Sri Sivasubramaniya Nadar College of Engineering, Chennai
(An Autonomous Institution affiliated to Anna University)

Degree & Branch	B.E. Computer Science & Engineering
Semester	VI
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Name	Piranow C

Experiment 1: Working with Python packages – NumPy, SciPy, Scikit-learn, Matplotlib

Aim:
To study and explore Python library packages such as Pandas, NumPy, Matplotlib, Scikit-learn, and SciPy to understand data science and machine learning concepts, and to analyze how datasets are explored and mapped to machine learning models using exploratory data analysis techniques.

Libraries Used:

- **NumPy:** Numerical computations and multi-dimensional array handling.
- **Pandas:** Data manipulation, cleaning, and analysis using DataFrames.
- **Matplotlib:** Visualization using line plots, bar charts, and histograms.
- **Seaborn:** Advanced statistical data visualization.
- **Scikit-learn:** Machine learning algorithms, preprocessing, training, and evaluation.
- **SciPy:** Scientific computing, optimization, and statistical analysis.

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January 26, 2026

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

from sklearn.model_selection import train_test_split, StratifiedKFold,␣
↪cross_val_score
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import (
    accuracy_score, precision_score, recall_score, f1_score,
    confusion_matrix, ConfusionMatrixDisplay,
    silhouette_score, davies_bouldin_score, adjusted_rand_score,
    classification_report
)
from sklearn.decomposition import PCA
from sklearn.feature_selection import SelectKBest, f_classif
from sklearn.ensemble import RandomForestClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC
from sklearn.cluster import KMeans

RANDOM_STATE = 42
```

#IRIS DATASET

[2]:
```
df = pd.read_csv("Iris.csv")
df.head()
```

[2]:

	Id	SepalLengthCm	SepalWidthCm	PetalLengthCm	PetalWidthCm	Species
0	1	5.1	3.5	1.4	0.2	Iris-setosa
1	2	4.9	3.0	1.4	0.2	Iris-setosa
2	3	4.7	3.2	1.3	0.2	Iris-setosa
3	4	4.6	3.1	1.5	0.2	Iris-setosa
4	5	5.0	3.6	1.4	0.2	Iris-setosa

[3]:
```python
print("Shape:", df.shape)

print("\nInfo:")
df.info()

print("\nSpecies counts:")
print(df["Species"].value_counts())
```

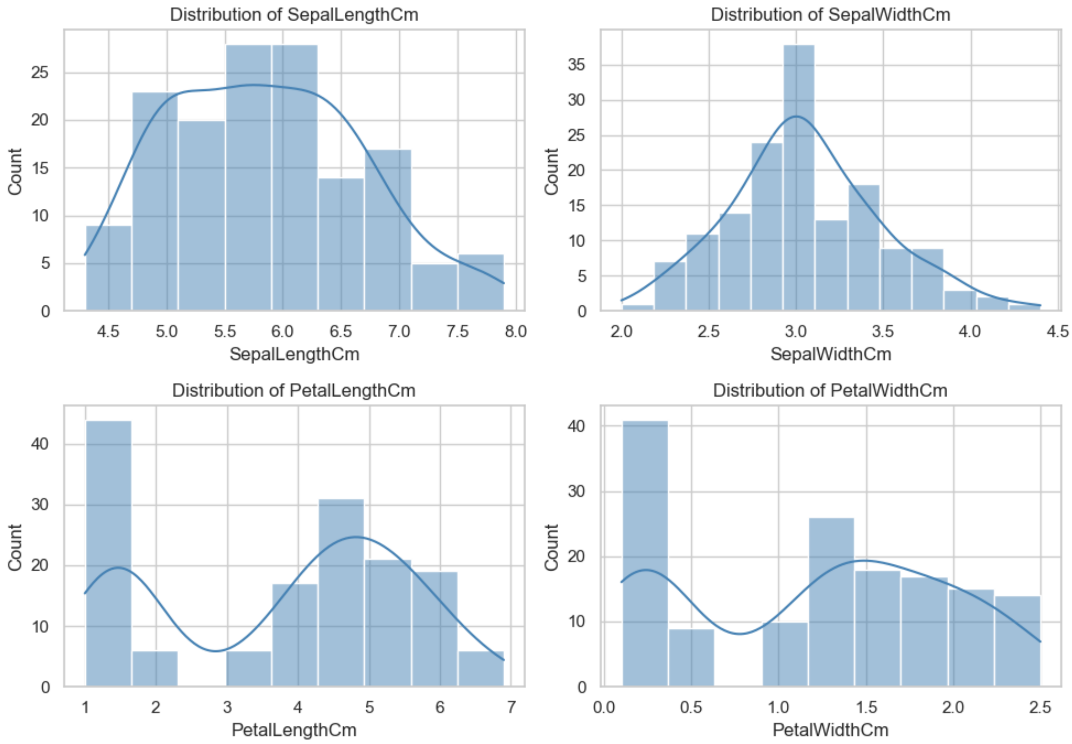
```
Shape: (150, 6)

Info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 6 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Id             150 non-null    int64
 1   SepalLengthCm  150 non-null    float64
 2   SepalWidthCm   150 non-null    float64
 3   PetalLengthCm  150 non-null    float64
 4   PetalWidthCm   150 non-null    float64
 5   Species        150 non-null    object
dtypes: float64(4), int64(1), object(1)
memory usage: 7.2+ KB

Species counts:
Species
Iris-setosa        50
Iris-versicolor    50
Iris-virginica     50
Name: count, dtype: int64
```

[4]:
```python
features = ["SepalLengthCm", "SepalWidthCm", "PetalLengthCm", "PetalWidthCm"]
df[features].describe()
```

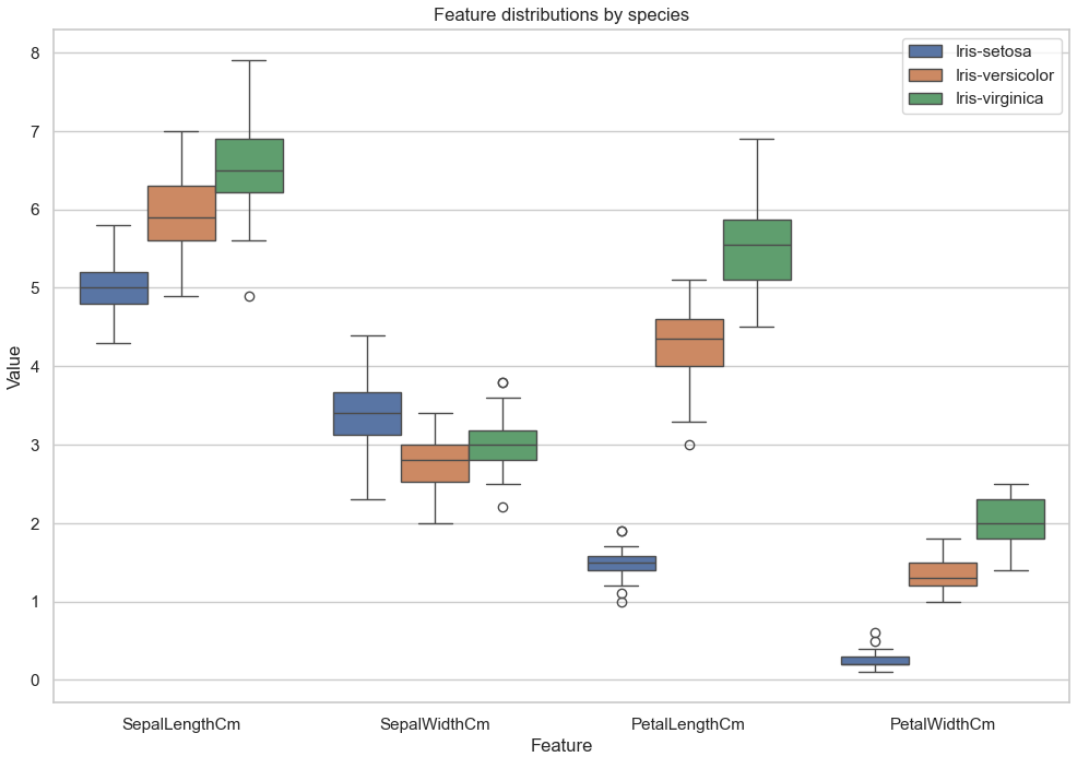
[4]:

	SepalLengthCm	SepalWidthCm	PetalLengthCm	PetalWidthCm
count	150.000000	150.000000	150.000000	150.000000
mean	5.843333	3.054000	3.758667	1.198667
std	0.828066	0.433594	1.764420	0.763161
min	4.300000	2.000000	1.000000	0.100000
25%	5.100000	2.800000	1.600000	0.300000
50%	5.800000	3.000000	4.350000	1.300000
75%	6.400000	3.300000	5.100000	1.800000
max	7.900000	4.400000	6.900000	2.500000

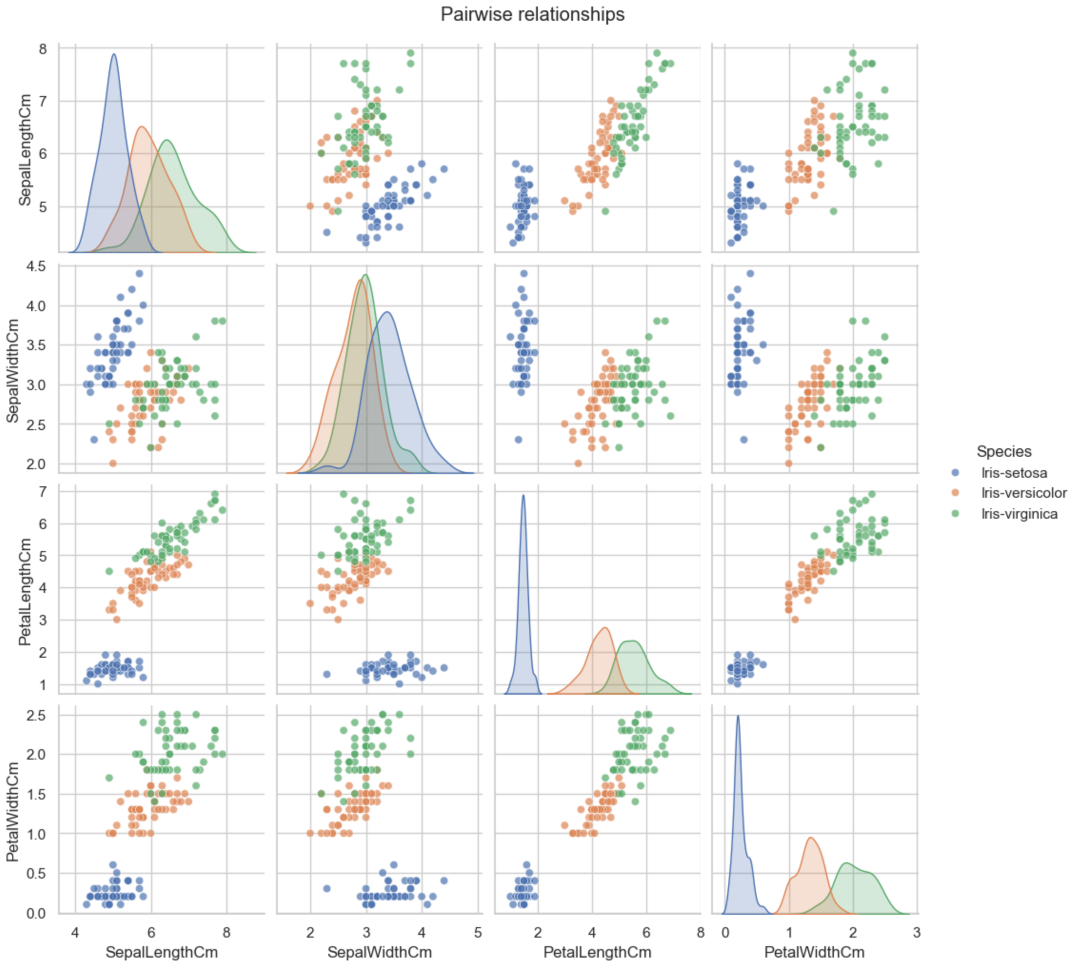
[5]:
```
sns.set(style="whitegrid")

fig, axes = plt.subplots(2, 2, figsize=(10, 7))
for ax, col in zip(axes.ravel(), features):
    sns.histplot(df[col], kde=True, ax=ax, color="steelblue")
    ax.set_title(f"Distribution of {col}")

plt.tight_layout()
plt.show()
```



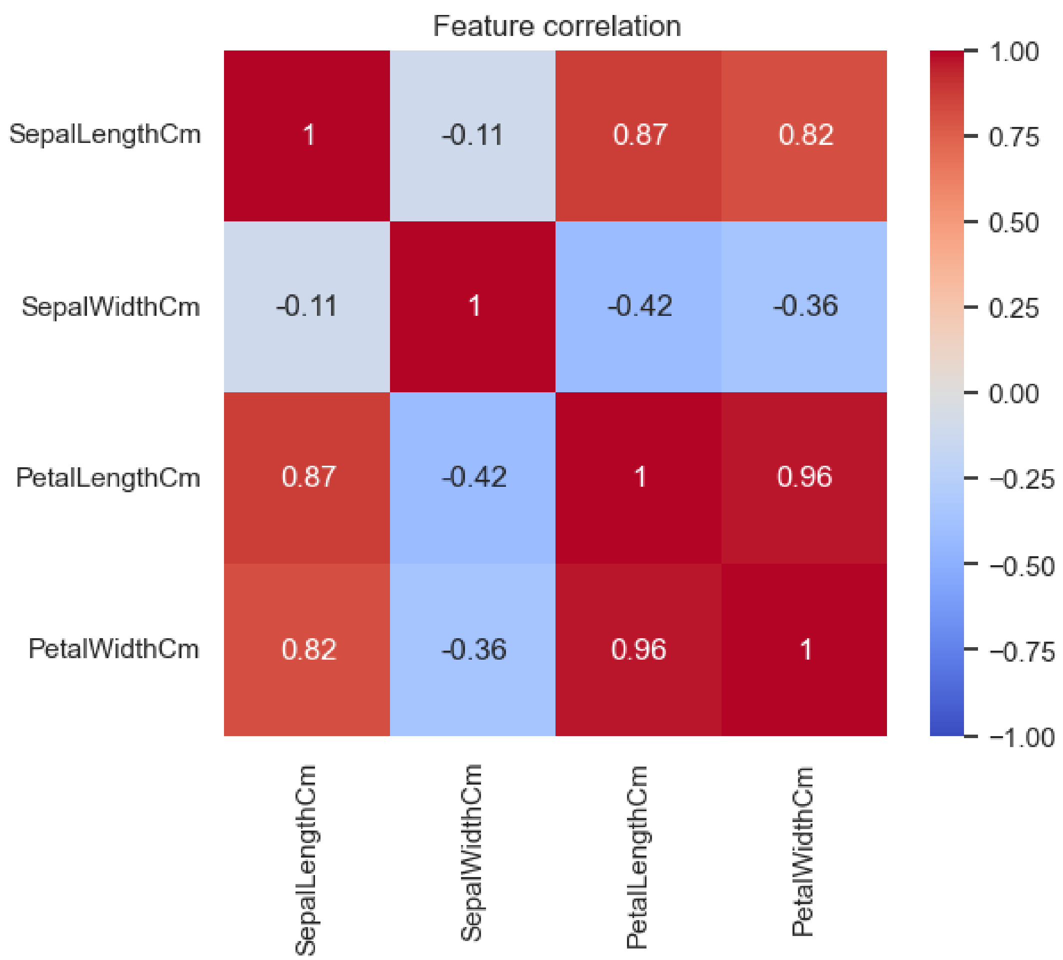
[6]:
```
plt.figure(figsize=(12, 8))

melted = df.melt(
    id_vars="Species",
    value_vars=features,
    var_name="Feature",
    value_name="Value"
)

sns.boxplot(data=melted, x="Feature", y="Value", hue="Species")
plt.title("Feature distributions by species")
plt.legend(loc="best")
plt.show()
```



[7]:
```
sns.pairplot(
    df,
    hue="Species",
    vars=features,
    diag_kind="kde",
    plot_kws={"alpha": 0.7}
)

plt.suptitle("Pairwise relationships", y=1.02)
plt.show()
```



[8]:
```
plt.figure(figsize=(6, 5))

corr = df[features].corr()
sns.heatmap(corr, annot=True, cmap="coolwarm", vmin=-1, vmax=1)

plt.title("Feature correlation")
plt.show()
```



#LOAN APPROVAL DATASET

[2]:
```
df = pd.read_csv("loan_train.csv")
df.head()
```

[2]:
```
  Customer ID               Name Gender  Age  Income (USD) Income Stability  \
0     C-36995   Frederica Shealy      F   56       1933.05              Low
1     C-33999  America Calderone      M   32       4952.91              Low
2      C-3770     Rosetta Verne       F   65        988.19             High
3     C-26480         Zoe Chitty      F   65           NaN             High
4     C-23459      Afton Venema       F   31       2614.77              Low

  Profession      Type of Employment    Location  Loan Amount Request (USD)  \
0    Working             Sales staff  Semi-Urban                   72809.58
1    Working                     NaN  Semi-Urban                   46837.47
2  Pensioner                     NaN  Semi-Urban                   45593.04
3  Pensioner                     NaN       Rural                   80057.92
4    Working  High skill tech staff  Semi-Urban                  113858.89
```

```
   ...  Credit Score No. of Defaults Has Active Credit Card  Property ID  \
0  ...        809.44               0                    NaN          746
1  ...        780.40               0            Unpossessed          608
2  ...        833.15               0            Unpossessed          546
3  ...        832.70               1            Unpossessed          890
4  ...        745.55               1                 Active          715

   Property Age  Property Type Property Location  Co-Applicant  \
0       1933.05              4             Rural             1
1       4952.91              2             Rural             1
2        988.19              2             Urban             0
3           NaN              2        Semi-Urban             1
4       2614.77              4        Semi-Urban             1

   Property Price  Loan Sanction Amount (USD)
0       119933.46                    54607.18
1        54791.00                    37469.98
2        72440.58                    36474.43
3       121441.51                    56040.54
4       208567.91                    74008.28

[5 rows x 24 columns]
```

[3]:

```python
print("Shape:", df.shape)

print("\nInfo:")
df.info()

print("\nMissing values per column:")
print(df.isnull().sum())
```

```
Shape: (30000, 24)

Info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 30000 entries, 0 to 29999
Data columns (total 24 columns):
 #   Column                       Non-Null Count  Dtype
---  ------                       --------------  -----
 0   Customer ID                  30000 non-null  object
 1   Name                         30000 non-null  object
 2   Gender                       29947 non-null  object
 3   Age                          30000 non-null  int64
 4   Income (USD)                 25424 non-null  float64
```

```
 5   Income Stability            28317 non-null  object
 6   Profession                  30000 non-null  object
 7   Type of Employment          22730 non-null  object
 8   Location                    30000 non-null  object
 9   Loan Amount Request (USD)   30000 non-null  float64
 10  Current Loan Expenses (USD) 29828 non-null  float64
 11  Expense Type 1              30000 non-null  object
 12  Expense Type 2              30000 non-null  object
 13  Dependents                  27507 non-null  float64
 14  Credit Score                28297 non-null  float64
 15  No. of Defaults             30000 non-null  int64
 16  Has Active Credit Card      28434 non-null  object
 17  Property ID                 30000 non-null  int64
 18  Property Age                25150 non-null  float64
 19  Property Type               30000 non-null  int64
 20  Property Location           29644 non-null  object
 21  Co-Applicant                30000 non-null  int64
 22  Property Price              30000 non-null  float64
 23  Loan Sanction Amount (USD)  29660 non-null  float64
dtypes: float64(8), int64(5), object(11)
memory usage: 5.5+ MB

Missing values per column:
Customer ID                     0
Name                            0
Gender                         53
Age                             0
Income (USD)                 4576
Income Stability             1683
Profession                      0
Type of Employment           7270
Location                        0
Loan Amount Request (USD)       0
Current Loan Expenses (USD)   172
Expense Type 1                  0
Expense Type 2                  0
Dependents                   2493
Credit Score                 1703
No. of Defaults                 0
Has Active Credit Card       1566
Property ID                     0
Property Age                 4850
Property Type                   0
Property Location             356
Co-Applicant                    0
```

```
Property Price                 0
Loan Sanction Amount (USD)   340
dtype: int64
```

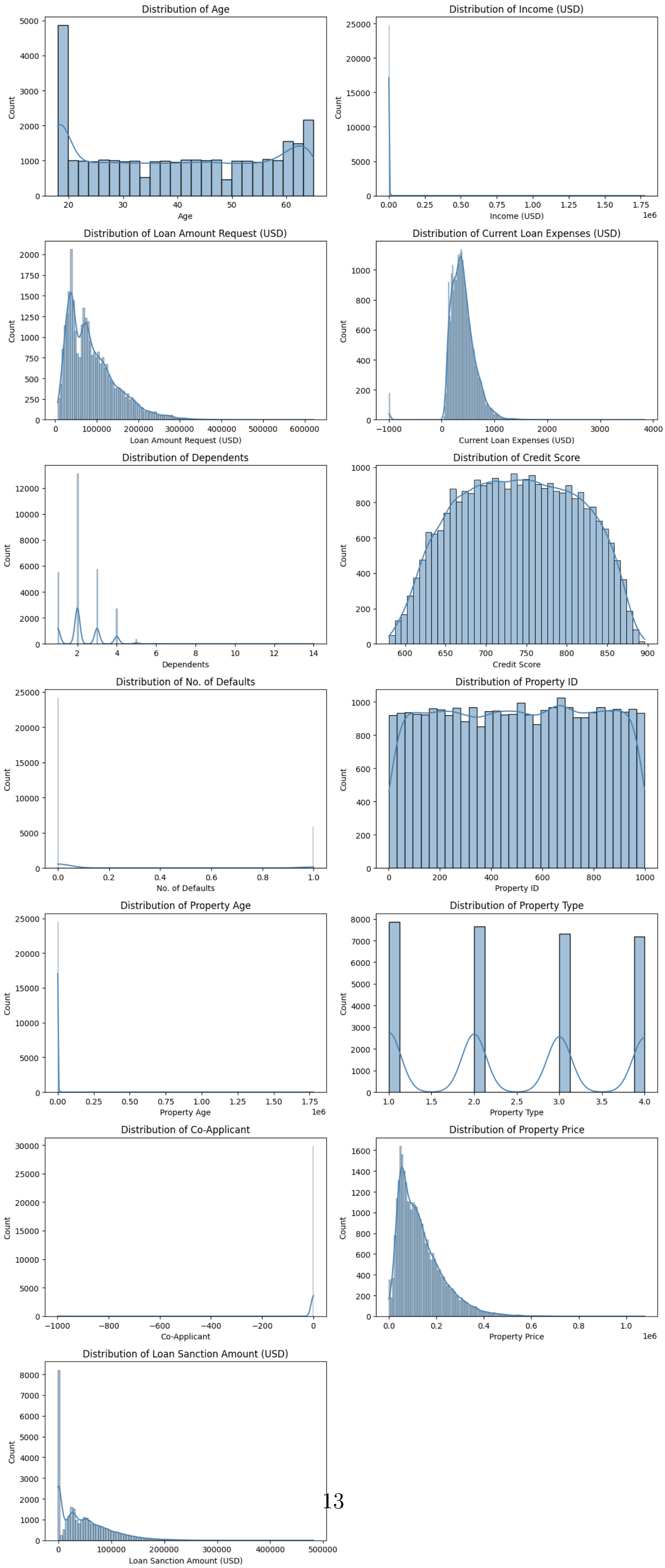
[4]:
```
df.describe(include="all")
```

[4]:
```
        Customer ID               Name Gender          Age  Income (USD)  \
count         30000              30000  29947  30000.000000  2.542400e+04
unique        30000              30000      2          NaN           NaN
top         C-36995  Frederica Shealy      M          NaN           NaN
freq              1                  1  15053          NaN           NaN
mean            NaN                NaN    NaN     40.092300  2.630574e+03
std             NaN                NaN    NaN     16.045129  1.126272e+04
min             NaN                NaN    NaN     18.000000  3.777000e+02
25%             NaN                NaN    NaN     25.000000  1.650457e+03
50%             NaN                NaN    NaN     40.000000  2.222435e+03
75%             NaN                NaN    NaN     55.000000  3.090593e+03
max             NaN                NaN    NaN     65.000000  1.777460e+06

       Income Stability Profession Type of Employment    Location  \
count             28317      30000              22730       30000
unique                2          8                 18           3
top                 Low    Working          Laborers  Semi-Urban
freq              25751      16926               5578       21563
mean                NaN        NaN                NaN         NaN
std                 NaN        NaN                NaN         NaN
min                 NaN        NaN                NaN         NaN
25%                 NaN        NaN                NaN         NaN
50%                 NaN        NaN                NaN         NaN
75%                 NaN        NaN                NaN         NaN
max                 NaN        NaN                NaN         NaN

        Loan Amount Request (USD)  ...  Credit Score No. of Defaults  \
count                30000.000000  ...  28297.000000     30000.000000
unique                        NaN  ...           NaN              NaN
top                           NaN  ...           NaN              NaN
freq                          NaN  ...           NaN              NaN
mean                 88826.333855  ...    739.885381         0.193933
std                  59536.949605  ...     72.163846         0.395384
min                   6048.240000  ...    580.000000         0.000000
25%                  41177.755000  ...    681.880000         0.000000
50%                  75128.075000  ...    739.820000         0.000000
75%                 119964.605000  ...    799.120000         0.000000
max                 621497.820000  ...    896.260000         1.000000
```

```
       Has Active Credit Card   Property ID  Property Age  Property Type  \
count                   28434  30000.000000  2.515000e+04   30000.000000
unique                      3           NaN           NaN            NaN
top                    Active           NaN           NaN            NaN
freq                     9771           NaN           NaN            NaN
mean                      NaN    501.934700  2.631119e+03       2.460067
std                       NaN    288.158086  1.132268e+04       1.118562
min                       NaN      1.000000  3.777000e+02       1.000000
25%                       NaN    251.000000  1.650450e+03       1.000000
50%                       NaN    504.000000  2.223250e+03       2.000000
75%                       NaN    751.000000  3.091408e+03       3.000000
max                       NaN    999.000000  1.777460e+06       4.000000

       Property Location  Co-Applicant  Property Price  \
count              29644  30000.000000    3.000000e+04
unique                 3           NaN             NaN
top           Semi-Urban           NaN             NaN
freq               10387           NaN             NaN
mean                 NaN     -4.743867    1.317597e+05
std                  NaN     74.614593    9.354955e+04
min                  NaN   -999.000000   -9.990000e+02
25%                  NaN      1.000000    6.057216e+04
50%                  NaN      1.000000    1.099936e+05
75%                  NaN      1.000000    1.788807e+05
max                  NaN      1.000000    1.077967e+06

        Loan Sanction Amount (USD)
count                 29660.000000
unique                         NaN
top                            NaN
freq                           NaN
mean                  47649.342208
std                   48221.146686
min                    -999.000000
25%                       0.000000
50%                   35209.395000
75%                   74261.250000
max                  481907.320000

[11 rows x 24 columns]
```

[5]:
```
numeric_cols = df.select_dtypes(include=["int64", "float64"]).columns

n_cols = 2
```

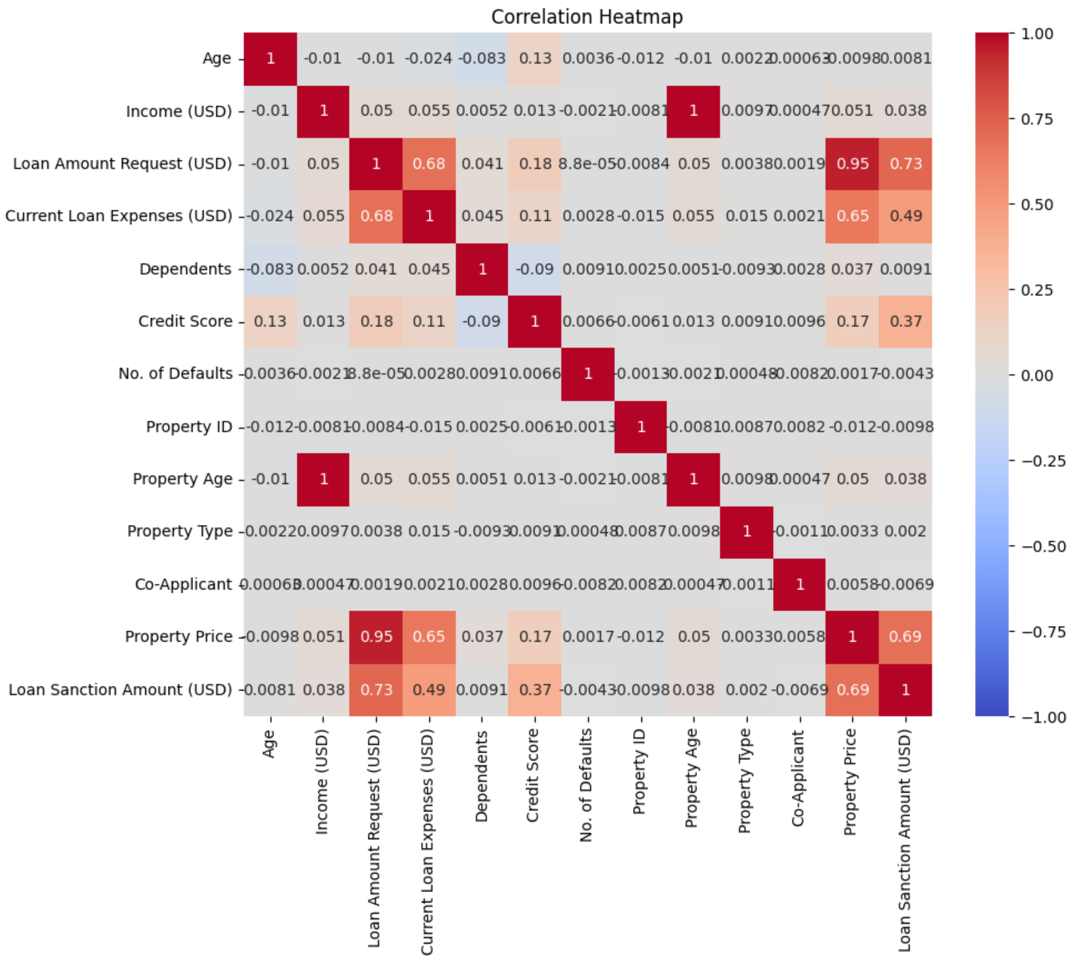
```python
n_rows = int(np.ceil(len(numeric_cols) / n_cols))

fig, axes = plt.subplots(n_rows, n_cols, figsize=(12, 4 * n_rows))
axes = axes.flatten()

for i, col in enumerate(numeric_cols):
    sns.histplot(df[col], kde=True, ax=axes[i], color="steelblue")
    axes[i].set_title(f"Distribution of {col}")

# Remove empty subplots (if any)
for j in range(i + 1, len(axes)):
    fig.delaxes(axes[j])

plt.tight_layout()
plt.show()
```



Distribution of Age
Age
Count
Distribution of Income (USD)
Income (USD)
1e6
Distribution of Loan Amount Request (USD)
Loan Amount Request (USD)
Distribution of Current Loan Expenses (USD)
Current Loan Expenses (USD)
Distribution of Dependents
Dependents
Distribution of Credit Score
Credit Score
Distribution of No. of Defaults
No. of Defaults
Distribution of Property ID
Property ID
Distribution of Property Age
Property Age
Distribution of Property Type
Property Type
Distribution of Co-Applicant
Co-Applicant
Distribution of Property Price
Property Price
Distribution of Loan Sanction Amount (USD)
Loan Sanction Amount (USD)

[6]:
```
if "Loan_Status" in df.columns:
    plt.figure(figsize=(12, 8))

    melted = df.melt(
        id_vars="Loan_Status",
        value_vars=numeric_cols,
        var_name="Feature",
        value_name="Value"
    )

    sns.boxplot(data=melted, x="Feature", y="Value", hue="Loan_Status")
    plt.title("Feature distributions by Loan Status")
    plt.xticks(rotation=45)
    plt.show()
```

[7]:
```
plt.figure(figsize=(10, 8))

corr = df[numeric_cols].corr()
sns.heatmap(corr, annot=True, cmap="coolwarm", vmin=-1, vmax=1)
plt.title("Correlation Heatmap")
plt.show()
```



#DIABETES DATASET

[8]:
```
df = pd.read_csv("diabetes.csv")
df.head()
```

[8]:
```
   Pregnancies  Glucose  BloodPressure  SkinThickness  Insulin   BMI  \
0            6      148             72             35        0  33.6
1            1       85             66             29        0  26.6
2            8      183             64              0        0  23.3
3            1       89             66             23       94  28.1
4            0      137             40             35      168  43.1

   DiabetesPedigreeFunction  Age  Outcome
0                     0.627   50        1
1                     0.351   31        0
2                     0.672   32        1
3                     0.167   21        0
4                     2.288   33        1
```

[9]:
```
print("Shape:", df.shape)

print("\nInfo:")
df.info()

print("\nMissing values per column:")
print(df.isnull().sum())
```

```
Shape: (768, 9)

Info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 768 entries, 0 to 767
Data columns (total 9 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   Pregnancies               768 non-null    int64
 1   Glucose                   768 non-null    int64
 2   BloodPressure             768 non-null    int64
 3   SkinThickness             768 non-null    int64
 4   Insulin                   768 non-null    int64
 5   BMI                       768 non-null    float64
 6   DiabetesPedigreeFunction  768 non-null    float64
 7   Age                       768 non-null    int64
 8   Outcome                   768 non-null    int64
dtypes: float64(2), int64(7)
memory usage: 54.1 KB

Missing values per column:
Pregnancies                 0
Glucose                     0
BloodPressure               0
SkinThickness               0
Insulin                     0
BMI                         0
DiabetesPedigreeFunction    0
Age                         0
Outcome                     0
dtype: int64
```

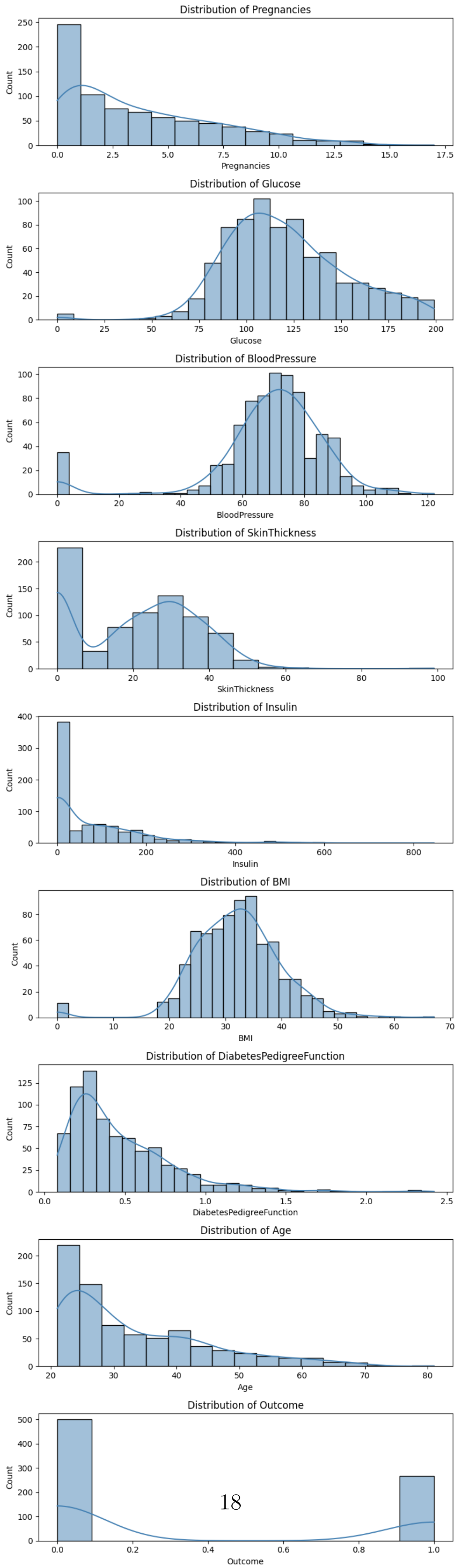
[10]:
```
df.describe(include="all")
```

[10]:
```
       Pregnancies     Glucose  BloodPressure  SkinThickness     Insulin  \
count   768.000000  768.000000     768.000000     768.000000  768.000000
mean      3.845052  120.894531      69.105469      20.536458   79.799479
```

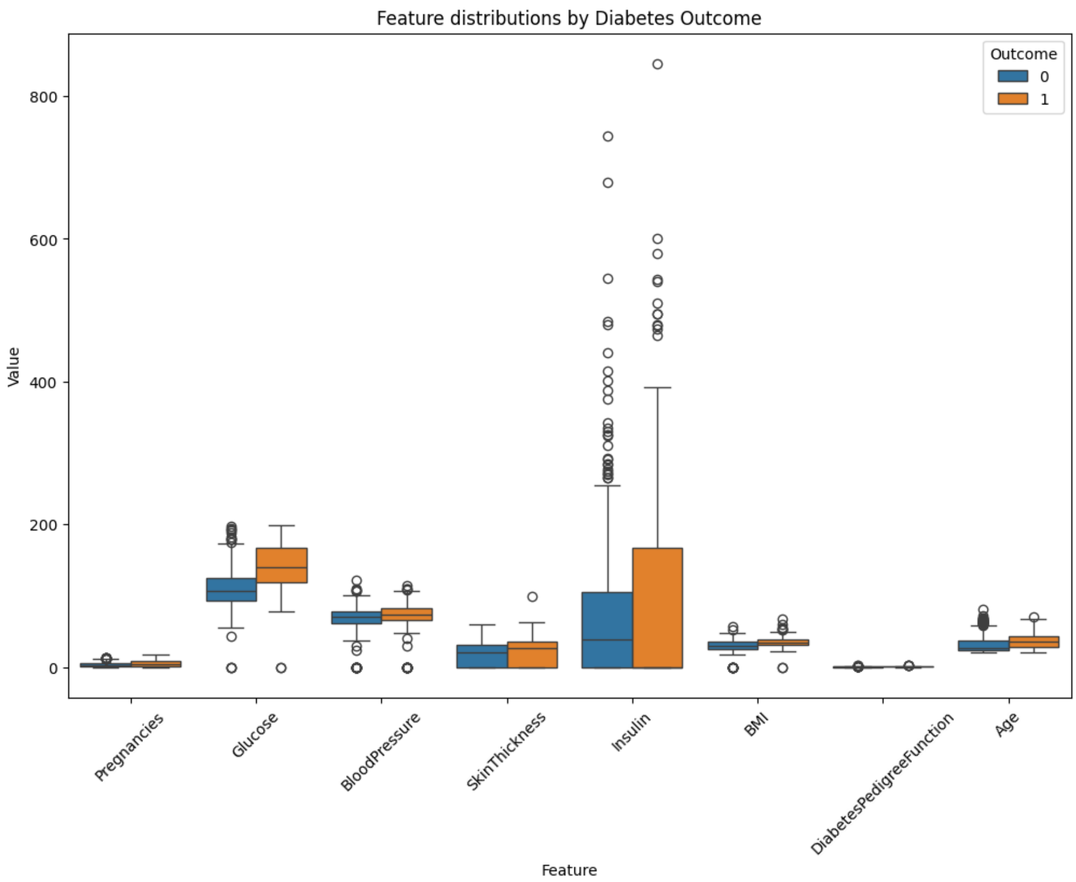
std	3.369578	31.972618	19.355807	15.952218	115.244002
min	0.000000	0.000000	0.000000	0.000000	0.000000
25%	1.000000	99.000000	62.000000	0.000000	0.000000
50%	3.000000	117.000000	72.000000	23.000000	30.500000
75%	6.000000	140.250000	80.000000	32.000000	127.250000
max	17.000000	199.000000	122.000000	99.000000	846.000000

	BMI	DiabetesPedigreeFunction	Age	Outcome
count	768.000000	768.000000	768.000000	768.000000
mean	31.992578	0.471876	33.240885	0.348958
std	7.884160	0.331329	11.760232	0.476951
min	0.000000	0.078000	21.000000	0.000000
25%	27.300000	0.243750	24.000000	0.000000
50%	32.000000	0.372500	29.000000	0.000000
75%	36.600000	0.626250	41.000000	1.000000
max	67.100000	2.420000	81.000000	1.000000

[11]:
```
numeric_cols = df.select_dtypes(include=["int64", "float64"]).columns

fig, axes = plt.subplots(len(numeric_cols), 1, figsize=(8,␣
↪3*len(numeric_cols)))

for i, col in enumerate(numeric_cols):
    sns.histplot(df[col], kde=True, ax=axes[i], color="steelblue")
    axes[i].set_title(f"Distribution of {col}")

plt.tight_layout()
plt.show()
```

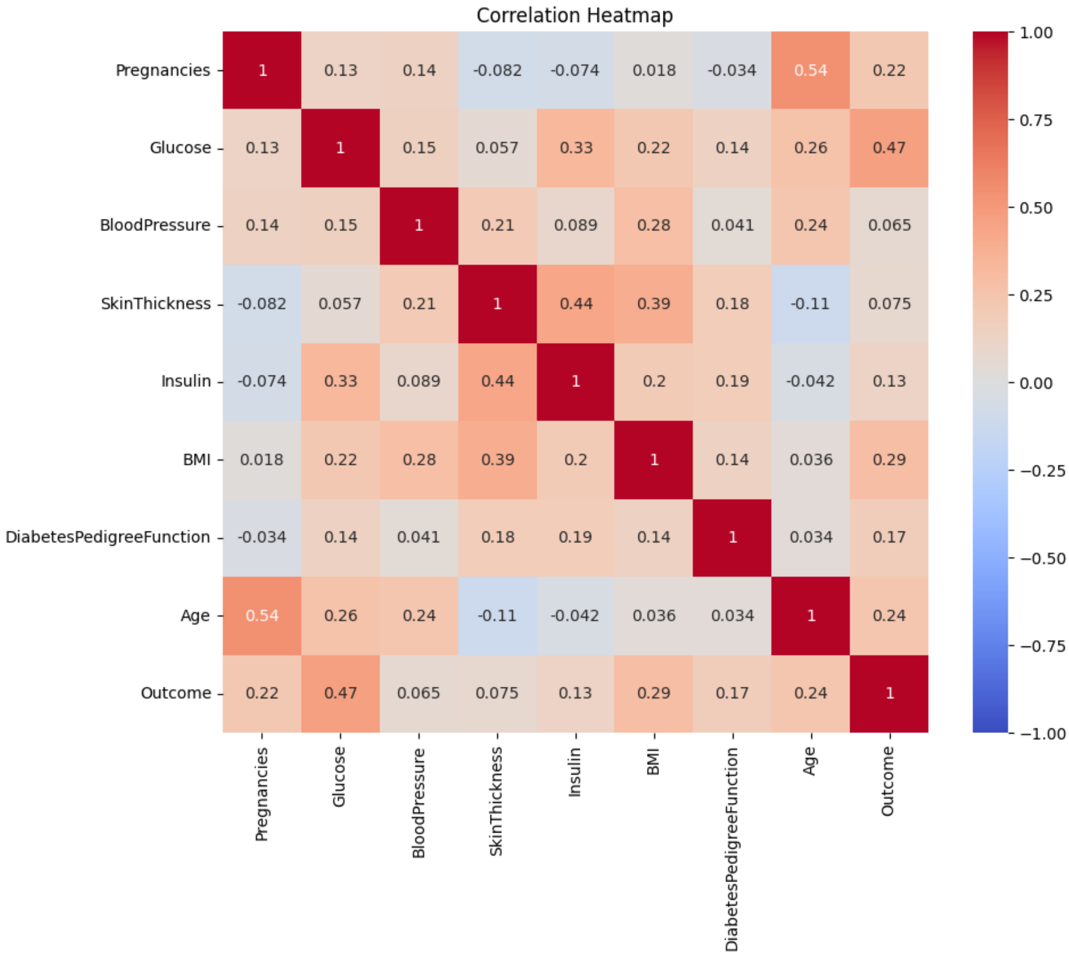

Distribution of Pregnancies
Count
Pregnancies
Distribution of Glucose
Count
Glucose
Distribution of BloodPressure
Count
BloodPressure
Distribution of SkinThickness
Count
SkinThickness
Distribution of Insulin
Count
Insulin
Distribution of BMI
Count
BMI
Distribution of DiabetesPedigreeFunction
Count
DiabetesPedigreeFunction
Distribution of Age
Count
Age
Distribution of Outcome
Count
Outcome

[12]:
```
if "Outcome" in df.columns:
    plt.figure(figsize=(12, 8))

    melted = df.melt(
        id_vars="Outcome",
        value_vars=numeric_cols,
        var_name="Feature",
        value_name="Value"
    )

    sns.boxplot(data=melted, x="Feature", y="Value", hue="Outcome")
    plt.title("Feature distributions by Diabetes Outcome")
    plt.xticks(rotation=45)
    plt.show()
```



[13]:
```
plt.figure(figsize=(10, 8))
```

```
corr = df[numeric_cols].corr()
sns.heatmap(corr, annot=True, cmap="coolwarm", vmin=-1, vmax=1)

plt.title("Correlation Heatmap")
plt.show()
```



	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
Pregnancies	1	0.13	0.14	-0.082	-0.074	0.018	-0.034	0.54	0.22
Glucose	0.13	1	0.15	0.057	0.33	0.22	0.14	0.26	0.47
BloodPressure	0.14	0.15	1	0.21	0.089	0.28	0.041	0.24	0.065
SkinThickness	-0.082	0.057	0.21	1	0.44	0.39	0.18	-0.11	0.075
Insulin	-0.074	0.33	0.089	0.44	1	0.2	0.19	-0.042	0.13
BMI	0.018	0.22	0.28	0.39	0.2	1	0.14	0.036	0.29
DiabetesPedigreeFunction	-0.034	0.14	0.041	0.18	0.19	0.14	1	0.034	0.17
Age	0.54	0.26	0.24	-0.11	-0.042	0.036	0.034	1	0.24
Outcome	0.22	0.47	0.065	0.075	0.13	0.29	0.17	0.24	1

[14]:
```
categorical_cols = df.select_dtypes(include=["object"]).columns

for col in categorical_cols:
    plt.figure(figsize=(6, 4))
    sns.countplot(data=df, x=col, hue="Outcome" if "Outcome" in df.columns␣
↪else None)
    plt.title(f"Counts of {col}")
    plt.xticks(rotation=45)
    plt.show()
```

#EMAIL CLASSIFICATION

[15]:
```
df = pd.read_csv("email.csv")
df.head()
```

[15]:

	Category	Message
0	ham	Go until jurong point, crazy.. Available only ...
1	ham	Ok lar... Joking wif u oni...
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...
3	ham	U dun say so early hor... U c already then say...
4	ham	Nah I don't think he goes to usf, he lives aro...

[16]:
```
print("Shape:", df.shape)
df.info()

print("\nMissing values:")
print(df.isnull().sum())
```

```
Shape: (5572, 2)
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5572 entries, 0 to 5571
Data columns (total 2 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   Category  5572 non-null   object
 1   Message   5572 non-null   object
dtypes: object(2)
memory usage: 87.2+ KB

Missing values:
Category    0
Message     0
dtype: int64
```

[17]:
```
df.describe(include="all")
```

[17]:

	Category	Message
count	5572	5572
unique	2	5157
top	ham	Sorry, I'll call later
freq	4825	30

[18]:
```
numeric_cols = df.select_dtypes(include=["int64", "float64"]).columns

if len(numeric_cols) > 0:
    rows = math.ceil(len(numeric_cols)/2)
    fig, axes = plt.subplots(rows, 2, figsize=(12, 4*rows))
    axes = axes.ravel()
```

```
for i, col in enumerate(numeric_cols):
    sns.histplot(df[col], kde=True, ax=axes[i], color="steelblue")
    axes[i].set_title(f"Distribution of {col}")

for j in range(i+1, len(axes)):
    fig.delaxes(axes[j])

plt.tight_layout()
plt.show()
```

[19]:
```
if len(numeric_cols) > 0:
    plt.figure(figsize=(10, 8))
    corr = df[numeric_cols].corr()
    sns.heatmap(corr, annot=True, cmap="coolwarm", vmin=-1, vmax=1)
    plt.title("Correlation Heatmap")
    plt.show()
```

#HANDWRITING RECOGNITION

[22]:
```
df = pd.read_csv("english.csv")
df.head()
```

[22]:
```
                image label
0  Img/img001-001.png     0
1  Img/img001-002.png     0
2  Img/img001-003.png     0
3  Img/img001-004.png     0
4  Img/img001-005.png     0
```

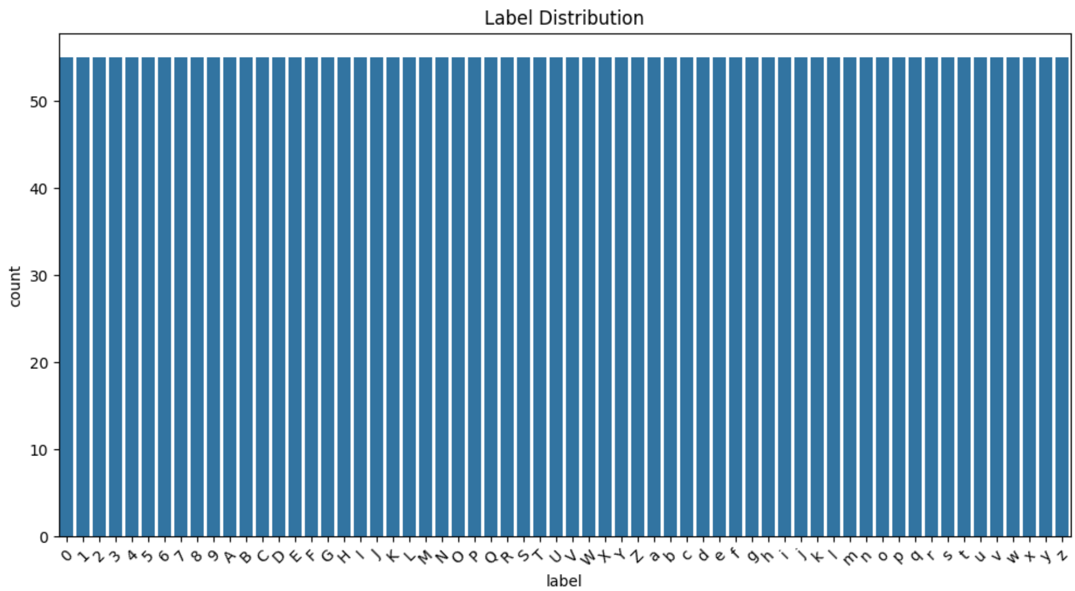
[23]:
```
print("Shape:", df.shape)
df.info()

print("\nMissing values:")
print(df.isnull().sum())
```

```
Shape: (3410, 2)
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3410 entries, 0 to 3409
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   image   3410 non-null   object
 1   label   3410 non-null   object
dtypes: object(2)
memory usage: 53.4+ KB
```

```
Missing values:
image    0
label    0
dtype: int64
```

[24]:

```python
plt.figure(figsize=(12, 6))
sns.countplot(data=df, x="label", order=df["label"].value_counts().index)
plt.title("Label Distribution")
plt.xticks(rotation=45)
plt.show()
```



[25]:

```python
def show_samples(df, labels, samples_per_label=5):
    fig, axes = plt.subplots(
        len(labels), samples_per_label,
        figsize=(samples_per_label*2, len(labels)*2)
    )

    for i, label in enumerate(labels):
        subset = df[df["label"] == label].sample(samples_per_label, random_state=42)
        for j, img_path in enumerate(subset["image"].values):
            path = "handwritten/" + img_path
            if os.path.exists(path):
                img = cv2.imread(path, cv2.IMREAD_GRAYSCALE)
                axes[i, j].imshow(img, cmap="gray")
                axes[i, j].axis("off")
```

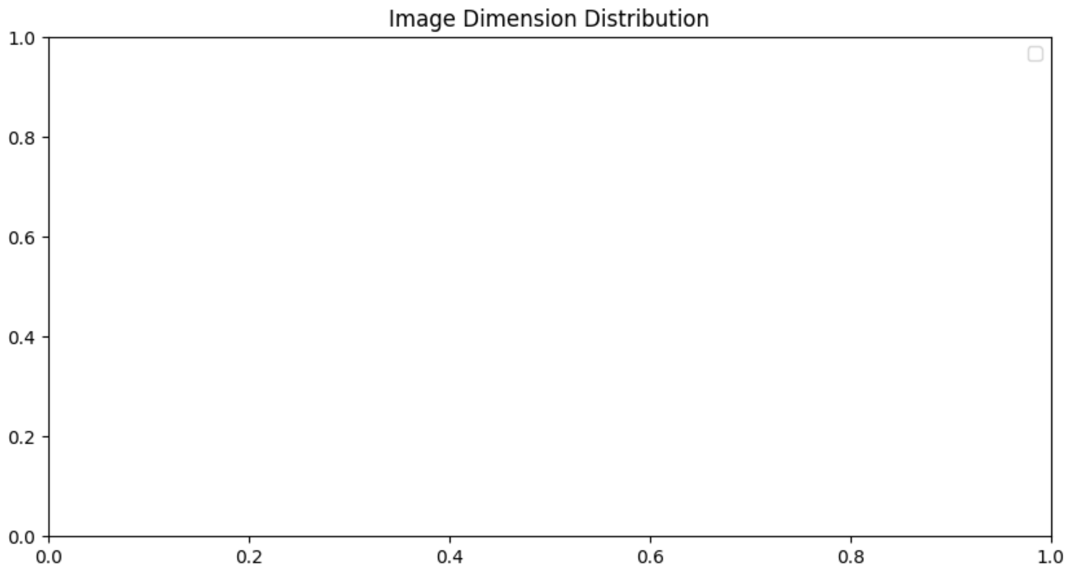
```python
                axes[i, j].set_title(str(label))
            else:
                axes[i, j].text(0.5, 0.5, "Missing", ha="center", va="center")
                axes[i, j].axis("off")

    plt.tight_layout()
    plt.show()
```

[26]:
```python
unique_labels = df["label"].unique()
show_samples(df, unique_labels[:5], samples_per_label=5)
```

[29]:
```python
heights, widths = [], []

for img_path in df["image"].sample(min(200, len(df)), random_state=42):
    path = "handwritten/" + img_path
```

```
    if os.path.exists(path):
        img = cv2.imread(path)
        if img is not None:
            h, w = img.shape[:2]
            heights.append(h)
            widths.append(w)

plt.figure(figsize=(10, 5))

ax = sns.histplot(heights, kde=True, color="steelblue", label="Heights")
sns.histplot(widths, kde=True, color="orange", label="Widths", ax=ax)

ax.legend()
ax.set_title("Image Dimension Distribution")

plt.show()
```

```
C:\Users\Sabarithan P\AppData\Local\Temp\ipykernel_1392\2171688439.py:17:
UserWarning: No artists with labels found to put in legend.  Note that artists
whose label start with an underscore are ignored when legend() is called with no
argument.
  ax.legend()
```



[ ]: