```
import pandas as pd
import numpy as np
from sklearn.datasets import make_blobs
import matplotlib
from matplotlib import pyplot as plt
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.neural_network import MLPClassifier
from sklearn import tree
from sklearn.metrics import accuracy_score
from sklearn.model_selection import train_test_split
from sklearn.feature_selection import f_regression
```

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=Tru
```

```
pwd
```

```
'/content/drive/My Drive/STAT535'
```

```
cd /content/drive/MyDrive/STAT535
```

```
/content/drive/MyDrive/STAT535
```

```
ls
```

```
 Admission_Predict.csv                          CPP.ipynb
'Conformal Prediction.pptx'                     Presentation_Title.docx
'Copy of Conformal Prediction Project.ipynb'    reference.gdoc
'Copy of CPP'                                  'Untitled presentation.gslides'
```

```
#displaying the data

#INFO about dataset: Rows represent students with their academic profile.
#University rating is the rating from the university they belong to
#Chance of admit is their own belief of their chances to be accepted.
data = pd.read_csv("Admission_Predict.csv")
data
```

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
0	1	337	118	4	4.5	4.5	9.65	1	0.92
1	2	324	107	4	4.0	4.5	8.87	1	0.76
2	3	316	104	3	3.0	3.5	8.00	1	0.72
3	4	322	110	3	3.5	2.5	8.67	1	0.80
4	5	314	103	2	2.0	3.0	8.21	0	0.65
...	...	...	...	...	...	...	...	...	...
495	496	332	108	5	4.5	4.0	9.02	1	0.87
496	497	337	117	5	5.0	5.0	9.87	1	0.96
497	498	330	120	5	4.5	5.0	9.56	1	0.93
498	499	312	103	4	4.0	5.0	8.43	0	0.73
499	500	327	113	4	4.5	4.5	9.04	0	0.84

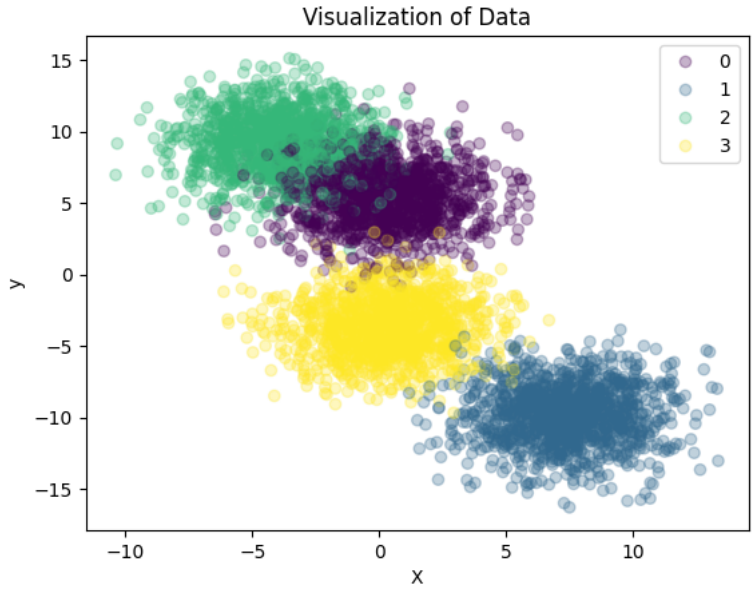
500 rows × 9 columns

```
#modifying and typecasting
data = data.rename(columns={"Serial No.":"SerialNo"})
del data['SerialNo']
del data['Research']
data = data.to_numpy()
a0 = np.max(data[:,0])
a1 = np.max(data[:,1])
a6 = np.max(data[:,6])
for row in data:
```

```
  row[0] = int((row[0]/a0)*10)
  row[1] = int((row[1]/a1)*10)
  row[2] = int(row[2]*2)
  row[3] = int(row[3]*2)
  row[4] = int(row[4]*2)
  row[5] = int(row[5])
  row[6] = int((row[6]/a6) * 10) - 5
  if row[6] < 0:
    row[6] = 0
data = data.astype(int)
X_data = data[:,:-1]
y_data = data[:,-1]


# data = data.rename(columns={"Serial No.":"SerialNo", "GRE Score":"GREScore", "TOEFL Score":"TOEFLScore", "University Rating":"Ur


# for col in data.columns:
#   print(col)


#Modifying the data
# Deleting the unwanted column
# del data['SerialNo']


# data = data.to_numpy()


# data.shape


# a0 = np.max(data[:,0])
# a1 = np.max(data[:,1])


# data


# X_data = data[:,:-1]


# X_data


# y_data = data[:,-1]


y_data
```

```
    array([4, 2, 2, 3, 1, 4, 2, 2, 0, 0, 0, 3, 3, 1, 1, 0, 1, 1, 1, 1, 1, 2,
           4, 4, 5, 4, 2, 0, 0, 0, 1, 2, 4, 4, 4, 4, 1, 0, 0, 0, 0, 0, 0, 3,
           4, 4, 3, 4, 3, 3, 2, 0, 3, 2, 2, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
           1, 0, 2, 3, 4, 4, 4, 3, 2, 2, 2, 1, 0, 0, 0, 4, 4, 4, 4, 2, 2, 1,
           1, 2, 1, 0, 0, 0, 0, 0, 0, 3, 4, 3, 2, 1, 1, 0, 2, 2, 3, 4, 4, 2,
           1, 2, 1, 2, 1, 1, 0, 0, 0, 2, 4, 4, 0, 1, 0, 1, 3, 3, 3, 4, 4, 2,
           2, 3, 4, 3, 2, 2, 3, 3, 3, 4, 4, 5, 3, 3, 2, 3, 4, 3, 4, 4, 3, 3,
           3, 2, 2, 1, 1, 0, 0, 0, 1, 2, 3, 3, 1, 1, 1, 1, 2, 4, 3, 4, 3, 3,
           4, 3, 2, 2, 2, 2, 2, 2, 2, 4, 3, 4, 4, 4, 4, 3, 3, 4, 2, 3, 2, 2,
           2, 2, 2, 2, 5, 5, 2, 0, 1, 1, 1, 2, 3, 3, 4, 4, 4, 4, 4, 3, 3, 2,
           2, 2, 2, 2, 1, 1, 1, 1, 2, 3, 2, 2, 2, 1, 4, 4, 3, 3, 2, 1, 1, 1,
           2, 2, 1, 3, 2, 2, 3, 2, 2, 2, 2, 4, 3, 3, 2, 3, 2, 4, 3, 2, 2, 2,
           2, 2, 2, 2, 3, 2, 2, 0, 0, 0, 0, 3, 4, 2, 1, 1, 2, 3, 3, 3, 4, 4,
           4, 4, 3, 3, 0, 0, 0, 1, 1, 2, 2, 3, 4, 2, 1, 1, 1, 2, 1, 2, 3, 3,
           2, 2, 2, 3, 3, 1, 1, 1, 0, 0, 3, 3, 2, 2, 2, 1, 1, 3, 1, 2, 3, 0,
           3, 2, 2, 2, 2, 3, 2, 4, 3, 3, 2, 3, 0, 1, 0, 0, 0, 0, 0, 1, 2, 2,
           1, 1, 1, 2, 3, 2, 2, 3, 3, 4, 4, 2, 2, 3, 2, 0, 0, 1, 2, 4, 4, 3,
           0, 0, 0, 0, 0, 2, 3, 2, 3, 1, 4, 4, 0, 0, 0, 2, 1, 2, 3, 2, 4, 3,
           3, 4, 1, 4, 1, 1, 3, 4, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 2, 2, 1, 0,
           1, 0, 0, 2, 2, 4, 4, 4, 2, 2, 2, 4, 2, 2, 3, 2, 1, 0, 0, 1, 1, 1,
           0, 3, 4, 3, 4, 4, 4, 3, 3, 3, 3, 4, 4, 2, 2, 1, 0, 0, 2, 4, 2, 2,
           1, 0, 0, 0, 2, 3, 3, 3, 3, 1, 4, 1, 1, 1, 1, 1, 2, 3, 3, 3, 3, 2,
           2, 2, 2, 3, 2, 1, 1, 0, 0, 1, 2, 3, 4, 4, 2, 3])
```

```
#Creting random data for experimenting
np.random.seed(14)
X, y = make_blobs(n_samples = 5000,
                  n_features = 2,
                  centers = 4,
                  cluster_std = 2,
                  shuffle = True)


#Visualizing Data
scatter = plt.scatter(X[:,0], X[:,1], c=y, alpha=0.3)
plt.title("Visualization of Data")
plt.legend(*scatter.legend_elements())
plt.xlabel("X")
plt.ylabel("y")
plt.show()
```




```
#Split our data into trainig, validation and testig parts
def split(X, y):
  X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=36)
  X_test, X_val, y_test, y_val = train_test_split(X_test, y_test, test_size=0.5, random_state=30)

  return X_train, y_train, X_val, y_val, X_test, y_test

  #train, test, val = 0.8, 0.1, 0.1


#KNN Classifier
def KNN(X_train, y_train, X_test, y_test):
  knn = KNeighborsClassifier(n_neighbors=10)
  knn.fit(X_train, y_train)
  y_pred = knn.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)
  # print(y_pred[14])
  # print(accuracy)
  return knn, accuracy


#Random Forest Classifier
def RandomForest(X_train, y_train, X_test, y_test):
  rf = RandomForestClassifier()
  rf.fit(X_train, y_train)
  y_pred = rf.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)
  # print(accuracy)
  # print(y_pred[14])
  return rf, accuracy


def NeuralNetwork(X_train, y_train, X_test, y_test):
  nn = MLPClassifier(hidden_layer_sizes=(250, 400, 400, 50), max_iter=250, activation='tanh', solver='adam')
```

```
  nn.fit(X_train, y_train)
  y_pred = nn.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)
  # print(accuracy)
  # print(y_pred[14])
  return nn, accuracy


X_train, y_train, X_val, y_val, X_test, y_test = split(X, y)
X_train.shape, y_train.shape, X_val.shape, y_val.shape, X_test.shape, y_test.shape
```

```
    ((4000, 2), (4000,), (500, 2), (500,), (500, 2), (500,))
```

```
knn, knn_acc = KNN(X_train, y_train, X_val, y_val)
print("Accuracy with KNN is :", knn_acc)
rf, rf_acc = RandomForest(X_train, y_train, X_val, y_val)
print("Accuracy with Random Forest is :", rf_acc)
nn, nn_acc = NeuralNetwork(X_train, y_train, X_val, y_val)
print("Accuracy with Neural Network is :", nn_acc)
```

```
    Accuracy with KNN is : 0.942
    Accuracy with Random Forest is : 0.94
    Accuracy with Neural Network is : 0.952
```

Then, the training step: Here we need to decide if we will include more: Also, Thomas used max_depth=3 for Random forest, so maybe for our problem we can or should modify. Similar with other parameters of the other models.

Now, from what I understand, for CP, you need to set a way to measure the agreement of having an specific input data and certain label. Thomas used the in-built function that tells you the probability of the input data being X and the label being Y.

FOR our project we can change that I THINK. Anyway, this part of the pseudocode corresponds to:

```
def nonconformity_probability(X, y):
  nc_score = []
  for i in range(len(X)):
    c = rf.predict_proba([X[i]])
    # print(c)
    k = c[0]
    # print(k)
    l = k[y[i]]
    print(l)
    nc_score.append(1-l)
  return nc_score


nc = nonconformity_probability(X_val, y_val)


def get_p_value(nc_list, new_nc_scores):
  p_list = []
  nc_list = np.asarray(nc_list)
  for score in new_nc_scores:
    p_list.append(len(nc_list[score>nc_list])/(len(nc_list)+1))
  return p_list


def get_labels(X, label, ncs, alpha=0.05):
  predictions = []
  for datapoint in X:
    new_ncs = []
    for y_i in label:
      new_ncs.append(nonconformity_probability([datapoint], [y_i]))
    ps = get_p_value(ncs, new_ncs)
    labels = []
    for i in range(len(ps)):
      if ps[i]<1-alpha:
        labels.append(i)
    predictions.append(labels)
  return predictions


prediction = get_labels(X_test, list(range(0,4)), nc)


X_test[]
```

```
def conformal_accuracy(prediction, y):
  correct = 0
  total = 0
  for i in range(len(y)):
    if y[i] in prediction[i]:
      correct += 1
    total += 1
    acc = correct/total
  return acc


conformal_acc = conformal_accuracy(prediction, y_test)


conformal_acc
```

```
0.948
```

```
rf_acc
```

```
0.94
```

Conformal Prediction on Admissions Data

```
X_train, y_train, X_val, y_val, X_test, y_test = split(X_data, y_data)


knn, knn_acc = KNN(X_train, y_train, X_val, y_val)
print("Accuracy with KNN is :", knn_acc)
rf, rf_acc = RandomForest(X_train, y_train, X_val, y_val)
print("Accuracy with Random Forest is :", rf_acc)
nn, nn_acc = NeuralNetwork(X_train, y_train, X_val, y_val)
print("Accuracy with Neural Network is :", nn_acc)
```

```
Accuracy with KNN is : 0.62
Accuracy with Random Forest is : 0.68
Accuracy with Neural Network is : 0.68
```

```
nc = nonconformity_probability(X_val, y_val)


prediction = get_labels(X_test, list(range(0,6)), nc)


X_test


y_test


prediction


conformal_acc = conformal_accuracy(prediction, y_test)


conformal_acc
```

```
0.96
```