Format for Project Report

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Optimizing Doctor Availability and Appointment Allocation in Hospital

A PROJECT REPORT

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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

TABLE OF CONTENTS

List of Figures

List of Tables

List of Standards (Mandatory For Engineering Programs)

Standard	Publishing Agency	About the standard	Page no
IEEE 802.11	IEEE	IEEE 802.11 is part of the IEEE 802 set of local area network (LAN) technical standards. It specifies the set of media access control (MAC) and physical layer (PHY) protocols for implementing wireless local area network (WLAN) computer communication.	Mention page nowhere standard is used

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ABSTRACT

This project aimed to design and implement an AI-enabled hospital appointment booking system using a combination of PHP, MySQL, HTML5, CSS, Python, and JavaScript. The system aimed to address the challenges of traditional appointment booking systems by providing an intuitive and efficient platform for patients, doctors, and hospital staff. The user interface was designed using HTML and CSS, with interactivity added through JavaScript to enable a multi-step booking modal. The backend requirements were fulfilled using a combination of jQuery Ajax and PHP, with appointment data stored and retrieved from a MySQL database. The logic to avoid booking clashes was implemented using PHP. Additionally, a machine learning model was trained using Python and data from the AI&IoT health app to predict the optimum period of the day to book an appointment based on the day of the week and desired service type. The integration of AI components aims to optimize scheduling, reduce congestion, and provide a seamless experience for users. The project's implementation showcased the successful integration of various technologies to create an intelligent appointment booking system for enhanced healthcare services. A comprehensive and easy-to-use digital platform, the Doctor Appointment Booking System was created to improve and expedite making and keeping doctor appointments with physicians of their choosing. The administration, the physician, and the patient are the three sides of the system. The doctors' information, specialty, and system credentials will be added by the system administrator. Individuals seeking a physician with a specialty in their area of need will utilize the website of the doctor's appointment system. Patients can view the doctor's weekly schedule and select a time and day that works for them before submitting their request for an appointment. Patients, physicians, and administrators are the three main components of the system. Administrators are in charge of entering the doctors' data into the system, including their credentials, availability, and areas of expertise. On the other side, patients use the user-friendly interface to browse a database of doctors and select appointments based on their needs and the doctors' availability. Patients can simply arrange appointments at any time and on any dayby using online appointment requests.

Keywords: Artificial intelligence, time management, healthcare, appointment scheduling, and health applications.

INTRODUCTION

The healthcare industry plays a vital role in society, ensuring the well-being and timely medical attention of individuals. However, the process of scheduling appointments in hospitals has long been plagued by inefficiencies, long waiting times, and miscommunication. To address these challenges, this project introduces an AI-enabled hospital appointment booking system that harnesses the power of advanced technologies to revolutionize the way appointments are managed.
In this era of rapid technological advancements, the integration of artificial intelligence (AI) has the potential to significantly enhance the efficiency and effectiveness of healthcare services. By combining PHP, MySQL, HTML5, CSS, Python, and JavaScript, this project aims to design and implement a comprehensive solution that streamlines the appointment booking process, improves patient experiences, and optimizes hospital resource allocation.
The user interface of the system is meticulously crafted using HTML and CSS, ensuring an intuitive and visually appealing experience. Interactivity is introduced through JavaScript, allowing for a multi-step booking modal that guides users through the appointment scheduling process. This intuitive interface empowers patients, doctors, and hospital staff with a user-friendly platform that simplifies appointment management. To fulfill the backend requirements, a combination of PHP and jQuery Ajax is utilized. PHP serves as the backbone for processing and storing appointment data in a robust MySQL database, ensuring secure and reliable access to information. By leveraging these technologies, the system can handle a significant volume of appointment requests and concurrent users, optimizing performance and responsiveness.
One of the key challenges addressed by this project is the prevention of booking clashes. Through intelligent algorithms implemented in PHP, the system analyzes and detects conflicts, thereby eliminating scheduling errors and reducing inconvenience for patients and doctors. By avoiding congestion and optimizing appointment slots, the system ensures efficient utilization of hospital resources, resulting in enhanced operational efficiency. Furthermore, this project incorporates an AI component powered by Python and data collected from the AI & IoT health app. Through machine learning algorithms, the system predicts the optimal period of the day to book appointments based on the day of the week and the desired service type. By analyzing patterns and trends, the AI component helps users make informed decisions, avoiding unnecessary waiting times and improving overall satisfaction.

The integration of AI technologies brings numerous benefits to both patients and healthcare providers. Patients experience a more fluid and personalized appointment booking process, reducing stress and enabling them to access timely medical care. Hospital staff and administrators benefit from optimized resource allocation, improved workflow management, and enhanced patient satisfaction.
This project presents an innovative approach to revolutionizing healthcare by introducing an AI-enabled hospital appointment booking system. By combining PHP, MySQL, HTML5, CSS, Python, and JavaScript, the system offers an intuitive user interface, efficient scheduling, and intelligent optimization. Through the integration of AI technologies, it empowers both patients and healthcare providers, creating a seamless experience and enhancing the overall efficiency of healthcare services. This project paves the way for a future where technology-driven solutions transform healthcare delivery and improve patient outcomes .

1.1. Identification of Client /Need / Relevant Contemporary Issue

[1] The healthcare industry is constantly changing to satisfy the increasing demands of customers and healthcare professionals in the quick-paced, technologically-driven world of today. A significant advancement in this progression is the Doctor Appointment System, an innovative technology created to streamline the administration and scheduling of medical visits. The framework's predictive modeling element learns sufficiently from the information to provide precise expectations about non-attendance. As a consequence, the framework may use the classifier component's anticipated result to overbook vacancies that will not be filled. This investigation investigates and evaluates several commonly used machine learning procedures to bring together the classifier aspect that can create extremely precise and dependable forecasts so that the overall framework plan can appropriately manage no-shows.

1.2. Identification of Problem

In our fast-paced and digitally driven world, the healthcare landscape is continually evolving to meet the ever-growing demands of patients and providers. An integral part of this evolution is the Doctor Appointment System, a modern and innovative solution designed to facilitate the booking and management of medical appointments. This system represents a significant shift away from traditional appointment scheduling methods, offering numerous benefits for both patients and healthcare providers. The Doctor Appointment System harnesses the power of technology to simplify booking appointments with healthcare professionals. It aims to eliminate the common associated with appointment scheduling, such as long wait times, overburdened administrative staff, and miscommunications. It empowers patients to take control of their healthcare by providing a user-friendly platform that allows them to access information about doctors, their specialties, and real-time appointment availability. Real-time availability information availability information allows patients to select appointment times that best suit their schedules, minimizing wait times and optimizing the use of healthcare resources. The Doctor Appointment Booking System not only simplifies the appointment scheduling process but also enhances the patient experience and improves healthcare providers' efficiency. Thus, it makes healthcare more accessible, convenient, and effective. Report on the Health Survey and Development Committee, commonly called the Bhore Committee Report, 1946, is a landmark report for India, from which the current health policy and systems have evolved. 1 The recommendation for a three-tiered healthcare system to provide preventive and curative healthcare in rural and urban areas placing health workers on government payrolls and limiting the need for private practitioners became the principles on which the current public healthcare systems were founded. This was done to ensure that access to primary care is independent of individual socioeconomic conditions. However, the lack of capacity of public health systems to provide access to quality care resulted in a simultaneous evolution of the private healthcare systems with a constant and gradual expansion of private healthcare services

1.3. Identification of Tasks

The healthcare industry is always changing to meet the ever-increasing needs of patients and providers in our fast-paced, technologically-driven society. A key component of this development is the Doctor Appointment System, a cutting-edge and inventive solution made to make scheduling and managing doctor visits easier. With so many advantages for patients and healthcare providers, this system marks a major departure from traditional appointment scheduling techniques. The Physician Appointment System streamlines the process of scheduling visits with medical specialists by utilizing technology. It seeks to get rid of issues like lengthy wait times, overworked administrative staff, and misunderstandings that are frequently related to appointment scheduling. It gives patients a user-friendly platform to obtain information about doctors, their specializations, and the availability of appointments in real-time, empowering them to take charge of their healthcare.

1.4 Problem Statement

The current process of scheduling appointments in hospitals is plagued with inefficiencies, long waiting times, and miscommunication. Patients often encounter difficulties in securing timely appointments, while doctors and hospital staff struggle to manage their schedules effectively. Moreover, the lack of intelligent optimization leads to scheduling conflicts and resource underutilization, resulting in decreased operational efficiency. To address these challenges, there is a critical need for an AI-enabled hospital appointment booking system that streamlines the appointment management process, enhances patient experiences, and optimizes resource allocation. The system should provide a user-friendly interface for patients to schedule appointments seamlessly, enable doctors to manage their schedules efficiently and facilitate real-time updates for hospital staff. Additionally, the system should integrate AI components, such as natural language processing and machine learning algorithms, to intelligently schedule appointments, predict optimal booking periods, and improve overall efficiency. By tackling these issues, the proposed solution aims to revolutionize healthcare services and provide a streamlined and intelligent platform for hospital appointment management. [2]There are many inefficiencies, lengthy wait times, and misunderstandings in the present hospital appointment scheduling process. While doctors and medical personnel find it challenging to adequately manage their calendars, patients frequently struggle to secure timely appointments. In addition, insufficient intelligence in optimization causes scheduling conflicts and underuse of resources, which lowers operational efficiency. An AI-powered hospital appointment booking system that improves patient experiences, expedites appointment administration, and maximizes resource allocation is desperately needed to address these issues.

2. LITERATURE REVIEW/BACKGROUND STUDY

We are currently introducing an interface that allows patients and physicians to communicate. Its exceptional multi-node administration improves communication between medical experts and patients. The hospital's server nodes are freely accessible to patients. [1] In this context, patients can discuss their symptoms with physicians. Physicians may keep track of and record persons who are scattered regionally, as well as provide appropriate diagnoses. Creating a new system that would allow doctors to monitor and manage patient visits while customers could schedule them effortlessly online. In this example, patients book their appointments online based on the doctor's availability and their time limits. In contrast, the physicians' working hours may vary depending on the number of patients arriving during the day The adoption of artificial intelligence (AI) in healthcare has the potential to revolutionize appointment booking systems, enhancing efficiency, optimizing resource allocation, and improving patient experiences. This review explores a collection of papers that contribute to the theme of AI-enabled appointment booking systems in healthcare. These papers showcase innovative approaches, ranging from web applications to mobile applications and machine learning algorithms, aimed at streamlining the appointment management process. By critically analyzing and synthesizing the findings of these papers, we gain insights into the advancements and challenges associated with AI-enabled appointment booking systems.

Public health-care infrastructure in India :

India has a mixed healthcare system, inclusive of public and private healthcare service providers.6 However, most of the private healthcare providers are concentrated in urban India, providing secondary and tertiary care healthcare services. The public healthcare infrastructure in rural areas has been developed as a three-tier system based on the population norms described below.7 The urban health system is discussed in the article on Urban Newborn.

Primary health centers :

A primary health center (PHC) is established in a plain area with a population of 30,000 people and in hilly/difficult-to-reach/tribal areas with a population of 20,000 and is the first contact point between the village community and the medical officer. PHCs were envisaged to provide integrated curative and preventive health care to the rural population with an emphasis on the preventive and promotive aspects of health care. The PHCs are established and maintained by the State Governments under the Minimum Needs Program (MNP)/Basic Minimum Services (BMS) Program. As per minimum requirement, a PHC is to be staffed by a medical officer supported by 14 paramedical and other staff. Under NRHM, there is a provision for two additional staff nurses at PHCs on a contract basis. It acts as a referral unit for 5-6 SCs and has 4-6 beds for in-patients. The activities of PHCs involve healthcare promotion and curative services.

2.1 Frameworks used in the e-healthcare system:

In e-healthcare systems, various types of frameworks are utilized to facilitate different aspects of healthcare delivery, management, and communication. Some common types of frameworks used in e-healthcare systems include:

1. **Emerging frameworks:**

Briefly mentioning newer or evolving frameworks (e.g., artificial intelligence-powered tools) could add future-oriented insights.

2. **Cross-cutting frameworks:**

Discussing frameworks facilitating collaboration across different e-healthcare domains (e.g., public health, research) could broaden the perspective.

3. **Challenges and limitations:**

Acknowledging potential challenges associated with framework implementation (e.g., data privacy, integration complexity) could offer a more nuanced understanding.

4. **Telemedicine Platforms:**

These frameworks enable remote consultations between healthcare providers and patients, often leveraging video conferencing, messaging, and file-sharing capabilities. Examples include Meet the Doc, Doc, and eDoc.

5. **Electronic Health Record (EHR) Systems:**

EHR frameworks are designed to store, manage, and retrieve patient health records electronically. They often incorporate features for documentation, clinical workflows, and interoperability. Examples include Apollo Health.

6. **Health Information Exchange (HIE) Frameworks:**

HIE frameworks facilitate the sharing of patient health information among different healthcare providers and organizations. They ensure interoperability and data exchange standards adherence.

Examples include Health Level 7 (HL7) and Fast Healthcare Interoperability Resources (FHIR).

7. **Remote Monitoring and Wearable Technology Frameworks:**

These frameworks involve devices and platforms for tracking and monitoring patients' health remotely, often in real-time. They may include wearable devices, sensors, and mobile apps. Examples include Fitbit Health Solutions and Apple HealthKit.

8. **Decision Support Systems (DSS):**

DSS frameworks provide healthcare professionals with insights and recommendations based on clinical guidelines, patient data, and other relevant information. They assist in clinical decision-making processes. Examples include IBM Watson Health and Cerner.

9. Healthcare Analytics Frameworks: These frameworks involve tools and technologies for analyzing healthcare data to derive insights, improve processes, and support decision-making. They may encompass data warehousing, data mining, and predictive analytics capabilities. Examples include Tableau Healthcare and SAS Health Analytics.

10. Patient Engagement and Education Frameworks: These frameworks aim to involve patients in their healthcare journey, providing them with access to educational resources, appointment scheduling tools, and communication channels with healthcare providers. Examples include MyChart and Healthgrades.

2.2 Modules of Hospital Management System Developed by Solution Dots Systems:

1-Patient Management System: The hospital Management System developed by Solution Dots Systems provides complete assistance in patient management. In the module of the patient management system, there is a facility to register patients and view their reports and history. The patient management system allows for getting detailed information on a patient’s health condition.
2- Doctor Management System: The Doctor Management System allows registering the doctors, working in a hospital as well as their clinic details. It helps in the duty management of doctors and updates them to complete appointment details with a patient's health history.

3- Drugs Management System: Drugs Management System is another module of the hospital Management System developed by Solution Dots Systems and allows to addition of the list of drugs mostly used for treatment in that specific hospital. The drugs used in the treatment of some specific patients could also be enlisted here. The list of available drugs is also managed in this drug management system.

4- Administrative Rights Management System: The administrative Rights Management System includes all rights of management including HR and administration. This payroll system helps in updating the inventory record as well as all records of payroll management. This is a key element of administration management that manages all purchases and employee management.

5- Online Appointment Management System: Online Appointment Management System allows getting online appointments instead of physical visits. With the help of an online appointment management system patients, staff and doctors can check the status of appointments easily. This appointment management system allows one to get an appointment for registered patients and also sends updates to the customer through SMS or email.

6- Invoice System: After the appointment confirmation Invoice System generates an automatic invoice against that specific patient, this invoice helps to know about the current status of payment as well as complete payment.

7- Medical Services System: The Medical Services System allows adding a list of services that are provided by the hospital such as dental treatment service, cardiac services, mental treatment services, bone treatment services, and much more. The patient can view the list of services and

departments offered by the hospital along with all other details of treatment. It also manages the service timing, and emergency services according to the condition of the patient.

8- Doctor Services Report System: The Doctor Services Report System allows getting complete information and management about the services of doctors. In this report details of doctors such as their specialization field, their work efficiency, and their duty hours, and many other details and information could be managed by the management.

9- Lab Test System: Lab Test Systems carry complete details of the test services that are available in the hospital such as X-ray, CBC test, blood test, and other test services. It also manages the history of test details according to the registered patient name.

10. Electronic medical records (EMR): Electronic medical records (EMR) is a centrally stored database that provides hospital staff with access to patient information. They display medical records generated along the patient’s journey across various patient touchpoints in the hospital and are centrally stored in a digitized format that makes it accessible across all departments, thereby reducing the chance of error.

2.3 Existing solutions

[5]Patient appointment scheduling and management in the current doctor appointment system are done through manual procedures and face-to-face communication. When patients make appointments, they usually give the healthcare facility a call. Receptionists or administrative staff answer the phone, manually checking for open times and scheduling appointments. Patients typically receive paper appointment cards as reminders, and appointment details are frequently entered into books or records. In this approach, on the day of their appointments, patients must physically visit the medical facility, wait in waiting areas, and check in at the front desk. The traditional appointment system may find it difficult to scale as medical facilities or patient populations increase. Maintaining paper records can become unfeasible as human processes grow more laborious. Occasionally, traditional methods limit the ability to reschedule or cancel appointments. The inefficiencies of manual appointment scheduling and management in healthcare systems can lead to various challenges. Firstly, reliance on face-to-face communication and phone calls for appointment booking can result in long wait times for patients trying to schedule appointments, leading to frustration and dissatisfaction. Additionally, human errors in manually checking for open times and scheduling appointments can occur, potentially leading to double bookings or missed appointments. Moreover, the use of paper appointment cards and manual entry of appointment details into records can contribute to issues such as lost or misplaced appointments, making it difficult for both patients and healthcare providers to track and manage appointments effectively. This can result in missed appointments, which not only disrupts the workflow of the medical facility but also leads to wasted resources and lost revenue Furthermore, the traditional appointment system's reliance on physical visits to the medical facility for appointment check-in and verification can be inconvenient for patients, particularly those with mobility issues or busy schedules.

It can also contribute to overcrowding in waiting areas, leading to longer wait times and increased risk of exposure to infectious diseases, especially in times of public health crises like the COVID-19 pandemic In addition to these operational challenges, the scalability of the traditional appointment system is limited, particularly as medical facilities or patient populations grow. Managing a larger volume of appointments manually becomes increasingly burdensome and prone to errors, ultimately impacting the quality of patient care and satisfaction Overall, the limitations of existing appointment scheduling and management solutions highlight the need for more efficient and scalable digital solutions that streamline the booking process, reduce errors and enhance the overall patient experience. Implementing advanced technologies such as online appointment booking systems, electronic health records, and automated appointment reminders can help address these challenges and improve the efficiency and effectiveness of healthcare service delivery.

DISADVANTAGES OF THE EXISTINGSYSTEM:

Some typical drawbacks of these systems are as follows:

Restrictions on Availability: [6]

Patients who need to make appointments outside of regular business hours may find that traditional systems only permit scheduling during these hours.

Rearranging Appointments Can Be Difficult: [7] Patients may find it difficult to rearrange or cancel appointments using traditional systems withouthaving to pay a fee or make multiple phone calls

Time-consuming: [8]

Administrative workers may find it laborious and possibly erroneous when using the manual appointment scheduling system that was once in use. The distribution of resources might be difficult at times; institutions may overbook personnel and supplies for appointments that don't materialize.

Communication Breakdown: [12]

Using phone calls or other traditional means, most communication takes place face-to-face contacts, which may lead to extended wait times, missed calls, or breaks in communication.

Ineffective Record-Keeping: [13]

Bookkeeping: Traditional systems frequently use paper records, which are prone to loss, damage, and inaccuracy in appointment scheduling. Additionally, physical storage space is needed for paper records.

Privacy of Data:

If strong security measures are not implemented, there may be worries about the security and privacy of patient data in both traditional and digital systems.

2.4 Bibliometric analysis

The majority of outpatient scheduling studies focus on one clinical pathway with a single appointment either using rule-based heuristics and simulation, integer programming, metaheuristics, and simulation, or stochastic programming. For example, formulate a model to optimally assign patients to a single stochastic server by utilizing two-stage stochastic programming. Their model considers patient no-shows and aims to optimize an objective function that combines resource overtime, resource idle time, and patient waiting time. Similarly, [19] uses two-stage stochastic optimization to find the optimal arrival times of patients visiting a single server with random service durations. However, these research studies do not consider multiple appointments and various clinical pathways.

Most outpatient clinics treat patients with various requirements, and these patients go through different sequences of appointments during their visits. Thus, several studies consider multi-appointments to incorporate real-world constraints and complex patient flows and apply integer programming and heuristics to solve them For example, utilize the mixed integer programming approach and consider multiple appointments by allowing patients to go through a sequence of procedures, each of which necessitates deterministic clinical resources and service durations. Similarly, [23] uses mixed integer programming and formulate an online patient scheduling problem with multiple appointments at a pathology laboratory. However, these studies do not address random service durations and patient no-shows.

In most outpatient scheduling studies, appointment durations are assumed to be deterministic and known in advance. Since it is established that appointment durations are stochastic, several papers incorporate uncertain appointment durations using probability distributions in the simulation stage of their models. Although considering stochastic appointment durations in the optimization stage allows the random nature of the problem to be preemptively reflected in the solution, providing better and more robust results, few studies use stochastic appointment durations in the optimization stage The research conducted by [30] offers a methodology predicting an appointment duration using ML algorithms. However, this paper does not incorporate multi-step appointments and patient shows. Although the literature is rich in predicting patient no-shows and preventing them with various intervention techniques using ML very few studies use patient no-show probabilities in appointment scheduling. While it is common for many papers to assume that patients show up for their appointments, there is evidence that this assumption is mostly unwarranted. To address this gap in the literature, few studies consider no-shows and overbooking. For example, [11] research how capacity-related decisions should be made when taking patient no-shows into account. Their research focuses on outpatient scheduling with a single appointment, utilizes both deterministic and exponentially distributed service durations, and builds two models using queuing theory.

Based on this literature review, we observe that many outpatient scheduling papers assume clinical pathways with one appointment. Studies considering multiple appointments [25] assume that all patients follow the same pathway. Among the papers considering patient no-shows, few employ an overbooking strategy. Additionally, most of these studies use probability distribution functions to compute no-show probabilities, instead of using machine learning to estimate individualized patient no-show probabilities based on historical data. Similarly, studies that formulate the scheduling problem using stochastic appointment durations use a probability distribution and do not build machine learning models to compute individualized appointment durations based on factors, such as patients' medical history.

This research makes its primary contribution to the literature by considering multi-pathways with multi-appointments and concurrently incorporating no-shows, overbooking, and individual stochastic appointment durations when scheduling outpatient chemotherapy visits. To the best of our knowledge, this is the first study simultaneously addressing all these elements in outpatient scheduling, particularly in outpatient chemotherapy scheduling. Additionally, no-show probabilities and individual stochastic appointment durations are computed through a machine algorithm called artificial neural networks (ANN). Instead of employing homogenous probability distributions that limit applicability and generalizability, using patient characteristics to compute patient no-show probabilities and capture stochasticity in appointment durations via ANN is also a new contribution to the literature.

Gaps of Existing Systems:

s.no:	Approach	objectives	Gaps	AI & ML
1.	AI power digital medicine	Reduce repetitive tasks and burdens of electronic medical records through the utilization of AI and ML.	Lack of emphasis on interoperability and data sharing standards across healthcare systems.	Deep convoluted neural network for skin cancer detection and reducing visit length. Deep neural network to evaluate images for diabetic retinopathy. Smartphone-based AI platform to measure adherence in patients on direct oral anticoagulants.
2.	ML in medicine	Examining the essential structural changes in the healthcare system that are necessary to unleash the full potential of machine learning in medicine.	Insufficient discussion on the long-term sustainability and scalability of AI/ML implementations.	We applied deep learning to the current EHR data to generate associations and meaningful data for personalized diagnosis and treatment.
3.	AI, ML, and the evolution of healthcare (34)	Examining AI integration in healthcare.	Limited consideration of bias mitigation strategies in AI algorithms for equitable healthcare delivery.	SVM model development for physiological data segmentation and analysis, disease progression prediction, and diagnosis.
4.	Role of AI in precision medicine (36)	Examining the role of AI in precision medicine implementation.	Inadequate exploration of patient-centered care approaches in AI/ML applications.	Combining DL with human pathologists to improve the success rate of diagnosis.
5.	AI in healthcare (39)	Analyzing AI applications in healthcare, and their potential outcome in the future.	Absence of systematic evaluation and validation methods for AI/ML solutions in healthcare.	ML algorithms to extract and cluster data, and perform principal component analysis, SVM to determine model parameters, and identify imaging biomarkers, NLP

				for text processing and classification, and DL for diagnostic imaging and electro-diagnosis.
6.	Data science, AI, and ML for laboratory medicine (41)	Predictive modeling for better collaboration between hospitals without sharing data and complying with privacy regulations.	Overlook of regulatory and legal frameworks governing AI/ML usein healthcare.	ML for healthcare data analysis and optimization, and reducing cost, improving efficiency of staff and resources.
7.	Use of EHR in comparative effectiveness research (46)	Reporting caveats in existing healthcare systems.	Sparse attention to resource allocation and cost-effectiveness in AI/ML implementations.	Implementing ML for overcoming existing big data limitations in healthcare systems.
8.	Deep learning health care system (47)	They are reporting unintended consequences due to the application of ML in existing healthcare systems.	Need for comprehensive education and training programs for healthcare professionals on AI/ML integration.	ML for prognosis modeling in oncology, and pattern recognition in radiology and pathology.
9.	DL to transform healthcare (48)	Transform healthcare by using ML.	Minimal discussion on ethical considerations and patient consent in AI-driven healthcare.	Implementation of DL forthe digital image analysis.
10.	AI, Big Data, and Cancer (45)	Application of AI and large-scale database for cancer diagnosis and treatment, worldwide.	Lack of integration between different AI/ML approaches for a comprehensive healthcare solution.	Cognitive computer systems provide rapid access to accurate information and treatment procedures and assist in decision-making.
11.	AI to solve the human resource crisis in healthcare (42)	Solve the human resource crisis in healthcare with AI.	Lack of integration between AI/ML approaches hampers a comprehensive healthcare solution, delineating specificAI types for distincttasks.	Artificial narrow intelligence for performing a single task. Artificial general intelligence for understanding and reasoning environment like humans. Artificial superintelligence forscientific creativity. Deep learning for imagerecognition, natural language processing, and translation.

12.	Data Analytics and ML for disease identification in EHR (44)	Analyzing EHR for the identification of a wide range of medical conditions and diagnoses.	The absence of structured risk predictors from EHR data analysis impedes disease identification, calling for ML algorithms for both structured and unstructured data.	ML algorithm for structured and unstructured big data analysis for the identification of a wide range of medical conditions and diagnoses.
13.	Ethical challenges of implementing ML in healthcare (58)	Challenges of implementing ML in healthcare	Ethical challenges of ML implementation in healthcare necessitate addressing current system challenges through literature review and field analysis.	Addressing current challenges in healthcare systems due to the implementation of ML.
14.	Data science, AI, and ML for laboratory medicine (59)	Implementing Data science, AI, and ML for laboratory medicine.	Data science, AI, and ML in laboratory medicine require a defined framework for tasks	ML for finding patterns, discovering inefficiencies, predicting outcomes, and making factual decisions.
15.	Causal inference and ML (60)	Examined the implications of progress in observational research design and healthcare databases.	Causal inference and ML necessitate ML application in (RWE) for data classification and clinical decision support.	ML for data classification and prediction in RWE to support clinical and regulatory decision-making.
16.	Big data analytics in healthcare (61)	Application of big data analytics in healthcare.	Efficient data mining and analysis in healthcare depend on ML applications within the conceptual architecture of big data analytics.	ML for data mining and analysis.
17.	ML and genomics in precision medicine (62)	Substantial improvements to address clinical and genomic data security problems.	Overcoming data security issues and addressing gene variation challenges require ML models in ML and genomics for precision medicine.	ML models to address the challenges of gene variations and similarities among patients.

2.5 Review Summary

The adoption of artificial intelligence (AI) in healthcare has the potential to revolutionize appointment booking systems, enhancing efficiency, optimizing resource allocation, and improving patient experiences. This review explores a collection of papers that contribute to the theme of AI-enabled appointment booking systems in healthcare. These papers showcase innovative approaches, ranging from web applications to mobile applications and machine learning algorithms, aimed at streamlining the appointment management process. By critically analyzing and synthesizing the findings of these papers, we gain insights into the advancements and challenges associated with AI-enabled appointment booking systems.

[1] M. A. Noori, S. A. S. Hussien, and T. A. Al-Janabi present a paper on "Blood donors appointment booking and managing system using PC and mobile web browsers in current pandemic (COVID-19)" [1]. The authors propose a system that leverages web browsers to facilitate blood donor appointment booking. The study addresses the challenges posed by the COVID-19 pandemic and provides a solution to manage blood donations efficiently.

[2] S. V Patil, S. B. Patil, O. A. Terdalkar, and B. S. Yelure contribute a paper titled "Smart Web Application for Efficient Management of Hospital Appointments" [2]. Their research focuses on developing a smart web application that optimizes hospital appointment management. The authors emphasize the importance of an efficient scheduling system to minimize waiting times and improve patient satisfaction.

[3] F. Mohd and N. I. Elanie Mustafah present the paper "'Hello, Dr': A Healthcare Mobile Application" [3]. The authors propose a healthcare mobile application that facilitates appointment booking and communication between patients and doctors. The study highlights the potential of mobile applications in enhancing healthcare services and improving patient-doctor interactions.

[4] I. B. Aishwarya, D. Unni, V. S. Rakesh, and S. Swapna Kumar contribute to the field with their paper titled "Smart token booking system for hospitals" [4]. Their research focuses on developing a smart token booking system that streamlines the appointment process in hospitals. The authors emphasize the importance of a user-friendly interface and efficient token management to improve the overall patient experience.

[5] P. R. Cronin and A. B. Kimball present a paper titled "Success of automated algorithmic scheduling in an outpatient setting" [5]. The authors investigate the success of automated algorithmic scheduling in an outpatient healthcare setting. Their study demonstrates the effectiveness of automated scheduling algorithms in reducing patient waiting times and improving resource utilization.

[6] A. Yelne and A. Raut contribute to the field with their paper "Digital Health-Care System for Smart IPD Booking" [6]. The authors propose a digital healthcare system that enables smart in-

patient department (IPD) booking. Their study emphasizes the importance of digitization in improving the IPD booking process and enhancing hospital operations.

F. Piccialli, S. Cuomo, D. Crisci, E. Prezioso, and G. Mei present a paper titled "A deep learning approach for facility patient attendance prediction based on medical booking data" [7]. The authors explore a deep-learning approach to predict patient attendance at healthcare facilities based on booking data. Their study highlights the potential of machine learning algorithms in forecasting patient attendance, allowing for better resource planning and allocation.
The paper by Odeh et al. [8] presents a smart software system for medical patient appointment management in the UAE. The study highlights the use of AI algorithms to optimize appointment scheduling, reduce waiting times, and enhance patient experiences. The authors demonstrate the effectiveness of their system in improving appointment management processes, leading to enhanced operational efficiency in healthcare settings.

Zea and Gutierrez [9] discuss the development of a mobile platform for managing hospital appointments using Bluetooth Low Energy (BLE) technology with external devices known as Beacons. The paper showcases the utilization of AI techniques to improve appointment scheduling accuracy and enable real-time updates. The integration of BLE technology enhances the system's efficiency by enabling seamless communication between patients and healthcare providers.
In the work by Sujatha et al. [10], the authors explore the concept of smart healthcare development and emphasize the role of AI in transforming healthcare systems. The paper highlights the potential of AI-enabled appointment booking systems to optimize resource allocation, improve patient access to healthcare services, and facilitate sustainable smart city development. The authors provide insights into the benefits and challenges of implementing such systems, laying the foundation for future advancements.

Lupton [12] offers critical perspectives on digital health technologies, including AI-enabled systems. The paper examines the ethical implications, privacy concerns, and potential social impacts associated with the adoption of these technologies in healthcare. It raises important questions regarding the fairness, transparency, and accountability of AI algorithms used in appointment booking systems, emphasizing the need for responsible implementation and regulatory frameworks.
Evangelista et al. [13] investigate the satisfaction and appointment access of patients in pediatric nurse practitioner-managed cardiology clinics. While not directly focused on AI-enabled systems, the study sheds light on the importance of efficient appointment scheduling in improving patient experiences. The findings highlight the significance of streamlined appointment booking processes in enhancing patient satisfaction and accessibility to specialized care.

Kevat et al. [14] present an online referral and immediate appointment selection system that empowers families and improves access to public community pediatric clinics. Although not explicitly AI-enabled, the study demonstrates the potential benefits of leveraging technology to enhance appointment management. The system streamlines the referral process, reduces waiting times, and provides patients with greater control over their healthcare journey.

Goals/Objectives:

Develop an automated appointment scheduling system that significantly reduces wait times, minimizes human errors, and eliminates data redundancy in healthcare facilities. Implement AI algorithms to optimize scheduling processes, ensuring efficient allocation of resources and enhancing the overall operational efficiency of medical personnel. Integrate blockchain technology to establish secure and transparent data management, safeguarding patient privacy and ensuring regulatory compliance throughout the healthcare system. Incorporate wireless body sensor networks (WBSN) for continuous monitoring of patient's physiological parameters, enabling timely intervention and personalized healthcare delivery. Design intuitive user interfaces that facilitate seamless interaction with the scheduling system, prioritizing patient satisfaction, accessibility, and ease of use. Ensure the scalability and interoperability of the proposed solution to accommodate the diverse needs of healthcare facilities, regardless of their size or complexity.

Validate the effectiveness of the implemented solution through measurable metrics, including reduced wait times, improved resource utilization, enhanced patient outcomes, and increased operational efficiency. The proposed solution seeks to prioritize patient satisfaction, operational efficiency, data privacy, and regulatory compliance. By introducing intuitive interfaces and leveraging advanced technologies, such as AI and blockchain, the solution aims to create a seamless and secure environment for scheduling appointments, managing healthcare data, and facilitating continuous monitoring of patient's health status. Ultimately, the goal is to transform healthcare delivery and management by providing a comprehensive solution that addresses the inefficiencies inherent in traditional scheduling practices and leverages cutting-edge technologies to improve patient outcomes and quality of care.

To address these challenges, there is a critical need for a comprehensive solution that introduces automated scheduling processes, leverages AI algorithms for optimization, implements blockchain for secure data management and integrates WBSN for continuous monitoring of patients' physiological parameters. This solution aims to revolutionize appointment scheduling practices, optimize resource allocation, and improve overall operational efficiency in medical facilities. By adopting a holistic approach that combines technological advancements with streamlined processes, healthcare systems can enhance patient experiences, reduce wait times, and ensure the efficient utilization of resources.

TIMELINE REPORT:

PHASE	JAN	FEB	MAR	APR
PHASE 1	✓			
PHASE 2		✓		
PHASE 3			✓	
PHASE 4				✓

3. DESIGN FLOW/PROCESS

3.1. Design Constraints

A proposed doctor appointment system represents an advanced and user-friendly solution designed to address the limitations of traditional appointment systems and enhance the patient and healthcare provider experience. The purpose of the project is to build an application program to reduce the manual work for managing Doctors, Appointments and Patients. This modern system leverages the power of digital technology to offer online appointment scheduling, enabling patients to book appointments 24/7, thus enhancing convenience and reducing the need for time-consuming phone calls. Patient portals are integrated, allowing individuals to access a secure online platform for managing appointments. Resource optimization and advanced scheduling algorithms ensure efficient use of resources, reducing wait times and improving the productivity of healthcare professionals. It not only reduces administrative costs but also significantly improves the patient experience by offering user-friendly interfaces, self-service capabilities, proactive patient experience.

ADVANTAGES OF PROPOSED SYSTEM:

Efficient Appointment Management: The system streamlines the process of appointment scheduling, making it efficient for both administrators and patients. This efficiency reduces administrative workload

Improved Patient Experience: Patients benefit from the convenience of making appointments online and viewing their booking history. They can create accounts, book appointments, and manage their schedules with ease. **Enhanced Doctor Productivity:** Doctors can view their appointments, scheduled sessions, and patient details, allowing them to better manage their time and provide more focused care.

Reduced Waiting Times: Real-time availability and AI-driven scheduling can significantly reduce waiting times for patients, making the scheduling process more patient-centric

Global Accessibility: The system can be adapted and expanded for use in various healthcare systems worldwide, improving access to care and addressing healthcare disparities.

Security and Privacy: Implementing strong security measures is crucial, ensuring that patient information is protected and in compliance with data privacy regulations.

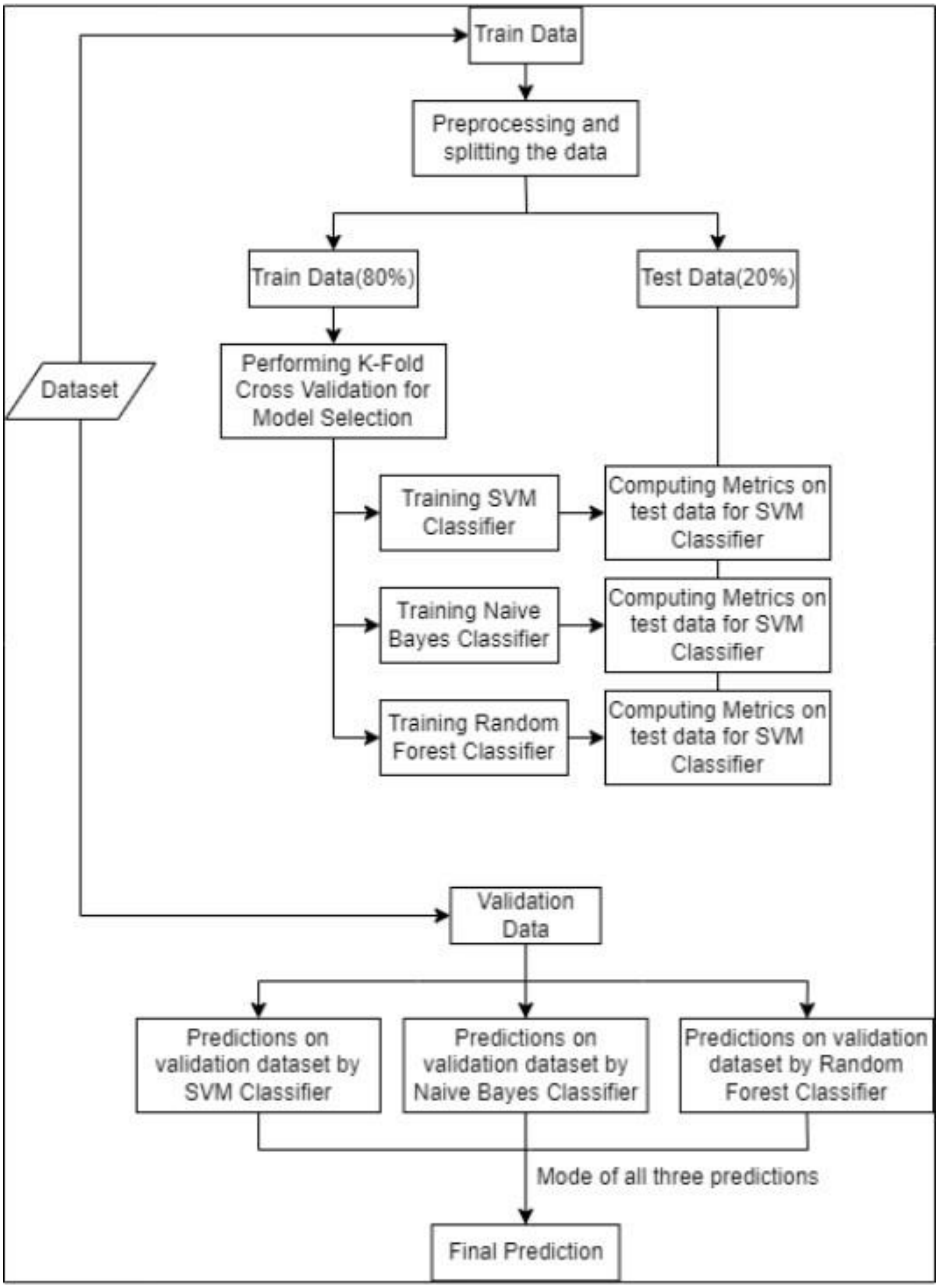

Fig1. Workflow of the implementation

3.2. Implementation plan/methodology

- ADMIN MODULE
- DOCTOR MODULE
- PATIENT MODULE

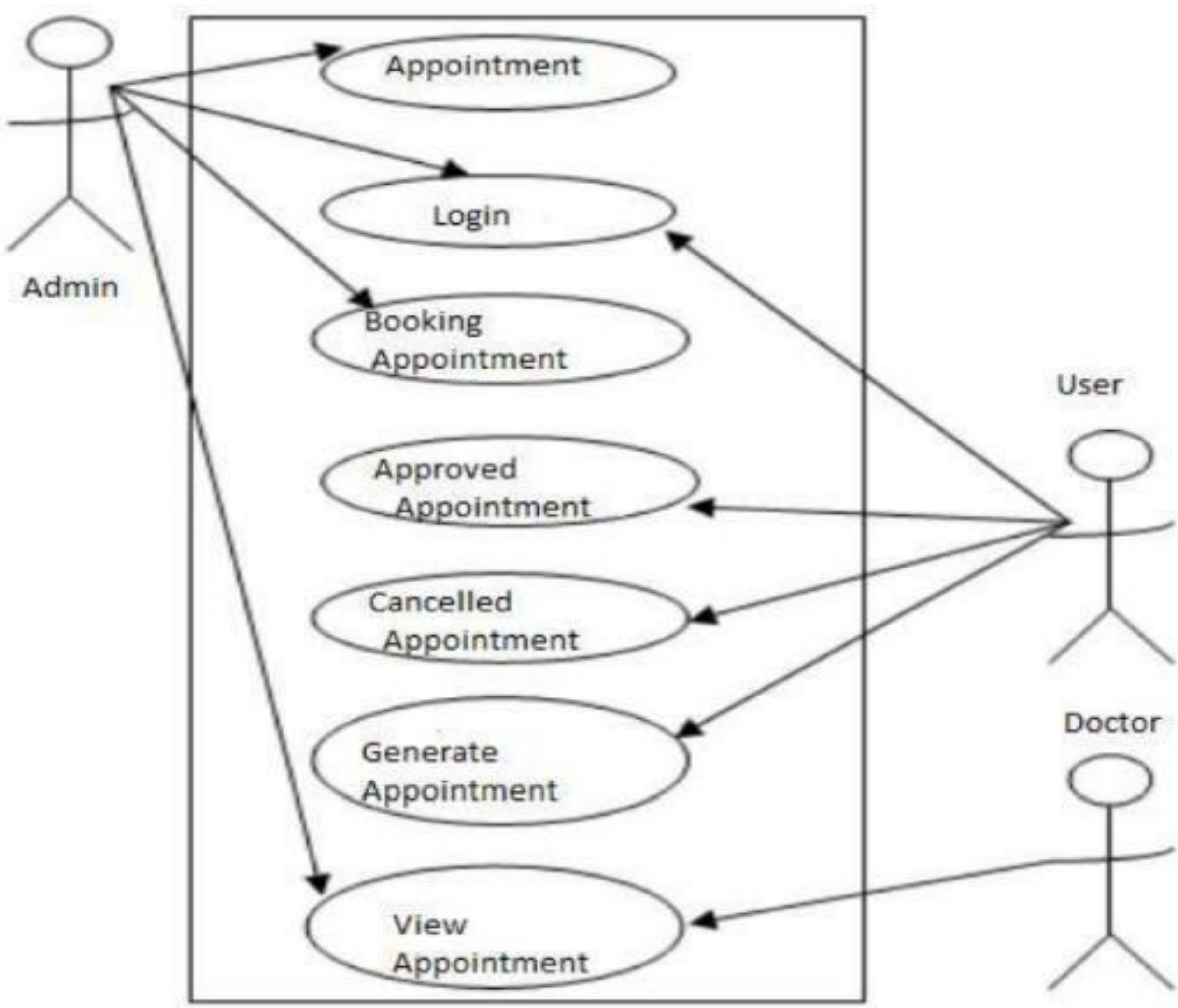

Fig 2. Flow chart of the interface

1. ADMIN MODULE:

Admin can log in with email and password, through the login page. Admin is the super user of the website who can manage everything on the website.

Administrative Workflow:

1. Manage Doctors:

Admin logs in to the system.

Admin selects the "Manage Doctors" option.

Admin can add new doctors by entering their details (name, specialty, contact information) and creating a profile.

Admin can edit existing doctor profiles, making changes to their information if needed.

Admin can delete doctor accounts if they are no longer part of the healthcare facility.

2. Manage Sessions:

Admin selects the "Manage Sessions" option.

Admin schedules new sessions for doctors by specifying the date, time, and location.

Admin can remove scheduled sessions if they need to be canceled or rescheduled.

3. View Patients' Details:

Admin can access patient records and view their details, including personal information and appointment history.

4. View Bookings:

Admin can view the booking records of all patients, allowing them to monitor and manage the appointment schedule effectively.

2. **DOCTOR MODULE**:

The doctor can log in with email and password. This module allows doctors to manage their profiles, appointments, and patient records, and provide medical services.

Doctor Workflow:

1. View Appointments:

- Doctor logs in to the system.
- Doctors can view a list of their upcoming appointments, including patient details and appointment times.

2. Scheduled Sessions:

- Doctors can access their scheduled sessions, ensuring they are aware of their upcoming appointments and availability.

3. View Patient Details:

- Doctors can access patient records to review their medical history, enabling more personalized care.

4. Edit Account Settings:

- Doctors can modify their account settings, including contact information and preferences, to keep their profiles up to date.

3. PATIENT MODULE:

Enables patients to create profiles, book appointments, access appointment history, and interact with healthcare providers.

Patient Workflow:

1. Browse Doctor Availability:

Patients log in to the system or create an account.

They can browse the profiles of available doctors and their respective schedules, displayed as open time slots.

2. Select a Doctor and Time Slot:

Patients select a doctor they wish to see and choose an available time slot from the doctor's schedule.

3. Confirm Appointment:

Patients confirm the appointment booking, providing any necessary information or specifying the reason for the visit.

4. View their old booking:

Patients can access their booking history, displaying past and upcoming appointments, for their reference.

3.3 SYSTEM SPECIFICATIONS

Software requirements

This section gives the details of the software that are used for the development.

- Operating System: Windows 10 /Linux
- Web Browser: Google Chrome
- Coding Language: PHP
- Database: MySQL

3.4 SOFTWARE DESCRIPTION

3.4.1 PHP

PHP is a general-purpose scripting language geared towards web development. It is an open-source environment that it is readily available and free. PHP is perfectly suited for Web development and can be embedded directly into the HTML code. On a web server, the result of the interpreted and executed PHP code which may be any type of data, such as generated HTML or binary image data would form the whole or part of an HTTP response. The PHP syntax is like Pearl and C. Its ability to interact with databases, including popular choices like MySQL, allows for the storage and retrieval of data, making it a go-to solution for content management systems, e-commerce platforms, and a wide array of web-based services.

3.4.2 MYSQL

A database is a structured collection of data. It may be anything from a simple shopping list to a picture gallery or the vast amount of information in a corporation network. MySQL is an open-source relational database management system (RDBMS) that is widely used for storing and managing structured data. It is a critical component in the development of dynamic web applications, content management systems, e-commerce platforms, and many other software systems. MySQL's relational database structure facilitates efficient data storage, retrieval, and manipulation, employing the universally recognized Structured Query Language (SQL).

3.4.3 VS CODE

Visual Studio Code (VS Code) is a free, open-source code editor developed by Microsoft. It is widely used by developers and software engineers for writing, testing, and debugging code across multiple programming languages and platforms.VS Code is a lightweight yet powerful tool that provides a user-friendly interface and a wide range of features, including code highlighting, autocompletion, debugging tools, version control integration, and more. It is highly customizable through extensions and themes, allowing developers to tailor the environment to their specific needs. One of the main advantages of VS Code is its cross-platform compatibility, as it can be used on Windows, macOS, and Linux. It also offers seamless integration with other Microsoft products, such as Azure cloud services and GitHub.

3.4.4 HTML

HTML stands for Hypertext Markup Language, and it is the standard markup language used for creating and structuring content on the World Wide Web. HTML is the backbone of every web page, and it provides the basic structure and semantics of a web page. Structure and Semantics: HTML provides a clear structure for web pages, making it easy to organize content into headings, paragraphs, lists, and other elements. It also provides semantic tags to describe the meaning and purpose of the content, which is important for accessibility and SEO. Cross-Platform Compatibility: HTML is platform-independent and can be viewed on any device with a web browser. This makes it easy to create web pages that are accessible to a wide audience. Ease of use: HTML is easy to learn and use, especially for beginners. It has a straightforward syntax that uses tags to define elements, and there are many resources available online for learning HTML.

3.4.5 CSS

CSS (Cascading Style Sheets) is a language used for styling web pages and making them visually appealing. Here are some of the key features of CSS: Separation of Content and Presentation: CSS separates the content of a web page from its presentation, making it easy to update the design of a website without affecting its content. This separation also allows developers to create consistent styles across multiple web pages. Selectors and Cascading: CSS uses selectors to target specific HTML elements and apply styles to them. Styles can be defined in multiple locations, and they cascade down to child elements, making it easy to create complex and dynamic styles. Layout Control: CSS provides a range of layout options, such as positioning, floats, and flexbox, that allow developers to control the layout and arrangement of elements on a web page. Responsive Design: CSS offers media queries and other responsive design techniques that allow developers to create web pages that adjust to different screen sizes and devices. Typography Control: CSS provides precise control over typography, allowing developers to customize the font family, size, color, spacing, and other aspects of text.

3.5. Methodology and Implementation: [11]

The main components of the suggested system are a database, a machine learning component, a mobile application, a web application, a mobile app server, and a mobile application. The database, application logic, and user interface layers comprise the three-tier architecture used to build the system. The layered method facilitates decoupling, which has several advantages such as easier future implementation upgrades and changes, more understandable code, and enhanced flexibility.

3.5.1 Analysis of Requirments:

We discovered important needs from these exchanges, including easy appointment scheduling, instant access to physicians and services, preventing scheduling conflicts, effective resource management, and customized user experiences. We established thesystem's scope, describing the attributes and capabilities that would address the identified needs, based on the data we had collected and the analysis we had done. Along with lowering waiting times, increasing operational efficiency, and optimizing resource allocation, we set important goals for the implementation. To identify the specific requirements and functionalities of the AI-enabled hospital appointment booking system, we conducted a thorough analysis of the existing appointment booking processes and systems in healthcare settings. Through these interactions, we identified key requirements such as a seamless appointment booking process, real-time availability of doctors and services, avoidance of scheduling conflicts, efficient resource allocation, and personalized user experiences. Based on the gathered information and analysis, we defined the scope of the system, outlining the features and functionalities that would address the identified requirements. We established key objectives for the implementation, including enhancing patient satisfaction, improving operational efficiency, reducing waiting times, and optimizing resource allocation. The scope and objectives were documented and shared with the stakeholders to ensure alignment and obtain their agreement and feedback. Regular communication and collaboration with the stakeholders throughout the process helped refine and validate the requirements and ensure that the system would meet their needs and expectations.

3.6 User Interface Design:

3.6.1 Designing the User Interface:

We created the user interface using HTML and CSS, carefully designing each element to achieve a clean and visually appealing layout. The interface was structured in a logical manner, making it intuitive for users to navigate and interact with the system. Attention was given to the arrangement of elements, typography, color schemes, and visual hierarchy to ensure a cohesive and professional appearance. Consistent branding elements were incorporated to maintain the hospital's identity and provide a sense of familiarity to users.

3.6.2 Implementing Responsive Design:

We followed responsive design principles to ensure that the user interface is compatible and adaptable across various devices and screen sizes. CSS media queries were utilized to define different styles and layouts based on the screen size and orientation. The interface dynamically adjusted its appearance and behavior to provide an optimal viewing and user experience on desktops, tablets, and smartphones. Elements were resized, rearranged, or hidden as necessary to ensure readability and usability on different devices.

3.6.3 Focus on Usability and Accessibility:

We prioritized usability and accessibility in the design process, considering the diverse needs of users, including patients and healthcare professionals. Clear and concise labels were used for form fields and buttons, making it easy for users to understand their purpose and provide the required information. The interface followed accessibility standards, such as providing alternative text for images and using semantic HTML markup for improved screen reader compatibility. Contrast ratios between text and background were optimized to enhance readability and font sizes were set to be legible for users with visual impairments. Consistent navigation patterns and visual cues were employed to guide users through the interface and provide a seamless experience.

3.6.4 Technology Selection:

To choose appropriate technologies for different components of the system, we conducted a thorough evaluation of various programming languages, frameworks, and tools available. We considered factors such as compatibility, performance, community support, and scalability. After careful consideration, we selected PHP as the programming language for server-side development. PHP is widely used in web development and has robust support for database connectivity, making it suitable for handling the backend operations of the appointment booking system. For storing and retrieving appointment data, we opted to utilize MySQL as the database management system. MySQL is a reliable and popular choice, known for its performance, scalability, and ease of integration with PHP. To ensure a visually appealing and user-friendly interface, we employed HTML5 and CSS to design the user interface. HTML5 provides advanced features for structuring web content, while CSS allows us to style and customize the appearance of the system, creating an engaging user experience. JavaScript was used to enhance interactivity and user experience. By leveraging JavaScript, we were able to implement a multi-step booking modal, guiding users through the appointment scheduling process and making it more intuitive and seamless. To facilitate seamless communication between the front-end and back-end components, we incorporated jQuery Ajax. Ajax enables asynchronous communication, allowing data to be sent and received without requiring a page reload. This enhances the user experience by providing real-time updates and improving system responsiveness. Python was chosen as the language for developing the machine learning model. Python offers a rich ecosystem of libraries and frameworks for machine learning, making it ideal for training and deploying the model. Python allowed us to leverage data from the AI&IoT health app and develop a model that predicts the optimum booking period based on user preferences and historical data, enhancing the system's intelligence and efficiency.

3.6.5 Adding Interactivity with JavaScript:

JavaScript was utilized to enhance interactivity and improve the user experience by adding dynamic elements and functionalities. A multi-step booking modal was implemented using JavaScript, guiding users through the appointment scheduling process in a step-by-step manner.
User inputs and selections were validated in real time, providing immediate feedback and preventing errors during the booking process. Autocomplete and suggestion features were implemented to assist users in selecting doctors, services, and appointment dates/times, improving efficiency and accuracy. The interactivity added a sense of responsiveness to the system, making it more engaging and user-friendly.

3.6.6 Back-End Development:

To implement server-side functionalities, we utilized PHP, a popular server-side scripting language known for its versatility and robustness. PHP allowed us to handle data processing and business logic effectively, ensuring seamless execution of appointment booking operations.
Using PHP, we established a connection to a MySQL database to store and retrieve appointment data. PHP's integration capabilities with MySQL enabled us to efficiently manage and manipulate appointment information, such as patient details, doctor availability, and scheduling preferences.
To avoid booking clashes, we implemented logic within the PHP code. By analyzing the existing appointments and checking for conflicts, we ensured that no overlapping or conflicting appointments were scheduled. This logic considered factors such as appointment duration, doctor availability, and room availability to optimize the booking process and prevent double bookings.

Employing PHP, we integrated the machine learning model developed in Python into the system. PHP acted as the bridge between the front end and the Python-based machine-learning component. It facilitated the passing of user preferences and historical data to the machine learning model, enabling accurate predictions for the optimal appointment period. This integration allowed for personalized appointment recommendations based on individual user preferences and historical patterns.

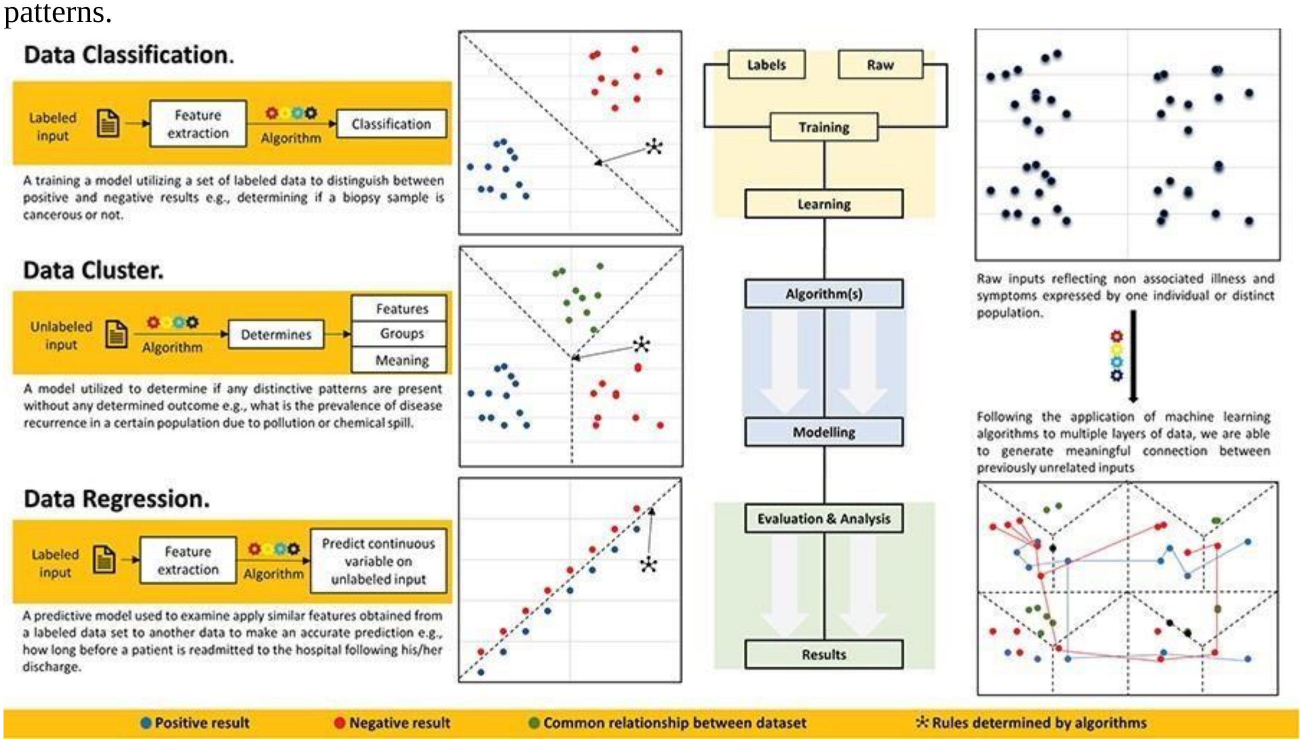

Fig 3. Data preprocessing and transformation

3.7 Machine Learning Model Development

We succeeded in exporting the model to JSON and after that then Included it in the web application that was created using JavaScript, HTML, and CSS. Using JavaScript, the exported model was loaded to provide predictions depending on user input. The webpage's recommendations from the machine learning model allowed users to book their appointments at the most convenient time of day.

The FJS library, Google Co-lab, and TensorFlow were used to integrate machine learning into the web application, enabling real-time forecasts and enhancing the hospital appointment booking system's operation with AI. Giving them the power to choose wisely when it came to booking appointments, enhanced patient satisfaction and raised the facility's general effectiveness.

- **K-Nearest Neighbour (KNN):**

For applications involving regression and classification, KNN is an easy-to-understand method. A simple and easy-to-understand approach for both regression and classification applications is K-Nearest Neighbors (KNN). In classification settings, KNN looks at the 'k' closest data points—that is, neighbors—from the training set whenever a new data point is introduced. From these 'k' neighbors, it then allocates the most common class label to the new data point. The choice of 'k' is an essential hyperparameter that must be made in advance. KNN works best with datasets that have clearly defined clusters or with relatively straightforward decision boundaries.

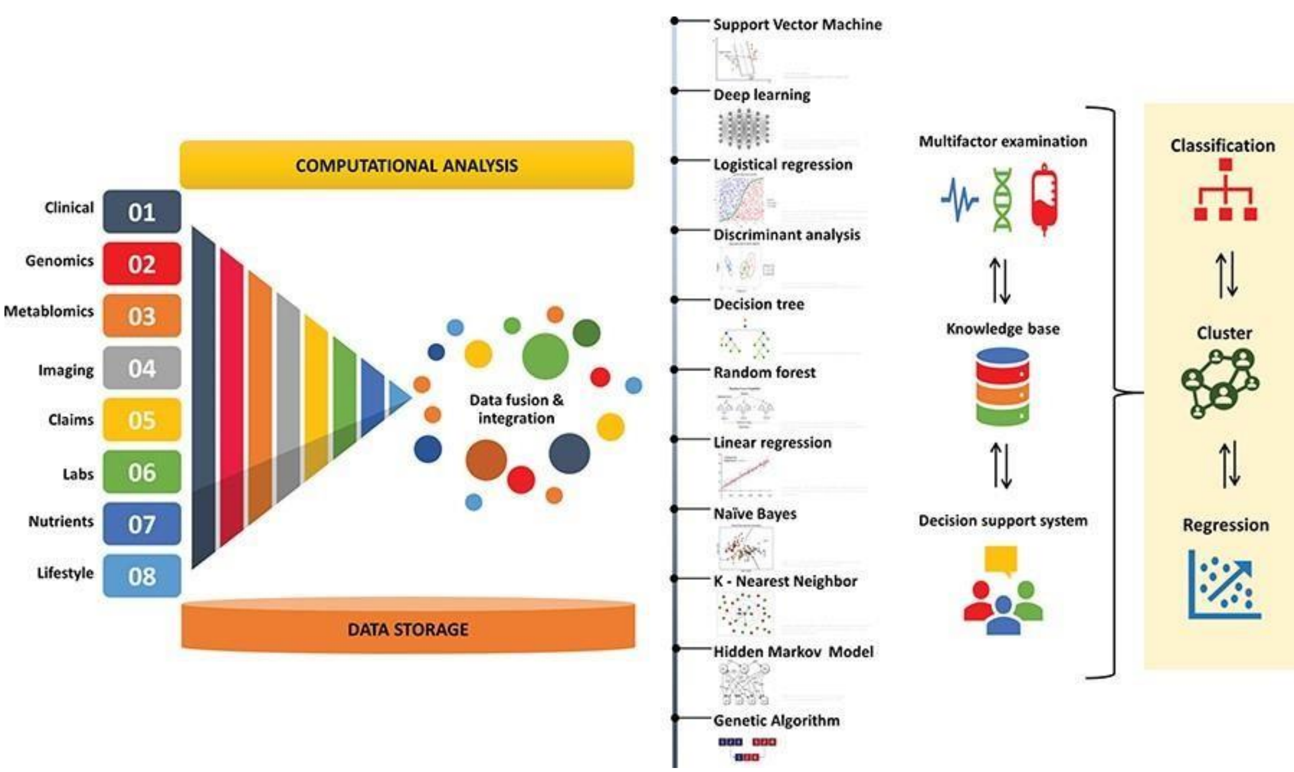

Fig 4 . Machine Learning models to classify and predict the data

- **Decision Trees:**

Decision trees are adaptable supervised learning algorithms that work well for both regression and classification problems. Although they can also be used to address regression issues, decision trees are a supervised learning technique that is most frequently employed to address classification issues. It is a tree-structured classifier, with each leaf node representing the results and inside nodes representing the dataset's features. The decision rules are represented by the branches.

- **Support Vector Machines (SVM):**

Support Vector Machines (SVM) may handle both linearly and non-linearly separable datasets by utilizing different kernel functions, such as radial basis function, polynomial kernel, or linear kernel. Because support vector machines (SVM) are popular and effective in high-dimensional spaces and tasks where the number of features exceeds the number of samples, they are often chosen for applications such as text classification, picture classification, and bioinformatics. Based on the evaluation results, we fine-tuned the machine learning model by adjusting its parameters, selecting different algorithms, or employing ensemble techniques. This iterative process aimed to improve the model's accuracy and performance, ensuring that it provides reliable predictions for the optimum appointment booking periods.
In the Machine Learning part of the project, TensorFlow, a popular deep learning framework, was utilized for training the machine learning model. The training process took place in Google Colab, a cloud-based platform that provides a GPU-accelerated environment for efficient model training. TensorFlow's extensive set of tools and libraries enabled us to develop and train a robust machine-learning model.

Once the model was trained and optimized, it was exported using the tfjs library. The tfjs library, short for TensorFlow.js, is a JavaScript library that allows trained TensorFlow models to be used directly in web browsers. This conversion process involved exporting the model from its native pickle format to a JSON format that could be easily interpreted by JavaScript. By exporting the model to JSON, we were able to integrate it into the web application developed using HTML, CSS, and JavaScript. JavaScript was employed to load the exported model and make predictions based on user input. The predictions made by the machine learning model were then displayed on the web page, providing users with the optimal period of the day to book their appointments.
This integration of machine learning into the web application through the use of TensorFlow, Google Colab, and the tfjs library allowed for real-time predictions and enhanced the functionality of the AI-enabled hospital appointment booking system. It empowered users to make informed decisions about appointment scheduling, optimizing their experience, and improving the overall efficiency of the healthcare facility.

3.8 System Integration and Testing:

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To verify the system's accuracy, performance, and usability, user acceptability testing, or UAT, was done During the testing process, we included stakeholders such as physicians, hospital administrators, and patients. Input from stakeholders was gathered, and test scenarios were created to mimic real-world usage. overall satisfaction, responsiveness, simplicity of use, and user interface of the system. They were quite helpful in pointing out any usability problems, performance snags, or differences in the functionality of the system as expected and as it was. The appropriate changes were made in light of the testing findings and input. The input from stakeholders and the results of the testing were thoroughly examined. Identifying the most important and high-impact solutions first, classifying the concerns, and creating a priority list produced. Implementing improvements, issue fixes, and optimizations was made easier by insightful input. To integrate the front-end and back-end components, we followed a modular approach, ensuring that the components could communicate seamlessly. We established APIs and endpoints for data exchange between the front-end (HTML, CSS, JavaScript) and back-end (PHP) components. We conducted rigorous testing to verify the integration, ensuring that data flows correctly and functionalities are synchronized. Any issues or conflicts were resolved by debugging and refining the integration code.

Thorough testing of the system was performed to identify and rectify any bugs or issues. We conducted unit testing, integration testing, and system testing to ensure the stability, reliability, and functionality of the entire system. Test cases were designed to cover different scenarios, edge cases, and user interactions. Bugs and issues were logged, prioritized, and fixed iteratively. This iterative testing process allowed us to enhance the quality of the system and ensure a smooth user experience. User acceptance testing (UAT) was conducted to validate the system's usability, performance, and accuracy. We involved stakeholders, including hospital administrators, doctors, and patients, in the testing process. Test scenarios were designed to simulate real-world usage, and stakeholders provided feedback on the system's user interface, ease of use, responsiveness, and overall satisfaction. Their input was crucial in identifying any usability issues, performance bottlenecks, or discrepancies between expected and actual system behavior.

Based on the feedback and testing results, necessary improvements were implemented. We carefully analyzed the feedback received from stakeholders and the findings from testing. Identified issues were categorized, and a priority list was created to address critical and high-impact improvements first. The feedback was valuable in guiding the implementation of enhancements, bug fixes, and optimizations. Regular updates and iterations were made to ensure that the system met the expectations and requirements of the stakeholders and provided a seamless user experience.

3.9 Deployment and Evaluation:

3.9.1 Deploying the AI-enabled hospital appointment booking system in a real-world environment:

We prepared the system for deployment by ensuring its compatibility with the target environment, including server configurations, database setup, and necessary software installations. We conducted rigorous testing to verify the system's functionality, stability, and security before deploying it in the live environment. We actively communicated with the administrator of the AI and IoT Research Centre web projects; Mr. Mercel to get feedback on his experience and satisfaction levels with the system. We encouraged open and honest feedback to capture both positive and negative aspects of the system's usability, functionality, and overall user experience.

3.9.2 Evaluating the system's performance, efficiency, and impact of the AI component:

We compared the system's performance against predefined benchmarks and industry standards to determine its effectiveness in streamlining appointment booking processes. We specifically evaluated the impact of the AI component on avoiding congestion and improving service fluidity by analyzing the reduction in scheduling conflicts, optimized resource allocation, and user feedback regarding appointment availability and convenience.

3.9.3 Analyzing the collected data and assessing the system's effectiveness:

We employed data analysis techniques to examine the collected feedback, performance metrics, and user satisfaction data. We identified patterns, trends, and correlations in the data to assess the system's effectiveness in meeting the defined objectives. We compared the system's performance against the key objectives established during the project's initiation and evaluated its alignment with the stakeholders' expectations.

3.9.4 Analysis of Features and finalization subject to constraints

In the realm of healthcare innovation, comprehensive considerations span regulatory compliance, economic viability, environmental impact, health implications, manufacturability, safety standards, professional ethics, and societal dynamics. Ensuring encrypted data handling and robust access controls maintain patient confidentiality while complying with regulations like HIPAA and GDPR. Cost-effective resource allocation algorithms and predictive analytics drive operational efficiency while prioritizing quality of care and financial sustainability. Environmental consciousness guides the selection of energy-efficient hardware and recycling initiatives. Health implications are addressed through advanced clinical decision support and real-time adverse event monitoring. Manufacturability emphasizes scalable architectures and simplified maintenance for seamless integration and usability. Safety standards are upheld through fail-safe mechanisms and continuous monitoring, ensuring reliability in critical healthcare settings. Professional and ethical considerations prioritize transparency, ethical guideline integration, and clinician override capabilities to uphold patient-centered care and professional autonomy. Acknowledging social and political dynamics, systems embrace cultural sensitivity, stakeholder engagement, and bias mitigation strategies, fostering inclusivity and fairness in healthcare delivery.

Fig 5. Benefits of the e-healthcare system

4. RESULTS ANALYSIS AND VALIDATION

One of the notable achievements of the system is the seamless and user-friendly interface designed using HTML, CSS, and JavaScript. The multi-step booking modal created with interactivity using JavaScript provided a smooth and intuitive user experience. The system's frontend design received positive feedback from users, with patients finding it easy to navigate and healthcare professionals appreciating its simplicity. Integrating machine learning into the system proved to be a significant advancement. TensorFlow was employed to train a machine learning model in Google Colab, utilizing a variety of healthcare data, including historical appointment records and service types. The model was successfully trained to predict the optimum period of the day for appointment bookings, considering factors such as the day of the week and user preferences. The trained model was exported to a JSON format using this library, enabling its seamless integration into the web application. JavaScript was utilized to load the model and make predictions based on user input, displaying the optimal appointment booking period on the web page. This AI component significantly contributed to the system's ability to avoid congestion and improve service fluidity, benefiting both the hospital and patients. To evaluate the system's performance and effectiveness, feedback was collected from users, who expressed satisfaction with the user-friendly interface, appreciating the ease of booking appointments and the accuracy of the suggested appointment times. Healthcare professionals acknowledged the system's contribution to reducing scheduling conflicts and optimizing resource allocation, leading to improved operational efficiency. Figure 3 showcases a preview of the appointment booking menu, which demonstrates the user interface designed for the AI-enabled hospital appointment booking system. This user-friendly menu allows patients to easily navigate through the booking process, select desired services, and choose suitable appointment slots. Additionally, by facilitating secure and confidential contact between patients and healthcare providers, the system ensures the confidentiality and security of medical information. Maintaining up-to-date, accurate medical information also makes it easier for doctors to give customized care, which speeds up the healthcare process. Through reduced administrative expenses, a decrease in absenteeism, and enhanced appointment management, technology enhances the effectiveness of healthcare institutions. Appointment day analysis identifies trends in attendance to help with schedule optimization. Attendance is compared to assess the effectiveness of SMS reminders. The effect of being awarded a scholarship on attendance is examined. Neighborhood dispersion has an impact on resource distribution. Analyzing appointment dates contributes to more effective scheduling. Finally, monthly data for programs that are particularly targeted demonstrates variations in seas.

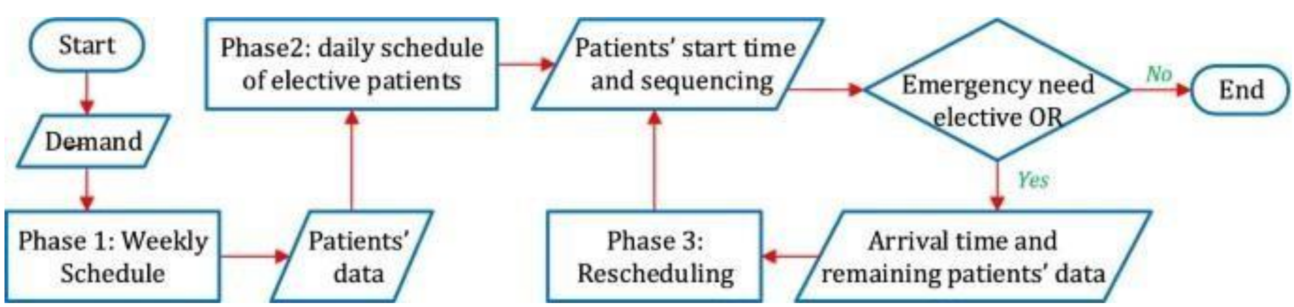


Fig 6. Flow chart of the workflow

Evaluation of the optimized algorithm:

Constructs high-performing no-show prediction models with accuracy and F1-measure scores close to 95%.

Decision Trees and Non-linear SVM classifiers are identified as the best performers, with Decision Trees selected for integration due to lower time complexity.

Confirms the significance of lead time as a determinant variable for predicting patient non-attendance, with its inclusion leading to significant performance improvement in all classification models tested.

The "Advanced Hospital Management System" described includes features like patient registration, storage of patient details, computerized billing in pharmacies and labs, unique patient IDs, and room status tracking. It provides user-friendly interfaces accessible to administrators or receptionists for data management and retrieval, ensuring data security and processing efficiency.

The existing manual systems are criticized for being time-consuming, insecure, paper-intensive, and lacking the direct involvement of higher officials. To address these limitations, computerization is proposed, aiming for a more accurate and efficient system.

The objectives of the proposed system include user-friendliness, comprehensive information collection about hospital and medical services, simplicity in design, and easy implementation.

Logistic Regression:

Accuracy	78.93
precision	0.71
F1-score	0.73

KNN:

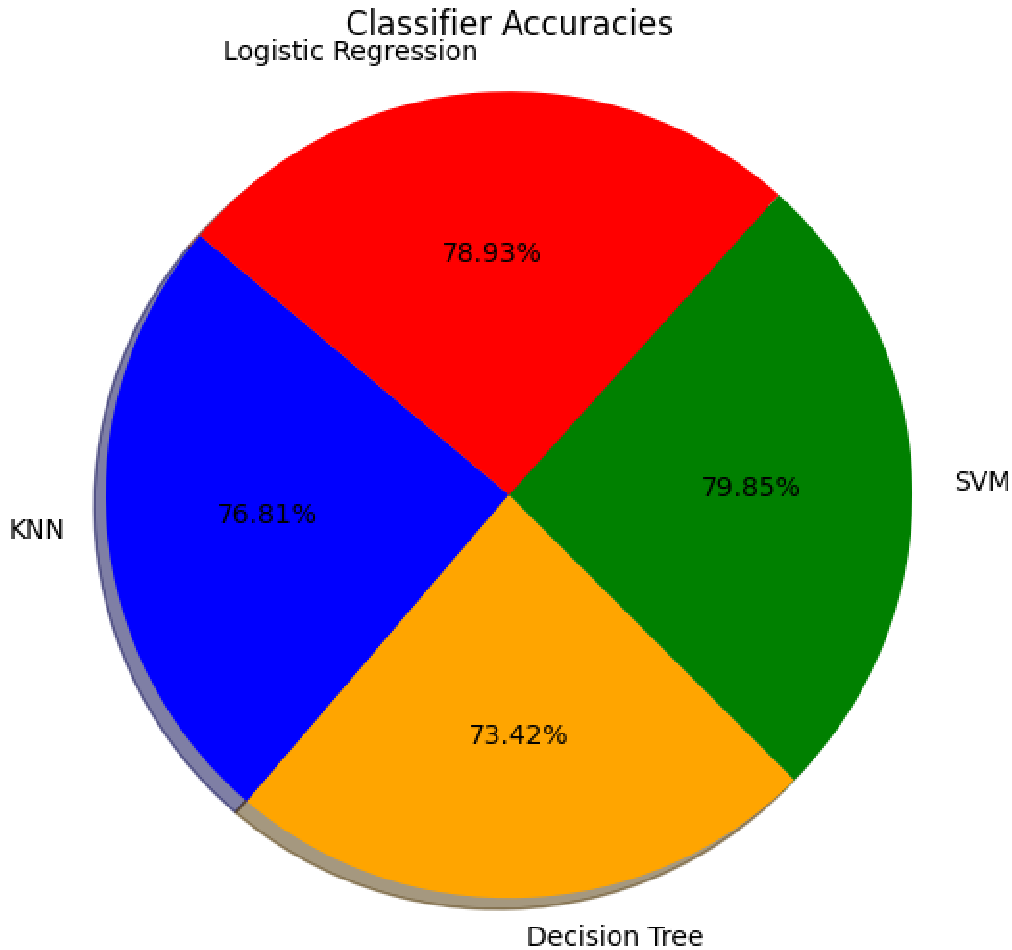
Accuracy	76.81
precision	0.76
F1-score	0.73

Decision Tree:

Accuracy	73.42
precision	0.72
F1-score	0.69

SVM:

Accuracy	79.99
precision	0.88
F1-score	0.81



Prediction model performance:

Key points-

SVM (SVM Classification)

LR (Logistic Regression)

KNN (K-Nearest Nighbour Classification)

DT (Decision Tree Classification)

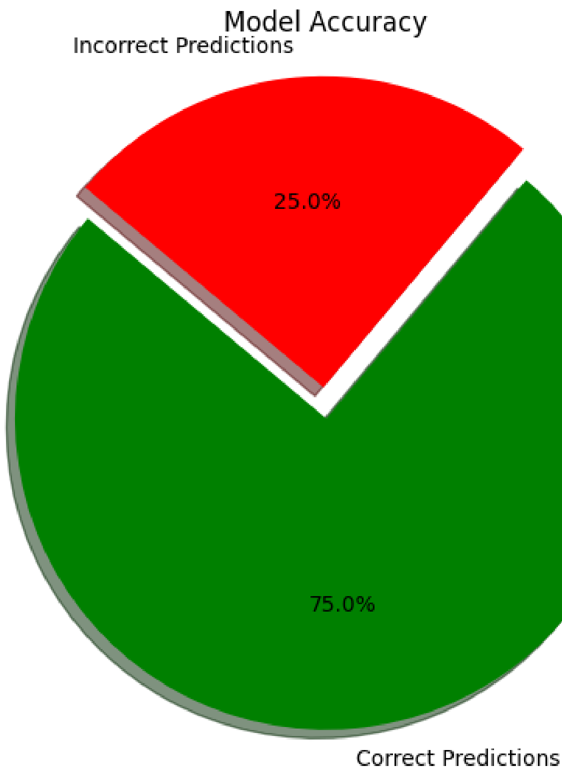


Fig 7. It represents the correct predictions

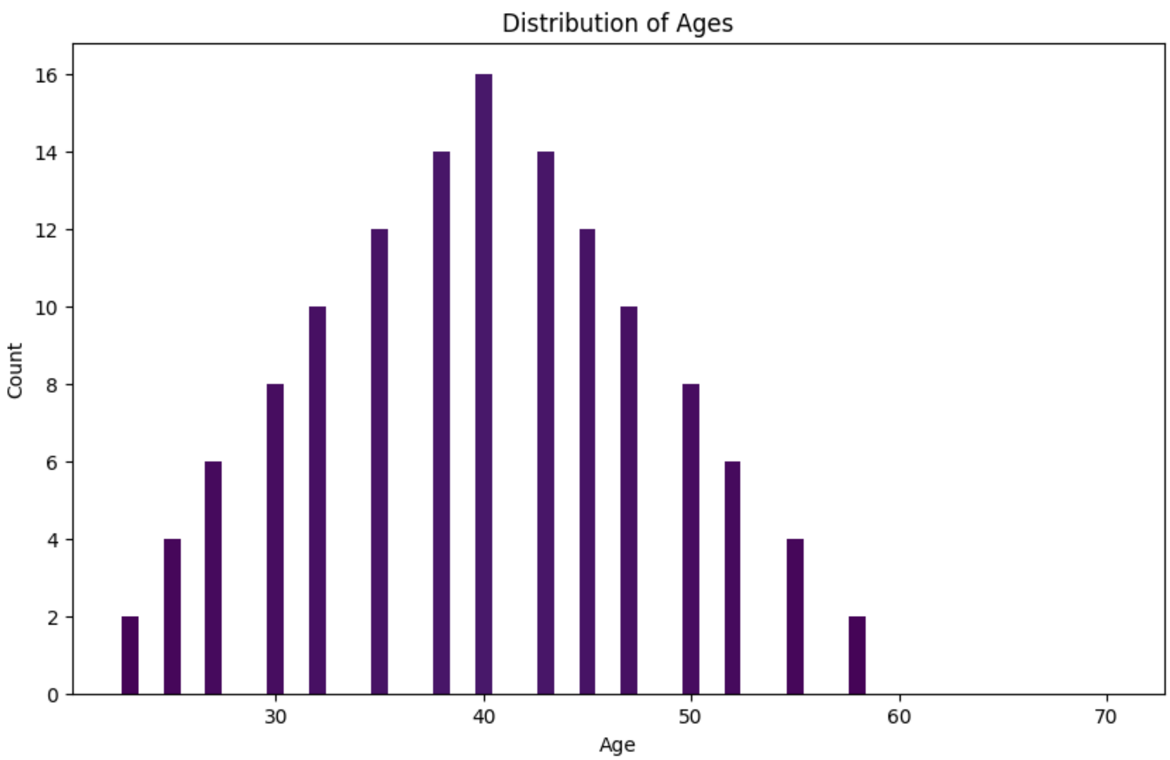


Fig 8 Distribution of the ages

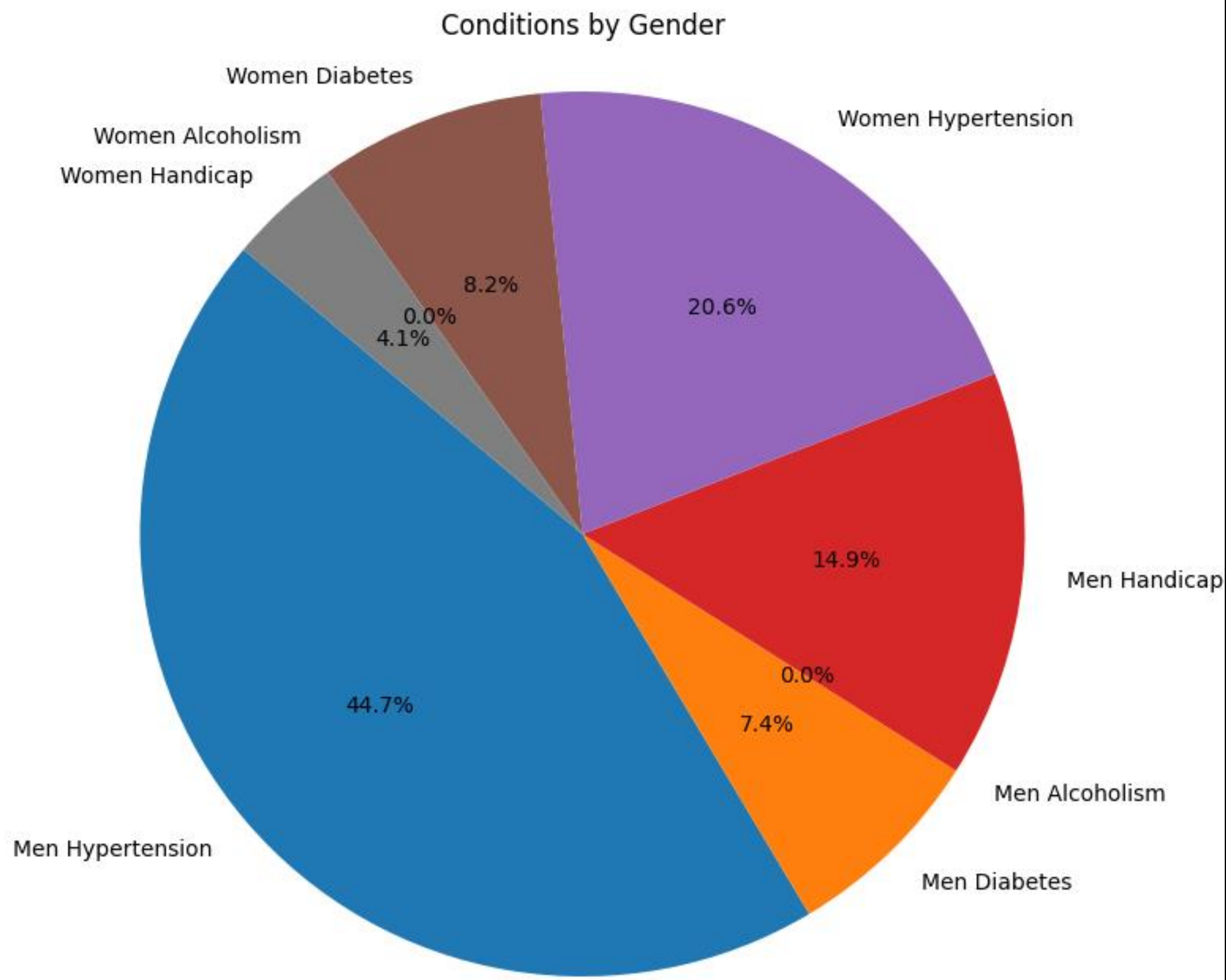


Fig 9(We can infer from the above graph distribution that weekdays are when most appointments are made, as opposed to weekends. Tuesdays are the most populardays for appointments because they fall in the middleof the week.)

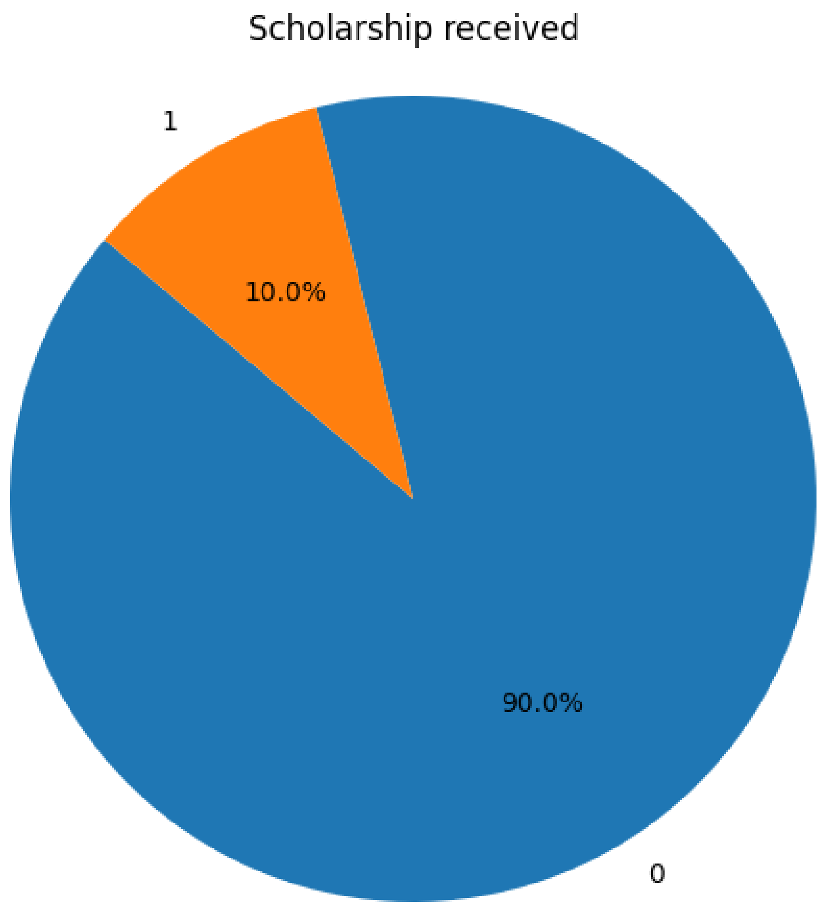


Fig 10. It represents the percent of scholarship recieved

5. CONCLUSION AND FUTURE WORK

5.1 Conclusion :

Traditional methods sometimes result in tedious and possibly incorrect procedures since they rely on phone conversations and manual record-keeping. Conversely, digital appointment systems leverage technology to offer patients online scheduling convenience, real-time availability information, and automatic reminders. Real-time availability information allows patients to select the most convenient appointment times, minimizing wait times and optimizing the use of medical resources. It reduces administrative costs and improves the patient experience significantly by offering self-service choices, proactive patient care, and user-friendly interfaces.

When everything is taken into account, the Doctor Appointment Booking System not only facilitates scheduling appointments but also enhances patient happiness, boosts the efficiency of medical professionals, and aids in optimizing the delivery of healthcare services. As a result, it raises the efficiency, accessibility, and convenience of healthcare. Healthcare technology evolved greatly with the development and Our system to improve process efficiency.

The design and implementation of an AI-enabled hospital appointment booking system have proven to be a significant advancement in healthcare technology. By leveraging technologies such as PHP, MySQL, HTML5, CSS, Python, and JavaScript, we successfully created a user-friendly interface that facilitates seamless appointment scheduling and provides enhanced functionalities for both patients and healthcare professionals. Throughout the project, we employed a comprehensive methodology that involved identifying specific requirements and functionalities through extensive stakeholder engagement. By gathering input from hospital administrators, doctors, and patients, we gained a deep understanding of their needs and expectations, which allowed us to define the scope of the system and establish key objectives for implementation. The deployment of the AI-enabled system in a real-world environment was a crucial milestone. Through meticulous testing, integration with existing infrastructure, and collaboration with the hospital's IT team, we ensured a successful deployment that met the specific requirements and effectively addressed the challenges faced in appointment booking processes.

The AI-enabled hospital appointment booking system has demonstrated its ability to optimize scheduling, enhance user experiences, and improve operational efficiency. By leveraging machine learning techniques, the system predicts the optimal period for appointment bookings based on user preferences and historical data, further enhancing the quality of service. As with any technological project, there is always room for further improvement and future enhancements. The project's conclusion marks the beginning of a continuous process of refinement and innovation. Based on the evaluation and feedback, identified areas for improvement will guide future development efforts to enhance the system's capabilities, adapt to evolving needs, and provide an even better user experience. The AI-enabled hospital appointment booking system holds great potential for transforming healthcare services. It streamlines the appointment scheduling process, reduces waiting times, and enables healthcare facilities to optimize resource allocation. With its successful implementation, the system paves the way for improved patient care, increased operational efficiency, and a more seamless and personalized healthcare experience for all stakeholders involved.

Environmental Impact:

While improving healthcare delivery remains the primary objective, it's crucial to consider the environmental impact of AI-driven systems, including appointment allocation solutions. These systems often rely on extensive data processing and infrastructure, which can contribute to significant energy consumption if not managed efficiently. Therefore, prioritizing energy-efficient design principles and optimizing resource utilization are essential to minimize the environmental footprint of these systems. This can involve leveraging cloud computing services, which offer scalability and energy efficiency benefits compared to on-premises data centers, as well as implementing algorithms and protocols that prioritize energy-efficient data processing and transmission.

Moreover, considerations of electronic waste and sustainability should be integrated into the procurement and disposal processes of hardware components used in AI-driven systems. This includes sourcing hardware from manufacturers committed to sustainable practices and prioritizing longevity and recyclability in equipment selection. Additionally, implementing strategies for responsible disposal and recycling of hardware at the end of its lifecycle can help minimize electronic waste and reduce environmental impact. By integrating environmental considerations into the design, implementation, and maintenance of AI-driven healthcare solutions, healthcare organizations can demonstrate their commitment to sustainability while improving healthcare delivery and patient outcomes.

5.2 Future work:

In addition to the advantages already enjoyed, adding email notification capabilities will give patients an additional means of communication and reminders for appointments, increasing engagement and lowering the likelihood of missed appointments. System optimization will require the incorporation of artificial intelligence (AI) .

By examining past appointment patterns and patient preferences, scheduling enabled by artificial intelligence (AI) can produce efficient and customized appointment recommendations. Future research in healthcare appointment scheduling should prioritize the integration of advanced AI and ML algorithms to refine scheduling models by adaptively learning from historical data, patient preferences, and provider availability patterns. Dynamic resource allocation strategies should be investigated to enhance system responsiveness by continuously monitoring patient flow, provider availability, and resource utilization metrics for real-time adjustments. Additionally, there is a need to incorporate patient preferences into scheduling algorithms through customizable interfaces, thereby improving patient satisfaction and engagement. Seamless integration of telemedicine and virtual care options into scheduling systems can expand access to care while reducing the burden on in-person appointments. Cross-institutional collaboration and interoperability efforts are essential for coordinating appointments across healthcare networks, enhancing care continuity and patient experience. Furthermore, longitudinal studies are necessary to evaluate the long-term impacts of optimized scheduling strategies on healthcare outcomes, resource utilization, and patient satisfaction, enabling continuous improvement in scheduling practices.

Fig 11. Impact of the E-healthcare system

References:

[1] Sugashini. K, "DOCTOR AVAILABILITY AND APPOINTMENT USING DIGITAL TECHNOLOGY," *Health care management*, 2023.

[2] Abhishek, "epoch-in-machine learning," Geeks for Geeks, 07 December 2023. [Online]. Available: https://www.geeksforgeeks.org/epoch-in-machine-learning/.

[3] J. K. Ahamadi-Javid, "Outpatient appoinment system in health care a review of optimization studies," *European Journal of Operational Research*, vol. 258, pp. 3-34, 2017.

[4] M. S. R. Amruta Nikam, "SMART E-HEALTHCARM MANAGEMENT SYSTEM," *IJRISE*, vol. 3, no. 2, p. 98, 2017.

[5] K. e. all, A STUDY OF ADVANCED HOSPITAL MANAGEMENT SYSTEM, Chennai: IOSR Journal of Dental and Medical Sciences, 2017.

[6] C. Alves M.A, "Explaining machine learning machine learning based diagnosis of COVID-19 from routine blood tests with decision trees and criteria Graphs," *Science Direct*, vol. 132, pp. 104-335, 2021.

[7] R. Srinivas.S, "Optimizing Outpatient appointment system using machine learning algorithms and scheduling rules," *ScienceDirect*, vol. 102, pp. 245-261, 2018.

[8] R. A. K. Edwin Kwadwo Tenagyei, "Design and implementation of Hospital Reservation System," *International Journal of Computer Science and Information Security*, pp. 31-37, 2021.

[9] D. Caloci, "mHealth interventions in low-income countries to address health," *Annals of Global Health*, vol. 82, no. 5, pp. 922-935, 2016.

[10] Y. Mey, "Near field communication-based patient Appointment," *IEEE*, pp. 98-103, 2013.

[11] K.NISHANTHAN, THE HOSPITAL MANAGEMENT SYSTEM, SRI LANKA: INTERNATIONAL JOURNAL OF ENGINEERING AND MANAGEMENT RESEARCH, 2022.

[12] Z. S. He D, "Authentication Protocol for an Ambient Assisted Living System," *IEEECommunications*, p. 77, 2015.

[13] C. Z. S. C. Y. MinMin Zhang, "Use of an online appointment booking system in one largetertiary public hospital outpatient service center," *BMC Medical Informatics*, 2014.

[14] Hao, "The development of online doctor reviews in China an analysis of largest online doctor review website in China," *Medical Internet Research*, vol. 17, no. Physician and Health Services Rating by Consumers, 2015.

[15] O. T. Y. Lim S, "Security Issues on Wireless Body Area Network for Remote Monitoring," *IEEE* p. 332, 2010.

[16] N. Liu, "Optimal choice for appointment scheduling window under Patient No-ShowBehaviour," *WILEY*, 2015.

[17] H. Haung. Y, "Patient No-Show predictive model development using multiple data sources foran effective overbooking approach," *Thieme*, 2014.

[18] Polikar, "Ensemble learning," *Scopus*, pp. 1-34, 2012.

[19] R. et. al, Design of e-Healthcare management system based on cloud and service.

[20] Z. Y. Guorui Fan, "Machine learning based prediction models for patients no-show in online outpatient appointments," *ScienceDirect*, p. 52, 2021.

[21] R. K. Kher, "Mobile and E-Healthcare: Recent Trends and Future Directions," *MedPub*, vol. 2,2016.

[22] D. a. B. Cardoen, "operating room scheduling," vol. 213, no. 2, pp. 655-687, 2010.

[23] A. J. Lekan., "Design and Implementation of a Patient Appointment and Scheduling System," *International Advanced Research Journal in Science, Engineering, and Technology*, vol. 4, no.12, pp. 16-23, 2017.

.

[24]. Kaur, R., Kumar, R., & Gupta, M. (2023). Deep neural network for food image classification and nutrient identification: A systematic review. *Reviews in Endocrine and Metabolic Disorders*, 1-21.

[25]. Jain, R., Gupta, M., Jain, K., & Kang, S. (2021). Deep learning-based prediction of COVID-19 virus using chest X-ray. *Journal of Interdisciplinary Mathematics*, *24*(1), 155-173.

[26]. A. Yelne and A. Raut, "Digital Health-Care System for Smart IPD Booking," in *13th International Conference on Advances in Computing, Control, and Telecommunication Technologies, ACT 2022*, 2022, vol. 8,

[27]. F. Piccialli, S. Cuomo, D. Crisci, E. Prezioso, and G. Mei, "A deep learning approach for facility patient attendance prediction based on medical booking data," *Sci. Rep.*, vol. 10, no. 1, 2020, doi: 10.1038/s41598-020-71613-7.

[28]. A. Odeh, R. Abdelhadi, and H. Odeh, "Medical patient appointments management using smart software system in UAE," in *Proceedings - 2019 International Arab Conference on Information Technology, ACIT 2019*, 2019, pp. 97–101, doi: 10.1109/ACIT47987.2019.8991064.

[29]. Kaur, R., Kumar, R., & Gupta, M. (2022). Predicting risk of obesity and meal planning to reduce the obese in adulthood using artificial intelligence. *Endocrine*, *78*(3), 458-469.

[30]. R. Sujatha, E. P. Ephzibah, and S. S. Dharinya, "Smart Health Care Development," *Role Edge Anal. Sustain. Smart City Dev.*, pp. 1–20, Jul. 2020, doi: 10.1002/9781119681328.CH1.

[31]. Puneet, Kumar, R., & Gupta, M. (2022). Optical coherence tomography image-based eye disease detection using deep convolutional neural network. *Health Information Science and Systems*, *10*(1), 13.

[32]. D. Lupton, "Critical Perspectives on Digital Health Technologies," *Social. Compass*, vol. 8, no. 12, pp. 1344–1359, Dec. 2014, doi: 10.1111/SOC4.12226.

[33]. J. A. K. Evangelista *et al.*, "Paediatric nurse practitioner managed cardiology clinics: Patient satisfaction and appointment access," *J. Adv. Nurs.*, vol. 68, no. 10, pp. 2165–2174, Oct. 2012, doi: 10.1111/J.1365-2648.2011.05901.X.

[34]. A. Kevat, J. Manohar, N. Bate, and K. Harris, "Online referral and immediate appointment selection system empowers families and improves access to public community pediatric clinics," *J. Paediatr. Child Health*, vol. 55, no. 4, pp. 454–458, Apr. 2019, doi: 10.1111/JPC.14228.

CODE:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import matplotlib.pyplot as plt
import seaborn as sns
from datetime import datetime
import sklearn
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
noshow_appointments = pd.read_csv("KaggleV2-May-2016.csv")
(noshow_appointments.head())
df.AppointmentDay = df.AppointmentDay.apply(np.datetime64)
df['WeekDay'] = df['AppointmentDay'].dt.day
df.ScheduledDay = df.ScheduledDay.apply(np.datetime64)
df['DayScheduled'] = df['ScheduledDay'].dt.day
df.drop(['PatientId', 'AppointmentID'], axis=1, inplace=True)
# Converting 'Gender' and 'Noshow' from object format to integer format.
df.Gender = df.Gender.apply(lambda x: 1 if x == 'M' else 0)
df['Noshow'] = df['Noshow'].replace('Yes',1)
df['Noshow'] = df['Noshow'].replace('No',0)
range_df = pd.DataFrame()
range_df['Age'] = range(95)
men = range_df.Age.apply(lambda x:len(df[(df.Age == x) & (df.Gender == 1)]))
women = range_df.Age.apply(lambda x:len(df[(df.Age == x) & (df.Gender ==
0)]))
plt.plot(range(95), men, color = 'b')
plt.plot(range(95), women, color = 'g')
plt.legend([1,0])
plt.xlabel('Age')
plt.ylabel('Frequency')
plt.title('Gender based difference')
men_Hypertension = range_df[range_df.columns[0]].apply(lambda x:
len(df[(df.Age == x) & (df.Gender == 1) & (df.Hypertension == 1)]))
women_Hypertension = range_df[range_df.columns[0]].apply(lambda x:
len(df[(df.Age == x) & (df.Gender == 0) & (df.Hypertension == 1)]))

men_Diabetes = range_df[range_df.columns[0]].apply(lambda x: len(df[(df.Age
== x) & (df.Gender == 1) & (df.Diabetes == 1)]))
women_Diabetes = range_df[range_df.columns[0]].apply(lambda x:
len(df[(df.Age == x) & (df.Gender == 0) & (df.Diabetes == 1)]))
```

```
men_Alcoholism = range_df[range_df.columns[0]].apply(lambda x:
len(df[(df.Age == x) & (df.Gender == 1) & (df.Alcoholism == 1)]))
women_Alcoholism = range_df[range_df.columns[0]].apply(lambda x:
len(df[(df.Age == x) & (df.Gender == 0) & (df.Alcoholism == 1)]))

men_Handicap = range_df[range_df.columns[0]].apply(lambda x: len(df[(df.Age
== x) & (df.Gender == 1) & (df.Handicap == 1)]))
women_Handicap = range_df[range_df.columns[0]].apply(lambda x:
len(df[(df.Age == x) & (df.Gender == 0) & (df.Handicap == 1)]))
plt.figure(figsize = (10,10))
plt.subplot(2,2,1)
plt.plot(range(95),men_Hypertension/men)
plt.plot(range(95),women_Hypertension/women, color = 'r')
plt.title('Hypertension')
plt.legend([1,0], loc = 2)
plt.xlabel('Age')
plt.ylabel('Frequency')

plt.subplot(2,2,2)
plt.plot(range(95),men_Diabetes/men)
plt.plot(range(95),women_Diabetes/women, color = 'r')
plt.title('Diabetes')
plt.legend([1,0], loc = 2)
plt.xlabel('Age')
plt.ylabel('Frequency')


plt.subplot(2,2,3)
plt.plot(range(95),men_Alcoholism/men)
plt.plot(range(95),women_Alcoholism/women, color = 'r')
plt.title('Alcoholism')
plt.legend([1,0], loc = 2)
plt.xlabel('Age')
plt.ylabel('Frequency')


plt.subplot(2,2,4)
plt.plot(range(95),men_Handicap/men)
plt.plot(range(95),women_Handicap/women, color = 'r')
plt.title('Handicap')
plt.legend([1,0], loc = 2)
plt.xlabel('Age')
plt.ylabel('Frequency')
x = df.drop(['Noshow','Neighbourhood','ScheduledDay','AppointmentDay'],
axis=1)
y = df['Noshow']
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.4,
random_state=42)
```

```python
logreg = LogisticRegression()
logreg.fit(x_train, y_train)
y_pred = logreg.predict(x_test)
acc_log = round(logreg.score(x_train, y_train) * 100, 2)
acc_log
from sklearn.neighbors import KNeighborsClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score
from sklearn.svm import SVC

# KNN Algorithm
knn = KNeighborsClassifier()
knn.fit(x_train, y_train)
y_pred_knn = knn.predict(x_test)
acc_knn = round(accuracy_score(y_test, y_pred_knn) * 100, 2)

# Decision Tree Algorithm
decision_tree = DecisionTreeClassifier()
decision_tree.fit(x_train, y_train)
y_pred_dt = decision_tree.predict(x_test)
acc_dt = round(accuracy_score(y_test, y_pred_dt) * 100, 2)

print("Logistic Regression Accuracy:", acc_log)
print("KNN  Accuracy:",  acc_knn)
print("Decision Tree Accuracy:", acc_dt)
svm = SVC()
svm.fit(x_train, y_train)
y_pred_svm = svm.predict(x_test)
acc_svm = round(accuracy_score(y_test, y_pred_svm) * 100, 2)

# Print  SVM  Accuracy
print("SVM Accuracy:", acc_svm)
from sklearn.metrics import classification_report

# Logistic Regression Classification Report
print("Logistic Regression Classification Report:")
print(classification_report(y_test, y_pred))

# KNN Classification Report
print("\nKNN Classification Report:")
print(classification_report(y_test, y_pred_knn))

# Decision Tree Classification Report
print("\nDecision Tree Classification Report:")
print(classification_report(y_test, y_pred_dt))
print("\nSVM Classification Report:")
print(classification_report(y_test, y_pred_svm))
```

```python
from sklearn.metrics import precision_recall_fscore_support

# Logistic Regression Precision, Recall, F1-score
precision_lr, recall_lr, f1_lr, _ = precision_recall_fscore_support(y_test,
y_pred, average='weighted')
print("Logistic Regression:")
print("Precision:", precision_lr)
print("Recall:", recall_lr)
print("F1-score:", f1_lr)

# KNN Precision, Recall, F1-score
precision_knn, recall_knn, f1_knn, _ =
precision_recall_fscore_support(y_test, y_pred_knn, average='weighted')
print("\nKNN:")
print("Precision:", precision_knn)
print("Recall:", recall_knn)
print("F1-score:", f1_knn)

# Decision Tree Precision, Recall, F1-score
precision_dt, recall_dt, f1_dt, _ = precision_recall_fscore_support(y_test,
y_pred_dt, average='weighted')
print("\nDecision Tree:")
print("Precision:", precision_dt)
print("Recall:", recall_dt)
print("F1-score:", f1_dt)

# SVM Precision, Recall, F1-score
precision_svm, recall_svm, f1_svm, _ =
precision_recall_fscore_support(y_test, y_pred_svm, average='weighted')
print("\nSVM:")
print("Precision:", precision_svm)
print("Recall:", recall_svm)
print("F1-score:", f1_svm)
from sklearn.metrics import confusion_matrix

# Confusion matrix for KNN
cm_knn = confusion_matrix(y_test, y_pred_knn)
print("Confusion Matrix for KNN:\n", cm_knn)

# Confusion matrix for Decision Tree
cm_dt = confusion_matrix(y_test, y_pred_dt)
print("\nConfusion Matrix for Decision Tree:\n", cm_dt)
from sklearn.metrics import confusion_matrix

# SVM Algorithm
svm = SVC()
svm.fit(x_train, y_train)
y_pred_svm = svm.predict(x_test)
```

```
acc_svm = round(accuracy_score(y_test, y_pred_svm) * 100, 2)

# Print SVM Accuracy
print("SVM Accuracy:", acc_svm)

# Confusion matrix for SVM
cm_svm = confusion_matrix(y_test, y_pred_svm)
print("\nConfusion Matrix for SVM:\n", cm_svm)
from sklearn.metrics import confusion_matrix

# Compute confusion matrix for Logistic Regression
conf_matrix_lr = confusion_matrix(y_test, y_pred)
print("\nConfusion Matrix for Logistic Regression:")
print(conf_matrix_lr)
```