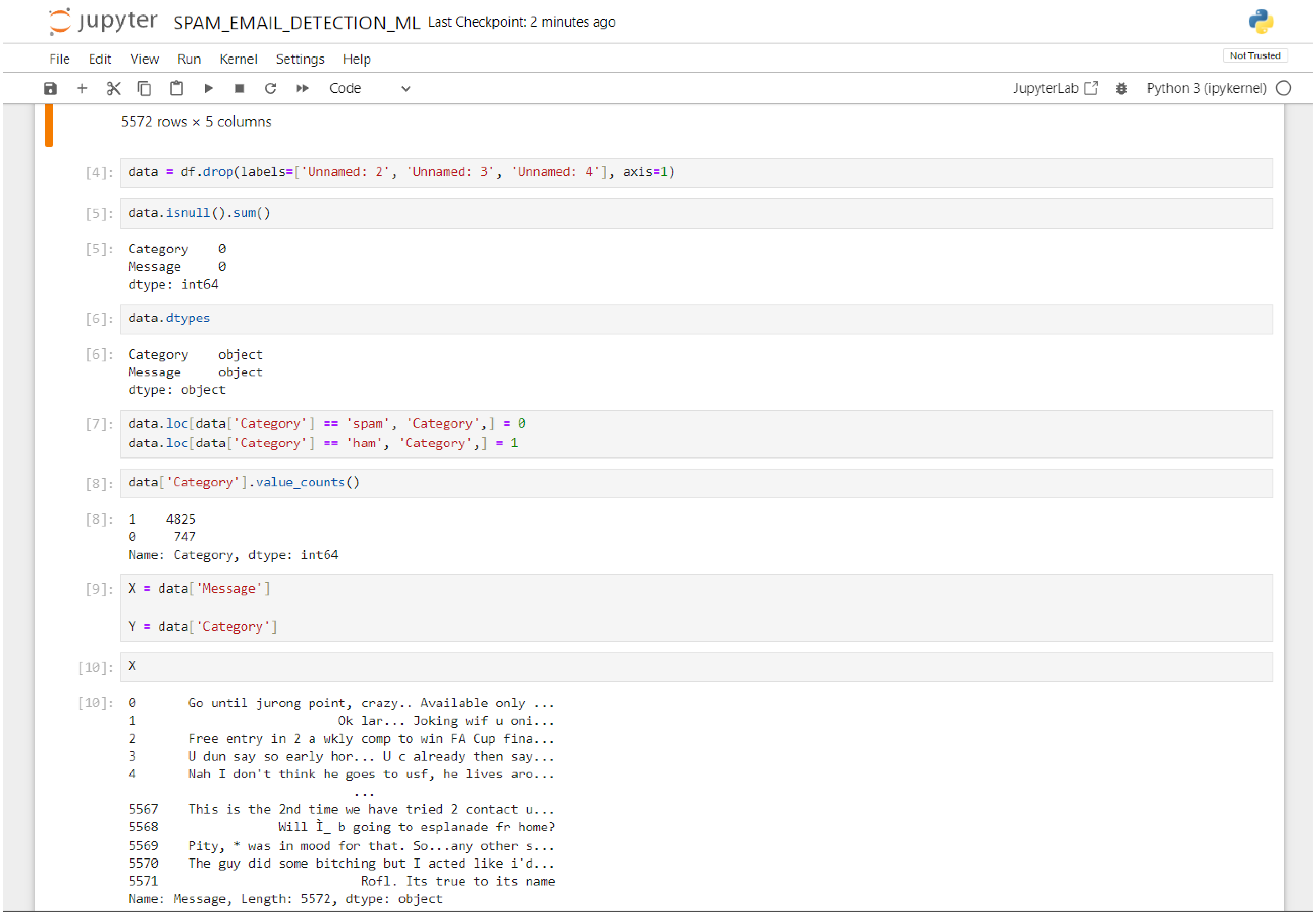
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```
5572 rows × 5 columns
```

```
[4]: data = df.drop(labels=['Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'], axis=1)
```

```
[5]: data.isnull().sum()
```

```
[5]: Category    0
     Message     0
     dtype: int64
```

```
[6]: data.dtypes
```

```
[6]: Category    object
     Message     object
     dtype: object
```

```
[7]: data.loc[data['Category'] == 'spam', 'Category',] = 0
     data.loc[data['Category'] == 'ham', 'Category',] = 1
```

```
[8]: data['Category'].value_counts()
```

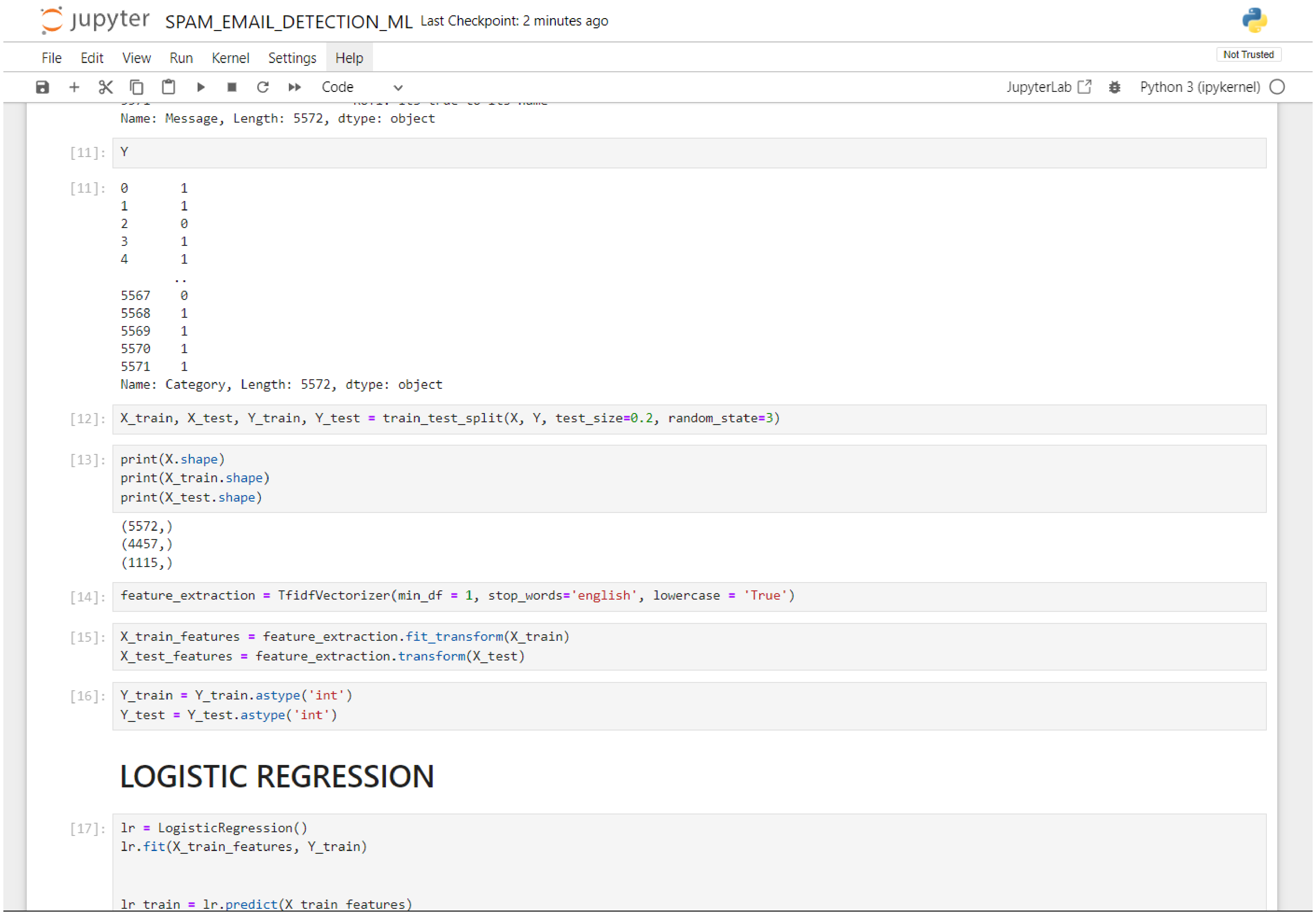
```
[8]: 1    4825
     0     747
     Name: Category, dtype: int64
```

```
[9]: X = data['Message']

     Y = data['Category']
```

```
[10]: X
```

```
[10]: 0       Go until jurong point, crazy.. Available only ...
      1                           Ok lar... Joking wif u oni...
      2       Free entry in 2 a wkly comp to win FA Cup fina...
      3       U dun say so early hor... U c already then say...
      4       Nah I don't think he goes to usf, he lives aro...
                                    ...
      5567    This is the 2nd time we have tried 2 contact u...
      5568                Will Ì_ b going to esplanade fr home?
      5569    Pity, * was in mood for that. So...any other s...
      5570    The guy did some bitching but I acted like i'd...
      5571                           Rofl. Its true to its name
      Name: Message, Length: 5572, dtype: object
```



```
Name: Message, Length: 5572, dtype: object
```

[11]:
```
Y
```

[11]:
```
0       1
1       1
2       0
3       1
4       1
       ..
5567    0
5568    1
5569    1
5570    1
5571    1
Name: Category, Length: 5572, dtype: object
```

[12]:
```
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.2, random_state=3)
```

[13]:
```
print(X.shape)
print(X_train.shape)
print(X_test.shape)
```

```
(5572,)
(4457,)
(1115,)
```

[14]:
```
feature_extraction = TfidfVectorizer(min_df = 1, stop_words='english', lowercase = 'True')
```

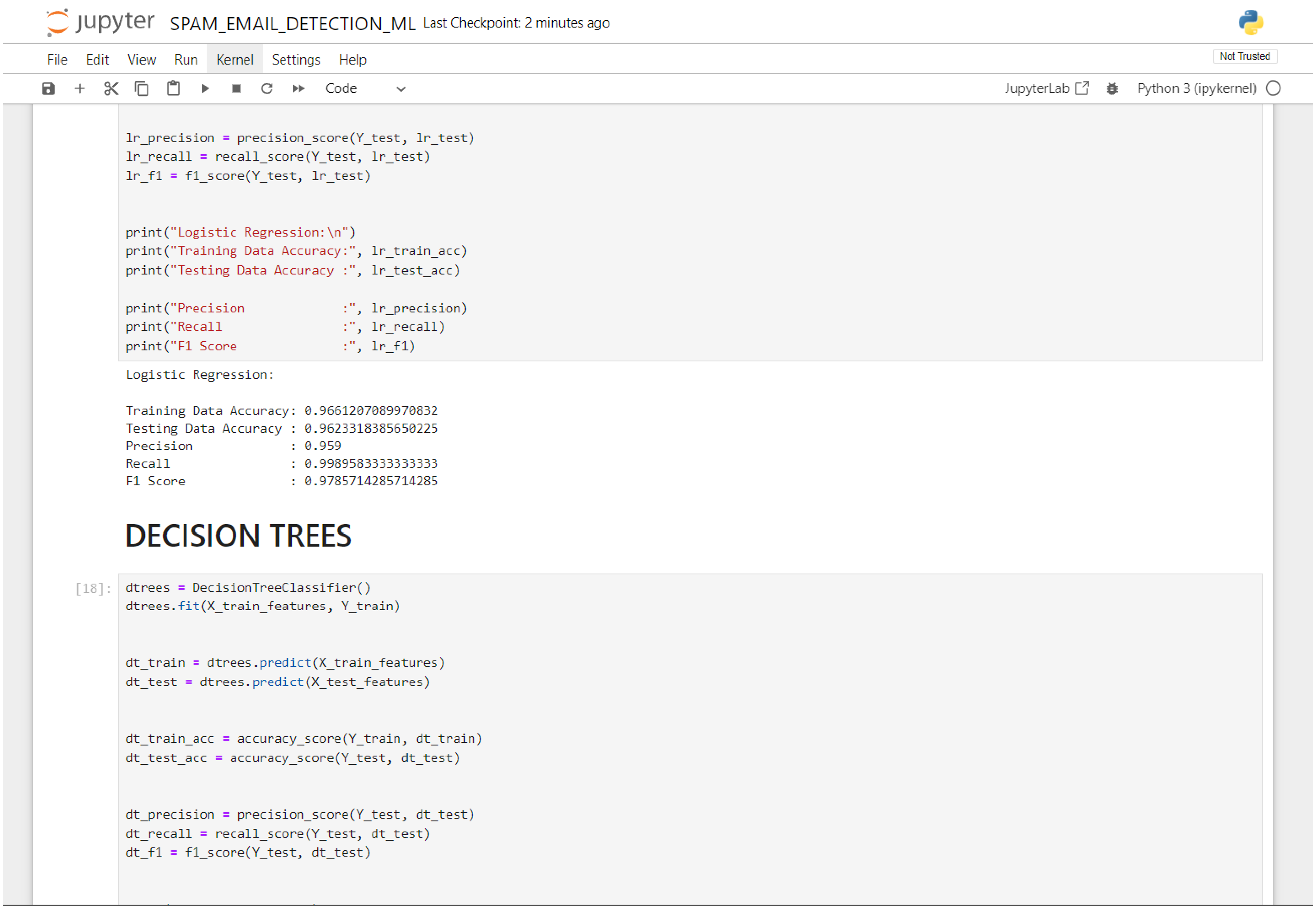
[15]:
```
X_train_features = feature_extraction.fit_transform(X_train)
X_test_features = feature_extraction.transform(X_test)
```

[16]:
```
Y_train = Y_train.astype('int')
Y_test = Y_test.astype('int')
```

LOGISTIC REGRESSION

[17]:
```
lr = LogisticRegression()
lr.fit(X_train_features, Y_train)


lr_train = lr.predict(X_train_features)
```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```
lr_precision = precision_score(Y_test, lr_test)
lr_recall = recall_score(Y_test, lr_test)
lr_f1 = f1_score(Y_test, lr_test)


print("Logistic Regression:\n")
print("Training Data Accuracy:", lr_train_acc)
print("Testing Data Accuracy :", lr_test_acc)

print("Precision             :", lr_precision)
print("Recall                :", lr_recall)
print("F1 Score              :", lr_f1)
```

```
Logistic Regression:

Training Data Accuracy: 0.9661207089970832
Testing Data Accuracy : 0.9623318385650225
Precision             : 0.959
Recall                : 0.9989583333333333
F1 Score              : 0.9785714285714285
```

DECISION TREES

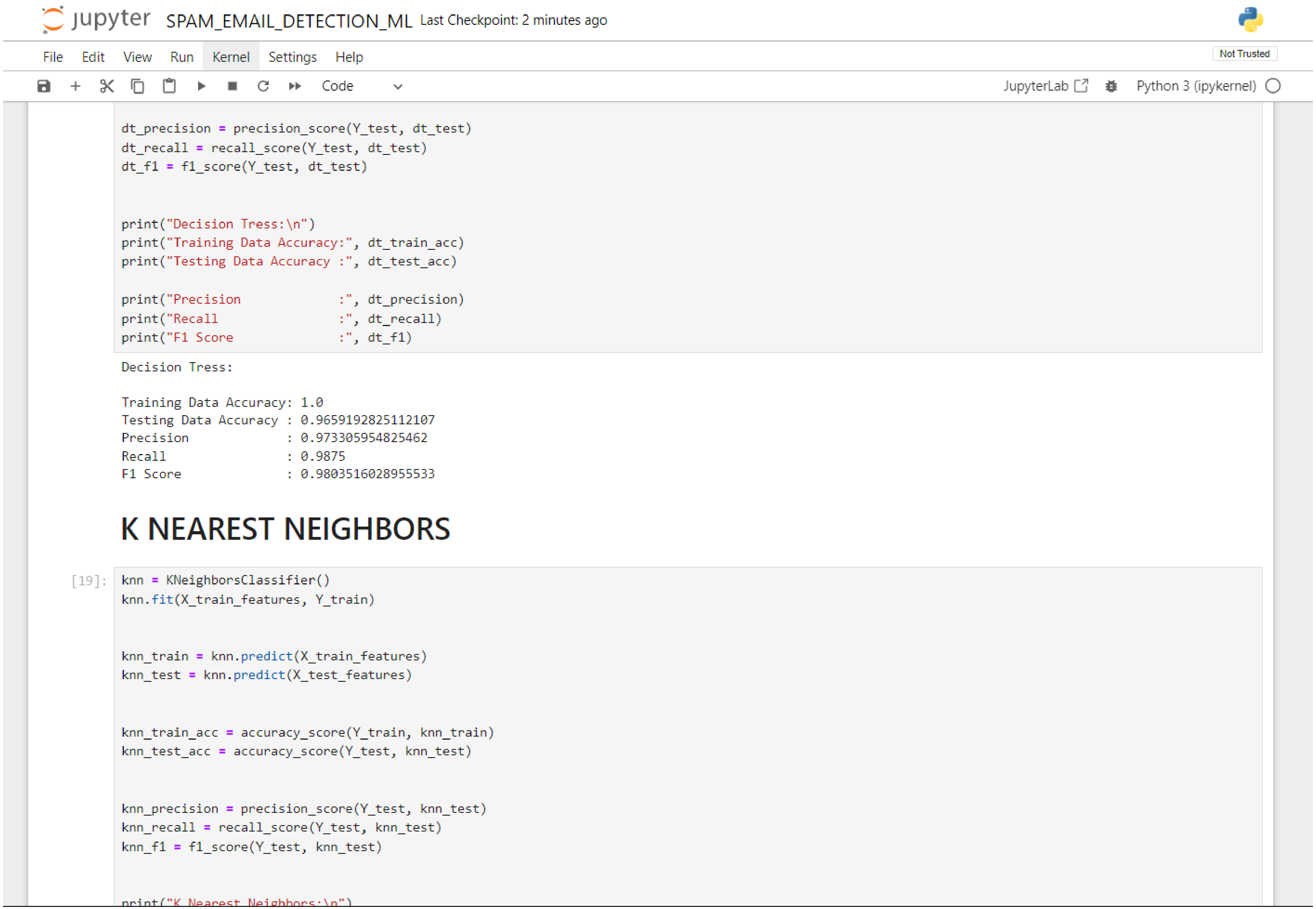
[18]:

```
dtrees = DecisionTreeClassifier()
dtrees.fit(X_train_features, Y_train)


dt_train = dtrees.predict(X_train_features)
dt_test = dtrees.predict(X_test_features)


dt_train_acc = accuracy_score(Y_train, dt_train)
dt_test_acc = accuracy_score(Y_test, dt_test)


dt_precision = precision_score(Y_test, dt_test)
dt_recall = recall_score(Y_test, dt_test)
dt_f1 = f1_score(Y_test, dt_test)
```



```
dt_precision = precision_score(Y_test, dt_test)
dt_recall = recall_score(Y_test, dt_test)
dt_f1 = f1_score(Y_test, dt_test)


print("Decision Tress:\n")
print("Training Data Accuracy:", dt_train_acc)
print("Testing Data Accuracy :", dt_test_acc)

print("Precision              :", dt_precision)
print("Recall                 :", dt_recall)
print("F1 Score               :", dt_f1)
```

```
Decision Tress:

Training Data Accuracy: 1.0
Testing Data Accuracy : 0.9659192825112107
Precision             : 0.973305954825462
Recall                : 0.9875
F1 Score              : 0.9803516028955533
```

K NEAREST NEIGHBORS

[19]:

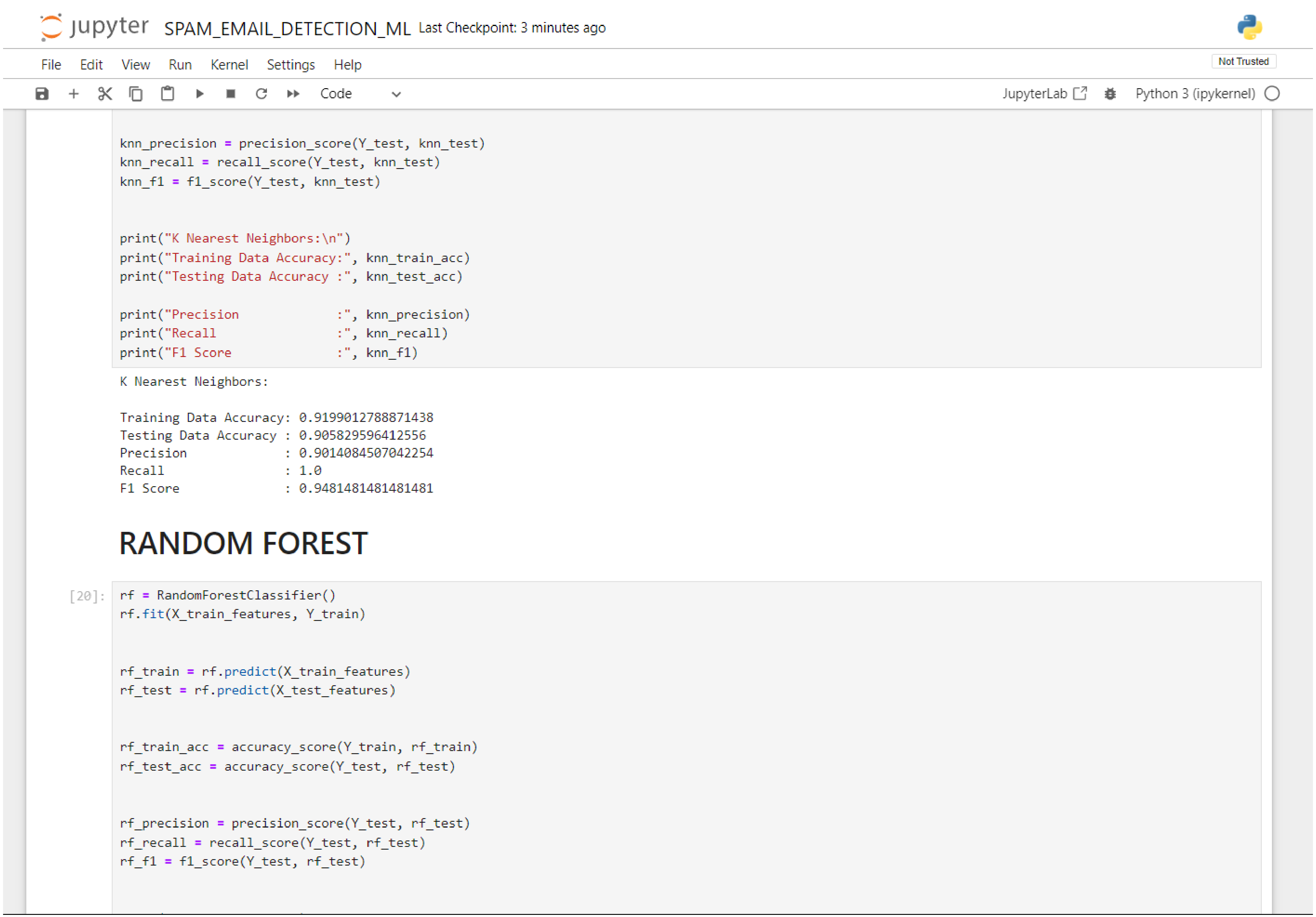
```
knn = KNeighborsClassifier()
knn.fit(X_train_features, Y_train)


knn_train = knn.predict(X_train_features)
knn_test = knn.predict(X_test_features)


knn_train_acc = accuracy_score(Y_train, knn_train)
knn_test_acc = accuracy_score(Y_test, knn_test)


knn_precision = precision_score(Y_test, knn_test)
knn_recall = recall_score(Y_test, knn_test)
knn_f1 = f1_score(Y_test, knn_test)


print("K Nearest Neighbors:\n")
```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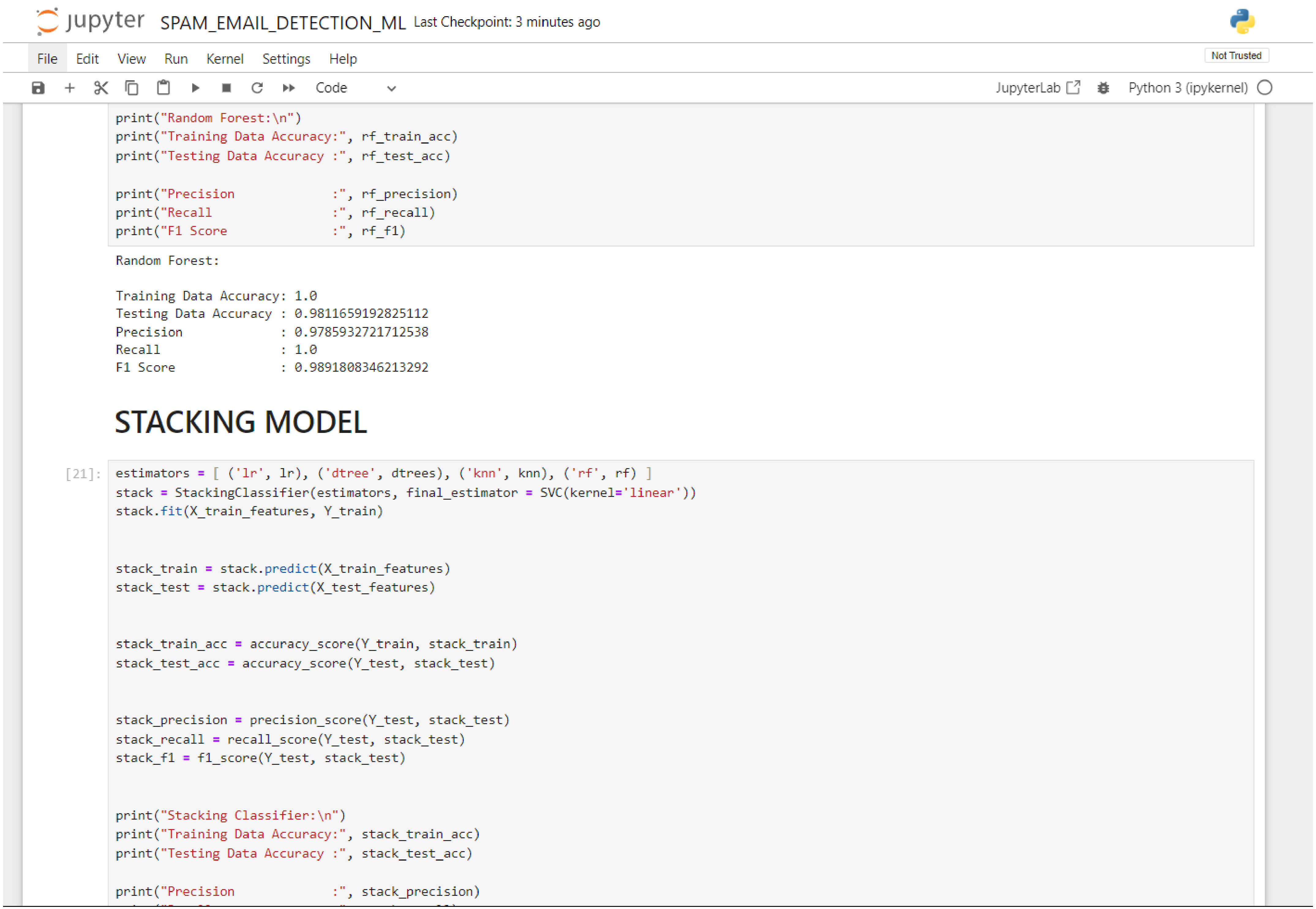
```
knn_precision = precision_score(Y_test, knn_test)
knn_recall = recall_score(Y_test, knn_test)
knn_f1 = f1_score(Y_test, knn_test)


print("K Nearest Neighbors:\n")
print("Training Data Accuracy:", knn_train_acc)
print("Testing Data Accuracy :", knn_test_acc)

print("Precision             :", knn_precision)
print("Recall                :", knn_recall)
print("F1 Score              :", knn_f1)
```

```
K Nearest Neighbors:

Training Data Accuracy: 0.9199012788871438
Testing Data Accuracy : 0.905829596412556
Precision             : 0.9014084507042254
Recall                : 1.0
F1 Score              : 0.9481481481481481
```

RANDOM FOREST

[20]:

```
rf = RandomForestClassifier()
rf.fit(X_train_features, Y_train)


rf_train = rf.predict(X_train_features)
rf_test = rf.predict(X_test_features)


rf_train_acc = accuracy_score(Y_train, rf_train)
rf_test_acc = accuracy_score(Y_test, rf_test)


rf_precision = precision_score(Y_test, rf_test)
rf_recall = recall_score(Y_test, rf_test)
rf_f1 = f1_score(Y_test, rf_test)
```



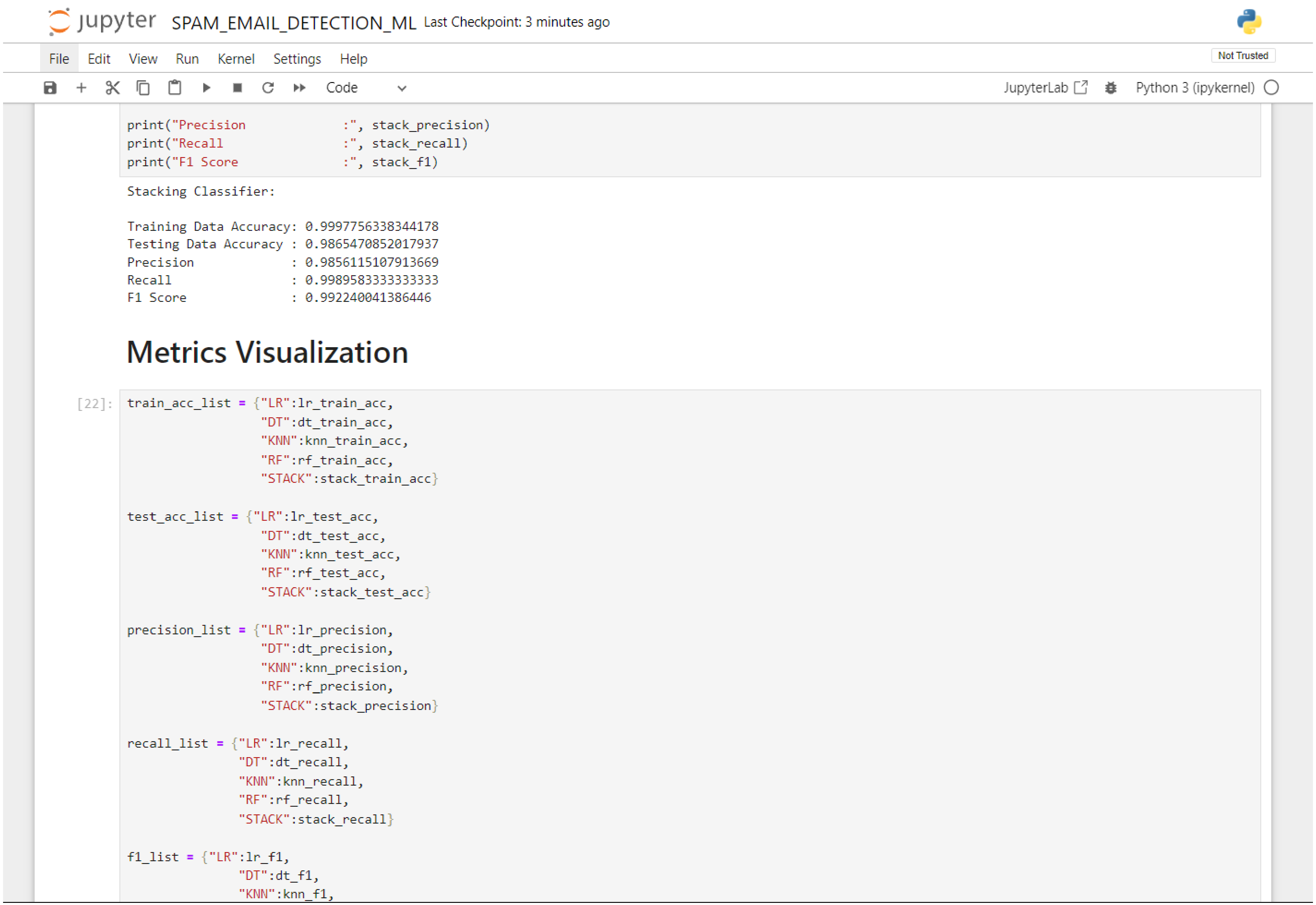
```
print("Random Forest:\n")
print("Training Data Accuracy:", rf_train_acc)
print("Testing Data Accuracy :", rf_test_acc)

print("Precision             :", rf_precision)
print("Recall                :", rf_recall)
print("F1 Score              :", rf_f1)
```

```
Random Forest:

Training Data Accuracy: 1.0
Testing Data Accuracy : 0.9811659192825112
Precision             : 0.9785932721712538
Recall                : 1.0
F1 Score              : 0.9891808346213292
```

STACKING MODEL

[21]:

```
estimators = [ ('lr', lr), ('dtree', dtrees), ('knn', knn), ('rf', rf) ]
stack = StackingClassifier(estimators, final_estimator = SVC(kernel='linear'))
stack.fit(X_train_features, Y_train)


stack_train = stack.predict(X_train_features)
stack_test = stack.predict(X_test_features)


stack_train_acc = accuracy_score(Y_train, stack_train)
stack_test_acc = accuracy_score(Y_test, stack_test)


stack_precision = precision_score(Y_test, stack_test)
stack_recall = recall_score(Y_test, stack_test)
stack_f1 = f1_score(Y_test, stack_test)


print("Stacking Classifier:\n")
print("Training Data Accuracy:", stack_train_acc)
print("Testing Data Accuracy :", stack_test_acc)

print("Precision             :", stack_precision)
```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```
print("Precision             :", stack_precision)
print("Recall                :", stack_recall)
print("F1 Score              :", stack_f1)
```

```
Stacking Classifier:

Training Data Accuracy: 0.9997756338344178
Testing Data Accuracy : 0.9865470852017937
Precision             : 0.9856115107913669
Recall                : 0.9989583333333333
F1 Score              : 0.992240041386446
```

Metrics Visualization

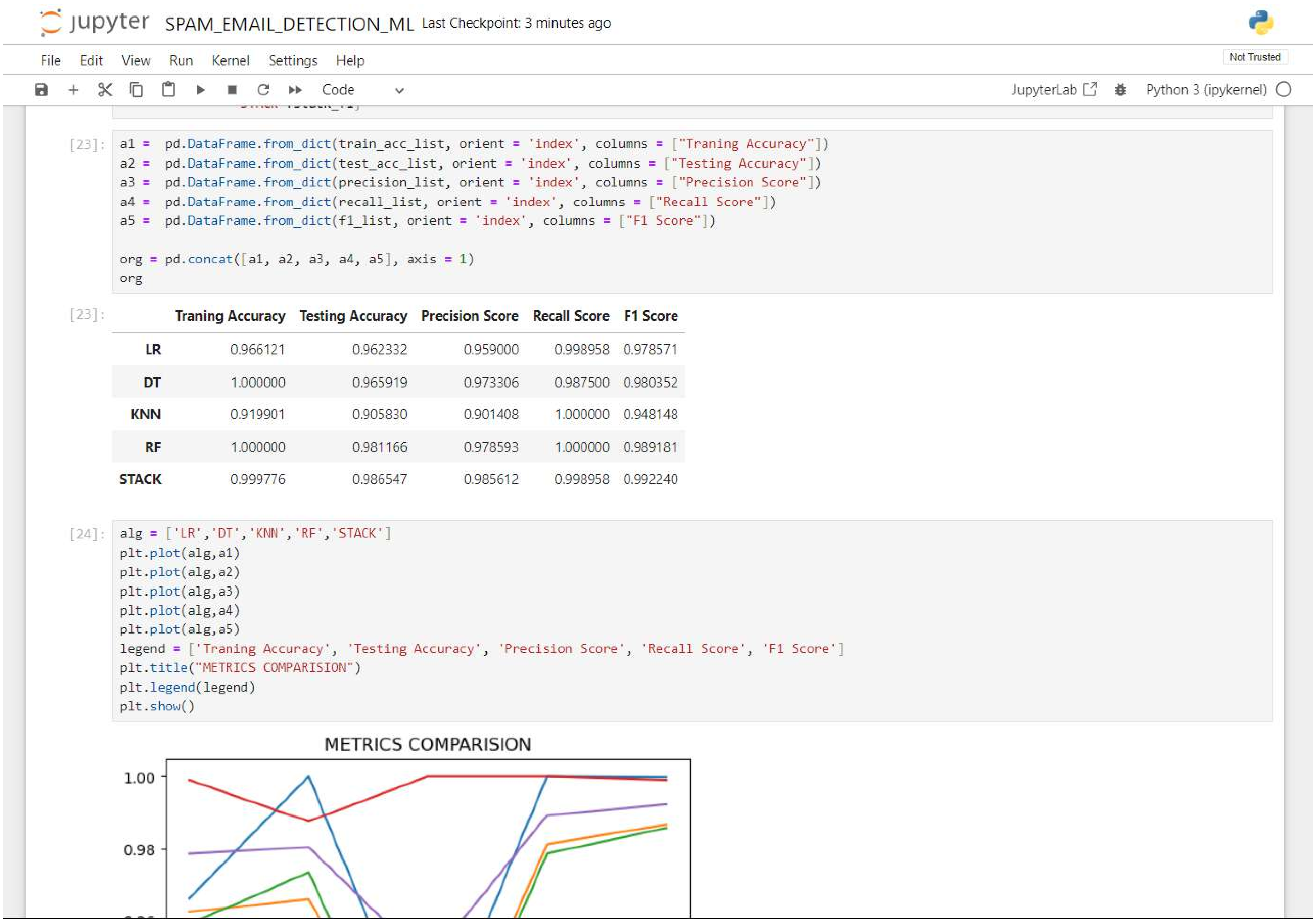
```
[22]: train_acc_list = {"LR":lr_train_acc,
                  "DT":dt_train_acc,
                  "KNN":knn_train_acc,
                  "RF":rf_train_acc,
                  "STACK":stack_train_acc}

test_acc_list = {"LR":lr_test_acc,
                  "DT":dt_test_acc,
                  "KNN":knn_test_acc,
                  "RF":rf_test_acc,
                  "STACK":stack_test_acc}

precision_list = {"LR":lr_precision,
                  "DT":dt_precision,
                  "KNN":knn_precision,
                  "RF":rf_precision,
                  "STACK":stack_precision}

recall_list = {"LR":lr_recall,
               "DT":dt_recall,
               "KNN":knn_recall,
               "RF":rf_recall,
               "STACK":stack_recall}

f1_list = {"LR":lr_f1,
               "DT":dt_f1,
               "KNN":knn_f1,
```



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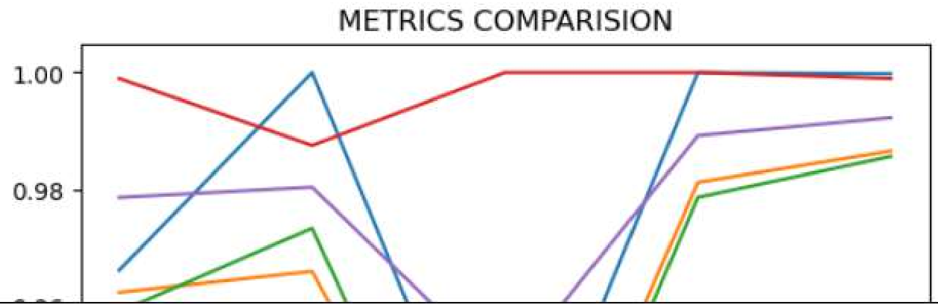
```
[23]: a1 =  pd.DataFrame.from_dict(train_acc_list, orient = 'index', columns = ["Traning Accuracy"])
      a2 =  pd.DataFrame.from_dict(test_acc_list, orient = 'index', columns = ["Testing Accuracy"])
      a3 =  pd.DataFrame.from_dict(precision_list, orient = 'index', columns = ["Precision Score"])
      a4 =  pd.DataFrame.from_dict(recall_list, orient = 'index', columns = ["Recall Score"])
      a5 =  pd.DataFrame.from_dict(f1_list, orient = 'index', columns = ["F1 Score"])

      org = pd.concat([a1, a2, a3, a4, a5], axis = 1)
      org
```

[23]:

	Traning Accuracy	Testing Accuracy	Precision Score	Recall Score	F1 Score
LR	0.966121	0.962332	0.959000	0.998958	0.978571
DT	1.000000	0.965919	0.973306	0.987500	0.980352
KNN	0.919901	0.905830	0.901408	1.000000	0.948148
RF	1.000000	0.981166	0.978593	1.000000	0.989181
STACK	0.999776	0.986547	0.985612	0.998958	0.992240

```
[24]: alg = ['LR','DT','KNN','RF','STACK']
      plt.plot(alg,a1)
      plt.plot(alg,a2)
      plt.plot(alg,a3)
      plt.plot(alg,a4)
      plt.plot(alg,a5)
      legend = ['Traning Accuracy', 'Testing Accuracy', 'Precision Score', 'Recall Score', 'F1 Score']
      plt.title("METRICS COMPARISION")
      plt.legend(legend)
      plt.show()
```



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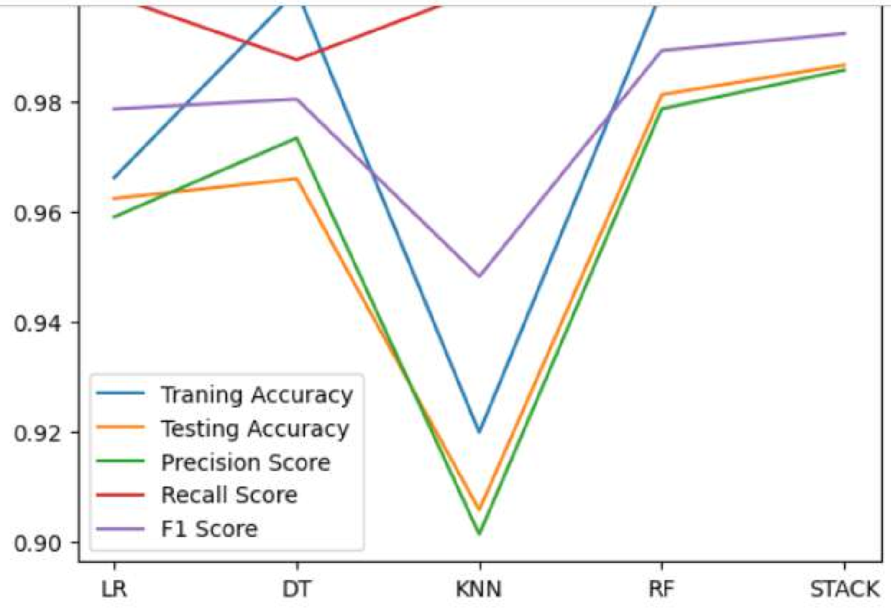
Code JupyterLab Python 3 (ipykernel)



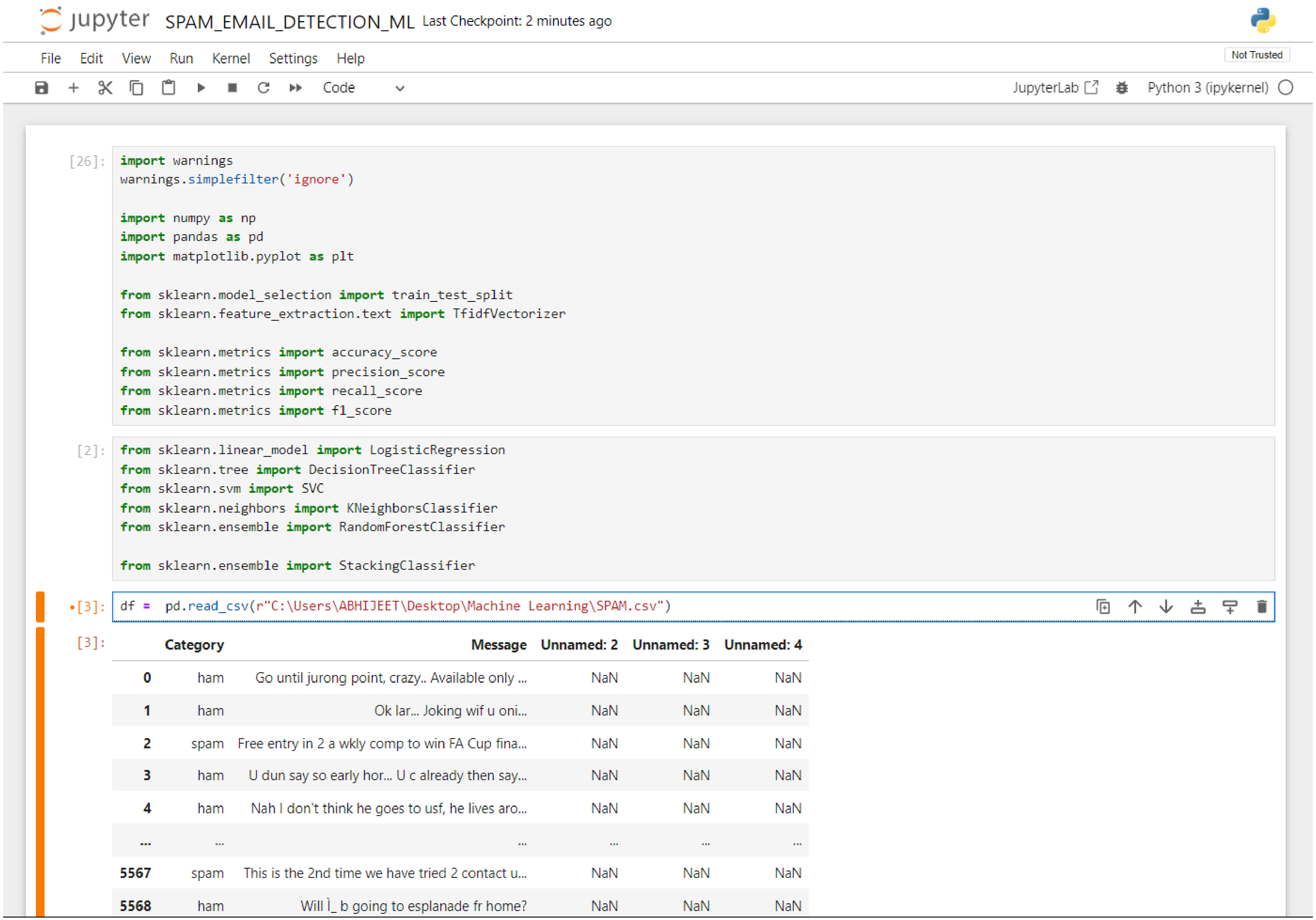
```
[25]: input_mail = ["Hi this is  kalyan"]

      input_mail_features = feature_extraction.transform(input_mail)

      prediction = stack.predict(input_mail_features)

      if(prediction == 0):
          print("SPAM MAIL")
      else:
          print("HAM MAIL")
```

```
HAM MAIL
```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[26]:
```
import warnings
warnings.simplefilter('ignore')

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import TfidfVectorizer

from sklearn.metrics import accuracy_score
from sklearn.metrics import precision_score
from sklearn.metrics import recall_score
from sklearn.metrics import f1_score
```

[2]:
```
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import RandomForestClassifier

from sklearn.ensemble import StackingClassifier
```

•[3]:
```
df =  pd.read_csv(r"C:\Users\ABHIJEET\Desktop\Machine Learning\SPAM.csv")
```

[3]:

	Category	Message	Unnamed: 2	Unnamed: 3	Unnamed: 4
0	ham	Go until jurong point, crazy.. Available only ...	NaN	NaN	NaN
1	ham	Ok lar... Joking wif u oni...	NaN	NaN	NaN
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...	NaN	NaN	NaN
3	ham	U dun say so early hor... U c already then say...	NaN	NaN	NaN
4	ham	Nah I don't think he goes to usf, he lives aro...	NaN	NaN	NaN
...	...	...	...	...	...
5567	spam	This is the 2nd time we have tried 2 contact u...	NaN	NaN	NaN
5568	ham	Will Ì_ b going to esplanade fr home?	NaN	NaN	NaN