# PROJECT REPORT
# ON

# “Stroke Prediction using Machine Learning Approach”

By

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In Partial Fulfilment of
Undergraduate Degree in Computer Engineering

**Department of Computer Engineering**
**BHARATI VIDYAPEETH (DEEMED TO BE UNIVERSITY)**
**COLLEGE OF ENGINEERING**
**PUNE-411043**
(2021-2022)

**BHARATI VIDYAPEETH (DEEMED TO BE UNIVERSITY)**
**COLLEGE OF ENGINEERING, PUNE**
**DEPARTMENT OF COMPUTER ENGINEERING**

# CERTIFICATE

This is certify that the project entitled "**Stroke Prediction using Machine Learning Approach**" submitted by Mudit Khandelwal (1814110054), Priyanka Agarwal(1814110077) & Nishtha(1814110066) is a record of bonafide work carried out by them, in the partial fulfilment of the requirement for the award of Degree of Bachelor of Technology in Computer Engineering at Bharati Vidyapeeth (Deemed To Be University) College of Engineering, Pune, India. This work is done during the academic year 2021-2022.

Date: / /

| | | |
|---|---|---|
| (Prof. Dr. SB Vanjale) | (Prof. Dr. Amol K. Kadam) | |
| HOD, Computer Engineering Department | Project Guide | External Examiner |

# CERTIFICATE OF APPROVAL

The project entitled, “Stroke Prediction using Machine Learning Approach” is hereby approved as a credible study carried out and presented by Mudit Khandelwal (1814110054), Priyanka Agarwal(1814110077) and Nishtha(1814110066) in satisfactory manner as a pre-requisite to their Bachelor of Technology in Computer Engineering.

**INTERNAL EXAMINER** **EXTERNAL EXAMINER**

# CERTIFICATE OF CONDUCTION OF EXAMINATION

This is to certify that viva examination of Mudit Khandelwal, Priyanka Agarwal & Nishtha with project title " **Stroke Prediction using Machine Learning Approach** " has been held at Department of Computer Engineering, Bharati Vidyapeeth Deemed University, College of Engineering, Pune-43.

Time:

Date:

Place:

**INTERNAL EXAMINER** **EXTERNAL**

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III. This is original and authentic Project work and has not been submitted earlier to other universities for entitlement of any degree / diploma by me or others.

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V. The references used in Project work or report do not violate state / country / international Copyright act, Intellectual Property Rights act, and Patent act.

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Yours truly,

(Signature)

Date:

Title of the Project: "Stroke Prediction using Machine Learning Approach"

Acknowledged by Guide: Prof. Dr. Amol K. Kadam Signature of Students

Place: BVDUCOE Pune -43

# ABSTRACT

A Stroke is an ailment that causes harm by tearing the veins in the mind. Stroke may likewise happen when there is a stop in the bloodstream and different supplements to the mind. As per the WHO, the World Health Organization, stroke is one of the world's driving reasons for death and incapacity.

In an adult human being even when the body is set to rest 20% of the oxygen and glucose also about 2% of the entire body weight is constituted by the brain. The blood flow in the brain is said to extend when recreation of the neurons takes place in certain parts of the brain. It is carried out through the internal carotid and vertebral arteries. The blood is then altered from head to heart through the internal jugular veins. The loss of the blood might be observed in two scenarios in which the flow of blood among the blood tissues decreases resulting in the ischemic stroke whereas if internal bleeding occurs among the brain tissues known as haemorrhagic stroke.

Stroke is the 2nd leading cause of death worldwide and remains an important health burden both for the individuals and for the healthcare systems. Potentially modifiable risk factors for stroke include hypertension, cardiac disease, diabetes, and dysregulation of glucose metabolism, atrial fibrillation, and lifestyle factors. Therefore, the goal of our project is to apply principles of machine learning over large existing data sets to effectively predict the stroke based on potentially modifiable risk factors. Then it intended to develop the application to provide a personalized warning based on each user's level of stroke risk and a lifestyle correction message about the stroke risk factors.

Most of the work has been completed on heart stroke prediction however not many works show the gamble of a cerebrum stroke. Subsequently, the AI models are worked to foresee the chance of cerebrum stroke. The project is pointed towards distinguishing the familiarity with being in danger of stroke and its determinant factors amongst victims. The research has taken numerous factors and utilized ML calculations like Logistic Regression, Decision Tree Classification, Random Forest Classification, KNN, and SVM for accurate prediction.

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# Chapter 1
# INTRODUCTION

## 1. Objective

Nowadays, stroke is a major health-related challenge. Stroke, also known as cerebrovascular accident, consists of a neurological disease that can result from ischemia or hemorrhage of the brain arteries, and usually leads to heterogeneous motor and cognitive impairments that compromise functionality. Annually, stroke affects about 16 million individuals worldwide and is associated with enormous societal costs. In recent years, ML has rapidly grown and evolved in several applications in a wide variety of health care systems. Figure 1 shows the latest global health estimates by cause from the year 2000-2016. It identifies ischemic heart disease and stroke as the two leading causes of mortality and disability Worldwide. According to the American Heart Association, stroke is considered a severe health issue due to its high mortality rate. Also, the cost of hospitalization for stroke is increasing and consequently, there is an increased need of advanced technologies that can assist in clinical diagnosis, treatment, predictions of clinical events, recommendation of promising therapeutic interventions, rehabilitation programs etc. Early detection of stroke is a crucial step for efficient treatment and ML can be of great value in this process. To be able to do that, Machine Learning (ML) is an ultimate technology which can help health professionals make clinical decisions and predictions. During the past few decades, several studies were conducted on the improvement of stroke diagnosis using ML in terms of accuracy and speed. With that consideration, the current work classifies some of those studies based on their similarity, reviews each classification methodically and provides valuable information regarding the application of ML-based methods in brain stroke. With this objective in mind, we conducted the research on brain stroke using machine learning algorithms.

## 2. Background

### 1.2.1 Machine Learning

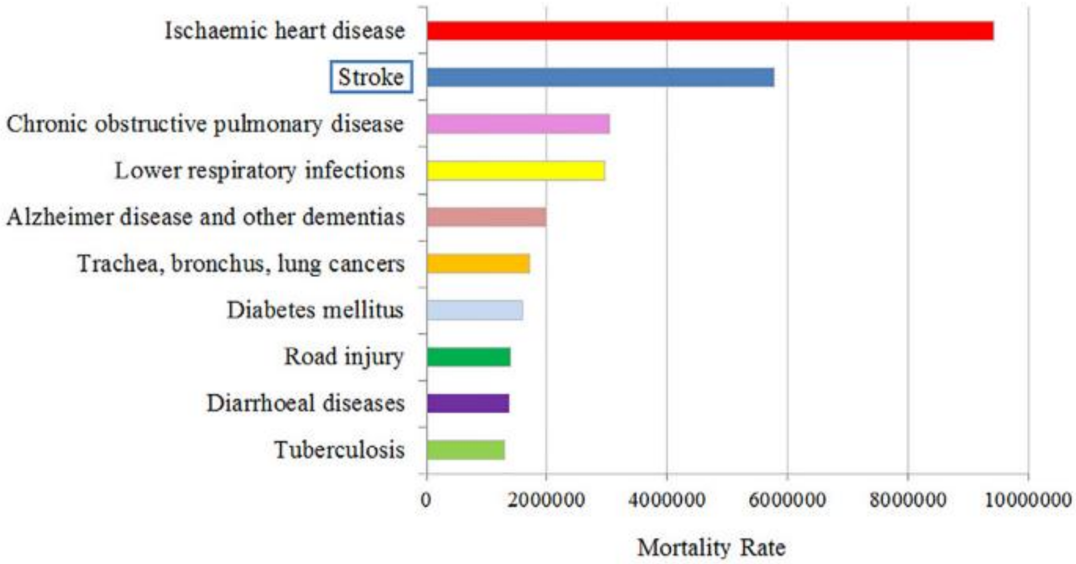



Figure 1.1: MORTALITY RATE

This section provides a brief overview of ML sub types. ML is a crucial branch of Artificial Intelligence (AI). ML is the study of algorithms that can learn and improve from past data without being explicitly programmed. There are several subtypes of ML, however in this review, we focus on supervised learning, unsupervised learning and deep learning are focused types in the current study. Supervised learning trains a model that maps an input to an output based on observations and predicts the output. It is categorized into classification and regression. Classification is to classify discrete target variables using predictors. Logistics Regression (LR), naive bayes classifier, Support Vector Machines (SVM) are some classification techniques. Regression investigates the relationship between numerical target variables and predictors. The study has done extensive experimental analysis of regression techniques from ML families over datasets. Unsupervised learning is used to group the observations for making clusters based on their similarity. Clustering, association analysis and dimensionality reduction are types of unsupervised learning. Deep learning (DL) develops a computational model [44] with multi-processing layers to learn data progressively from raw input. Some DL architectures are Convolutional Neural Networks (CNN) and Recurrent neural networks (RNN) and they are mostly used to solve image processing problems. Some of the top applications of DL are self-driving cars, natural language processing, fraud detection, health care, etc. Eventually, ML has a great implementation in the several fields like medicine, social networking, agriculture, sales and marketing, environmental science, etc. using several ML algorithms.

### 1.2.2 Stroke

Stroke consists of a heterogeneous group of disorders characterized by a sudden and focal disruption of the brain's vascular supply, causing neurologic symptoms that persist more than 24 hours. Broadly, strokes can be classified as either ischemic, which are the most common, happening in approximately 85% of the cases, or haemorrhagic. Ischemic strokes occur when blood vessels are occluded by a thrombus or an embolus, resulting in brain ischemia. Haemorrhagic strokes are caused by the rupture and bleeding of a weakened blood vessel into the surrounding brain tissue, which normally leads to intracranial pressure. There are many risk factors that can precipitate a stroke; these can be categorized as non-modifiable and modifiable. The first set of risk factors include age, gender, race and ethnicity. In contrast, modifiable risk factors are related to clinical conditions, such as cardiac diseases (e.g., hypertension, atrial fibrillation, hypercholesterolemia) and diabetes mellitus, and life-style factors, namely sedentarism, obesity, poor nutrition, tobacco use and alcohol consumption. Early identification and better control of modifiable risk factors is determinant for stroke prevention and to avoid the latter development of vascular dementia. Stroke diagnosis involves a detailed medical history, a physical and neurological examination, and a brain imaging test (e.g., computed tomography (CT) scan or magnetic resonance imaging (MRI)) to rule out other stroke mimics (e.g., brain tumours, subdural hematomas) and to determine the type of stroke, its location, and the extent of the brain injury. Treatment will depend on the cause and severity of the stroke, and it can include surgical procedures (e.g., thrombectomy in case of ischemic stroke), specific medication to dissolve blood clots (e.g., thrombolytic therapy for ischemic strokes) or to manage cardiovascular risk factors (e.g., statins used in the treatment of hypercholesterolemia) and rehabilitation (e.g., motor, and neurocognitive). It is important to note that since post-stroke survival rate is increasing, stroke patients tend to live longer with in numerous sequelae, which are not only physical, but also cognitive and emotional, and negatively influence their quality of life and functionality. Despite this fact, rehabilitation after stroke is still primarily directed towards motor function and, therefore, should follow an interdisciplinary and holistic approach to overcome and/or mitigate the multidimensional poststroke impairments. Finally, prognosis prediction following stroke is extremely relevant, namely in treatment selection (e.g., identifying which patients will benefit from a specific type of treatment), in determining long-term outcomes (e.g., motor, cognitive, functional) and in planning rehabilitation by establishing appropriate goals, considering the previous outcome predictions, and redefining unrealistic expectations that could hamper the patient's motivation and engagement in the rehabilitation process.

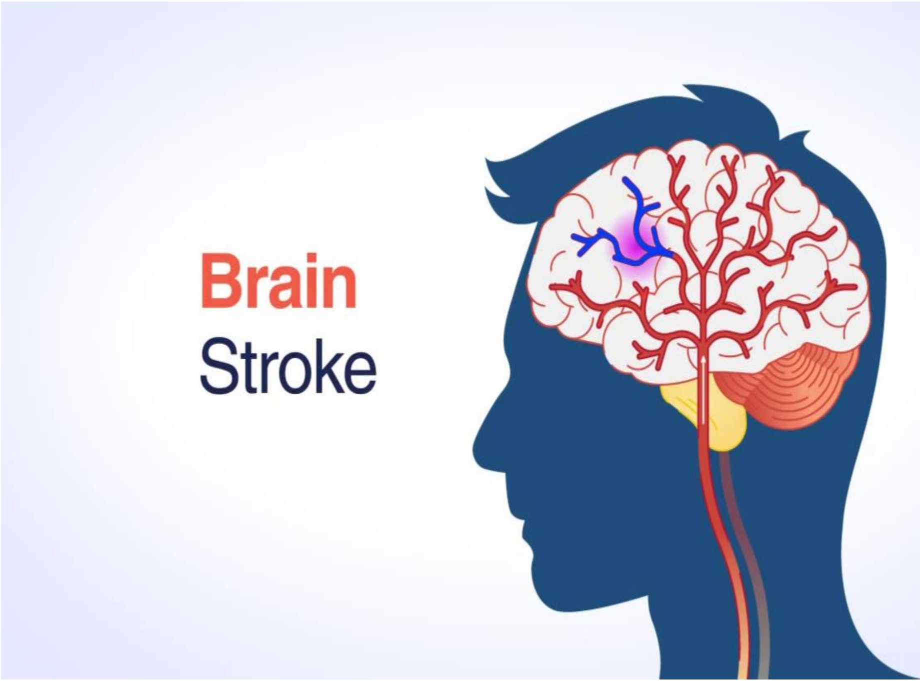


Figure 1.2: Brain Stroke

# Chapter 2
# LITERATURE SURVEY

## 2.1 Literature Survey

To get required knowledge about various concepts related to the present analysis, existing literature was studied. Some of the important conclusions were made through those are listed below:

"Probability of Stroke: A Risk Profile from the Framingham Study" - Philip A. Wolf, MD; Ralph B. D'Agostino, PhD, Albert J. Belanger, MA; and William B. Kannel, MD –

"Development of an Algorithm for Stroke Prediction"- A National Health Insurance Database Study" - Min SN, Park SJ, Kim DJ, Subramaniyam M, Lee KS

"Stroke prediction using artificial intelligence"- M. Sheetal Singh, Prakash Choudhary

"Medical software user interfaces, stroke MD application design (IEEE)"-Elena Zamsa

"Focus on stroke: Predicting and preventing stroke"-Michael Regnier

"Effective Analysis and Predictive Model of Stroke Disease using Classification Methods"- A.Sudha, P.Gayathri, N.Jaisankar-

"Computer Methods and Programs in Biomedicine" - Jae–woo Lee, Hyunsun Lim, Dong-wook Kim, Soon-ae Shin, Jinkwon Kim, Bora Yoo, Kyunghee Cho – The Purpose of this paper was Calculation of 10-year stroke prediction probability and classifying the user's individual probability of stroke into five categories.

"Probability of Stroke: A Risk Profile from the Framingham Study" - Philip A. Wolf, MD; Ralph B. D'Agostino, PhD, Albert J. Belanger, MA; and William B. Kannel, MD - In this paper, A health risk appraisal function has been developed for the prediction of stroke using the Framingham Study cohort.

"Development of an Algorithm for Stroke Prediction: A National Health Insurance Database Study" - Min SN, Park SJ, Kim DJ, Subramaniyam M, Lee KS – In this research, this paper aimed to derive a model equation for developing a stroke pre- diagnosis algorithm with the potentially modifiable risk factors.

"Stroke prediction using artificial intelligence"- M. Sheetal Singh, Prakash Choudhary - In this paper, Here, decision tree algorithm is used for feature selection process, principal component analysis algorithm is used for reducing the dimension and adopted back propagation neural network classification algorithm, to construct a classification model.

"Medical software user interfaces, stroke MD application design (IEEE)" Elena Zamsa-The article presents the design of an application interface for associated medical data visualization and management for neurologists in a stroke clustering and prediction system called Stroke MD.

"Focus on stroke: Predicting and preventing stroke" Michael RegnierThis paper focuses on cutting-edge prevention of stroke. "Effective Analysis and Predictive Model of Stroke Disease using Classification Methods"-A.Sudha, P.Gayathri, N.Jaisankar- This paper, principal component analysis algorithm is used for reducing the dimensions and it determines the attributes involving more towards the prediction of stroke disease and predicts whether the patient is suffering from stroke disease or not.

"Deep learning algorithms for detection of critical findings in headCT scans: a retrospective study" - Rohit Ghosh, Swetha Tanamala, Mustafa Biviji, Norbert G Campeau, Vasantha Kumar Venugopal - In this paper Non-contrast head CT scan is the current standard for initial imaging of patients with head trauma or stroke symptoms. This article aimed to develop and validate a set of deep learning algorithms for automated detection.

# Chapter 3

# PROJECT DESCRIPTION AND GOALS

## 3.1 Description

This Project aims to identify the risk of brain stroke in any individual using machine learning algorithms like:

- Decision Tree
- Logistic Regression
- Random forest
- KNN algorithm (K nearest neighbor)
- SVM algorithm (support vector machine)

With this the risk or probability of a brain stroke can be calculated in a person and further course can be suggested based on the outcome of the factors taken into account for the calculation of risk.

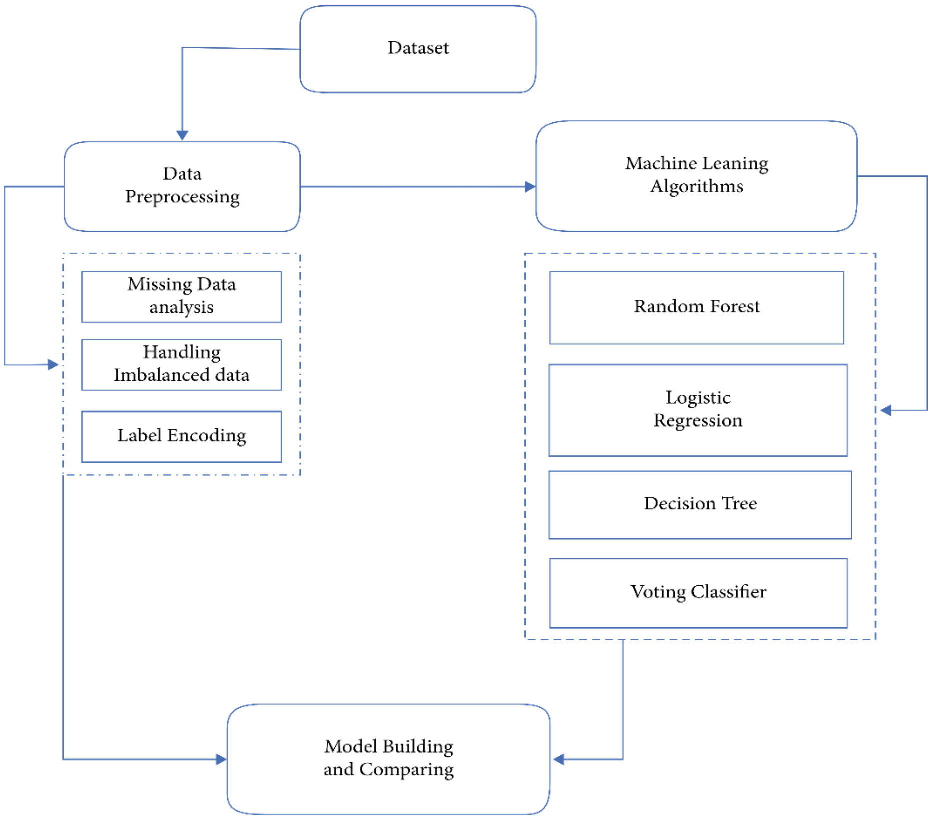



Figure 3.1: Flow chart

## 3.2 Goals

- Predict the stroke risk using prediction model in every age group of people.
- The model aims to prevent the deaths caused by strokes by informing the patients the potential risk of stroke.
- The model can also be used to find the stroke probabilities.
- Risk assessment for insurance companies
- The model can also be extended to find any other factor responsible for stroke
- The model can also be used as a precautionary at home test for several people
- The model can be used to identify at-risk individuals and medical attention can be given to them.

# Chapter 4

# EXTERNAL INTERFACE REQUIREMENTS

## 4.1 HARDWARE REQUIREMENTS:

• RAM Requirement:4 GB (Minimum) - 8 GB (Recommended)

• Processor: Minimum i3- 5th Generation

## 4.2 SOFTWARE REQUIREMENTS:

- Web Browser (Google Chrome, Safari, Firefox etc.)
- Numpy
- Matplotlib
- pyplot
- Scikit-learn
- Jupyter Notebook
- Visual Studio Code

# Chapter 5

# DESIGN APPROACH AND PREREQUISITES

## 5.1 Algorithms and Techniques

Algorithms used in our project are:

- Decision Tree
- Logistic Regression
- Random forest
- KNN algorithm (K nearest neighbor)
- SVM algorithm (support vector machine)

### Decision Tree Algorithm

The Decision Tree algorithm belongs to the family of supervised learning algorithms. Unlike other supervised learning algorithms, the decision tree algorithm can be used for solving regression and classification problems too.

The goal of using a Decision Tree is to create a training model that can use to predict the class or value of the target variable by learning simple decision rules inferred from prior data(training data).

In Decision Trees, for predicting a class label for a record we start from the root of the tree. We compare the values of the root attribute with the record's attribute. On the basis of comparison, we follow the branch corresponding to that value and jump to the next node.

### Decision Tree

```
In [44]: from sklearn.tree import DecisionTreeClassifier
         dt = DecisionTreeClassifier()

In [45]: dt.fit(X_train_std,Y_train)

Out[45]: DecisionTreeClassifier()

In [46]: dt.feature_importances_

Out[46]: array([0.03034909, 0.16343476, 0.02876101, 0.02658366, 0.00655284,
                0.02930136, 0.05266117, 0.32542073, 0.25563805, 0.08129734])

In [47]: X_train.columns

Out[47]: Index(['gender', 'age', 'hypertension', 'heart_disease', 'ever_married',
                'work_type', 'Residence_type', 'avg_glucose_level', 'bmi',
                'smoking_status'],
               dtype='object')

In [48]: Y_pred = dt.predict(X_test_std)
         Y_pred

Out[48]: array([0, 0, 1, ..., 1, 0, 0], dtype=int64)

In [49]: from sklearn.metrics import accuracy_score

In [50]: ac_dt = accuracy_score(Y_test,Y_pred)
         ac_dt

Out[50]: 0.9021526418786693
```

## Logistic regression

Logistic regression comes under the technique of supervised learning, which is used for analyzing the absolute dependent values by making use of the variable among the required blocks of the independent values. Analysis of the output values can be determined by the logistic regression of the absolute dependent values. Hence the solutions can be drawn as the absolute or the differential variables. It may be of any form either numerical or binary variables i.e., Yes or No, 0 or 1, true or false, etc. In the computer-determined language, the values are given in the 0 or a format but this model represents the feasible value that lies between 0 and 1. The usage of the values is the only difference between Logistic regression and Linear Regression. The retrogradation of the problems can be settled using linear regression whereas the categorization of the issues was carried out by the Logistic regressions is written as:

*Sigmoid Function* :

$$\text{Sigmoid Function } \emptyset(z) = \frac{1}{1+e^{-z}}$$

*where, z = b0 + b1 * age + b2 * systolicBP + b3 * diastolicBP + …… + b9 * cholesterol.*

### Logistic Regression

```
In [52]: from sklearn.linear_model import LogisticRegression
         lr = LogisticRegression()

In [53]: lr.fit(X_train_std,Y_train)

Out[53]: LogisticRegression()

In [54]: lr_y_pred = lr.predict(X_test_std)
         lr_y_pred

Out[54]: array([0, 0, 0, ..., 0, 0, 0], dtype=int64)

In [55]: ac_lr = accuracy_score(Y_test,lr_y_pred)
         ac_lr

Out[55]: 0.9471624266144814
```

## Random Forest

Random Forest is a classifier that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset. Instead of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output. The greater number of trees in the forest leads to higher accuracy and prevents the problem of overfitting.

### Random Forest

```
In [56]: from sklearn.ensemble import RandomForestClassifier
         rf = RandomForestClassifier()

In [57]: rf.fit(X_train_std,Y_train)

Out[57]: RandomForestClassifier()

In [58]: rf_y_pred = rf.predict(X_test_std)
         rf_y_pred

Out[58]: array([0, 0, 0, ..., 0, 0, 0], dtype=int64)

In [59]: ac_rf = accuracy_score(Y_test,rf_y_pred)
         ac_rf

Out[59]: 0.9471624266144814
```

## KNN

K-Nearest Neighbor is one of the most basic yet essential classification algorithms in Machine Learning. It belongs to the supervised learning domain and finds intense application in pattern recognition, data mining and intrusion detection. It is widely disposable in real-life scenarios since it is non-parametric, meaning, it does not make any underlying assumptions about the distribution of data (as opposed to other algorithms such as GMM, which assume a Gaussian distribution of the given data).

## KNN

```
In [60]: from sklearn.neighbors import KNeighborsClassifier
         knn=KNeighborsClassifier()

In [61]: knn.fit(X_train_std,Y_train)
Out[61]: KNeighborsClassifier()

In [62]: Y_pred=knn.predict(X_test_std)
         Y_pred
Out[62]: array([0, 0, 0, ..., 0, 0, 0], dtype=int64)

In [63]: ac_knn=accuracy_score(Y_test,Y_pred)

In [64]: ac_knn
Out[64]: 0.9452054794520548
```

## Support vector machine

The main aim of this algorithm is to develop the exact linear way or deterministic partition which separates n-proportional space into groups such that providing easy access of combining the data which is newly formed into their respective modules for further references. This type of sorting the data by an exact linear way can also be referred to as hyperplane.

Since considering these outermost vector points that are supportive in building the hyperplane are termed as support points and so the algorithm is named as Support vector algorithm.

## SVM

Model Optimization

```
In [62]: from sklearn.model_selection import GridSearchCV

In [63]: from sklearn.svm import SVC
         svc = SVC()

In [64]: C=[0.01,0.1,1.0,10]
         kernel = ['linear', 'poly', 'rbf', 'sigmoid']
         gamma = ['scale', 'auto']

In [65]: params = dict(C=C,kernel=kernel,gamma=gamma)
         params
Out[65]: {'C': [0.01, 0.1, 1.0, 10],
          'kernel': ['linear', 'poly', 'rbf', 'sigmoid'],
          'gamma': ['scale', 'auto']}

In [66]: clf = GridSearchCV(svc,params,cv=5)
         clf
Out[66]: GridSearchCV(cv=5, estimator=SVC(),
                      param_grid={'C': [0.01, 0.1, 1.0, 10], 'gamma': ['scale', 'auto'],
                                  'kernel': ['linear', 'poly', 'rbf', 'sigmoid']})

In [67]: best_model = clf.fit(X_train_std,Y_train)
         best_model
Out[67]: GridSearchCV(cv=5, estimator=SVC(),
                      param_grid={'C': [0.01, 0.1, 1.0, 10], 'gamma': ['scale', 'auto'],
                                  'kernel': ['linear', 'poly', 'rbf', 'sigmoid']})
```

## 5.2 Prerequisites

- **Gender -**This attribute is to find out the gender of the patient since the probability of risk of stroke is different for different gender.

- **Age** - This attribute of the patient is to take age of the patient into account.

- **Hypertension -** Hypertension, or high blood pressure, is the single most important risk factor for stroke. A blood pressure of 140/90 or above in adults is considered to be high. The usual target for blood pressure treatment in adults is to keep the blood pressure at 120/80 or below.

- **Heart Disease** - Common heart disorders can increase your risk for stroke. For example, coronary artery disease increases your risk for stroke, because plaque builds up in the arteries and blocks the flow of oxygen-rich blood to the brain.

- **Ever Married** - It has been shown that the well-being and stability of a marriage can have a notable impact on a person's health. And scientific studies are finding that marriage plays a consequential role on the risk of stroke, which is among the most life-altering medical events a person can experience.

- **Work type** - Having a high-stress job, particularly one that is demanding but offers little personal control, may raise the risk for a stroke.. It found those with high-stress jobs had a 22 percent higher risk of stroke than those with low-stress jobs.

- **Residence type -** There are also rural–urban disparities in acute stroke care that can be attributed to structural related barriers (organizational features, provider, facility, and access to care) and patient-level factors (eligibility for treatment and disease severity). There are striking and growing disparities in treatment for acute stroke in rural versus urban areas. Although rural residents are more likely to have a usual source of health care, They are still less likely to have a local hospital and physician, more likely to be uninsured, and tend to report fewer annual health care visits. Such disparities may have an impact on stroke incidence in rural and urban areas given that the availability of health care resources has a strong influence on risk factor prevalence, awareness, treatment, and control.

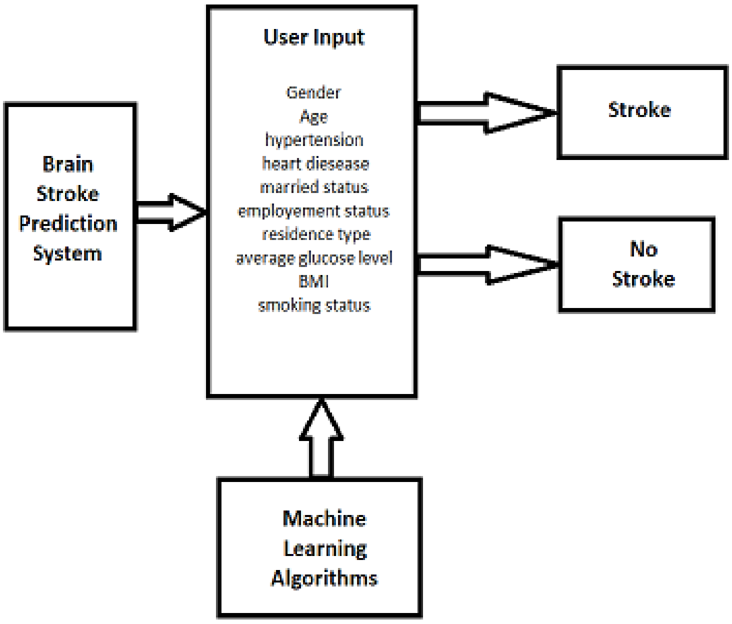
- **Average Glucose Level** - Elevated blood glucose is common in the early phase of stroke. The prevalence of hyperglycemia, defined as blood glucose level >6.0 mmol/L (108 mg/dL), has been observed in two thirds of all ischemic stroke subtypes on admission and in at least 50% in each subtype including lacunar strokes.Extensive experimental evidence in stroke models supports that hyperglycemia has adverse effects on tissue outcome, and an association between blood glucose and functional outcome has been found in an increasing number of clinical studies.

- **BMI** - High Body Mass Index (BMI) may increase the risk of total stroke,4,8,9 particularly ischemic stroke.

- **Smoking Status** - Smokers had an overall increased risk of stroke compared with nonsmokers, with a pooled odds ratio (OR) of 1.61 (95% confidence interval [CI]: 1.34–1.93, $P < .001$). A subgroup analysis conducted based on smoking status revealed ORs of 1.92 (95% CI: 1.49–2.48) for current smokers and 1.30 (95% CI: 0.93–1.81) for former smokers.

# Chapter 6

# PROJECT IMPLEMENTATION




Block Diagram for Implementation

# Chapter 7
# DATA ANALYSIS

## 7.1 Dataset

We have a given dataset for stroke prediction. This particular dataset has 12 columns and 5110 rows. The columns and rows have information about different individuals in different data types. They are as follows:

i. Patient ID
ii. Gender of the individual
iii. Age
iv. Information about prior occurrence of Hypertension
v. Previous heart Diseases
vi. Marital Status
vii. Work Status
viii. Residential Type
ix. Glucose level of different individuals
x. BMI value
xi. Smoking status

Based on the attributes mentioned above we find out the probability of a future stroke risk using the system we have developed. The output that we have is in binary form. '0' indicates no stroke risk detected, and '1' indicates a possible risk of stroke.

| id | gender | age | hypertension | heart_disease | ever_married | work_type | Residence_type | avg_glucose_level | bmi | smoking_status | stroke |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 48588 | Female | 59 | 0 | 0 | Yes | Private | Urban | 109.82 | 23.7 | never smoked | 0 |
| 70336 | Female | 25 | 0 | 0 | Yes | Private | Urban | 60.84 | 24.5 | never smoked | 0 |
| 59368 | Female | 78 | 0 | 0 | Yes | Private | Urban | 243.5 | 26.1 | never smoked | 0 |
| 10449 | Female | 24 | 0 | 0 | Yes | Private | Urban | 75.23 | 29 | never smoked | 0 |
| 62608 | Female | 47 | 0 | 0 | Yes | Private | Urban | 136.8 | 37.3 | never smoked | 0 |
| 69936 | Female | 39 | 0 | 0 | Yes | Private | Urban | 101.52 | 41.8 | never smoked | 0 |
| 13547 | Female | 37 | 0 | 0 | Yes | Private | Urban | 91.72 | 29.2 | never smoked | 0 |
| 22320 | Female | 37 | 0 | 0 | Yes | Private | Urban | 203.81 | 46.6 | never smoked | 0 |
| 20546 | Female | 68 | 0 | 0 | Yes | Private | Urban | 79.58 | 22.2 | never smoked | 0 |
| 3355 | Female | 64 | 0 | 0 | Yes | Private | Urban | 82.34 | 31.9 | never smoked | 0 |
| 67548 | Female | 31 | 0 | 0 | Yes | Private | Urban | 98.99 | 31.2 | never smoked | 0 |
| 34299 | Female | 71 | 0 | 0 | Yes | Private | Urban | 93.28 | 34.7 | never smoked | 0 |
| 6072 | Female | 57 | 0 | 0 | Yes | Private | Urban | 94.18 | 27.1 | never smoked | 0 |
| 6726 | Female | 31 | 0 | 0 | Yes | Private | Urban | 73.31 | 45 | never smoked | 0 |
| 65574 | Female | 54 | 0 | 0 | Yes | Private | Urban | 129.16 | 32.4 | never smoked | 0 |
| 39383 | Female | 30 | 0 | 0 | Yes | Private | Urban | 80.19 | 20.4 | never smoked | 0 |
| 31988 | Female | 56 | 0 | 0 | Yes | Private | Urban | 100.83 | 26.8 | never smoked | 0 |
| 59807 | Female | 30 | 0 | 0 | Yes | Private | Urban | 59.82 | 25.4 | never smoked | 0 |
| 39601 | Female | 33 | 0 | 0 | Yes | Private | Urban | 69.4 | 47.8 | never smoked | 0 |
| 21886 | Female | 40 | 0 | 0 | Yes | Private | Urban | 71.2 | 27.1 | never smoked | 0 |
| 34363 | Female | 27 | 0 | 0 | Yes | Private | Urban | 95.12 | 27 | never smoked | 0 |
| 22321 | Female | 44 | 0 | 0 | Yes | Private | Urban | 124.06 | 20.8 | never smoked | 0 |
| 54304 | Female | 22 | 0 | 0 | Yes | Private | Urban | 86.24 | 31.2 | never smoked | 0 |
| 41513 | Female | 20 | 0 | 0 | Yes | Private | Urban | 74.02 | 22.3 | never smoked | 0 |
| 18888 | Female | 20 | 0 | 0 | Yes | Private | Urban | 79.08 | 41.2 | never smoked | 0 |
| 26973 | Female | 31 | 0 | 0 | Yes | Private | Urban | 106.51 | 40.2 | never smoked | 0 |
| 31956 | Female | 58 | 0 | 0 | Yes | Private | Urban | 76.99 | 29 | never smoked | 0 |

Table 7.1: Data Table

The dataset discussed above is summarized in Table.This dataset has a total number of 249 individuals with a possible future stroke risk. These individuals are then alerted using the system to consult a medical professional for further follow-up.

Each attribute in the dataset is involved in the final prediction by the system.

The attributes itself have been thoroughly analyzed below:

TABLE I. STROKE DATASET

| Attribute Name | Type *(Values)* | Description |
|---|---|---|
| 1. id | Integer | A unique integer value for patients |
| 2. gender | String literal *(Male, Female, Other)* | Tells the gender of the patient |
| 3. age | Integer | Age of the Patient |
| 4. hypertension | Integer *(1, 0)* | Tells whether the patient has hypertension or not |
| 5. heart_disease | Integer *(1, 0)* | Tells whether the patient has heart disease or not |
| 6. ever_married | String literal *(Yes, No)* | It tells whether the patient is married or not |
| 7. work_type | String literal *(children, Govt_job, Never_worked, Private, Self-employed)* | It gives different categories for work |
| 8. Residence_type | String literal *(Urban, Rural)* | The patient's residence type is stored |
| 9. avg_glucose_level | Floating point number | Gives the value of average glucose level in blood |
| 10. bmi | Floating point number | Gives the value of the patient's Body Mass Index |
| 11. smoking_status | String literal *(formerly smoked, never smoked, smokes, unknown)* | It gives the smoking status of the patient |
| 12. stroke | Integer *(1, 0)* | Output column that gives the stroke status |

Table 7.2: STROKE DATASET

Numerous inferences could be drawn out from the said dataset. To represent the entire dataset, the following BI Dashboard has been created.

**Cleaning:** Primarily as a prerequisite for the dataset, we first checked for null values and replaced them by the average values.

**Data Analysis:** We then checked for outliers in the dataset and analysed it. Data in the form of 'yes/no', 'male/female' are converted to numeric form.

a) Here we observe a visual representation for the smoking habits of different age groups classifying our dataset into five separate classes.

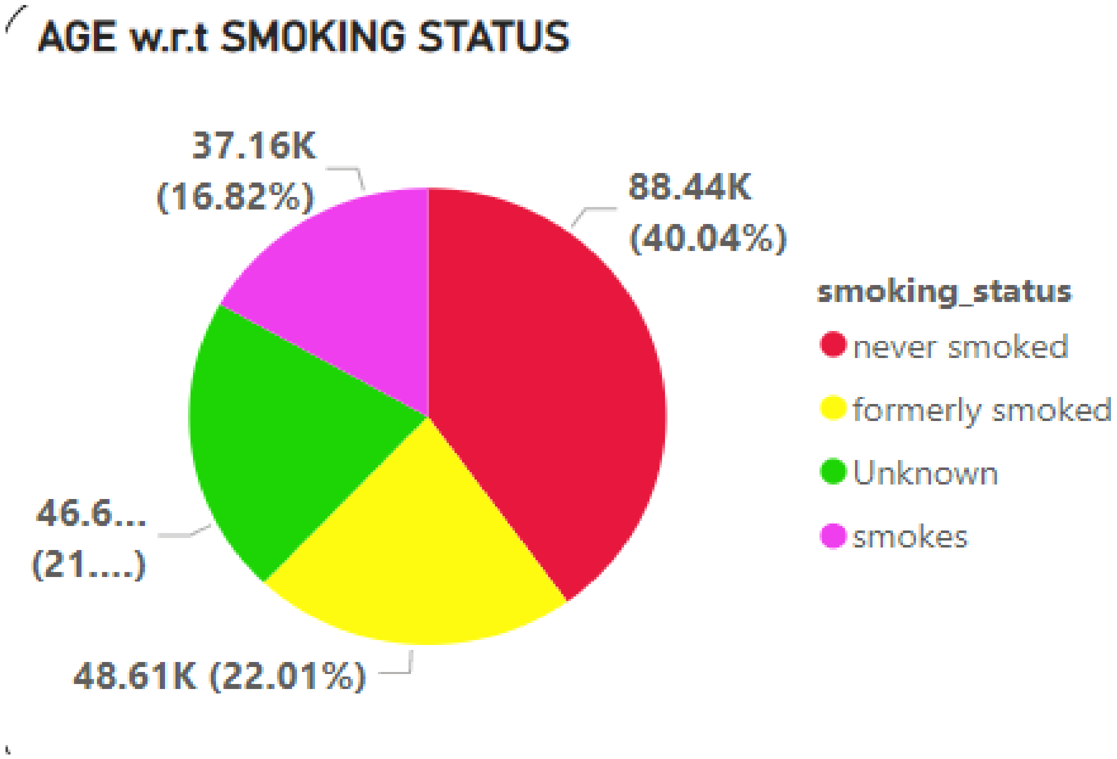



Figure 7.1

b) We also analyse the gender bifurcation of our dataset.

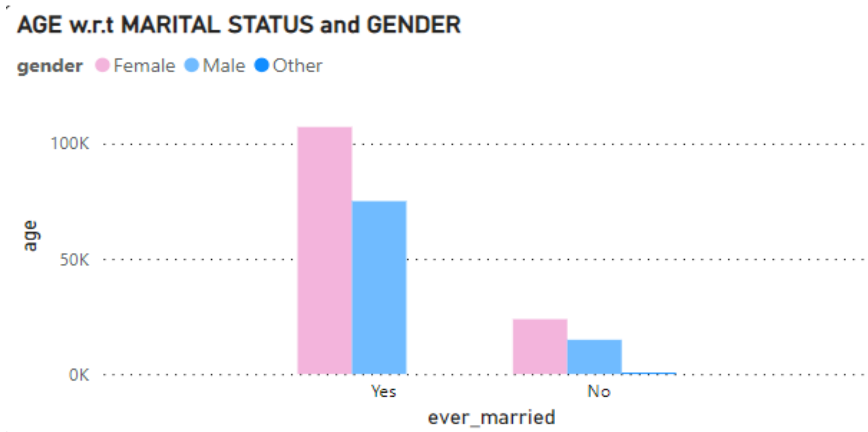



Figure 7.2

c) Our analysis also depends upon the residence type of the patient leading to Urban and Rural classes.

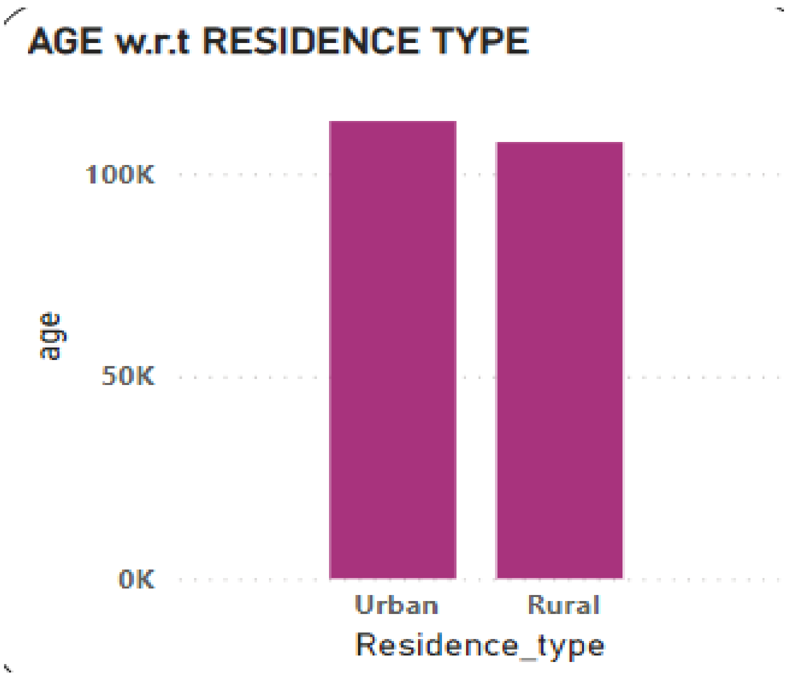



Figure 7.3

d) Marital status also affects our final outcome so we analyze whether our dataset has a higher number of married or unmarried people.

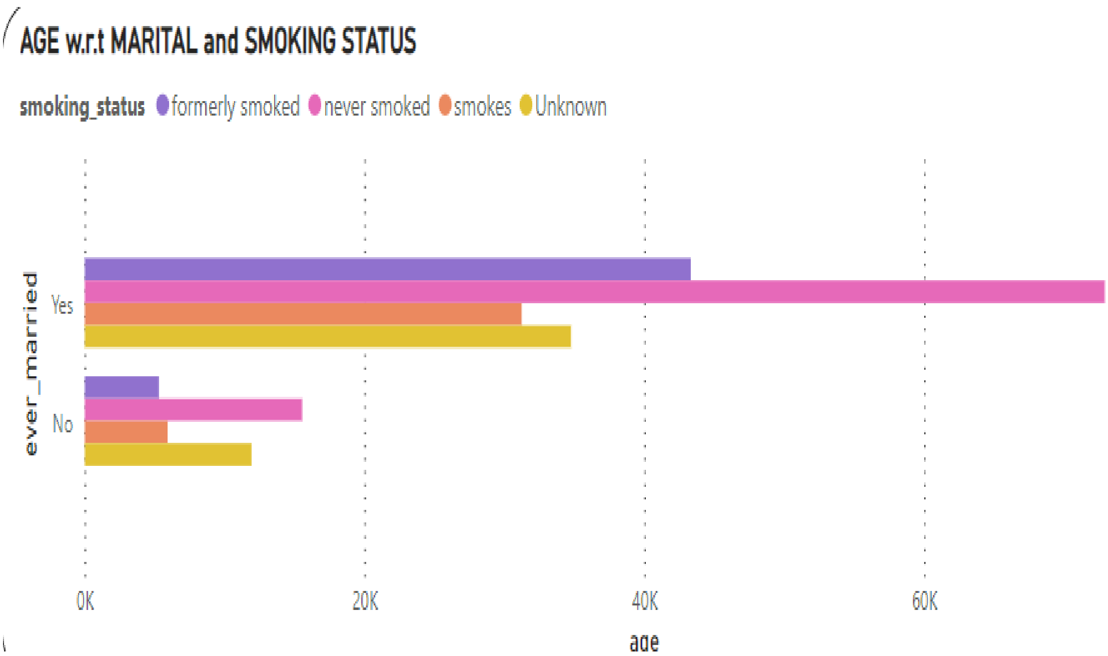



Figure 7.4

# CHAPTER 8

# SCHEDULE, TASKS AND MILESTONES

| | |
|---|---|
| WEEK 1 | Problem Identification |
| WEEK 2 | Project Discussion with guide |
| WEEK 3 | Requirement Analysis |
| WEEK 4 | Project Finalization |
| WEEK 5 | Project Optimization |
| WEEK 6 | In depth Research |
| WEEK 7 | Completion of Literature Review |
| WEEK 8,9 | Feature Finalization and preparing a basic demo for Review1 |
| WEEK10,11 | Increasing knowledge on ML and deciding on various algorithms of interest. |
| WEEK 12 | Initiation of implementation-on phase |
| WEEK 13,14 | Work on Dataset |
| WEEK 15 | Work on report and PPT for Review 2 |
| WEEK 16 | Widen the range of project |

| | |
|---|---|
| WEEK 17 | Understanding the working of Atari games and reading the strategies of the pro players |
| WEEK 18 | Exploring more ML algorithms |
| WEEK 19 | Understanding the working of ML Algorithms |
| WEEK 20 | Publishing of results |
| WEEK 21 | Project Optimization |
| WEEK 22 | Documentation and PPT |

# CHAPTER 9

# PROJECT RESULT

## 9.1 OUTPUT IN CASE OF NO STROKE RISK

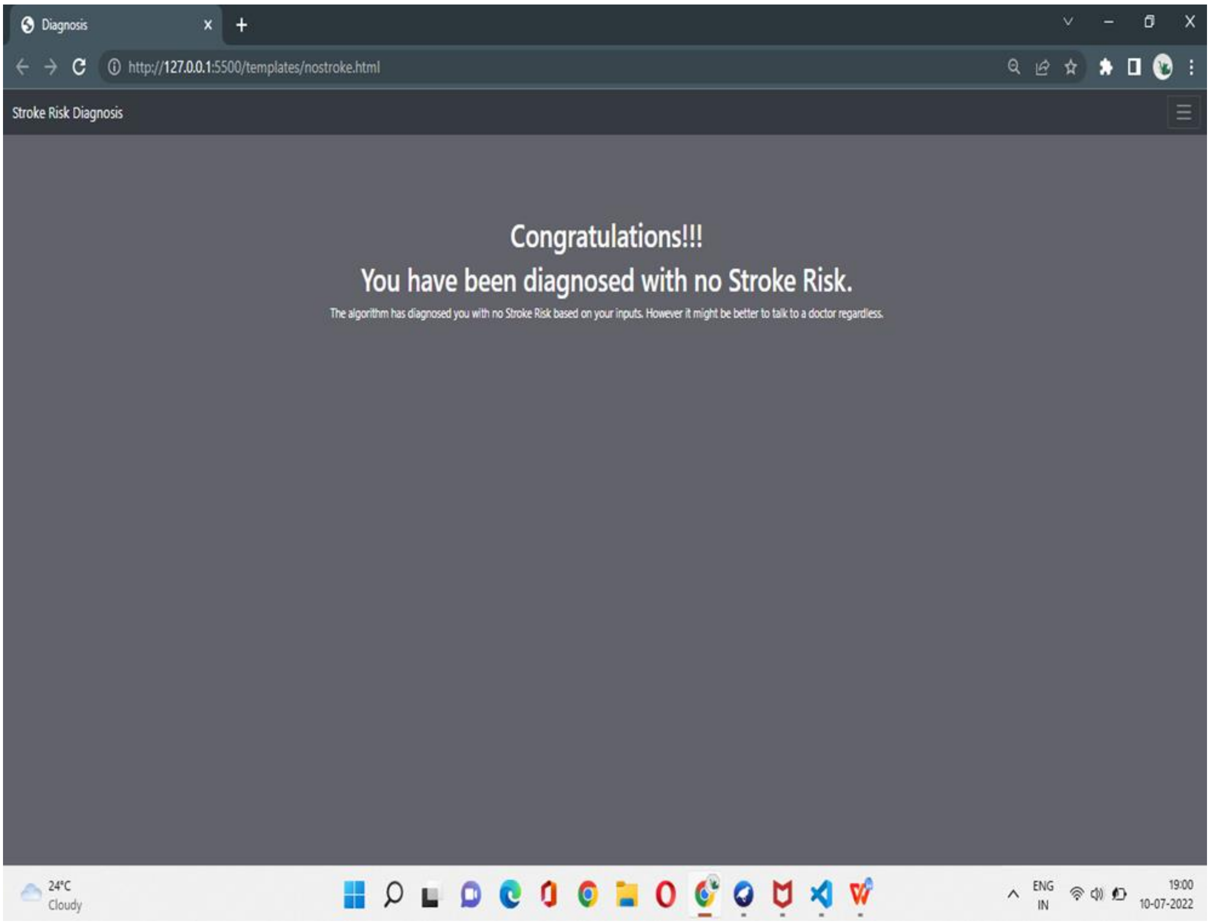



Figure 9.1: No Stroke Risk

# 9.2 OUTPUT IN CASE OF STROKE RISK

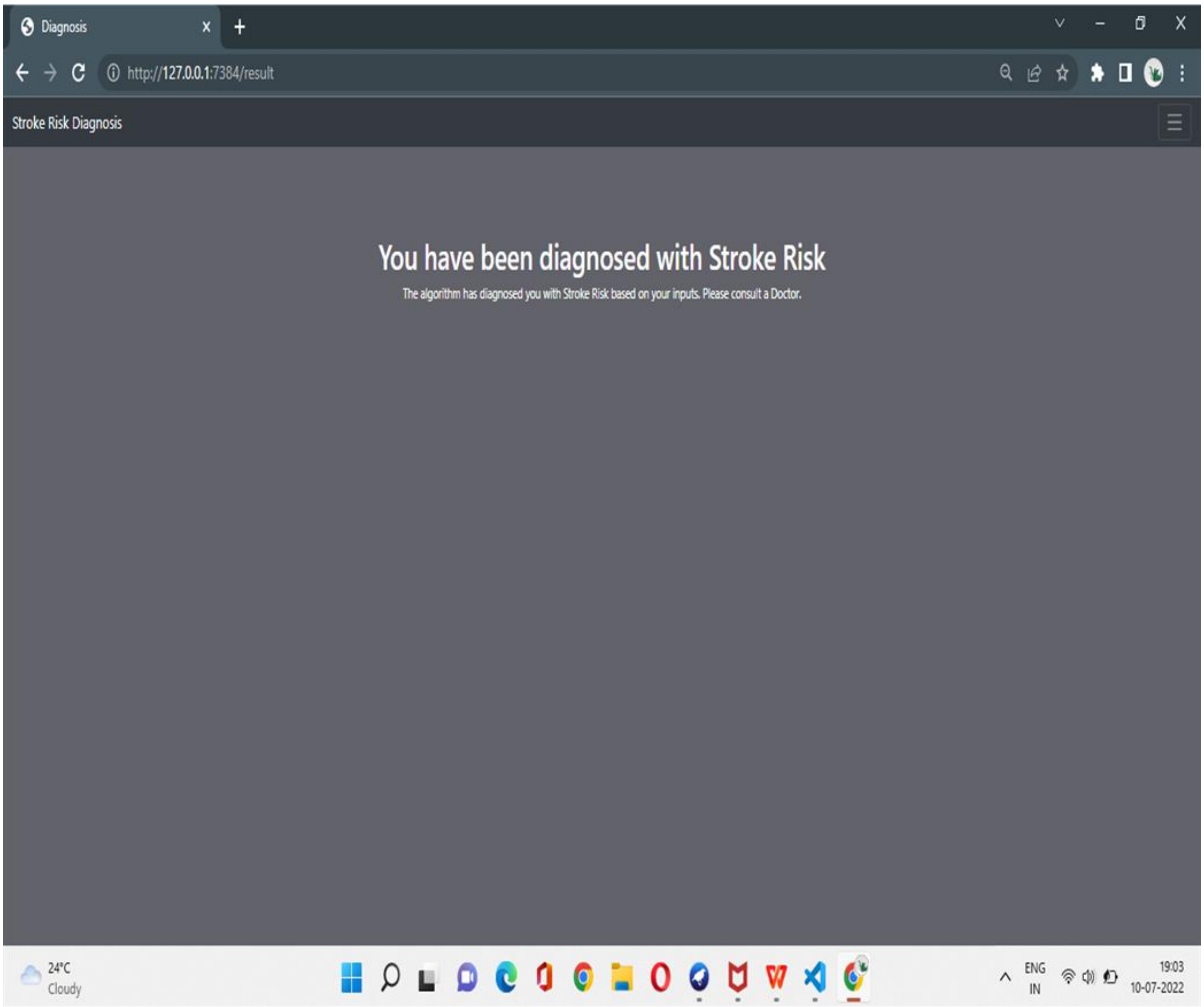



Figure 9.2: Stroke Risk

# CHAPTER 10
# CONCLUSION AND FUTURE SCOPE

## 10.1 Conclusion

To conclude the paper, a machine learning system has been created which would alert the person using about a probable future brain stroke and further suggests consulting a medical professional. The GUI is made using HTML, CSS, Flask. We get a total accuracy of 97% using various Machine learning algorithms. Several assessments and prediction models, Decision Tree, showed acceptable accuracy in identifying stroke-prone patients.
This project hence helps to predict stroke risk using prediction models and provide personalized warning and lifestyle correction messages through a web application. By doing so, it urges medical users to strengthen the motivation of health management and induce changes in their health behaviours.

## 10.2 Future Scope

This project helps to predict stroke risk using prediction models in older people and for people who are addicted to the risk factors as mentioned in the project. In future, the same project can be extended to give the stroke percentage using the output of the current project. This project can also be used to find the stroke probabilities in young people and underage people by collecting respective risk factor information and doctors consulting.

## 10.3 Accuracy

We get a total accuracy of 97% using various Machine learning algorithms.

| **ALGORITHM** | **PERCENTAGE ACCURACY** |
|---|---|
| Logistic Regression | 95.71% |
| Decision Tree | 90.21% |
| KNN | 94.52% |
| SVM | 94.71% |
| Random Forest | 94.52% |

Table 10.1 Percentage Accuracy

# CHAPTER 11
# RESEARCH PUBLICATION

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## Brain Stroke Prediction Using Machine Learning Approach

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*[2, 3, 4] Student, Department of Computer Engineering, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, Maharashtra, India*

***Abstract- A Stroke is an ailment that causes harm by tearing the veins in the mind. Stroke may likewise happen when there is a stop in the blood stream and different supplements to the mind. As per the WHO, the World Health Organization, stroke is one of the world's driving reasons for death and incapacity. The majority of the work has been completed on heart stroke forecast however not many works show the gamble of a cerebrum stroke. Subsequently, the AI models are worked to foresee the chance of cerebrum stroke. The project is pointed towards distinguishing the familiarity with being in danger of stroke and its determinant factors amongst victims. The research has taken numerous factors and utilized ML calculations like Logistic Regression, Decision Tree Classification, Random Forest Classification, KNN, and SVM for accurate prediction.***

***Indexed Terms- Machine learning; logistics regression; decision tree classification; random forest classification; k-nearest neighbor; support vector machine.***

### I. INTRODUCTION

As per the Centers for Disease Control and Prevention (CDC), stroke is the fifth Leading demise reason [1] in the US. Stroke is an infection that is responsible for around eleven percent of complete passings. Reliably, north of 795,000 people in the USA experience the impacts of a stroke [2]. It is the fourth main cause for demises in India. With the cutting-edge innovation in clinical science, foreseeing the event of a stroke can be made utilizing ML algorithms. The Machine learning calculations are valuable in making exact forecasts and can give right examination. The works recently performed on stroke generally remember the ones for Heart stroke expectation. Not much of work has been performed on Brain stroke. The study Centers around foreseeing cerebrum stroke event utilizing Machine Learning. The key methodologies were utilized, and results are gotten with five distinct grouping calculations. The disadvantage to this model is that it is being prepared on text-based information and not on constant cerebrum pictures. The paper shows the execution of 5 Machine Learning methodologies. This paper can be additionally reached out to execute all the ongoing AI calculations. A dataset is browsed Kaggle [3] with different qualities as its credits to continue further. A huge subject of AI in drug is used in this undertaking. An AI model would take the patient's data and propose a lot of reasonable Expectations. The system can eliminate hid data from a chronicled clinical informational index and can expect patients with contamination and use the clinical profiles like Age, circulatory strain, Glucose, etc it can predict the likelihood of patients getting a sickness. Gathering computations are used with the quantity of properties for the assumption for sickness [4].

### II. RELATED WORK

A great deal of work has been finished in the part of stroke expectation. Jeena et al. give an investigation of different gamble elements to comprehend the likelihood of stroke [5].

Govindarajan [6] managed the data assembled from Sugam Multispeciality Hospital. The dataset contained more than 500 records of patients and many fascinating class names of two huge Stroke types. They applied Support Vector Machine (SVM), Artificial Neural Network (ANN), Logistic Regression, Decision Tree, Bagging, and Boosting.

Among the above Machine Learning Algorithm, they got the highest accuracy using ANN Algorithm with ~95%.

Sung et al [7] dealt with clinical information which contained data about the ischemic stroke of 739 patients. This information contains 17 clinical factors which incorporated the historical backdrop of past TIA, a gamble factor for vascular illnesses, patient's segment data, stroke subtypes, neuroimaging boundaries, and so on and this will be utilized for working out the precision of an AI calculation in foreseeing END. They checked with 4 Machine Learning Algorithms: - Deep brain organization, Boosted Trees, Logistic Regression, and Bootstrap choice forest.0.966, 0.966, 0.966, and 0.946 are the exactness score got from the model. Among every one of the calculations the most elevated region under the bend worth of 0.934 and precision of 0.966 is accomplished by Boosted Tree calculation.

Choudhary and Singh [8] chipped away at information gathered from the workforce of Physical treatment. It contains data about cardiovascular wellbeing studies. The dataset comprises of more than 5,800 examples. They isolated the dataset into three distinct clinical phrasings: stroke and claudication, stroke and TIA, stroke and Angioplasty. It additionally incorporates in excess of 600 characteristics. They involved head part examination for dimensionality reduction.C4.5 calculation is utilized for include choice. By ANN execution they achieved 95%, 95.2%, and 97.7% Accuracy.

Selma gathered a dataset from a few emergency clinics and clinical Centers. The clinic report incorporates the patient serial number, CT, age of patient, gender, MRI analyse, and different factors for all patients hospitalized in the medical clinic. The dataset contained around 410 patients, whose age is mostly somewhere in the range of 48 and 87 years. A couple of cases in the age of 32 years and the vast majority of them are male. The presentation of Decision tree characterization is superior to the exhibition of the KNN calculation. Clinical experts utilized a decision tree calculation to order and analyze ischemic stroke patients.

## III. ANALYSIS DATASET

We have a given dataset for stroke prediction. This particular dataset has 12 columns and 5110 rows. The columns and rows have information about different individuals in different datatypes. They are as follows:

i. Patient ID
ii. Gender of the individual
iii. Age
iv. Information about prior occurance of Hypertention
v. Previous heart Diseases
vi. Marital Status
vii. Work Status
viii. Residential Type
ix. Glucose level of different individuals
x. BMI value
xi. Smoking status

Based on the attributes mentioned above we find out the probability of a future stroke risk using the system we have developed. The output that we have is in binary form. '0' indicates no stroke risk detected, and '1' indicates a possible risk of stroke.


This dataset has a total number of 249 individuals with a possible future stroke risk. These individuals are then alerted using the system to consult a medical professional for further follow-up.

The dataset discussed above is summarized in Table:

TABLE I. STROKE DATASET

| Attribute Name | Type *(Values)* | Description |
|---|---|---|
| 1. id | Integer | A unique integer value for patients |
| 2. gender | String literal *(Male, Female, Other)* | Tells the gender of the patient |
| 3. age | Integer | Age of the Patient |
| 4. hypertension | Integer *(1, 0)* | Tells whether the patient has hypertension or not |
| 5. heart_disease | Integer *(1, 0)* | Tells whether the patient has heart disease or not |
| 6. ever_married | String literal *(Yes, No)* | It tells whether the patient is married or not |
| 7. work_type | String literal *(children, Govt_job, Never_worked, Private, Self-employed)* | It gives different categories for work |
| 8. Residence_type | String literal *(Urban, Rural)* | The patient's residence type is stored |
| 9. avg_glucose_level | Floating point number | Gives the value of average glucose level in blood |
| 10. bmi | Floating point number | Gives the value of the patient's Body Mass Index |
| 11. smoking_status | String literal *(formerly smoked, never smoked, smokes, unknown)* | It gives the smoking status of the patient |
| 12. stroke | Integer *(1, 0)* | Output column that gives the stroke status |

Numerous inferences could be drawn out from the said dataset. To represent the entire dataset, the following BI Dashboard has been created:

## IV. METHODOLOGY

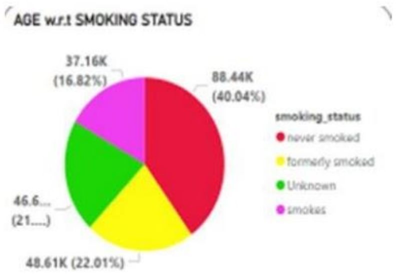
We first Import the following libraries:

1) Pandas
2) Numpy
3) Matplotlib
4) seaborn

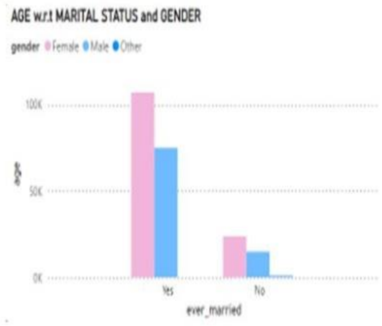
- Cleaning: Primarily as a prerequisite for the dataset, we first checked for null values and replaced them by the average values.

- Data Analysis: We then checked for outliers in the dataset and analysed it. Data in the form of 'yes/no', 'male/female' are converted to numeric form.

a) Here we observe a visual representation for the smoking habits of different age groups classifying our dataset into five separate classes.

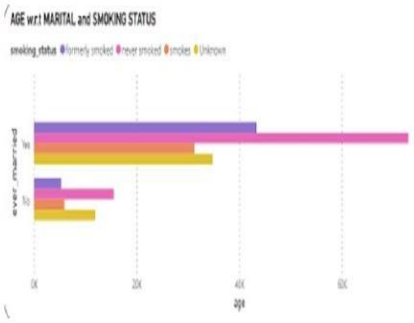



b) We also analyse the gender bifurcation of our dataset.




c) Our analysis also depends upon the residence type of the patient leading to Urban and Rural classes.


d) Marital status also affects our final outcome so we analyse whether our dataset has higher number of married or unmarried people.

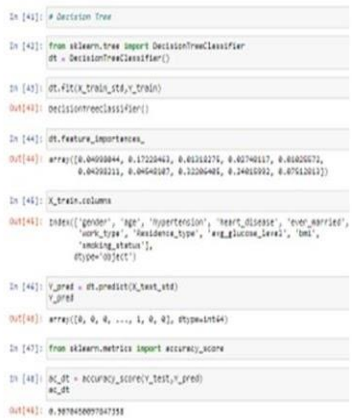



## V. IMPLEMENTATION

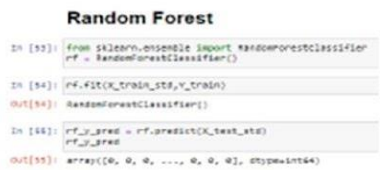
The following algorithms have been used for the brain stroke detection system that we have created:

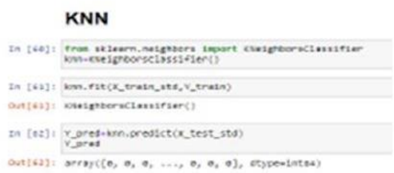
1) Decision Tree
2) Logistic Regression
3) Random Forest
4) Support Vector Machine
5) K Nearest Neighbour

All these are used to predict the possibility of stroke in a person.







**SVM**

Model Optimization

```
In [62]: from sklearn.model_selection import GridSearchCV

In [63]: from sklearn.svm import SVC
         svc = SVC()

In [64]: C=[0.01,0.1,1.0,10]
         kernel = ['linear', 'poly', 'rbf', 'sigmoid']
         gamma = ['scale', 'auto']

In [65]: params = dict(C=C,kernel=kernel,gamma=gamma)
         params
Out[65]: {'C': [0.01, 0.1, 1.0, 10],
          'kernel': ['linear', 'poly', 'rbf', 'sigmoid'],
          'gamma': ['scale', 'auto']}

In [66]: clf = GridSearchCV(svc,params,cv=5)
         clf
Out[66]: GridSearchCV(cv=5, estimator=SVC(),
                      param_grid={'C': [0.01, 0.1, 1.0, 10], 'gamma': ['scale', 'auto'],
                                  'kernel': ['linear', 'poly', 'rbf', 'sigmoid']})

In [67]: best_model = clf.fit(X_train_std,y_train)
         best_model
Out[67]: GridSearchCV(cv=5, estimator=SVC(),
                      param_grid={'C': [0.01, 0.1, 1.0, 10], 'gamma': ['scale', 'auto'],
                                  'kernel': ['linear', 'poly', 'rbf', 'sigmoid']})

In [68]: best_model.best_params_
Out[68]: {'C': 0.01, 'gamma': 'scale', 'kernel': 'linear'}

In [69]: #training score
         best_model.best_score_
Out[69]: 0.9522999995785782

In [70]: svc = SVC(C=0.01,gamma='scale',kernel='linear')

In [71]: svc.fit(X_train_std,y_train)
Out[71]: SVC(C=0.01, kernel='linear')

In [72]: svc_y_pred_hyper = svc.predict(X_test_std)
         svc_y_pred_hyper
Out[72]: array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

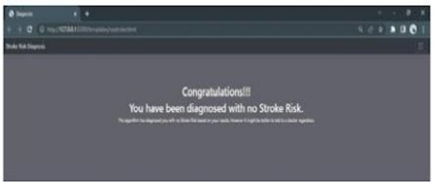
ACCURACY OF EACH ALGORITHM

| ALGORITHM | PERCENTAGE ACCURACY |
|---|---|
| Logistic Regression | 95.71% |
| Decision Tree | 90.21% |
| KNN | 94.52% |
| SVM | 94.71% |
| Random Forest | 94.52% |

## CONCLUSION

To conclude the paper, a machine learning system has been created which would alert the person using about a probable future brain stroke and further suggests to consult a medical professional. The GUI is made using HTML, CSS, Flask. We get a total accuracy of 97%.

SCREENSHOT OF UI





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