Machine Learning Space X Falcon 9 First Stage Landing Prediction**

Objectives Perform exploratory Data Analysis and determine Training Labels

- create a column for the class
- Standardize the data
- Split into training data and test data

-Find best Hyperparameter for SVM, Classification Trees and Logistic Regression

- Find the method performs best using test data

We will import the following libraries for the lab

```python
In [2]:   # Pandas is a software library written for the Python programming language for
          data manipulation and analysis.
          import pandas as pd
          # NumPy is a library for the Python programming language, adding support for l
          arge, multi-dimensional arrays and matrices, along with a large collection of
           high-level mathematical functions to operate on these arrays
          import numpy as np
          # Matplotlib is a plotting library for python and pyplot gives us a MatLab lik
          e plotting framework. We will use this in our plotter function to plot data.
          import matplotlib.pyplot as plt
          #Seaborn is a Python data visualization library based on matplotlib. It provid
          es a high-level interface for drawing attractive and informative statistical g
          raphics
          import seaborn as sns
          # Preprocessing allows us to standarsize our data
          from sklearn import preprocessing
          # Allows us to split our data into training and testing data
          from sklearn.model_selection import train_test_split
          # Allows us to test parameters of classification algorithms and find the best
           one
          from sklearn.model_selection import GridSearchCV
          # Logistic Regression classification algorithm
          from sklearn.linear_model import LogisticRegression
          # Support Vector Machine classification algorithm
          from sklearn.svm import SVC
          # Decision Tree classification algorithm
          from sklearn.tree import DecisionTreeClassifier
          # K Nearest Neighbors classification algorithm
          from sklearn.neighbors import KNeighborsClassifier
```

This function is to plot the confusion matrix.

```python
In [3]: def plot_confusion_matrix(y,y_predict):
            "this function plots the confusion matrix"
            from sklearn.metrics import confusion_matrix

            cm = confusion_matrix(y, y_predict)
            ax= plt.subplot()
            sns.heatmap(cm, annot=True, ax = ax); #annot=True to annotate cells
            ax.set_xlabel('Predicted labels')
            ax.set_ylabel('True labels')
            ax.set_title('Confusion Matrix');
            ax.xaxis.set_ticklabels(['did not land', 'land']); ax.yaxis.set_ticklabels
        (['did not land', 'landed'])
```

Load the data

```python
In [4]: data = pd.read_csv("https://cf-courses-data.s3.us.cloud-object-storage.appdoma
        in.cloud/IBM-DS0321EN-SkillsNetwork/datasets/dataset_part_2.csv")

        # If you were unable to complete the previous lab correctly you can uncomment
         and load this csv

        # data = pd.read_csv('https://cf-courses-data.s3.us.cloud-object-storage.appdo
        main.cloud/IBMDeveloperSkillsNetwork-DS0701EN-SkillsNetwork/api/dataset_part_
        2.csv')

        data.head()
```

Out[4]:

	FlightNumber	Date	BoosterVersion	PayloadMass	Orbit	LaunchSite	Outcome	Flights	Grid
0	1	2010-06-04	Falcon 9	6104.959412	LEO	CCAFS SLC 40	None None	1	
1	2	2012-05-22	Falcon 9	525.000000	LEO	CCAFS SLC 40	None None	1	
2	3	2013-03-01	Falcon 9	677.000000	ISS	CCAFS SLC 40	None None	1	
3	4	2013-09-29	Falcon 9	500.000000	PO	VAFB SLC 4E	False Ocean	1	
4	5	2013-12-03	Falcon 9	3170.000000	GTO	CCAFS SLC 40	None None	1	

```
In [5]:  X = pd.read_csv('https://cf-courses-data.s3.us.cloud-object-storage.appdomain.
         cloud/IBM-DS0321EN-SkillsNetwork/datasets/dataset_part_3.csv')

         # If you were unable to complete the previous lab correctly you can uncomment
          and load this csv

         # X = pd.read_csv('https://cf-courses-data.s3.us.cloud-object-storage.appdomai
         n.cloud/IBMDeveloperSkillsNetwork-DS0701EN-SkillsNetwork/api/dataset_part_3.cs
         v')

         X.head(100)
```
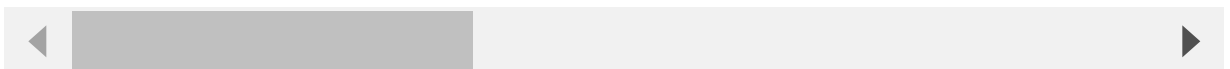
Out[5]:

	FlightNumber	PayloadMass	Flights	Block	ReusedCount	Orbit_ES-L1	Orbit_GEO	Orbit_GTO
0	1.0	6104.959412	1.0	1.0	0.0	0.0	0.0	0.0
1	2.0	525.000000	1.0	1.0	0.0	0.0	0.0	0.0
2	3.0	677.000000	1.0	1.0	0.0	0.0	0.0	0.0
3	4.0	500.000000	1.0	1.0	0.0	0.0	0.0	0.0
4	5.0	3170.000000	1.0	1.0	0.0	0.0	0.0	1.0
...	...	...	...	...	...	...	...	...
85	86.0	15400.000000	2.0	5.0	2.0	0.0	0.0	0.0
86	87.0	15400.000000	3.0	5.0	2.0	0.0	0.0	0.0
87	88.0	15400.000000	6.0	5.0	5.0	0.0	0.0	0.0
88	89.0	15400.000000	3.0	5.0	2.0	0.0	0.0	0.0
89	90.0	3681.000000	1.0	5.0	0.0	0.0	0.0	0.0

90 rows × 83 columns

TASK 1 Create a NumPy array from the column `Class` in `data`, by applying the method `to_numpy()` then assign it to the variable `Y`, make sure the output is a Pandas series (only one bracket df['name of column']).

```
In [6]:  y = data[['Class']].to_numpy()
```

Standardize the data in `X` then reassign it to the variable `X` using the transform provided below.

In [7]:
```python
# students get this
#transform = preprocessing.StandardScaler(X)
X= preprocessing.StandardScaler().fit(X).transform(X)
X[0:5]
```

```python
# students get this
#transform = preprocessing.StandardScaler(X)
```

```
Out[7]: array([[-1.71291154e+00, -1.94814463e-16, -6.53912840e-01,
        -1.57589457e+00, -9.73440458e-01, -1.05999788e-01,
        -1.05999788e-01, -6.54653671e-01, -1.05999788e-01,
        -5.51677284e-01,  3.44342023e+00, -1.85695338e-01,
        -3.33333333e-01, -1.05999788e-01, -2.42535625e-01,
        -4.29197538e-01,  7.97724035e-01, -5.68796459e-01,
        -4.10890702e-01, -4.10890702e-01, -1.50755672e-01,
        -7.97724035e-01, -1.50755672e-01, -3.92232270e-01,
         9.43398113e+00, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.50755672e-01, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.50755672e-01, -1.05999788e-01,
        -1.50755672e-01, -1.50755672e-01, -1.05999788e-01,
        -1.50755672e-01, -1.50755672e-01, -1.05999788e-01,
        -1.05999788e-01, -1.50755672e-01, -1.50755672e-01,
        -1.50755672e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.50755672e-01, -2.15665546e-01,
        -1.85695338e-01, -2.15665546e-01, -2.67261242e-01,
        -1.05999788e-01, -2.42535625e-01, -1.05999788e-01,
        -2.15665546e-01, -1.85695338e-01, -2.15665546e-01,
        -1.85695338e-01, -1.05999788e-01,  1.87082869e+00,
        -1.87082869e+00,  8.35531692e-01, -8.35531692e-01,
         1.93309133e+00, -1.93309133e+00],
       [-1.67441914e+00, -1.19523159e+00, -6.53912840e-01,
        -1.57589457e+00, -9.73440458e-01, -1.05999788e-01,
        -1.05999788e-01, -6.54653671e-01, -1.05999788e-01,
        -5.51677284e-01,  3.44342023e+00, -1.85695338e-01,
        -3.33333333e-01, -1.05999788e-01, -2.42535625e-01,
        -4.29197538e-01,  7.97724035e-01, -5.68796459e-01,
        -4.10890702e-01, -4.10890702e-01, -1.50755672e-01,
        -7.97724035e-01, -1.50755672e-01, -3.92232270e-01,
        -1.05999788e-01,  9.43398113e+00, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.50755672e-01, -1.05999788e-01,
        -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.50755672e-01, -1.05999788e-01,
        -1.50755672e-01, -1.50755672e-01, -1.05999788e-01,
        -1.50755672e-01, -1.50755672e-01, -1.05999788e-01,
        -1.05999788e-01, -1.50755672e-01, -1.50755672e-01,
        -1.50755672e-01, -1.05999788e-01, -1.05999788e-01,
        -1.05999788e-01, -1.50755672e-01, -2.15665546e-01,
        -1.85695338e-01, -2.15665546e-01, -2.67261242e-01,
        -1.05999788e-01, -2.42535625e-01, -1.05999788e-01,
        -2.15665546e-01, -1.85695338e-01, -2.15665546e-01,
        -1.85695338e-01, -1.05999788e-01,  1.87082869e+00,
        -1.87082869e+00,  8.35531692e-01, -8.35531692e-01,
         1.93309133e+00, -1.93309133e+00],
       [-1.63592675e+00, -1.16267307e+00, -6.53912840e-01,
```

```
         -1.57589457e+00,  -9.73440458e-01,  -1.05999788e-01,
         -1.05999788e-01,  -6.54653671e-01,  -1.05999788e-01,
          1.81265393e+00,  -2.90408935e-01,  -1.85695338e-01,
         -3.33333333e-01,  -1.05999788e-01,  -2.42535625e-01,
         -4.29197538e-01,   7.97724035e-01,  -5.68796459e-01,
         -4.10890702e-01,  -4.10890702e-01,  -1.50755672e-01,
         -7.97724035e-01,  -1.50755672e-01,  -3.92232270e-01,
         -1.05999788e-01,  -1.05999788e-01,   9.43398113e+00,
         -1.05999788e-01,  -1.05999788e-01,  -1.05999788e-01,
         -1.05999788e-01,  -1.05999788e-01,  -1.05999788e-01,
         -1.05999788e-01,  -1.05999788e-01,  -1.05999788e-01,
         -1.05999788e-01,  -1.05999788e-01,  -1.05999788e-01,
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         -1.05999788e-01,  -1.05999788e-01,  -1.05999788e-01,
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         -1.50755672e-01,  -1.50755672e-01,  -1.05999788e-01,
         -1.05999788e-01,  -1.50755672e-01,  -1.50755672e-01,
         -1.50755672e-01,  -1.05999788e-01,  -1.05999788e-01,
         -1.05999788e-01,  -1.50755672e-01,  -2.15665546e-01,
         -1.85695338e-01,  -2.15665546e-01,  -2.67261242e-01,
         -1.05999788e-01,  -2.42535625e-01,  -1.05999788e-01,
         -2.15665546e-01,  -1.85695338e-01,  -2.15665546e-01,
         -1.85695338e-01,  -1.05999788e-01,   1.87082869e+00,
         -1.87082869e+00,   8.35531692e-01,  -8.35531692e-01,
          1.93309133e+00,  -1.93309133e+00],
        [-1.59743435e+00,  -1.20058661e+00,  -6.53912840e-01,
         -1.57589457e+00,  -9.73440458e-01,  -1.05999788e-01,
         -1.05999788e-01,  -6.54653671e-01,  -1.05999788e-01,
         -5.51677284e-01,  -2.90408935e-01,  -1.85695338e-01,
          3.00000000e+00,  -1.05999788e-01,  -2.42535625e-01,
         -4.29197538e-01,  -1.25356634e+00,  -5.68796459e-01,
          2.43373723e+00,  -4.10890702e-01,  -1.50755672e-01,
         -7.97724035e-01,  -1.50755672e-01,  -3.92232270e-01,
         -1.05999788e-01,  -1.05999788e-01,  -1.05999788e-01,
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         -1.05999788e-01,  -1.05999788e-01,  -1.05999788e-01,
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         -1.05999788e-01,  -1.50755672e-01,  -1.05999788e-01,
         -1.05999788e-01,  -1.05999788e-01,  -1.05999788e-01,
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         -1.50755672e-01,  -1.05999788e-01,  -1.05999788e-01,
         -1.05999788e-01,  -1.50755672e-01,  -2.15665546e-01,
         -1.85695338e-01,  -2.15665546e-01,  -2.67261242e-01,
         -1.05999788e-01,  -2.42535625e-01,  -1.05999788e-01,
         -2.15665546e-01,  -1.85695338e-01,  -2.15665546e-01,
         -1.85695338e-01,  -1.05999788e-01,   1.87082869e+00,
         -1.87082869e+00,   8.35531692e-01,  -8.35531692e-01,
          1.93309133e+00,  -1.93309133e+00],
        [-1.55894196e+00,  -6.28670558e-01,  -6.53912840e-01,
         -1.57589457e+00,  -9.73440458e-01,  -1.05999788e-01,
```

```
         -1.05999788e-01,  1.52752523e+00, -1.05999788e-01,
         -5.51677284e-01, -2.90408935e-01, -1.85695338e-01,
         -3.33333333e-01, -1.05999788e-01, -2.42535625e-01,
         -4.29197538e-01,  7.97724035e-01, -5.68796459e-01,
         -4.10890702e-01, -4.10890702e-01, -1.50755672e-01,
         -7.97724035e-01, -1.50755672e-01, -3.92232270e-01,
         -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
         -1.05999788e-01,  9.43398113e+00, -1.05999788e-01,
         -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
         -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
         -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
         -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
         -1.05999788e-01, -1.50755672e-01, -1.05999788e-01,
         -1.05999788e-01, -1.05999788e-01, -1.05999788e-01,
         -1.05999788e-01, -1.50755672e-01, -1.05999788e-01,
         -1.50755672e-01, -1.50755672e-01, -1.05999788e-01,
         -1.50755672e-01, -1.50755672e-01, -1.05999788e-01,
         -1.05999788e-01, -1.50755672e-01, -1.50755672e-01,
         -1.50755672e-01, -1.05999788e-01, -1.05999788e-01,
         -1.05999788e-01, -1.50755672e-01, -2.15665546e-01,
         -1.85695338e-01, -2.15665546e-01, -2.67261242e-01,
         -1.05999788e-01, -2.42535625e-01, -1.05999788e-01,
         -2.15665546e-01, -1.85695338e-01, -2.15665546e-01,
         -1.85695338e-01, -1.05999788e-01,  1.87082869e+00,
         -1.87082869e+00,  8.35531692e-01, -8.35531692e-01,
          1.93309133e+00, -1.93309133e+00]])
```

We split the data into training and testing data using the function `train_test_split`. The training data is divided into validation data, a second set used for training data; then the models are trained and hyperparameters are selected using the function `GridSearchCV`.

TASK 3 Use the function train_test_split to split the data X and Y into training and test data. Set the parameter test_size to 0.2 and random_state to 2. The training data and test data should be assigned to the following labels.

```
X_train, X_test, Y_train, Y_test
```

```
In [11]:  #X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.2, rand
          om_state=2)
          #print ('Train set:', X_train.shape,  y_train.shape)
          #print ('Validation set:', X_val.shape,  y_val.shape)

          #X_train, X_test, Y_train, Y_test = train_test_split( X, Y, test_size=0.2, ran
          dom_state=2)
          #print ('Train set:', X_train.shape,  Y_train.shape)
          #print ('Test set:', X_test.shape,  Y_test.shape)
          X_train, X_test, Y_train, Y_test = train_test_split( X, y, test_size=0.2, rand
          om_state=2)
          print ('Train set:', X_train.shape,  Y_train.shape)
          print ('Test set:', X_test.shape,  Y_test.shape)
```

```
Train set: (72, 83) (72, 1)
Test set: (18, 83) (18, 1)
```

We can see we only have 18 test samples.

```
In [12]:  Y_test.shape
```

```
Out[12]:  (18, 1)
```

TASK 4 Create a logistic regression object then create a GridSearchCV object `logreg_cv` with cv = 10. Fit the object to find the best parameters from the dictionary `parameters`.

