Artificial Neural Network

Part 1 - Data Preprocessing ¶

In [8]:

```
# Importing the libraries
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

In [9]:

```
# Importing the dataset
dataset = pd.read_csv('D:\Courses\Deep_Learning_A_Z\Volume 1 - Supervised Deep Learning
\Part 1 - Artificial Neural Networks (ANN)\Section 4 - Building an ANN\Churn_Modelling.
csv')
X = dataset.iloc[:, 3:13].values
y = dataset.iloc[:, 13].values
```

Encoding categorical data

In [10]:

```
from sklearn.preprocessing import LabelEncoder, OneHotEncoder
labelencoder_X_1 = LabelEncoder()
X[:, 1] = labelencoder_X_1.fit_transform(X[:, 1])
labelencoder_X_2 = LabelEncoder()
X[:, 2] = labelencoder_X_2.fit_transform(X[:, 2])
onehotencoder = OneHotEncoder(categorical_features = [1])
X = onehotencoder.fit_transform(X).toarray()
X = X[:, 1:]
```

Splitting the dataset into the Training set and Test set

In [11]:

```
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_state
 = 0)
```

Feature Scaling

In [12]:

```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

In [13]:

```
# Importing the Keras libraries and packages
import keras
from keras.models import Sequential
from keras.layers import Dense
```

In [14]:

```
# Initialising the ANN
classifier = Sequential()

# Adding the input layer and the first hidden layer
classifier.add(Dense(units = 6, kernel_initializer = 'uniform', activation = 'relu', in
put_dim = 11))

# Adding the second hidden layer
classifier.add(Dense(units = 6, kernel_initializer = 'uniform', activation = 'relu'))

# Adding the output layer
classifier.add(Dense(units = 1, kernel_initializer = 'uniform', activation = 'sigmoid'
))

# Compiling the ANN
classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accura
cy'])

# Fitting the ANN to the Training set
classifier.fit(X_train, y_train, batch_size = 10, epochs = 100)
```

```
Epoch 1/100
8000/8000 [==============================] - 2s 254us/step - loss: 0.482
3 - acc: 0.7954
Epoch 2/100
8000/8000 [==============================] - 2s 202us/step - loss: 0.428
8 - acc: 0.7960
Epoch 3/100
8000/8000 [==============================] - 1s 177us/step - loss: 0.424
1 - acc: 0.7965
Epoch 4/100
8000/8000 [==============================] - ETA: 0s - loss: 0.4210 - ac
c: 0.817 - 1s 182us/step - loss: 0.4201 - acc: 0.8185
Epoch 5/100
8000/8000 [==============================] - 2s 194us/step - loss: 0.417
4 - acc: 0.8249
Epoch 6/100
8000/8000 [==============================] - 2s 203us/step - loss: 0.416
1 - acc: 0.8256
Epoch 7/100
8000/8000 [==============================] - 2s 198us/step - loss: 0.414
5 - acc: 0.8292
Epoch 8/100
8000/8000 [==============================] - 1s 186us/step - loss: 0.413
3 - acc: 0.8306
Epoch 9/100
8000/8000 [==============================] - 2s 233us/step - loss: 0.411
9 - acc: 0.8330
Epoch 10/100
8000/8000 [==============================] - 2s 280us/step - loss: 0.410
6 - acc: 0.8312
Epoch 11/100
8000/8000 [==============================] - 2s 220us/step - loss: 0.410
8 - acc: 0.8341
Epoch 12/100
8000/8000 [==============================] - 2s 221us/step - loss: 0.409
6 - acc: 0.8339
Epoch 13/100
8000/8000 [==============================] - 2s 209us/step - loss: 0.408
9 - acc: 0.8337
Epoch 14/100
8000/8000 [==============================] - 2s 200us/step - loss: 0.408
2 - acc: 0.8335
Epoch 15/100
8000/8000 [==============================] - 2s 203us/step - loss: 0.407
5 - acc: 0.8355
Epoch 16/100
8000/8000 [==============================] - 2s 199us/step - loss: 0.407
2 - acc: 0.8337
Epoch 17/100
8000/8000 [==============================] - 1s 179us/step - loss: 0.406
7 - acc: 0.8346
Epoch 18/100
8000/8000 [==============================] - 2s 194us/step - loss: 0.406
0 - acc: 0.8347
Epoch 19/100
8000/8000 [==============================] - 2s 212us/step - loss: 0.405
4 - acc: 0.8342
Epoch 20/100
8000/8000 [==============================] - 2s 192us/step - loss: 0.404
8 - acc: 0.8364
Epoch 21/100
```

```
8000/8000 [==============================] - 2s 229us/step - loss: 0.404
7 - acc: 0.8355
Epoch 22/100
8000/8000 [==============================] - 2s 212us/step - loss: 0.404
3 - acc: 0.8335
Epoch 23/100
8000/8000 [==============================] - 2s 208us/step - loss: 0.403
4 - acc: 0.8362
Epoch 24/100
8000/8000 [==============================] - 2s 244us/step - loss: 0.403
9 - acc: 0.8345
Epoch 25/100
8000/8000 [==============================] - 2s 247us/step - loss: 0.403
3 - acc: 0.8354
Epoch 26/100
8000/8000 [==============================] - 2s 220us/step - loss: 0.402
4 - acc: 0.8345
Epoch 27/100
8000/8000 [==============================] - 2s 195us/step - loss: 0.402
4 - acc: 0.8351
Epoch 28/100
8000/8000 [==============================] - 2s 221us/step - loss: 0.400
8 - acc: 0.8354
Epoch 29/100
8000/8000 [==============================] - 2s 204us/step - loss: 0.400
9 - acc: 0.8366 0s - loss: 0.4014 - acc: 0.83
Epoch 30/100
8000/8000 [==============================] - 2s 211us/step - loss: 0.400
1 - acc: 0.8360
Epoch 31/100
8000/8000 [==============================] - 2s 230us/step - loss: 0.399
7 - acc: 0.8357 0s - loss: 0.3993 - acc: 0.8
Epoch 32/100
8000/8000 [==============================] - 2s 216us/step - loss: 0.399
6 - acc: 0.8361
Epoch 33/100
8000/8000 [==============================] - 2s 206us/step - loss: 0.398
9 - acc: 0.8354
Epoch 34/100
8000/8000 [==============================] - 2s 215us/step - loss: 0.398
8 - acc: 0.8379 0s - loss: 0.3973 - a
Epoch 35/100
8000/8000 [==============================] - 2s 239us/step - loss: 0.397
6 - acc: 0.8369 1s - loss: 0.
Epoch 36/100
8000/8000 [==============================] - 2s 215us/step - loss: 0.397
9 - acc: 0.8366
Epoch 37/100
8000/8000 [==============================] - 2s 210us/step - loss: 0.397
4 - acc: 0.8359
Epoch 38/100
8000/8000 [==============================] - 2s 220us/step - loss: 0.396
7 - acc: 0.8367
Epoch 39/100
8000/8000 [==============================] - 2s 199us/step - loss: 0.396
7 - acc: 0.8362 0s - loss: 0.3935 - acc: 0.8
Epoch 40/100
8000/8000 [==============================] - 2s 241us/step - loss: 0.396
1 - acc: 0.8361 1s - l
Epoch 41/100
8000/8000 [==============================] - 2s 226us/step - loss: 0.395
```

```
8 - acc: 0.8377
Epoch 42/100
8000/8000 [==============================] - 2s 224us/step - loss: 0.396
0 - acc: 0.8386
Epoch 43/100
8000/8000 [==============================] - 2s 224us/step - loss: 0.395
6 - acc: 0.8367
Epoch 44/100
8000/8000 [==============================] - 2s 282us/step - loss: 0.395
9 - acc: 0.8392 0s - loss: 0.3948 - acc: 0.
Epoch 45/100
8000/8000 [==============================] - 2s 273us/step - loss: 0.395
3 - acc: 0.8377
Epoch 46/100
8000/8000 [==============================] - 2s 273us/step - loss: 0.395
2 - acc: 0.8376
Epoch 47/100
8000/8000 [==============================] - 2s 231us/step - loss: 0.395
1 - acc: 0.8370
Epoch 48/100
8000/8000 [==============================] - 2s 220us/step - loss: 0.394
9 - acc: 0.8370
Epoch 49/100
8000/8000 [==============================] - 2s 199us/step - loss: 0.394
6 - acc: 0.8385
Epoch 50/100
8000/8000 [==============================] - 2s 269us/step - loss: 0.394
6 - acc: 0.8385
Epoch 51/100
8000/8000 [==============================] - 3s 320us/step - loss: 0.394
6 - acc: 0.8379
Epoch 52/100
8000/8000 [==============================] - 2s 258us/step - loss: 0.393
7 - acc: 0.8369
Epoch 53/100
8000/8000 [==============================] - 2s 229us/step - loss: 0.393
2 - acc: 0.8386
Epoch 54/100
8000/8000 [==============================] - 2s 250us/step - loss: 0.394
2 - acc: 0.8379
Epoch 55/100
8000/8000 [==============================] - 2s 219us/step - loss: 0.394
2 - acc: 0.8370 1s
Epoch 56/100
8000/8000 [==============================] - 2s 213us/step - loss: 0.393
3 - acc: 0.8382
Epoch 57/100
8000/8000 [==============================] - 2s 214us/step - loss: 0.394
3 - acc: 0.8374 0s - loss: 0.3951 -
Epoch 58/100
8000/8000 [==============================] - 2s 214us/step - loss: 0.393
3 - acc: 0.8379
Epoch 59/100
8000/8000 [==============================] - 2s 197us/step - loss: 0.393
8 - acc: 0.8384
Epoch 60/100
8000/8000 [==============================] - 2s 208us/step - loss: 0.393
6 - acc: 0.8367
Epoch 61/100
8000/8000 [==============================] - 2s 242us/step - loss: 0.393
5 - acc: 0.8382
```

```
Epoch 62/100
8000/8000 [==============================] - 2s 224us/step - loss: 0.393
4 - acc: 0.8392
Epoch 63/100
8000/8000 [==============================] - 2s 232us/step - loss: 0.393
3 - acc: 0.8390
Epoch 64/100
8000/8000 [==============================] - 2s 225us/step - loss: 0.393
5 - acc: 0.8380
Epoch 65/100
8000/8000 [==============================] - 2s 239us/step - loss: 0.392
4 - acc: 0.8394
Epoch 66/100
8000/8000 [==============================] - 2s 236us/step - loss: 0.393
4 - acc: 0.8382
Epoch 67/100
8000/8000 [==============================] - 2s 217us/step - loss: 0.393
6 - acc: 0.8379
Epoch 68/100
8000/8000 [==============================] - 2s 235us/step - loss: 0.393
1 - acc: 0.8387
Epoch 69/100
8000/8000 [==============================] - 2s 237us/step - loss: 0.393
5 - acc: 0.8382
Epoch 70/100
8000/8000 [==============================] - 2s 231us/step - loss: 0.393
1 - acc: 0.8370
Epoch 71/100
8000/8000 [==============================] - 2s 224us/step - loss: 0.393
6 - acc: 0.8371
Epoch 72/100
8000/8000 [==============================] - 2s 223us/step - loss: 0.393
2 - acc: 0.8382
Epoch 73/100
8000/8000 [==============================] - 2s 223us/step - loss: 0.393
3 - acc: 0.8382
Epoch 74/100
8000/8000 [==============================] - 2s 238us/step - loss: 0.393
6 - acc: 0.8375 1s - loss: 0. - ETA: 0s - loss: 0.3904 - acc: 0
Epoch 75/100
8000/8000 [==============================] - 2s 218us/step - loss: 0.393
4 - acc: 0.8379
Epoch 76/100
8000/8000 [==============================] - 2s 221us/step - loss: 0.392
7 - acc: 0.8390 1s - loss:
Epoch 77/100
8000/8000 [==============================] - 2s 225us/step - loss: 0.393
4 - acc: 0.8386
Epoch 78/100
8000/8000 [==============================] - 3s 314us/step - loss: 0.393
0 - acc: 0.8376
Epoch 79/100
8000/8000 [==============================] - 2s 191us/step - loss: 0.393
2 - acc: 0.8371
Epoch 80/100
8000/8000 [==============================] - 1s 174us/step - loss: 0.393
1 - acc: 0.8386
Epoch 81/100
8000/8000 [==============================] - 1s 163us/step - loss: 0.393
3 - acc: 0.8380
Epoch 82/100
```

```
8000/8000 [==============================] - 1s 171us/step - loss: 0.392
8 - acc: 0.8394
Epoch 83/100
8000/8000 [==============================] - 1s 180us/step - loss: 0.393
3 - acc: 0.8380
Epoch 84/100
8000/8000 [==============================] - 1s 162us/step - loss: 0.393
1 - acc: 0.8361
Epoch 85/100
8000/8000 [==============================] - 1s 157us/step - loss: 0.392
8 - acc: 0.8390
Epoch 86/100
8000/8000 [==============================] - 1s 160us/step - loss: 0.393
2 - acc: 0.8379
Epoch 87/100
8000/8000 [==============================] - 1s 154us/step - loss: 0.393
0 - acc: 0.8374
Epoch 88/100
8000/8000 [==============================] - 1s 156us/step - loss: 0.392
4 - acc: 0.8377
Epoch 89/100
8000/8000 [==============================] - 1s 155us/step - loss: 0.392
5 - acc: 0.8394
Epoch 90/100
8000/8000 [==============================] - 1s 168us/step - loss: 0.392
5 - acc: 0.8390
Epoch 91/100
8000/8000 [==============================] - 1s 162us/step - loss: 0.393
0 - acc: 0.8381
Epoch 92/100
8000/8000 [==============================] - 1s 161us/step - loss: 0.393
0 - acc: 0.8362
Epoch 93/100
8000/8000 [==============================] - 1s 148us/step - loss: 0.392
8 - acc: 0.8370
Epoch 94/100
8000/8000 [==============================] - 1s 158us/step - loss: 0.392
8 - acc: 0.8370
Epoch 95/100
8000/8000 [==============================] - 1s 158us/step - loss: 0.393
0 - acc: 0.8380
Epoch 96/100
8000/8000 [==============================] - 1s 158us/step - loss: 0.392
4 - acc: 0.8387
Epoch 97/100
8000/8000 [==============================] - 1s 161us/step - loss: 0.392
9 - acc: 0.8372
Epoch 98/100
8000/8000 [==============================] - 1s 156us/step - loss: 0.392
1 - acc: 0.8370
Epoch 99/100
8000/8000 [==============================] - 1s 159us/step - loss: 0.393
0 - acc: 0.8366
Epoch 100/100
8000/8000 [==============================] - 2s 192us/step - loss: 0.393
4 - acc: 0.8371
```

Out[14]:

```
<keras.callbacks.History at 0x227b28ea518>
```

Predicting the Test set results

In [16]:

```
y_pred = classifier.predict(X_test)
y_pred = (y_pred > 0.5)
```

Making the Confusion Matrix

In [18]:

```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
cm
```

Out[18]:

```
array([[1550,   45],
       [ 265,  140]], dtype=int64)
```

Accuracy score

In [19]:

```
from sklearn.metrics import accuracy_score
accuracy_score(y_test,y_pred)
```

Out[19]:

```
0.845
```