titanic_ml

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1 Titanic - Machine Learning from Disaster

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MSDS 422 Practical Machine Learning

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File Load In

```
[236]: from scipy.stats import shapiro
       from statsmodels.stats.outliers_influence import variance_inflation_factor
```

```
[169]: import numpy as np
```

```
[170]: import matplotlib.pyplot as plt
```

```
[171]: import seaborn as sns
```

```
[172]: import pandas as pd
```

SECTION 01: Descriptive Statistics

TRAINING DATA

```
[173]: titanic_train_dataframe=pd.read_csv("/Users/isingh/Desktop/titanic/train.csv")
```

TESTING DATA

```
[174]: titanic_test_dataframe=pd.read_csv("/Users/isingh/Desktop/titanic/test.csv")
```

```
[175]: titanic_test_dataframe.columns
```

```
[175]: Index(['PassengerId', 'Pclass', 'Name', 'Sex', 'Age', 'SibSp', 'Parch',
              'Ticket', 'Fare', 'Cabin', 'Embarked'],
             dtype='object')
```

```
[176]: titanic_train_dataframe.describe()
```

```
[176]:        PassengerId    Survived      Pclass         Age       SibSp  \
       count   891.000000  891.000000  891.000000  714.000000  891.000000
       mean    446.000000    0.383838    2.308642   29.699118    0.523008
       std     257.353842    0.486592    0.836071   14.526497    1.102743
       min       1.000000    0.000000    1.000000    0.420000    0.000000
       25%     223.500000    0.000000    2.000000   20.125000    0.000000
       50%     446.000000    0.000000    3.000000   28.000000    0.000000
       75%     668.500000    1.000000    3.000000   38.000000    1.000000
       max     891.000000    1.000000    3.000000   80.000000    8.000000

                   Parch        Fare
       count  891.000000  891.000000
       mean     0.381594   32.204208
       std      0.806057   49.693429
       min      0.000000    0.000000
       25%      0.000000    7.910400
       50%      0.000000   14.454200
       75%      0.000000   31.000000
       max      6.000000  512.329200
```

```
[177]: missing_values = titanic_train_dataframe.isnull().sum()
```

```
[178]: missing_values
```

```
[178]: PassengerId      0
       Survived         0
       Pclass           0
       Name             0
       Sex              0
       Age            177
       SibSp            0
       Parch            0
       Ticket           0
       Fare             0
       Cabin          687
       Embarked         2
       dtype: int64
```

Outlier

```
[179]: titanic_train_dataframe['Age'].fillna(titanic_train_dataframe['Age'].median(),␣
         ↪inplace=True)
```

```
/var/folders/qx/htthbr0s1bx5ncc2f9j6j1qc0000gn/T/ipykernel_10058/2219488372.py:1
: FutureWarning: A value is trying to be set on a copy of a DataFrame or Series
through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.
```

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


  titanic_train_dataframe['Age'].fillna(titanic_train_dataframe['Age'].median(),
inplace=True)
```

[180]:

```
titanic_train_dataframe['Cabin'].fillna('Unknown', inplace=True)
titanic_train_dataframe['Embarked'].fillna(titanic_train_dataframe.
  ↪groupby('Pclass')['Embarked'].transform(lambda x: x.mode().iloc[0]),␣
  ↪inplace=True)
```

```
/var/folders/qx/htthbr0s1bx5ncc2f9j6j1qc0000gn/T/ipykernel_10058/2013883459.py:1
: FutureWarning: A value is trying to be set on a copy of a DataFrame or Series
through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

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


  titanic_train_dataframe['Cabin'].fillna('Unknown', inplace=True)
/var/folders/qx/htthbr0s1bx5ncc2f9j6j1qc0000gn/T/ipykernel_10058/2013883459.py:2
: FutureWarning: A value is trying to be set on a copy of a DataFrame or Series
through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

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


  titanic_train_dataframe['Embarked'].fillna(titanic_train_dataframe.groupby('Pc
lass')['Embarked'].transform(lambda x: x.mode().iloc[0]), inplace=True)
```

Title

[181]:

```
titanic_train_dataframe['Title'] = titanic_train_dataframe['Name'].str.
  ↪extract(' ([A-Za-z]+)\.', expand=False)
```

Family Size

[182]:
```
titanic_train_dataframe['FamilySize'] = titanic_train_dataframe['SibSp'] +␣
 ↪titanic_train_dataframe['Parch'] + 1
```

Whether a family member was alone or not

[183]:
```
titanic_train_dataframe['IsAlone'] = (titanic_train_dataframe['FamilySize'] ==␣
 ↪1).astype(int)
```

Feature Scaling

[184]:
```
from sklearn.preprocessing import StandardScaler
```

[185]:
```
scaler = StandardScaler()
titanic_train_dataframe[['Age', 'Fare']] = scaler.
 ↪fit_transform(titanic_train_dataframe[['Age', 'Fare']])
```

[186]:
```
titanic_train_dataframe.duplicated().sum()
```

[186]:
```
np.int64(0)
```

[187]:
```
missing_values = titanic_train_dataframe.isnull().sum()
print("Missing Values:")
print(missing_values)
```

```
Missing Values:
PassengerId    0
Survived       0
Pclass         0
Name           0
Sex            0
Age            0
SibSp          0
Parch          0
Ticket         0
Fare           0
Cabin          0
Embarked       0
Title          0
FamilySize     0
IsAlone        0
dtype: int64
```

Outlier IQR

[188]:
```
titanic_train_dataframe
```

[188]:
```
     PassengerId  Survived  Pclass  \
0              1         0       3
1              2         1       1
```

```
2              3         1       3
3              4         1       1
4              5         0       3
..           …       …     …
886          887         0       2
887          888         1       1
888          889         0       3
889          890         1       1
890          891         0       3

                                                  Name     Sex       Age  \
0                              Braund, Mr. Owen Harris    male -0.565736
1    Cumings, Mrs. John Bradley (Florence Briggs Th…  female  0.663861
2                               Heikkinen, Miss. Laina  female -0.258337
3         Futrelle, Mrs. Jacques Heath (Lily May Peel)  female  0.433312
4                             Allen, Mr. William Henry    male  0.433312
..                                                 …     …       …
886                              Montvila, Rev. Juozas    male -0.181487
887                       Graham, Miss. Margaret Edith  female -0.796286
888           Johnston, Miss. Catherine Helen "Carrie"  female -0.104637
889                              Behr, Mr. Karl Howell    male -0.258337
890                                Dooley, Mr. Patrick    male  0.202762

     SibSp  Parch            Ticket      Fare    Cabin Embarked Title  \
0        1      0         A/5 21171 -0.502445  Unknown        S    Mr
1        1      0          PC 17599  0.786845      C85        C   Mrs
2        0      0  STON/O2. 3101282 -0.488854  Unknown        S  Miss
3        1      0            113803  0.420730     C123        S   Mrs
4        0      0            373450 -0.486337  Unknown        S    Mr
..     …    …               …       …      …      …   …
886      0      0            211536 -0.386671  Unknown        S   Rev
887      0      0            112053 -0.044381      B42        S  Miss
888      1      2        W./C. 6607 -0.176263  Unknown        S  Miss
889      0      0            111369 -0.044381     C148        C    Mr
890      0      0            370376 -0.492378  Unknown        Q    Mr

     FamilySize  IsAlone
0             2        0
1             2        0
2             1        1
3             2        0
4             1        1
..          …      …
886           1        1
887           1        1
888           4        0
889           1        1
```

```
890           1        1

[891 rows x 15 columns]
```

[189]:

```
numeric_cols = titanic_train_dataframe.select_dtypes(include=[np.number]).
 ↪columns.tolist()
Q1 = titanic_train_dataframe[numeric_cols].quantile(0.25)
Q3 = titanic_train_dataframe[numeric_cols].quantile(0.75)
IQR = Q3 - Q1

lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR

# Filtering out outliers
titanic_train_dataframe1 =␣
 ↪titanic_train_dataframe[~((titanic_train_dataframe[numeric_cols] <␣
 ↪lower_bound) | (titanic_train_dataframe[numeric_cols] > upper_bound)).
 ↪any(axis=1)]
```

[190]:

```
titanic_train_dataframe1
```

[190]:

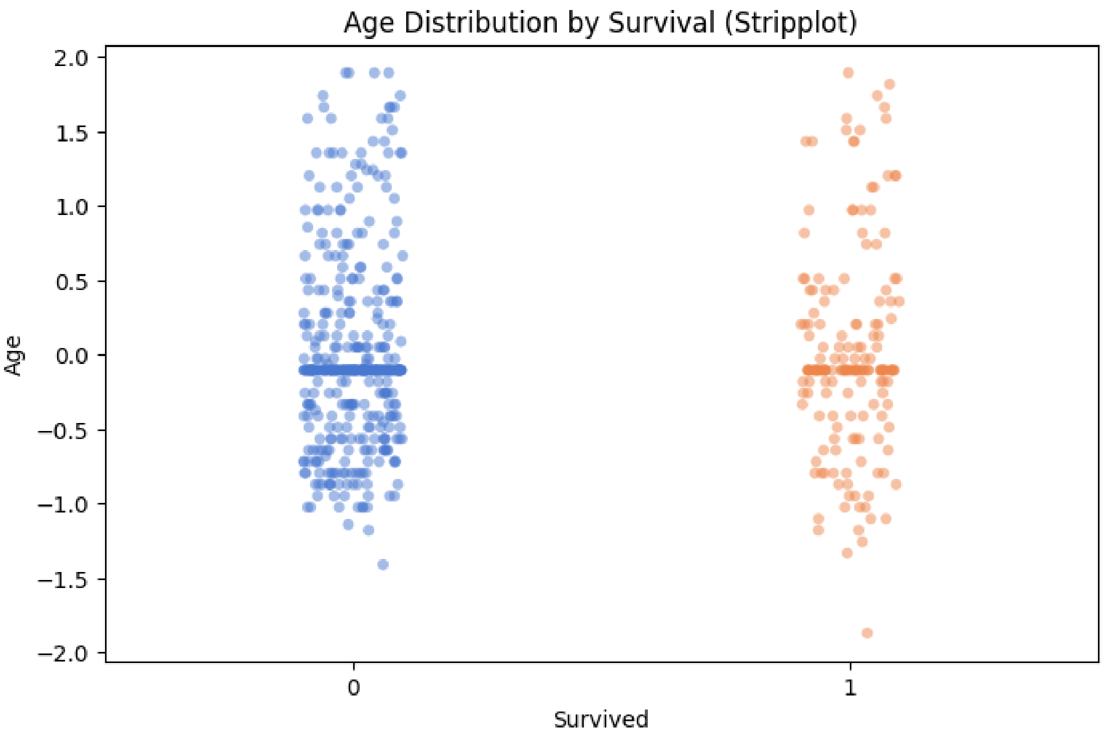
```
     PassengerId  Survived  Pclass  \
0              1         0       3
2              3         1       3
3              4         1       1
4              5         0       3
5              6         0       3
..           …         …       …
884          885         0       3
886          887         0       2
887          888         1       1
889          890         1       1
890          891         0       3

                                             Name     Sex       Age  SibSp  \
0                         Braund, Mr. Owen Harris    male -0.565736      1
2                          Heikkinen, Miss. Laina  female -0.258337      0
3    Futrelle, Mrs. Jacques Heath (Lily May Peel)  female  0.433312      1
4                        Allen, Mr. William Henry    male  0.433312      0
5                                Moran, Mr. James    male -0.104637      0
..                                            …     …       …    …
884                        Sutehall, Mr. Henry Jr    male -0.335187      0
886                         Montvila, Rev. Juozas    male -0.181487      0
887                  Graham, Miss. Margaret Edith  female -0.796286      0
889                         Behr, Mr. Karl Howell    male -0.258337      0
890                           Dooley, Mr. Patrick    male  0.202762      0
```

```
     Parch            Ticket      Fare    Cabin Embarked Title  FamilySize  \
0        0         A/5 21171 -0.502445  Unknown        S    Mr           2
2        0  STON/O2. 3101282 -0.488854  Unknown        S  Miss           1
3        0            113803  0.420730     C123        S   Mrs           2
4        0            373450 -0.486337  Unknown        S    Mr           1
5        0            330877 -0.478116  Unknown        Q    Mr           1
..     …             …        …     …       …    …         …
884      0   SOTON/OQ 392076 -0.506472  Unknown        S    Mr           1
886      0            211536 -0.386671  Unknown        S   Rev           1
887      0            112053 -0.044381      B42        S  Miss           1
889      0            111369 -0.044381     C148        C    Mr           1
890      0            370376 -0.492378  Unknown        Q    Mr           1

     IsAlone
0          0
2          1
3          0
4          1
5          1
..       …
884        1
886        1
887        1
889        1
890        1

[577 rows x 15 columns]
```

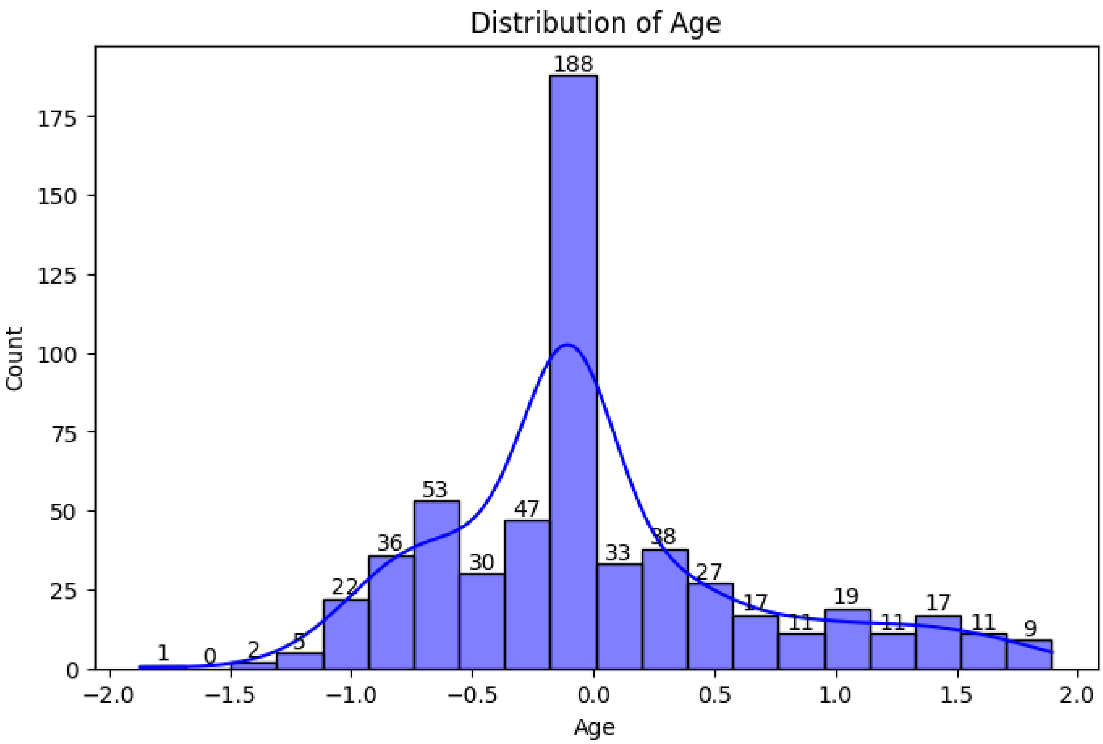
Visualizations - Exploratory Data Analysis

```
[191]: plt.figure(figsize=(8, 5))
sns.stripplot(x='Survived', y='Age', data=titanic_train_dataframe1,␣
  ↪palette='muted', alpha=0.5, jitter=True)
plt.title('Age Distribution by Survival (Stripplot)')
plt.show()
```

```
/var/folders/qx/htthbr0s1bx5ncc2f9j6j1qc0000gn/T/ipykernel_10058/3872080991.py:2
: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in
v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same
effect.

  sns.stripplot(x='Survived', y='Age', data=titanic_train_dataframe1,
palette='muted', alpha=0.5, jitter=True)
```

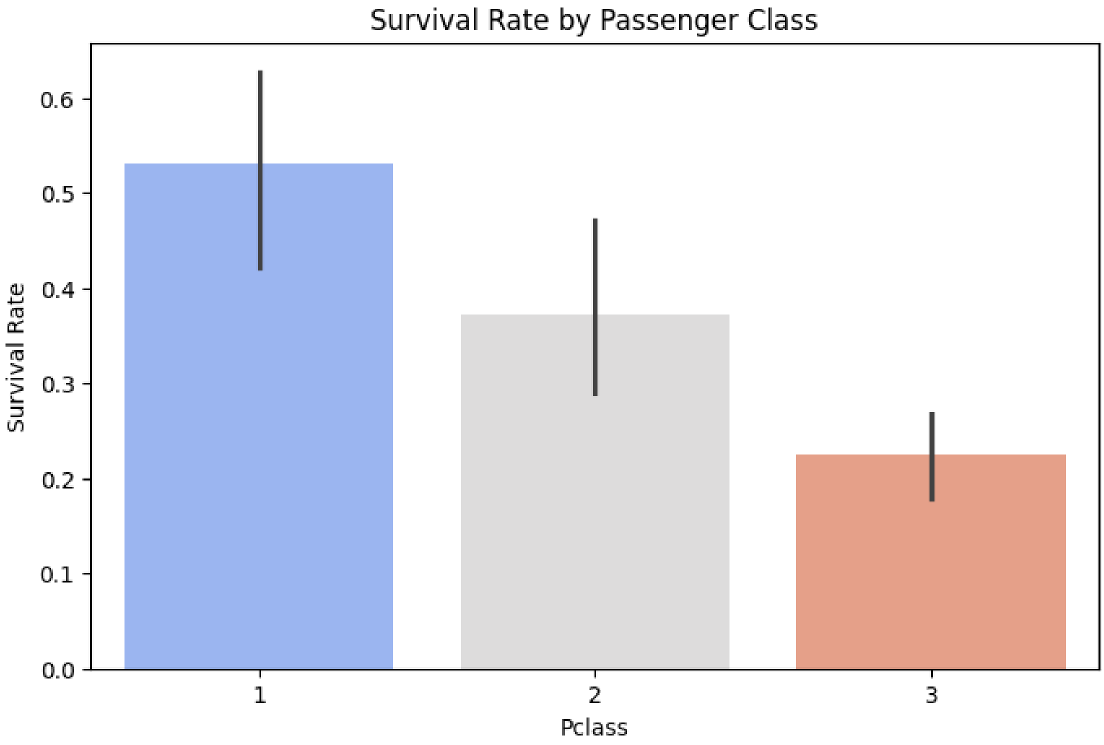


[192]:
```
plt.figure(figsize=(8, 5))
sns.histplot(titanic_train_dataframe1['Age'], bins=20, kde=True, color='blue')
plt.title('Distribution of Age')
for p in plt.gca().patches:
    plt.gca().annotate(f'{int(p.get_height())}', (p.get_x() + p.get_width() /␣
 ↪2, p.get_height()),
                       ha='center', va='bottom', fontsize=10, color='black')
plt.show()
```



[193]:
```
plt.figure(figsize=(8, 5))
sns.barplot(x='Pclass', y='Survived', data=titanic_train_dataframe1,␣
 ↪palette='coolwarm', estimator=np.mean)
plt.title('Survival Rate by Passenger Class')
plt.ylabel('Survival Rate')
plt.show()
```

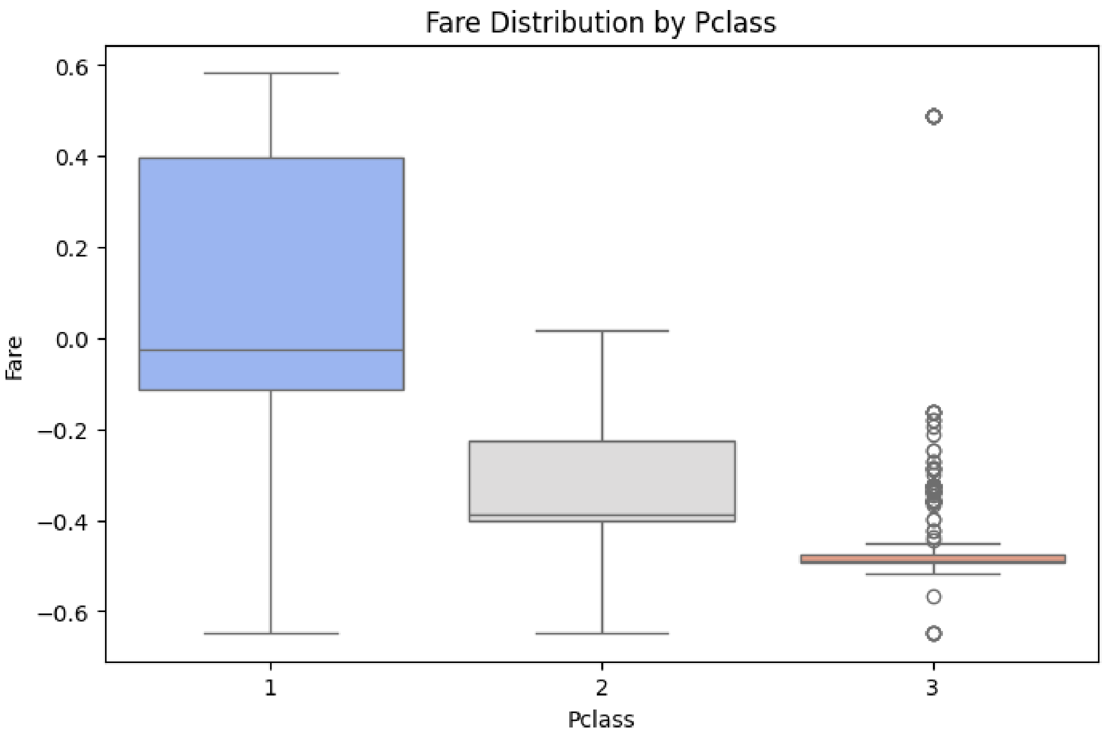
```
/var/folders/qx/htthbr0s1bx5ncc2f9j6j1qc0000gn/T/ipykernel_10058/3739617002.py:2
: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in
v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same
effect.

  sns.barplot(x='Pclass', y='Survived', data=titanic_train_dataframe1,
palette='coolwarm', estimator=np.mean)
```



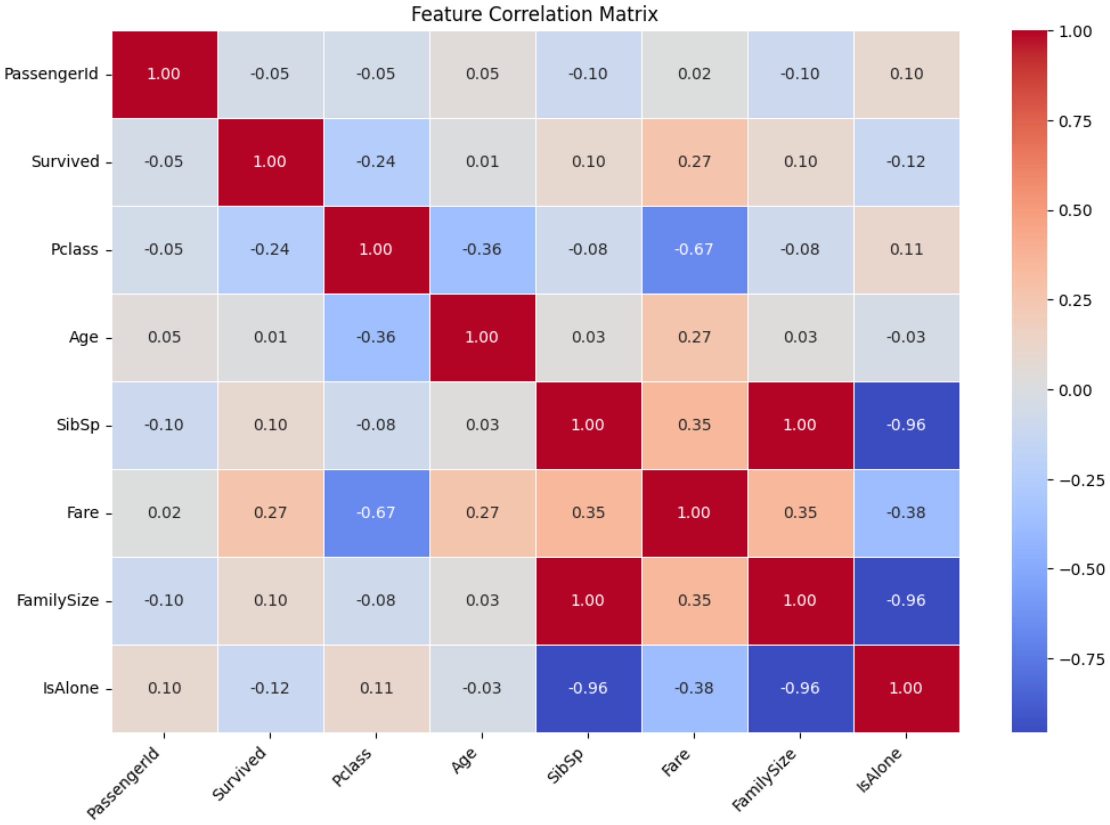
[194]:

```
plt.figure(figsize=(8, 5))
sns.boxplot(x='Pclass', y='Fare', data=titanic_train_dataframe1,␣
↪palette='coolwarm')
plt.title('Fare Distribution by Pclass')
plt.show()
```

```
/var/folders/qx/htthbr0s1bx5ncc2f9j6j1qc0000gn/T/ipykernel_10058/2735142903.py:2
: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in
v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same
effect.

  sns.boxplot(x='Pclass', y='Fare', data=titanic_train_dataframe1,
palette='coolwarm')
```

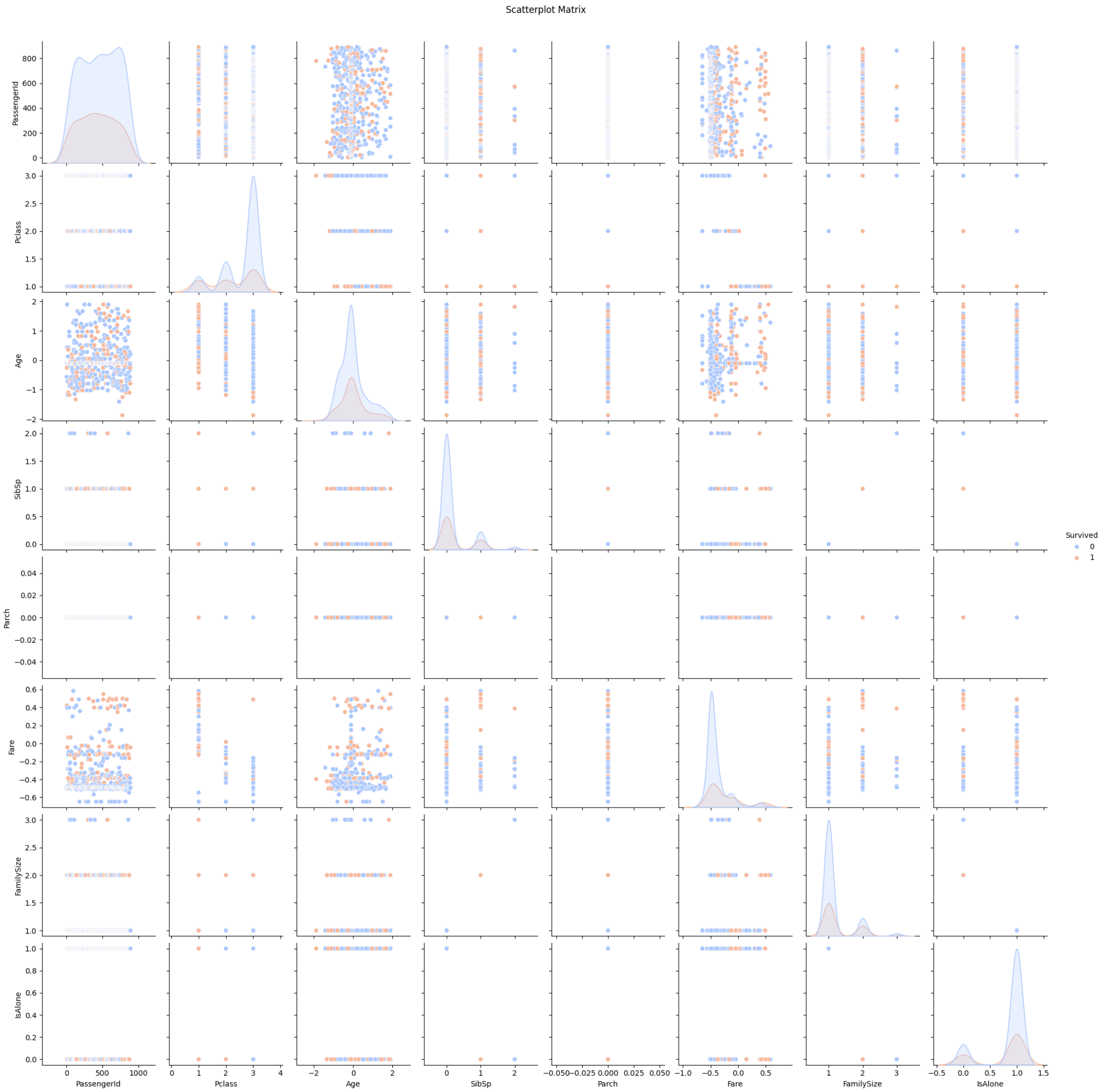


[195]:
```
numeric_df = titanic_train_dataframe1.select_dtypes(include=[np.number])
numeric_df = numeric_df.loc[:, (numeric_df.var() > 0)]
plt.figure(figsize=(12, 8))  # Larger figure size
sns.heatmap(numeric_df.corr(), annot=True, cmap='coolwarm', fmt='.2f',␣
 ↪linewidths=0.5)
plt.xticks(rotation=45, ha='right')
plt.yticks(rotation=0)
plt.title('Feature Correlation Matrix')

plt.show()
```



[196]:

```
numeric_cols = titanic_train_dataframe1.select_dtypes(include=[np.number])
sns.pairplot(numeric_cols, hue="Survived", palette="coolwarm")
plt.suptitle('Scatterplot Matrix', y=1.02)
plt.show()
```



[197]:
```python
print(titanic_train_dataframe1.isnull().sum())
```

```
PassengerId    0
Survived       0
Pclass         0
Name           0
Sex            0
Age            0
SibSp          0
Parch          0
Ticket         0
Fare           0
Cabin          0
Embarked       0
```

```
Title          0
FamilySize     0
IsAlone        0
dtype: int64
```

Train Test Split

[198]:

```python
from sklearn.model_selection import train_test_split

X = titanic_train_dataframe1.drop(columns=['Survived'])  # Features
y = titanic_train_dataframe1['Survived']  # Target
```

Cross Validation

[199]:

```python
from sklearn.model_selection import KFold

kf = KFold(n_splits=5, shuffle=True, random_state=42)
```

[200]:

```python
kf = KFold(n_splits=5, shuffle=True, random_state=42)

for train_index, test_index in kf.split(X, y):
    X_train, X_val = X.iloc[train_index], X.iloc[test_index]
    y_train, y_val = y.iloc[train_index], y.iloc[test_index]
```

[201]:

```python
X = X.drop(columns=['Name', 'Ticket', 'Cabin', 'PassengerId'], errors='ignore')
```

[202]:

```python
X = pd.get_dummies(X, columns=['Sex', 'Embarked', 'Title'], drop_first=True)
```

[203]:

```python
print(X.dtypes)
print(X.head())
```

```
Pclass              int64
Age               float64
SibSp               int64
Parch               int64
Fare              float64
FamilySize          int64
IsAlone             int64
Sex_male             bool
Embarked_Q           bool
Embarked_S           bool
Title_Dr             bool
Title_Jonkheer       bool
Title_Lady           bool
Title_Major          bool
Title_Master         bool
Title_Miss           bool
Title_Mlle           bool
Title_Mr             bool
```

```
Title_Mrs            bool
Title_Ms             bool
Title_Rev            bool
Title_Sir            bool
dtype: object
   Pclass       Age  SibSp  Parch      Fare  FamilySize  IsAlone  Sex_male  \
0       3 -0.565736      1      0 -0.502445           2        0      True
2       3 -0.258337      0      0 -0.488854           1        1     False
3       1  0.433312      1      0  0.420730           2        0     False
4       3  0.433312      0      0 -0.486337           1        1      True
5       3 -0.104637      0      0 -0.478116           1        1      True

   Embarked_Q  Embarked_S  ...  Title_Lady  Title_Major  Title_Master  \
0       False        True  ...       False        False         False
2       False        True  ...       False        False         False
3       False        True  ...       False        False         False
4       False        True  ...       False        False         False
5        True       False  ...       False        False         False

   Title_Miss  Title_Mlle  Title_Mr  Title_Mrs  Title_Ms  Title_Rev  Title_Sir
0       False       False      True      False     False      False      False
2        True       False     False      False     False      False      False
3       False       False     False       True     False      False      False
4       False       False      True      False     False      False      False
5       False       False      True      False     False      False      False

[5 rows x 22 columns]
```

[204]:
```
print("Current columns in X:", X.columns)
```

```
Current columns in X: Index(['Pclass', 'Age', 'SibSp', 'Parch', 'Fare',
'FamilySize', 'IsAlone',
       'Sex_male', 'Embarked_Q', 'Embarked_S', 'Title_Dr', 'Title_Jonkheer',
       'Title_Lady', 'Title_Major', 'Title_Master', 'Title_Miss', 'Title_Mlle',
       'Title_Mr', 'Title_Mrs', 'Title_Ms', 'Title_Rev', 'Title_Sir'],
      dtype='object')
```

Model Assumptions

KNN

[216]:
```
X
```

[216]:
```
    Pclass   Age  SibSp  Parch     Fare  FamilySize  IsAlone  Sex_male  \
0        3  22.0      1      0   7.2500           2        0      True
1        1  38.0      1      0  71.2833           2        0     False
2        3  26.0      0      0   7.9250           1        1     False
3        1  35.0      1      0  53.1000           2        0     False
4        3  35.0      0      0   8.0500           1        1      True
```

```
..      …   …    …    …      …         …      …       …
886       2  27.0      0      0  13.0000           1        1       True
887       1  19.0      0      0  30.0000           1        1      False
888       3  28.0      1      2  23.4500           4        0      False
889       1  26.0      0      0  30.0000           1        1       True
890       3  32.0      0      0   7.7500           1        1       True

     Embarked_Q  Embarked_S
0         False        True
1         False       False
2         False        True
3         False        True
4         False        True
..          …         …
886       False        True
887       False        True
888       False        True
889       False       False
890        True       False

[891 rows x 10 columns]
```

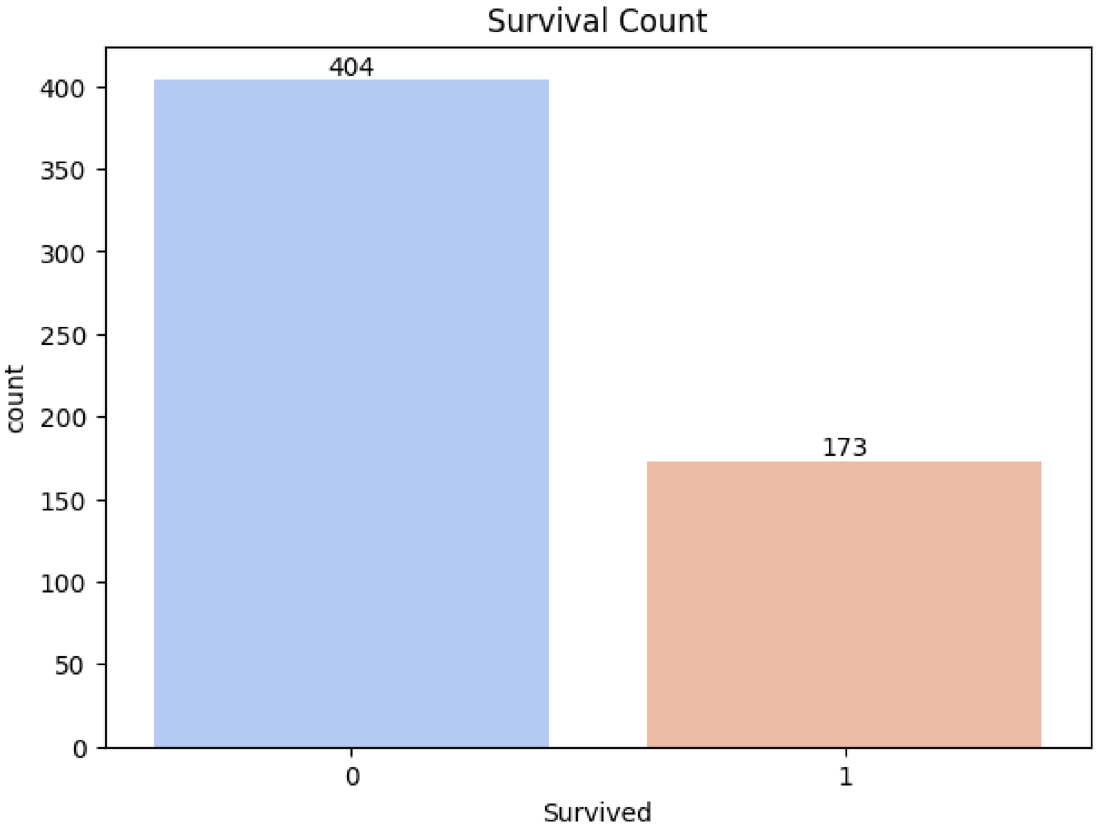
[221]:

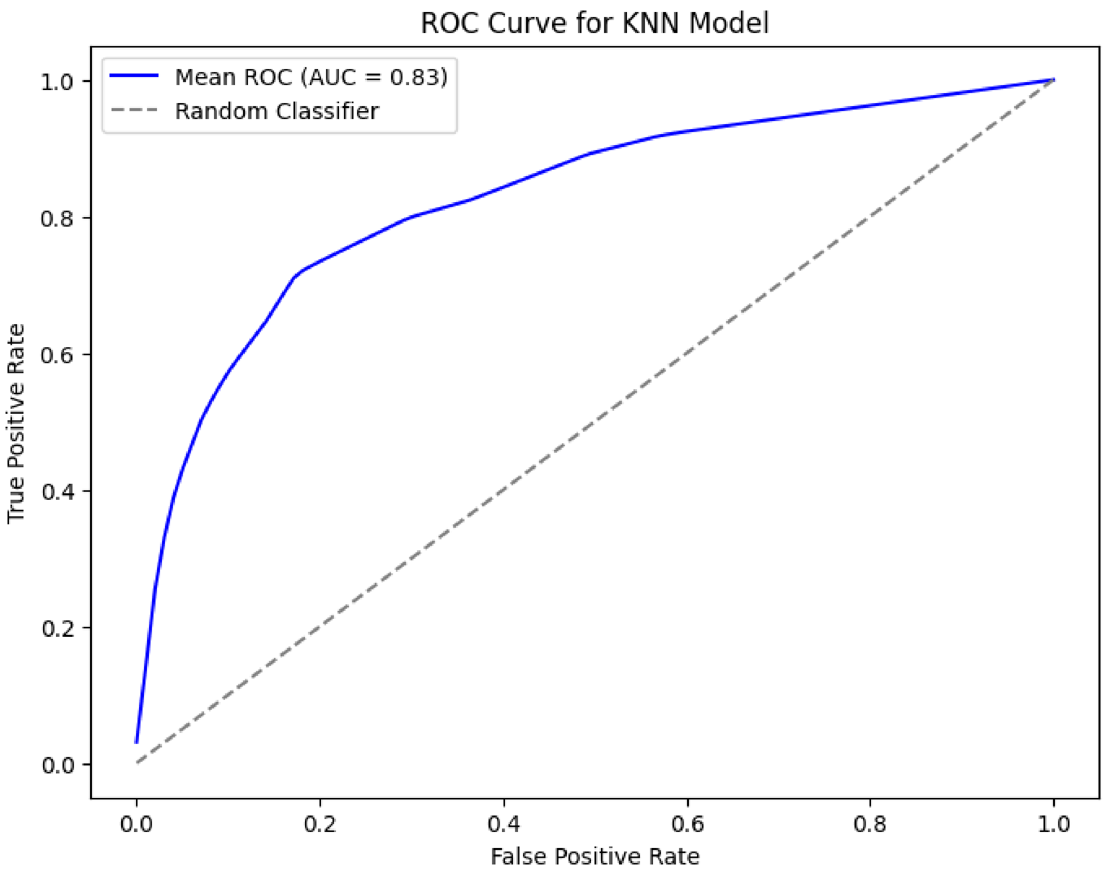
```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import KFold, GridSearchCV, train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import (
    accuracy_score, precision_score, recall_score, f1_score, roc_auc_score,
    roc_curve, precision_recall_curve, auc
)

# Drop unnecessary columns in training data
X = titanic_train_dataframe1.drop(columns=['Survived', 'Name', 'Ticket',␣
 ↪'Cabin', 'PassengerId'], errors='ignore')
y = titanic_train_dataframe1['Survived']

# One-hot encode categorical variables
X = pd.get_dummies(X, drop_first=True)

X.fillna(X.median(), inplace=True)

scaler = StandardScaler()
X_scaled = pd.DataFrame(scaler.fit_transform(X), columns=X.columns)
```

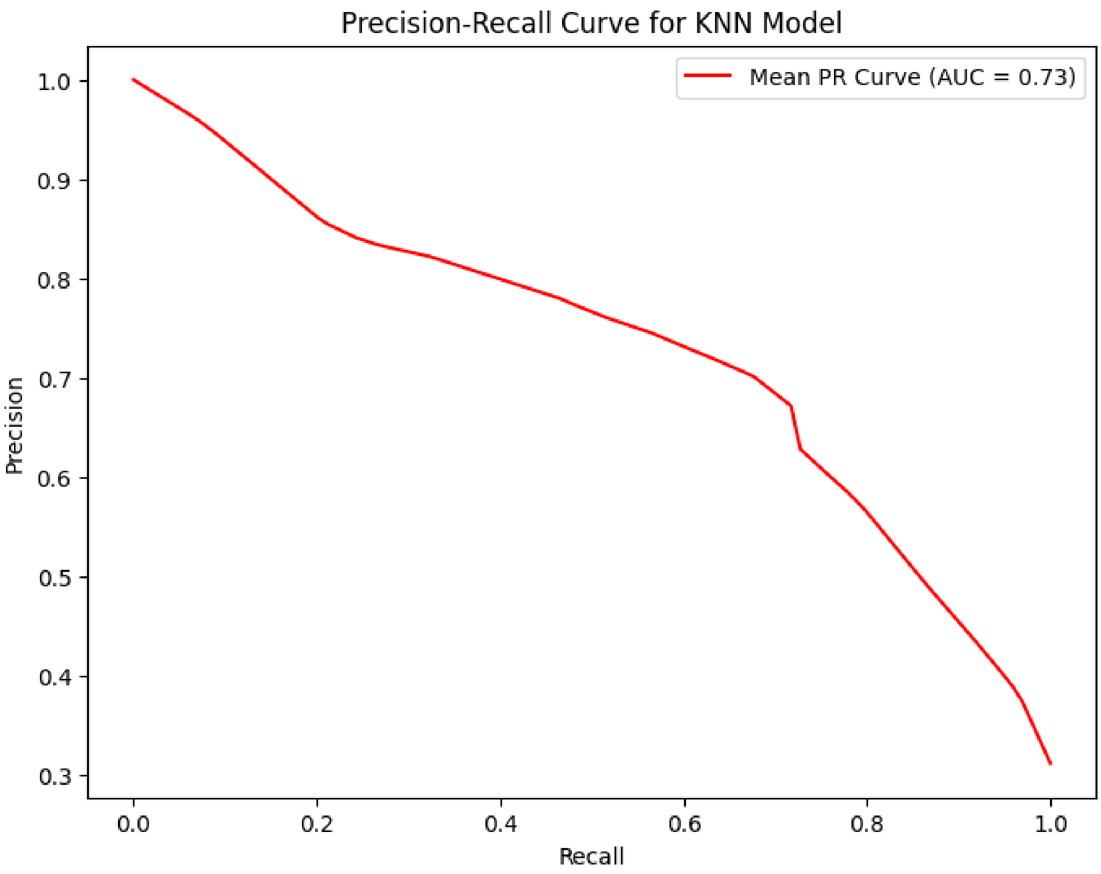
```python
X_train, X_test, y_train, y_test = train_test_split(X_scaled, y, test_size=0.2, random_state=42)

kf = KFold(n_splits=5, shuffle=True, random_state=42)

param_grid = {'n_neighbors': np.arange(1, 20)}
knn = KNeighborsClassifier()
grid_search = GridSearchCV(knn, param_grid, cv=kf, scoring='accuracy', n_jobs=1)  # FIX: n_jobs=1
grid_search.fit(X_train, y_train)
best_knn = grid_search.best_estimator_

accuracies, precisions, recalls, f1_scores, roc_aucs = [], [], [], [], []
tprs, precisions_list = [], []
mean_fpr = np.linspace(0, 1, 100)

for train_index, test_index in kf.split(X_train, y_train):
    X_train_fold, X_val = X_train.iloc[train_index], X_train.iloc[test_index]
    y_train_fold, y_val = y_train.iloc[train_index], y_train.iloc[test_index]

    best_knn.fit(X_train_fold, y_train_fold)
    y_pred = best_knn.predict(X_val)
    y_probs = best_knn.predict_proba(X_val)[:, 1]

    accuracies.append(accuracy_score(y_val, y_pred))
    precisions.append(precision_score(y_val, y_pred, zero_division=1))
    recalls.append(recall_score(y_val, y_pred, zero_division=1))
    f1_scores.append(f1_score(y_val, y_pred, zero_division=1))
    roc_aucs.append(roc_auc_score(y_val, y_probs))

    fpr, tpr, _ = roc_curve(y_val, y_probs)
    tprs.append(np.interp(mean_fpr, fpr, tpr))

    precision, recall, _ = precision_recall_curve(y_val, y_probs)
    precisions_list.append(np.interp(mean_fpr, recall[::-1], precision[::-1]))

# Compute mean ROC and PR AUC
mean_tpr = np.mean(tprs, axis=0)
mean_auc = auc(mean_fpr, mean_tpr)
mean_precision = np.mean(precisions_list, axis=0)
mean_pr_auc = auc(mean_fpr, mean_precision)

plt.figure(figsize=(7, 5))
sns.countplot(x='Survived', data=titanic_train_dataframe1, palette='coolwarm')
plt.title('Survival Count')
for p in plt.gca().patches:
    plt.gca().annotate(f'{int(p.get_height())}', (p.get_x() + p.get_width() /␣
 ↪2, p.get_height()),
                       ha='center', va='bottom', fontsize=10, color='black')
plt.show()

# ROC Curve
plt.figure(figsize=(8, 6))
plt.plot(mean_fpr, mean_tpr, color='b', label=f"Mean ROC (AUC = {mean_auc:.
 ↪2f})")
plt.plot([0, 1], [0, 1], linestyle="--", color="gray", label="Random␣
 ↪Classifier")
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title("ROC Curve for KNN Model")
plt.legend()
plt.show()

# Precision-Recall Curve
plt.figure(figsize=(8, 6))
plt.plot(mean_fpr, mean_precision, color='r', label=f"Mean PR Curve (AUC =␣
 ↪{mean_pr_auc:.2f})")
plt.xlabel("Recall")
plt.ylabel("Precision")
plt.title("Precision-Recall Curve for KNN Model")
plt.legend()
plt.show()

# Print Model Performance Metrics
print(f"Best Parameters: {grid_search.best_params_}")
print(f"Mean Accuracy: {np.mean(accuracies):.4f}")
print(f"Mean Precision: {np.mean(precisions):.4f}")
print(f"Mean Recall: {np.mean(recalls):.4f}")
print(f"Mean F1 Score: {np.mean(f1_scores):.4f}")
print(f"Mean ROC AUC: {np.mean(roc_aucs):.4f}")

titanic_test_dataframe = pd.read_csv("/Users/isingh/Desktop/titanic/test.csv")

# Store PassengerId separately for submission
passenger_ids = titanic_test_dataframe["PassengerId"]

X_kaggle = titanic_test_dataframe.drop(columns=['Name', 'Ticket', 'Cabin'],␣
 ↪errors='ignore')

# One-hot encode categorical variables in test data
X_kaggle = pd.get_dummies(X_kaggle, drop_first=True)

missing_cols = set(X_train.columns) - set(X_kaggle.columns)
```

```python
for col in missing_cols:
    X_kaggle[col] = 0

X_kaggle = X_kaggle[X_train.columns]

X_kaggle.fillna(X_kaggle.median(), inplace=True)

X_kaggle_scaled = pd.DataFrame(scaler.transform(X_kaggle), columns=X_kaggle.
 ↪columns)

y_kaggle_preds = best_knn.predict(X_kaggle_scaled)

submission_df = pd.DataFrame({
    "PassengerId": passenger_ids,
    "Survived": y_kaggle_preds
})

submission_df.to_csv("knn_submission.csv", index=False)
print("Submission file 'knn_submission.csv' created. Upload to Kaggle.")
```

```
/var/folders/qx/htthbr0s1bx5ncc2f9j6j1qc0000gn/T/ipykernel_10058/2957311614.py:6
6: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in
v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same
effect.

  sns.countplot(x='Survived', data=titanic_train_dataframe1, palette='coolwarm')
```


Survival Count
404
173
count
400
350
300
250
200
150
100
50
0
0
1
Survived


ROC Curve for KNN Model
Mean ROC (AUC = 0.83)
Random Classifier
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.2
0.4
0.6
0.8
1.0



```
Best Parameters: {'n_neighbors': np.int64(5)}
Mean Accuracy: 0.8069
Mean Precision: 0.7226
Mean Recall: 0.6498
Mean F1 Score: 0.6698
Mean ROC AUC: 0.8266
Submission file 'knn_submission.csv' created. Upload to Kaggle.
```

Logistic Regression

[239]:
```
# Multicollinearity Check (VIF)
vif_data = pd.DataFrame()
vif_data["Feature"] = X_scaled.columns
vif_data["VIF"] = [variance_inflation_factor(X_scaled.values, i) for i in␣
 ↪range(X_scaled.shape[1])]

print("VIF Values for Multicollinearity Check:")
print(vif_data.sort_values(by="VIF", ascending=False))
```

```
VIF Values for Multicollinearity Check:
           Feature         VIF
```

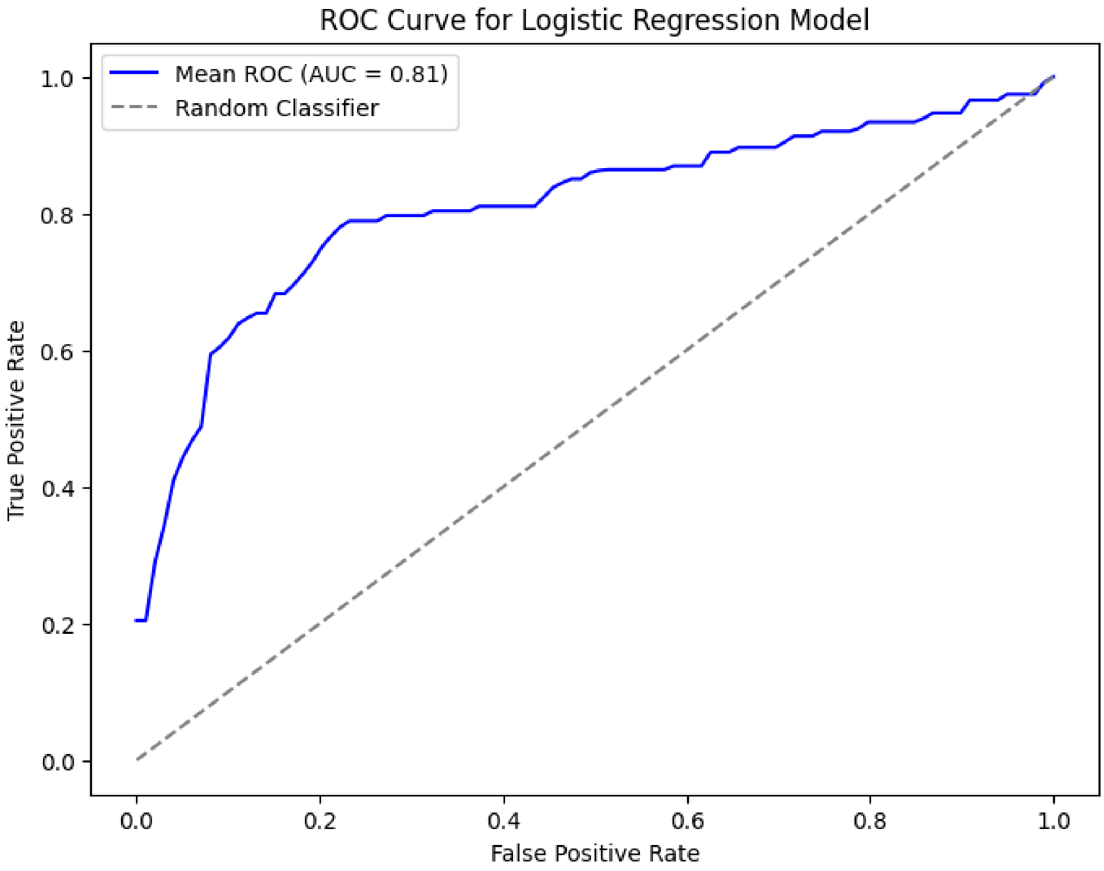
```
2            SibSp         inf
5       FamilySize         inf
15      Title_Miss  177.513865
7         Sex_male  135.483680
17        Title_Mr  117.068989
18       Title_Mrs   99.300740
6          IsAlone   12.850046
10        Title_Dr    6.223599
20       Title_Rev    5.052417
16      Title_Mlle    3.289702
19        Title_Ms    3.271164
12      Title_Lady    3.266631
13     Title_Major    3.023922
4             Fare    2.303734
0           Pclass    2.224417
14    Title_Master    2.042050
11  Title_Jonkheer    2.031291
21       Title_Sir    2.024616
8       Embarked_Q    1.823777
9       Embarked_S    1.729554
1              Age    1.261227
3            Parch         NaN
```

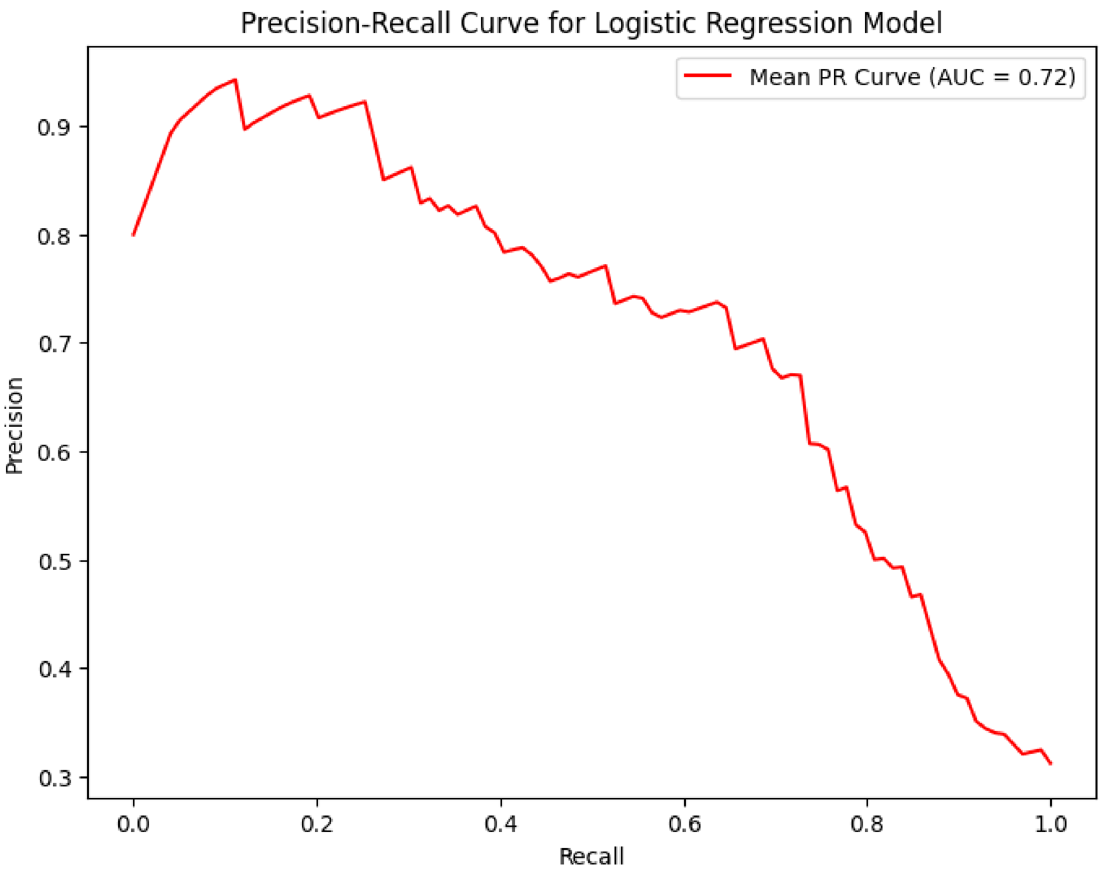
```
/Users/isingh/opt/miniconda3/lib/python3.9/site-
packages/statsmodels/stats/outliers_influence.py:195: RuntimeWarning: divide by
zero encountered in scalar divide
  vif = 1. / (1. - r_squared_i)
/Users/isingh/opt/miniconda3/lib/python3.9/site-
packages/statsmodels/regression/linear_model.py:1738: RuntimeWarning: invalid
value encountered in scalar divide
  return 1 - self.ssr/self.uncentered_tss
```

[224]:

```
kf = KFold(n_splits=5, shuffle=True, random_state=42)

# Logistic Regression Model
logreg = LogisticRegression(max_iter=500)
grid_search_logreg = GridSearchCV(logreg, {}, cv=kf, scoring='accuracy',␣
 ↪n_jobs=1)  # No hyperparams to tune
grid_search_logreg.fit(X_train, y_train)
best_logreg = grid_search_logreg.best_estimator_

# Model Evaluation
accuracies, precisions, recalls, f1_scores, roc_aucs = [], [], [], [], []
tprs, precisions_list = [], []
mean_fpr = np.linspace(0, 1, 100)

for train_index, test_index in kf.split(X_train, y_train):
    X_train_fold, X_val = X_train.iloc[train_index], X_train.iloc[test_index]
    y_train_fold, y_val = y_train.iloc[train_index], y_train.iloc[test_index]

    best_logreg.fit(X_train_fold, y_train_fold)
    y_pred = best_logreg.predict(X_val)
    y_probs = best_logreg.predict_proba(X_val)[:, 1]

    accuracies.append(accuracy_score(y_val, y_pred))
    precisions.append(precision_score(y_val, y_pred, zero_division=1))
    recalls.append(recall_score(y_val, y_pred, zero_division=1))
    f1_scores.append(f1_score(y_val, y_pred, zero_division=1))
    roc_aucs.append(roc_auc_score(y_val, y_probs))

    fpr, tpr, _ = roc_curve(y_val, y_probs)
    tprs.append(np.interp(mean_fpr, fpr, tpr))

    precision, recall, _ = precision_recall_curve(y_val, y_probs)
    precisions_list.append(np.interp(mean_fpr, recall[::-1], precision[::-1]))

# Compute mean ROC and PR AUC
mean_tpr = np.mean(tprs, axis=0)
mean_auc = auc(mean_fpr, mean_tpr)
mean_precision = np.mean(precisions_list, axis=0)
mean_pr_auc = auc(mean_fpr, mean_precision)



# ROC Curve
plt.figure(figsize=(8, 6))
plt.plot(mean_fpr, mean_tpr, color='b', label=f"Mean ROC (AUC = {mean_auc:.
 ↪2f})")
plt.plot([0, 1], [0, 1], linestyle="--", color="gray", label="Random␣
 ↪Classifier")
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title("ROC Curve for Logistic Regression Model")
plt.legend()
plt.show()

# Precision-Recall Curve
plt.figure(figsize=(8, 6))
plt.plot(mean_fpr, mean_precision, color='r', label=f"Mean PR Curve (AUC =␣
 ↪{mean_pr_auc:.2f})")
plt.xlabel("Recall")
plt.ylabel("Precision")
plt.title("Precision-Recall Curve for Logistic Regression Model")
plt.legend()
plt.show()
```

```
# Print Model Performance Metrics
print(f"Mean Accuracy: {np.mean(accuracies):.4f}")
print(f"Mean Precision: {np.mean(precisions):.4f}")
print(f"Mean Recall: {np.mean(recalls):.4f}")
print(f"Mean F1 Score: {np.mean(f1_scores):.4f}")
print(f"Mean ROC AUC: {np.mean(roc_aucs):.4f}")

titanic_test_dataframe = pd.read_csv("/Users/isingh/Desktop/titanic/test.csv")

# Store PassengerId separately for submission
passenger_ids = titanic_test_dataframe["PassengerId"]

X_kaggle = titanic_test_dataframe.drop(columns=['Name', 'Ticket', 'Cabin'],␣
 ↪errors='ignore')

X_kaggle = pd.get_dummies(X_kaggle, drop_first=True)

missing_cols = set(X_train.columns) - set(X_kaggle.columns)
for col in missing_cols:
    X_kaggle[col] = 0

X_kaggle = X_kaggle[X_train.columns]

X_kaggle.fillna(X_kaggle.median(), inplace=True)

X_kaggle_scaled = pd.DataFrame(scaler.transform(X_kaggle), columns=X_kaggle.
 ↪columns)

y_kaggle_preds_logreg = best_logreg.predict(X_kaggle_scaled)

submission_df_logreg = pd.DataFrame({
    "PassengerId": passenger_ids,
    "Survived": y_kaggle_preds_logreg
})

submission_df_logreg.to_csv("logreg_submission.csv", index=False)
print("Submission file 'logreg_submission.csv' ")
```


ROC Curve for Logistic Regression Model
Mean ROC (AUC = 0.81)
Random Classifier
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.2
0.4
0.6
0.8
1.0



```
Mean Accuracy: 0.7874
Mean Precision: 0.6917
Mean Recall: 0.6019
Mean F1 Score: 0.6305
Mean ROC AUC: 0.8102
Submission file 'logreg_submission.csv'
```

LDA (Linear Discriminant Analysis)

[241]:

```
print("\nShapiro-Wilk Normality Test for LDA:")
for col in numerical_cols:
    stat, p = shapiro(X[col])
    print(f"- {col}: p-value={p:.4f} {'(Normal)' if p > 0.05 else '(Not␣
 ↪Normal)'}")
```

```
Shapiro-Wilk Normality Test for LDA:
- Pclass: p-value=0.0000 (Not Normal)
- Age: p-value=0.0000 (Not Normal)
- SibSp: p-value=0.0000 (Not Normal)
- Parch: p-value=1.0000 (Normal)
- Fare: p-value=0.0000 (Not Normal)
- FamilySize: p-value=0.0000 (Not Normal)
- IsAlone: p-value=0.0000 (Not Normal)
```

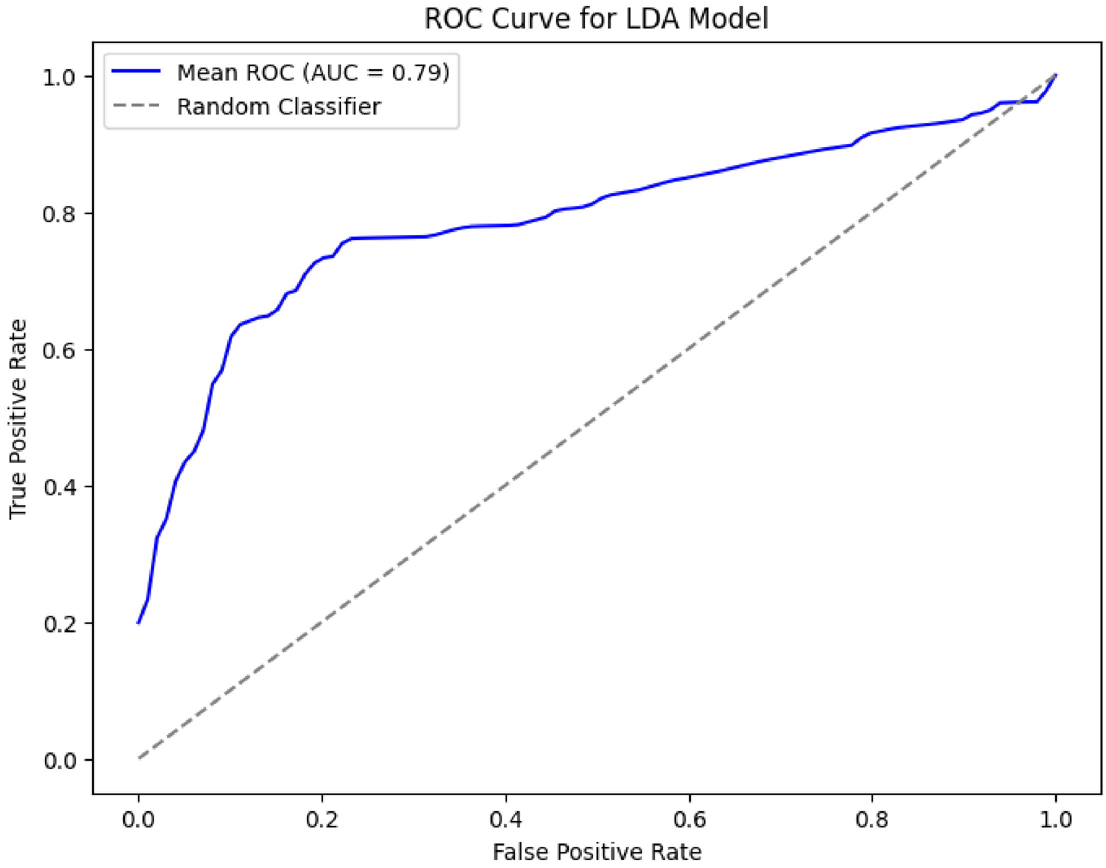
```
/Users/isingh/opt/miniconda3/lib/python3.9/site-
packages/scipy/stats/_axis_nan_policy.py:531: UserWarning: scipy.stats.shapiro:
Input data has range zero. The results may not be accurate.
  res = hypotest_fun_out(*samples, **kwds)
```

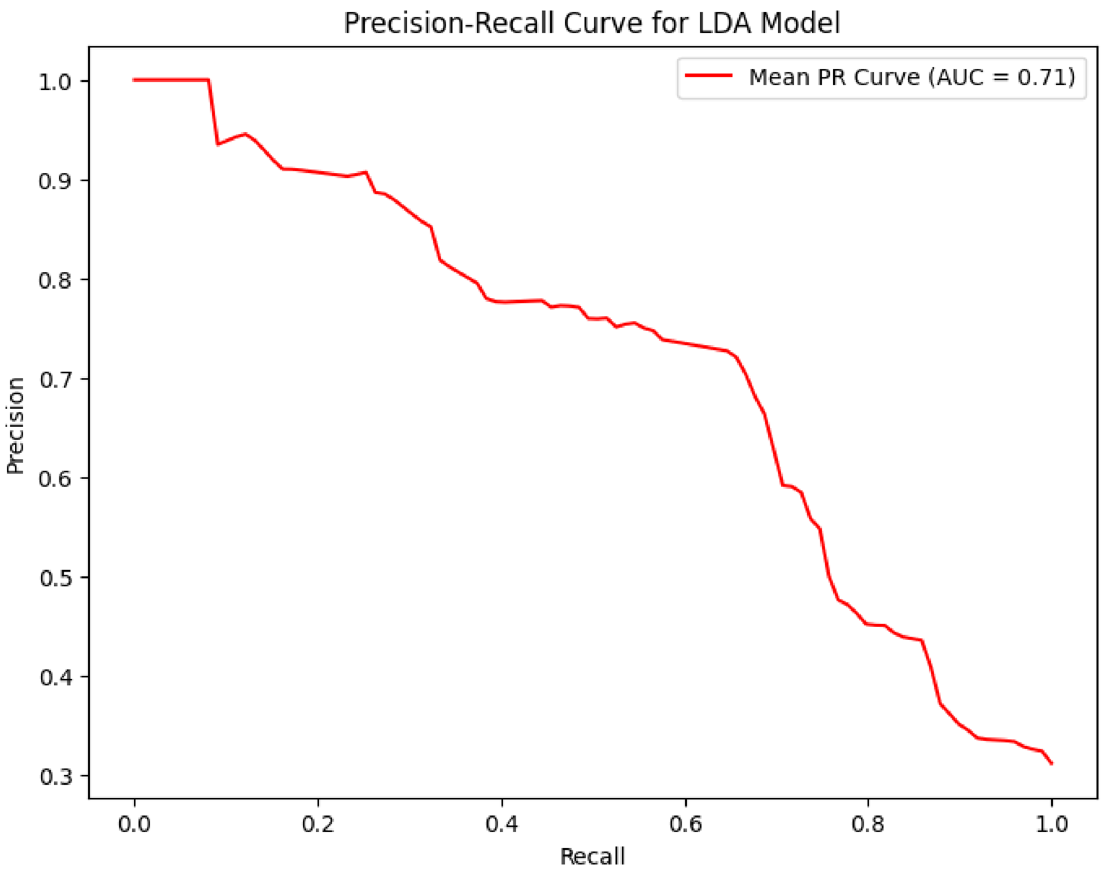
[227]:

```
kf = KFold(n_splits=5, shuffle=True, random_state=42)

lda = LinearDiscriminantAnalysis()
grid_search_lda = GridSearchCV(lda, {}, cv=kf, scoring='accuracy', n_jobs=1)  #␣
 ↪No hyperparameters for LDA
grid_search_lda.fit(X_train, y_train)
best_lda = grid_search_lda.best_estimator_

accuracies, precisions, recalls, f1_scores, roc_aucs = [], [], [], [], []
tprs, precisions_list = [], []
mean_fpr = np.linspace(0, 1, 100)

for train_index, test_index in kf.split(X_train, y_train):
    X_train_fold, X_val = X_train.iloc[train_index], X_train.iloc[test_index]
    y_train_fold, y_val = y_train.iloc[train_index], y_train.iloc[test_index]

    best_lda.fit(X_train_fold, y_train_fold)
    y_pred = best_lda.predict(X_val)
    y_probs = best_lda.predict_proba(X_val)[:, 1]

    accuracies.append(accuracy_score(y_val, y_pred))
    precisions.append(precision_score(y_val, y_pred, zero_division=1))
    recalls.append(recall_score(y_val, y_pred, zero_division=1))
    f1_scores.append(f1_score(y_val, y_pred, zero_division=1))
    roc_aucs.append(roc_auc_score(y_val, y_probs))

    fpr, tpr, _ = roc_curve(y_val, y_probs)
    tprs.append(np.interp(mean_fpr, fpr, tpr))

    precision, recall, _ = precision_recall_curve(y_val, y_probs)
    precisions_list.append(np.interp(mean_fpr, recall[::-1], precision[::-1]))

# Compute mean ROC and PR AUC
mean_tpr = np.mean(tprs, axis=0)
mean_auc = auc(mean_fpr, mean_tpr)
mean_precision = np.mean(precisions_list, axis=0)
mean_pr_auc = auc(mean_fpr, mean_precision)
```

```
# ROC Curve
plt.figure(figsize=(8, 6))
plt.plot(mean_fpr, mean_tpr, color='b', label=f"Mean ROC (AUC = {mean_auc:.
 ↪2f})")
plt.plot([0, 1], [0, 1], linestyle="--", color="gray", label="Random␣
 ↪Classifier")
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title("ROC Curve for LDA Model")
plt.legend()
plt.show()

# Precision-Recall Curve
plt.figure(figsize=(8, 6))
plt.plot(mean_fpr, mean_precision, color='r', label=f"Mean PR Curve (AUC =␣
 ↪{mean_pr_auc:.2f})")
plt.xlabel("Recall")
plt.ylabel("Precision")
plt.title("Precision-Recall Curve for LDA Model")
plt.legend()
plt.show()

# Print Model Performance Metrics
print(f"Mean Accuracy: {np.mean(accuracies):.4f}")
print(f"Mean Precision: {np.mean(precisions):.4f}")
print(f"Mean Recall: {np.mean(recalls):.4f}")
print(f"Mean F1 Score: {np.mean(f1_scores):.4f}")
print(f"Mean ROC AUC: {np.mean(roc_aucs):.4f}")

titanic_test_dataframe = pd.read_csv("/Users/isingh/Desktop/titanic/test.csv")

passenger_ids = titanic_test_dataframe["PassengerId"]

X_kaggle = titanic_test_dataframe.drop(columns=['Name', 'Ticket', 'Cabin'],␣
 ↪errors='ignore')

X_kaggle = pd.get_dummies(X_kaggle, drop_first=True)

missing_cols = set(X_train.columns) - set(X_kaggle.columns)
for col in missing_cols:
    X_kaggle[col] = 0

X_kaggle = X_kaggle[X_train.columns]

X_kaggle.fillna(X_kaggle.median(), inplace=True)
```

```
# Standardize test data
X_kaggle_scaled = pd.DataFrame(scaler.transform(X_kaggle), columns=X_kaggle.
  ↪columns)

y_kaggle_preds_lda = best_lda.predict(X_kaggle_scaled)

submission_df_lda = pd.DataFrame({
    "PassengerId": passenger_ids,
    "Survived": y_kaggle_preds_lda
})

submission_df_lda.to_csv("lda_submission.csv", index=False)
print("Submission file 'lda_submission.csv' created. Upload to Kaggle.")
```





```
Mean Accuracy: 0.8005
Mean Precision: 0.7178
Mean Recall: 0.6227
Mean F1 Score: 0.6549
Mean ROC AUC: 0.7888
Submission file 'lda_submission.csv' created. Upload to Kaggle.
```

[ ]: