# Classification Problem

Inside this code, have

1. **Random Forest Classifier**
2. **KN-Neighbors Classifier**
3. **Support vector machine**
4. **Decision Tree**

# Import Data and Libraries

In [1]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.ensemble import RandomForestClassifier
from sklearn import preprocessing
from sklearn.metrics import accuracy_score
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import randint
from IPython.display import Image
from sklearn.preprocessing import StandardScaler
```

In [3]:
```
data=pd.read_csv("data.csv")
```

In [4]:
```
data.head()
```

Out[4]:

| | baseline value | accelerations | fetal_movement | uterine_contractions | light_decelerations | severe_decelerations | prolongued_decelerations | abnormal_short_term |
|---|---|---|---|---|---|---|---|---|
| **0** | 120.0 | 0.000 | 0.0 | 0.000 | 0.000 | 0.0 | 0.0 | |
| **1** | 132.0 | 0.006 | 0.0 | 0.006 | 0.003 | 0.0 | 0.0 | |
| **2** | 133.0 | 0.003 | 0.0 | 0.008 | 0.003 | 0.0 | 0.0 | |
| **3** | 134.0 | 0.003 | 0.0 | 0.008 | 0.003 | 0.0 | 0.0 | |
| **4** | 132.0 | 0.007 | 0.0 | 0.008 | 0.000 | 0.0 | 0.0 | |

5 rows × 22 columns

In [5]:
```
data.nunique()
```

Out[5]:
```
baseline value                                            48
accelerations                                             20
fetal_movement                                           102
uterine_contractions                                      16
light_decelerations                                       16
severe_decelerations                                       2
prolongued_decelerations                                   6
abnormal_short_term_variability                           75
mean_value_of_short_term_variability                      57
percentage_of_time_with_abnormal_long_term_variability    87
mean_value_of_long_term_variability                      249
histogram_width                                          154
histogram_min                                            109
histogram_max                                             86
histogram_number_of_peaks                                 18
histogram_number_of_zeroes                                 9
histogram_mode                                            88
histogram_mean                                           103
histogram_median                                          95
histogram_variance                                       133
histogram_tendency                                         3
fetal_health                                               3
dtype: int64
```

In [6]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2126 entries, 0 to 2125
Data columns (total 22 columns):
 #   Column                                                  Non-Null Count  Dtype  
---  ------                                                  --------------  -----  
 0   baseline value                                          2126 non-null   float64
 1   accelerations                                           2126 non-null   float64
 2   fetal_movement                                          2126 non-null   float64
 3   uterine_contractions                                    2126 non-null   float64
 4   light_decelerations                                     2126 non-null   float64
 5   severe_decelerations                                    2126 non-null   float64
 6   prolongued_decelerations                                2126 non-null   float64
 7   abnormal_short_term_variability                         2126 non-null   float64
 8   mean_value_of_short_term_variability                    2126 non-null   float64
 9   percentage_of_time_with_abnormal_long_term_variability  2126 non-null   float64
 10  mean_value_of_long_term_variability                     2126 non-null   float64
 11  histogram_width                                         2126 non-null   float64
 12  histogram_min                                           2126 non-null   float64
 13  histogram_max                                           2126 non-null   float64
 14  histogram_number_of_peaks                               2126 non-null   float64
 15  histogram_number_of_zeroes                              2126 non-null   float64
 16  histogram_mode                                          2126 non-null   float64
 17  histogram_mean                                          2126 non-null   float64
 18  histogram_median                                        2126 non-null   float64
 19  histogram_variance                                      2126 non-null   float64
 20  histogram_tendency                                      2126 non-null   float64
 21  fetal_health                                            2126 non-null   float64
dtypes: float64(22)
memory usage: 365.5 KB
```

In [7]:
```
data.isnull().sum()
```

Out[7]:
```
baseline value                                            0
accelerations                                             0
fetal_movement                                            0
uterine_contractions                                      0
light_decelerations                                       0
severe_decelerations                                      0
prolongued_decelerations                                  0
abnormal_short_term_variability                           0
mean_value_of_short_term_variability                      0
percentage_of_time_with_abnormal_long_term_variability    0
mean_value_of_long_term_variability                       0
histogram_width                                           0
histogram_min                                             0
histogram_max                                             0
histogram_number_of_peaks                                 0
histogram_number_of_zeroes                                0
histogram_mode                                            0
histogram_mean                                            0
histogram_median                                          0
histogram_variance                                        0
histogram_tendency                                        0
fetal_health                                              0
dtype: int64
```

# Exploratory Data Analysis

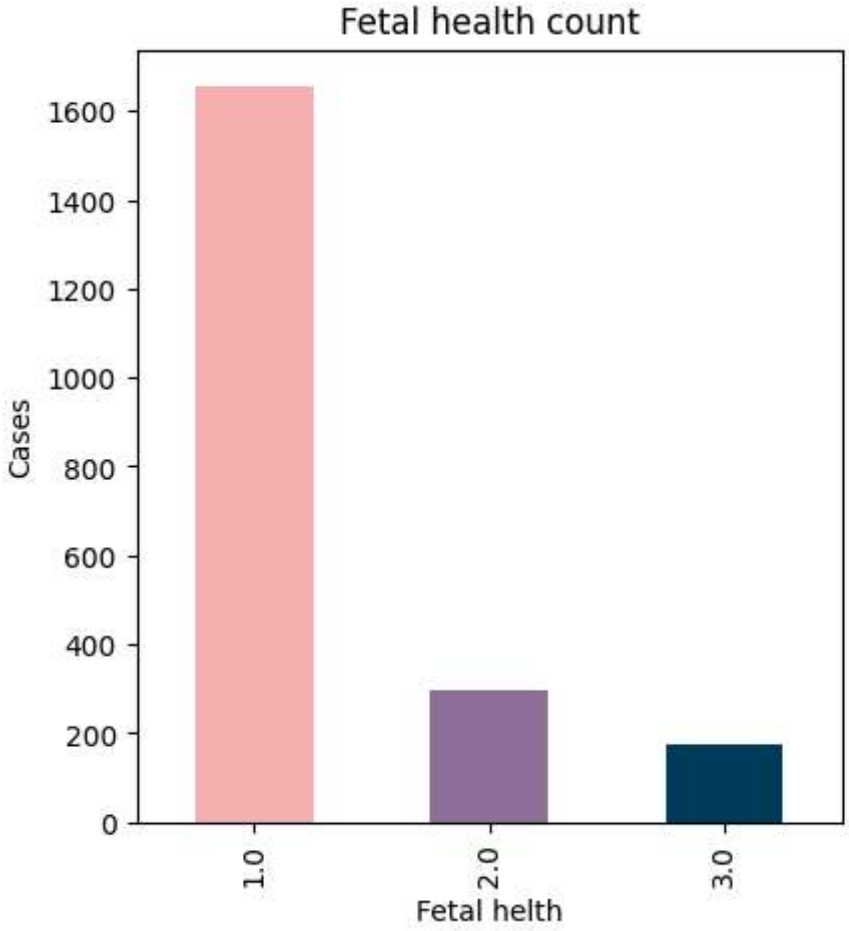
In [8]:
```
data.columns
```

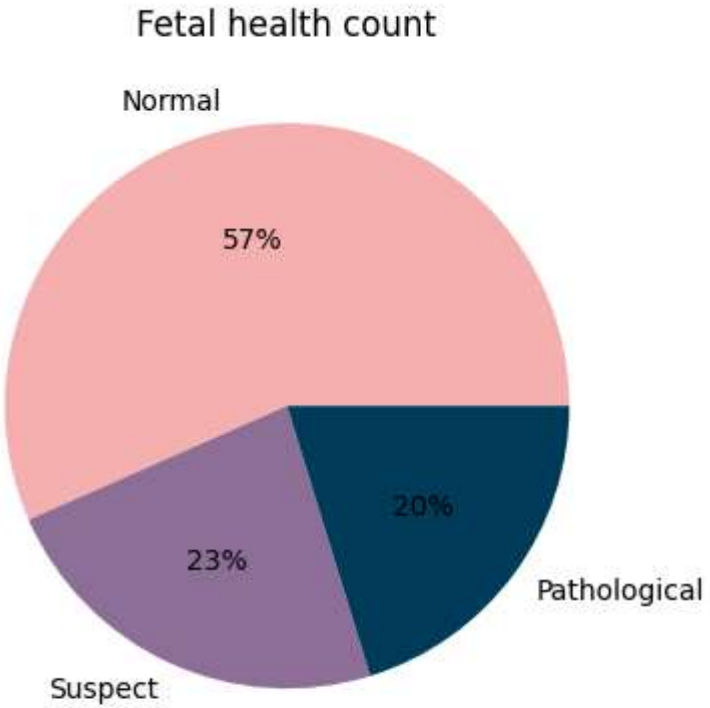
Out[8]:
```
Index(['baseline value', 'accelerations', 'fetal_movement',
       'uterine_contractions', 'light_decelerations', 'severe_decelerations',
       'prolongued_decelerations', 'abnormal_short_term_variability',
       'mean_value_of_short_term_variability',
       'percentage_of_time_with_abnormal_long_term_variability',
       'mean_value_of_long_term_variability', 'histogram_width',
       'histogram_min', 'histogram_max', 'histogram_number_of_peaks',
       'histogram_number_of_zeroes', 'histogram_mode', 'histogram_mean',
       'histogram_median', 'histogram_variance', 'histogram_tendency',
       'fetal_health'],
      dtype='object')
```

In [9]:
```
colours=["#f7b2b0","#8f7198", "#003f5c"]
```

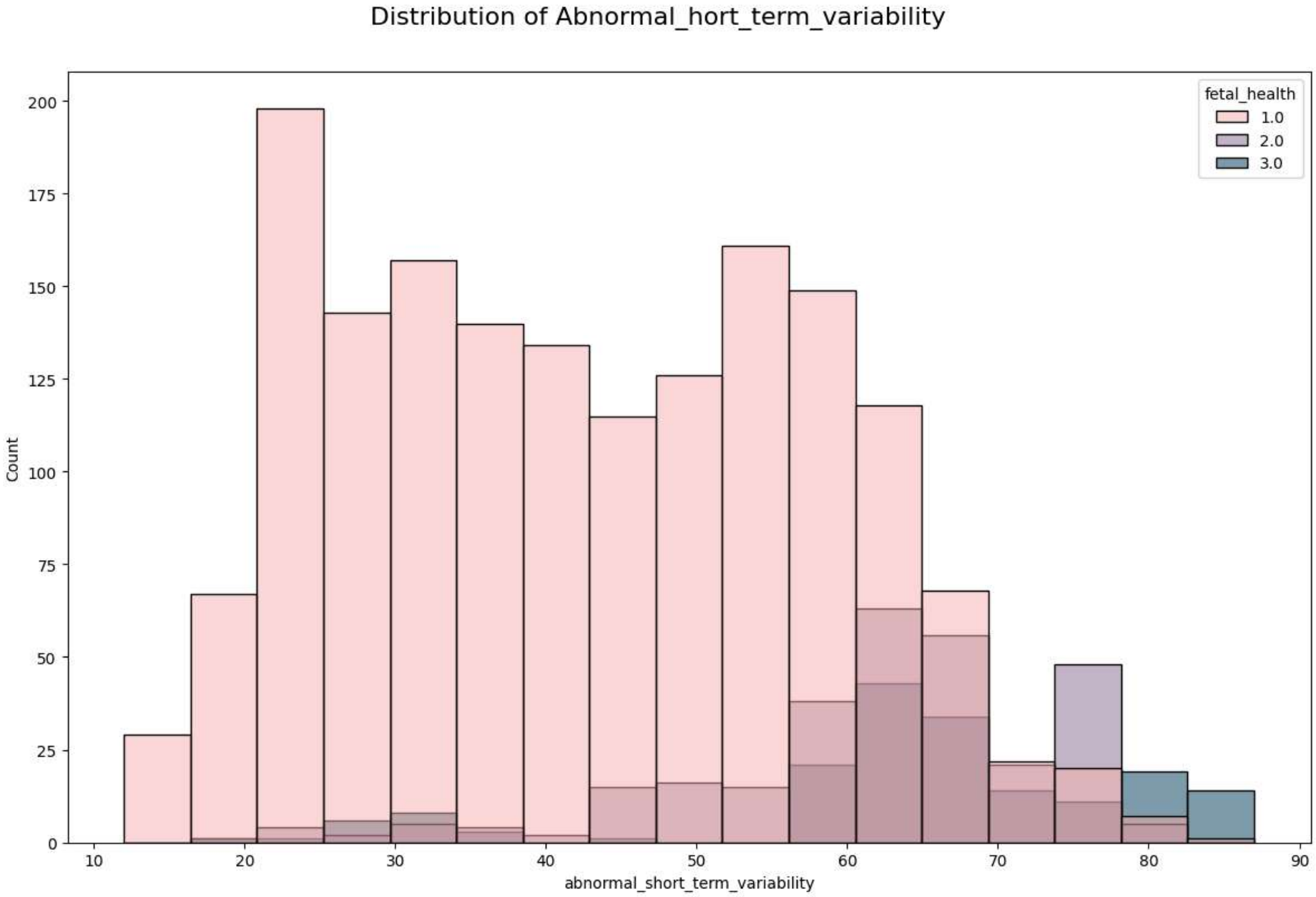
In [10]:

```
total = data["fetal_health"].sum()
normal = total - 471
suspect = total - 1831
pathological = total - 1950

plt.figure(figsize = (14,8))
plt.subplot(121)
vis_fetal_health = data.fetal_health.value_counts().plot(figsize=(10, 5), kind="bar", color = colours)
plt.title("Fetal health count")
plt.xlabel("Fetal helth")
plt.ylabel("Cases")

plt.subplot(122)
plt.title("Fetal state")

vis_pie_fetal_health = plt.pie([normal, suspect, pathological], labels=["Normal", "Suspect", "Pathological"], colors = colours, a
plt.title("Fetal health count")


plt.show()
```




In [11]:
```
plt.figure(figsize=(12,8))
sns.histplot(data=data, x='abnormal_short_term_variability', hue='fetal_health', palette=colours)
plt.suptitle('Distribution of Abnormal_hort_term_variability', size=16, y=1.01)
plt.tight_layout()
plt.show()
```




# Model Building

In [12]:
```
data.head()
```

Out[12]:

| | baseline value | accelerations | fetal_movement | uterine_contractions | light_decelerations | severe_decelerations | prolongued_decelerations | abnormal_short_term |
|---|---|---|---|---|---|---|---|---|
| **0** | 120.0 | 0.000 | 0.0 | 0.000 | 0.000 | 0.0 | 0.0 | |
| **1** | 132.0 | 0.006 | 0.0 | 0.006 | 0.003 | 0.0 | 0.0 | |
| **2** | 133.0 | 0.003 | 0.0 | 0.008 | 0.003 | 0.0 | 0.0 | |
| **3** | 134.0 | 0.003 | 0.0 | 0.008 | 0.003 | 0.0 | 0.0 | |
| **4** | 132.0 | 0.007 | 0.0 | 0.008 | 0.000 | 0.0 | 0.0 | |

5 rows × 22 columns

In [13]:
```
#assigning values to features as X and target as y
X=data.drop(["fetal_health"],axis=1)
y=data["fetal_health"]

#Set up a standard scaler for the features
col_names = list(X.columns)
s_scaler = preprocessing.StandardScaler()
X_df = s_scaler.fit_transform(X)
X_df = pd.DataFrame(X_df, columns=col_names)
```

In [14]:
```
X
```

Out[14]:

| | baseline value | accelerations | fetal_movement | uterine_contractions | light_decelerations | severe_decelerations | prolongued_decelerations | abnormal_short_te |
|---|---|---|---|---|---|---|---|---|
| **0** | 120.0 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.0 | |
| **1** | 132.0 | 0.006 | 0.000 | 0.006 | 0.003 | 0.0 | 0.0 | |
| **2** | 133.0 | 0.003 | 0.000 | 0.008 | 0.003 | 0.0 | 0.0 | |
| **3** | 134.0 | 0.003 | 0.000 | 0.008 | 0.003 | 0.0 | 0.0 | |
| **4** | 132.0 | 0.007 | 0.000 | 0.008 | 0.000 | 0.0 | 0.0 | |
| **...** | ... | ... | ... | ... | ... | ... | ... | |
| **2121** | 140.0 | 0.000 | 0.000 | 0.007 | 0.000 | 0.0 | 0.0 | |
| **2122** | 140.0 | 0.001 | 0.000 | 0.007 | 0.000 | 0.0 | 0.0 | |
| **2123** | 140.0 | 0.001 | 0.000 | 0.007 | 0.000 | 0.0 | 0.0 | |
| **2124** | 140.0 | 0.001 | 0.000 | 0.006 | 0.000 | 0.0 | 0.0 | |
| **2125** | 142.0 | 0.002 | 0.002 | 0.008 | 0.000 | 0.0 | 0.0 | |

2126 rows × 21 columns

In [15]:
```
print(y)
```

```
0       2.0
1       1.0
2       1.0
3       1.0
4       1.0
       ...
2121    2.0
2122    2.0
2123    2.0
2124    2.0
2125    1.0
Name: fetal_health, Length: 2126, dtype: float64
```

In [16]:
```
X_train, X_test, y_train,y_test = train_test_split(X_df,y,test_size=0.25,random_state=42)
```

# RandomForestClassifier

In [17]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn import svm

from sklearn.metrics import confusion_matrix
```

In [18]:
```
model = RandomForestClassifier()
model.fit(X_train, y_train)
```

Out[18]:
```
▾ RandomForestClassifier
RandomForestClassifier()
```

In [19]:
```
model_train_prediction = model.predict(X_train)
training_data_accuracy = accuracy_score(y_train, model_train_prediction)
print('Accuracy score of training data : ', training_data_accuracy)
```

```
Accuracy score of training data :  1.0
```

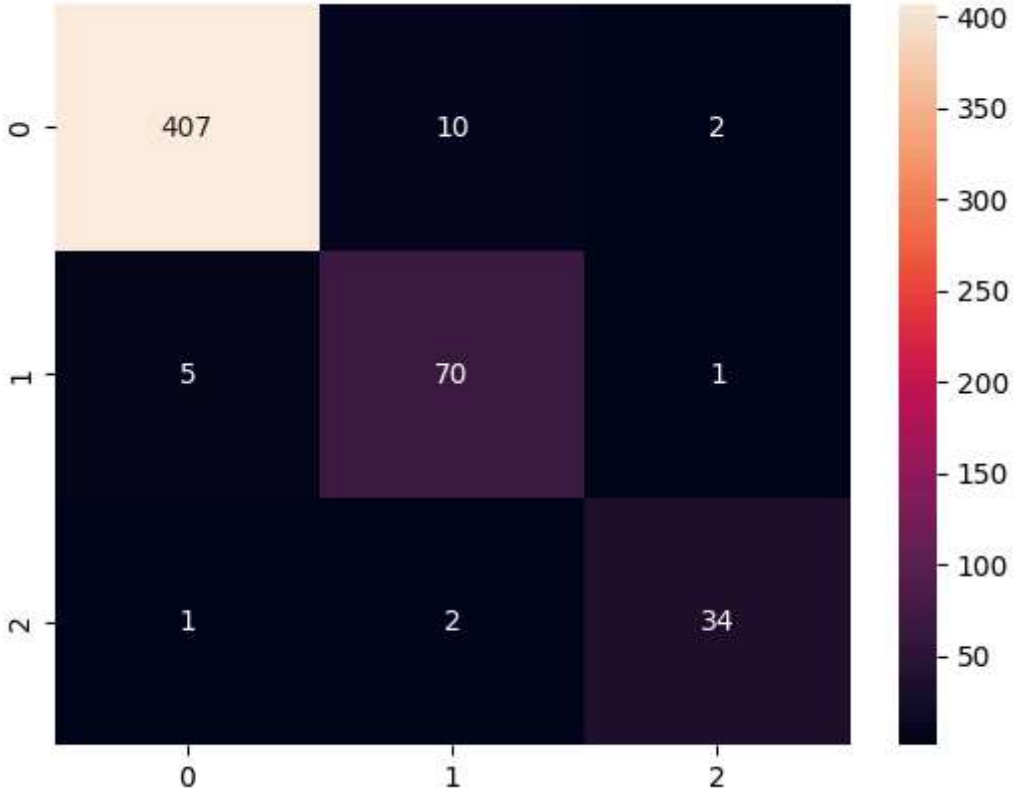
In [20]:
```
model_test_prediction = model.predict(X_test)
test_data_accuracy = accuracy_score(y_test, model_test_prediction)
print('Accuracy score of test data : ', test_data_accuracy)
```

```
Accuracy score of test data :  0.9605263157894737
```

In [40]:
```
comp = pd.DataFrame(
    {"Y_pred":model_test_prediction,
     "Y_test":y_test}
)

comp.to_csv('file1.csv')
```

In [22]:
```
cm=confusion_matrix(model.predict(X_test),y_test)
sns.heatmap(cm,annot=True, fmt='g')
cm
```

Out[22]:
```
array([[407,  10,   2],
       [  5,  70,   1],
       [  1,   2,  34]])
```




## KN-Neighbors Classifier

In [23]:
```
model_2=KNeighborsClassifier(n_neighbors=3)
model_2.fit(X_train,y_train)
```

Out[23]:
```
KNeighborsClassifier
KNeighborsClassifier(n_neighbors=3)
```

In [24]:
```
model_2_train_score=model_2.score(X_train,y_train)
print('Accuracy score of training data : ',model_2_train_score)
```

```
Accuracy score of training data :  0.9485570890840652
```

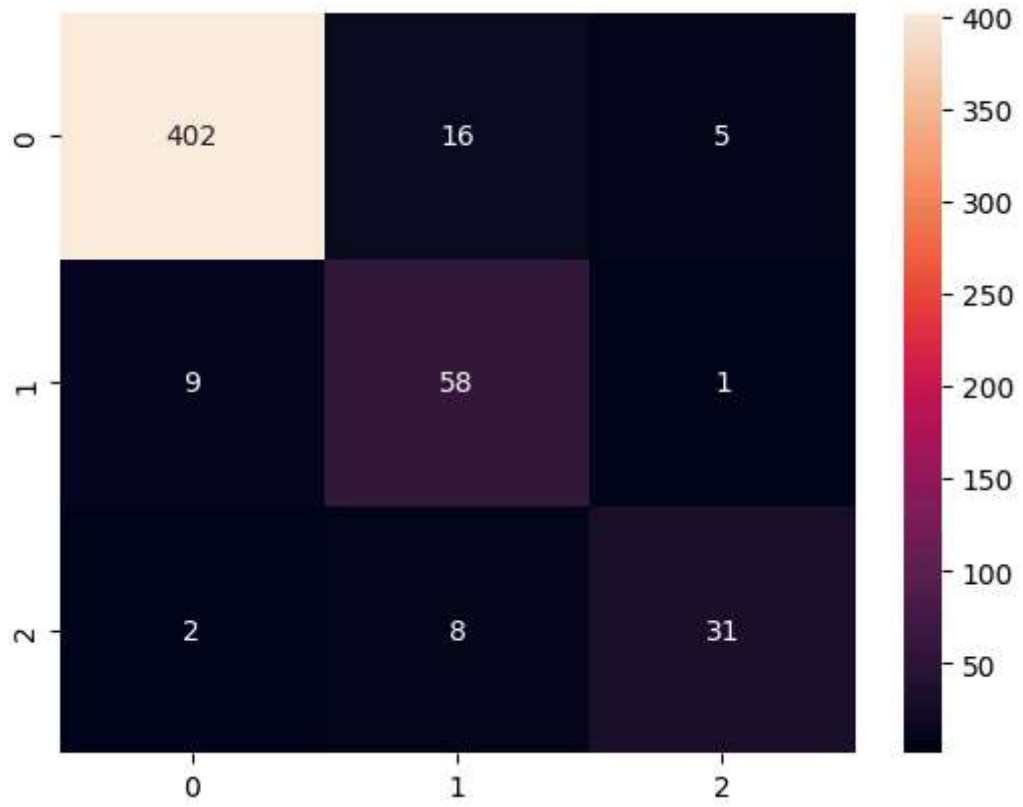
In [25]:
```
modul_2_pred=model_2.predict(X_test)
```

In [26]:
```
knn_pred_score=accuracy_score(y_test,modul_2_pred)
print('Accuracy score of test data : ',knn_pred_score)
```

```
Accuracy score of test data :  0.9229323308270677
```

In [27]:
```
cm=confusion_matrix(model_2.predict(X_test),y_test)
sns.heatmap(cm,annot=True, fmt='g')
```

Out[27]:
```
<Axes: >
```




In [27]:
```
```

## Support vector machine

In [28]:
```
model_3 = svm.SVC(kernel='rbf')
```

In [29]:
```
# training the SVM model with training data
model_3.fit(X_train,y_train)
```

Out[29]:
```
SVC()
```

In [30]:
```
model_3_train_score=model_3.score(X_train,y_train)
print('Accuracy score of training data : ',model_3_train_score)
```

```
Accuracy score of training data :  0.9316185696361355
```

In [31]:
```
modul_3_pred=model_3.predict(X_test)
```

In [32]:
```
svm_pred_score=accuracy_score(y_test,modul_3_pred)
print('Accuracy score of test data : ',svm_pred_score)
```

```
Accuracy score of test data :  0.9172932330827067
```

## Decision Tree

In [33]:
```
model_4 = DecisionTreeClassifier()
```

In [34]:
```
model_4.fit(X_train,y_train)
```

Out[34]:
```
DecisionTreeClassifier()
```

In [35]:
```
model_4_train_score=model_4.score(X_train,y_train)
print('Accuracy score of training data : ',model_4_train_score)
```

```
Accuracy score of training data :  1.0
```

In [36]:
```
modul_4_pred=model_4.predict(X_test)
```

In [37]:
```
dt_pred_score=accuracy_score(y_test,modul_4_pred)
print('Accuracy score of test data : ',dt_pred_score)
```

```
Accuracy score of test data :  0.9323308270676691
```

## Results

In [38]:
```
result=pd.DataFrame(columns=['Algorithm','Training-Result','Predictive-Result'])
```

In [39]:
```
m=['KN-Neighbors Classifier', model_2_train_score, knn_pred_score]
result.loc[0]=m
m = ['Random Forest', training_data_accuracy, test_data_accuracy]
result.loc[1]=m
m = ['Support Vector Machine', model_3_train_score, svm_pred_score]
result.loc[2]=m
m = ['Decision Tree Classifier', model_4_train_score, dt_pred_score]
result.loc[3]=m

result
```

Out[39]:

| | Algorithm | Training-Result | Predictive-Result |
|---|---|---|---|
| **0** | KN-Neighbors Classifier | 0.948557 | 0.922932 |
| **1** | Random Forest | 1.000000 | 0.960526 |
| **2** | Support Vector Machine | 0.931619 | 0.917293 |
| **3** | Decision Tree Classifier | 1.000000 | 0.932331 |

In [39]: