Thomas Kosiolek

1.

```
import pandas as pd

df = pd.read_csv('customer.csv')

df
```

	cust_key_value	cust_freq_address	cust_freq_pf	cust_freq_tel	cust_freq_cnic	cust_freq_mobile	cust_freq_internet	cust_freq_cricket	cust_freq_gaming	...	chg_freq_fixl	chg_freq_ftv
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	...	0.00	0.00
1	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.07	0.00	...	0.00	0.01
2	0.06	0.09	0.71	0.0	1.23	0.14	0.00	0.12	0.64	...	0.00	0.0
3	0.00	0.00	0.00	0.0	0.00	0.00	0.01	0.00	0.01	...	0.00	0.00
4	0.00	0.00	0.00	0.0	0.00	0.00	0.01	0.00	0.01	...	0.00	0.0
...	...	...	...	...	...	...	...	...	...	...	...	...
2994	0.01	0.00	0.02	0.0	0.00	0.01	0.00	0.00	0.00	...	0.00	0.00
2995	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	...	0.00	0.00
2996	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	...	0.00	0.0
2997	0.06	0.00	0.00	0.0	0.02	0.00	0.00	0.00	0.00	...	0.00	0.00
2998	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	...	0.00	0.0

4823 rows × 50 columns

```
for i in range(len(df):
    for column in df.columns:
        if df[column].isnull().any():
            print(f"{column}: {df[column].isnull().sum()}")
```

```
# Resources used:
# https://www.geeksforgeeks.org/dataclysm-pattern-recognition/dataclysm-pattern-recognition-using-numpy-and-pandas/#:~:text=Pandas%20is%20a%20powerful,%2C%20and%20much%20more.&text=Pandas%20%2D%20Dataclysm%20Pattern%20Recognition,-Dataclysm%20Pattern%20Recognition%20is%20a%20powerful%20and%20versatile%20tool%20for%20numerical%20and%20time%20series%20analysis.
```

```
# Running p_check
df.shape
for column in df.columns:
    print(f"{column}: {df[column].dtype}")
    if df[column].isnull().any():
        print("True")

# Resources used:
# https://stackoverflow.com/questions/40039689/how-to-use-the-if-all-statement-in-python

All of the columns are numeric.

num_data_points = [100, 500, 1000, 2000]
num_centers = [2, 5, 10, 15, 20]
```

```
from sklearn.cluster import KMeans
import time

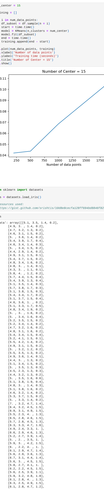
training = []

for i in num_centers:
    print("Clustering for", i)
    model = KMeans(n_clusters = i)
    model.fit(df)
    print("Done")
    training.append(end - start)

# Resources used:
# https://www.geeksforgeeks.org/how-to-find-optimal-clusters-in-keras-keras-and-tensorflow-and-pytorch/#:~:text=Finding%20the%20optimal%20number%20of,%2C%20Keras%20%2C%20TensorFlow%20%2C%20and%20PyTorch.
# https://www.geeksforgeeks.org/ml-hierarchical-clustering-agglomerative-and-divisive-clustering/
# https://www.programiz.com/python-programming/examples/kilometer-time
```

```
import matplotlib.pyplot as plt

plt.plot(num_centers, training)
plt.xlabel('Number of centers')
plt.ylabel('Training time (seconds)')
plt.show()
```




```
from sklearn.metrics import silhouette_score

cluster_score = []

for i in num_centers:
    print("Clustering for", i)
    model.fit(df)
    labels = model.labels_
    score = silhouette_score(df, labels)
    cluster_score.append(score)

plt.plot(num_centers, cluster_score)
plt.xlabel('Number of centers')
plt.ylabel('Clustering Score')
plt.show()

# Resources used:
# https://towardsdatascience.com/optimizing-kmeans-silhouette-clustering-part-3-clustering-a8b6b9b8a3dc#:~:text=Parameter%20%2D%20Number%20of,Score%20%2D%20Silhouette%20Score
# https://stackoverflow.com/questions/51382839/silhouette-score-explained-with-python-example/
```

```
num_center = 15

training = []

for i in num_data_points:
    print("Clustering for", i)
    start = time.time()
    model = KMeans(n_clusters = num_center)
    model.fit(df)
    end = time.time()
    training.append(end - start)

plt.plot(num_data_points, training)
plt.xlabel('Number of data points')
plt.ylabel('Training time (seconds)')
plt.title('Number of Center = 15')
plt.show()
```

2.

```
from sklearn import datasets

iris = datasets.load_iris()

# Resources used:
# https://plot.ly/ml-in-1-line/#/clustering/k-means-clustering
```

```
iris
```

```
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