In [2]:

```
#1. Download the employee attrition dataset
#https://www.kaggle.com/datasets/patelprashant/employee-attrition
#2. Perform data preprocessing
#3. Model building using logistic regression and decision tree
#4. Calculate Performance metrics
```

In [3]:

```
#For linear algebra
import numpy as np
#For data processing
import pandas as pd
#For Visualization
import matplotlib.pyplot as plt
import seaborn as sns
```

In [19]:

```
df=pd.read_csv("Employee-Attrition.csv")
print(df.head)
```

```
<bound method NDFrame.head of       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
...   ...       ...                ...        ...                     ...
1465   36        No  Travel_Frequently        884  Research & Development
1466   39        No      Travel_Rarely        613  Research & Development
1467   27        No      Travel_Rarely        155  Research & Development
1468   49        No  Travel_Frequently       1023                   Sales
1469   34        No      Travel_Rarely        628  Research & Development

      DistanceFromHome  Education EducationField  EmployeeCount  \
0                    1          2  Life Sciences              1
1                    8          1  Life Sciences              1
2                    2          2          Other              1
3                    3          4  Life Sciences              1
4                    2          1        Medical              1
...                ...        ...            ...            ...
1465                23          2        Medical              1
1466                 6          1        Medical              1
1467                 4          3  Life Sciences              1
1468                 2          3        Medical              1
1469                 8          3        Medical              1

      EmployeeNumber  ...  RelationshipSatisfaction StandardHours  \
0                  1  ...                         1            80
1                  2  ...                         4            80
2                  4  ...                         2            80
3                  5  ...                         3            80
4                  7  ...                         4            80
...              ...  ...                       ...           ...
1465            2061  ...                         3            80
1466            2062  ...                         1            80
1467            2064  ...                         2            80
1468            2065  ...                         4            80
1469            2068  ...                         1            80

      StockOptionLevel  TotalWorkingYears  TrainingTimesLastYear  \
0                    0                  8                      0
1                    1                 10                      3
2                    0                  7                      3
3                    0                  8                      3
4                    1                  6                      3
```

```
...                 ...                 ...                      ...
1465                  1                  17                        3
1466                  1                   9                        5
1467                  1                   6                        0
1468                  0                  17                        3
1469                  0                   6                        3

     WorkLifeBalance  YearsAtCompany YearsInCurrentRole  \
0                  1               6                  4   
1                  3              10                  7   
2                  3               0                  0   
3                  3               8                  7   
4                  3               2                  2   
...              ...             ...                ...   
1465               3               5                  2   
1466               3               7                  7   
1467               3               6                  2   
1468               2               9                  6   
1469               4               4                  3   

      YearsSinceLastPromotion  YearsWithCurrManager  
0                           0                     5  
1                           1                     7  
2                           0                     0  
3                           3                     0  
4                           2                     2  
...                       ...                   ...  
1465                        0                     3  
1466                        1                     7  
1467                        0                     3  
1468                        0                     8  
1469                        1                     2  

[1470 rows x 35 columns]>
```

In [5]:
```
df.info()
```

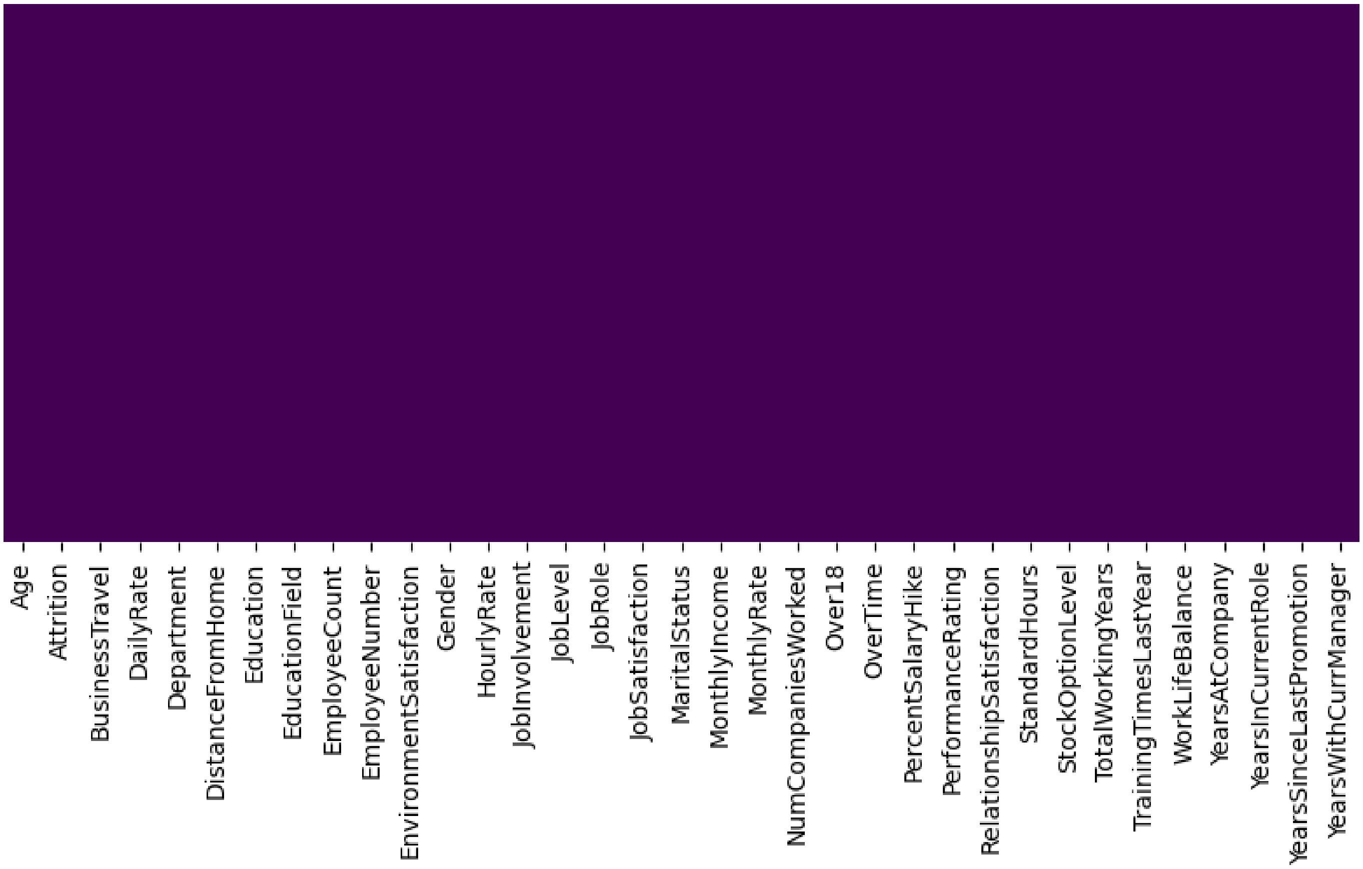
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1470 entries, 0 to 1469
Data columns (total 35 columns):
 #   Column                    Non-Null Count  Dtype 
---  ------                    --------------  ----- 
 0   Age                       1470 non-null   int64 
 1   Attrition                 1470 non-null   object
 2   BusinessTravel            1470 non-null   object
 3   DailyRate                 1470 non-null   int64 
 4   Department                1470 non-null   object
 5   DistanceFromHome          1470 non-null   int64 
 6   Education                 1470 non-null   int64 
 7   EducationField            1470 non-null   object
 8   EmployeeCount             1470 non-null   int64 
 9   EmployeeNumber            1470 non-null   int64 
 10  EnvironmentSatisfaction   1470 non-null   int64 
 11  Gender                    1470 non-null   object
 12  HourlyRate                1470 non-null   int64 
 13  JobInvolvement            1470 non-null   int64 
 14  JobLevel                  1470 non-null   int64 
 15  JobRole                   1470 non-null   object
 16  JobSatisfaction           1470 non-null   int64 
 17  MaritalStatus             1470 non-null   object
 18  MonthlyIncome             1470 non-null   int64 
 19  MonthlyRate               1470 non-null   int64 
 20  NumCompaniesWorked        1470 non-null   int64 
 21  Over18                    1470 non-null   object
 22  OverTime                  1470 non-null   object
 23  PercentSalaryHike         1470 non-null   int64 
 24  PerformanceRating         1470 non-null   int64
 25  RelationshipSatisfaction  1470 non-null   int64
 26  StandardHours             1470 non-null   int64
 27  StockOptionLevel          1470 non-null   int64
 28  TotalWorkingYears         1470 non-null   int64
 29  TrainingTimesLastYear     1470 non-null   int64
 30  WorkLifeBalance           1470 non-null   int64
 31  YearsAtCompany            1470 non-null   int64
 32  YearsInCurrentRole        1470 non-null   int64
 33  YearsSinceLastPromotion   1470 non-null   int64
 34  YearsWithCurrManager      1470 non-null   int64
dtypes: int64(26), object(9)
memory usage: 402.1+ KB
```

In [6]:

```
#For checking Missing values
plt.figure(figsize=(10,4))
sns.heatmap(df.isnull(), yticklabels=False, cbar=False, cmap='viridis')
```

Out[6]:

