.
 - 7) The Béchar Regional Directorate: which covers the following wilayas: Béchar, Naàma, Tindouf, El bayadh and Adrar
 - 8) The Ouargla Regional Directorate: which covers the following wilayas: Ouargla, Tamanrasset, Illizi, Ghardaia, Laghouat, El Oued and Biskra . [7]

6.5 Places of existence on the digital world:

6.5.1 Website:

The official Mobilis website is www.mobilis.dz. It was launched in 2003 as a database of information about the company and its offers. Through its development strategy, the company has integrated new sections on the site, to make it more attractive and even more useful. Today the Mobilis site is an increasingly efficient site thanks to improvements based on the marketing study with regard to the planning of a site.

To make the site more interactive, the company links it to other sites or social networks to keep the customer more connected, give them more choices to surf and find all the offers and

information they want. This is another strategy launched by the incumbent operator, it consists of linking customer complaints expressed by the site directly to the CRM.



FIGURE 1.2: mobilis site web [8]

6.5.2 Facebook:

Is the social network most used by Mobilis fans with more than 2.7 million subscribers. This channel is primarily used to communicate all the news of Mobilis, its products and its social activities. However, this channel is not yet automatically linked with the company's CRM since there are employees responsible for responding to these complaints. The link of the official Facebook page :

<https://www.facebook.com/MobilisOfficielle/app/151858328287166/>

6.5.3 Instagram:

With more than 84,000 subscribers, Mobilis opens this page to launch and promote its promotions, offers and activities during national or religious events, through photos opening a link for interactivity and the exchange of comments, share and like allowing customers to express their opinions. The link of the official Instagram page :

<https://www.instagram.com/mobilis.dz/>

6.5.4 **Linkedin:**

A social network that invites companies, professionals but also job seekers, to share professional themes, and discuss all possible employment opportunities. The number of Mobilis subscribers on LinkedIn is more than 38 thousand subscribers.

6.5.5 **Twitter:**

Wanting to be more informative, Mobilis shares with its 379 thousand subscribers on Twitter all the Twitters, concerning its activities towards society and the news of its products and services.[9]

6.6 A sample of Mobilis agency complaints in M'sila

Mobilis seeks through its strategy to reach the largest possible number of subscribers by providing all the necessary information and exchanging it with its customers. They are still facing difficulties in communicating with the company due to the lack of immediate and convincing responses to their problems on the electronic platforms. Also, the personal presence of the client in the agency to inquire is not the appropriate solution for him. On this basis, we have studied the sample of the Mobilis agency in M'sila, the complaints it receives and how they are dealt with, and here we will present the most important examples:

- **What are the different complaints that you receive and the most frequent?**
 - Procedures for disposing of third party property that contain several administrative conditions in person. Discharge of a private agency in the disposal order (the agency is brought from the municipality). Determine who was responsible for the card in the years prior to the change (new owner or old owner)
 - Ask for suggestions on calls and internet offers, especially regarding internet speed and live streaming
 - Proposal to create more than one agency
 - Request to improve the communication network in an area. The problem is directed to the technical interests through a request to collect the signatures of customers by the official of the association or the

neighborhood and then submit them to the technical departments and then study and then make a decision

- **What are the most commonly used methods for receiving complaints?**
 - The majority of complaints are presented by a person or group
- **For employees, what are the difficulties they encounter in responding to customer complaints?**

There are some requests that are impossible by the citizen so that the complaints are subject to:

- Complaints that require time to study, and the response to them is not immediate, which annoys the customer
- Complaints are subject to the company's laws.

- **Does the large number of complaints affect the psychology and feedback of employees?**

The large number of complaints does not directly affect the psychology of the workers, because they are mostly trained to deal with customers (the field of emotion control) Customers are treated with respect in a professional manner.

- **What are the ways to respond to customer complaints?**

Yes, there is, without giving details
- **How many complaints has the company received in the last three years?**

Statistics cannot be given
- **How does the company seek to satisfy its customers?**

Private information that cannot be disclosed
- **How do you rate the speed of your response to customer complaints?**

-Private information that cannot be disclosed

- **How do you deal with unclear complaints?**

- There are no unclear complaints, the customer must be understood in any way
- There is no problem with the time that the worker wastes with the customer because the worker is restricted to working hours and the time he spends with the customer's preoccupation is open

How wide is the space allocated for the customer to express his complaint?

There are no unclear complaints, the customer must be understood in any way

- There is no problem with the time that the worker wastes with the customer because the worker is restricted to working hours and the time he spends with the customer's preoccupation is open.

Chapter 2

Artificial Intelligence and chatbot

1. Artificial Intelligence

Artificial intelligence is a field of computing that focuses primarily on the transmission of anthropomorphic intelligence and thinking into machines that can assist humans in many ways. Artificial intelligence was a term that John McCarthy used in 1956.

AI has slowly sprung up and grown stronger in many fields such as engineering, mathematics, physics, technology all of which have led to the current tremendous shift in this field which we are witnessing now. This is an idea that proposes that machinery can acquire intelligence. It encompasses areas like machines can learn on their own, adapt to a specific circumstance and self-correct their own mistakes. i.e., Machinery may think on their own without being encoded with commands. [10]

There are three levels of artificial intelligence: ANI, AGI and ASI.

- **ANI (Artificial Narrow Intelligence)** – is the first level that can make a decade only in one sphere. For example, there 's AI that can beat the world chess champion in chess, but that 's the only thing it does.
- **AGI (Artificial General Intelligence)** – AI that reaches and then passes the Intelligence level of a human, meaning it has the ability to _reason, plan, and solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience
- **ASI (Artificial Super Intelligence)** – An intellect that is much smarter than the best human brain in practically every field, including scientific creativity, general wisdom and social skills. [11]

1.1 Categorization of Artificial Intelligence

Artificial intelligence can be divided into two different categories: weak and strong.

- **Weak artificial intelligence** embodies a system designed to carry out one particular job. Weak AI systems include video games such as the chess example from above and personal assistants such as Amazon's Alexa and Apple's Siri. You ask the assistant a question, it answers it for you.
- **Strong artificial intelligence** systems are systems that carry on the tasks considered to be human-like. These tend to be more complex and complicated systems. They are programmed to handle situations in which they may be required to problem solve without having a person intervene. These kinds of systems can be found in applications like self-driving cars or in hospital operating rooms. [12]

1.2 Types of Artificial Intelligence

Work in AI has primarily focused on two broad areas: developing logic-based systems that perform common-sense and expert reasoning, and using cognitive and biological models to simulate and explain the information-processing capabilities of the human brain. In general, work in AI can be categorized within three research and development types: symbolic, connectionist, and evolutionary. Each has characteristic strengths and weaknesses.

1.2.1 Symbolic AI

Symbolic AI is based in logic. It uses sequences of rules to tell the computer what to do next. Expert systems consist of many so-called IF-THEN rules: IF this is the case, THEN do that. Since both sides of the rule can be defined in complex ways, rule-based programs can be very powerful. The performance of a logic-based program need not appear “logical,” as some rules may cause it to take apparently irrational actions. “Illogical” AI programs are not used for practical problem-solving, but are useful in modeling how humans think. Symbolic programs are good at dealing with set problems, and at representing hierarchies (in grammar, for example,

or planning). But they are inflexible: If part of the expected input data is missing or mistaken, they may give a bad answer, or no answer at all.

1.2.2 Connectionist AI

Connectionism is inspired by the human brain. It is closely related to computational neuroscience, which models actual brain cells and neural circuits. Connectionist AI uses artificial neural networks made of many units working in parallel. Each unit is connected to its neighbors by links that can raise or lower the likelihood that the neighbor unit will “fire” (excitatory and inhibitory connections, respectively).

Neural networks that are able to learn do so by changing the strengths of these links, depending on past experience. These simple units are much less complex than real neurons. Each can do only one thing; such as report a tiny vertical line at a particular place in an image. What matters is not what any individual unit is doing, but the overall activity pattern of the whole network.

Consequently, connectionist systems are more flexible than symbolic AI programs. Even if the input data is faulty, the network may give the right answer. They are therefore good at pattern recognition, where the input patterns within a certain class need not be identical. But connectionism is weak at doing logic, following action sequences, or representing hierarchies of goals. What symbolic AI does well, connectionism does badly, and vice versa. Hybrid systems combine the two, switching between them as appropriate. And work on recurrent neural networks, where the output of one layer of units is fed back as input to some previous layer, aims to enable connectionist systems to deal with sequential action and hierarchy. The emerging field of *connectomics* could help researchers decode the brain’s approach to information processing.

1.2.3 Evolutionary AI

Evolutionary AI draws on biology. Its programs make random changes in their own rules, and select the best daughter programs to breed the next generation. This method develops problem-solving programs, and can evolve the “brains” and “eyes” of robots. A practical application of evolutionary AI would be a computer model of the long-term growth of a

business in which the evolution of the business is set within a simulated marketplace. Evolutionary AI is often used in modeling artificial life (commonly known as A-Life), a spin-off from AI. One focus of study in artificial life is on self-organization, namely how order arises from something that is ordered to a lesser degree. Biological examples include the flocking patterns of birds and the development of embryos. Technological examples include the flocking algorithms used for computer animation. [13]

2. Machine Learning

Machine learning (ML) is a field of inquiry devoted to understanding and building methods that 'learn', that is, methods that leverage data to improve performance on some set of tasks. It is seen as a part of artificial intelligence. Machine learning algorithms build a model based on sample data, known as training data, in order to make predictions or decisions without being explicitly programmed to do so.

Machine learning algorithms are used in a wide variety of applications, such as in medicine, email filtering, speech recognition, and computer vision, where it is difficult or unfeasible to develop conventional algorithms to perform the needed tasks.

A subset of machine learning is closely related to computational statistics, which focuses on making predictions using computers; but not all machine learning is statistical learning. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Data mining is a related field of study, focusing on exploratory data analysis through unsupervised learning.

Some implementations of machine learning use data and neural networks in a way that mimics the working of a biological brain. In its application across business problems, machine learning is also referred to as predictive analytics.[14]

3. Deep learning

Deep learning is a subset of machine learning where artificial neural networks, algorithms inspired by the human brain, learn from large amounts of data. Similarly, to how we learn from experience, the deep learning algorithm would perform a task repeatedly, each time tweaking

it a little to improve the outcome. We refer to ‘deep learning’ because the neural networks have various (deep) layers that enable learning. Just about any problem that requires “thought” to figure out is a problem deep learning can learn to solve.

The amount of data we generate every day is staggering—currently estimated at 2.6 quintillion bytes—and it’s the resource that makes deep learning possible. Since deep-learning algorithms require a ton of data to learn from, this increase in data creation is one reason that deep learning capabilities have grown in recent years. In addition to more data creation, deep learning algorithms benefit from the stronger computing power that’s available today as well as the proliferation of Artificial Intelligence (AI) as a Service. AI as a Service has given smaller organizations access to artificial intelligence technology and specifically the AI algorithms required for deep learning without a large initial investment. [15]

3.1 Deep learning methods

Various methods can be used to create strong deep learning models. These techniques include learning rate decay, transfer learning, training from scratch and drop-out.

3.1.1 Learning rate decay

Learning rate decay is a technique for training modern neural networks. It starts training the network with a large learning rate and then slowly reducing/decaying it until local minima is obtained. It is empirically observed to help both optimization and generalization.

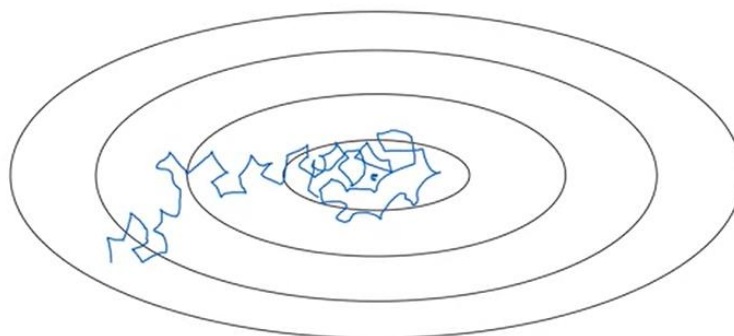


Figure 2 1: (Algorithm converging with a constant learning rate (Noisy and represented with Blue) [16]

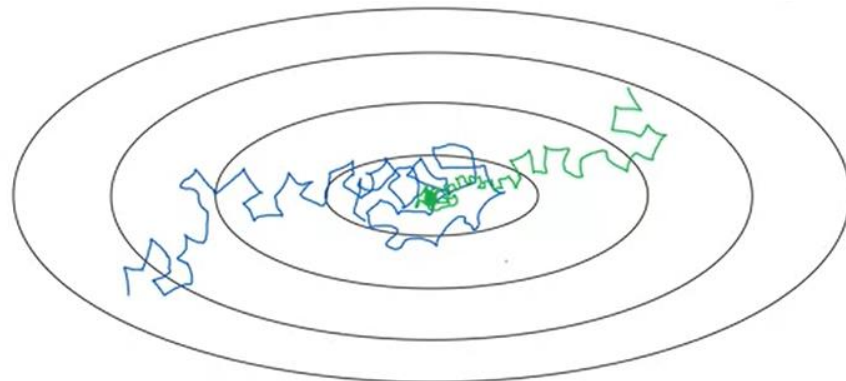


Figure 2 2:Algorithm converging while decaying Learning Rate over time (less noisy and represented with green) [16]

In the very first image where we have a constant learning rate, the steps taken by our algorithm while iterating towards minima are so noisy that after certain iterations it seems wandering around the minima and do not actually converges.

But in the second image where learning rate is reducing over time (represented with green line), since the learning rate is large initially we still have relatively fast learning but as tending towards minima learning rate gets smaller and smaller, end up oscillating in a tighter region around minima rather than wandering far away from it.

$$“\alpha=(1/(1+decayRate\times epochNumber)) * \alpha_0”$$

Let’s take a rough example for the above method for better intuition:

Suppose we have $\alpha_0 = 0.2$ and decay rate=1, then for each epoch we can examine the fall in learning rate α as:

Epoch 1: alpha 0.1

Epoch 2: alpha 0.067

Epoch 3: alpha 0.05

Epoch 4: alpha 0.04

This is a typical method (commonly used) to apply learning rate decay for training neural networks , hope I’m able to provide you desired intuition for the topic , let’s check some more methods of decaying learning rate.[16]

3.1.2 Transfer learning.

This process involves perfecting a previously trained model; it requires an interface to the internals of a preexisting network. First, users feed the existing network new data containing previously unknown classifications. Once adjustments are made to the network, new tasks can be performed with more specific categorizing abilities. This method has the advantage of requiring much less data than others, thus reducing computation time to minutes or hours.

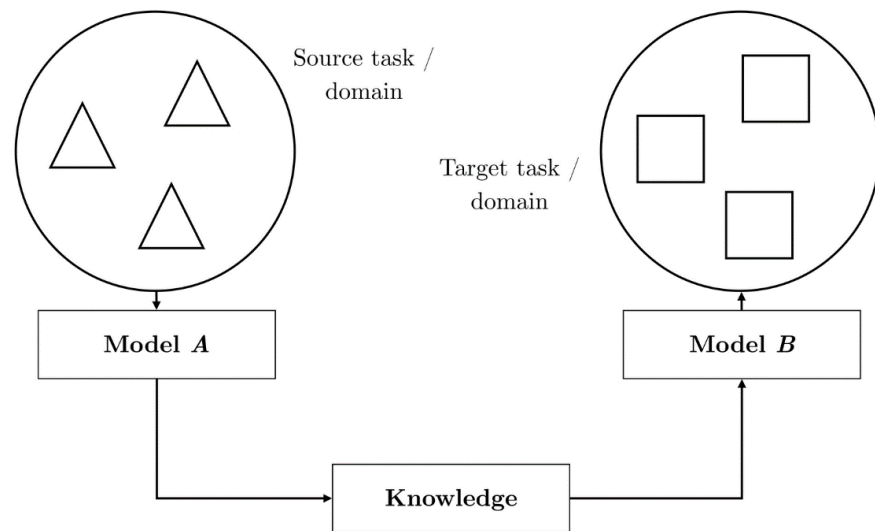


Figure 2 3:Transfer learning scenario [17]

3.1.3 Training from scratch.

This method requires a developer to collect a large labeled data set and configure a network architecture that can learn the features and model. This technique is especially useful for new applications, as well as applications with a large number of output categories. However, overall, it is a less common approach, as it requires inordinate amounts of data, causing training to take days or weeks.

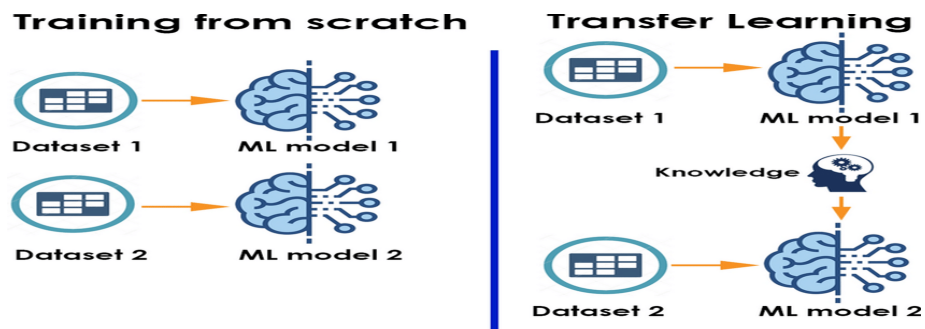


Figure 2 4: Difference between training a model from scratch and transfer learning [18]

3.1.4 Dropout.

This method attempts to solve the problem of overfitting in networks with large amounts of parameters by randomly dropping units and their connections from the neural network during training. It has been proven that the dropout method can improve the performance of neural networks on supervised learning tasks in areas such as speech recognition, document classification and computational biology.[19]

4. Deep Learning vs. Machine Learning

While there are many differences between these two subsets of artificial intelligence, here are five of the most important:

- **Human Intervention:** Machine learning requires more ongoing human intervention to get results. Deep learning is more complex to set up but requires minimal intervention thereafter.
- **Hardware:** Machine learning programs tend to be less complex than deep learning algorithms and can often run on conventional computers, but deep learning systems require far more powerful hardware and resources. This demand for power has driven has meant increased use of graphical processing units. GPUs are useful for their high bandwidth memory and ability to hide latency (delays) in memory transfer due to thread parallelism (the ability of many operations to run efficiently at the same time.)
- **Time:** Machine learning systems can be set up and operate quickly but may be limited in the power of their results. Deep learning systems take more time to set up but can

generate results instantaneously (although the quality is likely to improve over time as more data becomes available).

- **Approach:** Machine learning tends to require structured data and uses traditional algorithms like linear regression. Deep learning employs neural networks and is built to accommodate large volumes of unstructured data.
- **Applications:** Machine learning is already in use in your email inbox, bank, and doctor's office. Deep learning technology enables more complex and autonomous programs, like self-driving cars or robots that perform advanced surgery. [20]

5. Natural Language Processing

Natural language processing (NLP) refers to the branch of computer science, and more specifically, the branch of artificial intelligence or AI concerned with giving computers the ability to understand text and spoken words in much the same way human beings can.

NLP combines computational linguistics—rule-based modeling of human language—with statistical, machine learning, and deep learning models. Together, these technologies enable computers to process human language in the form of text or voice data and to ‘understand’ its full meaning, complete with the speaker or writer’s intent and sentiment.

NLP drives computer programs that translate text from one language to another, respond to spoken commands, and summarize large volumes of text rapidly—even in real time. There’s a good chance you’ve interacted with NLP in the form of voice-operated GPS systems, digital assistants, speech-to-text dictation software, customer service chatbots, and other consumer conveniences. But NLP also plays a growing role in enterprise solutions that help streamline business operations, increase employee productivity, and simplify mission-critical business processes. [21]

Natural Language Processing (NLP) chatbot takes some steps to convert the customer’s text or speech into structured data to select the related answer. Some of the Natural Language Processing steps are:

- **Sentiment Analysis:** With this, the algorithm tries to interpret the sentiment of the user's query by reading into the entities, themes, and topics.
- **Tokenization:** The NLP divides a string of words into pieces or tokens. These tokens are linguistically symbolic or are differently helpful for the application.
- **Named Entity Recognition:** The chatbot program model looks for categories of words, like the name of the product, the user's name or address, whichever data is required.
- **Normalization:** The chatbot program model processes the text to find common spelling mistakes or typographical errors in the user's intent. It gives a more human-like effect of the chatbot to the users.
- **Dependency Parsing:** The chatbot looks for the objects and subjects- verbs, nouns and common phrases in the user's text to find dependent and related terms that users might be trying to convey.

Like most applications, the chatbot is also connected to the database. The knowledge base or the database of information is used to feed the chatbot with the information required to give a suitable response to the user.

The information about whether or not your chatbot could match the users' questions is captured in the data store. NLP helps translate human language into a combination of patterns and text that can be mapped in real-time to find appropriate responses. [22]

5.1 The importance of natural language processing

5.1.1 Large volumes of textual data

Natural language processing helps computers communicate with humans in their own language and scales other language-related tasks. For example, NLP makes it possible for computers to read text, hear speech, interpret it, measure sentiment and determine which parts are important.

Today's machines can analyze more language-based data than humans, without fatigue and in a consistent, unbiased way. Considering the staggering amount of unstructured data that's

generated every day, from medical records to social media, automation will be critical to fully analyze text and speech data efficiently.

5.1.2 Structuring a highly unstructured data source

Human language is astoundingly complex and diverse. We express ourselves in infinite ways, both verbally and in writing. Not only are there hundreds of languages and dialects, but within each language is a unique set of grammar and syntax rules, terms and slang. When we write, we often misspell or abbreviate words, or omit punctuation. When we speak, we have regional accents, and we mumble, stutter and borrow terms from other languages.

While supervised and unsupervised learning, and specifically deep learning, are now widely used for modeling human language, there's also a need for syntactic and semantic understanding and domain expertise that are not necessarily present in these machine learning approaches. NLP is important because it helps resolve ambiguity in language and adds useful numeric structure to the data for many downstream applications, such as speech recognition or text analytics. [23]

5.2 NLP vs. NLU vs. NLG: the differences between three natural language processing concepts

While natural language processing (NLP), natural language understanding (NLU), and natural language generation (NLG) are all related topics, they are distinct ones. At a high level, NLU and NLG are just components of NLP. Given how they intersect, they are commonly confused within conversation, but in this post, we'll define each term individually and summarize their differences to clarify any ambiguities.[24]

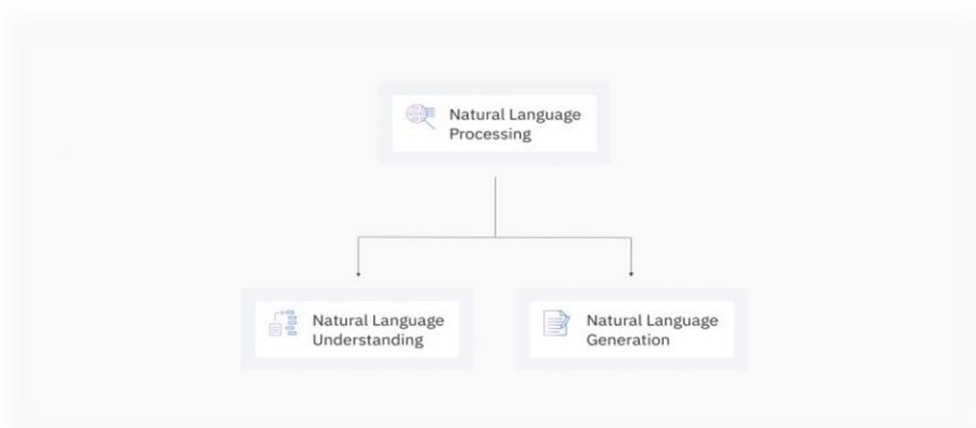


Figure 2 5: Three natural language processing concepts [24]

5.2.1 Natural Language Understanding

Natural language understanding is a subset of natural language processing, which uses syntactic and semantic analysis of text and speech to determine the meaning of a sentence. Syntax refers to the grammatical structure of a sentence, while semantics alludes to its intended meaning. NLU also establishes a relevant ontology: a data structure which specifies the relationships between words and phrases. While humans naturally do this in conversation, the combination of these analyses is required for a machine to understand the intended meaning of different texts. Our ability to distinguish between homonyms and homophones illustrates the nuances of language well.

5.2.2 Natural Language Generation

Natural language generation is another subset of natural language processing. While natural language understanding focuses on computer reading comprehension, natural language generation enables computers to write. NLG is the process of producing a human language text response based on some data input. This text can also be converted into a speech format through text-to-speech services.

NLG also encompasses text summarization capabilities that generate summaries from input documents while maintaining the integrity of the information. Extractive summarization is the AI innovation powering Key Point Analysis used in That's Debatable.

Initially, NLG systems used templates to generate text. Based on some data or query, an NLG system would fill in the blank, like a game of Mad Libs. But over time, natural language

generation systems have evolved with the application of hidden Markov chains, recurrent neural networks, and transformers, enabling more dynamic text generation in real time. [24]

6. Neural networks for natural language processing

6.1 Multilayer Perceptron (MLP)

A Multilayer Perceptron (MLP) is a feedforward network with one input layer, one output layer, and at least one hidden layer. To classify data which is not linear in nature, it uses non-linear activation functions, mainly hyperbolic tangent or logistic function. The network is fully connected, which means that every node in the current layer is connected to each node in the next layer. This architecture with the hidden layer forms the basis of deep learning architecture which has at least three hidden layers. Multilayer Perceptron is used for speech recognition and translation operations of NLP.[25]

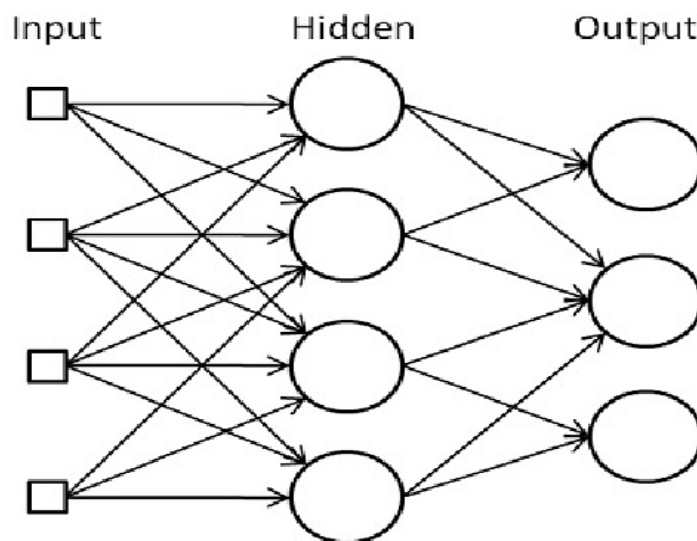


Figure 2 6:Multilayer Perceptron with one hidden layer [25]

6.2 Convolutional Neural Network (CNN)

A Convolutional Neural Network (CNN) is a variation of MLP with at least one convolutional layer. The convolutional layer reduces the complexity of the network by applying

a convolution function on the input and passing the output to the next layer, analyzing a part of the data (sentence/image) at a time. Since the complexity is reduced with CNN, the network can be much deeper and handle more complex data.

CNNs are popular for computer vision tasks. However, Collobert et al. used CNNs for NLP tasks, such as part of speech (POS) tagging and semantic analysis which are the preprocessing steps for any NLP algorithm. They also proposed a general-purpose CNN architecture to perform all the NLP related tasks at once, which generated interest in CNN for NLP. [25]

6.3 Recurrent Neural Network (RNN)

A Recurrent Neural Network (RNN) is designed to preserve the previous neuron state. This allows the neural network to retain context and produce output based on previous state. This approach makes RNNs desirable for chatbots as retaining context in a conversation is essential to understand the user. RNNs are extensively used for NLP tasks such as translation, speech recognition, text generation and image captioning. [25]

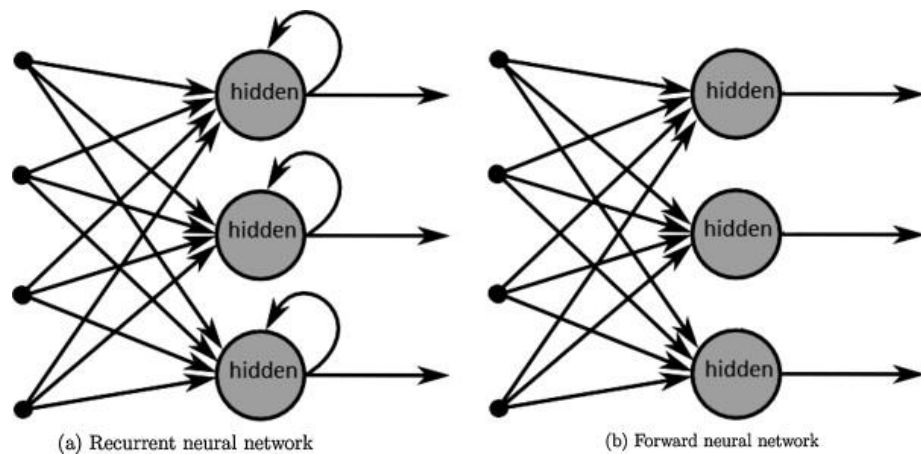


Figure 2 7: Comparison of RNN and Forward neural [25]

6.4 Long Short-Term Memory (LSTM)

LSTM is a special kind of RNN, which has special forget gates, in addition to input and output gates of the simple RNN? LSTMs are designed to remember the input state for a longer time than an RNN, hence allowing long sequences to be processed accurately. Wang et al in

presented an LSTM based model for POS tagging having an accuracy of 97%. LSTMs are a fundamental part of NLP architecture for Apple, Amazon, Google and other tech companies. [25]

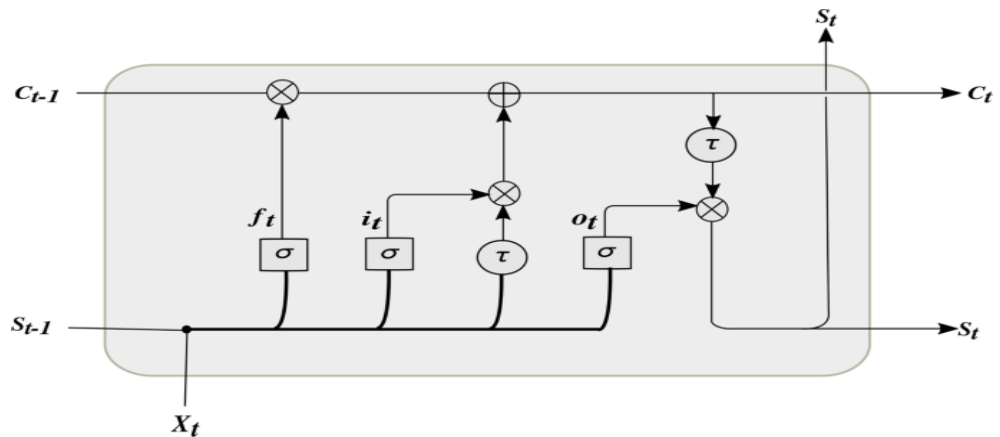


Figure 2 8:An LSTM cell. The figure shows forget gate (f), input gate (i), output gate (o) [25]

6.5 Sequence to Sequence Models

Sequence to sequence models are based on RNN architecture and consists of two RNNs: an encoder and a decoder. The encoder's task is to process the input, and the decoder to process the output. Sequence to sequence models can be thought of as one decoder node producing output corresponding to one encoder node. This model has straightforward application in machine translation as a corresponding word for the output language can be generated by decoder easily by looking only at one word of input language at a time. [25]

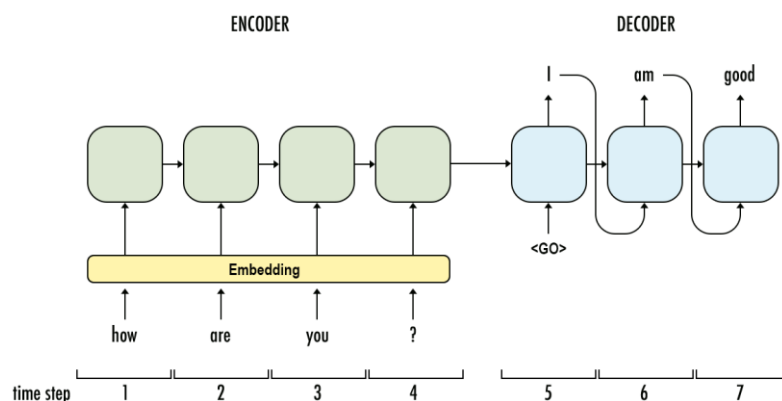


Figure 2 9:Sequence to sequence model architecture [25]

7. Chatbot

7.1 Definition:

Chatbots are intelligent conversational computer programs that mimic human conversation in its natural form. A chatbot can process user input and produce an output. Usually, chatbots take natural language text as input, and the output should be the most relevant output to the user input sentence. Chatbots can also be defined as “online human-computer dialogue system(s) with natural language”.

Recent developments in Artificial Intelligence and Natural Language Processing techniques have made chatbots easier to implement, more flexible in terms of application and maintainability, and increasingly capable to mimic human conversation. [26]

7.2 Chatbot History

In 1950, Alan Turing asked the question “Can machines think?” Turing conceptualized the problem as an “imitation game” (now called the Turing Test), in which an “interrogator” asked questions to human and machine subjects, with the goal of identifying the human. If the human and machine are indistinguishable, we say the machine can think.

In 1966, Joseph Weizenbaum at MIT created the first chatbot that, arguably, came close to imitating a human: ELIZA. Given an input sentence, ELIZA would identify keywords and pattern match those keywords against a set of pre-programmed rules to generate appropriate responses. Since ELIZA, there has been progress in the development of increasingly intelligent chatbots. In 1972, Kenneth Colby at Stanford created PARRY, a bot that impersonated a paranoid schizophrenic.

In 1995, Richard Wallace created A.L.I.C.E, a significantly more complex bot that generated responses by pattern matching inputs against (input) (output) pairs stored in documents in a knowledge base. These documents were written in Artificial Intelligence Markup Language (AIML), an extension of XML, which is still in use today. ALICE is a three-time winner of the Loebner prize, a competition held each year which attempts to run the Turing Test, and awards the most intelligent chatbot. Modern chatbots include: Amazon’s Echo and Alexa, Apple’s Siri, and Microsoft’s Cortana. The architectures and retrieval processes of these

bots take advantage of advances in machine learning to provide advanced “information retrieval” processes, in which responses are generated based on analysis of the results of web searches. Others have adopted “generative” models to respond; they use statistical machine translation (SMT) techniques to “translate” input phrases into output responses. Seq2Seq, an SMT algorithm that used recurrent neural networks (RNNs) to encode and decode inputs into responses is a current best practice. [27]

7.3 The functions expected from modern chatbots

- **Dialogic Agent:** must understand the user, i.e. provide the function of comprehension. Bots are provided with a textual (or oral) input, which are analyzed with natural language processing tools, and used to generate appropriate responses.

- **Rational Agent:** must have access to an external base of knowledge and common sense (e.g. via corpora of data) such that it can provide the function of competence, answering user questions. Should store context-specific information (e.g. user’s name, etc.).

- **Embodied Agent:** should “provide the function of presence...once regarded as very optional...this function proves to be crucial in the case of ordinary users.” Even the earliest bots were given names (ELIZA, ALICE, CHARLIE, etc.) in order to satisfy this condition. Today, developers are focused on the use of language tricks to create personas for chatbots in order to build trust with users and give the impression of an embodied agent. [27]

7.4 FAQ Chatbot

An FAQ chatbot is a bot that assists users by providing answers to the most frequently asked questions. It operates based on the question-answer format, which feels a lot like a conversation with a real-life person. Basically, it’s like an FAQ page but much better.

How does it work? A user provides a query in chat and gets their reply immediately from a bot. It’s an easy way to teach customers about the brand, product, and service and direct them to the appropriate website page. The best part here is that chatbot is available 24/7 with no breaks (except for technical ones)

Chatbot for FAQ can be powered by pre-set responses, artificial intelligence, or both. Thus, we can break it down into three main types of bots:

- Rule-based
- AI
- Hybrid. [28]

Type	Pros	Cons
Rule-based	Easy and fast training Easy integration with available legacy systems Dependable and do not go off the rails	Not flexible Limited conversation flow Limited personalization
AI/NLP	Ability to learn from new data Understand patterns and customer behavior Support different language depending on the user	Longer training time Require larger data volumes to avoid underfitting Data bias
Hybrid	Leverage NLP technology Ability to predict conversation flow Easier to tweek database than rule-based chatbots	Have a restricted conversation compared to AI chatbots Difficult to program the conversation flip from rule-based to AI

7.5 Open domain vs. Closed domain conversation:

- **Open domain:** Open domain system is expected to understand any topic and return relevant responses. For example, Meena — Google’s open domain bot that can “chat about anything.” Open domain is more like talking to a friend where the conversation

can go in any direction — from what series you’re bingeing to why your client demo stopped working exactly two seconds after sending it. This free-flowing conversation has no defined objective, so your responses need to adapt to whatever information you’re given. [29]

- **Closed domain:** A closed domain system, focuses a particular set of topics and has limited responses based on the business problem. For example, a pizza delivery chatbot can only help your place, track, or cancel an order

But most of closed domain bots must have human decisions at the end because the conversation flow must be predefined, and they can’t answer or do tasks that are not preprogrammed, they just need to fulfill their specific tasks as efficiently as possible. [29]

7.6 Retrieval-Based vs. Generative Models

Deciding on the best technique for processing dialogue inputs and generating responses, is one of the first decisions you need to make. Most current systems use retrieval-based methods, while generative methods are still in research [30]

- **Retrieval-Based Models:** Retrieval-based chatbots work on the principle of graphs or directed flows. The chatbot is trained to provide the best possible response from a database of predefined responses. The responses are based on existing information. Retrieval-based chatbots use techniques like keywords matching, machine learning or deep learning to identify the most appropriate response. Regardless of the techniques, these chatbots provide only predefined responses and do not generate new output. [30]

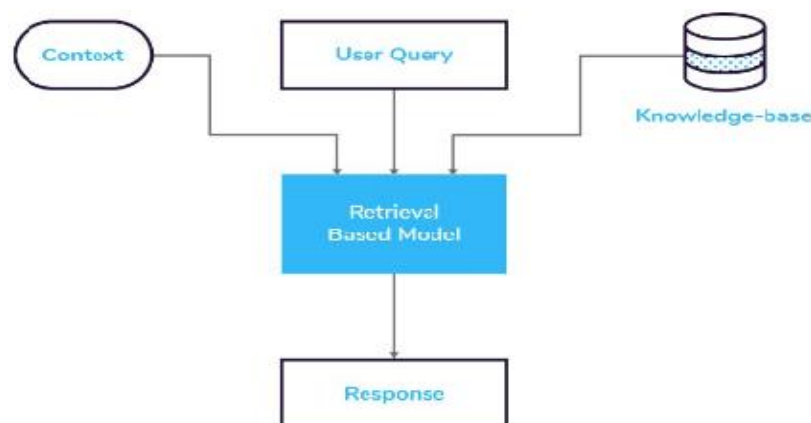


Figure 2 10:Flow of Retrieval-based model [31]

- **Generative Models:** Generation-based Neural Networks, as opposed to Retrieval-based systems do not rely on fixed responses. They generate new responses from scratch. Responses are based purely on machine learning and the training data. Sequence to sequence models. Chatbots that use generative methods can generate new dialogue based on large amounts of conversational training data. [25]

Both approaches have some obvious pros and cons, but the majority of chatbots in digital assistants are using retrieval-based methods. Due to the repository of handcrafted responses, retrieval-based methods don't make grammatical mistakes, however they may be unable to handle unforeseen cases for which no appropriate predefined response exist. For the same reason, these models can't refer back to contextual entity information like names mentioned earlier in the conversation. Generative models are "smarter", they refer back to entities in the input and give the impression of talking to a human. However, these models are hard to train, are quite likely to make grammatical mistakes (especially on longer sentences), and typically require huge amount of training data.

7.7 Common Challenges

There are some undeniable and not really evident difficulties when building conversational operators, the majority of which are dynamic research regions:

- **Security:** Threats for Chatbot implementation can include events such as Repudiation, Spoofing, Tampering, Information Disclosure, Denial of Service, Elevation of Privileges etc. A Chatbot solution can become vulnerable and open to attacks when it is not well maintained, has poor programming or lacks protection. Fear for security is very vital Chatbot as they may bring new dangers, however, companies should be taking better security measures to ensure that users' information is safe.
- **Context Integration:** Making sense in responses is very important for chatbots. Integration of context into the chatbot is the first challenge to conquer. In integrating sensible responses, both the physical context and the linguistic context must be incorporated. For incorporating linguistic context, conversations are embedded into a

vector, which presents a challenge. Contextual data, location, relationship, time, date, details about users, and other such data must be incorporated with the chatbot.

- **Exit Strategy:** Chatbots are not that good at keeping up a conversation. Their pre-established number of answers and reactions is limited. So when Chatbot is stuck in finding solution to user problem, exit strategy is required. [32]

Chapter 3

A chatbot for ATM Mobilis complaints

1. Introduction

Choosing the correct chatbot depends on what type of domain the chatbot will have. For example, you might ask a chatbot something and the chatbot replies to that. Maybe in mid-conversation, you leave the conversation, only to pick the conversation up later. Based on the type of chatbot you choose to build, the chatbot may or may not save the conversation history. For narrow domains a pattern matching architecture would be the ideal choice.

However, for chatbots that deal with multiple domains or multiple services, broader domain. In these cases, sophisticated, state-of-the-art neural network architectures, such as Long Short-Term Memory (LSTMs) and reinforcement learning agents are your best bet. Due to the varying nature of chatbot usage, the architecture will change upon the unique needs of the chatbot.

In this chapter, we'll give an overview of the chatbots we've worked on with design and how each of them works

2. Understanding the Chatbot Architecture

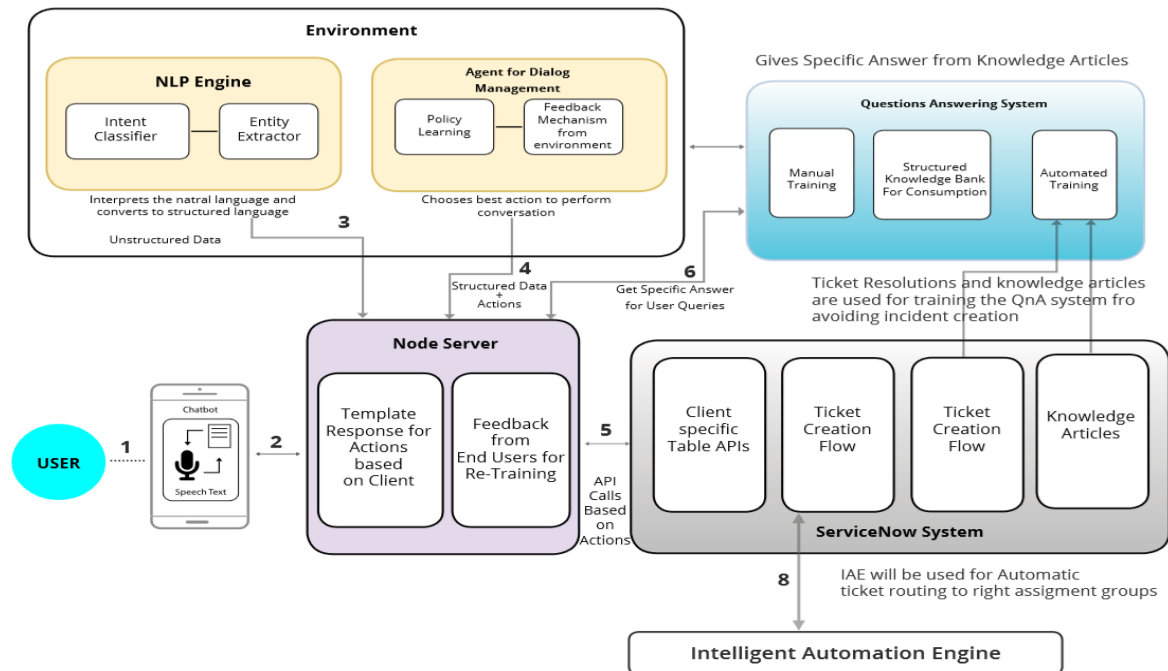


Figure 3 1:Architecture of a Conversational Chatbot [33]

As we can see in fig. 3.1 this is the proposed architecture for our chatbot, and we will explain every part of it in the following.

1) **Environment:** The place where the fundamental Natural Learning Process (NLP) engine and context clarification occurs.

- **NLP Engine:** A fundamental component understands what any user says at a given time and then converts this language into well-defined input that can be further processed by the system. As chatbots are domain-specific so they should support multiple features. The natural language processing engine consists of the latest algorithms of machine learning that are used to identify the intent of the user and then match them with the list of those intents that are supported by the bots.

- **Intent Classifier:** It takes input from the user, interprets its meaning, and then relates it to that intent which is supported by the chatbot.

- **Entity Extractor:** It extracts the critical information from the query of a user

- **Agent for Dialogue Management**

It can manage the real context of the user saying. For example: If a user said “He needs to call a heart specialist” and then chatbot should make the call. If the user then said that “Change my request to the chest specialist,” here the user is referring to that demand, which he has requested earlier, the chatbot must interpret it correctly and should make changes before confirming from the user side. For this purpose, dialogue management plugins are helpful. Dialogue management further has following key plugins:

- **Feedback Mechanism:** In this mechanism, an agent is responsible for taking the user’s feedback from time to time to verify that either the bot is working correctly with the dialogues of the user or the user is satisfied with the Responses of the bot. This thing supports the chatbot to understand all the mistakes and to improve itself for future conversations.
- **Policy Learning:** A framework enables the bot to take a maximum of happy paths from the conversation so that we may increase the satisfaction of the end-user. This higher-level framework creates a network that has happy paths, and then it directs the conversation to the satisfaction of the end-user. After this, the bot goes on learning from interaction and then it follows that flow of communication, which it had in the past with another user

2) **Question and Answer System:** It is a fundamental component to answer the users frequently asked questions. This system understands the user's questions properly and responds to those questions with the related answers stored in the knowledge base.

- **Manual Training:** In this training, the domain experts create a list of frequently asked questions and then map the answers. This mechanism is helpful for the bot to recognize the answers to the many important queries.
- **Automated Training:** In this training, different types of company documents such as Q&A documents and policy documents are submitted to the bot, and it is asked to train itself for these documents. This training results in a list of questions and answers from these provided documents. This bot can answer all these questions with full confidence.

3) **Plugins/Components** Plugins provide smart chatbot automation components and chatbot solution APIs for those chatbots which are used inside of the companies such as field worker and HR management chatbots

4) **Node Server / Traffic Server** A server that is responsible for handling the user's request and then route it to the suitable components. This server also directs the response of the internal component back to the front-end system.

5) **Front-End Systems** Several systems that has a client-facing platform can be candidate to develop the front-end. These systems can be the chatbot interfaces that exist in many platforms such as:

- Microsoft Teams
- Facebook
- Google Hangouts
- Slack
- Skype for Business [33]

3. Project description

At first we wanted to build a conversation bot for telecom companies based on natural language processing after we got the data from Mobilis Telecom and its website. But we had a problem with our computers. Training a deep learning neural network needs at least a very powerful computer with huge GPUs to get an acceptable result.

As an alternative, we have relied on two different chatbot systems in our work. The first is a AI-chatbot that we built and trained on Google cloud (Dialogflow). The second one is a rule based chatbot because we are working in a closed domain which was the right solution.

3.1 Dialogflow chatbot

Dialogflow is a natural language understanding platform that makes it easy to design and integrate a conversational user interface into your mobile app, web application, device, bot, interactive voice response system, and so on. Using Dialogflow, can provide new and engaging ways for users to interact with product.

Dialogflow can analyze multiple types of input from customers, including text or audio inputs (like from a phone or voice recording). It can also respond to customers in a couple of ways, either through text or with synthetic speech.

3.1.1 Agents

A Dialogflow agent is a virtual agent that handles concurrent conversations with your end-users. It is a natural language understanding module that understands the nuances of human language. Dialogflow translates end-user text or audio during a conversation to structured data that your apps and services can understand. You design and build a Dialogflow agent to handle the types of conversations required for your system.

A Dialogflow agent is similar to a human call center agent. They are training both to handle expected conversation scenarios, and your training does not need to be overly explicit.

3.1.2 Intents

An intent categorizes an end-user's intention for one conversation turn. For each agent, you define many intents, where your combined intents can handle a complete conversation. When an end-user writes or says something, referred to as an end-user expression, Dialogflow matches the end-user expression to the best intent in your agent. Matching an intent is also known as intent classification. [34]

For example, could create a company agent (like Mobilis) that recognizes and responds to end-user complaints about mobile services of the company. You would likely define an intent for complaints about the agency location. If an end-user says "Where's the nearest agency?", Dialogflow would match that end-user expression to the complaint. It can also define the intent to extract useful information from the end-user expression, like a time or location for the desired response. This extracted data is important for system to perform a complaint response for the end-user.

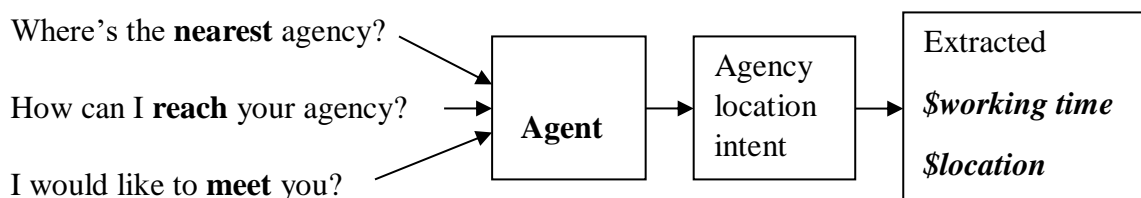


Figure 3 2: An example of a chatbot acquaintance with the user's intent to determine the agency location.

A basic intent contains the following:

- **Training phrases**: These are example phrases for what end-users might say. When an end-user expression resembles one of these phrases, Dialogflow matches the intent. You don't have to define every possible example, because Dialogflow's built-in machine learning expands on your list with other, similar phrases.
- **Action**: You can define an action for each intent. When an intent is matched, Dialogflow provides the action to your system, and you can use the action to trigger certain actions defined in your system.
- **Parameters**: When an intent is matched at runtime, Dialogflow provides the extracted values from the end-user expression as *parameters*. Each parameter has a type, called the entity type, which dictates exactly how the data is extracted. Unlike raw end-user input, parameters are structured data that can easily be used to perform some logic or generate responses.
- **Responses**: You define text, speech, or visual responses to return to the end-user. These may provide the end-user with answers, ask the end-user for more information, or terminate the conversation. [34]

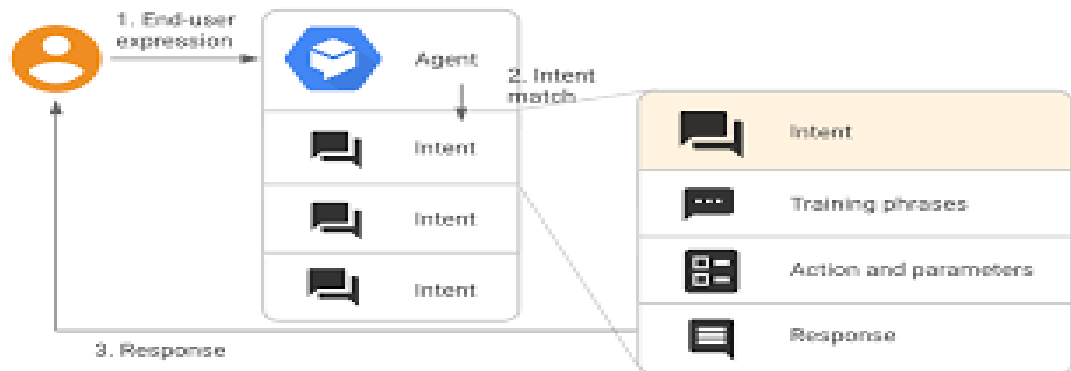


Figure 3 3:the basic flow for intent matching and responding to the end-user [34]

Entities

Each intent parameter has a type, called the entity type, which dictates exactly how data from an end-user expression is extracted.

Dialogflow provides predefined system entities that can match many common types of data. For example, there are system entities for matching dates, times, colors, email addresses, and so on. You can also create your own custom entities for matching custom data. For example, you could define a *vegetable* entity that can match the types of vegetables available for purchase with a grocery store agent.

Contexts

Dialogflow contexts are similar to natural language context. If a person says to you "they are orange", you need context in order to understand what "they" is referring to. Similarly, for Dialogflow to handle an end-user expression like that, it needs to be provided with context in order to correctly match an intent.

Using contexts, you can control the flow of a conversation. You can configure contexts for an intent by setting input and output contexts, which are identified by string names. When an intent is matched, any configured *output contexts* for that intent become active. While any contexts

are active, Dialogflow is more likely to match intents that are configured with *input contexts* that correspond to the currently active contexts. [34]

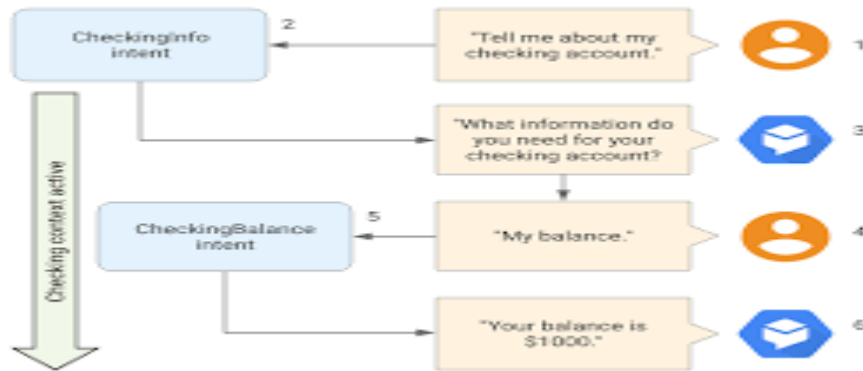


Figure 3 4:an example that uses context for a banking agent[34]

1. The end-user asks for information about their checking account.
2. Dialogflow matches this end-user expression to the CheckingInfo intent. This intent has a checking output context, so that context becomes active.
3. The agent asks the end-user for the type of information they want about their checking account.
4. The end-user responds with "my balance".
5. Dialogflow matches this end-user expression to the CheckingBalance intent. This intent has a checking input context, which needs to be active to match this intent. A similar Savings Balance intent may also exist for matching the same end-user expression when a savings context is active.
6. After your system performs the necessary database queries, the agent responds with the checking account balance.

Follow-up intents

You can use follow-up intents to automatically set contexts for pairs of intents. A follow-up intent is a child of its associated *parent intent*. When you create a follow-up intent, an output context is automatically added to the parent intent and an input context of the same name is

added to the follow-up intent. A follow-up intent is only matched when the parent intent is matched in the previous conversational turn. You can also create multiple levels of nested follow-up intents.

Dialogflow provides many predefined follow-up intents for common end-user replies like "yes", "no", or "cancel". You can also create your own follow-up intents to handle custom replies.

Dialogflow Console

Dialogflow provides a web user interface called the *Dialogflow Console*. You use this console to create, build, and test agents.

The Dialogflow Console is different from the Google Cloud Platform (GCP) Console. The Dialogflow Console is used to manage Dialogflow agents, while the GCP Console is used to manage GCP-specific Dialogflow settings (for example, billing) and other GCP resources.

In most cases you should use the Dialogflow Console to build agents, but you can also use the Dialogflow API to build agents for advanced scenarios.

User interactions with integrations

Dialogflow integrates with many popular conversation platforms like Google Assistant, Slack, and Facebook Messenger. If you want to build an agent for one of these platforms, you should use one of the many integrations options. Direct end-user interactions are handled for you, so you can focus on building your agent. Each integration handles end-user interactions in a platform-specific way. [34]

Fulfillment for integrations

By default, your agent responds to a matched intent with a static response. If you're using one of the integration options, you can provide a more dynamic response by using fulfillment. When you enable fulfillment for an intent, Dialogflow responds to that intent by calling a service that you define. For example, if an end-user wants to schedule a haircut on Friday, your

service can check your database and respond to the end-user with availability information for Friday.

Each intent has a setting to enable fulfillment. If an intent requires some action by your system or a dynamic response, you should enable fulfillment for the intent. If an intent without fulfillment enabled is matched, Dialogflow uses the static response you defined for the intent.

When an intent with fulfillment enabled is matched, Dialogflow sends a request to your webhook service with information about the matched intent. Your system can perform any required actions and respond to Dialogflow with information for how to proceed. When fulfillment is enabled, the static response you defined for the intent is only used if your webhook service fails. [34]

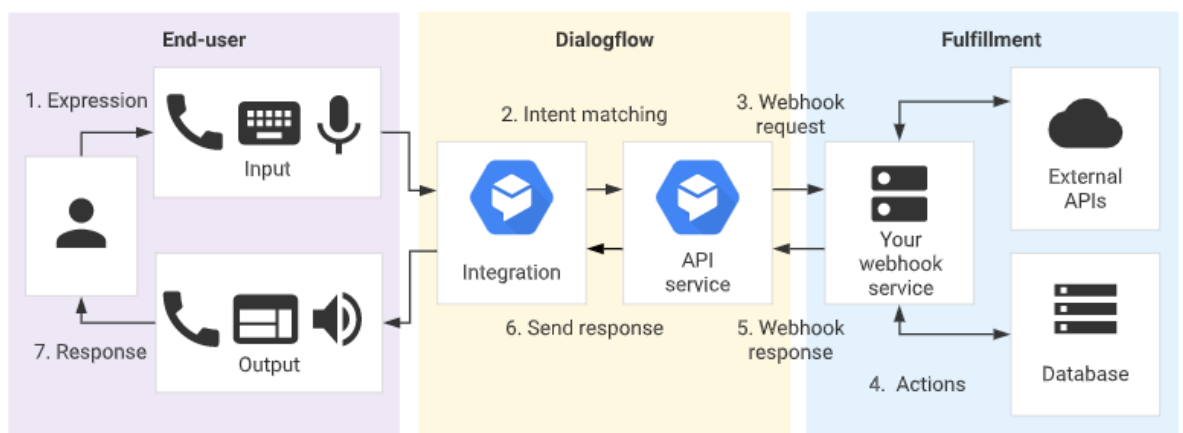


Figure 3 5:the processing flow for fulfillment [34]

1. The end-user types or speaks an expression.
2. Dialogflow matches the end-user expression to an intent and extracts parameters.
3. Dialogflow sends a webhook request message to your webhook service. This message contains information about the matched intent, the action, the parameters, and the response defined for the intent.
4. Your service performs actions as needed, like database queries or external API calls.
5. Your service sends a webhook response message to Dialogflow. This message contains the response that should be sent to the end-user.

6. Dialogflow sends the response to the end-user.
7. The end-user sees or hears the response.

User interactions with the API

If you are not using one of the integration options, you must write code that directly interacts with the end-user. You must also directly interact with Dialogflow's API for each conversational turn to send end-user expressions and receive intent matches.[34]

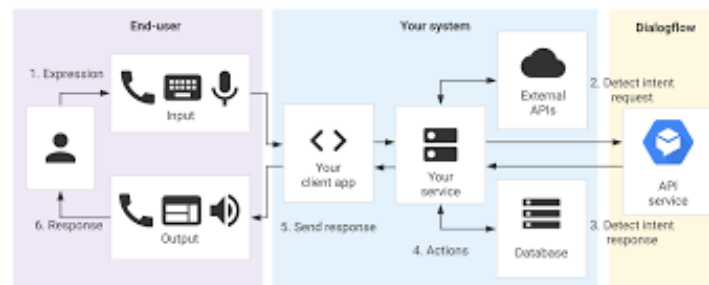


Figure 3 6:the processing flow when interacting with the API. [34]

1. The end-user types or speaks an expression.
2. Your service sends this end-user expression to Dialogflow in a detect intent request message.
3. Dialogflow sends a detect intent response message to your service. This message contains information about the matched intent, the action, the parameters, and the response defined for the intent.
4. Your service performs actions as needed, like database queries or external API calls.
5. Your service sends a response to the end-user.
6. The end-user sees or hears the response. [34]

3.2 Rule-Based Chatbot

- **rule-based mean:** A rule-based system is a system that applies human-made rules to store, sort and manipulate data. In doing so, it mimics human intelligence. To work, rule-based systems require a set of facts or source of data, and a set of rules for manipulating that data.

- **Rule-Based Chatbot:** The chatbot answers the customer queries based on the predefined rules. The rule-based chatbot implementation is very straightforward and cheap. [35]

3.2.1 The most important reasons why we choose to work with a rule-based chatbot:

First of all, our chatbot is directed to a specific category which are Mobilis customers, meaning that most conversations and customer inquiries can be expected.

While AI chatbots are more advanced, they're not always necessary. For smaller companies or those with specific goals, rule-based chatbots are a more appropriate solution. Companies that fall into the categories below should consider a rule-based chatbot. Some other advantages of a rule-based chatbot are that they:

- are generally faster to train (less expensive)
- integrate easily with legacy systems
- streamline the handover to a human agent
- are highly accountable and secure
- can include interactive elements and media
- are not restricted to text interactions

3.2.2 The basics of our rule-based chatbot:

Our rule based chatbot will work by searching for specific *keywords* in inputs given by a user. The keywords will be used to understand what action the user wants to take (user's intent). Once the intent is identified, the bot will then pick out a response appropriate to the intent. [36]

The list of keywords the bot will be searching for and the dictionary of responses will be built up manually based on the specific use case for the chatbot. We'll be designing a very simple chatbot for a mobile phone companies. The bot will be able to respond to greetings (Hi, Hello etc.) and will be able to answer to clients.



Figure 3 7:Our rule-based processing flow.[36]

For example, if we consider a flow-based design, then it's easy to identify the intent and entities to a set of the predefined intents.

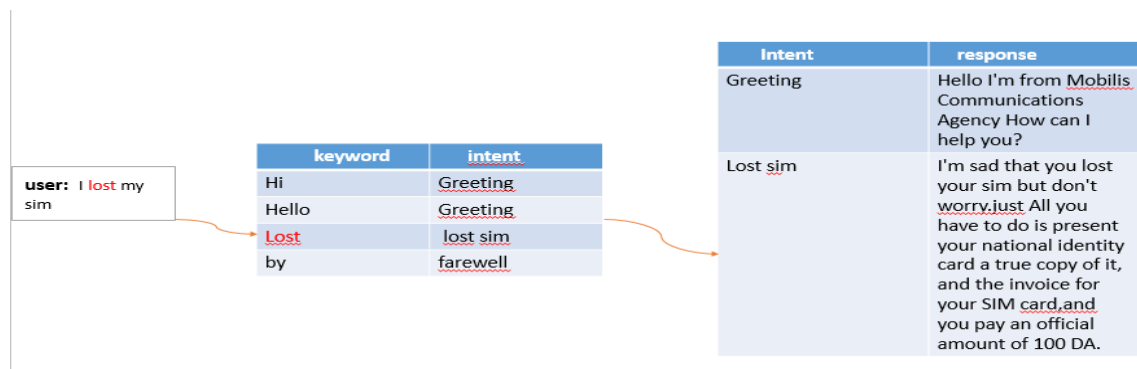


Figure 3 8:Our rule-based processing flow example.[36]

4. Conclusion

We presented in this a chapter, the architecture and flow processing of two chatbots that designed. The first one is a AI chatbot using DialogFlow of Google. The second one is a Rule-based chatbot.

The next chapter will present the implementation way and tools of these chatbots.

Chapter 4

Implementation

1. Tools

1.1 python

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics. Its high-level built in data structures, combined with dynamic typing and dynamic binding, make it very attractive for Rapid Application Development, as well as for use as a scripting or glue language to connect existing components together.

Python's simple, easy to learn syntax emphasizes readability and therefore reduces the cost of program maintenance. Python supports modules and packages, which encourages program modularity and code reuse. The Python interpreter and the extensive standard library are available in source or binary form without charge for all major platforms, and can be freely distributed. [37]

1.2 Dialogflow Dialogflow

Dialogflow (formerly Api.ai, Speaktoit) is a Google-owned developer of human-computer interaction technologies based on natural language conversations. The company is best known for creating the Assistant (by Speaktoit), a virtual buddy for Android, iOS, and Windows Phone smartphones that performs tasks and answers users' question in a natural language. Speaktoit has also created a natural language processing engine that incorporates conversation context like dialogue history, location and user preferences. [38]

1.3 Spider IDE

Spyder is a free and open source scientific environment written in Python, for Python, and designed by and for scientists, engineers and data analysts. It features a unique combination of the advanced editing, analysis, debugging, and profiling functionality of a comprehensive

development tool with the data exploration, interactive execution, deep inspection, and beautiful visualization capabilities of a scientific package. [49]

2. Implementation of our chatbots

2.1 AI chatbot for Mobilis complaints:

We implemented the chatbot on the Google cloud (Dialogflow). Interface design uses Natural Language Processing (NLP) and machine learning algorithms. The system is trained using unstructured input.

The input-output features are shaped in order to improve the efficiency of the system. This application acts as human replacement for proper guidance or information retrieval. In the beginning, the agent is created and given a name with the initial settings specified, such as the languages that will be worked on.

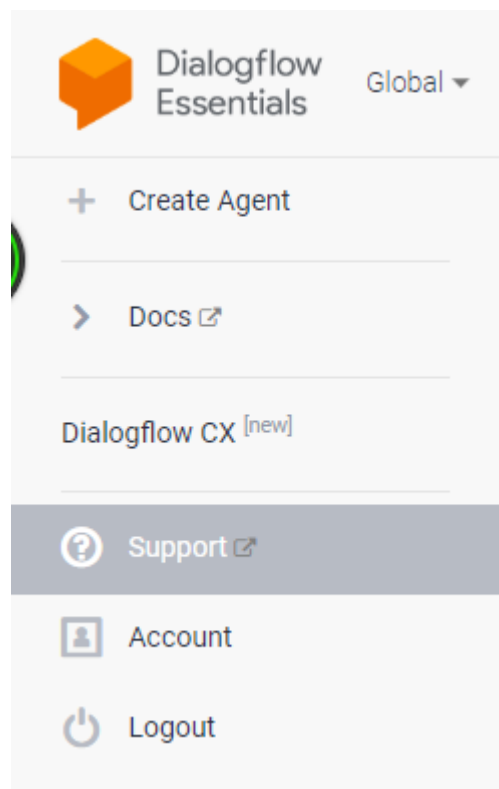


Figure 4 1:Creating Agent

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We have created targets for each type of frequently asked questions (various offers and inquiries) that Mobilis customers ask. Then we gave them the possible expressions grouped correctly within well-defined goals and the appropriate answers to them.



Figure 4 2: Screenshot of intents

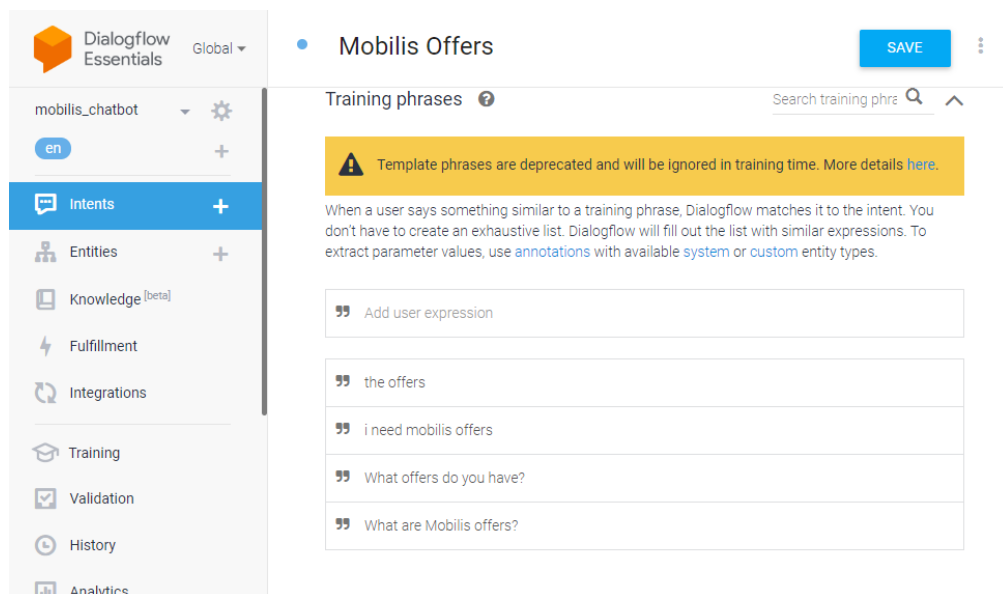


Figure 4 3: Dialogflow environment for building inputs or queries' intents

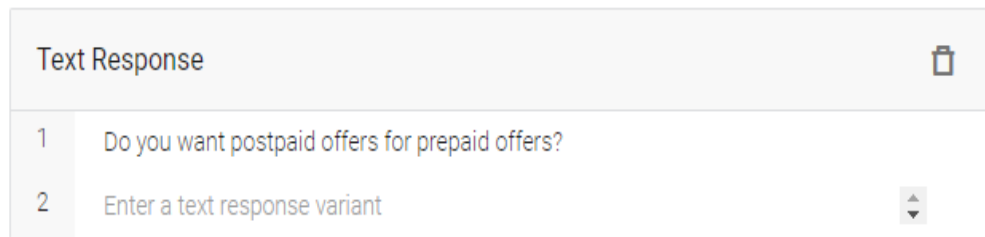


Figure 4 4:Response of a New Intent

Finally, here is a screenshot of our AI chatbot for mobilis complaints.

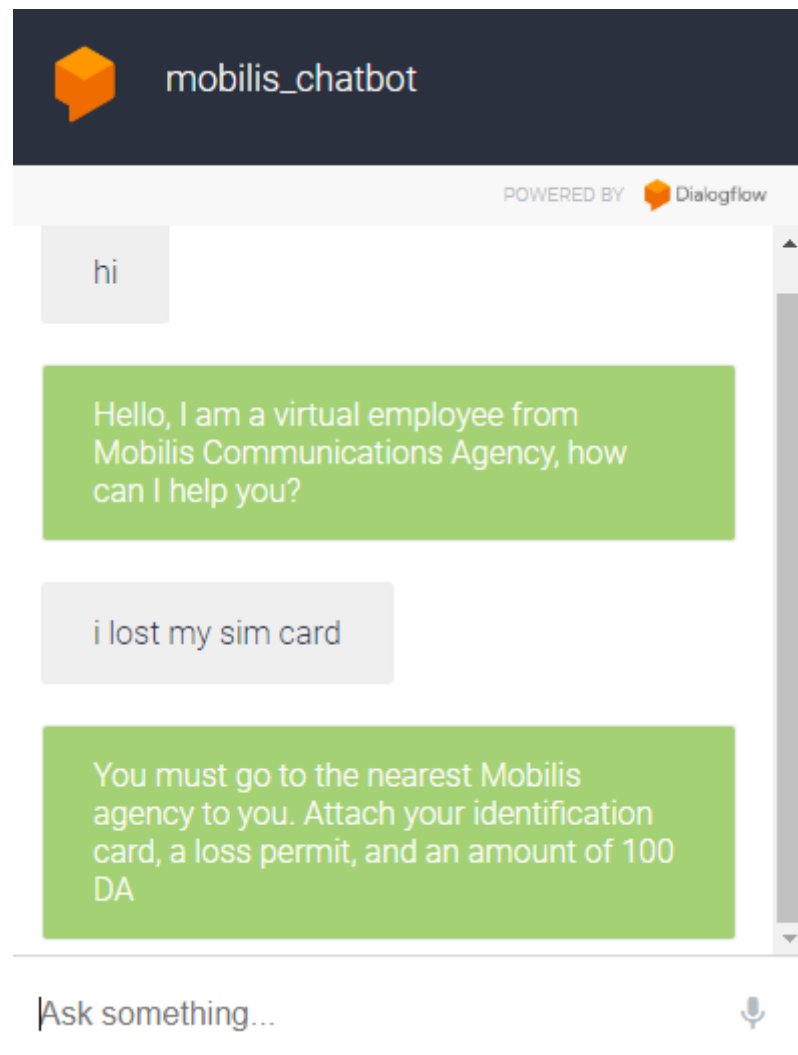


Figure 4 5:A screenshot of our AI chatbot.

Knowing that we found that it is not possible to create an agent that uses the Arabic language, which is the problem that we worked on and solved using a Rule-Based Chatbot, explained in the next section.

2.2 A Rule-based chatbot for Mobilis complaints:

We have relied on building our rules-based chatbot on some steps, which we will now explain:

- The first thing we'll need to do is import the packages/libraries we'll be using. `re` is the package that handles regular expression in Python, then we create a Python file and name it `long_responses.py` to write responses with long texts.

```
# Importing modules
import re
import long_responses as long
```

- Next, we create a function that calculates the probability that the message is the corresponding message, and to do this we will just write the probability of the function message and it will require some parameters, the first of which will be the user message after that the recognized words. Then we need to understand if it is one answer and we will initially set that to false and we want to provide a list of required words which will just be an empty list.
- Then the first thing we want to do is to create a variable that says certainty message and it will initially be set to zero, then we need to create a boolean that says it's required. words and that will be set to true at first so the first trick we are going to use which is one of the most basic things we have for text recognition is the for loop so we will check for a word in the user message (for the word at that time we will just say if the word was in the recognized words then we will increase the confirmation of the message by one means it's a more accurate sentence and then we calculate the percentage so we are just going to write in percentage and this is the percentage of accuracy so that will just equal to a decimal number of the certainty

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message divided by the number of float length The recognized words are in the matrix of recognized words, so the recognized words will be where we are We will enter the words that we want the robot to recognize and depending on how many of these words are recognized in that list. A certain percentage between zero and 100.

```
def message_probability (user_message, recognised_words,
                        single_response=False, required_words=[]):
    message_certainty = 0
    has_required_words = True
# Counts how many words are present in each predefined message
    for word in user_message:
        if word in recognised_words:
            message_certainty += 1
# Calculates the percent of recognised words in a user message
    percentage = float(message_certainty) / float(len(recognised_words))
# Checks that the required words are in the string
    for word in required_words:
        if word not in user_message:
            has_required_words = False
            break
# Must either have the required words, or be a single response
    if has_required_words or single_response:
        return int(percentage * 100)
    else:
        return 0
```

- Then we need to check that the required words are also included, so we will write to the required words if the word is not in the user message, then we have to set the required words to false because we are missing a required word and this will only prevent us from matching a different configuration wrongly.
- Finally, we can create a return statement for the function that returns us the precision of each sentence so that it can be compared later, and then it can later return us the best possible response, so if we write whether the requested words are true or it is a single

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answer, we want to return an integer value of the ratio Percent is multiplied by 100. So it just converts the percentage to an integer and makes it an integer otherwise we will make it an integer otherwise we will return the value 0 which means nothing matches so it will be the lowest possible value Finally we can go down and fix this error by creating this function as well , so here we are going to write a function. So at the bottom we will create another function called Check All Messages and it will take a message of course. And the first thing we have to do inside is to create a dictionary so that at the top of the protocol list is equal to this dictionary which will become an empty dictionary, then we will create a helper function that will simplify response generation, so we will write a def response and that will take a bot response a list of words that will include the first answer to the error in the beginning and will have the same requirement words as an empty list, then we need to refer to this higher-likelihood list as a non-local variable so that we can use it inside.

- Next we have to point to the top of a probability list and we need to generate a key in the bot response index, this will take the probability of the message by word list in word list one response and required words one response and required words so all this function simplifies adding items to our dictionary which It means we have an easier way to generate a key and an easier way to enter values here now

```
def check_all_messages(message):
```

```
    highest_prob_list = {}
```

```
    # Simplifies response creation / adds it to the dict
```

```
    def response (bot_response, list_of_words, single_response=False, required_words=[]):
```

```
        nonlocal highest_prob_list
```

```
        highest_prob_list[bot_response] = message_probability(message, list_of_words, single_response, required_words)
```

- Then we can do that is to create our response so that the key is the response. So the key will be the response you want the bot to answer your recognized words, for example: Here it will say: *Hello I'm from Mobilis Communications Agency How can I help you?* and we need to enter some keywords that should be like if we say hi or say hi or if we say let's say or if we say hey, if you find any of these we will of course Calculates the percentage of if

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that's hi and then it'll return hi to us as an appropriate answer and we must also specify that this is a single response and we'll set that to true which means you don't need to look up if it contains any required words or not, like *there are offers For pix and sama what words do you want to know?* This will be the response and of course here we will create an array and here we need to enter a required word and of course we need to select the widths of the required word. Understand that we want them to understand how a keyword is very important to them and ask how you do it for this keyword we will add the required words

```
response('Hello i am from Mobilis communication Agency .how can i helo you?', ['hello', 'hi', 'hey', 'sup', 'heyo'], single_response=True)
```

```
response('There are offers for pix and sama, which ones do you want to know?', [ 'are', 'offers'], required_words=['offers'])
```

But when we have long answers like Express offers here, we create a Python file. We created something like this a variable located inside the python file for long responses and named it according to what we need to know the answer and inside we added a very long answer what you want of course.

As you can see here now we have an answer pointing to a long point we are still adding keywords and required words but this time when you return the sentence it will return.

long_responses.py

```
import random
```

```
R_offers = "There are offers for pix and sama, which ones do you want to know?"
```

```
R_lost = "All you have to do is present your national identity card a true copy of it, and the invoice for your SIM card,and you pay an official amount of 100 DA.
```

Then we call these answers in main body with the name of the variable they were named with

```
response(long.R_lost, ['i', 'want', 'get', 'my', 'lost', 'sim', 'card back'], required_words=['lost', 'sim'])
```

```
response(long.R_offers, ['i', 'want', 'mobilis', 'offers', 'what', 'is', ], required_words=['offers', 'mobilis'])
```

and we will create a function called unknown just as we defined it there and first reaction we will write can you refactor unless we add ellipses or let's add another like it looks true and

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Finally we can add another placeholder message like what does that mean we need to use our function Own randomness is very random. Brand range that will go up to four because we have four random responses here if you have more

```
def unknown():
    response = ["Could you please re-phrase that? ",
               "...",
               "Sounds about right.",
               "What does that mean?"]
    [random.randrange(4)]
    return response
```

Result:

As a result : we created a chatbot that automatically recognizes the client's language (Arabic - French - English) and responds to it automatically so that it responds to common questions for Mobilis customers.

With our rule based chatbot, one can write complaints with any language he/she wants, in the beginning of the session, and the chatbot recongnizes the language and send responses with the same languages. The languages offered are: Arabic, French and English. However, the chatbot can be expanded to recognize other languages. (See Fig. 4.5)



```
Bot: مرحبا انا هنا من وكالة موبيليس للاتصالات كيف يمكنني مساعدتك
You: cv
Bot: Bienvenue je suis de l'agence de communication mobilis,comment puis-je vous aider?
You: hi
Bot: Hello i am from Mobilis communication Agency .how can i helo you?
You: i need help
Bot: i'm here for help !i will heppy if i can :)
    what it is your problem
You: احتاج مساعدة
Bot: : احبرني بمشكلتك ساكون سعيد ان استطعت مساعدتك:)
You: i lost ;y si;
Bot: What does that mean?
You: i lost my sim
Bot: All you have to do is present your national identity card a true copy of it, and the
    invoice for your SIM card,and you pay an official amount of 100 DA.
You: |
```

Figure 4 6:A screenshot of our Rule-Based chatbot.

General Conclusion

In this thesis, we have created a chatbot directed to answer common questions for telecom customers without having to contact a direct agent. It is available all the time to provide assistance, and it is easy to integrate into the help pages on the company's websites.

At first we wanted to create a chatbot based on artificial intelligence and natural language processing, but our computers were not helpful to us and were not as efficient as we wanted. We suggested a different solution since we work in a closed field and the robot we want in the end is dedicated to answering common questions. An alternative suggestion was a chatbot powered by Rule_based . Where it can be provided with information by modifying the program according to the user's need.

The results were satisfactory after we presented most of the possible statements, but the problem was that our robot was not able to provide a personal experience at the level, for example: if the user's question was in a way that was different from the questions that had been trained, he would be unable to respond

So we created another chatbot on Google clouds using artificial intelligence. Everything was smooth and easy, and the chatbot was more flexible. But the problem was that it does not support the Arabic language, which was essential in our research, and here was the point of our chatbot's superiority in that it supports the three languages of Arabic, French and English. These are the languages spoken in Algeria

For future work, we will endeavor to create a chatbot using new and different methods of deep learning. So that it achieves the desired result by covering most of the customers' interests with telecom companies.

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ملخص

يؤدي تطبيق تقنيات الذكاء الاصطناعي من قبل شركات الاتصال إلى تغيير طبيعة التفاعلات مع العملاء بحيث أصبح من الممكن الآن أتمت العمل المتكرر والعادي، مما يؤدي إلى زيادة إنتاجية المنظمات وإبداعها وكفاءتها. كما ان العميل يريد المزيد من خيارات الاستقلالية والخدمة الذاتية مفضلين إجراء عملية او حصول على معلومة دون اضاعة الوقت او تجاهله، ومن جهة اخرى في ظل المنافسة بين شركات الاتصال تسعى كل واحدة منهم الى فرض نفسها في السوق وذلك بالحفاظ على عملائها واكتساب عملاء جدد. لذلك الحل الفعال والمربح لهذه المشكلة لطرفين هو روبوت دردشة. يتمثل في تطبيق برمجي يحاكي موظف مركز اتصال يقوم بالرد على الاسئلة الشائعة ويوجه العملاء لتقليل الوقت الذي يقضيه المستخدم في العثور على المعلومات الصحيحة.

في عملنا، قمنا باستكشاف نظامي روبوتات دردشة مختلفين، أول روبوت هو برنامج روبوت دردشة باستعمال Dialogflow اما الثاني هو روبوت دردشة على اساس القواعد يدعم ثلاث لغات ويتعرف على لغة المستخدم تلقائيا من بين اللغات لغة العربية التي لا يدعمها النوع الاول.

الكلمات المفتاحية: التعلم العميق، روبوت الدردشة، خدمة العملاء، Dialogflow، شركات الهاتف

Abstract

The application of artificial intelligence techniques by communication companies is changing the nature of interactions with customers. It is now possible to automate repetitive and regular work, increasing the productivity, creativity and efficiency of organizations. The customer also wants more options of independence and self-service, preferring to conduct an operation or obtain information without wasting time or ignoring it. On the other hand, in light of the competition between communication companies, each of them seeks to impose itself in the market by maintaining its customers and acquiring new customers. Therefore, an effective and profitable solution to this problem for two parties is a chatbot. It is a software application that simulates a call center employee that responds to common questions and directs customers to reduce the time spent by the user in finding the right information.

In our work, we explored two different chatbot systems, the first is a Dialogflow chat bot and the second is a rules-based chat bot that supports three languages and automatically recognizes the user's language among the languages Arabic is not supported by the first type.

Keywords: Deep learning, chatbot, customer service, Dialogflow, company mobile

Résumé

L'application des techniques d'intelligence artificielle par les entreprises de communication modifie la nature des interactions avec les clients. Il est désormais possible d'automatiser le travail répétitif et régulier, augmentant la productivité, la créativité et l'efficacité des organisations. Le client souhaite également plus d'options d'indépendance et de libre-service, préférant effectuer une opération ou obtenir une information sans perdre de temps ou l'ignorer. D'autre part, compte tenu de la concurrence entre les entreprises de communication, chacune d'entre elles cherche à s'imposer sur le marché en conservant ses clients et en acquérant de nouveaux clients. Par conséquent, une solution efficace et rentable à ce problème pour deux parties est un chatbot. Il s'agit d'une application logicielle qui simule un employé

d'un centre d'appels qui répond aux questions courantes et dirige les clients pour réduire le temps passé par l'utilisateur à trouver la bonne information.

Dans notre travail, nous avons exploré deux systèmes de chatbot différents, le premier est un chat bot Dialogflow et le second est un chat bot basé sur des règles qui prend en charge trois langues et reconnaît automatiquement la langue de l'utilisateur parmi les langues. L'arabe n'est pas pris en charge par le premier genre.

Mots clés : Deep learning, chatbot, service client, Dialogflow, mobile d'entreprise