BUILDING THE TRAINED MODEL

DATA PREPROCESSING

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

In [2]:
```
dataset = pd.read_csv('../dataset/train_dataset.csv', index_col = 0)
```

In [3]:
```
dataset.head()
```

Out[3]:

	trans_hour	trans_day	trans_month	trans_year	category	card_number	age	trans_amount	state	zip	fraud_risk
0	0	1	1	2019	12	6.300000e+11	54	66.21	22	49879	0
1	1	1	1	2019	3	3.540000e+15	15	55.81	14	62668	0
2	3	1	1	2019	8	5.020000e+11	60	8.68	4	96037	0
3	6	1	1	2019	4	3.530000e+15	44	89.52	40	29911	0
4	6	1	1	2019	0	2.350000e+15	72	1.90	38	16421	0

In [4]:
```
import numpy as np
```

In [5]:
```
x = dataset.iloc[ : , : 10].values
y = dataset.iloc[ : , 10].values
```

In [6]:
```
from sklearn.model_selection import train_test_split
```

In [7]:
```
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.15, random_state = 0)
```

In [8]:
```
x_train.shape
```

Out[8]: (10210, 10)

In [9]:
```
x_test.shape
```

Out[9]: (1802, 10)

In [10]:
```
fraud = np.count_nonzero(y_train == 1)
valid = np.count_nonzero(y_train == 0)
```

In [11]:
```
print('Fraud cases in training data =', fraud)
print('Valid cases in training data =', valid)
```

```
Fraud cases in training data = 5106
Valid cases in training data = 5104
```

In [12]:
```
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
```

In [13]:
```
x_train = scaler.fit_transform(x_train)
x_test = scaler.transform(x_test)
```

In [14]:
```
x_train[ : 5]
```

Out[14]:
```
array([[ 0.66337259,  1.24104545,  0.45653094, -0.37826057,  0.83408097,
        -0.30554032,  2.3966382 , -0.73068363,  0.0181697 , -0.77660466],
       [-1.6023747 , -0.07304053, -0.90455674, -0.37826057, -1.22335066,
        -0.30836573,  0.74498916, -0.74861649,  0.64443135,  0.93890762],
       [-1.12537527,  0.1459738 ,  0.45653094, -0.37826057,  0.57690202,
        -0.30362247,  1.18542891, -0.79511806,  0.78360061, -1.2179066 ],
       [-1.6023747 , -0.29205486, -0.36012167, -0.37826057, -0.70899275,
        -0.30397763,  1.46070375, -0.51118115, -1.58227676,  1.76478537],
       [-0.7676257 , -0.29205486, -1.44899181, -0.37826057, -0.70899275,
        -0.30836532, -0.08083536,  0.02559291,  0.78360061, -1.18526965]])
```

In [15]:
```
x_test[ : 5]
```

Out[15]:
```
array([[ 1.02112216, -0.51106919,  1.27318354, -0.37826057,  1.34843888,
         3.15638262,  0.35960438,  1.60624238,  0.64443135,  0.91726066],
```

```
       [-0.05212655,  0.58400246,  0.1843134 , -0.37826057,  0.83408097,
        -0.30822372, -0.08083536, -0.65192446,  0.29650821, -1.52769864],
       [ 1.14037202,  1.56956694,  0.72874847, -0.37826057,  1.09125992,
        -0.30560345,  1.29553884,  1.71351642,  1.13152375,  1.07356281],
       [ 1.02112216, -0.73008352,  0.1843134 , -0.37826057,  1.09125992,
        -0.30500363,  1.51575871,  1.6205402 ,  0.15733896,  0.77172649],
       [-1.6023747 , -0.07304053, -0.08790413, -0.37826057,  1.34843888,
        -0.30819767,  0.80004413, -0.06571388, -0.60809196,  0.84854544]])
```

LOGISTIC REGRESSION (LR)

In [16]:

```
from sklearn.linear_model import LogisticRegression
LR_model = LogisticRegression(random_state = 0)
LR_model.fit(x_train, y_train)
```

Out[16]:

```
LogisticRegression(random_state=0)
```

In [17]:

```
y_pred = LR_model.predict(x_test)
```

In [18]:

```
from sklearn.metrics import accuracy_score
```

In [19]:

```
acc_lr = accuracy_score(y_test, y_pred)
```

In [20]:

```
print(acc_lr)
```

```
0.8485016648168702
```

K-NEAREST NEIGHBORS (KNN)

In [21]:

```
from sklearn.neighbors import KNeighborsClassifier
KNN_model = KNeighborsClassifier(n_neighbors = 5, metric = 'minkowski', p = 2)
KNN_model.fit(x_train, y_train)
```

Out[21]:

```
KNeighborsClassifier()
```

In [22]:

```
y_pred = KNN_model.predict(x_test)
```

In [23]:
```
acc_knn = accuracy_score(y_test, y_pred)
```

In [24]:
```
print(acc_knn)
```

```
0.8657047724750278
```

SUPPORT VECTOR MACHINE (SVM)

In [25]:
```
from sklearn.svm import SVC
SVM_model = SVC(kernel = 'linear', random_state = 0)
SVM_model.fit(x_train, y_train)
```

Out[25]:
```
SVC(kernel='linear', random_state=0)
```

In [26]:
```
y_pred = SVM_model.predict(x_test)
```

In [27]:
```
acc_svm = accuracy_score(y_test, y_pred)
```

In [28]:
```
print(acc_svm)
```

```
0.8479467258601554
```

NAIVE BAYES (NB)

In [29]:
```
from sklearn.naive_bayes import GaussianNB
NB_model = GaussianNB()
NB_model.fit(x_train, y_train)
```

Out[29]:
```
GaussianNB()
```

In [30]:
```
y_pred = NB_model.predict(x_test)
```

In [31]:
```
acc_nb = accuracy_score(y_test, y_pred)
```

In [32]:
```
print(acc_nb)
```

0.8496115427302997

DECISION TREE (DT)

In [33]:
```
from sklearn.tree import DecisionTreeClassifier
DT_model = DecisionTreeClassifier(criterion = 'entropy', random_state = 0)
DT_model.fit(x_train, y_train)
```

Out[33]: DecisionTreeClassifier(criterion='entropy', random_state=0)

In [34]:
```
y_pred = DT_model.predict(x_test)
```

In [35]:
```
acc_dt = accuracy_score(y_test, y_pred)
```

In [36]:
```
print(acc_dt)
```

0.967258601553829

RANDOM FOREST (RF)

In [37]:
```
from sklearn.ensemble import RandomForestClassifier
RF_model = RandomForestClassifier()
RF_model.fit(x_train, y_train)
```

Out[37]: RandomForestClassifier()

In [38]:
```
y_pred = RF_model.predict(x_test)
```

In [39]:
```
acc_rf = accuracy_score(y_test, y_pred)
```

In [40]:
```
print(acc_rf)
```

0.9705882352941176

ARTIFICIAL NEURAL NETWORK (ANN)

In [41]:
```python
import tensorflow as tf
```

In [42]:
```python
ANN_model = tf.keras.models.Sequential()
```

In [43]:
```python
ANN_model.add(tf.keras.layers.Dense(64, input_dim = 10, activation = 'relu'))
ANN_model.add(tf.keras.layers.Dense(128, activation = 'relu'))
ANN_model.add(tf.keras.layers.Dense(1, activation = 'sigmoid'))
```

In [44]:
```python
ANN_model.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accuracy'])
```

In [45]:
```python
ANN_model.fit(x_train, y_train, batch_size = 32, epochs = 200)
```

```
Epoch 1/200
320/320 [==============================] - 1s 1ms/step - loss: 0.4871 - accuracy: 0.7848
Epoch 2/200
320/320 [==============================] - 0s 1ms/step - loss: 0.3288 - accuracy: 0.8532
Epoch 3/200
320/320 [==============================] - 0s 1ms/step - loss: 0.3058 - accuracy: 0.8604
Epoch 4/200
320/320 [==============================] - 0s 1ms/step - loss: 0.3019 - accuracy: 0.8578
Epoch 5/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2956 - accuracy: 0.8622
Epoch 6/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2859 - accuracy: 0.8675
Epoch 7/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2853 - accuracy: 0.8706
Epoch 8/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2643 - accuracy: 0.8806
Epoch 9/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2739 - accuracy: 0.8755
Epoch 10/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2706 - accuracy: 0.8765
Epoch 11/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2590 - accuracy: 0.8826
Epoch 12/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2601 - accuracy: 0.8851
Epoch 13/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2406 - accuracy: 0.8971
Epoch 14/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2290 - accuracy: 0.9060
Epoch 15/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2254 - accuracy: 0.9096
```

```
Epoch 16/200
320/320 [==============================] - ETA: 0s - loss: 0.2096 - accuracy: 0.91 - 0s 1ms/step - loss: 0.2097 - accurac
y: 0.9156
Epoch 17/200
320/320 [==============================] - 0s 1ms/step - loss: 0.2094 - accuracy: 0.9132
Epoch 18/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1947 - accuracy: 0.9230
Epoch 19/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1955 - accuracy: 0.9206
Epoch 20/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1868 - accuracy: 0.9309
Epoch 21/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1732 - accuracy: 0.9318
Epoch 22/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1698 - accuracy: 0.9302
Epoch 23/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1753 - accuracy: 0.9272
Epoch 24/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1633 - accuracy: 0.9363
Epoch 25/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1552 - accuracy: 0.9382
Epoch 26/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1541 - accuracy: 0.9405
Epoch 27/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1529 - accuracy: 0.9411
Epoch 28/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1526 - accuracy: 0.9409
Epoch 29/200
320/320 [==============================] - 0s 985us/step - loss: 0.1434 - accuracy: 0.9438
Epoch 30/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1384 - accuracy: 0.9466
Epoch 31/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1319 - accuracy: 0.9481
Epoch 32/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1401 - accuracy: 0.9447
Epoch 33/200
320/320 [==============================] - 0s 995us/step - loss: 0.1318 - accuracy: 0.9484
Epoch 34/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1246 - accuracy: 0.9519
Epoch 35/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1233 - accuracy: 0.9534
Epoch 36/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1247 - accuracy: 0.9502
Epoch 37/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1296 - accuracy: 0.9467
Epoch 38/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1399 - accuracy: 0.9414
Epoch 39/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1210 - accuracy: 0.9517
```

```
Epoch 40/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1194 - accuracy: 0.9515
Epoch 41/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1158 - accuracy: 0.9559
Epoch 42/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1188 - accuracy: 0.9526
Epoch 43/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1130 - accuracy: 0.9553
Epoch 44/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1144 - accuracy: 0.9560
Epoch 45/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1209 - accuracy: 0.9546
Epoch 46/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1094 - accuracy: 0.9572
Epoch 47/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1043 - accuracy: 0.9597
Epoch 48/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1227 - accuracy: 0.9505
Epoch 49/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1125 - accuracy: 0.9558
Epoch 50/200
320/320 [==============================] - 0s 994us/step - loss: 0.1084 - accuracy: 0.9581
Epoch 51/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1106 - accuracy: 0.9566
Epoch 52/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1159 - accuracy: 0.9539
Epoch 53/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1127 - accuracy: 0.9567
Epoch 54/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1082 - accuracy: 0.9578
Epoch 55/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1022 - accuracy: 0.9629
Epoch 56/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1071 - accuracy: 0.9571
Epoch 57/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0956 - accuracy: 0.9642
Epoch 58/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1034 - accuracy: 0.9611
Epoch 59/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1070 - accuracy: 0.9563
Epoch 60/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0926 - accuracy: 0.9660
Epoch 61/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0983 - accuracy: 0.9607
Epoch 62/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0972 - accuracy: 0.9667
Epoch 63/200
320/320 [==============================] - 0s 1ms/step - loss: 0.1016 - accuracy: 0.9611
Epoch 64/200
```

```
320/320 [==============================] - 0s 1ms/step - loss: 0.0973 - accuracy: 0.9616
Epoch 65/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0939 - accuracy: 0.9635
Epoch 66/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0961 - accuracy: 0.9665
Epoch 67/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0933 - accuracy: 0.9638
Epoch 68/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0921 - accuracy: 0.9629
Epoch 69/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0845 - accuracy: 0.9661
Epoch 70/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0984 - accuracy: 0.9603
Epoch 71/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0890 - accuracy: 0.9657
Epoch 72/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0912 - accuracy: 0.9630
Epoch 73/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0861 - accuracy: 0.9675
Epoch 74/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0808 - accuracy: 0.9696
Epoch 75/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0829 - accuracy: 0.9693
Epoch 76/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0836 - accuracy: 0.9662
Epoch 77/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0824 - accuracy: 0.9666
Epoch 78/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0795 - accuracy: 0.9657
Epoch 79/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0824 - accuracy: 0.9685
Epoch 80/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0773 - accuracy: 0.9698
Epoch 81/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0744 - accuracy: 0.9726
Epoch 82/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0757 - accuracy: 0.9732
Epoch 83/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0779 - accuracy: 0.9677
Epoch 84/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0790 - accuracy: 0.9659
Epoch 85/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0828 - accuracy: 0.9653
Epoch 86/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0807 - accuracy: 0.9665
Epoch 87/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0759 - accuracy: 0.9681
Epoch 88/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0761 - accuracy: 0.9709
```

```
Epoch 89/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0809 - accuracy: 0.9682
Epoch 90/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0744 - accuracy: 0.9723
Epoch 91/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0739 - accuracy: 0.9720
Epoch 92/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0714 - accuracy: 0.9738
Epoch 93/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0713 - accuracy: 0.9732
Epoch 94/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0964 - accuracy: 0.9623
Epoch 95/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0727 - accuracy: 0.9721
Epoch 96/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0678 - accuracy: 0.9731
Epoch 97/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0976 - accuracy: 0.9663
Epoch 98/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0671 - accuracy: 0.9730
Epoch 99/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0750 - accuracy: 0.9694
Epoch 100/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0634 - accuracy: 0.9781
Epoch 101/200
320/320 [==============================] - 0s 992us/step - loss: 0.0732 - accuracy: 0.9715
Epoch 102/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0698 - accuracy: 0.9735
Epoch 103/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0626 - accuracy: 0.9782
Epoch 104/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0632 - accuracy: 0.9777
Epoch 105/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0630 - accuracy: 0.9768
Epoch 106/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0652 - accuracy: 0.9735
Epoch 107/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0617 - accuracy: 0.9775
Epoch 108/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0788 - accuracy: 0.9686
Epoch 109/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0619 - accuracy: 0.9770
Epoch 110/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0647 - accuracy: 0.9745
Epoch 111/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0601 - accuracy: 0.9784
Epoch 112/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0608 - accuracy: 0.9791
Epoch 113/200
```

```
320/320 [==============================] - 0s 1ms/step - loss: 0.0604 - accuracy: 0.9758
Epoch 114/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0592 - accuracy: 0.9784
Epoch 115/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0625 - accuracy: 0.9750
Epoch 116/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0568 - accuracy: 0.9752
Epoch 117/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0587 - accuracy: 0.9789
Epoch 118/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0607 - accuracy: 0.9759
Epoch 119/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0599 - accuracy: 0.9776
Epoch 120/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0689 - accuracy: 0.9761
Epoch 121/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0557 - accuracy: 0.9799
Epoch 122/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0573 - accuracy: 0.9786
Epoch 123/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0588 - accuracy: 0.9779
Epoch 124/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0577 - accuracy: 0.9785
Epoch 125/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0690 - accuracy: 0.9728
Epoch 126/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0522 - accuracy: 0.9803
Epoch 127/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0624 - accuracy: 0.9742
Epoch 128/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0519 - accuracy: 0.9783
Epoch 129/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0503 - accuracy: 0.9826
Epoch 130/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0450 - accuracy: 0.9845
Epoch 131/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0648 - accuracy: 0.9751
Epoch 132/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0509 - accuracy: 0.9800
Epoch 133/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0480 - accuracy: 0.9816
Epoch 134/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0481 - accuracy: 0.9823
Epoch 135/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0543 - accuracy: 0.9772
Epoch 136/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0500 - accuracy: 0.9821
Epoch 137/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0437 - accuracy: 0.9834
```

```
Epoch 138/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0465 - accuracy: 0.9828
Epoch 139/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0465 - accuracy: 0.9819
Epoch 140/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0502 - accuracy: 0.9818
Epoch 141/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0509 - accuracy: 0.9776
Epoch 142/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0520 - accuracy: 0.9785
Epoch 143/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0475 - accuracy: 0.9812
Epoch 144/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0485 - accuracy: 0.9824
Epoch 145/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0442 - accuracy: 0.9837
Epoch 146/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0440 - accuracy: 0.9844
Epoch 147/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0447 - accuracy: 0.9845
Epoch 148/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0385 - accuracy: 0.9850
Epoch 149/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0393 - accuracy: 0.9848
Epoch 150/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0544 - accuracy: 0.9774
Epoch 151/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0398 - accuracy: 0.9855
Epoch 152/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0396 - accuracy: 0.9846
Epoch 153/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0429 - accuracy: 0.9813
Epoch 154/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0417 - accuracy: 0.9824
Epoch 155/200
320/320 [==============================] - ETA: 0s - loss: 0.0404 - accuracy: 0.98 - 0s 1ms/step - loss: 0.0405 - accurac
y: 0.9851
Epoch 156/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0394 - accuracy: 0.9848
Epoch 157/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0431 - accuracy: 0.9836
Epoch 158/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0392 - accuracy: 0.9857: 0s - loss: 0.0363 - accu
Epoch 159/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0391 - accuracy: 0.9872
Epoch 160/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0381 - accuracy: 0.9882
Epoch 161/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0367 - accuracy: 0.9873
```

```
Epoch 162/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0392 - accuracy: 0.9835
Epoch 163/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0478 - accuracy: 0.9819
Epoch 164/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0346 - accuracy: 0.9875
Epoch 165/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0349 - accuracy: 0.9865
Epoch 166/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0346 - accuracy: 0.9890
Epoch 167/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0408 - accuracy: 0.9841
Epoch 168/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0290 - accuracy: 0.9903
Epoch 169/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0346 - accuracy: 0.9873
Epoch 170/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0378 - accuracy: 0.9871
Epoch 171/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0382 - accuracy: 0.9867
Epoch 172/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0429 - accuracy: 0.9852
Epoch 173/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0303 - accuracy: 0.9904
Epoch 174/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0322 - accuracy: 0.9878
Epoch 175/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0305 - accuracy: 0.9893
Epoch 176/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0295 - accuracy: 0.9893
Epoch 177/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0366 - accuracy: 0.9867
Epoch 178/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0379 - accuracy: 0.9865
Epoch 179/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0293 - accuracy: 0.9888
Epoch 180/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0373 - accuracy: 0.9874
Epoch 181/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0286 - accuracy: 0.9911
Epoch 182/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0352 - accuracy: 0.9881
Epoch 183/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0297 - accuracy: 0.9893
Epoch 184/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0302 - accuracy: 0.9894
Epoch 185/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0275 - accuracy: 0.9909
Epoch 186/200
```

```
320/320 [==============================] - 0s 1ms/step - loss: 0.0309 - accuracy: 0.9889
Epoch 187/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0401 - accuracy: 0.9861
Epoch 188/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0273 - accuracy: 0.9900
Epoch 189/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0292 - accuracy: 0.9918
Epoch 190/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0449 - accuracy: 0.9816
Epoch 191/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0249 - accuracy: 0.9933
Epoch 192/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0262 - accuracy: 0.9917
Epoch 193/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0225 - accuracy: 0.9938
Epoch 194/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0275 - accuracy: 0.9899
Epoch 195/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0263 - accuracy: 0.9917
Epoch 196/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0305 - accuracy: 0.9889
Epoch 197/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0465 - accuracy: 0.9824
Epoch 198/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0218 - accuracy: 0.9938
Epoch 199/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0225 - accuracy: 0.9925
Epoch 200/200
320/320 [==============================] - 0s 1ms/step - loss: 0.0243 - accuracy: 0.9932
```

Out[45]:
```
<tensorflow.python.keras.callbacks.History at 0x1c56862beb0>
```

In [46]:
```
loss, acc_ann = ANN_model.evaluate(x_train, y_train, verbose = 0)
```

In [47]:
```
print(acc_ann)
```

```
0.994025468826294
```

In [48]:
```
y_pred = ANN_model.predict(x_test)
y_pred[y_pred <= 0.5] = 0
y_pred[y_pred > 0.5] = 1
```

ACCURACY COMPARISON OF ALL THE MODELS

In [49]:

```
scores = [acc_lr * 100,
          acc_knn * 100,
          acc_svm * 100,
          acc_nb * 100,
          acc_dt * 100,
          acc_rf * 100,
          acc_ann * 100]
```

In [50]:

```
names = ["Logistic Regression",
        "K-Nearest Neighbors",
        "Support Vector Machine",
        "Naive Bayes",
        "Decision Tree",
        "Random Forest",
        "Artificial Neural Network"]
```

In [51]:

```
df = pd.DataFrame()
df['Algorithm Name'] = names
df['Accuracy Score (%)'] = scores
df = df.sort_values('Accuracy Score (%)', ascending = False)
```

In [52]:

```
df
```

Out[52]:

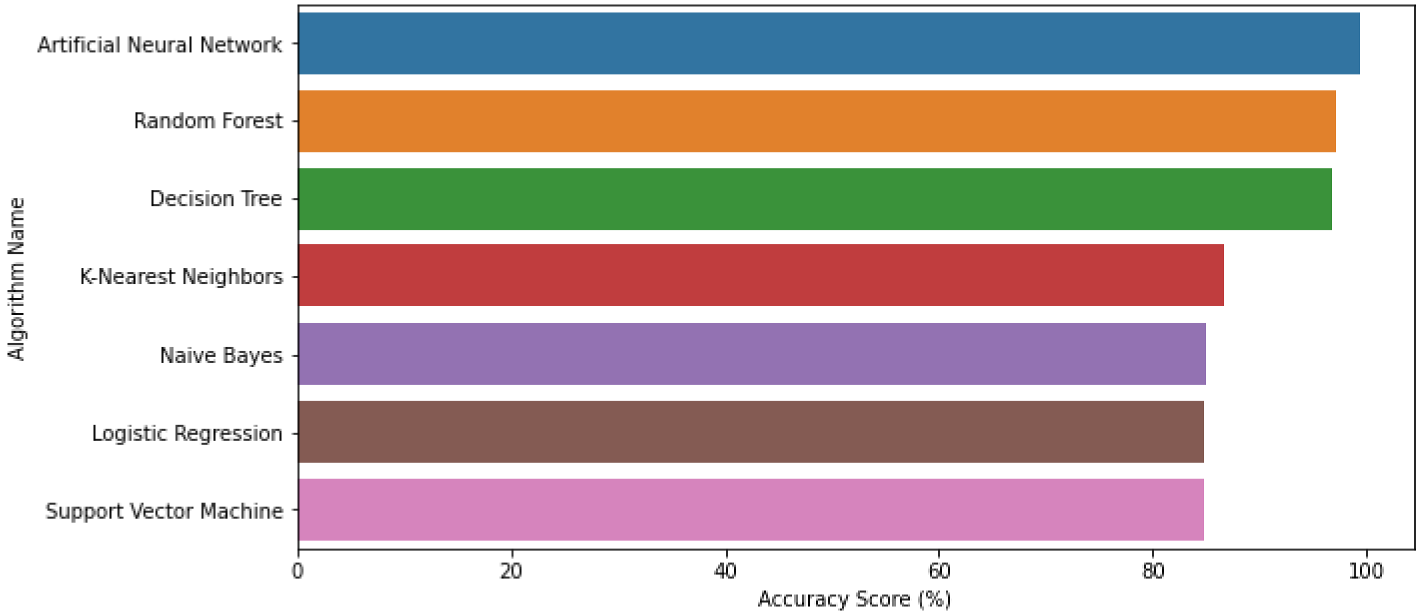
	Algorithm Name	Accuracy Score (%)
6	Artificial Neural Network	99.402547
5	Random Forest	97.058824
4	Decision Tree	96.725860
1	K-Nearest Neighbors	86.570477
3	Naive Bayes	84.961154
0	Logistic Regression	84.850166
2	Support Vector Machine	84.794673

In [53]:

```
import matplotlib.pyplot as plt
import seaborn as sns
```

In [54]:

```
fig = plt.subplots(figsize = (10, 5))
ax = sns.barplot(x = "Accuracy Score (%)", y = "Algorithm Name", data = df)
```



SAVING THE BEST TRAINED MODEL

In [55]:

```
import os.path
```

In [56]:

```
if os.path.isfile('../model/project_model.h5') is False:
    ANN_model.save('../model/project_model.h5')
```

In [ ]: