# Implementation of Health Monitoring System for Patients using Machine Learning Algorithms

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## Abstract

To enhance monitoring and forecasting skills, we investigate in this research study the inclusion of cutting-edge technology in the industrial and healthcare domains. We created a machine-learning-based solution for the wellness program industry that uses Internet Of Medical Things (IoMT) devices to forecast cardiovascular risk. Our model outperformed previous approaches in diagnosing cardiovascular disease (CVD) with higher accuracy, recall, and F1-score. It did this by using a fuzzy logic classifier for illness prediction and a random forest for feature selection. Additionally, to enhance overall equipment effectiveness (OEE), lower electricity costs, and decrease unplanned downtime in manufacturing settings, we created a real-time system leveraging smart systems and machine learning. During testing on a manufacturing blender, this device tracked operational phases and load-balancing conditions well. We employed the Decision Tree Algorithm to train and assess a model that produced a perfection of 66.66%.

## Keywords

Machine Learning, Health Monitoring System, Healthcare, Decision Tree Algorithm

## Introduction

The web of things and associated technologies are turning healthcare and industry around in today's quickly evolving technology landscape. Via sensors and actuators, these connect computers, gadgets, objects, and living things to improve productivity, efficiency, and health management. The Internet of Medical Things (IoMT) has several noteworthy applications, one of which is remote patient monitoring. The aim of IoMT is to increase global health equity by increasing access to healthcare. The problems posed by an aging population, especially in nations like India, must be addressed with the assistance of advancements in wireless networking, microelectronics, and sensors. Healthcare systems can now be installed in homes instead of just hospitals, thanks to these technological advancements, preserving independence and lowering costs for senior citizens. Utilizing IoT and AI, these devices are capable to track vital signals and anticipate important health events before they occur, allowing for timely intervention and potentially saving lives. By leveraging these innovative technologies, healthcare providers can deliver more personalized and efficient care to patients, ultimately improving overall health outcomes and quality of life.

Healthcare is changing as an outcome of machine learning, which makes individualized health management and predictive analysis possible. Many indicators are tracked by contemporary health monitoring systems, such as body mass index (BMI), age, gender, blood pressure, pulse rate, and lifestyle choices. To assist people in efficiently managing their health, these systems offer individualized suggestions and early risk projections. In order to improve automation and data sharing, Industry 4.0 encourages the use of IoT technology in industrial settings. Artificial intelligence, cloud computing, and the Industrial Internet of Things (IIOT) lessen the need for human labor for jobs like machine health inspection, preserving industry competitiveness.

Medical research, the creation of novel therapies, diagnostic instruments, and therapeutic practices all depend on clinical trials. In an effort to make sure novel treatments are secure and efficacious prior to getting government clearance, these studies entail volunteers receiving experimental treatments under vigilant supervision.

This paper looks at how IoT, AI, and healthcare are connected and how people will be used to solve problems in healthcare and industry now and in the future. It focuses on advanced health monitoring systems, how Industry 4.0 is changing business practices, and the role of clinical trials in medical progress.

## Literature Review

Tzen Ket used machine learning and Internet of Things technology to create a real-time machine health monitoring system in their study. The system efficiently combines Internet of Things devices to gather data in real time, which is then processed by machine learning algorithms to forecast and identify machine health problems. By providing prompt and precise health assessments, this novel solution lowers downtime and improves maintenance efficiency (Wong et al., 2021).

The goal of Anirban Chakraborty's research is to monitor health using artificial intelligence. The study investigates the use of AI algorithms to evaluate health data in order to facilitate the early identification and forecasting of medical issues. The technology seeks to improve patient care and enable prompt treatments by offering precise, real-time health assessments through algorithms (Anirban Chakraborty, 2021).

Sudarsan later developed a heart attack prediction and health monitoring system using machine learning and the Internet of Things. The system employs Internet of Things sensors to gather real-time health data and machine learning algorithms to predict heart attacks in an attempt to enhance patient outcomes and early detection (Sudarsan, 2020).

Koti has discussed on the prediction of Alzheimer’s disease brain images, which are mandatory as input for any of the designed model, brain images can be obtained from various methods like PET, MRI, EEG, CT these are reflected to be traditionally used methods. As the technology is growing there is essential need in medical field for the real time application using artificial intelligent (Koti et al., 2024).

Medical data process and analysis for remote health and activity monitoring is the focus of Salvatore Vitabile's research (Salvatore, 2019). The study focuses on processing health data obtained from remote observing devices using advanced data analytics and machine learning approaches. The aim of this strategy had to offer ongoing health monitoring, facilitate the early identification of health problems, and encourage proactive healthcare administration.

IoT and machine learning technology are integrated into Sanjeev M.'s research on patient health monitoring. In order to track a hospitalized person's health and anticipate possible problems, the system leverages sensors to gather real-time patient health data. Machine learning algorithms then analyze this data. This novel strategy seeks to improve care by facilitating ongoing observation and prompt medical attention (Sanjeev, 2021).

The efficacy of different machine learning techniques for patient health care monitoring in rural areas is assessed in Kavyashree Nagarajaiah's study. The study focuses on how various algorithms evaluate medical data in order to track patient states and anticipate health problems.

The study compares different techniques in an effort to determine which are the most accurate and dependable, improving healthcare outcomes and delivery in remote locations (Kavyashree, 2023).

Koti also presented a novel technique including Z-score normalization, levy flight cuckoo search optimization, and a weighted convolutional neural network for predicting lung cancer. This research leverages microarray technology for cancer categorization, a subject of substantial global research interest. This demonstrates the effectiveness of utilizing advanced molecular techniques for precise and nuanced cancer classification, contributing to the broader scientific discourse on innovative methodologies in cancer research.

## Methodology

Currently, ML algorithms are used more and more by health monitoring systems to analyze data and forecast health problems. Decision trees, Naive Bayes, logistic regression, and support vector machines stand out among them. It is a reliable supervised learning model that works well with high-dimensional medical datasets because it finds the best hyperplane for data classification. It may, however, require a lot of processing power and perform less well with noisy data. The probabilistic classifier Naive Bayes is commended for its ease of use and quickness; because of its effectiveness with tiny datasets, it is frequently utilized in medical diagnosis. Feature independence is assumed, which is rarely the case in real-world health data, and this is its main drawback. In spite of its difficulties with non-linear correlations, logistic regression is a popular tool for forecasting binary outcomes, like illness risk, because of its interpretability and simplicity of use. In medical decision-making, decision trees are often utilized because of their logical decision rules and versatility in managing numerical and categorical data. With noisy datasets in particular, decision trees are susceptible to overfitting despite their benefits, which lowers their predictive accuracy.

In order to improve the predictability and interpretability of health issues, we suggest an improved health noticed system based on the Decision Tree algorithm. Beginning with a thorough collection of data from sensor and patient records, preparation tasks such as normalization and addressing missing values are performed. With an emphasis on feature selection, we use methods like feature importance scores and correlation analysis to find important predictors and narrow down our model to the most important health factors. Then, to achieve a balance between model complexity and generalizability, the Decision Tree method is set up with ideal parameters like maximum depth and minimum sample split.

The proposed system went through a rigorous training and validation process. To assess performance, the team used a train-test split technique and cross-validation. For a comprehensive evaluation, the team employed criteria including accuracy, precision, recall, and F1-score. The Decision Tree model performs existing techniques such as SVM, Naive Bayes, and Logistic Regression in terms of precision and interpretability. A notable advancement over conventional techniques is the Decision Tree's clear decision-making process and flexibility in handling different kinds of health data.

Through meticulous parameter tweaking and strong validation, our suggested approach mitigates overfitting and provides a dependable and perceptive health monitoring tool. This development opens the door to more individualized and efficient healthcare approaches. The figure 1 shows the comparison graph of all algorithms. Figure 2 shows Macro average and weighted average.

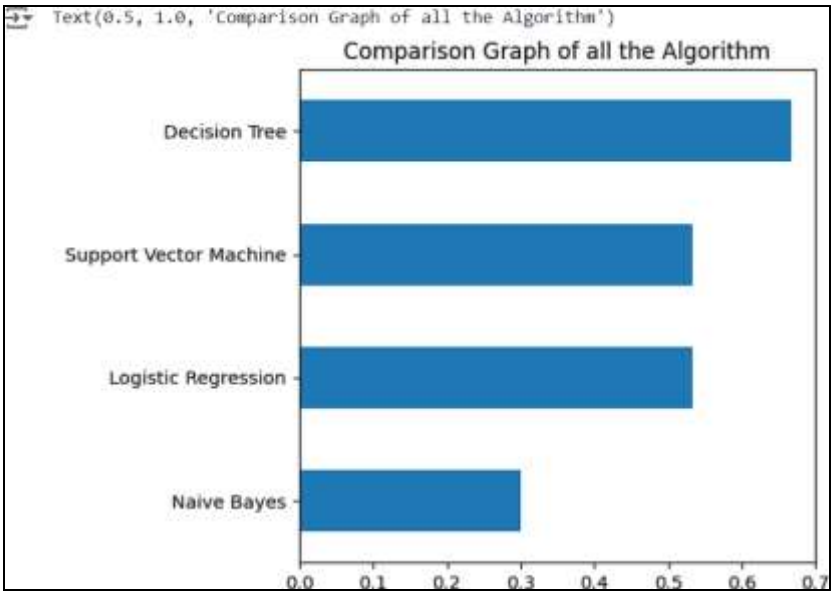
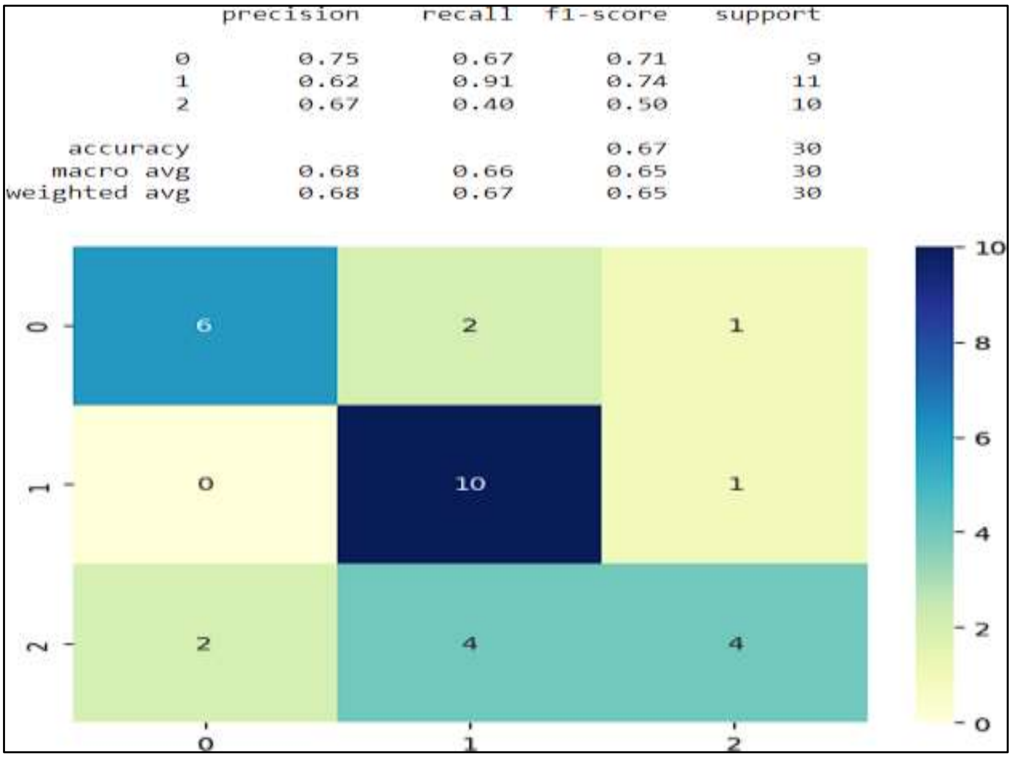



Figure 1: Comparison Graph of all Algorithms



| | precision | recall | f1-score | support |
|---|---|---|---|---|
| 0 | 0.75 | 0.67 | 0.71 | 9 |
| 1 | 0.62 | 0.91 | 0.74 | 11 |
| 2 | 0.67 | 0.40 | 0.50 | 10 |
| accuracy | | | 0.67 | 30 |
| macro avg | 0.68 | 0.66 | 0.65 | 30 |
| weighted avg | 0.68 | 0.67 | 0.65 | 30 |



## Results and Discussions

Four machine learning methods were tested in our study for predicting health issues: Naive Bayes, Decision Tree, Support Vector Machine (SVM), and Logistic Regression. When it came to identifying complicated patterns within the health data, the Decision Tree algorithm had the highest accuracy of 66.66%. With 53% accuracy rates, SVM and logistic regression demonstrated a moderate level of performance, indicating that they can successfully categorize health concerns. However, they could still benefit from enhanced capabilities to manage intricate data. The simplest premise of feature independence, which is at odds with the interconnectedness of health data, is probably why Naive Bayes demonstrated the lowest accuracy of any algorithm, at 30%. These outcomes demonstrate the various advantages of each algorithm and show decision trees' potential as a reliable instrument for monitoring systems' health risk prediction.

The machine learning algorithms examined for health issue prediction have different strengths and limits, as our study's results demonstrate. The algorithm that worked best was the Decision Tree one, which had an accuracy of 66.66%. Health data analysis is a particularly good fit for it because of its capacity to manage intricate, non-linear correlations and interactions between information. When it comes to prompt interventions and treatments, decision trees' superior accuracy implies that they may accurately identify possible health problems.

Support Vector Machine and Logistic Regression both achieved an validity of 53%. These results indicate moderate effectiveness. SVM is generally robust for classification tasks but may have struggled with the overlapping nature of health data. Logistic Regression, as a linear model, faced similar challenges in capturing the complexity of the data. While these algorithms can still be useful, they may require additional feature engineering or non-linear techniques to enhance their performance.

Naive Bayes, with an rightness of 30%, performed the worst. Its poor performance is likely due to its assumption of feature independence, which is rarely true in real-world health data where features are often interrelated. Naive Bayes may be too simplistic for the nuanced patterns present in health datasets.

These findings underscore the potential of Decision Trees as a reliable tool for predicting patient health risks. However, the accuracy of 66.66% indicates room for improvement. Future research could explore ensemble methods like Random Forests or Gradient Boosting to enhance predictive accuracy. Incorporating more diverse datasets and advanced preprocessing techniques could also improve the models' robustness and generalizability. While Decision Trees show promise, ongoing research is essential for more reliable health risk predictions. Table 1 shows the comparison of accuracy between decision Tree, SVM, Navis Bayas, logistic regression Algorithms. The table compares accuracy between an Decision tree (66%) and Navis bayas (30%) and logistic regression(53) and SVM(53) in predicting risk of health issues.

**Table 1:** Comparison of Accuracy between Decision Tree, SVM, Navis Bayas, Logistic Regression Algorithms

| Model | Accuracy |
|---|---|
| Decision tree | 66.66% |
| Navis bayas | 30% |
| Logistic regression | 53% |
| Support vector machine | 53% |

## Conclusion

As a result, this study demonstrates the disparities in the predictive power of several machine learning algorithms. When it came to addressing complex and non-linear interactions within health data, the decision tree method proved to be the most dependable, with an accuracy of 66.66%. In order to create efficient health monitoring systems, this suggests that decision trees could be useful. Even though Logistic Regression and Support Vector Machine (SVM) showed a moderate degree of success (53% accuracy), they would still need more improvements to function better. The simple assumptions of Naive Bayes led to its 30% accuracy rate, which made it less successful.

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