```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import LabelEncoder, StandardScaler
from sklearn.model_selection import train_test_split, GridSearchCV, StratifiedKFold
from sklearn.svm import SVC
from sklearn.tree import DecisionTreeClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import accuracy_score, confusion_matrix

# Load the data
df = pd.read_csv("/content/healthcare-dataset-stroke-data.csv")
df.head()
```

	id	gender	age	hypertension	heart_disease	ever_married	work_type	Residence_type	avg_glucose_level	bmi	smoking_status	stroke
0	9046	Male	67.0	0	1	Yes	Private	Urban	228.69	36.6	formerly smoked	1
1	51676	Female	61.0	0	0	Yes	Self-employed	Rural	202.21	NaN	never smoked	1
2	31112	Male	80.0	0	1	Yes	Private	Rural	105.92	32.5	never smoked	1
3	60182	Female	49.0	0	0	Yes	Private	Urban	171.23	34.4	smokes	1
4	1665	Female	79.0	1	0	Yes	Self-employed	Rural	174.12	24.0	never smoked	1

Next steps: View recommended plots

```
df.shape
```

```
(5110, 12)
```

```
df.columns
```

```
Index(['id', 'gender', 'age', 'hypertension', 'heart_disease', 'ever_married',
       'work_type', 'Residence_type', 'avg_glucose_level', 'bmi',
       'smoking_status', 'stroke'],
      dtype='object')
```

```
df.dtypes
```

```
id                     int64
gender                object
age                  float64
hypertension           int64
heart_disease          int64
ever_married          object
work_type             object
Residence_type        object
avg_glucose_level    float64
bmi                  float64
smoking_status        object
stroke                 int64
dtype: object
```

```
df[df.duplicated()]
```

id	gender	age	hypertension	heart_disease	ever_married	work_type	Residence_type	avg_glucose_level	bmi	smoking_status	stroke

```
df.isnull().sum()
```

```
id                   0
gender               0
age                  0
hypertension         0
heart_disease        0
ever_married         0
work_type            0
Residence_type       0
avg_glucose_level    0
bmi                201
smoking_status       0
stroke               0
dtype: int64
```

```
df['bmi'].mean()
```

```
28.893236911794666
```

```
df['bmi']=df['bmi'].fillna(df['bmi'].mean())
```

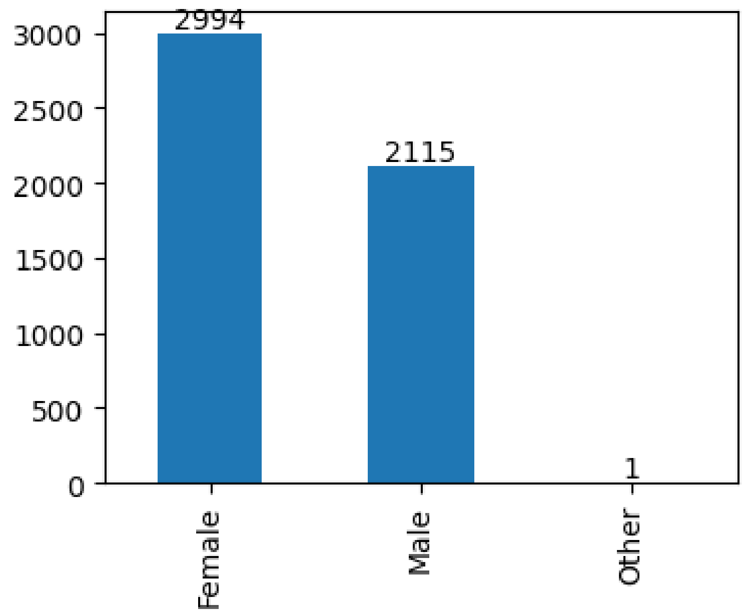
```
df.isnull().sum()
```

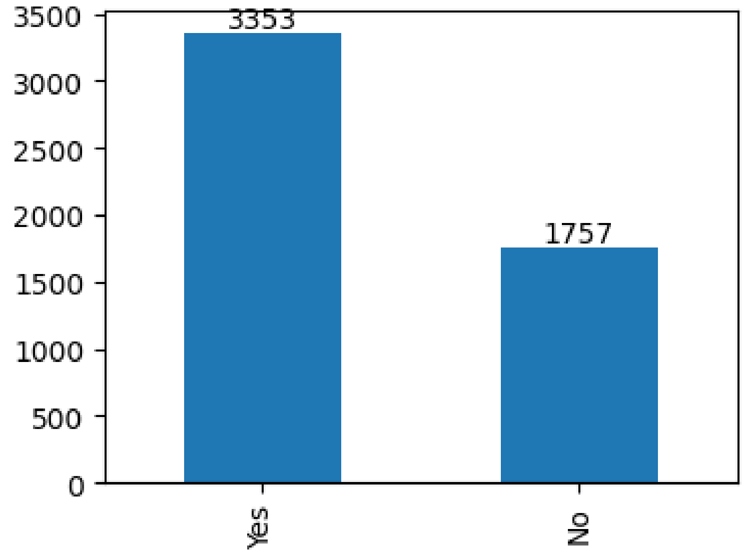
```
id                   0
gender               0
age                  0
hypertension         0
heart_disease        0
ever_married         0
work_type            0
Residence_type       0
avg_glucose_level    0
bmi                  0
smoking_status       0
stroke               0
dtype: int64
```

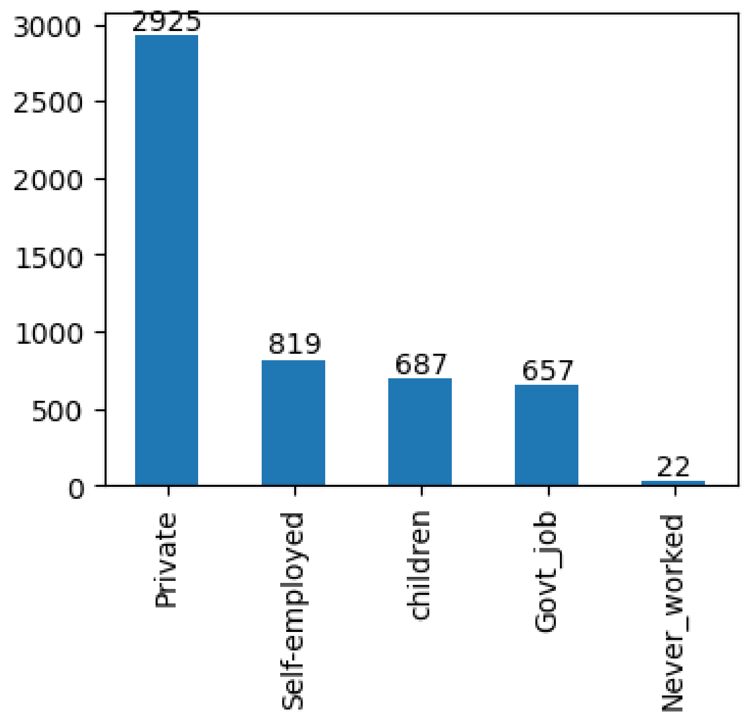
```
# Visualization of Categorical Columns
Cat_columns = df.select_dtypes(exclude=np.number).columns
Cat_columns
```

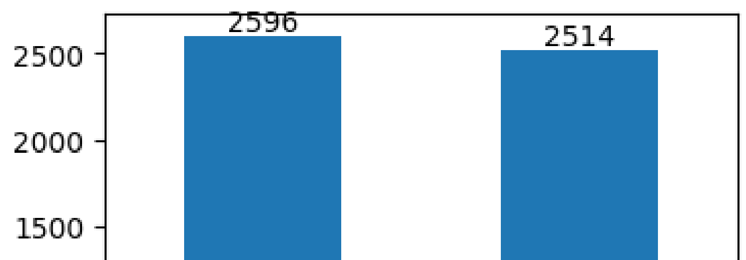
```
Index(['gender', 'ever_married', 'work_type', 'Residence_type',
       'smoking_status'],
      dtype='object')
```

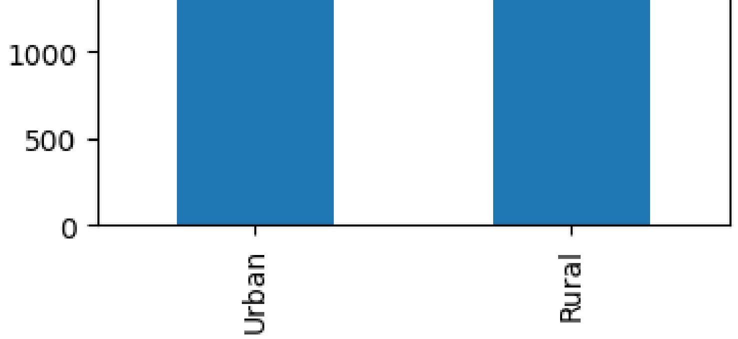
```
for col in Cat_columns:
    plt.figure(figsize=(4, 3))
    ax = df[col].value_counts().plot(kind='bar')
    for i in ax.containers:
        ax.bar_label(i)
    plt.show()
```

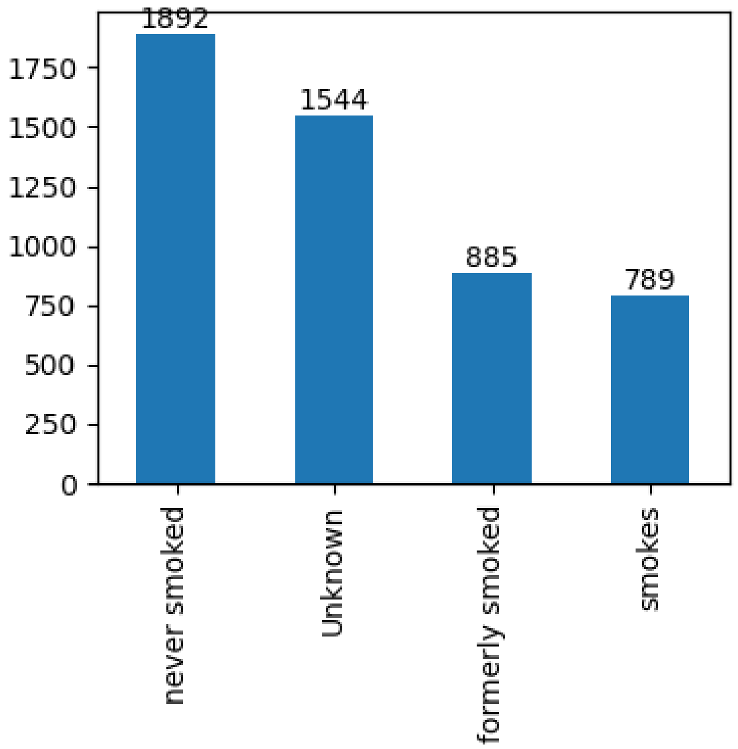

2994
2115
1
Female
Male
Other


3353
1757
Yes
No


2925
819
687
657
22
Private
Self-employed
children
Govt_job
Never_worked


2596
2514

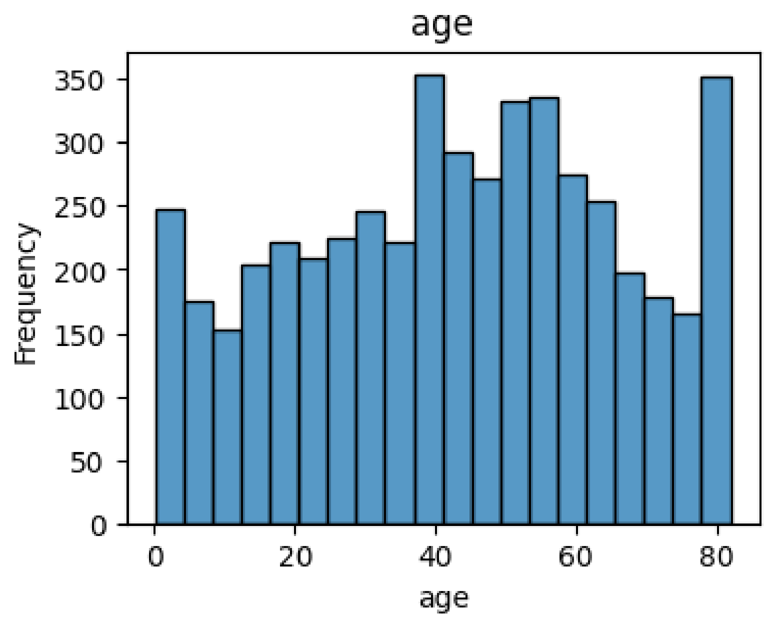


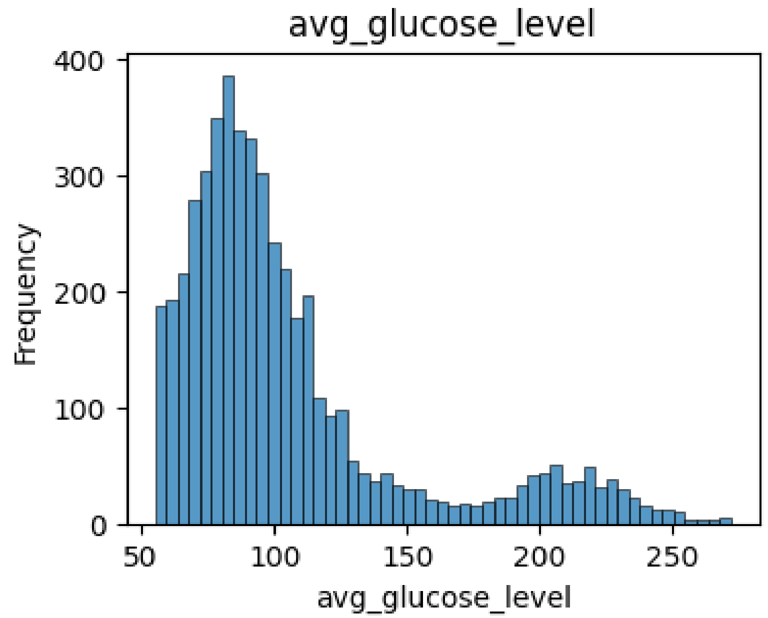


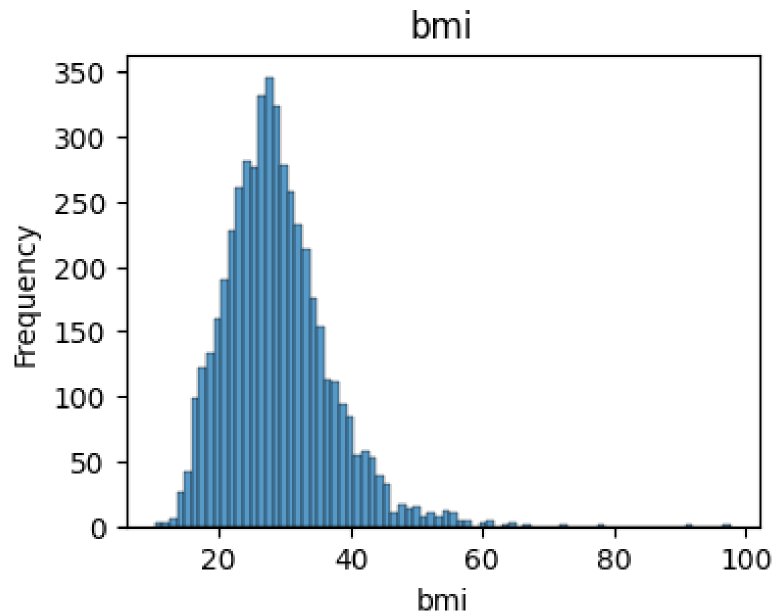

```
# Check for missing values
df.drop(['id'], axis=1, inplace=True)
df.dropna(axis=0, inplace=True)
```

```
# Data Preprocessing
label_encoder = LabelEncoder()
for col in df.columns:
    if df[col].dtype == 'object':
        df[col] = label_encoder.fit_transform(df[col])

x = df.drop(['stroke'], axis=1)
y = df['stroke']
```

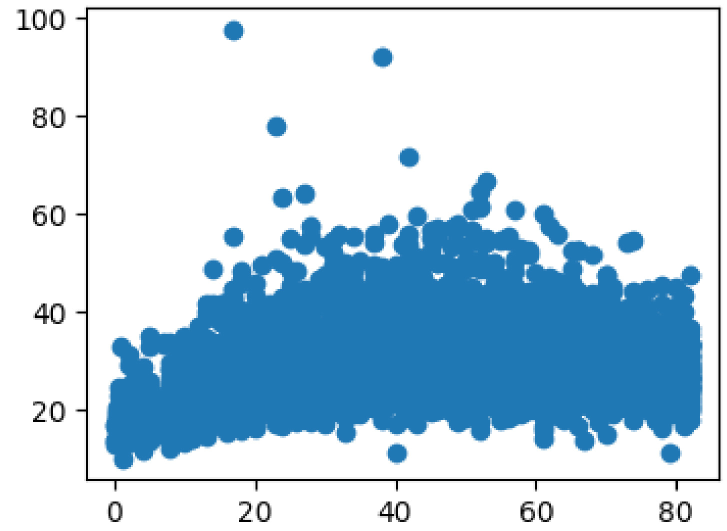
```
# Numerical columns
Num_columns = df.select_dtypes(include=np.number).columns
Num_cols = ['age', 'avg_glucose_level', 'bmi']
for col in Num_cols:
    plt.figure(figsize=(4, 3))
    sns.histplot(df[col], kde=False)
    plt.title(col)
    plt.xlabel(col)
    plt.ylabel('Frequency')
    plt.show()
```

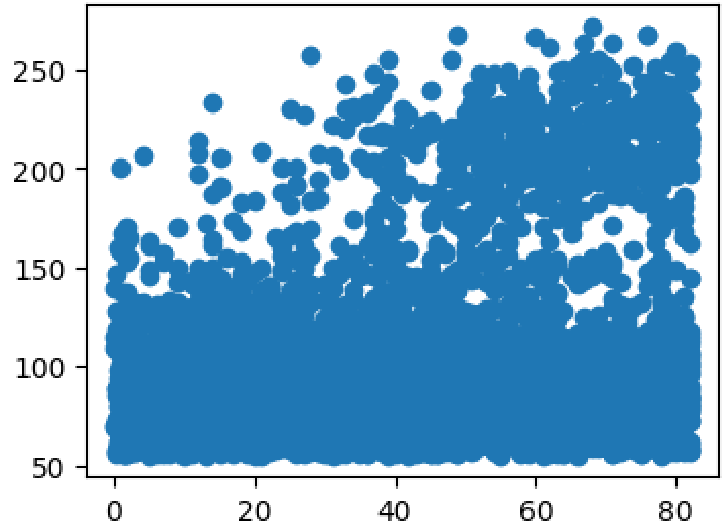

age
Frequency
350
300
250
200
150
100
50
0
0
20
40
60
80
age

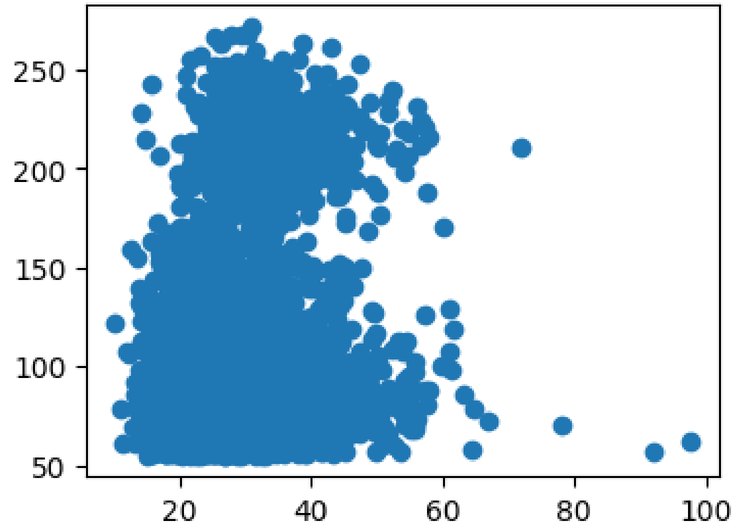

avg_glucose_level
Frequency
400
300
200
100
0
50
100
150
200
250
avg_glucose_level


bmi
Frequency
350
300
250
200
150
100
50
0
20
40
60
80
100
bmi

```
plt.figure(figsize=(4, 3))
plt.scatter(df.age, df.bmi)
plt.show()

plt.figure(figsize=(4, 3))
plt.scatter(x=df.age, y=df.avg_glucose_level)
plt.show()

plt.figure(figsize=(4, 3))
plt.scatter(x=df.bmi, y=df.avg_glucose_level)
plt.show()
```

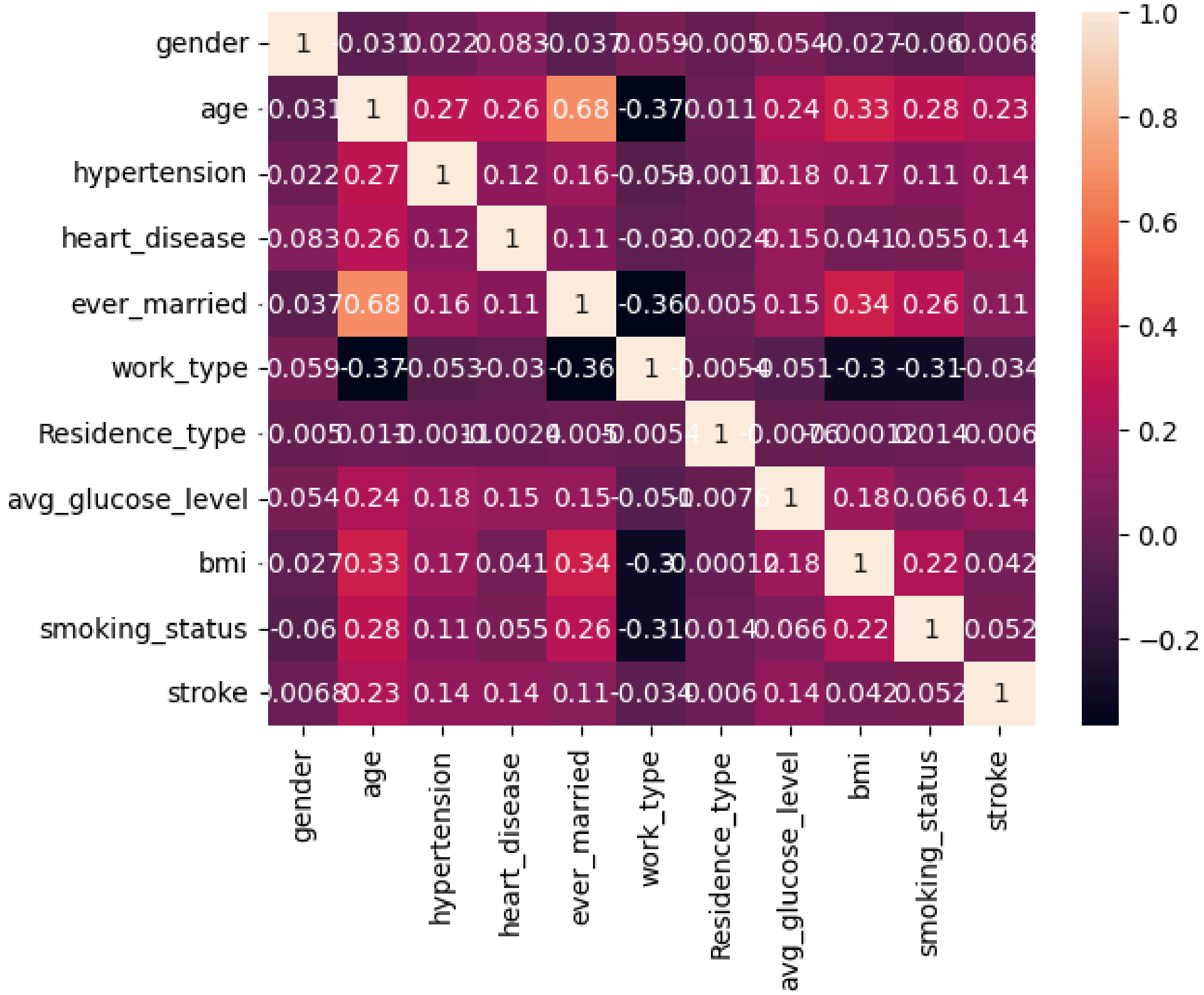







```
cor_matrix = df[Num_columns].corr()
sns.heatmap(cor_matrix, annot=True)
```

<Axes: >

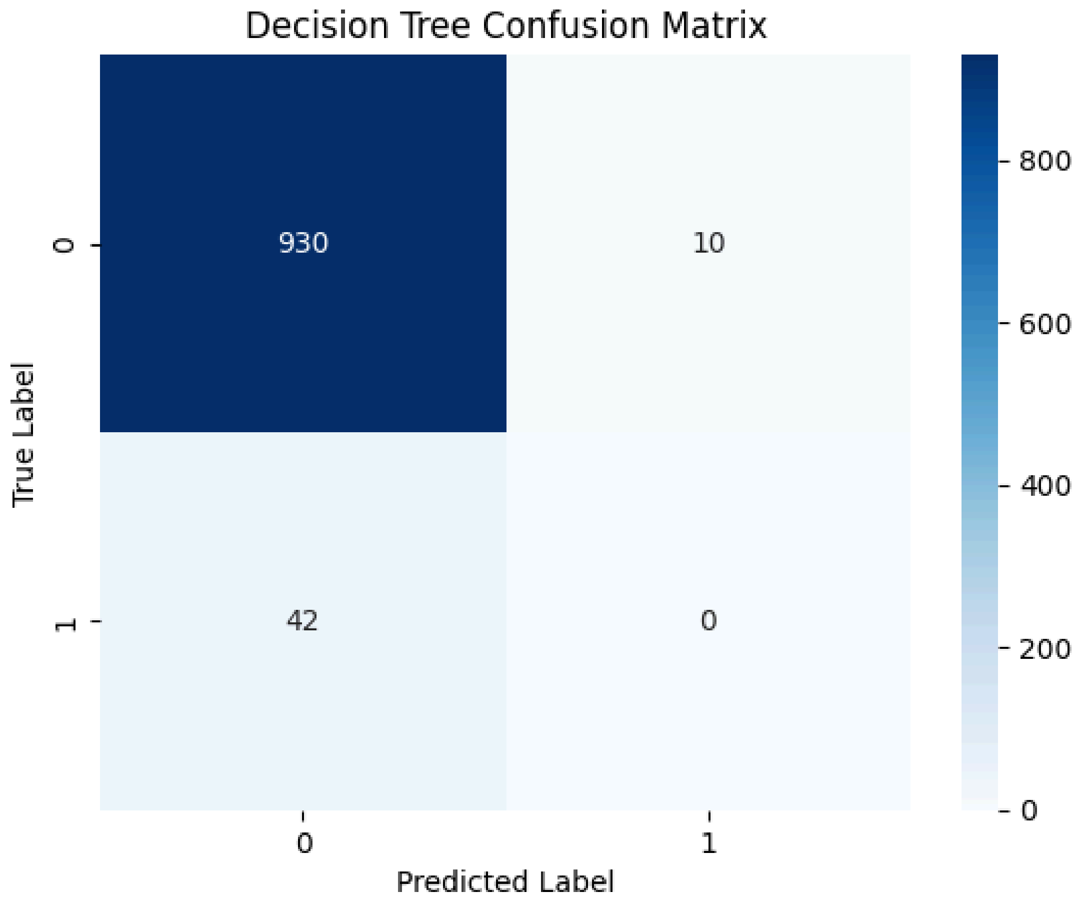


```
# Stratified sampling and feature scaling
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_state=42, stratify=y)
scaler = StandardScaler()
x_train_scaled = scaler.fit_transform(x_train)
x_test_scaled = scaler.transform(x_test)

# Define a StratifiedKFold object for cross-validation
skf = StratifiedKFold(n_splits=5)
```

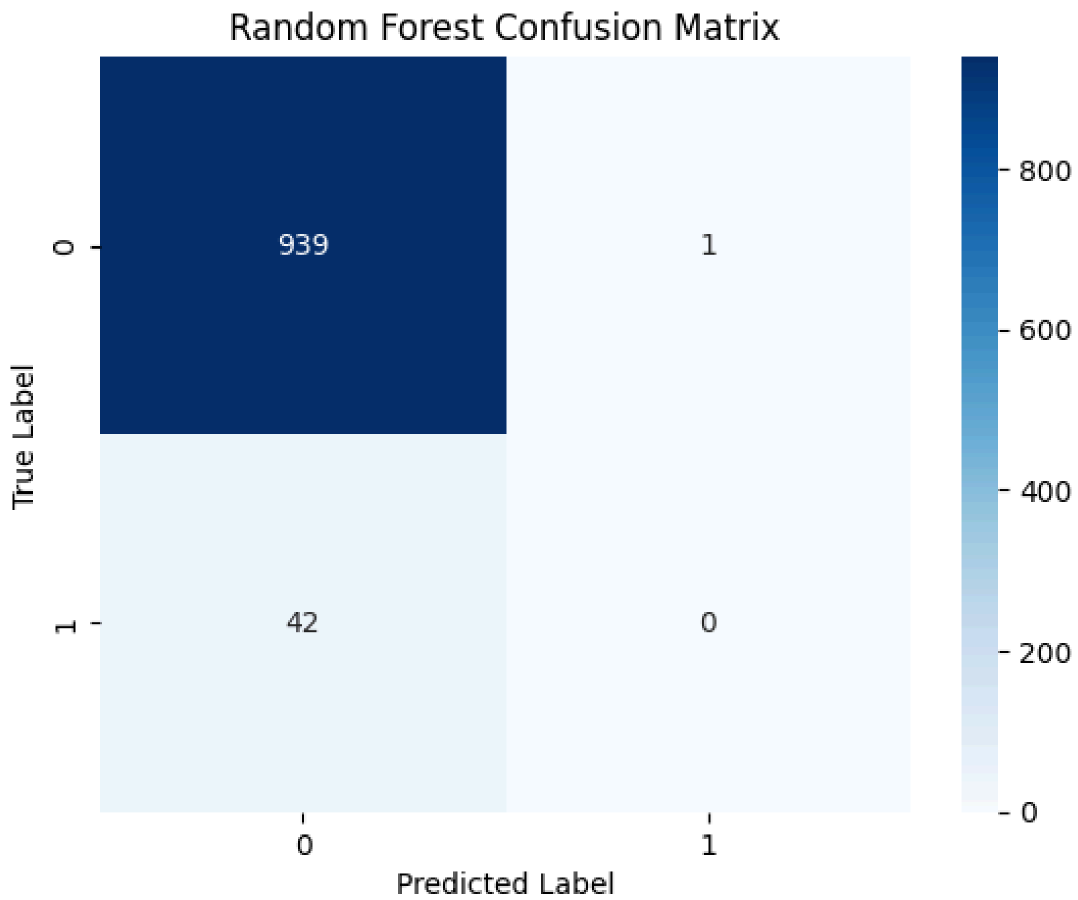
```python
# Define classifiers and their hyperparameter spaces
classifiers = {
    'Decision Tree': {
        'model': DecisionTreeClassifier(),
        'param_grid': {
            'max_depth': [None, 10, 20, 30],
            'min_samples_split': [2, 5, 10],
            'min_samples_leaf': [1, 2, 4]
        }
    },
    'Random Forest': {
        'model': RandomForestClassifier(),
        'param_grid': {
            'n_estimators': [10, 50, 100],
            'max_depth': [None, 10, 20, 30],
            'min_samples_split': [2, 5, 10],
            'min_samples_leaf': [1, 2, 4]
        }
    },
    'SVM': {
        'model': SVC(),
        'param_grid': {
            'C': [0.01, 0.1, 1, 10, 100],
            'kernel': ['linear', 'rbf']
        }
    },
    'Logistic Regression': {
        'model': LogisticRegression(),
        'param_grid': {
            'C': [0.01, 0.1, 1, 10, 100]
        }
    },
    'KNN': {
        'model': KNeighborsClassifier(),
        'param_grid': {}
    },
    'Naive Bayes': {
        'model': GaussianNB(),
        'param_grid': {}
    }
}
```

```python
# Train and evaluate the models
for clf_name, clf_params in classifiers.items():
    model = clf_params['model']
    param_grid = clf_params['param_grid']

    if param_grid:
        grid_search = GridSearchCV(model, param_grid, cv=skf, return_train_score=False)
        grid_search.fit(x_train_scaled, y_train)
        model = grid_search.best_estimator_
    else:
        model.fit(x_train_scaled, y_train)

    y_pred_train = model.predict(x_train_scaled)
    y_pred_test = model.predict(x_test_scaled)

    train_acc = accuracy_score(y_train, y_pred_train)
    test_acc = accuracy_score(y_test, y_pred_test)

    print(f"{clf_name} Train Accuracy: {train_acc:.4f}")
    print(f"{clf_name} Test Accuracy: {test_acc:.4f}")

    conf_matrix = confusion_matrix(y_test, y_pred_test)
    plt.figure()
    sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues')
    plt.title(f"{clf_name} Confusion Matrix")
    plt.xlabel("Predicted Label")
    plt.ylabel("True Label")
    plt.show()
```

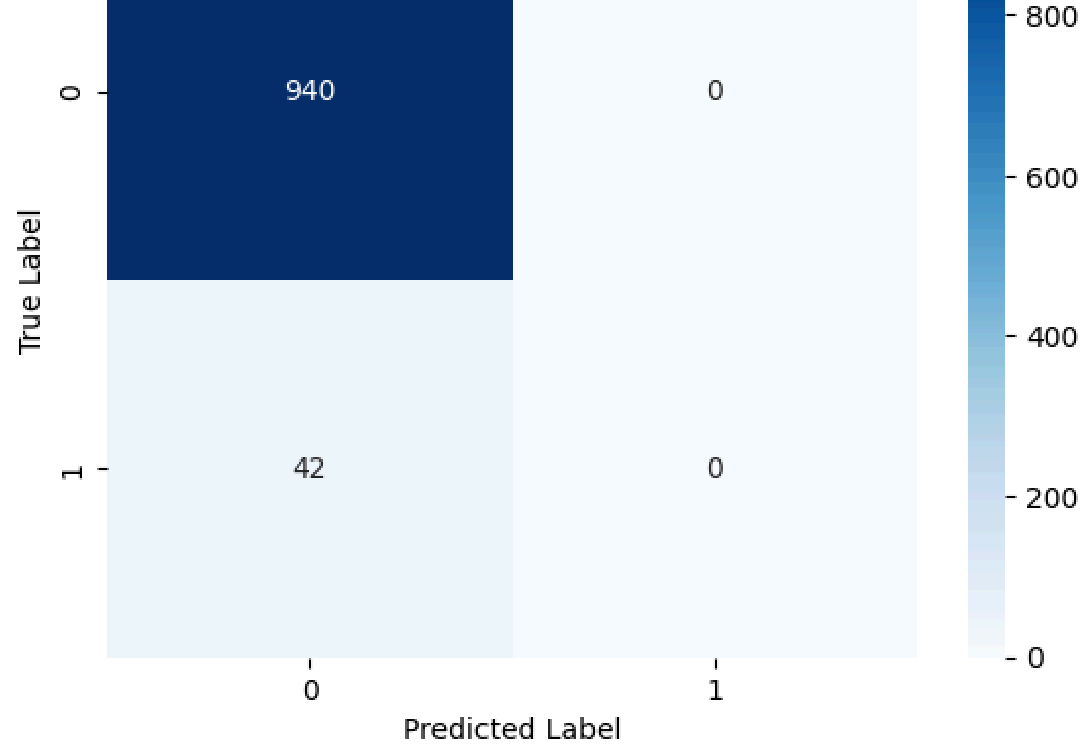
```
Decision Tree Train Accuracy: 0.9700
Decision Tree Test Accuracy: 0.9470
```




```
Random Forest Train Accuracy: 0.9638
Random Forest Test Accuracy: 0.9562
```

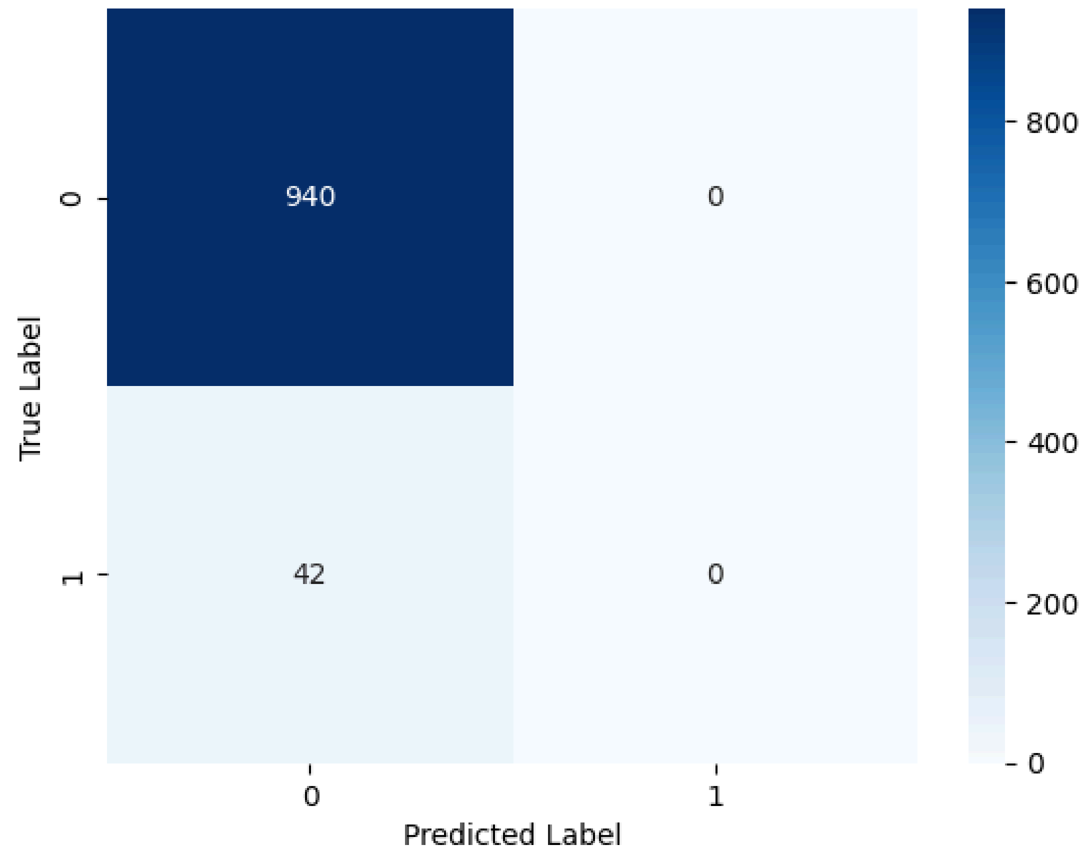



```
SVM Train Accuracy: 0.9575
SVM Test Accuracy: 0.9572
```



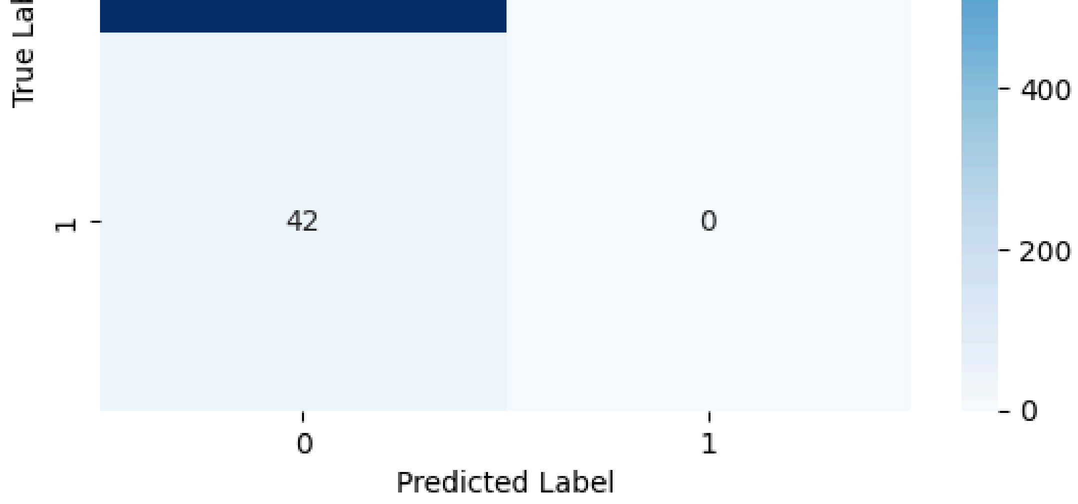

```
Logistic Regression Train Accuracy: 0.9575
Logistic Regression Test Accuracy: 0.9572
```

Logistic Regression Confusion Matrix

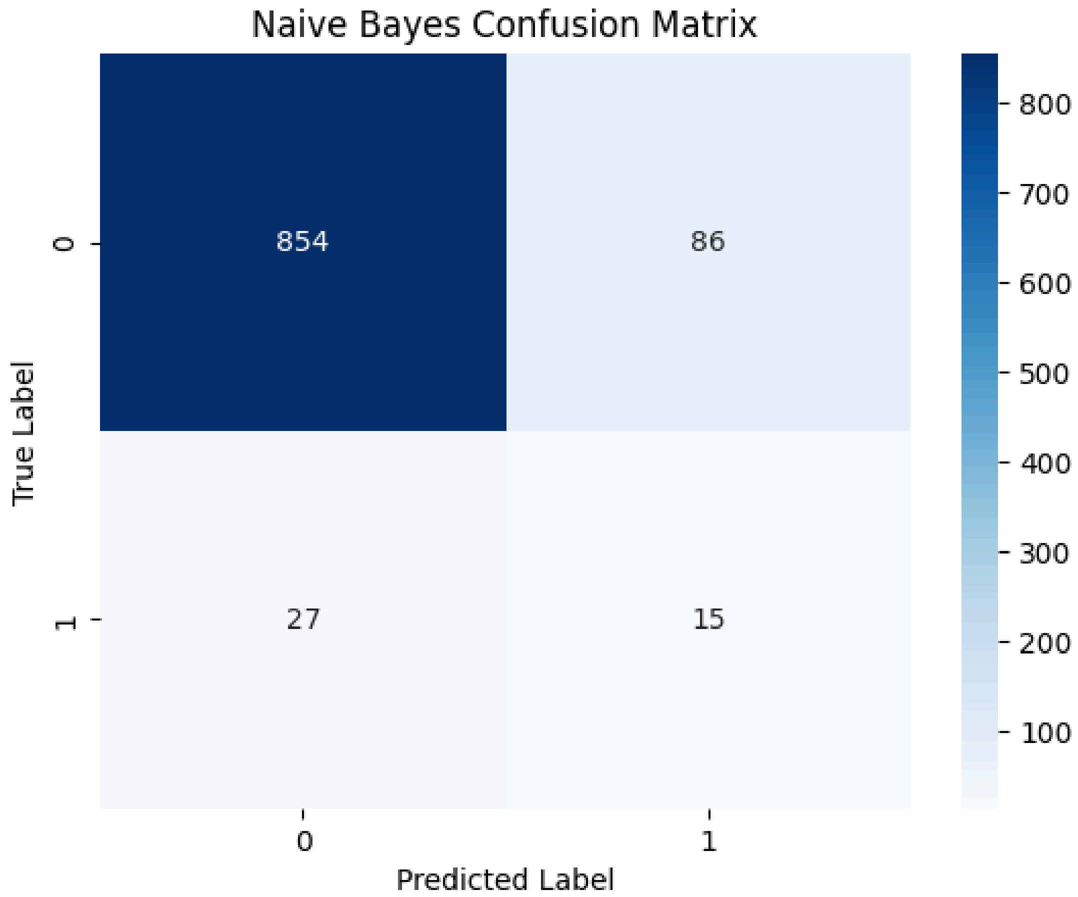



```
KNN Train Accuracy: 0.9585
KNN Test Accuracy: 0.9552
```

KNN Confusion Matrix




```
Naive Bayes Train Accuracy: 0.8737
Naive Bayes Test Accuracy: 0.8849
```




```
# Prediction for a new patient
new_patient_data = []
for col in df.columns[:-1]:  # Exclude the target variable 'stroke'
    if df[col].dtype == 'object':
        value = input(f"Enter the {col}: ")
        new_patient_data.append(label_encoder.transform([value])[0])
    else:
```