Project Phase 2 Report On

Artificial Intelligence based Medical Health Care Assistant and Casesheet Generation

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CERTIFICATE

This is to certify that the project report entitled ***"Artificial Intelligence based Health Care Assistant and Casesheet Generation"*** *is a bonafide record of the work done by* ***Albin Rony(u2003021)***, ***Annmaria Jaxon (U2003039)***, ***Ashmi Jomon (U2003045)***, ***Christy Varghese Chacko (U2003063)*** *submitted to the Rajagiri School of Engineering & Technology (RSET) (Autonomous) in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology (B. Tech.) in Computer Science and Engineering during the academic year 2023-2024.*

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Abstract

Imagine a world where a virtual assistant analyzes your symptoms, generates a list of potential diagnoses, and even prepares a preliminary case sheet for your doctor. This is the ambitious vision of our project: an AI-powered medical Assistant to empower patients and streamline initial healthcare interactions.

This project bridges two critical gaps. First, it utilizes Natural Language Processing (NLP) to delve into your unique story, understanding the specifics of your symptoms, medical history, and even lifestyle factors[1]. A robust Machine Learning (ML) model, trained on a vast medical dataset, then analyzes this information, generating a personalized list of potential diagnoses with their estimated probabilities. This empowers you to take charge of your health, seeking appropriate medical attention with an initial understanding of your potential concerns[1].

But the project doesn't stop there. Armed with your data and pre-defined medical templates, it leverages ML algorithms to dynamically craft a concise case sheet. This document mimics the initial diagnosis document prepared by a physician, summarizing your information for further evaluation[2]. This not only saves you time and anxiety but also streamlines your entry into the healthcare system, allowing medical professionals to quickly grasp your case and provide focused care.

Our project unfolds in four stages: data curation, NLP and ML model development, case sheet generation algorithm development, and rigorous user testing. We aim to bridge the gap between patients and medical professionals, particularly in resource-limited regions. This AI-powered solution has the potential to revolutionize initial diagnoses, democratize healthcare access, and ultimately empower individuals to proactively manage their health, leading to improved outcomes for all.

Contents

List of Abbreviations

LSTM - Long Short Term Memory

RNN - Recuurent Neural Memory

BiLSTM - Bidirectional Long Short Term Memory

BiRNN - Bidirectional Recuurent Neural Memory

CVOA - Corona Virus Optimization Algorithm

GRU - Gated Recurrent Unit

CNN - Convolutional Neural Network

AI - Artificial Intelligence

NLP - Natural Language Processing

BERT - Bidirectional Encoder Representations from Transformers

KM-BERT - Korean Medical Bidirectional Encoder Representations from Transformers

MLM - Masked Language Model

NSP - Next Sentence Predicition

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Chapter 1

Introduction

The healthcare industry is undergoing significant transformation due to the growing potential of artificial intelligence. This project aims to create an AI-powered medical chatbot using BERT and LSTM, aiming to close the information gap between patients and reliable medical data, promote educated decision-making, and encourage active participation in healthcare processes. This innovative strategy aims to simplify repetitive questions and make AI a reliable healthcare partner.

1.1 Background

The boundaries between technology and medicine are rapidly becoming more hazy in today's healthcare environment. The rise of AI-driven medical chatbots, virtual assistants that can comprehend your symptoms, provide a preliminary diagnosis, and even create simple case sheets, is one particularly fascinating development. Picture a tireless, information-hungry friend that examines your descriptions of aches, coughs, and sneezes using its extensive medical knowledge base as a guide. This is the realm that chatbots reveal[1].

It can be difficult to navigate the confusing world of medical issues without these digital healthcare assistants. Frequently, the first difficult duty of a doctor's appointment is to translate vague symptoms into simple, understandable English. Basic information collection takes up valuable time, and miscommunication occurs. However, chatbots serve as your first point of contact. They listen to your problems with patience, using sophisticated algorithms to interpret what you say and associate it with a range of possible diagnoses. Based on this analysis, they provide not only speculative suggestions but also pointers to trustworthy medical sites and practical advice on how to handle your symptoms until you see a doctor.

However, the advantages go much beyond just providing a rough diagnosis. In places where access to medical personnel is limited, chatbots can literally save lives. They are available around-the-clock, providing crucial direction and assistance in isolated rural areas or during the dead of night. Additionally, by debunking urban legends about common illnesses and offering fact-based guidance on healthy lifestyle choices, they can be extremely important in the field of preventive healthcare. Chatbots open the door to a proactive, personalized, and accessible healthcare future by enabling people to take an active role in their own health[5].

But it's crucial to keep in mind that chatbots are not miraculous tools. They can't take the place of a doctor's refined judgment and knowledge. Their function is to serve as an intermediary, providing people with knowledge and assisting them in making well-informed decisions regarding their health. These virtual assistants will surely advance in sophistication as AI technology develops, providing more precise information and in-depth understanding of the intricacies of human health. One thing is certain, though: AI-powered medical chatbots are paving the way for a future in which everyone has the ability to understand their health and make decisions about their well-being, even though the future of healthcare may still be entirely composed of pixels and algorithms[5].

1.2 Problem Definition

Acknowledging the significant drawbacks of conventional healthcare systems—specifically, the impracticality of delayed responses and accessibility restrictions—the current project aims to transform the way medical advice is provided. Our main goal is to remove these basic obstacles and create a new standard for prompt, convenient, and preventive healthcare. By utilizing creative solutions, we hope to provide people with quick, evidence-based advice, reducing health risks, making the best use of available resources, and eventually advancing the field of healthcare toward more effectiveness, better results, and preventive treatment. This project is a significant stride toward creating a new healthcare system in which faster turnaround times and equal access ensure that everyone gets the help and direction they require, just when they need it[3].

1.3 Scope and Motivation

1.3.1 Scope

Our project imagines a time when medical chatbots driven by artificial intelligence (AI) steer healthcare toward a more seamless future. Imagine having this friend in your pocket, always ready to hear your worries and assess your symptoms with the expertise of a seasoned doctor. It solves the puzzle of your wellbeing by interpreting the subtleties of your descriptions using natural language processing. It creates a brief case sheet, similar to a doctor's initial evaluation, that summarizes your symptoms, possible diagnosis, and pertinent medical history. But this is not a closed book. You are in control of an extensive collection of trustworthy sources and instructional materials that you may use to take an active role in your own health journey. This digital ally acts as a bridge, providing instant help and bridging the gap between your worries and timely information, rather than replacing the invaluable role of professional medical counsel[1].

1.3.2 Motivation

This initiative aims to gently transform healthcare by addressing the dangerous gap that exists between individuals and timely care, where factors such as geography, economics, and overworked systems create long-lasting effects. Our AI-powered medical chatbot is the result of a thorough understanding of these barriers and how they could endanger health and put a strain on resources, not technological hubris. It seeks to be a bridge over this dangerous gap by empowering people with quick, easily accessible, and educational advice, turning them from passive beneficiaries of care into active participants in their own well-being management instead of using force. Imagine a world in which prompt and proactive health monitoring and consultations are woven together to create a future where people confidently prioritize their health, lessen the strain on healthcare systems, and receive immediate guidance and assistance. We see a future in which everyone has the knowledge and self-assurance to make educated decisions about their health, with the steadfast assistance of their digital companion at every turn. Access will no longer be hampered by the dangerous gulf because we will construct a bridge of empowerment and knowledge, opening the door for a time when prompt healthcare will be considered a right rather than a privilege[1].

1.4 Objectives

- Develop a user-friendly AI chatbot interface to facilitate seamless interaction.
- Enable the chatbot to effectively understand user input, interpret natural language, and accurately extract relevant medical information from user descriptions.
- Implement advanced machine learning algorithms to analyze diverse user-reported symptoms.
- Subject the chatbot to thorough testing with diverse user groups and clinical scenarios to evaluate its accuracy, reliability, and user-friendliness, ensuring its safety and effectiveness before deployment.
- Generate personalized health precautions and a basic case sheet for users, fostering proactive health management.

1.5 Challenges

The AI-powered health companion has some drawbacks despite its potential. Although empowering, misinterpreting user descriptions could result in incorrect diagnoses, therefore it shouldn't take the place of expert medical advice. Another challenge is the absence of a human touch and sophisticated emotional comprehension, since certain medical issues call for compassion and individualized attention that AI would find difficult to deliver. Innovation in technology and the indispensable human component in healthcare are in a delicate dance[3].

1.6 Assumptions

Although our initiative recognizes the inherent limits of AI, it places a high priority on reducing chatbot-related risks through a diverse strategy. By promoting thorough symptom descriptions, we highlight user accuracy and transparency. Additionally, the chatbot is based on a large, representative dataset for reliable diagnosis. But, mindful of the limitations of technology, we educate users on the chatbot's capabilities and promote appropriate healthcare-seeking behavior, making sure they understand when to seek professional

advice for complicated or serious instances. By working together, we can take use of technology's advantages while avoiding its drawbacks, which makes the chatbot an invaluable instrument for better health awareness and well-informed decision-making—rather than a substitute for medical advice.

1.7 Societal / Industrial Relevance

Many areas are plagued by the threat of healthcare deserts, where access is determined by money and geography. In the future that our project imagines, this ghost will be exorcised and replaced with a society of empowered people who are actively involved in their own well-being. In this unfamiliar landscape, the AI-driven medical chatbot shines like a lighthouse, providing prompt, reasonably priced medical advice where traditional access falls short. Beyond merely disseminating information, this technological bridge promotes agency by providing people with the information and tools they need to make wise decisions and actively engage in their own health journeys. This empowerment has far-reaching benefits that improve health outcomes for entire communities by encouraging preventive treatment, reducing complications, and so on. This revolutionary effect is not unique; the chatbot maximizes resources by relieving strain on overworked healthcare systems[1].

Beyond the change in society, chatbots have a lot of potential in the healthcare sector. Envision a future in which seamless patient engagement is a reality rather than a pipe dream. The chatbot turns into a constant friend, quickly attending to non-urgent issues and enabling efficient communication with medical specialists. This improves patient happiness while freeing up professionals' critical time so they may concentrate on difficult cases and provide individualized care. The data tapestry created by user interactions opens up new avenues for medical research and spurs the creation of cutting-edge products and services that are changing the face of healthcare. The chatbot's ability to provide patients with accurate and unbiased information on medications and treatments can be advantageous to pharmaceutical companies as it can facilitate informed decision-making and streamline the recruiting process for clinical trials[2].

Thus, this project becomes more than just a technical achievement; rather, it is a sign of a changing industry and society. It seeks to transform the healthcare system by giving

people more authority, transforming access, and encouraging a proactive care culture. It is evidence of the ability of technology to create a tapestry of well-being woven with the strands of knowledge, accessibility, and patient empowerment. This is more than simply a project; it's a vision of a better future in which everyone is empowered to take charge of their health and make educated decisions.

1.8 Organization of the Report

This report is meticulously organized, presenting a comprehensive overview of the proposed AI medical chatbot in five distinct chapters.The project's purpose and aims are laid out in detail in the introduction, which includes background information, a definition of the problem, scope and motivation, objectives, obstacles, assumptions, and social significance. In order to provide a solid theoretical foundation for the project's methodology, the second chapter explores the body of current literature, highlighting pertinent research publications and their major conclusions. The comprehensive requirements chapter that follows describes the functional requirements as well as the hardware and software requirements, guaranteeing implementation clarity and viability. The chapter on system architecture delves further into the technical issues, including an architectural design, an overview, and in-depth module breakdowns to help understand the inner workings of the chatbot.The project's trajectory and positive effects on healthcare are effectively conveyed to the reader through the conclusion, which concludes with a summary of the main elements and an exciting section on future scope and growth opportunities.

1.9 Summary of the chapter

The intricacies of medical language, impediments to accessibility, and a reactive approach to illness treatment are some of the characteristics that give rise to the limits in healthcare that confront us with this project. Our proposal aims to tackle these issues by creating a medical chatbot powered by artificial intelligence. This innovative healthcare assistant would provide patients with round-the-clock support, decode medical information to empower themselves, and manage their health proactively by utilizing personalized insights from cutting-edge machine learning algorithms.

Chapter 2

Literature Survey

This section explores the use of AI-powered medical chatbots, focusing on models using LSTM and BERT. It looks at the intricate workings of BERT and LSTM, how well they can understand user queries, and how they can help with context-aware speech and symptom interpretation. Important information is extracted by comparative analysis. This research paves the way for further advancements in AI-driven medical chatbots, offering astute and knowledgeable companions for health-related data.

2.1 Paper 1 - An AI-Based Medical Chatbot Model for Infectious Disease Prediction

The paper "An AI-Based Medical Chatbot Model for Infectious Disease Prediction" examines the creation and operation of a potent artificial intelligence tool for the medical field. This paper explores the particular machine learning (ML) models used in the chatbot in further detail, emphasizing their distinctive qualities and contributions to this significant technology[1].

2.1.1 The LSTM Network for Precise FOG Detection

LSTM Architecture

An essential component of the AI-powered medical chatbot's ability to identify Freezing of Gait (FOG) in Parkinson's disease patients is the Long Short-Term Memory (LSTM) network. In-depth discussion of the LSTM architecture and the underlying equations is provided in this part, giving readers a thorough grasp of how the system evaluates patient data and spots minute variations that may be signs of FOG [1]. The LSTM network comprises four key components (from Figure 2.1):

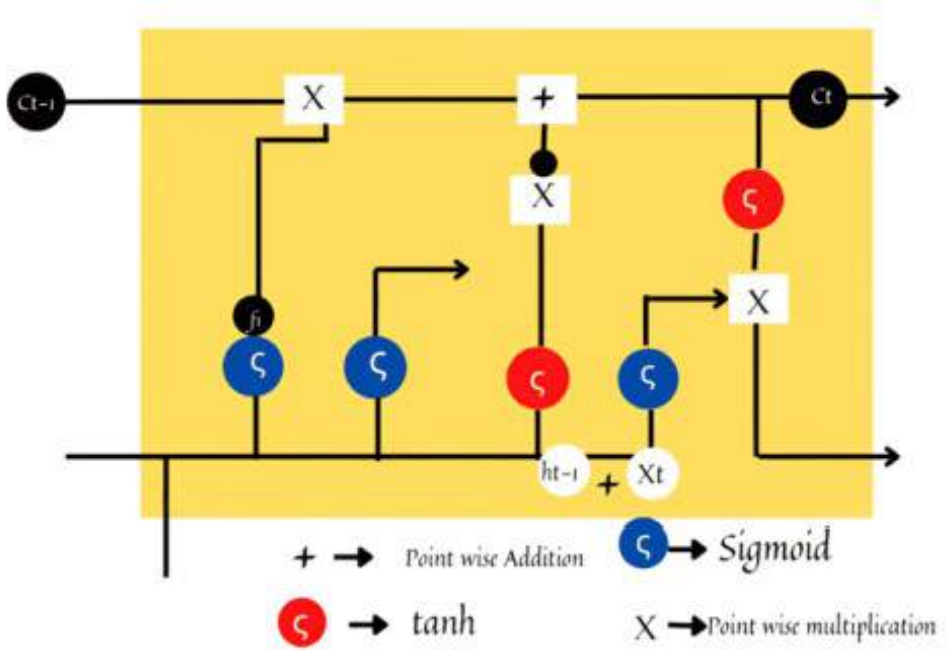


Figure 2.1: LSTM[1]

- **Cell state:** This part serves as the network's central hub and is in charge of preserving long-term dependencies in the data. Similar to a conveyor belt, it lets data move through the network while selectively recalling and discarding pertinent data as needed.

- **Input gate:** Information entering the cell state is managed by this gate. It serves as a filter, selecting pertinent data from the previous concealed state and current input to include in the cell state.

- **Forget gate:** When data is removed from the cell state, it is controlled by this gate. It recognizes and eliminates information that is out of date, freeing the network to concentrate on more recent and important data.

- **Output gate:** This gate selects which information from the cell state contributes to the current output and regulates the flow of information exiting the cell state.

Equations

The internal workings of the LSTM network are governed by the following equations:

Cell state update:

$$C_t = f_t * C_{t-1} + i_t * \tanh(W_c * [h_{t-1}, x_t]) \tag{2.1}$$

where:

- Cell State (C_t) denotes the cell state at time t. It represents the core of the LSTM network, responsible for storing long-term dependencies within the data.
- Previous Cell State (C_t-1) represents the cell state at the previous time step t1.
- Forget Gate Activation (f_t) refers to the activation of the forget gate at time t.
- Input Gate Activation (i_t) signifies the activation of the input gate at time t.
- Weight Matrix for Cell State (W_c) represents the weight matrix for the cell state.
- Previous Hidden State (h_t-1) represents the hidden state at the previous time step t1.
- Current Input (x_t) denotes the input to the network at time t. This input can be any type of data, such as a sensor measurement or a numerical value.
- Hyperbolic Tangent Function (tanh) represents the hyperbolic tangent function, which is used to non-linearly transform the input and previous hidden state before incorporating them into the cell state.

Hidden state update:

$$h_t = o_t * \tanh(C_t) \tag{2.2}$$

where:

- h_t refers to the hidden state at time t.
- o_t signifies the output gate activation at time t.
- tanh represents the hyperbolic tangent function.

Gate activations:

$$f_t = \sigma(W_f * [h_{t-1}, x_t] + b_f) \tag{2.3}$$

$$i_t = \sigma(W_i * [h_{t-1}, x_t] + b_i) \tag{2.4}$$

$$o_t = \sigma(W_o * [h_{t-1}, x_t] + b_o) \tag{2.5}$$

where:

- f_t, i_t, and o_t represent the forget gate activation, input gate activation, and output gate activation at time t, respectively.
- h_t1 represents the hidden state at the previous time step.
- x_t represents the input at the current time step.
- W_f, W_i, and W_o are the corresponding weight matrices for forget gate, input gate, and output gate respectively.
- b_f, b_i, and b_o are the corresponding bias vectors for forget gate, input gate, and output gate respectively.

2.1.2 Role in FOG Detection

Through the examination of patient-specific information, such as gait signals, the LSTM network is able to detect minute alterations in gait patterns that may signify the development of FOG. While the input gate selectively accepts new data pertinent to identifying FOG, the forget gate permits the network to dismiss unnecessary information. Through this approach, the network is able to discover patterns that distinguish FOG episodes from healthy gait and understand long-term connections within the data[1].

2.1.3 Benefits

The LSTM network offers several advantages for FOG detection:

- **High accuracy:** The ability to learn long-term dependencies allows the network to achieve high accuracy in identifying FOG, even with subtle changes in gait patterns.
- **Adaptive learning:** The network can continuously learn and adapt based on new data, improving its performance over time.

- **Generalizability:** The network can be trained on data from different individuals, allowing it to generalize its findings and detect FOG in diverse patient populations.

2.2 Paper 2 - An intelligent Chatbot using deep learning with Bidirectional RNN and attention model

This study explores the use of Bidirectional RNNs and attention techniques to improve the model's conversational capabilities as it dives into the design and operation of a chatbot driven by deep learning. The study provides insight into how well this method works to create conversational agents that are both clever and interesting by examining its modeling and performance[2].

2.2.1 Motivation

Conventional Recurrent Neural Nets (RNNs) handle input sequences element by element, accumulating history of previous elements in a hidden state. Long sequences may suffer from information loss as a result of this, especially if comprehension of the context necessitates knowledge of both the start and finish of the sequeunce[2].

In order to overcome this restriction, Bidirectional Recurrent Neural Networks (BRNNs) process the input sequence in both the forward and backward directions simultaneously. As a result, the model performs better on tasks like machine translation and sentiment analysis since it can access information about the complete sequence at every time step[2].

2.2.2 Working of BRNNs

A BRNN is made up of two independent RNNs, one of which processes the input sequence forward and the other backward. The final result is then generated by combining these two RNNs which is shwon in Figure 2.2.[2].

2.2.3 Equations

Forward RNN

$$h_t^f = \sigma(W_f * x_t + U_f * h_{t-1}^f) \tag{2.6}$$

where:

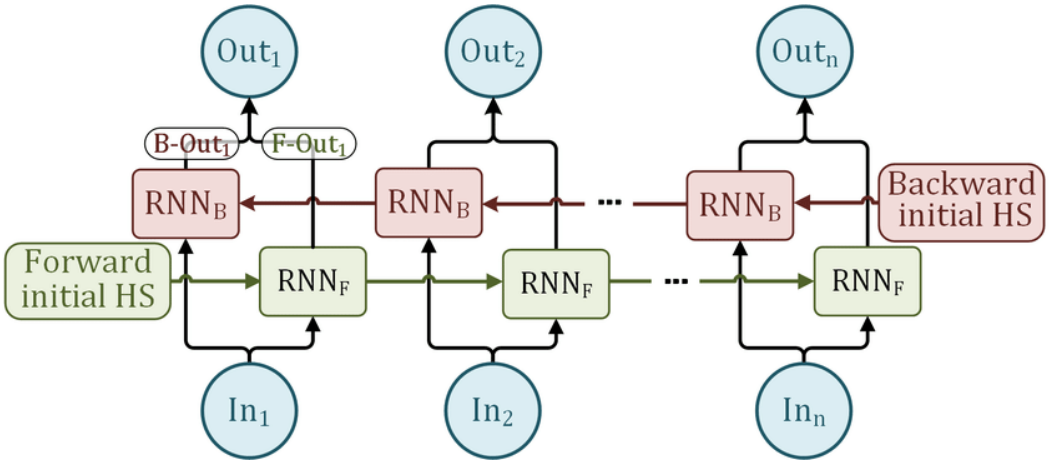


Figure 2.2: BRNN [2]

- h_t_f is the hidden state of the forward RNN at time step t
- W_f and U_f are weight matrices
- x_t is the input at time step t

Backward RNN

$$h_t^b = \sigma(W_b * x_t + U_b * h_{t+1}^b) \tag{2.7}$$

where:

- h_t_b is the hidden state of the backward RNN at time step t
- W_b and U_b are weight matrices

Combined Hidden State

The final hidden state h_tis obtained by concatenating the hidden states of the forward and backward RNNs:

$$h_t = [h_t^f; h_t^b] \tag{2.8}$$

2.2.4 Output

The output y_t is generated using the combined hidden state and an output weight matrix W_o:

$y_t = W_o * h_t$

2.2.5 Benefits

- Capture more context and long-range dependencies in the input sequence. Improve performance on tasks involving sequential data.
- Improve performance on tasks involving sequential data.

2.3 Paper 3 - Mental Healthcare Chatbot using Sequence-to-Sequence Learning and BiLSTM

The paper addresses the pressing need for mental health support, particularly during the challenging times of the COVID-19 pandemic. The study focuses on creating an integrated chatbot specifically designed for individuals dealing with mental health issues. By leveraging a Sequence-to-Sequence (Seq2Seq) encoder-decoder architecture with a Bi-directional Long Short Term Memory (BiLSTM) encoder, the chatbot aims to offer empathetic responses, combat societal stigma, and provide a supportive platform for those in need.[3]

2.3.1 Architecture

The architecture utilized in the paper encompasses a Sequence-to-Sequence (Seq2Seq) model integrated with an encoder-decoder framework, leveraging Bi-directional Long Short Term Memory (BiLSTM) units.

Encoder-Decoder Structure

The Seq2Seq model consists of two primary components: the encoder and the decoder. The encoder processes input data, converting variable-length input sequences into fixed-length vectors. In this architecture, the encoder employs BiLSTM units, which enable the network to consider both preceding and succeeding words simultaneously, capturing comprehensive contextual information.

BiLSTM Units

Bi-directional Long Short Term Memory networks (BiLSTMs) offer enhanced memory capabilities compared to unidirectional LSTMs. These units consist of forward and back-

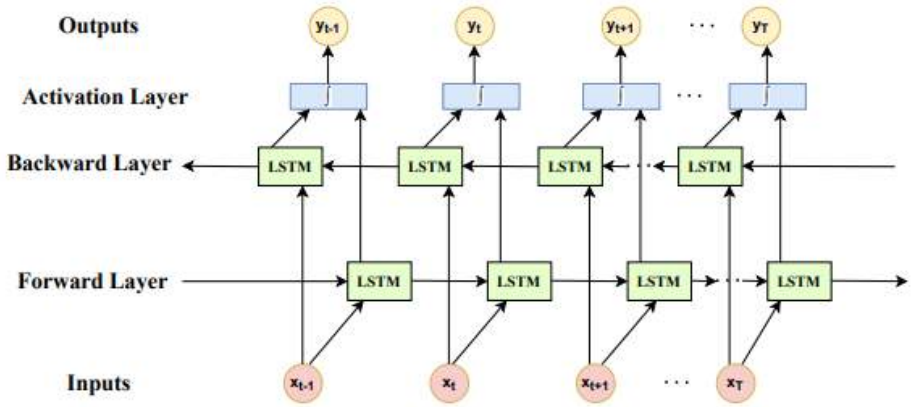


Figure 2.3: Architecture of BiLSTM[3]

ward LSTM layers. The forward layer processes the input sequence in its original order, while the backward layer processes a reversed version of the sequence. This bidirectional approach enables the network to capture context from both past and future data points, providing richer contextual representations. LSTM contains of three gates: input gate, an output gate and a forget gate. These gates have an additional layer called Sigmoid neural network layer. The Sigmoid layer serves a critical role in controlling the flow of information through the gates. The Sigmoid activation function($\int$) produces outputs between the range of 0 and 1. A value closer to 1 means "let this information in," while a value closer to 0 means "omit this information." Figure 2.3 illustrates the BiLSTM architecture where x_t represents the input x at time t, y_t represents the output y at time t and so on.

Decoder with Attention Mechanism

The decoder, equipped with Gated Recurrent Unit (GRU) networks, receives the encoded information from the BiLSTM-based encoder. Additionally, the decoder integrates an attention mechanism. This mechanism allows the decoder to focus selectively on specific parts of the input sequence during the decoding process, aiding in generating more accurate and contextually relevant responses. The attention mechanism in Sequence-to-Sequence model is shown in Figure 2.4.

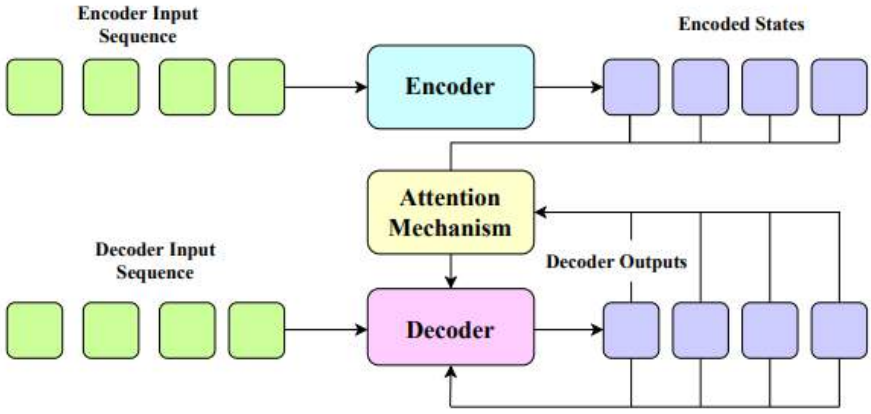


Figure 2.4: Attention Mechanism in Sequence-to-Sequence Model[3]

2.3.2 Datasets

- **Mental Health FAQ Dataset:** This dataset comprises 98 questions and corresponding answers related to mental health issues. The information within this dataset is sourced from various mental health-focused organizations such as the Kim Foundation, Mental Health America, Wellness in Mind, and heretohelp. The dataset aims to assist individuals dealing with mental health problems by providing relevant information and support. It serves as a fundamental source of information for the chatbot to understand and respond to mental health-related queries.

- **Therapist-Client Conversation Dataset:**The second dataset centers around conversations between a therapist and a client, derived from grounded theory analysis. It aims to model the therapist's interaction with the client and incorporates the therapist's responses based on their inner conversation consisting of four positions. These conversations involve the therapist listening to the client's narrative and providing responses based on analysis and therapeutic practices. The chatbot's design, drawing insights from these therapist-client interactions, aims to create a similar supportive environment for users to express their emotions and concerns.

2.3.3 Preprocessing

The dataset, sourced from mental health-related FAQs and therapist-client conversations, undergoes preprocessing. This involves tokenizing the text, mapping unique words to

index values using a vocabulary class, removing non-letter characters, and filtering out sentences with rare words. Additionally, sentences exceeding a specified length are filtered to aid training convergence[3].

2.3.4 Training Process

The training involves feeding input batches into the decoder at each time step. The model utilizes LSTM (Long Short Term Memory) networks to handle the vanishing gradient problem, ensuring the gradients do not grow exponentially. Techniques like teacher forcing and gradient clipping are employed to facilitate efficient and stable training[3].

2.3.5 Evaluation

The paper evaluates two decoder models—Beam Search and Greedy Search—by presenting both models with the same set of questions. The evaluation considers the BLEU (Bilingual Evaluation Understudy) scores, which measure the similarity between generated responses and reference texts. Additionally, loss values and model performance concerning response quality and speed are analyzed[3].

Beam Search Decoder Results

- **Empathetic Responses:** The chatbot model utilizing Beam Search Decoder provided responses that exhibited a higher degree of empathy towards users expressing their mental health concerns or queries.
- **Response Quality:** The responses generated by the chatbot using Beam Search Decoder were generally more contextually accurate and coherent, resulting in a better quality of conversation.
- **BLEU Scores:** When evaluated using BLEU scores (Bilingual Evaluation Understudy), the Beam Search Decoder model displayed higher scores for 1-gram and 2-gram on testing pairs. This indicated better precision and similarity between generated responses and reference texts.

Greedy Search Decoder Results

- **Speed of Responses:** The chatbot model employing Greedy Search Decoder exhibited faster response times compared to the Beam Search Decoder model.
- **Response Quality:** While responses were faster, the Greedy Search Decoder model's responses were observed to be slightly less contextually accurate and empathetic compared to the Beam Search Decoder.
- **Lower BLEU Scores:** The BLEU scores for 1-gram and 2-gram on testing pairs were comparatively lower for the Greedy Search Decoder model, indicating slightly lower precision and similarity in responses compared to the Beam Search Decoder.

To conclude, through the development of a chatbot using sophisticated encoder-decoder architectures, particularly the Seq2Seq model with Beam Search and Greedy Search Decoders, the study has showcased the efficacy of AI-driven interventions. While the Beam Search Decoder exhibited superior empathy and precision in responses related to mental health issues, the Greedy Search Decoder provided faster but slightly less accurate responses[3].

2.4 Paper 4 - Predicting medical specialty from text based on a domain-specific pre-trained BERT.

Bidirectional Encoder Representations from Transformers, or BERT, has revolutionized natural language processing by beating its peers in several tasks. Its main advantage is transfer learning: a model pre-trained on a large unlabeled corpus is then refined for particular downstream applications. As a result, BERT can better grasp a given area by utilizing its extensive knowledge base[4].

2.4.1 Unsupervised Pre-training: Unveiling the Essence of Language

Prior to task-specific fine-tuning, BERT undergoes a crucial pre-training phase. It involves two key supervised learning tasks[4]:

- **Masked Language Model (MLM)**: BERT engages in a game of "fill in the blanks." It receives text with randomly masked words and predicts the missing tokens, fostering a deep grasp of word relationships and context.

- **Next Sentence Prediction (NSP)**: BERT enhances its ability to discern sentence coherence. It receives pairs of sentences and predicts whether the second sentence logically follows the first, strengthening its understanding of sentence flow and structure.

These tasks, though seemingly simple, equip BERT with a profound understanding of linguistic structure and meaning[4].

2.4.2 Fine-tuning for Medical Specialty Prediction

BERT changes during the fine-tuning stage to become an expert in predicting medical specialties. A fully-connected layer created especially for this purpose replaces the last layer in charge of MLM and NSP. The output size of this layer, which focuses on the initial token tensor for classification, relates to the number of predicted specializations.

BERT becomes a single-specialty prediction engine by fine-tuning using softmax activation in the last layer. This allows BERT to analyze medical queries and precisely determine the most pertinent specialty[4]. The pictorial representation of the the process is shown below at Figure 2.5.

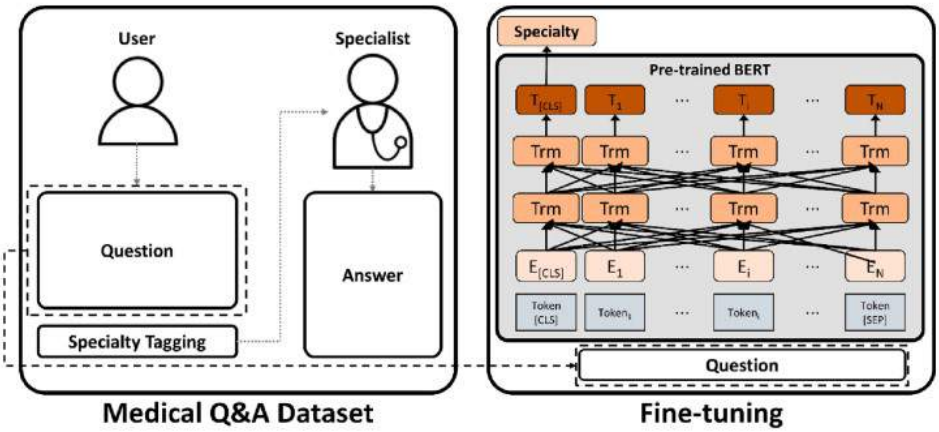


Figure 2.5: A framework for medical specialty prediction from question text using a pre-trained BERT[4]

2.4.3 KM-BERT: A Domain-Specific Ace

The paper uses KM-BERT, or Korean Medical BERT, a domain-specific version of BERT. Using a bidirectional wordpiece tokenizer for Korean language processing, KM-BERT is

pre-trained on an extensive corpus of Korean medical text data. With the help of this domain-specific pre-training, KM-BERT is better equipped to understand the subtleties of typical medical language and sentence patterns in the healthcare industry[4].

2.4.4 Attention: The Engine of Understanding

The key to BERT's remarkable understanding skills is its attention mechanism. The attention layer uses softmax activation to award relevance ratings to each element after performing a weighted sum of the input characteristics.

A complex augmentation of the conventional attention mechanism, multi-head attention increases the capacity of the model by doing calculations for individual attention heads in simultaneously. These heads concentrate on different parts of the input, and a fully-connected layer combines their outputs to improve the representation as a whole.

Each brain in the self-attention layer expands on the output of the one before it, allowing for more in-depth contextual comprehension and recursive information processing. Notably, the first encoder layer takes input generated from positional encoding of the embedded tokens. To help with comprehension even further, this encoding incorporates information about each token's relative location inside the sequence[4].

In the end,The powerful combination of BERT and KM-BERT paves the way for accurate medical specialty prediction. By leveraging pre-trained models and fine-tuning them for specific tasks, knowledge from one domain can be efficiently transferred to another. By mastering the intricacies of language through pre-training and then specializing in the medical domain, KM-BERT achieves impressive accuracy in predicting the most relevant specialty for a given medical question[4]. This technical exploration highlights the potential of BERT-based architectures to address complex tasks within healthcare, paving the way for further advancements in medical diagnosis and treatment.

2.5 Paper 5 - Diagnostic Accuracy of Differential-Diagnosis Lists Generated by Generative Pretrained Transformer 3 Chatbot for Clinical Vignettes with Common Chief Complaints: A Pilot Study

The healthcare industry is constantly changing and adopting artificial intelligence (AI) more and more. Using AI skills for differential diagnosis—the critical process of deter-

mining potential explanations behind a patient's symptoms—is one especially interesting approach. In an effort to better understand this, researchers conducted a pilot study titled "Diagnostic Accuracy of Differential-Diagnosis Lists Generated by Generative Pretrained Transformer 3 Chatbot for Clinical Vignettes with Common Chief Complaints," which was released in February 2023. The purpose of this investigation was to evaluate the precision of differential diagnoses produced for scenarios emulating actual clinical interactions using the GPT-3 chatbot, a potent language model[5].

2.5.1 Clinical Vignettes and Diagnoses

- Ten general internal medicine physicians created 30 clinical vignettes, each representing a common chief complaint like fever, cough, or abdominal pain.
- Vignettes incorporated demographic data, presenting symptoms, past medical history, and relevant physical examination findings[5].
- For each vignette, physicians established the correct diagnosis and five additional plausible differential diagnoses.

2.5.2 GPT-3 Input and Generation

- Researchers formulated prompts for GPT-3 based on each vignette's narrative description[5].
- Prompts included demographic information, chief complaint, detailed symptoms, past medical history, and key physical examination findings.
- For each vignette, GPT-3 was instructed to generate 10 differential diagnoses.

Evaluation of GPT-3 Generated Lists

- Two independent general internal medicine physicians, blinded to the correct diagnosis and GPT-3 outputs, reviewed each list of 10 diagnoses.
- They assessed each diagnosis for:
  - Relevance to the vignette's presentation.
  - Plausibility based on medical knowledge.
  - Inclusion in the original list of physician-established diagnoses.

- Reviewers graded each list on a 4-point scale (0-3) based on these criteria, with higher scores indicating greater accuracy and completeness.

2.5.3 Statistical Analysis

- Agreement between reviewers' evaluations and original diagnoses was analyzed using Cohen's kappa coefficient.
- The rate of correct diagnoses identified by GPT-3 and physicians was compared, both within the top ranked diagnosis and considering all 10 generated diagnoses.
- Consistency of diagnoses generated by GPT-3 across different prompts for the same vignette was assessed[5].

Ethical Considerations

- The study obtained informed consent from all participating physicians.
- Authors emphasized that GPT-3 should not be used for patient diagnosis or treatment without further validation and integration into clinical decision support systems.

In conclusion, this pilot research provides an insightful look at the advantages and disadvantages of applying AI to differential diagnosis early on. Even while GPT-3 showed a lot of potential in producing accurate and credible diagnoses, its performance was still inferior to that of skilled human doctors. However, this work establishes a vital framework for more investigation, providing avenues for future study to improve and optimize AI-based diagnostic instruments. Encouraging research and development, in conjunction with meticulous ethical deliberations, are essential to fully actualizing AI's promise to transform healthcare in the future and eventually enhance patient outcomes[5].

2.6 Summary of the Chapter

This setion investigates the possible applications of deep learning methods in natural language processing, healthcare, and false news detection. It emphasizes the possibilities of employing Bi-directional LSTM-Recurrent Neural Networks for the identification

SNo.	Paper	Authors	Methodology	Advantages	Disadvantages
1	An AI-Based Medical Chatbot Model for Infectious Disease Prediction[1]	Sanjay Chakraborty et al.	LSTM, ML Algorithms, Various Models, Data Analysis	Personalized predictions, Empowered chatbots, Disease mechanism analysis	High computational cost, Overfitting risk, Data quality dependence, Privacy concerns
2	Intelligent Chatbot using BRNN and Attention Model[2]	Manyu Dhyani and Rajiv Kumar	BRNNs, Attention Models	Natural conversations, Contextual understanding, Decision insights	High computational cost, Model interpretation, Vanishing gradient, Hyperparameter tuning
3	Mental Healthcare Chatbot using Sequence-to-Sequence Learning and BiLSTM[3]	Rakib et al.	Seq2Seq (BiLSTM+GRU)	Tailored support, emotional understanding, wider access	No diagnosis, data bias, resource demands
4	Predicting medical specialty from text based on a domain-specific pre-trained BERT[4]	Yoojoong Kim et al.	Domain-specific pre-trained BERT, Multi-class classification	Improved accuracy and F1 scores for most specialties compared to generic BERT and other baseline models	Limited generalizability to other medical data sources, potential bias in the dataset
5	Diagnostic Accuracy of Differential-Diagnosis Lists Generated by GPT-3[5]	Takanobu Hirosawa et al.	Clinical vignettes, GPT-3 prompts, blind expert review	Early diagnosis support, efficient list generation	Lower accuracy than physicians, small dataset, potential biases

Table 2.1: Comparsion of methodologies involved in different research papers

of fake news and AI-powered medical chatbots for the prediction of infectious illnesses. Additionally, the work contrasts CNN and RNN models for natural language processing, suggesting directions for further investigation. Research is moving more quickly, opening the door for more creative solutions to challenging problems.

Chapter 3

Requirements

This section outlines the fundamental specifications for our AI-powered medical chatbot in order to close the gap between patients and easily available healthcare information. We carefully design user-centric functions enabled by the combined power of BERT and LSTM, drawing on insights from previous research. This section lays the groundwork for creating a chatbot that can comprehend, educate, and counsel, ultimately forming a more intelligent healthcare encounter.

3.1 Hardware and Software Requirements

While our AI medical chatbot project eliminates the need for dedicated hardware, its software requirements deserve meticulous attention.

The project's success depends on a robust software ecosystem that is based on Google Colab and Jupyter Notebook, two well-known tools for group cloud-based experimentation and analysis. The core of the chatbot's web interface is Flask, a flexible Python web framework that guarantees easy user interaction and effective communication. We make use of the well-known and adaptable combination of HTML for layout and CSS for style to provide a user-friendly experience.

In the meanwhile, massive datasets are managed and stored safely using MySQL, which also acts as the project's reliable database. The project's foundation is Python 3, a strong and adaptable programming language that makes it possible to construct intricate algorithms and features.

We make use of the well-liked and incredibly configurable code editor VS Code to facilitate development and troubleshooting. Ultimately, Microsoft Excel is a useful tool for pre-processing data, helping to turn raw data into insights that can be put to use.

3.2 Functional Requirements

1. **User Interaction and Dialogue Management**

   - Engage in natural, conversational dialogue, leveraging NLP techniques like intent recognition and entity extraction to accurately interpret user queries.
   - Provide clear and concise answers, tailored to the user's level of medical understanding through context-aware language generation.
   - Employ techniques such as semantic similarity analysis and dialogue context tracking to maintain coherence and continuity in conversations.

2. **Symptom Analysis and Disease Prediction**

   - Utilize BERT (Bidirectional Encoder Representations from Transformers)[4] to extract relevant medical entities, concepts, and relationships from user input, effectively capturing contextual nuances and semantic dependencies.
   - Employ an LSTM (Long Short-Term Memory)[3] network, trained on comprehensive medical datasets, to:
     - Model temporal dependencies in symptom sequences for enhanced diagnostic accuracy.
     - Uncover hidden patterns in patient data to predict potential diagnoses with associated probabilities.
     - Assess risk levels for various medical conditions, providing a more comprehensive assessment.
   - Generate a ranked list of possible diagnoses, accompanied by supporting evidence and explanations, fostering transparency and user trust.

3. **Casesheet Generation and Data Storage**

   - Create a structured casesheet summarizing the user's symptoms, predicted diagnoses, risk scores, and relevant medical information, facilitating efficient communication and knowledge sharing.
   - Securely store this casesheet in the MySQL database, ensuring data integrity and accessibility for both users and healthcare professionals.

- Provide users with a copy of their casesheet for personal reference and potential sharing with healthcare providers, empowering patient involvement in their health management.

4. **Healthcare Information Access**

   - Provide accurate and reliable medical information upon request, sourced from credible databases or medical literature, ensuring evidence-based guidance.
   - Tailor the information delivery to the user's level of knowledge, using techniques like text simplification and summarization to enhance comprehension.
   - Include links to relevant external resources for further exploration, fostering patient education and self-advocacy.

5. **User Feedback and Logging**

   - Collect user feedback to evaluate performance, identify areas for improvement, and guide model refinement, ensuring continuous optimization.
   - Log all user interactions, including symptoms, diagnoses, feedback, and system responses, for analysis and potential model personalization, fostering evidence-based decision-making.
   - Maintain user confidentiality and data privacy in accordance with ethical guidelines and regulations, fostering trust and protecting sensitive information.

3.3 Summary of the chapter

The functional needs of our project were thoroughly described in this chapter, laying the groundwork for both its effective functioning and memorable user experience. These features, which include accurate illness prediction utilizing BERT and LSTM and captivating dialogue management, provide consumers with individualized health insights and guarantee smooth contact with medical specialists. These requirements, which put an emphasis on information access, user engagement, and ongoing development, open the door for a disruptive healthcare assistant that democratizes medical knowledge and gives people the power to take control of their own health journey.

Chapter 4

System Architecture

This section presents the architectural blueprint of an AI-powered medical chatbot, focusing on the interplay between BERT and LSTM, their strengths, and their design choices for accurate symptom analysis, context-aware dialogue generation, and seamless user interaction. The aim is to demonstrate the technical feasibility and functional elegance of the proposed architecture.

4.1 System Overview

Picture a healthcare environment in which the first steps towards diagnosis entail a subtle conversation with a digital companion made of a tapestry of complex algorithms rather than sterile forms and never-ending waiting rooms. Our AI-powered medical chatbot, your companion, combines a symphony of computational processes to turn your symptom descriptions into a clear, educational casesheet, giving you the autonomy and clarity to follow the path to well-being.

Whether you provide spoken or textual data, the journey starts with your input. Bert, the master of natural language processing (NLP), uses this data as his raw material. Bert dives into the complexities of human language, using its trained comprehension of sentiment, context, and linguistic subtleties to break down your stories and identify key medical elements such as symptoms, durations, degrees of severity, and any pertinent medical history. Bert takes this painstakingly created language map and extracts the core of your worries.

But comprehending the significance of symptoms is just half the fight. The temporal detective, LSTM, steps in to examine how your health issues have developed over time. With time, this advanced recurrent neural network becomes exceptionally good at identifying patterns and making sequence predictions. It painstakingly analyzes the historical

mosaic of your symptoms, pinpointing their beginning, middle, and end, as well as any possible connections between them. With its ability to comprehend the temporal dynamics of your health concerns, LSTM contributes an essential layer of information to the diagnostic process.

Bert and LSTM don't operate independently. Their constant resource is a digital library full of information about symptom presentations, possible diagnosis, available treatments, and the most recent developments in medicine. It is a massive medical knowledge base. This extensive book is the basis of their diagnostic reasoning, anchoring their findings in the vast body of medical knowledge.

Bert and LSTM work together to perform a collaborative diagnostic dance in which they assess potential diagnoses, assign likelihoods to each, and compare your symptoms to the knowledge base. Transparency is guaranteed by this probabilistic method, which gives you the ability to comprehend the level of confidence attached to any potential diagnosis. After this complex exchange, a customized casesheet—your virtual medical assistant—is created. This brief document provides a clear summary of the symptoms you have reported, the most likely diagnoses, ranked by likelihood, pertinent educational resources specific to your concerns, precise instructions on when to seek medical attention from a professional, and additional suggestions for self-care or symptom monitoring.

But the chatbot's journey doesn't finish with the casesheet. By continuously learning from your interactions, its customization engine adjusts its recommendations and reactions to your changing medical history and health profile. With this dynamic method, you will gradually obtain more individualized and pertinent assistance.

Equipped with your individualised casesheet and the continuous assistance of the chatbot, you are enabled to take an active role in your healthcare process. You can look into educational materials, take care of yourself proactively, and decide when to consult a doctor when necessary. As a result, the chatbot is an invaluable resource for comprehending your symptoms and confidently navigating the healthcare system.

This project has developed into a proactive health partner, going beyond symptom analysis. Through ongoing learning and integration of varied data, it improves care processes, demystifies medical information, and provides individuals with individualized insights. In the end, it ushers in a future in which AI and humans work together to create a society that is healthier and more empowered.

4.2 Architectural Design

The Figure 4.1 showcases the overall design architecture of the project.

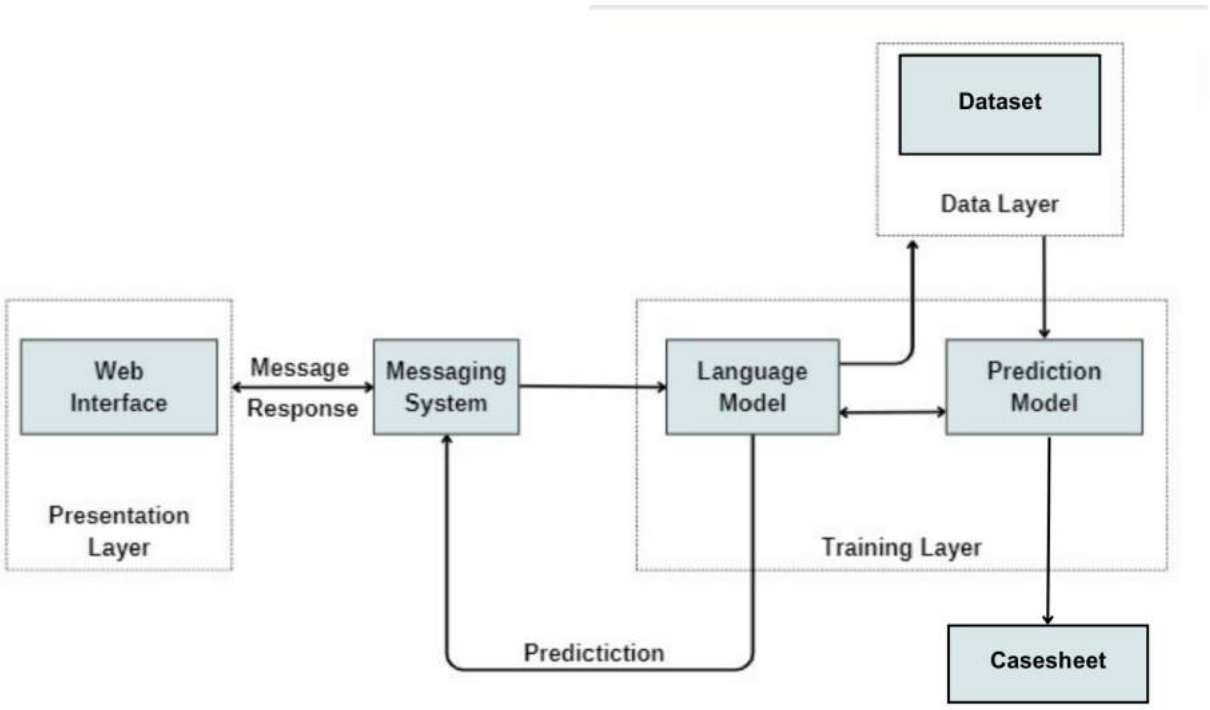


Figure 4.1: Architectural Design

4.3 Module Division

4.3.1 User Module: A Gateway to Personalized Care

This module serves as your entry point for interacting with the chatbot, offering:

- **Interactive Interface:** User-friendly HTML web pages provide a visually accessible and intuitive experience, currently focusing on precise and clear text-based input. Future iterations might explore multimodal inputs like voice and image recognition.
- Personalization Engine: Driven by advanced machine learning, this engine continuously learns from your interactions, tailoring responses and recommendations to your evolving health profile and medical history. This fosters trust and personalized care, ensuring the information you receive is increasingly relevant and aligned with your unique needs.

- **Account Management:** Recognizing the importance of data security and privacy, the chatbot offers a secure system for managing your account credentials and controlling access to your sensitive health information. Robust security measures ensure its protection.

- **Test Results Uploading Module:** To provide the chatbot with a more comprehensive picture of your health, this module allows you to upload additional test results like lab reports, imaging scans, or other documents, empowering the algorithms for more informed analyses and accurate recommendations.

4.3.2 Dataset Module: The Foundation of Knowledge

This module serves as the bedrock for the chatbot's reasoning, housing a vast and continuously updated medical knowledge base:

- **Medical Knowledge Base:** This comprehensive repository includes:
  - **Symptom Descriptions and Potential Diagnoses:** A meticulously curated catalog linking symptom presentations with a spectrum of potential diagnoses, encompassing common and rare conditions.
  - **Treatment Options and Educational Resources:** For each potential diagnosis, the knowledge base provides a range of treatment options and links to authoritative resources for further education and empowerment.
  - **Drug Interactions and Side Effects:** Recognizing the complexities of medication regimes, the knowledge base comprehensively details potential drug interactions and their associated side effects, promoting safety and informed decision-making.
  - **Latest Medical Advancements and Research Findings:** To ensure the chatbot remains at the forefront of medical knowledge, the knowledge base is continuously updated with the latest research findings and advancements in healthcare.

- **Data Cleaning and Preprocessing:** Before feeding information into the algorithms, this module ensures data quality and consistency through techniques like

handling missing values, addressing inconsistencies, and transforming data into formats compatible with the AI models.

- **Data Splitting:** To guarantee robust model development and evaluation, the dataset is strategically divided into training, validation, and testing sets. The training set provides raw material for the algorithms to learn, the validation set fine-tunes their performance, and the testing set objectively assesses their generalizability to unseen data.

4.3.3 NLP Bert Module: Unraveling the Linguistic Tapestry

This module delves into the intricacies of your narrative, employing the pre-trained Bert model, a powerhouse of Natural Language Processing (NLP):

- **Core Engine:** Bert expertly dissects your sentence structure, analyzes word choices and context, and recognizes medical jargon and abbreviations. This enables it to extract critical medical entities like symptoms, durations, severity levels, and relevant medical history, constructing a clear and accurate picture of your concerns.

- **Fine-tuning:** To further enhance its understanding of the specific domain of medical language, Bert undergoes additional training on medical datasets tailored to the chatbot's purpose. This fine-tuning ensures the model accurately interprets medical terminology, nuances, and complexities, improving its diagnostic accuracy and relevance.

4.3.4 LSTM Module: Unveiling the Temporal Landscape

This module excels at identifying patterns and relationships within the sequence of your symptoms, employing sophisticated recurrent neural networks:

- **Temporal Analysis:** LSTM analyzes the chronological tapestry of your health concerns, recognizing how symptoms have emerged, progressed, and potentially interacted. This temporal understanding adds a crucial layer of insight to the diagnostic process, allowing the chatbot to uncover potential underlying causes and predict future health trajectories.

4.3.5 Casesheet Generation Module: Synthesizing Insights into Actionable Information

The casesheet offers more than a list of possibilities; it serves as a personalized roadmap for informed decision-making:

- **A Concise Overview of Reported Symptoms:** A clear summary of your reported symptoms and their characteristics ensures accurate representation and understanding.
- **Relevant Educational Resources:** Tailored to your specific concerns, the chatbot provides links to authoritative medical websites, articles, and other resources to empower you with knowledge and understanding about your health.
- **Guidance on Seeking Professional Medical Attention:** Recognizing the limitations of AI, the chatbot offers clear guidance on when to seek professional medical advice, ensuring you can access healthcare when necessary.
- **Recommendations for Self-care or Monitoring:** For conditions potentially managed at home, the chatbot provides evidence-based recommendations for self-care practices and symptom monitoring, promoting proactive well-being management.

4.4 Work Schedule - Gantt Chart

The Figure 4.2 showcases the overall tentative work schedule of the project development in the form of gannt chart.

4.5 Summary of the chapter

This chapter explores the complex internal workings of the architecture of our AI-powered medical chatbot. We present a modular architecture made up of five main parts: the User Module that allows for smooth interaction; the Dataset Module that contains the knowledge base; the NLP Bert Module that is capable of advanced language processing; the LSTM Module that is devoted to risk assessment and disease prediction; and the Casesheet Generation Module that converts results into organized reports. Between these

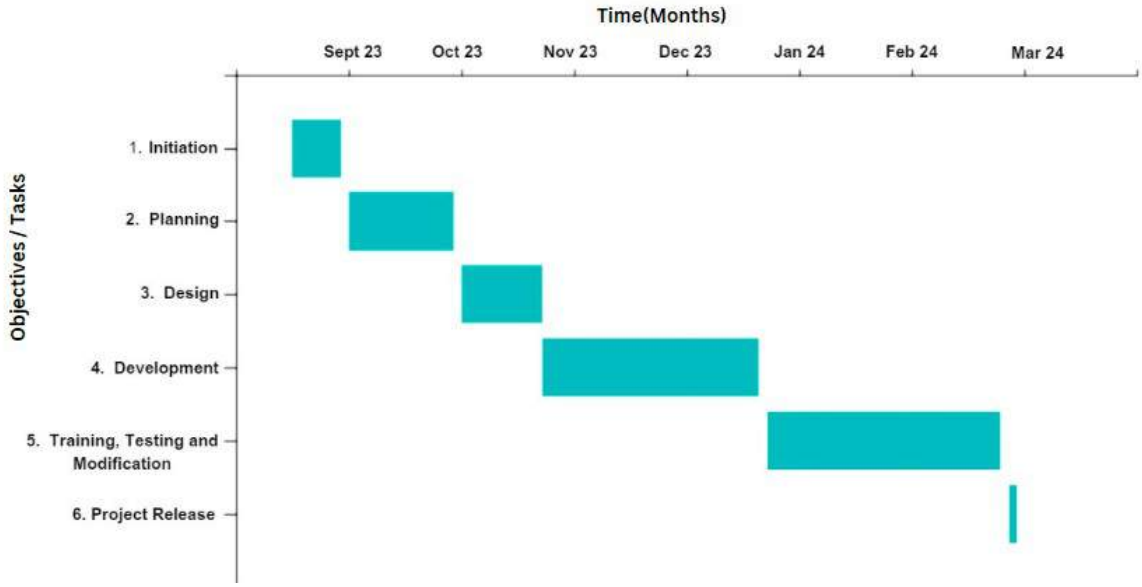


Figure 4.2: Gannt Chart

components, data flows naturally, allowing the system to quickly assess user complaints, provide precise diagnoses, and present health insights in an easily comprehensible manner. Because of its modular design, which guarantees scalability, flexibility, and effective information processing, the system is ideal for integration with the current healthcare infrastructure.

Chapter 5

Results

This chapter includes the thorough findings from our AI-powered medical assistant system, which was created to expedite diagnosis by utilizing symptoms and personal information supplied by the user. Through an easy-to-use interface, the system gathers relevant data and creates a comprehensive case sheet with suggested diagnostic tests and anticipated diseases. We evaluate our AI assistant's overall effectiveness, accuracy, and efficiency in helping medical professionals diagnose and arrange treatments through extensive testing and review.

5.1 System as a Whole

Our AI-based medical assistant system employs a user-friendly interface to seamlessly capture and process user input, ensuring a streamlined and intuitive experience for both patients and healthcare providers. Users enter their symptoms and personal information via this interface in a structured fashion, which is subsequently sent to the system's backend for processing. After submission, the system uses the LSTM and BERT models to do a thorough analysis of the data that the user has supplied. Renowned for its contextual comprehension of natural language, BERT analyzes the input text, extracting relevant information and identifying contextual subtleties that are essential for a precise diagnosis. LSTM networks model sequentiality in symptom reports at the same time, capturing temporal connections and spotting minor patterns that point to certain medical disorders.

Following the BERT and LSTM models' processing and analysis of the user input, the system produces a comprehensive case sheet that includes the anticipated diseases and suggested diagnostic procedures. The user's personal information, symptoms reported, anticipated diseases with corresponding confidence scores, and recommended diagnostic

tests for additional assessment are all arranged in a structured manner on the case sheet. This all-inclusive document acts as a central repository for patient data, enabling healthcare providers to make well-informed decisions and guaranteeing continuity of care.

Our AI-based medical assistant system offers a sophisticated yet approachable way to improve clinical decision-making and diagnostic accuracy in healthcare settings through the smooth integration of user input capture, processing, and case sheet creation. The system's unmatched precision in analyzing complicated medical data is attributed to its effective use of BERT and LSTM models, which give healthcare providers with tailored treatment suggestions and actionable insights.

5.2 BERT-LSTM Model

Our AI-powered medical assistant transforms disease prediction by combining the strength of BERT and LSTM models, providing healthcare professionals with a reliable and extremely accurate diagnostic tool. Combining BERT, which is well-known for its contextual comprehension of natural language, with LSTM, which is an expert in modeling sequential data, creates a powerful prediction framework that can identify complex patterns in symptoms that users enter. While LSTM is skilled at processing the temporal dependencies seen in sequential symptom presentation, BERT excels at catching the contextual subtleties of symptom descriptions.

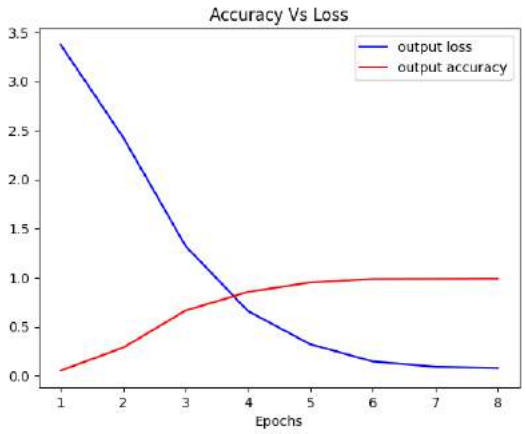


Figure 5.1: output accuracy and loss of the model

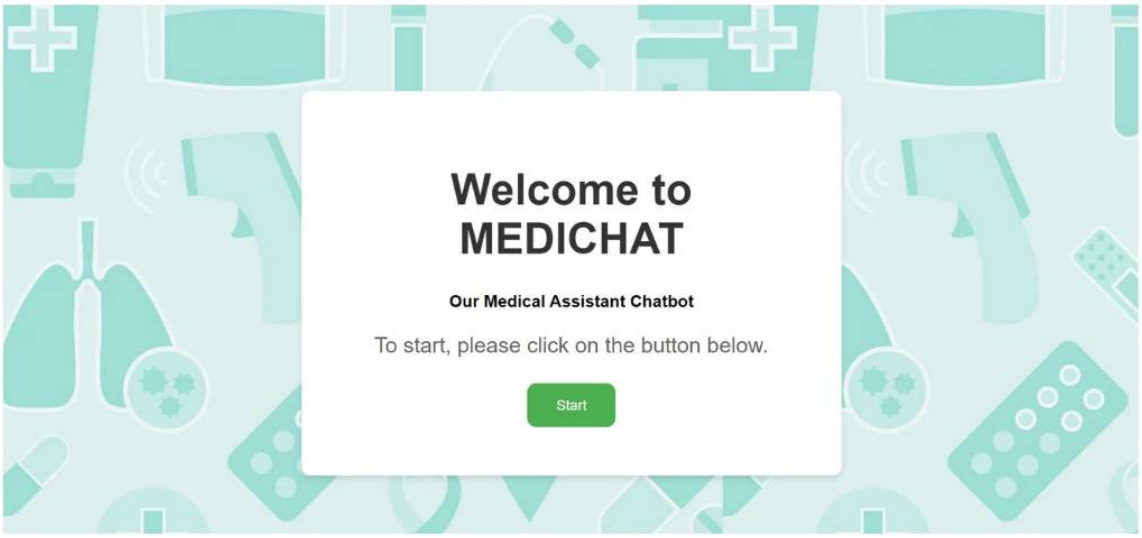
With a remarkable accuracy rate of 94–95% as shown in Figure 5.1, our model can

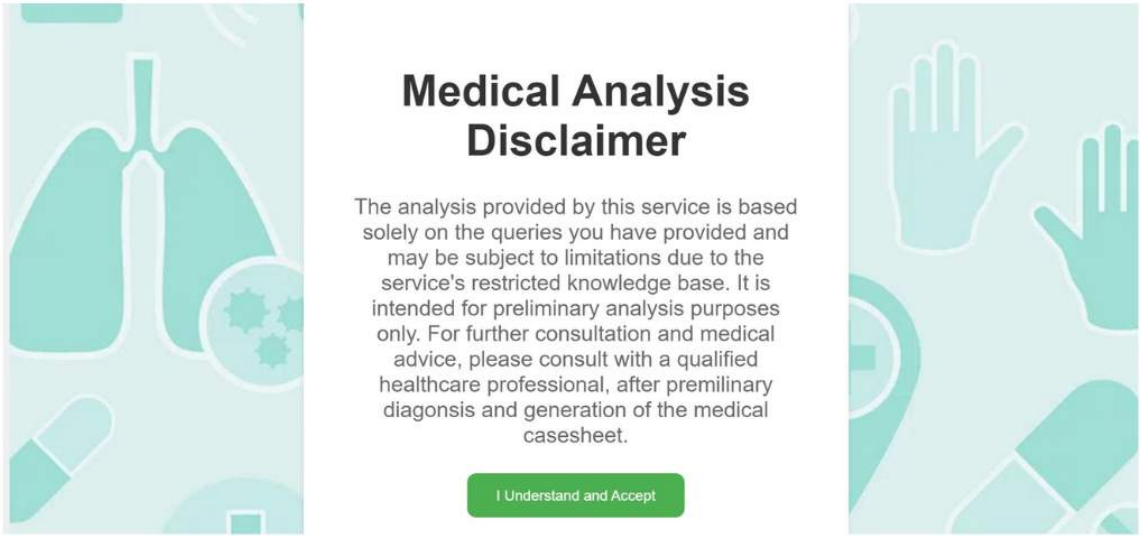
forecast underlying diseases with remarkable precision because to its synergistic approach. With rigorous fine-tuning and extensive training on a variety of medical datasets, the BERT-LSTM model has become remarkably adept at interpreting complicated symptomatology and linking them to relevant medical disorders. Our model surpasses the constraints of conventional rule-based diagnostic techniques by effectively finding minor associations between symptoms and diseases by utilizing the rich contextual embeddings created by BERT and the sequential learning capabilities of LSTM.

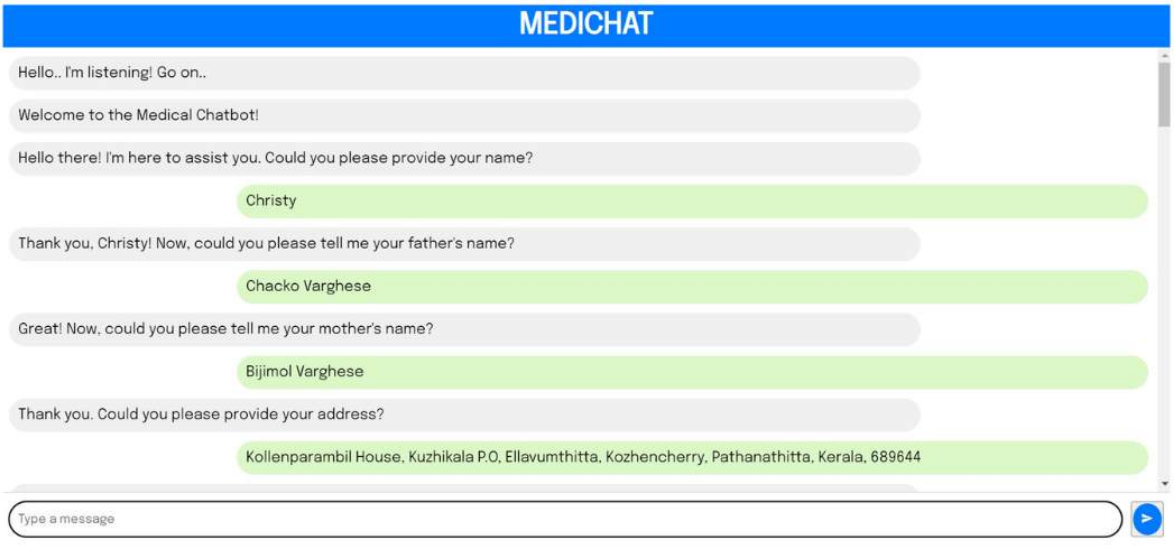
Additionally, our BERT-LSTM model's robustness and dependability have been confirmed by extensive testing and assessment, showing consistent performance across a range of clinical circumstances and patient populations. Our model's excellent accuracy gives confidence to medical practitioners by providing them with useful insights that enable prompt intervention and treatment planning. Furthermore, the BERT-LSTM architecture's transparency and interpretability improve the reliability of our predictions and promote cooperation between AI systems and human professionals in clinical decision-making.

5.3 User Interface

The user interface of the MediChat platform starts with an HTML page that invites users to engage with the system through a designated "Start" button. Upon initiation, users are directed to a disclaimer page, emphasizing the importance of consulting a medical professional following any preliminary diagnosis provided by the platform. Subsequently, users enter the chatbot interface, where they are prompted to respond to predefined questions regarding their personal details. Following the collection of personal details, users are prompted to select their symptoms from a dropdown list. This symptom list is then transmitted to the BERT-LSTM model for advanced natural language processing, improving the diagnostic accuracy of the platform.


Welcome to MEDICHAT
Our Medical Assistant Chatbot
To start, please click on the button below.
Start


Medical Analysis Disclaimer
The analysis provided by this service is based solely on the queries you have provided and may be subject to limitations due to the service's restricted knowledge base. It is intended for preliminary analysis purposes only. For further consultation and medical advice, please consult with a qualified healthcare professional, after premilinary diagonsis and generation of the medical casesheet.
I Understand and Accept


MEDICHAT
Hello.. I'm listening! Go on..
Welcome to the Medical Chatbot!
Hello there! I'm here to assist you. Could you please provide your name?
Christy
Thank you, Christy! Now, could you please tell me your father's name?
Chacko Varghese
Great! Now, could you please tell me your mother's name?
Bijimol Varghese
Thank you. Could you please provide your address?
Kollenparambil House, Kuzhikala P.O, Ellavumthitta, Kozhencherry, Pathanathitta, Kerala, 689644
Type a message

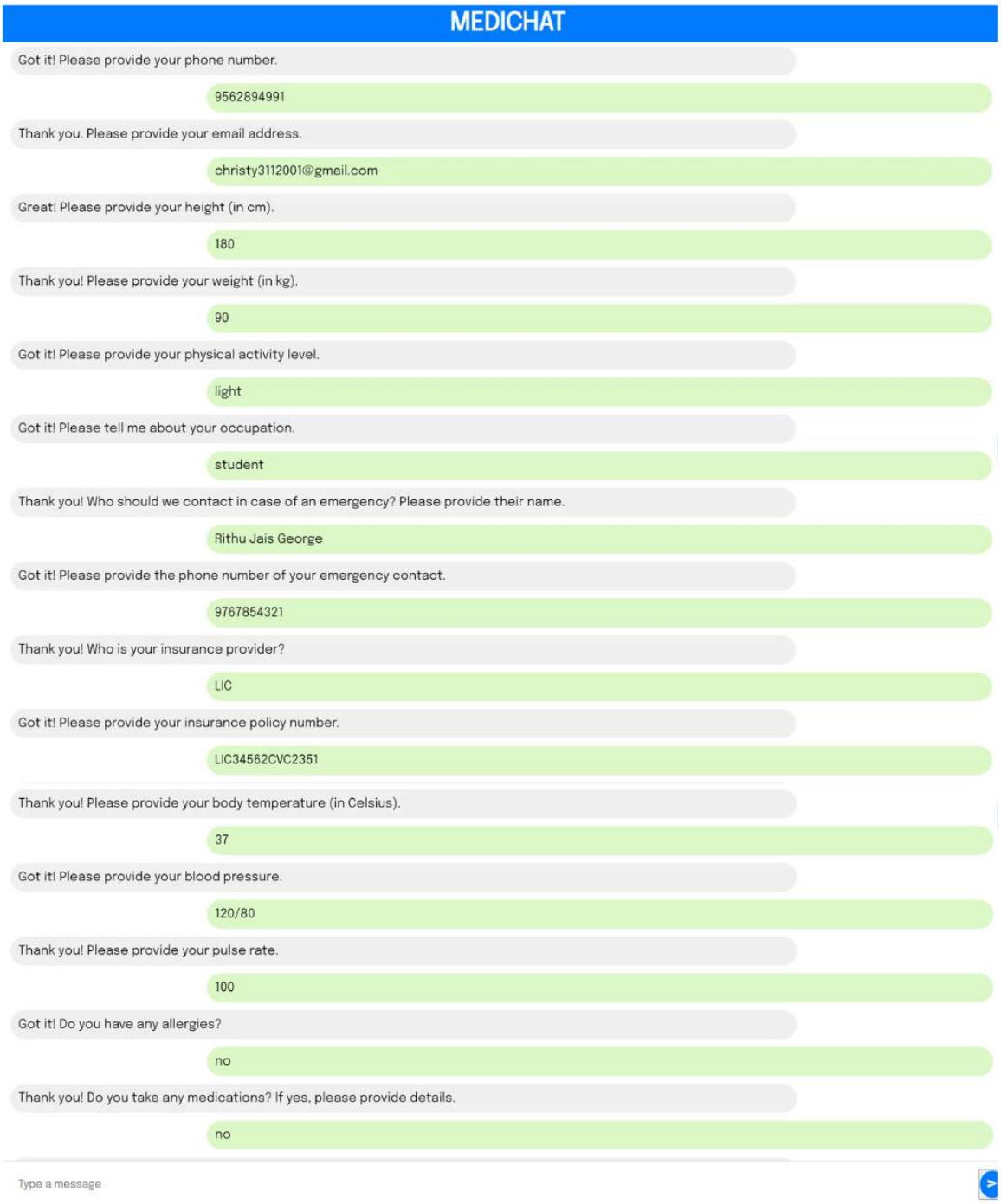


Figure 5.2: User Interface snapshots

5.4 Case Sheet Generation

The Case Sheet Generation Module is an important instrument revolutionizing medical practice, streamlining patient care, and enhancing diagnostic accuracy. Fundamentally, this module is a lighthouse of efficiency, enabling physicians to maximize their time by automating the tiresome process of patient interviews. Its careful design allows for the rapid and thorough assessment of the patient's health status by distilling critical patient data into a manageable three-page booklet.

The case sheet's opening page provides access to the patient's identify by gathering crucial personal information derived from user input. By creating the framework for later evaluations, this fundamental page guarantees a comprehensive approach to patient treatment. Quick access to relevant data, including demographics and contact information, allows medical practitioners to accelerate the diagnostic process.

The next section of the case sheet explores the complex web of the patient's past medical history and current symptoms. Here, the module summarizes a thorough account of the patient's medical history, giving doctors insightful knowledge about previous illnesses and present problems. With this all-inclusive picture, medical professionals may spot trends, pinpoint possible risk factors, and efficiently customize interventions to meet each patient's needs.

The third and last page combines clinical knowledge with sophisticated predictive modeling, is the pinnacle of data-driven healthcare innovation. This section uses cutting-edge BERT LSTM models to provide predictive insights into possible diagnosis in addition to highlighting presenting symptoms. Enhanced by a well selected dataset, the module suggests customized diagnostic tests according to anticipated illnesses, thereby optimizing resource distribution and accelerating the start of therapy.

Furthermore, the module makes sure that suggested investigations and anticipated diagnoses are in line with each other by mapping tests and characteristics from an extensive dataset. Predictive analytics and empirical data work together to strengthen diagnostic accuracy, giving doctors the confidence to make well-informed judgments.

In essence, the Case Sheet Generation Module is an innovative health records tool that transcends conventional practices and shows how technical innovation and clinical expertise may be used to create personalized healthcare that focuses on the patient.

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5.5 Summery of the Chapter

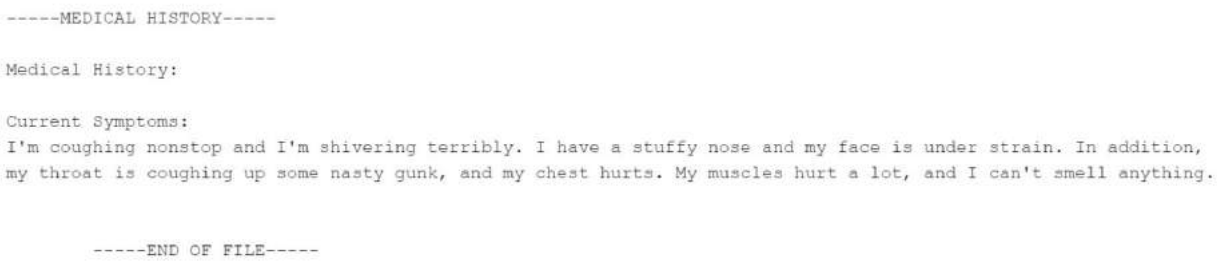
This chapter explores the results of the project, showing how various modules work with each other, what each module outputs and how efficient the project as a whole is. The BERT-LSTM model was able show an accuracy rate of 95% within the available dataset. The UI is able to obtain inputs from the user effectively and the chat design works flawlessly. The Case sheet generation module also show good results, with proper display of personal details, symptoms, predictions as well as the tests and test results.

```
-----PERSONAL DETAILS-----

Name: Albin
Father's Name: Rony
Mother's Name: Jeena
Address: No Address
Phone Number: 989898989
Email ID: arm29292
Height: 98
Weight: 99
Physical Activity Level: light
Body Temperature: 35
Blood Pressure: 1.5
Pulse Rate: 100
Allergies: none
Medications: none
Occupation: student
Emergency Contact Name: nill
Emergency Contact Number: nill
Insurance Provider: no
Insurance Policy Number: no

-----END OF FILE-----
```

Figure 5.3: Page 1 of case sheet



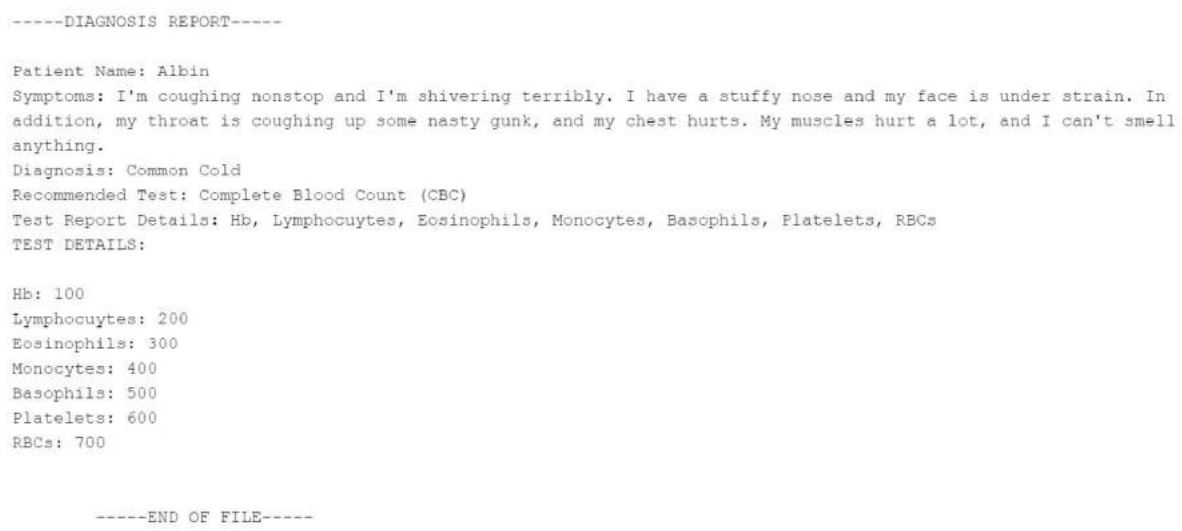
```
-----MEDICAL HISTORY-----

Medical History:

Current Symptoms:
I'm coughing nonstop and I'm shivering terribly. I have a stuffy nose and my face is under strain. In addition,
my throat is coughing up some nasty gunk, and my chest hurts. My muscles hurt a lot, and I can't smell anything.

-----END OF FILE-----
```

Figure 5.4: Page 2 of case sheet



```
-----DIAGNOSIS REPORT-----

Patient Name: Albin
Symptoms: I'm coughing nonstop and I'm shivering terribly. I have a stuffy nose and my face is under strain. In
addition, my throat is coughing up some nasty gunk, and my chest hurts. My muscles hurt a lot, and I can't smell
anything.
Diagnosis: Common Cold
Recommended Test: Complete Blood Count (CBC)
Test Report Details: Hb, Lymphocuytes, Eosinophils, Monocytes, Basophils, Platelets, RBCs
TEST DETAILS:

Hb: 100
Lymphocuytes: 200
Eosinophils: 300
Monocytes: 400
Basophils: 500
Platelets: 600
RBCs: 700

-----END OF FILE-----
```

Figure 5.5: Page 3 of case sheet

Chapter 6

Conclusions & Future Scope

This section explores the use of AI-powered medical chatbots through BERT and LSTM, focusing on their limitations and achievements. It then outlines potential research avenues for future advancements, aiming to make AI a beacon of healthcare guidance and understanding in the future.

6.1 Conclusion

Using a symphony of AI and human knowledge to reinvent patient care, the initiative represents a turning point in the history of healthcare. It's a monument to the times ahead, when intelligent algorithms intertwined with profound medical expertise will enable people and transform the availability of intelligent advice.Through the joint blending of AI and human intellect, this initiative deconstructs the conventional healthcare paradigm. With the help of large data sets and sophisticated algorithms, healthcare professionals' years of experience blend together in a seamless way. No matter where you are or how much time you have, this dynamic union can provide individualized help.

This project represents a paradigm change rather than just being a technological wonder. Equipped with data-driven insights to augment their judgment and intuition, it enables physicians to dive deeper into particular situations. By putting prevention measures and early intervention front and center and moving the emphasis from reactive sickness treatment to comprehensive well-being, this enables proactive, tailored care.As the project develops, a vivid picture of a transformed healthcare environment is painted. One in which artificial intelligence (AI) serves as a potent ally, enhancing human knowledge and clearing the path for a day when everyone may receive individualized, proactive, and easily available well-being. This initiative is a game-changer that will improve healthcare, not merely a technological advancement.

6.2 Future Scope

This project creates the foundation for proactive, empowered, and easily accessible healthcare in the future. Although its initial aim was on producing case sheets for healthcare staff and streamlining the examination of symptoms, its potential goes much beyond that. This project foresees an ever-learning artificial intelligence assistant that can analyze large amounts of health data, provide tailored preventive advice, and adjust to a variety of needs. Language barriers melting away to allow for smooth communication and easy interaction with current technologies are only the beginning. Instead of trying to replace human care, this initiative aims to create a potent instrument that will enhance it and enable professionals and patients to collaborate toward a healthier future.

With a greater grasp of each patient's medical background and prescription regimen, care might become more individualized, with actions being precisely tailored to possible health hazards. It is possible that the project may change from being a reactive adviser to a proactive health companion that will help you move toward a future of wellbeing. By utilizing these developments, our initiative has the potential to completely transform healthcare and make intelligent, individualized support accessible to everyone.

6.3 Summary of the chapter

To conclude, our initiative presents a revolutionary idea for healthcare facilitated by artificial intelligence. By providing dependable medical information around-the-clock, empowering patients with individualized health insights, and optimizing processes for healthcare providers, the suggested medical chatbot has the potential to completely transform the delivery of healthcare. As a first step towards this revolutionary reality, our initiative aims to provide healthcare that is proactive, accessible, and empowering for everyone. Going forward, we are dedicated to investigating potential avenues for growth, such as incorporating a variety of data sources, creating multimodal interaction models, and strictly adhering to ethical guidelines when developing and implementing new features. We feel that this initiative is a critical step towards a healthier, more empowered future for everyone as we continue to progress AI in healthcare.

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[3] A. B. Rakib, E. A. Rumky, A. J. Ashraf, M. M. Hillas, and M. A. Rahman, "Mental healthcare chatbot using sequence-to-sequence learning and bilstm," in *International Conference on Brain Informatics*. Springer, 2021, pp. 378–387.

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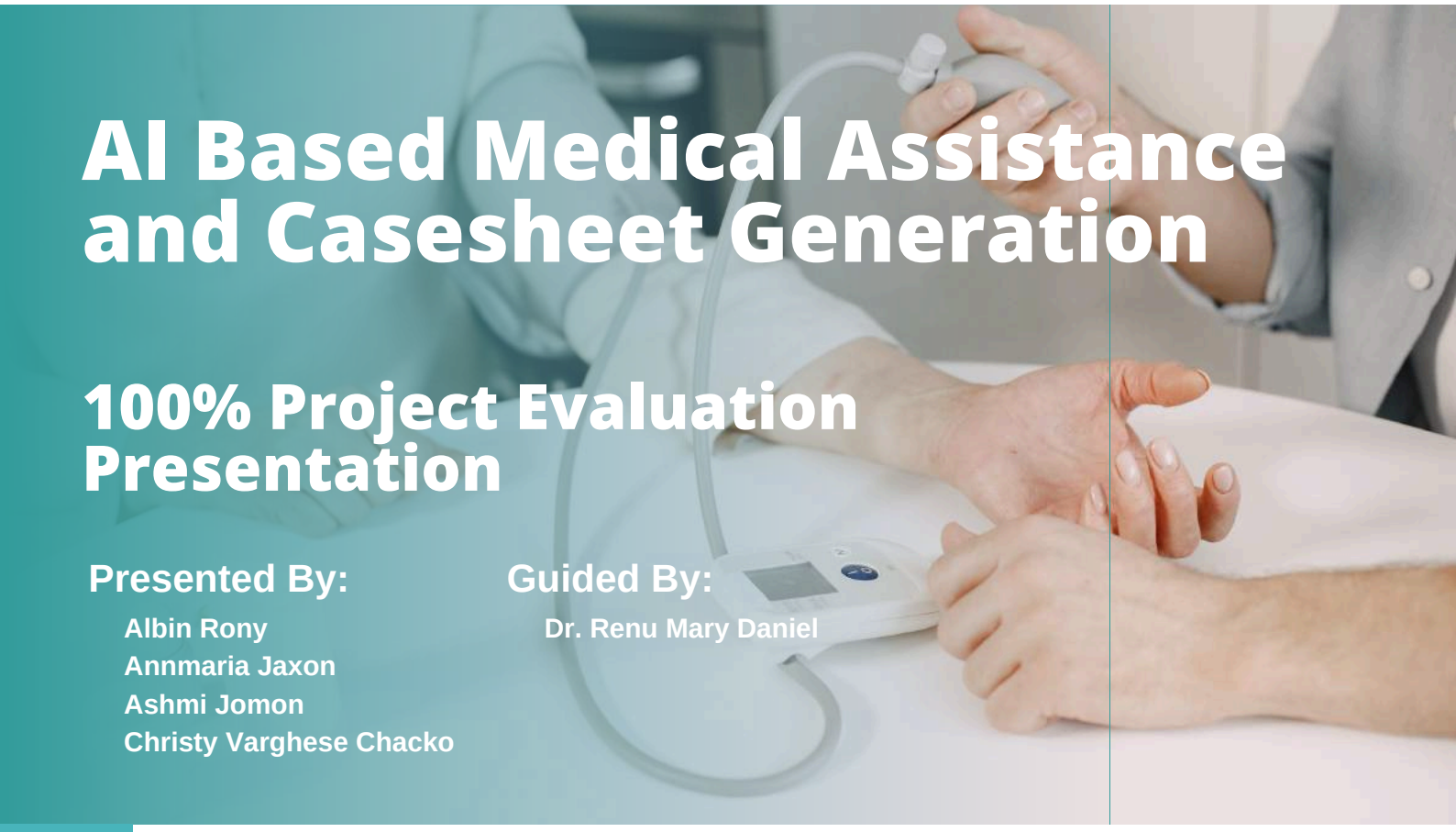
Appendix A: Presentation



AI Based Medical Assistance and Casesheet Generation

100% Project Evaluation Presentation

Presented By:

Albin Rony
Annmaria Jaxon
Ashmi Jomon
Christy Varghese Chacko

Guided By:

Dr. Renu Mary Daniel

Contents

Problem Definition

- Traditional healthcare faces issues like limited accessibility and delayed responses, impacting timely medical advice.
- Users encounter obstacles in obtaining prompt non-emergency medical guidance, leading to potential health risks and straining healthcare resources.
- Non-urgent concerns get trapped in lengthy queues, hindering proactive interventions and optimal outcomes.

Purpose and Need

- **Purpose:** To complement existing healthcare practices, enriching data, informing clinical decisions, and empowering proactive health management for improved patient outcomes and medical diagonsis.

- **Need:** The project aims to provide an immediate and accurate response to user-reported symptoms, ensuring a more accessible and responsive healthcare solution, beneficial for both, the patients and the hospital staff.

Project Objectives

- Develop a user-friendly chatbot interface to facilitate seamless interaction.
- Implement advanced machine learning algorithms to analyze diverse user-reported symptoms.
- Generate personalized health precautions and a basic case sheet for users, fostering proactive health management.

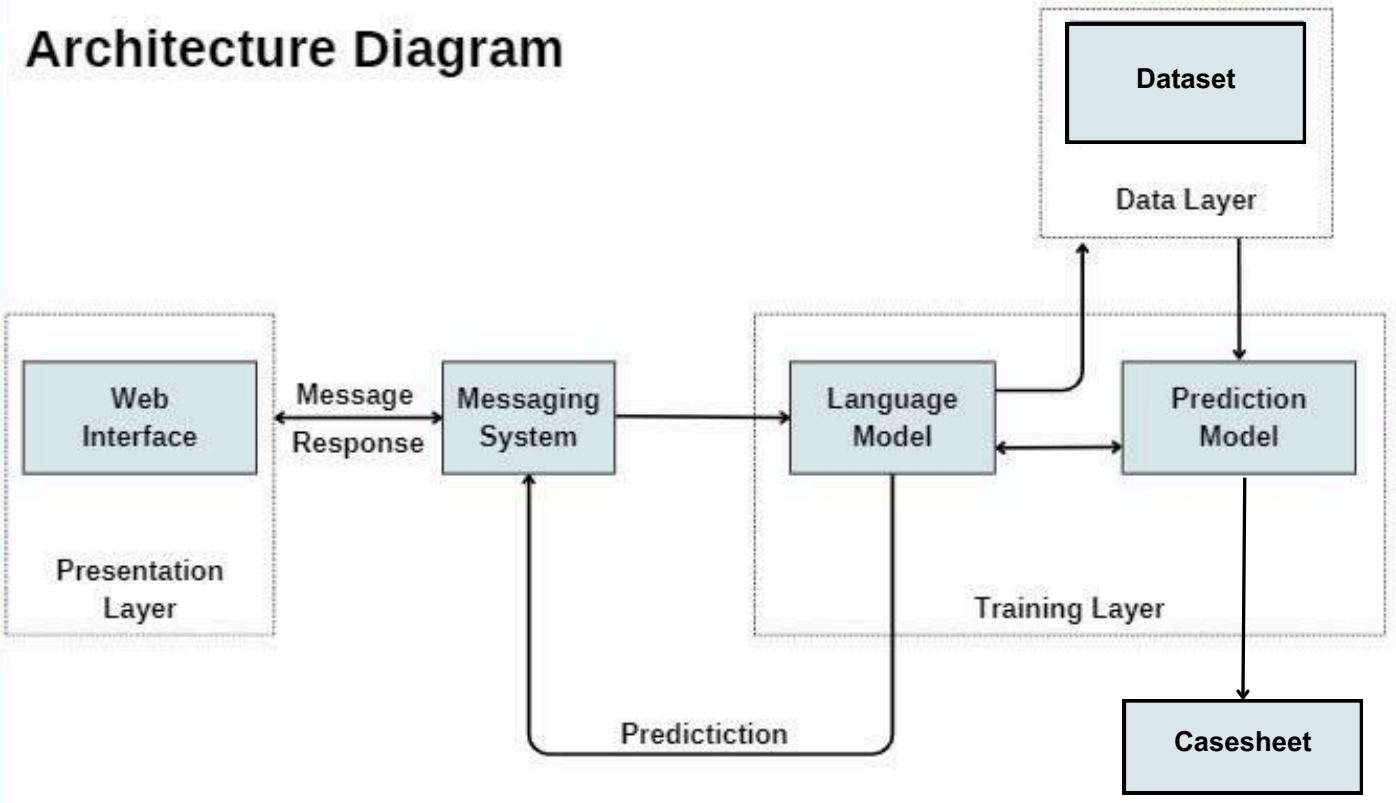
Scope of Implementation

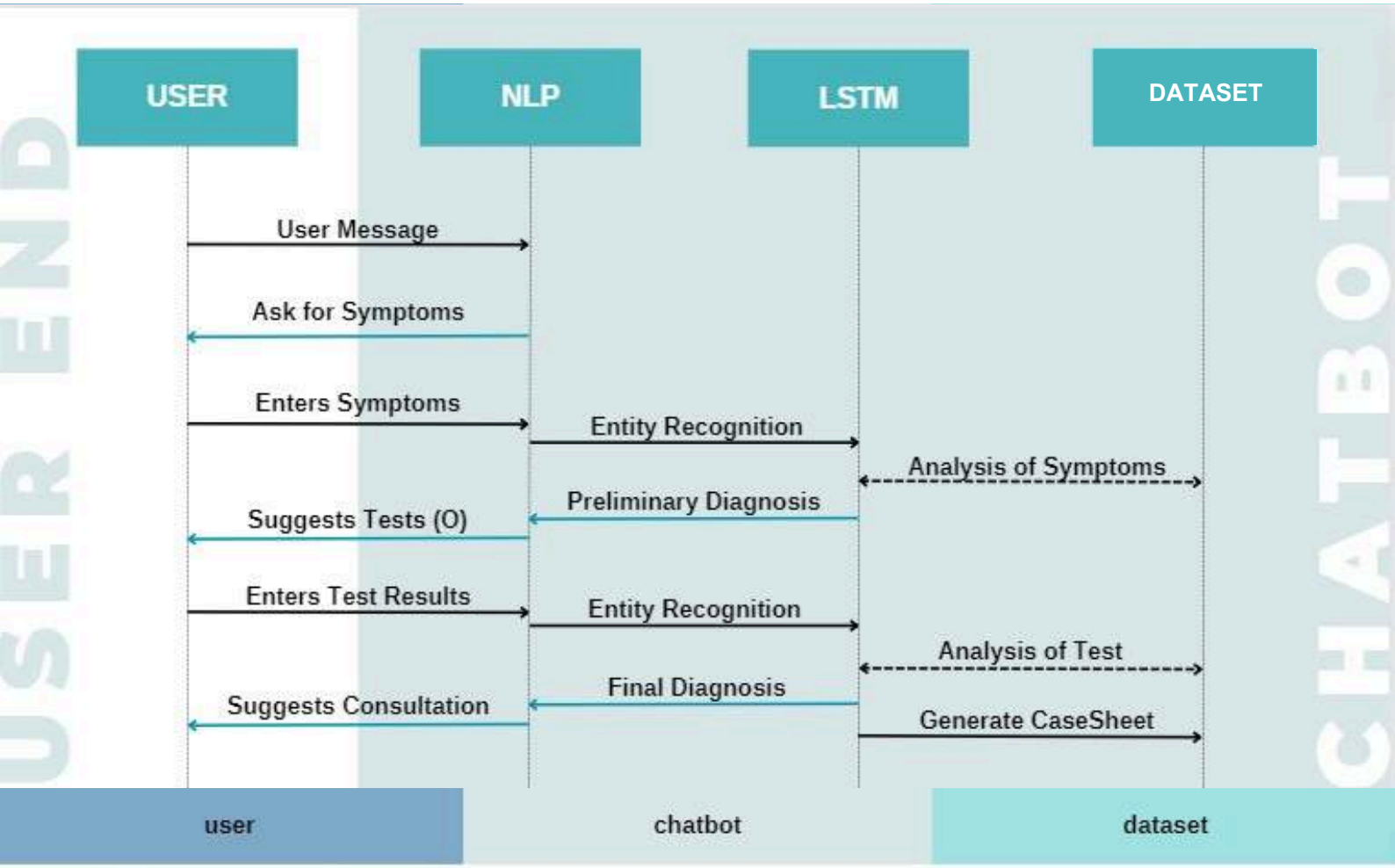
1. **Implementation Assistance:**
   - Patients receive personalized health advice and guidance, facilitating proactive health management and reducing strain on hospital resources.
2. **Personalized Recommendations:**
   - By offering guidance and scheduling follow-ups for non-urgent cases, the project reduces unnecessary visits to overcrowded government hospitals, optimizing resource usage.
3. **Scalability:**
   - The project is designed with scalability in mind, allowing for easy expansion to accommodate growing user demand and new features in the future.

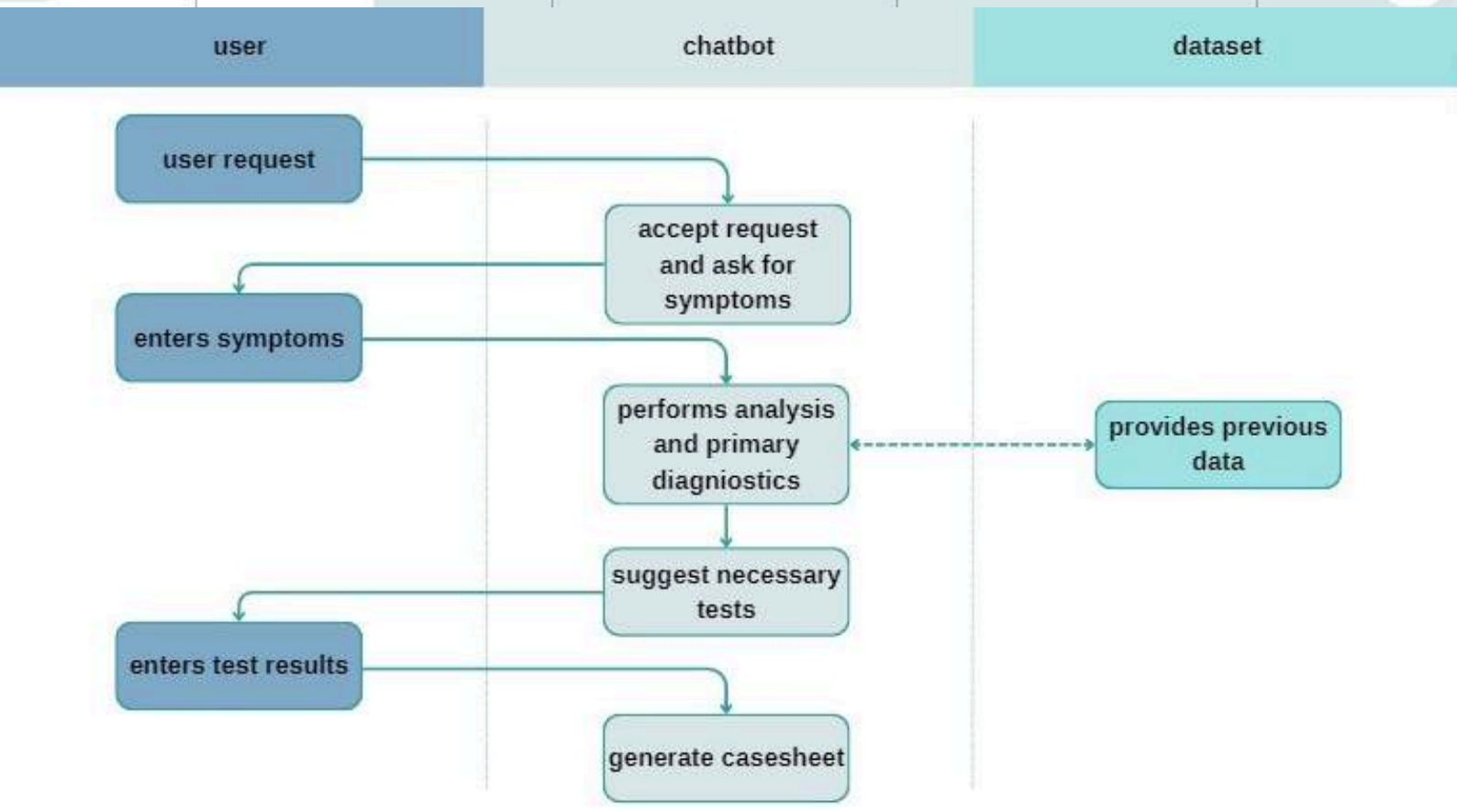
Novelty of Idea

1. **Enhanced Accessibility:**
- Offers additional avenues for healthcare support, improving accessibility for individuals in need.
2. **Integrated Support:**
- Seamlessly integrates with existing healthcare systems, enhancing overall efficiency and data management.
3. **Rapid Preliminary Diagnosis:**
- Offers quick initial assessments based on user input, expediting the diagnostic process.

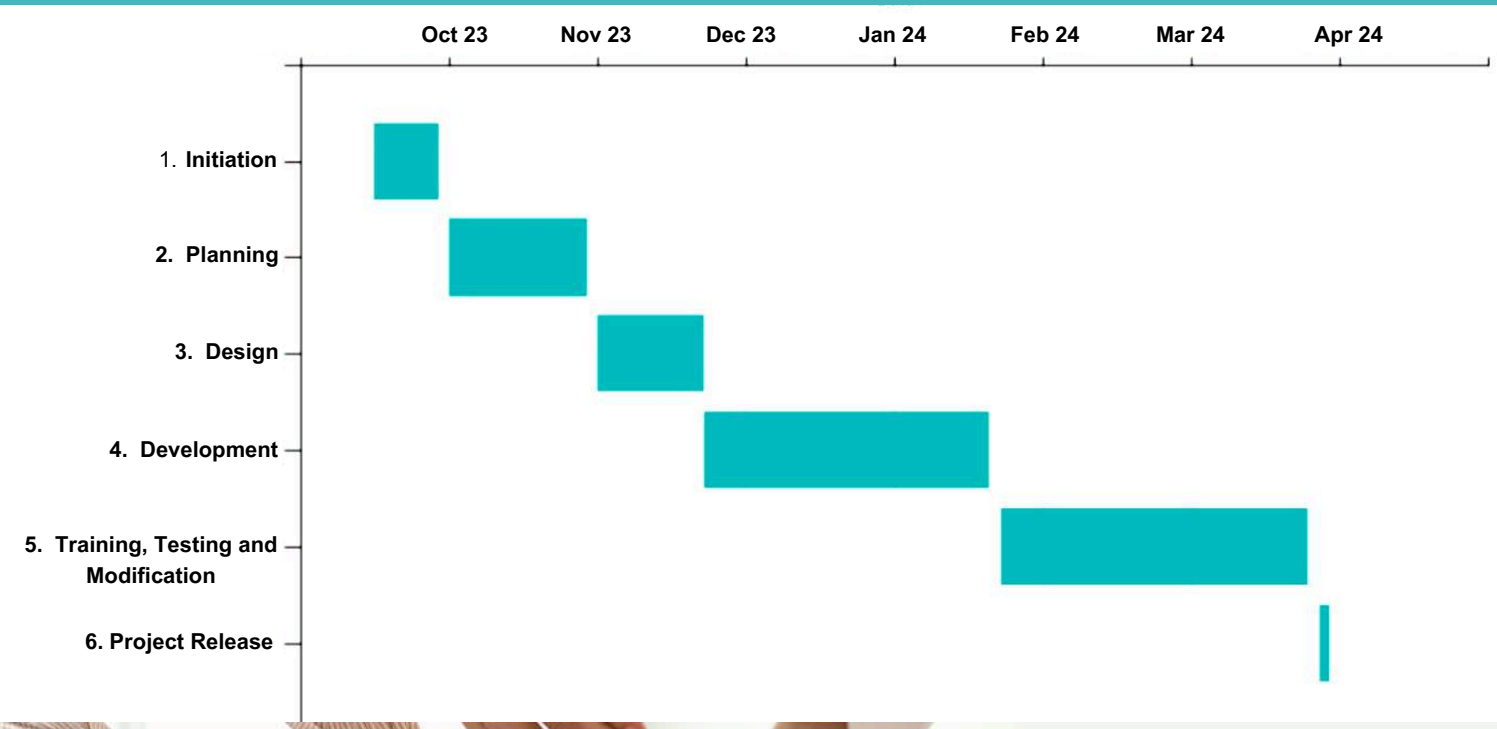
Architecture Diagram




USER
NLP
LSTM
DATASET
User Message
Ask for Symptoms
Enters Symptoms
Entity Recognition
Analysis of Symptoms
Preliminary Diagnosis
Suggests Tests (O)
Enters Test Results
Entity Recognition
Analysis of Test
Final Diagnosis
Suggests Consultation
Generate CaseSheet
USER END
CHATBOT


user
chatbot
dataset
user request
accept request and ask for symptoms
enters symptoms
performs analysis and primary diagniostics
provides previous data
suggest necessary tests
enters test results
generate casesheet

GANTT CHART



Project Work Evaluation

Work Done during 30% Evaluation:

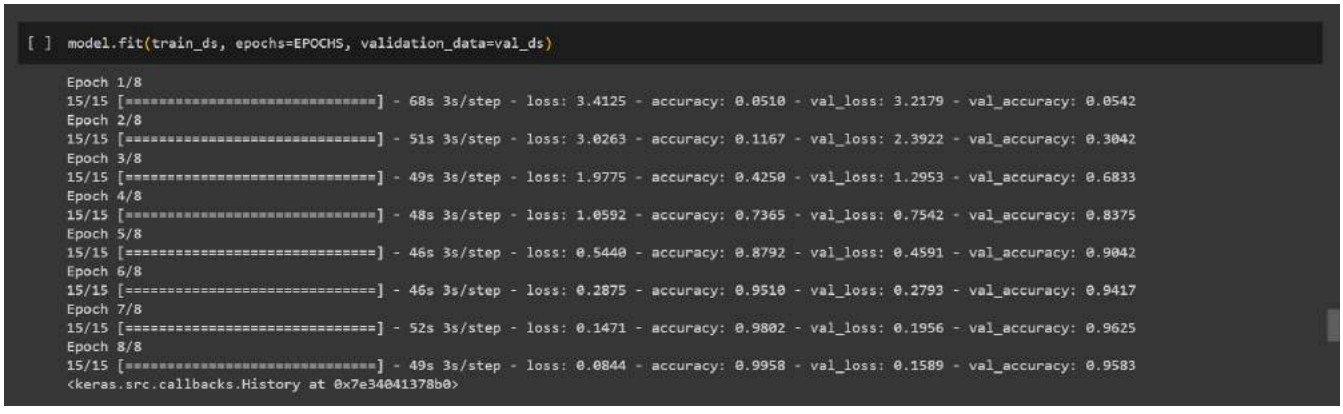
1. **BERT model training:**

- A BERT model was initialized and trained using the dataset obtained where the model accepts the input query from the user and generates the disease based on the query and matching with the dataset content.
- The Output provided is the analysis of the query given as input from the user and the probability level of the the analysis.

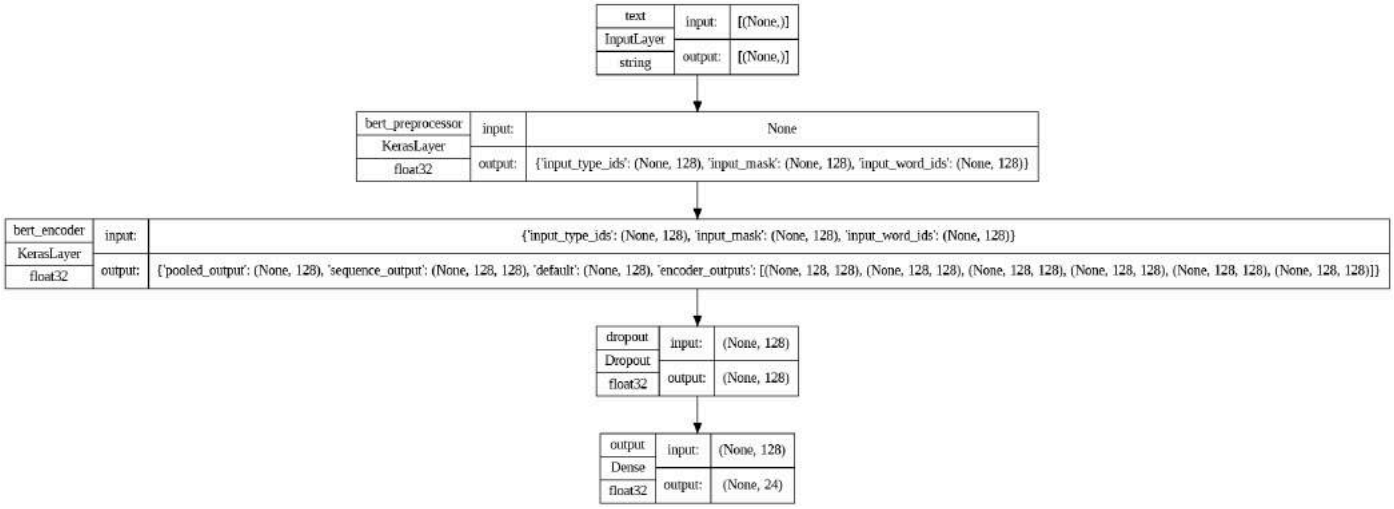
2. **Dataset Identification:**

- A dataset was obtained with the diseases and its corresponding sample queries containing symptoms. The dataset contains 24 diseases with 50 sample queries for each disease, making the dataset size with 1200 entries.
- The dataset is obtained from a credible source in Kaggle, under the disease symptom multi text classification dataset category,

30% Output (Sample Cases):



30% Output (Sample Cases):



30% Output (Sample Cases):

```
I inadvertently lose weight and have a hard time gaining it back. I use antacids to get rid of the pain and discomfort I experience. It aches so much
Peptic Ulcer Disease: 98.59536290168762%
Gastroesophageal Reflux Disease: 0.193773978397996%
Chicken Pox: 0.18404216971248388%

My vision is foggy, and it appears to be growing worse. I feel exhausted and worn out all the time. I also have severe dizziness and lightheadedness o
Diabetes: 92.79565811157227%
Impetigo: 3.3266961574554443%
Migraine: 1.6898659989237785%

I get wheezing and breathing difficulties, which are asthma symptoms. I frequently have headaches and fever. I am continuously exhausted.
Allergy: 98.84015917778015%
Common Cold: 0.21487788762897253%
Cervical Spondylosis: 0.16984953545033932%
```

Work Done during 60% Evaluation:

1. **LSTM model training and integration with BERT model:**

- A LSTM model was integrated along with the previously trained BERT model and trained using the same dataset utilized for BERT training.
- This model integration helped to analysis the sequential relation between the queries, thus improving the accuracy levels while integrating with BERT model.

2. **Dataset Integration:**

- 2 additional datasets were created along with the previously obtained dataset, which contains the mapping of diseases to the respective medical tests and the test result input details respectively.
- This is done to integrate test result input feature for the casesheet generation.

3. **Test Result Input feature:**

- Based on the results obtained from the model and from the additional datasets created, a feature to input the medical tests is created which is then displayed in the casesheet.
- The feature input is done based on the dataset obtained from Kaggle, the same dataset used in for the model also.

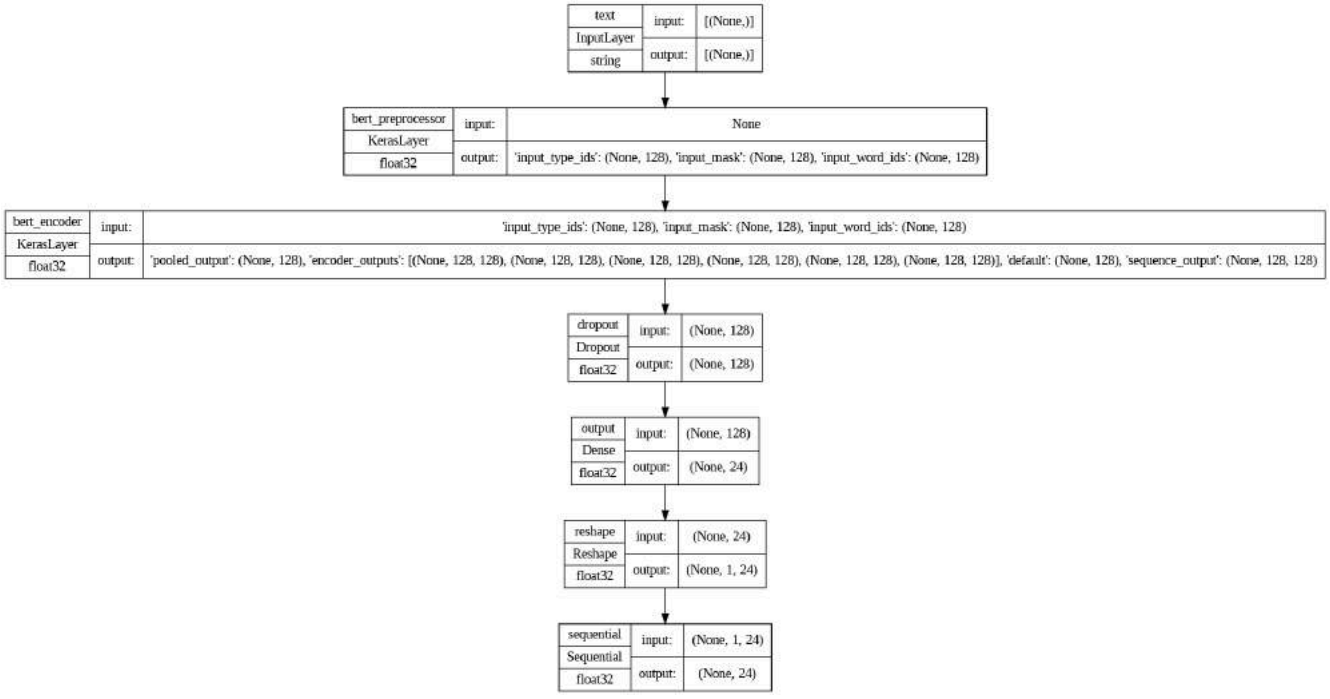
60% Output (Sample Cases):

```
Epoch 1/8
15/15 [==============================] - 49s 2s/step - loss: 6.5754 - output_loss: 3.3968 - sequential_loss: 3.1786 - output_accuracy: 0.0500 -
Epoch 2/8
15/15 [==============================] - 35s 2s/step - loss: 6.2033 - output_loss: 3.0257 - sequential_loss: 3.1776 - output_accuracy: 0.1198 -
Epoch 3/8
15/15 [==============================] - 43s 3s/step - loss: 4.9820 - output_loss: 1.8075 - sequential_loss: 3.1745 - output_accuracy: 0.5094 -
Epoch 4/8
15/15 [==============================] - 36s 2s/step - loss: 4.0722 - output_loss: 0.9144 - sequential_loss: 3.1578 - output_accuracy: 0.7688 -
Epoch 5/8
15/15 [==============================] - 34s 2s/step - loss: 3.5480 - output_loss: 0.4396 - sequential_loss: 3.1084 - output_accuracy: 0.9104 -
Epoch 6/8
15/15 [==============================] - 33s 2s/step - loss: 3.2087 - output_loss: 0.2179 - sequential_loss: 2.9908 - output_accuracy: 0.9656 -
Epoch 7/8
15/15 [==============================] - 34s 2s/step - loss: 2.8751 - output_loss: 0.1151 - sequential_loss: 2.7600 - output_accuracy: 0.9854 -
Epoch 8/8
15/15 [==============================] - 36s 2s/step - loss: 2.4110 - output_loss: 0.0664 - sequential_loss: 2.3446 - output_accuracy: 0.9948 -
<keras.callbacks.History at 0x7c1b03eb9a50>
```

60% Output (Sample Cases):

```
racy: 0.0292 - val_loss: 6.3927 - val_output_loss: 3.2131 - val_sequential_loss: 3.1797 - val_output_accuracy: 0.0458 - val_sequential_accuracy: 0.0292
racy: 0.0385 - val_loss: 5.4521 - val_output_loss: 2.2710 - val_sequential_loss: 3.1811 - val_output_accuracy: 0.3875 - val_sequential_accuracy: 0.0167
racy: 0.1000 - val_loss: 4.4441 - val_output_loss: 1.2684 - val_sequential_loss: 3.1756 - val_output_accuracy: 0.6917 - val_sequential_accuracy: 0.0750
racy: 0.2281 - val_loss: 3.8391 - val_output_loss: 0.6903 - val_sequential_loss: 3.1488 - val_output_accuracy: 0.8333 - val_sequential_accuracy: 0.3458
racy: 0.5146 - val_loss: 3.5446 - val_output_loss: 0.4609 - val_sequential_loss: 3.0836 - val_output_accuracy: 0.8833 - val_sequential_accuracy: 0.5958
racy: 0.7271 - val_loss: 3.2347 - val_output_loss: 0.2928 - val_sequential_loss: 2.9419 - val_output_accuracy: 0.9292 - val_sequential_accuracy: 0.6500
racy: 0.7760 - val_loss: 2.9945 - val_output_loss: 0.3188 - val_sequential_loss: 2.6757 - val_output_accuracy: 0.9250 - val_sequential_accuracy: 0.6917
racy: 0.7990 - val_loss: 2.4585 - val_output_loss: 0.2325 - val_sequential_loss: 2.2260 - val_output_accuracy: 0.9500 - val_sequential_accuracy: 0.7500
```

60% Output (Sample Cases):



60% Output (Sample Cases):

```
Enter your name: Albin Rony
Patient Name: Albin Rony
Enter your height in cm: 175
Enter your weight in kg: 92
Enter your date of birth (or 'skip' to skip): 2002-09-29
Enter your age (or 'skip' to skip): 22
Enter your gender (or 'skip' to skip): male
Enter your physical activity level (or 'skip' to skip): light
Enter a medical condition (or 'done' to finish): done

Here is your case sheet:
|        Category         |  Details   |
|:-----------------------:|:----------:|
|      Patient Name       | Albin Rony |
|          Date           | 2024-02-20 |
|          Time           |  15:25:12  |
|      Patient Name       | Albin Rony |
|      Date of Birth      | 2002-09-29 |
|           Age           |     22     |
|         Gender          |    male    |
|         Height          |   175.0    |
|         Weight          |    92.0    |
| Physical Activity Level |   light    |
|     Medical History     |            |
Enter your symptoms: I can't stop sneezing and I've been coughing a lot. My fever is really high too, like way above normal.
Based on the symptoms provided, there exist a 98.72% chance that you are suffering from Common Cold

Common Cold
The recommended test for Common Cold is Complete Blood Count (CBC)
Hb: 11.1
Lymphocuytes: 33
Eosinophils: 02
Monocytes: 10
Basophils: 10
Platelets: 3000
RBCs: 4000
File '/content/drive/MyDrive/Colab Notebooks/patient.txt' created successfully.

Thank you for using our Medical Assistance Chatbot!
```

60% Output (Sample Cases):

```
Common Cold
The recommended test for Common Cold is Complete Blood Count (CBC)
Hb: 100
Lymphocuytes: 250
Eosinophils: 80
Monocytes: 280
Basophils: 400
Platelets: 290
RBCs: 1730
File '/content/drive/MyDrive/Colab Notebooks/patient.txt' created successfully.

Thank you for using our Medical Assistance Chatbot!
```

60% Output (Sample Cases):

Work Progress - 100% Evaluation:

1. **implementation of User Web Interface:**
- We have implemented a well based user interface on a HTML web based platform to utilized for the users.
- It involves a welcome page, followed by a disclamer alert and then later directed to the chatbot interface.
2. **Casesheet generation:**
- A sample set of casesheets are implemented and displayed with the patient's details and basic physical features, provided by user as input, along with the symptoms faced and the disease with highest probability based on the user's query and test result input feature.
3. **Further research for dataset expansion:**
- During the whole process, we continued our research on expanding our dataset and the possibility for our model to integrate more than 1200 entries from the dataset. Expansion of dataset involves identifying diseases apart from the involved dataset used, irrespective of gender and age.

Project Work Division

ALBIN RONY	ANNMARIA JAXON	ASHMI JOMON	CHRISTY VARGHESE CHACKO
BERT model Training and Testing	HTML Web UI Page Creation	Test Result Feature Creation into Casesheet	LSTM Model Testing and Training
Accuracy Testing of the integrated LSTM-BERT model	Chatbot User Interface	Dataset Creation for Test results Inputs	Integrating LSTM with the BERT model
Casesheet Generation and management	Additional Dataset Creation and Medical Test Research	Documentation and User testing of model and UI	Main Dataset Handling and Medical Data Research

Results and Outputs

100% Progress (Sample Output):

```
Requirement already satisfied: python-docx in /usr/local/lib/python3.10/dist-packages (1.1.0)
Requirement already satisfied: lxml>=3.1.0 in /usr/local/lib/python3.10/dist-packages (from python-docx) (4.9.4)
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.10/dist-packages (from python-docx) (4.10.0)
File '/content/drive/MyDrive/Colab Notebooks/patient_details.txt' created successfully.

Enter patient's medical history:
Enter a medical condition (or 'done' to finish): done

Enter current symptoms: I'm coughing nonstop and I'm shivering terribly. I have a stuffy nose and my face is under strain. In addition, my throat is c
File '/content/drive/MyDrive/Colab Notebooks/medical_file.txt' created successfully.
Based on the symptoms provided, there exist a 97.83% chance that you are suffering from Common Cold

Common Cold
The recommended test for Common Cold is Complete Blood Count (CBC)
Hb: 100
Lymphocuytes: 200
Eosinophils: 300
```

100% Progress - Casesheet (Sample Output):

```
-----PERSONAL DETAILS-----

Name: Albin
Father's Name: Rony
Mother's Name: Jeena
Address: No Address
Phone Number: 989898989
Email ID: arm29292
Height: 98
Weight: 99
Physical Activity Level: light
Body Temperature: 35
Blood Pressure: 1.5
Pulse Rate: 100
Allergies: none
Medications: none
Occupation: student
Emergency Contact Name: nill
Emergency Contact Number: nill
Insurance Provider: no
Insurance Policy Number: no


-----END OF FILE-----
```

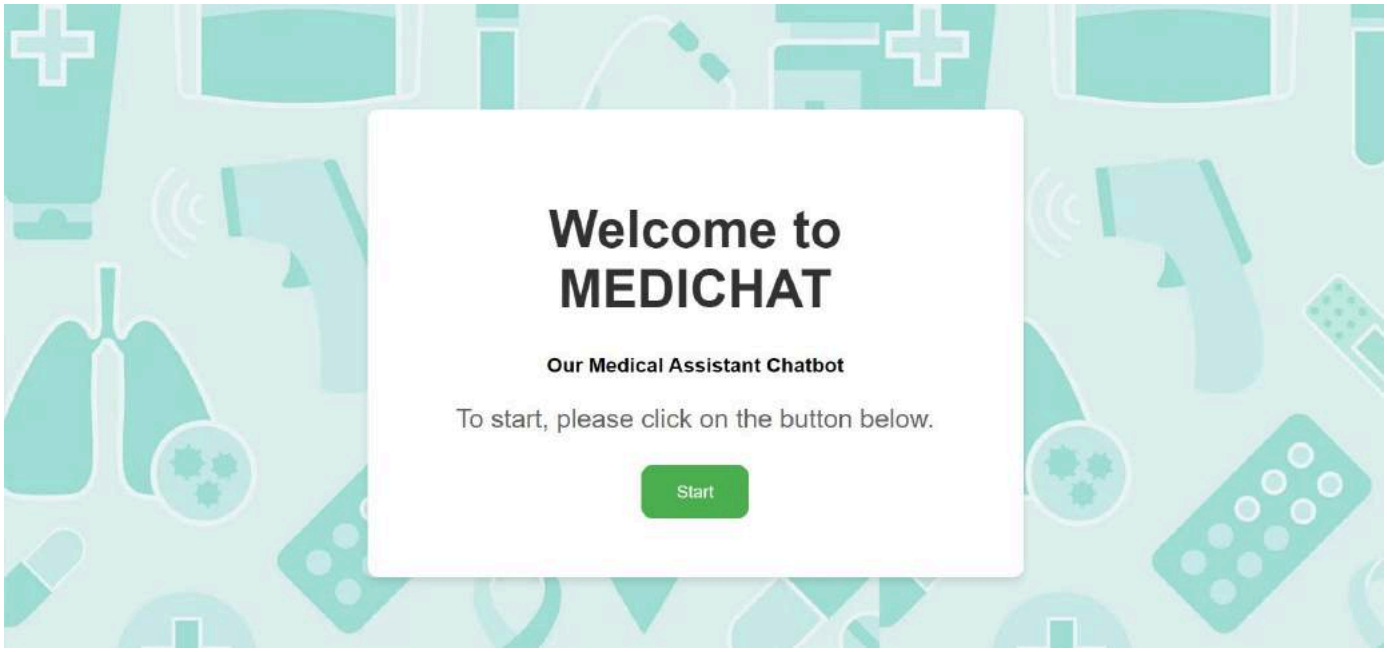
100% Progress - Casesheet (Sample Output):

```
-----MEDICAL HISTORY-----

Medical History:

Current Symptoms:
I'm coughing nonstop and I'm shivering terribly. I have a stuffy nose and my face is under strain. In addition,
my throat is coughing up some nasty gunk, and my chest hurts. My muscles hurt a lot, and I can't smell anything.


        -----END OF FILE-----
```

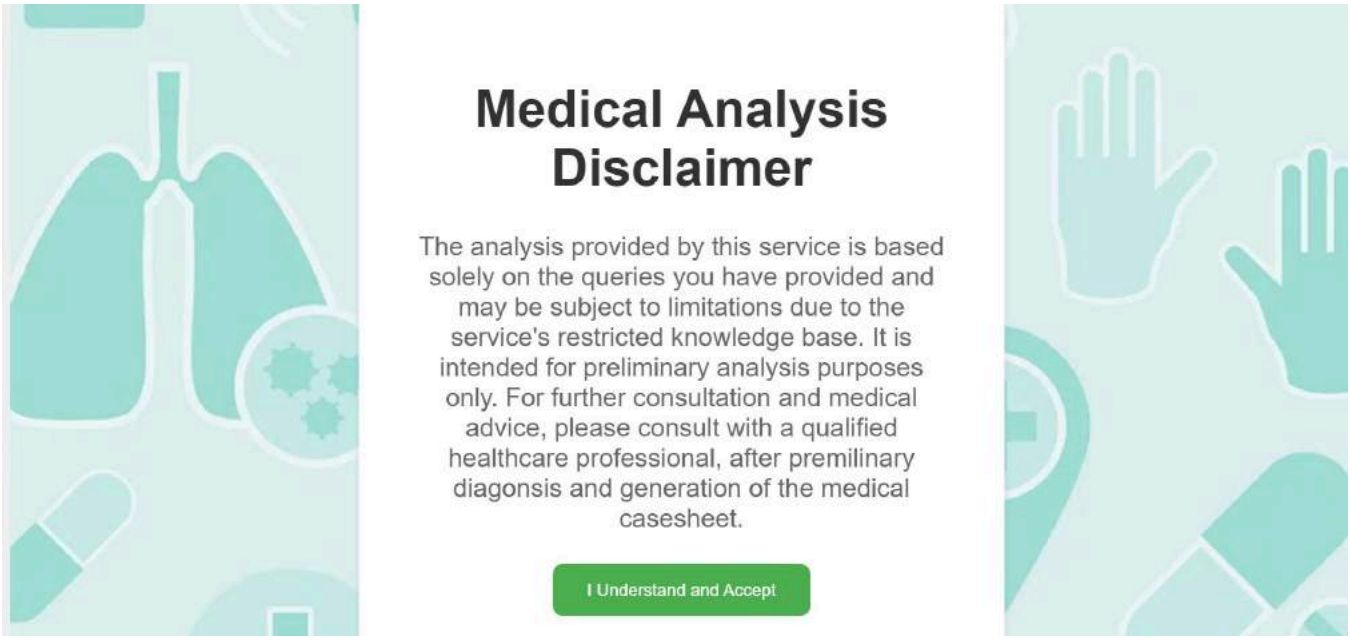
100% Progress - Casesheet (Sample Output):

```
-----DIAGNOSIS REPORT-----

Patient Name: Albin
Symptoms: I'm coughing nonstop and I'm shivering terribly. I have a stuffy nose and my face is under strain. In
addition, my throat is coughing up some nasty gunk, and my chest hurts. My muscles hurt a lot, and I can't smell
anything.
Diagnosis: Common Cold
Recommended Test: Complete Blood Count (CBC)
Test Report Details: Hb, Lymphocuytes, Eosinophils, Monocytes, Basophils, Platelets, RBCs
TEST DETAILS:

Hb: 100
Lymphocuytes: 200
Eosinophils: 300
Monocytes: 400
Basophils: 500
Platelets: 600
RBCs: 700


       -----END OF FILE-----
```

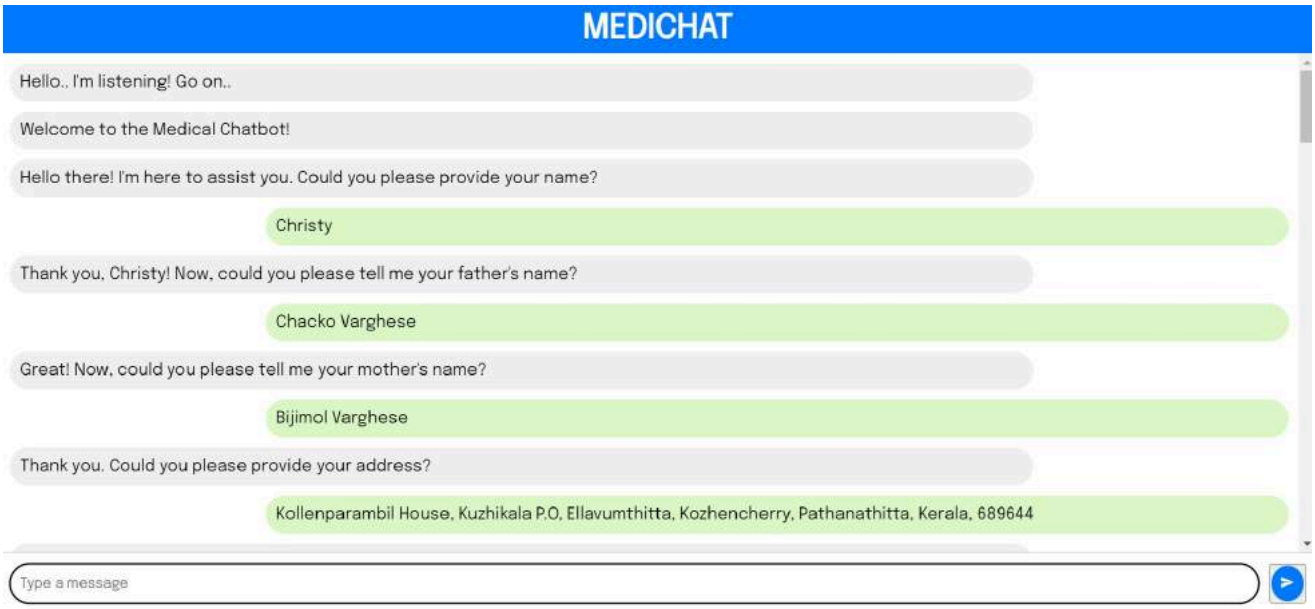
Welcome Page:



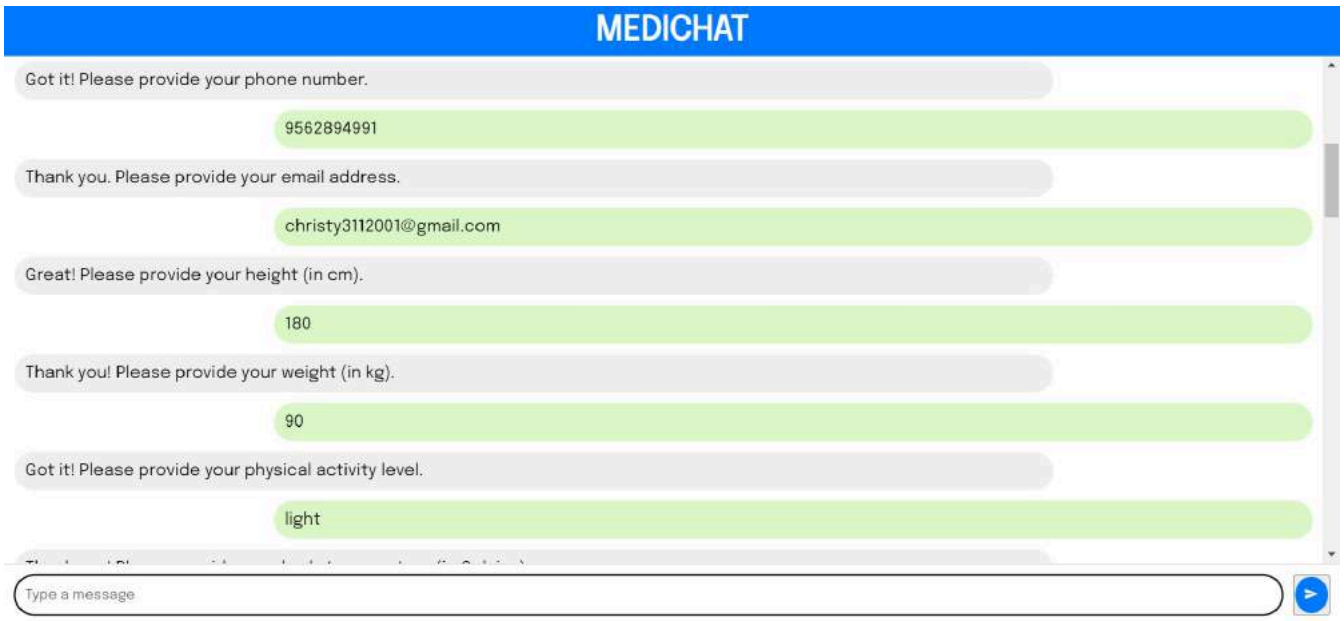
Disclaimer Page:



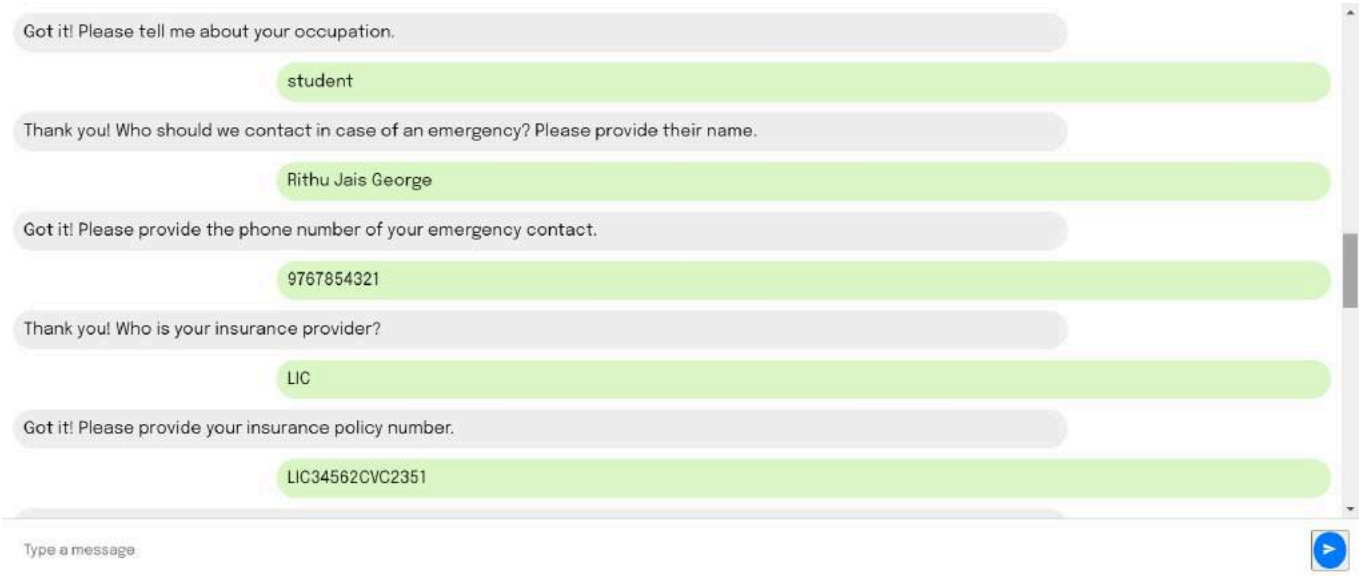
Chatbot Interface Page:



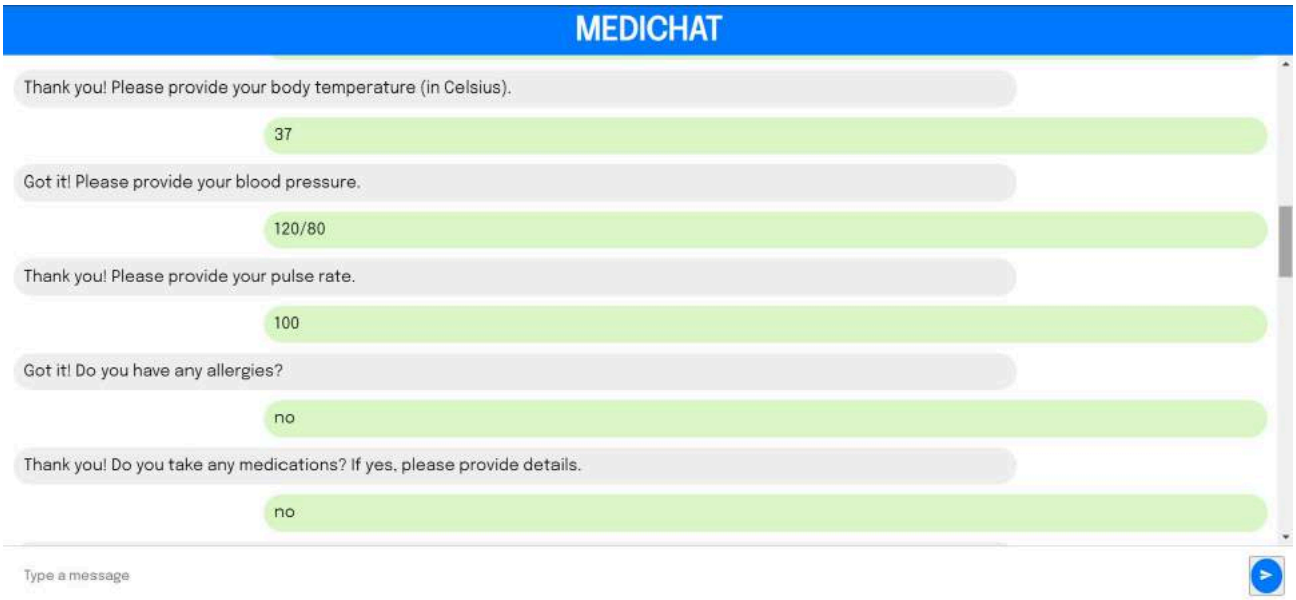
Chatbot Interface Page:



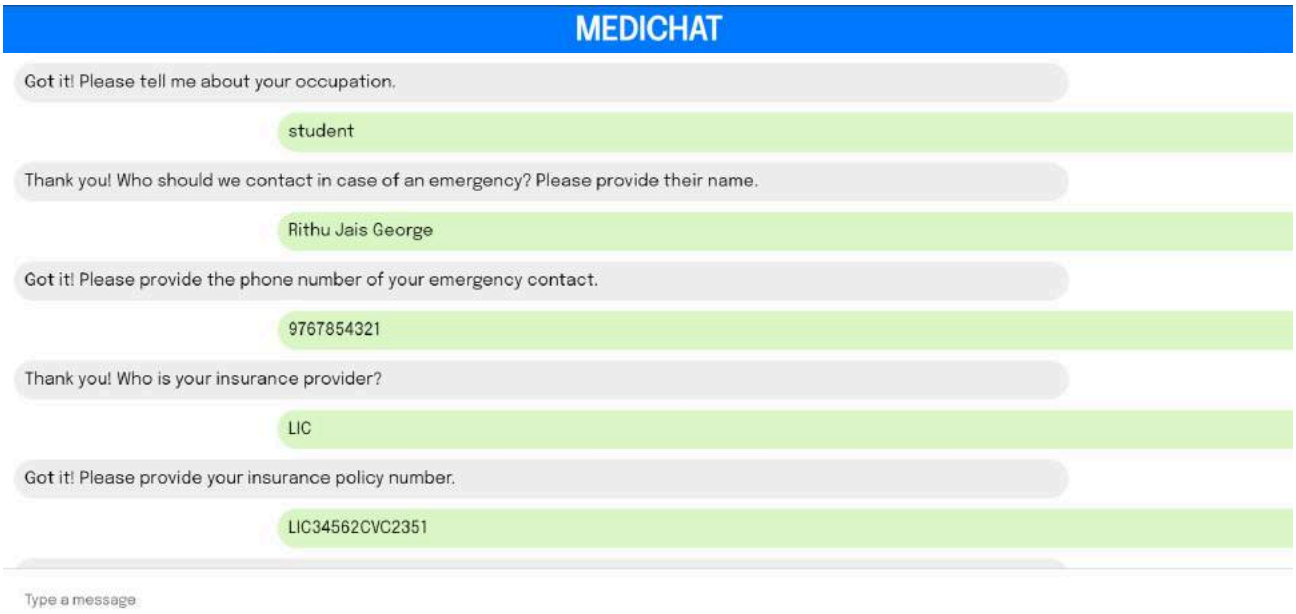
Chatbot Interface Page:



Chatbot Interface Page:



Chatbot Interface Page:



Conclusion

- Our project demonstrated the efficacy of crafting a user-centric interface for the medical chatbot, characterized by intuitive navigation and seamless communication, leading to optimal symptom acquisition and facilitating accurate diagnoses.

- Through the implementation of advanced NLP and ML algorithms, we unveiled the potential for robust symptom analysis, empowering the chatbot to generate accurate disease predictions and personalized insights, contributing to more precise healthcare interventions.

- The project showcased the ability of an AI medical chatbot to empower individuals through personalized health precautions and basic case sheets, which fosters proactive health management by encouraging early intervention and preventative measures, ultimately driving improved health outcomes.

Status of Research Paper

- Initial Draft has been created. We are consider our paper to be presented as a conference paper. We are looking into a conference event that could help us to showcase our paper.

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Thank You!

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Appendix B: Vision, Mission, Programme Outcomes and Course Outcomes

Vision, Mission, Programme Outcomes and Course Outcomes

Institute Vision

To evolve into a premier technological institution, moulding eminent professionals with creative minds, innovative ideas and sound practical skill, and to shape a future where technology works for the enrichment of mankind.

Institute Mission

To impart state-of-the-art knowledge to individuals in various technological disciplines and to inculcate in them a high degree of social consciousness and human values, thereby enabling them to face the challenges of life with courage and conviction.

Department Vision

To become a centre of excellence in Computer Science and Engineering, moulding professionals catering to the research and professional needs of national and international organizations.

Department Mission

To inspire and nurture students, with up-to-date knowledge in Computer Science and Engineering, ethics, team spirit, leadership abilities, innovation and creativity to come out with solutions meeting societal needs.

Programme Outcomes (PO)

Engineering Graduates will be able to:

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and Team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

10. Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Programme Specific Outcomes (PSO)

A graduate of the Computer Science and Engineering Program will demonstrate:

PSO1: Computer Science Specific Skills
The ability to identify, analyze and design solutions for complex engineering problems in multidisciplinary areas by understanding the core principles and concepts of computer science and thereby engage in national grand challenges.

PSO2: Programming and Software Development Skills
The ability to acquire programming efficiency by designing algorithms and applying standard practices in software project development to deliver quality software products meeting the demands of the industry.

PSO3: Professional Skills
The ability to apply the fundamentals of computer science in competitive research and to develop innovative products to meet the societal needs thereby evolving as an eminent researcher and entrepreneur.

Course Outcomes (CO)

Course Outcome 1: Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: Apply).

Course Outcome 2: Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: Apply).

Course Outcome 3: Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: Apply).

Course Outcome 4: Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: Apply).

Course Outcome 5: Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: Analyze).

Course Outcome 6: Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: Apply).

Appendix C: CO-PO-PSO Mapping

CO-PO AND CO-PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	1	2	2	2	1	1	1	1	2	3		
CO2	2	2	2		1	3	3	1	1		1	1		2	
CO3									3	2	2	1			3
CO4					2			3	2	2	3	2			3
CO5	2	3	3	1	2							1	3		
CO6					2			2	2	3	1	1			3

3/2/1: high/medium/low

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	LOW/MEDIUM/HIGH	JUSTIFICATION
100003/ CS722U.1-PO1	M	Knowledge in the area of technology for project development using various tools results in better modeling.
100003/ CS722U.1-PO2	M	Knowledge acquired in the selected area of project development can be used to identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions.
100003/ CS722U.1-PO3	M	Can use the acquired knowledge in designing solutions to complex problems.
100003/ CS722U.1-PO4	M	Can use the acquired knowledge in designing solutions to complex problems.
100003/ CS722U.1-PO5	H	Students are able to interpret, improve and redefine technical aspects for design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
100003/ CS722U.1-PO6	M	Students are able to interpret, improve and redefine technical aspects by applying contextual knowledge to assess societal, health and consequential

		responsibilities relevant to professional engineering practices.
100003/ CS722U.1-PO7	M	Project development based on societal and environmental context solution identification is the need for sustainable development.
100003/ CS722U.1-PO8	L	Project development should be based on professional ethics and responsibilities.
100003/ CS722U.1-PO9	L	Project development using a systematic approach based on well defined principles will result in teamwork.
100003/ CS722U.1-PO10	M	Project brings technological changes in society.
100003/ CS722U.1-PO11	H	Acquiring knowledge for project development gathers skills in design, analysis, development and implementation of algorithms.
100003/ CS722U.1-PO12	H	Knowledge for project development contributes engineering skills in computing & information gatherings.
100003/ CS722U.2-PO1	H	Knowledge acquired for project development will also include systematic planning, developing, testing and implementation in computer science solutions in various domains.

100003/ CS722U.2-PO2	H	Project design and development using a systematic approach brings knowledge in mathematics and engineering fundamentals.
100003/ CS722U.2-PO3	H	Identifying, formulating and analyzing the project results in a systematic approach.
100003/ CS722U.2-PO5	H	Systematic approach is the tip for solving complex problems in various domains.
100003/ CS722U.2-PO6	H	Systematic approach in the technical and design aspects provide valid conclusions.
100003/ CS722U.2-PO7	H	Systematic approach in the technical and design aspects demonstrate the knowledge of sustainable development.
100003/ CS722U.2-PO8	M	Identification and justification of technical aspects of project development demonstrates the need for sustainable development.
100003/ CS722U.2-PO9	H	Apply professional ethics and responsibilities in engineering practice of development.
100003/ CS722U.2-PO11	H	Systematic approach also includes effective reporting and documentation which gives clear instructions.
100003/ CS722U.2-	M	Project development using a systematic approach

PO12		based on well defined principles will result in better teamwork.
100003/ CS722U.3-PO9	H	Project development as a team brings the ability to engage in independent and lifelong learning.
100003/ CS722U.3-PO10	H	Identification, formulation and justification in technical aspects will be based on acquiring skills in design and development of algorithms.
100003/ CS722U.3-PO11	H	Identification, formulation and justification in technical aspects provides the betterment of life in various domains.
100003/ CS722U.3-PO12	H	Students are able to interpret, improve and redefine technical aspects with mathematics, science and engineering fundamentals for the solutions of complex problems.
100003/ CS722U.4-PO5	H	Students are able to interpret, improve and redefine technical aspects with identification formulation and analysis of complex problems.
100003/ CS722U.4-PO8	H	Students are able to interpret, improve and redefine technical aspects to meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
100003/ CS722U.4-	H	Students are able to interpret, improve and redefine

PO9		technical aspects for design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
100003/ CS722U.4-PO10	H	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools for better products.
100003/ CS722U.4-PO11	M	Students are able to interpret, improve and redefine technical aspects by applying contextual knowledge to assess societal, health and consequential responsibilities relevant to professional engineering practices.
100003/ CS722U.4-PO12	H	Students are able to interpret, improve and redefine technical aspects for demonstrating the knowledge of, and need for sustainable development.
100003/ CS722U.5-PO1	H	Students are able to interpret, improve and redefine technical aspects, apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
100003/ CS722U.5-PO2	M	Students are able to interpret, improve and redefine technical aspects, communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

100003/ CS722U.5-PO3	H	Students are able to interpret, improve and redefine technical aspects to demonstrate knowledge and understanding of the engineering and management principle in multidisciplinary environments.
100003/ CS722U.5-PO4	H	Students are able to interpret, improve and redefine technical aspects, recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
100003/ CS722U.5-PO5	M	Students are able to interpret, improve and redefine technical aspects in acquiring skills to design, analyze and develop algorithms and implement those using high-level programming languages.
100003/ CS722U.5-PO12	M	Students are able to interpret, improve and redefine technical aspects and contribute their engineering skills in computing and information engineering domains like network design and administration, database design and knowledge engineering.
100003/ CS722U.6-PO5	M	Students are able to interpret, improve and redefine technical aspects and develop strong skills in systematic planning, developing, testing, implementing and providing IT solutions for different domains which helps in the betterment of life.
100003/ CS722U.6-PO8	H	Students will be able to associate with a team as an effective team player for the development of technical projects by applying the knowledge of mathematics,

		science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
100003/ CS722U.6-PO9	H	Students will be able to associate with a team as an effective team player for Identify, formulate, review research literature, and analyze complex engineering problems
100003/ CS722U.6-PO10	M	Students will be able to associate with a team as an effective team player for designing solutions to complex engineering problems and design system components.
100003/ CS722U.6-PO11	M	Students will be able to associate with a team as an effective team player use research-based knowledge and research methods including design of experiments, analysis and interpretation of data.
100003/ CS722U.6-PO12	H	Students will be able to associate with a team as an effective team player, applying ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
100003/ CS722U.1-PSO1	H	Students are able to develop Computer Science Specific Skills by modeling and solving problems.
100003/ CS722U.2-PSO2	M	Developing products, processes or technologies for sustainable and socially relevant applications can promote Programming and Software Development Skills.

100003/ CS722U.3-PSO3	H	Working in a team can result in the effective development of Professional Skills.
100003/ CS722U.4-PSO3	H	Planning and scheduling can result in the effective development of Professional Skills.
100003/ CS722U.5-PSO1	H	Students are able to develop Computer Science Specific Skills by creating innovative solutions to problems.
100003/ CS722U.6-PSO3	H	Organizing and communicating technical and scientific findings can help in the effective development of Professional Skills.