Importing Necessary Libraries

In [ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.metrics import confusion_matrix
plt.style.use('seaborn')
```

Importing the Data

In [ ]:
```
df = pd.read_csv('adult.data')
df.columns = ['age','workclass','fnlwgt','education','education-num','marital-status
```

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

Out[ ]:

	age	workclass	fnlwgt	education	education-num	marital-status	occupation	relationship	race	sex
0	50	Self-emp-not-inc	83311	Bachelors	13	Married-civ-spouse	Exec-managerial	Husband	White	Male
1	38	Private	215646	HS-grad	9	Divorced	Handlers-cleaners	Not-in-family	White	Male
2	53	Private	234721	11th	7	Married-civ-spouse	Handlers-cleaners	Husband	Black	Male
3	28	Private	338409	Bachelors	13	Married-civ-spouse	Prof-specialty	Wife	Black	Female
4	37	Private	284582	Masters	14	Married-civ-spouse	Exec-managerial	Wife	White	Female

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

Out[ ]:

	age	fnlwgt	education-num	capital-gain	capital-loss	hours-per-week
count	32560.000000	3.256000e+04	32560.000000	32560.000000	32560.000000	32560.000000
mean	38.581634	1.897818e+05	10.080590	1077.615172	87.306511	40.437469
std	13.640642	1.055498e+05	2.572709	7385.402999	402.966116	12.347618
min	17.000000	1.228500e+04	1.000000	0.000000	0.000000	1.000000
25%	28.000000	1.178315e+05	9.000000	0.000000	0.000000	40.000000
50%	37.000000	1.783630e+05	10.000000	0.000000	0.000000	40.000000
75%	48.000000	2.370545e+05	12.000000	0.000000	0.000000	45.000000

	age	fnlwgt	education-num	capital-gain	capital-loss	hours-per-week
max	90.000000	1.484705e+06	16.000000	99999.000000	4356.000000	99.000000

In [ ]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 32560 entries, 0 to 32559
Data columns (total 15 columns):
 #   Column          Non-Null Count  Dtype 
---  ------          --------------  ----- 
 0   age             32560 non-null  int64 
 1   workclass       32560 non-null  object
 2   fnlwgt          32560 non-null  int64 
 3   education       32560 non-null  object
 4   education-num   32560 non-null  int64 
 5   marital-status  32560 non-null  object
 6   occupation      32560 non-null  object
 7   relationship    32560 non-null  object
 8   race            32560 non-null  object
 9   sex             32560 non-null  object
 10  capital-gain    32560 non-null  int64 
 11  capital-loss    32560 non-null  int64 
 12  hours-per-week  32560 non-null  int64 
 13  native-country  32560 non-null  object
 14  salary          32560 non-null  object
dtypes: int64(6), object(9)
memory usage: 3.7+ MB
```

Cleaning And Augmenting the DataSet

In [ ]:
```
df_clean = df.replace(to_replace='?',value = np.nan)
df_clean = df_clean.fillna(value = df_clean.median())
df_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 32560 entries, 0 to 32559
Data columns (total 15 columns):
 #   Column          Non-Null Count  Dtype 
---  ------          --------------  ----- 
 0   age             32560 non-null  int64 
 1   workclass       32560 non-null  object
 2   fnlwgt          32560 non-null  int64 
 3   education       32560 non-null  object
 4   education-num   32560 non-null  int64 
 5   marital-status  32560 non-null  object
 6   occupation      32560 non-null  object
 7   relationship    32560 non-null  object
 8   race            32560 non-null  object
 9   sex             32560 non-null  object
 10  capital-gain    32560 non-null  int64 
 11  capital-loss    32560 non-null  int64 
 12  hours-per-week  32560 non-null  int64 
 13  native-country  32560 non-null  object
 14  salary          32560 non-null  object
dtypes: int64(6), object(9)
memory usage: 3.7+ MB
```

Encoding the Dataset

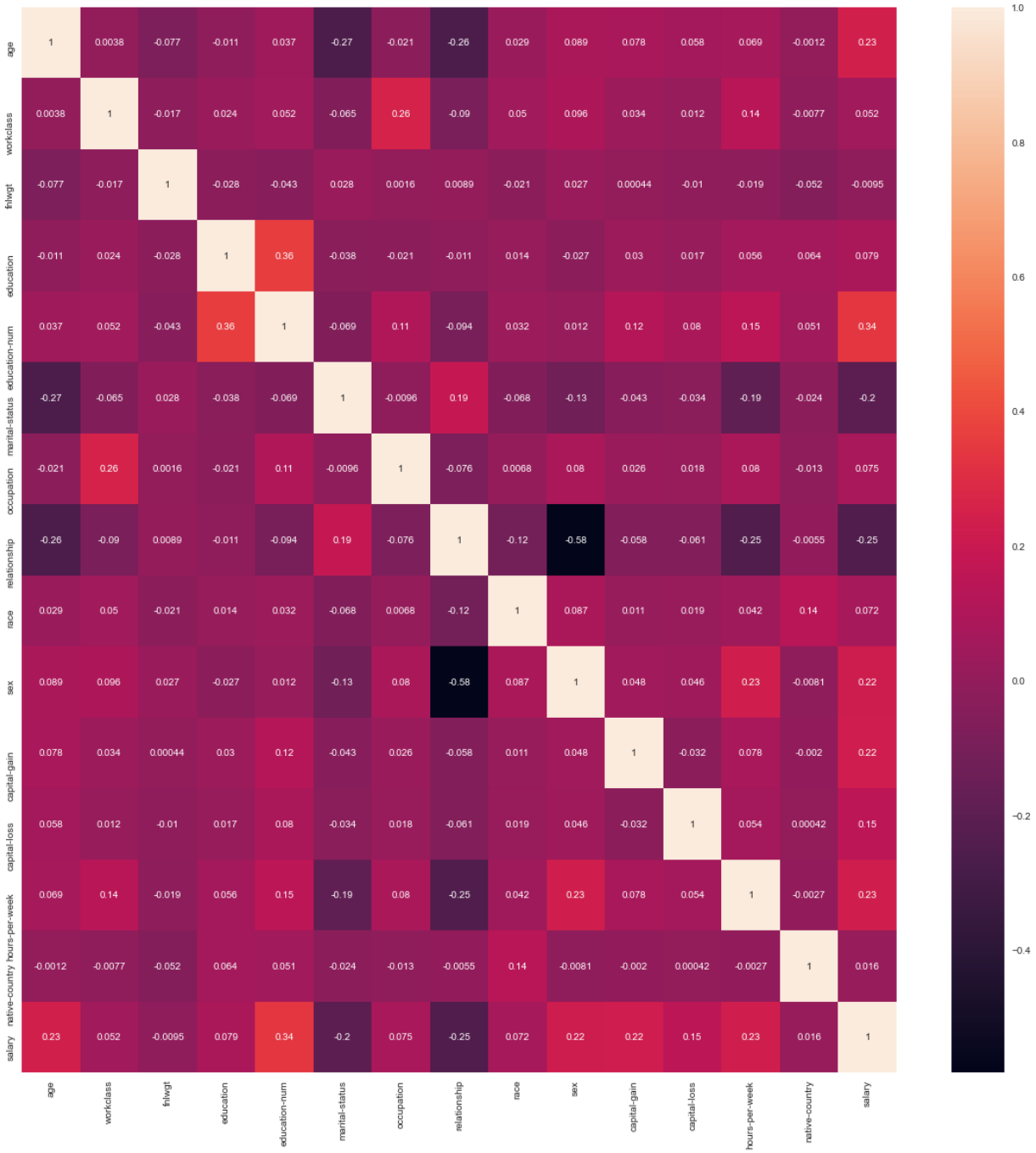
In [ ]:
```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
columns_to_encode = ['workclass', 'education','marital-status','occupation','relatio
for i in columns_to_encode:
    df_clean[i] = le.fit_transform(df_clean[i].astype(str))
```

In [ ]:
```
df_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 32560 entries, 0 to 32559
Data columns (total 15 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   age             32560 non-null  int64
 1   workclass       32560 non-null  int32
 2   fnlwgt          32560 non-null  int64
 3   education       32560 non-null  int32
 4   education-num   32560 non-null  int64
 5   marital-status  32560 non-null  int32
 6   occupation      32560 non-null  int32
 7   relationship    32560 non-null  int32
 8   race            32560 non-null  int32
 9   sex             32560 non-null  int32
 10  capital-gain    32560 non-null  int64
 11  capital-loss    32560 non-null  int64
 12  hours-per-week  32560 non-null  int64
 13  native-country  32560 non-null  int32
 14  salary          32560 non-null  int32
dtypes: int32(9), int64(6)
memory usage: 2.6 MB
```

Data Visualization

In [ ]:
```
import seaborn as sns
plt.figure(figsize=(20,20))
sns.heatmap(df_clean.corr(),annot=True)
plt.show()
```



In [ ]:

```
columns_to_drop = ['workclass','fnlwgt','education','occupation','race','native-coun
df = df_clean.drop(columns_to_drop,axis=1)
```

In [ ]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 32560 entries, 0 to 32559
Data columns (total 9 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   age             32560 non-null  int64
 1   education-num   32560 non-null  int64
 2   marital-status  32560 non-null  int32
 3   relationship    32560 non-null  int32
 4   sex             32560 non-null  int32
 5   capital-gain    32560 non-null  int64
 6   capital-loss    32560 non-null  int64
 7   hours-per-week  32560 non-null  int64
 8   salary          32560 non-null  int32
```

```
dtypes: int32(4), int64(5)
memory usage: 1.7 MB
```

Splitting the Data

In [ ]:
```
X,Y = df_clean.values[:,:-1],df_clean.values[:,-1]
```

In [ ]:
```
X.shape,Y.shape
```

Out[ ]:
```
((32560, 14), (32560,))
```

Normalisation and Standardisation

In [ ]:
```
u = np.mean(X, axis=0)
std = np.std(X, axis=0)
X = (X-u)/std
```

In [ ]:
```
ones = np.ones((X.shape[0],1))
X = np.hstack((ones,X))
print(X.shape)
```

```
(32560, 15)
```

Creating Test Train Split

In [ ]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.2, random_stat
```

Writing Error, Hypothesis and Gradient Function

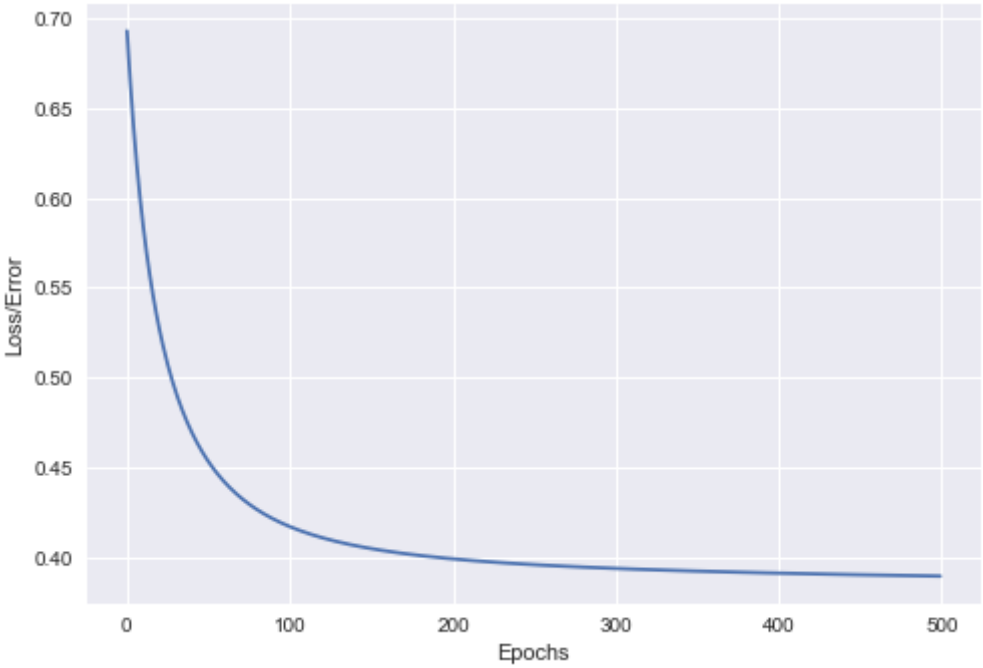
In [ ]:
```
def sigmoid(x):
    return 1.0/(1.0 + np.exp(-x))
def hypothesis(X,theta):
    return sigmoid(np.dot(X,theta))
def error(X,y,theta):
    hi = hypothesis(X,theta)
    e = -1*np.mean((y*np.log(hi) + ((1-y)*np.log(1-hi))))
    return e
def gradient(X,y,theta):
    hi = hypothesis(X,theta)
    grad = -(np.dot(X.T,(y-hi)))
    m = X.shape[0]
    return grad/m
def gradientDescent(X_,y,lr = 0.1, epochs = 300):
    # ones = np.ones((X.shape[0],1))
    # X_ = np.hstack((ones,X))
    y = y.reshape((-1,1))

    n = X_.shape[1]
    theta = np.zeros((n,1))
```

```
    error_list = []
    for i in range(epochs):
        error_list.append(error(X_,y,theta))
        grad = gradient(X_,y,theta)
        theta = theta - lr*grad
    return theta,error_list
```

In [ ]:
```
theta,err = gradientDescent(X,Y, lr=0.1,epochs=500)
```

Plotting Error

In [ ]:
```
plt.plot(err)
plt.xlabel("Epochs")
plt.ylabel("Loss/Error")
plt.show()
```



Predict Method

In [ ]:
```
def predict(X_,theta):
    # ones = np.ones((X.shape[0],1))
    # X_ = np.hstack((ones,X))
    h = hypothesis(X_,theta)
    output = np.zeros(h.shape)
    output[h>=0.5] = 1
    output = output.astype('int')
    return output
XT_pred = predict(X,theta)
```

Plotting Confusion Matrix

In [ ]:
```
CM = confusion_matrix(XT_pred, Y, labels=[1,0])
TP=CM[0][0]
```

```
FP=CM[0][1]
FN=CM[1][0]
TN=CM[1][1]

ACC = (TP+TN)/(TP+TN+FP+FN)
print('Accuracy is : \n', ACC)
print('--------------------------------')
Rec = TP/(TP+FN)
print('Recall is : \n', Rec)
print('--------------------------------')
Prec = TP/(TP+FP)
print('Precsion is : \n', Prec)
print('--------------------------------')
F1 = 2 * ((Prec * Rec)/(Prec + Rec))
print('F1 score is : \n', F1)
print('--------------------------------')
```

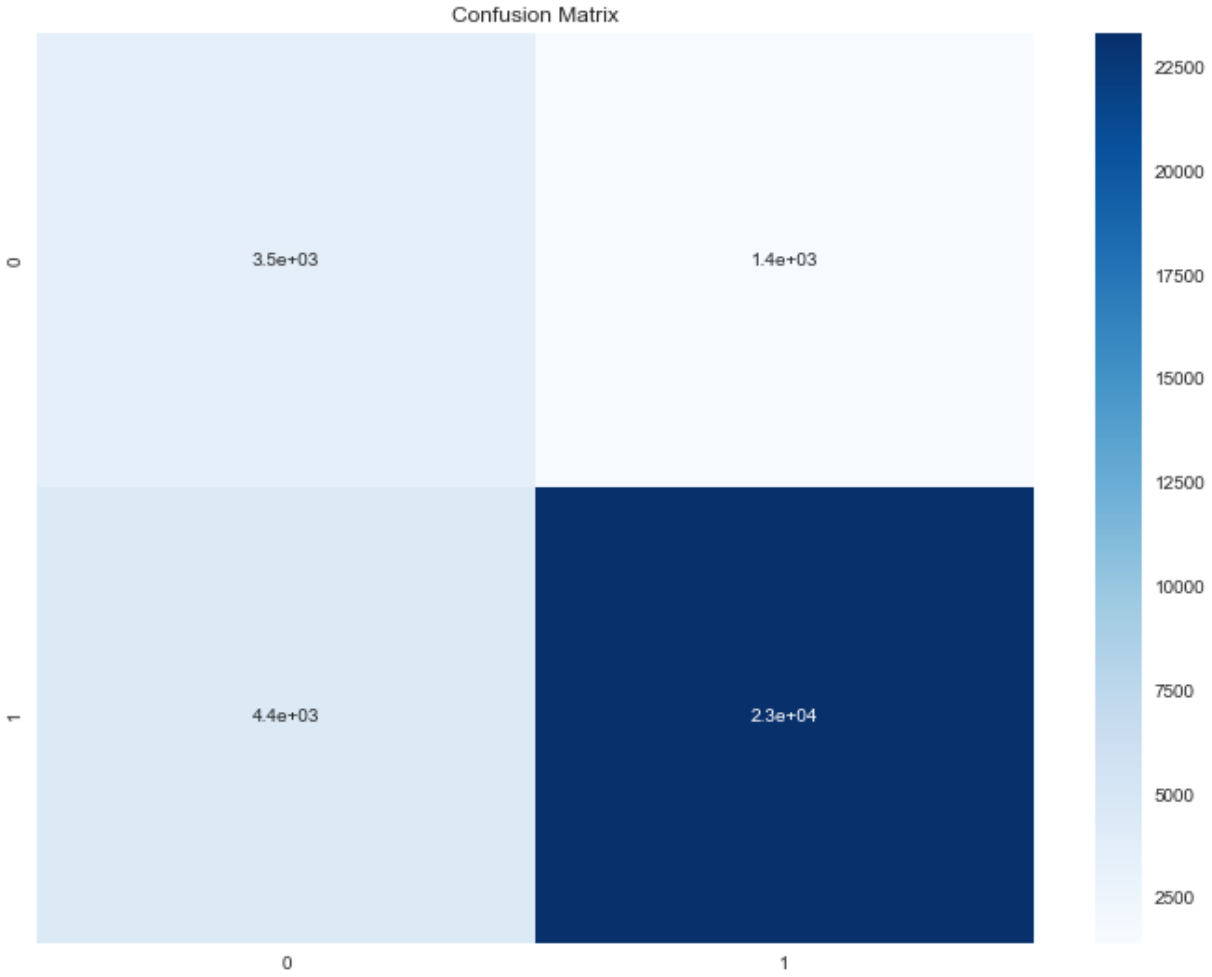
```
Accuracy is :
 0.8223280098280098
--------------------------------
Recall is :
 0.4406325723759725
--------------------------------
Precsion is :
 0.711784095591265
--------------------------------
F1 score is :
 0.5443087829854274
--------------------------------
```

In [ ]:

```
import seaborn as sns

plt.figure(figsize=(12,9))
plt.ticklabel_format(useOffset=False, style='plain')
plt.title("Confusion Matrix")
sns.heatmap(CM,annot=True,cmap=plt.cm.Blues)
plt.plot()
```

Out[ ]:

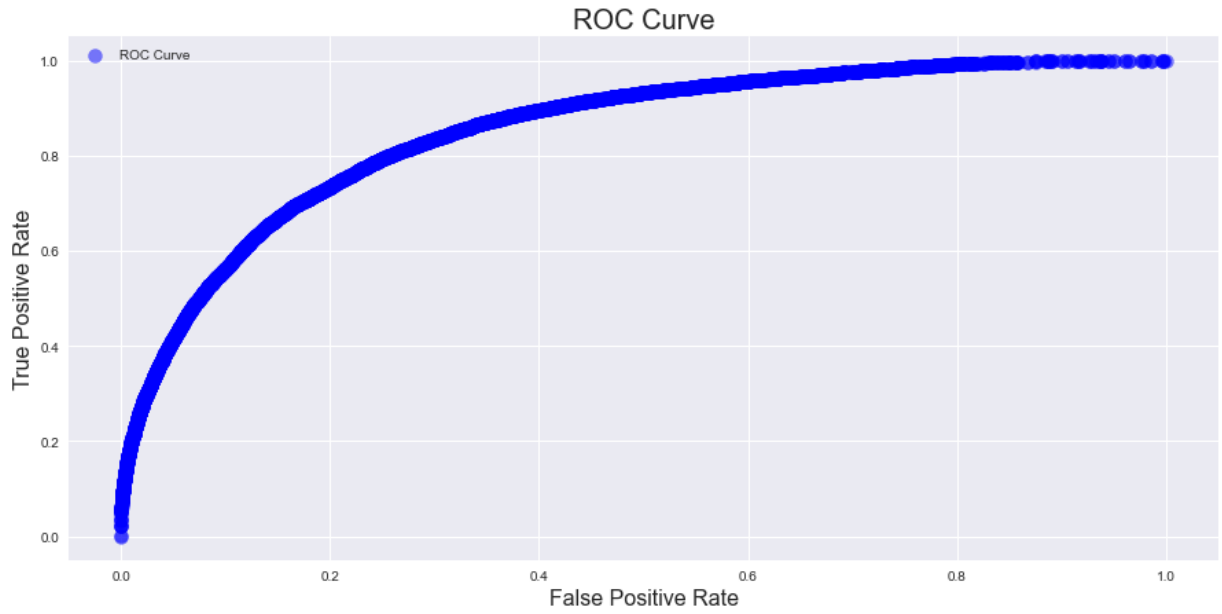
```
[]
```



ROC (Receiver Operating Characteristics) Curve

In [ ]:

```
def probabilities(X_,theta):
    h = hypothesis(X_,theta)
    return h
prob_vector = probabilities(X,theta)
from sklearn.metrics import roc_curve
fpr, tpr, thresholds = roc_curve(Y, prob_vector)

plt.figure(figsize=(15, 7))
plt.scatter(fpr, tpr, s=100, alpha=0.5, color="blue", label="ROC Curve")
plt.title("ROC Curve", fontsize=20)
plt.xlabel("False Positive Rate", fontsize=16)
plt.ylabel("True Positive Rate", fontsize=16)
plt.legend()
plt.show()
```


ROC Curve
ROC Curve
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0

In [ ]: