Attaching Libraries

In [6]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score
```

Data Collection

In [7]:
```
df = pd.read_csv("emails.csv")
```

In [8]:
```
df.head(5)
```

Out[8]:

	Email No.	the	to	ect	and	for	of	a	you	hou	...	connevey	jay	valued	lay	infrastructure	military	allowing	ff	dry	Prediction
0	Email 1	0	0	1	0	0	0	2	0	0	...	0	0	0	0	0	0	0	0	0	0
1	Email 2	8	13	24	6	6	2	102	1	27	...	0	0	0	0	0	0	0	1	0	0
2	Email 3	0	0	1	0	0	0	8	0	0	...	0	0	0	0	0	0	0	0	0	0
3	Email 4	0	5	22	0	5	1	51	2	10	...	0	0	0	0	0	0	0	0	0	0
4	Email 5	7	6	17	1	5	2	57	0	9	...	0	0	0	0	0	0	0	1	0	0

5 rows × 3002 columns

Data Processing

In [9]:
```
df.isnull().sum()
```

Out[9]:
```
Email No.     0
the           0
to            0
ect           0
and           0
             ..
military      0
allowing      0
ff            0
dry           0
Prediction    0
Length: 3002, dtype: int64
```

In [10]:
```
df.shape
```

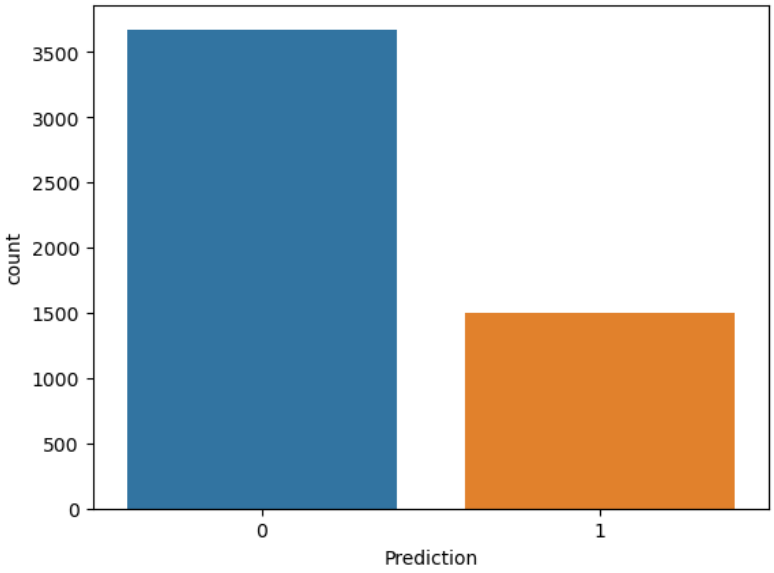
Out[10]:
```
(5172, 3002)
```

In [11]:
```
df.columns
```

Out[11]:
```
Index(['Email No.', 'the', 'to', 'ect', 'and', 'for', 'of', 'a', 'you', 'hou',
       ...
       'connevey', 'jay', 'valued', 'lay', 'infrastructure', 'military',
       'allowing', 'ff', 'dry', 'Prediction'],
      dtype='object', length=3002)
```

In [12]:
```
# import seaborn library
import seaborn as sns
```

In [13]:
```
sns.countplot(data = df, x= 'Prediction')
plt.show()
```



In [14]:
```
df.describe()
```

Out[14]:

	the	to	ect	and	for	of	a	you	hou	in	...	connevey	
count	5172.000000	5172.000000	5172.000000	5172.000000	5172.000000	5172.000000	5172.000000	5172.000000	5172.000000	5172.000000	...	5172.000000	5172
mean	6.640565	6.188128	5.143852	3.075599	3.124710	2.627030	55.517401	2.466551	2.024362	10.600155	...	0.005027	0
std	11.745009	9.534576	14.101142	6.045970	4.680522	6.229845	87.574172	4.314444	6.967878	19.281892	...	0.105788	0
min	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.000000	0
25%	0.000000	1.000000	1.000000	0.000000	1.000000	0.000000	12.000000	0.000000	0.000000	1.000000	...	0.000000	0
50%	3.000000	3.000000	1.000000	1.000000	2.000000	1.000000	28.000000	1.000000	0.000000	5.000000	...	0.000000	0
75%	8.000000	7.000000	4.000000	3.000000	4.000000	2.000000	62.250000	3.000000	1.000000	12.000000	...	0.000000	0
max	210.000000	132.000000	344.000000	89.000000	47.000000	77.000000	1898.000000	70.000000	167.000000	223.000000	...	4.000000	7

8 rows × 3001 columns

Training and Testing DataFrame

In [15]:
```
x = df.iloc[:,1:3001]
x
```

Out[15]:

	the	to	ect	and	for	of	a	you	hou	in	...	enhancements	connevey	jay	valued	lay	infrastructure	military	allowing	ff	dry
0	0	0	1	0	0	0	2	0	0	0	...	0	0	0	0	0	0	0	0	0	0
1	8	13	24	6	6	2	102	1	27	18	...	0	0	0	0	0	0	0	0	1	0
2	0	0	1	0	0	0	8	0	0	4	...	0	0	0	0	0	0	0	0	0	0
3	0	5	22	0	5	1	51	2	10	1	...	0	0	0	0	0	0	0	0	0	0
4	7	6	17	1	5	2	57	0	9	3	...	0	0	0	0	0	0	0	0	1	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5167	2	2	2	3	0	0	32	0	0	5	...	0	0	0	0	0	0	0	0	0	0
5168	35	27	11	2	6	5	151	4	3	23	...	0	0	0	0	0	0	0	0	1	0
5169	0	0	1	1	0	0	11	0	0	1	...	0	0	0	0	0	0	0	0	0	0
5170	2	7	1	0	2	1	28	2	0	8	...	0	0	0	0	0	0	0	0	1	0
5171	22	24	5	1	6	5	148	8	2	23	...	0	0	0	0	0	0	0	0	0	0

5172 rows × 3000 columns

In [16]:
```
y = df.iloc[:,-1].values
y
```

Out[16]:
```
array([0, 0, 0, ..., 1, 1, 0], dtype=int64)
```

In [17]:
```
from sklearn.metrics import f1_score, recall_score, roc_auc_score

train_x, test_x, train_y, test_y = train_test_split(x,y,test_size = 0.2)
```

In [18]:
```
from sklearn.naive_bayes import MultinomialNB
```

In [19]:
```
mnb = MultinomialNB()
```

In [20]:
```
mnb.fit(train_x,train_y)
```

Out[20]:
```
MultinomialNB()
```

In [21]:
```
mnb_pred = mnb.predict(x)
mnb_accuracy = accuracy_score(y,mnb_pred)
```

In [22]:
```
mnb_f1= f1_score(y,mnb_pred)
mnb_recall = recall_score(y,mnb_pred)
mnb_roc_auc = roc_auc_score(y, mnb_pred)
```

In [23]:
```
print(f"Accuracy of MultinomialNB model: {mnb_accuracy * 100:0.2f}%" )
print(f"f1- Score of MultinomialNB model: {mnb_f1:0.2f}" )
print(f"Recall Score of MultinomialNB model: {mnb_recall:0.2f}" )
print(f"ROC AUC Score of MultinomialNB model: {mnb_roc_auc:0.2f}" )
```

```
Accuracy of MultinomialNB model: 94.61%
f1- Score of MultinomialNB model: 0.91
Recall Score of MultinomialNB model: 0.95
ROC AUC Score of MultinomialNB model: 0.95
```

Gaussian Naive Bayes

In [24]:
```
from sklearn.naive_bayes import GaussianNB
```

In [25]:
```
gnb = GaussianNB()
```

In [26]:
```
gnb.fit(train_x,train_y)
```

Out[26]:
```
GaussianNB()
```

In [27]:
```
gnb_pred = gnb.predict(x)
gnb_accuracy = accuracy_score(y,gnb_pred)
gnb_f1= f1_score(y,gnb_pred)
gnb_recall = recall_score(y,gnb_pred)
gnb_roc_auc = roc_auc_score(y, gnb_pred)
```

In [28]:
```
print(f"Accuracy of GaussianNB model: {gnb_accuracy * 100:0.2f}%" )
print(f"f1- Score of GaussianNB model: {gnb_f1:0.2f}" )
print(f"Recall Score of GaussianNB model: {gnb_recall:0.2f}" )
print(f"ROC AUC Score of GaussianNB model: {gnb_roc_auc:0.2f}" )
```

```
Accuracy of GaussianNB model: 96.11%
f1- Score of GaussianNB model: 0.94
Recall Score of GaussianNB model: 0.99
ROC AUC Score of GaussianNB model: 0.97
```

Bernoulli Naive Bayes

In [29]:
```
from sklearn.naive_bayes import BernoulliNB

bnb = BernoulliNB()
bnb.fit(train_x,train_y)
```

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

In [30]:
```
bnb_pred = bnb.predict(x)
bnb_accuracy = accuracy_score(y,bnb_pred)
bnb_f1= f1_score(y,gnb_pred)
bnb_recall = recall_score(y,bnb_pred)
bnb_roc_auc = roc_auc_score(y, bnb_pred)
```

```
print(f"Accuracy of BernoulliNB model: {bnb_accuracy * 100:0.2f}%" )
print(f"f1- Score of BernoulliNB model: {bnb_f1:0.2f}" )
print(f"Recall Score of BernoulliNB model: {bnb_recall:0.2f}" )
print(f"ROC AUC Score of BernoulliNB model: {bnb_roc_auc:0.2f}" )
```

```
Accuracy of BernoulliNB model: 87.45%
f1- Score of BernoulliNB model: 0.94
Recall Score of BernoulliNB model: 0.75
ROC AUC Score of BernoulliNB model: 0.84
```

Logistic Regression

In [31]:
```
lreg = LogisticRegression()
```

In [32]:
```
lreg.fit(train_x,train_y)
```

```
C:\Users\Red Devil\anaconda3.4\lib\site-packages\sklearn\linear_model\_logistic.py:458: ConvergenceWarning: lbfgs failed to converge
(status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
```

Out[32]:
```
LogisticRegression()
```

In [33]:
```
lreg_pred = lreg.predict(x)
lreg_accuracy = accuracy_score(y,lreg_pred)
lreg_f1= f1_score(y,lreg_pred)
lreg_recall = recall_score(y,lreg_pred)
lreg_roc_auc = roc_auc_score(y,lreg_pred)


print(f"Accuracy of LogisticRegression model: {lreg_accuracy * 100:0.2f}%" )
print(f"f1- Score of LogisticRegression model: {lreg_f1:0.2f}" )
print(f"Recall Score of LogisticRegression model: {lreg_recall:0.2f}" )
print(f"ROC AUC Score of LogisticRegression model: {lreg_roc_auc:0.2f}" )
```

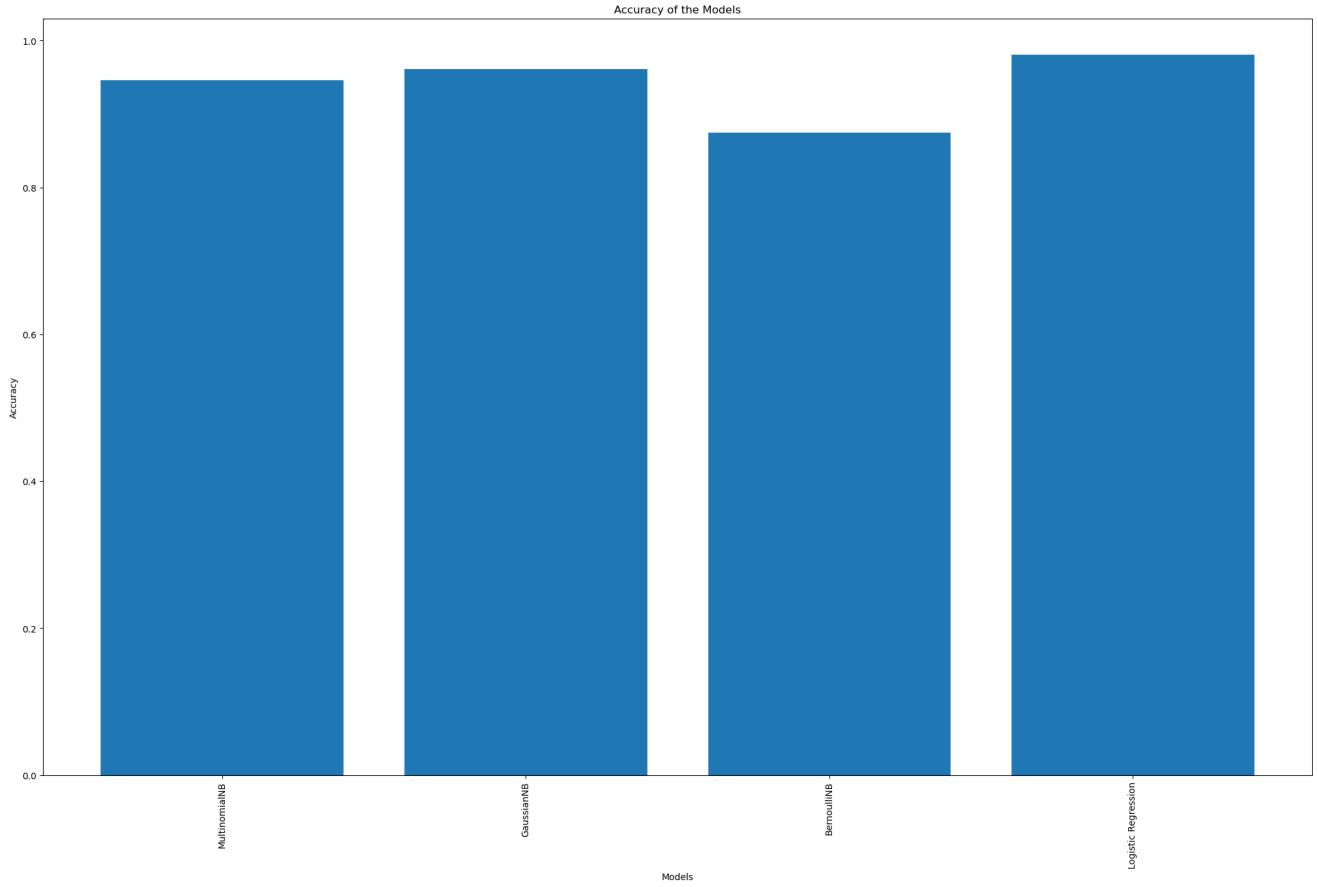
```
Accuracy of LogisticRegression model: 98.11%
f1- Score of LogisticRegression model: 0.97
Recall Score of LogisticRegression model: 0.97
ROC AUC Score of LogisticRegression model: 0.98
```

Model Comparision

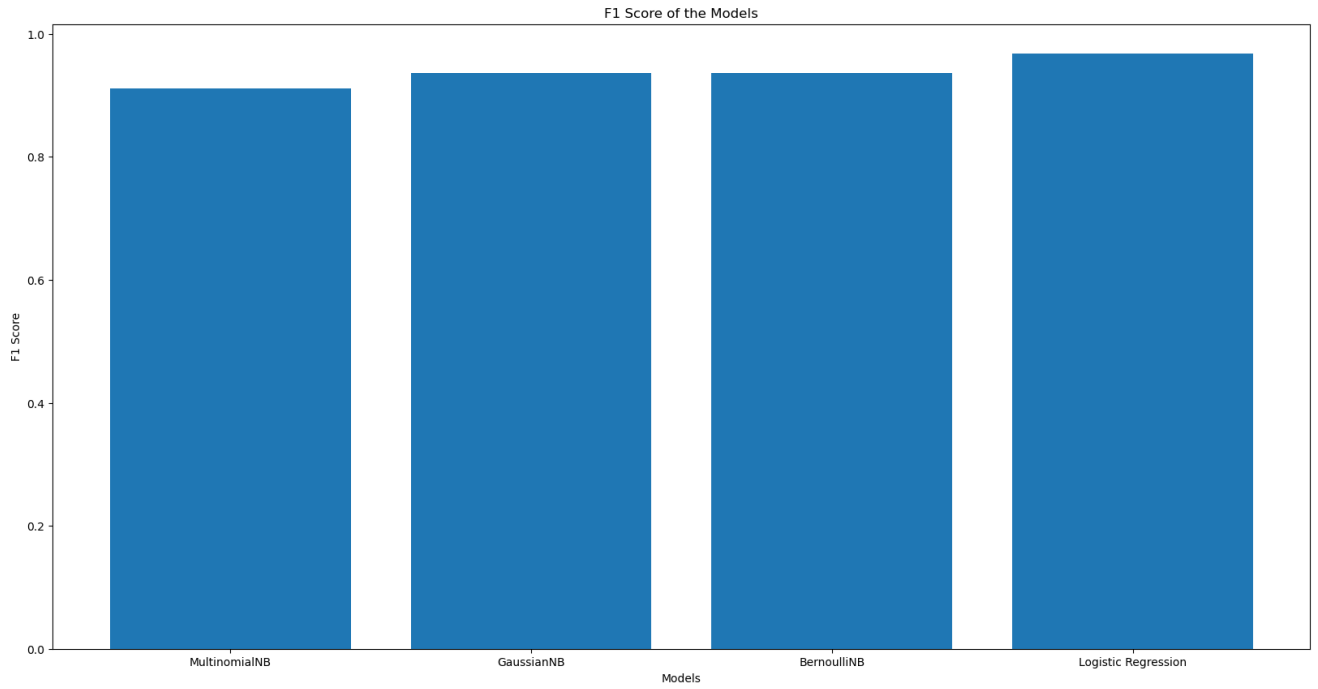
In [34]:
```
accuracy = [mnb_accuracy, gnb_accuracy, bnb_accuracy, lreg_accuracy]
f1_score = [mnb_f1, gnb_f1, bnb_f1, lreg_f1]
recall = [mnb_recall, gnb_recall, bnb_recall, lreg_recall]
roc_auc = [mnb_roc_auc, gnb_roc_auc, bnb_roc_auc, lreg_roc_auc]

models = ["MultinomialNB", "GaussianNB", "BernoulliNB", "Logistic Regression"]

plt.figure(figsize = (25,15))
plt.bar(models, accuracy)
plt.xticks(rotation = 90)
plt.xlabel("Models")
plt.ylabel("Accuracy")
plt.title("Accuracy of the Models")
plt.show()
```

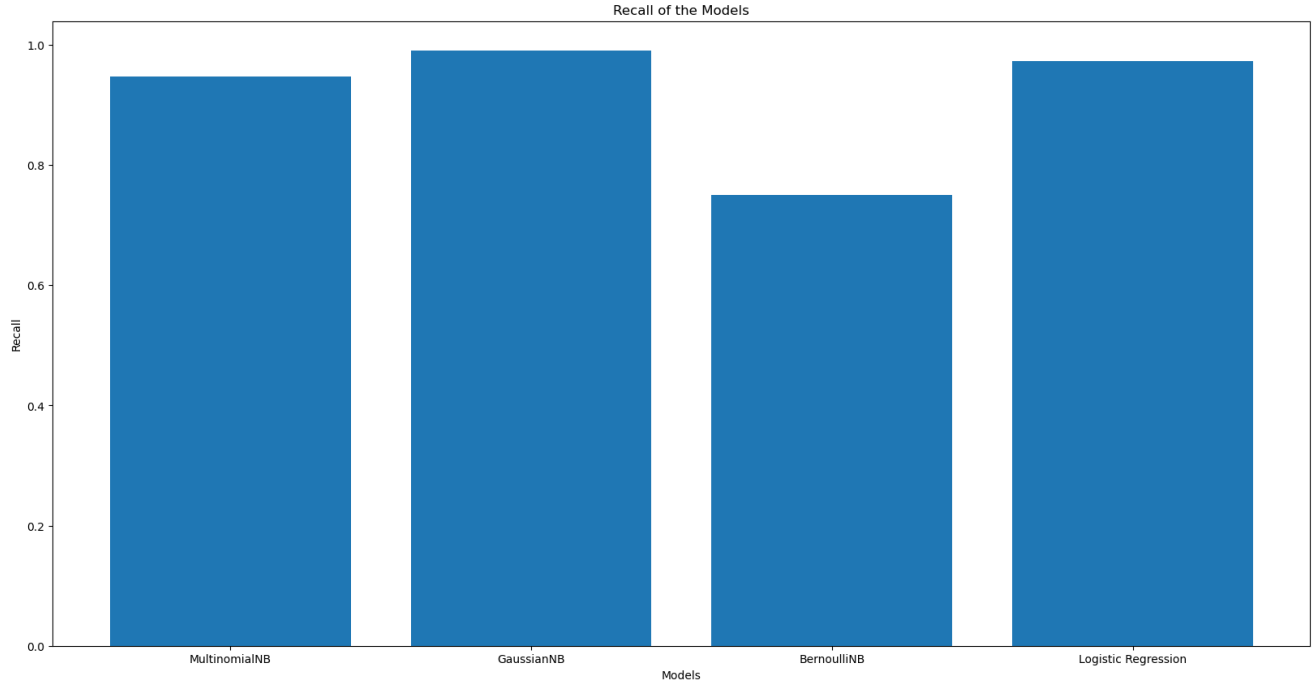


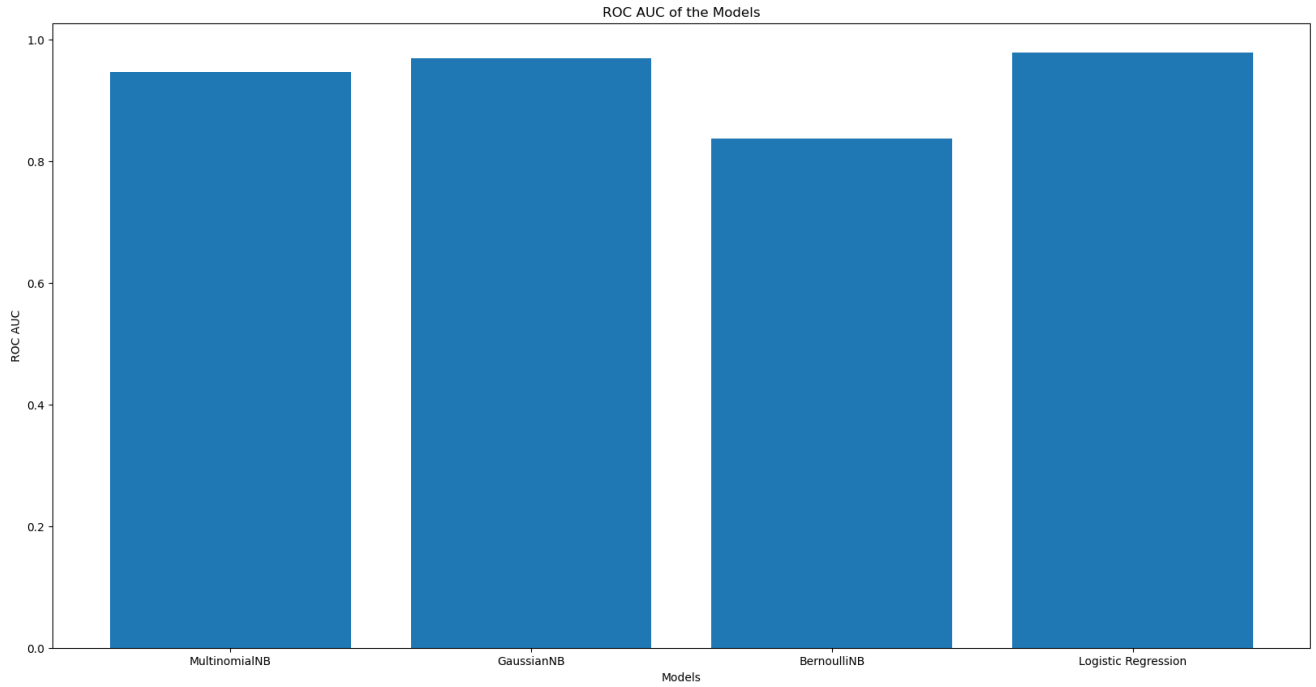
In [35]:
```
plt.figure(figsize = (20,10))
plt.bar(models, f1_score)
plt.xlabel("Models")
plt.ylabel("F1 Score")
plt.title("F1 Score of the Models")
plt.show()
```



In [36]:
```
plt.figure(figsize = (20,10))
plt.bar(models, recall)
plt.xlabel("Models")
plt.ylabel("Recall")
plt.title("Recall of the Models")
plt.show()
```

```
plt.figure(figsize = (20,10))
plt.bar(models, roc_auc)
plt.xlabel("Models")
plt.ylabel("ROC AUC")
plt.title("ROC AUC of the Models")
plt.show()
```





DecisionTreeClassifier

In [37]:
```
from sklearn.tree import DecisionTreeClassifier
```

In [38]:
```
dlf = DecisionTreeClassifier()
```

In [39]:
```
dlf.fit(train_x,train_y)
```

Out[39]:
```
DecisionTreeClassifier
DecisionTreeClassifier()
```

In [42]:
```
dlf_pred = dlf.predict(x)
dlf.score(train_x,train_y)
```

Out[42]:
```
1.0
```

In [43]:
```
dlf.score(test_x,test_y)
```

Out[43]:
```
0.9217391304347826
```

In [44]:
```
dlf_pred
```

Out[44]:
```
array([0, 0, 0, ..., 1, 1, 0], dtype=int64)
```

In [46]:
```
dlf.predict(test_x)
```

Out[46]:
```
array([1, 0, 0, ..., 1, 0, 1], dtype=int64)
```