```
<Axes: >
```

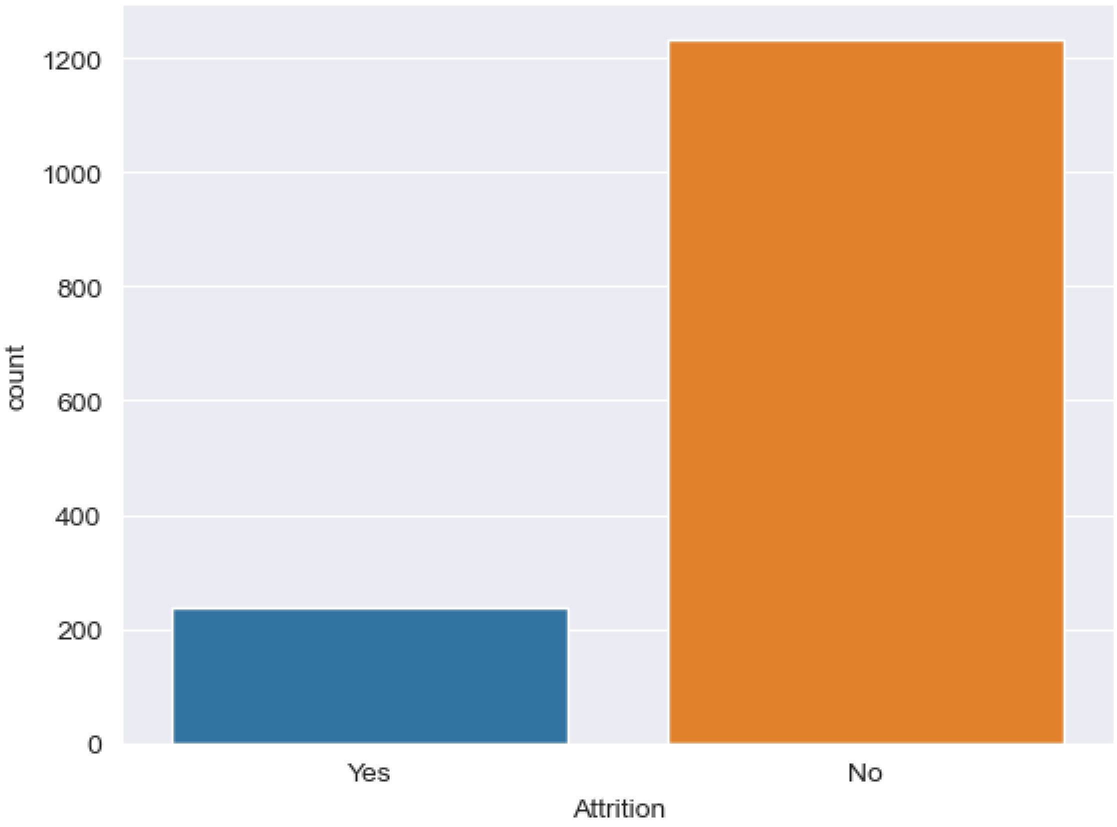


In [7]:

```
sns.set_style('darkgrid')
sns.countplot(x='Attrition', data=df)
```

Out[7]:

```
<Axes: xlabel='Attrition', ylabel='count'>
```

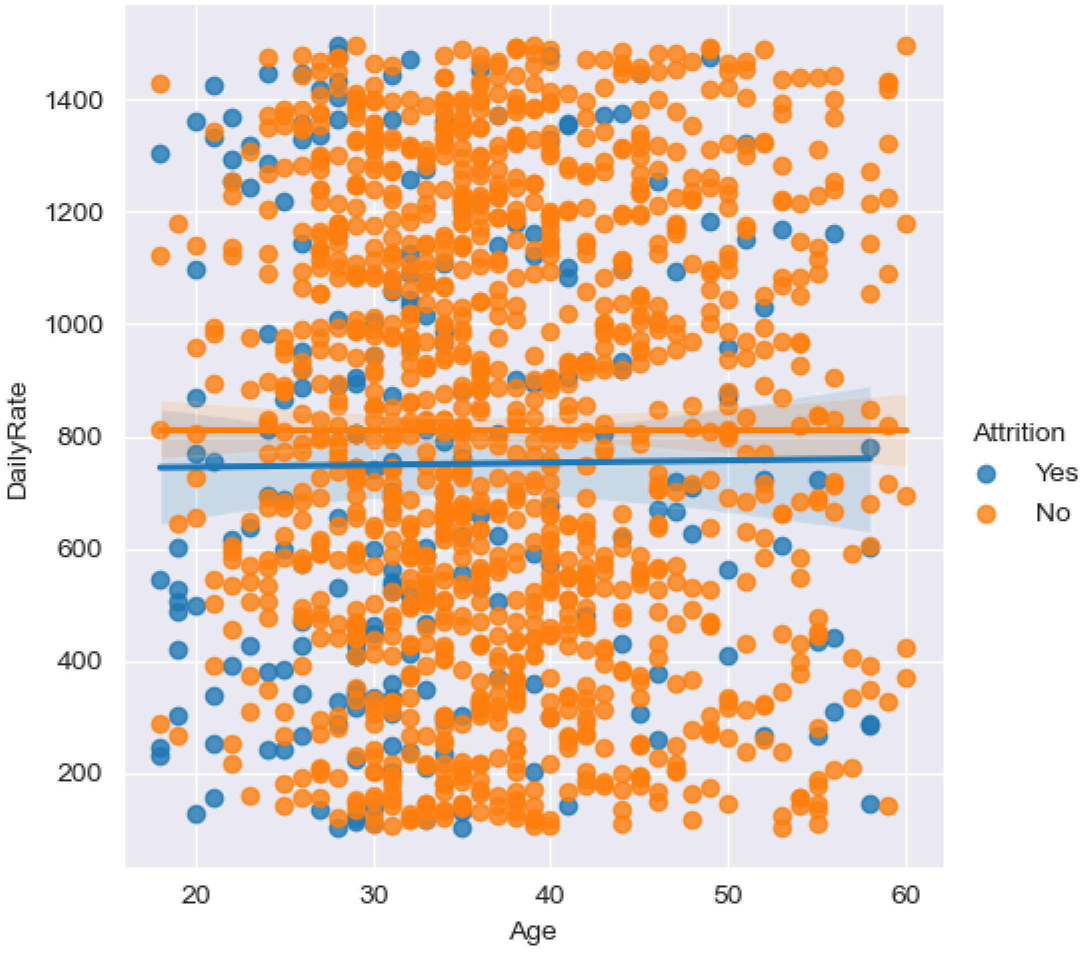


In [8]:

```
sns.lmplot(x='Age', y='DailyRate', hue='Attrition', data=df)
```

Out[8]:

```
<seaborn.axisgrid.FacetGrid at 0x224bb84bfd0>
```

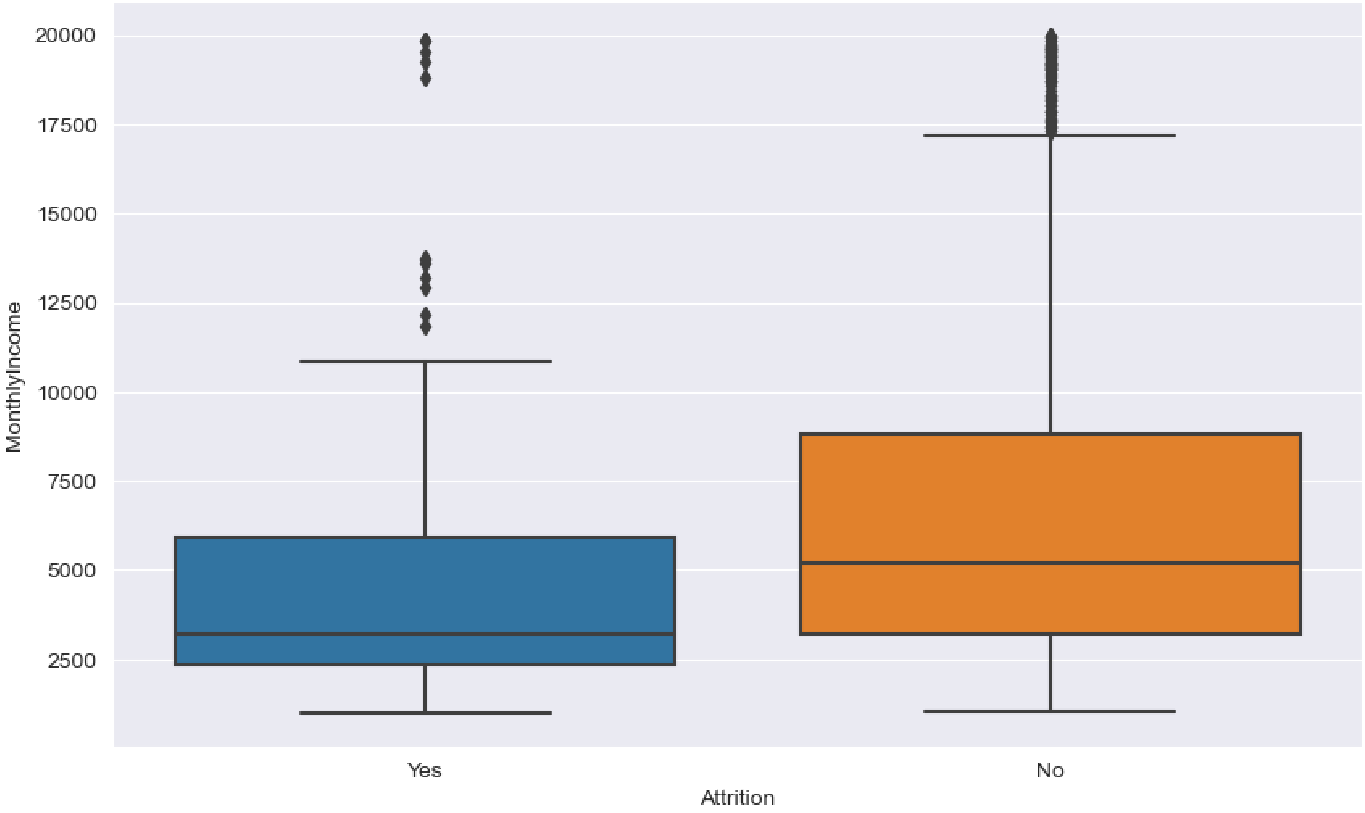


In [9]:

```
plt.figure(figsize=(10,6))
sns.boxplot(y='MonthlyIncome', x='Attrition', data=df)
```

Out[9]:

```
<Axes: xlabel='Attrition', ylabel='MonthlyIncome'>
```



In [10]:

```
df.drop(['EmployeeCount','StandardHours','EmployeeNumber','Over18'], axis=1, inplace=Tru
print(df.shape)
```

```
(1470, 31)
```

In [11]:

```
y=df.iloc[:,1]
x=df
x.drop('Attrition', axis=1, inplace=True)
```

In [12]:

```
from sklearn.preprocessing import LabelEncoder
lb=LabelEncoder()
y=lb.fit_transform(y)
```

In [13]:

```
dum_BusinessTravel = pd.get_dummies(df['BusinessTravel'], prefix='BusinessTravel')
dum_Department = pd.get_dummies(df['Department'], prefix='Department')
dum_EducationField = pd.get_dummies(df['EducationField'], prefix='EducationField')   # Fi
dum_Gender = pd.get_dummies(df['Gender'], prefix='Gender', drop_first=True)
dum_JobRole = pd.get_dummies(df['JobRole'], prefix='JobRole')
dum_MaritalStatus = pd.get_dummies(df['MaritalStatus'], prefix='MaritalStatus')
dum_OverTime = pd.get_dummies(df['OverTime'], prefix='OverTime', drop_first=True)

# Adding these dummy variable to input X
X = pd.concat([x, dum_BusinessTravel, dum_Department, dum_EducationField, dum_Gender, du

# Removing the categorical data
X.drop(['BusinessTravel', 'Department', 'EducationField', 'Gender', 'JobRole', 'MaritalS

print(X.shape)
print(y.shape)
```

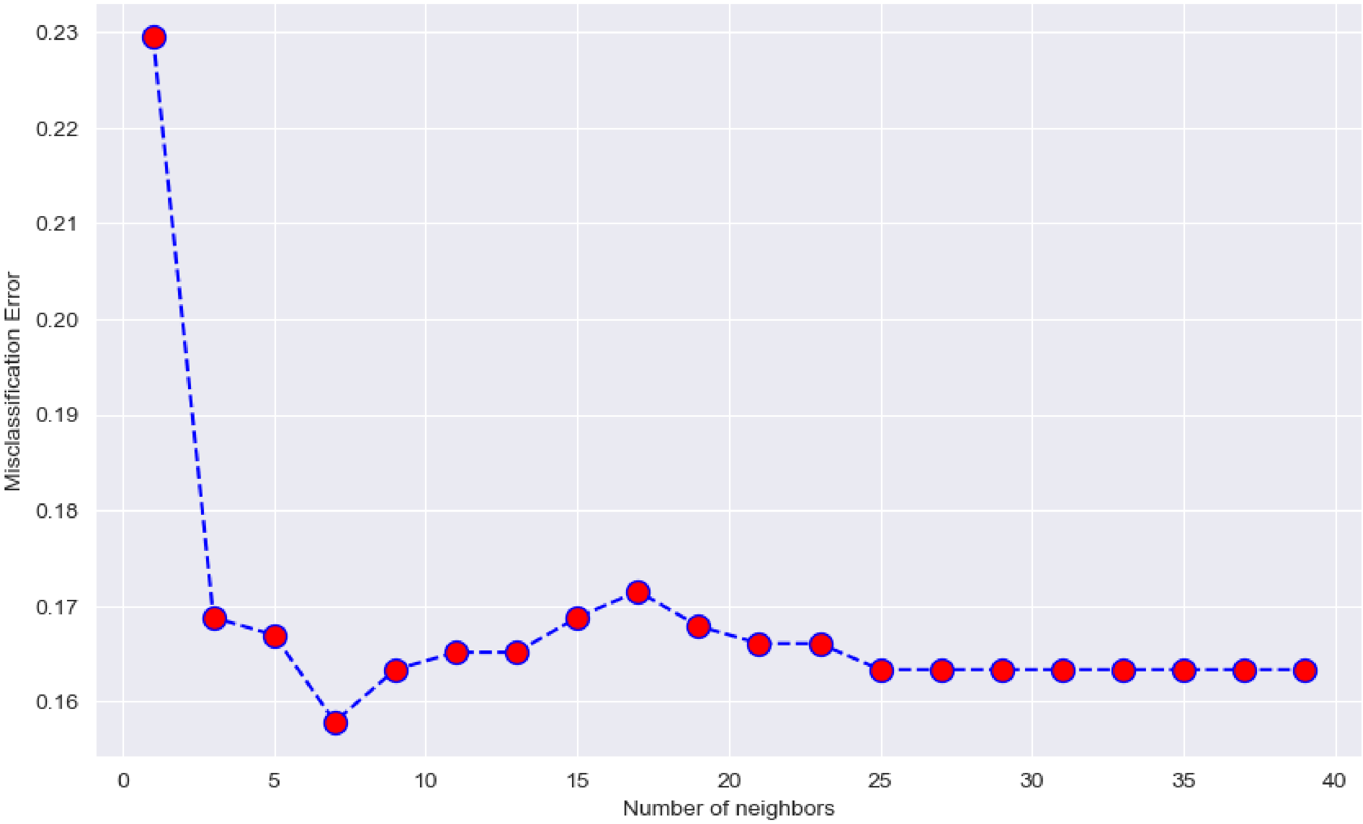
```
(1470, 49)
(1470,)
```

In [14]:

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.25, random_state
from sklearn.neighbors import KNeighborsClassifier
neighbors = []
cv_scores = []
```

In [15]:
```
from sklearn.model_selection import cross_val_score

# Perform 10 fold cross-validation
for k in range(1, 40, 2):
    neighbors.append(k)
    knn = KNeighborsClassifier(n_neighbors=k)
    scores = cross_val_score(knn, X_train, y_train, cv=10, scoring='accuracy')
    cv_scores.append(scores.mean())

# Calculate the error rate
error_rate = [1-x for x in cv_scores]

# Determine the best k
optimal_k = neighbors[error_rate.index(min(error_rate))]
print('The optimal number of neighbors is %d' % optimal_k)

# Plot misclassification error versus k
plt.figure(figsize=(10, 6))
plt.plot(range(1, 40, 2), error_rate, color='blue', linestyle='dashed', marker='o', mark
plt.xlabel('Number of neighbors')
plt.ylabel('Misclassification Error')
plt.show()
```

```
The optimal number of neighbors is 7
```



In [16]:
```
from sklearn.model_selection import cross_val_predict, cross_val_score
from sklearn.metrics import accuracy_score, classification_report
from sklearn.metrics import confusion_matrix
def print_score(clf, X_train, y_train, X_test, y_test, train = True):
    if train:
        print("Train Result:")
        print("___________________________")
        print("Classification Report: \n {}\n".format(classification_report(y_train, clf
        print("Confusion Matrix: \n 0\n".format(confusion_matrix(y_train, clf.predict(X_
        res = cross_val_score(clf, X_train, y_train, cv = 10, scoring ='accuracy')
        print("Average Accuracy: \t {0:.4f}".format(np.mean(res)))
        print("Accuracy SD: \t\t {0:.4f}".format(np.std(res)))
        print("accuracy score: {0:.4f}\n".format(accuracy_score(y_train, clf.predict(X_t
        print("_______________________________________________________________________________________
    elif train == False:
        print("Test Result:")
        print("___________________________")
        print("Classification Report: \n {}\n".format(classification_report(y_test, clf.
        print("Confusion Matrix: \n {}\n".format(confusion_matrix(y_test, clf.predict(X_
        print("accuracy score: {0:.4f}\n".format(accuracy_score(y_test, clf.predict(X_te
        print("_______________________________________________________________________________________
knn=KNeighborsClassifier(n_neighbors=7)
knn.fit(X_train, y_train)
print_score(knn, X_train, y_train, X_test, y_test, train=True)
print_score(knn, X_train, y_train, X_test, y_test, train=False)
```

```
Train Result:

___________________________
Classification Report:
              precision    recall  f1-score   support

           0       0.86      0.99      0.92       922
           1       0.83      0.19      0.32       180

    accuracy                           0.86      1102
   macro avg       0.85      0.59      0.62      1102
weighted avg       0.86      0.86      0.82      1102


Confusion Matrix:
 0

Average Accuracy:        0.8421
Accuracy SD:             0.0148
accuracy score: 0.8621

________________________________________________________________________________________
__________
Test Result:

___________________________
Classification Report:
              precision    recall  f1-score   support

           0       0.84      0.96      0.90       311
           1       0.14      0.04      0.06        57

    accuracy                           0.82       368
   macro avg       0.49      0.50      0.48       368
weighted avg       0.74      0.82      0.77       368


Confusion Matrix:
 [[299  12]
 [ 55   2]]

accuracy score: 0.8179

________________________________________________________________________________________
__________
```

```
In [17]: import pandas as pd
         from sklearn.model_selection import train_test_split
         from sklearn.preprocessing import StandardScaler, OneHotEncoder
         from sklearn.compose import ColumnTransformer
         from sklearn.pipeline import Pipeline
         from sklearn.linear_model import LogisticRegression
         from sklearn.tree import DecisionTreeClassifier
         from sklearn.metrics import accuracy_score, classification_report, confusion_matrix
```

In [42]:

```
#separate the target variable (Attrition) from features
X=df.drop('Attrition', axis=1)
y=df['Attrition']

#Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42

#Define categorical and numerical columns
categorical_columns=['Department', 'JobRole', 'MaritalStatus', 'Gender', 'OverTime']
numerical_columns=['Age', 'DailyRate', 'HourlyRate','MonthlyRate', 'NumCompaniesWorked',

#Create transformers for preprocessing
categorical_transformer=Pipeline(steps=[('onehot', OneHotEncoder(handle_unknown='ignore'
numerical_transformer=Pipeline(steps=[('scaler', StandardScaler())])

#combine transformers using a columnTransforemer
preprocessor=ColumnTransformer(transformers=[('num', numerical_transformer, numerical_co

#Create pipelines for models
logistic_pipeline=Pipeline(steps=[('preprocessor', preprocessor),('classifier', Logistic
tree_pipeline=Pipeline(steps=[('preprocessor', preprocessor), ('classifier', DecisionTre
```

In [43]:

```
from sklearn.preprocessing import OneHotEncoder

#Create a inehot encoder object
encoder=OneHotEncoder(handle_unknown='ignore')
```

In [44]:

```
import pandas as pd
from scipy.sparse import csr_matrix

#create a asparse matrix
X=csr_matrix([[1,2], [3,4]])

#convert the sparse matrix to a dense matrix
X_dense=X.todense()

#create a pandas dataframe from the dense matrix
X_df=pd.DataFrame(X_dense)

#print the dataframe
print(X_df)
```

```
   0  1
0  1  2
1  3  4
```

In [45]:

```
from scipy.sparse import csr_matrix
```

In [40]:

```
#convert the sparse matrices to dense matrices
X_train_dense=X_train.any()
X_test_dense=X_test.any()

#creat pandas DataFrames from the dense matrices
X_train_df=pd.DataFrame(X_train_dense)
X_test_df=pd.DataFrame(X_test_dense)

#Now you can use strings to specify columns
#X_train_encoded=encoder.fit_transform(X_train_df)
#X_test_df=pd.DataFrame(X_test_dense)
X_train_encoded = encoder.transform(X_train)
X_test_df = encoder.transform(X_test)
```

```
#Fit the models
logistic_pipeline.fit(X_train_encoded, y_train)
tree_pipeline.fit(X_train_encoded, y_train)
```

```
---------------------------------------------------------------------------
NotFittedError                            Traceback (most recent call last)
Cell In[40], line 12
      7 X_test_df=pd.DataFrame(X_test_dense)
      9 #Now you can use strings to specify columns
     10 #X_train_encoded=encoder.fit_transform(X_train_df)
     11 #X_test_df=pd.DataFrame(X_test_dense)
---> 12 X_train_encoded = encoder.transform(X_train)
     13 X_test_df = encoder.transform(X_test)
     15 #Fit the models

File ~\anaconda3\Lib\site-packages\sklearn\utils\_set_output.py:157, in _wrap_method_out
put.<locals>.wrapped(self, X, *args, **kwargs)
    155 @wraps(f)
    156 def wrapped(self, X, *args, **kwargs):
--> 157     data_to_wrap = f(self, X, *args, **kwargs)
    158     if isinstance(data_to_wrap, tuple):
    159         # only wrap the first output for cross decomposition
    160         return_tuple = (
    161             _wrap_data_with_container(method, data_to_wrap[0], X, self),
    162             *data_to_wrap[1:],
    163         )

File ~\anaconda3\Lib\site-packages\sklearn\preprocessing\_encoders.py:1013, in OneHotEnc
oder.transform(self, X)
    994 def transform(self, X):
    995     """
    996     Transform X using one-hot encoding.
    997
   (...)
   1011         returned.
   1012     """
-> 1013     check_is_fitted(self)
   1014     transform_output = _get_output_config("transform", estimator=self)["dense"]
   1015     if transform_output == "pandas" and self.sparse_output:

File ~\anaconda3\Lib\site-packages\sklearn\utils\validation.py:1461, in check_is_fitted
(estimator, attributes, msg, all_or_any)
   1458     raise TypeError("%s is not an estimator instance." % (estimator))
   1460 if not _is_fitted(estimator, attributes, all_or_any):
-> 1461     raise NotFittedError(msg % {"name": type(estimator).__name__})

NotFittedError: This OneHotEncoder instance is not fitted yet. Call 'fit' with appropria
te arguments before using this estimator.
```

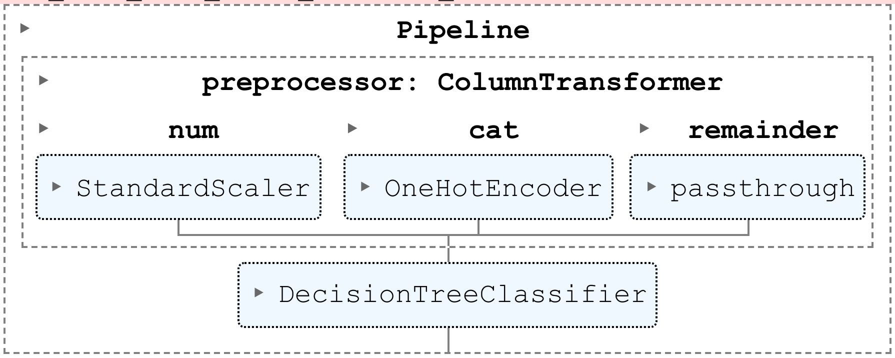
In [46]:

```
import pandas as pd
from sklearn.preprocessing import LabelEncoder

# Create a LabelEncoder for each categorical column
encoders = {}
for column in X_train.columns:
    if X_train[column].dtype == 'object':
        encoder = LabelEncoder()
        encoder.fit(pd.concat([X_train[column], X_test[column]]))
        encoders[column] = encoder

# Encode categorical variables in both X_train and X_test
X_train_encoded = X_train.copy()
X_test_encoded = X_test.copy()
```

```
for column, encoder in encoders.items():
    if column in X_train_encoded.columns:
        X_train_encoded[column] = encoder.transform(X_train_encoded[column])
    if column in X_test_encoded.columns:
        X_test_encoded[column] = encoder.transform(X_test_encoded[column])

# Fit the models
logistic_pipeline.fit(X_train_encoded, y_train)
tree_pipeline.fit(X_train_encoded, y_train)
```

```
C:\Users\DELL\anaconda3\Lib\site-packages\sklearn\linear_model\_logistic.py:460: Converg
enceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
```

Out[46]:



In [49]:

```
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score

#Encode the categorical features
categorical_features=['Gender', 'Department']
for feature in categorical_features:
    df=pd.get_dummies(df, drop_first=True, columns=[feature])

#split the data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(df[['Age', 'DailyRate', 'Gender', 'D
```

```
---------------------------------------------------------------------------
KeyError                                  Traceback (most recent call last)
Cell In[49], line 9
      6     df=pd.get_dummies(df, drop_first=True, columns=[feature])
      8 #split the data into train and test sets
----> 9 X_train, X_test, y_train, y_test = train_test_split(df[['Age', 'DailyRate', 'Gen
der', 'Department']], df['Attrition'], test_size=0.25, random_state=42)

File ~\anaconda3\Lib\site-packages\pandas\core\frame.py:3813, in DataFrame.__getitem__(s
elf, key)
   3811     if is_iterator(key):
   3812         key = list(key)
-> 3813     indexer = self.columns._get_indexer_strict(key, "columns")[1]
   3815 # take() does not accept boolean indexers
   3816 if getattr(indexer, "dtype", None) == bool:

File ~\anaconda3\Lib\site-packages\pandas\core\indexes\base.py:6070, in Index._get_index
er_strict(self, key, axis_name)
   6067 else:
   6068     keyarr, indexer, new_indexer = self._reindex_non_unique(keyarr)
-> 6070 self._raise_if_missing(keyarr, indexer, axis_name)
   6072 keyarr = self.take(indexer)
   6073 if isinstance(key, Index):
   6074     # GH 42790 - Preserve name from an Index
```

```
File ~\anaconda3\Lib\site-packages\pandas\core\indexes\base.py:6133, in Index._raise_if_
missing(self, key, indexer, axis_name)
   6130     raise KeyError(f"None of [{key}] are in the [{axis_name}]")
   6132 not_found = list(ensure_index(key)[missing_mask.nonzero()[0]].unique())
-> 6133 raise KeyError(f"{not_found} not in index")

KeyError: "['Gender', 'Department'] not in index"
```

In [ ]: