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End of Year Internship Report
Submitted for the purpose of obtaining
National Degree in Applied Mathematics
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Specialty: Data Science

Presented by:
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Creation of a Chatbot Solution for BNA Bank

Realized within:

BNA BANK

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Dedication

I dedicate my work, as well as my sincere thanks and gratitude:

To my wonderful parents, who formed the foundation of my existence. I would never have made it without them. Thank you for all of your sacrifices, love, and moral support over the years.

To my sister and my brother, whom I adore and who have never stopped encouraging me, I wish them a life filled with pleasure, prosperity, and love.

To all my friends, who have always encouraged me and who have been able to give me help and support.

To everyone I adore and everyone who has shown me love throughout this internship.

To everyone I love.

Thank you!

Acknowledgement

Before I deliver my end-of-year internship report, I'd want to thank everyone who contributed to the success of my internship in various ways, especially those mentioned below.

I would like to thank **Mr Slim Omri**, Director of the Department of Mathematics at the Faculty of Sciences in Tunis, as well as all of our teachers and members of the administration.

I also like to thank my academic supervisor, Mrs. **Asma Mekki**. I can only respect her expertise and method of operation. I would like to express my gratitude to her once more for her patience, generosity, and human warmth. As well as, **Mr Maher Kedhai**, my Professionnel supervisor, who consented to lead my work despite his many responsibilities.

In light of this, I would want to express my gratitude to **BNA Bank** for their kind welcome.

Finally, I would like to express a word of gratitude to all our **LMSD** professors for all their knowledge that they have been able to transmit to us and the jury members for accepting to judge this modest work.

Abstract

This project was undertaken to fulfill the requirements for a graduation degree in Applied Mathematics with a specialization in Data Science from the Faculty of Sciences of Tunis (FST).

This project consists of the creation of a smart chatbot for the bank "BNA" using Machine Learning and Deep Learning techniques. The chatbot aims to provide efficient and automated customer service by simulating human-like conversations and delivering real-time assistance. By leveraging advanced algorithms and models, the chatbot is designed to accurately understand and respond to user requests. The project involved various stages, including data preprocessing, model training, and system integration. Through the utilization of cutting-edge methodologies and tools, the chatbot's performance and effectiveness were optimized. The outcomes of this project contribute to the advancement of chatbot technology in the banking sector, improving customer experience and reducing response time.
This work showcases the potential of Machine Learning and Deep Learning techniques in developing intelligent conversational agents.

Keywords: Chatbot, Machine Learning, NLTK, Deep Learning, neural network, Tenserflow, Natural Language Processing.

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Abbreviations

AI	Artificial intelligence
BNA	Banque National Agricole
DL	Deep Learning
FNN	Feedforward Neural Network
LSTM	Long Short-Term Memory
ML	Machine Learning
NLG	Natural Language Generation
NLP	Natural Language Processing
NLU	Natural Language Understanding
RNN	Recurrent Neural Network

General introduction

Ensuring customer satisfaction is a primary objective for banks in their sales operations. Customers expect prompt resolution of their issues, and automating the handling of these problems can significantly enhance efficiency.

To achieve this, banks need to have readily available information and documentation, enabling employees to respond to tasks effectively. Despite information being easily accessible, employees often spend a significant amount of time searching for it, impacting productivity and task processing time.

Chatbots provide a solution by serving as virtual assistants capable of simulating human conversations in real-time. Equipped with specific algorithms, these computer programs can offer customer service without the need for human intervention.

In the context of this project, we propose the development of a chatbot for BNA Bank, focused on reading and processing user requests to provide accurate responses. This report is structured as follows:

1. Introduction to the host institution and problem resolution: This chapter presents an overview of the host organization and outlines the problem addressed.
2. State of the art: This chapter explores the theoretical foundations of the project and provides insights into its maintenance.
3. The third chapter entitled “Methodology and integration” outlines the work methodology with relevant examples and discusses the integration of the chatbot into a website.

By following this structure, we aim to present a comprehensive analysis of the chatbot’s development and its application within BNA bank.

Chapter 1

Introduction to the host institution and problem resolution

In this chapter, we present the general framework of the project, starting with the presentation of the host organization in which our work took place. For this, we will present BNA Bank. Finally, we introduced the project's topic.

1.1 Introducing the BNA.

BNA is the first Tunisian public bank. It was officially founded on the initiative of the Tunisian government on 1 June 1959 with a staff of 90 employees.

Figure 1.1: BNA Bank

The purpose of the creation of the BNA was essentially to provide Tunisian farmers with an effective system of agricultural credits.

Its social objective consists in the realization of the banking profession notably by mobilizing savings and granting credits. It is a public limited company whose shareholders may be physical or moral persons, Tunisian or foreign nationality.
At the end of 2017, the BNA was the head of the "BNA Group", which is composed of 23

companies operating in several business areas such as the financial sector, real estate promotion, and other services.

Today, with 183 agencies in all of Tunisia, the BNA confirms its presence and consolidates its position in the Tunisian banking market.

The table below presents the key features of the BNA.

Name	BANQUE NATIONALE AGRICOLE
legal status	Publicly traded firm with a board of directors and general management
founding date	1 June 1959
main office	Avenue Mohamed V Bab Bhar 1002 Tunis
Objet social	banking activities
duration	99 years
Tax Number	000 123 LAM 000
social capital	320.000.000 Dinars
website	www.bna.tn

Table 1.1: BNA Data Sheet

1.1.1 Historic of BNA

1959, THE CREATION OF THE BNA
A strong political gesture and a major economic act

More than 55 years ago, the National Agricultural Bank was born in the euphoria of national independence and the proclamation of the Republic that followed immediately afterward. A premonitory sign and probably full of meaning, the Bank is the age of the Constitution, ratified in 1959. As if one wanted the bank, at its birth, to be for the economy what the Constitution was for the Republic.

Three years earlier, in 1956, the country gained political independence. He inherited an economy that was drained, deprived of infrastructure, of the productive fabric of economic actors and even more, of sources and mechanisms of financing. Money, the nerve of the economy, was lacking; at best it was under the control of financial institutions reduced to their simplest expression and linked to the former colonial power.There was little or nothing that could channel national savings to finance the economy.

However, only a rapidly growing and developing economy could give body and soul to the political project of emancipation and national recovery, dear to national leaders.

The BNA was born from this ambition: it was the arm and lever of the State's financing to build a future economy. With the creation of the BNA, the young Tunisian state has given itself the instrument of its attributes of sovereignty and national independence.

More than a decisive source of funding, the BNA was the symbol of a fierce desire for independence and therefore a choice of the most relevant that contrasted with the prevailing ideology of the time and which gave pride of place to industry and trade at the expense of agriculture. The industry was synonymous with progress and modernity, while agriculture aroused little enthusiasm and attracted little means. We know what happens to this erroneous theory which obscures and evades the role and weight of the agricultural sector and its contribution to the growth of the economy and even more its effects on the cohesion and the solidity of the economic and social fabric.

The creation of the BNA was a strong political gesture and a major economic act. The financing of agriculture - of which she developed the appropriate tools and mechanisms very early on - did not cover all the activities of the bank as far as necessary. The BNA already had a universal vocation: industry, services and commerce were part of its vast field of competence.

The BNA has positioned itself from the outset as the central element of the country's balanced and harmonious economic development system.

The BNA is, of course, the expression of the will to modernize the country, it is also by its plural vocation and its pronounced agricultural inclination, the harbinger of what has since become the Tunisian exception. Behind these three words inscribed in gold letters in the register of the contemporary economic history of Tunisia, the BNA was the affirmation of a strong desire for development and independence.It was also a demonstration of a vision as profound as it was distant. It alone evoked the perspective of the country's future.

The BNA was the embodiment of a great national design in these heroic times. It took immense talent and all the patriotism known to the pioneers of the bank to force fate, build a real institution for development and bring it very early to the forefront of our economy under construction.

The bank had an extraordinary leverage effect at the outset and upon the arrival of almost all the projects that marked the course of the Tunisian economy. There are few industrial projects which have not benefited from BNA's assistance in terms of advice and financing, whereas BNA plays a vital role in promoting the agricultural sector.

The bank, and this is its character trait, promises as much as it promotes. Its purpose is to develop our national savings, to finance the development of our young nation.

1969, CONVERSION INTO UNIVERSAL BANKING
The BNT, much more than a new reorganization.

The first decade of the BNA was as active as it was rich in achievements. Deep roots in the Tunisian banking sector with a specialization in agriculture, but also development of activities related to the sector, in particular, agri-food.

Similarly and in less time than expected, Tunisian agriculture bore the indelible trace and the

label of the BNA. Success was almost immediate. Industry and commerce were no exception. So much so that for the sake of coherence, and with regard to the opening of the bank on all the sectors of the national economy - while giving priority to the financing of the agricultural sector.

But also, and as a corollary for the bank, an opening to the international with the multiplication of correspondents abroad and a better connection on the sources of financing.

Thus, as of October 1, 1969, the bank announced its conversion into a universal bank, ensuring its opening to all sectors of economic and financial activity, by the new name: National Bank of Tunisia. This is much more than the announcement of a new reorganization.

This extension of the bank's field of action, motivated by the links of solidarity existing between the various economic sectors, should enable the bank to create the conditions for ensuring healthy and balanced growth.

1989, MERGER BY ABSORPTION OF BNDA
The Bank takes over its new brand "Banque Nationale Agricole"

Caught up in history and challenged again by success, twenty years after it changed its name, the Bank regains its original name. In October 1989, in order to unify the main structures of agricultural credit, the National Bank of Tunisia merged and absorbed the National Bank of Agricultural Development "BNDA". The rest is in order and in the logic of this merger. The Bank has taken over its new brand: Banque Nationale Agricole.

The BNA also wants to showcase Tunisia's social advances; it intends to place itself at the forefront-The European Council, in particular, called on the Commission and the Member States to ensure that Member States continue to respect the principle of subsidiarity.

The bank advances with its eyes fixed on the well-defined horizon, its visibility is perfect, its development model has already proven its worth; it is validated by facts, by partners, by customers and by shareholders. The NBA has been effective in creating new wealth, jobs and value.

The bank puts its know-how, expertise and professionalism at the service of its clients to better serve the national economy. Each additional growth point, each new space conquered by the different economic and financial sectors is one more point for entrepreneurship and regional development.

Deeply rooted in the national soil, the BNA is deliberately open to the world, technological innovations of whatever nature: financial, economic, agricultural, etc.

Beyond its rigour and professional requirements, the BNA is also a group culture, a code of conduct that makes the bank a corporate citizen, which has been able to raise public morality to its highest level. It is this set of values that nourishes its dynamism and maintains its vitality.

More than half a century of activities on all fronts and not a wrinkle. Probably because the BNA is a new idea. She knew how to constantly invent a future, carried that she is by her youth momentum.

The BNA, its executives and its employees draw from the moral principles and ethics of the new Tunisia the springs of their inspiration and action. Nourished by these values, the bank can rightly prepare for its centenary. It was and remains an institution rooted in the depths of Tunisian memory.

From the moment she was born, she expressed both great ambition and a promise for the future, an innovative idea served by women and men mobilized for this purpose. It was carried by the force of the arms of exemplary personnel.

On the bank's pediment, in its registers, one sees, beyond the emblem of the demanding profession, a mission at the service of the nation.

1.1.2 BNA's development process

In this level, we outline significant turning points since founding the BNA:

- **In 1959:** the creation of the BNA with 90 staff and 17 agencies in various regions.
- **In 1969:** the opening of the BNA to other economic sectors while confirming its agricultural vocation.
  Change of its name to BNT (National Banks of Tunisia) due to the development of the bank's field.
- **In 1989:** the merger-absorption of the National Bank for Agricultural Development "BNDA" and the National Bank of Tunisia "BNT" to take its original name BNA.
- **Between 1990 and 1998 :** Due to its increased exposure to the outside world and environmental changes, BNA has continued to adapt:
  - Restructured its organization.
  - Modernized its organizational management method.
  - Implemented a business strategy based on the customer/product approach to improve the quality of financial services.
- **In 2014:** To address the issues and provide opportunities for improvement in its HR processes, the BNA has undertaken a thorough audit by the worldwide auditing company "price Waterhouse Cooper".
- **In 2019:** by celebrating its sixty years of existence, the BNA increased its capital from 176 billion to 320 MD.
  At the end of the year, it achieved a net income of 13 MD.
- **In 2020:** the BNA is ranked first in the ranking of banks in Tunisia in terms of equity. They announced a Net Banking Income of 457 MD at the end of the third quarter and a half-year net profit of 67 million dinars.

1.1.3 BNA's main missions and values

Since its launch and with the new restructuring, the BNA has been given the main task of promoting and supporting the economic operators of its customers by providing them with the most suitable products and services. It is constantly seeking to meet the expectations of its clientele and individuals by offering them a proactive network spread across the country.BNA also continues to consolidate its position as the leading Tunisian contributor to the financing of agriculture and agri-foodindustry, while retaining its status as a universal bank.

the BNA is founded on a charter of values that all of its internal and external contracting parties are required to uphold. These values cover:

- **Citizenship :** it concerns assuring the social and economic development of all its stakeholders.
- **Efficiency:** is concerned with making a better combination between the resources used and the expected results.
- **Ethics :** it involves putting moral and human values at the center of its concerns.
- **Teamwork :** It is about showing solidarity and altruism between the different members of the BNA.
- **Proximity :** Keeping the stakeholder relationships based on trust is important.

Among the most significant characteristics of the BNA are citizenship and commitment. Since adopting the tagline "The BNA is committed," it has continued to fund social initiatives aimed at enhancing educational standards and learning environments for children in underprivileged communities. It has therefore been devoted for years to defending the right to education under reasonable circumstances. The BNA provided the Ministry of Education with a 22.382 MD grant in 2021 for the renovation and expansion of rural elementary schools.

1.1.4 Products and services of BNA

BNA bank provides different products and services for their client's needs in various domains:

- Daily banking: offer products and services to help clients to manage their money.
- Saving and investment: offer products and services to grow your excess money and/or cash at the best conditions safely.
- Credits and financing: offer products and services to help clients to finance their personnel or business needs.
- International services: offer products and services to help their international clients.

1.1.5 Problematic

Due to the diversity of products and services, BNA Bank has faced several problems such as:

- High demand for customer services.
- Long wait time which means customers have to wait

- Extended periods to speak with a customer service representative.
- Human errors which mean human customer service may make mistakes that could lead to incorrect information being provided to customers.
- Expectation of 24/7 which means customers expect banks to be available 24/7, but providing human customer service representatives around the clock can be so challenging.

1.1.6 Proposed Solution

Using machine learning and deep learning algorithms, the proposed solution is to create a smart chatbot to simulate a human conversation and to assist the client with their needs.

1.2 Conclusion

This chapter allowed us to present the internship host organization as well as the overall background of this project. In the next chapter, we will represent the main concepts that we need to build our chatbot.

Chapter 2

State of the art

2.1 Introduction

This chapter defines the domain that studies and develops chatbot models, natural language processing (NLP). Therefor this chapter provides a broad overview of what chatbots are and how they work.

2.2 What is a chatbot

A chatbot is an "online human-computer dialog system with natural language." [5]. It provides a basic framework which outlines 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 is analyzed with natural language processing tools, and used to generate appropriate responses. [9]

Rational Agent: must have access to an external base of knowledge and common sense (e.g. via corpora) such that it can provide the function of competence, answering user questions. Should store context-specific information (e.g. user's name, etc.) [9].

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. [9]

Chatbot is a technology that is used to mimic human behavior using natural language. There are different types of Chatbots that can be used as conversational agent in various business domains in order to inhance the customer service and satisfaction. For any business domain, it requires a knowledge base to be built for that domain and design an information retrieval based system that can respond the user with a piece of documentation or generated sentences. The core component of a Chatbot is Natural Language Understanding (NLU) which has been impressively improved by deep learning methods.[1]

A chatbot is therefore an application designed to automate tasks or simulate conversations. This

computer program can read messages (email, SMS, Chat...) and respond to them in seconds, thanks to a set of pre-recorded answers.

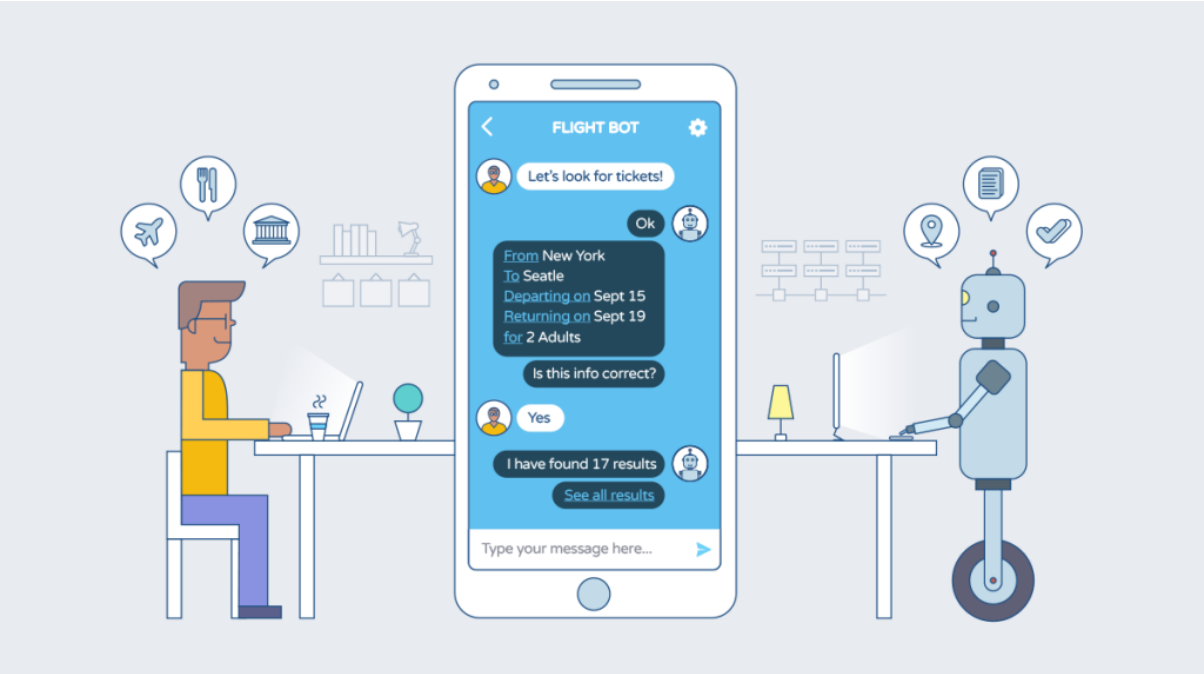

Figure 2.1: conversation example between chatbot and customer

2.2.1 Some uses of a chatbot

A chatbot, also known as a conversational agent, is a computer program capable of simulating a conversation with one or more humans by voice or text exchange. This tool is now widely used on the Internet by client services through instant messaging.

Customer service: chatbots can be used to rapidly and efficiently answer customer's questions.

Marketing: chatbots can be used to tell customers about new products, discounts, and upcoming events, etc.

Online sales: chatbots can be used to help customers in finding and buy products online.

Personal assistance: chatbots can be used to assist people in time management, and appointement reminders,...

Medical assistance: chatbots can be used to assist patients in taking care of their health, answering medical concerns, and providing advice,...

Recruitment: chatbots can be used to assist recruiters in screening candidates,...

2.2.2 Some benefits of chatbot for customers

Conversational agents change the way we think and live, as they have the ability of being present and ready to provide help anytime and anywhere. [3]

Figure 2.2: Some benefits of chatbot

2.3 Artificial intelligence and natural language processing

Moreover, Natural Language Processing (NLP) is a branch of artificial intelligence (IA) where it applies Machine Learning (ML) and Deep Learning (DL) methodologies, we will explore more in detail these three fundamental components of AI.

Artificial Intelligence (AI) is revolutionizing various industries and transforming the way we live and work IA is an intelligent devices that behave like humans.The benefit of intelligent machine is that can complete tasks faster and more efficiently than humans.

Artificiel intelligence is a large topic that includes ML and DL.

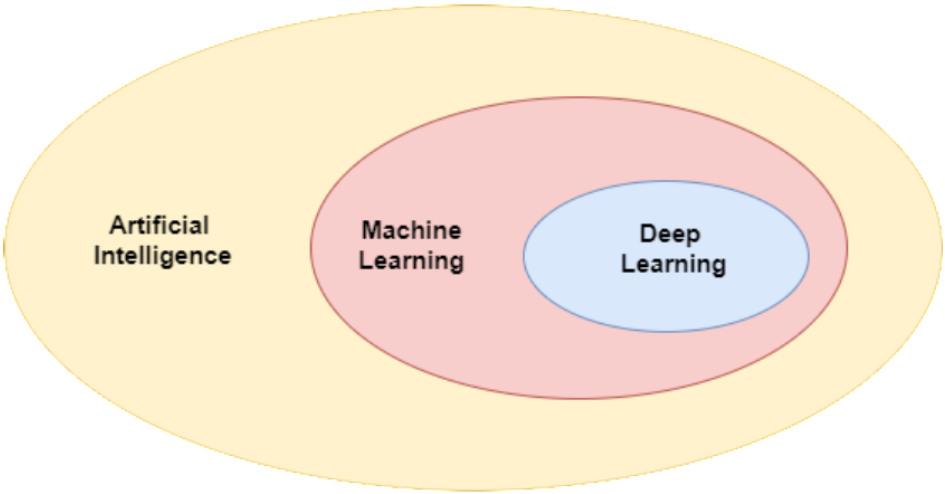

Figure 2.3: Artificial intelligence

2.4 Machine learning

ML is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy.

Figure 2.4: difference between machine learning and human learning

Human learning is a complex process that begins with sensory input (which includes information received through our five senses) and involves the integration of new information with past knowledge and experience. However, ML algorithms are often designed to automatically process massive volumes of data and discover patterns and relationships.

Machine learning and human learning both entail the acquisition of knowledge and abilities via experience. They differ in their learning process, creativity, and adaptability

Learning process: human learning needs to acquire new knowledge, skills, or behaviors through experience, study, or instruction, however, processes large amounts of data.

Adaptability: humans are very flexible and may quickly learn new abilities, in contrast, machine learning algorithms are often intended to accomplish specific tasks and may fail to adapt to new or unexpected conditions.

Creativity: humans are capable of creative thinking and invention, while, machine learning algorithms can recognize patterns and make predictions based on existing data.

2.4.1 Types of machine learning

Supervised learning: the algorithm is trained and learns to make predictions on labeled data and can then be used to make predictions on new unseen data.

Unsupervised learning: the algorithm is trained on unlabeled data and must identify patterns and relationships within the data on its own.

Reinforcement learning: learning training strategy that rewards desired behaviors while penalizing undesirable ones. A reinforcement learning agent, in general, can detect and comprehend its surroundings, act, and learn through trial and error.

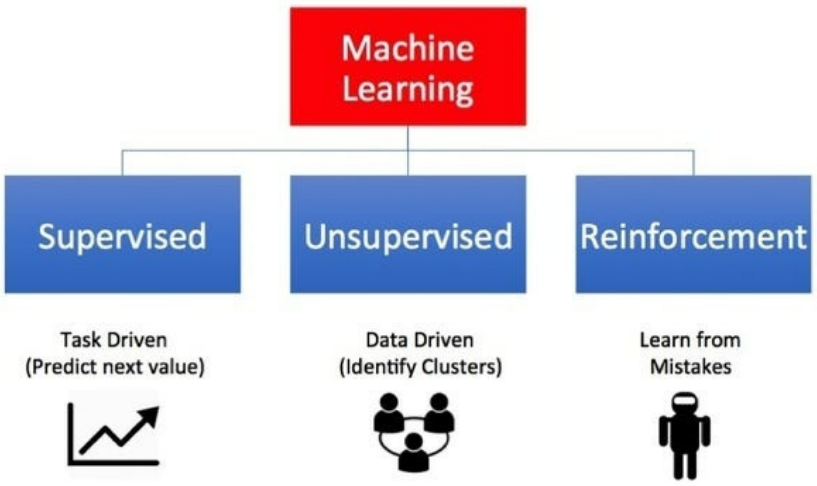

Figure 2.5: Types of machine learning

2.4.2 Neural network

The neural network is a model inspired by the structure and function of the human brain.
Like the neurons in our brain, the circles above represent a node. Green circles represent the input layer (input layers), red circles represent hidden layers or intermediate layers and the blue circle represents the output layer. That work together to process information.

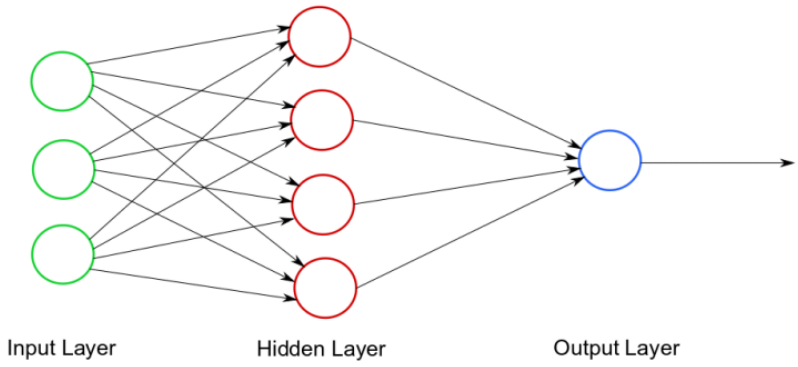

Figure 2.6: Neural Network and its functionality

Each neuron takes input from other neurons and uses this information to produce an output value. The output of each neuron is then passed on to other neurons on the network, allowing information to be processed and sent throughout the network.

Neural networks have been effectively used in a variety of applications, including image recognition, audio recognition, natural language preprocessing, and autonomous vehicle.

2.4.3 Deep learning

DL is a subset of machine learning, which is essentially a neural network with three or more layers.

Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction. These methods have dramatically improved the state-of-the-art in speech recognition, visual object recognition, object detection and many other domains such as drug discovery and genomics. Deep learning discovers intricate structures in large data sets by using the back propagation algorithm to indicate how a machine should change its internal parameters These parameters are used to compute the representation in each layer based on the representation in the previous layer. Deep convolutional nets have brought about breakthroughs in processing images, video, speech and audio, whereas recurrent nets have shone a light on sequential data such as text and speech[7].

DL architecture you choose is determined by the specific problem you are attempting to answer, the nature of the data you are working with, and the computational resources available to you. Experiment with several designs and pick the one that performs best on a validation set it's a good idea.

2.4.4 Machine learning vs Deep learning

Through table 2.1 we make a simple resume that makes easy to understand the difference between ML and DL.

	Machine learning	**Deep learning**
Data	Performs well on small to medium dataset	Performs well on a large dataset.
Hardware	Able to function on CPU.	Requires significant computing e.g. GPU.
Features	features need to be manually identified.	learns features automatically.
Training time	Quick to train.	computationally to train.

Table 2.1: ML vs DL

2.4.5 When to use ML or DL

Machine learning is typically used when the data is well-structured and the features are well-defined. The purpose of ML is to detect the patterns in data that may be utilized to generate predictions or decisions.

Deep learning models can handle complex tasks and use unstructured data, they can also learn features directly from the data.

The decision between DL and ML is also influenced by the size of a dataset, computational resources available and the level of accuracy necessary for the task.

2.5 Natural language processing

Natural language processing (NLP) is an interdisciplinary subfield of linguistics, computer science, and artificial intelligence concerned with the interactions between computers and human language as mentioned in Figure 2.7. Natural language processing (NLP) refers to computer systems that analyze, attempt to understand, or produce one or more human languages, such as English, Japanese, Italian, or Russian. The input might be text, spoken language, or keyboard input. The task might be to translate to another language, to comprehend and represent the content of the text, to build a database or generate summaries, or to maintain a dialogue with a user as part of an interface for database/information retrieval [4].

NLP came into existence to ease the user's work and to satisfy the wish to communicate with the computer in natural language, and can be classified into two parts as mentioned in Figure 2.8. Natural Language Understanding (NLU) and Linguistics and Natural Language Generation (NLG) evolve the task to understand and generate the text [6].

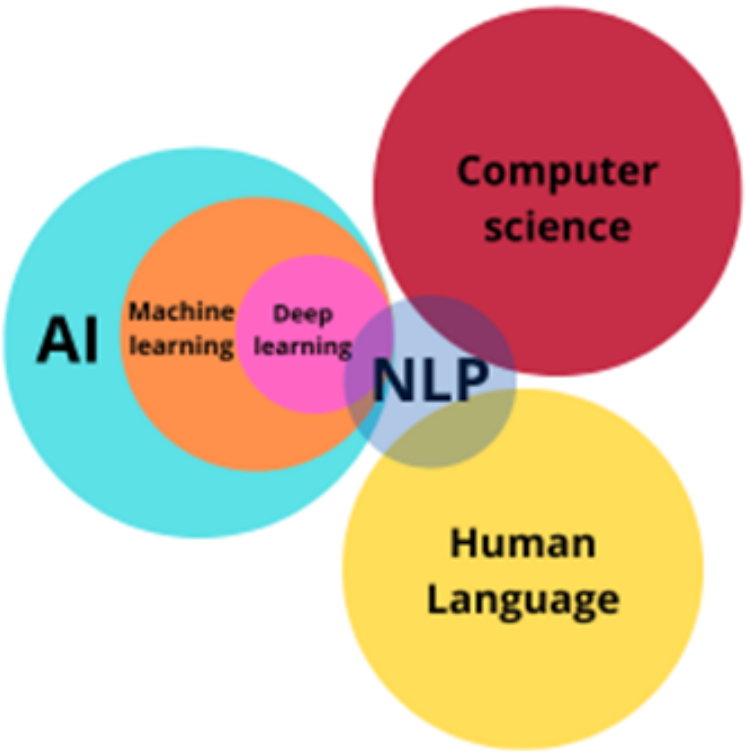

Figure 2.7: NLP

2.5.1 Some applications of NLP

we define some applications of NLP such as:
- Text Classification
- Language Modelling
- Question Answering (QA)
- Text summarizer
- Chatbot
- Machine Translation
- Natural Entity Recognition

2.5.2 Components of NLP

NLU and NLG are two key components of Natural Language Processing (NLP) as mentioned in Figure 2.8 that allow machines to comprehend and generate human language.

NLU and NLG are utilized in a wide range of applications, including chatbots, virtual assistants, and machine translation systems. NLU is used to analyze and interpret user input, whereas NLG is used to generate human-like responses or outputs.

In Figure 2.9 we represent a Broad classification of NLP.

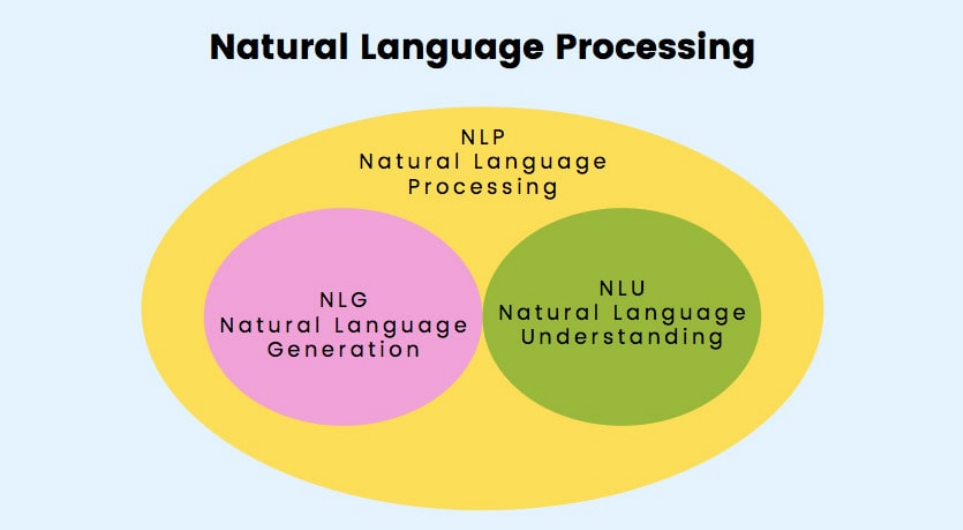

Figure 2.8: NLP's components

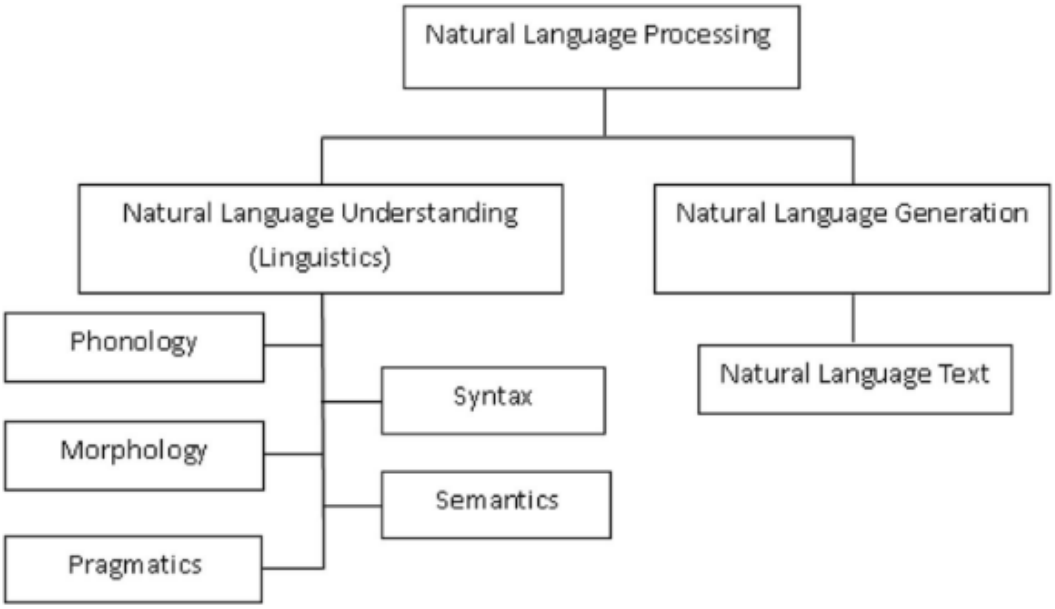

Figure 2.9: Broad classification of NLP
[6]

- **NLU:** Natural Language Understanding (NLU) is an established component within a conversational AI or digital assistant system, and it is responsible for producing a semantic understanding of a user request [8].
  - Phonology is the study of the sound system of a language, including the way sounds are organized and used to create meaningful units such as words and phrases.
  - Morphology is the study of the structure of words and how they are formed from smaller meaningful units called morphemes.

  - Lexical refers to the vocabulary of a language, including individual words, their meanings, and how they are used in different contexts.

  - Syntactic is the study of the rules and principles that govern the structure of sentences and phrases in a language, including how words are combined to create meaning.

  - Semantic is the study of the meaning of words, phrases, and sentences, including how meaning is conveyed through context, connotation, and denotation.

  - Pragmatic is the study of how language is used in context to achieve specific goals, including the social and cultural factors that influence communication.

- **NLG:** is a method of creating meaningful phrases and sentences (natural language) from data, which may be divided into stages.

  - Text planning: The basic content of the text is selected for the particular readership and organized coherently. Theories of text organization may be used to find a good ordering of information [2].

  - Sentence planning: The information is split into sentences and paragraphs, and appropriate use is made of conjunctions, pronouns, etc [2].

  - Realization: Grammatically correct sentences are produced. A grammar of the language (e.g., English) may be used, and knowledge of when different grammatical forms are appropriate[2].

2.5.3 Methodology for applying NLP

Solving a problem with the NLP tools requires the monitoring of a methodology specific common to all artificial intelligence projects.

Building a pipeline to clean up our data is the first step in NLP. We go through the following procedures to clean up the textual data:
Tokenization: This phase divides the sentence into individual words or tokens.
Elimination of special characters: This step involves removing special characters that can skew model results and do not add useful information. Examples: points, virgules...
Elimination of Stopwords: Stopwords are words that do not contribute to the meaning of a phrase. Stopwords like ”the”, ”one”, ”and”, ”is” (and so on) are the most common words that have no true meaning and are not meaningful. Stopwords differ from one language to the next.
Lemmatisation and Stemming: methods will assist the algorithm in extracting patterns and developing the logic of classification of the labeled phrases through token transformations (produced during the tokenization phase). The following is the distinction between these two

transformations:
- Stemming is the process of removing prefixes and suffixes from words: Caring' would return 'Care'
- Lemmatisation converts a word into its root: 'Caring' would return 'Care'.

2.6 Convertionnal chatbot

NLP is used in conversational chatbots to reply to user requests. They give users the option of asking whatever question they want. This form of chatbot learns from user inquiries and builds a template to provide the most trustworthy response possible. A conversational chatbot takes the user's unstructured human language communication and converts it into structured data called intents.

2.6.1 Definition of intents

An intent explains and captures the meaning of the user's entry. It is defined for each sort of request that the chatbot must support. In other words, intents enable the chatbot to interpret and categorize user demands based on actions and activities that it may do. A response is triggered once the intent has been identified and processed. Entities can be attached to intents: while intent allows the chatbot to comprehend the user, entities extract information from natural language entries. An entity represents what is important to the intent as a phrase or item with a specific context. A user can insert a list of possible values and synonyms into an entity.

```
{"intents": [
        {"tag": "greeting",
         "patterns": ["Hi there", "How are you", "Is anyone there?","Hey","Hola", "Hello", "Good day"],
         "responses": ["Hello, thanks for asking", "Good to see you again", "Hi there, how can I help?"],
         "context": [""]
        },
        {"tag": "goodbye",
         "patterns": ["Bye", "See you later", "Goodbye", "Nice chatting to you, bye", "Till next time"],
         "responses": ["See you!", "Have a nice day", "Bye! Come back again soon."],
         "context": [""]
        },
        {"tag": "thanks",
         "patterns": ["Thanks", "Thank you", "That's helpful", "Awesome, thanks", "Thanks for helping me"],
         "responses": ["Happy to help!", "Any time!", "My pleasure"],
         "context": [""]
        },
        {"tag": "noanswer",
         "patterns": [],
         "responses": ["Sorry, can't understand you", "Please give me more info", "Not sure I understand"],
         "context": [""]
        },
```

Figure 2.10: Example of a simple intent

2.6.2 The detection of intent

There are a limited number of questions with a limited set of predefined intents. Messages from users to be classified are relatively short, may include abbreviations or slang or grammatical errors, and have poor structure. The purpose of intention detection is to map user inputs to the information as much as possible, the intent detection task is divided into 3 main sub-tasks executed sequentially on the user message: preprocessing, vectorization and classification.

Preprocessing: involves several steps. Depending on the NLP system, one can limit oneself to a subset of these steps or introduce an additional one. Preprocessing has a significant impact on the effectiveness of intention detection.

Vectorization: is a mechanism that converts the message into a vector representation of real numbers.

Classification: during classification, a machine learning or neural network algorithm is applied.

2.7 Conclusion

In this chapter, we discussed the basic concepts necessary for the development of our project as AI, ML, DL, and NLP. We highlighted the importance of these domains in different fields of work. Also, we mentioned the methodology for applying NLP which we need barely in creating a chatbot. Next chapter, we will explain more clearly about the methodology with examples in our case of project.

Chapter 3

Methodology and integration

In this chapter, we will present the working environment as well as focus on the methodology of work and we will explain with examples through our project. Finally, we end by integrating our solution into a web interface.

3.1 Working environment

In this section, we will present the hardware configuration and software environment used.

3.1.1 Hardware configuration

During this project we used the following machine configuration:

- **Brand:** DELL.
- **RAM Memory:** 16 Go.
- **Processor:** Intel Core i5-1135G7 processor, up to 4.2 GHz, 8 MB cache.
- **Graphics card:** Nvidea GeForce MX350, 2 GB dedicated memory.
- **Hard disk :** SSD 256 Go .

3.1.2 Software tools

- **Anaconda**

Anaconda is an open-source data science distribution for the Python and R programming languages that seeks to simplify package management and deployment. Anaconda's package management system, conda, manages package versions by analyzing the current environment before completing an installation to prevent interrupting other frameworks and packages.

- **Jupyter Notebook**

Created from Python in 2014, Jupyter is an open source, free and interactive computational notebook. It is a client-based web application for creating and sharing code, equations, visualizations or text.

- **visual studio code**

Working with Python in Visual Studio Code, using the Microsoft Python extension, is simple, fun, and productive. The extension makes VS Code an excellent Python editor, and works on any operating system with a variety of Python interpreters. It leverages all of VS Code's power to provide auto complete and IntelliSense, linting, debugging, and unit testing, along with the ability to easily switch between Python environments, including virtual and conda environments.

- **Overleaf**

Overleaf is a free online platform allowing you to edit LATEX text without any application download. In addition, it offers the possibility to write documents in a collaborative way, to offer its documents directly to different editors (IEEE Journal, Springer, etc.) or open archive platforms (arXiv, engrxiv, etc.) for a possible publication.

- **HTML**

HTML stands for HyperText Markup Language. It is a standard markup language for web page creation. It allows the creation and structure of sections, paragraphs, and links using HTML elements (the building blocks of a web page) such as tags and attributes.

- **CSS**

CSS, or Cascading Style Sheets, is a simple design language designed to make the process of making web pages presentable easier. CSS is in charge of a web page's appearance and feel. CSS allows you to manage the color of the text, font style, paragraph spacing, how columns are scaled and laid out, what background pictures or colors are used, layout designs, display variants for different devices and screen sizes, and a multitude of other effects.

- **JS**

JavaScript is a lightweight programming language that web developers commonly use to create more dynamic interactions when developing web pages, applications, servers, and or even games.

3.1.3 Development language

Python

Python is the open source programming language most used by informants. It is used in machine learning and data science, the Python language also imposes itself in other sectors of activity thanks to its simplicity and compatibility.

Labraries

One of the great strengths of Python is that it contains a very large number of biblio-libraries. Among these, let us introduce:

- **NLTK:** Is a Python library dedicated to natural language processing or Natural Language Processing.
- **Tensorflow:** is an open-source end-to-end platform for creating Machine Learning applications. It is a symbolic math library that uses dataflow and differentiable programming to perform various tasks focused on training and inference of deep neural networks. It allows developers to create machine learning applications using various tools, libraries, and community resources.
- **Keras:** is a high-level deep learning API developed by Google for constructing neural networks. It is developed in Python and is used to simplify the implementation of neural networks. It also enables various backend neural network computations.

- **NumPy:** NumPy is the foundational Python library for scientific computing. It is a Python library that includes a multidimensional array object, various derived objects (such as masked arrays and matrices), and a variety of routines for performing fast array operations such as mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms, basic linear algebra, basic statistical operations, random simulation, and much more.
- **Matplotlib :** Designed to plot and visualize data in graph form.
- **Flask :** Flask is a popular web framework for building web applications using the Python programming language. It is a lightweight and modular framework that provides tools and libraries for creating web applications quickly and easily.

3.2 Methodology of work

The CRISP-DM (CRoss Industry Standard Process for Data Mining) project proposed a comprehensive process model for carrying out data mining projects. The process model is independent of both the industry sector and the technology used[11].

CRISP–DM is a hierarchical process consisting of 5 main steps and a final optional step as shown in Figure 3.1.

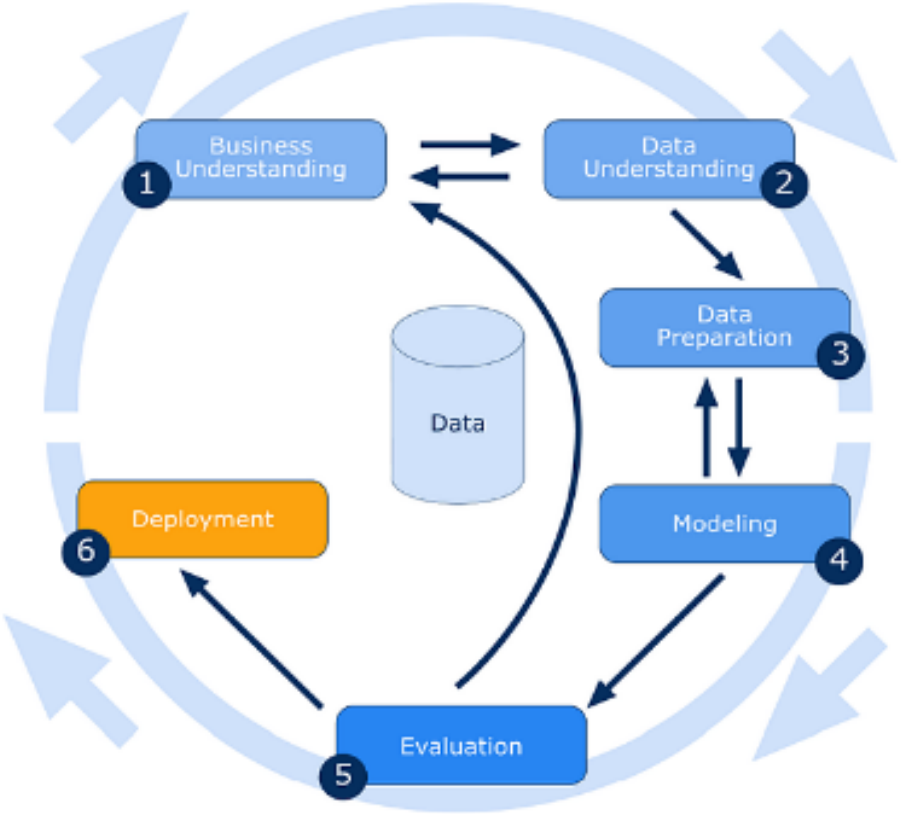

Figure 3.1: Processus CRISP-DM

The data mining process is cyclical and it is possible to move back and between phases:

1. Understanding the business: focuses on understanding the business objectives and requirements and then translates this knowledge to produce a project plan.
2. Understanding data: Begin by identifying what data is relevant to the project, then describe, explore and identify its quality issues to get a first look at the data. The next phase of the process resolves detected issues.
3. Data Preparation: contains all the operations necessary to obtain the final data set for the project from the original raw data.
4. Modelling techniques: are selected, implemented and evaluated. Since some approaches such as neural networks have data structure specifications, a return to the data preparation phase is necessary in some cases.
5. Evaluation: To ensure performance and accuracy and to consider the objectives that were set at the beginning of the process, an evaluation of the model is required to evaluate the results, review the process and decide on the next steps.
6. Deployment: In this phase, the aim is to bring together the relevant knowledge and represent the model in a way that the end-user can explore. Deployment could be a generation of a report describing acquired knowledge, application development and more. This phase is considered as an optional step in data science projects.

3.2.1 Understanding the business

Here we are talking about bank sector which revolve around achieving financial growth, maintaining stability, and providing excellent customer service. Here we focus on customer service.As BNA bank provides a variety of services and products, the client may get confused then the solution is to create a smart chatbot to simulate a human conversation and to assist the client with their needs

3.2.2 Understanding data

Here the data we need should be about the services and products.

3.2.3 Data Preparation

We cannot go directly from text to adjusting a machine learning or deep learning model.

Tokenization and removing punctuations

The first step in NLP is to identify tokens, or those basic units which need not be decomposed in a subsequent processing. The entity word is one kind of token for NLP, the most basic one[10].

Looking at the intents file, we see that each tag contains a list of patterns and responses.

```
{
  "intents": [
      {
          "tag": "salutation",
          "patterns": ["Bonjour", "Salut", "Hello", "Hi"],
          "responses": ["Bonjour, comment puis-je vous aider ?", "Salut, que puis-je faire pour vous ?", "Hello, comment puis-je vous aider
?", "Hi, que puis-je faire pour vous ?"]
        },
        {
          "tag": "au revoir",
          "patterns": ["Au revoir", "À bientôt", "Bye", "Ciao"],
          "responses": ["Au revoir, à la prochaine fois !", "À bientôt, passez une bonne journée !", "Bye, à la prochaine fois !", "Ciao, à
bientôt !"]
        },

        {
          "tag": "service",
          "patterns": [ "quelles sont votre services?"],
          "responses": [" Notre produits et services sont variés, ils dépendent de votre besoins "]
        },
```


We tokenize each pattern and add the words to a list and we remove duplicated words.


```
['Salut', '?', 'Y', "d'encaissement", 'utiliser', '!', 'siége', 'services', 'Au', 'envoyer', 'revoir', 'Quels', 'suis', 'À', 'p
ar', 'des', 'forts', 'BNA', 'Merci', 'Où', 'Pourquoi', 'est', "l'envoi", 'situé', 'de', 'points', 'mBanking', 'client', 'beauco
up', 'service', 'options', 'Hello', "C'est", 'le', 'mandat', "c'est", 'ebanking', 'sont', 'sécurisé', 'que', 'Cash', 'pour', 'q
uelles', 'Bonjour', "qu'est", 'a-t-il', 'clients', 'un', 'Comment', 'la', 'quoi', 'vous', 'Mandat', 'encaisser', 'Bye', 'avanta
ges', 'prises', 'reconnaissant', 'les', 'eBanking', 'sécurité', 'Est-ce', 'aide', "d'envoi", 'Je', 'du', 'Quelles', 'mesures',
'limites', 'avec', 'être', "Qu'est-ce", 'bientôt', 'mandats', 'Ciao', 'Hi', 'votre', 'Dois-je']
```


Lemmatization, removing punctuations and stopwords

It consists in converting the words into the form of lemma to reduce all the canonical words. For example, the words play, play, play, play, etc. will all be replaced by play.

We remove the punctuation (’!’, ’?’, ’,’, ’.’), As well as we remove the French stop words.


```
['a-t-il', 'aide', 'avantages', 'beaucoup', 'bientôt', 'bna', 'bonjour', 'bye', "c'est", 'cash', 'ciao', 'client', 'comment', "
d'encaissement", "d'envoi", 'dois-je', 'ebanking', 'encaisser', 'envoyer', 'est-ce', 'fort', 'hello', 'hi', "l'envoi", 'limites
', 'mandat', 'mandats', 'mbanking', 'merci', 'mesures', 'option', 'où', 'point', 'pourquoi', 'prises', "qu'est", "qu'est-ce", '
quelles', 'quels', 'quoi', 'reconnaissant', 'revoir', 'salut', 'service', 'situé', 'siége', 'sécurisé', 'sécurité', 'utiliser',
'être']
```


One hot encoder

One-hot encoding is a popular technique used in data preprocessing and feature engineering, particularly in machine learning and data analysis. It is used to convert categorical variables or features into a binary representation that can be used by machine learning or deeplearning algorithms.

Here’s how one-hot encoding works:

Categorical Variables: One-hot encoding is typically applied to categorical variables that have discrete values or levels. These variables can be nominal (no particular order) or ordinal (with a specific order).

Creating Binary Features: For each unique value in the categorical variable, a new binary

feature (also called a ”dummy variable”) is created. The number of binary features created is equal to the number of unique values in the original variable.

Binary Representation: The binary features are set to 1 if the corresponding categorical value matches the category in that column, and 0 otherwise. Each observation or data point will have a 1 in the column corresponding to its category and 0s in all other columns.

Data Splitting

Data splitting is a crucial step in machine learning and data analysis, where a dataset is divided into separate subsets for training, validation, and testing. The purpose of data splitting is to assess and evaluate the performance of machine learning models on unseen data and to prevent overfitting.

Training Set: The training set is used to train the machine learning model. It contains a significant portion of the dataset, typically around 80. The model learns patterns and relationships from this data to make predictions or classify new instances.

Testing Set: The testing set is a separate subset of the dataset that is used to evaluate the final performance of the trained model. It is used to simulate real-world scenarios and assess how well the model generalizes to new, unseen data. The testing set should not be used during the model development or parameter tuning process.

3.2.4 Modelling

For the modelling we test two types of models FNN and LSTM

- **FNN (Feedforward Neural Network):** FNN is the most basic type of neural network where information flows in only one direction, from the input layer to the output layer.
  It consists of an input layer, one or more hidden layers, and an output layer.
  Each neuron in a layer is connected to all neurons in the next layer, and there are no feedback connections.
  FNNs are primarily used for tasks such as classification and regression, where the input and output are independent of each other.
- **LSTM (Long Short-Term Memory):** LSTM is a type of recurrent neural network (RNN) architecture specifically designed to handle long-term dependencies in sequential data.
  RNNs, including LSTMs, have a feedback connection, allowing information to be passed from one step to the next within the network.
  LSTMs have memory cells that can store and retrieve information over long sequences.

- **RNN (Recurrent Neural Network:)** RNN is a type of neural network architecture designed to handle sequential or time-dependent data.
  RNNs have a hidden state that is updated at each time step and serves as a memory

of past information.

3.2.5 Evaluation

We will now explore the evaluation measures used to evaluate our models

- **Accuracy:** Accuracy is a metric that measures the overall correctness of the predictions made by the model.
  The higher the accuracy, the better the model's ability to make correct predictions.
- **Test loss:** Test loss quantifies the mistake or difference between the model's anticipated results and the test dataset's actual ground truth values.
  It quantifies how well the model is able to make predictions by comparing the predicted values to the true values in the test data.
  The lower the test loss, the better the model's ability to minimize the error and make accurate predictions.

Experimental results

We have experienced two different deep learning models: FNN and LSTM
The metrics used to evaluate the models are accuracy and test loss.

But, Here we compare the FNN and LSTM results.

- **FNN:**
  the evaluation results of the score:

```
[3.624314922490157e-05, 1.0]
Test loss: 3.624314922490157e-05
Test accuracy: 1.0
```

- **LSTM:**
  the evaluation results of the score:

```
Test loss: 1.0818877220153809
Test accuracy: 0.6666666865348816
```

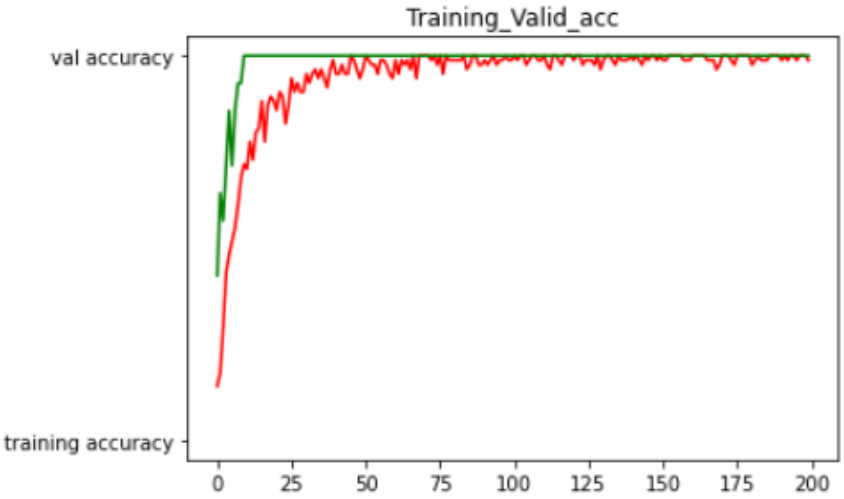

Figure 3.2: The FNN accuracy curve over 200 epochs

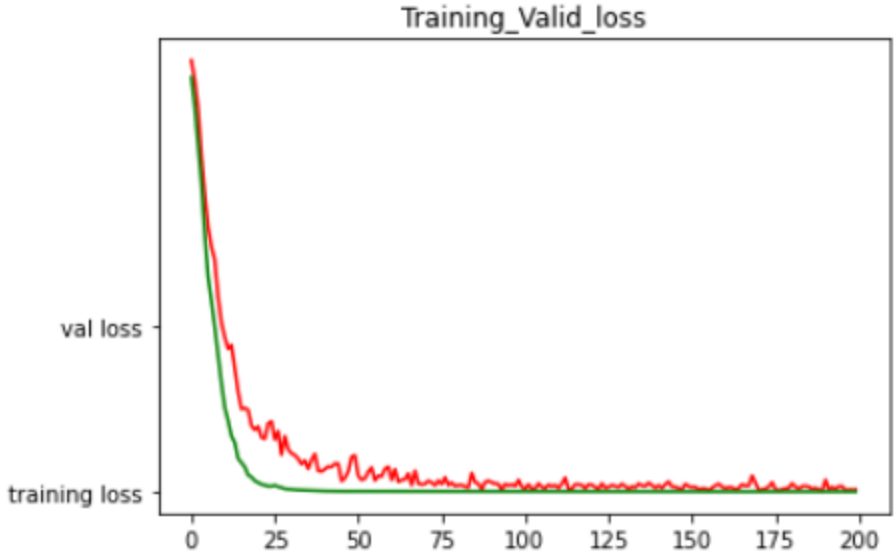

Figure 3.3: The FNN loss curve over 200 epochs

Figure 3.4: The LSTM accuracy curve over 200 epochs

Figure 3.5: The LSTM loss curve over 200 epochs

Results and discussion

The FNN model demonstrated exceptional performance, achieving an accuracy of 1.0. Figures 3.2 and 3.3 clearly illustrate the steady and consistent increase in accuracy, accompanied by a gradual decrease in loss. This pattern indicates that the FNN model is effective in capturing the underlying patterns in the data, resulting in accurate predictions.

On the other hand, the LSTM model achieved an accuracy of 0.66, as shown in Figures 3.5 and 3.5. Comparing the observations between LSTM and FNN, it is evident that the FNN model outperforms LSTM in terms of both accuracy and test loss. The LSTM model exhibits more fluctuations and variations in accuracy and loss, indicating a less stable performance compared to FNN.

However, it is important to note that the fluctuations in accuracy and loss of the LSTM model are expected in certain scenarios, especially when dealing with complex sequential data. These fluctuations may be attributed to the inherent nature of the LSTM architecture, which allows it to capture long-term dependencies but can be more sensitive to variations in the input data.

Considering our evaluation criteria, where the lowest test loss value and the highest accuracy value are desirable, the FNN model emerges as the superior choice for our specific task. It is worth mentioning that the choice between FNN and LSTM depends on the specific characteristics of the dataset and the objectives of the application. Despite the better performance of the FNN model in this study, LSTM may still offer advantages in scenarios where capturing long-term dependencies is crucial. In conclusion, the evaluation of our deep learning models revealed that the FNN model outperforms the LSTM model in terms of accuracy and loss.

3.2.6 Deployment

we present some screenshots of our website realized with flask as the back-end and for the front-end we used HTML, CSS, and javascript .

Figure 3.6 represents the front-end of the website.
Figure 3.7 represents the interface of the chatbot.
Figure 3.8 represents an example of a discussion between a client and a chatbot, where we write incorrectly the input ”Bonjours” and ”quels sont votre services”, it was on purpose to show that our chatbot understand the input even the spelling is not correct.

Figure 3.6: Interface of the website

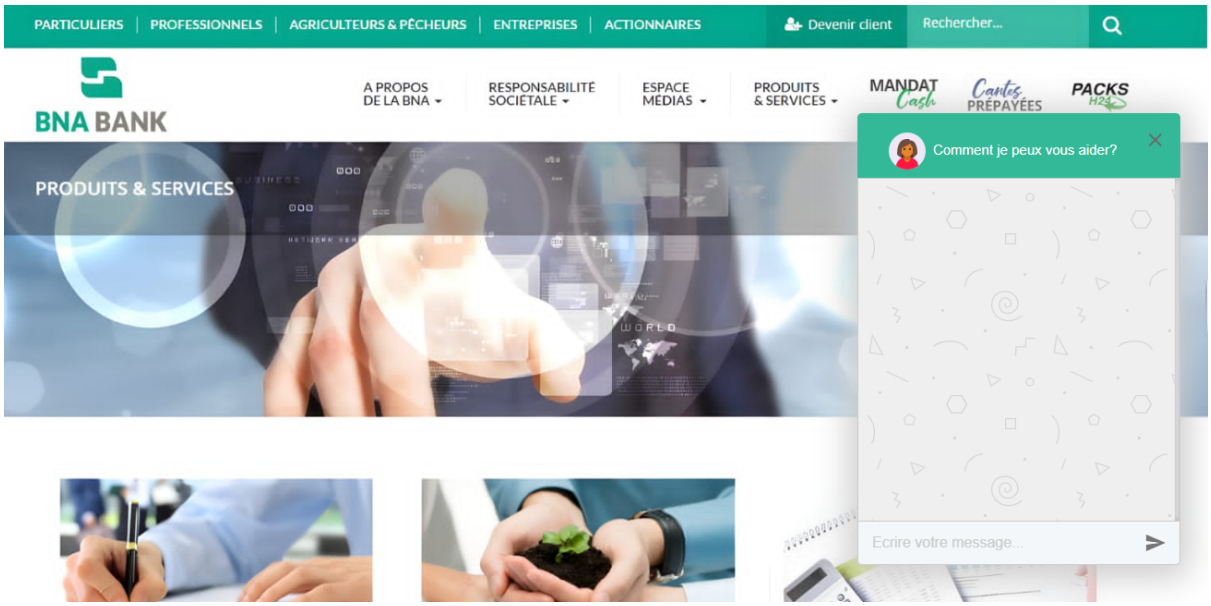

Figure 3.7: Interface of the chatbot

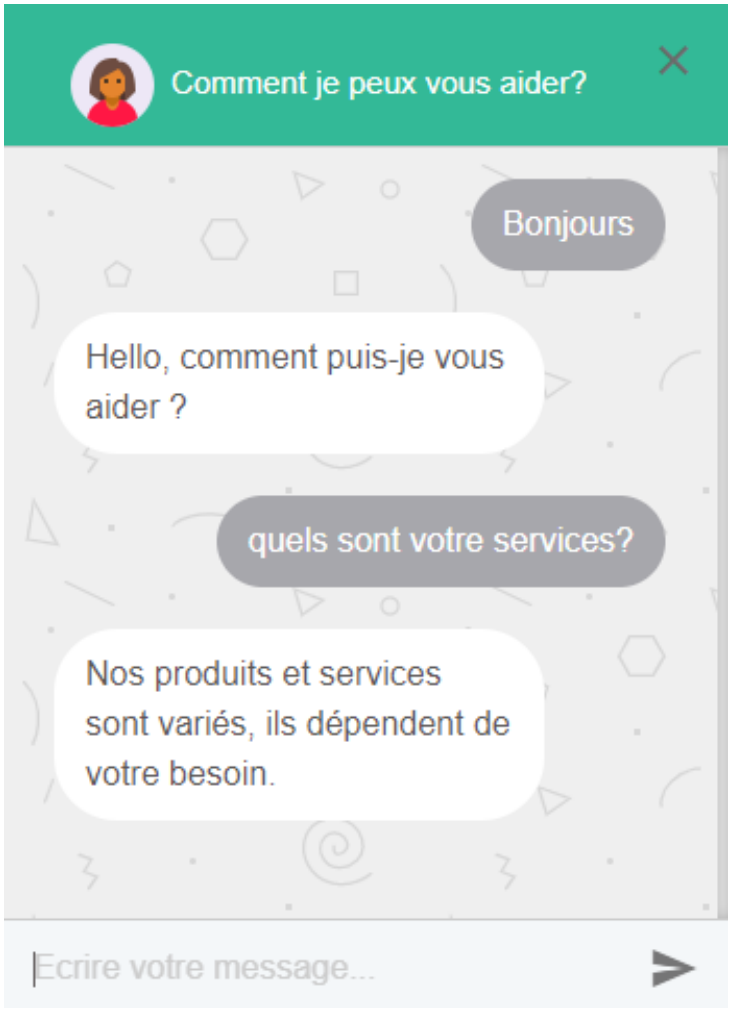

Figure 3.8: Example of a discussion

3.3 Conclusion

In this chapter we presented the working environment then we mention the methodology used and we explained it with examples according to the realized work finally we presented the final result of the realization of a chatbot.

General conclusion

Chatbots are typically developed and tailored to specific domains, which means they may produce inaccurate results when exposed to unknown conditions or faced with ambiguities arising from unusual user requests. These requests are typically defined and structured as intentions within the chatbot.

To ensure the effectiveness of chatbots, companies must rigorously test and refine them before deploying them for customer use. In this context, our graduation project was undertaken at BNA bank with the objective of creating an intelligent chatbot.

This report provides a summary of the various phases we went through during the project. It concludes with a description of the creation phase, including technology selection, methodologies employed, and illustrations of the completed work, which are detailed in the final chapter. During the project, we experimented with two different deep learning models: FNN and LSTM. The models were evaluated using accuracy and loss metrics. The results showed that the FNN model achieved a better accuracy reaching an optimal value, while the test loss gradually decreases.

Despite encountering difficulties and challenges throughout the project, we successfully completed all priority tasks. These obstacles, including technical issues and time constraints, taught us valuable lessons in time management, working methodologies, and adhering to specifications. The experience helped us enhance our programming skills.

In conclusion, we have successfully achieved the objectives outlined in this project, and the results indicate that the FNN model is the most performant. Looking ahead, future improvements can include incorporating new scenarios to enhance user assistance and implementing additional features such as image and voice recognition.

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