In [13]:
```python
parameters ={'C':[0.01,0.1,1],
             'penalty':['l2'],
             'solver':['lbfgs']}
lr=LogisticRegression()
grid_search = GridSearchCV(lr, parameters, cv=10)
logreg_cv = grid_search.fit(X_train, Y_train)
```

```
         y = column_or_1d(y, warn=True)
       C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72
       4: DataConversionWarning: A column-vector y was passed when a 1d array was ex
       pected. Please change the shape of y to (n_samples, ), for example using rave
       l().
         y = column_or_1d(y, warn=True)
       C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72
       4: DataConversionWarning: A column-vector y was passed when a 1d array was ex
       pected. Please change the shape of y to (n_samples, ), for example using rave
       l().
         y = column_or_1d(y, warn=True)
       C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72
       4: DataConversionWarning: A column-vector y was passed when a 1d array was ex
       pected. Please change the shape of y to (n_samples, ), for example using rave
       l().
         y = column_or_1d(y, warn=True)
       C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72
       4: DataConversionWarning: A column-vector y was passed when a 1d array was ex
       pected. Please change the shape of y to (n_samples, ), for example using rave
       l().
         y = column_or_1d(y, warn=True)
       C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72
       4: DataConversionWarning: A column-vector y was passed when a 1d array was ex
       pected. Please change the shape of y to (n_samples, ), for example using rave
       l().
         y = column_or_1d(y, warn=True)
       C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72
       4: DataConversionWarning: A column-vector y was passed when a 1d array was ex
       pected. Please change the shape of y to (n_samples, ), for example using rave
       l().
         y = column_or_1d(y, warn=True)
       C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72
       4: DataConversionWarning: A column-vector y was passed when a 1d array was ex
       pected. Please change the shape of y to (n_samples, ), for example using rave
       l().
         y = column_or_1d(y, warn=True)
       C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\model_selection\_searc
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       from True to False in version 0.22 and will be removed in 0.24. This will cha
       nge numeric results when test-set sizes are unequal.
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       pected. Please change the shape of y to (n_samples, ), for example using rave
       l().
         y = column_or_1d(y, warn=True)
```

```
In [14]:   parameters ={"C":[0.01,0.1,1],'penalty':['l2'], 'solver':['lbfgs']}# l1 lasso
           l2 ridge
           lr=LogisticRegression()
```

We output the `GridSearchCV` object for logistic regression. We display the best parameters using the data attribute `best_params\_` and the accuracy on the validation data using the data attribute `best_score\_` .

```
In [15]: print("tuned hpyerparameters :(best parameters) ",logreg_cv.best_params_)
         print("accuracy :",logreg_cv.best_score_)
```

```
tuned hpyerparameters :(best parameters)  {'C': 0.01, 'penalty': 'l2', 'solve
r': 'lbfgs'}
accuracy : 0.8472222222222222
```
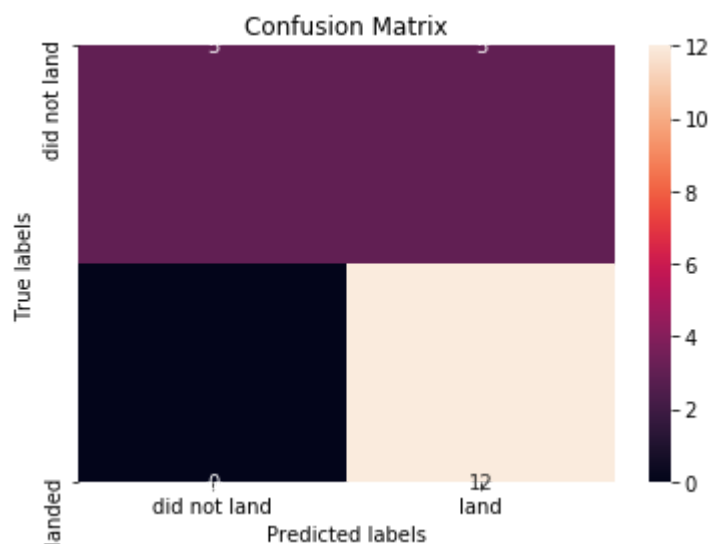
TASK 5 Calculate the accuracy on the test data using the method `score` :

```
In [16]: logreg_cv.score(X_test, Y_test)
```

```
Out[16]: 0.8333333333333334
```

Lets look at the confusion matrix:

```
In [17]: yhat=logreg_cv.predict(X_test)
         plot_confusion_matrix(Y_test,yhat)
```


Examining the confusion matrix, we see that logistic regression can distinguish between the different classes. We see that the major problem is false positives.

TASK 6 Create a support vector machine object then create a `GridSearchCV` object `svm_cv` with cv - 10. Fit the object to find the best parameters from the dictionary `parameters` .

```
In [18]: parameters = {'kernel':('linear', 'rbf','poly','rbf', 'sigmoid'),
                       'C': np.logspace(-3, 3, 5),
                       'gamma':np.logspace(-3, 3, 5)}
         svm = SVC()
```

```
In [19]:  grid_search = GridSearchCV(svm, parameters, cv=10)
          svm_cv = grid_search.fit(X_train, Y_train)
```

```
C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72
4: DataConversionWarning: A column-vector y was passed when a 1d array was ex
pected. Please change the shape of y to (n_samples, ), for example using rave
l().
  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72
4: DataConversionWarning: A column-vector y was passed when a 1d array was ex
```

```
1().
  y = column_or_1d(y, warn=True)
C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72
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C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\model_selection\_searc
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  DeprecationWarning)
C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72
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pected. Please change the shape of y to (n_samples, ), for example using rave
1().
  y = column_or_1d(y, warn=True)
```

In [20]:
```python
print("tuned hpyerparameters :(best parameters) ",svm_cv.best_params_)
print("accuracy :",svm_cv.best_score_)
```

```
tuned hpyerparameters :(best parameters)  {'C': 1.0, 'gamma': 0.0316227766016
8379, 'kernel': 'sigmoid'}
accuracy : 0.8472222222222222
```

TASK 7 Calculate the accuracy on the test data using the method `score` :

In [21]: `svm_cv.score(X_test, Y_test)`

Out[21]: `0.8333333333333334`

We can plot the confusion matrix

In [22]:
```
yhat=svm_cv.predict(X_test)
plot_confusion_matrix(Y_test,yhat)
```


TASK 8 Create a decision tree classifier object then create a `GridSearchCV` object `tree_cv` with cv = 10. Fit the object to find the best parameters from the dictionary `parameters` .

In [23]:
```
parameters = {'criterion': ['gini', 'entropy'],
        'splitter': ['best', 'random'],
        'max_depth': [2*n for n in range(1,10)],
        'max_features': ['auto', 'sqrt'],
        'min_samples_leaf': [1, 2, 4],
        'min_samples_split': [2, 5, 10]}

tree = DecisionTreeClassifier()
```

In [24]:
```
grid_search = GridSearchCV(tree, parameters, cv=10)
tree_cv = grid_search.fit(X_train, Y_train)
```

```
C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\model_selection\_searc
h.py:814: DeprecationWarning: The default of the `iid` parameter will change
from True to False in version 0.22 and will be removed in 0.24. This will cha
nge numeric results when test-set sizes are unequal.
  DeprecationWarning)
```

```
In [25]: print("tuned hpyerparameters :(best parameters) ",tree_cv.best_params_)
         print("accuracy :",tree_cv.best_score_)
```

```
tuned hpyerparameters :(best parameters)  {'criterion': 'gini', 'max_depth':
2, 'max_features': 'auto', 'min_samples_leaf': 2, 'min_samples_split': 2, 'sp
litter': 'best'}
accuracy : 0.8888888888888888
```
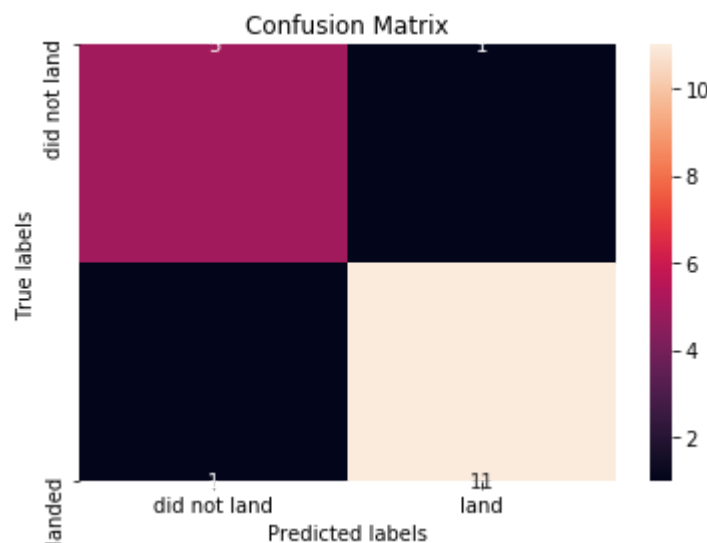
TASK 9 Calculate the accuracy of tree_cv on the test data using the method `score` :

```
In [26]: tree_cv.score(X_test, Y_test)
```

```
Out[26]: 0.8888888888888888
```

We can plot the confusion matrix

```
In [27]: yhat = tree_cv.predict(X_test)
         plot_confusion_matrix(Y_test,yhat)
```


TASK 10 Create a k nearest neighbors object then create a `GridSearchCV` object `knn_cv` with cv = 10. Fit the object to find the best parameters from the dictionary `parameters` .

```
In [28]: parameters = {'n_neighbors': [1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
                       'algorithm': ['auto', 'ball_tree', 'kd_tree', 'brute'],
                       'p': [1,2]}

         KNN = KNeighborsClassifier()
```

In [29]:
```python
grid_search = GridSearchCV(KNN, parameters, cv=10)
KNN_cv = grid_search.fit(X_train, Y_train)
```

```
C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\model_selection\_valida
tion.py:516: DataConversionWarning: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of y to (n_samples, ), for example
using ravel().
  estimator.fit(X_train, y_train, **fit_params)
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```

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   estimator.fit(X_train, y_train, **fit_params)
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h.py:814: DeprecationWarning: The default of the `iid` parameter will change
 from True to False in version 0.22 and will be removed in 0.24. This will ch
ange numeric results when test-set sizes are unequal.
   DeprecationWarning)
C:\Users\Seahawks\Anaconda3\lib\site-packages\sklearn\model_selection\_searc
h.py:715: DataConversionWarning: A column-vector y was passed when a 1d array
was expected. Please change the shape of y to (n_samples, ), for example usin
g ravel().
   self.best_estimator_.fit(X, y, **fit_params)
```

In [30]:
```python
print("tuned hpyerparameters :(best parameters) ",KNN_cv.best_params_)
print("accuracy :",KNN_cv.best_score_)
```

```
tuned hpyerparameters :(best parameters)  {'algorithm': 'auto', 'n_neighbor
s': 9, 'p': 1}
accuracy : 0.8472222222222222
```

TASK 11 Calculate the accuracy of tree_cv on the test data using the method score :
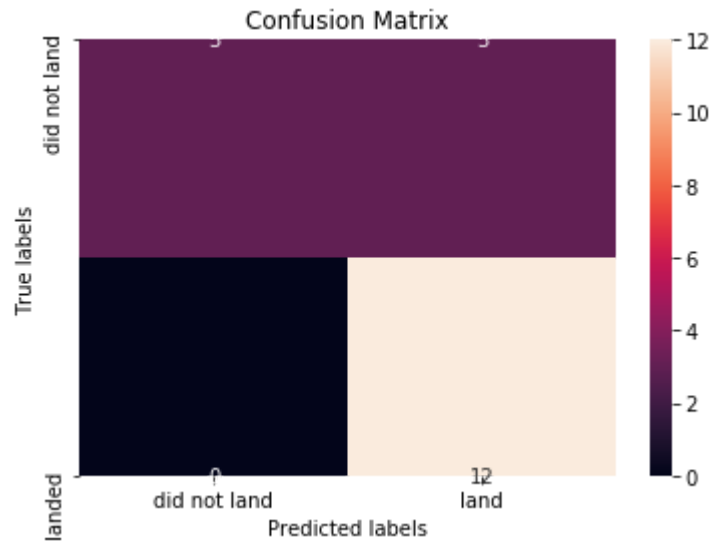
In [31]:
```python
KNN_cv.score(X_test, Y_test)
```

Out[31]: 0.8333333333333334

We can plot the confusion matrix

In [32]:
```
yhat = KNN_cv.predict(X_test)
plot_confusion_matrix(Y_test,yhat)
```


TASK 12 Find the method performs best:

In [33]:
```
print('Accuracy for Logistics Regression method:', logreg_cv.score(X_test, Y_t
est))
print( 'Accuracy for Support Vector Machine method:', svm_cv.score(X_test, Y_t
est))
print('Accuracy for Decision tree method:', tree_cv.score(X_test, Y_test))
print('Accuracy for K nearsdt neighbors method:', KNN_cv.score(X_test, Y_test
))
```

```
Accuracy for Logistics Regression method: 0.8333333333333334
Accuracy for Support Vector Machine method: 0.8333333333333334
Accuracy for Decision tree method: 0.888888888888888
Accuracy for K nearsdt neighbors method: 0.8333333333333334
```