



[area under curve](#). These are some of the metrics suitable for classification problems, such as logistic regression and neural networks. There are others that we will discuss in subsequent blog posts.

For data, we use this [this data set](#) posted by an anonymous statistics professor. The Zeppelin notebook for the code shown below is stored [here](#).

## The Code

We use Pandas and scikit-learn to do the heavy lifting. We read the data into a dataframe then take two slices, `x` is columns 2 through 16. `x` is the column labeled 'Buy'. Since this is a logistic regression problem `y` is equal to either 1 or 0.

```
import pandas as pd

url =
'https://raw.githubusercontent.com/werowe/logisticRegressionBestModel/master/
KidCreative.csv'

data = pd.read_csv(url, delimiter=',')
```

```
y=data
x = data.iloc
```

Next we use two of the classification metrics available to us: **accuracy** and **roc\_auc**. We explain those below.

First, we can comment on **cross-validation**, used in the algorithm below. We use [model\\_selection.cross\\_val\\_score](#) with **cv=kfold**. Basically, what this does is test predictions against observed values by looping over different divisions of the input data and taking the average of the area. This is helpful mainly with small data sets when you don't have enough training data to split it into test, training, and validation sets.

```
from sklearn import model_selection
from sklearn.linear_model import LogisticRegression

for scoring in:
    seed = 7
    kfold = model_selection.KFold(n_splits=10, random_state=seed)
    model = LogisticRegression()
    results = model_selection.cross_val_score(model, x, y, cv=kfold,
scoring=scoring)
    print("Model", scoring, " mean=", results.mean() , "stddev=",
results.std())
```

Results in:

```
Model accuracy mean= 0.8886084284460052 stddev= 0.03322328503979156
Model roc_auc mean= 0.9185419071788103 stddev= 0.05710985874305497
```

And the individual scores:

```
print ("scores", results)
```

```
Model accuracy mean= 0.8886084284460052 stddev= 0.03322328503979156  
scores
```

```
Model roc_auc mean= 0.9185419071788103 stddev= 0.05710985874305497  
scores
```

According to Wikipedia, **accuracy and precision** are defined to be "In simplest terms, given a set of data points from repeated measurements of the same quantity, the set can be said to be precise if the values are close to each other, while the set can be said to be accurate if their average is close to the true value of the quantity being measured."

Then the ROC: "A **receiver operating characteristic (ROC)**, or simply ROC curve, is a graphical plot which illustrates the performance of a binary classifier system as its discrimination threshold is varied. It is created by plotting the fraction of true positives out of the positives (TPR = true positive rate) vs. the fraction of false positives out of the negatives (FPR = false positive rate), at various threshold settings"

In other words a threshold is set and then the ratio of false positive and false negatives is calculated.

We calculate that as shown below. We can run this calculation on the training data. In other words we feed the actual y values and the predicted ones, **model.predict(x)**, into **roc\_curve()**.

```
model.fit(x, y)  
predict = model.predict(x)  
from sklearn.metrics import roc_curve  
fpr, tpr, thresholds = roc_curve(y, predict)  
print ("fpr=", fpr)  
print ("tpr=", tpr)  
print ("thresholds=", thresholds)
```

results in:

```
fpr=  
tpr=  
thresholds=
```

We can calculate the area under the curve the receiver operating characteristic (ROC) curve:

```
auc = roc_auc_score(y, predict)  
print (auc)
```

Results in:

```
0.8028029197080292
```

We can plot the ROC curve like this:

```
import matplotlib.pyplot as plt  
from sklearn.metrics import roc_curve, auc  
  
fpr = dict()
```

```

tpr = dict()
roc_auc = dict()

n_classes = 2
for i in range(n_classes):
    fpr, tpr, _ = roc_curve(predict, y)
    roc_auc = auc(fpr, tpr, auc(y,predict, reorder=True))

plt.figure()
lw = 2
plt.plot(fpr, tpr, color='darkorange',lw=lw, label='ROC curve (area = %0.2f)'
% roc_auc)
plt.plot(, , color='navy', lw=lw, linestyle='--')
plt.xlim()
plt.ylim()
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic example')
plt.legend(loc="lower right")
plt.show()

```

Results in this plot:

