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DESIGN OF INTELLIGENT CHATBOT FOR STRESS MANAGEMENT

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المستخلص

مع تسارع الحياة، ترتفع مستويات القلق والتوتر، وتصبح أسوأ في البلدان المتضررة من الحرب. ومن هنا تصبح الحاجة إلى الحصول على المساعدة من مركز رسمي للصحة النفسية ضرورة، ولكن بسبب نقص الموارد المالية والخوف من وصمة العار الاجتماعية، يمتنع معظم الناس عن طلب المساعدة.

تهدف هذه الرسالة إلى تطبيق أحدث التقنيات في مجال معالجة اللغة الطبيعية المتمثلة في روبوتات المحادثة، وإلى تحديد معوقات استخدام التكنولوجيا في معالجة هذا النوع من المشاكل الدقيقة؛ إدارة الضغط النفسي، وماهي التحسينات الممكنة لتحقيق نتيجة أفضل في هذا الصدد، وفي النهاية تهدف الدراسة أيضاً لتمهيد الطريق للبحاث المستقبليين المهتمين بنفس الموضوع.

تم تصميم روبوت المحادثة الذكي بلغة الجافا، بهدف التخفيف من توتر مستخدم الروبوت، وذلك بإبداء التعاطف مع المستخدم باستخدام خوارزميتين لتلخيص وتحليل مشاعر المستخدم (TextRank) و (Stanford_CoreNLP)، وقد تم اختيار كل خوارزمية بناء على دقتها في الاستنتاج وبناء على حجم بيانات التدريب لكل خوارزمية والوقت المطلوب لتجهيز هذه الخوارزمية للعمل، وعلي الرغم من صعوبة وتعقيد عملية ربط الخوارزميات ببعض وبالتطبيق، إلا أنه تم حل الإشكالية بتوظيف مكون إضافي يعمل على ربط وتكامل الخوارزميات المكتوبة بلغة الجافا بالخوارزميات المكتوبة بلغة البايثون.

تم توزيع التطبيق على مجموعة اختبار تتكون من عدد خمسة عشر مستخدم مختارين بناء على معايير محددة، وأظهرت ردود فعل المستخدمين قيد الاختبار الشعور العام بالرضا. تم إجراء العديد من التعديلات بناءً على تعليقات واقتراحات المستخدمين. حظيت خدمة كتابة اليوميات باهتمام ورضا جميع المستخدمين، حيث عبر كل مستخدم مشارك عن سعادته باستخدامها. كما عبر المستخدمون أيضا عن بعض أوجه القصور المتوقعة، مثل الافتقار إلى دعم اللغة العربية وميزة المحادثة الصوتية.

ABSTRACT

As life speeds up, anxiety and stress levels rise, and it becomes worse in war-affected countries. Hence the need to obtain help from a formal mental health center becomes a necessity, but due to lack of financial resources and fear of social stigma, most people refrain from asking for help.

This dissertation aims at applying the state of art in NLP applications exemplified in chatbots, furthermore, identifying limitations of utilizing technology in such delicate problem, i.e., stress management, the possible improvements for a better result, and eventually to pave the way for future interested researchers.

An intelligent Java-based chatbot was designed with the aim of relieving user stress level by expressing sympathy to the user using two algorithms to summarize and analyze user feelings (TextRank) and (Stanford_CoreNLP). Each algorithm was chosen based on its conclusion accuracy, volume of training data, and the time required to deploy this algorithm. Despite the difficulty and complexity of integrating different languages algorithms such as the case in this thesis work; the Stanford_CoreNLP is java-based while the TextRank is python-based, the problem was solved by utilizing a plugin that connects and integrates different languages algorithms. The chatbot was distributed to a test group consisting of fifteen people selected based on specific criteria, and the feedback from the test group showed a general feeling of satisfaction. Several modifications have been made based on user feedback and suggestions. The journaling feature was a winner feature, with each participating user expressing their happiness to use it. Users also expressed some expected shortcomings, such as the lack of Arabic language support and voice chat feature.

Keywords - ChatBot, Artificial Intelligence, Machine Learning, Sentiment Analysis, Web-Scraping, Text Summarization, Java, NLP, Python, Android Studio, Stress.

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DEDICATION

This work is completely dedicated to my beloved and great husband, Adol, and my beautiful little angels; Lito, Ramromi and Assora, without your existence in my life this thesis would not be possible. You push me to be a better human being in every possible way. I love you all to the moon and back.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviation	Definition
AI	Artificial Intelligence
NLP	Natural Language Processing
ML	Machine Learning
HER	Health Record
SMI	Severe Mental Illness
CBT	Cognitive Behavioral Therapy
IDE	Integrated Development Environment
SA	Sentiment Analysis
CNN	Convolutional Neural Network
LR	Logistic Regression
RF	Random Forest

CHAPTER 1: INTRODUCTION

1.1. Introduction

This chapter describes the importance of the conducted research. It starts with an overview of types and origins of psychotherapy, a quick overview of Artificial Intelligence (AI) and the use of Natural Language Processing (NLP) in mental healthcare. It also defines chatbots, their types and applications across industry, especially in mental healthcare area. Finally, it provides statement of problem, research questions, related work, objective, and outline of the study.

1.2. Psychotherapy

Psychotherapy is also known as talk therapy. It can be any method used to help people living with emotional, psychological, or behavioral challenges. The prefix "psycho" comes from the Greek language and means "soul" or "mind" and it's part of many words related to mental health, including psychotherapy. People might seek psychotherapy for many reasons, including relationship conflict, professional challenges, personal doubts and fears, changes in behavior or mood, difficulty coping with stress, traumatic experiences, childhood events and mental health disorders.

1.2.1. Types of Psychotherapy

Psychotherapy is a varied discipline, and people often need to try multiple modalities before finding what works best for them. Psychotherapy can take many different forms, including cognitive behavior therapy, interpersonal therapy, dialectical behavior therapy, psychodynamic therapy, psychoanalysis, supportive therapy, animal assisted therapy, creative arts therapy and play therapy (for children).

1.2.2. Origins Of Psychotherapy

Theoretically based psychotherapy was first developed in the Middle East during the 9th century by the physician and psychological thinker, Al-Razi, who was at one time the chief

physician of the Baghdad hospital. Next came the philosopher, physician, and psychiatrist Ibn-Sina, who proposed that humans have seven inner senses to complement the outer senses (I and N 1997). His proposal was one of the first attempts in the history of psychology to try to understand the way that the mind and reasoning operate (Pajević, et al. 2021) (Ghaffari, et al. 2017). Their and other's work on studying the mind and proposing treatments for mental conditions underpins many of our modern techniques. However, at the same time in the West, serious mental disorders were generally treated as demonic or medical conditions requiring punishment and confinement. It wasn't until the end of the 19th century, around the time when Sigmund Freud was first developing his "talking cure" in Vienna, that the first scientifically clinical application of psychology began at the University of Pennsylvania, to help children with learning disabilities. Yet the practice of psychotherapy began after the Second World War (1945) with the practice of psychoanalysis, the "talking cure" developed by Sigmund Freud. In the 1950s, Carl Rogers continued the work of Freud's successors and created the person-centered therapy approach. By the 1960s, Aaron T. Beck had further expanded psychotherapy modalities by developing cognitive therapy, which led to what known today as cognitive behavioral therapy (Narynov, et al. 2021).

Since the 1970s, major perspectives have been developed and adopted within the field. The two biggest have been Systems Therapy—which focuses on family and group dynamics—and Transpersonal psychology, which focuses on the spiritual side of human experience. Psychotherapy today is ever evolving, much like it was centuries ago. Today, mental health professionals have access to volumes of empirical data and research backed by practice laws and diagnostic standards that were unavailable to scientists and therapists in the past (Valverde 2022).

In addition to gaining knowledge and evidence through time, modern psychotherapy can now reach more people through online formats. Anyone now can find information on mental health diagnoses, seek support groups, search for psychotherapists and mental health support and participate in virtual psychotherapy sessions.

Virtual psychotherapy sessions form the basis for this research, as this thesis discusses the effectiveness of such virtual method in relieving stress.

1.3. Artificial Intelligence

At its simplest form, AI is a field, which combines computer science and robust datasets, to enable problem-solving. It also encompasses sub-fields of Machine Learning (ML) and deep learning, which are frequently mentioned in conjunction with artificial intelligence. These disciplines are comprised of AI algorithms which seek to create expert systems which make predictions or classifications based on input data (IBM Cloud Education 2020). While several major sectors of society are ready to embrace the potential of AI, caution remains common in medicine, including psychiatry, as the stakes are much greater than those of the AI that facilitates modern-day conveniences.

1.3.1. Artificial Intelligence in Healthcare

AI is being used to facilitate early disease detection, understand disease progression, optimize treatment dosages, and uncover new treatments. Areas of medicine leverages pattern recognition include ophthalmology, cancer detection, and radiology, where AI algorithms can perform better than experienced clinicians in evaluating images for abnormalities. While it is unlikely that intelligent machines would ever completely replace clinicians, intelligent systems are increasingly being used to support clinical decision-making. While human learning is limited by capacity to learn, access to knowledge sources, and lived experience, AI-powered machines can rapidly synthesize information from an unlimited amount of medical information sources (Graham, et al. 2019).

1.3.2. Artificial Intelligence in Mental Healthcare

Mental health practitioners are more hands-on and patient-centered in their clinical practice than most non-psychiatric practitioners, relying more on “softer” skills, including forming relationships with patients, and directly observing patient behaviors and emotions. And because of this specific and delicate method of work, the adopt to AI has been slower in

comparison with other medical fields. However, AI has great potential to optimize the mental health care performance, as AI could re-define diagnosis and understanding of mental illnesses. Also leveraging AI techniques offers the ability to develop better pre-diagnosis screening tools and formulate risk models to determine an individual's vulnerability for, or risk of developing, mental illness (Graham, et al. 2019).

1.4. Natural Language Processing

NLP refers to the branch of AI concerned with giving computers the ability to understand text and spoken words in the same way human beings can (IBM Cloud Education 2020).

1.4.1. Natural Language Processing in Mental Healthcare

Mental health practice will rely heavily on NLP, prior to being able to perform other AI techniques, due to considerable raw input data in the form of text (e.g., clinical notes) and conversation (e.g., counseling sessions). The ability of an algorithm to automatically understand meanings of underlying words, despite the generativity of human language, is a huge advancement in technology and essential for mental healthcare applications (Graham, et al. 2019). NLP has proved the ability to identify & classify suicide ideation & attempts in Electronic Health Record (HER) data with an accuracy (92%, 83%) for suicide ideation and a suicide attempts respectively (Fernandes, et al. 2018). Utilizing English text discharge summaries for patients with severe mental illness (SMI), NLP has succeeded in extracting about 90% of these symptoms in 87% patients with SMI & 60% patients with non-SMI diagnosis (Jackson RG, et al. 2017).

(Cook BL, et al. 2016) used two predictors; survey (sleep, depressive symptoms, medications) and text response to "how are you feeling today?". And the NLP-based models have shown a high predictive value for suicide ideation and may require less time & effort from subjects. (Aldarwish and Ahmad 2017) in their NLP-based experiment had achieved an accuracy of 63% of identifying social network users with depression based on their posts.

1.5. ChatBot

Short for chat robot, a chatbot is a computer program that uses AI and NLP to understand users' questions and automate responses to them, simulating human conversation (IBM Cloud Education 2019).

1.5.1. Types of Chatbots

Chatbot has three types based on structure and capacity:

- **Simple chatbots**

Simple chatbots have limited capabilities and are usually called rule-based bots. The chatbot poses questions based on predetermined options and the users can choose from the options until they get answers to their query. The chatbot will not make any inferences from its previous interactions. Example: Ordering Pizza.

- **Smart chatbots**

AI-enabled smart chatbots are designed to simulate near-human interactions with users. They can have free-flowing conversations and understand intent, language, and sentiment. These chatbots require programming to help them understand the context of interactions. They are much harder to implement and execute and need a lot of data to learn. Example: Virtual Assistants

- **Hybrid chatbots**

They are a combination of simple and smart chatbots. This combination makes them a balanced tool for businesses to interact with users. Example: Medical Diagnosis

1.5.2. Chatbot Applications Across Industries

Over the past few years, chatbots have been utilized in a variety of industries include but not limited to e-commerce, human resource, travel, banking, hospitality, healthcare, and real estate, just to mention a few. For customers, chatbots mean faster replies, better customer service, easier sales flow, and a more personal connection with the companies

they purchase from. For industries using chatbots, aids in lowering support costs, increasing conversion rates, boosting customer loyalty, accelerating sales cycles, and generating more leads.

1.5.3. Chatbot Applications in Mental Healthcare

There has been a recent drive toward creating digital interventions that can either supplement or replace face-to-face mental health services. As access to mental health services remains an issue worldwide, with the mental health workforce insufficient to meet the growing demand for mental health services, automated procedures hold great promise for both mental healthcare providers and for those in need of this services and provide them the ability to benefit from the service whenever and wherever they choose. (Kyo-Joong Oh, et al. 2017)

One of the better-known mental health chatbots is **Woebot**, which is a chatbot therapist. The chatbot allows patients to express their thoughts when they engage in therapeutic conversations. Initially built for young adults and graduate school students, Woebot utilizes CBT. The results of a randomized controlled trial among students found that Woebot significantly reduced symptoms of depression within two weeks (Fitzpatrick, Darcy and Vierhile 2017).

Wysa is another emotionally intelligent chatbot. Wysa helps manage thoughts and emotions via a combination of tools and techniques like evidence-based CBT and guided meditation. (Beatty, et al. 2022)

Babylon is a mental health chatbot that allows users to describe their symptoms to a text-based chatbot, consult with a provider via video, and store medical information and notes. (Azevedo, Legay and Kieffer 2022)

Although critics of these technology-based platforms continue to raise concerns over something they lack; a human connection between the provider and patient, yet the technology could be truly helpful at an emotional level, if it’s designed and delivered in a

human-centered way, and as the world marches toward more tech-based medicine, one can expect the creation of more robust and effective AI-based chatbots and treatment platforms. (Narynov, et al. 2021)

1.6. Problem Statement

As people around the world face everyday events that cause them stress, the need for an accessible and reliable way to deal with this stress is sorely needed. Almost everyone has a smart phone in his hands, the ChatBot presents the best choice for applying AI techniques in handling the stress problem. A hybrid (Rule-based and ML-based) chatbot is going to be built using multiple ML techniques with the intention of determining the stress factors and stress levels among users and offer recommendations on how to ease these factors, consequently, ease the stress level.

1.7. Research Question

Could chatbots help support a person's mental health?

1.8. Related Work

People often avoid disclosing to others out of a fear of negative evaluation. Because chatbots do not think or form judgments on their own, people may feel more comfortable disclosing to a chatbot compared to a person, changing the nature of disclosure and its outcomes (Lucas, et al. 2014). (Ho, Hancock and Miner 2018) found that interactions with chatbots were as effective as human interactions in offering emotional, relational, and psychological benefits and that they focused on the impact of personal disclosure. Participants in the experiment conducted by (Cameron, et al. 2018) had found the tested chatbot to be enjoyable and easy to use because it had a consistent personality throughout the conversation. (Vaidyam, et al. 2019) in their review concluded that preliminary evidence for psychiatric use of chatbots is favorable. However, given the heterogeneity of the reviewed studies, further research with standardized outcomes reporting is required to examine the effectiveness of conversational agents more thoroughly. Regardless, early evidence shows that with the proper approach and research, the mental health field could

use conversational agents in psychiatric treatment. (Abd-Alrazaq A, et al. 2021) in their study had demonstrated overall positive perceptions and opinions of patients about chatbots for mental health. Yet, it also stated that linguistic capabilities of the chatbots needed more improvement; they need to be able to deal adequately with unexpected user input, provide high-quality responses, and show high variability in responses. (Ly, Ly and Andersson 2017) in a pilot study to assess the effectiveness and adherence of a smartphone app to promote mental health, has concluded that the chatbot can improve well-being and reduce stress and at the same time can be highly engaging, where the participants showed high engagement during the two weeks long intervention, with an average open app ratio of 17.71 times for the whole period. This engagement is higher compared to other studies on fully automated interventions claiming to be highly engaging, such as Woebot and the Panoply app. (TW, et al. 2010) in their study aimed to evaluate how hospitalized medical patients would respond to a chatbot that has been developed to provide information in an empathic fashion about a patient's hospital discharge plan, concluded that empathic agents represent a promising technology for the patients, where most of them preferred receiving their discharge information from the agent compared to their doctors or nurses in the hospital. Conversational Agents may play an important role in bringing about changes in attitude and behavior because they potentially allow tailored but anonymous, free, and convenient access and can deliver the information in a conversational way that overcomes health literacy barriers (Sebastian and Richards 2017).

The proposed chatbot in this research work was built with serious focus on the previous related work results. The chatbot kept a fun and sympathetic personality through the whole conversation with the user, also the chatbot was programmed to randomly select a response from a set of statements different in syntax and equal in meaning as a response to the unexpected user input, hence it gave user the impression that the chatbot is smart and understands what the user is saying not just repeating the same sentence to all unexpected user inputs. The chatbot is free, and it works with or without internet connection, though it

would give better results when online, but being able to use it 24/7 makes it an ideal option for those who may need to use it to help them deal with their dilemma.

1.9. Research Aim

To assess the effectiveness of utilizing AI techniques and methods, i.e., NLP, Sentiment Analysis (SA), text summarization and supervised ML to reduce stress among users through designing a conversational user interface.

1.10. Thesis Outline

This dissertation is split into six chapters:

Chapter One: Details the background of this master's research, the problem and its sources, research question, and the aim of the research.

Chapter Two: presents a brief explanation of related concepts.

Chapter Three: Illustrates tools, materials used in developing the chatbot. it also explains the selection process and specification of the implemented techniques.

Chapter Four: Discusses the chatbot design and its development.

Chapter Five: Discusses and evaluates the collected user feedback on the chatbot, indicates how the chatbot implementation had answered the research questions.

Chapter Six: Concludes the research, states the results of the study, and provides recommendations for further research.

CHAPTER 2: LITERATURE REVIEW

2.1. INTRODUCTION

This chapter explains the most common AI techniques applied in psychotherapy and mental healthcare with focus on sentiment analysis, text summarization and data scraping.

2.2. Machine Learning

ML is a branch of AI and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy (IBM Cloud Education 2020).

2.2.1. Applications of Machine Learning in Day-to-Day Life

ML has been applied in many aspects of people's lives. For instance, in smartphones ML is the main core of voice assistants and face unlock. In transportation ML applications include dynamic pricing in travel, transportation, and commuting, google maps, and self-driving cars. As for web services, ML has been playing a key role in email filtering, Google search, Google Translate, LinkedIn and Facebook recommendations.

2.2.2. Machine Learning Types

ML problems can be divided into three broad classes:

- **Supervised Learning**

Supervised learning, also known as supervised ML, is a subcategory of ML and artificial intelligence. It is defined by its use of labeled datasets to train algorithms to classify data or predict outcomes accurately (IBM Cloud Education 2020). The training process continues until the model achieves a desired level of accuracy on the training data. Supervised ML can be divided into two kinds of problems:

- **Classification Problems**: Concerns with labelling the class of data. For example – finding out if a person is at risk of developing heart disease or not, is a classification problem. The outcome can be one of two classes – Yes or No.
- **Regression Problem**: Concerns with answering the 'how much' questions. For example – finding out the probability of a person developing a heart disease, is a regression problem. The outcome will be a number indicating the probability.

- **Unsupervised Learning**

Unsupervised learning uses ML algorithms to analyze and cluster unlabeled datasets. These algorithms discover hidden patterns without the need for human intervention. Its ability to discover similarities and differences in information make it the ideal solution for exploratory data analysis (IBM Cloud Education 2020). Email spam-detecting technology is an example of unsupervised learning.

- **Reinforcement Learning**

Reinforcement learning is a behavioral learning model. The algorithm receives feedback from the analysis of the data, so the user is guided to the best outcome. Reinforcement learning differs from other types of supervised learning because the system is not trained with the sample data set. Rather, the system learns through trial and error. Therefore, a sequence of successful decisions will result in the process being "reinforced" because it best solves the problem at hand (Hurwitz and Kirsch 2018). Reinforcement learning applications include robotics, game playing, self-driving cars, and many others.

2.2.3. Machine Learning Algorithms

ML algorithms are different from other algorithms. With most algorithms, a programmer starts by inputting the algorithm. However, with ML the process is flipped. With ML, the data itself creates the model. The more data that is added to the algorithm, the more sophisticated the algorithm becomes. As the ML algorithm is exposed to more data, it can create increasingly accurate algorithm (Hurwitz and Kirsch 2018).

Various algorithms and computation techniques are used in ML processes. The most used supervised learning algorithms include linear regression, Logistic Regression (LR), k-nearest neighbors, decision trees, Random Forest (RF), gradient boosting machines, Xgboost, support vector machines and neural networks. As for the unsupervised learning, the most popular algorithms are k means clustering, hierarchical clustering, and neural network.

2.2.4. Machine Learning Software Tools

There are different tools and languages being used in ML. The exact choice of the tool depends on the need and scale of operations. The most used tools in ML include R, Python, SAS, Java, JavaScript, Scala, SQL, and Hadoop.

2.3. Sentiment Analysis

SA (or opinion mining) is an NLP technique used to determine whether data is positive, negative, or neutral. SA is often used in monitoring brand and product text feedback from customers.

2.3.1. Types of Sentiment Analysis

SA focuses on the polarity of a text, but it also goes beyond polarity to detect specific feelings and emotions, urgency and even intentions. SA uses two methods; the one is rule-based and the other is ML-based. The rule-based analysis is more rigid and might not always be accurate. On the other hand, the ML-based analysis is more detailed and in-depth. Next are some of the most popular types of sentiment analysis:

- **Graded SA**

When polarity precision is important, polarity categories can be expanded to include different levels of positive and negative; very positive, positive, neutral, negative, and very negative.

- **Aspect-based**

Aspect-based SA (ABSA) aims to analyze and understand people's opinions at the aspect level (Wenxuan Zhang 2022). For example, the bike's color, the cloth's texture.

- **Intent Analysis**

This is a deeper understanding of the intention of the customer. For example, a company can predict if a customer intends to use the product or not. This means that the intention of a particular customer can be tracked, forming a pattern, and then used for marketing and advertising (Say Hong Lye 2021).

- **Emotion Detection**

Emotion detection allows going beyond polarity to detect emotions, like happiness, frustration, anger, and sadness. Emotion detection systems use either lexicons (i.e., lists of words and the emotions they convey), or use other advanced methods that include ML (Kaur and R. Saini 2014). Examples of ML-based emotion detection systems: Stanford CoreNLP - NLTK - openNLP – spaCy.

- **Stanford CoreNLP**

It is a deep learning model that can identify the sentiment of a sentence rather than treating the words in the sentence separately (Manning 2014).

- **Stanford CoreNLP Mechanism of Action**

  The Stanford model uses a specific logical sequence as follows:

  1. User passes the whole text to the model.
  2. The model splits the text into sentences and tokens.
  3. The sentiment is assigned to each sentence, not the whole text.
  4. The mean sentiment value is used to estimate the sentiment of the whole text.
  5. The average sentiment of a sentence is between Neutral (2) and Negative (1), the range is from Very Negative (0) to Very Positive (4) which appear to be quite rare (Manning 2014).

Example on using CoreNLP model:

Text = 'I love you. I hate him. You are nice. He is dumb'

Model's feedback is illustrated in Table 2.1

Table 2.1 - Corenlp Model Scores of a Sentence

Sentence	Score	Sentiment
I love you	3	Positive
I hate him	1	Negative
You are nice	3	Positive
He is dumb	1	Negative

2.3.2. Sentiment Analysis Challenges

SA is the practice of applying NLP and Text Analysis techniques to identify and extract subjective information from text. Some of main challenges of machine-based SA include subjectivity & tone, context & polarity, irony & sarcasm, comparisons, emojis, and defining neutral (El-Din 2016).

2.3.3. Sentiment Analysis Tools

SA tool is a software that analyzes a message and evaluates the tone, intent, and emotion behind each message. This is done by breaking the message into chunks and then assigning a sentiment score to each chunk. This is useful for companies that actively engage with their customers on social media, live chat, and email where it can be difficult to determine the sentiment behind a message (Rani, Gil and Guli 2021)

There are many tools for SA, but in this thesis the is focus on Python and Java tools only, since they are easy to implement, understand, manipulate, and have a large community for support. SA Python tools include Scikit-learn, NLTK, and SpaCy. As for SA Java tools, they include OpenNLP, Stanford CoreNLP, and many other.

2.4. Text Summarization

Text summarization is the technique to identify the most useful and necessary information in a text (Madhuri and Kumar 2019) as shown in Figure 2.1

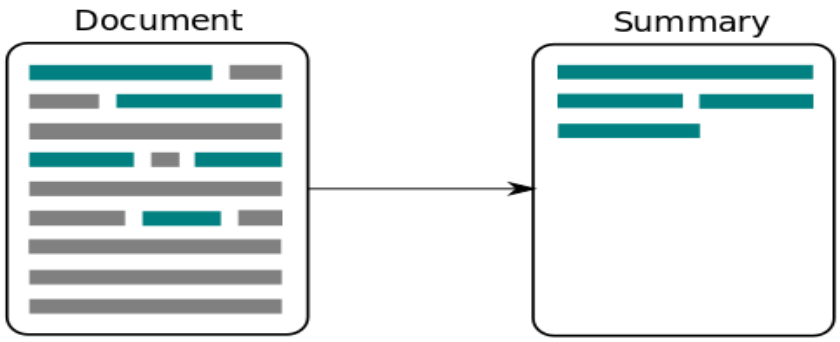

Figure 2.1 Text Summarization Concept

Google uses text summarization techniques to show the summary of the article or the answer for the user's query (Patel, Shah and Hole 2020)

2.4.1. Types of Text Summarization

There are two approaches of text summarization, extractive and abstractive.

2.4.1.1. Extractive Summarization

An extractive text summarization means an important information or sentence are extracted from the given text file or original document (Madhuri and Kumar 2019). Figure 2.2 shows a general example of extractive summarization.

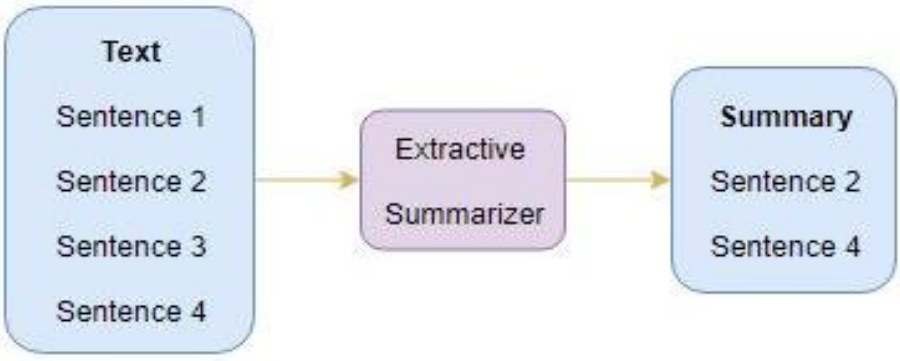

Figure 2.2 Extractive Text Summarization

Ex: Source Text: Peter and Elizabeth took a taxi to attend the night party in the city. While in the party, Elizabeth collapsed and was rushed to the hospital

Summary: Peter and Elizabeth attend party city. Elizabeth rushed hospital.

2.4.1.2. Abstractive Summarization

Where the model forms its own phrases and sentences to offer a more coherent summary, like what a human would generate. This approach is much more difficult than extractive summarization (Patel, Shah and Hole 2020). The Figure 2.3 shows a general example of abstractive summarization.

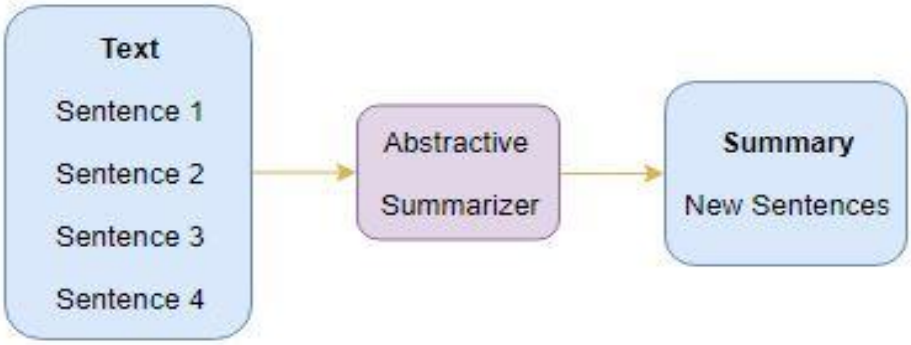

Figure 2.3 Abstractive Text Summarization

Ex: Source Text: Peter and Elizabeth took a taxi to attend the night party in the city. While in the party, Elizabeth collapsed and was rushed to the hospital

Summary: Elizabeth was hospitalized after attending a party with Peter.

2.5. Data Scraping

Is a technique in which a computer program extracts data from output generated from another program (Singrodia, Mitra and Paul 2019).

2.5.1. Types of Data Scraping

There are two types of data scraping; screen scraping and web scraping, which are defined as follows:

2.5.1.1. Screen Scrapping

Screen scraping is the process of collecting screen display data from one application and translating it so that another application can display it (Flores-Ruiz, et al. 2018).

2.5.1.2. Web Scraping

Web scraping is the process of collecting structured web data in an automated fashion. web data extraction is used by people and businesses who want to make use of the vast amount of publicly available web data to make smarter decisions (Mathur and Thomas 2019).

CHAPTER 3: TOOLS & MATERIALS

3.1. Introduction

Illustrates tools (IDEs, databases), materials (programming languages, libraries, plugins) used in developing the chatbot. It also explains the selection and evaluation of the implemented techniques.

3.2. Tools

Different tools have been utilized according to the need and the target of the research, i.e., building an intelligent chatbot.

3.2.1. IDEs

IDE is an abbreviation for integrated development environment. It is a software for building applications that combines common developer tools into a single graphical user interface. Table 3.1 illustrates IDEs' specifications used in developing the chatbot.

Table 3.1 - IDEs Used in Developing the Chatbot

IDE	Version	License	Selection Reason
Android Studio	2021.1.1	Open Source	The official IDE for Google's Android OS
PyCharm	2022.1	Community Edition	To code and test python libraries

3.2.2. Databases

Table 3.2 illustrates databases' specifications used in building the chatbot and the reasons behind selecting these databases.

Table 3.2 - Databases Used in Building the Chatbot

Name	Version	License	Selection Reason
SQLite	3.25.0	Public domain	- Easy to install and use - Resulting database is a light single file that can be sent over any network regardless it's speed
DB browser for SQLite	3.12.0	Public domain	- It's a high quality, visual, open-source tool to create, design, and edit database files compatible with SQLite

3.3. Materials

The term ‘Materials’ refers to the languages, libraries and plugins that have been used in building the proposed chatbot.

3.3.1. Languages

Two languages have been used in building the chatbot, i.e., Java and Python.

- **Java**: is a general-purpose, free, concurrent, strongly typed, class-based object-oriented language. It has a platform independent feature; hence it is used for android development.

- **Python**: Python is an interpreted, object-oriented, open-source, high-level programming language with dynamic semantics. Python's simple, easy to learn syntax emphasizes readability and therefore reduces the cost of program maintenance. And above all that it has a huge developer community than Java does regarding text summarization.

3.3.2. Libraries

A library is a collection of methods, algorithms, documents, or any other components that usually revolve around the same concept. Software developers use libraries to reuse code that have been written previously by other programmers. Table 3.3 illustrates libraries used in building the chatbot.

Table 3.3 - List of Libraries Used in Building the Chatbot

Library	Language	Version
androidx.appcompat:appcompat	Java	1.4.1
stanford-corenlp-4.4.0	Java	4.4.0
stanford-corenlp-4.4.0-models	Java	4.4.0
ejml-core-0.39	Java	0.39
ejml-ddense-0.39	Java	0.39
androidx.lifecycle:lifecycle-livedata-ktx	Java	2.4.1
androidx.lifecycle:lifecycle-viewmodel-ktx	Java	2.4.1
androidx.room:room-common	Java	2.4.2
androidx.navigation:navigation-runtime	Java	2.4.2
androidx.legacy:legacy-support-v4	Java	1.0.0
androidx.annotation:annotation	Java	1.3.0
androidx.lifecycle:lifecycle-extensions	Java	2.2.0
androidx.vectordrawable:vectordrawable	Java	1.1.0

Table 3.3 Continued - List of Libraries Used in Building the Chatbot

androidx.recyclerview:recyclerview	Java	1.2.1
androidx.constraintlayout:constraintlayout	Java	2.1.3
com.google.android.material:material	Java	1.5.0
androidx.navigation:navigation-fragment	Java	2.4.2
androidx.navigation:navigation-ui	Java	2.4.2
pl.droidsonroids.gif:android-gif-drawable	Java	1.2.24
com.mikepenz:materialdrawer	Java	7.0.0
org.jsoup	Java	1.14.3
com.google.code.gson	Java	2.9.0
com.squareup.leakcanary:leakcanary-android	Java	2.8.1
com.android.support.constraint:constraint-layout	Java	2.0.4
ChatterBot	Python	1.0.4
NLTK	Python	3.7
numpy	Python	1.22.3
networkx	Python	2.8
mathparse	Python	0.1.2
python-dateutil	Python	2.7.5
sqlalchemy	Python	1.2.19
pytz	Python	2022.1
Cython	Python	0.29.28
spacy	Python	3.2.3

3.3.3. Plugins

A plugin is a small program used to add functionality to another software without affecting this software structure or its approach. In this thesis, there was a need to use Python and Java together to build the chatbot, this need came with a challenge in how to integrate these two languages and make them work together under one project. The solution for this challenge was using a plugin named '**Chaquopy'.** Chaquopy is a plugin for Android's Gradle-based build system.

3.4. The Selection and Evaluation of Implemented Models

The field of AI has many techniques and tools, and to decide on which one to use in executing a project, these tools must be experimented and compared to each other to select the best one. Multiple models were studied, deployed, tuned, trained, and tested against four parameters. Models included Vader, TextBlob (Naive bayes classifier/Decision tree

classifier), RF, LR, Convolutional Neural Network (CNN), and Stanford CoreNLP. The comparison was based on the following parameters: training time, prediction accuracy with small data/large data, and usability level. Training dataset was = 50,000 records, divided as follows: (80% training and 20% testing), 10k-folds Cross-Validation method was used to ensure that every record from dataset has the chance to appear in training and test set. Dataset source was AI Lab @ Stanford Uni. Table 3.4 illustrates the results of comparing these different tools.

Table 3.4 – Results from Comparing Multiple Models for Sentiment Analysis Task

Model	Concept	Training Time	Prediction Accuracy		Usability
			Small data	Large data	
Vader	Rule-Based	0	96%	71%	Very simple
TextBlob	Naive bayes classifier	30 mins	85%	63%	Moderate
TextBlob	Decision tree classifier	20 mins	61%	91%	Moderate
RF	Many decision trees		95%	82%	Simple
LR	probability	≈ 4hrs	83%	73%	Simple
CNN	Multiple layers of different models and concepts	≈ 9hrs	97%	89%	Hard
Stanford CoreNLP	rule-based, probabilistic ML, and deep learning components	≈ 5hrs	91%	98%	Very simple

The results of this comparison along with the fact that the Stanford CoreNLP is used widely due to its simplicity and capability of providing text processing tasks such as tokenization, part of speech tagging, and SA (Kaur and Solanki 2018) had formed the reason behind

adopting the Stanford CoreNLP framework as the best tool in developing the sentiment analysis aspect of the chatbot.

There were another two techniques that were selected to build the chatbot: Abstractive text summarization using (Cosine Similarity and TextRank), and web scraping using Jsoup library. These two were selected mainly due to their popularity.

3.5. Implementing the Selected Techniques in Building the Chatbot

The following paragraphs describe the implementation of Stanford framework, text summarization, and data scraping.

3.5.1. Implementing Stanford CoreNLP Framework

The following steps describe how does CoreNLP process the user input:

1. In chat view when chatbot asks user 'how are you?', then the chatbot analyses user's answer and scores it between (0,4). Figure 3.1 illustrates the range of scores for the SA.

Figure 3.1 Sentiment Analysis Scores Range

Code used to perform the sentiment analysis:

```
public static int getPrediction(String userMsg) {
    nlpPipeline.init();
    return nlpPipeline.estimatingSentiment(userMsg);
}
```

```
public class nlpPipeline {
    static StanfordCoreNLP pipeline;

    public static void init() {
        Properties props = new Properties();
        props.setProperty("annotators", "tokenize, ssplit, parse, sentiment");
        pipeline = new StanfordCoreNLP(props);
    }

    public static int estimatingSentiment(String text) {
        int sentimentInt = 2;//defaults to neutral sentiment
        Annotation annotation = pipeline.process(text);
        for (CoreMap sentence : annotation.get(CoreAnnotations.SentencesAnnotation.class)) {
            Tree tree = sentence.get(SentimentCoreAnnotations.SentimentAnnotatedTree.class);
            sentimentInt = RNNCoreAnnotations.getPredictedClass(tree);
        }
        return sentimentInt;
```

2. In journaling view where user can write his random thoughts. After user saves his writings, the chatbot analyses user's writings, scores it between (0,4), waits for the user's preferred time to talk, and offer the user to discuss his thoughts.

3.5.2. Implementing Abstractive Text Summarization

Text summarization is performed when user chooses to resume a previous chat, in this case the chatbot summarizes and displays the summary of the previous conversation. The summarization is utilizing two methods, the first is Cosine Similarity and the second is TextRank model.

Cosine Similarity: Each user entry will be represented as a vector; therefore, cosine similarity measure can be used to find the similarity among user's sentences. It measures cosine of the angle between vectors. Angle = 0 if sentences are similar.

TextRank: is unsupervised graph-based ranking model for text processing which can be used to find the most relevant sentences in text and to find keywords.

Code used to perform abstractive text summarization:

```
def summarize(text, per):
    try:
        nlp = spacy.load('en_core_web_sm')
        doc = nlp(text)
        tokens = [token.text for token in doc]
        word_frequencies = {}
        for word in doc:
            if word.text.lower() not in list(STOP_WORDS):
                if word.text.lower() not in punctuation:
                    if word.text not in word_frequencies.keys():
                        word_frequencies[word.text] = 1
                    else:
                        word_frequencies[word.text] += 1
        if len(word_frequencies.values()):
            max_frequency = max(word_frequencies.values())
            for word in word_frequencies.keys():
                word_frequencies[word] = word_frequencies[word] / max_frequency
            sentence_tokens = [sent for sent in doc.sents]
            sentence_scores = {}
            for sent in sentence_tokens:
                for word in sent:
                    if word.text.lower() in word_frequencies.keys():
                        if sent not in sentence_scores.keys():
                            sentence_scores[sent] = word_frequencies[word.text.lower()]
                        else:
                            sentence_scores[sent] += word_frequencies[word.text.lower()]
            select_length = int(len(sentence_tokens) * per)
            summary = nlargest(select_length, sentence_scores, key=sentence_scores.get)
            final_summary = [word.text for word in summary]
            summary = ''.join(final_summary)
        else:
            summary = "Lost Internet Connection!"
    except Exception:
        summary = "Lost Internet Connection!"
    return summary
```

3.5.3. Implementing Web Scraping Technique

Jsoup: is an open-source Java library designed to parse, extract, and manipulate data stored in HTML documents. It provides a very convenient API for fetching URLs, extracting, and manipulating data, using the best of HTML5 DOM methods and CSS selectors. Web scraping is used as a last resort when chatbot fails to help the user in all other possible ways or when chatbot does not understand the user's request.

Code used to perform web scraping:

```
def parseWebToText(url):
    try:
        user_agent = "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36"
        config = Config()
        config.browser_user_agent = user_agent
        article = Article(url,config=config)
        article.download()
        article.parse()
    except Exception as e:
        return "Lost Internet Connection!"
    return summarize(article.text, 0.5)
```

3.6. Ethics

There are several ethics codes that researchers are expected to follow to conduct research in an ethical way. These codes are rules that attempts to clarify how researchers should ethically act towards participants for the study. There are codes stated how to act before, during and after conducting the research (Swedish Research Council 2019).

For this study, four principles have been taken into consideration to make sure that the participants were informed and felt comfortable with their participation within the study. The first principle is about information which led to informing all participants about the study and their role but also describing the terms of the participation. Further, the next

principle requires the participants to confirm their consent to participate in the test. For this study, all information was described in an informed consent document (**Appendix 1**) that was sent out to all individuals that showed their interest in participating. The informed consents were collected with the participants signatures which was crucial to be able to run the tests. Additionally, the participants were told that it was optional and up to themselves if they wanted to go through the whole test or discontinue at any time. All collected data from the tests was processed confidentially to maintain the anonymity of the participants. This involves the last two principles that encompass the requirement of the participants right of being anonymous within the study and that the collected data are only allowed for the purpose of the study. This meant that the collected data was used for this study only and was not shared with others and will not be shared in the future either.

CHAPTER 4: CHATBOT IMPLEMENTATION

4.1. Introduction

This chapter defines the concept and implementation of the proposed chatbot, lists the different chatbot views, explains possible workflow scenarios, and what are the possible forks and ends for each scenario.

4.2. The Chatbot Concept

chatbot concept means; the problem the chatbot is trying to address, the proposed solution, the chatbot's targeted audience, and the content of the chatbot. The problem should be specific and well understood. After defining the problem and the proposed solution, a feasibility study of the chatbot should be conducted before its implementation either by reviewing similar projects or by conducting a survey. After verifying the project's feasibility, the targeted audience and chatbot content is determined. All this information together forms the chatbot concept.

4.2.1. The Proposed Chatbot Concept

The problem the chatbot is trying to address is dealing with daily stressful events, and the proposed solution is implementing multiple AI techniques to solve the problem. After reviewing research and experiments that almost have the same problem this thesis is addressing, it is determined that the best option would be to build a chatbot especially since almost everyone nowadays have mobile phones attached to them all the time. This chatbot is targeting people who are sixteen or above and those who can speak English since the chatbot is all in English.

4.3. Chatbot Interface Design

The interface was designed in a proficient, clear, and uncomplicated way. The proposed chatbot has the following views (forms):

4.3.1. Authentication Views

Two views were developed for authentication process; register new users and login subscribed users, as shown in Figure 4.1 and Figure 4.2 respectively.

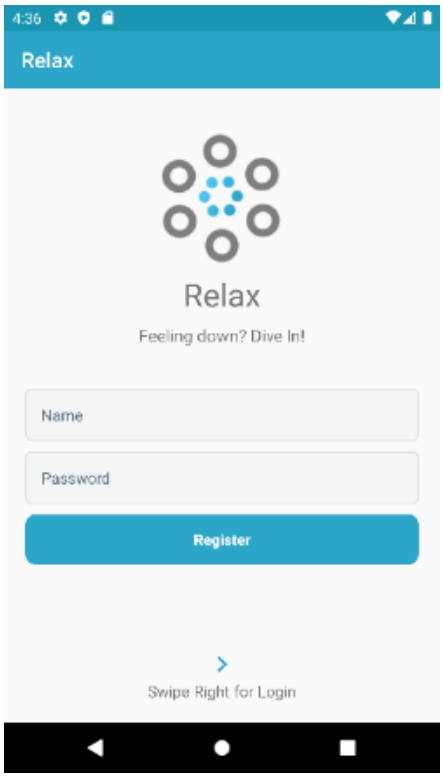

Figure 4.1 Register View

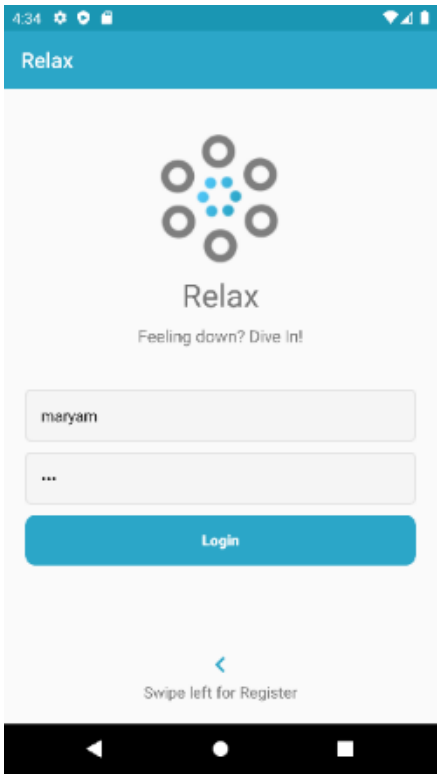

Figure 4.2 Login View

4.3.2. Survey Views

The chatbot contains a survey which would help the chatbot assessing the user's psychological state. The chatbot process flow and behavior would be determined by the user decision to take the survey at the beginning of his interaction with the chatbot or not. The survey is a revised version from a survey conducted by a private company that is specializes in providing mental health services to private, public, local, and international bodies (The Counseling Team International 2000). The revised survey is divided into five sections; the physical survey section which determines user physical status as illustrated in Figure 4.3, the sleep survey section that determines user sleep system as illustrated in Figure 4.4, the behavior survey section that determines user attitude to his surroundings as

illustrated in Figure 4.5, the emotion survey section that determines user reactions to life changes as illustrated in Figure 4.6, and the results view that evaluates the user responses on each survey section and determines the user weak points that mostly would be the reason behind their stress as illustrated in Figure 4.7.

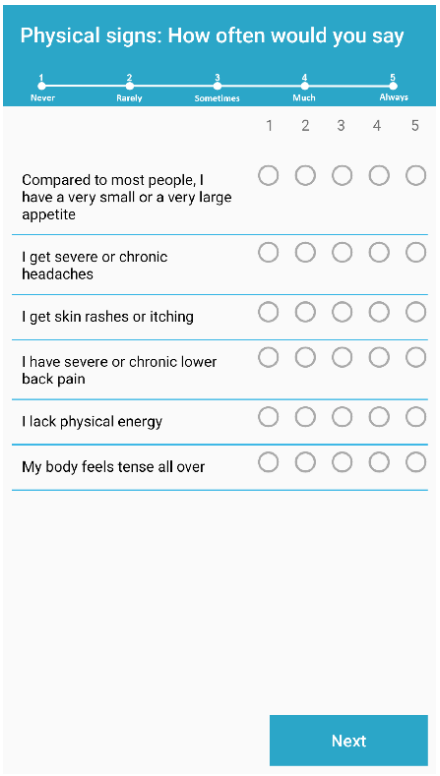

Figure 4.3 Physical Survey Section

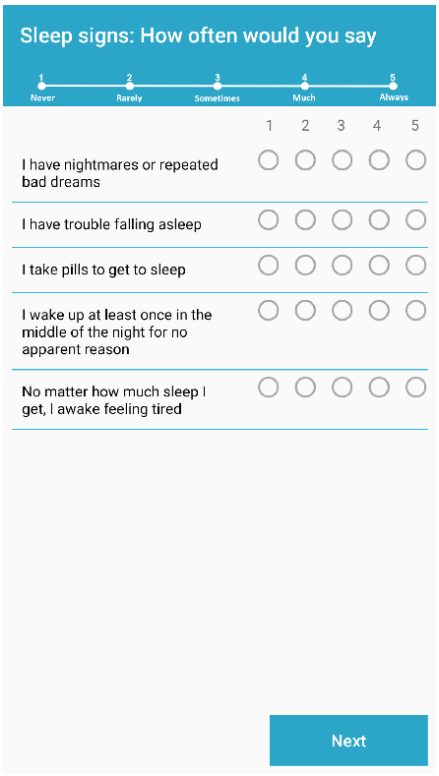

Figure 4.4 Sleep Survey Section

Figure 4.5 Behavioral Survey Section

Figure 4.6 Emotional Survey Section

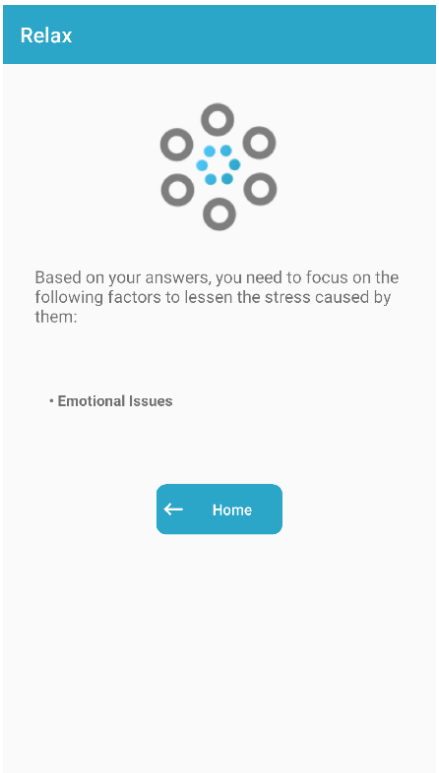

Figure 4.7 Survey Results

4.3.3. Main Views

Main views are where majority of chatbot's functionality is executed, hence they are the most visited views by users. The chatbot has three main views, the first is Chat view where the user-chatbot interaction is happening with the addition of all the intelligent implemented techniques i.e., sentiment analysis, text summarization and web scraping are happing in this view as illustrated in Figure 4.8. the second main view is home view in which user would be redirected after logging in and which user could navigate through the whole chatbot views as illustrated in Figure 4.9. the third and last main view is the journaling view, in which the user can write whatever comes to their mind and leave the chatbot without having to interact with the chatbot as illustrated in Figure 4.10.

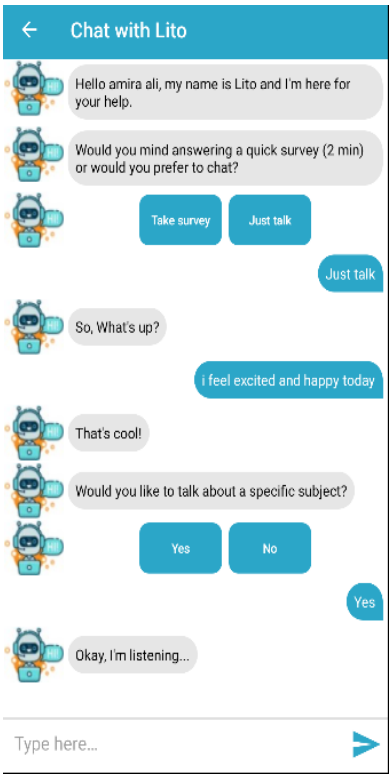

Figure 4.8 Chat View

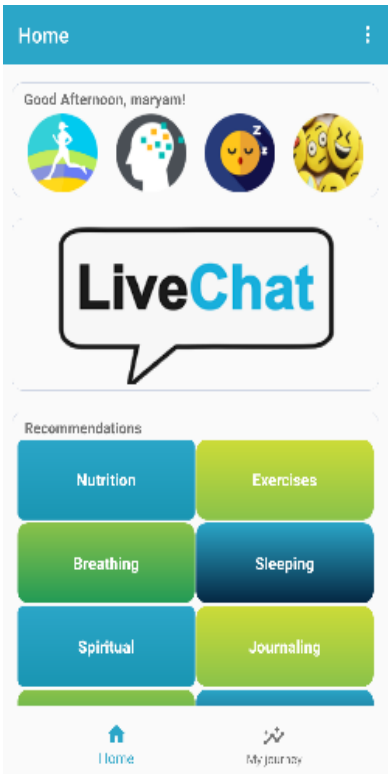

Figure 4.9 Home View

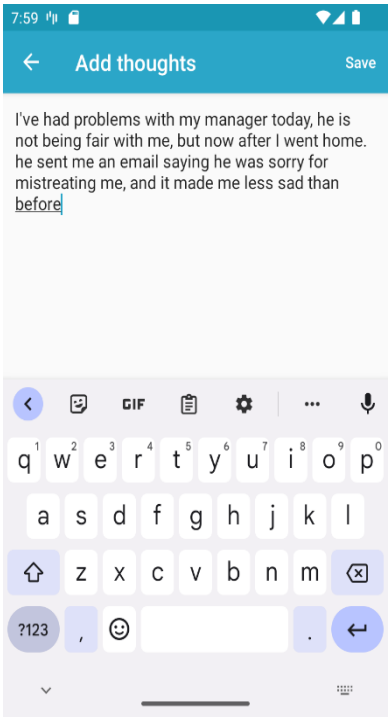

Figure 4.10 Journaling View

4.3.4. Recommendations Views

The chatbot offers a group of recommendations to users that were collected from various resources from specialized medical and nutritional web sites. There are eight recommendations; Journaling view that explains journaling, its benefits and a link to do it upon user choice as illustrated in Figure 4.11, Nutrition view that provides a list of stress-busting foods as illustrated in Figure 4.12, Self Esteem view that defines self-esteem, its causes and how to improve it as illustrated in Figure 4.13, Breathing view that provides a list of exercises for better breathing as illustrated in Figure 4.14, Spiritual view that provides a list of Surahs and Duas for stress relieve as illustrated in Figure 4.15, Sport view that provides a list of easy and effective exercises for all ages for better health as illustrated in Figure 4.16, Sleeping view that provides a list of simple yet strong tactics for better sleep as illustrated in Figure 4.17, and Coping with Changes view that lists the most common change-related stress symptoms and how to deal with the changes in life as illustrated in Figure 4.18.

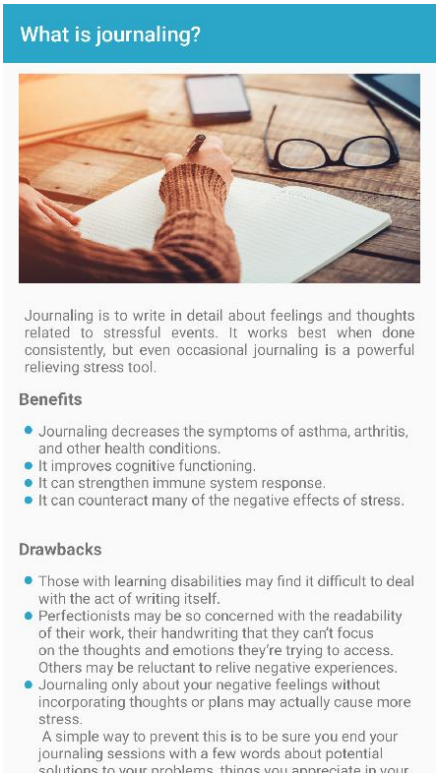

Figure 4.11 Journaling Recommendation View

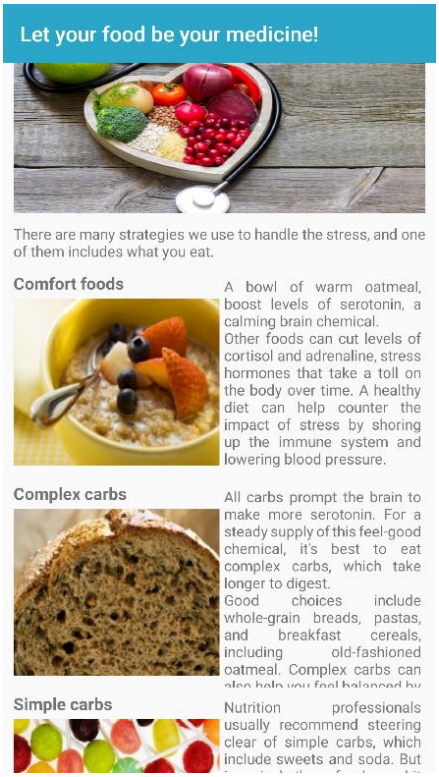

Figure 4.12 Nutrition View

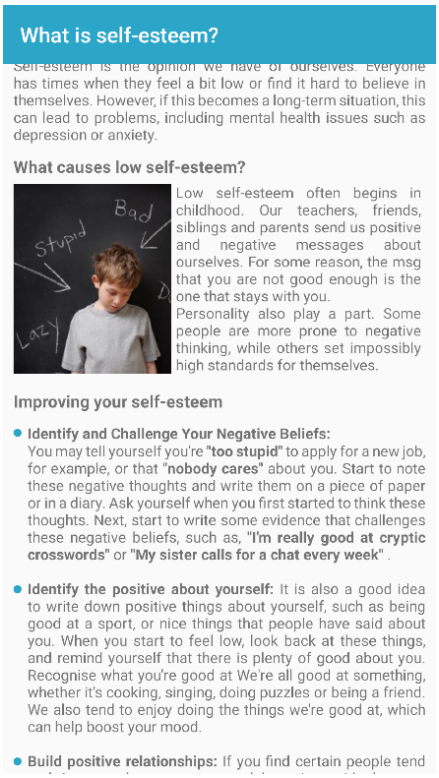

Figure 4.13 Self Esteem View

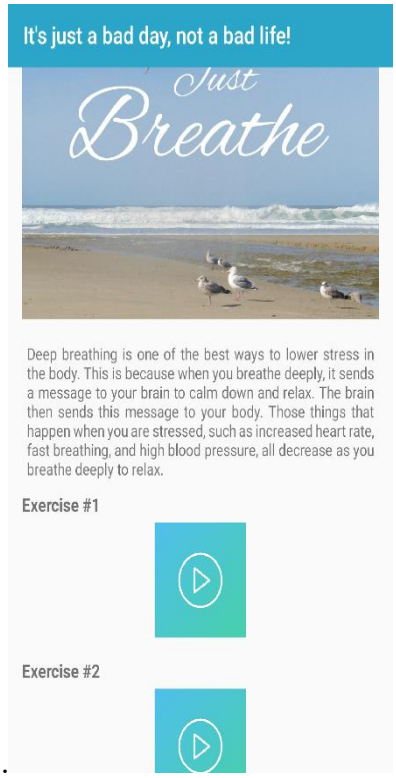

Figure 4.14 Breathing View

Figure 4.15 Spiritual View

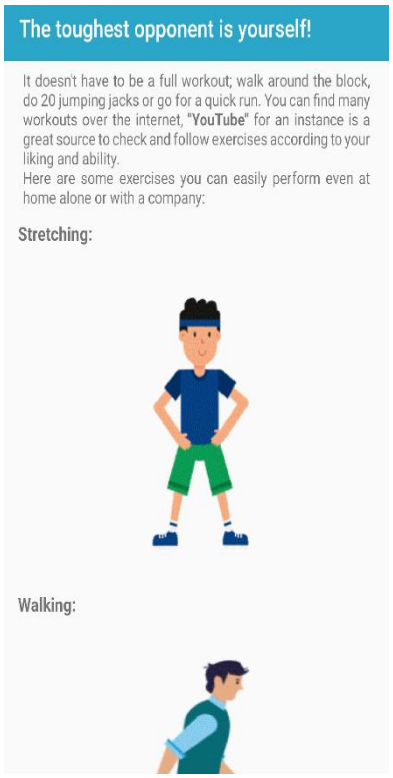

Figure 4.16 Sport View

Figure 4.17 Sleeping View

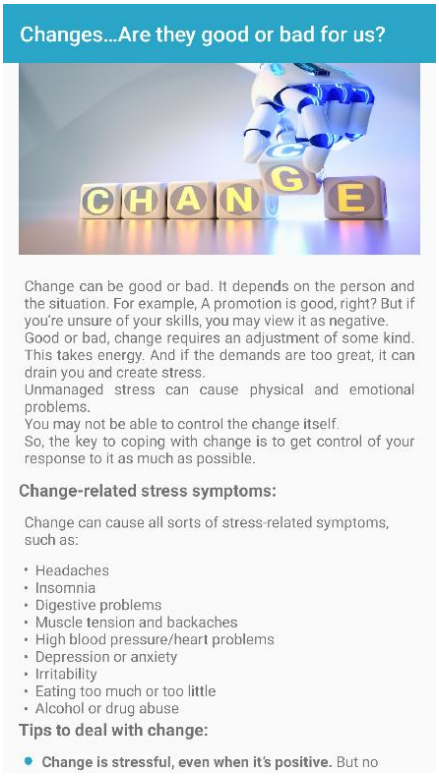

Figure 4.18 Coping with Changes View

4.3.5. Features Views

The chatbot provides additional three features views; a dashboard view in which the user can overview his interaction history with the chatbot since the first time using the chatbot up until the current day as illustrated in Figure 4.19, a feedback view in which user can rate and provide feedback on the chatbot directly to the chatbot author as illustrated in Figure 4.20, and a notification service view in which user can select a preferred time for the chatbot to get in touch with the user as illustrated in Figure 4.21.A and Figure 4.21.B.

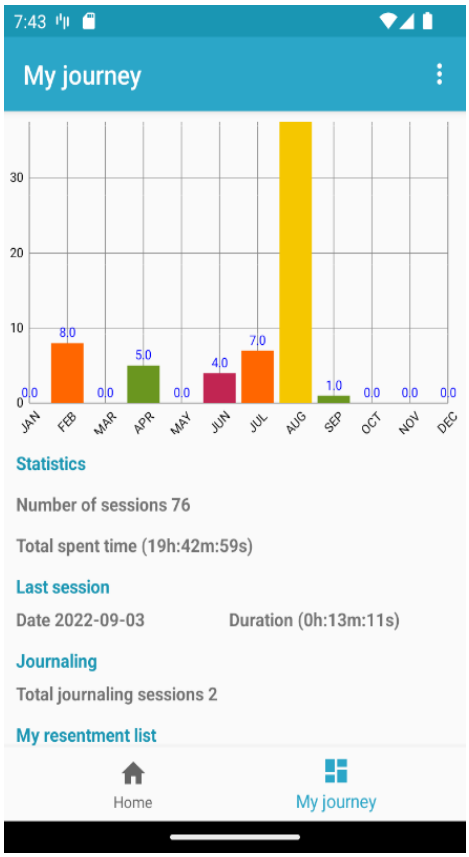

Figure 4.19 Dashboard View

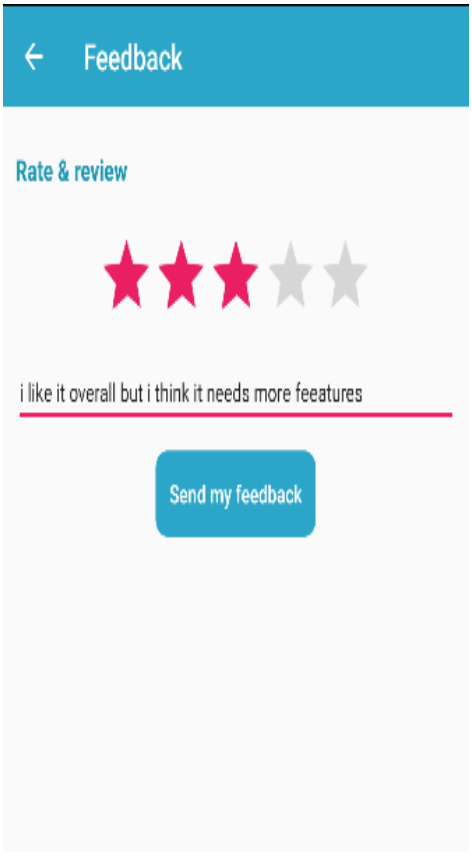

Figure 4.20 User Feedback View

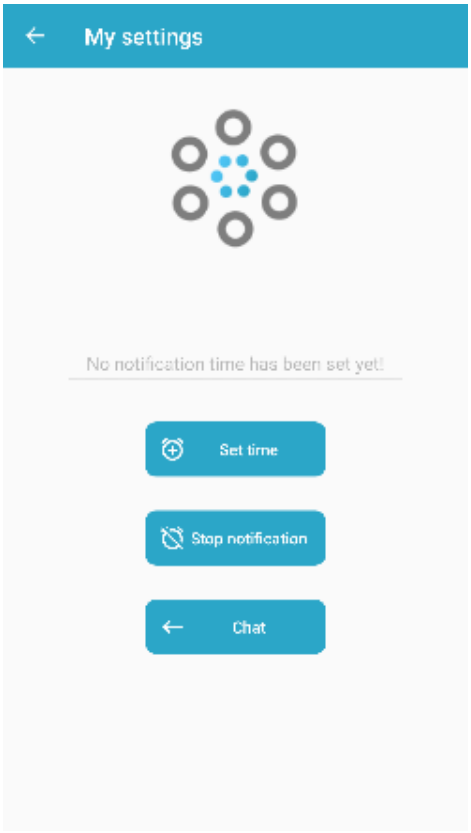

Figure 4.21.A Notification View

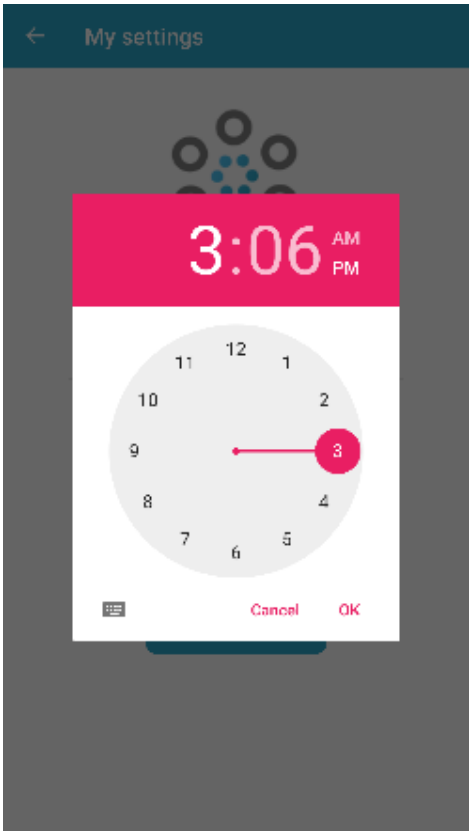

Figure 4.21.B Notification View

4.4. Chatbot Process Flow

The chatbot process flow has four scenarios, each scenario flow is determined by whether user had taken the survey or not, and had the user chatted with the chatbot before or not. In each scenario, the chatbot will offer different options to the user by displaying buttons with text over them indicating the option being offered to the user. All scenarios were built in which every scenario starts with greeting the user and ends with solving the user's problem. Scenario **no.1** describes the case of a first-time user. In this scenario the chatbot would offer two options for the user; take survey or chat with chatbot. Scenario **no.2** describes the user who had taken the survey and had not chatted with chatbot before. In this scenario the chatbot would offer two options; analyze survey results or chat with chatbot. Figure 4.22 illustrates both of scenario **1** & scenario **2**. Scenario **no.3** describes the user who had previously chatted with chatbot and had not done the survey. In this scenario

the chatbot would offer three options; take survey, new chat, or resume previous chat. Scenario **no.4** describes the user who chatted before with chatbot and had taken the survey, the chatbot would offer two options; new chat or resume previous chat. Figure 4.23 illustrates both of scenario **3** & scenario **4**.

All the three intelligent techniques that have been utilized in building the chatbot, i.e., sentiment analysis, web scraping, abstractive text summarization, are implemented in each one of the four scenarios.

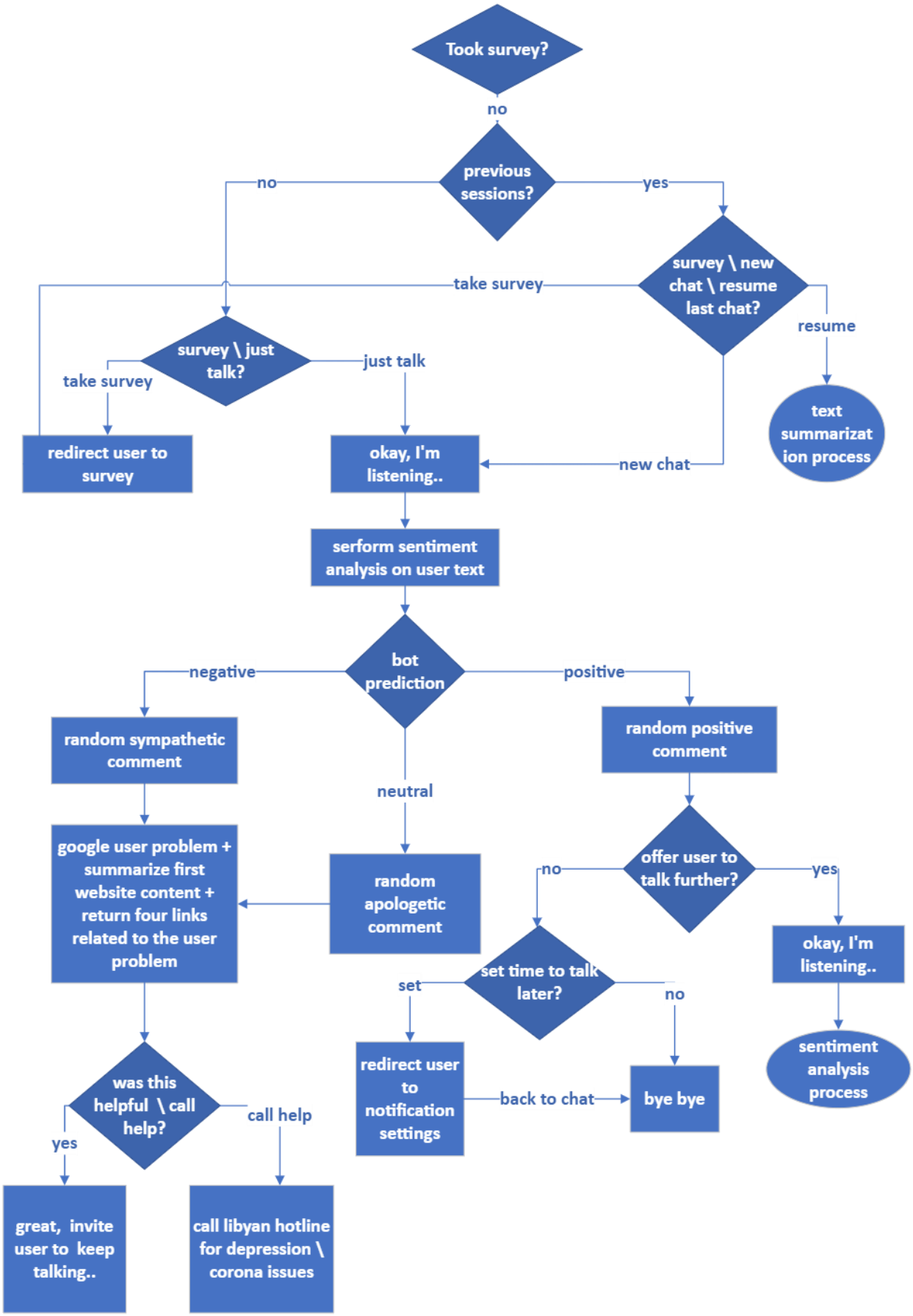

Figure 4.22 Scenario 1 & Scenario 2

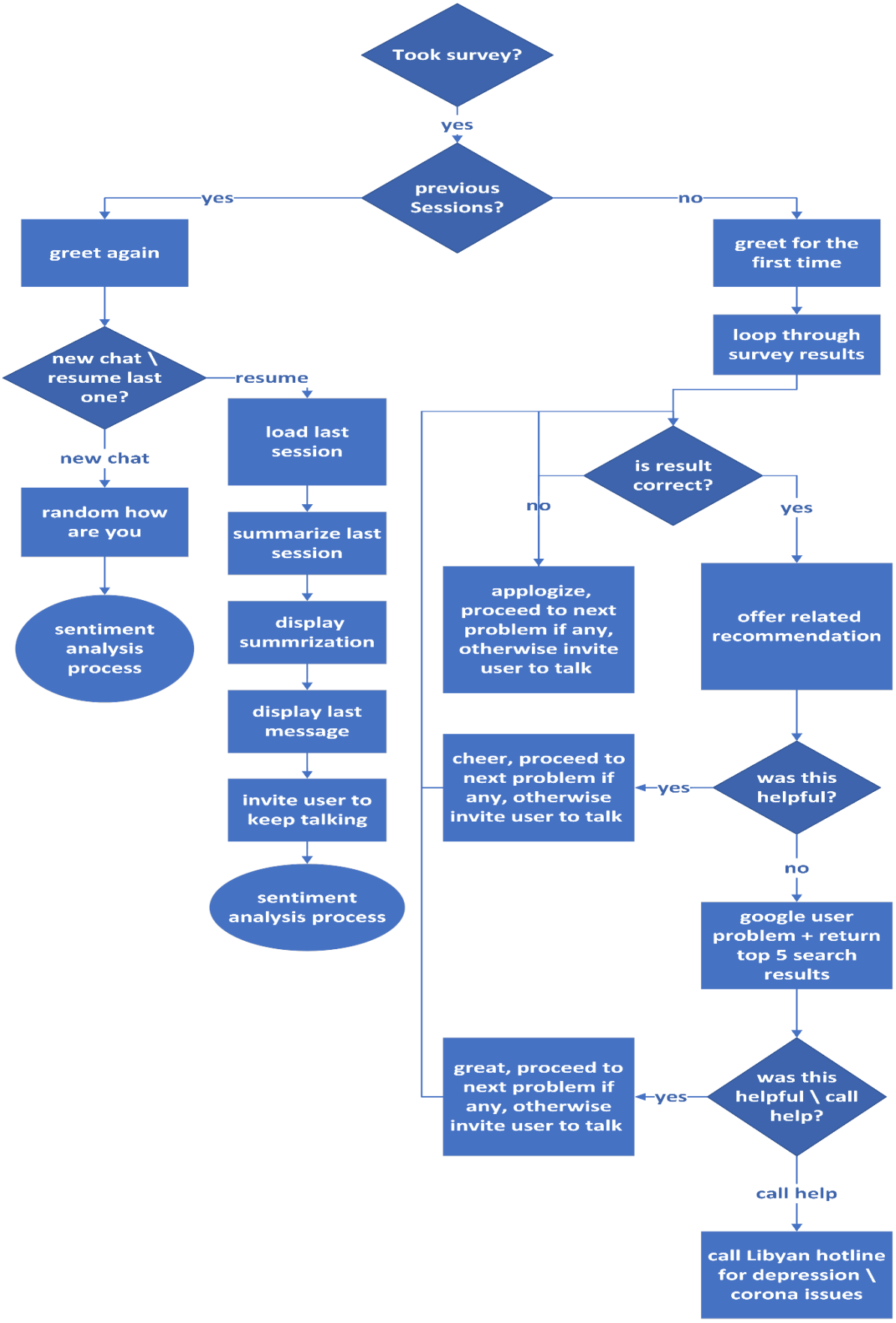

Figure 4.23 Scenario 3 & Scenario 4

CHAPTER 5: EVALUATION & DISCUSSION

5.1. Introduction

This chapter discusses and evaluates the user feedback on design, features, level of control and the ability of the chatbot to refer to the past. It also lists the changes that were made based on user feedback, and how the implementation of the proposed chatbot had answered the research questions.

The main objective of this thesis work is to build a chatbot to reduce stress among users, therefore it is crucial to observe user's interaction and feedback on all aspects of the proposed chatbot. A group of fifteen people were selected as a test group with the following criteria for selection process: each member must be older than 16 years because the proposed chatbot does not comply with Children's Online Privacy Protection Act (COPPA) (Federal Trade Commission 2013), each member need to demonstrate an adequate level of English skills due to the fact that the chatbot is in English, and no member should be informed by the chatbot author identity to avoid bias in user feedback. A group of questions were carefully formed in a way that would be precise to answer and to analyze as well. The questions were divided into two sections to be distributed to the test group in two rounds, the first section was concerned with user feedback on chatbot design (colors, text size, images, …) and chatbot features (setting notifications time, navigation, …), while the second section was concerned with the chatbot level of control and its ability to refer to the past. The two questions sections were sent through email to the test group. Some of user feedback was sent through the chatbot feedback feature and received through a Gmail account connected with the chatbot, other users have sent their feedback through social media while other provided their feedback in person. All feedback were collected in one excel file and analyzed accordingly.

5.2. Iteration One

This round of questions concerned with user feedback on chatbot design and features. Next are the eleven questions that were sent to the test group:

Q1. Do you find chatbot colors uncomfortable when looking at them in a dark room?

Q2. Can you easily read the chatbot different texts and titles in a bright room? If not, please explain what the problem is.

Q3. Can you clearly read the text in the chat? If not, please explain what the problem is.

Q4. Do you think images in the chatbot are too small?

Q5. Do you think images in the chatbot are too big?

Q6. Do you find navigation through the chatbot is easy? If no, please mention the case\cases in which you had a problem with navigation from\to it.

Q7. Do you find chatbot notifications feature is likeable?

Q8. Do you find that being able to select a preferred time to talk with chatbot is a necessary feature to have?

Q9. Does the chatbot send you notifications exactly at the time you selected for notifications? If not, please illustrate the case in which this incidence happened.

Q10. Do you have any complains about the chatbot design other than the ones that are mentioned here in these questions? If yes, please illustrate your answer.

Q11. Do you have any suggestion to enhance the chatbot design? If yes, please illustrate your answer.

The collected user feedback has been sentimentally classified into three classes: positive, neutral, and negative as illustrated in Table 5.1.

Table 5.1 - Classification of Feedback on App Design and Features

Positive	Neutral	Negative
Theme color is quite and convenient for any time of the day	Text size is okay overall, but it lacks consistency in some views	Exercise image in sport view is still, therefore it wasn't clear how to do the exercise
Home layout is well organized	Images are preferable to be the same size in all views	Breathing exercise is too long to memorize especially for the newbies
Head images in recommendations are nice	I prefer to see a chart to show me how am I doing over time	Nutrition should have images next to each food type
App can tell what time of the day and greets me properly	I do not like typing or reading too many statements. it would be better if it is voice chat instead of text chat	Some buttons in chat view are so small that not all their text is visible
Easy access to all recommendations even if I had not answered the survey or chatted with the chatbot	I was able to benefit from recommendations, but I could not chat properly with the chatbot because my English is not that good. I prefer using Arabic instead	Chat with chatbot lacks emojis
The ability to set time is great because some apps tend to invade one's privacy		Unable to update notification time after setting it once
Back button in recommendation is good especially when I am in full screen mode		Bot reached to me out of selected notification times
Journaling is a particularly good feature as I can write whatever comes to my mind anytime without having to talk to the chatbot		Unable to retrieve my deleted notes after I accidently erased them
Looking at my thoughts after a while, I can see that I have been through tough times, and I was able to overcome these times successfully. So, reading that it gave me a sense of my inner strength and increased my self-esteem.		Could not use the hot line feature because I was outside the country

Table 5.1 Continued - Classification of Feedback on App Design and Features

Positive	Neutral	Negative
When chatbot could not answer my question, he googled it and returned useful links		I feel uncomfortable talking about my deep thoughts with an outsider be it a robot or else.
I like that writing feedback is optional, so I can just rate it without having to type anything		Using the app offline prevented the chatbot from googling my question
The chatbot has a good sense of humor, especially the rock picture, it was funny.		
I like how the chatbot was able to tell if we talked before or not. It felt smarter this way		
I like that chatbot admits being a chatbot. I hate bots tries to foolishly imitate human as if that were possible.		
I can contact a depression hot line. I did not know Libya has one.		
I can go back to survey views and update my answers before I submit them.		
I do not need internet connection to use the app		

5.3. Summary and discussion of results from Iteration one

After sentimentally classifying the feedback from users on chatbot design and chatbot features, a general satisfaction could be clearly seen as illustrated in Figure 5.1 and Figure 5.2.

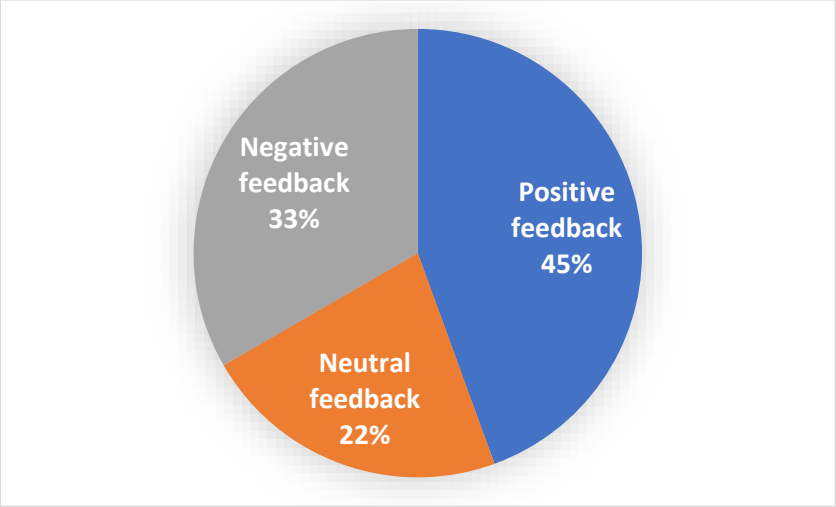

Figure 5.1 Sentiment Classification of User Feedback on Design

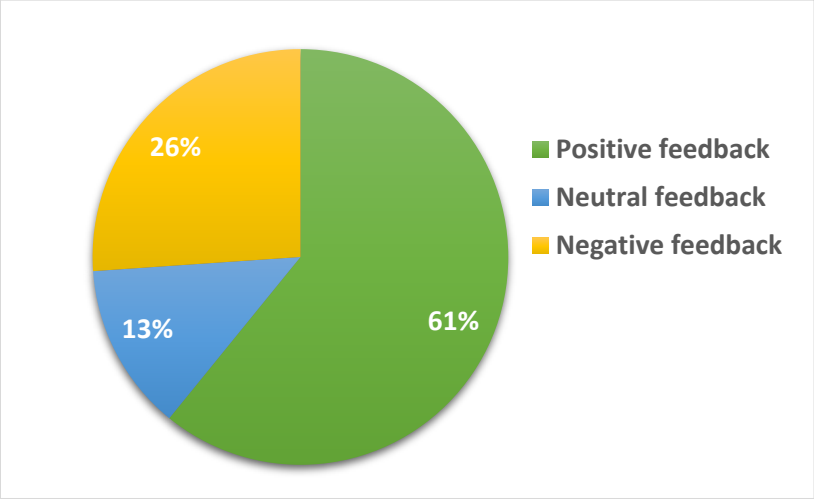

Figure 5.2 Sentiment Classification of User Feedback on Features

The feedback also had negative and neutral points that needed to be addressed properly. Thus, the following measures were taken:

1. Put more focus on the chatbot design especially buttons and images sizes.
2. Analyze, fix, and evaluate the setting time feature code in every viable way to guarantee the best performance in future.
3. Show an alert message to the user before deleting any note, so that the user does not mistakenly delete the notes.

4. Add terms and conditions form to the chatbot, which includes a clear statement explaining that even if the chatbot was working online, no one can see what the user is typing, data is only saved on user's mobile phone and can be deleted anytime by uninstalling the chatbot.
5. In terms and conditions form, add another statement explains that the chatbot needs internet connection only to google user's question if the chatbot was not able to help him in any other available way.
6. Add a dashboard view to summarize user interaction and improvement over time.
7. Include a request for using mobile internet connection that pops up to the user when installing the chatbot for the first time.

5.4. Iteration Two

This round of questions concerned with user feedback on chatbot's level of control and its ability to refer to the past. Next are the ten questions that were sent to the test group:

Q1. Does chatbot accept wrong authentications?

Q2. Does chatbot accept empty username\password?

Q3. Does chatbot redirect user to the home view after registering or logging?

Q4. Is it able to return to the previous view correctly?

Q5. Does chatbot allow user to resubmit the survey's answers?

Q6. Can user manipulate the chatbot in a way makes the chat pointless?

Q7. Does chatbot recognize old users?

Q8. Does chatbot summarize previous conversation correctly?

Q9. Does chatbot summarize user notes in journaling?

Q10. Does chatbot provide a correct sentiment score for user notes in journaling?

Analyzing answers for these questions, showed that the overall chatbot's level of control is **90%** as illustrated in Figure 5.3 and the chatbot's ability to refer to the past is **83%** as illustrated in Figure 5.4.

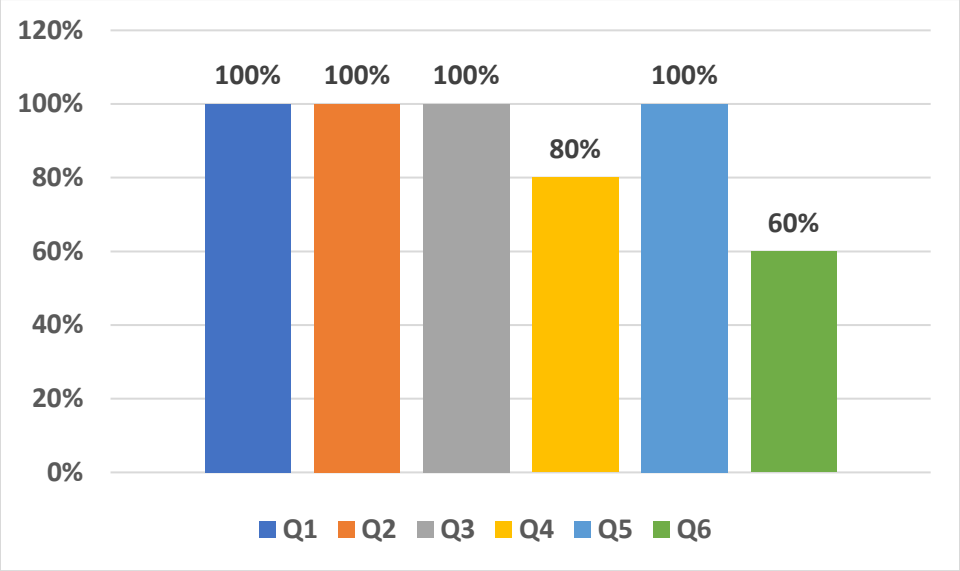

Figure 5.3 User Feedback on Chatbot's Level of Control

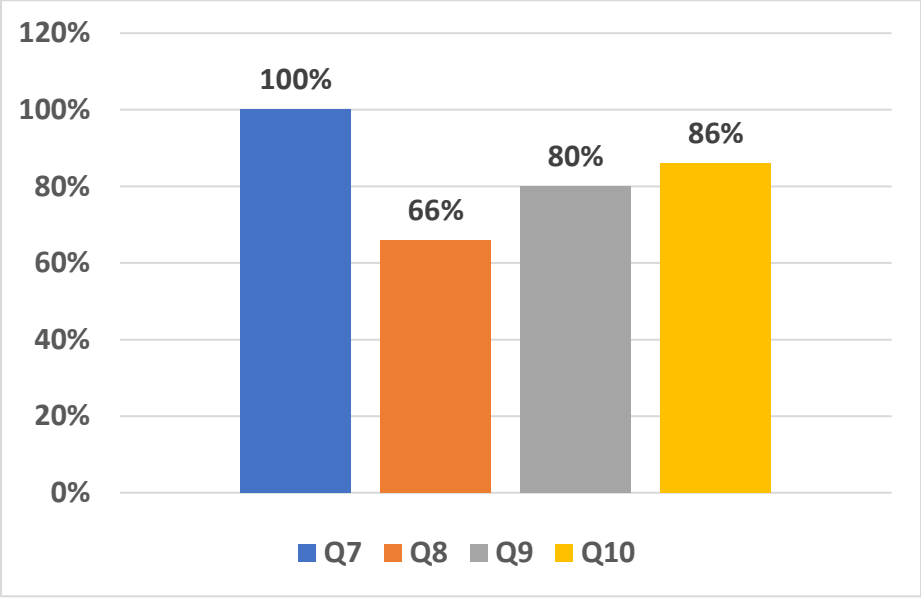

Figure 5.4 User Feedback on Chatbot's Ability to Refer to the Past

5.5. Summary and discussion of results from Iteration two

It is well known that no artificial intelligent method is 100% accurate. The accuracy for each method or model depends vastly on the size and quality of data used to feed the model. Hence enhancing these chatbot's abilities requires a continues work and strong

commitment to the cause. In the level of control feedback, the Q4 and Q6 got the lowest positive feedback with (80% & 60%) respectively, and for the feedback on chatbot's ability to refer to the past, the questions with least positive feedback were Q8, Q9 and Q10 where they had (66%, 80%, 86%) respectively. However, since the level of control is 90% and the ability to refer to the past is 83%, it is safe to say that the overall user feedback is positive.

CHAPTER 6: CONCLUSION & RECOMMENDATIONS

6.1. CONCLUSION

Starting from a subjective definition of the chatbot's goal, i.e., stress management, a set of suggested targets, designs, rules, flows, problems were recorded on papers. Then a prototype for mobile chatbot was designed, developed, and tested in Java language using Android Studio IDE. Two intelligent models were selected for both of SA and text summarization, based on their accuracy, size of training data, and the required time to deploy these models. All intelligent models and techniques have been explored, tested, evaluated separately from the android mobile application project, using PyCharm IDE, Jupyter Notebook platform, Kivy framework, Python language, Java language whenever needed. The chatbot was distributed to a group of fifteen willing people to test and evaluate the chatbot. In the first round, there were overall sense of satisfaction with the chatbot's design and features. A couple of modification were made based on user's feedback. Second round was about chatbot's personality, level of control, ability to refer to the past. A rather very good impression was clear from user's feedback. Using the chatbot did help those participated people in the evaluation. Some liked that a set of stress reducing recommendations were grouped in one place, so less wasted time for googling them or asking around and more accurate information instead of personal speculations. Other pointed that journaling feature was a great one, and just by writing their thoughts and letting all negative emotions out reduced their stress tremendously. A few limitations were mentioned by users, they were about support for Arabic language, chatbot's lacking audio capability. These limitations were provided as recommendations for future work.

It is not a perfect solution, but it has very good base that leaves the door open to future improvements by other prospective researchers interested in Artificial Intelligence.

6.2. FUTURE WORK

Based on feedback from users participated in evaluating this chatbot, and due to time constraints and search capabilities, the following recommendations are hereby made:

1. Add Arabic language support (the Stanford-CoreNLP supports Arabic language, so no further library or intelligent model is needed).
2. Implement voice interaction in the chatbot.
3. Make the chatbot aware of user current location and get that country hot line number by automatically searching the web, instead of hardcoding the Libyan hotline number inside the chatbot.

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APPENDICES

Appendix A: Informed consent for master's thesis research

Project Title: Design of Intelligent Chatbot for Stress Management

Researcher Name: Amira Abubkr Shlebik

Researcher Email: amira.shlebik@academy.edu.ly

Researcher Tel: 0911304608

Project Objective

Utilize intelligent chatbot in stress management, identify the possible improvements for a better result, and eventually to pave the way for future interested researchers

Project Methodology

Develop an intelligent mobile chatbot, distribute the chatbot to a group of people, collect their feedback and make amendments to the chatbot based on their feedback, and eventually answering study questions.

Duration of the evaluation period

6 months

Terms and Conditions

- ✓ I have received sufficient information about the purpose of the research.
- ✓ I understand what is expected of me in the study.
- ✓ I am aware that I will participate in the experiment and evaluation of a chatbot for stress management.
- ✓ I consent to the interview(s) being audio (video) recorded.
- ✓ I understand that my participation may involve inconvenience like my inner thoughts being saved and analysed by the chatbot and read by the chatbot author to evaluate the chatbot's accuracy and functioning level.
- ✓ Taking part in the study may provide the following benefits to me or others: identify my stress reasons and get rid of them subsequently.
- ✓ I understand that my participation in this study is voluntary. I am aware that I can discontinue my participation at any time. I will not have to provide a reason for this, and I will not suffer any disadvantages.

- ✓ I understand that my interaction data with the chatbot will be collected for the purposes of this study. Hereby I expressly consent to the collection of these data anonymously for the purposes of this study.
- ✓ The findings may be used for research purposes and may be published. My name will not be published; anonymity and confidentiality are guaranteed at every stage of the research project. The complete dataset can be made available to the research community in the anonymised manner described.
- ✓ I understand that I will receive no following payment for participating in the research.
- ✓ I would like to be informed of the results of this research. The student researcher may contact me at the following e-mail address:
- ✓ I understand that I can contact t*he student researcher (see above for contact details)* for any questions or to exercise my rights (access to or correction of data, ...) after participating in the study.

I have read and understand the information above and have received answers to all my questions regarding this study. I agree to participate in the study.

Date:

Name \ signature of the participant Name \ signature of the researcher