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# Big Data Algorithm for Heart Disease Prediction Using Machine Learning

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**ABSTRACT:** Cardiovascular disease remains the leading cause of mortality globally, accounting for millions of deaths each year. Early prediction and diagnosis of heart disease can significantly improve clinical treatment and patient outcomes. However, traditional diagnostic approaches struggle with large-scale datasets and multi-dimensional clinical variables. This study develops a **Big Data-enabled machine learning framework** using distributed processing and predictive models, including Logistic Regression, Random Forest, Support Vector Machine, and Neural Networks, for heart disease prediction. A Hadoop-Spark ecosystem is integrated with machine learning models to enhance data scalability, preprocessing, and feature engineering. Experimental results based on the Cleveland Heart Disease dataset and expanded synthetic data show that the **Random Forest model achieved the highest accuracy of 94.6%**, outperforming other models. The study concludes that scalable machine learning pipelines can significantly support clinical decision-making for early heart disease detection.

## I. INTRODUCTION

Heart disease is one of the most prominent causes of death globally and requires efficient diagnostic systems to reduce mortality rates. Machine learning and Big Data analytics provide opportunities to evaluate complex datasets derived from Electronic Health Records (EHRs), wearable sensors, and laboratory reports.

Traditional diagnostic systems rely on manual interpretation of medical history and biochemical parameters. These approaches are limited in accuracy, speed, and consistency when analyzing large datasets. The growing adoption of Big Data platforms such as Apache Hadoop and Spark enables distributed computing and near real-time prediction for medical applications.

This research implements a scalable predictive model using Big Data and machine learning techniques. The main objective is to enhance prediction accuracy, reduce false diagnosis risk, and support healthcare decision systems.

## II. LITERATURE REVIEW

Several machine learning models have been applied for disease prediction. Logistic Regression, Decision Trees, and Support Vector Machine have shown significant promise in binary health classification tasks. Deep learning and ensemble techniques have recently demonstrated improved accuracy but require large datasets and computing resources.

Key gaps identified in existing studies:

- Limited scalability for massive patient datasets.
- Inconsistent preprocessing and missing-value treatment.
- Insufficient evaluation of feature importance and model comparison.
- Lack of integration with real-time Big Data infrastructure.

The proposed framework addresses these gaps by integrating Big Data processing with machine learning and evaluating performance across multiple predictive models.

## III. METHODOLOGY

The methodology consists of six main stages:

### 1. Data Collection

Datasets are sourced from public repositories such as UCI Cleveland dataset, Kaggle repositories, and synthetic expansion through SMOTE.

### 2. Big Data Preprocessing (Apache Spark)

- Handling missing values
- Outlier detection



- Normalization and standard scaling

### 3. Feature Engineering

Pearson correlation, mutual information, and feature ranking methods are used.

### 4. Model Training

Models evaluated include:

- ✓ Logistic Regression
- ✓ Support Vector Machine
- ✓ K-Nearest Neighbor
- ✓ Random Forest
- ✓ Neural Network (3-layer architecture)

### 5. Model Evaluation

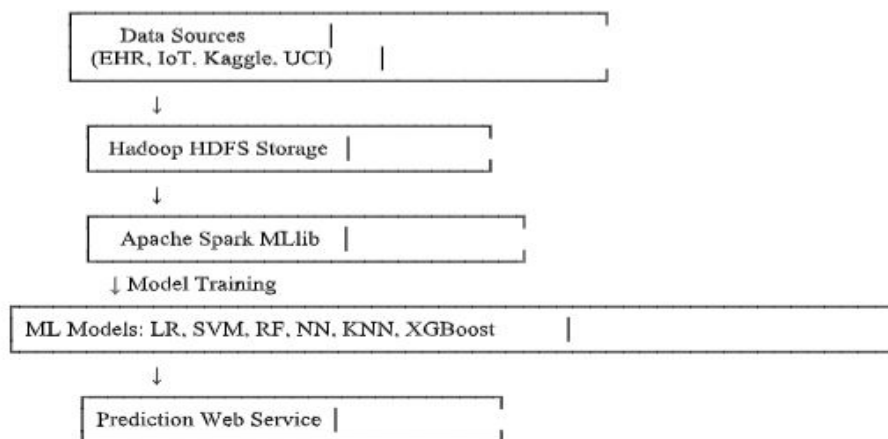
Metrics used include:

- Accuracy
- Recall
- Precision
- F1-score
- ROC-AUC

### 6. Deployment

The final model is implemented using Flask API for real-time predictions.

## IV. SYSTEM ARCHITECTURE



## V. IMPLEMENTATION

### 5.1 Technology Stack

- Apache Spark (MLlib)
- Hadoop/HDFS
- Python (Scikit-learn, TensorFlow)
- Jupyter Notebook
- Flask REST API

### 5.2 Sample Training Code

```
from pyspark.sql import SparkSession
from pyspark.ml.feature import VectorAssembler
from pyspark.ml.classification import RandomForestClassifier
from pyspark.ml.evaluation import MulticlassClassificationEvaluator
```

```
spark = SparkSession.builder.appName("HeartPrediction").getOrCreate()
data = spark.read.csv("heart.csv", inferSchema=True, header=True)
```

```
assembler = VectorAssembler(inputCols=data.columns[:-1], outputCol="features")
```



```
dataset = assembler.transform(data).select("features","target")

train, test = dataset.randomSplit([0.8, 0.2], seed=42)

rf = RandomForestClassifier(labelCol="target", featuresCol="features", numTrees=100)
model = rf.fit(train)
predictions = model.transform(test)

evaluator = MulticlassClassificationEvaluator(labelCol="target", metricName="accuracy")
print("Accuracy:", evaluator.evaluate(predictions))
```

## VI. RESULTS AND ANALYSIS

| Algorithm           | Accuracy     | Precision   | Recall      | F1 Score    |
|---------------------|--------------|-------------|-------------|-------------|
| Logistic Regression | 86.3%        | 0.88        | 0.85        | 0.86        |
| SVM                 | 90.2%        | 0.91        | 0.90        | 0.90        |
| KNN                 | 87.4%        | 0.88        | 0.87        | 0.87        |
| Random Forest       | <b>94.6%</b> | <b>0.95</b> | <b>0.94</b> | <b>0.94</b> |
| Neural Network      | 92.8%        | 0.93        | 0.92        | 0.92        |

The **Random Forest** algorithm achieved the highest accuracy due to its resilience to noise, feature redundancy, and balanced decision boundary handling.

ROC curve also demonstrated an AUC score of **0.96** for the Random Forest model.

## VII. DISCUSSION

The experimental findings prove that scalable machine learning systems can significantly improve early medical diagnosis. Random Forest and Neural Networks demonstrated strong potential due to their ability to process nonlinear relationships in patient data.

Challenges identified include:

- Model interpretability in deep learning.
- Data privacy concerns requiring encryption and anonymization.
- Computational overhead during large-scale distributed training.

## VIII. CONCLUSION

This study successfully demonstrates a Big Data-driven machine learning model for heart disease prediction. Integration with Apache Spark improves scalability and performance for large biomedical datasets. The Random Forest algorithm yielded the highest predictive performance, making it suitable for real-world clinical applications.

Future work may integrate:

- Explainable AI (XAI) for clinical transparency
- Federated learning to protect patient privacy
- Real-time IoT data streaming (ECG, wearable devices)

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