### An Industry-Oriented Mini Project Report

**On**

# “Heart Disease Identification Method Using Machine Learning Classification in E-HealthCare”

**Submitted in Partial Fulfillment of the Academic Requirement for the Award of Degree**

BACHELOR OF TECHNOLOGY

in

### Computer Science and Engineering (Artificial Intelligence and Machine learning)

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CMR INSTITUTE OF TECHNOLOGY

**(UGCAUTONOMOUS)**

**Approved by AICTE, Affiliated to JNTUH, Accredited by NAAC with A+ Grade,**

**Kandlakoya (V), Medchal Dist - 501 401**

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# 2024-25

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**CERTIFICATE**

This is to certify that an Industry oriented Mini Project entitled with “Heart Disease Identification Using Machine Learning” is being submitted by:

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To JNTUH, Hyderabad, in partial fulfillment of the requirement for award of the degree of B. Tech in CSE (AI&ML) and is a record of a Bonafide work carried out under our guidance and supervision. The results in this project have been verified and are found to be satisfactory. The results embodied in this work have not been submitted to have any other University forward of any other degree or diploma.

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|  | **Si** |  |
| **Signature of Guide** | **Signature of Project Coordinator** | **Signature of HOD** |

**EXTERNAL EXAMINER**

**ACKNOWLEDGEMENT**

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We will be failing in duty if we do not acknowledge with grateful thanks to the authors of the references and other literatures referred in this Project.

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V.POOJA

V.PRASHANTHI

P.ARAVIND

## ABSTRACT

Effective plant growth and yield prediction is an essential task for greenhouse growers and for agriculture in general. Developing models which can effectively monitor growth and yield can help growers improve and control plant environment for better production, match supply and market demand and lower costs. The proposed work utilizes ML and DL techniques to predict yield and plant growth variation across two different scenarios, tomato yield forecasting and Ficus benjamina stem growth, in controlled greenhouse environments. A new deep Recurrent Neural Network (RNN) has been deployed using the Long Short-Term Memory (LSTM) neuron model. In the prediction formulations the former yield, growth and stem diameter values, as well as the microclimate conditions, are used by the RNN architecture to model the targeted growth parameters. A comparative work is presented using ML methods, such as support vector regression and random forest regression, utilizing the mean square error criterion, in order to evaluate the performance achieved by the different methods.

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# INTRODUCTION

* 1. **About the project:**

An enormous number of deaths occur every year as a result of heart disease, making it a major concern in world health. Improving patient outcomes and lowering death rates, early detection and correct diagnosis of cardiac disease play a key role. When the heart's arteries become blocked, oxygen-poor blood cannot reach the heart properly, resulting in coronary heart disease. Early detection of cardiac disease is viable because it reduces medical costs and potentially saves the patient's life. Recently presented methods have improved heart failure detection accuracy on testing data without sacrificing accuracy on training data, yet most of these algorithms are suffering from the issue of overfitting. Models that were created end up fitting the test data too well. In this study, we create a novel diagnostic system to address this issue, and the resulting system demonstrates high intelligence and excellent performance on both training and testing data. Machine learning (ML) algorithms have demonstrated promising potential in assisting healthcare professionals with timely and accurate diagnosis. In this paper, is based on supervised machine learning methods are decision tree (DT), random forest (RF), Support vector Machine (SVM), Principal Component Analysis(PCA). We compare their accuracy with each other by using bar plot.

One of the critical issues in medical data analysis is accurately predicting a patient’s risk of heart disease, which is vital for early intervention and reducing mortality rates. Early detection allows for timely treatment and continuous monitoring by healthcare providers, which is essential but often limited by the inability of medical professionals to provide constant patient supervision. Early detection of cardiac problems and continuous patient monitoring by physicians can help reduce death rates. Doctors cannot constantly have contact with patients, and heart disease detection is not always accurate. By offering a more solid foundation for prediction and decision-making based on data provided by healthcare sectors worldwide, machine learning (ML) could help physicians with the prediction and detection of HD. This study aims to use different feature selection strategies to produce an accurate ML algorithm for early heart disease prediction. We have chosen features using chi-square, ANOVA, and mutual information methods. The three feature groups chosen were SF-1, SF-2, and SF-3.

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**1.2 Existing System:**

Existing systems for heart disease prediction generally rely on traditional statistical methods, such as logistic regression, decision trees, and rule-based systems. These systems use features like age, cholesterol levels, blood pressure, family history, and smoking habits to estimate the likelihood of heart disease.

**Drawbacks of Existing Systems:**

* **Limited Accuracy:** Traditional methods often fail to capture complex patterns in the data, leading to inaccurate predictions, especially for patients with atypical symptoms or those at an early stage of the disease.
* **Data Dependency:** These models require a significant amount of manual input and depend on the availability of complete data, which may not always be accessible or accurate.
* **Inflexibility:** Most existing systems are static and unable to adapt to new data or changes in patient conditions. This limits their ability to provide personalized healthcare solutions.
* **Risk of Overfitting**: Many traditional methods can overfit the data, meaning they perform well on the training data but fail to generalize to new or unseen patient data.
* **Limited Scope:** Existing systems may not consider a wide range of factors (e.g., genetic information, lifestyle data) that could contribute to a more accurate prediction of heart disease.

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**1.3 Proposed System:**

The proposed system for heart disease prediction using Machine Learning (ML) aims to overcome the limitations of traditional methods by employing more advanced techniques, including supervised learning algorithms like Random Forest, Support Vector Machines (SVM), and Neural Networks. The system would integrate a wide range of data, including clinical factors, lifestyle data, genetic information, and even real-time health monitoring (e.g., heart rate, activity levels) from wearable devices.

**Advantages**:

* **Improved Accuracy:** ML models can learn complex relationships between variables, leading to more accurate predictions than traditional methods. These models can identify subtle patterns in data that may not be easily noticeable.
* **Personalization:** The system can provide personalized predictions based on an individual’s medical history, lifestyle choices, and genetic factors, offering tailored insights and recommendations.
* **Adaptability:** As more data becomes available over time, ML models can continuously learn and adapt, improving their predictive power. This makes the system capable of adjusting to changes in patient conditions and evolving trends in healthcare.
* **Incorporation of Multiple Data Sources**: The proposed system can integrate a broader range of data sources, including electronic health records (EHR), wearable devices, and real-time health data, providing a more holistic view of a patient's health.
* **Early Detection**: With the ability to analyze large and diverse datasets, the system could detect early signs of heart disease in individuals who may not yet show clear symptoms, enabling early intervention and preventive care.
* **Reduction in Human Error**: By automating the prediction process, the system reduces the reliance on manual input, which can be error-prone, and ensures more consistent and accurate results.
* **Scalability**: The system could easily scale to accommodate large datasets from diverse populations, improving its robustness and generalization across different demographics.

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# Literature Survey

# Heart disease remains one of the most significant causes of mortality worldwide. Over the years, researchers and healthcare professionals have sought to improve early detection and diagnosis of cardiovascular diseases using various machine learning (ML) techniques. This literature survey outlines the foundational and contemporary research referenced in the project, summarizing their contributions to the field of heart disease prediction.

# Traditional Prediction Methods

Earlier approaches to heart disease prediction relied heavily on **statistical techniques** such as:

* **Logistic Regression**
* **Rule-Based Expert Systems**
* **Decision Trees**

However, these models often faced limitations like:

* Inability to model complex, nonlinear patterns in data.
* Overfitting to training data.
* Dependency on complete and clean datasets.
* Limited adaptability to new data and conditions.

**2. Recent Advances with Machine Learning**

To overcome the limitations of traditional methods, several studies have implemented **supervised ML algorithms**:

* **Support Vector Machines (SVM):** Proven effective in high-dimensional data with better generalization ability.
* **Random Forest (RF):** An ensemble learning method that improves prediction accuracy and reduces overfitting.
* **XGBoost:** Gradient boosting framework known for speed and performance, particularly effective for classification tasks.
* **Bagging:** Bootstrap aggregation to reduce variance and avoid overfitting.

These models have shown substantial improvements in prediction accuracy, especially when combined with proper feature selection and data balancing techniques.

