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Assignment: 4

Part 1: Data Wrangling

You have to write code to answer the questions below

- Import pandas library
- Read the data stored in your local machine https://www.kaggle.com/datasets/yasserh/student-marks-dataset (https://www.kaggle.com/datasets/yasserh/student-marks-dataset)
- Name the variable df

Show information about the dataset

In [6]:
```
import pandas as pd
import numpy as np

df = pd.read_csv('/Users/roja/Downloads/Student_Marks.csv')
df
```

Out[6]:

	number_courses	time_study	Marks
0	3	4.508	19.202
1	4	0.096	7.734
2	4	3.133	13.811
3	6	7.909	53.018
4	8	7.811	55.299
...	...	...	...
95	6	3.561	19.128
96	3	0.301	5.609
97	4	7.163	41.444
98	7	0.309	12.027
99	3	6.335	32.357

100 rows × 3 columns

Show the last 10 rows

In [7]:
```
rows = df.tail(10)
rows
```

Out[7]:

	number_courses	time_study	Marks
90	7	4.182	24.394
91	8	2.730	19.564
92	4	5.027	23.916
93	8	6.471	42.426
94	8	3.919	24.451
95	6	3.561	19.128
96	3	0.301	5.609
97	4	7.163	41.444
98	7	0.309	12.027
99	3	6.335	32.357

Reset the index such that it starts from 1 (instead of 0)

In [8]:
```
df.index = np.arange(1, len(df) + 1)
df
```

Out[8]:

	number_courses	time_study	Marks
1	3	4.508	19.202
2	4	0.096	7.734
3	4	3.133	13.811
4	6	7.909	53.018
5	8	7.811	55.299
...	...	...	...
96	6	3.561	19.128
97	3	0.301	5.609
98	4	7.163	41.444
99	7	0.309	12.027
100	3	6.335	32.357

100 rows × 3 columns

Lowercase all columns

In [9]:

```
# Basically column heads are already lowercase except 'Marks'column

t1 = pd.read_csv('/Users/roja/Downloads/Student_Marks.csv')
t1.head()
t1.columns = t1.columns.str.lower()
t1
```

Out[9]:

	number_courses	time_study	marks
0	3	4.508	19.202
1	4	0.096	7.734
2	4	3.133	13.811
3	6	7.909	53.018
4	8	7.811	55.299
...	...	...	...
95	6	3.561	19.128
96	3	0.301	5.609
97	4	7.163	41.444
98	7	0.309	12.027
99	3	6.335	32.357

100 rows × 3 columns

In [10]:

```
# Uppercase all columns

t2 = pd.read_csv('/Users/roja/Downloads/Student_Marks.csv')
t2.head()
t2.columns = t2.columns.str.upper()
t2
```

Out[10]:

	NUMBER_COURSES	TIME_STUDY	MARKS
0	3	4.508	19.202
1	4	0.096	7.734
2	4	3.133	13.811
3	6	7.909	53.018
4	8	7.811	55.299
...	...	...	...
95	6	3.561	19.128
96	3	0.301	5.609
97	4	7.163	41.444
98	7	0.309	12.027
99	3	6.335	32.357

100 rows × 3 columns

Return a boolean value indicating whether the dataset has missing values

In [11]:

```
df.isnull()
```

Out[11]:

	number_courses	time_study	Marks
1	False	False	False
2	False	False	False
3	False	False	False
4	False	False	False
5	False	False	False
...	...	...	...
96	False	False	False
97	False	False	False
98	False	False	False
99	False	False	False
100	False	False	False

100 rows × 3 columns

Show average of all columns grouped by number_course in a same DataFrame table

In [12]:

```
avg = df.groupby(['number_courses']).mean()
avg
```

Out[12]:

	time_study	Marks
number_courses		
3	3.685773	18.433318
4	3.598524	19.029952
5	3.070600	17.641000
6	4.838750	29.863062
7	4.242667	29.401467
8	4.955750	33.835375

Show the sum of time_study and mean of marks grouped by each number_course in a same DataFrame table

In [13]:

```
df.mean()
```

Out[13]:

```
number_courses     5.29000
time_study         4.07714
Marks             24.41769
dtype: float64
```

In [14]:

```
sum = df.groupby(['number_courses'])['time_study'].sum()
sum
```

Out[14]:

```
number_courses
3    81.087
4    75.569
5    30.706
6    77.420
7    63.640
8    79.292
Name: time_study, dtype: float64
```

In [15]:

```
mean = df.groupby(['number_courses'])['Marks'].mean()
mean
```

Out[15]:

```
number_courses
3    18.433318
4    19.029952
5    17.641000
6    29.863062
7    29.401467
8    33.835375
Name: Marks, dtype: float64
```

In [16]:

```
pip install -U prettytable
```

```
Requirement already satisfied: prettytable in /Users/roja/opt/anaconda3/lib/python3.9/site-packages
(3.5.0)
Requirement already satisfied: wcwidth in /Users/roja/opt/anaconda3/lib/python3.9/site-packages (from
prettytable) (0.2.5)
Note: you may need to restart the kernel to use updated packages.
```

In [17]:

```
from prettytable import PrettyTable

res = PrettyTable([sum, mean])
res
```

Out[17]:

```
                 number_courses              number_courses
                       3 81.087                 3 18.433318
                       4 75.569                 4 19.029952
                       5 30.706                 5 17.641000
                       6 77.420                 6 29.863062
                       7 63.640                 7 29.401467
                       8 79.292                 8 33.835375
 Name: time_study, dtype: float64   Name: Marks, dtype: float64
```

Write a class My_KMeans that implements k-means clustering algorithm. You are required to have the following attributes

- Parameters:
  - Default clusters
  - max_iter
- Method:
  - fit
  - predict

Reference: https://scikit-learn.org/stable/modules/generated/sklearn.cluster.KMeans.html (https://scikit-learn.org/stable/modules/generated/sklearn.cluster.KMeans.html)
Using a pre-built library yields no credit. You have to write everything from scratch

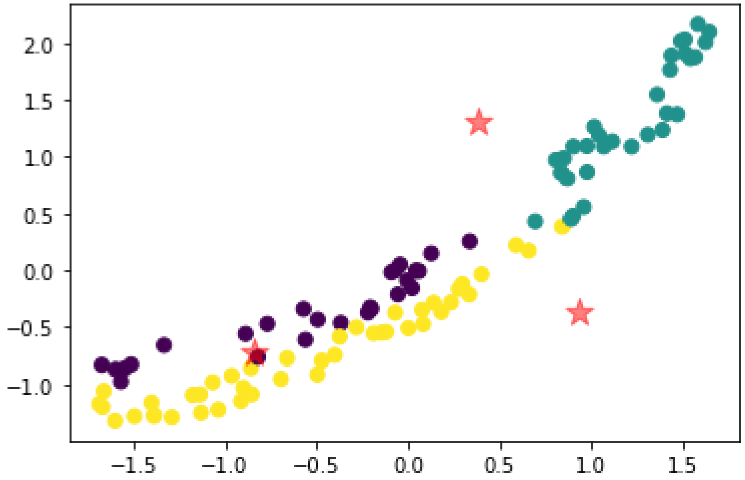
In [18]:

```
import math
import numpy as np

def euclidean(point, data):
    return np.sqrt(np.sum((point - data)**2, axis=1))

class My_KMeans:

    l= []

    def __init__(self, n_clusters = 3, max_iter = 100):

        self.n_clusters = n_clusters
        self.max_iter = max_iter
        self.centroids =0

    def fit(self, X_train):

        min_, max_ = np.min(X_train, axis=0), np.max(X_train, axis=0)
        self.centroids = [np.random.uniform(min_, max_) for _ in range(self.n_clusters)]
        iteration = 0

        prev_centroids = None

        while np.not_equal(self.centroids, prev_centroids).any() and iteration < self.max_iter:

            sorted_points = [[] for _ in range(self.n_clusters)]
            for x in X_train:
                dists = euclidean(x, self.centroids)
                centroid_idx = np.argmin(dists)
                sorted_points[centroid_idx].append(x)
            prev_centroids = self.centroids
            self.centroids = [np.mean(cluster, axis=0) for cluster in sorted_points]
            for i, centroid in enumerate(self.centroids):
                if np.isnan(centroid).any():
                    self.centroids[i] = prev_centroids[i]
            iteration += 1

    def predict(self, X):
        centroids = []
        centroid_idxs = []
        for x in X:
            dists = euclidean(x, self.centroids)
            centroid_idx = np.argmin(dists)
            t = self.centroids[centroid_idx]
            centroids.append(t)
            centroid_idxs.append(centroid_idx)
        cluster_centers_ = centroid_idxs
        self.l = centroid_idxs
        return centroid_idxs
```

Run the code

In [19]:
```
learn.preprocessing import StandardScaler
matplotlib.pyplot as plt
seaborn as sns

ardize the data
 StandardScaler().fit_transform(df)

ocal implementation of kmeans
= My_KMeans(3,100)
fit(X_std)
s = kmeans.predict(X_std)




, 1]: X_std dataset with all rows and the second column (time_study in this case)
, 2]: X_std dataset with all rows and the third column (marks in this case)


cluster elements
tter(x=X_std[:, 1], y=X_std[:, 2], c=y_kmeans, s=50, cmap='viridis')


cluster centers
tter([x for x, _, _ in kmeans.centroids], [y for _, _, y in kmeans.centroids],marker='*', color='r', s=2
```

Out[19]:
```
<matplotlib.collections.PathCollection at 0x7f792a020490>
```



Your analysis about the plot

According to my inspection of the previous plot, both the points and clusters, as well as the centroid that was created, are not precise. Even if the model appears to be functioning OK, a few corrections should still need to be made. However, the model that is now being created may be applied since the outcomes are adequate.

Type *Markdown* and LaTeX: α^2

(Bonus 20pts) Modify your algorithm to k-means++ with a smart initialization, and repeat the task above

In [20]:

```
def get_kmeans_pp_centroids(X1,k = 5):
    centroids = []
    for i in range(k):
        centroids.append([X1[10,0],X1[10,1],X1[10,2]])
    i = 1
    d = []
    while i <= k:
        r = centroids[i-2 if i-2 >=0 else 0]
        maxd = 0
        for j in X1:
            d = np.sqrt((j[1] - r[1])**2 +(j[2] - r[2])**2)
            if d > maxd:
                centroids[i-1] = [j[0],j[1],j[2]]
                maxd = d
        i+=1
    min_, max_ = np.min(X1, axis=0), np.max(X1, axis=0)
    iteration = 0
    prev_centroids = None

    while np.not_equal(centroids, prev_centroids).any() and iteration < k:

        sorted_points = [[] for _ in range(k)]

        for x in X1:
            dists = euclidean(x, centroids)
            centroid_idx = np.argmin(dists)
            sorted_points[centroid_idx].append(x)

        prev_centroids = centroids
        centroids = [np.mean(cluster, axis=0) for cluster in sorted_points]
        for i, centroid in enumerate(centroids):
            if np.isnan(centroid).any():
                centroids[i] = prev_centroids[i]
        iteration += 1
    return centroids

def predict(X,c):
    centroids = []
    centroid_idxs = []
    for x in X:
        dists = euclidean(x,c)
        centroid_idx = np.argmin(dists)
```

```
            t = c[centroid_idx]
            centroids.append(t)
            centroid_idxs.append(centroid_idx)
        return centroid_idxs
```

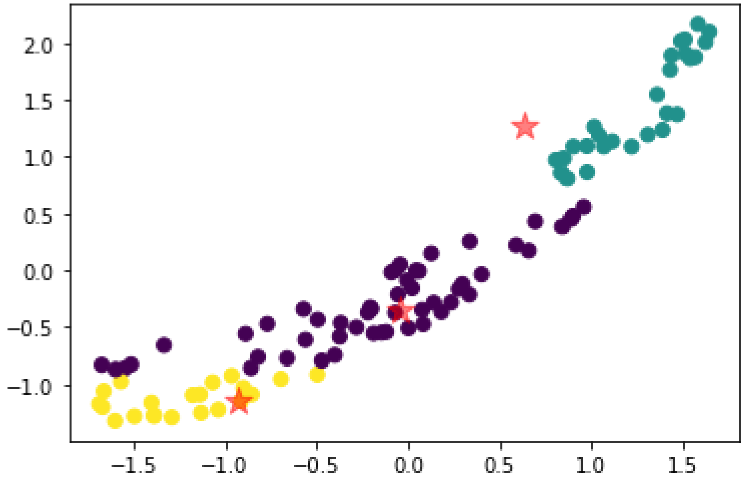
In [21]:

```
centroids = get_kmeans_pp_centroids(X_std, k = 3)
y_kmeans = predict(X_std,centroids)


# Plot cluster elements
plt.scatter(x=X_std[:, 1], y=X_std[:, 2], c=y_kmeans, s=50, cmap='viridis')


# Plot cluster centers
plt.scatter([x for x, _, _ in centroids], [y for _, _, y in centroids],marker='*', color='r', s=200, alp
```

```
/Users/roja/opt/anaconda3/lib/python3.9/site-packages/numpy/core/fromnumeric.py:3419: RuntimeWarning:
Mean of empty slice.
  return _methods._mean(a, axis=axis, dtype=dtype,
/Users/roja/opt/anaconda3/lib/python3.9/site-packages/numpy/core/_methods.py:188: RuntimeWarning: inva
lid value encountered in double_scalars
  ret = ret.dtype.type(ret / rcount)
```

Out[21]:

```
<matplotlib.collections.PathCollection at 0x7f792a1ea280>
```



In [ ]: