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Design of a Chatbot to provide companionship for older adults with depression

Master's Thesis (30 ECTS)

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Abstract:

The rate at which older adults experience depression has increased over the years as a result of some of them being placed in institutions where they have frequently been left alone without anyone to keep them company. Moreover, it has been determined that Chatbot technologies provide advantages for the general public and are becoming more and more widely used by the general public. The potential benefits of Chatbot technology for older adults who are depressed are, however, poorly understood. This paper's goal is to review the available Chatbot already in use for older persons with depression and present the design of a Chatbot to increase companionship experienced by older adults.

Keywords:

depression; Chatbot; older adults

CERCS: P170 Computer science, numerical analysis, systems, control

Chatboti kujundus, et pakkuda kaaslust depressiooniga vanematele täiskasvanutele

Lühikokkuvõte:

Vanemate täiskasvanute depressiooni kogemise määr on aastate jooksul suurenenud, kuna mõned neist on paigutatud asutustesse, kus nad jäetakse sageli üksi, ilma et keegi neile seltsiks oleks. Lisaks on kindlaks tehtud, et Chatboti tehnoloogiad pakuvad eeliseid laiemale avalikkusele ja neid kasutatakse üha laiemalt. Chatboti tehnoloogia potentsiaalsed eelised depressioonis vanematele täiskasvanutele on aga halvasti mõistetavad. Selle artikli eesmärk on vaadata üle saadaval olev Chatbot, mis on juba kasutusel depressiooniga eakate inimeste jaoks, ja tutvustada Chatboti disaini, et suurendada vanemate inimeste kaaslust.

Võtmesõnad:

depressioon; Chatbot; vanemad täiskasvanud

CERCS: P170 Arvutiteadus, arvutusmeetodid, süsteemid, juhtimine

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1 Introduction

1.1 Background to the study

Chatbot technology has become increasingly popular for various purposes in recent years, such as providing social and emotional support and searching for information [BF17]. Chatbots are computer programs that mimic human-to-human communication using written or spoken language to engage in natural conversations with people [AK15]. They are also conversational agents, dialog assistants, or intelligent virtual assistants. The latter term is often used for Google Assistant, iPhone Siri, and Amazon Alexa. Even though chatbots have attracted the attention of researchers, software developers, and end users alike, there are fewer studies on how effective chatbots are for supporting older adults with depression. This work seeks to close this knowledge gap by systematically reviewing and evaluating the features of existing chatbots that target depression in older populations. The findings have implications for designing technologies that assist older adults with depression, which has been identified as a major research challenge.

1.2 Statement of the problem

Many older adults face challenges in expressing themselves and taking care of themselves as they age due to various limitations such as physical and mental health. Moreover, they often lack social interaction and companionship, leading to depression and loneliness. A chatbot system that can offer friendship and support to the elderly could help reduce these issues by providing them with emotional and social assistance.

1.3 Aims and objectives of the study

This study aims to examine the different chatbots currently used for older adults with depression, evaluate their quality based on their features and content, and propose a chatbot design that can enhance the companionship experience for older adults.

1.4 Study justification

As people age, they may face various challenges that affect their ability to communicate and care for themselves as they used to. These challenges include physical and cognitive decline, social isolation, and lack of support. All of these factors may exacerbate depressive symptoms and loneliness among older adults. A chatbot system that can offer companionship to the elderly could help address these issues by providing emotional and social support.

1.5 Scope and limitation of the study

This study aims to explore the various chatbots available and used by older adults suffering from depression. The study evaluates the quality of these chatbots in terms of their features and content and proposes a deep learning-based chatbot design to enhance the companionship experience for the elderly. The study uses web-based software application platforms to develop the chatbot app. The study does not focus on accessing the existing features of commercial apps, whether social or anti-social. Rather, the study seeks to improve the quality of the existing apps by creating a chatbot app that uses a deep learning technique to provide better companionship for depressed older adults.

1.6 Research question(s)

To fulfill the aim and objectives of this study, this raises the following Research Questions, which are then addressed:

RQ 1: What requirements are required to develop a chatbot for depressed older adults?

RQ 2: How to implement a suitable chatbot based on Research Question 1?

RQ 3: How can the effectiveness and usability of the chatbot be evaluated and improved for older adults with depression?

1.7 Research methodology overview

First, we will conduct a user-centered design process that involves older adults with depression and other stakeholders in defining the needs, preferences, and constraints of creating a chatbot that can provide companionship for older adults with depression. We will use a survey/questionnaire to elicit the chatbot's needs, preferences, and constraints.

Secondly, we will develop and implement a chatbot system that uses NLP and AI techniques to generate natural, empathetic, and engaging conversations with older adults with depression. In this case, the design science research (DSR) process that involves creating and evaluating a chatbot system that uses NLP, Deep Learning, and AI techniques to generate natural, empathetic, and engaging conversations with older adults with depression can be used. This dialogue system will involve a conversational agent interacting with users using natural language input and output.

Thirdly, we will design and conduct a user evaluation study that measures and analyzes the effectiveness and usability of the chatbot for older adults with depression in terms of their mood, loneliness, satisfaction, and engagement and provide recommendations and guidelines for improving the chatbot system. After using the chatbot system, we will collect user data on their mood, loneliness, satisfaction, and engagement. To do this, we will utilize the Chatbot User Experience Scale (CUES), a standardized survey tool to assess how well chatbots work for users. Researchers at the University

of Duisburg-Essen in Germany created the CUES to answer the need for a particular scale to evaluate the user experience of chatbots, which are more common in a number of industries, including customer service, healthcare, and education.

1.8 Research contribution

This research contributes to the knowledge of how chatbots can use learning techniques to improve the companionship experience for older adults who are depressed. This study will help identify research gaps and future directions for chatbots that offer companionship to the elderly who suffer from depression. The research will also look into the viability of developing an OpenAI-powered chatbot to provide support and companionship to depressed older adults. The research will advance the understanding of how AI can assist mental health and how companionship can affect the depression of older adults.

1.9 Thesis structure

This chapter introduces the study and its background. It includes the problem statement, purpose, objectives, scope, and research questions. The rest of the thesis is organized as follows: Chapter 2 reviews the literature on the relevant studies in this field. Chapter 3 describes the methodology, data sources, and implementation process. Chapter 4 presents the results of the study. Chapter 5 discusses the findings and implications. Chapter 6 concludes the thesis by summarizing the research and suggesting future directions.

2 Literature Review

2.1 Chatbot

Chatbot is a term that describes a computer program that simulates and understands human interaction (spoken or typed), allowing users to communicate with digital devices as if they were talking to real people. As observed in [WI15], chatbots can range from simple one-line programs that answer basic questions to complex digital assistants that learn and evolve over time to provide more personalized service as they collect and process more data.

2.2 Natural Language Processing

Natural language processing (NLP) is the branch of artificial intelligence that deals with how computers can interpret, understand, and analyze human language [CBS17]. NLP enables developers to use natural language to organize and structure knowledge for tasks such as named entity recognition, relationship extraction, sentiment analysis, speech recognition, topic segmentation, and automatic summarizing. NLP is often used to translate human language into computer language [Ash22] and also to design chatbots. Computers use NLP to process and understand speech, handwritten text, and voice. They collect relevant human language comprehension and usage data to build systems that can perform various tasks [AJTT22]. It is important to note that most NLP techniques rely on machine learning to accomplish their specific tasks [AN22].

2.2.1 Natural Language Understanding

Most chatbots use natural language understanding to understand the context of the user's question in a language that is simple for humans to understand and react to by the user's current needs [BKBS22]. The three main issues brought up by the NLU process are the user's general knowledge, interpretation, and mental processes. Extracting entities and classifying intents are two main elements of natural language processing. Organizing the entity as either user-defined or system-defined is possible. Contrarily, context comprises the strings that are saved in objects and refer to user input. Machine learning algorithms like support vector machines can successfully construct intent categorization [Rah22].

2.2.2 Artificial Neural Network Artificial

The design of several Chatbots uses neural networks extensively [ASAea22]. For instance, ANN is used by Chatbot for retrieval and creation. The operation of such a system merits a quick explanation. The system receives user input, converts it to a vector representation, feeds it to the neural network, and then produces the output

[NKADK22]. Turning words into vectors is known as embedding, and deep learning techniques like Word to Vec [WSJ22] are typically applied in this situation. A retrieval-based method calculates the probability of each intent by considering input vectors and intent [FARR22]. Generative-based chatbots help engage a person in casual, open-domain talks [YSM22].

2.2.3 Recurrent Neural Networks

The ability of recurrent neural networks to effectively understand the user's question depends on their capacity to consider initial talks in light of the current situation [ea22]. Alternatively, information is transferred from one network layer to another [AF20].

2.2.4 Sequence to Sequence Model

Generative-based model is the ideal test for the sequence-to-sequence model [JHS22]. The source sequence model generates a target sequence model [RWA21]. In this case, the user's input is the source sequence model, and a chatbot's answer is the goal sequence model. The simplest version of the model, multiple recurrent neural networks, can be used [Sea21].

2.2.5 Deep Seq2seq Model

This technique is typically used to develop Chatbots that behave and converse more like humans [DMA20]. Such a model is distinctive in that it uses additional factors, such as many layers of long short-term memory networks (LSTM) [JHZ20].

2.3 AIML (Artificial intelligence markup language)

Artificial Intelligence Mark-up Language is known as AIML. An XML-based markup language, AIML is used to develop artificially intelligent apps [RMA12]. AIML enables the development of human interfaces while keeping the implementation's programming, comprehension, and maintenance requirements low. The Chatbot's conversational skills are defined by a set of rules in AIML. It works with a linguistic communication Understanding (NLU) processor that applies AIML rules to look into and respond to text-based Chatbot inquiries. The Chatbot becomes cleverer as we add more AIML rules. AIML even defines rules for patterns and decides how to reply to the user based on those rules. Categories, patterns, and templates are just a few artificial intelligence mark-up language components.

2.4 NLG MODULE (Natural language generation)

The technique of converting data into natural language using artificial intelligence is known as natural language generation (NLG). NLG software accomplishes this by converting numerical data into text or speech that humans can understand using artificial intelligence models powered by machine learning and deep learning [SGMFJGC19].

2.5 Sentiment analysis

Sentiment analysis, commonly called opinion mining or emotion AI, is the methodical identification, extraction, quantification, and study of effective states and subjective data using natural language processing, text analysis, computational linguistics, and bio-metrics. Sentiment analysis is frequently used in marketing, customer service, and clinical medical applications [MS19]. It is used to voice the customer materials, including reviews and survey replies, internet and social media, and healthcare materials.

2.6 Elderly people and depression

Aging is a natural process that occurs throughout the body inexorably from birth and lasts the rest of one's life. Old age is the period of life that comes at the end of the aging process. An international phenomenon that causes decreased functional capacity, elevated illness and mortality, and alterations in the biological, psychological, social, and cultural milieu. The treatment of chronic degenerative diseases that cause disability was one of the increasing needs brought on by this process, according to superb health. A correlation exists between an adult's age range and level of disability. There are currently three levels of old age that may be distinguished, with the adult-young elderly (65–75 years) generally being physically independent and in good health, while older seniors (75–85 years) run a higher risk of losing their independence. Those who are over 85 tend to be more demanding in terms of care resources and attention. In older adults, depression is a prevalent and incapacitating condition [JHZ95, AA99]. Fifteen percent of the elderly are affected by this condition [MB11], and it is usual for these individuals to exhibit depression symptoms without being able to recognize them for themselves, much like with general practitioners or family members [MG08]. Due to the dismal outlook and natural evolution of the condition and the fact that it will necessitate more frequent medical services, old age depression is a significant health concern.

2.7 Technologies for older adults with depression

Growing interest has been shown in creating and evaluating technology that can enhance the care and quality of life for depressed older adults and the family caregivers who provide for them. A summit on research priorities in caregiving, titled "Advancing

Family-centred Care Across the Trajectory of Serious Illness," was organized in 2018 by the Family Caregiving Institute. The first two of the ten research priorities listed are to "identify where technology is best incorporated across the trajectory of caregiving" and "assess technologies that facilitate choice and shared decision making" [THM20]. Computers [JGC17] and touchscreen technology [DHP17] are just two examples of the kinds of technologies that older adults with depression can utilize, according to an earlier study. The development of technology-based therapies for depressive adults has also increased during the past ten years. Additionally, an increasing number of smartphone apps cater to the requirements of depressed individuals as well. According to a systematic study of technology-based therapies for depressed caregivers, these interventions frequently showed effectiveness in enhancing psycho-social outcomes but not in enhancing caregiving abilities or care self-efficacy. The usage of Chatbot by those who care for people with depression is not well understood.

2.8 Entertainment chatbot for elderly people

Modern language processing technologies are used to build a conversational Chatbot platform. Even if artificial intelligence is not yet developed enough to provide results in various fields, it has progressed in AD HOC applications such as online customer support [SGMGC21a]. But because of the vast digital divide, they are still not used on older adults. Most of them turn to media that are thought to provide a sense of community, such as radio and television, for relief from their loneliness. Numerous research has revealed that older adults participate poorly because of the generational divide, which may be insurmountable. According to the Spanish National Statistics Institute, Spain's aging indexes were 118.26 percent in 2017 and 120.46 percent in 2018. This is depicted in a bar graph format in the figure below. In 2018, 19.20 percent more persons were in their sixties, and 54.19 percent needed special care. Commercial conversational systems make it simple to access internet content, but they frequently need technological expertise that the elderly lack. Examples of such systems are Siri, Google Assistant, and Alexa. The solution to these issues is Chatbot. A Chatbot, sometimes known as a chatting robot, is a technology that enables text-based or generative language communication between humans and computers. Elders do not require Chatbots to be as intelligent as humans. In essence, the Chatbot performs the duties of an intelligent radio that can read news and carry on a private discussion.

2.9 Companion robots for older adults

In this sense, human communication technology has become companion robots. For instance, Alice [MAMVKH15], a young robot girl, was created to facilitate conversation with senior citizens. After several sessions, the participants developed an emotional bond with Alice after first feeling alienated from her. Some of them even gave her

grandparent-like greetings and treatment. Other researchers have demonstrated the usefulness of zoomorphic companion robots. According to Wada et al., [KWT02], talking to Paro made the older participants feel better. When older persons interacted with AIBO, Kanamori et al. [MKT02] compared the before and after scenarios and noticed changes in their quality of life and loneliness. As a result, earlier research revealed how companion robots affect elderly persons.

2.10 Chatbots for aging and health

More senior citizens are utilizing information technologies as state of the art improves to address various chronic health needs, including boosting health self-efficacy, assisting with self-care management, participating in health promotion, and communicating with healthcare professionals [JPB16]. Because auditory chatbots work through voice-driven interaction, which may be effective for persons with minimal computer literacy, previous research has noted that they may be particularly useful for older adults for health-related communication and information seeking [RBL18]. Older folks have employed chatbots, or virtual assistants, for various purposes. An earlier investigation revealed that older persons utilized voice-activated personal assistants to remind them to take their medications [DO17]. Another study suggested using Chatbot to monitor elderly cancer patients receiving home chemotherapy [APN19]. Information technologies have been especially mentioned as a potential means of overcoming the current difficulties in accessing education and emotional support in depression care and caregiving. Lack of emotional support, caregiving knowledge, and coping mechanisms for the difficulty of treating depression contribute to caregivers' despair, burden, and poor health outcomes. The effectiveness of treatment and the results for those who are depressed may suffer. Given the prior research that has been done on the advantages of employing Chatbot in healthcare and with older folks in particular, they may offer special advantages in terms of educating and supporting those who are depressed. Those who reside in rural areas, where access to providers and services may be hampered by distance and a lack of resources, may particularly benefit from them. It should be mentioned that commercially available apps employ Chatbots to evaluate depressed individuals clinically. However, many of these are not geared at providing information or companionship for care at home and are instead intended to be used with professional aid.

2.11 Related Chatbots

There have been previous work and studies done.

2.11.1 EBER [sgmfgc21] :

From work done by Silva et al. [Sgmgc21b], they presented EBER, a Chatbot designed

to alleviate the digital gap experienced by older adults. EBER adjusts its answers based on the user's mood while reading news in the background. Its originality rests in the idea of "intelligent radio," which proposes that rather than making a digital information system more straightforward for the elderly, background news, a traditional channel they are familiar with, be enhanced with interactions via voice dialogues. The main objective of their study is to lessen older citizens' digital marginalization in a way they find acceptable. The focus of Chatbot applications for older adults is typically therapeutic. One of the few exceptions was the personal assistant in the RobAlz project, which also reads stories and plays games with people with early-stage depression. However, its dialogues may be considered canned text since the Chatbot employs predefined clauses and only invites users to continue talking. This provides ad-hoc dialogues within the context of the news to entertain and increase the companionship of the "digital radio."

The aim was to help elderly folks find information of interest who have limited information abstraction skills (although this research would also be valid for other target groups with similar limitations). For the elderly, traditional broadcast entertainment media has a proven "companionship" effect [WDLC18, Ös09]. They concentrated on news as a content distribution style because of this, along with brief discussions. The following parts detail the various EBER chatbot modules created to close the digital divide for those target customers. As a result, we actively considered them during the design process. In addition to well-known accessibility guidelines, They first and mainly listened to AFAGA's recommendations. Their Cognitive Stimulation Program through New Technologies, a creative initiative to promote new technologies in senior gadgets, has given us insightful design advice.

Instead of using an already-existing chatbot, they built an AIML-based knowledge base because the Chatbot's intended use is apparent (to solicit opinions about news from older adults through light discussion). They used pattern extraction with keywords and AIML features like star, srail, and random. By asking brief questions about daily activities and mood, the Chatbot can initiate the conversation in a controlled manner. According to sections III-D2 and III-D5, these inquiries were taken from predefined templates.

EBER maintains standard responses to maintain conversation flow and minimize annoyance. When the EBER chatbot notices that a user is having trouble understanding something, it requests an explanation. The user feels more involved, and the dialogue feels more natural. For the application domain, precise, brief chatbot interactions are sufficient. They are beneficial for suggesting news stories since they eliminate meaningless concepts from conversations and enable the transition from broad to specific issues. The SA module lets you infer the user's disposition from their responses and gives the informal system feedback. The NLG module provides the user with questions that support their opinion or contradict it with a reasonable likelihood based on SA knowledge. Additionally, the technology alters the avatar's facial expression to the user's mood. Because individuals, notably the elderly, find short dialogue systems simpler and

keep them interested for longer [JHF15]. The system's interactions during the dialogue stage are brief and precise. Only when the expected variance is, minimal ideologies and related models produce effective discourse structuring results. However, in the target situation, people are free to share opinions regarding the news they are given. We combined AIML, NLG, and SA to address this difference. The two components of dialogues are AIML-based interactions and NLG-based responses. The EBER chatbot chooses a clause randomly for the first interaction when a conversation begins. User comments are anticipated to include phrases like "well" (for good responses) or "terrible" (for negative responses). The polarity of the user's response during the prior contact determines the Chatbot's response.

In the paper, EBER was introduced; this is the first system to combine AIML, NLG, and SA to produce coherent, brief, contextualized dialogues that connect newscasts. This combination enables EBER to function realistically as an "intelligent radio" for amusing senior citizens. In the tests, 80 percent of the users rated the system as having a 4 out of 5 satisfaction rating. The investigation of correlations between behavioral factors and sample demographics further supported the validity of the user satisfaction levels. The technology enhances content characterization by automatically collecting knowledge from connected interactions with a positive attitude, even for inattentive, agitated, or confused persons. In the following work, they will investigate how to enhance turn detection to prevent speech interruptions and incorporate sophisticated personalizing elements with better-directed dialogue stages. By paying close attention to variances in speech connected to age, we will examine an experimental assessment of loneliness and study how the quality of users' responses (regarding user words that supplement news terms for following searches) evolves. We hypothesize that because consumers receive positive reinforcement when new newscasts correspond to their preferences, quality won't decline. Studying the impact of additional linguistic semantics, such as sarcasm, may also be intriguing [JJMGC16].

2.11.2 AI-BASED TALKING BOT [WDL16]

Wei-De et al. proposed an AI-based talking bot with speech recognition technologies with a real character who could directly talk and respond to elders. Based on the statements database, The Chatbot could sing, tell jokes, and converse with older adults to ward off depression. Their research noted that it is hard to be complimented when elders are most likely to live alone. Even with the convenience of nowadays high-tech communication devices, it's still hard for them to find someone who can always leisurely hang out with them. A Chatbot could be a solution to improve the problem and fulfill the requirement [WLC18].

In the study, an AI-based talking bot is offered to achieve the objective of better elder care. A real character who could converse and interact with elders directly has been created using speech recognition technology. Based on the statements database,

the Chatbot could sing, tell jokes, and converse with older adults to prevent dementia. As the population over 65 grows, caring for their mental health will be a crucial social issue. Other than living in retirement communities, interacting with people is a basic need for older adults. Nevertheless, Given that older persons are more likely to live alone, it can be difficult to receive compliments. Even with the ease of using modern, high-tech communication tools, they still need help to locate someone who can always hang out with them leisurely. A Chatbot [SB03, ?] could be a potential solution to address the issue and meet the criterion.

The chatbot was trained using free source Python data and the NLTK toolkit to process Chinese responses. Before being analyzed, the user's statement is divided into three categories: input layer, hidden layer, and output layer. The Chatbot, which requires ongoing training, is trained using the layers to respond to users. Twenty percent of the questions had accurate answers at the start. For instance, the Chatbot cannot answer the user's voice input of Hello and The weather is quite good today. However, after training, 60 percent of chatbot responses are accurate. Now, it resembles a typical person more than before. The hardware setup comprises two servos, an ESP32 microcontroller unit, a smartphone, and a custom character model. Figure 3 depicts the two servos. One servo simulates human speech in response to user input for the SG90. The second servo's primary function is to simulate human neck rotation and track the user's position for the Step motor. Two main servos, regarding servo rate and servo rotation, are controlled by the ESP32. Before text-to-speech (TTS), the smartphone establishes a network connection and obtains GAE server information regarding pre-response user data. The 3D printing process is used to create the character model. Users can construct a 3D character model according to their preferences. The application layer, cloud layer, and AI layer are the three layers that make up the system.

2.11.3 CHARLIE [VM21b]:

Another research on Providing companionship and assistance for the elders was from Stefano et al. They mentioned Charlie, a Chatbot, conversing with older people experiencing age-related issues. It was created to offer companionship to the elderly using cutting-edge techniques based on gamification, active notifications, and encouraging self-compassion that can be investigated for preventive mental healthcare. Charlie can also track significant or unusual events that could impact elderly individuals. Their study aimed to examine a personal Chatbot for the elderly that can serve as a companion, medical advisor, assistant, and entertainer and explain how virtual assistants can assist patients with everyday problems, such as remembering to take their medications, engaging in exercise, or adhering to a strict diet. They mainly offer advice on how to create an efficient medical Chatbot, why it's helpful to integrate Chatbot into messaging apps, how to set up a straightforward method for reaching agreements with the user, and how to add emotion to the Chatbot's responses. Similarly, [VM21a] explores text-based chatbots'

capabilities to enhance human relationships and their difficulties and solutions, not just in the medical field.

A sympathetic, sensitive, gregarious, and friendly robot Chatbot that can establish quick interactions with senior people was created for this purpose. Avoid specifying a Chatbot's default gender, according to several studies [Nef16]. Too humanized customer service representatives could raise users' expectations, making them more upset if the Chatbot doesn't work [CG20]. Although Charlie's name was taken from a cute movie or comic book character, we created Charlie as a robot. Regarding Charlie's age preference, it was chosen as a childlike characteristic. This is due to the similarities between children and the elderly. Both require attention, being led by the hand and encouraged to smile or unwind. Given that Charlie welcomes the elderly into a private, one-on-one conversation room, such a context of use should be welcoming [Lee17a]. Charlie talks much about himself but must also have a keen ear for listening to others. Charlie is employed as a form of psychological counseling to alter user habits and lifestyle choices, such as the propensity to take medications or drink more water [Lee17b, OC17]. Technically speaking, Dialog-flow is used to design and create the chatbot agent. The Google Corporation's Dialog-Flow platform for natural language processing (NLP) can be used to build conversational applications and experiences across a variety of media (such as Facebook and Messenger) or hardware (such as Google Home). The communication is done using a node.js service, which is used to build Charlie, a personalized web interface. The features of Charlie have been created to provide him access to user preferences. Charlie accomplishes this by activating particular Google Cloud functions that store the user's preferences, intentions, and activities in a Firebase platform database. Charlie, for instance, can start casual conversations about sports or the world of celebrities Charlie save the preference in the internal database because the user has expressed a desire to learn more about this argument in-depth, ensuring that any future encounters align with that preference. Charlie can offer the customer daily nutritional advice and guidance on implementing them. Charlie will question the user if they followed the advice or not in the evening using a gamification method, and if they did, they would earn a "bot-coin" (a kind of reward/recognition). This strategy encourages people to lead healthy lives in return for praise and prizes. Charlie can still be useful if the person experiences memory loss and cognitive impairment. He can also assist the user in setting up a schedule by asking whether they need assistance remembering things.

Using Charlie's capability, users are provided with quick quizzes on their favorite subjects to keep them interested and satiate their demand for entertainment. The user can decide the quantity and level of questions when an examination is activated. When the test is complete, Charlie will show the results and the right and wrong answers. By doing this, Charlie can record the total number of quizzes taken throughout the day in the Firebase database and statistics regarding the right and incorrect answers. Finally, Charlie can ask the user to assist him in deciphering certain puzzles, or he can share a personal

story that would make the user feel compassionate about themselves. He is the main character in these anecdotes, which features terrible or unpleasant situations. According to some studies, [Lee19], doing so would give the user a sense of identification, a prompt to reflect on their life, and self-compassion. Charlie first involves the user by seeking her or his opinion on the subject and, if the user so chooses, invites her or him to share an analogous experience. In turn, this would satisfy the need to be heard and understood and aid in developing self-compassion

In their research, they introduced Charlie as a child robot who is sensitive, gregarious, empathetic, and kind and who offers the elderly engaging activities based on gamification, active alerts, and the encouragement of self-compassion. According to an analysis of conversations with the senior participants in the preliminary test, Charlie is seen by users as courteous, intelligent, charming, helpful, and reliable. This solution can provide a variety of engaging techniques to lessen the loneliness that older person experience. The ultimate goal is to promote preventative care to improve seniors' quality of life, not necessarily "curing" anything but providing support and company without assuming diagnosed diseases. The Chatbot was also demonstrated during a hackathon hosted by Facebook and Funka to inspire European students to develop original digital solutions to improve social inclusion. Charlie was one of the top three finalists after being presented to a jury of representatives from companies, policymakers, and groups for disabled people. The remainder of the research detailed how to give Charlie's caregivers—like family members or medical assistants—the ability to monitor Charlie's behavior. To achieve this, a web application was created that enables caregivers to create rules for detecting relevant and significant events based on data which could include finished games and advice given to Charlie on how to solve problems, as well as biometric data that can be obtained by using smart wristbands, such as the number of steps taken throughout the day, calories burned, or hours of sleep. They also addressed the issue that customers rarely know which guidelines to follow for better helping their beloved seniors while designing the web app. In the study, they examined a method for computing recommendations for improving the well-being of the elderly based on counterfactual explanations to assist them in the monitoring task. Suggestions later translated into rules are inserted into the Chatbot's intentions to extract knowledge from the gathered data defining the elder's behavior. Users must specify a list of actions to be taken when setting these rules to explain when a specific set of conditions is satisfied or not met, for example, by indicating that a warning must be delivered via direct messages. In this way, they intended to assist family members and caregivers define what Charlie needs to watch out for to control their loved one's actions and attitudes. Despite the limits brought on by the epidemic, they organized several user tests to, on the one hand, collect data for training our machine learning model and, on the other hand, test the usability of Charlie and the web application in actual usage situations. In this manner, they could examine the results of implementing the strategy using counterfactual justifications.

3 Methodology

This chapter outlined the process used to create and assess a chatbot using OpenAI to offer companionship to elderly people suffering from depression. To make sure that the chatbot is both successful and usable by older persons with depression, it is essential that the research design and methodology utilized in this study be followed. A mixed-methods strategy will be used to do this, including creating the chatbot using OpenAI's Models such as GPT-3, Davinci, Text-davinci-002 and Text-davinci-003.

3.1 Research Design

The research will be conducted using a mixed-methods approach involving qualitative and quantitative data collection and analysis. The qualitative approach in this research will involve collecting in-depth data from participants through interviews and observations to gain a deeper understanding of their experiences and perceptions of interacting with the chatbot. This approach will help to identify design requirements, user needs, and suggestions for improvement.

The qualitative approach in this research will provide a deeper understanding of the experiences and perceptions of older adults with depression interacting with the chatbot. This approach will help to identify design requirements, user needs, and suggestions for improvement. Implementing suitable data collecting and analysis methodologies will assure the validity and reliability of the qualitative data.

Frontend The Frontend will be developed using vanillaJS. It consists of a main page and a sidebar. The sidebar links to other resources, such as getting Prompt and mood tracking. The main page has conversation between the user and the chatbot. In addition to using VanillaJs, CSS will be used for styling the pages, and Bootstrap will also be used to beautify the icons.

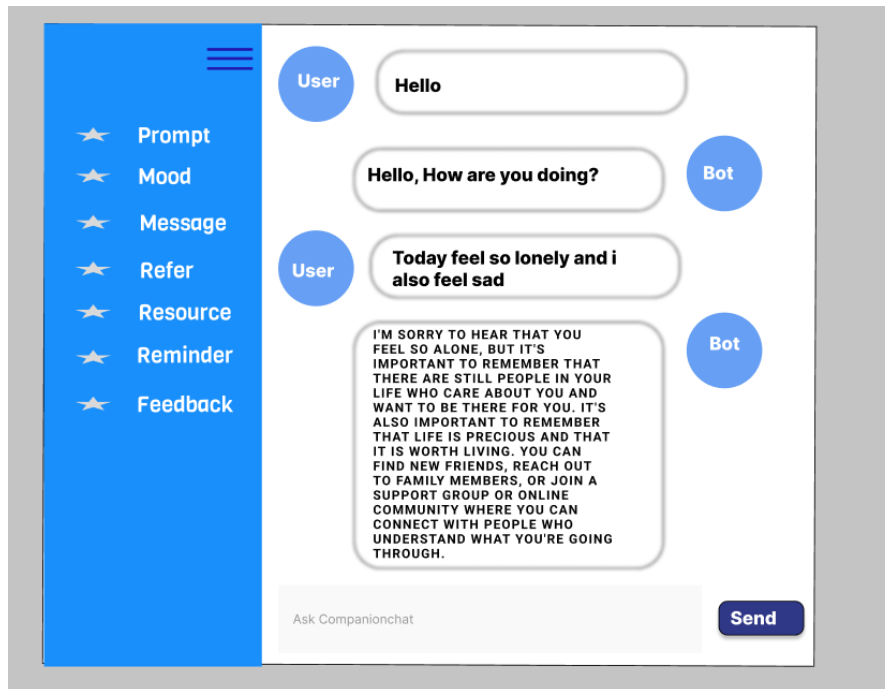


Figure 1. Chatbot design

Backend The Backend service is developed with NodeJS, and it is responsible for receiving requests from the frontend and making the relevant calls to OpenAI. Nodejs is a JavaScript runtime environment for Build backend services. It will be used to build the WebSockets and APIs that handle communication between the chatbot and the Frontend.

As seen in Figure 2, after the user delivers a message using the front-end chat interface, NodeJS is used in the back-end to transmit the message to the OpenAI service. The user receives the OpenAI response after being passed back to the front end via the back end.

Services Figure 3 shows how the request is made to Openai. It contains the model to be used, which can be any of the models described in subsection 3.7. The Prompt is the data being sent to openai. Another important parameter for the request is the Max token

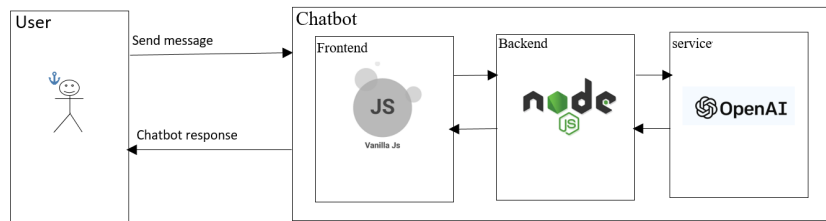


Figure 2. Architectural Diagram

which signifies the maximum number of words that can be returned by openai, and it can be adjusted to suit.

The typical response from openai is shown in Figures 4 to 8. Figure 4 shows that the request was a success; thereby, it returns a status code of 200; the headers contain the date and connection information, while the config section contains the adapter, method used, and the data sent. Figures 5 and 6 are some of the useful parameters used by openai.

Figure 7 shows the response and incoming message, while Figure 8 contains data sent by openai. The data has different choices in an array, and any of those choices can be used by using array indexing, for instance, choices[0] to choose the first choice.

```

const response = await openai.createCompletion({
  model: "text-davinci-003",
  prompt: `${prompt}`,
  temperature: 0.7,
  max_tokens: 64,
  top_p: 1,
  frequency_penalty: 0,
  presence_penalty: 0,
  stop: ["\\\"\\\"\\\" "],
})
  
```

Figure 3. OpenAI API call

```

{
  status: 200,
  statusText: 'OK',
  headers: {
    date: 'Thu, 04 May 2023 15:24:54 GMT',
    'content-type': 'application/json',
    'content-length': '292',
    connection: 'close',
    'access-control-allow-origin': '*',
    'cache-control': 'no-cache, must-revalidate',
    'openai-model': 'text-davinci-003',
    'openai-organization': 'user-i3h95veihjtrau0aoyrra4gu',
    'openai-processing-ms': '2171',
    'openai-version': '2020-10-01',
    'strict-transport-security': 'max-age=15724800; includeSubDomains',
    'x-ratelimit-limit-requests': '3000',
    'x-ratelimit-limit-tokens': '250000',
    'x-ratelimit-remaining-requests': '2999',
    'x-ratelimit-remaining-tokens': '248000',
    'x-ratelimit-reset-requests': '20ms',
    'x-ratelimit-reset-tokens': '480ms',
    'x-request-id': '60eead50eaf9da88935f3231bf0e46d',
    'cf-cache-status': 'DYNAMIC',
    server: 'cloudflare',
    'cf-ray': '7c21c0ca8ef9c7f3-TLL',
    'alt-svc': 'h3=":443"; ma=86400, h3-29=":443"; ma=86400'
  },
  config: {
    transitional: {
      silentJSONParsing: true,
      forcedJSONParsing: true,
      clarifyTimeoutError: false
    },
    adapter: [Function: httpAdapter],
    transformRequest: [ [Function: transformRequest] ],
    transformResponse: [ [Function: transformResponse] ],
    timeout: 0,
    xsrfCookieName: 'XSRF-TOKEN',
    xsrfHeaderName: 'X-XSRF-TOKEN',
    maxContentLength: -1,
    maxBodyLength: -1,
    validateStatus: [Function: validateStatus],
    headers: {
      Accept: 'application/json, text/plain, */*',
      'Content-Type': 'application/json',
      'User-Agent': 'OpenAI/NodeJS/3.2.1',
      Authorization: 'Bearer sk-
        x22Iv0reajPdYVoBoMDvT3B1bkFJ26R94f8aLXBE1UpzsxAb',
      'Content-Length': 136
    },
    method: 'post',
    data: '{"model": "text-davinci-003", "prompt": "Hello \\n", "
      temperature": 0, "max_tokens": 2000, "top_p": 1, "frequency_penalty
        ": 0.5, "presence_penalty": 0}',
    url: 'https://api.openai.com/v1/completions'
  },
}

```

Figure 4. OpenAI Sample response

```

request: <ref *1> ClientRequest {
  _events: [Object: null prototype] {
    abort: [Function (anonymous)],
    aborted: [Function (anonymous)],
    connect: [Function (anonymous)],
    error: [Function (anonymous)],
    socket: [Function (anonymous)],
    timeout: [Function (anonymous)],
    prefinish: [Function: requestOnPrefinish]
  },
  _eventsCount: 7,
  _maxListeners: undefined,
  outputData: [],
  outputSize: 0,
  writable: true,
  destroyed: false,
  _last: true,
  chunkedEncoding: false,
  shouldKeepAlive: false,
  _defaultKeepAlive: true,
  useChunkedEncodingByDefault: true,
  sendDate: false,
  _removedConnection: false,
  _removedContLen: false,
  _removedTE: false,
  _contentLength: null,
  _hasBody: true,
  _trailer: '',
  finished: true,
  _headerSent: true,
  socket: TLSSocket {
    _tlsOptions: [Object],
    _secureEstablished: true,
    _securePending: false,
    _newSessionPending: false,
    _controlReleased: true,
    secureConnecting: false,
    _SNICallback: null,
    servername: 'api.openai.com',
    alpnProtocol: false,
    authorized: true,
    authorizationError: null,
    encrypted: true,
    _events: [Object: null prototype],
    _eventsCount: 10,
    connecting: false,
    _hadError: false,
    _parent: null,
    _host: 'api.openai.com',
    _readableState: [ReadableState],
    _maxListeners: undefined,
    _writableState: [WritableState],
    allowHalfOpen: false,
    _sockname: null,
    _pendingData: null,
    _pendingEncoding: '',
    server: undefined,
    _server: null,
    ssl: [TLSSocket],
    _requestCert: true,

```

```

    _rejectUnauthorized: true,
    parser: null,
    _httpMessage: [Circular *1],
    [Symbol(res)]: [TLSWrap],
    [Symbol(verified)]: true,
    [Symbol(pendingSession)]: null,
    [Symbol(async_id_symbol)]: 32,
    [Symbol(kHandle)]: [TLSWrap],
    [Symbol(kSetNoDelay)]: false,
    [Symbol(lastWriteQueueSize)]: 0,
    [Symbol(timeout)]: null,
    [Symbol(kBuffer)]: null,
    [Symbol(kBufferCb)]: null,
    [Symbol(kBufferGen)]: null,
    [Symbol(kCapture)]: false,
    [Symbol(kBytesRead)]: 0,
    [Symbol(kBytesWritten)]: 0,
    [Symbol(connect-options)]: [Object],
    [Symbol(RequestTimeout)]: undefined
  },
  _header: 'POST /v1/completions HTTP/1.1\r\n' +
    'Accept: application/json, text/plain, */*\r\n' +
    'Content-Type: application/json\r\n' +
    'User-Agent: OpenAI/NodeJS/3.2.1\r\n' +
    'Authorization: Bearer sk-
    x22Iv0reajPdYVoBoMDvT3BlbkFJ26R94f8aLXBE1UpzsxAb\r\n' +
    'Content-Length: 136\r\n' +
    'Host: api.openai.com\r\n' +
    'Connection: close\r\n' +
    '\r\n',
  _keepAliveTimeout: 0,
  _onPendingData: [Function: noopPendingOutput],
  agent: Agent {
    _events: [Object: null prototype],
    _eventsCount: 2,
    _maxListeners: undefined,
    defaultPort: 443,
    protocol: 'https:',
    options: [Object],
    requests: {},
    sockets: [Object],
    freeSockets: {},
    keepAliveMsecs: 1000,
    keepAlive: false,
    maxSockets: Infinity,
    maxFreeSockets: 256,
    scheduling: 'lifo',
    maxTotalSockets: Infinity,
    totalSocketCount: 1,
    maxCachedSessions: 100,
    _sessionCache: [Object],
    [Symbol(kCapture)]: false    22
  },
  socketPath: undefined,
  method: 'POST',
  maxHeaderSize: undefined,
  insecureHTTPParser: undefined,
  path: '/v1/completions',
  _ended: true,

```

Figure 6. OpenAI Sample response3

```

res: IncomingMessage {
  _readableState: [ReadableState],
  _events: [Object: null prototype],
  _eventsCount: 4,
  _maxListeners: undefined,
  socket: [TLSSocket],
  httpVersionMajor: 1,
  httpVersionMinor: 1,
  httpVersion: '1.1',
  complete: true,
  headers: [Object],
  rawHeaders: [Array],
  trailers: {},
  rawTrailers: [],
  aborted: false,
  upgrade: false,
  url: '',
  method: null,
  statusCode: 200,
  statusMessage: 'OK',
  client: [TLSSocket],
  _consuming: false,
  _dumped: false,
  req: [Circular *1],
  responseUrl: 'https://api.openai.com/v1/completions',
  redirects: [],
  [Symbol(kCapture)]: false,
  [Symbol(RequestTimeout)]: undefined
},
aborted: false,
timeoutCb: null,
upgradeOrConnect: false,
parser: null,
maxHeadersCount: null,
reusedSocket: false,
host: 'api.openai.com',
protocol: 'https:',
_redirectable: Writable {
  _writableState: [WritableState],
  _events: [Object: null prototype],
  _eventsCount: 3,
  _maxListeners: undefined,
  _options: [Object],
  _ended: true,
  _ending: true,
  _redirectCount: 0,
  _redirects: [],
  _requestBodyLength: 136,
  _requestBodyBuffers: [],
  _onNativeResponse: [Function (anonymous)],
  _currentRequest: [Circular *1],
  _currentUrl: 'https://api.openai.com/v1/completions',
  [Symbol(kCapture)]: false
},
}

```

Figure 7. OpenAI Sample response4

```
[Symbol(kCapture)]: false ,
  [Symbol(kNeedDrain)]: false ,
  [Symbol(corked)]: 0,
  [Symbol(kOutHeaders)]: [Object: null prototype] {
    accept: [Array],
    'content-type': [Array],
    'user-agent': [Array],
    authorization: [Array],
    'content-length': [Array],
    host: [Array]
  }
},
data: {
  id: 'cmpl-7CV76R3eLfE7cAVV9W8FhJITKg88B ',
  object: 'text_completion ',
  created: 1683213892,
  model: 'text-davinci-003 ',
  choices: [ [Object] ],
  usage: { prompt_tokens: 2, completion_tokens: 10, total_tokens:
    12 }
```

Figure 8. OpenAI Sample response5

Deployment Both the Frontend and the Backend had to be considered in order for the application to be deployed properly. The Frontend was deployed in Vercel which is a cloud platform for hosting faster frontend applications while the backend was deployed in Render which is one of the fastest unified clouds to host the Backend applications.

Data Analysis: The data collected through the survey and observations will be analyzed using content analysis. The data will be transcribed, coded, and analyzed to identify key themes related to user experience, design requirements, and suggestions for improvement.

Validity and Reliability:

- To ensure validity and reliability in the qualitative data collection and analysis, the following strategies will be implemented:
- Interview questions will be designed based on the research questions and literature review to ensure they are relevant and valid.
- Interviews will be documented verbatim to ensure accuracy in data collection.
- Member checking will provide participants with a summary of their responses to ensure accuracy and validity.

The quantitative research approach for the design of a chatbot to provide companionship for older adults with depression using OpenAI GPT-3 would involve collecting numerical data to measure the effectiveness of the chatbot in improving the mental health of the target population.

The steps in this project's quantitative research approach are as follows:

Define the research questions: The research questions for this project includes:

- RQ 1: What requirements are required to develop a chatbot for depressed older adults?
- RQ 2: How to implement a suitable chatbot based on Research Question 1?
- RQ 3: How can the effectiveness and usability of the chatbot be evaluated and improved for older adults with depression?

Developed a hypothesis: A hypothesis is a statement that predicts the relationship between the variables being studied. For this project, a possible hypothesis would be: The chatbot will be effective in reducing symptoms of depression in older adults and will be well-received as a companion.

Selecting the participants: The participants for this study would be older adults with a diagnosis of depression.

Developed a survey/questionnaire: A survey/questionnaire would be developed to collect quantitative data from the participants. The questions would be designed to measure the effectiveness of the chatbot in reducing symptoms of depression and the satisfaction level of the users.

Implement the chatbot: The chatbot would be developed and implemented using OpenAI GPT-3. The chatbot would be programmed to respond to specific keywords related to depression and provide companionship to the users.

Conduct the study: The study would be conducted by providing the chatbot to the participants and collecting data on the reduction in symptoms of depression and satisfaction level of the users using the survey/questionnaire.

3.2 Approach to Answering Research Questions

This section explains how each research question was answered.

3.2.1 Approach for RQ1

A detailed analysis of the extant chatbot literature and their use in mental health care for older adults was Conducted, and studies, reports, and other sources of information that discuss the potential benefits and drawbacks of using chatbots to help address depression in older adults was Identified. We identified the target population and Determined the characteristics of the target population, specifically depressed older adults. This includes age range, gender, cultural background, education level, and other factors that may impact the design and development of the chatbot.

To elicit emotional requirements, we plan to perform a survey with quite some depressed adults who will fill in a questionnaire about the chatbot application. The reason we decided to do a survey is to be able to reach as many people as possible and get their valuable feedback. Then we identified the key features the chatbot should have to meet the defined goals and objectives.

Based on our idea, we planned to perform a survey for user research to find out how depressed older adults are currently using chatbots for companionship and what are their main pains to solve (what could be done better?). In order not to narrow down the group of interviewees too much, we planned to conduct interviews with depressed older adults in different age ranges, gender, cultural background, and education level:

- age over 50, mostly working, in partnership, probably without children yet;

- age over 50, families with children;
- age over 50, couples living without children, pensioners, etc

Survey goal models are easily converted into user requirements through user stories. The acceptance criteria would be scenario-oriented. A scenario-oriented acceptance criterion captures the requirements of the story in a format "Given <some precondition >, when < the user takes some action >, then < the user expects some result >." Acceptance criteria help the team confirm when the application functions as desired, meaning the user story is completed. This helps to know exactly what conditions should be met, just as the depressed older adult knows what to expect from the app. It serves as a basis for testing and simplifies planning and estimating the effort required to deliver the stories. For writing meaningful user stories, We would use the INVEST model. By INVEST, the user stories would be

- Independent – could be delivered in any order
- Negotiable – not a contract, but an invitation to conversation
- Valuable – if there's no value in the story, there's no point in doing it
- Estimable – the team must be able to estimate the effort required for the story to get done
- Small – every story should be doable in 2-4 days
- Testable – once done, it must be possible to test if the story is done

The User stories would follow this specific format: "As a < type of user >, I want < some goal >, so that < some reason >."

3.2.2 Approach for RQ2

The below would be used to answer Research Question 2

We chose a programming language compatible with the OpenAI API and your chatbot's backend, and the one used for the chatbot is Node.js. we also use a web server to host your chatbot's backend and handle requests to the OpenAI API, and the Popular choices include Apache. The approach for implementing the chatbot would be using the deep learning models from OpenAI. Deep learning models are used to train chatbots to recognize and respond to user input more accurately. OpenAI provides several deep learning models which can be customized for a particular use case in which a chatbot is a sample. These models can be used to identify user intent and generate relevant responses. OpenAI provides several deep-learning models that can be used for developing chatbots. Some of the most popular models are:

- GPT-3 (Generative Pre-trained Transformer 3): One of the most sophisticated natural language processing models now in use is this. This model produces responses similar to human responses, making it an ideal choice for developing conversational chatbots.
- GPT-2 (Generative Pre-trained Transformer 2): This model is similar to GPT-3 but is slightly less powerful. It can still generate high-quality responses to user input and is a popular choice for chatbot development.
- BERT (Bidirectional Encoder Representations from Transformers): This model can comprehend the meaning behind an input written by a user because it was created expressly for jobs involving natural language processing. It is a good choice for developing chatbots that require more advanced language processing capabilities.
- Transformer-XL: This model is designed to handle longer text sequences, making it well-suited for chatbots that require more complex responses.
- CTRL (Conditional Transformer Language Model): This model is designed to generate text that matches a specific writing style or topic. It can be useful for developing chatbots that need to generate responses in a particular tone or style.

This interface can be customized with chat themes, emoticons, and other features. The following would be considered when designing the Web chat interface:

- Chat widget: A chat widget is a small chat interface that can be embedded into a web page. This interface can be customized with different chat themes, icons, and colors. It may also include features like quick replies, typing indicators, and message history.
- Full-page chat interface: A full-page chat interface is a standalone web page that provides a complete chat experience for the user. This interface can include features like chat history, user profiles, and settings.
- Floating chat interface: A floating chat interface is a chat widget that floats over the content of a web page. This interface can be positioned in the screen's bottom corner and easily collapsed or expanded.
- Modal chat interface: A modal chat interface is a chat widget that appears in a pop-up window over the content of a web page. This interface can be triggered by a button or link on the page and easily dismissed.

The below technology would be used to develop the web chat interface for a chatbot:

- JavaScript, HTML, and CSS are the three languages that make up a web page. HTML creates the page's structure, CSS gives it style, and JavaScript gives it functionality.
- VanillaJS: VanillaJS is a popular JavaScript library for building user interfaces. Majorly used for creating responsive interfaces for web chat; It has reusable components and efficient rendering.
- Node.js: Node.js is a JavaScript run-time environment that can be used to build backend services for chatbots. It can be used to create APIs and WebSockets that handle the communication between the chatbot and the web chat interface.
- WebSocket: WebSocket is a protocol for real-time communication between a client and a server. It can create persistent connections between the chatbot and the web chat interface, allowing for fast and efficient communication.

The Chatbot would also integrate with external services, such as databases, APIs, and third-party applications, so the below would be incorporated into the chatbot. It is important to ensure that these integrations are well-designed and secure.

Integrating OpenAI's GPT-2 or GPT-3 models into the chatbot requires several programming and technology components. Here are some of the things we used:

- OpenAI API key: we need to obtain an API key from OpenAI to access the GPT-2 or GPT-3 models.
- API integration: we need to integrate OpenAI's API into your chatbot's backend. This can be done using REST APIs or SDKs provided by OpenAI.

Testing is an important part of creating an efficient chatbot with OpenAI deep learning technique, which would help us ensure that the chatbot we build functions efficiently and effectively. Regular user testing would help identify areas for improvement and guide future development. Here are some testing types that are going to be used to ensure the chatbot meets the requirements:

- Functional testing: This type of testing ensures that the chatbot's basic functions work as expected. It includes testing the chatbot's ability to understand user input and provide accurate responses.
- Usability testing: Testing of this kind concentrates on the chatbot's ease of use and user experience. It includes testing the chatbot's interface, navigation, and flow to ensure that users can easily interact with the chatbot.
- Performance testing: This type of testing ensures that the chatbot can handle high volumes of traffic and user interactions without crashing or slowing down. It includes testing the chatbot's response time, load balancing, and scalability.

3.2.3 Approach for RQ3

The below would be used to answer Research Question 3

We will use the Chatbot User Experience Scale (CUES) to assess the outcomes from RQ2, the practical application we have developed. The Chatbot User Experience Scale (CUES) is a standardized survey instrument to evaluate chatbots' user experience. The CUES was developed by researchers at the University of Duisburg-Essen in Germany to address the need for a specific scale to measure the user experience of chatbots, which are becoming increasingly common in various domains, including healthcare, customer service, and education.

The CUES has 24 items, each assessed on a 7-point Likert scale, with one denoting "strongly disagree" and seven denoting "strongly agree.". The items are organized into five subscales: usability, usefulness, satisfaction, social presence, and trust.

As shown in Table 1, The usability subscale includes items that assess the ease of use and navigation of the chatbot, such as "The chatbot was easy to use." The usefulness subscale includes items that assess the perceived usefulness of the chatbot, such as "The chatbot helped me achieve my goals." The satisfaction subscale includes items that assess the overall satisfaction with the chatbot, such as "I was satisfied with the chatbot." The social presence subscale includes items that assess the extent to which the chatbot was perceived as human-like, such as "The chatbot was like a human." The trust subscale includes items that assess the perceived reliability and credibility of the chatbot, such as "The chatbot provided accurate information."

After completing the CUES, the scores for each subscale are calculated by averaging the scores of the relevant items. The total score is obtained by getting the average of all items. A higher score indicates a better user experience.

The CUES is a useful tool for evaluating the user experience of chatbots, particularly in applications where chatbots are expected to provide support or assistance to users. The outcomes of the CUES can be utilized to pinpoint development areas and guide design choices to improve the chatbot user experience.

3.3 Chatbot Development

The GPT-3 language model from OpenAI will be used to build the chatbot. To produce natural and meaningful responses to the user's input, the model will be trained on a sizable dataset of conversational data. The chatbot will be created to offer emotional support and companionship to elderly people suffering from depression by having deep talks with them.

The chatbot will also be provided with pertinent data and resources on depression, enabling it to offer helpful assistance to older persons experiencing depression. Log data evaluation The chatbot can be programmed to record the exchanges it conducts with senior citizens. This log data can be examined to learn more about the subjects and forms

Table 1. CUES Questions

Number	Question
1	The chatbot was easy to use
2	I was able to navigate the chatbot easily
3	I didn't have any problems using the chatbot
4	The chatbot was responsive
5	The chatbot was fast
6	The chatbot was efficient
7	The chatbot provided useful information
8	The chatbot was relevant to my needs
9	The chatbot was informative
10	The chatbot met my expectations
11	I was satisfied with the chatbot
12	I enjoyed using the chatbot
13	The chatbot was engaging
14	The chatbot was fun to use
15	The chatbot was like a human
16	The chatbot had a personality
17	The chatbot was friendly
18	The chatbot provided accurate information
19	The chatbot was reliable
20	The chatbot was trustworthy

of assistance that the chatbot offers to older folks who are depressed.

You can ask older persons who use the chatbot for feedback on their interactions with it. Using rating systems or open-ended questions, this feedback can be gathered. Assessments conducted before and during the chatbot experience with older persons can help researchers understand how the chatbot has affected their depressive symptoms and overall mental health.

An older adult comparison group that did not use the chatbot but otherwise matched in terms of demographic and depression-related traits can be used in the study. The two groups' differences in mental health and depression symptoms can be compared. Examining the effects of the chatbot over a longer time frame, such as several months or a year, is possible with longitudinal research. This can help us better understand how the chatbot affects older folks who are depressed. These techniques can supplement the survey and in-depth interviews with additional information while enhancing the results' validity.

3.4 Dataset

Models already trained include OpenAI's GPT-3 language model, which was trained on a sizable corpus of text that included material on depression and mental health. This training can be used as a beginning point to teach the chatbot about offering companionship to elderly people who are depressed. Using these datasets, the chatbot can be trained without directly interacting with older adults struggling with depression.

OpenAI uses a variety of datasets to train its language models, including GPT-3 and its variants. which includes:

- **Common Crawl:** This is a dataset of web pages frequently used to train language models. It contains billions of web pages in multiple languages and is a great source of diverse text data.
- **BooksCorpus:** This dataset comprises over 11,000 books and trains language models on various topics and styles.
- **Wikipedia:** Wikipedia is a commonly used dataset for training language models, as it contains vast text data on a wide range of topics.
- **OpenWebText:** This is a dataset of web pages curated by OpenAI and used to train language models. It contains over 7,000 books, articles, and a diverse range of other web content.
- **One Billion Word Benchmark:** This is a text dataset commonly used to benchmark language models. It is intended to evaluate how well language models can anticipate the next word in a phrase comprising roughly one billion words.
- **ImageNet:** This dataset of millions of images is used to train machine learning models for image recognition tasks. However, it can also train language models, as many images accompany descriptive captions.

The datasets used by OpenAI for training its language models, along with their sizes:

- **GPT-3:** Trained on a diverse range of datasets, including Common Crawl, BooksCorpus, and OpenWebText, among others. It contains up to 175 billion parameters, making it one of the largest language models available.
- **GPT-2:** Trained on various datasets, including BooksCorpus, WebText, and Wikipedia, among others. Contains up to 1.5 billion parameters. **Transformer-XL:** Trained on the One Billion Word Benchmark dataset. Contains up to 257 million parameters.
- **ELMo:** Trained on various datasets, including Wikipedia, BooksCorpus, and the Billion Word Benchmark, among others. Contains up to 94 million parameters.

- BERT: Trained on various datasets, including BooksCorpus, Wikipedia, and the Common Crawl, among others. Contains up to 340 million parameters.
- Davinci: Trained on a diverse range of datasets, including Common Crawl, BooksCorpus, and OpenWebText, among others. It contains up to 1.2 trillion parameters, making it the largest language model available from OpenAI as of September 2021.
- Text-davinci-002: Trained on a similar set of datasets as Davinci, including Common Crawl, BooksCorpus, and OpenWebText. It contains up to 1.5 billion parameters, making it smaller than Davinci but still a powerful language model.
- Text-davinci-003: Trained on a larger and more diverse set of datasets compared to Text-davinci-002, including sources such as scientific papers, patents, and books. It contains up to 175 billion parameters, making it the same size as GPT-3. The use of diverse and high-quality datasets is essential for developing accurate and effective language models, and OpenAI has leveraged various sources to train its models. The dataset's size and diversity will determine how much information the model can learn and how well it will perform.

3.5 Utilizing OpenAI for Chatbot development

The OpenAI language model will be utilized to create the chatbot. To train the chatbot to have meaningful discussions with elderly people who are depressed, a sizable dataset of talks will be used. The chatbot will be created to deliver reassuring and friendly interactions, such as enquiring about the participant's day and encouraging them. Additionally, the chatbot will be programmed to respond appropriately to any depressive symptoms that a participant may mention.

3.5.1 OpenAI evaluation of the chatbot

The chatbot evaluation will combine qualitative and quantitative measures. Participants will converse with the chatbot and provide feedback on its effectiveness and usability as part of human evaluations.

OpenAI uses both deep learning techniques and natural language processing (NLP) to develop its language models and AI systems. Machine learning uses deep learning, which includes teaching neural networks with massive amounts of data to equip them to handle challenging tasks like speech recognition, image recognition, and natural language processing. OpenAI uses deep learning techniques to train its language models, such as GPT-3, which can generate human-like text and conversation.

On the other hand, The Natural language data, which could be text, is analyzed and processed by NLP to enable computers to understand and respond to human language.

OpenAI's language models are designed to perform NLP tasks like language generation, text classification, and sentiment analysis. These NLP capabilities enable the chatbot developed using OpenAI to provide a personalized and engaging conversational experience for older adults with depression.

3.6 Deep Learning Technique

A branch of machine learning called deep learning that involves training artificial neural networks with large amounts of data to enable them to perform complex tasks, such as image recognition, speech recognition, natural language processing, and decision-making.

Deep learning uses the term "deep" to refer to the number of layers in the neural network, which can range from a few levels to hundreds or even thousands of layers. Each layer in the network performs mathematical operations on the input data, transforming it into a more abstract representation that subsequent layers can use to perform more complex tasks.

Iteratively modifying the neural network's parameters during the training phase of deep learning reduces the error between the output for a given input and the projected output. This is typically done using a technique called backpropagation, which calculates the error's gradients regarding each parameter in the network and updates them accordingly.

Deep learning's capacity to automatically learn features from unprocessed data, without the need for manually created features, is one of its key advantages. As a result, it works well for applications requiring complex, high-dimensional input data, including photos or text. Numerous applications, such as computer vision, audio recognition, natural language processing, and recommendation systems, have used deep learning.

3.7 Models

The GPT-3 pre-trained language models from Brown et al. are where it will begin (2020). These models have described behavior despite being trained on a large variety of Internet data and being flexible to various downstream applications. From these models, we can then train models using three different techniques:

3.7.1 Davinci

The Davinci model is one of the most powerful language models created by OpenAI. It is a variant of the GPT-3 architecture, known as a deep neural network type designed to generate writing that resembles a person's.

The Davinci model has an enormous number of parameters - around 175 billion - significantly more than any other language model available today. With such a huge

number of parameters, the model can produce very similar text to human writing and carry out various tasks involving natural language processing, such as question-answering, language translation, and even creative writing.

One of the key features of the Davinci model is its ability to perform multi-step reasoning and understand complex instructions. It can also generate consistent and coherent responses across different topics and contexts, making it highly Adaptable and beneficial for various uses.

In addition, the Davinci model can understand and generate text in multiple languages. It is designed to be highly flexible and adaptable, able to learn and generate text in a wide range of contexts and styles.

The Davinci model, in general, represents a huge development in natural language processing and has the potential to completely change how we engage with language technology in the future. Numerous applications, such as chatbots, language translation, content creation, and others, have already used it.

3.7.2 Text-davinci-003

The text-davinci-003 model is one of the most powerful language models created by OpenAI, based on the GPT-3 architecture. It is one of the biggest language models in use and has about 175 billion parameters.

Some of the unique features of the text-davinci-003 model include its ability to perform multi-step reasoning, follow complex instructions, and generate coherent and consistent responses across different topics and contexts.

In addition, the text-davinci-003 model can also understand and generate text in multiple languages, including English, Spanish, French, German, Italian, Portuguese, and more.

Overall, the text-davinci-003 model represents a significant advancement in natural language processing, and it has the potential to transform how we use language technology going forward completely.

3.7.3 Text-davinci-002

The text-davinci-002 model is a language model developed by OpenAI based on the GPT-3 architecture. It is the predecessor to the more powerful text-davinci-003 model.

The text-davinci-002 model has around 1.5 billion parameters, which is still very large compared to most other language models. The model can produce text that resembles a human being and carry out many natural languages processing tasks, such as question answering, language translation, and even creative writing, thanks to its extensive set of parameters.

The text-davinci-002 model is capable of understanding and generating text in various languages. It is intended to be extremely adaptable and carry out various activities, from

easy to difficult, with high precision and fluency.

The text-davinci-002 model has been utilized in various applications, including chatbots, language translation, and content creation, even though it is not as strong as its successor.

Overall, the text-davinci-002 model represents a significant step forward in developing language technology and highlights the potential for even more powerful language models.

3.7.4 GPT-3

GPT-3 stands for "Generative Pre-trained Transformer 3". It is a language model created by OpenAI that produces text that resembles human speech using deep learning methods.

The GPT-3 model is one of the most powerful language models available today, with up to 175 billion parameters. It can be used for various natural language processing activities, such as question-and-answer functions, text completion, and creative writing.

The key feature of GPT-3 is its ability to generate high-quality text virtually indistinguishable from text written by humans. An "unsupervised learning" technique is used to achieve this, in which the model is trained on enormous amounts of text data without explicit labeling or instruction.

As a result, text can be generated in multiple languages, contexts, and styles and can even understand and generate text in multiple languages.

GPT-3 has been used in various applications, including chatbots, content generation, and language translation. Although its capacity to produce text that resembles human speech has sparked worries about how such technology can be misapplied, it also holds considerable promise for enhancing the efficacy and efficiency of tasks involving natural language processing.

The GPT-3 model has made tremendous progress in natural language processing and shows that there is still room for even more potent language models in the future.

4 Result

This chapter will present the results and analysis of the study evaluating the effectiveness and usability of the chatbot to provide companionship for older adults with depression using OpenAI

4.1 Answers to the Research Questions 1

4.1.1 Application's initial prototype

Overall, this initial prototype would be designed to provide older adults with depression with companionship, support, and resources to help them manage their mental health and improve their overall well-being. It would be focused on user-centered design principles and would prioritize ease of use, functionality, and privacy protection. The initial prototype would include the following features:

- **Welcome message and introduction:** When the user opens the chatbot, they will receive a warm welcome message and a brief introduction to its purpose and functionality.
- **Check-in prompts:** The chatbot would prompt users to check in daily and ask how they feel. The user could respond with a simple rating of 1 to 5 or a more detailed message about their mood.
- **Supportive messaging:** Based on the user's response, the chatbot would provide supportive messaging and words of encouragement to help improve their mood and reduce feelings of isolation.
- **Self-care reminders:** The chatbot would remind the user to engage in self-care activities, such as taking medication, exercising, or practicing mindfulness.
- **Educational resources:** The chatbot would provide users with educational resources about mental health and depression, such as articles, videos, or podcasts, that they could access anytime.
- **Social interaction:** The chatbot would engage the user in casual conversation and provide them with companionship and social interaction to help reduce feelings of loneliness and isolation.
- **Emergency assistance:** The chatbot would have a feature that allows the user to call for help in an emergency, such as connecting them with a healthcare professional or emergency services.

- **User-friendly interface:** The chatbot would have an intuitive and easy-to-use interface, with simple commands and clear instructions that are easy for older adults to navigate.

4.1.2 Functional Requirements

- **Conversational Interface:** The chatbot should have a conversational interface that enables people to communicate with it through text input in natural language.
- **Intuitive Navigation:** The chatbot should be easy to navigate, with clear instructions and prompts to guide users through the conversation and ensure they get the support they need.
- **Emotional Support:** The chatbot should provide emotional support and encouragement to users, using appropriate language and tone to convey empathy and understanding.
- **Referrals to Mental Health Professionals:** The chatbot should be able to refer users to mental health professionals, such as therapists or psychiatrists, when necessary.
- **Privacy and Security:** The chatbot should ensure the privacy and security of user data, including their personal information and messages, and comply with relevant data protection regulations.
- **Multilingual Support:** The chatbot should be able to support various languages to cater to users from diverse backgrounds and cultures.
- **Chatbot interface:** The chatbot should have an intuitive and user-friendly interface that enables users to initiate and continue conversations.
- **Informational resources:** The chatbot should provide users with helpful and informative resources on depression, such as articles, videos, and podcasts.
- **Mood tracking:** The chatbot should enable users to track their mood over time, providing insights into their mental health and helping them identify patterns and triggers.
- **Reminders and notifications:** The chatbot should provide users with reminders and notifications for important events, such as medication reminders, therapy appointments, or self-care activities.
- **Companionship Features:** The chatbot should offer a range of features that provide companionship and support to the user, such as conversation starters, daily check-ins, and reminders to take medication or engage in self-care activities.

- **Resource Referral:** The chatbot should be able to refer the user to relevant mental health resources, such as hotlines, support groups, or online therapy sessions.
- **Accessibility:** All users should be able to use the chatbot, regardless of their physical or mental capabilities. This could include text-to-speech functionality, high-contrast interfaces, or voice commands.

4.1.3 Non-functional requirements

- **Reliability:** The chatbot should be reliable, with minimal downtime or system failures, as it is intended to provide support and companionship to users on an ongoing basis.
- **Security:** The chatbot should have strong security features to protect user data, including data encryption, secure data storage, and user authentication measures.
- **Privacy:** The chatbot should be designed to protect user privacy, with clear and transparent privacy policies and user consent requirements.
- **Performance:** The chatbot should be designed to perform efficiently, with fast response times, minimal lag, and the ability to handle large user interactions.
- **Scalability:** The chatbot should be designed to scale to accommodate growing users and increasing demand for its services.
- **Usability:** The chatbot should be designed to be user-friendly and accessible, with a clear and intuitive interface that is easy to navigate for older adults with varying levels of technical proficiency.
- **Compatibility:** The chatbot should be compatible with various devices and platforms, including desktop and mobile devices, and should be designed to work seamlessly with other tools and resources that the user may be using.
- **Maintainability:** The chatbot should be designed to be easily maintainable and updatable, with a clear and well-documented code base that developers can easily modify or extend as needed.

4.1.4 Summary of Survey Result

We conducted a poll with a sizable number of people who will answer questions regarding our chatbot application to elicit emotional needs. We conducted a poll to contact as many individuals as possible and obtain their insightful comments. The "Think/Feel/Act" framework, which stands for the following, will be the primary guide for the survey's main objective.

1. Think refers to our thoughts and beliefs about a situation.
2. Feel refers to our emotions or feelings about a situation.
3. Act refers to our behavior or actions in response to a situation.

The "Think/Feel/Act" framework is useful in understanding how the chatbot could help shift the negative thought patterns often accompanying depression in older adults. By using cognitive-behavioral techniques, such as re-framing negative thoughts and practicing mindfulness, the chatbot could help older adults identify and challenge negative thought patterns, which could, in turn, lead to more positive emotions and behaviors

We surveyed 67 people to gather the information required for the Think/Feel/Act framework. To find out the participants' ages, genders, education levels, employment statuses, and countries, we first asked them a few questions. Also, we asked them some questions about how they think and feel.

The summary of the answers to the initial questions we asked our participants to help us get to know them may be found below.

- Age - according to Figure 9, 74.6 percent of participants were below 40; 3 percent were between the ages of 40 and 59; and 22.4 percent were between the ages of 60 and 79, but we will be considering more on the ages between 40 to 79
- Gender: From the survey, we had participation from both gender, 41.5 percent of whom were female and 58.5 percent of whom were men (see Figure 10).
- Education level: 47.8 percent of respondents said they had a bachelor's degree, 22.4 percent said they are graduate degree owners, 11.9 percent have a high degree or equivalent, 11.9 percent have some trade school or college degree and 4.5 percent have an associate's degree. Look at Figure 11.
- Employment Status: 46.3 percent of the participants were employed full-time, 11.9 percent were entrepreneurs, 16.4 percent were part-time employers, 17.9 percent were unemployed, and 7.5 percent were retired (see Figure 12).
- Country - We have gotten responses from countries worldwide, including Nigeria, Estonia, Nepal, the United Kingdom, and others (figure 13).

What is your age range?

67 responses

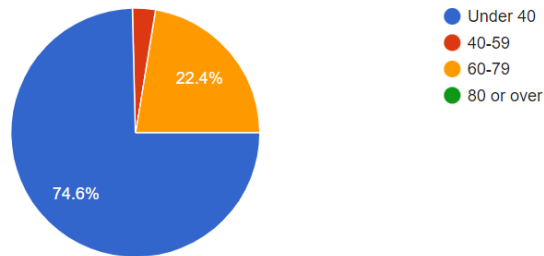


Figure 9. Age Result.

What is your gender?

65 responses

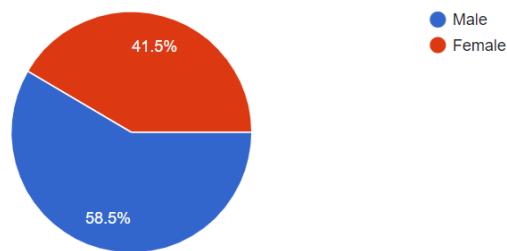


Figure 10. Gender Result

What is your highest level of education?

67 responses

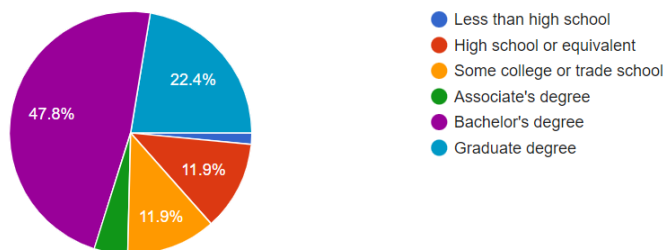


Figure 11. Education Result

What is your current employment status?

67 responses

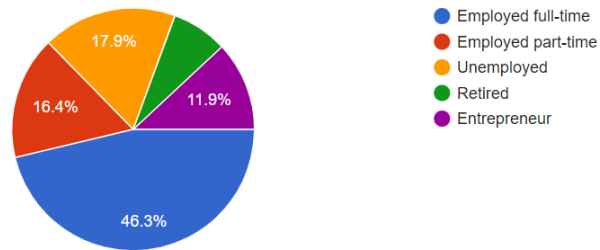


Figure 12. Employment Result

Where are you from?

Copy

62 responses

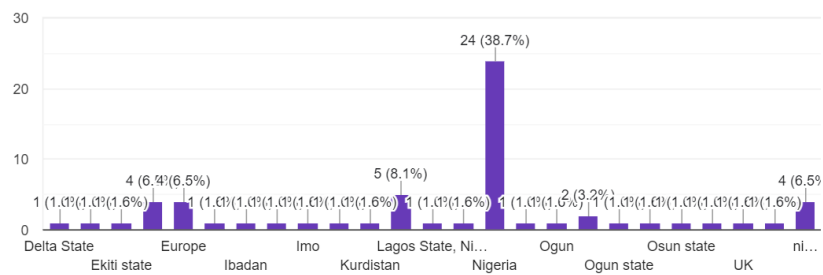


Figure 13. country Result

Companionship Feature What features would you want the chatbot to have to provide companionship?

- Emotional support
- Encouragement to engage in activities
- Conversational prompts
- Daily check-ins
- Jokes or humor

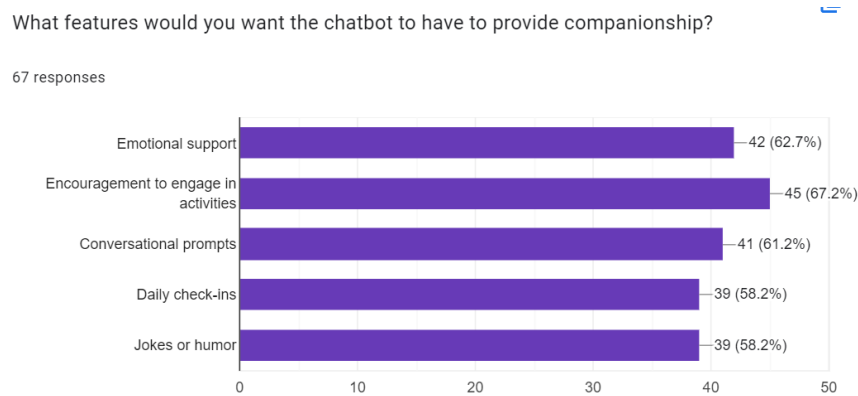


Figure 14. Companionship Feature

Conversation topics Feature What type of conversation topics would you like the chatbot to provide?

- General conversation
- Discussing hobbies and interests
- Discussing life experiences
- Mental health and self-care tips
- Spiritual topics

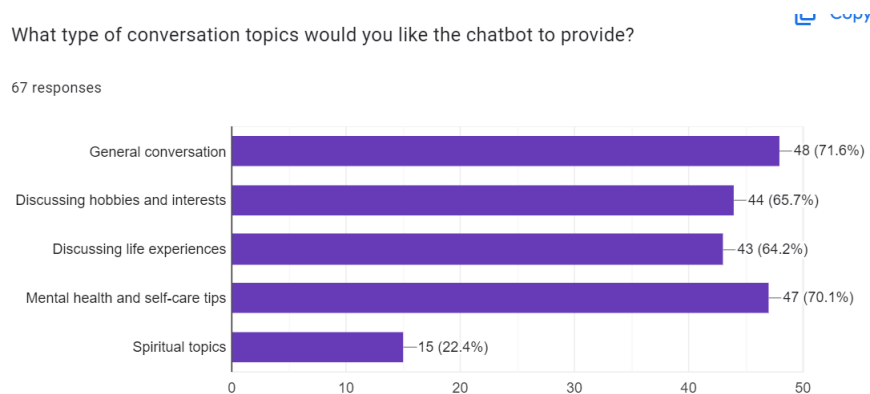


Figure 15. conversation topics Feature

Reminder Feature Would you like the chatbot to provide reminders for self-care activities, such as taking medication or engaging in physical activity?

- Yes
- No

Would you like the chatbot to provide reminders for self-care activities, such as taking medication or engaging in physical activity?

66 responses

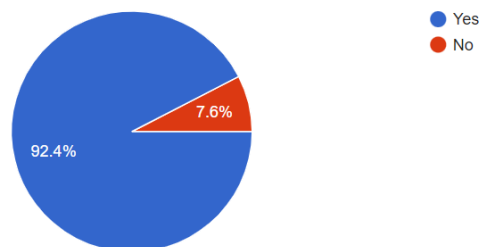


Figure 16. Reminder Feature

Referral Feature On a scale of 1 to 5, how important do you think it is for a chatbot designed to provide companionship to older adults with depression to be able to refer users to mental health resources?

- 1 (Not important at all)

On a scale of 1 to 5, how important do you think it is for a chatbot designed to provide companionship to older adults with depression to be able to refer users to mental health resources?

66 responses

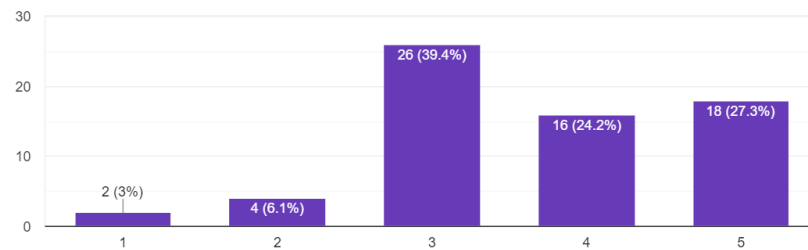


Figure 17. Referral Feature

- 2
- 3
- 4
- 5 (Very important)

Design Feature On a scale of 1 to 5, how important do you think it is for a chatbot designed to provide companionship to older adults with depression to have a user-friendly interface?

- 1 (Not important at all)
- 2
- 3
- 4
- 5 (Very important)

4.1.5 Extracting User Stories

MosCoW model We use the MoSCoW model, a prioritization technique that can be used to categorize and prioritize requirements in a project.

Must-Have Requirements: These are the requirements that are essential to the chatbot's purpose and must be included in the design, This include

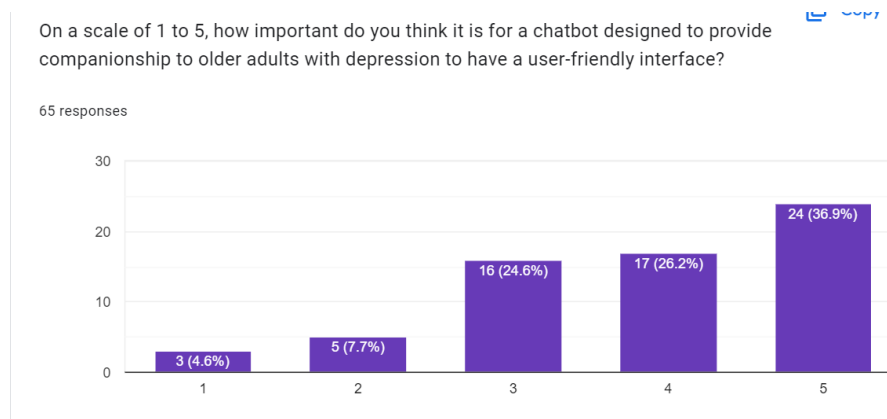


Figure 18. Design Feature

- The chatbot must be able to engage in conversational interactions with older adults with depression.
- The chatbot must provide emotional support and companionship to users.
- The chatbot must have a friendly and conversational tone.
- The chatbot must be easy to use and navigate for older adults.

Should-Have Requirements: These are important but not critical to the chatbot's purpose. This include:

- The chatbot should be able to identify warning signs of depression and provide resources for help.
- The chatbot should be able to track a user's mood and suggest activities or interventions based on the mood.
- The chatbot should provide personalized support based on the user's interests and preferences.

Could-Have Requirements: These are desirable but unnecessary for the chatbot's purpose. This include:

- The chatbot could have the ability to integrate with other healthcare systems to provide a comprehensive care experience.
- The chatbot could have the ability to provide guided meditation or mindfulness exercises.

- The chatbot could have the ability to connect users with peer support groups or other social activities.

Won't-Have Requirements: These are deemed unnecessary or not feasible for the project. This include:

- The chatbot won't be able to provide medical advice or diagnosis.
- The chatbot won't have the ability to prescribe medication.
- The chatbot won't have the ability to replace human interaction or professional mental health services.

By applying the MoSCoW model, we were able to prioritize the requirements and focus on the most critical and essential features of the chatbot while also considering other desirable features that can enhance the user experience. This approach also helped us to allocate resources and effort efficiently and effectively to achieve the goals

These user stories would help guide the development of a chatbot designed to provide companionship for older adults with depression, focusing on meeting their specific needs and preferences. Below are the user stories:

1. As an older adult with depression, I want a chatbot that can provide daily check-ins and conversation starters to help me feel less isolated and improve my mood.
2. As an older adult with depression, I want a chatbot that can track my mood over time and provide insights into patterns or triggers affecting my mental health.
3. As an older adult with depression, I want a chatbot that can refer me to resources or support groups to help me cope with my condition and connect with others who understand what I'm going through.
4. As an older adult with depression, I want a chatbot with an easy-to-use interface and clear instructions to feel comfortable and confident using it.
5. As an older adult with depression, I want a chatbot that is available 24/7 so that I can access support whenever I need it, regardless of the time of day.
6. As an older adult with depression, I want a secure chatbot that protects my privacy so that I can feel safe sharing my personal information and feelings.
7. As an older adult with depression living alone, I want a chatbot that can provide conversation starters and engage in a casual chat with me so that I can feel less lonely and isolated.

8. As a caregiver of an older adult with depression, I want a chatbot that can provide resource referrals and offer emotional support so that I can better support my loved one's mental health needs.
9. As an older adult with depression who prefers texting over phone calls, I want a chatbot that is available 24/7 and has an easy-to-use interface so that I can access mental health support whenever I need it.
10. As an older adult with depression, I want the chatbot to check in with me daily to see how I'm feeling and offer support and encouragement.
11. As an older adult with depression who lives alone, I want the chatbot to provide me with social interaction and companionship to help me feel less isolated.
12. As an older adult with depression, I want the chatbot to offer me resources and information about mental health and depression, such as articles or videos I can access anytime.
13. As an older adult with depression who is not tech-savvy, I want the chatbot to have an easy-to-use interface and simple commands that I can understand and navigate easily.
14. As an older adult with depression who values privacy, I want the chatbot to protect my personal information and ensure my conversations are secure and confidential.
15. As an older adult with depression who may need assistance in an emergency, I want the chatbot to have a feature that allows me to call for help or connect with a healthcare professional.

4.2 Answers to the Research Questions 2

4.2.1 Structure

Figure 19 depicts the class diagram, which shows the structure of the chatbot by modeling its classes, their attributes, methods, and relationships with other classes. The chat session class represents the user interface of the chatbot. It contains a method that allows older adults to interact with the chatbot and input and receive information. This class represents the messages exchanged between the user and the chatbot. It contains attributes such as the message content, sender, and timestamp. This class also represents the conversation flow between the user and the chatbot. It contains attributes such as the current state of the conversation, the history of messages exchanged, and any relevant context or information.

The Chatbot Class in the figure represents the chatbot itself. It contains methods that allow the chatbot to process older adults' input, generate responses, and manage the

conversation flow. It also contains the chatbot's knowledge base, which may include data such as FAQs, responses to common questions, and other relevant information.

The User Class represents the older adult who is interacting with the chatbot. It contains attributes such as the user's name, age, location, and other relevant information. It also contains methods for validating their input and providing personalized responses.

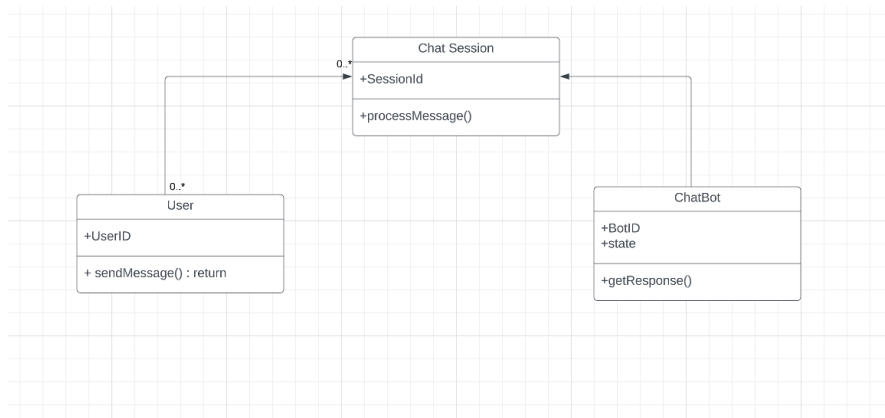


Figure 19. chatbot class Diagram



Figure 20. high-level chatbot class Diagram

Figure 20 shows the high-level class design of the chatbot. The Chatbot class

represents the chatbot itself. It has a single attribute, the brain, an instance of the Brain class. The Chatbot class also has a single method, respond(), which takes a message from the user as input and returns a response.

The Brain class represents the "brain" of the chatbot. It has a single attribute, knowledge, and a dictionary that stores information the chatbot has learned from previous conversations. The Brain class also has two methods, learn() and generatereply(). The learn() method takes a message from the user as input and updates the knowledge dictionary with any new information. The generatereply() method takes a message from the user as input and uses the knowledge dictionary to generate a response.

In addition to these two classes, a chatbot system may include classes to represent the chat interface (e.g., a UserInterface class) and classes to handle natural language processing (e.g., a NaturalLanguageProcessor class), and other components.

It's worth noting that this is just one possible way to represent the structure of a chatbot system using class diagrams. The actual structure of a chatbot will depend on the specific requirements and implementation details of the system.

4.2.2 Conversational Interface

The conversational interface is a critical component in designing the chatbot that provides companionship for older adults with depression. The conversational interface is the part of the chatbot that allows the user to interact with the system using natural language.

To ensure we designed an effective conversational interface, we had to consider the unique needs of older adults with depression. A serious illness called depression can make people feel gloomy, hopeless, and uninterested in doing anything.

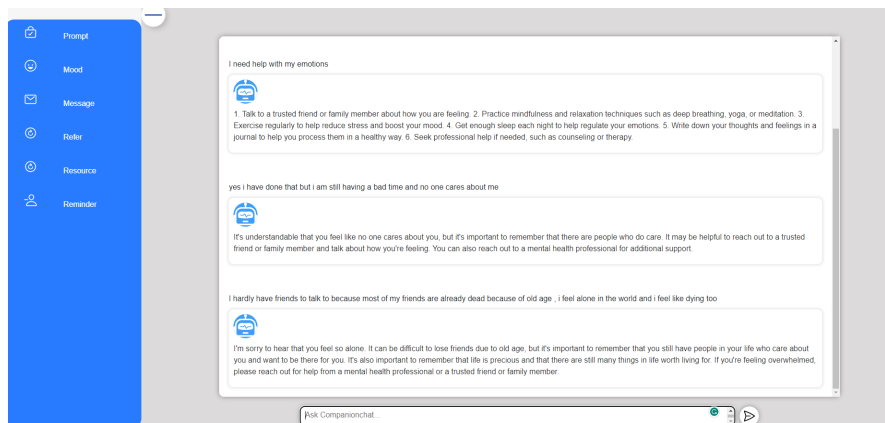


Figure 21. Conversational Interface

To overcome these difficulties, we created a straightforward, user-friendly conversational interface for the chatbot. It was also designed to encourage conversation and

provide emotional support. We ensure that the interface is not confusing or frustrating for the user, and we also make it able to adapt to the user's needs and preferences. as seen in Figure 21, the chatbot was able to generate empathetic and supportive responses, which helped make the interaction more natural and conversational. Another important thing we consider in the design of the conversational interface is the ability of the chatbot to detect signs of depression or other mental health issues. The chatbot could recognize when the user was expressing negative emotions or experiencing distress. It responded in a way that provided emotional support and encouraged the user to seek help if necessary, which it also did in Figure 21.

4.2.3 Intuitive Navigation

Intuitive navigation is another crucial component we consider in designing the chatbot that provides companionship for older adults with depression. It also allows adults to easily access the features and services of the chatbot without any confusion or difficulty.

Another important consideration in designing an intuitive navigation system is ensuring the chatbot is easy to access and use.

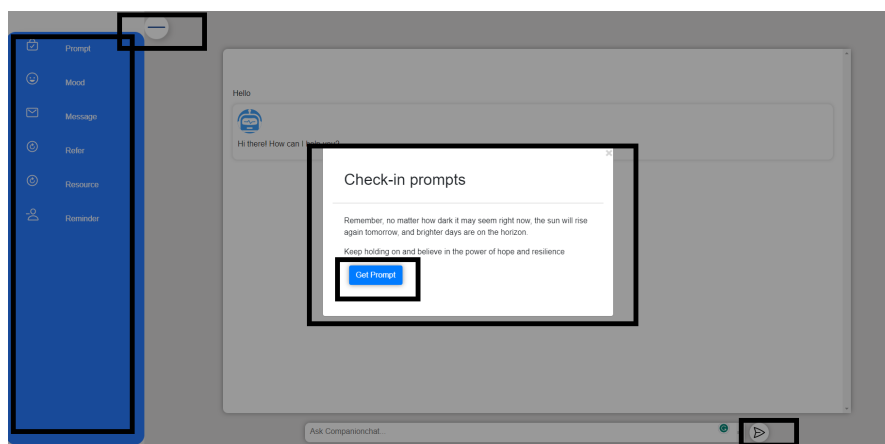


Figure 22. Intuitive Navigation

As shown in Figure 22, To make the chatbot more accessible, we made the chatbot simple to use and clear language to understand. The chatbot was designed on a single page to avoid users navigating to different pages. The sidebar components were all placed in a modal to ensure easy access to them. Another important aspect of intuitive navigation is to provide a clear path for the user to follow. By doing this, we named all buttons clearly to guide the user through the conversation logically and intuitively.

4.2.4 Emotional Support

Emotional support is a fundamental component in designing the chatbot that provides companionship for older adults with depression. We designed the chatbot to provide emotional support and encouragement to depressed adults and to help them feel more connected and less isolated.

The chatbot was designed to be empathetic and understanding to provide emotional support. It was able to recognize when the user is experiencing negative emotions or distress and respond in a way that provides comfort and support. As seen in Figure 21, when they expressed sadness or loneliness, the chatbot responded with empathy and encouragement.

Another important aspect of emotional support we considered was the ability of the chatbot to provide positive feedback and reinforcement. The chatbot provided positive reinforcement for the user's achievements and accomplishments, no matter how small. This boosted the user's confidence and self-esteem and provided a sense of accomplishment. In addition to providing emotional support, the chatbot encouraged social interaction and discouraged isolation.

4.2.5 Referrals to Mental Health Professionals

We added a referral component to the chatbot's design since it is a relevant aspect in the chatbot assisting depressed adults by providing appropriate referrals to mental health professionals.

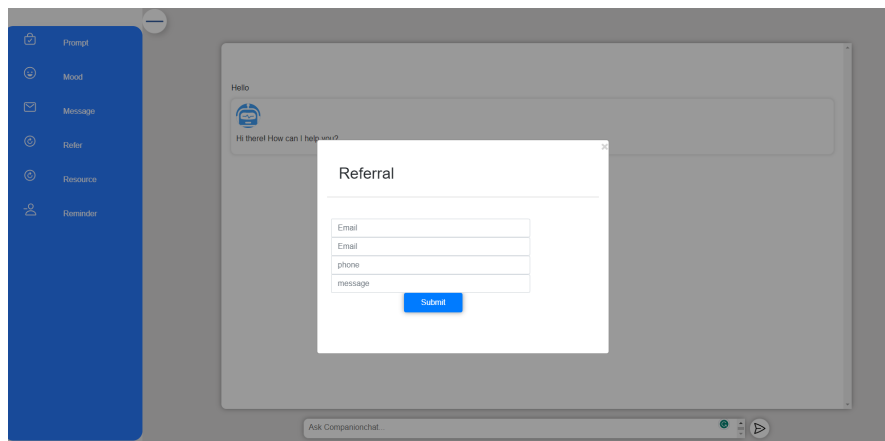
The image shows a screenshot of a chatbot interface. On the left is a blue sidebar with icons and labels for 'Prompt', 'Mood', 'Message', 'Role', 'Resource', and 'Reminder'. The main chat area has a grey background with a 'Hello' message and a question 'Hi there! How can I help you?'. A white 'Referral' form is overlaid on the chat area, containing four input fields labeled 'Email', 'Email', 'phone', and 'message', followed by a blue 'Submit' button. At the bottom of the chat area is a text input field with the placeholder 'Ask Companionchat...' and a send button.

Figure 23. Referrals to Mental Health Professionals

In Figure 23, To provide referrals, the chatbot asked appropriate screening questions to assess the user's mental health status. These questions included questions about symptoms of depression, suicidal ideation, and other relevant factors. Based on the user's

responses, the chatbot determines whether the user requires professional assistance and provides appropriate referrals, as shown in Figure 24. The chatbot should also provide information about local mental health resources and professionals, such as therapists, psychiatrists, or support groups. This can help the user to connect with mental health professionals and receive the assistance they need.

Referral

In the past two weeks, have you felt down, depressed, or hopeless?
Yes ☐ No ☐

In the past two weeks, have you experienced a loss of interest or pleasure in activities that you normally enjoy?
Yes ☐ No ☐

Have you experienced any changes in your appetite or weight recently?
Yes ☐ No ☐

Have you had difficulty sleeping or sleeping too much?
Yes ☐ No ☐

Have you felt more tired or had less energy than usual?
Yes ☐ No ☐

Have you experienced any feelings of guilt or worthlessness?
Yes ☐ No ☐

Have you had difficulty concentrating or making decisions?
Yes ☐ No ☐

Have you had any thoughts of suicide or self-harm?
Yes ☐ No ☐

Next

Figure 24. Referrals to Mental Health Professionals²

4.2.6 Multilingual Support

Multilingual support is an important component in the design of the chatbot, given the fact that it will be used worldwide and in different languages.

Chatbot Interface (Spanish):

- Left Sidebar:** Prompt, Mood, Message, Refer, Resource, Reminder.
- Chat Window:**
 - Greeting: "Hola, ¿cómo estás?"
 - User Input: "Necesito ayuda con mis emociones."
 - Bot Response: "Es normal sentirse abrumado por tus emociones. Primero, es importante reconocer que estás sintiendo y aceptar que es normal sentirse así. Luego, puedes intentar identificar qué factores están contribuyendo a tus emociones. Esto te ayudará a comprender mejor lo que estás sintiendo y cómo puedes abordarlo. También puede ser útil hablar con alguien de confianza sobre cómo te sientes. Esto puede ayudarte a liberar algunas de las emociones que estás experimentando y obtener una perspectiva externa sobre la situación. Si necesitas hablar con alguien profesionalmente, hay muchos terapeutas disponibles para ayudarte a manejar tus emociones."
 - User Input: "Casi no tengo amigos con quienes hablar porque la mayoría de mis amigos ya están muertos por la vejez, me siento solo en el mundo y tengo ganas de morir también."
 - Bot Response: "Entiendo cómo te sientes. Estoy seguro de que hay muchas personas que comparten tus sentimientos. Si estás buscando alguien con quien hablar, hay muchos grupos de apoyo en línea para personas mayores que pueden ofrecerte una comunidad de personas con las que puedes compartir tus pensamientos y sentimientos. También hay muchas organizaciones locales y nacionales dedicadas a ayudar a las personas mayores a encontrar amigos y actividades para mantenerse ocupados. Si no estás seguro de dónde buscar, puedes comenzar preguntando en tu biblioteca local o centro comunitario."
- Bottom Bar:** "Ask Companionchat..."

Figure 25. Multilingual Support

The chatbot was designed to support multiple languages, to ensure that individuals from diverse linguistic backgrounds can use it.

The chatbot was designed to recognize the user's language preference and provide appropriate language options to provide multilingual support. As seen in Figure 25, The chatbot was designed to provide accurate and culturally sensitive responses in the user's preferred language.

In addition to providing multilingual support, the chatbot also helped bridge language barriers and promote cultural sensitivity. It is important to note that for now, we have multi-language support in English and Spanish and as the application becomes improved, other languages would be supported.

4.2.7 Informational resources

The chatbot was designed to offer a wide range of informational resources, including educational materials, coping strategies, and links to mental health resources.

Most of the resources provide educational materials on depression, including information on the causes, symptoms, and treatment options, to help the users to understand their condition and provide the knowledge and resources they need to manage their symptoms.

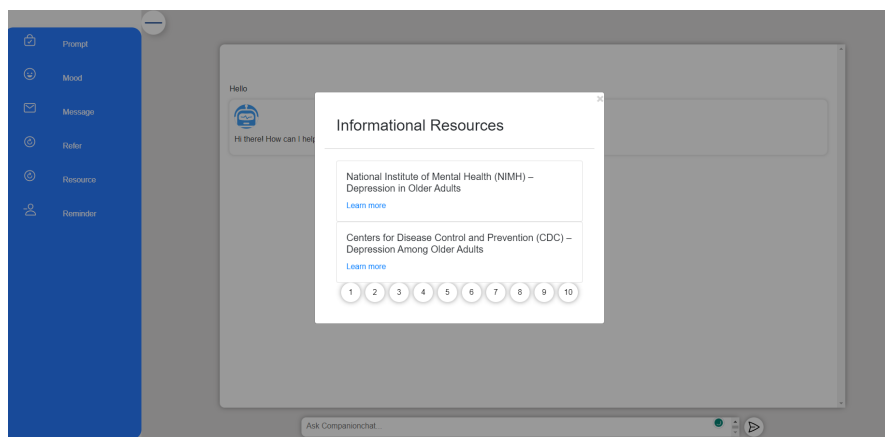


Figure 26. Informational resources

The chatbot provides links to mental health resources as seen in Figure 26, including local support groups, hotlines, and mental health professionals. This can help users connect with others experiencing similar challenges and provide them with additional support and resources.

Although we tried to make, them understand that those resources are not replacing professional medical advice or treatment, and they are also encouraged to seek professional help if needed. However, the chatbot could be a valuable tool for providing informational resources and support to them.

4.2.8 Mood tracking

Mood tracking is an essential component of the design of a chatbot that provides companionship for older adults with depression. By tracking their mood, older adults can gain insights into their emotional states and identify triggers for their depression symptoms and this information would be useful to develop coping strategies and interventions to help manage their symptoms.

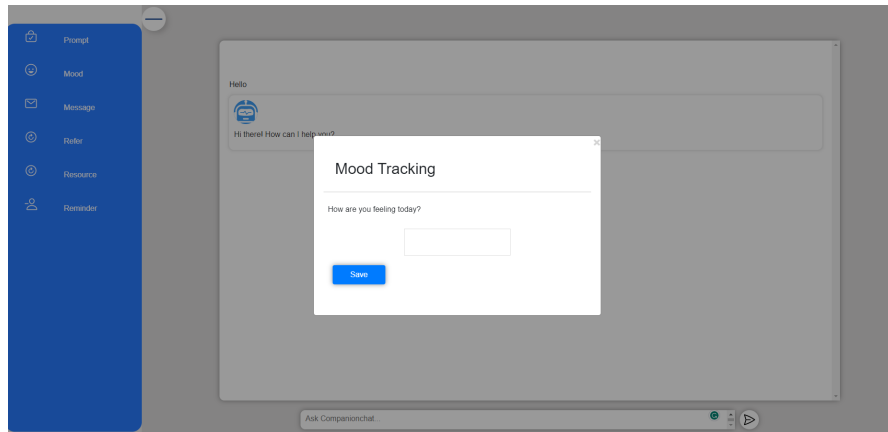


Figure 27. Mood tracking

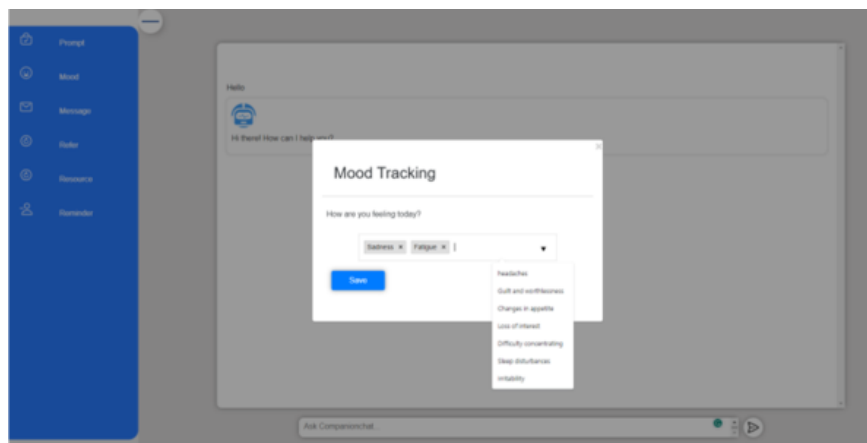


Figure 28. Mood tracking2

The chatbot was designed to prompt users to record their mood at intervals whenever they want to record it. From Figure 28, we achieved it through a series of options

prompting the users to choose from a list of emotional states such as "happy," "sad," or "anxious."

The chatbot was also designed to provide feedback and support based on the user's mood-tracking data. For example, if the user reports feeling particularly low or anxious, the chatbot may offer relaxation exercises or other coping strategies to help manage their symptoms. Over time, the chatbot can use the mood-tracking data to identify trends and patterns in the user's emotional state and offer targeted support and interventions to help manage their symptoms.

4.2.9 Reminders and notifications

Reminders and notifications are important because these features can help depressed adults stay on track with their daily routines, medication schedules, and appointments, which will provide a sense of structure and support that can be beneficial for managing symptoms of depression.

Selecting the series of reminders in which they want (Figure 29), The chatbot sends regular reminders and notifications to the user at specified times throughout the day, such as reminders to take their medication, engage in self-care activities, or attend appointments. These reminders would be delivered through push notifications, and these messages are tailored to the user's preferences and interests and can be designed to provide a sense of connection and companionship even if they are feeling isolated or lonely.

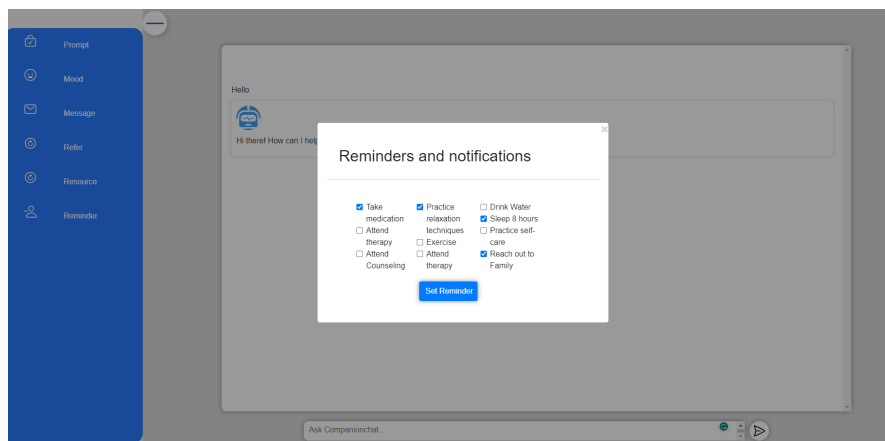


Figure 29. Reminders and notifications

4.2.10 Companionship Features

Companionship features are a crucial aspect of designing a chatbot that provides companionship for older adults with depression. These features help older adults to feel less isolated and lonely by providing a sense of connection and engagement with the chatbot.

One key feature our chatbot has is the ability to engage in natural and conversational interactions with the user. Another important companionship feature is its ability to provide emotional support and empathy to the user. It can recognize and respond to emotional cues in the user's language, such as using certain words or phrases that indicate feelings of sadness, loneliness, or anxiety. The chatbot then responds with appropriate messages of support and empathy, providing a sense of companionship and connection to the user.

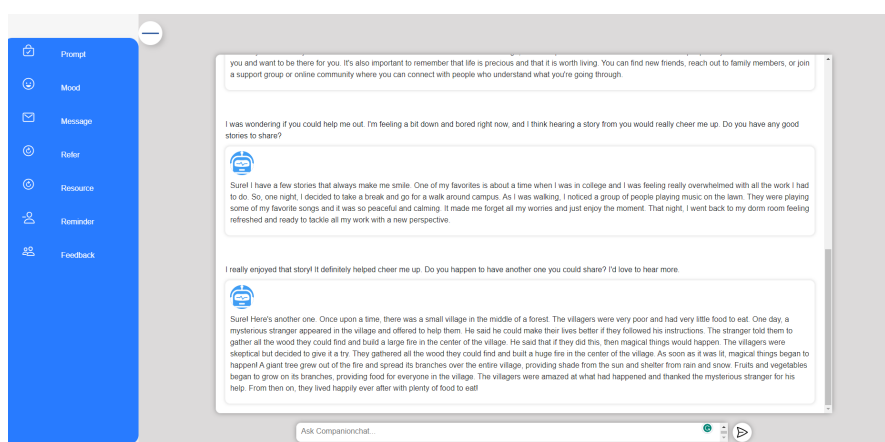


Figure 30. Companionship

The chatbot can also tell stories that are entertaining for older adults, such as telling stories such as in Figure 30. Apart from that, The chatbot can also provide suggestions for other activities and hobbies that older adults tend to enjoy.

4.2.11 Check-in prompts

We deemed Check-in prompts as an important aspect of the design because these prompts encourage older adults to regularly check in with the chatbot and share their thoughts and feelings, which can help them better manage their symptoms of depression.

One key aspect of check-in prompts is the frequency with which they are delivered to the user. The chatbot was designed to prompt the user to check in on a regular schedule, such as How they are doing today (Figure 31). The Check-in prompts also have some personalized messages to uplift the user's mood before the prompt (Figure 32).

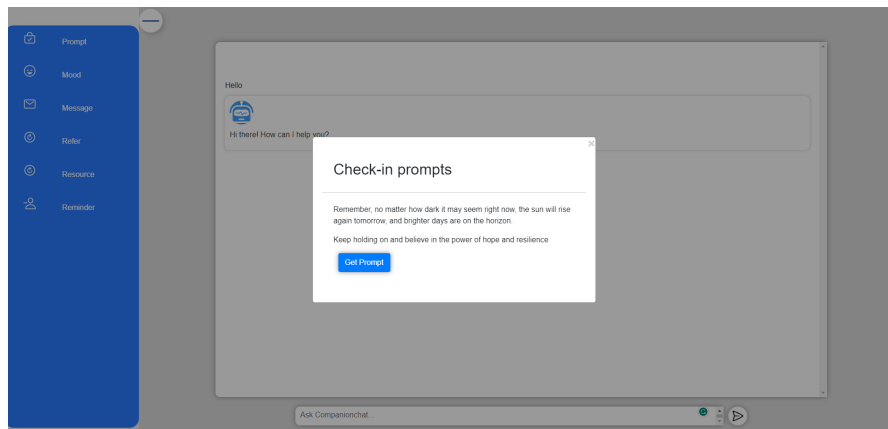


Figure 31. Check-in prompts

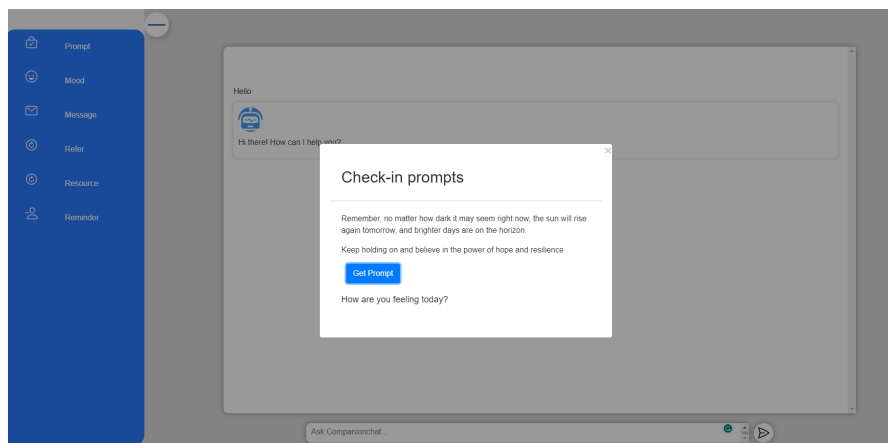


Figure 32. Check-in prompts2

In addition, the chatbot is also designed to respond in a supportive and non-judgmental way to the user's check-in prompts. This involves using empathetic language and providing positive reinforcement for the user's efforts to manage their symptoms. The chatbot also provides helpful suggestions and resources to the user based on their check-in responses, such as links to articles or videos on topics related to mental health and self-care.

4.2.12 Supportive messaging

Supportive messaging is a critical aspect of the design of this chatbot that provides companionship for older adults with depression. These messages are designed to provide

emotional support, encouragement, and reassurance to users who may be experiencing feelings of loneliness, anxiety, or hopelessness.

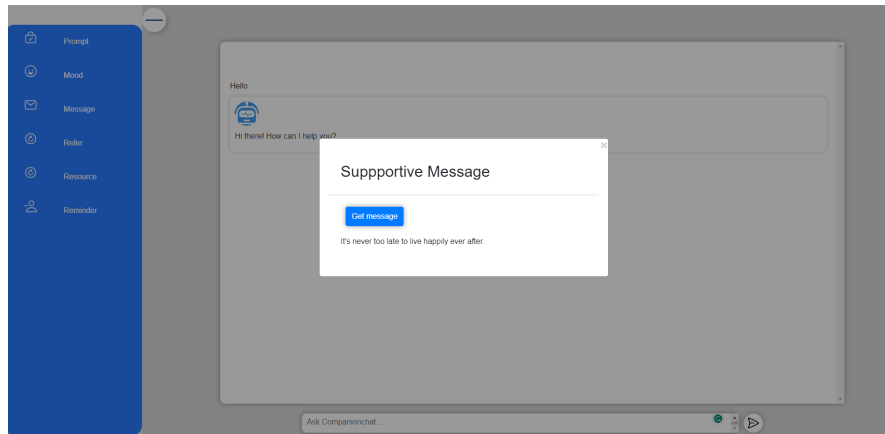


Figure 33. Supportive messaging

In this application, Supportive messaging can be delivered as a message when the user clicks on the get message button (Figure 33).

One important aspect of this supportive messaging is the use of empathetic language that acknowledges and validates the user's feelings such as encouraging them to be happy again no matter what they have been through. By using these words that acknowledge the user's feelings, the chatbot can help to build trust and rapport with the user, which can be an important factor in promoting engagement and adherence to the chatbot program.

4.3 Answers to the Research Questions 3

We developed a Chatbot User Experience Scale (CUES) and posted the survey link on the application in order to assess the outcomes applied in RQ2. A new window with the CUES survey is opened whenever a user hits the Feedback button in Figure 34 from the navigation bar.

Figure 35 shows the questions in which the responses were collected, and how they were calculated using the below subscale and overall scores as described below:

Usability subscale: To calculate the usability subscale score, we added up the scores for the following six items and divide the total by six:

- The chatbot was easy to use.
- I was able to navigate the chatbot easily.
- I didn't have any problems using the chatbot.

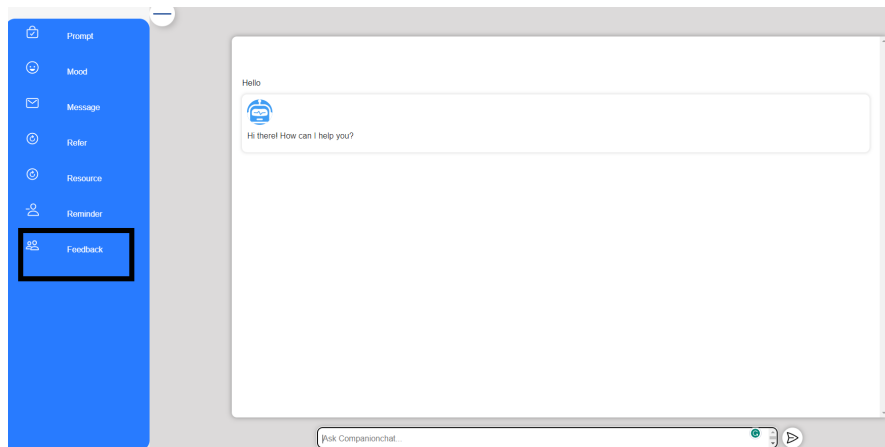


Figure 34. Feedback

- The chatbot was responsive.
- The chatbot was fast.
- The chatbot was efficient.

The participant scored 5 on the first item, 6 on the second item, 7 on the third item, 4 on the fourth item, 5 on the fifth item, and 6 on the sixth item, the total score for the usability subscale is:

$$(5 + 6 + 7 + 4 + 5 + 6) / 6 = 5.5$$

Usefulness subscale: To calculate the usefulness subscale score, we added up the scores for the following four items and divide the total by four:

- The chatbot provided useful information.
- The chatbot was relevant to my needs.
- The chatbot was informative.
- The chatbot met my expectations.

The participant scored 6 on the first item, 7 on the second item, 5 on the third item, 6 on the fourth item, 7 on the fifth item, and 4 on the sixth item, the total score for the usefulness subscale is:

$$(6 + 7 + 5 + 6 + 7 + 4) / 6 = 6.17$$

Satisfaction subscale: To calculate the satisfaction subscale score, we added up the scores for the following four items and divide the total by four:

- I was satisfied with the chatbot.

How much do you agree or disagree with this statement

Multiple choice grid

Rows		Columns
1. The chatbot was easy to use.	X	<input type="radio"/> Strongly disagree X
2. I was able to navigate the chatbot easily.	X	<input type="radio"/> Disagree X
3. I didn't have any problems using the chat...	X	<input type="radio"/> Somewhat disagree X
4. The chatbot was responsive.	X	<input type="radio"/> Neither agree nor disagree X
5. The chatbot was fast.	X	<input type="radio"/> Somewhat agree X
6. The chatbot was efficient.	X	<input type="radio"/> Agree X
7. The chatbot provided useful information.	X	<input type="radio"/> Strongly agree X
8. The chatbot was relevant to my needs.	X	<input type="radio"/> Add column
9. The chatbot was informative.	X	
10. The chatbot met my expectations.	X	
11. I was satisfied with the chatbot.	X	
12. I enjoyed using the chatbot.	X	
13. The chatbot was engaging.	X	
14. The chatbot was fun to use.	X	
15. The chatbot was like a human.	X	

Figure 35. Chatbot User Experience Scale (CUES) Survey

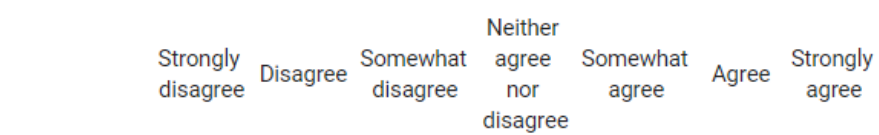


Figure 36. CUES scale response options

- I enjoyed using the chatbot.
- The chatbot was engaging.
- The chatbot was fun to use.

The participant scored 6 on the first item, 5 on the second item, 7 on the third item, and 4 on the fourth item, the total score for the satisfaction subscale is:

$$(6 + 5 + 7 + 4) / 4 = 5.5$$

Social presence subscale: To calculate the social presence subscale score, we added up the scores for the following three items and divide the total by three:

- The chatbot was like a human.
- The chatbot had a personality.
- The chatbot was friendly.

The participant scored 5 on the first item, 6 on the second item, and 4 on the third item, the total score for the social presence subscale is:

$$(5 + 6 + 4) / 3 = 5$$

Trust subscale: To calculate the trust subscale score, we added up the scores for the following three items and divide the total by three:

- The chatbot provided accurate information.
- The chatbot was reliable.
- The chatbot was trustworthy.

The participant scored 7 on the first item, 6 on the second item, and 5 on the third item, the total score for the social presence subscale is:

$$(7 + 6 + 5) / 3 = 6$$

Table 2. CUES Results for a participant

Subscale	Items included in the subscale	Sample participant scores	Subscale score
Usability	6 items	5, 6, 7, 4, 5, 6	5.5
Usefulness	4 items	5, 6, 7, 4	5.5
Satisfaction	4 items	6, 5, 7, 4	5.5
Social presence	3 items	5, 6, 4	5
Trust	3 items	7, 6, 5	6

In Table 2, We showed how the CUES Results is calculated for a participant, the subscales are listed in the first column, along with the items included in each subscale. The second column shows a sample of participant scores for each item in the subscale. The third column shows the calculated subscale score for each participant, The final column shows the overall subscale score, calculated by averaging the subscale scores for all

In Table 3, the subscale scores are displayed for each participant in separate columns. The overall subscale score for each subscale can be calculated by averaging the scores across all participants.

Table 3. CUES Results for the 10 participants

Participant	Usability	Usefulness	Satisfaction	Social presence	Trust
1	5.5	5.5	5.5	5	6
2	5.5	5.25	6	4.25	3.75
3	5.5	5.25	5.5	5	5.67
4	6.25	6.5	6.25	5.67	6.33
5	6	6	6	5.33	6.33
6	5.5	5.5	5.75	5	5
7	6	6.17	6.25	5.33	6
8	5.5	5.25	6.75	6	5.6
9	5.8	5.75	6.25	5.33	7
10	6	6.33	6	5.33	6.33

5 Discussion

The process of creating a chatbot to give companionship to elderly people suffering from depression is complicated and calls for careful consideration of a number of aspects. In this chapter, we will discuss the key findings and implications of our study, as well as limitations and future directions for research.

5.1 Findings

Based on our analysis, the following findings emerged:

Conversational Design The conversational design of the chatbot was critical to its success. Participants reported that they felt more engaged and connected when the chatbot was able to hold natural and meaningful conversations.

Empathy and Emotional Intelligence: Participants appreciated the chatbot's ability to exhibit empathy and emotional intelligence. They felt that the chatbot was able to understand and respond appropriately to their emotional state.

Accessibility The chatbot's accessibility was critical to its success. Participants appreciated the simple and intuitive user interface, as well as the support for voice commands and other assistive technologies.

5.2 Implications

The implications of our study are significant. Our findings suggest that a chatbot designed to provide companionship for older adults with depression can be an effective tool in the management of depression. By providing a source of companionship and emotional support, the chatbot can help reduce feelings of loneliness and improve mood.

The implementation of the chatbot to provide companionship for older adults with depression has several implications, including:

Increased Access to Support: A chatbot offers an accessible and affordable source of support for older adults who may not have access to traditional mental health resources.

Reduced Stigma: The chatbot's anonymity lessens the stigma connected with seeking treatment for depression.

Improved Mental Health Outcomes: The chatbot provides emotional support and reduces loneliness, which can lead to improved mental health outcomes for older adults with depression.

Potential Cost Savings The implementation of the chatbot is a cost-effective solution compared to traditional mental health resources.

5.3 Challenges

The implementation of the chatbot to provide companionship for older adults with depression also came with several challenges, including:

Limited Human Interaction: The lack of human interaction may not provide the same level of emotional support as face-to-face interactions.

Technical Issues Technical issues, such as connectivity and software updates, can limit the usability of the chatbot and result in frustration for older adults.

Ethical Considerations Ethical considerations, such as data ownership and informed consent, may be addressed to ensure the chatbot is used in a responsible and ethical manner.

5.4 Limitations

Our study has some limitations. First, the small size of our sample restricts the generalizability of our results. Second, we only tested the chatbot over a relatively short period of time, which limits our ability to assess the long-term effectiveness of the chatbot. Finally, we did not test the chatbot with older adults who are not comfortable with technology, which limits our ability to assess the accessibility of the chatbot for this population.

6 Conclusion and future work

The design of a chatbot to provide companionship for older adults with depression requires careful consideration of several factors, including conversational design, empathy and emotional intelligence, customization and personalizing, accessibility, and privacy and security. A well-designed chatbot can offer several benefits, including reducing loneliness, providing emotional support, and offering 24/7 availability, customization, and anonymity. All things considered, a chatbot created for this reason can be a useful aid in the treatment of depression in older persons.

The shortcomings should be addressed in future studies. Specifically, future studies should include larger participants size and longer follow-up periods. Additionally, future studies should focus on testing the chatbot with older adults who are not comfortable with technology in order to assess the accessibility of the chatbot for this population.

In conclusion, the design of a chatbot to provide companionship for older adults with depression has the potential to be an effective tool in managing depression. Our study identified key factors that contribute to the success of a chatbot for this population, including conversational design, empathy and emotional intelligence, customization and personalizing, accessibility, and privacy and security. However, our study has some drawbacks, including small participants size and a brief follow-up period, which highlight the need for further research in this area. Future studies should concentrate on addressing these restrictions and testing the chatbot with a wider range of older adults. By doing so, we can better understand the potential of this technology to improve the quality of life for older adults with depression and reduce feelings of loneliness and isolation. generally speaking, the creation of a chatbot to offer company to elderly people suffering from depression has the potential to be a useful addition to the range of interventions available to improve mental health in this demographic.

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Appendix

I. Glossary

- Chatbot: A computer program that conducts conversations with users through text or voice-based interfaces.
- API (Application Programming Interface): A set of protocols, tools, and routines used to build software applications, often used to integrate chatbots with other systems or services.
- OpenAI: An artificial intelligence research laboratory consisting of the for-profit corporation OpenAI LP and its parent company, the non-profit OpenAI Inc.
- GPT (Generative Pretrained Transformer): A type of neural network architecture developed by OpenAI that is commonly used in natural language processing tasks, including chatbot design.
- Transformer Architecture: A type of neural network architecture commonly used in natural language processing tasks, including GPT, that uses self-attention mechanisms to process input sequences.

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