Classification-2

November 12, 2024

[1]:
```
try:
    import os
    import glob
    import pandas as pd

    import matplotlib.pyplot as plt
    import seaborn as sns

    from sklearn.cluster import KMeans
    from kneed import KneeLocator

except Exception as e:
    print(f"Error : {e}")
```

[2]:
```
# Find the CSV file in the Datasets directory
data_path = '../Datasets/*.csv'
file_list = glob.glob(data_path)

for file in file_list:
    print(f"Found file: {file}")

# Ensure there is exactly one file
if len(file_list) == 1:
    # Load the dataset
    df = pd.read_csv(file_list[0])
    print(f"Loaded dataset: {file_list[0]}")
else:
    raise FileNotFoundError("No CSV file found or multiple CSV files found in␣
 ↪the Datasets directory.")
```

```
Found file: ../Datasets/Dataset.csv
Loaded dataset: ../Datasets/Dataset.csv
```

[3]:
```
# File path to save the trained model
destination = '../Models/'
os.makedirs(destination, exist_ok=True)
print(f"Model will be saved to: {destination}")
```

```
Model will be saved to: ../Models/
```

[4]:
```
clf_df = df.copy()

clf_df['1500_labels'] = clf_df['Lifespan'].apply(lambda x: 1 if x >= 1500 else␣
↪0)

clf_df.head()
```

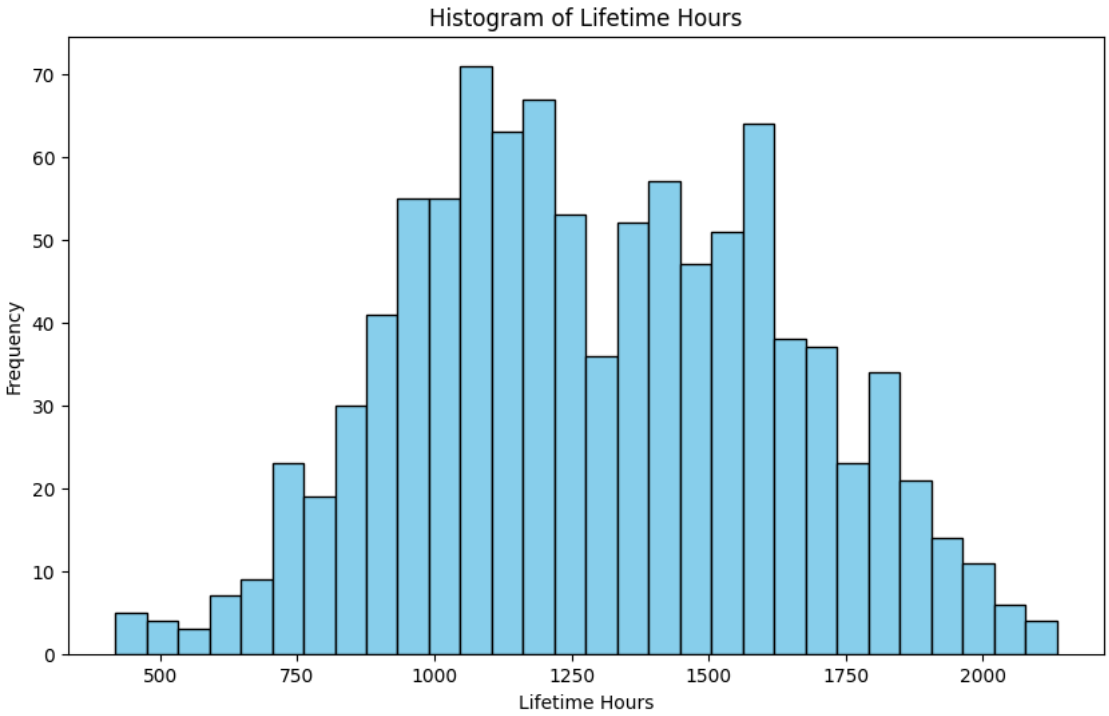
[4]:

	Lifespan	partType	microstructure	coolingRate	quenchTime	forgeTime	HeatTreatTime	Nickel%	Iron%	Cobalt%	Chromium%	smallDefects	largeDefects	sliverDefects	seedLocation	castType	1500_labels
0	1469.17	Nozzle	equiGrain	13	3.84	6.47	46.87	65.73	16.52	16.82	0.93	10	0	0	Bottom	Die	0
1	1793.64	Block	singleGrain	19	2.62	3.48	44.70	54.22	35.38	6.14	4.26	19	0	0	Bottom	Investment	1
2	700.60	Blade	equiGrain	28	0.76	1.34	9.54	51.83	35.95	8.81	3.41	35	3	0	Bottom	Investment	0
3	1082.10	Nozzle	colGrain	9	2.01	2.19	20.29	57.03	23.33	16.86	2.78	0	1	0	Top	Continuous	0
4	1838.83	Blade	colGrain	16	4.13	3.87	16.13	59.62	27.37	11.45	1.56	10	0	0	Top	Die	1

[5]:
```
min_lifespan = clf_df['Lifespan'].min()
max_lifespan = clf_df['Lifespan'].max()

print(f"Minimum Lifespan: {min_lifespan}")
print(f"Maximum Lifespan: {max_lifespan}")
```

```
Minimum Lifespan: 417.99
Maximum Lifespan: 2134.53
```

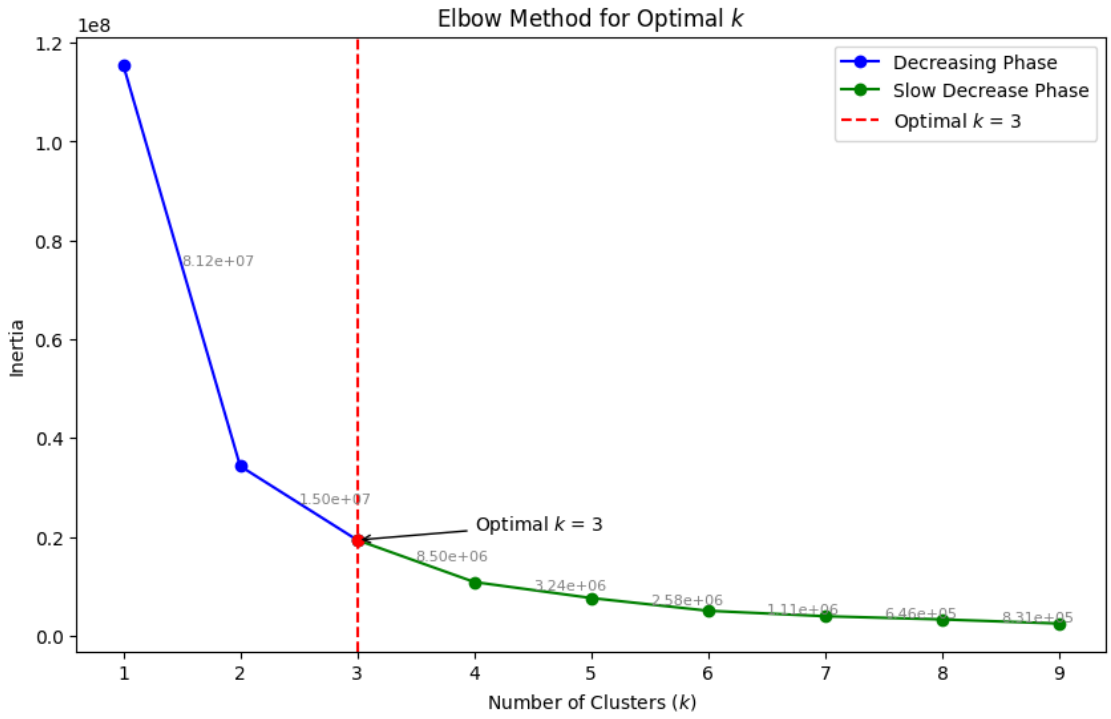
[6]:
```
# Histogram to understand the distribution of 'lifetime_hours'
plt.figure(figsize=(10, 6))
plt.hist(clf_df['Lifespan'], bins=30, color='skyblue', edgecolor='black')
plt.xlabel('Lifetime Hours')
plt.ylabel('Frequency')
plt.title('Histogram of Lifetime Hours')
plt.show()
```



[7]:
```
# Selecting only 'Lifespan' for simplicity
X = clf_df[['Lifespan']]
```

[8]:
```
# Initialize a list to store inertia values
inertia = []
k_values = range(1, 10)

# Calculate inertia for each k
for k in k_values:
    kmeans = KMeans(n_clusters=k, random_state=42)
    kmeans.fit(X)
    inertia.append(kmeans.inertia_)

# Dynamically determine the elbow point using KneeLocator
kneedle = KneeLocator(k_values, inertia, curve='convex', direction='decreasing')
elbow_k = kneedle.elbow

# Plotting the Elbow Method with all indicators
plt.figure(figsize=(10, 6))
# Plot line segments with different colors
plt.plot(k_values[:elbow_k], inertia[:elbow_k], 'bo-', label="Decreasing Phase")
plt.plot(k_values[elbow_k - 1:], inertia[elbow_k - 1:], 'go-', label="Slow␣
 ↪Decrease Phase")
```

```
# Vertical line at elbow
plt.axvline(x=elbow_k, linestyle='--', color='r', label=f'Optimal $k$ =␣
 ↪{elbow_k}')

# Highlight the elbow point with a red marker and annotation
plt.plot(elbow_k, inertia[elbow_k - 1], 'ro')  # red point at elbow
plt.annotate(f"Optimal $k$ = {elbow_k}", xy=(elbow_k, inertia[elbow_k - 1]),
             xytext=(elbow_k + 1, inertia[elbow_k - 1] + 0.2e7),
             arrowprops=dict(facecolor='black', arrowstyle="->"))

# Annotate each segment with inertia differences
for i in range(1, len(k_values)):
    plt.annotate(f"{inertia[i-1] - inertia[i]:.2e}",
                 (k_values[i] - 0.5, (inertia[i-1] + inertia[i]) / 2),
                 fontsize=8, color='gray')

# Set plot labels and title
plt.xlabel(f'Number of Clusters ($k$)')
plt.ylabel('Inertia')
plt.title(f'Elbow Method for Optimal $k$')
plt.legend()
plt.show()
```

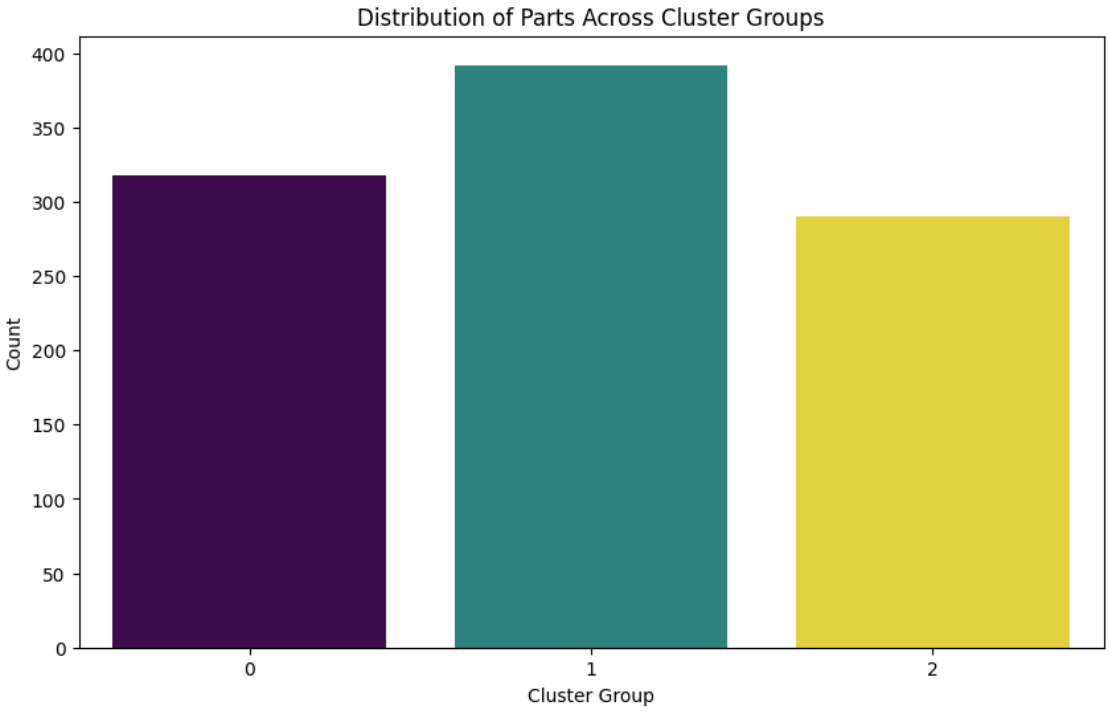


[9]:
```
kmeans = KMeans(n_clusters=elbow_k, random_state=42)
clf_df['cluster_group'] = kmeans.fit_predict(X)
```

[10]:
```
# Group the data by 'cluster_group' and aggregate to find the min and max␣
 ↪Lifespan for each cluster
cluster_ranges = clf_df.groupby('cluster_group')['Lifespan'].agg(['min',␣
 ↪'max']).reset_index()

# Display the value ranges for each cluster
print(cluster_ranges)
```

```
   cluster_group      min      max
0              0  1483.73  2134.53
1              1  1085.23  1480.43
2              2   417.99  1085.01
```

[11]:
```
plt.figure(figsize=(10, 6))
sns.countplot(x='cluster_group', data=clf_df, hue='cluster_group',␣
 ↪palette='viridis', legend=False)
plt.xlabel('Cluster Group')
plt.ylabel('Count')
plt.title('Distribution of Parts Across Cluster Groups')
plt.show()
```



[12]:
```
from sklearn.metrics import silhouette_score

silhouette_avg = silhouette_score(X, kmeans.labels_)
print(f'Silhouette Score for k={elbow_k}: {silhouette_avg:.2f}')
```

```
Silhouette Score for k=3: 0.52
```