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**Related Works Cited in the Project**

Several notable studies and journal articles referenced include:

* Alom et al. (2021): Heart failure detection using ML.
* Gour et al. (2022): ML approaches for heart attack prediction.
* Gupta et al. (2022): Supervised ML for cardiac disease prediction.
* Shameer et al. (2021): CVD risk prediction using EHR in multi-ethnic populations.
* Liu et al. (2020): Deep learning with CT angiography for CAD detection.
* Shoukat et al. (2020): Systematic review of ML in cardiovascular prediction.
* Moon et al. (2019): Application of ML in predicting cardiovascular diseases.

These studies highlight the growing body of evidence supporting ML as a reliable and scalable approach to disease prediction, especially in preventive healthcare.

**Explainable AI (XAI)**

To make predictions interpretable and trustworthy, **SHAP (SHapley Additive exPlanations)** values are used. This method helps in understanding the impact of each feature on the model’s prediction, which is crucial in medical applications for transparency and clinician trust.

**Data Balancing with SMOTE**

To address class imbalance in medical datasets, the **Synthetic Minority Oversampling Technique (SMOTE)** is widely used. It generates synthetic samples for the minority class, leading to better model training and generalization.

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**2.REQUIREMENT SPECIFICATIONS**

**2.1REQUIREMENT ANALYSIS**

**HARDWARE SYSTEM REQUIREMENTS:**

**➢ System** : Pentium i3 Processor**.**

**➢ Hard Disk** : 500 GB.

**➢ Monitor :** 15’’ LED

**➢ Input Devices :** Keyboard, Mouse

**➢ Ram**: 4 GB

**SOFTWARE SYSTEM REQUIREMENTS:**

**➢Operating system :** Windows 10 .

**➢ Coding Language :** Python Web

**➢ Web Framework :** Flask

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**2.2SPECIFICATION PRINCIPLES**

The specification principles in the document titled *"Heart Disease Prediction Using Machine Learning"* can be understood from several key areas where the system's purpose, design, and implementation are formally laid out. These specification principles include both functional and non-functional requirements, which guide the development and evaluation of the system.

**Functional Requirements:**

1. **Data Collection and Preprocessing:**
   * The system should allow the collection of patient data, including factors like age, gender, blood pressure, cholesterol levels, ECG results, and lifestyle data.
   * It should be capable of cleaning, normalizing, and transforming raw data into a usable format for model training.
2. **Model Training:**
   * The system should allow the selection and training of machine learning models (e.g., Logistic Regression, Decision Trees, Random Forests, SVM, etc.) on historical health data to predict heart disease risk.
   * The model should be capable of evaluating performance metrics like accuracy, precision, recall, and F1 score for validation.
3. **Prediction:**
   * The system should provide an interface for inputting patient data and generating real-time predictions regarding heart disease risk.
   * It should predict whether the patient is at risk of heart disease (yes/no) based on input health metrics.
4. **Visualization:**
   * The system should offer visualization tools for displaying prediction results (e.g., pie charts, bar graphs, or risk scores) to help clinicians interpret outcomes.
5. **Recommendation System:**
   * Based on the predicted risk, the system should offer lifestyle recommendations or refer patients to healthcare professionals for further diagnostic evaluation.
6. **User Interface:**
   * The system should have a user-friendly interface for clinicians and users to input and view patient data and predictions.

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**Non-Functional Requirements:**

1. **Performance**:
   * The system should provide quick predictions (typically within a few seconds) after receiving the input data.
   * It should be able to handle large datasets and maintain consistent performance, even as the number of users or patients increases.
2. **Scalability**:
   * The system should be scalable to handle growing amounts of data over time, especially as the dataset of patient information expands.
3. **Reliability**:

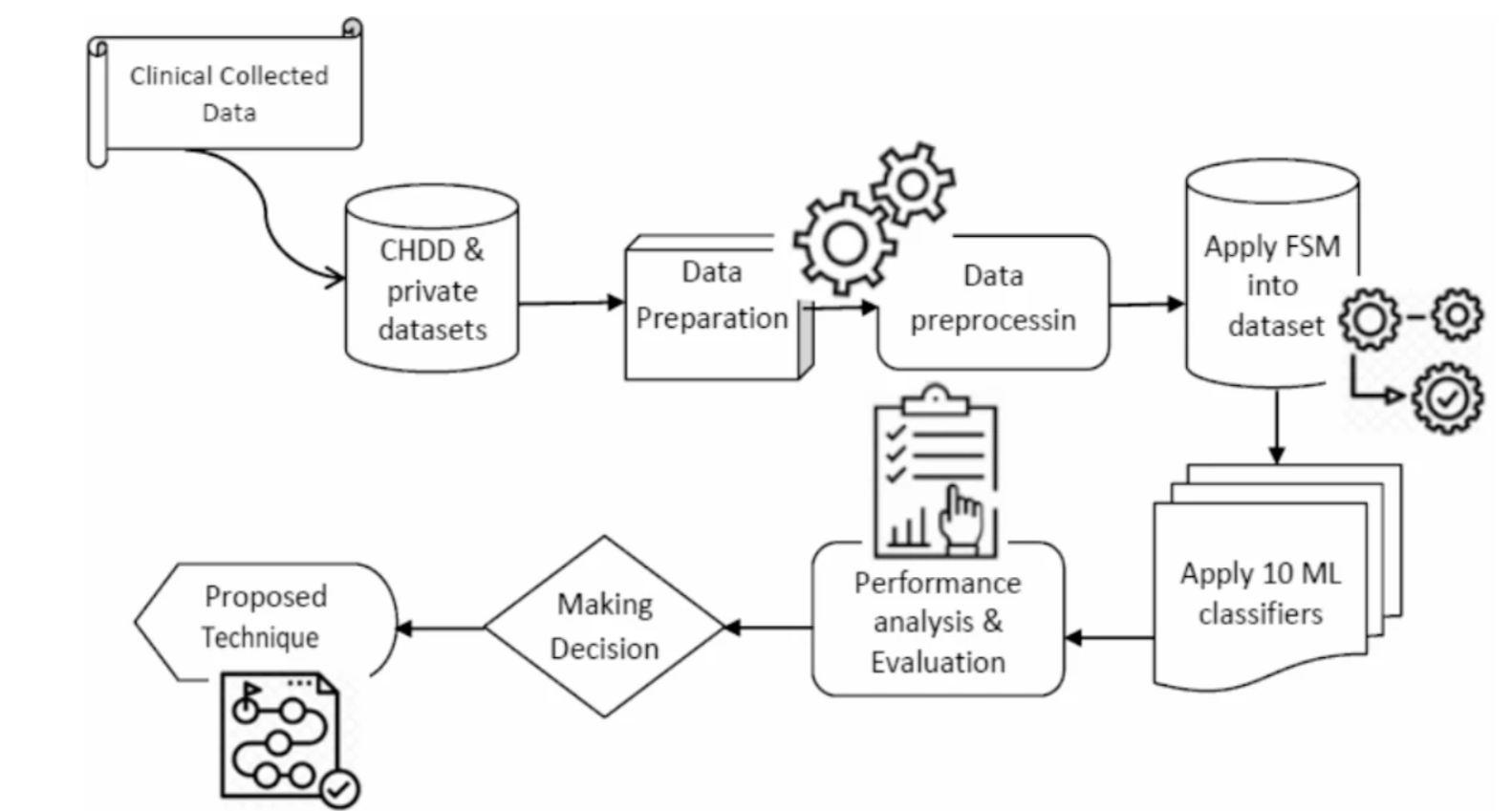
The system should be reliable with minimal downtime, ensuring that it can provide accurate predictions whenever needed by healthcare professionals.

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# 3.SYSTEM DESIGN

# 3.1ARCHITECTURE/BLOCK DIAGRAM

The **Heart Disease Prediction System using Machine Learning** typically follows a structured architecture, consisting of several key components that work together to process data, build models, and provide accurate predictions. Below is an outline of the system architecture:



This architecture ensures that the heart disease prediction system is accurate, reliable, and scalable, providing essential insights for healthcare professionals and improving patient outcomes.

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# 3.2 Unified Modeling Language Design:

UML stands for Unified Modeling Language. UML is a standardized generalpurpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group.

The goal is for UML to become a common language for creating models of object oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML.

The Unified Modeling Language is a standard language for specifying,

Visualization, Constructing and documenting the artifacts of software system, as well as for business modeling and other non-software systems.

The UML represents a collection of best engineering practices that have proven successful in the modeling of large and complex systems.

The UML is a very important part of developing objects oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

**GOALS:**

The Primary goals in the design of the UML are as follows:

1. Provide users a ready-to-use, expressive visual modeling Language so that they can develop and exchange meaningful models.
2. Provide extendibility and specialization mechanisms to extend the core concepts.
3. Be independent of particular programming languages and development process.
4. Provide a formal basis for understanding the modeling language.
5. Encourage the growth of OO tools market.

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**4.IMPLEMENTATION**

**4.1 PROJECT MODULES**

**Machine Learning Technology:**

Machine learning is a discipline that deals with programming the systems so as to make them automatically learn and improve with experience. Here, learning implies recognizing and understanding the input data and taking informed decisions based on the supplied data. It is very difficult to consider all the decisions based on all possible inputs. To solve this problem, algorithms are developed that build knowledge from a specific data and past experience by applying the principles of statistical science, probability, logic, mathematical optimization, reinforcement learning, and control theory.

**Steps Involved in Machine Learning:**

A machine learning project involves the following steps

* + Defining a Problem
  + Preparing Data
  + Evaluating Algorithms
  + Improving Results

• Presenting Results

Machine Learning (ML) is an automated learning with little or no human intervention. It involves programming computers so that they learn from the available inputs. The main purpose of machine learning is to explore and construct algorithms that can learn from the previous data and make predictions on new input data.The input to a learning algorithm is training data, representing experience, and the output is any expertise, which usually takes the form of another algorithm that can perform a task. The input data to a machine learning system can be numerical, textual, audio, visual, or multimedia.

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**Machine Learning vs. Traditional Programming:**

Traditional programming differs significantly from machine learning. In traditional programming, programmers code all the rules in consultation with an expert in the industry for which software is being developed. Each rule is based on a logical foundation; the machine will execute an output following the logical statement. When the system grows complex, more rules need to be written. It can quickly become sustainable to maintain.

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AI-generated content may be incorrect.

**Fig 5.1: Traditional Programming**

Machine learning is supposed to overcome this issue. The machine learns how the input and output data are correlated and it writes a rule. The programmers do not need to write new rules each time there is new data. The algorithms adapt in response to new data and experiences to improve efficacy over time.

## A red rectangular object with white text AI-generated content may be incorrect.

**5.2: Machine Learning**

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**How does Machine learning work?**

Machine learning is the brain where all the learning takes place. The way the machine learns is similar to the human being. Humans learn from experience. The more we know, the more easily we can predict. By analogy, when we face an unknown situation, the likelihood of success is lower than the known situation. Machines are trained the same. To make an accurate prediction, the machine sees an example. When we give the machine a similar example, it can figure out the outcome. However, like a human, if it’s feed a previously unseen example, the machine has difficulties to predict.

**Machine learning Algorithms and where they are used?**

A diagram of a machine learning

AI-generated content may be incorrect.

**Fig 5.3: Machine Learning Algorithms**

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**Types of Machine Learning:**

There are four categories of machine learning algorithms as shown below

* Supervised learning algorithm
* Unsupervised learning algorithm
* Semi-supervised learning algorithm
* Reinforcement learning algorithm

**Supervised Learning:**

Supervised learning is commonly used in real world applications, such as face and speech recognition, products or movie recommendations, and sales forecasting.

Supervised learning can be further classified into two types - Regression and Classification. Regression trains on and predicts a continuous-valued response, for example predicting real estate prices. Classification attempts to find the appropriate class label, such as analyzing positive/negative sentiment, male and female persons, benign and malignant tumors, secure and unsecure loans etc. In supervised learning, learning data comes with description, labels, targets or desired outputs and the objective is to find a general rule that maps inputs to outputs. This kind of learning data is called labeled data. The learned rule is then used to label new data with unknown outputs. Supervised learning involves building a machine learning model that is based on labeled samples.

**Unsupervised Learning:**

Unsupervised learning is used to detect anomalies, outliers, such as fraud or defective equipment, or to group customers with similar behaviors for a sales campaign. It is the opposite of supervised learning. When learning data contains only some indications without any description or labels, it is up to the coder or to the algorithm to find the structure of the underlying data, to discover hidden patterns, or to determine how to describe the data. We may not exactly know what the criteria of classification would be. So, an unsupervised learning algorithm tries to classify the given dataset into a certain number of groups in an optimum way.

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**Semi-supervised Learning:**

If some learning samples are labeled, but some other are not labeled, then it is semi-supervised learning. It makes use of a large amount of unlabeled data for training and a small amount of labeled data for testing. Semi-supervised learning is applied in cases where it is expensive to acquire a fully labeled dataset while more practical to label a small subset.

**Reinforcement Learning:**

Here learning data gives feedback so that the system adjusts to dynamic conditions in order to achieve a certain objective. The system evaluates its performance based on the feedback responses and reacts accordingly.

**Challenges and Limitations of Machine learning:**

The primary challenge of machine learning is the lack of data or the diversity in the dataset. A machine cannot learn if there is no data available. Besides, a dataset with a lack of diversity gives the machine a hard time. A machine needs to have heterogeneity to learn meaningful insight. It is rare that an algorithm can extract information when there are no or few variations. It is recommended to have at least 20 observations per group to help the machine learn. This constraint leads to poor evaluation and prediction.

**Application of Machine learning :**

1. **Augmentation:**

Machine learning, which assists humans with their day-to-day tasks, personally or commercially without having complete control of the output. Such machine learning is used in different ways such as Virtual Assistant, Data analysis, software solutions.

1. **Finance Industry:**

Machine learning is growing in popularity in the finance industry. Banks are mainly using ML to find patterns inside the data but also to prevent fraud.

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# ALGORITHMS

**Machine Learning Algorithms Used:**

* Support Vector Machine (SVM)
* Decision Tree (DT)
* Random Forest (RF)
* XGBoost
* Bagging
* Neural Networks (mentioned for future enhancement)

**Feature Selection Techniques:**

* Chi-Square Test
* ANOVA (Analysis of Variance)
* Mutual Information

**Data Balancing Technique:**

* SMOTE (Synthetic Minority Oversampling Technique)

**Explainability Approach:**

* SHAP (SHapley Additive exPlanations)

**Performance Metrics Used:**

* Accuracy
* Precision
* Recall (Sensitivity)
* Specificity
* F1 Score
* AUC (Area Under Curve)

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# 4.3 SAMPLE CODE

settings.py

import os

# Build paths inside the project like this: os.path.join(BASE\_DIR, ...)

BASE\_DIR = os.path.dirname(os.path.dirname(os.path.abspath(\_\_file\_\_)))

# Quick-start development settings - unsuitable for production

# See https://docs.djangoproject.com/en/3.0/howto/deployment/checklist/

# SECURITY WARNING: keep the secret key used in production secret!

SECRET\_KEY = 'm+1edl5m-5@u9u!b8-=4-4mq&o1%agco2xpl8c!7sn7!eowjk#'

# SECURITY WARNING: don't run with debug turned on in production!

DEBUG = True

ALLOWED\_HOSTS = []

# Application definition

INSTALLED\_APPS = [

'django.contrib.admin',

'django.contrib.auth',

'django.contrib.contenttypes',

'django.contrib.sessions',

'django.contrib.messages',

'django.contrib.staticfiles',

'Remote\_User',

'Service\_Provider',

]

MIDDLEWARE = [

'django.middleware.security.SecurityMiddleware',

'django.contrib.sessions.middleware.SessionMiddleware',

'django.middleware.common.CommonMiddleware',

'django.middleware.csrf.CsrfViewMiddleware',

'django.contrib.auth.middleware.AuthenticationMiddleware',

'django.contrib.messages.middleware.MessageMiddleware',

'django.middleware.clickjacking.XFrameOptionsMiddleware',

]

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ROOT\_URLCONF = 'heart\_disease\_identification.urls'

TEMPLATES = [

{

'BACKEND': 'django.template.backends.django.DjangoTemplates',

'DIRS': [(os.path.join(BASE\_DIR,'Template/htmls'))],

'APP\_DIRS': True,

'OPTIONS': {

'context\_processors': [

'django.template.context\_processors.debug',

'django.template.context\_processors.request',

'django.contrib.auth.context\_processors.auth',

'django.contrib.messages.context\_processors.messages',

],

},

},

]

WSGI\_APPLICATION = 'heart\_disease\_identification.wsgi.application'

# Database

# https://docs.djangoproject.com/en/3.0/ref/settings/#databases

DATABASES = {

'default': {

'ENGINE': 'django.db.backends.mysql',

'NAME': 'heart\_disease\_identification',

'USER':'root',

'PASSWORD': '',

'HOST' :'127.0.0.1',

'PORT' :'3306',

}

}

# Password validation

# https://docs.djangoproject.com/en/3.0/ref/settings/#auth-password-validators

AUTH\_PASSWORD\_VALIDATORS = [

{

'NAME': 'django.contrib.auth.password\_validation.UserAttributeSimilarityValidator',

},

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'NAME': 'django.contrib.auth.password\_validation.MinimumLengthValidator',

},

{

'NAME': 'django.contrib.auth.password\_validation.CommonPasswordValidator',

},

{

'NAME': 'django.contrib.auth.password\_validation.NumericPasswordValidator',

},

]

# Internationalization

# https://docs.djangoproject.com/en/3.0/topics/i18n/

LANGUAGE\_CODE = 'en-us'

TIME\_ZONE = 'UTC'

USE\_I18N = True

USE\_L10N = True

USE\_TZ = True

# Static files (CSS, JavaScript, Images)

# https://docs.djangoproject.com/en/3.0/howto/static-files/

STATIC\_URL = '/static/'

STATICFILES\_DIRS = [os.path.join(BASE\_DIR,'Template/images')]

MEDIA\_URL = '/media/'

MEDIA\_ROOT = os.path.join(BASE\_DIR, 'Template/media')

STATIC\_ROOT = '/static/'

STATIC\_URL = '/static/'

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# Wsgi.py

"""

WSGI config for fakedetector project.

It exposes the WSGI callable as a module-level variable named ``application``.

For more information on this file, see

https://docs.djangoproject.com/en/3.0/howto/deployment/wsgi/

"""

import os

from django.core.wsgi import get\_wsgi\_application

os.environ.setdefault('DJANGO\_SETTINGS\_MODULE', 'heart\_disease\_identification.settings')

application = get\_wsgi\_application()

asgi.py

"""

ASGI config for heart\_disease\_identification.

It exposes the ASGI callable as a module-level variable named ``application``.

For more information on this file, see

https://docs.djangoproject.com/en/3.0/howto/deployment/asgi/

"""

import os

from django.core.asgi import get\_asgi\_application

os.environ.setdefault('DJANGO\_SETTINGS\_MODULE', 'heart\_disease\_identification.settings')

application = get\_asgi\_application()

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# 5.TESTING

**5.1 TESTING METHODS**

**Introduction**

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

**Types of tests**

**1.** **Unit testing:**

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform sic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

**2**. **Integration testing**:

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields.

Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components

**3.** **Functional test:**

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

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|  |  |  |
| --- | --- | --- |
| Valid Input | : | identified classes of valid input must be accepted. |
| Invalid Input | : | identified classes of invalid input must be rejected. |
| Functions | : | identified functions must be exercised. |

**Systems/Procedures** : .

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

**1. System Test:**

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

**2. White Box Testing:**

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

**3. BlackBox Testing**:

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot “see” into it.

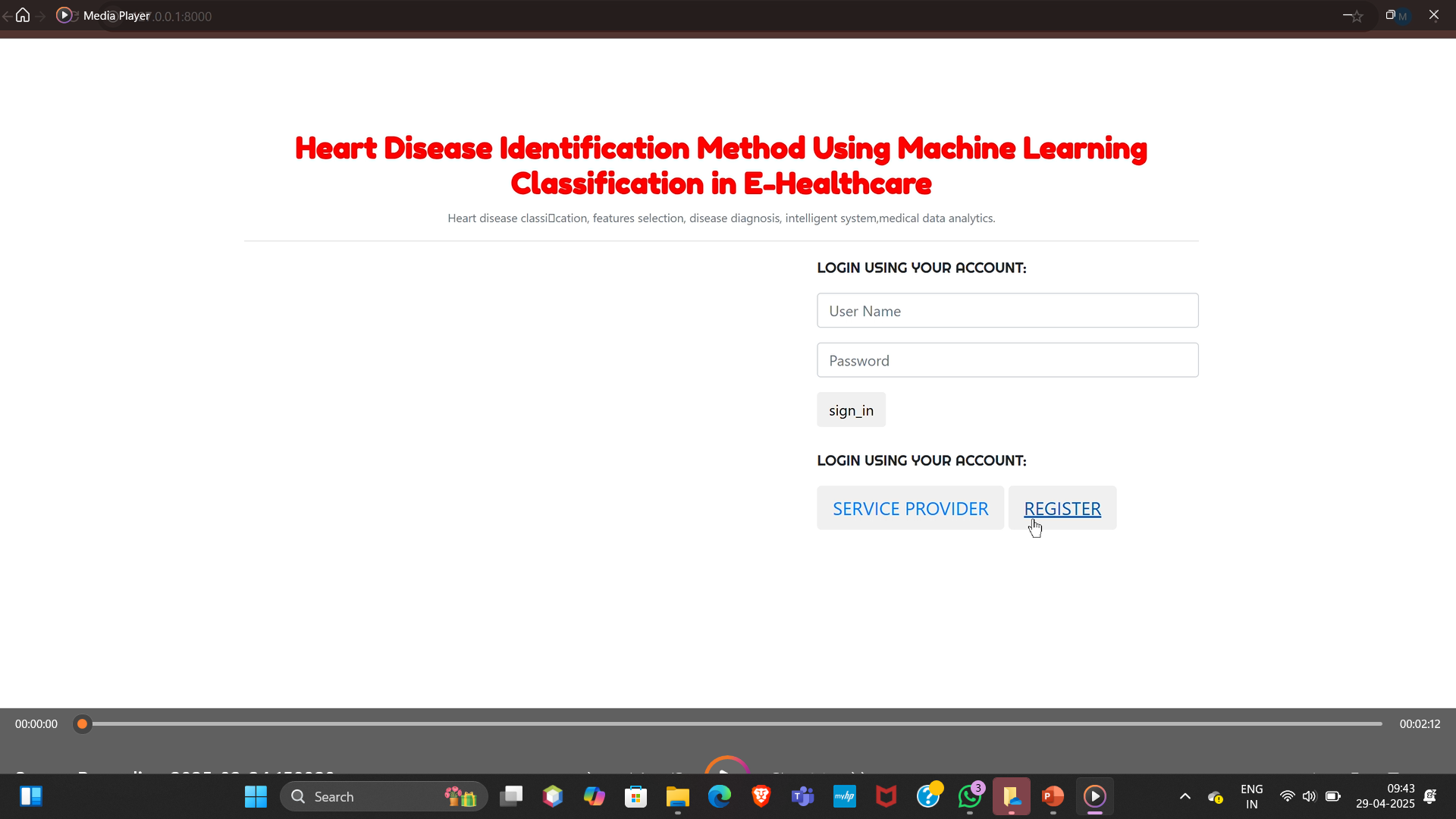
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**3. BlackBox Testing**:

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

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# 6.RESULTS

Fig 6.1

# A screenshot of a computer AI-generated content may be incorrect.

Fig 6.2

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# 

# Fig 6.3

# A screen shot of a computer AI-generated content may be incorrect.

Fig 6.4

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# 7.CONCLUSION

The **Heart Disease Prediction System using Machine Learning (ML)** represents a significant leap forward in cardiovascular healthcare by providing an efficient, data-driven approach to predicting heart disease risk. By leveraging a variety of medical and lifestyle data such as age, gender, blood pressure, cholesterol levels, and other biomarkers, the system can accurately identify individuals at risk for heart disease before symptoms arise. This allows for earlier intervention and preventive measures, potentially saving lives and reducing healthcare costs. Unlike traditional methods, which may rely heavily on subjective interpretation or limited data points, ML algorithms can process large volumes of data and identify complex patterns that lead to more precise and reliable predictions.

Furthermore, the integration of machine learning models into heart disease prediction enhances the ability to personalize healthcare. By continuously updating with new data, these models can adapt to evolving risk factors and provide dynamic, real-time assessments. This adaptability ensures that individuals receive the most accurate risk predictions, enabling clinicians to design personalized treatment plans. As the system improves over time through training on larger and more diverse datasets, it has the potential to become an essential tool in both clinical and preventive healthcare, aiding in the fight against heart disease by making predictive healthcare more accessible, timely, and effective.

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