Students_Data_EDA

July 25, 2023

1 Task 1: 20 data science questions that you can explore using your dataset of 300 students with columns for name, university, and CGPA:

[3]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

[4]:
```
df = pd.read_csv("students_data.csv", header=None)
df
```

[4]:
```
                    0                                                1     2
0    Oliver Thompson                                Harvard University     2
1       Emma Johnson                               Stanford University  3.82
2         Liam Smith     Massachusetts Institute of Technology (MIT)   3.6
3       Olivia Brown                          University of Cambridge  2.93
4         Noah Davis                             University of Oxford   3.3
..               …                                               …     …
295       Max Turner                          University of Amsterdam  3.09
296  Brooklyn Wilson                         University of Copenhagen  3.23
297    Colton Carter  University of California, Santa Barbara (UCSB)   2.2
298    Gabriella Lee                            King's College London   2.5
299       Jack Green                    University of California, Irvine  2.43

[300 rows x 3 columns]
```

[5]:
```
column_names = ['Name', 'University', 'CGPA']
df.columns = column_names
```

[6]:
```
df
```

[6]:
```
                 Name                                       University  CGPA
0    Oliver Thompson                                Harvard University     2
1       Emma Johnson                               Stanford University  3.82
2         Liam Smith     Massachusetts Institute of Technology (MIT)   3.6
3       Olivia Brown                          University of Cambridge  2.93
4         Noah Davis                             University of Oxford   3.3
```

```
..                 …                                             …    …
295       Max Turner                         University of Amsterdam  3.09
296  Brooklyn Wilson                        University of Copenhagen  3.23
297     Colton Carter  University of California, Santa Barbara (UCSB)   2.2
298    Gabriella Lee                            King's College London   2.5
299       Jack Green                 University of California, Irvine  2.43

[300 rows x 3 columns]
```

1.1 Data Pre-processing

[22]:
```
df['CGPA'].replace('Annual ', np.nan, inplace=True)
```

[23]:
```
df['CGPA'].replace('2.6/4', '2.6', inplace=True)
df['CGPA'].replace('3.93/4', '3.93', inplace=True)
```

[24]:
```
df['CGPA'].replace('7.5', np.nan, inplace=True)
```

[25]:
```
df['CGPA'].replace('3.08(updated after 4 semester).', 3.08, inplace=True)
df['CGPA'].replace('3.21 (6th semester completed)', 3.21, inplace=True)
```

[26]:
```
df.isna().sum()
```

[26]:
```
Name            0
University      0
CGPA           15
Name_Length     0
dtype: int64
```

[27]:
```
df['CGPA'].fillna(df.CGPA.astype(float).mean(), inplace=True)
```

[28]:
```
df.isna().sum()
```

[28]:
```
Name           0
University     0
CGPA           0
Name_Length    0
dtype: int64
```

1.2 1. What are the top 5 universities with the highest average CGPA?

[14]:
```
# Clean the 'CGPA' column by removing non-numeric characters
df['CGPA'] = df['CGPA'].str.replace('[^\d.]', '', regex=True)
df['CGPA'] = pd.to_numeric(df.CGPA, errors='coerce')

top_5 = df.groupby('University')['CGPA'].mean().sort_values(ascending=False).
  ↪head(5)
```

```
top_5
```

[14]:
```
University
University of Toronto                                         3.525000
University of Southern California (USC)                       3.455000
University of Bristol                                         3.440000
University of Michigan, Ann Arbor                             3.433333
Swiss Federal Institute of Technology Zurich (ETH Zurich)     3.410000
Name: CGPA, dtype: float64
```

1.3 2. Is there a correlation between the CGPA and the length of the student's name?

[15]:
```
df['Name_Length'] = df['Name'].str.len()
df
```

[15]:
```
                Name                                       University  CGPA  \
0    Oliver Thompson                               Harvard University  2.00
1       Emma Johnson                              Stanford University  3.82
2         Liam Smith     Massachusetts Institute of Technology (MIT)  3.60
3       Olivia Brown                         University of Cambridge  2.93
4         Noah Davis                            University of Oxford  3.30
..               …                                              …     …
295       Max Turner                         University of Amsterdam  3.09
296  Brooklyn Wilson                        University of Copenhagen  3.23
297    Colton Carter  University of California, Santa Barbara (UCSB)  2.20
298    Gabriella Lee                           King's College London  2.50
299       Jack Green                  University of California, Irvine  2.43

     Name_Length
0             15
1             12
2             10
3             12
4             10
..           …
295           10
296           15
297           13
298           13
299           10

[300 rows x 4 columns]
```

[16]:
```
df['CGPA'].corr(df.Name_Length)

# A positive value close to 1 indicates a strong positive correlation
# (as CGPA increases, the length of the student's name tends to increase).
```

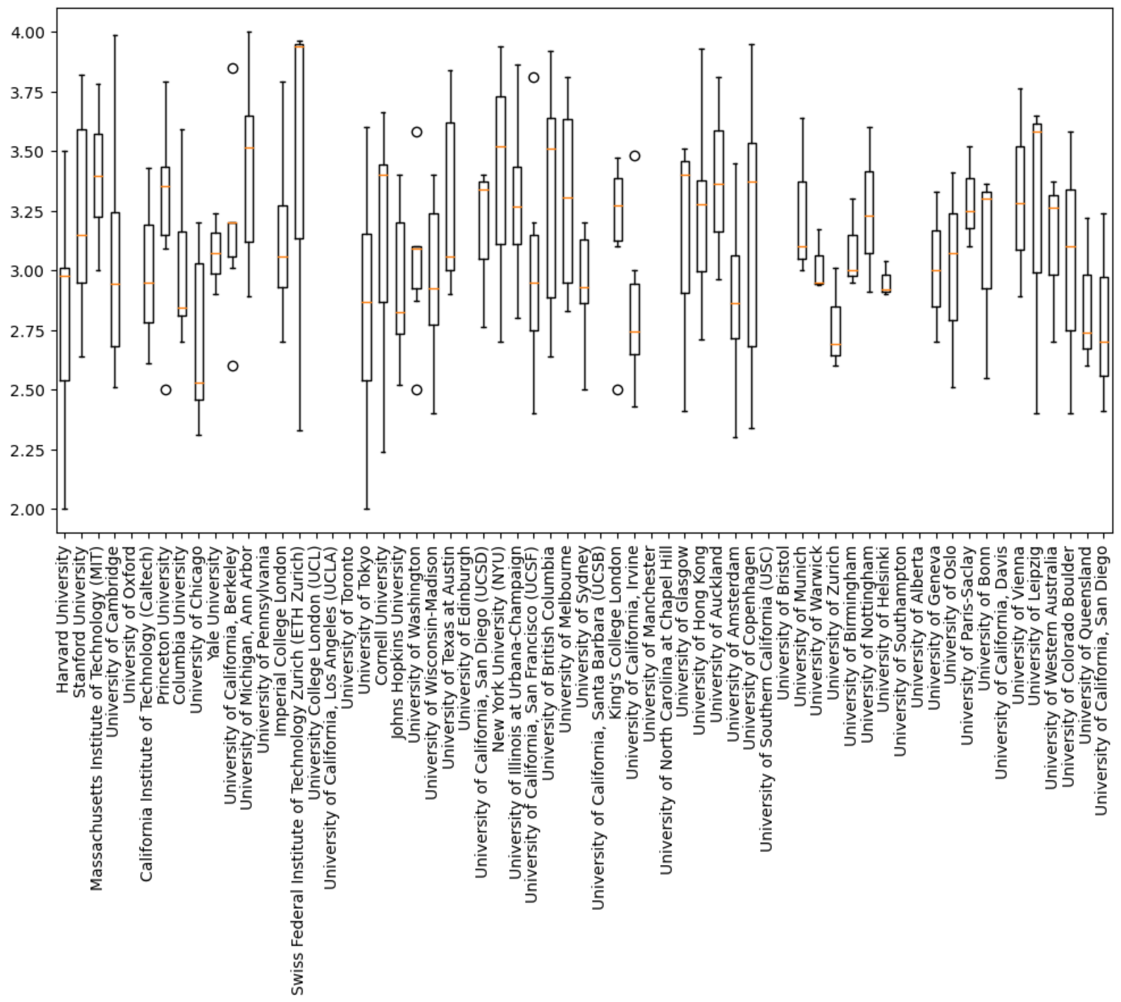
```
[16]: 0.013791382774874452
```

1.4 3. How does the CGPA vary across different universities?

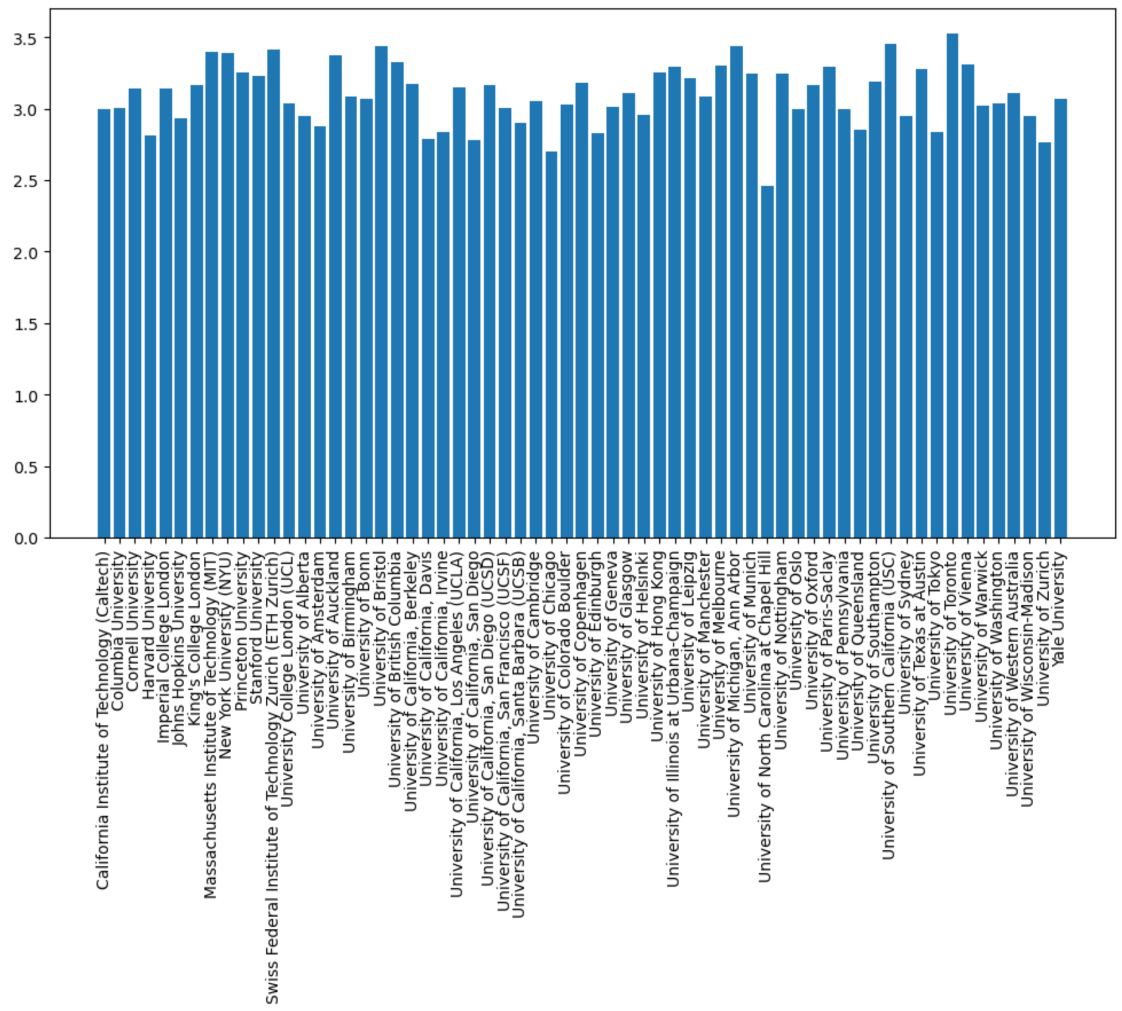
```
[17]: cgpa_stats = df.groupby('University')['CGPA'].agg(['mean', 'median', 'std',␣
      ↪'min', 'max'])
      cgpa_stats
```

```
[17]:                                                  mean  median       std  \
      University
      California Institute of Technology (Caltech)  2.996667   2.950  0.411987
      Columbia University                           3.006667   2.845  0.344654
      Cornell University                            3.141667   3.400  0.549014
      Harvard University                            2.810000   2.975  0.528394
      Imperial College London                       3.138333   3.055  0.381650
      …                                                  …       …         …
      University of Washington                      3.038333   3.090  0.352387
      University of Western Australia               3.110000   3.260  0.359305
      University of Wisconsin-Madison               2.951667   2.925  0.373117
      University of Zurich                          2.766667   2.690  0.215484
      Yale University                               3.070000   3.070  0.170000

                                                     min   max
      University
      California Institute of Technology (Caltech)  2.61  3.43
      Columbia University                           2.70  3.59
      Cornell University                            2.24  3.66
      Harvard University                            2.00  3.50
      Imperial College London                       2.70  3.79
      …                                              …     …
      University of Washington                      2.50  3.58
      University of Western Australia               2.70  3.37
      University of Wisconsin-Madison               2.40  3.40
      University of Zurich                          2.60  3.01
      Yale University                               2.90  3.24

      [63 rows x 5 columns]
```

```
[18]: # box plot for cgpa stats
      data_plot = [df[df.University == uni]['CGPA'] for uni in df.University.unique()]
      plt.figure(figsize=(12, 6))
      plt.boxplot(data_plot, labels=df.University.unique())
      plt.xticks(rotation=90)
      plt.show()
```

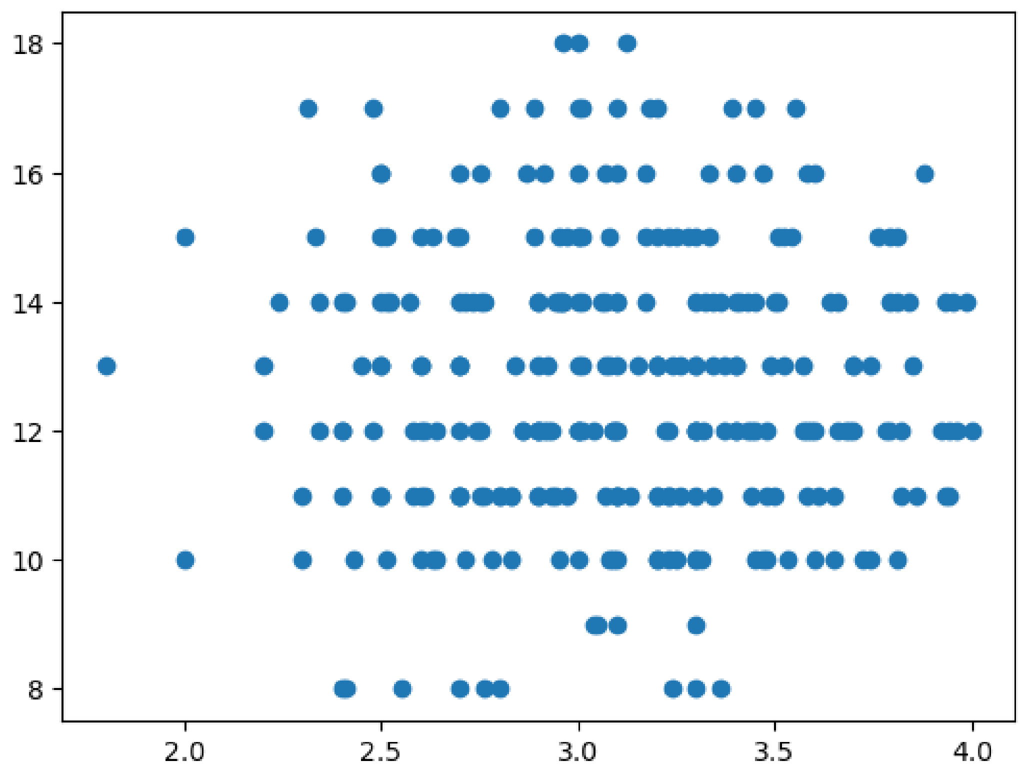


[19]:
```python
# plot mean
plt.figure(figsize=(12,6))
plt.bar(cgpa_stats.index, cgpa_stats['mean'])
plt.xticks(rotation=90)
plt.show()
```



1.5 4. Can we predict a student's CGPA based on the length of their name using linear regression?

[20]:
```
plt.scatter(df.CGPA, df.Name_Length)
plt.show()
```



[29]:
```
from sklearn.linear_model import LinearRegression

model = LinearRegression()
model.fit(df[['Name_Length']], df.CGPA)

new_data = pd.DataFrame(df.Name_Length)
predictions = model.predict(new_data)
# print(predictions)

name_length = 15
print(f'student with {name_length} chars name has: {model.
 ↪predict([[name_length]])} cgpa')
```

```
student with 15 chars name has: [3.09802569] cgpa
```

```
D:\apps\anaconda\files\lib\site-packages\sklearn\base.py:439: UserWarning: X
does not have valid feature names, but LinearRegression was fitted with feature
names
  warnings.warn(
```

1.6 5. Which university has the highest number of students with a CGPA above a certain threshold?

```
[30]: threshold = 3

      df.loc[df.CGPA > threshold].groupby("University").value_counts().idxmax()
```

```
[30]: ('University of California, Berkeley', 'Aria Clark', 3.2, 10)
```

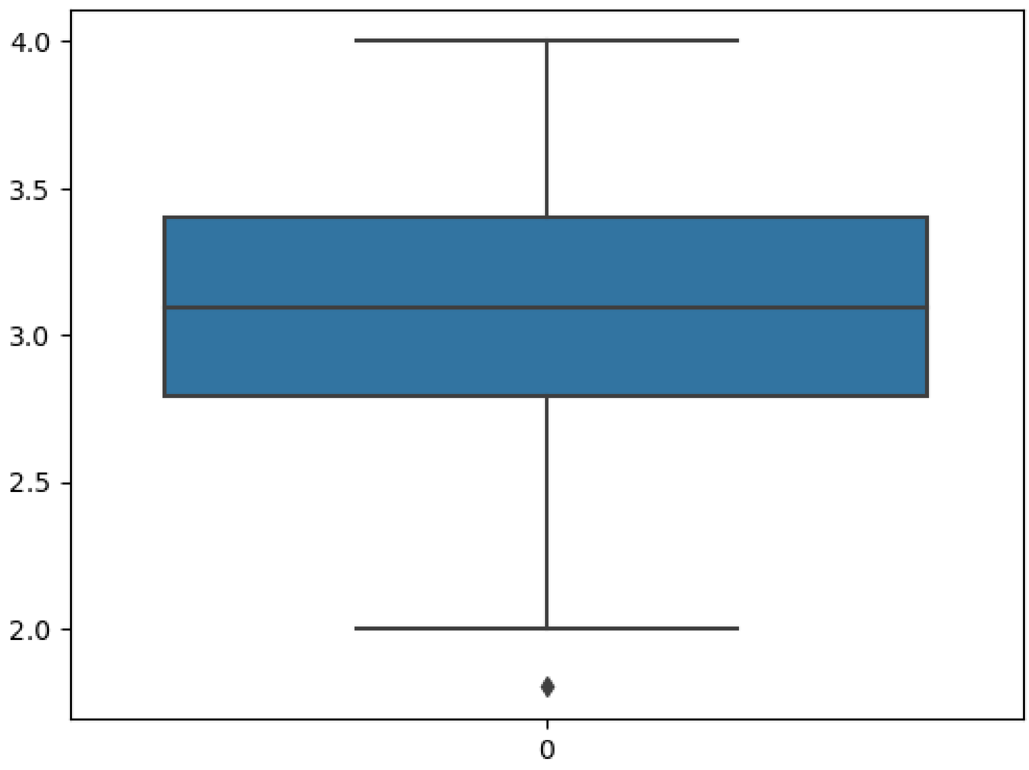
1.7 6. Can we identify any outliers in the CGPA distribution within each university?

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

```
[31]:              CGPA  Name_Length
      count  300.000000   300.000000
      mean     3.091905    12.680000
      std      0.428361     2.177169
      min      1.800000     8.000000
      25%      2.795000    11.000000
      50%      3.091905    12.000000
      75%      3.400000    14.000000
      max      4.000000    18.000000
```

```
[32]: import seaborn as sns

      sns.boxplot(df.CGPA)
```

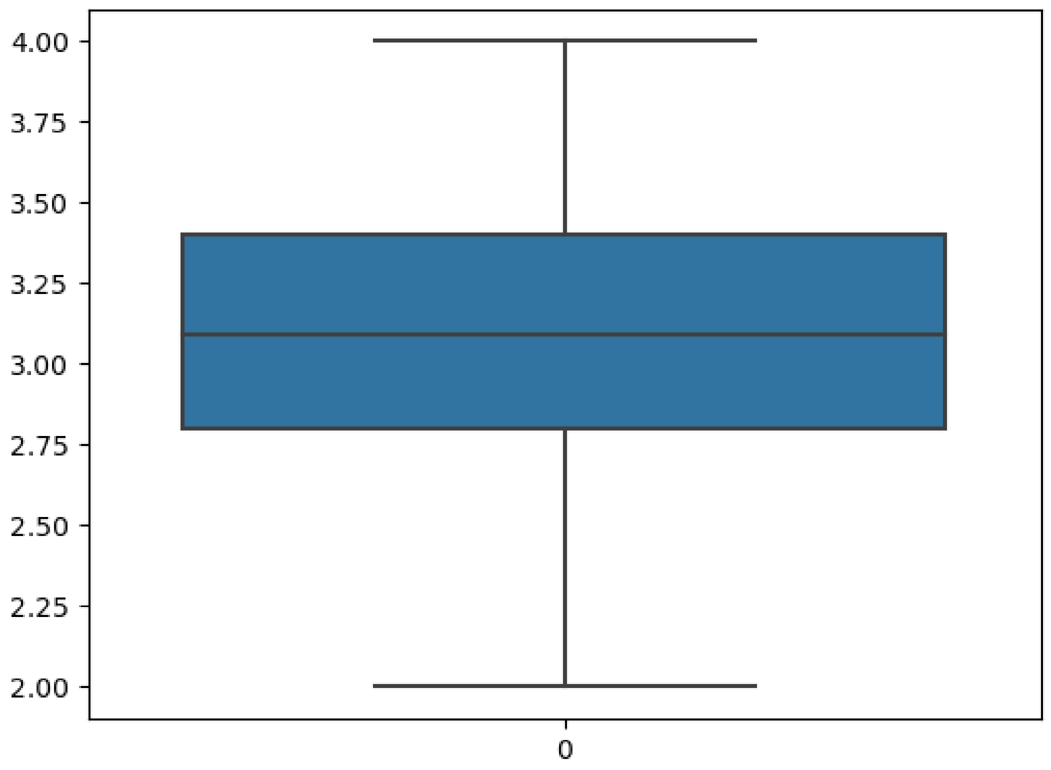
```
[32]: <Axes: >
```



```
[33]: # as we can see there is one outlier in lower boundary

      # IQR
      Q1 = df.CGPA.quantile(0.25)
      Q3 = df.CGPA.quantile(0.75)

      IQR = Q3-Q1
      lower_bound = Q1 - 1.5 * IQR
      lower_array = df.loc[df.CGPA <= lower_bound]

      df.drop(index=lower_array.index, inplace=True)
```

```
[34]: # outlier emoved
      sns.boxplot(df.CGPA)
```

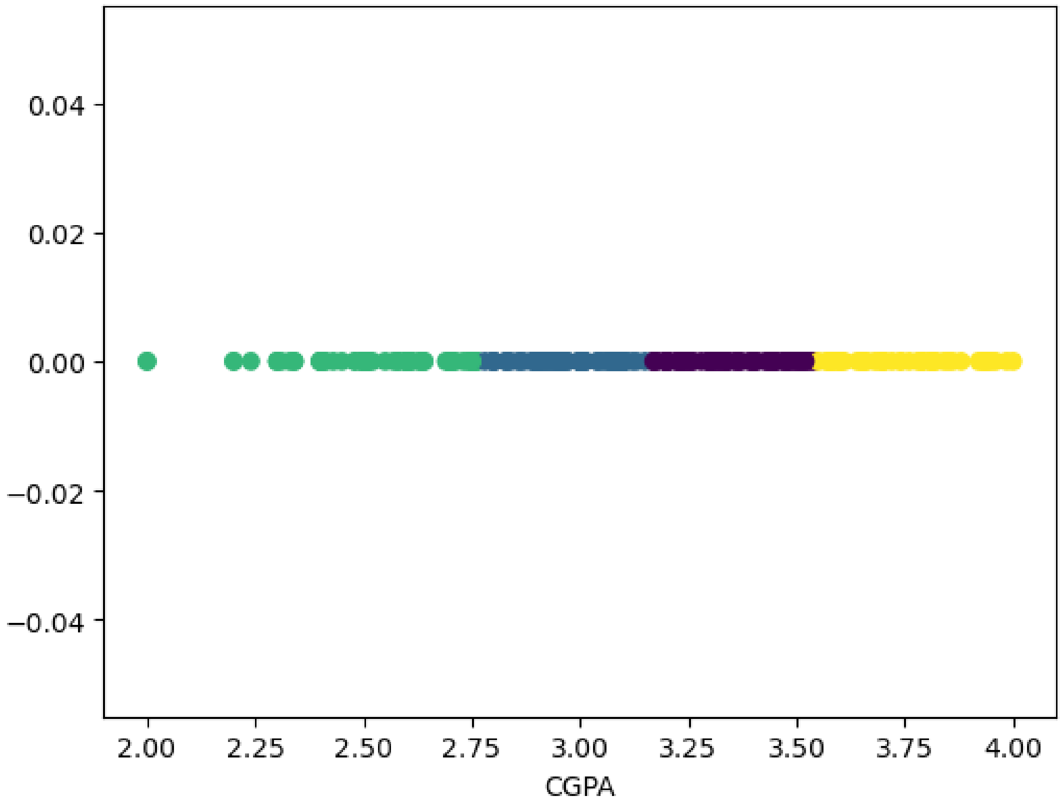
```
[34]: <Axes: >
```



1.8 7. Can we cluster students based on their CGPA using k-means clustering?

[35]:
```
from sklearn.cluster import KMeans

k=4
kmeans = KMeans(n_clusters=k, random_state=40)
df['Cluster'] = kmeans.fit_predict(df[['CGPA']])

plt.scatter(df['CGPA'], np.zeros(len(df)), c=df.Cluster)
plt.xlabel("CGPA")
plt.show()
```

```
D:\apps\anaconda\files\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
D:\apps\anaconda\files\lib\site-packages\sklearn\cluster\_kmeans.py:1382:
UserWarning: KMeans is known to have a memory leak on Windows with MKL, when
there are less chunks than available threads. You can avoid it by setting the
environment variable OMP_NUM_THREADS=2.
  warnings.warn(
```



1.9 8. What is the average CGPA for each cluster identified in the previous question?

[96]:
```
df.groupby('Cluster')['CGPA'].mean()
```

[96]:
```
Cluster
0    3.751596
1    3.004104
2    2.530676
3    3.344909
Name: CGPA, dtype: float64
```

1.10 9. Can we classify students into universities based on their CGPA using a decision tree?

[36]:
```
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score

# Separate features (CGPA) and target (University)
X = df[['CGPA']]
```

```
y = df['University']

# split data
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
↪random_state=42)

# train decision tree classifier
classifier = DecisionTreeClassifier()
classifier.fit(X_train, y_train)

# predict on test data
y_pred = classifier.predict(X_test)

new_cgpa = 3.2
print(f'Student with {new_cgpa} cgpa is from: {classifier.
↪predict([[new_cgpa]])}')
```

```
Student with 3.2 cgpa is from: ["King's College London"]
```

```
D:\apps\anaconda\files\lib\site-packages\sklearn\base.py:439: UserWarning: X
does not have valid feature names, but DecisionTreeClassifier was fitted with
feature names
  warnings.warn(
```

1.11 10. How accurate is the decision tree model in predicting the university?

[127]:
```
# model accuracy
accuracy = accuracy_score(y_test, y_pred)
print(f'Model Accurracy: {accuracy}')
```

```
Model Accurracy: 0.016666666666666666
```

1.12 11. What is the overall average CGPA across all universities?

[134]:
```
print(f'Average CGPA: {df.CGPA.mean()}')
```

```
Average CGPA: 3.091905263157897
```

1.13 12. Can we build a regression model to predict a student's CGPA based on their university?

[220]:
```
from sklearn.preprocessing import OneHotEncoder

# Convert 'University' column into dummy variables/numerical data using one-hot␣
↪encoding
encoder = OneHotEncoder(sparse=False)
university_encoded = encoder.fit_transform(df[['University']])

# Create a new DataFrame with the encoded university names
```

```
university_df = pd.DataFrame(university_encoded, columns=encoder.
 ↪get_feature_names_out(['University']))

# Concatenate the new DataFrame with the 'CGPA' column to form the feature␣
 ↪matrix
X = pd.concat([university_df, df['CGPA']], axis=1)

# Separate the target variable 'CGPA' from the feature matrix
X_features = X.drop('CGPA', axis=1)
y = X['CGPA']

# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X_features, y, test_size=0.
 ↪2, random_state=42)

# Train the linear regression model
model = LinearRegression()
model.fit(X_train, y_train)

# Test Predict CGPA for new data
student_universities = ['Harvard University', 'Stanford University', 'Yale␣
 ↪University']
new_data = pd.DataFrame({'University': student_universities})
student_university_encoded = encoder.transform(new_data)
new_data_features = pd.DataFrame(student_university_encoded, columns=encoder.
 ↪get_feature_names_out(['University']))

predictions = model.predict(new_data_features)
predictions
```

```
D:\apps\anaconda\files\lib\site-packages\sklearn\preprocessing\_encoders.py:868:
FutureWarning: `sparse` was renamed to `sparse_output` in version 1.2 and will
be removed in 1.4. `sparse_output` is ignored unless you leave `sparse` to its
default value.
  warnings.warn(
```

[220]:
```
array([2.81738281, 3.13867188, 3.24316406])
```

1.14 13. How well does the regression model perform in predicting the CGPA?

[223]:
```
from sklearn.metrics import r2_score

predictions = model.predict(X_test)

# Calculate R-squared (R2)
r2 = r2_score(y_test, predictions)
print(f"R-squared (R2): {r2}")
```

```
R-squared (R2): -0.4129463082836211
```

1.15 14. Are there any missing or erroneous values in the CGPA column?

[225]:
```
# as we have preprocessed/cleaned the data. so It will not have any missing␣
↪values
df.CGPA.isna().sum()
```

[225]:
```
0
```

1.16 15. What is the range of CGPA scores for each university?

[249]:
```
df.groupby("University")['CGPA'].agg(['min', 'max'])
```

[249]:
```
                                              min   max
University
California Institute of Technology (Caltech)  2.61  3.43
Columbia University                           2.70  3.59
Cornell University                            2.24  3.66
Harvard University                            2.00  3.50
Imperial College London                       2.70  3.79
…                                              …     …
University of Washington                      2.50  3.58
University of Western Australia               2.70  3.37
University of Wisconsin-Madison               2.40  3.40
University of Zurich                          2.60  3.01
Yale University                               2.90  3.24

[63 rows x 2 columns]
```

1.17 16. Can we identify any clusters or groups of students based on the CGPA and university using hierarchical clustering?

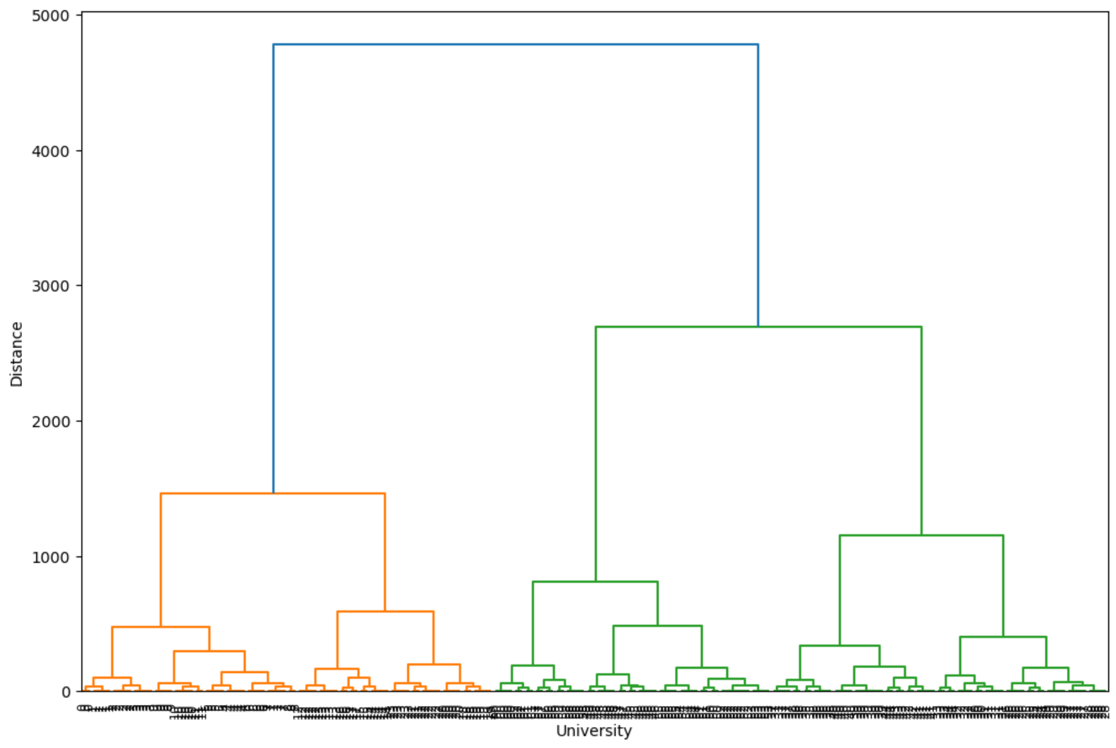
[63]:
```
from sklearn.preprocessing import LabelEncoder
from scipy.spatial.distance import pdist, squareform
from scipy.cluster.hierarchy import linkage, dendrogram

# required data
data = df[['CGPA', 'University']]

# Encode the 'University' column into numerical values using LabelEncoder
encoder = LabelEncoder()
data['University'] = encoder.fit_transform(data['University'])

# Calculate the pairwise distance between data points using Euclidean distance
distances = pdist(data, metric='euclidean')
```

```
# # Convert the pairwise distances into a square distance matrix
distance_matrix = squareform(distances)

# # Perform hierarchical clustering using the linkage function
clusters = linkage(distance_matrix, method='ward')

clusters
```

```
C:\Users\Hp\AppData\Local\Temp\ipykernel_5932\514498369.py:10:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data['University'] = encoder.fit_transform(data['University'])
C:\Users\Hp\AppData\Local\Temp\ipykernel_5932\514498369.py:19: ClusterWarning:
scipy.cluster: The symmetric non-negative hollow observation matrix looks
suspiciously like an uncondensed distance matrix
  clusters = linkage(distance_matrix, method='ward')
```

```
[63]: array([[1.10000000e+02, 2.10000000e+02, 0.00000000e+00, 2.00000000e+00],
             [2.77000000e+02, 2.99000000e+02, 0.00000000e+00, 3.00000000e+00],
             [1.70000000e+01, 1.17000000e+02, 0.00000000e+00, 2.00000000e+00],
             …,
             [5.89000000e+02, 5.91000000e+02, 1.46495802e+03, 1.20000000e+02],
             [5.92000000e+02, 5.93000000e+02, 2.69721742e+03, 1.79000000e+02],
             [5.94000000e+02, 5.95000000e+02, 4.78240085e+03, 2.99000000e+02]])
```

```
[68]: plt.figure(figsize=(12, 8))
dendrogram(clusters, labels=data['University'].values, leaf_font_size=8,␣
  ↪leaf_rotation=90)
plt.xlabel('University')
plt.xticks(rotation=90)
plt.ylabel('Distance')
plt.show()
```



1.18 18. Can we build a classification model to predict the university based on the CGPA and the length of the student's name?

[77]:
```
from sklearn.linear_model import LogisticRegression

# Features (CGPA and Name Length) and target (University)
X = df[['CGPA', 'Name_Length']]
y = df.University

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)

model = LogisticRegression()
model.fit(X_train, y_train)

y_pred = model.predict(X_test)


# test model
cgpa = 3.2
name_length = 13
new_student_data = [[cgpa, name_length]]
```

```
print(f'Student uni is: {model.predict(new_student_data)}')
```

```
Student uni is: ['University of Manchester']

D:\apps\anaconda\files\lib\site-packages\sklearn\linear_model\_logistic.py:458:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(
D:\apps\anaconda\files\lib\site-packages\sklearn\base.py:439: UserWarning: X
does not have valid feature names, but LogisticRegression was fitted with
feature names
  warnings.warn(
```

1.19 19. How accurate is the classification model in predicting the university?

[79]:
```
print(f'Model Accuracy is: {accuracy_score(y_test, y_pred)}')
```

```
Model Accuracy is: 0.016666666666666666
```

1.20 20. What is the correlation between the length of the student's name and the CGPA within each university?

[83]:
```
df.Name_Length.corr(df.CGPA)

corrs = df.groupby('University')['CGPA'].corr(df['Name_Length'])

print(corrs)
```

```
University
California Institute of Technology (Caltech)    0.098097
Columbia University                            -0.199380
Cornell University                             -0.203747
Harvard University                             -0.219273
Imperial College London                         0.684085
                                                  …
University of Washington                       -0.163357
University of Western Australia                      NaN
University of Wisconsin-Madison                 0.742487
University of Zurich                           -0.977951
Yale University                                 0.866025
Name: CGPA, Length: 63, dtype: float64
```

[ ]:
```

```

```
[ ]:
```