BƯỚC 1: Tải dữ liệu

In [ ]:

```
import numpy as np
import pandas as pd

from google.colab import drive
drive.mount('/content/drive')
%cd /content/drive/MyDrive/Colab Notebooks/DataScience/preprocessing
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, cal
l drive.mount("/content/drive", force_remount=True).
/content/drive/MyDrive/Colab Notebooks/DataScience/preprocessing
```

In [ ]:

```
df = pd.read_csv("achive.csv")
df[26:36]
```

Out[ ]:

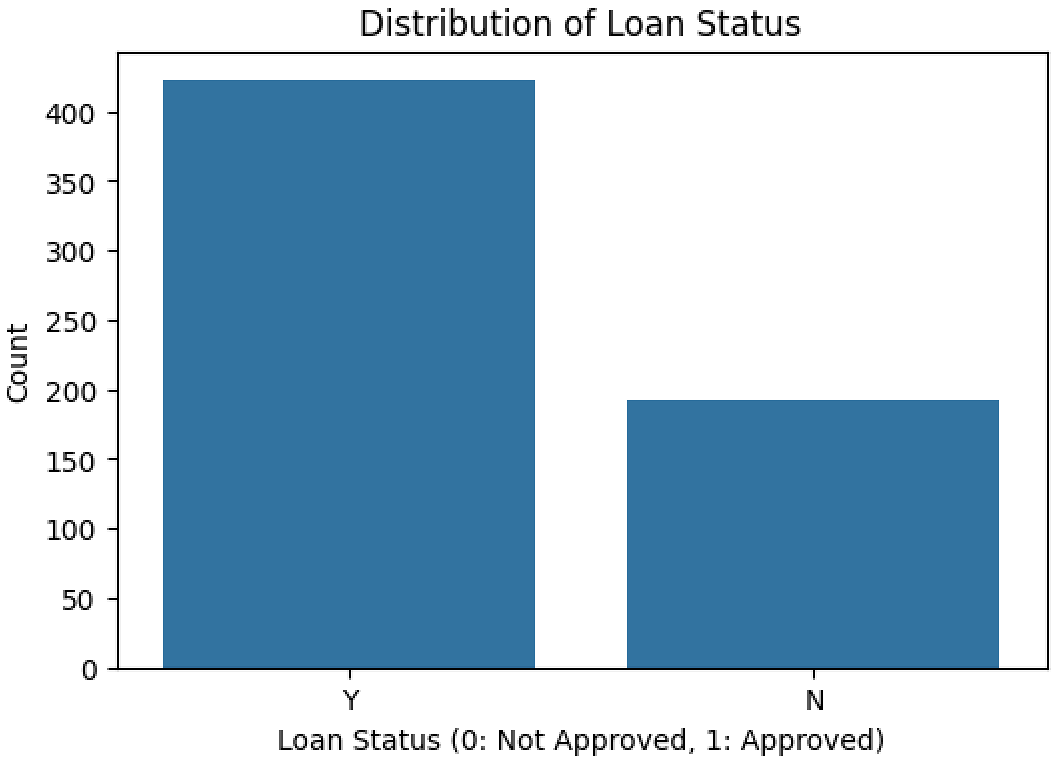
	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantInco
26	LP001068	Male	Yes	0	Graduate	No	27
27	LP001073	Male	Yes	2	Not Graduate	No	42
28	LP001086	Male	No	0	Not Graduate	No	14
29	LP001087	Female	No	2	Graduate	NaN	37
30	LP001091	Male	Yes	1	Graduate	NaN	41
31	LP001095	Male	No	0	Graduate	No	31
32	LP001097	Male	No	1	Graduate	Yes	46
33	LP001098	Male	Yes	0	Graduate	No	35
34	LP001100	Male	No	3+	Graduate	No	125
35	LP001106	Male	Yes	0	Graduate	No	22

Đây là bộ dữ liệu Loan Approval dùng để dự đoán hồ sơ vay có được phê duyệt hay không. Đầu tiên ta quan sát thấy tập dữ liệu có nhiều Missing Value, và có những cột có dữ liệu chưa được chuẩn hóa, ví dụ Dependents (dữ liệu lẫn 0, 1, 2 và 3+)

In [ ]:

```
import matplotlib.pyplot as plt
import seaborn as sns

plt.figure(figsize=(6, 4))
sns.countplot(x='Loan_Status', data=df)
plt.title('Distribution of Loan Status')
plt.xlabel('Loan Status (0: Not Approved, 1: Approved)')
plt.ylabel('Count')
plt.show()
```



```
In [ ]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 614 entries, 0 to 613
Data columns (total 13 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   Loan_ID            614 non-null    object 
 1   Gender             601 non-null    object 
 2   Married            611 non-null    object 
 3   Dependents         599 non-null    object 
 4   Education          614 non-null    object 
 5   Self_Employed      582 non-null    object 
 6   ApplicantIncome    614 non-null    int64  
 7   CoapplicantIncome  614 non-null    float64
 8   LoanAmount         592 non-null    float64
 9   Loan_Amount_Term   600 non-null    float64
 10  Credit_History     564 non-null    float64
 11  Property_Area      614 non-null    object 
 12  Loan_Status        614 non-null    object 
dtypes: float64(4), int64(1), object(8)
memory usage: 62.5+ KB
```

Dataset được cung cấp có nhiều cột có kiểu dữ liệu Object, điều đó khá khó xử lý đối với các mô hình ML, DL, vì vậy cũng cần được xử lý

```
In [ ]: df.describe()
```

Out[ ]:

	ApplicantIncome	CoapplicantIncome	LoanAmount	Loan_Amount_Term	Credit_
count	614.000000	614.000000	592.000000	600.00000	564
mean	5403.459283	1621.245798	146.412162	342.00000	0
std	6109.041673	2926.248369	85.587325	65.12041	0
min	150.000000	0.000000	9.000000	12.00000	0
25%	2877.500000	0.000000	100.000000	360.00000	1
50%	3812.500000	1188.500000	128.000000	360.00000	1
75%	5795.000000	2297.250000	168.000000	360.00000	1
max	81000.000000	41667.000000	700.000000	480.00000	1

In [ ]:

```python
# Explore categorical data

categorical_columns = ['Gender', 'Married', 'Dependents', 'Education', 'Self

for col in categorical_columns:
    print(f"\nColumn '{col}':")

    # Unique values
    unique_values = df[col].unique()
    print(f"  Unique values: {unique_values}")
    print(f"  Number of unique values: {len(unique_values)}")

    # Value counts and percentages
    print(" Distribution:")
    value_counts = df[col].value_counts()
    for value, count in value_counts.items():
        percentage = (count / len(df)) * 100
        print(f"    • {value}: {count} ({percentage:.1f}%)")
```

```
Column 'Gender':
  Unique values: ['Male' 'Female' nan]
  Number of unique values: 3
 Distribution:
    • Male: 489 (79.6%)
    • Female: 112 (18.2%)

Column 'Married':
  Unique values: ['No' 'Yes' nan]
  Number of unique values: 3
 Distribution:
    • Yes: 398 (64.8%)
    • No: 213 (34.7%)

Column 'Dependents':
  Unique values: ['0' '1' '2' '3+' nan]
  Number of unique values: 5
 Distribution:
    • 0: 345 (56.2%)
    • 1: 102 (16.6%)
    • 2: 101 (16.4%)
    • 3+: 51 (8.3%)

Column 'Education':
  Unique values: ['Graduate' 'Not Graduate']
  Number of unique values: 2
 Distribution:
    • Graduate: 480 (78.2%)
    • Not Graduate: 134 (21.8%)

Column 'Self_Employed':
  Unique values: ['No' 'Yes' nan]
  Number of unique values: 3
 Distribution:
    • No: 500 (81.4%)
    • Yes: 82 (13.4%)
```

BƯỚC 2: Làm sạch dữ liệu

Phần này tập trung vào việc xử lý các giá trị thiếu và loại bỏ các hàng trùng lặp trong tập dữ liệu.

Xử lý giá trị thiếu

Các giá trị thiếu trong cột số được điền bằng giá trị trung bình, trong khi các giá trị thiếu trong cột phân loại được điền bằng giá trị mode.

In [ ]:

```python
# Check for missing values
print(df.isnull().sum())

# Fill missing values in numerical columns with the mean
```

```python
numerical_cols = df.select_dtypes(include=np.number).columns
for col in numerical_cols:
    df[col].fillna(df[col].mean(), inplace=True)

# Fill missing values in categorical columns with the mode
categorical_cols = df.select_dtypes(include='object').columns
for col in categorical_cols:
    df[col].fillna(df[col].mode()[0], inplace=True)

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

```
Loan_ID               0
Gender               13
Married               3
Dependents           15
Education             0
Self_Employed        32
ApplicantIncome       0
CoapplicantIncome     0
LoanAmount           22
Loan_Amount_Term     14
Credit_History       50
Property_Area         0
Loan_Status           0
dtype: int64

Missing values after filling:
Loan_ID              0
Gender               0
Married              0
Dependents           0
Education            0
Self_Employed        0
ApplicantIncome      0
CoapplicantIncome    0
LoanAmount           0
Loan_Amount_Term     0
Credit_History       0
Property_Area        0
Loan_Status          0
dtype: int64
```

```
/tmp/ipython-input-1878815428.py:7: FutureWarning: A value is trying to be s
et on a copy of a DataFrame or Series through chained assignment using an in
place method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behave
s as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using 'd
f.method({col: value}, inplace=True)' or df[col] = df[col].method(value) ins
tead, to perform the operation inplace on the original object.


  df[col].fillna(df[col].mean(), inplace=True)
/tmp/ipython-input-1878815428.py:12: FutureWarning: A value is trying to be
set on a copy of a DataFrame or Series through chained assignment using an i
nplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behave
s as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using 'd
f.method({col: value}, inplace=True)' or df[col] = df[col].method(value) ins
tead, to perform the operation inplace on the original object.


  df[col].fillna(df[col].mode()[0], inplace=True)
```

Xóa các hàng trùng lặp

Bước này loại bỏ bất kỳ hàng trùng lặp nào khỏi tập dữ liệu để đảm bảo tính toàn vẹn của dữ liệu.

In [ ]:

```python
before = len(df)
df = df.drop_duplicates()
after = len(df)
print(f"Removed {before - after} duplicate rows.\n")
```

```
Removed 0 duplicate rows.
```

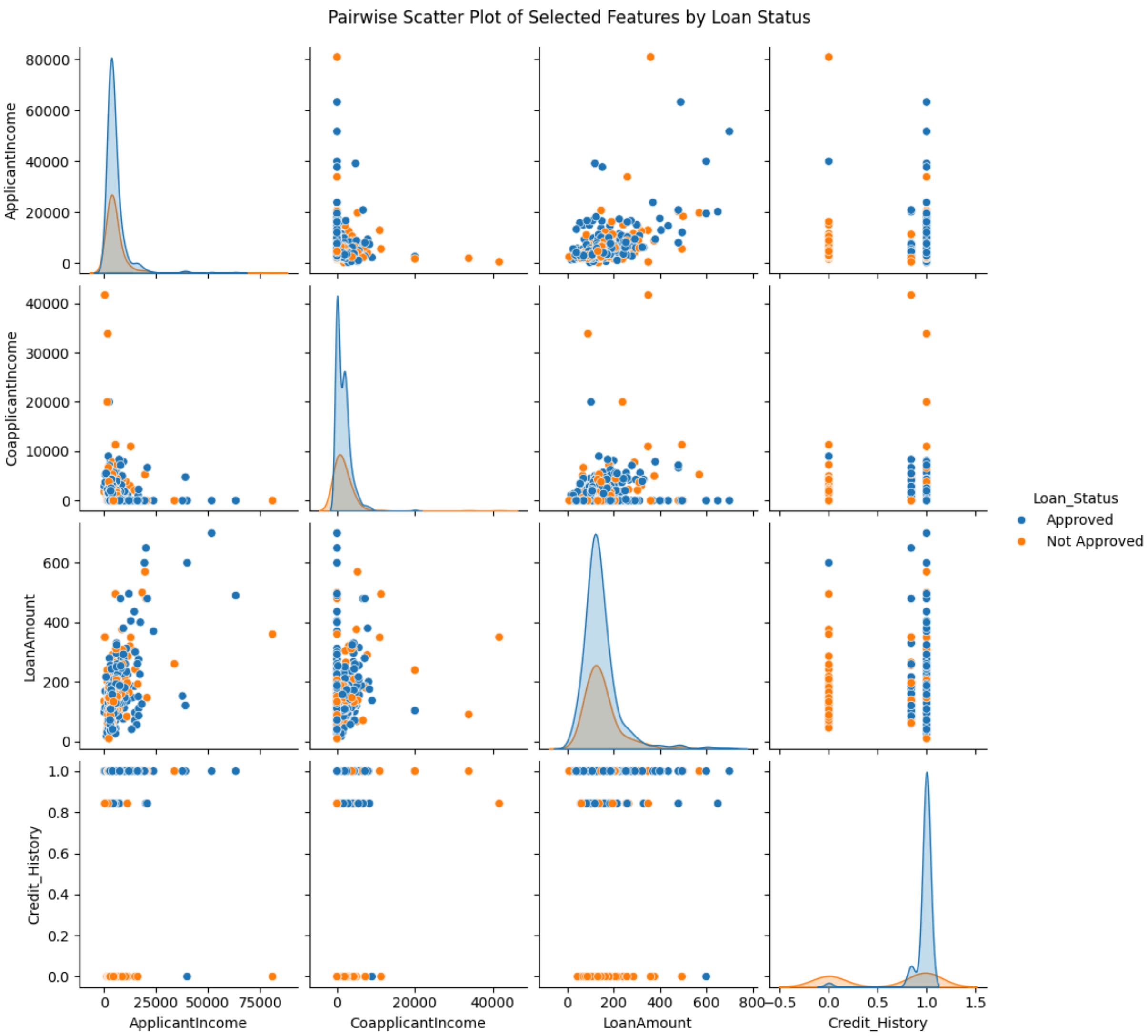
BƯỚC 3: Trực quan hóa (Visualization)

In [ ]:

```python
import seaborn as sns

columns_to_plot = ['ApplicantIncome', 'CoapplicantIncome', 'LoanAmount', 'Cr
df_subset = df[columns_to_plot].copy()
df_subset['Loan_Status'] = df_subset['Loan_Status'].map({0: 'Not Approved',
numerical_cols_subset = [col for col in columns_to_plot if df_subset[col].dt

sns.pairplot(df_subset, vars=numerical_cols_subset, hue='Loan_Status', diag_
plt.suptitle('Pairwise Scatter Plot of Selected Features by Loan Status', y=
plt.show()
```



BƯỚC 4: Chuẩn bị dữ liệu cho mô hình

Phần này chuẩn bị dữ liệu cho các mô hình học máy bằng cách tách các đặc trưng và biến mục tiêu.

Mã hóa nhãn (Label Encoding)

Sử dụng LabelEncoder để chuyển đổi các giá trị phân loại trong các cột đã chọn thành các giá trị số.

In [ ]:

```
from sklearn.preprocessing import LabelEncoder

print("\n1. LABEL ENDCODING COLUMN GENDER: ")
le_gender = LabelEncoder()
df['Gender'] = le_gender.fit_transform(df['Gender'])
print(f"   Classes learned: {le_gender.classes_}")
print(f"   Transformed values: {df['Gender'].unique()}")
print("\n2. LABEL ENDCODING COLUMN MARRIED: ")
```

```
le_married = LabelEncoder()
df['Married'] = le_married.fit_transform(df['Married'])
print(f"   Classes learned: {le_married.classes_}")
print(f"   Transformed values: {df['Married'].unique()}")

print("\n3. LABEL ENDCODING COLUMN DEPENDENTS: ")
# Replace '3+' with '3' before encoding
df['Dependents'] = df['Dependents'].replace('3+', '3')
le_dependents = LabelEncoder()
df['Dependents'] = le_dependents.fit_transform(df['Dependents'])
print(f"   Classes learned: {le_dependents.classes_}")
print(f"   Transformed values: {df['Dependents'].unique()}")

print("\n4. LABEL ENDCODING COLUMN EDUCATION: ")
le_education = LabelEncoder()
df['Education'] = le_education.fit_transform(df['Education'])
print(f"   Classes learned: {le_education.classes_}")
print(f"   Transformed values: {df['Education'].unique()}")

print("\n5. LABEL ENDCODING COLUMN SELF_EMPLOYED: ")
le_self_employed = LabelEncoder()
df['Self_Employed'] = le_self_employed.fit_transform(df['Self_Employed'])
print(f"   Classes learned: {le_self_employed.classes_}")
print(f"   Transformed values: {df['Self_Employed'].unique()}")

print("\n6. LABEL ENDCODING COLUMN PROPERTY_AREA: ")
le_property_area = LabelEncoder()
df['Property_Area'] = le_property_area.fit_transform(df['Property_Area'])
print(f"   Classes learned: {le_property_area.classes_}")
print(f"   Transformed values: {df['Property_Area'].unique()}")

print("\n7. LABEL ENDCODING COLUMN LOAN_STATUS: ")
le_loan_status = LabelEncoder()
df['Loan_Status'] = le_loan_status.fit_transform(df['Loan_Status'])
print(f"   Classes learned: {le_loan_status.classes_}")
print(f"   Transformed values: {df['Loan_Status'].unique()}")

# Display the first few rows of the transformed DataFrame
print("\nDataFrame after Label Encoding:")
display(df.head())
```

```
1. LABEL ENDCODING COLUMN GENDER:
   Classes learned: ['Female' 'Male']
   Transformed values: [1 0]

2. LABEL ENDCODING COLUMN MARRIED:
   Classes learned: ['No' 'Yes']
   Transformed values: [0 1]

3. LABEL ENDCODING COLUMN DEPENDENTS:
   Classes learned: ['0' '1' '2' '3']
   Transformed values: [0 1 2 3]

4. LABEL ENDCODING COLUMN EDUCATION:
   Classes learned: ['Graduate' 'Not Graduate']
   Transformed values: [0 1]

5. LABEL ENDCODING COLUMN SELF_EMPLOYED:
   Classes learned: ['No' 'Yes']
   Transformed values: [0 1]

6. LABEL ENDCODING COLUMN PROPERTY_AREA:
   Classes learned: ['Rural' 'Semiurban' 'Urban']
   Transformed values: [2 0 1]

7. LABEL ENDCODING COLUMN LOAN_STATUS:
   Classes learned: ['N' 'Y']
   Transformed values: [1 0]

DataFrame after Label Encoding:
```

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome
0	LP001002	1	0	0	0	0	5849
1	LP001003	1	1	1	0	0	4583
2	LP001005	1	1	0	0	1	3000
3	LP001006	1	1	0	1	0	2583
4	LP001008	1	0	0	0	0	6000

Tạo ma trận đặc trưng (X)

Chọn các cột đặc trưng và chuyển đổi chúng thành mảng NumPy.

In [58]:

```python
# Create feature matrix X
# Select feature columns and convert to NumPy array
feature = df.columns.drop("Loan_ID", "Loan_Status")
X = df[feature].values

print(f"   Shape: {X.shape}")
print(f"   Data type: {X.dtype}")
print(f"   First 5 rows:")
```

```
for i in range(5):
    print(f"   Patient {i}: {X[i]}")

print('\n')
X[0:5]
```

```
   Shape: (614, 12)
   Data type: float64
   First 5 rows:
   Patient 0: [1.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00
 0.00000000e+00 5.84900000e+03 0.00000000e+00 1.46412162e+02
 3.60000000e+02 1.00000000e+00 2.00000000e+00 1.00000000e+00]
   Patient 1: [1.000e+00 1.000e+00 1.000e+00 0.000e+00 0.000e+00 4.583e+03
1.508e+03
 1.280e+02 3.600e+02 1.000e+00 0.000e+00 0.000e+00]
   Patient 2: [1.0e+00 1.0e+00 0.0e+00 0.0e+00 1.0e+00 3.0e+03 0.0e+00 6.6e+
01 3.6e+02
 1.0e+00 2.0e+00 1.0e+00]
   Patient 3: [1.000e+00 1.000e+00 0.000e+00 1.000e+00 0.000e+00 2.583e+03
2.358e+03
 1.200e+02 3.600e+02 1.000e+00 2.000e+00 1.000e+00]
   Patient 4: [1.00e+00 0.00e+00 0.00e+00 0.00e+00 0.00e+00 6.00e+03 0.00e+0
0 1.41e+02
 3.60e+02 1.00e+00 2.00e+00 1.00e+00]
```

```
Out[58]: array([[1.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
                 0.00000000e+00, 5.84900000e+03, 0.00000000e+00, 1.46412162e+02,
                 3.60000000e+02, 1.00000000e+00, 2.00000000e+00, 1.00000000e+00],
                [1.00000000e+00, 1.00000000e+00, 1.00000000e+00, 0.00000000e+00,
                 0.00000000e+00, 4.58300000e+03, 1.50800000e+03, 1.28000000e+02,
                 3.60000000e+02, 1.00000000e+00, 0.00000000e+00, 0.00000000e+00],
                [1.00000000e+00, 1.00000000e+00, 0.00000000e+00, 0.00000000e+00,
                 1.00000000e+00, 3.00000000e+03, 0.00000000e+00, 6.60000000e+01,
                 3.60000000e+02, 1.00000000e+00, 2.00000000e+00, 1.00000000e+00],
                [1.00000000e+00, 1.00000000e+00, 0.00000000e+00, 1.00000000e+00,
                 0.00000000e+00, 2.58300000e+03, 2.35800000e+03, 1.20000000e+02,
                 3.60000000e+02, 1.00000000e+00, 2.00000000e+00, 1.00000000e+00],
                [1.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
                 0.00000000e+00, 6.00000000e+03, 0.00000000e+00, 1.41000000e+02,
                 3.60000000e+02, 1.00000000e+00, 2.00000000e+00, 1.00000000e+00]])
```

Tạo biến mục tiêu (y)

Trích xuất biến mục tiêu ('Loan_Status') và chuyển đổi nó thành mảng NumPy.

```
In [ ]: y = df['Loan_Status'].values
        y[:5]
```

```
Out[ ]: array([1, 0, 1, 1, 1])
```

Chuẩn hóa dữ liệu (Feature Scaling)

In [59]:

```
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()

X_scaled = scaler.fit_transform(X)

print("\nShape of X after Feature Scaling:", X_scaled.shape)
print("\nFirst 5 rows of X after Feature Scaling:")
print(X_scaled[:5])
```

```
Shape of X after Feature Scaling: (614, 12)

First 5 rows of X after Feature Scaling:
[[ 0.47234264 -1.37208932 -0.73780632 -0.52836225 -0.39260074  0.07299082
  -0.55448733  0.          0.27985054  0.45164045  1.22329839  0.67451931]
 [ 0.47234264  0.72881553  0.25346957 -0.52836225 -0.39260074 -0.13441195
  -0.03873155 -0.21927331  0.27985054  0.45164045 -1.31851281 -1.48253724]
 [ 0.47234264  0.72881553 -0.73780632 -0.52836225  2.54711697 -0.39374734
  -0.55448733 -0.957641    0.27985054  0.45164045  1.22329839  0.67451931]
 [ 0.47234264  0.72881553 -0.73780632  1.89264089 -0.39260074 -0.46206247
   0.2519796  -0.31454656  0.27985054  0.45164045  1.22329839  0.67451931]
 [ 0.47234264 -1.37208932 -0.73780632 -0.52836225 -0.39260074  0.09772844
  -0.55448733 -0.06445428  0.27985054  0.45164045  1.22329839  0.67451931]]
```

In [ ]: