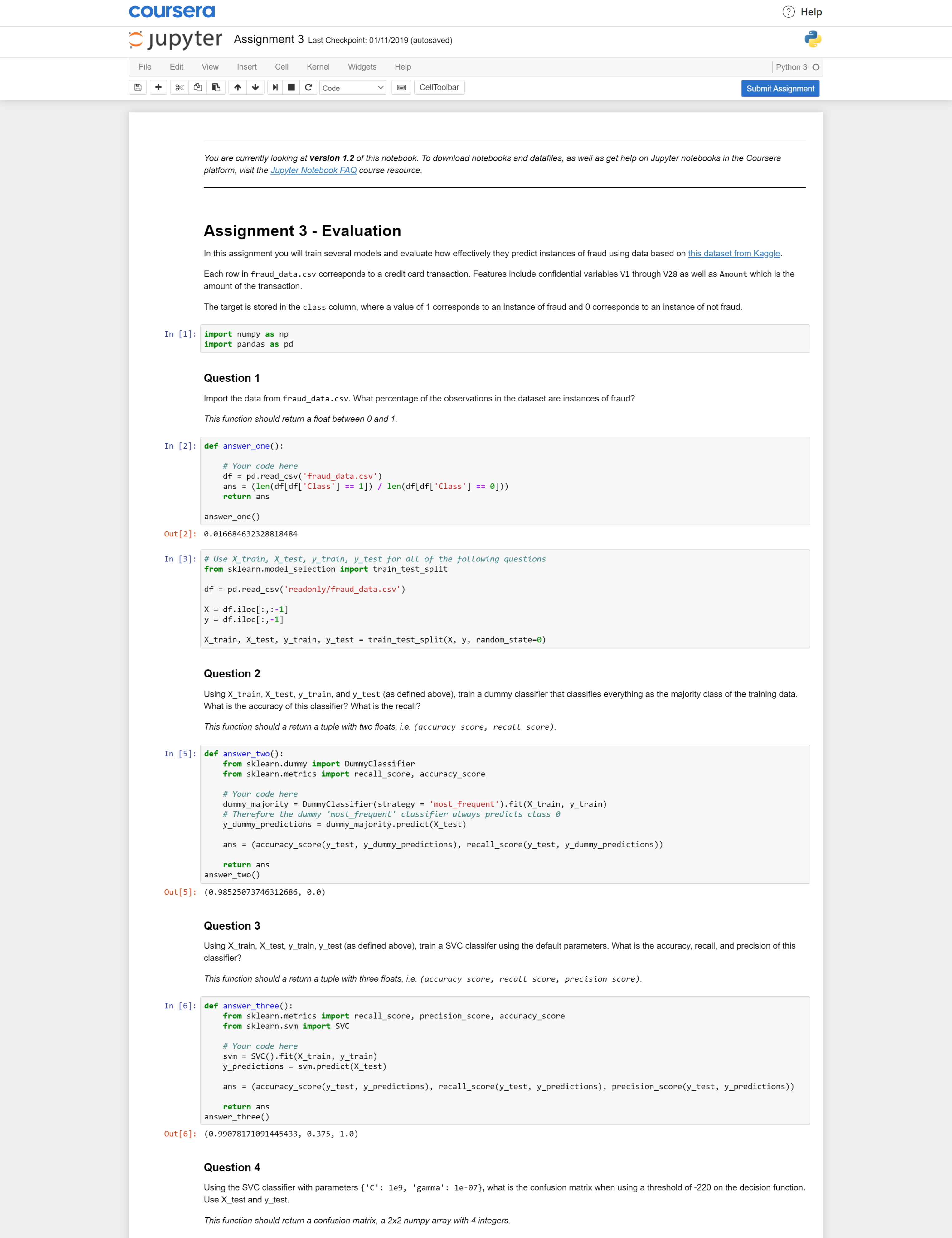
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*You are currently looking at **version 1.2** of this notebook. To download notebooks and datafiles, as well as get help on Jupyter notebooks in the Coursera platform, visit the [Jupyter Notebook FAQ]() course resource.*

Assignment 3 - Evaluation

In this assignment you will train several models and evaluate how effectively they predict instances of fraud using data based on [this dataset from Kaggle]().

Each row in `fraud_data.csv` corresponds to a credit card transaction. Features include confidential variables `V1` through `V28` as well as `Amount` which is the amount of the transaction.

The target is stored in the `class` column, where a value of 1 corresponds to an instance of fraud and 0 corresponds to an instance of not fraud.

In [1]:
```
import numpy as np
import pandas as pd
```

Question 1

Import the data from `fraud_data.csv`. What percentage of the observations in the dataset are instances of fraud?

This function should return a float between 0 and 1.

In [2]:
```
def answer_one():

    # Your code here
    df = pd.read_csv('fraud_data.csv')
    ans = (len(df[df['Class'] == 1]) / len(df[df['Class'] == 0]))
    return ans

answer_one()
```

Out[2]:
```
0.016684632328818484
```

In [3]:
```
# Use X_train, X_test, y_train, y_test for all of the following questions
from sklearn.model_selection import train_test_split

df = pd.read_csv('readonly/fraud_data.csv')

X = df.iloc[:,:-1]
y = df.iloc[:,-1]

X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=0)
```

Question 2

Using `X_train`, `X_test`, `y_train`, and `y_test` (as defined above), train a dummy classifier that classifies everything as the majority class of the training data. What is the accuracy of this classifier? What is the recall?

This function should a return a tuple with two floats, i.e. `(accuracy score, recall score)`.

In [5]:
```
def answer_two():
    from sklearn.dummy import DummyClassifier
    from sklearn.metrics import recall_score, accuracy_score

    # Your code here
    dummy_majority = DummyClassifier(strategy = 'most_frequent').fit(X_train, y_train)
    # Therefore the dummy 'most_frequent' classifier always predicts class 0
    y_dummy_predictions = dummy_majority.predict(X_test)

    ans = (accuracy_score(y_test, y_dummy_predictions), recall_score(y_test, y_dummy_predictions))

    return ans
answer_two()
```

Out[5]:
```
(0.9852507374631268б, 0.0)
```

Question 3

Using X_train, X_test, y_train, y_test (as defined above), train a SVC classifer using the default parameters. What is the accuracy, recall, and precision of this classifier?

This function should a return a tuple with three floats, i.e. `(accuracy score, recall score, precision score)`.

In [6]:
```
def answer_three():
    from sklearn.metrics import recall_score, precision_score, accuracy_score
    from sklearn.svm import SVC

    # Your code here
    svm = SVC().fit(X_train, y_train)
    y_predictions = svm.predict(X_test)

    ans = (accuracy_score(y_test, y_predictions), recall_score(y_test, y_predictions), precision_score(y_test, y_predictions))

    return ans
answer_three()
```

Out[6]:
```
(0.99078171091445433, 0.375, 1.0)
```

Question 4

Using the SVC classifier with parameters `{'C': 1e9, 'gamma': 1e-07}`, what is the confusion matrix when using a threshold of -220 on the decision function. Use X_test and y_test.

This function should return a confusion matrix, a 2x2 numpy array with 4 integers.

In [10]:

```
def answer_four():
    from sklearn.metrics import confusion_matrix
    from sklearn.svm import SVC

    # Your code here
    svm = SVC(C = 1e9, gamma = 1e-07).fit(X_train, y_train)
    svm_predicted = svm.decision_function(X_test) > -220

#     print(svm_predicted)

    confusion = confusion_matrix(y_test, svm_predicted)

    ans = confusion

    return ans

answer_four()
```

Out[10]:

```
array([[5320,   24],
       [  14,   66]])
```

Question 5

Train a logisitic regression classifier with default parameters using X_train and y_train.

For the logisitic regression classifier, create a precision recall curve and a roc curve using y_test and the probability estimates for X_test (probability it is fraud).

Looking at the precision recall curve, what is the recall when the precision is `0.75`?

Looking at the roc curve, what is the true positive rate when the false positive rate is `0.16`?

This function should return a tuple with two floats, i.e. `(recall, true positive rate)`.

In [11]:

```
def answer_five():

    # Your code here
    from sklearn.linear_model import LogisticRegression
    from sklearn.metrics import precision_recall_curve
    from sklearn.metrics import roc_curve

    lr = LogisticRegression().fit(X_train, y_train)

    y_scores_lr = lr.fit(X_train, y_train).decision_function(X_test)

#     lr_predicted = lr.predict(X_test)

    precision, recall, thresholds = precision_recall_curve(y_test, y_scores_lr)
    closest_zero_p = np.argmin(np.abs(precision-0.75))
#     closest_zero_p = precision[closest_zero]
    closest_zero_r = recall[closest_zero_p]

#     print(closest_zero_r)


    fpr_lr, tpr_lr, _ = roc_curve(y_test, y_scores_lr)
#     roc_auc_lr = auc(fpr_lr, tpr_lr)

    closest_zero_fpr_lr = np.argmin(np.abs(fpr_lr - 0.16))
#     closest_zero_p = precision[closest_zero]
    closest_zero_tpr_lr = recall[closest_zero_fpr_lr]

#     print(closest_zero_tpr_lr)


#     y_proba_lr = lr.fit(X_train, y_train).predict_proba(X_test)

#     confusion = confusion_matrix(y_test, lr_predicted)

    ans = (closest_zero_r, closest_zero_tpr_lr)

    return ans
answer_five()
```

Out[11]:

```
(0.82499999999999996, 0.98750000000000004)
```

Question 6

Perform a grid search over the parameters listed below for a Logisitic Regression classifier, using recall for scoring and the default 3-fold cross validation.

`'penalty': ['l1', 'l2']`

`'C':[0.01, 0.1, 1, 10, 100]`

From `.cv_results_`, create an array of the mean test scores of each parameter combination. i.e.

	l1	l2
0.01	?	?
0.1	?	?
1	?	?
10	?	?
100	?	?

This function should return a 5 by 2 numpy array with 10 floats.

Note: do not return a DataFrame, just the values denoted by '?' above in a numpy array. You might need to reshape your raw result to meet the format we are looking for.

In [12]:

```
def answer_six():
    from sklearn.model_selection import GridSearchCV
    from sklearn.linear_model import LogisticRegression

    # Your code here
    lr = LogisticRegression()

    grid_values = {'C': [0.01, 0.1, 1, 10, 100], 'penalty': ['l1', 'l2']}

    # default metric to optimize over grid parameters
    grid_lr = GridSearchCV(lr, param_grid = grid_values, scoring = 'recall')
    grid_lr.fit(X_train, y_train)

#     print(grid_lr.cv_results_['mean_test_score'].reshape(5,2))
    ans = np.array(grid_lr.cv_results_['mean_test_score'].reshape(5,2))
    return ans

answer_six()
```

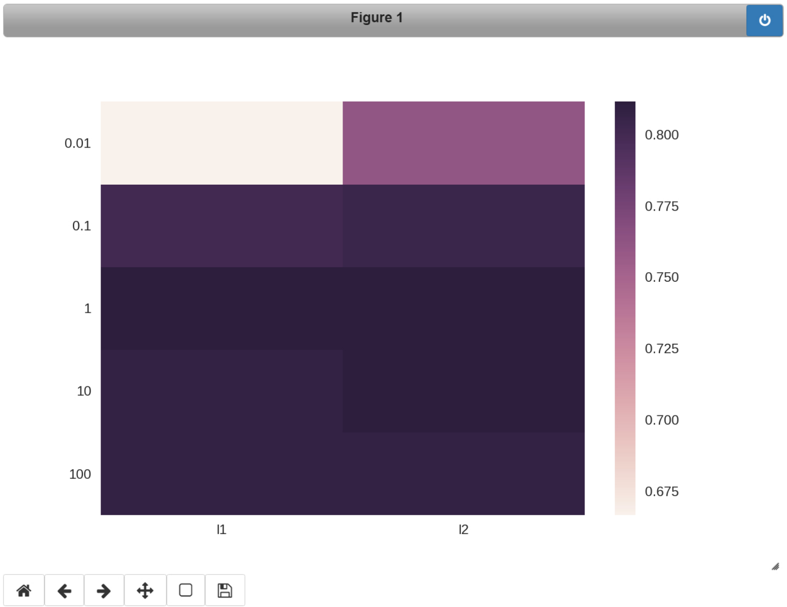
Out[12]:

```
array([[ 0.66666667,  0.76086957],
       [ 0.80072464,  0.80434783],
       [ 0.8115942 ,  0.8115942 ],
       [ 0.80797101,  0.8115942 ],
       [ 0.80797101,  0.80797101]])
```

In [14]:

```
# Use the following function to help visualize results from the grid search
def GridSearch_Heatmap(scores):
    %matplotlib notebook
    import seaborn as sns
    import matplotlib.pyplot as plt
    plt.figure()
    sns.heatmap(scores.reshape(5,2), xticklabels=['l1','l2'], yticklabels=[0.01, 0.1, 1, 10, 100])
    plt.yticks(rotation=0);

GridSearch_Heatmap(answer_six())
```



In [ ]: