FAKE CURRENCY ANOMALY DETECTION

This dataset contains synthetic data representing fake currency samples. It includes information such as the country of origin, denomination, whether the currency is genuine or counterfeit, serial numbers, security features, weight, length, width, and thickness of the currency. The dataset can be used for various machine-learning tasks such as classification, anomaly detection, and feature engineering. It is suitable for exploring patterns and trends in counterfeit currency and analyzing the effectiveness of security features.

1.Importing the dependencies and dataset

About this file

- Country: Country of origin for the currency
- Denomination: Currency denomination.
- Counterfeit: Binary indicator (0 for genuine, 1 for counterfeit)
- SerialNumber: Serial number of the currency.
- Security Features: Security features present in the currency.
- Weight: Weight of the currency in grams.
- Length: Length of the currency in mm.
- Width: Width of the currency in mm.
- Thickness: Thickness of the currency in mm.

```
import numpy as np
import pandas as pd
```

```
df=pd.read_csv("/content/fake_currency_data.csv")
df
```

	Country	Denomination	Counterfeit	SerialNumber	SecurityFeatures	Weight
0	USA	$100	1	25973198	Hologram	1.731759
1	USA	$20	1	95903230	Security Thread	1.002179
2	EU	€10	0	82937914	Hologram	2.306713
3	USA	€20	1	23612989	Microprint	1.366965
4	EU	€20	1	56025342	Watermark	1.796075
...	...	...	...	...	...	...
999995	EU	$100	1	24436622	Watermark	1.472511
999996	EU	£20	1	82654212	Hologram	2.355633
999997	USA	$5	0	59174754	Microprint	1.393764
999998	EU	£10	0	55268089	Watermark	2.026417
999999	EU	£10	0	59464296	Watermark	0.867139

1000000 rows × 9 columns

2.Preprocessing the dataset

we perform univariate analysis on the dataset. First, we print the dataset information and descriptive statistics.

```
df.describe()
```

	Counterfeit	SerialNumber	Weight	Length	Width	1
count	1000000.000000	1.000000e+06	1000000.000000	1000000.000000	1000000.000000	
mean	0.499391	5.502259e+07	1.649766	140.020542	70.003944	
std	0.500000	2.598490e+07	0.490712	11.544293	5.772709	
min	0.000000	1.000015e+07	0.800003	120.000073	60.000005	
25%	0.000000	3.249784e+07	1.224855	130.034878	64.999762	
50%	0.000000	5.506594e+07	1.649137	140.032496	70.008440	
75%	1.000000	7.751115e+07	2.074540	150.022309	75.006372	
max	1.000000	9.999994e+07	2.499999	159.999961	79.999983	

Then, not Any missing values in dataset

```
df.isnull().sum()
```

```
Country             0
Denomination        0
Counterfeit         0
SerialNumber        0
SecurityFeatures    0
Weight              0
Length              0
Width               0
Thickness           0
dtype: int64
```

Adding the features from exsting dataset

- Area: Area of the currency in mm^2.
- volume: volume of the currency in mm^3.
- Aspect_ratio: length/Width of the currency .
- Weight_to_Area_Ratio: weight/area of the currency.
- Weight_to_Volume_Ratio: weight/volume of the currency.

```
df['Area'] = df['Length'] * df['Width']
df['Volume'] = df['Length'] * df['Width'] * df['Thickness']
df['Aspect_Ratio'] = df['Length'] / df['Width']
df['Weight_to_Area_Ratio'] = df['Weight'] / df['Area']
df['Weight_to_Volume_Ratio'] = df['Weight'] / df['Volume']
```

```
df
```

	Country	Denomination	Counterfeit	SerialNumber	SecurityFeatures	Weight
0	USA	$100	1	25973198	Hologram	1.731759
1	USA	$20	1	95903230	Security Thread	1.002179
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...	...	...	...	...	...	...
999995	EU	$100	1	24436622	Watermark	1.472511
999996	EU	£20	1	82654212	Hologram	2.355633
999997	USA	$5	0	59174754	Microprint	1.393764
999998	EU	£10	0	55268089	Watermark	2.026417
999999	EU	£10	0	59464296	Watermark	0.867139

1000000 rows × 14 columns

Dropping the not effective features here it is a serial number beacuse they are unique identity.

```
df = df.drop(['SerialNumber'], axis=1)
df
```

	Country	Denomination	Counterfeit	SecurityFeatures	Weight	Length	
0	USA	$100	1	Hologram	1.731759	130.243185	66
1	USA	$20	1	Security Thread	1.002179	152.596364	76
2	EU	€10	0	Hologram	2.306713	152.857126	66
3	USA	€20	1	Microprint	1.366965	143.133672	78
4	EU	€20	1	Watermark	1.796075	129.664777	75
...	...	...	...	...	...	...	
999995	EU	$100	1	Watermark	1.472511	134.888731	75
999996	EU	£20	1	Hologram	2.355633	147.830149	65
999997	USA	$5	0	Microprint	1.393764	150.050308	69
999998	EU	£10	0	Watermark	2.026417	142.852137	77
999999	EU	£10	0	Watermark	0.867139	127.645125	72

1000000 rows × 13 columns

3.Exploratory Data Analysis (EDA)

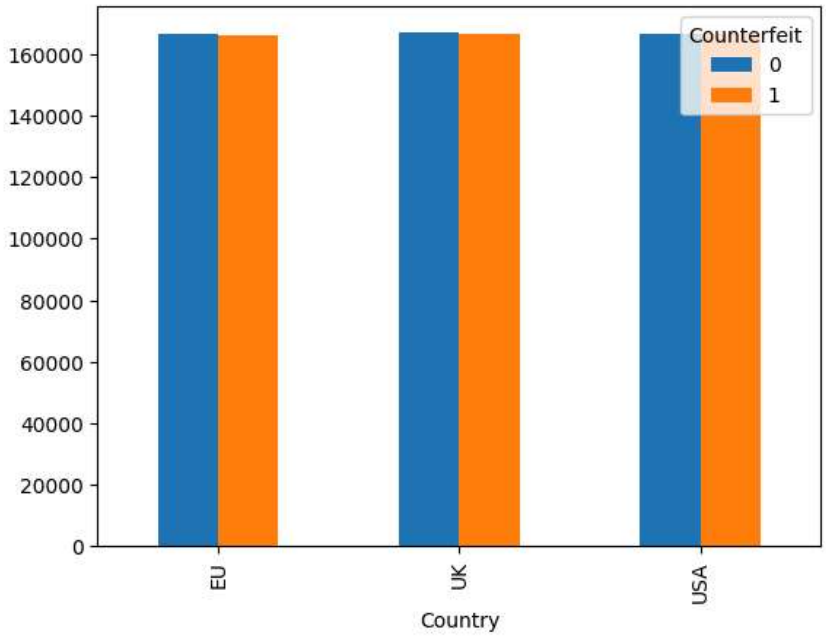
A.number of counterfeit & real note v/s country table & graph

- Almost same number of counterfeit and real note to all three countries (EU,UK,USA)

```
# prompt: country vs number of counterfeit & real not graph

country_counts = df.groupby('Country')['Counterfeit'].value_counts()
print(country_counts)
country_counts.unstack().plot(kind='bar')
```

```
Country  Counterfeit
EU       0              166763
         1              166288
UK       0              167112
         1              166499
USA      0              166734
         1              166604
Name: count, dtype: int64
<Axes: xlabel='Country'>
```



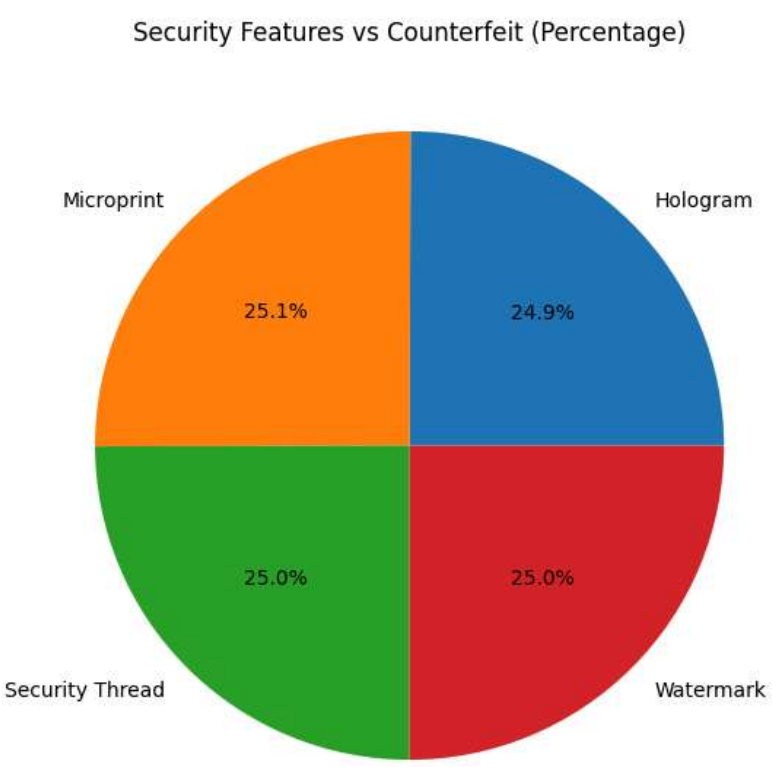
B. percentage of security features

- same percentage of all security features in this dataset

```
# prompt: securty features vs counter feit pie chart

security_features = df.groupby('SecurityFeatures')['Counterfeit'].value_counts()
security_features_unstacked = security_features.unstack()
security_features_unstacked['Total'] = security_features_unstacked[1] + security_features_unstacked[0]
security_features_unstacked['Percentage'] = (security_features_unstacked[1] / security_features_unstacked['Total']) * 100

plt.figure(figsize=(10, 7))
plt.pie(security_features_unstacked['Percentage'], labels=security_features_unstacked.index, autopct='%1.1f%%')
plt.title('Security Features vs Counterfeit (Percentage)')
plt.show()
```



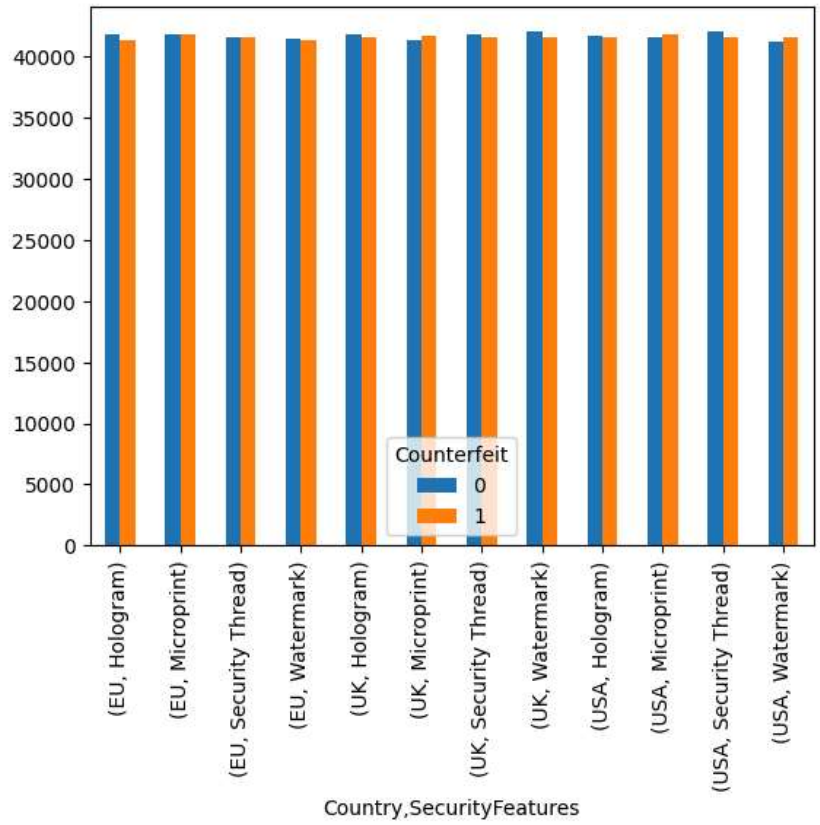
C.security features v/s country table & graph

- Almost same number of all seacurityfeatures and real note to all three countries (EU,UK,USA)

```
# prompt: secrity features vs country

security_features_country = df.groupby(['Country', 'SecurityFeatures'])['Counterfeit'].value_counts()
print(country_security_features)
security_features_country.unstack().plot(kind='bar')
```

```
Country  SecurityFeatures
EU       Microprint          83702
         Hologram            83246
         Security Thread     83183
         Watermark           82920
UK       Watermark           83646
         Security Thread     83430
         Hologram            83416
         Microprint          83119
USA      Security Thread     83595
         Microprint          83544
         Hologram            83384
         Watermark           82815
Name: count, dtype: int64
<Axes: xlabel='Country,SecurityFeatures'>
```



D.number of counterfeit & real note v/s Denomination pie chart

- Almost same number of counterfeit and real note to all three countries (EU,UK,USA)

Generate

C.number of counterfeit & real note v/s Denomination pie chart removing overlapping

Close

4 of 4 Undo Changes Use code with caution

```
# prompt: C.number of counterfeit & real note v/s Denomination pie chart  removing overlapping
denomination_counts = df.groupby('Denomination')['Counterfeit'].value_counts()
denomination_counts_unstacked = denomination_counts.unstack()
denomination_counts_unstacked['Total'] = denomination_counts_unstacked[1] + denomination_counts_unstacked[0]

print(denomination_counts_unstacked)

import matplotlib.pyplot as plt
import numpy as np

# Group data by denomination and counterfeit status
grouped_data = df.groupby(['Denomination', 'Counterfeit']).size().unstack()
```

```
# Create a figure with a 2x2 grid of subplots
fig, axs = plt.subplots(3, 4, figsize=(12, 8))
axs = axs.ravel()  # Flatten the axes

# Iterate over the first four denominations
for i, denomination in enumerate(grouped_data.index[:12]):
    group = grouped_data.loc[denomination]
    colors = ['red' if counterfeit else 'blue' for counterfeit in group.index]
    wedges, texts, autotexts = axs[i].pie(group, labels=group.index, colors=colors, autopct="%1.1f%%", shadow=True, explode=
    axs[i].set_title(f"Denomination: {denomination}")

# Adjust spacing between subplots
plt.subplots_adjust(wspace=0.4, hspace=0.6)

# Add a legend
fig.legend([plt.Rectangle((0, 0), 1, 1, fc='blue'), plt.Rectangle((0, 0), 1, 1, fc='red')], ['Genuine', 'Counterfeit'], loc=

plt.show()
```

```
Counterfeit       0      1  Total
```

E.seacurty features graph by country

- all of security features presents.

```
$20          41654  41407  83061
```

Generate | denomination vs seacurty features graph print the value also | Close

2 of 4 | Undo Changes | Use code with caution

```
# prompt: denomination vs seacurty features graph print the value also

import matplotlib.pyplot as plt

# Create a crosstab of denomination vs security features
security_features_by_denomination = pd.crosstab(df['Denomination'], df['SecurityFeatures'])

# Print the values of the crosstab
print(security_features_by_denomination)

# Plot the crosstab as a bar chart
security_features_by_denomination.plot(kind='bar', figsize=(10, 6))
plt.title('Security Features by Denomination')
plt.xlabel('Denomination')
plt.ylabel('Count')
plt.xticks(rotation=45)
plt.show()
```

```
SecurityFeatures  Hologram  Microprint  Security Thread  Watermark
Denomination
$1                  20887       20848            20912      20699
$10                 20682       20986            20837      20727
$100                20843       21074            20845      20850
```

F.Corelation matrix shown by Heatmap

- weight,length,width,thichness not any relation as expected.
- newly created a columns was highly corelated with they formed.

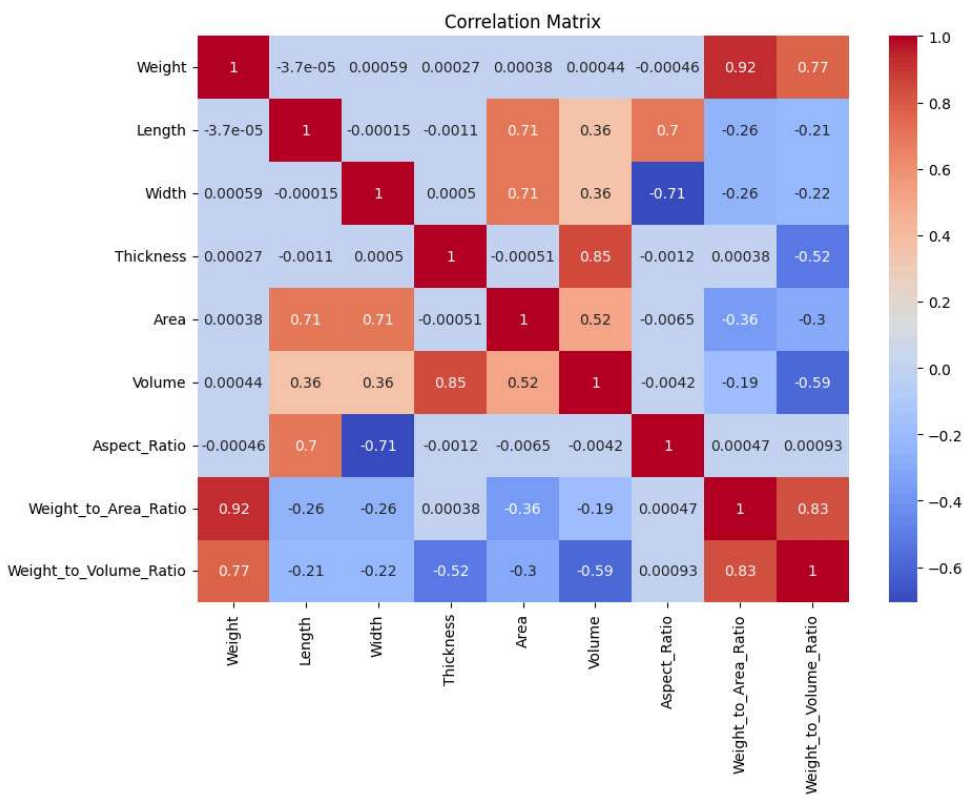
```
€10                 20823       20696            20798      20842
```

```
# prompt: corellation matrix Weight Length  Width   Thickness   Area    Volume  Aspect_Ratio    Weight_to_Area_Ratio    Wei

import matplotlib.pyplot as plt
import seaborn as sns

corr = df[['Weight', 'Length', 'Width', 'Thickness', 'Area', 'Volume', 'Aspect_Ratio', 'Weight_to_Area_Ratio', 'Weight_to_\

plt.figure(figsize=(10, 7))
sns.heatmap(corr, annot=True, cmap='coolwarm')
plt.title('Correlation Matrix')
plt.show()
```



G. distrubation plot of Numerical colums

- here all types of value of weight between 0.8 to 2.5
- here all types of value of length between 120 to 160

- here all types of value of width between 60 to 80
- here all types of value of thickness between 0.0500 to 0.1000

```
# prompt: Weight    Length  Width   Thickness   Area    Volume  Aspect_Ratio    Weight_to_Area_Ratio    Weight_to_Volume_Ra

# Import the necessary libraries
import matplotlib.pyplot as plt
import seaborn as sns

# Create a list of the columns to be analyzed
columns = ['Weight', 'Length', 'Width', 'Thickness', 'Area', 'Volume', 'Aspect_Ratio', 'Weight_to_Area_Ratio', 'Weight_to_\

# Iterate through each column and create a distribution plot
for column in columns:
  plt.figure()
  sns.distplot(df[column])
  plt.title(f'Distribution of {column}')
  plt.show()
```

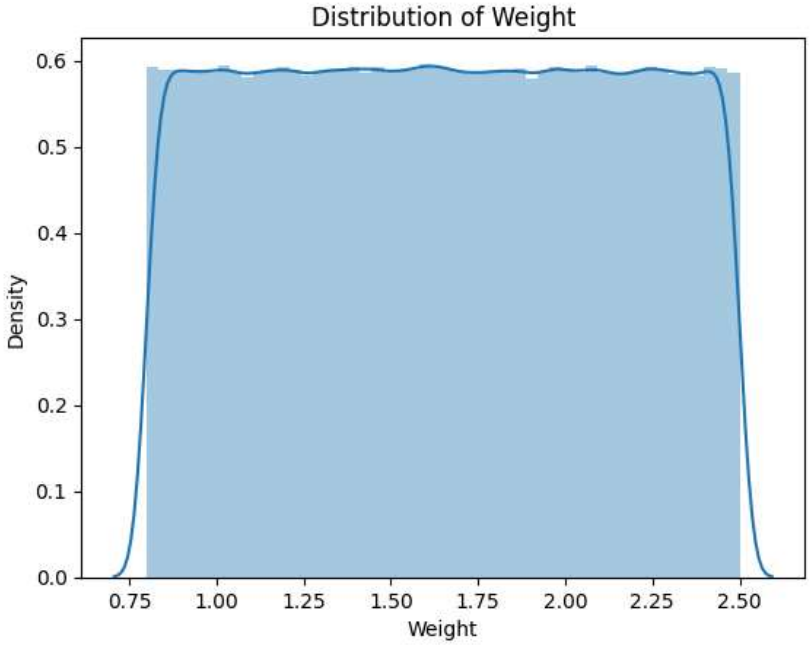
```
<ipython-input-103-16b6a7be08fc>:13: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column])
```

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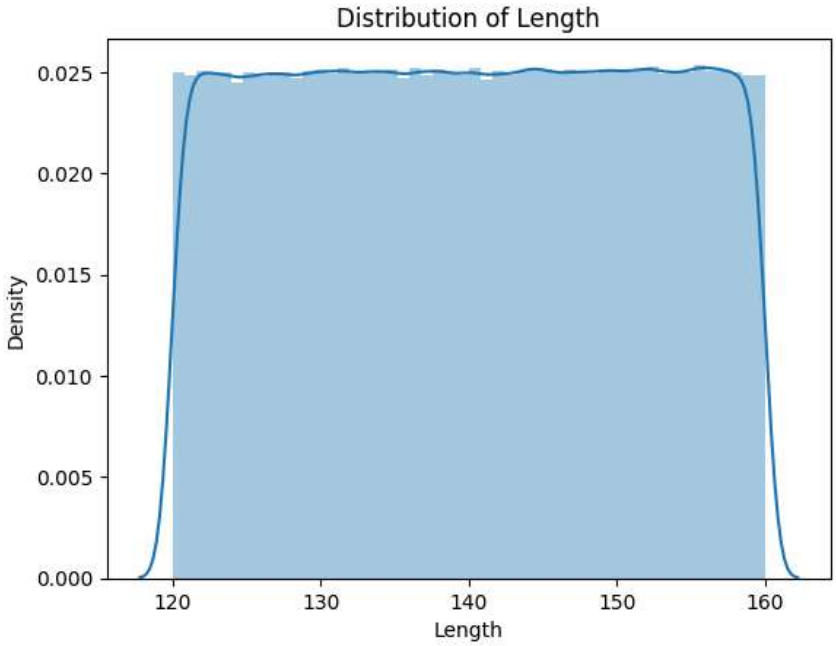


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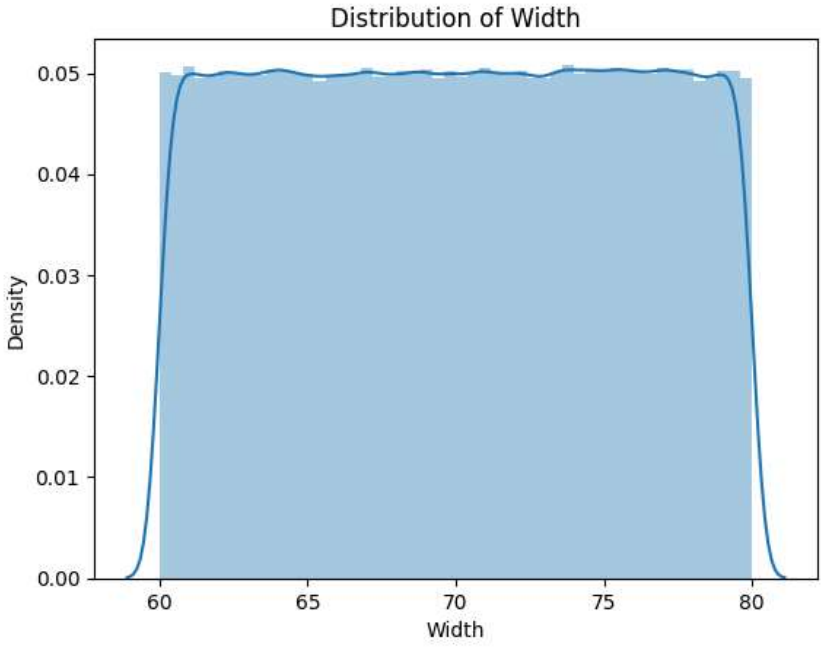


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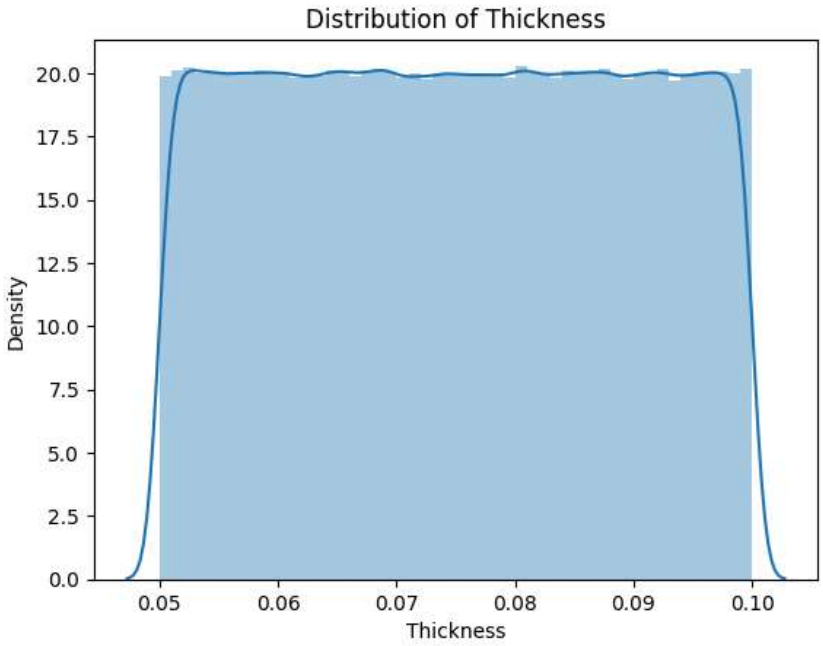


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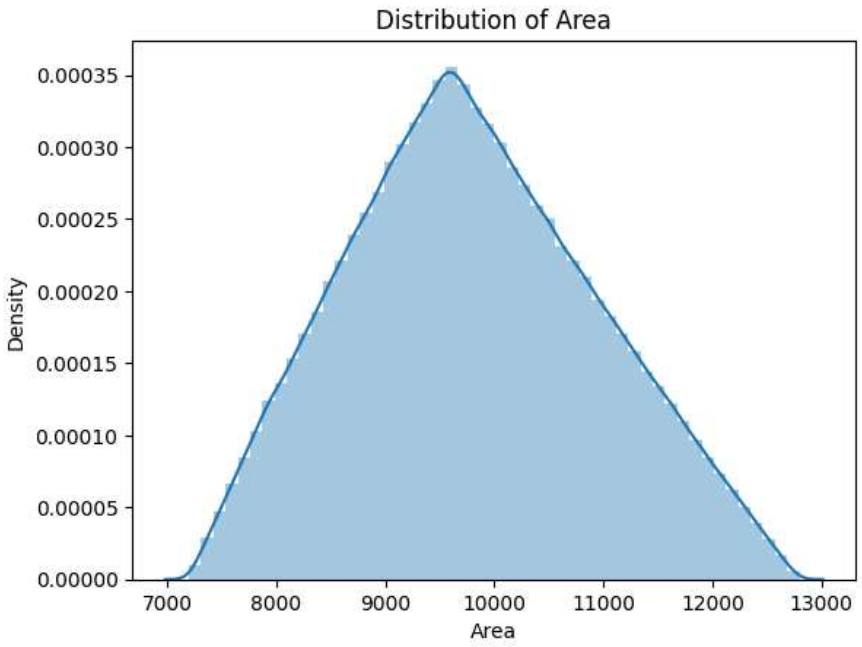
```

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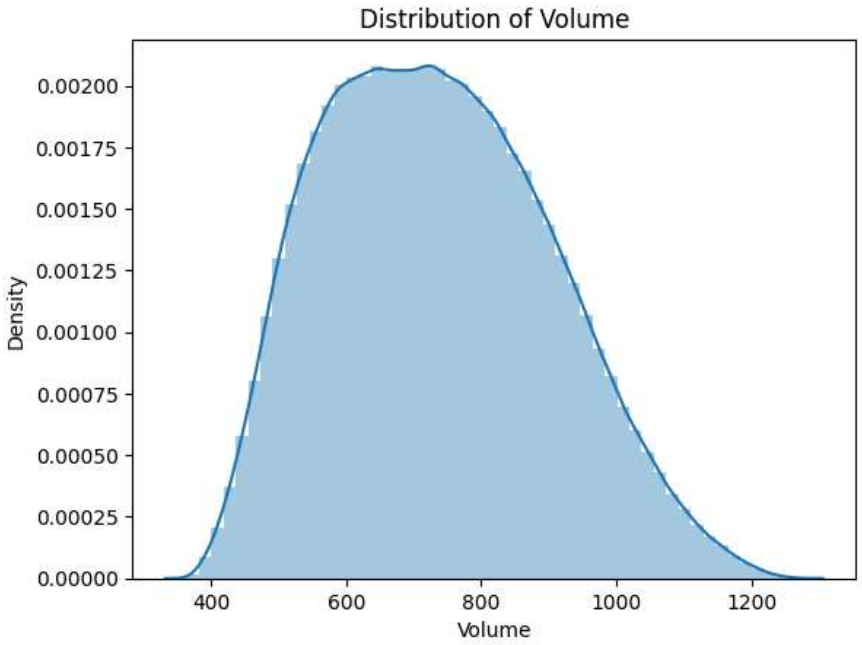
  sns.distplot(df[column])
```

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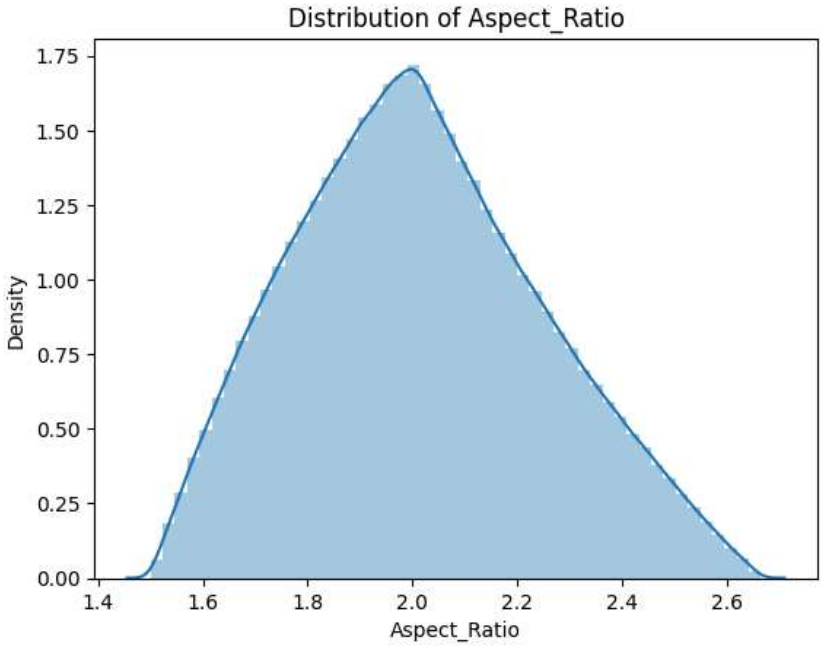
```

```
sns.distplot(df[column])
```

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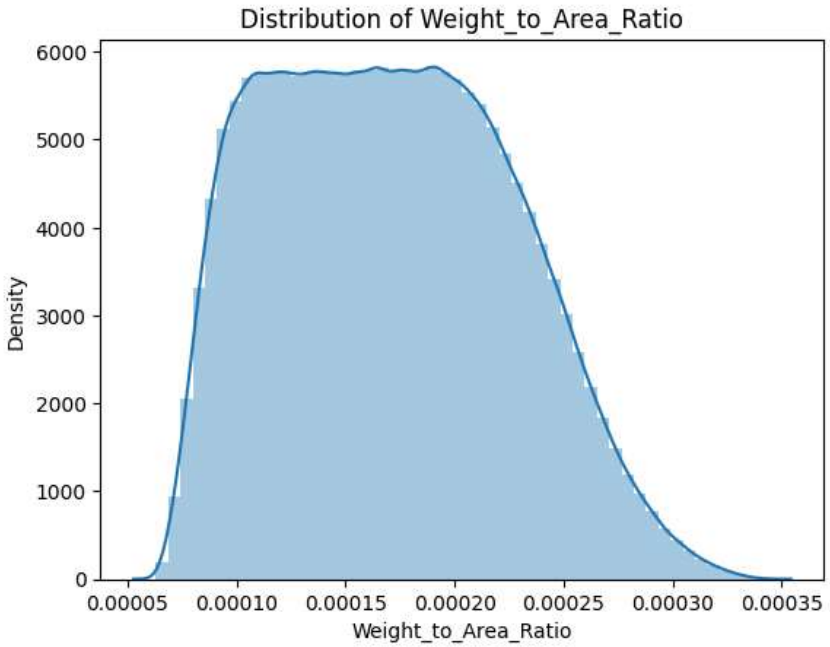
```

```
sns.distplot(df[column])
```

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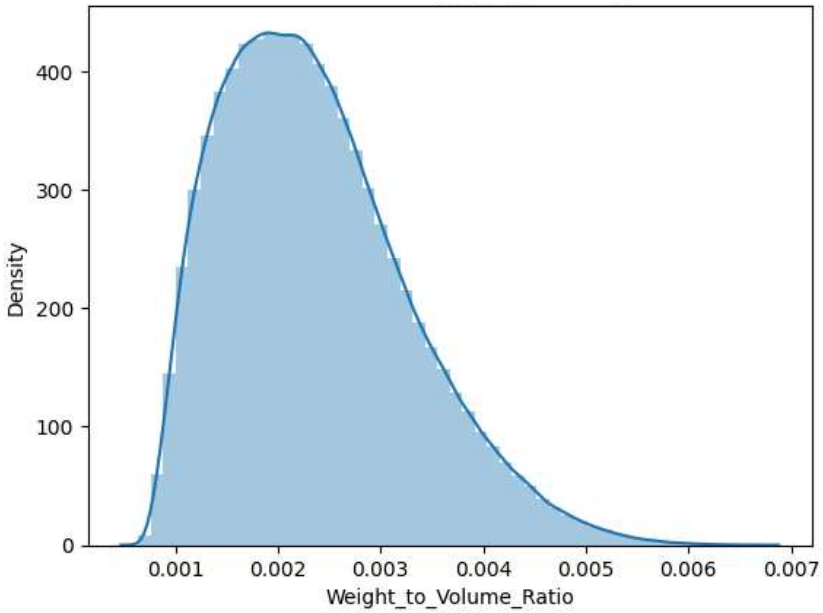
```

```
sns.distplot(df[column])
```



histplot

```
# Import the necessary libraries
import matplotlib.pyplot as plt
import seaborn as sns

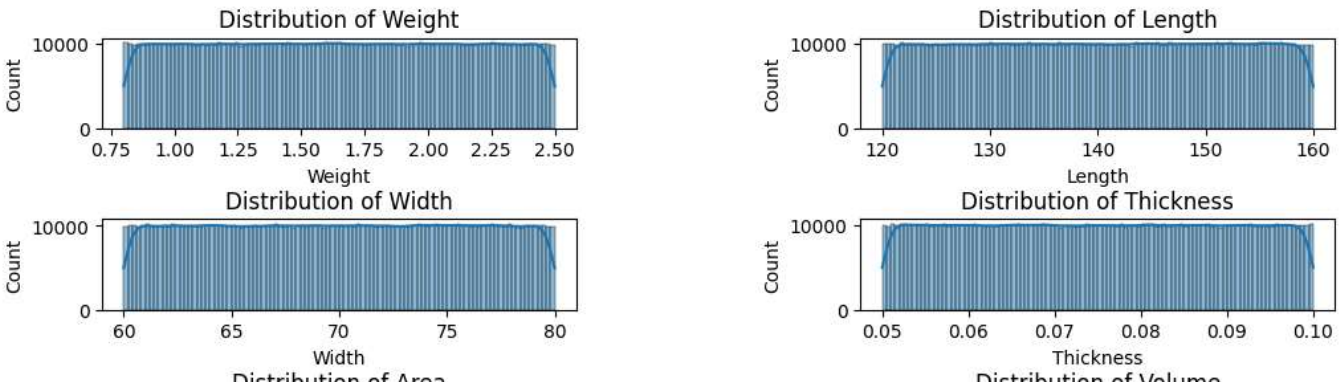
# Create a list of the columns to be analyzed
columns = ['Weight', 'Length', 'Width', 'Thickness', 'Area', 'Volume', 'Aspect_Ratio', 'Weight_to_Area_Ratio', 'Weight_to_Vo

# Create a figure with a 2x2 grid of subplots
fig, axs = plt.subplots(5, 2, figsize=(20, 8))
axs = axs.ravel()  # Flatten the axes

# Iterate through the first four columns and create histogram plots
for i, column in enumerate(columns[:9]):
    sns.histplot(data=df, x=column, ax=axs[i], kde=True)
    axs[i].set_title(f'Distribution of {column}')

# Adjust spacing between subplots
plt.subplots_adjust(wspace=0.6, hspace=1)

plt.show()
```



H. box plot of numerical featurres

- they indicates no outliers present in this datasets

```
# Create a box plot of Weight by Counterfeit
plt.figure()
sns.boxplot(x='Counterfeit', y='Weight', data=df)
plt.xlabel('Counterfeit')
plt.ylabel('weight')
plt.title('Box Plot of Weight by Counterfeit')
plt.show()

# Create a box plot of Length by Counterfeit
plt.figure()
sns.boxplot(x='Counterfeit', y='Length', data=df)
plt.xlabel('Counterfeit')
plt.ylabel('length')
plt.title('Box Plot of Length by Counterfeit')
plt.show()

# Create a box plot of Thickness by Counterfeit
plt.figure()
sns.boxplot(x='Counterfeit', y='Width', data=df)
plt.xlabel('Counterfeit')
plt.ylabel('width')
plt.title('Box Plot of Width by Counterfeit')
plt.show()

# Create a box plot of Thickness by Counterfeit
plt.figure()
sns.boxplot(x='Counterfeit', y='Thickness', data=df)
plt.xlabel('Counterfeit')
plt.ylabel('Thickness')
plt.title('Box Plot of Thickness by Counterfeit')
```