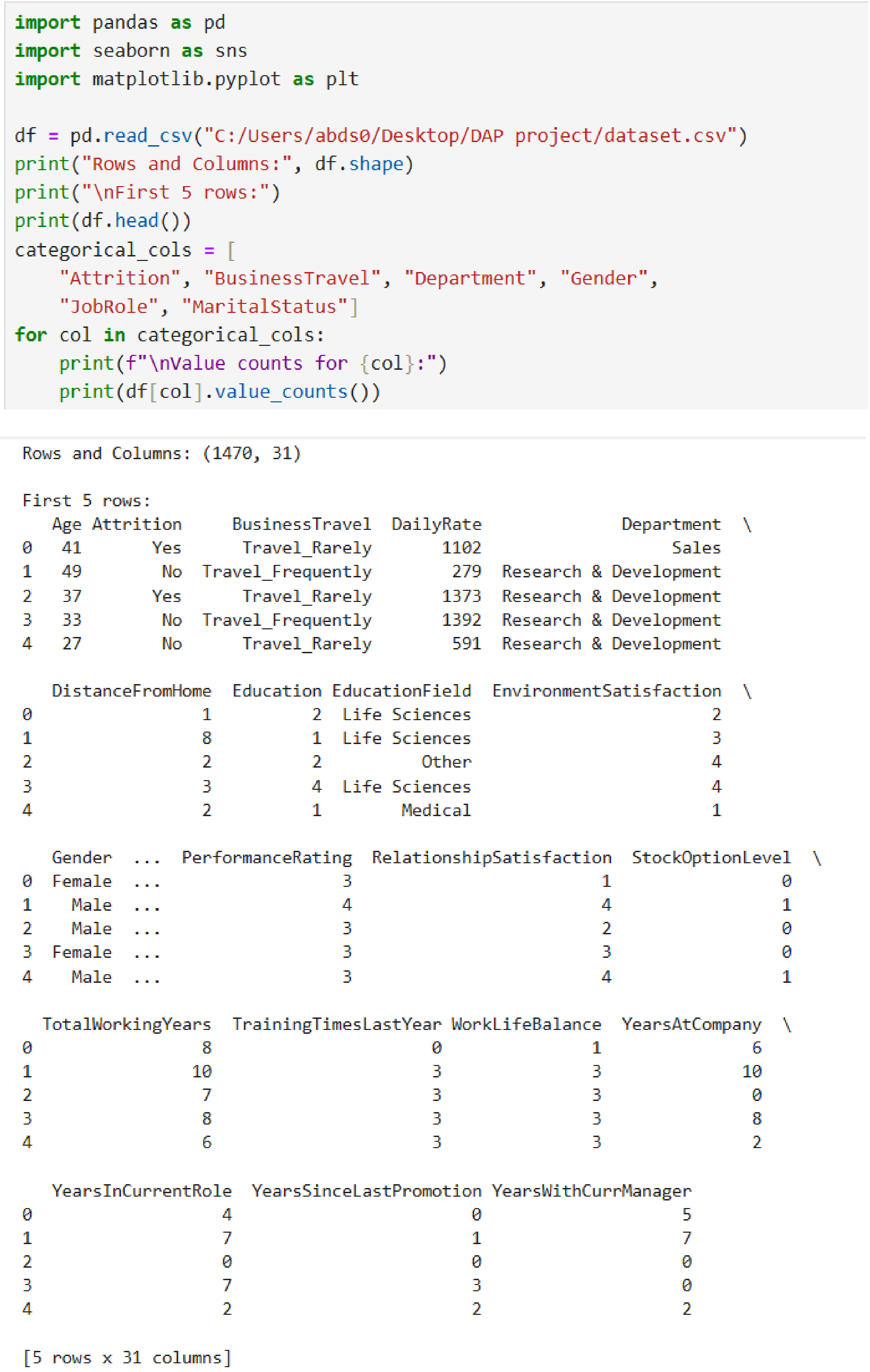
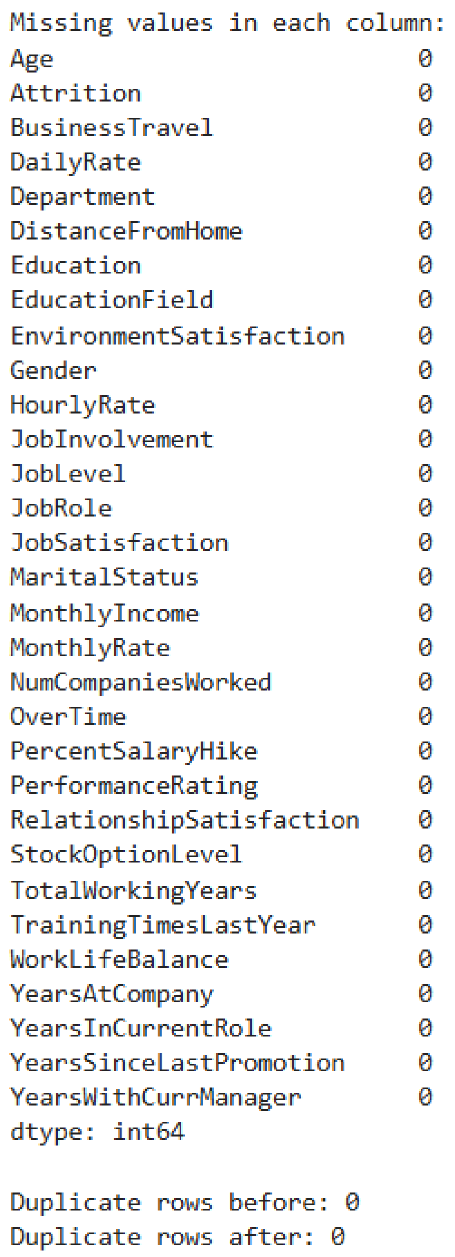


```python
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

df = pd.read_csv("C:/Users/abds0/Desktop/DAP project/dataset.csv")
print("Rows and Columns:", df.shape)
print("\nFirst 5 rows:")
print(df.head())
categorical_cols = [
    "Attrition", "BusinessTravel", "Department", "Gender",
    "JobRole", "MaritalStatus"]
for col in categorical_cols:
    print(f"\nValue counts for {col}:")
    print(df[col].value_counts())
```

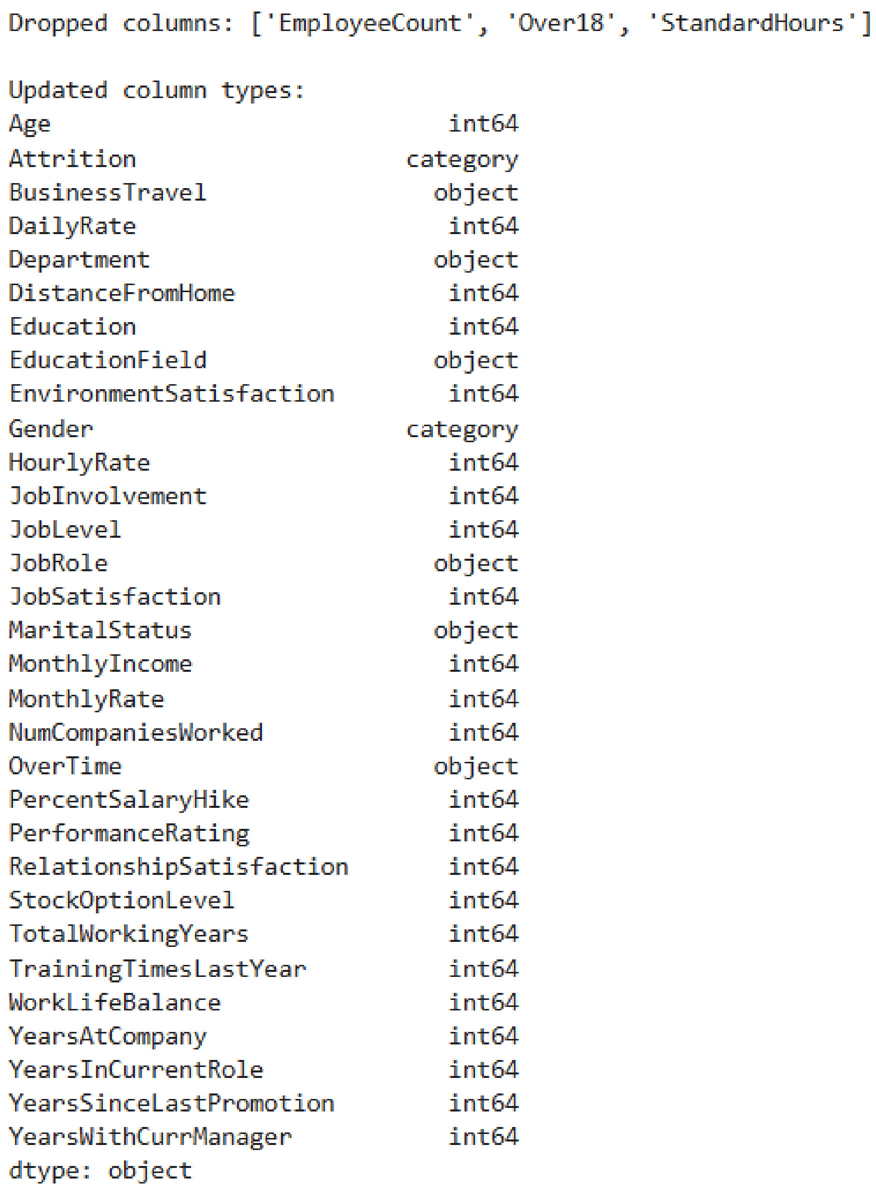
```
Rows and Columns: (1470, 31)

First 5 rows:
   Age Attrition     BusinessTravel  DailyRate              Department  \
0   41       Yes      Travel_Rarely       1102                   Sales   
1   49        No  Travel_Frequently        279  Research & Development   
2   37       Yes      Travel_Rarely       1373  Research & Development   
3   33        No  Travel_Frequently       1392  Research & Development   
4   27        No      Travel_Rarely        591  Research & Development   

   DistanceFromHome  Education EducationField  EnvironmentSatisfaction  \
0                 1          2  Life Sciences                        2   
1                 8          1  Life Sciences                        3   
2                 2          2          Other                        4   
3                 3          4  Life Sciences                        4   
4                 2          1        Medical                        1   

   Gender  ...  PerformanceRating  RelationshipSatisfaction  StockOptionLevel  \
0  Female  ...                  3                         1                 0   
1    Male  ...                  4                         4                 1   
2    Male  ...                  3                         2                 0   
3  Female  ...                  3                         3                 0   
4    Male  ...                  3                         4                 1   

  TotalWorkingYears  TrainingTimesLastYear WorkLifeBalance  YearsAtCompany  \
0                 8                      0               1               6   
1                10                      3               3              10   
2                 7                      3               3               0   
3                 8                      3               3               8   
4                 6                      3               3               2   

   YearsInCurrentRole  YearsSinceLastPromotion YearsWithCurrManager
0                   4                        0                    5
1                   7                        1                    7
2                   0                        0                    0
3                   7                        3                    0
4                   2                        2                    2

[5 rows x 31 columns]
```

```
Value counts for Attrition:
Attrition
No     1233
Yes     237
Name: count, dtype: int64

Value counts for Department:
Department
Research & Development    961
Sales                     446
Human Resources            63
Name: count, dtype: int64

Value counts for Gender:
Gender
Male      882
Female    588
Name: count, dtype: int64

Value counts for JobRole:
JobRole
Sales Executive              326
Research Scientist           292
Laboratory Technician        259
Manufacturing Director       145
Healthcare Representative    131
Manager                      102
Sales Representative          83
Research Director             80
Human Resources               52
Name: count, dtype: int64

Value counts for MaritalStatus:
MaritalStatus
Married     673
Single      470
Divorced    327
Name: count, dtype: int64
```

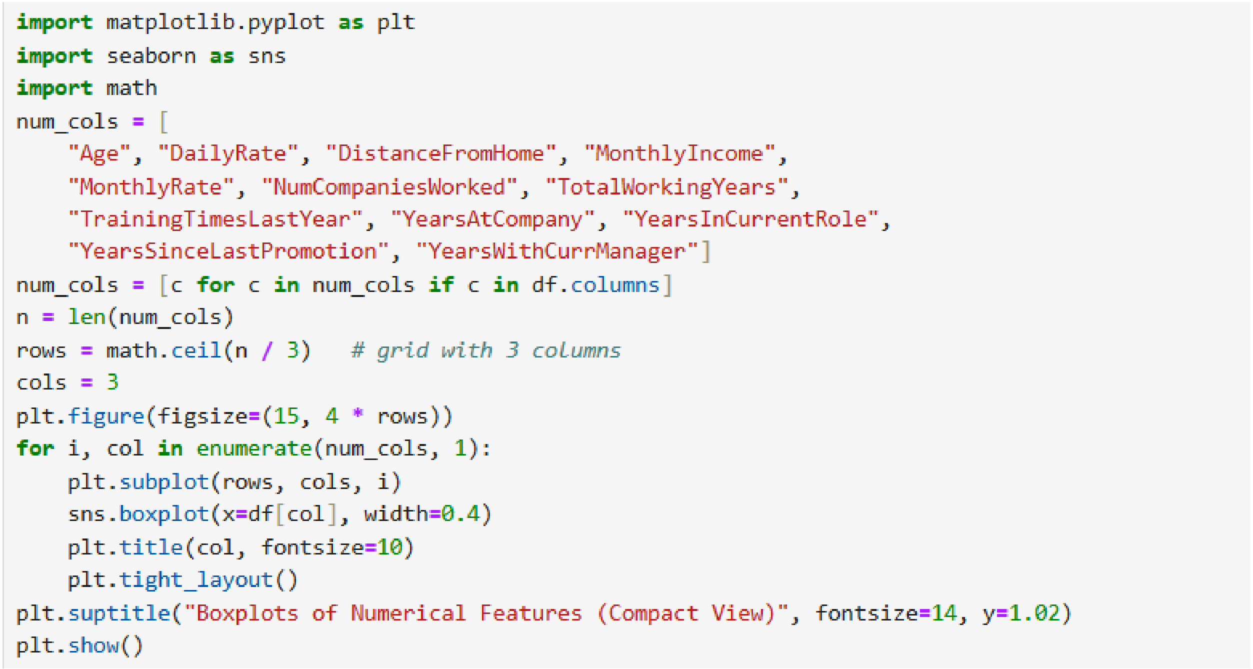
```python
import pandas as pd
df = pd.read_csv("C:/Users/abds0/Desktop/DAP project/dataset.csv")
print("\nMissing values in each column:")
print(df.isnull().sum())
print("\nDuplicate rows before:", df.duplicated().sum())
df = df.drop_duplicates()
print("Duplicate rows after:", df.duplicated().sum())
df['OverTime'] = df['OverTime'].str.strip()
df['OverTime'] = df['OverTime'].replace({
    'yes': 'Yes',
    'YES': 'Yes',
    'no': 'No',
    'NO': 'No'
})
remove_cols = ["EmployeeCount", "Over18", "StandardHours"]
df = df.drop(columns=["EmployeeCount", "Over18", "StandardHours"], errors='ignore')
print("\nDropped columns:", remove_cols)
df['Attrition'] = df['Attrition'].astype('category')
df['Gender'] = df['Gender'].astype('category')
print("\nUpdated column types:")
print(df.dtypes)
```



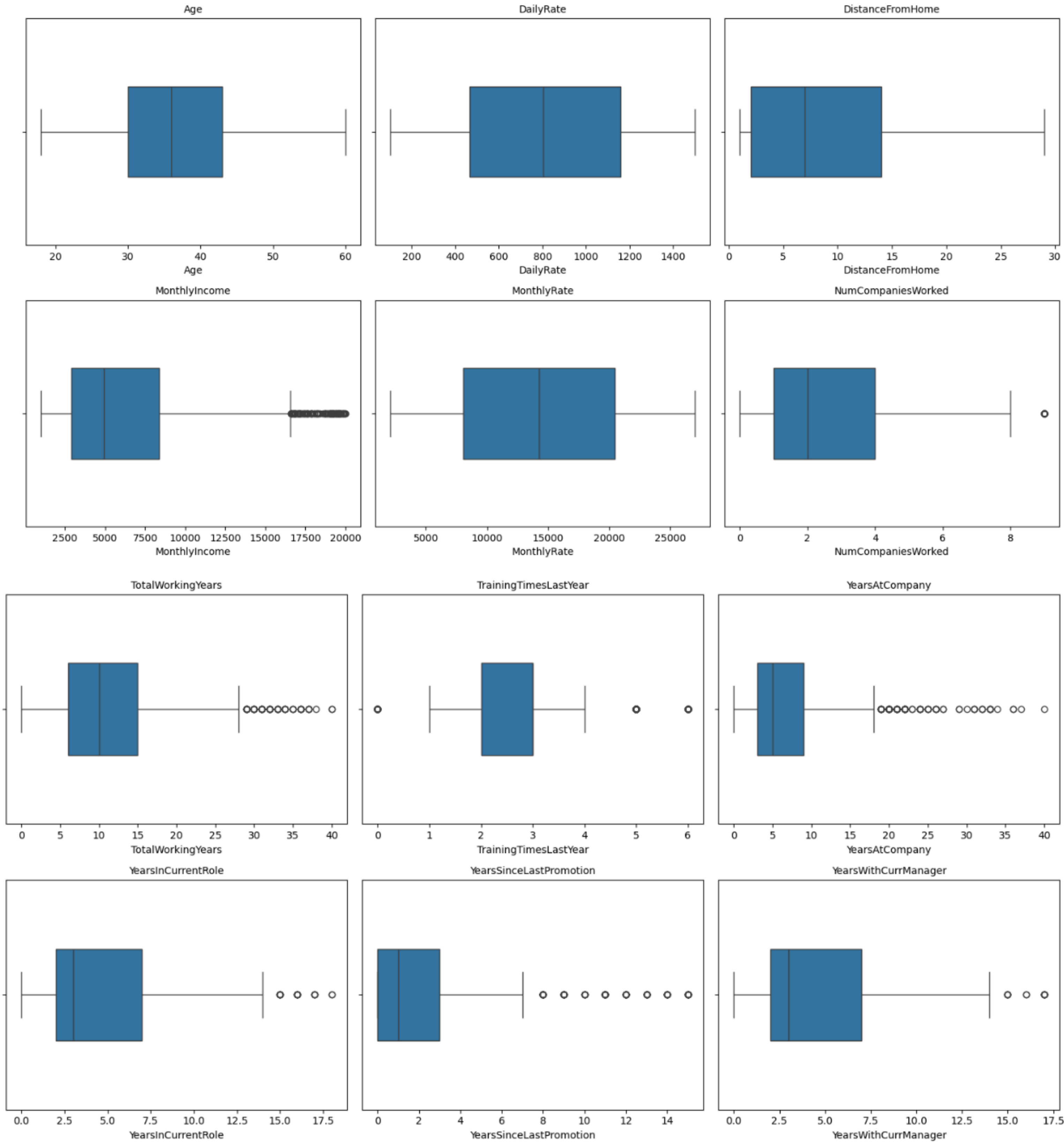
```
Missing values in each column:
Age                         0
Attrition                   0
BusinessTravel              0
DailyRate                   0
Department                  0
DistanceFromHome            0
Education                   0
EducationField              0
EnvironmentSatisfaction     0
Gender                      0
HourlyRate                  0
JobInvolvement              0
JobLevel                    0
JobRole                     0
JobSatisfaction             0
MaritalStatus               0
MonthlyIncome               0
MonthlyRate                 0
NumCompaniesWorked          0
OverTime                    0
PercentSalaryHike           0
PerformanceRating           0
RelationshipSatisfaction    0
StockOptionLevel            0
TotalWorkingYears           0
TrainingTimesLastYear       0
WorkLifeBalance             0
YearsAtCompany              0
YearsInCurrentRole          0
YearsSinceLastPromotion     0
YearsWithCurrManager        0
dtype: int64

Duplicate rows before: 0
Duplicate rows after: 0
```

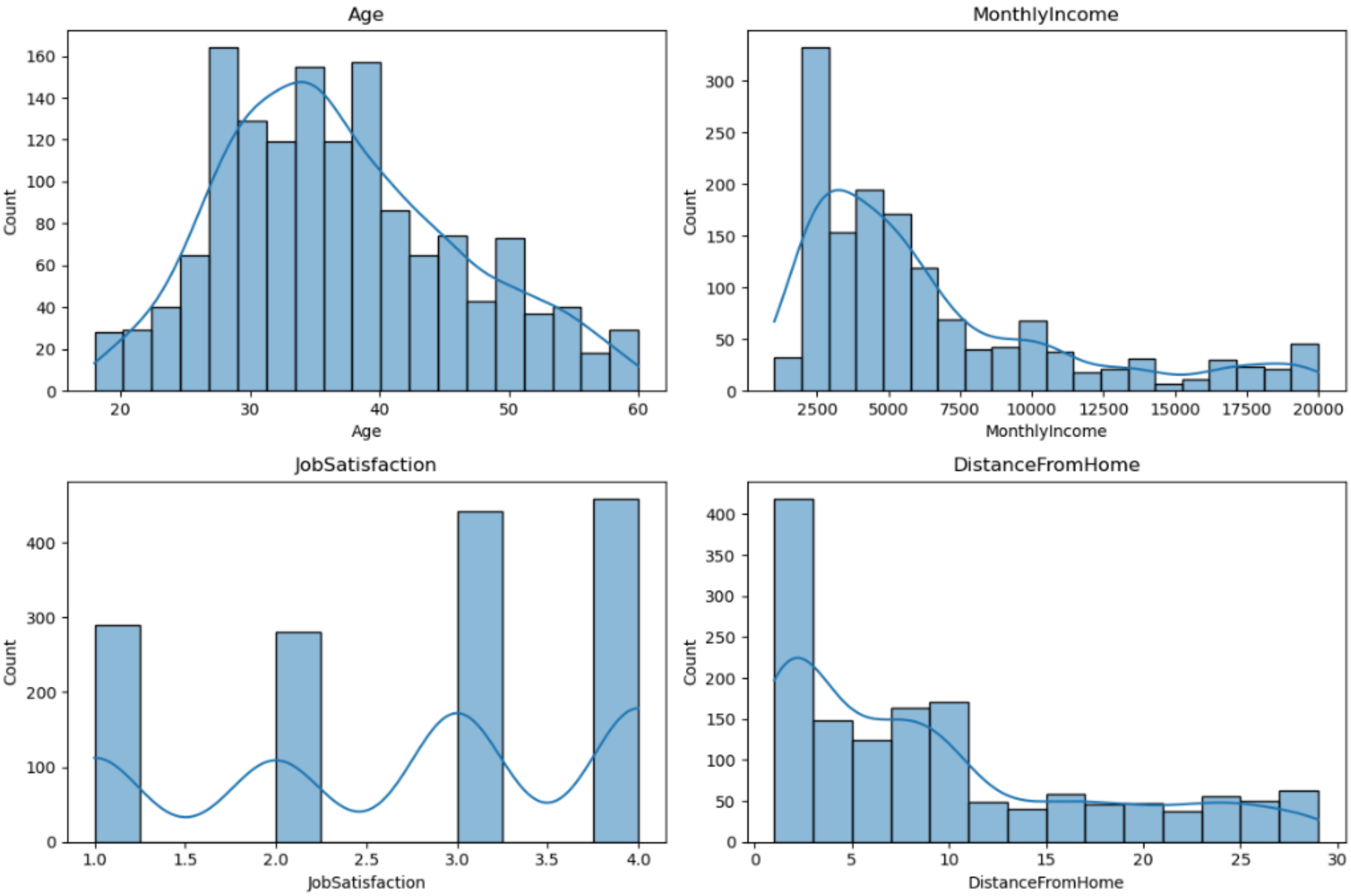


```
Dropped columns: ['EmployeeCount', 'Over18', 'StandardHours']

Updated column types:
Age                            int64
Attrition                   category
BusinessTravel                object
DailyRate                      int64
Department                    object
DistanceFromHome               int64
Education                      int64
EducationField                object
EnvironmentSatisfaction        int64
Gender                      category
HourlyRate                     int64
JobInvolvement                 int64
JobLevel                       int64
JobRole                       object
JobSatisfaction                int64
MaritalStatus                 object
MonthlyIncome                  int64
MonthlyRate                    int64
NumCompaniesWorked             int64
OverTime                      object
PercentSalaryHike              int64
PerformanceRating              int64
RelationshipSatisfaction       int64
StockOptionLevel               int64
TotalWorkingYears              int64
TrainingTimesLastYear          int64
WorkLifeBalance                int64
YearsAtCompany                 int64
YearsInCurrentRole             int64
YearsSinceLastPromotion        int64
YearsWithCurrManager           int64
dtype: object
```



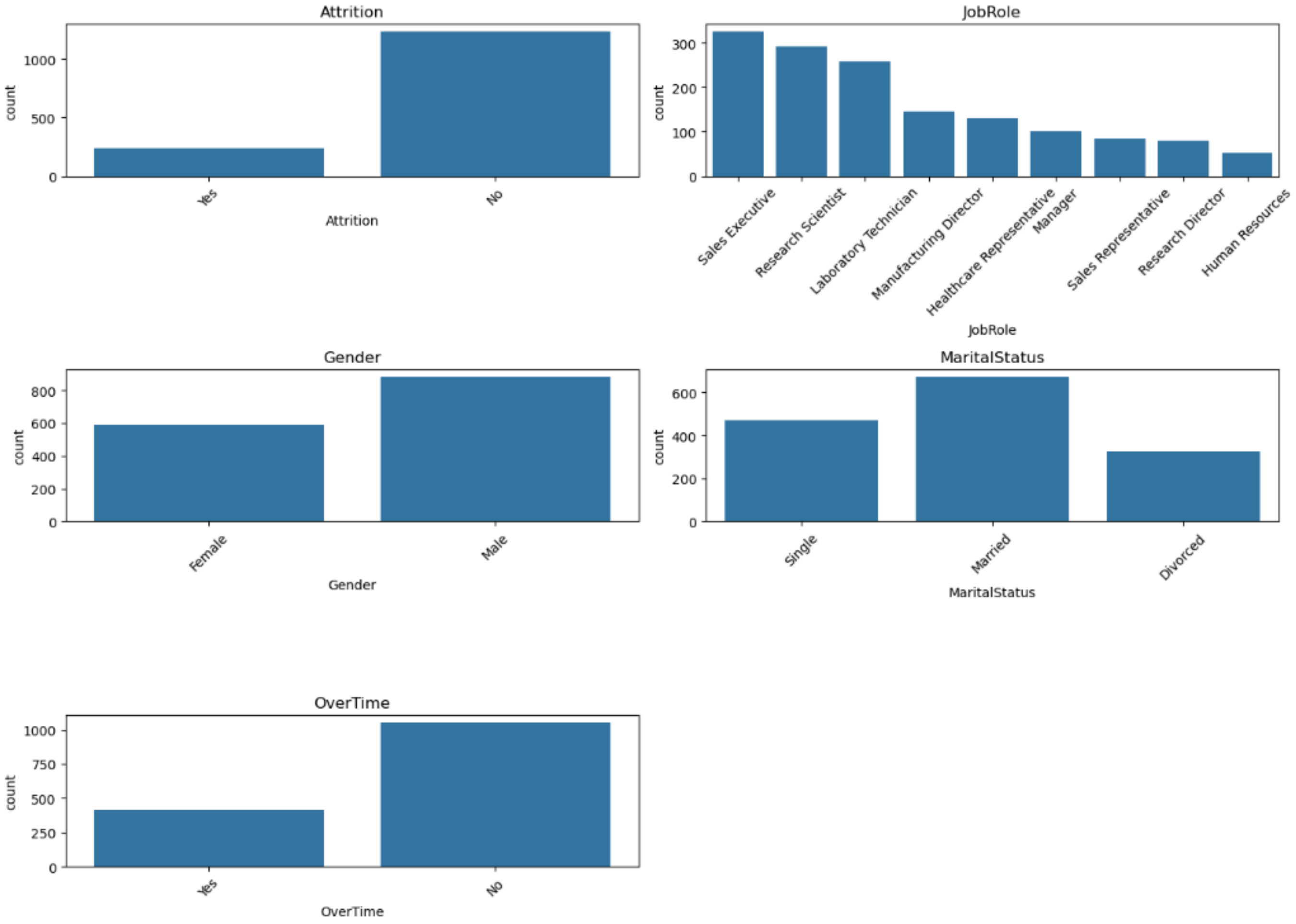
```python
import matplotlib.pyplot as plt
import seaborn as sns
import math
num_cols = [
    "Age", "DailyRate", "DistanceFromHome", "MonthlyIncome",
    "MonthlyRate", "NumCompaniesWorked", "TotalWorkingYears",
    "TrainingTimesLastYear", "YearsAtCompany", "YearsInCurrentRole",
    "YearsSinceLastPromotion", "YearsWithCurrManager"]
num_cols = [c for c in num_cols if c in df.columns]
n = len(num_cols)
rows = math.ceil(n / 3)   # grid with 3 columns
cols = 3
plt.figure(figsize=(15, 4 * rows))
for i, col in enumerate(num_cols, 1):
    plt.subplot(rows, cols, i)
    sns.boxplot(x=df[col], width=0.4)
    plt.title(col, fontsize=10)
    plt.tight_layout()
plt.suptitle("Boxplots of Numerical Features (Compact View)", fontsize=14, y=1.02)
plt.show()
```

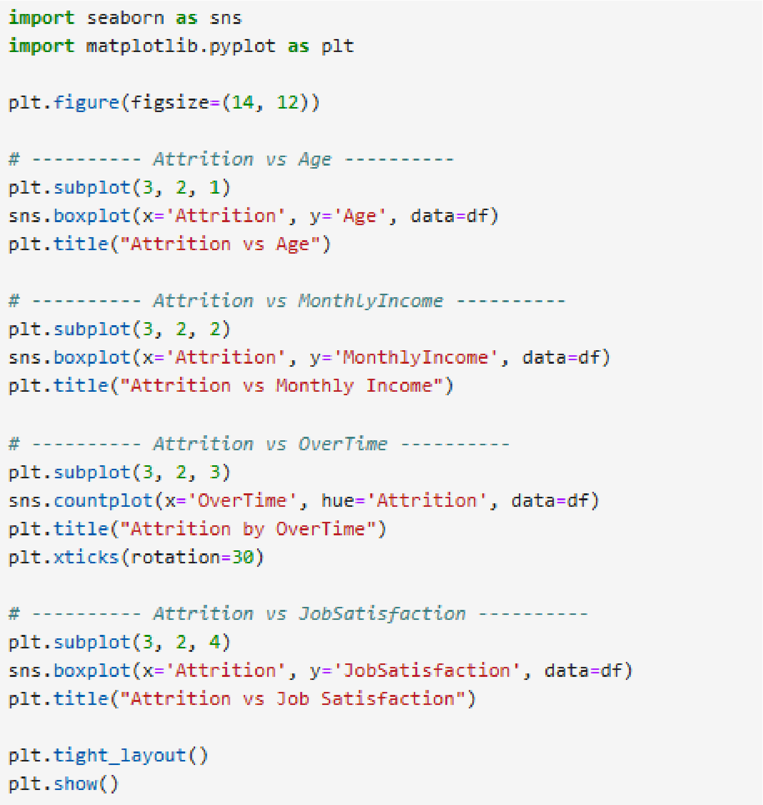

Age
20 30 40 50 60
Age
DailyRate
200 400 600 800 1000 1200 1400
DailyRate
DistanceFromHome
0 5 10 15 20 25 30
DistanceFromHome
MonthlyIncome
2500 5000 7500 10000 12500 15000 17500 20000
MonthlyIncome
MonthlyRate
5000 10000 15000 20000 25000
MonthlyRate
NumCompaniesWorked
0 2 4 6 8
NumCompaniesWorked
TotalWorkingYears
0 5 10 15 20 25 30 35 40
TotalWorkingYears
TrainingTimesLastYear
0 1 2 3 4 5 6
TrainingTimesLastYear
YearsAtCompany
0 5 10 15 20 25 30 35 40
YearsAtCompany
YearsInCurrentRole
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5
YearsInCurrentRole
YearsSinceLastPromotion
0 2 4 6 8 10 12 14
YearsSinceLastPromotion
YearsWithCurrManager
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5
YearsWithCurrManager



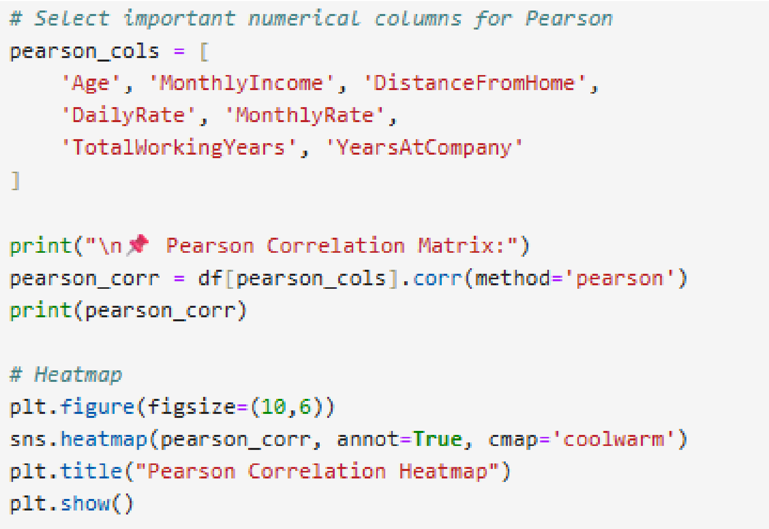
JobSatisfaction

DistanceFromHome

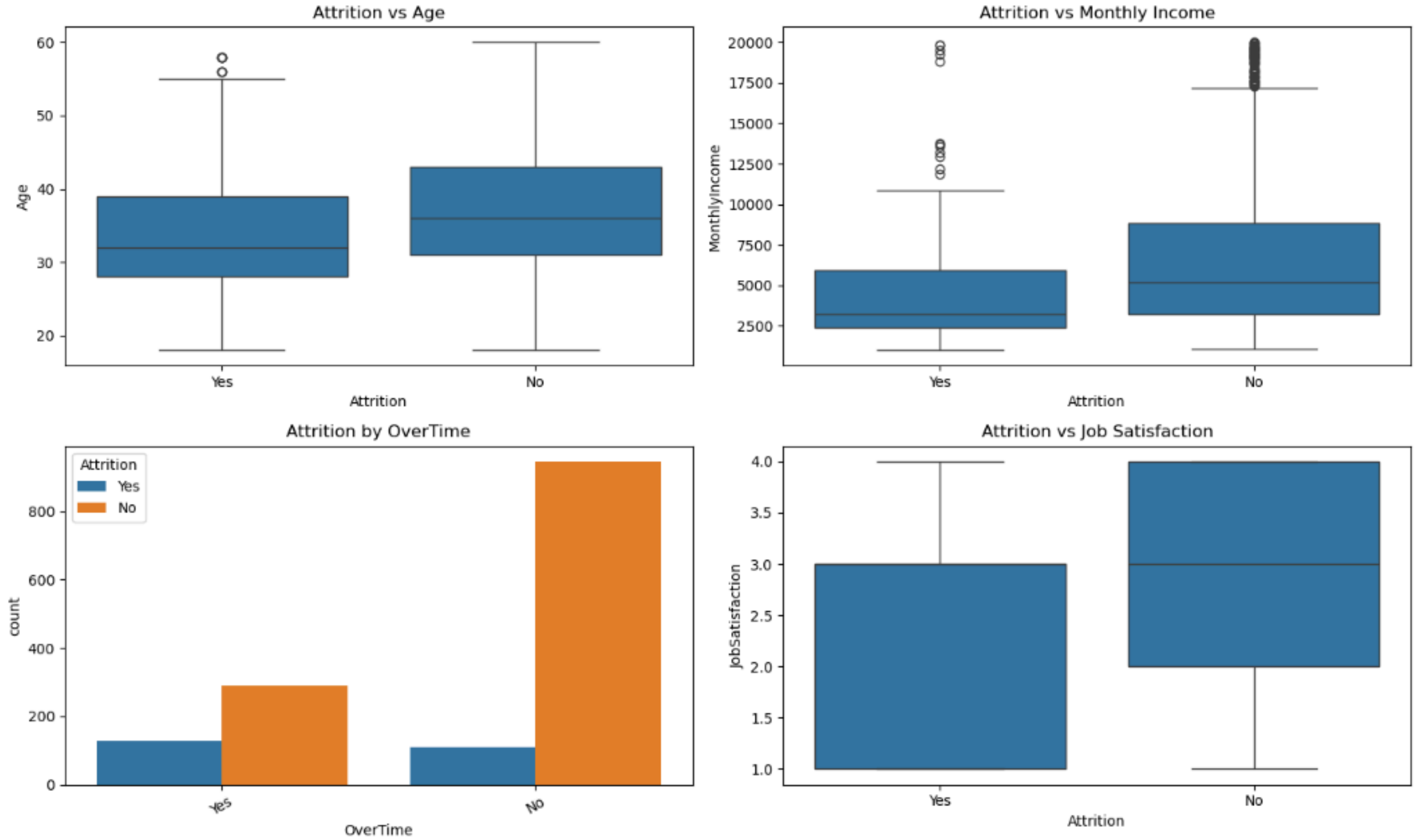




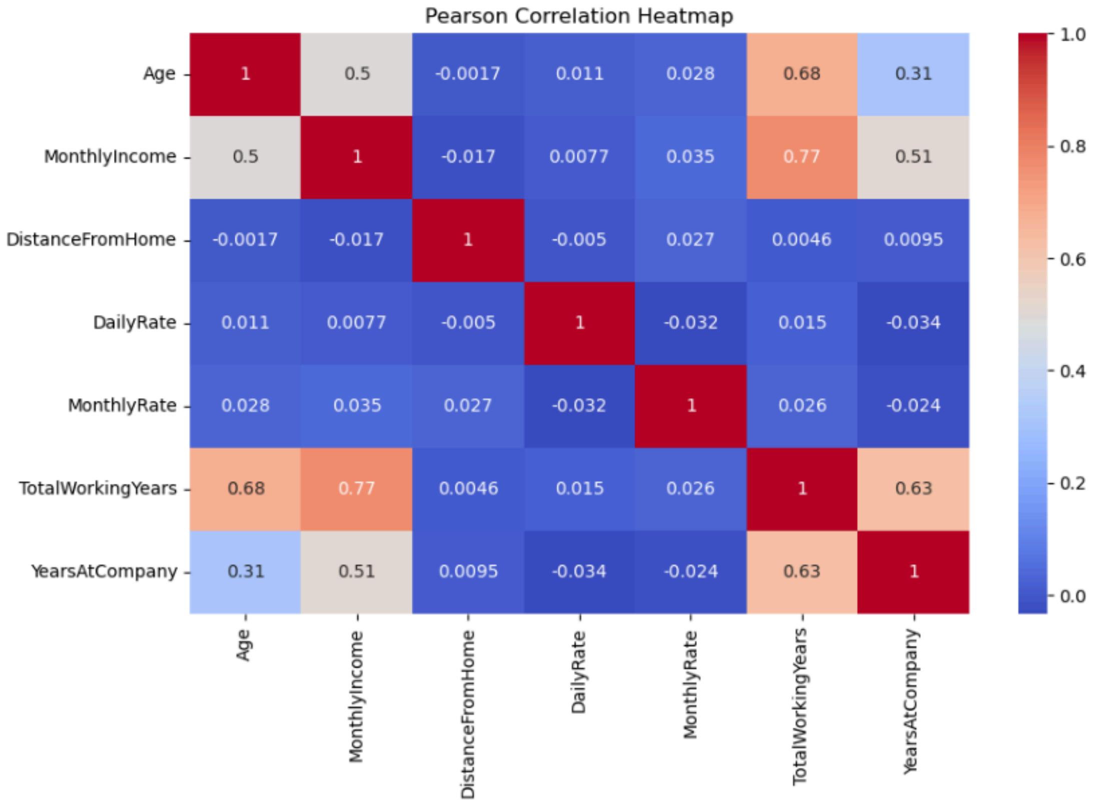
```
import seaborn as sns
import matplotlib.pyplot as plt

plt.figure(figsize=(14, 12))

# ---------- Attrition vs Age ----------
plt.subplot(3, 2, 1)
sns.boxplot(x='Attrition', y='Age', data=df)
plt.title("Attrition vs Age")

# ---------- Attrition vs MonthlyIncome ----------
plt.subplot(3, 2, 2)
sns.boxplot(x='Attrition', y='MonthlyIncome', data=df)
plt.title("Attrition vs Monthly Income")

# ---------- Attrition vs OverTime ----------
plt.subplot(3, 2, 3)
sns.countplot(x='OverTime', hue='Attrition', data=df)
plt.title("Attrition by OverTime")
plt.xticks(rotation=30)

# ---------- Attrition vs JobSatisfaction ----------
plt.subplot(3, 2, 4)
sns.boxplot(x='Attrition', y='JobSatisfaction', data=df)
plt.title("Attrition vs Job Satisfaction")

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

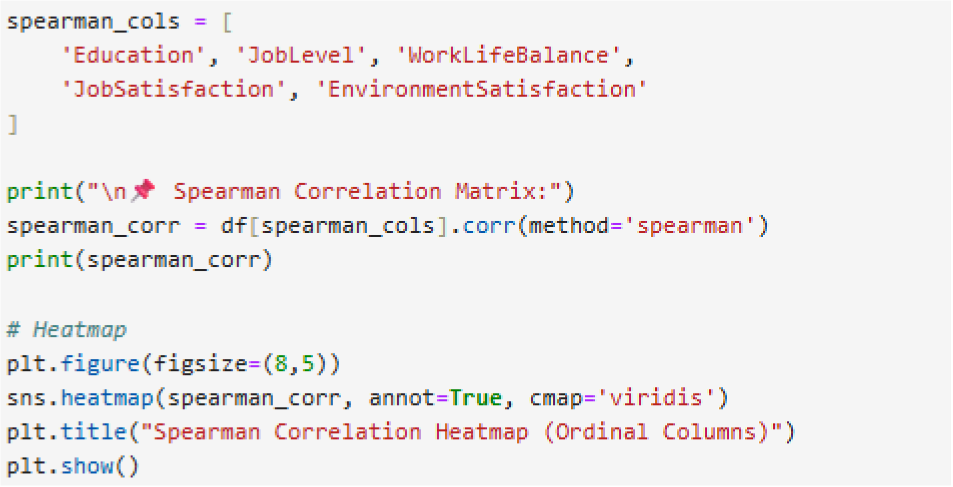


```
# Select important numerical columns for Pearson
pearson_cols = [
    'Age', 'MonthlyIncome', 'DistanceFromHome',
    'DailyRate', 'MonthlyRate',
    'TotalWorkingYears', 'YearsAtCompany'
]

print("\n📌 Pearson Correlation Matrix:")
pearson_corr = df[pearson_cols].corr(method='pearson')
print(pearson_corr)

# Heatmap
plt.figure(figsize=(10,6))
sns.heatmap(pearson_corr, annot=True, cmap='coolwarm')
plt.title("Pearson Correlation Heatmap")
plt.show()
```



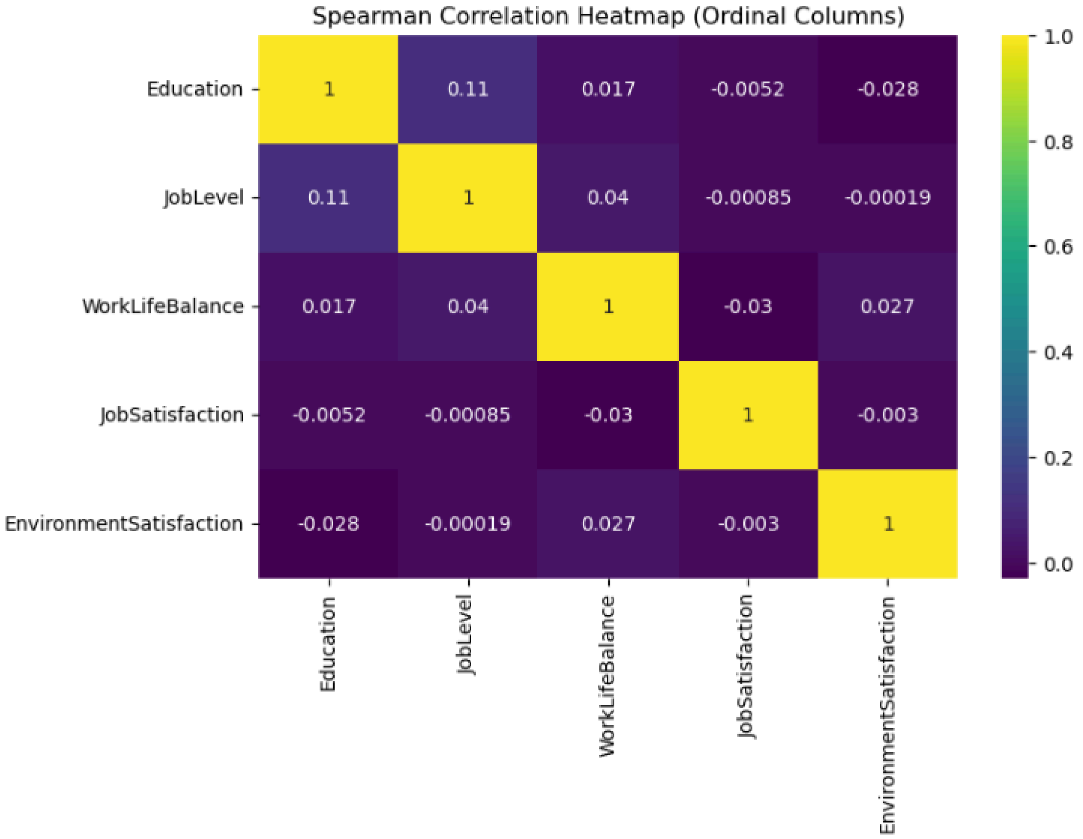
```
📌 Pearson Correlation Matrix:
                        Age  MonthlyIncome  DistanceFromHome  DailyRate  \
Age                1.000000       0.497855         -0.001686   0.010661
MonthlyIncome      0.497855       1.000000         -0.017014   0.007707
DistanceFromHome  -0.001686      -0.017014          1.000000  -0.004985
DailyRate          0.010661       0.007707         -0.004985   1.000000
MonthlyRate        0.028051       0.034814          0.027473  -0.032182
TotalWorkingYears  0.680381       0.772893          0.004628   0.014515
YearsAtCompany     0.311309       0.514285          0.009508  -0.034055

                   MonthlyRate  TotalWorkingYears  YearsAtCompany
Age                   0.028051           0.680381        0.311309
MonthlyIncome         0.034814           0.772893        0.514285
DistanceFromHome      0.027473           0.004628        0.009508
DailyRate            -0.032182           0.014515       -0.034055
MonthlyRate           1.000000           0.026442       -0.023655
TotalWorkingYears     0.026442           1.000000        0.628133
YearsAtCompany       -0.023655           0.628133        1.000000
```





```python
spearman_cols = [
    'Education', 'JobLevel', 'WorkLifeBalance',
    'JobSatisfaction', 'EnvironmentSatisfaction'
]

print("\n📌 Spearman Correlation Matrix:")
spearman_corr = df[spearman_cols].corr(method='spearman')
print(spearman_corr)

# Heatmap
plt.figure(figsize=(8,5))
sns.heatmap(spearman_corr, annot=True, cmap='viridis')
plt.title("Spearman Correlation Heatmap (Ordinal Columns)")
plt.show()
```

```
📌 Spearman Correlation Matrix:
                          Education  JobLevel  WorkLifeBalance  \
Education                  1.000000  0.107419         0.017350   
JobLevel                   0.107419  1.000000         0.040466   
WorkLifeBalance            0.017350  0.040466         1.000000   
JobSatisfaction           -0.005175 -0.000852        -0.029781   
EnvironmentSatisfaction   -0.027625 -0.000192         0.027169   

                          JobSatisfaction  EnvironmentSatisfaction  
Education                       -0.005175                -0.027625  
JobLevel                        -0.000852                -0.000192  
WorkLifeBalance                 -0.029781                 0.027169  
JobSatisfaction                  1.000000                -0.002993  
EnvironmentSatisfaction         -0.002993                 1.000000  
```



```python
df['Attrition'] = df['Attrition'].astype(str).str.strip().str.title()
df['Attrition_numeric'] = df['Attrition'].map({'Yes': 1, 'No': 0})
print("\n📌 Correlation of Numerical Features with Attrition:")
corr_attr = df.corr(numeric_only=True)['Attrition_numeric'].sort_values(ascending=False)
print(corr_attr)
```

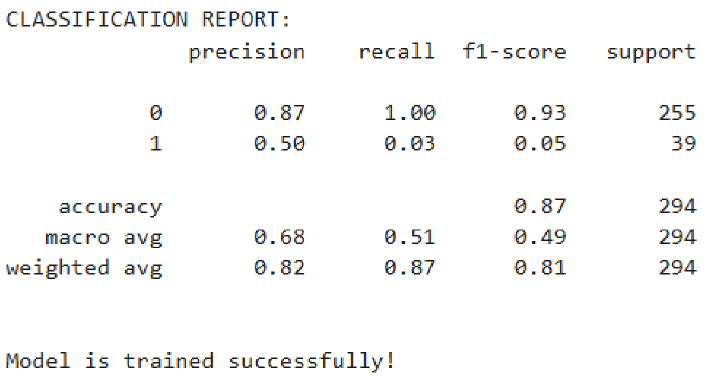
```
📌 Correlation of Numerical Features with Attrition:
Attrition_numeric           1.000000
DistanceFromHome            0.077924
NumCompaniesWorked          0.043494
MonthlyRate                 0.015170
PerformanceRating           0.002889
HourlyRate                 -0.006846
PercentSalaryHike          -0.013478
Education                  -0.031373
YearsSinceLastPromotion    -0.033019
RelationshipSatisfaction   -0.045872
DailyRate                  -0.056652
TrainingTimesLastYear      -0.059478
WorkLifeBalance            -0.063939
EnvironmentSatisfaction    -0.103369
JobSatisfaction            -0.103481
JobInvolvement             -0.130016
YearsAtCompany             -0.134392
StockOptionLevel           -0.137145
YearsWithCurrManager       -0.156199
Age                        -0.159205
MonthlyIncome              -0.159840
YearsInCurrentRole         -0.160545
JobLevel                   -0.169105
TotalWorkingYears          -0.171063
Name: Attrition_numeric, dtype: float64
```

```
🔹 CHI-SQUARE TESTS (Categorical vs Categorical)

Gender: p-value = 0.2906  --> Not Significant
Department: p-value = 0.0045  --> Significant
BusinessTravel: p-value = 0.0000  --> Significant
JobRole: p-value = 0.0000  --> Significant
MaritalStatus: p-value = 0.0000  --> Significant
EducationField: p-value = 0.0068  --> Significant
OverTime: p-value = 0.0000  --> Significant
```

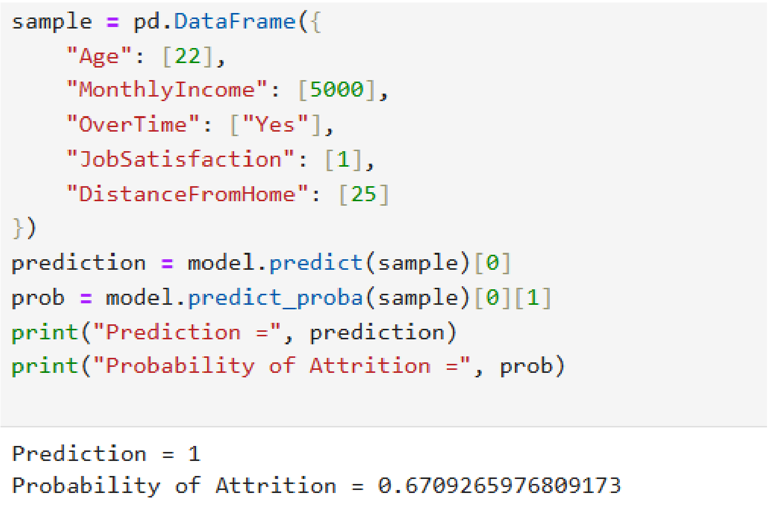
```python
from scipy.stats import ttest_ind

print("\n\n🔹 t-TESTS (Numerical vs Attrition)\n")

df['Attrition_numeric'] = df['Attrition'].map({'Yes':1, 'No':0})

num_cols_to_test = [
    'MonthlyIncome','Age','DailyRate','HourlyRate',
    'MonthlyRate','TotalWorkingYears','DistanceFromHome',
    'YearsAtCompany','YearsInCurrentRole','YearsSinceLastPromotion'
]

for col in num_cols_to_test:
    yes = df[df['Attrition']=='Yes'][col].dropna()
    no = df[df['Attrition']=='No'][col].dropna()

    t_stat, p = ttest_ind(yes, no, equal_var=False)

    print(f"{col}: p-value = {p:.4f}  --> {'Significant' if p < 0.05 else 'Not Significant'}")
```

```
🔹 t-TESTS (Numerical vs Attrition)

MonthlyIncome: p-value = 0.0000  --> Significant
Age: p-value = 0.0000  --> Significant
DailyRate: p-value = 0.0300  --> Significant
HourlyRate: p-value = 0.7914  --> Not Significant
MonthlyRate: p-value = 0.5653  --> Not Significant
TotalWorkingYears: p-value = 0.0000  --> Significant
DistanceFromHome: p-value = 0.0041  --> Significant
YearsAtCompany: p-value = 0.0000  --> Significant
YearsInCurrentRole: p-value = 0.0000  --> Significant
YearsSinceLastPromotion: p-value = 0.1987  --> Not Significant
```

```python
from scipy.stats import chi2_contingency
import pandas as pd

print("\n🔹 CHI-SQUARE TESTS (Categorical vs Categorical)\n")

cat_cols = [
    'Gender','Department','BusinessTravel','JobRole',
    'MaritalStatus','EducationField','OverTime'
]

chi_results = {}

for col in cat_cols:
    table = pd.crosstab(df['Attrition'], df[col])
    chi2, p, dof, exp = chi2_contingency(table)
    chi_results[col] = p
    print(f"{col}: p-value = {p:.4f}  --> {'Significant' if p < 0.05 else 'Not Significant'}")
```

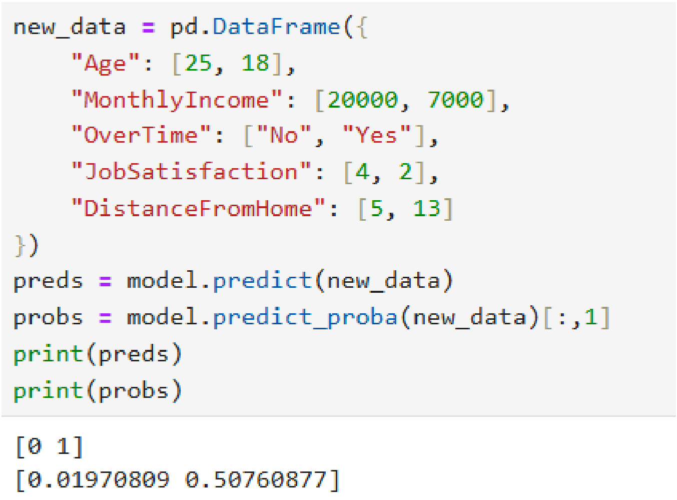


```
CLASSIFICATION REPORT:
              precision    recall  f1-score   support

           0       0.87      1.00      0.93       255
           1       0.50      0.03      0.05        39

    accuracy                           0.87       294
   macro avg       0.68      0.51      0.49       294
weighted avg       0.82      0.87      0.81       294


Model is trained successfully!
```



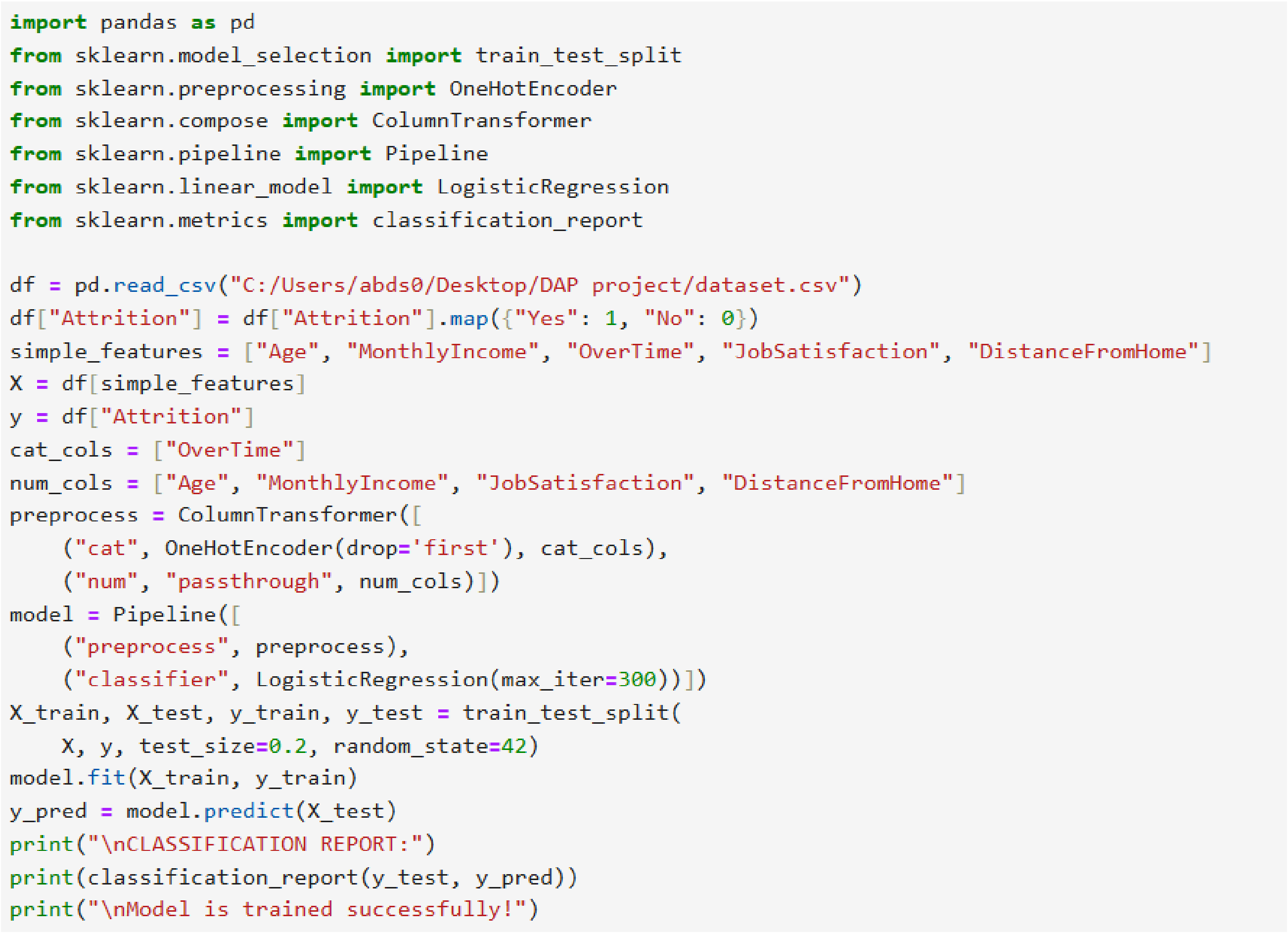
```python
sample = pd.DataFrame({
    "Age": [22],
    "MonthlyIncome": [5000],
    "OverTime": ["Yes"],
    "JobSatisfaction": [1],
    "DistanceFromHome": [25]
})
prediction = model.predict(sample)[0]
prob = model.predict_proba(sample)[0][1]
print("Prediction =", prediction)
print("Probability of Attrition =", prob)
```

```
Prediction = 1
Probability of Attrition = 0.6709265976809173
```



```python
new_data = pd.DataFrame({
    "Age": [25, 18],
    "MonthlyIncome": [20000, 7000],
    "OverTime": ["No", "Yes"],
    "JobSatisfaction": [4, 2],
    "DistanceFromHome": [5, 13]
})
preds = model.predict(new_data)
probs = model.predict_proba(new_data)[:,1]
print(preds)
print(probs)
```

```
[0 1]
[0.01970809 0.50760877]
```



```python
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import OneHotEncoder
from sklearn.compose import ColumnTransformer
from sklearn.pipeline import Pipeline
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report

df = pd.read_csv("C:/Users/abds0/Desktop/DAP project/dataset.csv")
df["Attrition"] = df["Attrition"].map({"Yes": 1, "No": 0})
simple_features = ["Age", "MonthlyIncome", "OverTime", "JobSatisfaction", "DistanceFromHome"]
X = df[simple_features]
y = df["Attrition"]
cat_cols = ["OverTime"]
num_cols = ["Age", "MonthlyIncome", "JobSatisfaction", "DistanceFromHome"]
preprocess = ColumnTransformer([
    ("cat", OneHotEncoder(drop='first'), cat_cols),
    ("num", "passthrough", num_cols)])
model = Pipeline([
    ("preprocess", preprocess),
    ("classifier", LogisticRegression(max_iter=300))])
X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.2, random_state=42)
model.fit(X_train, y_train)
y_pred = model.predict(X_test)
print("\nCLASSIFICATION REPORT:")
print(classification_report(y_test, y_pred))
print("\nModel is trained successfully!")
```