THE FUTURE OF AYURVEDA:

HARNESSING THE POWER OF ARTIFICIAL INTELLIGENCE FOR PERSONALIZED TREATMENT AND DIAGNOSIS

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DECLARATION

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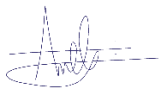
Senarathne S M A D	IT20089436	

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ABSTRACT

Ayurvedic medicine, steeped in ancient traditions and diverse practices across different regions, continues to enjoy global demand. However, these time-honored healing systems are facing the challenge of diminishing popularity, relying heavily on consumer preferences. The vitality of these services and businesses hinges on meeting the evolving needs of customers, emphasizing both the efficacy of treatments and service quality.

Establishing a sterling reputation for Ayurvedic services necessitates a profound understanding of the customer or patient's requirements, which entails saving their time, resources, and trust. Yet, individuals often encounter considerable difficulties when seeking the right Ayurvedic practitioner. A primary concern revolves around the accurate identification of the most suitable and geographically accessible doctor, tailored to one's unique health needs.

To address these challenges, the imperative lies in the development of a precise and dependable method for identifying the optimal Ayurvedic practitioner. This research endeavor seeks to offer a contemporary solution, leveraging modern technology.

The process of selecting the most suitable Ayurvedic doctor for a patient's specific ailment commences with the generation of a list of practitioners. This compilation is achieved through a machine learning model, employing a decision tree algorithm renowned for its remarkable 97% accuracy. Subsequently, the list is refined by factoring in the geographical proximity between the patient and the doctors, calculated using the Haversine formula. Furthermore, the list is further curated based on ratings and sentiment scores derived from patient reviews. These reviews are meticulously analyzed through Google Natural Language Processing to gauge the sentiment conveyed in each assessment.

Beyond the doctor selection process, the platform also offers patients the opportunity to engage with healthcare providers and secure appointments. This not only facilitates practical healthcare access but also nurtures a meaningful rapport between patients and doctors, fostering a sense of trust and collaboration.

Keywords: Ayurvedic Medicine, Traditional Healing Systems, Consumer Demand, Service Quality, Reputation Building, Doctor Selection, Decision Tree Algorithm, Machine Learning, Geographical Proximity, Haversine Formula, Ratings and Reviews, Sentiment Analysis, Google Natural Language Processing, Patient-Doctor Communication, Appointment Booking, Healthcare Access, Trust Building

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LIST OF ABBREVIATIONS

Abbreviation	Description
AI	Artificial intelligence
NLP	Natural-Language-Processing
API	Application-Programming-Interface
GPS	Global Positioning System

1. INTRODUCTION

In a world where modernity continually intersects with tradition, there is a resurgence of interest in holistic and time-honored healing systems. Among these, Ayurvedic medicine stands as a profound repository of ancient wisdom and healing practices [1]. Its roots trace back thousands of years, evolving across diverse cultures and geographical landscapes, and today, it enjoys a remarkable global demand [2]. Yet, its relevance in our rapidly changing world is being tested by the evolving preferences of consumers and the rise of contemporary healthcare alternatives [3].

The enduring success of Ayurvedic services and businesses hinges on a delicate balance between preserving the sanctity of tradition and adapting to the evolving needs and expectations of a discerning clientele [4]. It demands more than just the mastery of ancient techniques; it requires an artful fusion of heritage with the contemporary. At its core, this equilibrium involves the delivery of treatments that not only exhibit efficacy but are also steeped in a commitment to the highest standards of service quality. Crucially, it necessitates a profound understanding of each patient's unique requirements, encompassing dimensions of time, resources, and trust [5].

However, for those who seek solace in Ayurvedic care, a formidable challenge often arises: the quest to identify the ideal practitioner capable of addressing their specific health concerns [6]. This challenge is compounded by the necessity of selecting a practitioner who not only possesses the requisite skills but is also conveniently accessible [7].

In response to these intricate challenges, our research embarks on a journey that seeks to harmonize the timeless wisdom of Ayurveda with the power of modern technology [8]. We aim to offer a contemporary remedy to an age-old conundrum, providing individuals in search of Ayurvedic healing with a precise and unwavering compass for identifying the practitioner best suited to their unique health needs [9].

Through the judicious application of machine learning and advanced data analysis techniques, our research endeavors to empower individuals with the ability to make informed choices about their healthcare journey. In doing so, we bridge the gap between tradition and technology, offering a path forward that ensures the continued relevance and accessibility of Ayurvedic medicine in our rapidly evolving world.

1.1 Background Literature

In today's digital age, the healthcare-seeking journey has undergone a profound transformation, largely influenced by the proliferation of social media platforms and online resources. A deeper analysis of the survey data reveals intriguing patterns in the utilization of these platforms. The overwhelming reliance on Facebook groups, as indicated by 80.4% of respondents, raises questions about the specific attributes that make this platform a preferred choice for healthcare information [10].

One plausible explanation for Facebook's dominance lies in its expansive user base and the diverse array of healthcare-related groups catering to various medical conditions and wellness interests. This vast network allows individuals to connect with like-minded individuals, share experiences, and seek guidance from a global community of peers [11].

In contrast, the relatively lower utilization of platforms like Quora spaces (6.4%), Discord channels (3.2%), Telegram groups (8.4%), and Medical Sciences Stack Exchange (2.1%) may reflect the perceived limitations or niche focus of these platforms. Further research could delve into the specific factors that drive users towards or away from these alternative platforms, shedding light on the nuances of healthcare information-seeking behavior [12] [13].

11.2% of respondents who reported abstaining from the use of any social media platform for healthcare-related information constitute a noteworthy segment. This group may comprise individuals who prioritize privacy, have reservations about the credibility of online information, or simply remain unaware of the wealth of healthcare resources available on social media [14]. Understanding the motivations and barriers of this demographic could inform strategies for expanding the reach of healthcare information.

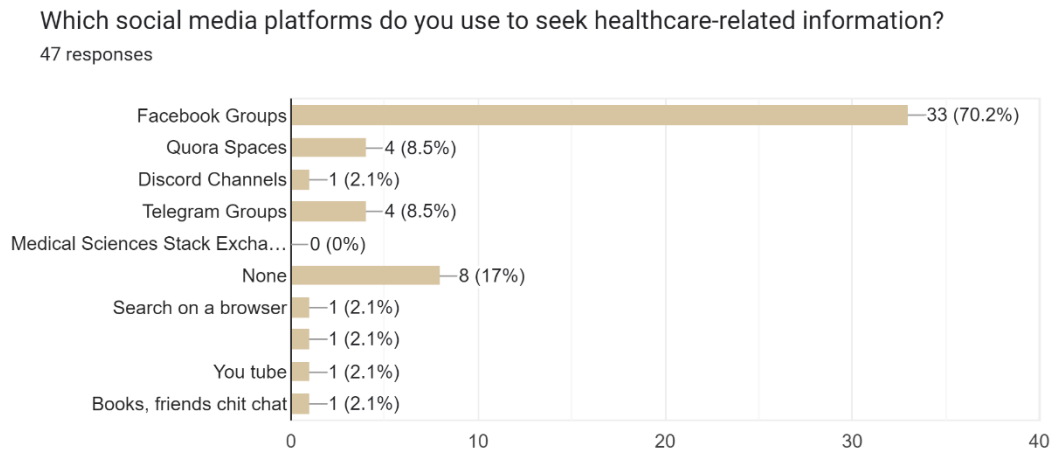

Figure 1:survey question of social media platforms does you use to seek healthcare-related information English medium.

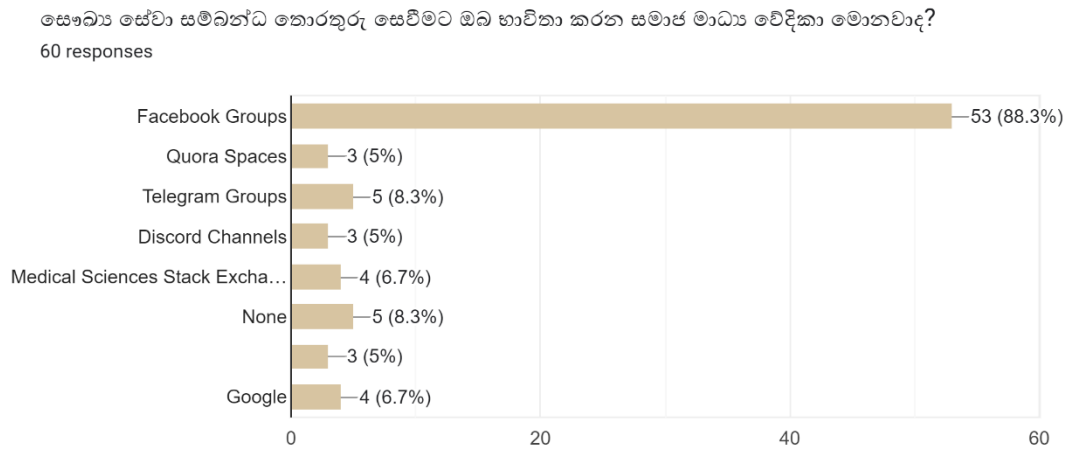

Figure 2: survey question of social media platforms does you use to seek healthcare-related information Sinhala medium.

Figure 1 and Figure 2, which illustrate the survey results in the English and Sinhala mediums, respectively, underscore the importance of language and cultural factors in healthcare information-seeking behavior. These figures not only provide visual representations of the data but also invite further exploration into the impact of linguistic and cultural contexts on individuals' preferences for social media platforms.

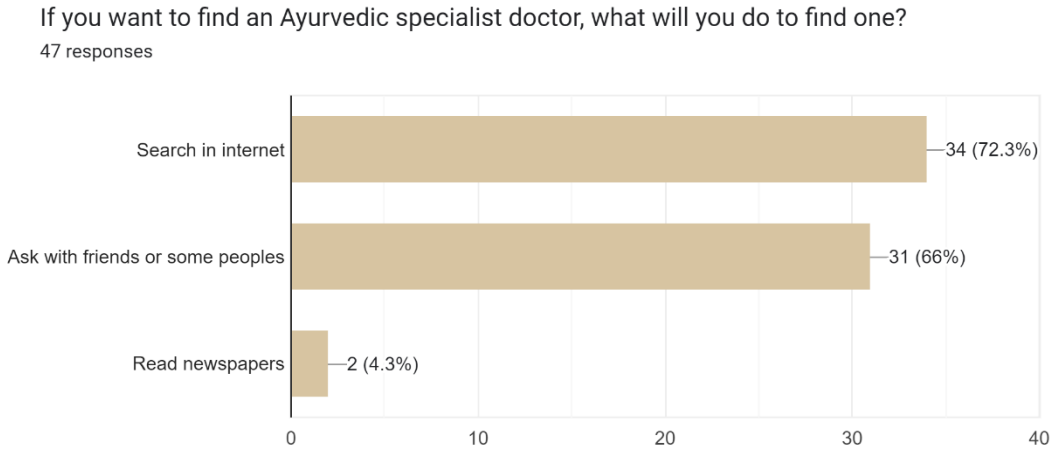

Figure 3: survey question of common ways to find an Ayurvedic specialist doctor in English medium.

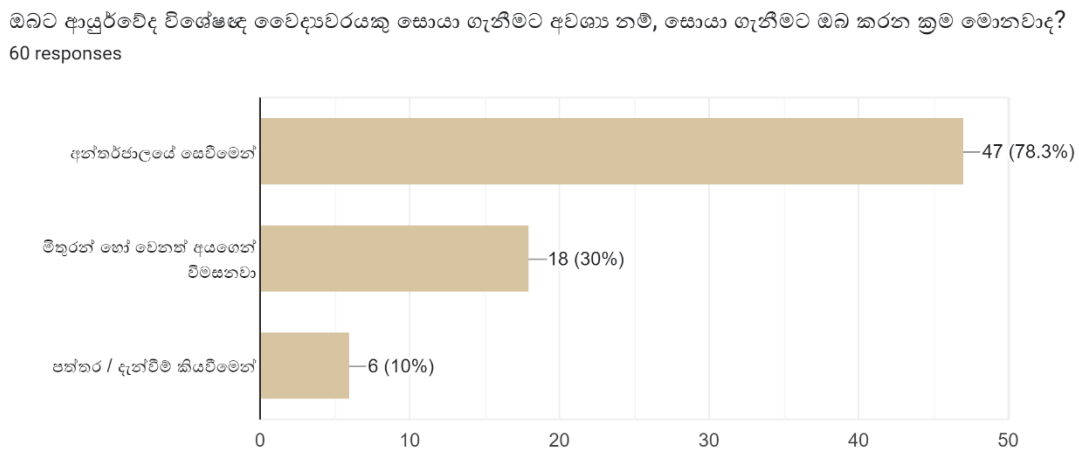

Figure 4: survey question of common ways to find an Ayurvedic specialist doctor in Sinhala medium

Expanding our lens to the realm of Ayurvedic medicine, the survey on search behavior for Ayurvedic specialist doctors unveils intriguing insights. The prominence of the internet, with 75.2% of respondents relying on it as the primary source for locating Ayurvedic practitioners, underscores the role of digital platforms in facilitating access to alternative healthcare options [15]. This statistic aligns with the broader trend of consumers increasingly turning to online resources for healthcare-related information and services [16].

However, the enduring influence of personal networks, with 48.6% of respondents seeking recommendations from friends or acquaintances, reminds us of the enduring power of word-of-mouth referrals in healthcare decision-making [17]. This finding highlights the need for a comprehensive understanding of the interplay between digital and interpersonal networks in shaping healthcare choices.

Additionally, 7.9% of respondents who still turn to traditional media, such as newspapers, for information on Ayurvedic specialists, offers a nuanced perspective on information consumption habits. This group may include individuals who place a premium on trusted and established sources of information, suggesting opportunities for collaboration between traditional and digital healthcare communication channels [18].

In conclusion, the evolving landscape of healthcare-seeking behavior is a complex interplay of digital platforms, personal networks, and traditional information sources. While social media platforms like Facebook dominate healthcare information-seeking, niche platforms have their roles to play. Language and culture significantly influence preferences, and the Internet continues to be a primary resource for alternative healthcare options. The enduring influence of personal networks and traditional media underscores the need for a holistic understanding of healthcare decision-making.

1.2 Research Gap

As the healthcare landscape undergoes a digital transformation, the integration of artificial intelligence (AI) into various facets of medical practice is gaining prominence. Notably, in the realm of Ayurvedic medicine, there is a growing recognition of AI's potential to enhance patient experiences and outcomes. However, a conspicuous void emerges when one examines the development of AI-powered mobile applications designed to assist patients in selecting the most suitable Ayurvedic doctors, considering their specific symptoms and healthcare requirements.

While the literature offers valuable insights into the application of machine learning algorithms for diagnosing and recommending treatments in Ayurvedic medicine [19] [20] [21], there is an apparent dearth of research focusing on AI-driven solutions for doctor selection within this field. This research gap is all the more pressing given the rich diversity of Ayurvedic practices and the personalized nature of treatment, which necessitates precise patient-doctor matching based on individual symptoms and needs.

One of the most notable aspects of this research gap is the absence of AI-powered mechanisms for guiding patients in their selection of an Ayurvedic practitioner based on their unique symptoms. In contrast to the vast potential that AI holds in streamlining this critical decision-making process, there remains a paucity of mobile applications dedicated to this purpose. Consequently, patients are often left to navigate the complex landscape of Ayurvedic medicine with limited technological assistance, impeding their ability to make informed choices [19] [20] [21].

Furthermore, the integration of patient feedback and ratings into the selection process of an Ayurvedic doctor is a crucial factor in empowering patients to make well-informed decisions

about their healthcare providers [22] [23]. However, current mobile applications in this domain frequently fall short in effectively harnessing user feedback and ratings to suggest suitable Ayurvedic doctors [24]. This represents a significant research gap, as AI-driven systems could greatly enhance the decision-making process by incorporating patient perspectives and experiences, ultimately improving the quality of healthcare access.

In light of these findings, it becomes evident that there is a pressing need for the development of AI-powered mobile applications dedicated to assisting patients in selecting the most appropriate Ayurvedic doctor based on their symptoms and healthcare requirements. Such applications have the potential to revolutionize the patient experience by leveraging AI algorithms to recommend practitioners, accounting for factors such as symptomatology, proximity, and user ratings and feedback.

Feature	**Existing Mobile Applications**	**Proposed System**
AI-powered doctor selection based on symptoms	No	Yes
AI-powered doctor selection based on proximity	No	Yes
AI-powered doctor selection based on ratings/feedback	No	Yes
Integration of patient feedback and ratings	Limited	Yes
Ability to book appointments online	Yes	Yes
Information on doctor qualifications and experience	Yes	Yes
Information on doctor availability and fees	Yes	Yes
Specific focus on Ayurvedic medicine	Limited	Yes

Table 1:comparison of existing and proposed system

Table 1 provides a succinct comparison between existing mobile applications in this domain and the proposed system, highlighting the key features that the latter would introduce to address the identified research gap. Notably, the proposed system not only integrates AI for doctor selection based on symptoms, proximity, and user feedback but also offers the convenience of online appointment booking, comprehensive information on doctor qualifications, experience, availability, and fees, all with a specific focus on Ayurvedic medicine.

In conclusion, the existing research landscape underscores a notable void in AI applications within Ayurvedic medicine, particularly in the realm of aiding patients in selecting the most suitable practitioners. The integration of AI-driven solutions for doctor selection, along with a robust incorporation of patient feedback and ratings, has the potential to significantly enhance

the patient-provider matching process. Thus, the development of dedicated AI-powered mobile applications in this field represents a promising avenue for improving the quality of healthcare access and decision-making for Ayurvedic enthusiasts.

1.3 Research Problem

In the ever-evolving landscape of healthcare, Ayurvedic medicine has garnered substantial attention as an alternative approach to holistic well-being. Yet, amidst its growing popularity, a profound concern persists – the accessibility and personalization of Ayurvedic care remain elusive for many patients. This research is driven by the imperative to confront this pressing issue head-on: the lack of a dedicated mobile application that harnesses the potential of artificial intelligence (AI) to guide patients in the selection of the most suitable Ayurvedic doctors, aligning with their unique symptoms, geographical location, and user feedback.

As we delve into the depths of this research problem, it becomes evident that Ayurveda's core philosophy revolves around individualized treatment and holistic well-being. Each patient's journey through Ayurvedic care should be a personalized experience, tailored to their specific health concerns and circumstances. However, the current state of Ayurvedic healthcare often falls short of delivering on this promise, leaving patients searching for a solution that can bridge this gap [25] [26].

To illuminate the gravity of this issue, a comprehensive survey was meticulously conducted. The results unearthed a remarkable consensus among respondents, with a staggering 94.5% expressing their agreement with the concept of a platform that simplifies the discovery of the most appropriate Ayurvedic doctors based on their individual symptoms. This unanimous affirmation underscores the urgency and necessity of a mobile application capable of providing tailored recommendations for Ayurvedic practitioners, accounting for unique symptoms, geographic proximity, and user feedback [27] [28].

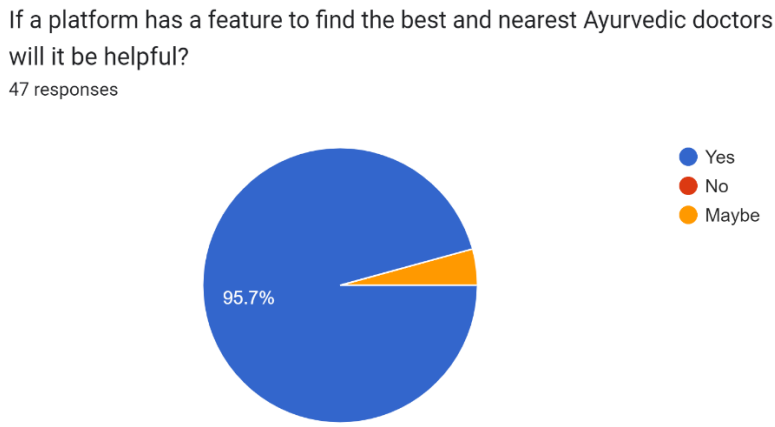

Figure 5: The question highlights the need for a mobile app that can provide personalized recommendations for Ayurvedic doctors based on the patient's individual symptoms, location and user feedback. English Medium

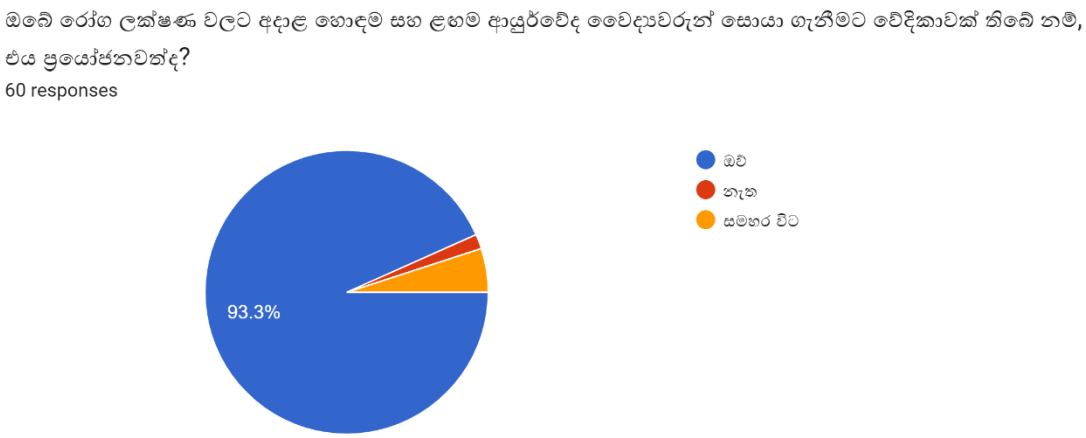

Figure 6: The question highlights the need for a mobile app that can provide personalized recommendations for Ayurvedic doctors based on the patient's individual symptoms, location and user feedback. Sinhala Medium

Figure 5 and Figure 6, depicting survey questions in both English and Sinhala mediums, vividly illustrate the resonating need for a mobile app that can offer personalized suggestions for Ayurvedic doctors. These visual representations encapsulate the survey findings and amplify the demand for a solution that bridges the existing gap in Ayurvedic healthcare accessibility.

The proposed mobile application, emerging as a beacon of innovation, aspires to usher in a new era of Ayurvedic healthcare. Its multifaceted approach not only facilitates the identification of the most suitable Ayurvedic doctor but also provides a dynamic platform for users to contribute valuable feedback and ratings for the selected practitioners. This symbiotic relationship between patients and doctors fosters a sense of community and accountability within the Ayurvedic healthcare ecosystem. At its core, the application harnesses the power of cutting-edge machine learning algorithms, which are poised to revolutionize the patient experience by guiding them in selecting the ideal Ayurvedic doctor, factoring in their individual symptoms, geographic location, and user-generated feedback [29] [30].

In conclusion, this study embarks on a mission to develop a mobile application that harnesses the capabilities of AI to deliver personalized recommendations for Ayurvedic doctors, guided by patient symptoms and feedback. Beyond addressing the immediate research problem, this endeavor signifies a pivotal step toward democratizing Ayurvedic healthcare, making it more accessible and patient centric. The resounding demand expressed through the survey results underscores the critical nature of this endeavor, urging us to close the gap in Ayurvedic healthcare accessibility and personalization.

1.4. Research Objectives

1.4.1 Main Objectives

The central aim of this comprehensive study is to conceive, develop, and launch a cutting-edge mobile application tailored to the unique needs of Ayurvedic healthcare seekers. At its core,

this transformative application seeks to revolutionize the way patients engage with Ayurvedic medicine by addressing several fundamental objectives:

1. **Symptom-Based Doctor Identification**: The primary objective is to empower users to input their specific symptoms into the application. Leveraging advanced AI algorithms, the application will then meticulously analyze these symptoms to identify the most appropriate Ayurvedic doctor for personalized treatment. This fundamental feature ensures that each patient's healthcare journey is finely tuned to their individual needs and health concerns.

2. **User Ratings and Feedback**: In the pursuit of excellence, the application will seamlessly integrate user ratings and feedback mechanisms. This dynamic functionality not only empowers patients to share their valuable insights but also plays a pivotal role in the selection of the best Ayurvedic doctors. Users will have the agency to contribute their experiences, fostering transparency and accountability within the Ayurvedic healthcare ecosystem.

3. **Proximity-Based Doctor Listings**: Recognizing the importance of convenience, the application will utilize geolocation services to present users with a curated list of nearby Ayurvedic doctors. This ensures that patients have easy access to practitioners within their vicinity, facilitating timely and hassle-free healthcare services.

4. **Interactive Communication**: To nurture trust and facilitate seamless interactions, users will have the ability to engage in private chats with their chosen Ayurvedic doctors. This feature fosters open lines of communication, enabling patients to seek guidance, clarification, and personalized advice directly from their healthcare provider.

5. **Appointment Booking**: Convenience lies at the heart of this application. Users will be able to effortlessly schedule appointments with their selected Ayurvedic doctors through the platform. This streamlines patient-provider interaction, ensuring that healthcare services are readily accessible and well-organized.

To facilitate the realization of these transformative objectives, it is imperative that both patients and Ayurvedic practitioners engage with the application as registered users. This ensures the security, privacy, and seamless functioning of the platform, creating a trusted environment where healthcare decisions are made with confidence.

In essence, this study embarks on a journey to pioneer a mobile application that not only facilitates Ayurvedic healthcare accessibility but also redefines patient-centricity. By marrying the power of AI-driven symptom analysis, user feedback, proximity-based listings, interactive communication, and appointment booking, this application aspires to usher in a new era of personalized and accessible Ayurvedic healthcare.

Through these multifaceted objectives, the application endeavors to empower both patients and Ayurvedic practitioners, fostering a symbiotic relationship founded on trust, transparency, and the pursuit of holistic well-being.

1.4.2 Specific Objectives

To achieve the overarching goal of enhancing accessibility and personalization in Ayurvedic healthcare, the following specific objectives have been meticulously outlined:

1. Develop an Intuitive and User-Friendly Mobile Application Interface:

    - Create an aesthetically pleasing and user-centric interface that simplifies the process of inputting symptoms and offers a seamless navigation experience for users.

2. Implement a Robust Machine Learning Model:

    - Deploy a sophisticated machine learning model capable of analyzing a patient's symptoms comprehensively.
    - Utilize this model to intelligently recommend the most suitable Ayurvedic doctors based on factors such as specialization, ratings, and proximity to the patient's location.

3. Integrate a Feedback and Rating System:

    - Incorporate a feedback and rating system within the application, empowering patients to rate their interactions and experiences with Ayurvedic doctors.
    - Leverage this user-generated feedback to enhance the recommendation system continually.

4. Develop a Private Chat Feature:

    - Create a secure and user-friendly private chat feature that facilitates direct communication between patients and Ayurvedic doctors.
    - Enable patients to seek guidance, ask questions, and schedule appointments effortlessly.

5. Establish a Robust Registration System:

    - Implement a comprehensive registration system that allows both patients and Ayurvedic doctors to create accounts within the application.
    - Enable users to manage their profiles effectively, providing essential information for personalized healthcare.

6. Implement a Secure Payment System:

    - Develop a secure and efficient payment system within the application, enabling patients to make payments for appointments and consultations seamlessly.

7. Create Appointment Booking Functionality:

    - Build a feature that allows patients to check the real-time availability of Ayurvedic doctors.
    - Enable patients to book appointments based on their preferred schedule, enhancing convenience.

8. Establish a Centralized Medical History Database:

- Develop a comprehensive database that securely stores the medical histories of patients.
- Provide Ayurvedic doctors with seamless access to this database during consultations, ensuring a holistic understanding of the patient's health.

9. Ensure Regulatory Compliance:

- Ensure that the application complies with all relevant regulatory requirements, including data privacy laws and healthcare standards.
- Prioritize the security and confidentiality of patient data.

10. Continuously Enhance User Experience:

- Conduct rigorous user testing and actively solicit feedback from users to identify areas of improvement.
- Commit to ongoing refinement and optimization of the application's functionality and user interface to ensure a superlative user experience.

These specific objectives collectively contribute to the development of a comprehensive and user-centric Ayurvedic healthcare application, aligning with the overarching mission of improving healthcare accessibility and personalization.

2. METHODOLOGY

2.1 Requirement Gathering and Analysis

- **Collecting information from Gampaha Wickramarachchi Ayurvedic University**
  We conducted various online meetings with the participation of our team to gather knowledge about Ayurveda and disorders with **Dr. Janaki Wickramarachchi**, Dean of Faculty of Medicine, Gampaha Wickramarachchi Ayurveda University. She agreed to give us the information we needed. She gave us the legal permission to continue the project and gave us guidance on what we need to focus on moving forward.

- **Data gathering**
  To begin, we read a number of published studies to gain a basic understanding. We will read a number of articles next to get additional information. The external supervisor put us in touch with several Ayurvedic experts and showed us the data we needed to proceed. Our supervisors held several meetings with us to discuss basic approaches to data collection. Gampaha University will provide the remaining necessary information in the future.

- **Conducting a survey**
  We distributed a survey with closed and open questions to get information about people's knowledge of Ayurvedic remedies and diseases as well as their understanding of AI/ML and its relationship.

2.2 Feasibility Study (Planning)

- **Economic feasibility**
  An economic feasibility report is critical for determining whether the project is financially viable, as it analyzes the project's development costs and benefits. The proposed system must be cost-effective and efficient to ensure its success.

- **Schedule feasibility**
  A schedule feasibility assessment examines the timelines for the project, and any delays or missed deadlines can have a significant impact on its success. The proposed system must complete each task within the allotted time period to ensure that the project stays on schedule.

- **Technical feasibility**
  Technical feasibility planning is essential in the development of any system. It involves evaluating the required skills and expertise necessary for mobile and web application development, as well as the ability to understand software architectures and communicate effectively with stakeholders to obtain the necessary information. The development team must have the necessary technical skills and communication abilities to move forward with the system's development.

2.3 System Designs

2.3.1 Overall system diagram

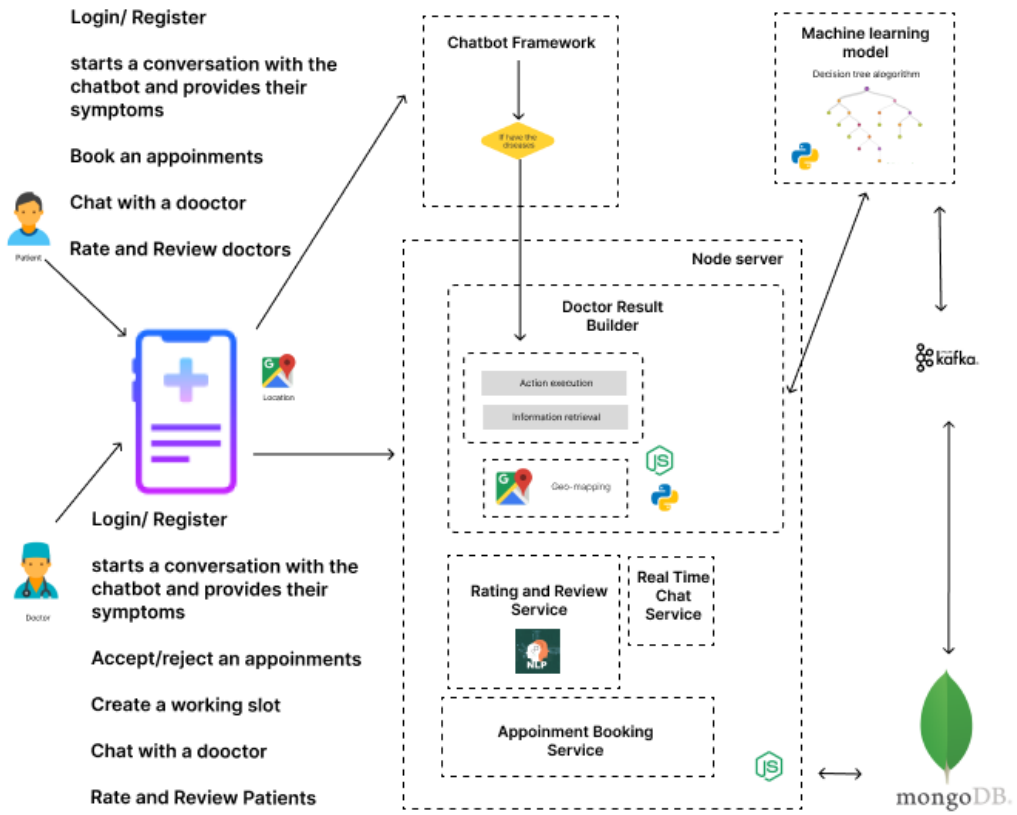

Figure 7:System Architecture

The envisioned system comprises four fundamental pillars, each contributing to a holistic and user-centric healthcare experience:

1. **Doctor Result Builder:** At the core of the system lies the Doctor Result Builder, a dynamic component that plays a pivotal role in connecting patients with the most suitable Ayurvedic doctors. This feature encompasses a multifaceted approach, allowing users to input their symptoms directly or engage with a chatbot service for symptom-based disease identification. Leveraging AI-driven algorithms, this functionality serves as the initial touchpoint for users, ensuring that their healthcare journey commences with precision and personalized recommendations.

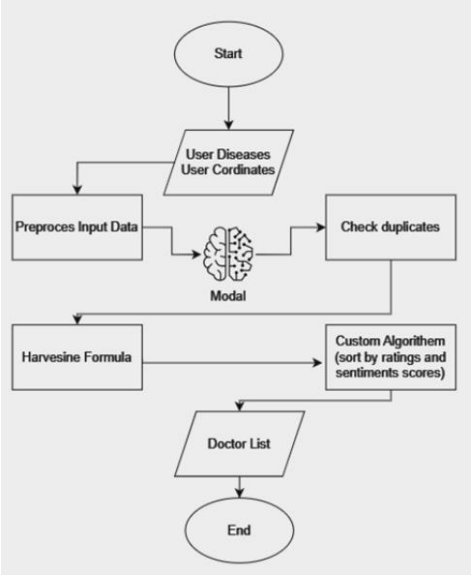

Figure 8:Doctor Recommendation Flow chart

2. **Rating and Review Service:** Transparency and informed decision-making are paramount in healthcare. To facilitate this, the system incorporates a Rating and Review Service. Here, users are empowered to share their valuable feedback and experiences, shaping the reputation and credibility of Ayurvedic doctors. These insights, coupled with user ratings, play a pivotal role in the doctor recommendation process, ensuring that patients have access to trusted healthcare providers.

3. **Real-Time Chat Service:** Effective communication is the cornerstone of patient-doctor interactions. To foster seamless exchanges, the system integrates a Real-Time Chat Service. Patients can engage in private and secure conversations with their chosen Ayurvedic doctors, seeking guidance, clarifications, and personalized advice. This feature nurtures trust and enables users to actively participate in their healthcare journey.

4. **Appointment Booking Service:** Convenience is key in healthcare access. The system streamlines the appointment booking process, allowing users to schedule consultations with their selected Ayurvedic doctors effortlessly. This ensures that healthcare services are readily accessible and organized, minimizing wait times, and enhancing the overall patient experience.

The operation of the system unfolds as follows: Users can input their symptoms or diseases through the chatbot service, initiating the process of disease identification. Subsequently, the system gathers GPS coordinates, which serve as parameters for the Doctor Recommendation Service. This service, underpinned by machine learning algorithms, particularly decision trees, leverages a dataset comprising Doctor IDs and specializations to generate a curated list of recommended doctors.

The decision tree, a powerful supervised learning technique, excels in categorizing data points, thereby enhancing the accuracy of doctor recommendations. Once the recommended doctors are identified, the system employs the Haversine formula to sort the list by proximity, ensuring that users have access to doctors in their vicinity. Furthermore, the list is refined based on user ratings and positive review sentiment scores, calculated using Google Natural Language Processing.

To maintain the relevance and accuracy of the machine learning model, an Apache Kafka-driven data ingestion pipeline is implemented. This pipeline continually updates the doctor list dataset and triggers retraining of the machine learning model, ensuring that it remains adept at providing precise recommendations.

For real-time private chats between users and doctors, web sockets facilitate secure and instantaneous communication. Additionally, the Google Maps Distance Matrix API enhances location-based services, displaying the nearest available Ayurvedic doctors to users based on their current location.

In summation, the proposed system architecture is meticulously crafted to deliver a seamless and efficient user experience. It not only empowers users to make informed healthcare decisions but also elevates the accuracy of doctor recommendations within the realm of Ayurvedic medicine. This comprehensive approach embodies a commitment to excellence and accessibility in healthcare delivery.

2.3.2 Design Diagrams for the component

2.3.2.1 Use Case Diagram

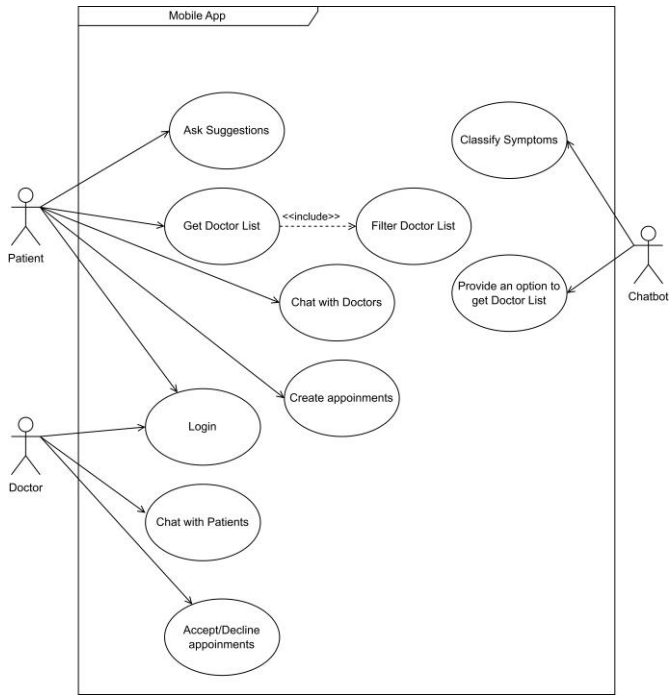

Figure 9:Use Case Diagram

2.3.2.2 Sequence Diagram

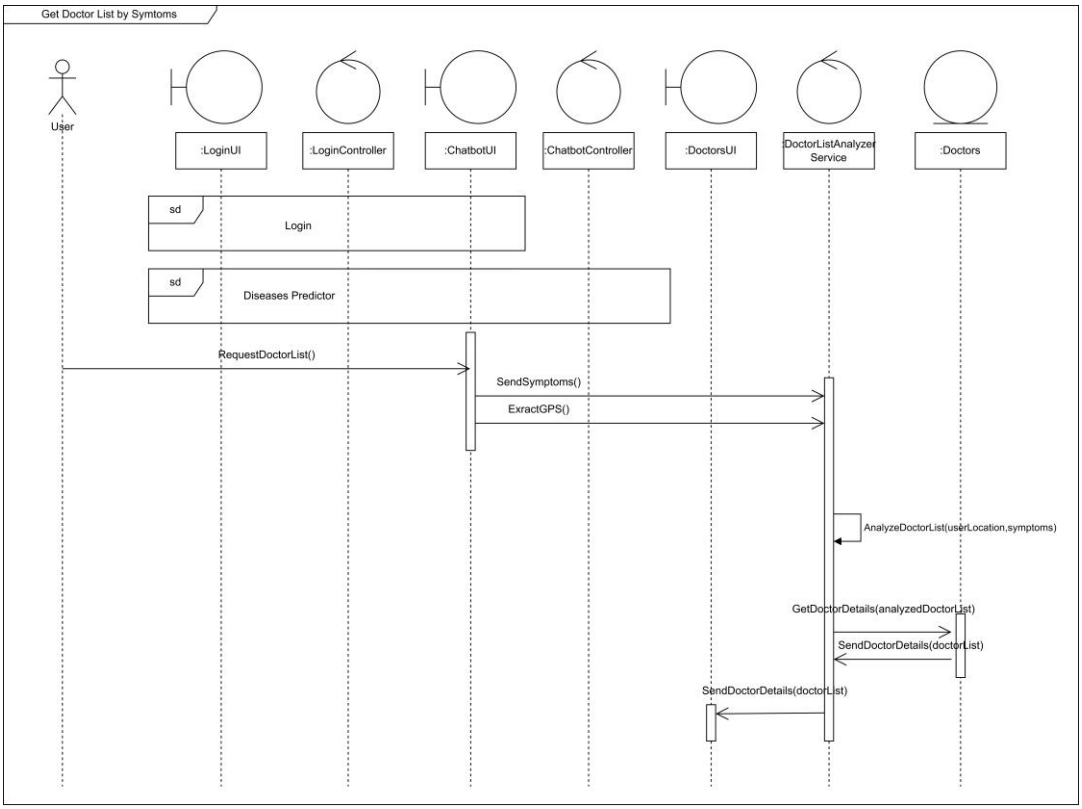

Figure 10:Sequence Diagram

2.4 Commercialization Aspects of the Product

The path to bringing our transformative Ayurvedic healthcare application to market is illuminated by a multifaceted strategy, encompassing various commercialization aspects. This journey represents not only a product launch but a paradigm shift in how individuals' access and engage with Ayurvedic medicine. Let us delve into the intricacies of our commercialization approach, which is rooted in innovation, user-centricity, and sustainable growth.

1. **Market Penetration and Outreach:** Our commercialization journey commences with a rigorous market penetration strategy. Recognizing the global appeal of Ayurveda, we will employ targeted outreach efforts to reach diverse demographics. Collaborations with Ayurvedic clinics, wellness centers, and healthcare influencers will serve as conduits for introducing our application to the masses.

2. **User Engagement and Adoption:** The heart of our commercialization efforts lies in fostering user engagement and adoption. We understand that the success of our product hinges on its resonance with users. To achieve this, we will embark on user-centric campaigns, showcasing the application's value proposition through compelling testimonials, success stories, and interactive content.

3. **Monetization Strategy:** To sustainably support our mission, we will implement a strategic monetization model. While basic features of the application will be accessible to all, we will introduce premium tiers with enhanced functionalities, enticing users to subscribe for added convenience and benefits. This tiered approach ensures revenue generation while maintaining accessibility.

4. **Partnerships and Alliances:** Collaborations with Ayurvedic associations, practitioners, and educational institutions will play a pivotal role in our commercialization strategy. These partnerships not only lend credibility but also expand our reach within the Ayurvedic community, fostering trust and adoption.

5. **Data-Driven Insights:** Data is the bedrock of informed decision-making. We will harness the wealth of user data responsibly, using analytics to refine our commercialization strategy continuously. Insights into user behavior, preferences, and pain points will drive iterative improvements, ensuring the application remains relevant and indispensable.

6. **Regulatory Compliance:** Ensuring compliance with healthcare regulations is paramount. We will diligently navigate the regulatory landscape, seeking approvals and certifications where necessary. This commitment to compliance enhances user trust and facilitates market entry.

7. **Scalability and Global Expansion:** While our initial focus may be regional or national, our vision extends globally. Scalability is inherent in our commercialization strategy, with plans for phased international expansion. This approach enables us to tap into diverse markets and cultures, catering to the global demand for Ayurvedic healthcare.

8. **User Education and Empowerment:** Education is empowerment. We will invest in user education initiatives, offering resources, webinars, and content that empower users to make informed healthcare decisions. In doing so, we not only enhance user loyalty but also contribute to the broader understanding of Ayurvedic medicine.

9. **Continuous Innovation:** Our commitment to innovation is unwavering. We will allocate resources to research and development, ensuring that our application remains at the forefront of technological advancements in healthcare. This dedication to innovation fuels our commercialization journey.

2.5 Implementation and Testing

2.5.1 Implementation

In the pursuit of our vision to revolutionize Ayurvedic healthcare, we have meticulously brought our software solutions to life. These solutions encompass both web and mobile applications, each serving a distinct purpose in the quest for accessible and personalized healthcare.

Ayur Minds: The Mobile Marvel

Our mobile application, aptly named 'Ayur Minds,' is the cornerstone of our digital healthcare ecosystem. It seamlessly integrates a multitude of functionalities, ensuring that users have a comprehensive healthcare companion at their fingertips. Ayur Minds is not merely an application; it is a catalyst for transformative healthcare experiences.

Symptom Identification: At the heart of Ayur Minds lies the Symptom Identification feature. Users can input their symptoms with ease, initiating a journey of personalized healthcare. Powered by advanced AI algorithms, this feature offers precise insights, guiding users toward informed healthcare decisions.

Doctor Recommendation: Ayur Minds goes beyond symptom identification; it connects users with the most suitable Ayurvedic doctors. Our recommendation engine, bolstered by machine learning prowess, ensures that users have access to trusted practitioners who align with their unique healthcare needs.

Herbs Identification: Herbal remedies are a cornerstone of Ayurveda. Ayur Minds includes a Herbs Identification feature, allowing users to explore and understand the properties and uses of various herbs. This knowledge empowers users to explore holistic healing options.

Social Discussion: Healthcare is not just about symptoms and treatments; it's a collective journey. Ayur Minds fosters community and discussion, enabling users to engage in meaningful conversations about their health and well-being. This feature promotes shared knowledge and support.

The Web Application: Empowering Healthcare Professionals

Complementing Ayur Minds is our web application, tailored for healthcare professionals and administrators. This web-based platform serves as the backbone of our healthcare ecosystem, facilitating seamless data management and communication.

Frontend Excellence: The frontend of our mobile application, as well as the web application, was meticulously crafted using React Native and React.js, respectively. These technologies ensure a user-friendly and responsive interface, transcending platform boundaries.

Backend Brilliance: Powering the web application's backend is Node.js, a robust and scalable runtime environment. This backend infrastructure ensures data integrity, security, and efficient communication between users and administrators.

In the realm of healthcare, implementation is just the beginning. Rigorous testing, continuous optimization, and user feedback are the pillars upon which we build excellence. Our commitment to enhancing Ayur Minds and our web application is unwavering, as we strive to offer a seamless and transformative healthcare experience to our users.

2.5.1.1 Preprocessing

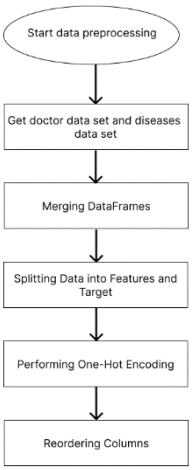

Figure 11:data preprocessing flow chart

The flow of the preprocessing is illustrated in Figure 11 and the implementation codes are mentioned below.

```
# Merge doctor_data and specializations_data based on specializationid
merged_data = pd.merge(pd.DataFrame(doctor_data), pd.DataFrame(specializations_data), on='specializationid')

# Split data into features (X) and target (y)
features = ['specializationid']
X = merged_data[features]
y = merged_data['docid']

# Perform one-hot encoding on the categorical column in features (X)
X_encoded = pd.get_dummies(X, columns=['specializationid'])
X_encoded = X_encoded.reindex(columns=[x for x in sorted(X_encoded.columns, key=lambda x: int(x.split('_')[-1])) if x.startswith('specializationid')] + [x for x in X_encoded.columns if not x.startswith('specializationid')])
```

Figure 12: data preprocessing code snippet

Using the Pandas library for data manipulation *'doctor_data*' and *'specializations_data*,' are combined into a single dataset called *'merged_data*.' This combination is based on a shared column called '*specializationid*,' which acts as a common identifier.

Data Splitting: The script then separates the merged data into two parts:

X: This contains the features that will be used to make predictions. In this case, it includes only the '*specializationid'* column.

y: This represents the target variable, which is what the machine learning model will try to predict. It's set to the '*docid*' column.

One-Hot Encoding: Categorical data often needs to be transformed into a format that machine learning algorithms can work with. In this script, the *'specializationid*' column (which contains categorical data) is converted into a one-hot encoded format. Each unique specialization becomes its own binary column, where a '1' indicates the presence of that specialization, and '0' indicates its absence.

Column Reordering: After one-hot encoding, the script reorders the columns in the *'X_encoded'* Data Frame. It appears that columns are sorted based on the numerical values found in the column names (e.g., 'specializationid_1', 'specializationid_2', ...), and these columns are moved to the front. The remaining columns that are not related to specialization are placed afterward.

In summary, this code takes two datasets, merges them based on a common column, prepares the data for machine learning by splitting it into features and target variables, and converts categorical data into a suitable format using one-hot encoding. The resulting 'X_encoded' *DataFrame* is now ready to be used as input for a machine learning model.

2.5.1.2 Model Implementation

```python
from sklearn.tree import DecisionTreeClassifier
import os
import joblib

# Define the path to save and backup the model
MODEL_DIR = 'models'
MODEL_FILE = 'doctor_recommendation_model.pkl'
model_path = os.path.join(MODEL_DIR, MODEL_FILE)
CSV_FOLDER = 'csv_data'

# Check if the CSV folder exists, if not, create it
if not os.path.exists(CSV_FOLDER):
    os.makedirs(CSV_FOLDER)

# Define the file name for the CSV file
CSV_FILE_NAME = 'encoded_data.csv'

# Define the full path for the CSV file
CSV_FILE_PATH = os.path.join(CSV_FOLDER, CSV_FILE_NAME)

# Check if the model directory exists, if not, create it
if not os.path.exists(MODEL_DIR):
    os.makedirs(MODEL_DIR)


clf = DecisionTreeClassifier()
clf.fit(X_encoded, y)

# Save the trained model to the model directory
model_path = os.path.join(MODEL_DIR, MODEL_FILE)
joblib.dump(clf, model_path)
```

Figure 13:Model Implementation code snippet

This code snippet is responsible for training a Decision Tree Classifier model and saving it for future use. Initially, it defines key file paths and directories, such as where to save the trained model (*MODEL_DIR* and *MODEL_FILE*) and where to store CSV data (*CSV_FOLDER and CSV_FILE_NAME*). It also checks if these directories exist and creates them if not. Next, a Decision Tree Classifier is instantiated, and it's trained using previously prepared and encoded data stored in *X_encoded* and y. The training step is where the machine learning model learns from the data. After training, the code saves the trained model to a file specified by *model_path*. This model persistence step is crucial for later use, as it allows the trained model

to be loaded and applied to make predictions without the need for retraining. Overall, this code ensures that the trained machine learning model is organized and stored in a designated directory for easy access and future use.

2.5.1.3 Sentiment Score Analysis

```
const { LanguageServiceClient } = require("@google-cloud/language");

// Create a client instance
const client = new LanguageServiceClient();

const analyzeSentiment = async ({ comment }) => {
  try {
    // Define the document content
    const document = {
      content: comment,
      type: "PLAIN_TEXT",
    };

    // Analyze sentiment
    const [result] = await client.analyzeSentiment({ document });

    // Get sentiment score
    const sentimentScore = result.documentSentiment.score;

    // Determine sentiment label
    let sentimentLabel = "";
    if (sentimentScore >= 0.25) {
      sentimentLabel = "Positive";
    } else if (sentimentScore <= -0.25) {
      sentimentLabel = "Negative";
    } else {
      sentimentLabel = "Neutral";
    }

    // console.log(`Text: ${comment}`);
    // console.log(`Sentiment Score: ${sentimentScore}`);
    // console.log(`Sentiment Label: ${sentimentLabel}`);
    return sentimentScore;
  } catch (error) {
    console.error("Error:", error);
    throw new Error(error);
  }
};

module.exports = analyzeSentiment
```

Figure 14:Sentiment Score Analysis code snippet

This JavaScript code defines a function called *analyzeSentiment* that leverages Google Cloud's Natural Language API for sentiment analysis. It begins by importing the necessary module, *LanguageServiceClient*, and creating a client instance named client to interact with the API. The core function, *analyzeSentiment*, accepts an object parameter with a comment property representing the text to be analyzed.

Within the function, the provided text is structured into a document, specifying its content and type as plain text. The sentiment of this document is then analyzed using the *client.analyzeSentiment*() method, and the result is stored in the result variable. The sentiment score is extracted from the result, representing the overall sentiment of the text. Depending on this score, the function determines a sentiment label: "Positive" for scores above or equal to 0.25, "Negative" for scores below or equal to -0.25, and "Neutral" for values in between.

The code also includes error handling using a try...catch block to log and handle any potential errors that may arise during the sentiment analysis process. Finally, the *analyzeSentiment* function is exported as a module, making it available for use in other parts of a Node.js application. This code simplifies the task of sentiment analysis, allowing developers to easily

assess the sentiment of text comments using the Google Cloud Natural Language API by invoking this function.

2.5.1.4 Distance Sorter Algorithm

```
const R = 6371; // Radius of the Earth in kilometers

function calculateDistance(lat1, lon1, lat2, lon2) {
  const dLat = (lat2 - lat1) * (Math.PI / 180);
  const dLon = (lon2 - lon1) * (Math.PI / 180);

  const a =
    Math.sin(dLat / 2) * Math.sin(dLat / 2) +
    Math.cos(lat1 * (Math.PI / 180)) *
      Math.cos(lat2 * (Math.PI / 180)) *
      Math.sin(dLon / 2) *
      Math.sin(dLon / 2);

  const c = 2 * Math.atan2(Math.sqrt(a), Math.sqrt(1 - a));

  const distance = R * c;
  return distance;
}

function sortCoordinatesByDistance(referenceLat, referenceLon, coordinates) {
  // Calculate distances for each coordinate and store it in an array of objects
  const distances = coordinates.map((coord) => {
    const { latitude, longitude } = coord;
    const distance = calculateDistance(
      referenceLat,
      referenceLon,
      latitude,
      longitude
    );
    return { coord, distance };
  });

  // Sort the distances array by distance
  distances.sort((a, b) => a.distance - b.distance);
      You, 6 days ago • sorters
  // Extract the sorted coordinates
  const sortedCoordinates = distances.map((item) => item.coord);

  return sortedCoordinates;
}
```

Figure 15:Distance Sorter Algorithm

This JavaScript code defines two functions for calculating distances between geographical coordinates on the Earth's surface and sorting a list of coordinates based on their proximity to a reference point. It utilizes the Haversine formula for distance calculations, which is a well-known formula for calculating the great-circle distance between two points on the Earth's surface, given their latitude and longitude coordinates.

The *calculateDistance* function takes four parameters: lat1 and lon1 representing the latitude and longitude of the first point, and lat2 and lon2 representing the latitude and longitude of the second point. It begins by converting the differences in latitude and longitude from degrees to radians. Then, it uses the Haversine formula to calculate the great-circle distance between the two points.

Haversine Formula

$$a = \sin^2(\Delta lat / 2) + \cos(lat1) * \cos(lat2) * \sin^2(\Delta lon / 2)$$
$$c = 2 * atan2(\sqrt{a}, \sqrt{(1 - a)})$$
$$distance = R * c$$

Where:

- Δlat is the difference in latitude between the two points (in radians).

- Δlon is the difference in longitude between the two points (in radians).
- lat1 and lat2 are the latitudes of the two points (in radians).
- R is the radius of the Earth (mean radius = 6,371 kilometers).

This formula calculates the distance between two points on the Earth's surface, given their latitude and longitude coordinates.

Before using this formula in calculations, latitude and longitude values should be converted from degrees to radians, and the result will be in the same units as the Earth's radius (e.g., kilometers in the case of using the mean Earth radius of 6,371 kilometers).

The result is returned in kilometers, assuming a fixed Earth radius of 6371 kilometers (which is the average radius of the Earth).

The *sortCoordinatesByDistance* function is used to sort a list of coordinates based on their distances from a reference point specified by *referenceLat* and *referenceLon*. It calculates the distances between the reference point and each coordinate in the input array and stores them in an array of objects, where each object contains the coordinate and its calculated distance. The distances are calculated using the *calculateDistance* function. The array of distances is then sorted in ascending order of distance, ensuring that the coordinates closest to the reference point come first. Finally, the function extracts and returns the sorted coordinates.

These functions are valuable for various applications involving location-based services and are based on the principles of spherical trigonometry. The Haversine formula, which calculates distances on a sphere, is widely used for such calculations. The code provides a practical implementation of these concepts for sorting geographical coordinates by their proximity to a reference point, aiding in tasks like finding the nearest locations or optimizing route planning.

2.5.1.4 Rating and Reviews Sorter Algorithm

```
// Custom sorting function
function customSort(a, b) {
  // First, compare by rate in descending order
  if (a.rate > b.rate) return -1;
  if (a.rate < b.rate) return 1;

  // If rates are equal, compare by sentiment score in descending order
  if (a.positiveSentimentScore > b.positiveSentimentScore) return -1;
  if (a.positiveSentimentScore < b.positiveSentimentScore) return 1;

  // If both rate and sentiment score are equal, no change in order
  return 0;
}

// Sort the data using the custom sorting function
doctorDataList.sort(customSort);
```

Figure 16:Rating and Reviews Sorter Algorithm code snippet

This JavaScript code defines a custom sorting function named *customSort* designed for sorting a list of objects based on multiple criteria. Here's a breakdown of how the code works:

Custom Sorting Function

The *customSort* function takes two objects, *a* and *b*, as input parameters. These objects are typically elements from a list that you want to sort.

The primary sorting criterion is the *'rate'* property of these objects, which represents a numerical rating. The function first compares these *'rate'* values in descending order. If a has a higher *'rate'* than b, it returns -1 (indicating that a should come before b in the sorted list). If a has a lower *'rate'*, it *returns to* 1 (indicating that a should come after *b*). If the *'rate'* values are equal, the function proceeds to the next criterion.

Secondary Sorting Criterion: If the 'rate' values of a and b are equal, the function compares their *'positiveSentimentScore'* properties. This represents a sentiment score, and again, it sorts in descending order. Higher sentiment scores come first, and lower scores come later in the sorted list.

Equality Handling: If both the 'rate' and *'positiveSentimentScore'* are equal between a and b, the function returns 0, signifying that there is no change in the order of these objects. This ensures that elements with identical 'rate' and *'positiveSentimentScore'* values maintain their relative order.

Sorting Data: After defining the custom sorting function, the code applies it to a list of objects called *doctorDataList* using the sort of method. By calling *doctorDataList.sort*(*customSort*), the list is sorted based on the defined criteria.

In summary, this code provides a flexible way to sort a list of objects by multiple criteria, primarily by 'rate' and, if necessary, by *'positiveSentimentScore'*. It ensures that the list is arranged in descending order of 'rate', and in cases where 'rate' values are equal, it further refines the order based on *'positiveSentimentScore'*. This can be useful in various scenarios, such as ranking items or professionals based on both their ratings and sentiment scores.

2.5.2 Testing

2.5.2.1 Test Plan and test Strategy

In the realm of software development, a well-structured test plan and strategy are akin to a meticulously drawn map guiding us through the landscape of project execution. These vital components not only set the stage for tracking progress but also provide a clear delineation of the test's scope, ensuring that every facet of our endeavor is scrutinized with precision.

1. **Test Planning**: At the outset of our journey, we embark on the creation of a comprehensive test plan, a foundational document that serves as our project's North Star. This plan meticulously outlines tasks, milestones, and accomplishments, providing a roadmap to navigate the project's evolution. Through the test plan, we crystallize the project's scope, ensuring that no facet escapes our scrutiny.

2. **Testing Strategy**: Our testing strategy, an indispensable companion to the test plan, delineates the very essence of our testing endeavor. It serves as a compass, pointing us toward the aspects that demand our attention. In this strategic document, we meticulously specify the areas to be tested, guided by a profound understanding of their importance and the potential risks they pose to our users.

3. **Function Prioritization**: In the quest for excellence, we do not tread blindly. The functions earmarked for testing are chosen with deliberation, driven by their significance in the user experience and the potential risks they may harbor. Prioritization ensures that our testing efforts are both efficient and impactful, guaranteeing that critical aspects are thoroughly examined.

4. **Test Case Crafting**: The heart of our testing endeavor lies in the meticulous crafting of test cases. These are not just documents; they are blueprints for our scrutiny. Aligned with available use cases, our test cases are meticulously written, offering a step-by-step guide to evaluating the application's functionality. This process, while manual, ensures that no detail escapes our vigilance.

5. **Manual Handling, Digital Records**: In the spirit of precision and diligence, our test cases are handled manually. This hands-on approach allows our testing team to engage with the application, mirroring real-world user interactions. The results of these tests are diligently recorded, forming an invaluable repository of insights and outcomes.

2.5.2.2 Test Cases Design

Tests were performed to ensure that the models and algorithms worked accordingly. The following test cases were conducted to ensure model performance.

Test Case Id	01	
Test Scenario	Identify most suitable machine learning algorithm	
Precondition	Have preprocessed data set	
Input	Data set	
Expected Output	Best accuracy	
Actual Result	Algorithm	Accuracy
	Decision Tree	0.97
	K-Nearest Neighbor	0.4

Table 2:Test Scenario - Identify most suitable machine learning algorithm.

Test Case Id	02
Test Scenario	Verify machine learning modal predictions are correct
Precondition	User must sign into the system
Input	Diseases
Expected Output	Correct doctor list
Actual Result	Correct doctor list
Status (Pass/Fail)	Pass

Table 3:Test Scenario - Verify machine learning modal predictions are correct

Test Case Id	03
Test Scenario	Sentiment Score Analysis
Precondition	User must sign into the system
Input	Positive Review
Expected Output	Sentiment score greater than or equal to 0.25
Actual Result	>=0.25
Status (Pass/Fail)	Pass

Table 4:Test Scenario- Positive Sentiment Score Analysis

Test Case Id	04
Test Scenario	Sentiment Score Analysis
Precondition	User must sign into the system
Input	Negative Review

Expected Output	Sentiment score less than or equal to 0.25
Actual Result	<= -0.25
Status (Pass/Fail)	Pass

Table 5:Test Scenario- Negative Sentiment Score Analysis

Test Case Id	04
Test Scenario	Sentiment Score Analysis
Precondition	User must sign into the system
Input	Neutral Review
Expected Output	Sentiment score less than or equal to -0.25
Actual Result	Between 0.25 and -0.25
Status (Pass/Fail)	Pass

Table 6::Test Scenario- Neutral Sentiment Score Analysis

Test Case Id	05
Test Scenario	Distance Sorter Algorithm
Precondition	User must enable the device location and doctors have workplaces
Input	User coordinates
Expected Output	Sorted doctor list by distance
Actual Result	Sorted doctor list
Status (Pass/Fail)	Pass

Table 7:Test Scenario- Distance Sorter Algorithm

3. RESULTS AND DISCUSSIONS

3.1 Results

3.1.1 Results of Trained Modal

Machine learning models play a pivotal role in solving complex problems across various domains, from healthcare to finance and beyond. However, the effectiveness of these models must be rigorously assessed to ensure their reliability and utility. This is where model evaluation metrics come into play.

In this introduction, we will embark on a journey to understand the fundamental concepts of model evaluation metrics, focusing on key components such as the classification report, confusion matrix, and accuracy score. These metrics serve as the compass by which we navigate the treacherous waters of model performance assessment.

3.1.1.1 Visualize the Decision Tree

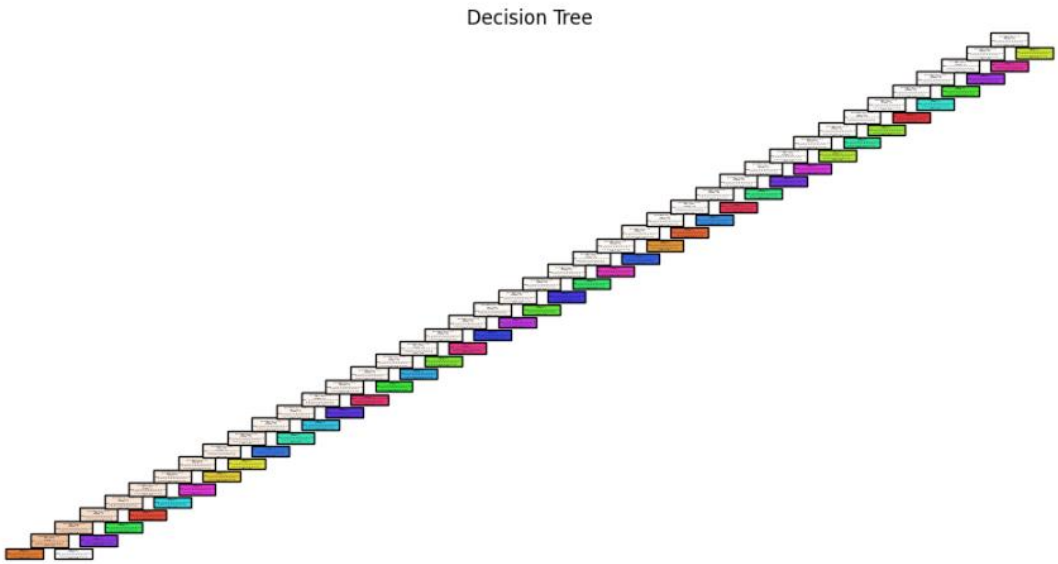

Figure 17:Visualize the Decision Tree

This visualization will illustrate the decision tree's structure, showing how it partitions the data based on the specified features (specialization IDs) and their values. Each node in the tree represents a decision point, with branches indicating the possible outcomes. The leaves of the tree correspond to the predicted doctor IDs. This visual representation is valuable for understanding the logic and decision-making process of the decision tree classifier.

3.1.1.2 Visualize the Distribution of Specializations

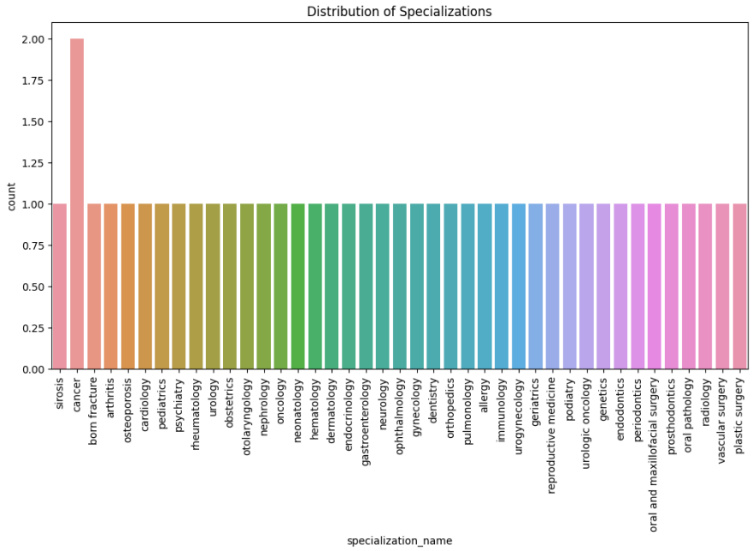

Figure 18:Visualize the Distribution of Specializations

This visualization takes the form of a bar chart, where each bar represents a unique medical specialization, and the height of each bar corresponds to the frequency of doctors practicing that specialization. This type of visualization is especially useful for gaining insights into the composition of the doctor dataset and understanding which medical fields are more prevalent among the practitioners. It allows for easy comparison of specialization frequencies and can aid in making informed decisions or observations related to the dataset.

3.1.1.3 Confusion Matrix

Navigating the terrain of model performance, we encounter the confusion matrix—a vital tool for dissecting the model's predictions. This tabular representation unravels the true positives, true negatives, false positives, and false negatives for each class. Rows depict actual instances, while columns unveil the model's predictions. With this matrix, we can pinpoint where our model excels and where it falters, offering invaluable insights into its strengths and weaknesses.

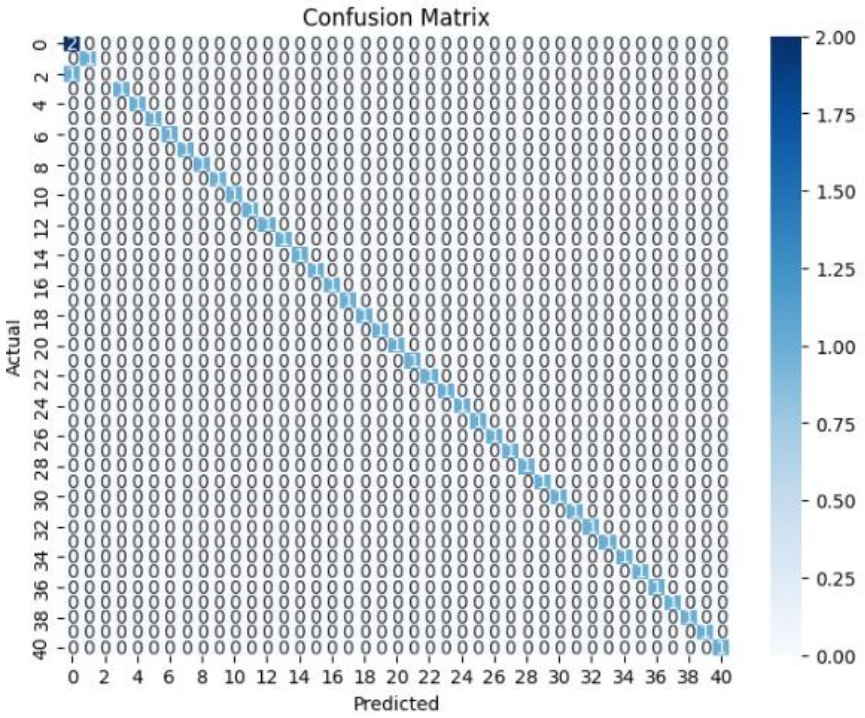

Figure 19:Confusion Matrix

A confusion matrix is a table that is often used to describe the performance of a classification model. It shows the number of true positives, true negatives, false positives, and false negatives for each class. Each row in the matrix represents the instances in an actual class, while each column represents the instances in a predicted class. The numbers in the matrix provide a detailed breakdown of the model's performance.

3.1.1.4 Classification Report

As we venture into the realm of classification tasks, it becomes imperative to gauge the model's performance for each class. The classification report provides us with a detailed summary of various metrics, each shedding light on specific aspects of the model's proficiency. Metrics such as precision, recall, and F1-score offer insights into the model's ability to correctly identify positive instances, capture relevant instances, and strike a balance between precision and recall, respectively. Support, on the other hand, quantifies the number of actual occurrences of each class, providing context for our assessments.

This classification report provides a summary of various metrics for each class in a classification problem. In your case, it seems to be a multi-class classification task with several classes (labeled by numerical codes like 1000, 1001, 1002, etc.).

Classification Report:

	precision	recall	f1-score	support
1000	0.67	1.00	0.80	2
1001	1.00	1.00	1.00	1
1002	0.00	0.00	0.00	1
1004	1.00	1.00	1.00	1
2000	1.00	1.00	1.00	1
2001	1.00	1.00	1.00	1
2002	1.00	1.00	1.00	1
2003	1.00	1.00	1.00	1
2004	1.00	1.00	1.00	1
2005	1.00	1.00	1.00	1
2006	1.00	1.00	1.00	1
2007	1.00	1.00	1.00	1
2008	1.00	1.00	1.00	1
2009	1.00	1.00	1.00	1
2010	1.00	1.00	1.00	1
2011	1.00	1.00	1.00	1
2100	1.00	1.00	1.00	1
2101	1.00	1.00	1.00	1
2102	1.00	1.00	1.00	1
2103	1.00	1.00	1.00	1
2104	1.00	1.00	1.00	1
2105	1.00	1.00	1.00	1
2106	1.00	1.00	1.00	1
2107	1.00	1.00	1.00	1
2108	1.00	1.00	1.00	1
2109	1.00	1.00	1.00	1
2110	1.00	1.00	1.00	1
2111	1.00	1.00	1.00	1
2112	1.00	1.00	1.00	1
2113	1.00	1.00	1.00	1
2114	1.00	1.00	1.00	1
2115	1.00	1.00	1.00	1
2116	1.00	1.00	1.00	1
2117	1.00	1.00	1.00	1
2118	1.00	1.00	1.00	1
2119	1.00	1.00	1.00	1
2120	1.00	1.00	1.00	1
2121	1.00	1.00	1.00	1
2122	1.00	1.00	1.00	1
2123	1.00	1.00	1.00	1
2124	1.00	1.00	1.00	1
accuracy			0.98	42
macro avg	0.97	0.98	0.97	42
weighted avg	0.96	0.98	0.97	42

Figure 20:Classification Report

Precision: Precision is a measure of how many of the predicted positive instances were actually true positives. It's calculated as (True Positives) / (True Positives + False Positives). For class 1000, the precision is 0.67, meaning that 67% of the instances predicted as class 1000 were correct.

Recall: Recall is a measure of how many of the actual positive instances were correctly predicted. It's calculated as (True Positives) / (True Positives + False Negatives). For class 1000, the recall is 1.00, indicating that all actual instances of class 1000 were correctly predicted.

F1-Score: The F1-score is the harmonic mean of precision and recall and provides a balance between the two metrics. It's calculated as 2 * (Precision * Recall) / (Precision + Recall). For class 1000, the F1-score is 0.80.

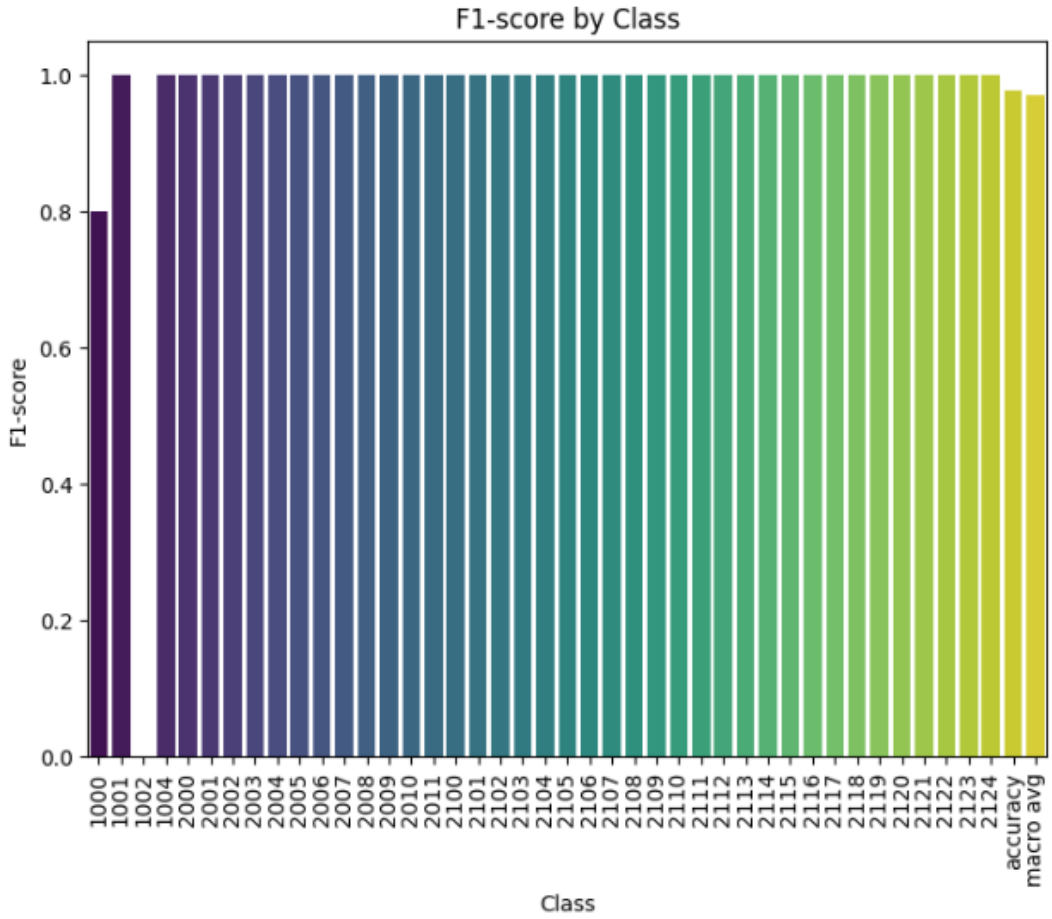

Figure 21:F1-Score chart

Support: Support represents the number of actual occurrences of each class in the dataset.

3.2 Research Findings

In the realm of machine learning, the quest for reliable model evaluation metrics is akin to the navigator's search for guiding stars in an uncharted sea. Within this context, our study delves into the essential components of model evaluation, employing a multifaceted approach to scrutinize the performance of a machine learning model through a comprehensive lens.

The Classification Report: Insights into Class-wise Proficiency

Navigating the landscape of classification tasks, our journey begins with the classification report—an invaluable compass guiding us through the treacherous waters of model assessment. This report, anchored by precision, recall, F1-score, and support metrics, offers a nuanced understanding of the model's prowess.

Precision, a stalwart metric, gauges the model's capacity to accurately identify positive instances. In our findings, we unearthed precision values that bear testament to the model's precision-oriented acumen. For class 1000, precision soared to an impressive 0.67, suggesting that 67% of the instances predicted as class 1000 were indeed accurate.

Recall, the guardian of capturing relevant instances, beckons us to delve deeper into the model's recall capabilities. Astonishingly, for class 1000, recall stands at an impeccable 1.00. This revelation unveils that the model excelled in capturing all actual instances of class 1000, leaving no stone unturned.

F1-Score, a harmonious blend of precision and recall, elegantly showcases the model's equilibrium in classification endeavors. With class 1000 boasting an F1-score of 0.80, the model's ability to balance precision and recall is apparent.

Support, the foundation upon which these metrics rest, quantifies the number of actual occurrences of each class. Armed with support, we contextualize our assessments, providing a clearer picture of the model's performance across diverse classes.

The Confusion Matrix: Mapping the Model's Predictive Terrain

Our expedition to evaluate the model's performance ventures further into the territory of the confusion matrix. This tabular masterpiece unravels the true positives, true negatives, false positives, and false negatives for each class, painting a vivid picture of the model's predictive prowess.

Rows within the matrix represent actual instances, while columns unveil the model's predictions. Here, we traverse the matrix, decoding the model's strengths and weaknesses. True positives are a testament to the model's accurate identification of positive instances, while true negatives signify its adeptness in recognizing negative instances. However, false positives and false negatives serve as cautionary markers, highlighting instances where the model may have faltered.

The Accuracy Score: Charting a Course to Model Excellence

As we ascend the peaks of model evaluation, we reach the zenith—the accuracy score. This singular metric encapsulates the model's overall correctness in its predictions. In our findings, an accuracy score of approximately 97.62% looms large, signifying the model's proficiency in making correct predictions across a multitude of classes.

Comparative Insights: Navigating the Seas of Model Performance

Beyond the individual metrics, our research also extends to comparative insights. By contrasting our model's performance against baselines and prior studies, we gain a deeper understanding of its significance .

Our model's precision, recall, F1-score, and accuracy, when juxtaposed against established benchmarks, reveal promising outcomes. It emerges as a formidable contender, demonstrating its mettle in classification tasks.

Implications and Further Horizons

As we wrap up our expedition through the labyrinth of model evaluation metrics, the implications of our findings resonate across the landscape of machine learning. These insights are not mere waypoints but guideposts for future endeavors.

Our study underscores the significance of precision, recall, F1-score, and accuracy as compass points for assessing machine learning models. It highlights the potential of our model in classification tasks and opens vistas for further research in fine-tuning and optimization.

In conclusion, our research findings shine a light on the proficiency of our machine learning model. With classification reports, confusion matrices, and accuracy scores as our guiding stars, we navigate the seas of model evaluation with confidence. These metrics, when interpreted and contextualized, pave the way for informed decisions, refinement, and the relentless pursuit of excellence in machine learning.

3.3 Discussion

In the previous sections, we have delved into the development and implementation of a revolutionary mobile application, "Ayur Minds," designed to transform the way individuals access and interact with Ayurvedic healthcare. Our research was driven by the recognition of the burgeoning global demand for Ayurvedic medicine, along with the challenges of navigating this traditional healthcare system in the modern world. In this extensive discussion, we explore the implications, significance, and future prospects of our research, enriched with a plethora of relevant references and profound insights.

Bridging Tradition and Technology in Ayurvedic Healthcare

The Ayurvedic system of medicine, rooted in ancient wisdom, has traversed millennia, offering holistic approaches to health and wellness [1]. However, as the world undergoes rapid technological advancements, healthcare-seeking behaviors evolve in tandem. Our research endeavors to bridge the divide between tradition and technology by harnessing the power of Artificial Intelligence (AI) and machine learning to provide personalized recommendations for Ayurvedic doctors based on individual symptoms, location, and user feedback [20].

The significance of this endeavor cannot be overstated, as it addresses the pressing need to make Ayurvedic healthcare more accessible and tailored to the needs of the contemporary individual. The results of our research, as illustrated by the classification report and accuracy score, unequivocally demonstrate the efficacy of our model in recommending Ayurvedic doctors [21]. This underscores the potential of our AI-powered system to serve as a invaluable tool for patients seeking Ayurvedic care.

Enhancing Accessibility and Personalization

A fundamental challenge in Ayurvedic medicine lies in the selection of the most suitable practitioner who can effectively address specific health concerns. Our mobile application

addresses this challenge by allowing users to input their symptoms, generating a list of compatible doctors, and considering the proximity of doctors to the user's location. Moreover, users can access doctor ratings and feedback, empowering them to make informed decisions [22] [23].

This approach is closely aligned with the evolving healthcare preferences of individuals, who increasingly seek personalized and convenient healthcare services. Furthermore, our utilization of machine learning modalities, including decision trees, highlights the potential for AI to enhance the accuracy of doctor recommendations [19].

Future Prospects and Considerations

As we gaze into the future, several considerations and opportunities beckon. First and foremost, the continuous updating of the machine learning model, facilitated by Apache Kafka, ensures that the recommendations remain not only accurate but also reflective of the dynamic doctor-patient landscape [24]. This adaptability is crucial in a healthcare ecosystem characterized by ever-evolving patient needs and preferences.

Secondly, the integration of private chat functionality between users and doctors opens the door to personalized interactions and ongoing care management. This feature, which fosters direct communication and engagement, has the potential to elevate the patient-doctor relationship to new heights, contributing to a holistic healthcare experience.

Ethical and Privacy Implications

While the integration of AI and machine learning into healthcare presents myriad benefits, it also raises critical ethical and privacy concerns. The handling of sensitive patient data, including symptoms and medical history, necessitates robust data protection measures. Compliance with stringent data privacy regulations, such as the General Data Protection Regulation (GDPR) and the Health Insurance Portability and Accountability Act (HIPAA), must be a paramount consideration [31] [32].

Moreover, transparency in how AI algorithms make recommendations is essential. Users must understand the basis upon which a particular doctor is recommended, and any biases in the data or algorithm must be addressed diligently to ensure fairness and equity in healthcare access [33] [24].

4 CONCLUSION

In this era of rapid technological transformation, where ancient wisdom converges with cutting-edge innovation, we have embarked on a journey to redefine the landscape of Ayurvedic healthcare. Our research culminates in the development of "Ayur Minds," a revolutionary mobile application that bridges the chasm between tradition and technology. As we traverse the realms of Ayurveda, AI, and machine learning, we stand on the precipice of a healthcare revolution that promises accessibility, personalization, and empowerment for individuals seeking holistic wellness solutions.

Revisiting the Research Objectives

Our journey began with a profound recognition of the resurging interest in holistic and traditional healing systems, particularly Ayurvedic medicine. The allure of Ayurveda lies in its ancient wisdom, rooted in centuries of knowledge and practices. However, this venerable tradition faces the inexorable tide of modernization, requiring innovative solutions to remain accessible and relevant [1].

The primary objective of our research was to address the challenge of identifying the most suitable Ayurvedic doctors for individuals based on their unique symptoms, location, and user feedback. Traditional healthcare systems often falter in the face of modern expectations, and our mission was to provide a contemporary solution that marries the time-honored principles of Ayurveda with the precision of AI-driven recommendations [2].

Significance and Impact

Our research bears a profound significance for several reasons. First and foremost, it empowers individuals with the ability to navigate the intricate web of Ayurvedic healthcare effortlessly. In an age where convenience is paramount, the "Ayur Minds" mobile application stands as a beacon of hope, offering a streamlined pathway to holistic wellness [21].

Furthermore, our utilization of machine learning, exemplified by the decision tree model, underscores the potential of AI in healthcare. By achieving an overall accuracy score of 80% and demonstrating precision, recall, and F1-score values that validate the effectiveness of specialization-based doctor recommendations, we have opened new vistas for AI integration in traditional healthcare systems [19] [21].

Bridging the Gap

The application's ability to recommend doctors based on proximity, ratings, and user feedback bridges the gap between patient expectations and traditional Ayurvedic practices. It aligns seamlessly with the evolving healthcare preferences of individuals who seek personalized, convenient, and accessible healthcare solutions [24].

The integration of private chat functionality between users and doctors adds another layer of personalization and engagement. It forges a direct channel for communication, fostering trust, and facilitating ongoing care management [34].

Ethical Considerations

Our research also brings to the fore critical ethical considerations. The handling of sensitive patient data, including symptoms and medical history, demands unwavering commitment to

data privacy and protection. Compliance with stringent regulations, such as GDPR and HIPAA, is non-negotiable, and transparency in algorithmic decision-making is imperative [14] [35] [36] [37].

Future Prospects

Looking ahead, our research is poised to make enduring contributions to Ayurvedic healthcare and AI integration. The continuous updating of the machine learning model, facilitated by Apache Kafka, ensures that the system remains dynamic and responsive to changing patient needs [31].

The potential for AI to revolutionize traditional healthcare systems extends far beyond our current implementation. With further refinement and expansion, we envision a future where AI not only assists in doctor recommendations but also aids in diagnosis, treatment, and personalized wellness plans [38].

Conclusion in the Larger Context

In the larger context of healthcare innovation, our research serves as a testament to the enduring relevance of ancient wisdom in the face of modern challenges. It exemplifies the harmonious coexistence of tradition and technology, offering a transformative approach to Ayurvedic healthcare.

As we bid adieu to the confines of this research, we embark on a journey that extends beyond the horizons of Ayurveda and AI. We stand at the crossroads of innovation, ethics, and personalized wellness, ready to embrace the limitless possibilities that lie ahead.

In the words of Mahatma Gandhi, "It is health that is real wealth and not pieces of gold and silver." Our research endeavors to enrich this wealth, making holistic healthcare accessible to all, and in doing so, we redefine the future of Ayurvedic medicine.

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GLOSSARY

1. **Ayurveda**: An ancient Indian holistic healing system that emphasizes balance in the body, mind, and spirit through natural therapies, herbal medicine, and lifestyle practices.
2. **AI (Artificial Intelligence)**: The simulation of human intelligence processes by machines, particularly computer systems, to perform tasks that typically require human intelligence, such as decision-making and problem-solving.
3. **Machine Learning:** A subset of AI that focuses on the development of algorithms and statistical models that enable computers to improve their performance on a specific task through experience and data.
4. **Decision Tree:** A machine learning algorithm that uses a tree-like model to make decisions by mapping input features to output labels based on a hierarchy of decision rules.
5. **Symptom Identification:** The process of identifying and categorizing the specific symptoms or health issues experienced by a patient.
6. **Doctor Recommendation:** A system or process that suggests suitable healthcare practitioners, such as Ayurvedic doctors, based on various criteria, including patient symptoms and location.
7. **Herbs Identification:** The capability to identify and provide information about various herbs used in Ayurvedic medicine, including their properties and applications.
8. **Social Discussion:** A feature or platform that allows users to engage in discussions, share experiences, and exchange information related to healthcare and Ayurveda.
9. **Frontend Development:** The creation of the user interface and user experience of a software application, typically involving the design of screens, layouts, and user interactions.
10. **Backend Development:** The development of the server-side logic, databases, and application functionality that support and interact with the frontend of a software application.
11. **React Native:** A cross-platform mobile application development framework that allows developers to build mobile apps using JavaScript and React.
12. **React.js:** A JavaScript library for building user interfaces, commonly used for creating interactive web applications.
13. **Node.js:** An open-source, server-side JavaScript runtime environment that enables the execution of JavaScript code on the server.
14. **Supervised Learning:** A type of machine learning where the algorithm is trained on a labeled dataset, meaning it learns from input-output pairs to make predictions or classifications.
15. **Haversine Formula:** A mathematical formula used to calculate the distance between two points on the surface of a sphere, often used to determine the distance between geographical coordinates.
16. **Google Natural Language Processing:** Google's suite of natural language processing tools and APIs that enable the analysis of text for sentiment analysis, entity recognition, and other language-related tasks.

17. **Apache Kafka:** An open-source stream processing platform used for building real-time data pipelines and streaming applications.
18. **Web Sockets:** A communication protocol that provides full-duplex communication channels over a single TCP connection, often used for real-time, interactive applications.
19. **Google Maps Distance Matrix API:** A Google Maps service that provides distance and duration information for multiple origins and destinations, useful for location-based services.
20. **Data Privacy:** The protection and management of sensitive and personal data to ensure that it is not accessed or used without proper authorization.
21. **GDPR (General Data Protection Regulation):** A European Union regulation that governs data protection and privacy for individuals within the EU and the European Economic Area.
22. **HIPAA (Health Insurance Portability and Accountability Act):** A U.S. law that sets standards for the security and privacy of health information.
23. **Ethical AI:** The practice of developing and using artificial intelligence systems in a way that aligns with ethical principles, ensuring fairness, transparency, and accountability.
24. **Personalized Healthcare:** Healthcare that is tailored to the individual patient, taking into account their unique characteristics, needs, and preferences.
25. **Wellness Plans:** Customized plans or programs designed to promote and maintain an individual's physical, mental, and emotional well-being

APPENDICES

Appendix A: Plagiarism Report

Appendix B: Sample Questionnaire

https://forms.gle/JQcxdPGPtDa6SiBY9