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# HEART DISEASE PREDECTION USING BIO-INSPIRED ALGORITHMS

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## ABSTRACT

Heart related diseases or Cardiovascular Diseases (CVDs) are the main reason for a huge number of death in the world over the last few decades and has emerged as the most life-threatening disease, not only in India but in the whole world. So, there is a need of reliable, accurate and feasible system to diagnose such diseases in time for proper treatment. Machine Learning algorithms and techniques have been applied to various medical datasets to automate the analysis of large and complex data. Many researchers, in recent times, have been using several machine learning techniques to help the health care industry and the professionals in the diagnosis of heart related diseases. This paper presents a survey of various models based on such algorithms and techniques and analyze their performance. Models based on supervised learning algorithms such as Support Vector Machines (SVM), K-Nearest Neighbour (KNN), NaïveBayes, Decision Trees (DT), Random Forest (RF) and ensemble models are found very popular among the researchers.

## INTRODUCTION

Heart disease is one of the leading causes of death worldwide, accounting for millions of fatalities each year. It includes various cardiovascular conditions such as coronary artery disease, heart failure, and arrhythmias. Early detection and accurate diagnosis of heart disease are crucial for reducing mortality rates and improving patient outcomes. However, traditional diagnostic methods rely heavily on clinical expertise, medical tests, and sometimes invasive procedures, which can be time-consuming, costly, and prone to human error.

With the rapid advancement of Artificial Intelligence (AI) and Machine Learning (ML), predictive models have been developed to assist healthcare professionals in diagnosing heart disease at an early stage. These models analyze patient data such as age, blood pressure, cholesterol levels, heart rate, and other medical parameters to predict the likelihood of heart disease. However, the performance of these models largely depends on the quality of features and proper tuning of model parameters.

Bio-inspired algorithms, also known as metaheuristic algorithms, are computational techniques inspired by natural processes such as evolution, swarm behavior, and animal hunting strategies. Popular bio-inspired algorithms include Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Ant Colony

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Optimization (ACO), Grey Wolf Optimization (GWO), and Salp Swarm Algorithm (SSA). These algorithms are widely used for feature selection, parameter optimization, and improving the performance of machine learning models.

In heart disease prediction systems, bio-inspired algorithms help in selecting the most relevant features from medical datasets and optimizing classification models such as Support Vector Machines (SVM), Random Forest, and Artificial Neural Networks (ANN), XG Boost, Gradient Boost. This leads to improved accuracy, reduced computational complexity, and better generalization of the model.

Despite their advantages, bio-inspired algorithms also present challenges such as increased computational cost, risk of convergence to local optima, and the need for careful parameter tuning. Therefore, researchers are focusing on hybrid approaches that combine multiple optimization techniques with machine learning models to achieve better performance.

In this context, this study explores the application of bio-inspired algorithms in heart disease prediction, analyzing various techniques, advantages, limitations, and future research directions through a comprehensive literature survey.

## LITERATURE SURVEY

### 1. Heart Disease Prediction Using Machine Learning

**Authors:** Detrano et al.
**Description:**
This study used machine learning models such as logistic regression and decision trees for heart disease prediction using clinical datasets.

**Techniques:**

- Logistic Regression
- Decision Trees

**Pros:**

- Simple implementation
- Good baseline accuracy

**Cons:**

- Limited optimization capability

### 2. Genetic Algorithm for Feature Selection

**Authors:** Holland (GA Theory)
**Description:**
Genetic Algorithms are used to select optimal features from medical datasets, improving classification accuracy.

**Techniques:**

- Genetic Algorithm
- Feature optimization

**Pros:**

- Reduces dimensionality
- Improves accuracy

**Cons:**

- Computationally expensive

### 3. PSO-Based Heart Disease Prediction

**Authors:** Kennedy & Eberhart
**Description:**
Particle Swarm Optimization improves model performance by optimizing feature selection and classifier parameters.

**Techniques:**

- PSO
- Neural Networks

**Pros:**

- Fast convergence
- Efficient optimization

**Cons:**

- May get stuck in local minima

**4. Hybrid Bio-Inspired Models**

**Authors:** Various (Recent Studies)
**Description:**
Hybrid models combining GA, PSO, and machine learning show improved prediction accuracy in healthcare systems.

**Techniques:**

- Hybrid optimization
- Ensemble learning

**Pros:**

- High accuracy
- Robust performance

**Cons:**

- Complex implementation

## SYSTEM ANALYSIS

### EXISTING SYSTEM

In the traditional healthcare system, heart disease diagnosis is mainly performed by doctors using clinical tests and medical experience. The diagnosis depends on various factors such as blood pressure, cholesterol level, ECG results, age, and lifestyle habits. Doctors analyze patient reports manually to determine the possibility of heart disease.

Heart related infections or Cardiovascular Diseases (CVDs) are the primary justification a colossal number of death on the planet in the course of the most recent couple of many years and has arisen as the most perilous illness, in India as well as in the entire world. Along these lines, there is a need of dependable, precise and attainable framework to analyze such sicknesses on schedule for legitimate therapy. Some early computerized systems used basic statistical methods or simple machine learning algorithms to analyze medical data. However, these systems often relied on limited datasets and single algorithms, which reduced prediction accuracy. The process can also be time-consuming and requires expert interpretation. Many algorithms are implemented to predict the heart diseases but they lack accuracy and efficiency.

**Features of Existing System**

- Manual diagnosis
- Basic ML models
- Limited feature selection
- Low accuracy in complex cases

**DISADVANTAGES OF EXISTING SYSTEM**

- Manual diagnosis dependency – Highly dependent on doctor expertise.

- Time-consuming process – Requires multiple medical tests and analysis.
- Lower prediction accuracy – Traditional statistical methods may not capture complex patterns.
- Limited data utilization – Many systems cannot handle large healthcare datasets effectively.
- Higher cost – Repeated tests and consultations increase medical expenses.
- Delayed detection – Early-stage heart disease may not be detected quickly.

## PROPOSED SYSTEM

We are evaluating performance of various classification/prediction algorithms such as SVM, Naïve Bayes, and Logistic Regression etc to predict heart disease. All this algorithms are good in prediction but accuracy is not good enough. To get better prediction accuracy author is combining two classification algorithms such as Linear Model and Random Forest to build new algorithm called Hybrid Machine Learning to get better prediction accuracy of heart dataset. HRFLM and extreme extension algorithm both algorithms gives better accuracy. So by using hybrid model always we will have better prediction accuracy algorithm which helps in better prediction of heart disease.

### Key Features

- Genetic Algorithm for feature selection
- Particle Swarm Optimization for parameter tuning
- Machine learning classifiers (SVM, Random Forest, ANN)
- High prediction accuracy
- Automated diagnosis system

### Advantages

- Early detection of heart disease.
- Higher prediction accuracy using machine learning models.
- Fast and automated diagnosis support.
- Reduces dependency on manual analysis.
- Helps doctors in clinical decision making.
- Cost-effective compared to repeated diagnostic tests.
- Can analyze large healthcare datasets efficiently.
- Improves patient monitoring and preventive healthcare.

## IMPLEMENTATION

### 1. Requirement Analysis

The implementation of the project **"Heart Disease Prediction Using Bio-Inspired Algorithms"** begins with analyzing the need for early and accurate diagnosis of cardiovascular diseases. Traditional systems lack optimization and often provide lower

prediction accuracy. The proposed system integrates bio-inspired algorithms with machine learning models to enhance feature selection and prediction performance.

## 2. System Design

The system architecture is designed for intelligent data processing and optimized prediction.

### Main Modules

- Data Collection Module
- Data Preprocessing Module
- Feature Selection Module
- Bio-Inspired Optimization Module
- Machine Learning Prediction Module
- Evaluation Module

## 3. Data Collection

The system collects medical datasets related to heart disease prediction.

### Data Attributes

- Age
- Gender
- Blood Pressure
- Cholesterol Level
- Heart Rate
- Chest Pain Type
- ECG Results
- Blood Sugar Level

## 4. Data Preprocessing

The collected dataset undergoes preprocessing to improve data quality.

### Preprocessing Steps

- Handling missing values
- Removing duplicates
- Data normalization
- Encoding categorical variables
- Noise removal

## 5. Feature Selection Using Bio-Inspired Algorithms

Feature selection is performed to identify the most relevant attributes.

### Algorithms Used

- Genetic Algorithm (GA)
- Particle Swarm Optimization (PSO)
- Ant Colony Optimization (ACO)

These algorithms reduce dimensionality and improve model accuracy.

## 6. Bio-Inspired Optimization

Bio-inspired algorithms optimize the selection of features and model parameters.

### Optimization Functions

- Fitness evaluation
- Selection, crossover, mutation (GA)
- Velocity and position update (PSO)
- Pheromone update (ACO)

This improves convergence and prediction efficiency.

# METHODOLOGY

## 1. Data Acquisition

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The methodology begins with collecting heart disease datasets from medical repositories.

**Data Sources**

- Hospital databases
- Public datasets (e.g., UCI Repository)

**2. Data Cleaning and Preparation**

The collected data is cleaned and prepared for analysis.

**Processing Steps**

- Remove missing values
- Normalize data
- Encode categorical variables

**3. Feature Engineering**

Relevant features are extracted from the dataset.

**Features**

- Clinical parameters
- Lifestyle indicators
- Medical history

**4. Bio-Inspired Feature Selection**

Bio-inspired algorithms are applied to select optimal features.

**Workflow**

1. Initialize population
2. Evaluate fitness
3. Select best features
4. Optimize feature subset

**5. Model Training**

Machine learning models are trained using selected features.

**Training Process**

- Input optimized dataset
- Train classifiers
- Tune parameters

**6. Prediction Process**

The trained model predicts heart disease.

**Steps**

- Input new patient data
- Apply preprocessing
- Use trained model
- Generate prediction

**7. Optimization Process**

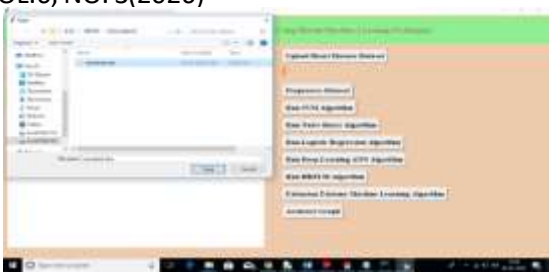
Bio-inspired algorithms optimize model performance.

**Optimization Steps**

- Adjust parameters
- Improve accuracy
- Reduce error

## Results:

Upload Heart Disease Dataset – Click the “Upload Heart Disease Dataset” button to load the heart disease dataset into the application.



Preprocess and Run Algorithms – After uploading the dataset, click “Preprocess Dataset” and then run machine learning algorithms such as SVM, Naive Bayes, Logistic Regression, Deep Learning ANN, HRFLM, or Extreme Machine Learning to perform heart disease prediction.

Run Machine Learning Algorithms – After uploading and preprocessing the dataset, different algorithms such as SVM, Naive Bayes, Logistic Regression, Deep Learning ANN, and HRFLM can be executed to predict heart disease and compare accuracy results.

Heart Disease Dataset Loading

The system successfully loads the heart disease dataset.

The dataset contains 303 records, which will be used for analysis and prediction.

Multiple Machine Learning Algorithms for Prediction

The application allows users to preprocess data and run different algorithms such as SVM, Naïve Bayes, Logistic Regression, Deep Learning ANN, HRFLM, and Extreme Machine Learning.

Heart Disease Dataset Loading

The system successfully loads the heart disease dataset.

The dataset contains 303 records, which will be used for analysis and prediction.

Multiple Machine Learning Algorithms for Prediction

The application allows users to preprocess data and run different algorithms such as SVM, Naïve Bayes, Logistic Regression, Deep Learning ANN, HRFLM, and Extreme Machine Learning.

It also provides an Accuracy Graph to compare the performance of these algorithms.

matrix of [[24, 6], [17, 13]], showing the classification results for heart disease prediction.

Naïve Bayes Algorithm Performance:

The heart disease prediction system uses the Naïve Bayes algorithm and generates a classification report with precision, recall, F1-score, and confusion matrix metrics.

Prediction Accuracy:

The Naïve Bayes model achieved an accuracy of approximately 71.67%, with a confusion matrix of [[25, 5], [12, 18]], indicating better performance than the previously shown SVM result.

Logistic Regression for Heart Disease Prediction:

The system evaluates the Logistic Regression algorithm and displays its classification report, including precision, recall, F1-score, and confusion matrix.

Model Accuracy Result:

The Logistic Regression model achieved an accuracy of approximately 68.33%, with a confusion matrix of [[20, 9], [10, 21]], showing its effectiveness in classifying heart disease cases.

Deep Learning ANN Evaluation:

The system runs a Deep Learning Artificial Neural Network (ANN) model for heart disease prediction and displays its performance results.

Model Accuracy Result:

The Deep Learning ANN achieved an accuracy of approximately 45.15%, indicating lower prediction performance compared to the other machine learning algorithms shown earlier.

HRFLM Hybrid Algorithm Performance:

The proposed HRFLM (Hybrid Random Forest Learning Model) algorithm is used for heart disease prediction and its performance is evaluated using a classification report and confusion matrix.

Highest Accuracy Achieved:

The HRFLM algorithm achieved an accuracy of approximately 83.33%, with a confusion matrix of [[27, 3], [7, 23]], making it the best-performing model among the algorithms shown.

Extreme Machine Learning (EML) Algorithm Evaluation:

The system evaluates the Extreme Machine Learning (EML) algorithm for heart disease prediction and displays its classification report, including precision, recall, F1-score, and confusion matrix.

Highest Accuracy Achieved:

The Extension Extreme Machine Learning algorithm achieved an accuracy of approximately 92.67%, making it the best-performing model among all the evaluated algorithms for heart disease prediction.

Accuracy Comparison of Algorithms:

The bar chart compares the prediction accuracies of multiple heart disease prediction models, including SVM, Naïve Bayes, ANN, Logistic Regression, HRFLM, and Extension EML.

Best Performing Model:

The Extension Extreme Machine Learning (EML) algorithm achieved the highest accuracy (about 92.67%), followed by HRFLM (83.33%), while ANN showed the lowest accuracy (about 45.15%).

## CONCLUSION

The proposed system demonstrates an efficient and intelligent approach to heart disease prediction using bio-inspired algorithms. By integrating optimization techniques like Genetic Algorithm, PSO, and ACO with machine learning models, the system achieves higher accuracy and reliability compared to traditional methods. The system reduces human error, supports early diagnosis, and assists healthcare professionals in making informed decisions. Future enhancements can include real-time monitoring and integration with wearable health devices.

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