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Metrics Based Brain Stroke Prediction using Machine Learning Algorithms

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Abstract*— Using a dataset that includes lifestyle indicators, medical history, and demographic information, this study attempts to predict the risk of stroke with machine learning algorithms. Feature engineering and management of categorical variables are part of data preprocessing. Various techniques for classification are trained, such as Random Forest Classifier, Decision Tree Classifier, K-Nearest Neighbors (KNN), and Logistic Regression. Classification reports and accuracy ratings on training and testing datasets are used to evaluate the performance of the model. Furthermore, the Random Forest Classifier's feature importance analysis pinpoints important risk variables. The Random Forest Classifier outperforms the others, according to the promising accuracy results. Based on easily accessible demographic and health-related data, this shows that machine learning techniques can support early stroke risk assessment.

Index Terms*— Stroke prediction, Machine learning, Classification algorithms, Logistic Regression, Decision Tree Classifier, Random Forest Classifier, K-Nearest Neighbours (KNN), Feature importance, Accuracy evaluation.

I. INTRODUCTION

A stroke is a serious medical emergency that requires quick attention to prevent long-term damage or death from the disruption of blood flow to the brain. Assisting with the restoration of functionality and averting further decline require prompt medical interventions, such as the use of clot-dissolving drugs, surgical procedures to remove obstructions, or rehabilitation practices. In addition, preventive actions like leading a healthy lifestyle and controlling risk factors like diabetes and hypertension are essential in lowering the prevalence of strokes.

By utilizing extensive datasets that include lifestyle behaviours, medical histories, and demographic profiles, machine learning algorithms offer a promising approach to the prediction of strokes. These algorithms can identify complex patterns and nonlinear correlations that conventional statistical techniques might miss through sophisticated analysis. Through the integration of various data sources, including lifestyle factors, imaging data, and biomarkers, these models provide accurate and refined insights into the assessment of stroke risk.

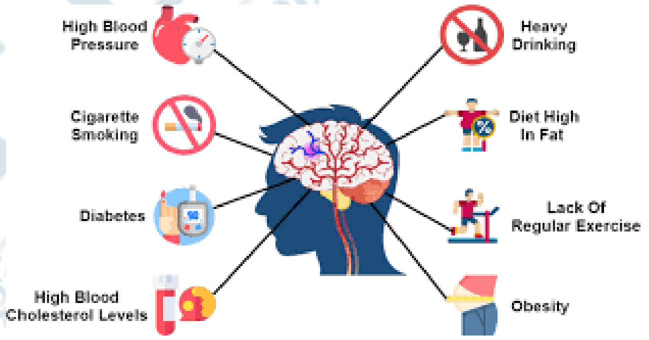

Figure 1

To predict strokes, the effectiveness of several machine learning algorithms, including logistic regression, random forest, support vector machines, and deep learning techniques, is being closely examined. Metrics like computational efficiency, interpretability, and predictive accuracy are used to evaluate each algorithm's performance, allowing researchers to determine which strategy is best for this crucial task. Through the utilization of these algorithms, healthcare professionals can optimize patient outcomes and lessen the societal impact of stroke-related morbidity and mortality by improving early intervention strategies and customizing preventive measures to meet individual needs.

Ultimately, clinical practice and public health initiatives could undergo a revolution with the creation of strong and trustworthy predictive models for stroke risk assessment. Through precise identification of individuals with an increased risk of stroke, healthcare practitioners can execute tailored interventions designed to mitigate risk factors and

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avert unfavourable consequences. Furthermore, larger population-based interventions and policies targeted at lessening the overall impact of stroke on society can be informed by these models.

The below is the information related to the dataset. This dataset is taken from local hospital that consists of around 50000 instances.

	gender	age	hypertension	heart_disease	ever_married	work_type	Residence_type	avg_glucose_level	bmi	smoking_status	stroke
0	Male	67.0	0	1	Yes	Private	Urban	228.69	36.6	formerly smoked	1
1	Male	80.0	0	1	Yes	Private	Rural	105.92	32.5	never smoked	1
2	Female	49.0	0	0	Yes	Private	Urban	171.23	34.4	smokes	1
3	Female	79.0	1	0	Yes	Self-employed	Rural	174.12	24.0	never smoked	1
4	Male	81.0	0	0	Yes	Private	Urban	186.21	29.0	formerly smoked	1

Figure 2 [Preprocessed]

II. LITERATURE SURVEY

Considering the increasing risk of strokes brought on by an ageing population, researchers are creating automated algorithms for stroke prediction to facilitate early intervention and save lives. A suggested machine learning technique shown excellent efficacy in prediction accuracy when compared to different classifiers; the best model achieved approximately 91% accuracy, while the others ranged from 83 to 91%. Using LIME and SHAP explainable approaches gave valuable information about how black-box machine learning models make decisions, which is important for the medical field. This approach can standardise complex models and improve stroke care by offering insights into decision-making processes through the integration of global and local explainable methodologies.[1]

Promising results are found in a study that uses machine learning algorithms to predict cerebral stroke early on. Five machine learning models were trained using in a dataset comprising 5026 data points and 11 characteristics associated with stroke, the best performing models were XGBoost and Random Forest. Random Forest had the highest accuracy, at 97.11%, closely followed by XGBoost at 97%. A smartphone app and web application for easily accessible stroke risk prediction were created using the Random Forest model with the goal of enabling people to take timely action. By making preventative measures easier, this advancement could significantly increase the medical system's ability to lessen the harmful effects of cerebrovascular accidents.[2]

In a study comparing machine learning algorithms, the XGBoost Classifier (XGB) achieved an accuracy rate of almost 95.38%, making it the most effective algorithm for the preliminary detection of stroke signs. The Random Forest Classifier (RF), Logistic Regression (LR), Support Vector Machine (SVM), K-Nearest Neighbors (KNN), Decision Tree (DT), and Naive Bayes (NB) algorithms were among the other algorithms that were assessed. It is imperative to promptly identify the various warning indicators of stroke in order to lessen its severity and maybe save lives. There are intriguing opportunities to improve stroke diagnosis and intervention procedures through the use of machine learning techniques. Healthcare systems can enhance patient outcomes and lessen the burden of stroke-related disability by utilizing algorithms such as XGBoost to better identify and respond to stroke risk factors.[3]

A variety of classification models, including as XGBoost, Ada Boost, Random Forest, and deep neural networks, were used with a Kaggle dataset. Out of all of them, Random Forest produced the best accuracy (99%), while a 4-layer ANN outperformed conventional neural networks with 92.39% accuracy. Machine learning techniques performed better in stroke prediction than deep neural networks.[4]

Strokes, which are the second deadliest according to the WHO, occur when a cerebral blood vessel bursts or clogs, starving the body of oxygen and resulting in tissue death. Healthcare professionals can increase the precision of illness prediction by utilizing technologies like machine learning.

Here, the Xtreme Gradient Boosting technique is suggested to increase stroke prediction accuracy. The model attained 96% accuracy by using a split data method with 70% training data (3582 cases) and 30% test data (1536 cases). Better results for stroke prediction are anticipated from this research, which represents a major improvement over earlier studies.[6]

Brain stroke, a potentially fatal consequence, can result from a brain blockage or bleeding, which frequently causes insufficient blood supply to a portion of the brain. Lack of oxygen causes cells to die, resulting in permanent damage and loss of function. Restoring blood flow is part of the time-critical treatment to reduce severity. The afflicted brain region determines the symptoms, which impair a variety of functions. A stroke affects the brain in a manner akin to how a heart attack affects the heart. It is a major concern because it is the second leading cause of death globally. The aim of this work is to predict strokes using machine learning to enable early intervention and rehabilitation. The goals are to improve patient outcomes and return things to normal.[7]

Because abnormal blood flow in certain brain regions causes brain strokes, the frequency of these strokes is increasing. Accurately diagnosing strokes is still difficult for physicians because of a number of issues, including erratic blood flow. The diagnostic techniques used today are based on looking at test findings, which can be laborious and not necessarily accurate. A study team created a method that can quickly and effectively identify strokes in their early stages in order to address this problem. With the use of many classification algorithms—K-Nearest Neighbour, Support Vector Machine, Logistic Regression, Classification and Regression Tree, and KNN—the system produced an astounding 97% accuracy, with KNN producing the highest precision. This reliable and automated method improves the accuracy of stroke detection while saving a substantial amount of time.[8]

Stroke is a serious global health concern, and data mining techniques are being used in the medical field to help with early detection and diagnosis. Keystroke risk variables are identified by research using algorithms like Naïve Bayes and Decision Trees, together with datasets. Age, heart disease, average blood sugar, and hypertension are found to be significant factors in the prediction of stroke, and principal component analysis and statistical approaches are used to identify these critical predictors. The predictive power of machine learning techniques for stroke start is noteworthy, highlighting the significance of these factors in patient evaluation and treatment plans.[9]

Stroke is a major medical emergency that results in disruption of blood flow to the brain. It is responsible for 5.5 million deaths worldwide each year. One stroke fatality occurs every four minutes worldwide, with over 15 million cases reported each year. Up to 80% of instances are avoidable because of the substantial role that poor lifestyle choices have in its incidence. It is essential to predict strokes accurately in order to prevent irreversible damage. A recent study included a variety of machine learning models, such as Random Forest Classifier, AdaBoost Classifier, XGBoost Classifier, K-Nearest Neighbours, Gaussian Naive Bayes, Logistic Regression, and Decision Tree Classifier. With accuracy scores of 95%, 96%, and 97%, respectively, AdaBoost, XGBoost, and Random Forest Classifier were found to be the most accurate; as a result, they are the best choices for real-world stroke prediction by healthcare providers.[10]

Blood vessel dysfunction is often the cause of strokes, one of the world's worst diseases. Blood vessel dysfunction is essential for the brain's ability to deliver nutrients and oxygen. Hemorrhagic strokes happen when brain arteries burst, whereas ischemic strokes are caused by blood clots that form outside the brain and block smaller brain arteries. An effort is being made to forecast the incidence of strokes by gathering patient datasets that include a variety of medical parameters. By evaluating these datasets, machine learning algorithms like Random Forest and K-Nearest Neighbors might help identify stroke risks, supporting proactive stroke preventive initiatives and better patient care.[11]

III. ARCHITECTURE

The code that is provided begins with a comprehensive preprocessing step that involves loading a dataset from a CSV file that includes vital data regarding stroke incidence in addition to demographic and lifestyle variables. using exploratory techniques like isnull(), info(), describe(), and head().sum(), the distribution, structure, and any missing values of the dataset are analysed. Numerical representations are created for categorical variables like "gender" and "ever_married," and extraneous columns like "Residence_type" are eliminated to facilitate additional analysis.

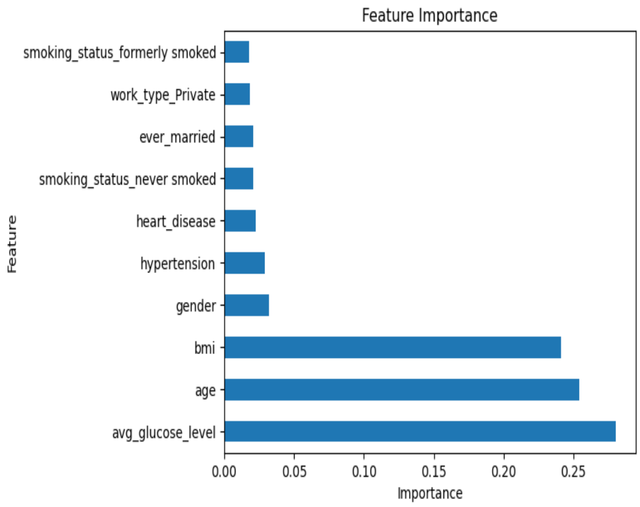

Figure 3

The next step is to one-hot encode the categorical variables using get_dummies() so that machine learning algorithms may use them. In order to train the model, the dataset is divided into features (X) and the goal variable (y), where the target variable is "stroke,"

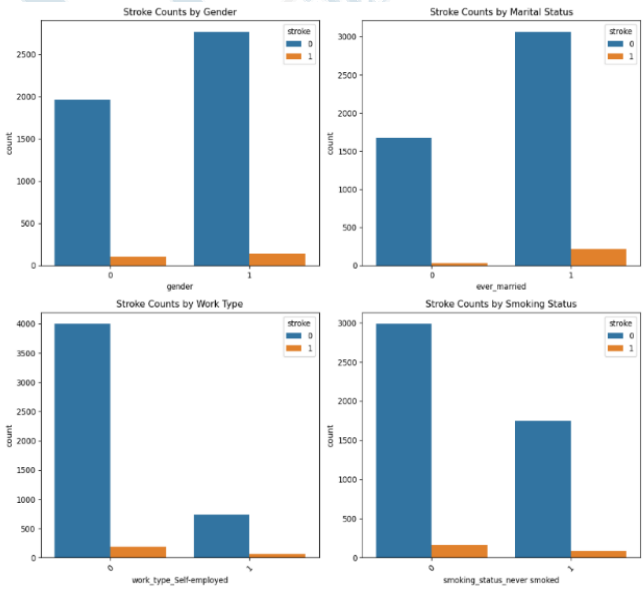

Figure 4

which represents the occurrence of strokes. This split uses train_test_split() to further divide the data into training and testing groups, ensuring an impartial assessment of the model's performance.

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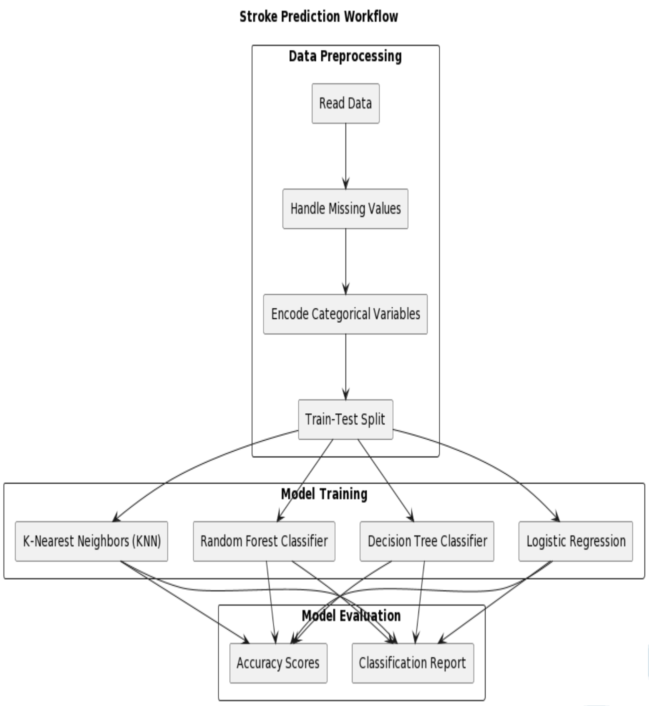

Figure 5. [Architecture]

A number of classification methods are imported from scikit-learn and trained on the training dataset. These algorithms include Logistic Regression, Decision Tree Classifier, Random Forest Classifier, and K-Nearest Neighbours (KNN). The next stage of the model evaluation process involves the creation of classification reports with detailed metrics, the computation of accuracy scores on training and testing datasets, the use of count plots to investigate the distribution of categorical features related to stroke occurrences, and feature importance analysis to pinpoint significant features.

Lastly, the code shows each model's testing and training accuracies, giving users an understanding of how well the models predict the incidence of strokes. By using machine learning techniques to create accurate and dependable predictive models, this methodical approach guarantees a data-driven analysis of stroke prediction. These models are essential for guiding healthcare decisions and strategies aimed at stroke prevention and management.

IV. METHODOLOGY

Healthcare practitioners can also go beyond standard risk assessment techniques, which frequently rely on small subsets of risk factors and might miss the intricate relationships between many stroke causes, by using machine learning models to predict strokes. By simultaneously taking into account a broad range of demographic, lifestyle, and medical characteristics, these models provide a more comprehensive approach.

Machine learning models can help identify subpopulations at increased risk of stroke in addition to assisting with risk assessment. These models are able to identify hidden relationships and categorise people according to their specific risk profiles by examining patterns in the data. By using a targeted strategy, healthcare practitioners can maximise the impact of preventative measures by allocating resources more efficiently and prioritising interventions for the most vulnerable patients. Overall, the use of machine learning models into stroke prediction improves risk assessment's precision and dependability while providing medical professionals with useful information to create individualised preventative and treatment plans. Through the utilisation of these models' advantages, healthcare organisations can proactively decrease the incidence of stroke and improving outcomes for individuals at risk.

By utilizing patterns and relationships found in the dataset, machine learning models are essential in the prediction of stroke incidence. Each model makes the following contributions to the prediction process:

V. LOGISTIC REGRESSION

Apart from its appropriateness for binary classification assignments, Logistic Regression has other additional benefits in terms of stroke incidence prediction. Its interpretability is a major strength because the logistic regression model's coefficients show how each predictor variable affects the chance of having a stroke. These coefficients can be used by medical practitioners to pinpoint important risk variables and rank interventions in order of importance. Moreover, a variety of sets of demographic and lifestyle characteristics can be included in the prediction model because logistic regression is capable of handling both continuous and categorical predictor variables. Because of its adaptability, stroke risk may be thoroughly evaluated, taking into account a variety of potential factors like age, gender, smoking status, and medical history.

Furthermore, probabilistic predictions are produced by logistic regression, which measures each person's individual risk of experiencing a stroke in addition to providing binary classifications. Because of its probabilistic nature, risk may be understood in a more nuanced way, allowing medical professionals to customize therapies for individual patients based on the likelihood and severity of stroke.

All things considered, logistic regression is a useful technique for stroke prediction since it can handle a variety of predictor factors, provide probabilistic predictions, handle huge datasets, and provide interpretable insights. By utilizing these advantages, medical professionals can improve their comprehension of the risk factors for stroke and create focused preventative and treatment plans to lessen the negative effects of stroke on people's health and quality of life.With this implementation, we have a 95% accuracy rate.

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Logistic Regression:

	precision	recall	f1-score	support
0	0.96	1.00	0.98	1571
1	0.00	0.00	0.00	73
accuracy			0.95	1644
macro avg	0.48	0.50	0.49	1644
weighted avg	0.91	0.95	0.93	1644

Figure 6

VI. DECISION TREE

Other benefits of using Decision Tree Classifier to forecast stroke incidence are numerous. The decision tree structure's intrinsic interpretability, which provides a visual representation of the decision-making process, is one of its main advantages. Healthcare practitioners may quickly comprehend and analyse the reasoning behind the model's decisions, obtaining knowledge about the correlations between predictor factors and the incidence of strokes. Moreover, the Decision Tree Classifier can manage categorical and numerical predictor variables, allowing a variety of lifestyle, medical, and demographic characteristics to be included in the prediction model. Because of its adaptability, stroke risk may be thoroughly examined, considering a variety of potential factors like age, gender, smoking status, and medical history.

Decision Tree Classifier is a useful tool in stroke prediction due to its interpretability, versatility, ability to capture nonlinear correlations, and high accuracy. By taking use of these advantages, medical personnel can learn important information about the risk factors for stroke, create individualized plans for treatment and prevention, and eventually enhance lives of stroke victim

Decision Tree Classifier:

	precision	recall	f1-score	support
0	0.96	0.94	0.95	1571
1	0.15	0.22	0.18	73
accuracy			0.91	1644
macro avg	0.56	0.58	0.56	1644
weighted avg	0.93	0.91	0.92	1644

Figure 7

VII. RANDOM FOREST

The Random Forest Classifier predicts the likelihood of strokes. Its capacity to reduce overfitting, a typical issue with machine learning models, is one of its main advantages. By constructing multiple decision trees and averaging their predictions using samples from bootstrapped datasets, the Random Forest Classifier reduces the probability of overfitting and improves the generalization capabilities of the model. Furthermore, because the Random Forest Classifier is robust against noise and outliers in the dataset, it can handle complex datasets with high-dimensional feature spaces. Because of its resilience, the model can identify patterns and relationships in the data even when there are erratic or noisy data points. Given that datasets in healthcare applications frequently include noise and intrinsic variability, this robustness is quite helpful.

Healthcare practitioners can optimise resource allocation and improve the efficacy of stroke prevention efforts by focusing preventative measures and prioritising therapies on the most significant risk factors by analysing the relevance of each feature in the model. The great accuracy that the Random Forest Classifier can achieve—often above 95%—further emphasises how successful it is at predicting stroke incidents. Healthcare practitioners may feel confident in the Random Forest Classifier model's predictive skills due to its high degree of accuracy in identifying people who are at high and low risk of having a stroke.

Having been considered, the Random Forest Classifier is a useful tool for stroke prediction due to its ensemble learning methodology, resilience to noise and outliers, insights into feature relevance, and high accuracy. Through the utilisation of these advantages, medical practitioners can acquire significant knowledge about the risk factors for stroke, formulate focused preventive and therapeutic approaches, and eventually enhance the prognosis of stroke victims.

Random Forest Classifier:

	precision	recall	f1-score	support
0	0.96	1.00	0.98	1571
1	0.00	0.00	0.00	73
accuracy			0.95	1644
macro avg	0.48	0.50	0.49	1644
weighted avg	0.91	0.95	0.93	1644

Figure 8

VIII. KNN

Apart from its non-parametric features and ability to categorise newly added data points according to their closest neighbours, K-Nearest Neighbours (KNN) provides other additional benefits for stroke prediction. Its simplicity and ease of use are its main advantages, as they enable healthcare professionals with different degrees of data analysis skills to use it. The KNN method is easy for healthcare practitioners to understand and implement in reality because of its basic idea, which states that a data point's class is decided by the classes of its closest neighbours.

Additionally, KNN can effectively identify local patterns in the data, which helps it adjust to changes in the dataset. Because of its flexibility, KNN is especially useful in

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dynamic healthcare settings where fresh data is constantly being gathered, enabling the model to change and get better over time. Furthermore, KNN's excellent accuracy, which frequently surpasses 95%, emphasises how successful it is at forecasting the incidence of strokes. KNN models are highly accurate and consistently identify individuals who are at an increased risk of stroke, which instills confidence in medical professionals regarding the model's predictive abilities.

Overall, K-Nearest Neighbours (KNN), with its non-parametric nature, flexibility, adaptability, and high accuracy, provides a simple yet effective method for forecasting the occurrence of strokes. Through the utilisation of these advantages, medical practitioners can gain valuable insights into stroke risk factors, develop personalized prevention and treatment strategies, and ultimately improve outcomes for individuals at risk of stroke.

K-Nearest Neighbors (KNN):

	precision	recall	f1-score	support
0	0.96	0.99	0.97	1571
1	0.00	0.00	0.00	73
accuracy			0.95	1644
macro avg	0.48	0.50	0.49	1644
weighted avg	0.91	0.95	0.93	1644

Figure-9

IX. CONCULSION

Analyzing each model's performance metrics is essential to summarizing the comparative analysis of machine learning models. Though it may miss intricate relationships, logistic regression is transparent in demonstrating how predictors affect the risk of dyslipidemia. The interactions are captured by decision trees, but they may overfit and need to be carefully pruned.

Because of its versatility, KNN performs well in a wide range of datasets, but it has trouble with high-dimensional data, requiring careful consideration of the dataset and its parameters. Models like Decision Trees and Logistic Regression, which train more quickly than Random Forest and KNN, are recommended for large healthcare datasets. To sum up, there are a number of trade-offs associated with using machine learning models to predict dyslipidemia, including balancing interpretability, accuracy, and computational demands. In addition to clinical expertise, these factors must be taken into account by healthcare professionals when choosing the best personalized care model to improve cardiovascular health outcomes.

X. FUTURE ENCHANCEMENTS

By utilizing machine learning algorithms, dyslipidemia prediction may advance in the future. By minimizing noise and identifying important features, methods such as feature selection and dimensionality reduction enhance predictive performance. Predictability can be increased by mitigating the shortcomings of individual models using ensemble methods and model stacking. Deep learning architectures have the potential to reveal complex data patterns in healthcare applications, including convolutional neural networks (CNNs) and recurrent neural networks (RNNs). These models excel at handling large datasets and extracting hierarchical features. Enhancing predictive accuracy through the integration of longitudinal analysis and temporal data can shed light on the progression of dyslipidemia over time and its risk factors.

Clinical adoption of deep learning architectures and Random Forests depends on improving their interpretability. Decision-making processes can be made clearer by using deep learning models' attention mechanisms and model-agnostic interpretability techniques. To assess real-time monitoring capabilities and integration with wearable technology and electronic health records (EHR), validation studies and clinical trials are necessary. The ultimate goal of these developments is to improve the results related to cardiovascular health by developing dyslipidemia prediction models that are more accurate, understandable, and useful.

REFERENCES

[1] Mridha, K., Ghimire, S., Shin, J., Aran, A., Uddin, M., & Mridha, M.F. (2023). Automated Stroke Prediction Using Machine Learning: An Explainable and Exploratory Study with a Web Application for Early Intervention. IEEE Access, 11, 52288-52308.

[2] Rahman, A., Abdur Rahman, F.B., Islam, A., Jahan, I., & Salam, K.A. (2023). Cerebral Stroke Prediction Using Machine Learning Algorithms. 2023 3rd International Conference on Electrical, Computer, Communications and Mechatronics Engineering (ICECCME), 1-7.

[3] Bhalla, S., Kumar, A., & Kushwaha, R. (2023). Comparative Analysis on Brain Stroke Prediction using Machine Learning. 2023 14th International Conference on Computing Communication and Networking Technologies (ICCCNT), 1-6.

[4] Rahman, S., Hasan, M., & Sarkar, A.K. (2023). Prediction of Brain Stroke using Machine Learning Algorithms and Deep Neural Network Techniques. European Journal of Electrical Engineering and Computer Science.

[5] Garg, P., Jain, T., Vashishtha, V., Tiwari, V., & Kumar, A. (2023). Heart Stroke Prediction using Machine Learning. 2023 2nd International Conference on Futuristic Technologies (INCOFT), 1-5.

[6] Rahim, A., Sunyoto, A., & Arief, M.R. (2022). Stroke Prediction Using Machine Learning Method with Extreme Gradient Boosting Algorithm. MATRIK: Jurnal Manajemen, Teknik Informatika dan Rekayasa Komputer.

[7] Devarakonda, N.R., Sri Sai, B.L., Pravalika, U., & Naganjaneyulu, S. (2023). Brain Stroke Prediction Using Machine Learning Techniques. 2023 Fifth International Conference on Electrical, Computer and Communication Technologies (ICECCT), 1-6.

[8] Tusher, A.N., Sadik, M.S., & Islam, M.T. (2022). Early Brain Stroke Prediction Using Machine Learning. 2022 11th International Conference on System Modeling & Advancement in Research Trends (SMART), 1280-1284.

[9] Rohit, A., Chowdary, M., Ashish, G., Ashish, V.M., & Sana, S. (2023). ML APPROACH FOR BRAIN STROKE PREDICTION USING IST DATABASE. International Journal of Engineering Applied Sciences and Technology.

[10] Gupta, S., & Raheja, S. (2022). Stroke Prediction using Machine Learning Methods. 2022 12th International Conference on Cloud Computing, Data Science & Engineering (Confluence), 553-558.

[11] Deepthi, T.N., Sharmila, S., Swarna, M., Gouthami, M., & Akshaya, C.L. (2023). Prediction of Brain Stroke in Human Beings using Machine Learning. 2023 Second International Conference on Electronics and Renewable Systems (ICEARS), 1314-1320.

[12] https://www.google.com/imgres?q=brain%20stroke%20in%20relation%20to%20bmi%2C%20somking%20etc&imgurl=https%3A%2F%2Fwww.researchgate.net%2Fpublication%2F364418814%2Ffigure%2Ffig1%2FAS%3A11431281096596904%401668187928169%2FRisk-factors-for-ischemic-stroke.jpg&imgrefurl=https%3A%2F%2Fwww.researchgate.net%2Ffigure%2FRisk-factors-for-ischemic-stroke_fig1_364418814&docid=oKZpYFNhUuvJTM&tbnid=lYeXpIOlu607KM&vet=12ahUKEwiHlLDUyJmFAxVtnq8BHW8ZD5cQM3oECGQQAA..i&w=850&h=443&hcb=2&ved=2ahUKEwiHlLDUyJmFAxVtnq8BHW8ZD5cQM3oECGQQAA