Data Dictionary

Column	Variable	Class
age	age of customer	numeric
job	type of job	categorical: "admin.","blue-collar","entrepreneur","housemaid","management","retired","self-employed","services","student","technician","unemployed","unknown"
marital	marital status	categorical: "divorced","married","single","unknown"; note: "divorced" means divorced or widowed
education	highest degree of customer	categorical: "basic.4y","basic.6y","basic.9y","high.school","illiterate","professional.course","university.degree","unknown"
default	has credit in default?	categorical: "no","yes","unknown"
housing	has housing loan?	categorical: "no","yes","unknown"
loan	has personal loan?	categorical: "no","yes","unknown"
contact	contact communication type	categorical: "cellular","telephone"
month	last contact month of year	categorical: "jan", "feb", "mar", ..., "nov", "dec"
day_of_week	last contact day of the week	categorical: "mon","tue","wed","thu","fri"
duration	last contact duration, in seconds	numeric
campaign	number of contacts performed during this campaign and for this client	numeric, includes last contact
pdays	number of days that passed by after the client was last contacted from a previous campaign	numeric; 999 means client was not previously contacted
previous	number of contacts performed before this	numeric

Column	Variable	Class
	campaign and for this client	
poutcome	outcome of the previous marketing campaign	categorical: "failure","nonexistent","success"
emp.var.rate	employment variation rate - quarterly indicator	numeric
cons.price.idx	consumer price index - monthly indicator	numeric
cons.conf.idx	consumer confidence index - monthly indicator	numeric
euribor3m	euribor 3 month rate - daily indicator	numeric
nr.employed	number of employees - quarterly indicator	numeric
y	has the client subscribed a term deposit?	binary: "yes","no"

Motivation:

Introduction: The financial services industry is highly competitive, and effective marketing strategies play a pivotal role in achieving success. One of the key objectives for financial institutions is to attract deposits, as they serve as a stable source of funding and contribute to the overall financial health of the organization. Term deposits, in particular, offer a secure investment option for customers while providing banks with a reliable source of funds for lending and investment activities.

Importance: Optimizing marketing efforts for term deposit subscriptions is crucial for financial services firms for several reasons. Firstly, successful marketing campaigns can significantly impact the bottom line by increasing revenue through the acquisition of new deposits. Moreover, attracting term deposit customers can enhance customer engagement and loyalty, leading to long-term relationships and potential cross-selling opportunities. Additionally, by effectively targeting the right audience and promoting term deposit products, banks can strengthen their market position and competitive advantage in the industry.

Goal: My primary objective is to develop a predictive model that can accurately forecast the likelihood of a customer subscribing to a term deposit. By leveraging machine learning algorithms and analyzing historical campaign data, I aim to identify key factors that influence customers' decision-making processes. Understanding these factors will enable financial institutions to tailor their marketing strategies effectively, thereby maximizing the success of their campaigns and optimizing the allocation of resources.

Through this project, I seek to empower financial services firms with actionable insights to enhance their marketing efforts, drive customer acquisition, and ultimately achieve sustainable growth in the competitive landscape of the industry.

1. Import libary

In [ ]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import GridSearchCV
from sklearn.model_selection import RandomizedSearchCV
from sklearn.ensemble import RandomForestClassifier
```

2. Data Exploration

- Read and understand the structure of the data.
- Check for missing values and handle them if necessary.
- Examine the distribution of numerical variables.
- Calculate descriptive statistics such as mean, variance, min, max of numerical variables.

In [ ]:
```
data = open("D:\\bank-additional-full.csv")
data = pd.read_csv(data)
data.tail()
```

Out[ ]:

	age	job	marital	education	default	housing	loan	contact	month	day_of_week	...	campaign	pdays	previous	po
41183	73	retired	married	professional.course	no	yes	no	cellular	nov	fri	...	1	999	0	no
41184	46	blue-collar	married	professional.course	no	no	no	cellular	nov	fri	...	1	999	0	no
41185	56	retired	married	university.degree	no	yes	no	cellular	nov	fri	...	2	999	0	no
41186	44	technician	married	professional.course	no	no	no	cellular	nov	fri	...	1	999	0	no
41187	74	retired	married	professional.course	no	yes	no	cellular	nov	fri	...	3	999	1	

5 rows × 21 columns

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

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 41188 entries, 0 to 41187
Data columns (total 21 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   age             41188 non-null  int64  
 1   job             41188 non-null  object 
 2   marital         41188 non-null  object 
 3   education       41188 non-null  object 
 4   default         41188 non-null  object 
 5   housing         41188 non-null  object 
 6   loan            41188 non-null  object 
 7   contact         41188 non-null  object 
 8   month           41188 non-null  object 
 9   day_of_week     41188 non-null  object 
 10  duration        41188 non-null  int64  
 11  campaign        41188 non-null  int64  
 12  pdays           41188 non-null  int64  
 13  previous        41188 non-null  int64  
 14  poutcome        41188 non-null  object 
 15  emp.var.rate    41188 non-null  float64
 16  cons.price.idx  41188 non-null  float64
 17  cons.conf.idx   41188 non-null  float64
 18  euribor3m       41188 non-null  float64
 19  nr.employed     41188 non-null  float64
 20  y               41188 non-null  object 
dtypes: float64(5), int64(5), object(11)
memory usage: 6.6+ MB
```

In [ ]:
```
data.describe(include='all')
```

Out[ ]:

	age	job	marital	education	default	housing	loan	contact	month	day_of_week	...	campaign	pdays
count	41188.00000	41188	41188	41188	41188	41188	41188	41188	41188	41188	...	41188.000000	41188.000000
unique	NaN	12	4	8	3	3	3	2	10	5	...	NaN	NaN
top	NaN	admin.	married	university.degree	no	yes	no	cellular	may	thu	...	NaN	NaN
freq	NaN	10422	24928	12168	32588	21576	33950	26144	13769	8623	...	NaN	NaN
mean	40.02406	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	2.567593	962.475454
std	10.42125	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	2.770014	186.910907
min	17.00000	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	1.000000	0.000000
25%	32.00000	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	1.000000	999.000000
50%	38.00000	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	2.000000	999.000000
75%	47.00000	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	3.000000	999.000000
max	98.00000	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	56.000000	999.000000

11 rows × 21 columns

In [ ]:
```
data.isnull().sum()
```

Out[ ]:
```
age               0
job               0
marital           0
education         0
default           0
housing           0
loan              0
contact           0
month             0
day_of_week       0
duration          0
campaign          0
pdays             0
previous          0
poutcome          0
emp.var.rate      0
cons.price.idx    0
cons.conf.idx     0
euribor3m         0
nr.employed       0
y                 0
dtype: int64
```

3. Data Visualization

In [ ]:
```
# Calculate descriptive statistics for 'age'
age_stats = data['age'].describe()
print("Descriptive statistics for 'age':")
print(age_stats)
```

```
Descriptive statistics for 'age':
count    41188.00000
mean        40.02406
std         10.42125
min         17.00000
25%         32.00000
50%         38.00000
75%         47.00000
max         98.00000
Name: age, dtype: float64
```

Count the number of samples in each group of 'job', 'marital', 'education'

In [ ]:
```
group_counts = data.groupby('job').size()
print("\nNumber of samples in each group of 'job':")
print(group_counts)
```

```
Number of samples in each group of 'job':
job
admin.           10422
blue-collar       9254
entrepreneur      1456
housemaid         1060
management        2924
retired           1720
self-employed     1421
services          3969
student            875
technician        6743
unemployed        1014
unknown            330
dtype: int64
```

In [ ]:
```
group_counts = data.groupby('marital').size()
print("\nNumber of samples in each group of 'marital':")
print(group_counts)
```

```
Number of samples in each group of 'marital':
marital
divorced     4612
married     24928
single      11568
unknown        80
dtype: int64
```

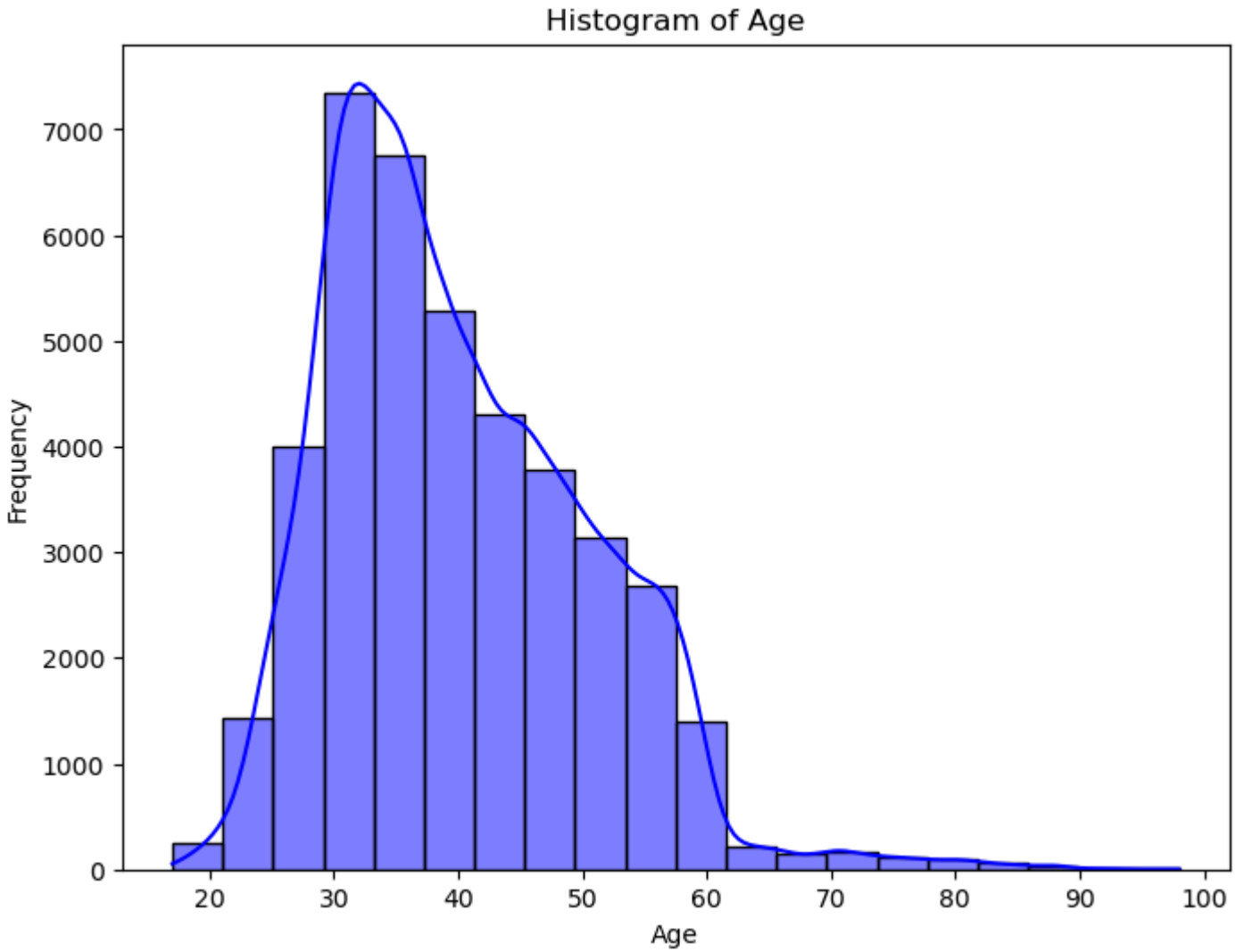
In [ ]:
```
group_counts = data.groupby('education').size()
print("\nNumber of samples in each group of 'education':")
print(group_counts)
```

```
Number of samples in each group of 'education':
education
basic.4y                4176
basic.6y                2292
basic.9y                6045
high.school             9515
illiterate                18
professional.course     5243
university.degree      12168
unknown                 1731
dtype: int64
```

In [ ]:

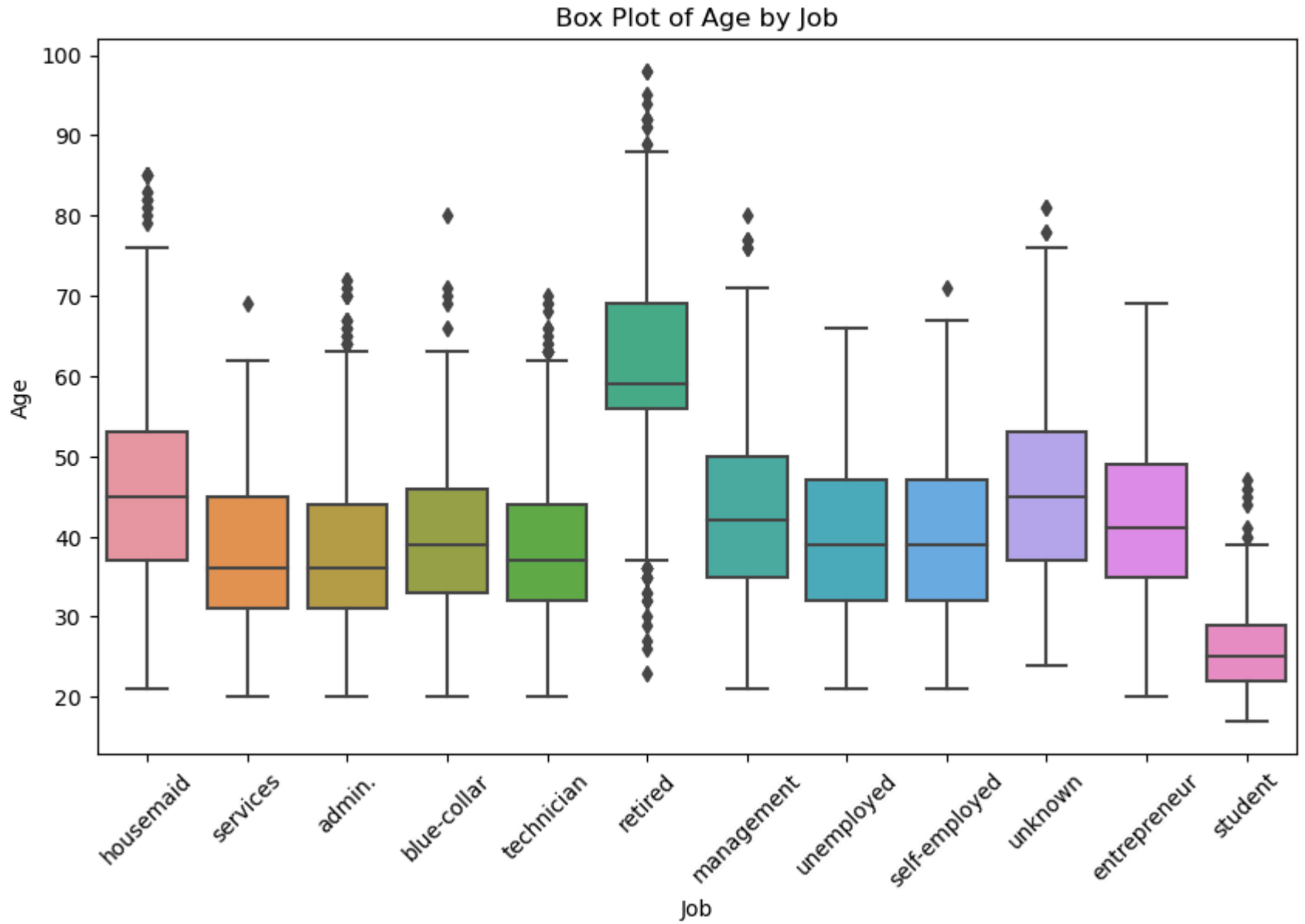
```python
# Histogram of 'age'
plt.figure(figsize=(8, 6))
sns.histplot(data['age'], bins=20, kde=True, color='blue')
plt.title('Histogram of Age')
plt.xlabel('Age')
plt.ylabel('Frequency')
plt.show()
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is deprecated and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1119: FutureWarning: use_inf_as_na option is deprecated and will be removed in a future version. Convert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
```



In [ ]:
```
# Bar plot or box plot of 'job' and 'age'
plt.figure(figsize=(10, 6))
sns.boxplot(x='job', y='age', data=data)
plt.title('Box Plot of Age by Job')
plt.xlabel('Job')
plt.ylabel('Age')
plt.xticks(rotation=45)
plt.show()
```

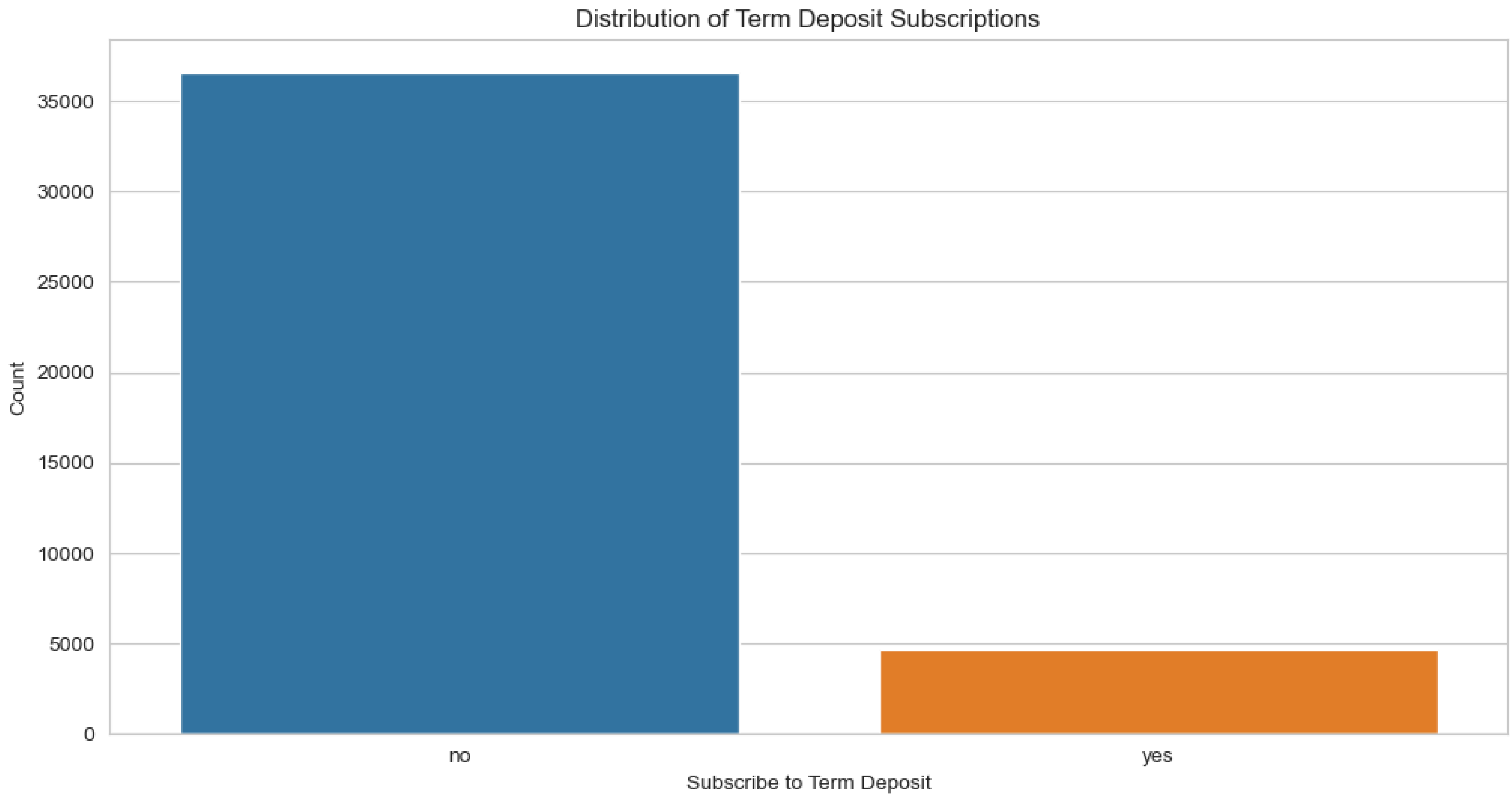
```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
```



In [ ]:
```
sns.set_style('whitegrid')

# Plot the distribution of the target variable
plt.figure(figsize=(12,6))
sns.countplot(data=data, x='y')
plt.title("Distribution of Term Deposit Subscriptions")
```

```
plt.xlabel('Subscribe to Term Deposit')
plt.ylabel('Count')
plt.show()
```

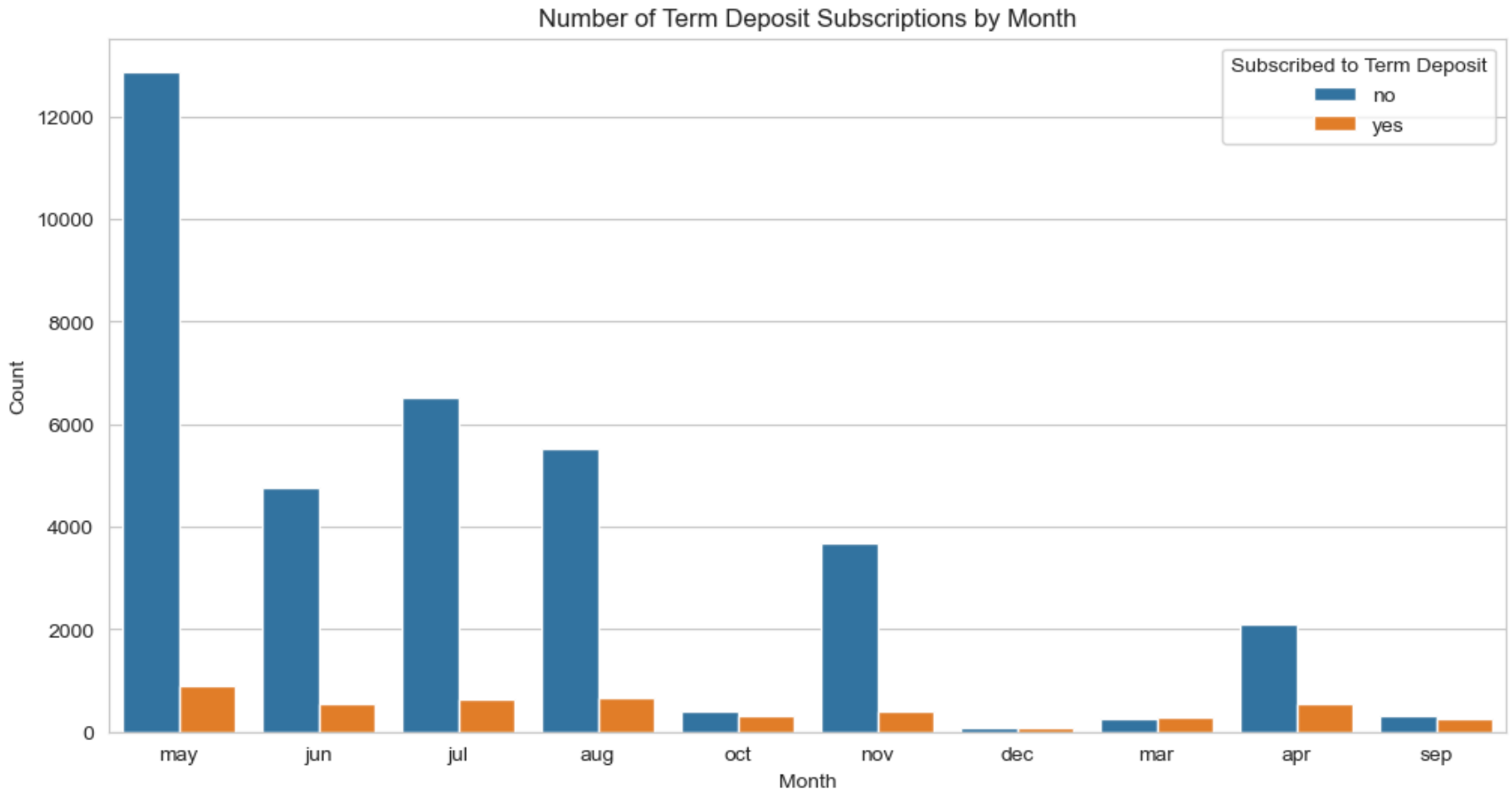
```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
```



In [ ]:
```
# Plot the number of subscribers by Month
plt.figure(figsize=(12,6))
sns.countplot(data=data, x='month', hue='y')
```

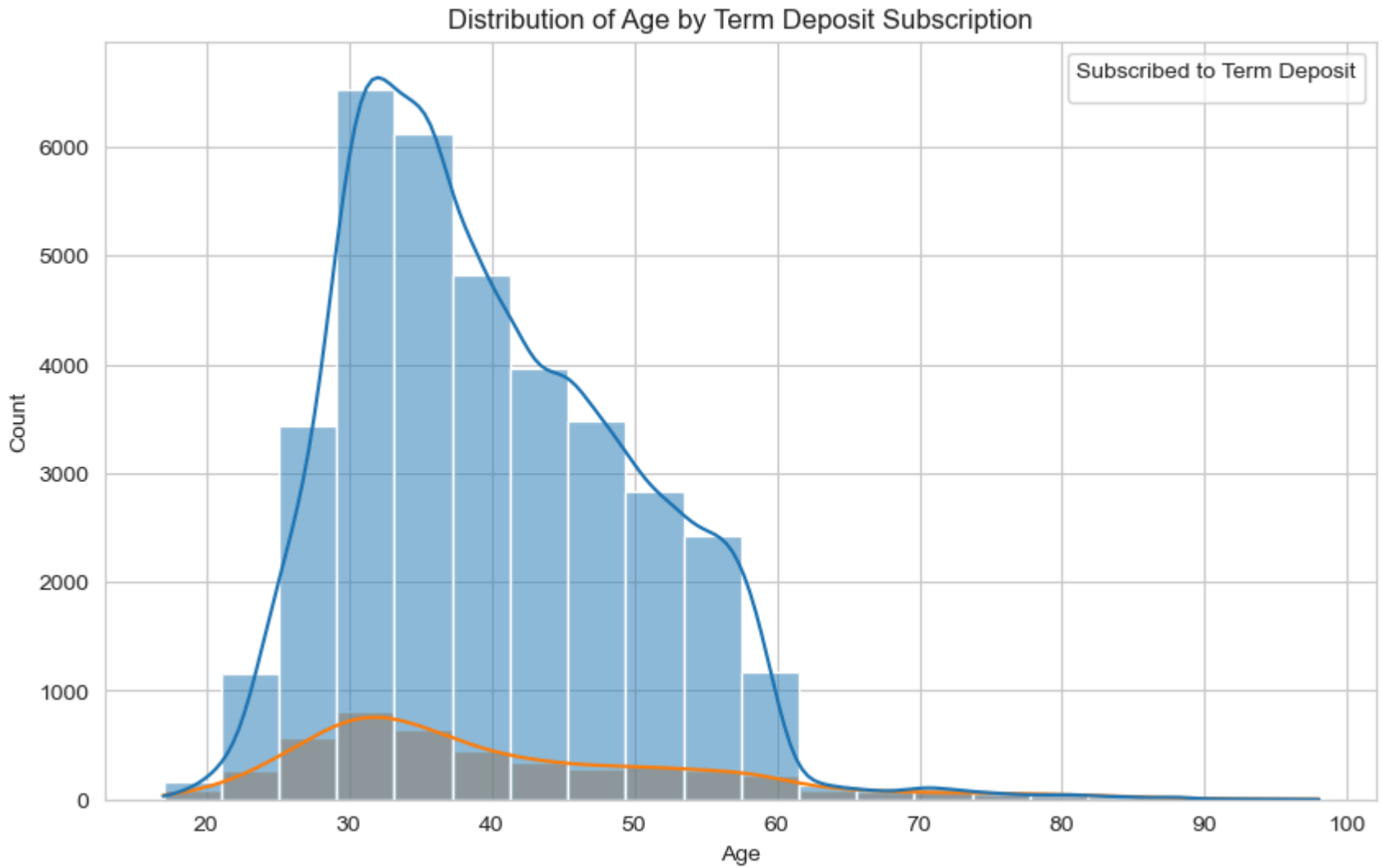
```python
plt.title('Number of Term Deposit Subscriptions by Month')
plt.xlabel('Month')
plt.ylabel('Count')
plt.legend(title='Subscribed to Term Deposit', loc='upper right')
plt.show()
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
```



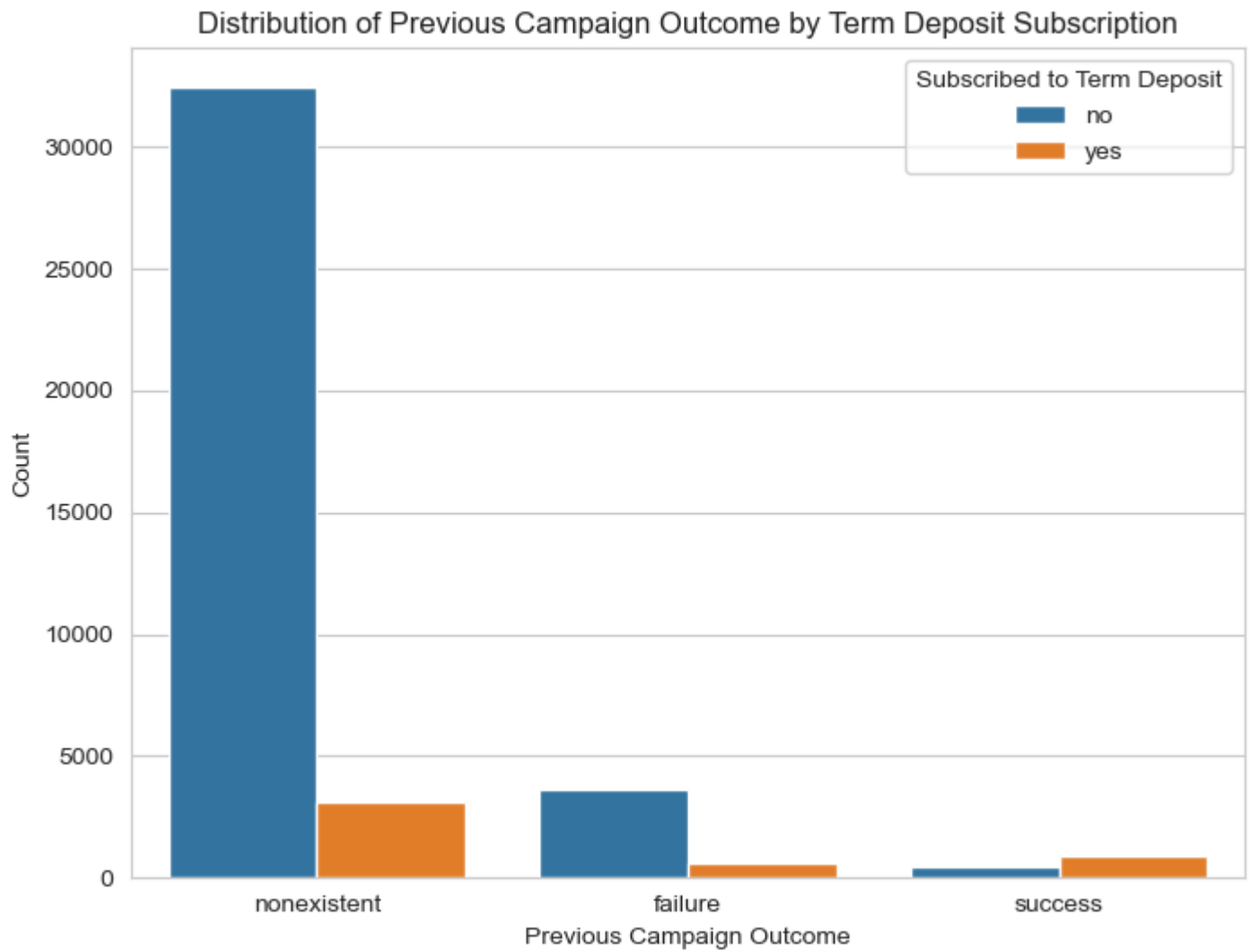
In [ ]:
```
# Plot the distribution of age for subscribers and non-subscribers
plt.figure(figsize=(10, 6))
sns.histplot(data=data, x='age', hue='y', bins=20, kde=True)
plt.title('Distribution of Age by Term Deposit Subscription')
plt.xlabel('Age')
plt.ylabel('Count')
plt.legend(title='Subscribed to Term Deposit', loc='upper right')
plt.show()
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1119: FutureWarning: use_inf_as_na option is depreca
ted and will be removed in a future version. Convert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
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.
```



In [ ]:
```
# Plot the distribution of previous campaign outcome for subscribers and non-subscribers
plt.figure(figsize=(8, 6))
sns.countplot(data=data, x='poutcome', hue='y')
plt.title('Distribution of Previous Campaign Outcome by Term Deposit Subscription')
plt.xlabel('Previous Campaign Outcome')
plt.ylabel('Count')
plt.legend(title='Subscribed to Term Deposit', loc='upper right')
plt.show()
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
```



In [ ]:
```
# Group data by subscription status (yes/no)
subscribed = data[data['y'] == 'yes']
not_subscribed = data[data['y'] == 'no']

# Compare mean age between subscribers and non-subscribers
print("Mean age of subscribers:", subscribed['age'].mean())
print("Mean age of non-subscribers:", not_subscribed['age'].mean())

# Compare distribution of contact types between subscribers and non-subscribers
contact_distribution_subscribed = subscribed['contact'].value_counts(normalize=True)
contact_distribution_not_subscribed = not_subscribed['contact'].value_counts(normalize=True)
```

```
print("\nDistribution of contact types among subscribers:")
print(contact_distribution_subscribed)
print("\nDistribution of contact types among non-subscribers:")
print(contact_distribution_not_subscribed)
```

```
Mean age of subscribers: 40.91314655172414
Mean age of non-subscribers: 39.911185290576775

Distribution of contact types among subscribers:
contact
cellular     0.830388
telephone    0.169612
Name: proportion, dtype: float64

Distribution of contact types among non-subscribers:
contact
cellular     0.60991
telephone    0.39009
Name: proportion, dtype: float64
```

In [ ]:

```
from sklearn.ensemble import RandomForestClassifier

# Prepare data for modeling
X = data.drop(columns=['y'])  # Features
y = data['y']  # Target variable

# Encode categorical variables
X_encoded = pd.get_dummies(X)

# Initialize and train Random Forest model
rf_model = RandomForestClassifier(random_state=42)
rf_model.fit(X_encoded, y)

# Get feature importances
feature_importances = rf_model.feature_importances_

# Create a DataFrame to display feature importances
feature_importance_df = pd.DataFrame({'Feature': X_encoded.columns, 'Importance': feature_importances})
feature_importance_df = feature_importance_df.sort_values(by='Importance', ascending=False)

# Display the top features
print("Top features influencing subscription likelihood:")
print(feature_importance_df.head(10))
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

```
Top features influencing subscription likelihood:
             Feature  Importance
1           duration    0.282914
8          euribor3m    0.097433
0                age    0.081052
9        nr.employed    0.048068
2           campaign    0.040044
3              pdays    0.030514
5       emp.var.rate    0.025021
7      cons.conf.idx    0.023299
6     cons.price.idx    0.022579
62  poutcome_success    0.014163
```

3. Data Preprocessing

- Convert categorical variables into numerical form to use machine learning algorithms.
- Normalize the data if necessary.
- Split the data into training and testing sets.

In [ ]:

```
base_data = data.copy()
categorical_cols = ['age','job','marital','education','default','housing','loan','contact','month','day_of_week']
result_col = ['y']
all_cols = categorical_cols + result_col

base_data = base_data[all_cols]
```

```
base_data.shape
```

Out[ ]:
```
(41188, 11)
```

In [ ]:
```
# check unique type
for cols in base_data:
    print(base_data[cols].unique())
```

```
[56 57 37 40 45 59 41 24 25 29 35 54 46 50 39 30 55 49 34 52 58 32 38 44
 42 60 53 47 51 48 33 31 43 36 28 27 26 22 23 20 21 61 19 18 70 66 76 67
 73 88 95 77 68 75 63 80 62 65 72 82 64 71 69 78 85 79 83 81 74 17 87 91
 86 98 94 84 92 89]
['housemaid' 'services' 'admin.' 'blue-collar' 'technician' 'retired'
 'management' 'unemployed' 'self-employed' 'unknown' 'entrepreneur'
 'student']
['married' 'single' 'divorced' 'unknown']
['basic.4y' 'high.school' 'basic.6y' 'basic.9y' 'professional.course'
 'unknown' 'university.degree' 'illiterate']
['no' 'unknown' 'yes']
['no' 'yes' 'unknown']
['no' 'yes' 'unknown']
['telephone' 'cellular']
['may' 'jun' 'jul' 'aug' 'oct' 'nov' 'dec' 'mar' 'apr' 'sep']
['mon' 'tue' 'wed' 'thu' 'fri']
['no' 'yes']
```

In [ ]:
```
# drop "unknown"
base_data = base_data.replace({'marital': {'unknown':np.nan}})
base_data = base_data.replace({'education': {'unknown':np.nan}})
base_data = base_data.replace({'job': {'unknown':np.nan}})
base_data = base_data.replace({'default': {'unknown':np.nan}})
base_data = base_data.replace({'housing': {'unknown':np.nan}})
base_data = base_data.replace({'loan': {'unknown':np.nan}})
base_data = base_data.dropna()
base_data.shape
```

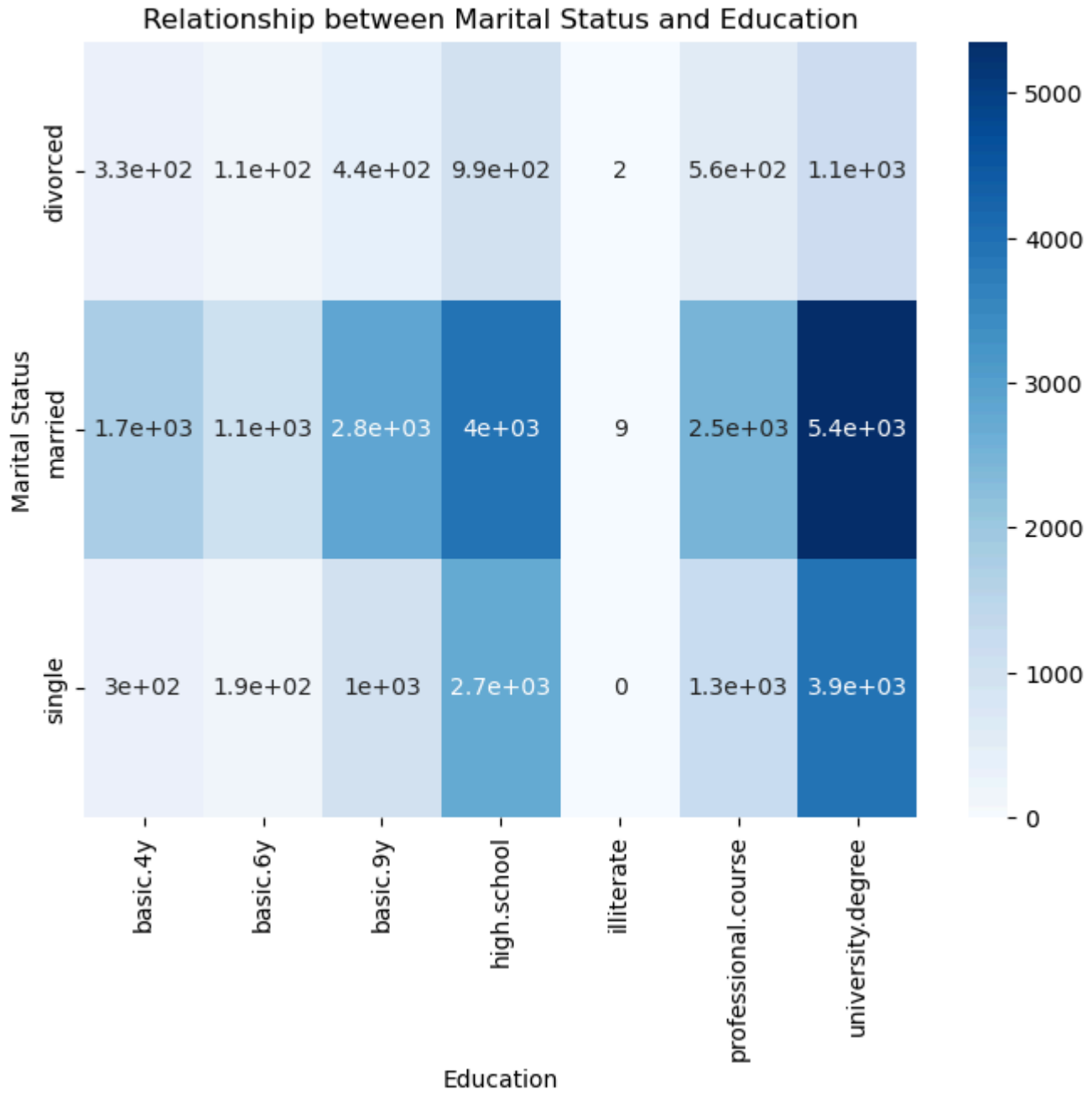
Out[ ]:
```
(30488, 11)
```

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

```
<class 'pandas.core.frame.DataFrame'>
Index: 30488 entries, 0 to 41187
Data columns (total 11 columns):
 #   Column       Non-Null Count  Dtype 
---  ------       --------------  ----- 
 0   age          30488 non-null  int64 
 1   job          30488 non-null  object
 2   marital      30488 non-null  object
 3   education    30488 non-null  object
 4   default      30488 non-null  object
 5   housing      30488 non-null  object
 6   loan         30488 non-null  object
 7   contact      30488 non-null  object
 8   month        30488 non-null  object
 9   day_of_week  30488 non-null  object
 10  y            30488 non-null  object
dtypes: int64(1), object(10)
memory usage: 2.8+ MB
```

In [ ]:

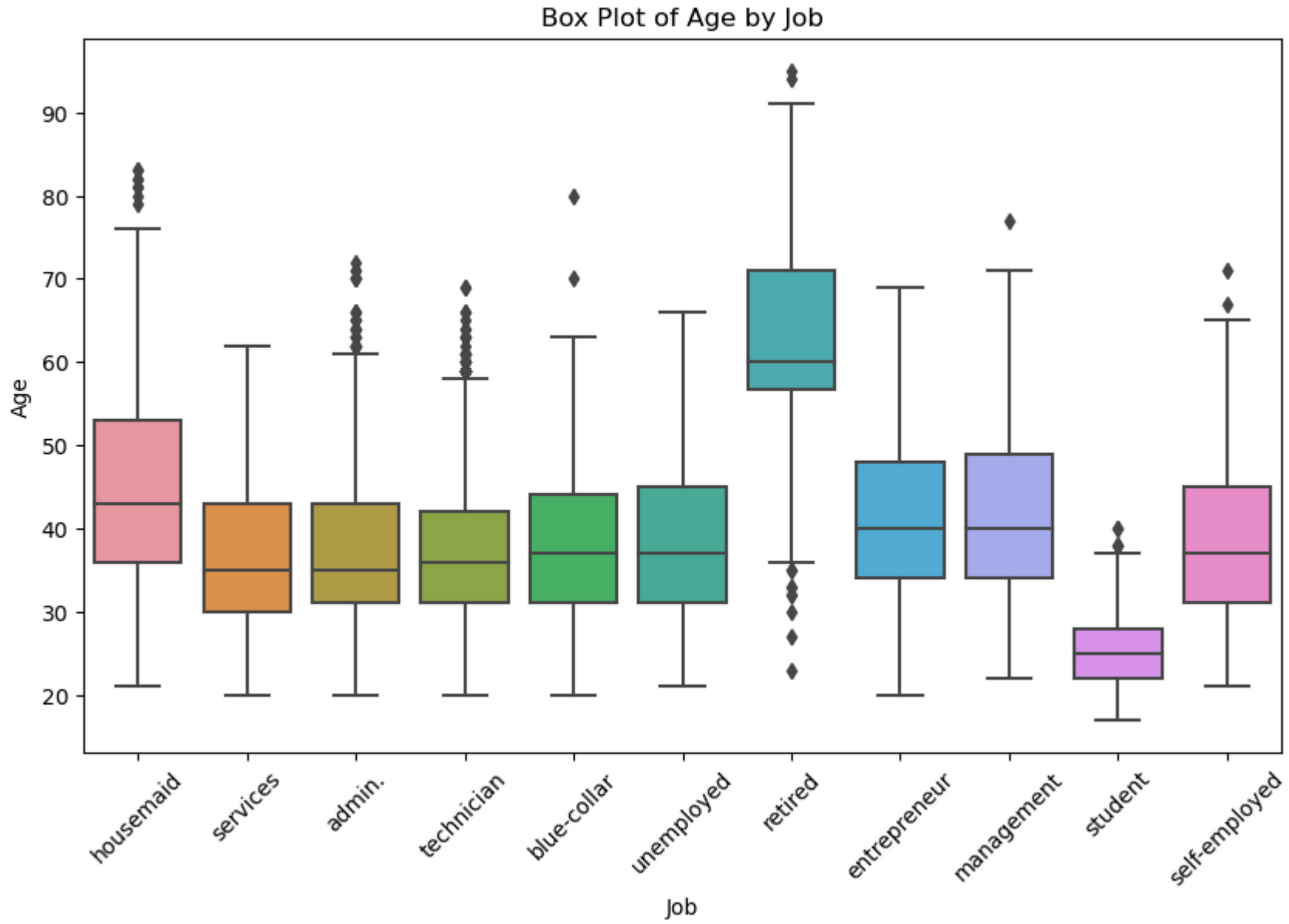
```python
# Heatmap or count plot of 'marital' and 'education'
plt.figure(figsize=(8, 6))
sns.heatmap(pd.crosstab(base_data['marital'], base_data['education']), annot=True, cmap='Blues')
plt.title('Relationship between Marital Status and Education')
plt.xlabel('Education')
plt.ylabel('Marital Status')
plt.show()
```



In [ ]:
```
# Bar plot or box plot of 'job' and 'age'
plt.figure(figsize=(10, 6))
sns.boxplot(x='job', y='age', data=base_data)
```

```python
plt.title('Box Plot of Age by Job')
plt.xlabel('Job')
plt.ylabel('Age')
plt.xticks(rotation=45)
plt.show()
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is depreca
ted and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
```

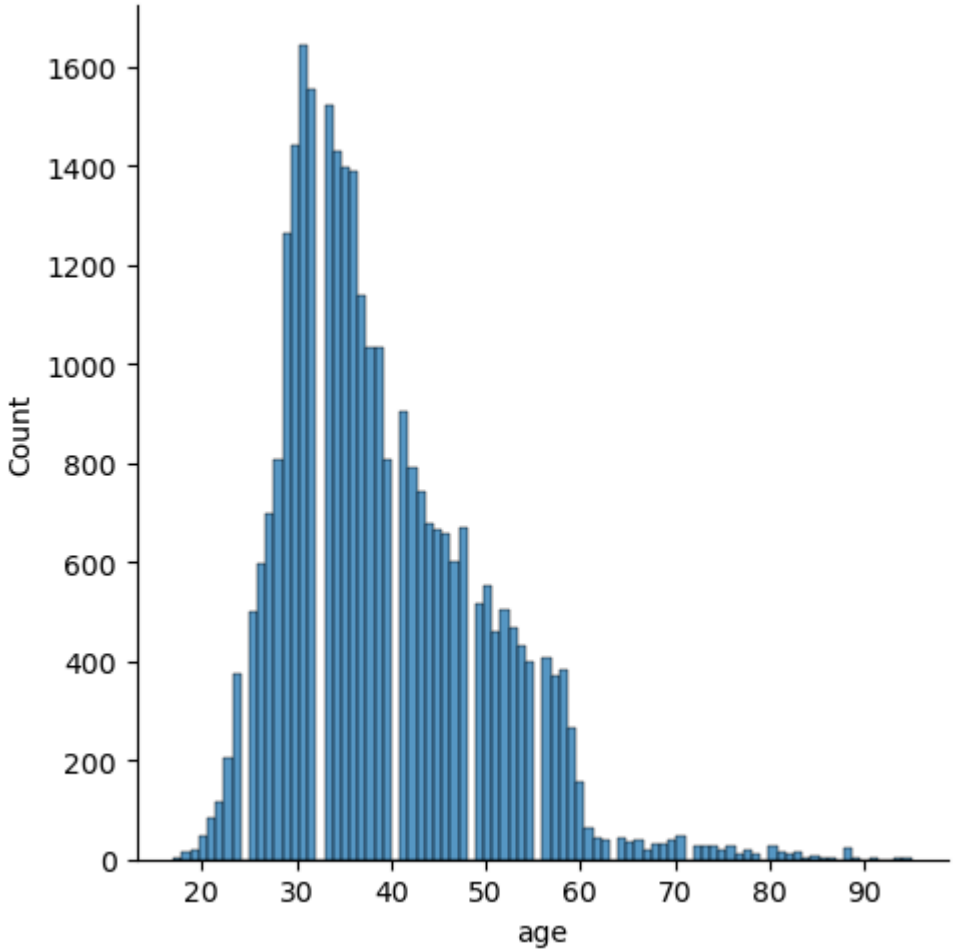


In [ ]:
```
plt.figure(figsize=(12,6))
sns.displot(base_data['age'])
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is deprecated and will be removed in a future version. Use isinstance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1119: FutureWarning: use_inf_as_na option is deprecated and will be removed in a future version. Convert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\seaborn\axisgrid.py:118: UserWarning: The figure layout has changed to tight
  self._figure.tight_layout(*args, **kwargs)
```

Out[ ]:

```
<seaborn.axisgrid.FacetGrid at 0x2138f533110>

<Figure size 1200x600 with 0 Axes>
```



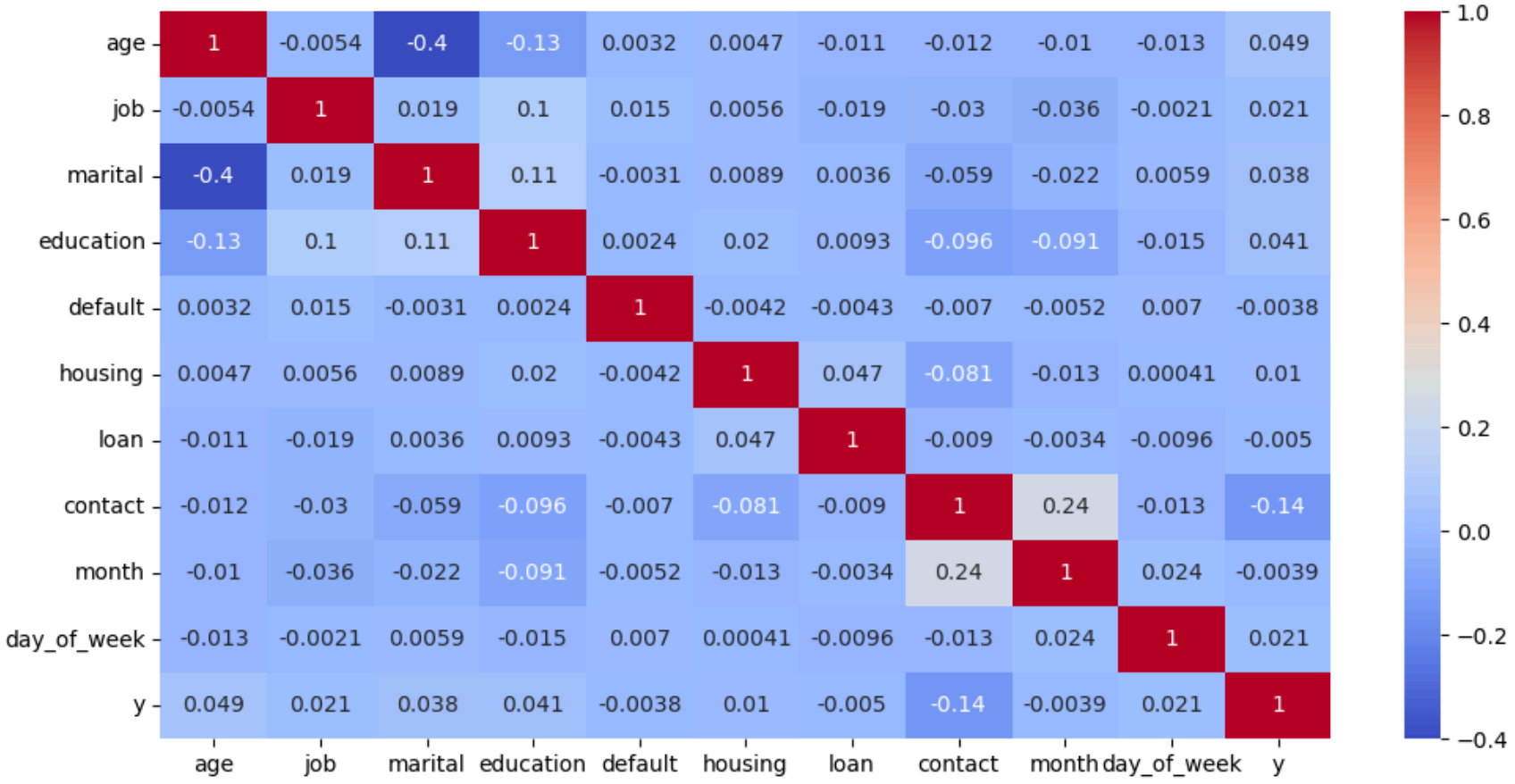
4. Model Tuning

- Optimize the hyperparameters of the model to improve performance.
- Use techniques such as random search or grid search.

In [ ]:
```
# Convert categorical variables into numerical form
label_encoder = LabelEncoder()
for column in base_data.columns:
    if base_data[column].dtype == 'object':  # Check if the column is categorical
        base_data[column] = label_encoder.fit_transform(base_data[column])

plt.figure(figsize=(12,6))
sns.heatmap(base_data.corr(), annot=True, cmap='coolwarm')

# Split the data into training and testing sets
X = base_data.drop('y', axis=1)  # Features
X = X.drop('age', axis=1)
y = base_data['y']  # Target variable

# Split the data into 80% training and 20% testing
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42, stratify=base_data['y'])
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```



5. Model Evaluation:

- Use metrics such as accuracy, recall, precision to evaluate the performance of the model.

In [ ]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, classification_report, confusion_matrix, ConfusionMatrixDisplay
from sklearn.metrics import recall_score, precision_score
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC

# List of models
models = {
    "LogisticRegression": LogisticRegression(),
```

```
    "Decision Tree": DecisionTreeClassifier(),
    'SVM': SVC(),
    "RandomForest": RandomForestClassifier()
}

# Initialize lists to store model names and accuracies
model_names = []
accuracies = []
recalls = []
precisions = []
conf_matrixs = []

# Train and evaluate each model
for name, model in models.items():
    #Train the model
    model.fit(X_train, y_train)

    # Make predictions on the testing set
    y_pred = model.predict(X_test)

    # Evaluate the model
    y_test_numeric = y_test.replace({'yes': 1, 'no': 0})
    y_pred_numeric = pd.Series(y_pred).replace({'yes': 1, 'no': 0})

    accuracy = accuracy_score(y_test_numeric, y_pred_numeric)
    recall = recall_score(y_test_numeric, y_pred_numeric)
    precision = precision_score(y_test_numeric, y_pred_numeric)

    # Store model name and accuracy
    model_names.append(name)
    accuracies.append(accuracy)
    recalls.append(recall)
    precisions.append(precision)

# Create a DataFrame to store the results
results_df = pd.DataFrame({'Model': model_names, 'Accuracy': accuracies})
results_df_1 = pd.DataFrame({'Model': model_names, 'Recall': recalls})
results_df_2 = pd.DataFrame({'Model': model_names, 'Precision': precisions})

# Display the comparison table
print(results_df)
print(results_df_1)
print(results_df_2)
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\metrics\_classification.py:1344: UndefinedMetricWarning: Precisi
on is ill-defined and being set to 0.0 due to no predicted samples. Use `zero_division` parameter to control this behav
ior.
  _warn_prf(average, modifier, msg_start, len(result))
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
```

```
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
```

```
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
```

```
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
```

```
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
```

```
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
```

```
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
```

```
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
```

```
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
```

```
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\metrics\_classification.py:1344: UndefinedMetricWarning: Precisi
on is ill-defined and being set to 0.0 due to no predicted samples. Use `zero_division` parameter to control this behav
ior.
  _warn_prf(average, modifier, msg_start, len(result))
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
```

```
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
                Model  Accuracy
0  LogisticRegression  0.873401
1       Decision Tree  0.847655
2                 SVM  0.873401
3        RandomForest  0.855690
                Model    Recall
0  LogisticRegression  0.000000
1       Decision Tree  0.189119
2                 SVM  0.000000
3        RandomForest  0.163212
                Model  Precision
0  LogisticRegression   0.000000
1       Decision Tree   0.325167
2                 SVM   0.000000
3        RandomForest   0.350000
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
```

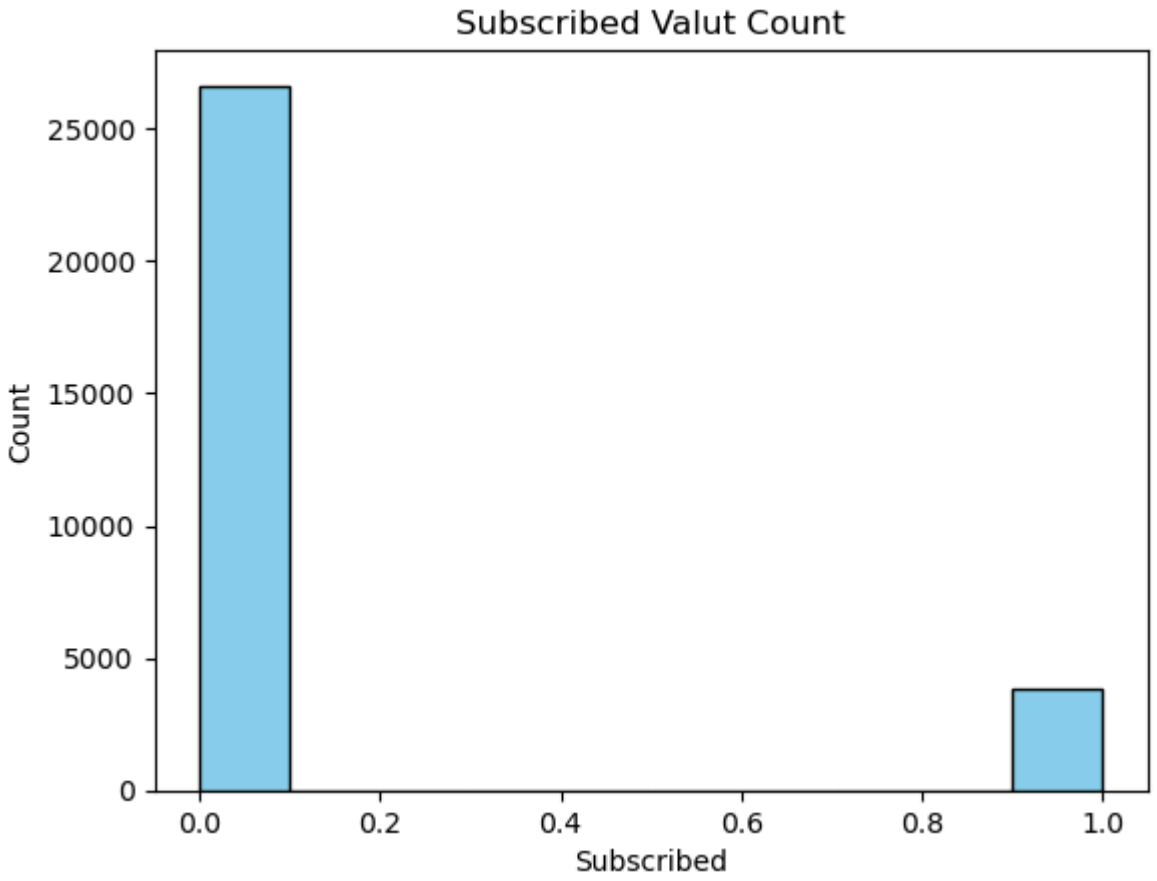
```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

In [ ]:

```
#plot the target column
plt.hist(base_data['y'],color='skyblue', edgecolor='black')
plt.xlabel('Subscribed')
plt.ylabel('Count')
plt.title('Subscribed Valut Count')
```

Out[ ]:

```
Text(0.5, 1.0, 'Subscribed Valut Count')
```



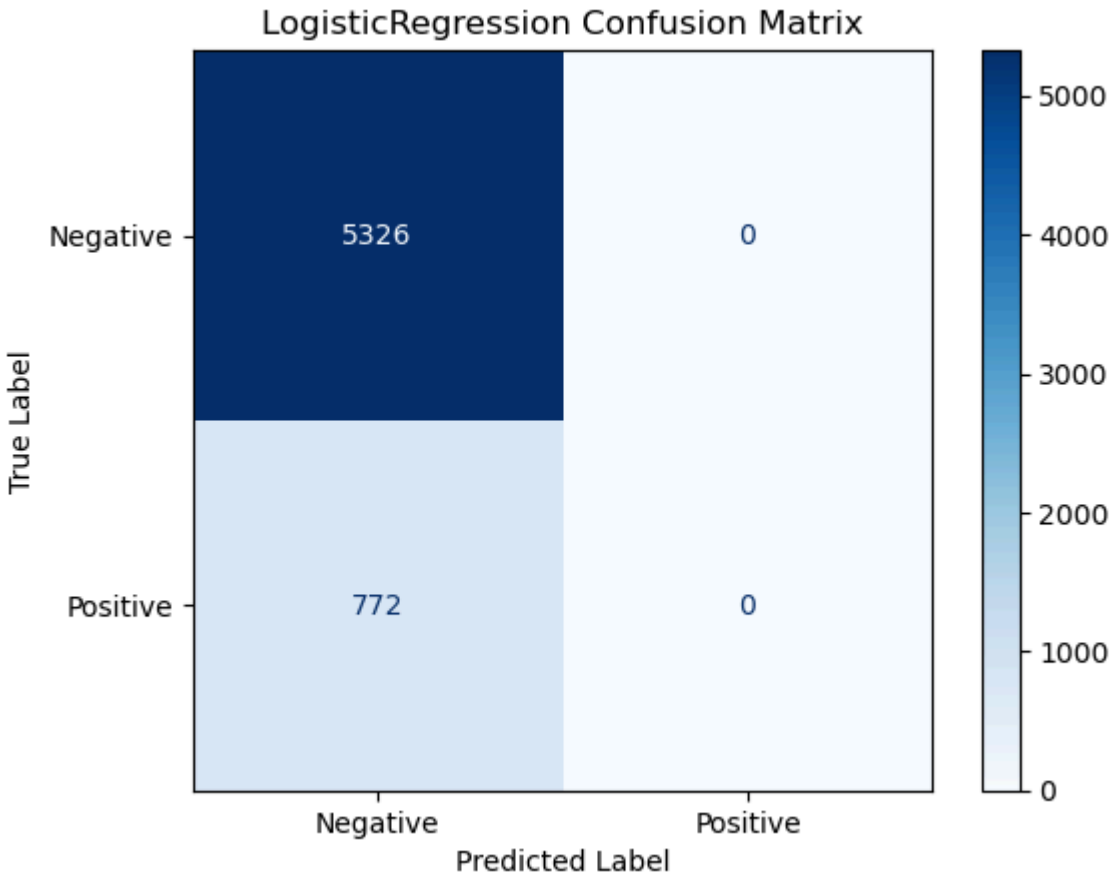
In [ ]:
```
baseline = base_data['y'].value_counts(normalize=True)
baseline
```

Out[ ]:
```
y
0    0.873426
1    0.126574
Name: proportion, dtype: float64
```

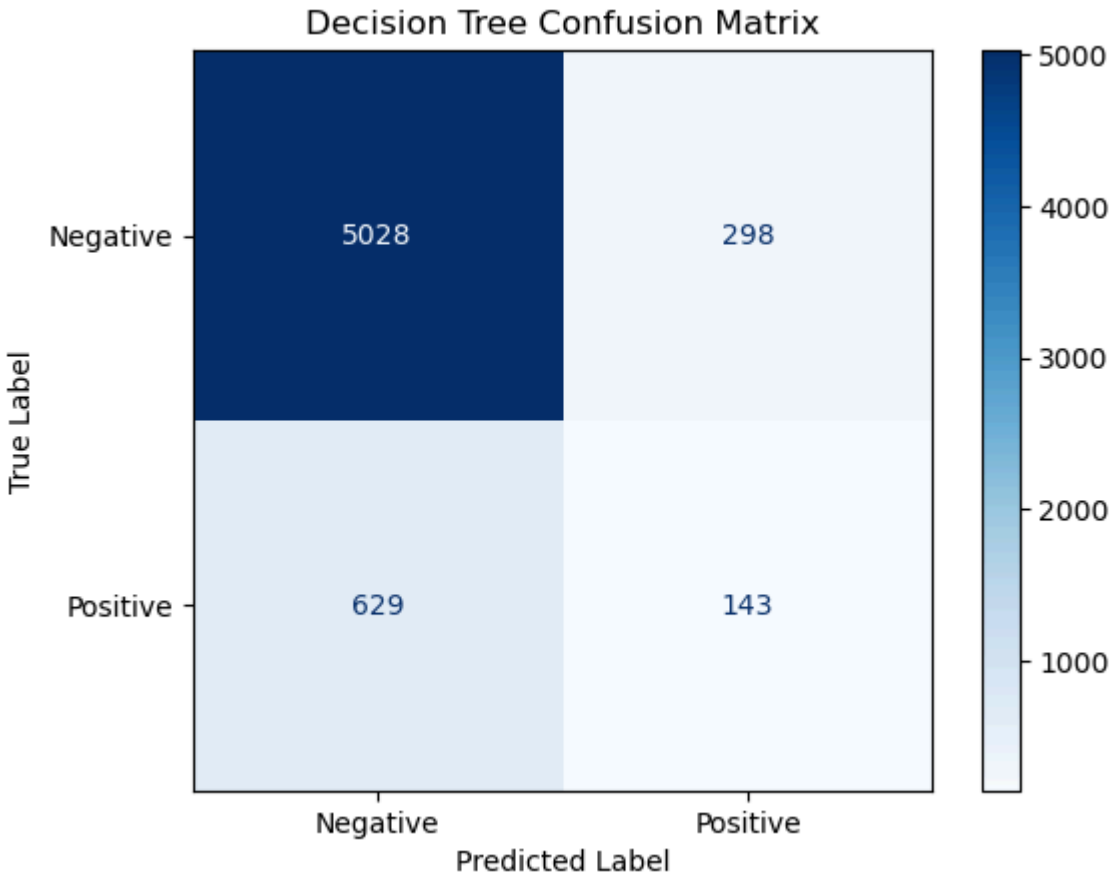
In [ ]:
```
for name, model in models.items():
    # Train model
    model.fit(X_train, y_train)

    # Make predictions
    y_pred = model.predict(X_test)

    # Calculate confusion matrix
```

```
    cm = confusion_matrix(y_test, y_pred)

    # Plot confusion matrix
    labels = ['Negative', 'Positive']
    display = ConfusionMatrixDisplay(confusion_matrix=cm, display_labels=labels)
    display.plot(cmap=plt.cm.Blues)
    plt.title(f"{name} Confusion Matrix")
    plt.xlabel("Predicted Label")
    plt.ylabel("True Label")
    plt.show()
```

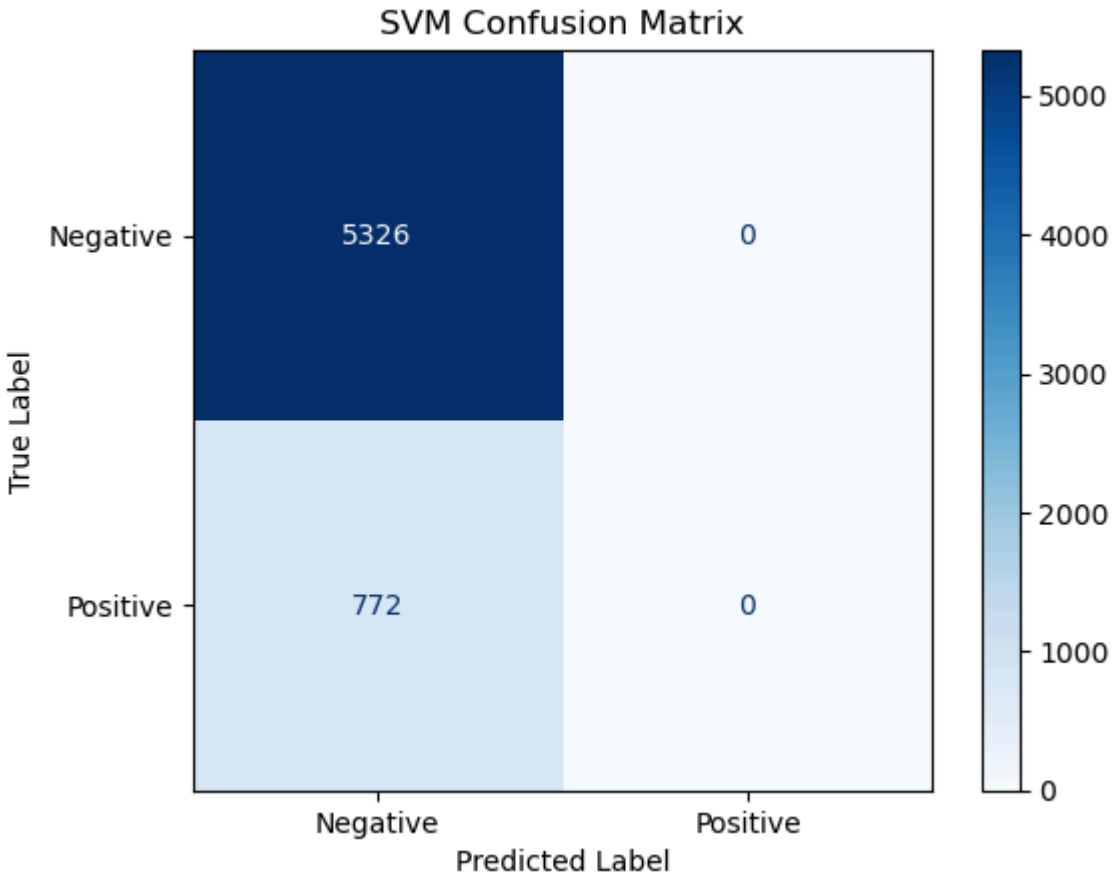
```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```


LogisticRegression Confusion Matrix
Negative
Positive
True Label
5326
0
772
0
Negative
Positive
Predicted Label
5000
4000
3000
2000
1000
0

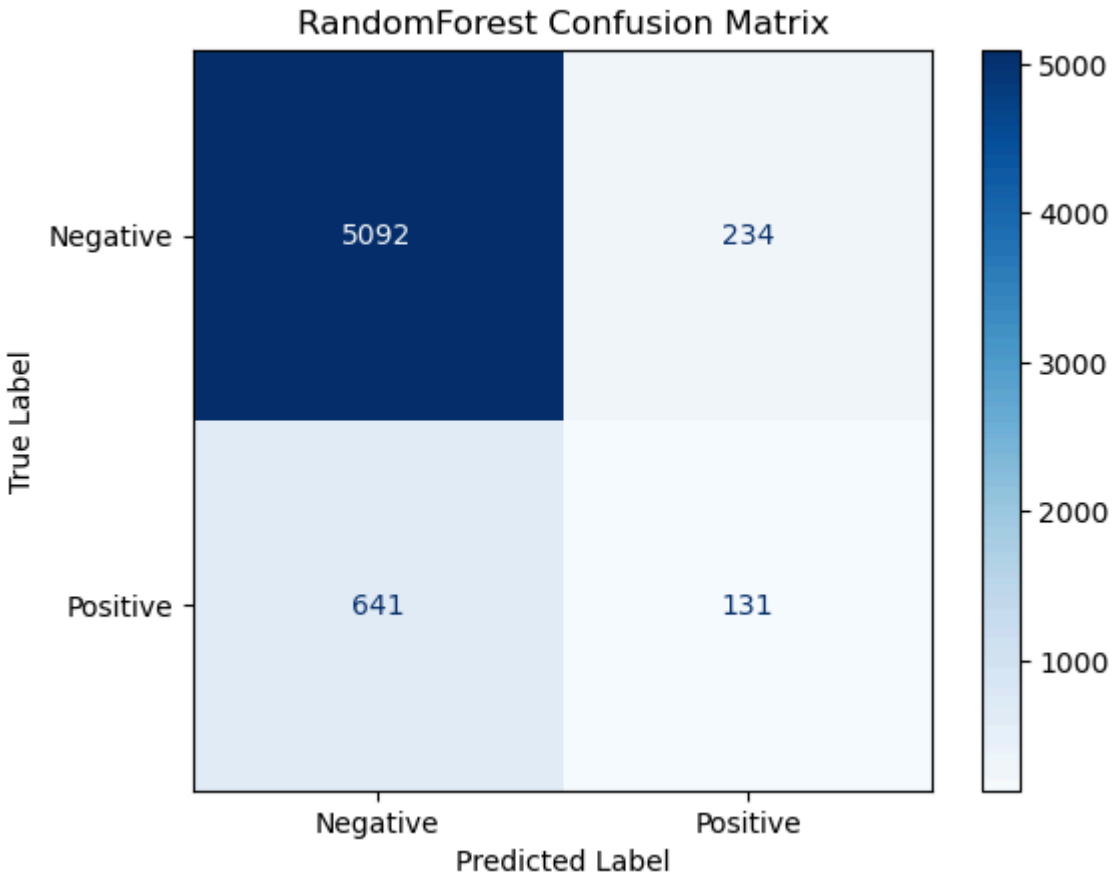
```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```


Decision Tree Confusion Matrix
Negative
Positive
True Label
5028
298
629
143
Negative
Positive
Predicted Label
5000
4000
3000
2000
1000

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```


SVM Confusion Matrix
Negative
Positive
True Label
5326
0
772
0
Negative
Positive
Predicted Label
5000
4000
3000
2000
1000
0

```
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\Users\Quynh Nhu\anaconda3\Lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```


RandomForest Confusion Matrix
Negative
Positive
True Label
5092
234
641
131
Negative
Positive
Predicted Label
5000
4000
3000
2000
1000