```python
import pandas as pd
data=pd.read_csv('D:\\Python\\Football_injury.csv')
print(data.head())
```

```
            p_id2  start_year  season_days_injured  total_days_injured
\
0   aaronconnolly        2019                   13                 161

1   aaronconnolly        2020                   71                 161

2  aaroncresswell        2016                   95                 226

3  aaroncresswell        2018                   87                 226

4  aaroncresswell        2019                   35                 226


   season_minutes_played  season_games_played  season_matches_in_squad
\
0                 1312.0                   24                       28

1                  836.0                   17                       28

2                 2247.0                   26                       27

3                 1680.0                   20                       27

4                 2870.0                   31                       31


   total_minutes_played  total_games_played         dob  ...  \
0                2148.0                  41  2000-01-28  ...
1                2148.0                  41  2000-01-28  ...
2               13368.0                 149  1989-12-15  ...
3               13368.0                 149  1989-12-15  ...
4               13368.0                 149  1989-12-15  ...

   cumulative_games_played  minutes_per_game_prev_seasons  \
0                      NaN                            NaN
1                     24.0                      54.666667
2                      NaN                            NaN
3                     26.0                      86.423077
4                     46.0                      85.369565

  avg_days_injured_prev_seasons avg_games_per_season_prev_seasons
bmi  \
0                           NaN                               NaN
24.613627
1                          13.0                              24.0
24.613627
```

```
2                            NaN                                  NaN
22.396079
3                           95.0                                 26.0
22.396079
4                           91.0                                 23.0
22.396079

   work_rate_numeric  position_numeric significant_injury_prev_season
\
0                2.5               2.0                             NaN

1                2.5               2.0                             0.0

2                3.5               1.0                             NaN

3                3.5               1.0                             0.0

4                3.5               1.0                             0.0


   cumulative_days_injured  season_days_injured_prev_season
0                      NaN                              NaN
1                    161.0                             13.0
2                      NaN                              NaN
3                    226.0                             95.0
4                    452.0                             87.0

[5 rows x 30 columns]
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1301 entries, 0 to 1300
Data columns (total 30 columns):
 #   Column                           Non-Null Count  Dtype
---  ------                           --------------  -----
 0   p_id2                            1301 non-null   object
 1   start_year                       1301 non-null   int64
 2   season_days_injured              1301 non-null   int64
 3   total_days_injured               1301 non-null   int64
 4   season_minutes_played            1301 non-null   float64
 5   season_games_played              1301 non-null   int64
 6   season_matches_in_squad          1301 non-null   int64
 7   total_minutes_played             1301 non-null   float64
 8   total_games_played               1301 non-null   int64
 9   dob                              1301 non-null   object
 10  height_cm                        1301 non-null   float64
 11  weight_kg                        1301 non-null   float64
 12  nationality                      1301 non-null   object
 13  work_rate                        1301 non-null   object
 14  pace                             1206 non-null   float64
 15  physic                           1206 non-null   float64
 16  fifa_rating                      1301 non-null   float64
```

```
 17  position                            1299 non-null   object
 18  age                                 1301 non-null   int64
 19  cumulative_minutes_played           697 non-null    float64
 20  cumulative_games_played             697 non-null    float64
 21  minutes_per_game_prev_seasons       685 non-null    float64
 22  avg_days_injured_prev_seasons       697 non-null    float64
 23  avg_games_per_season_prev_seasons   697 non-null    float64
 24  bmi                                 1301 non-null   float64
 25  work_rate_numeric                   1301 non-null   float64
 26  position_numeric                    1299 non-null   float64
 27  significant_injury_prev_season      697 non-null    float64
 28  cumulative_days_injured             697 non-null    float64
 29  season_days_injured_prev_season     697 non-null    float64
dtypes: float64(18), int64(7), object(5)
memory usage: 305.1+ KB
None
```

```
print(data.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1301 entries, 0 to 1300
Data columns (total 30 columns):
 #   Column                              Non-Null Count  Dtype
---  ------                              --------------  -----
 0   p_id2                               1301 non-null   object
 1   start_year                          1301 non-null   int64
 2   season_days_injured                 1301 non-null   int64
 3   total_days_injured                  1301 non-null   int64
 4   season_minutes_played               1301 non-null   float64
 5   season_games_played                 1301 non-null   int64
 6   season_matches_in_squad             1301 non-null   int64
 7   total_minutes_played                1301 non-null   float64
 8   total_games_played                  1301 non-null   int64
 9   dob                                 1301 non-null   object
 10  height_cm                           1301 non-null   float64
 11  weight_kg                           1301 non-null   float64
 12  nationality                         1301 non-null   object
 13  work_rate                           1301 non-null   object
 14  pace                                1206 non-null   float64
 15  physic                              1206 non-null   float64
 16  fifa_rating                         1301 non-null   float64
 17  position                            1299 non-null   object
 18  age                                 1301 non-null   int64
 19  cumulative_minutes_played           697 non-null    float64
 20  cumulative_games_played             697 non-null    float64
 21  minutes_per_game_prev_seasons       685 non-null    float64
 22  avg_days_injured_prev_seasons       697 non-null    float64
 23  avg_games_per_season_prev_seasons   697 non-null    float64
 24  bmi                                 1301 non-null   float64
 25  work_rate_numeric                   1301 non-null   float64
```

```
 26  position_numeric                    1299 non-null   float64
 27  significant_injury_prev_season      697 non-null    float64
 28  cumulative_days_injured             697 non-null    float64
 29  season_days_injured_prev_season     697 non-null    float64
dtypes: float64(18), int64(7), object(5)
memory usage: 305.1+ KB
None
```

```
target = 'significant_injury_prev_season'

if data[target].nunique() <= 10:
    problem_type = 'Classification'
else:
    problem_type = 'Regression'

print(f"Problem Type: {problem_type}")
```

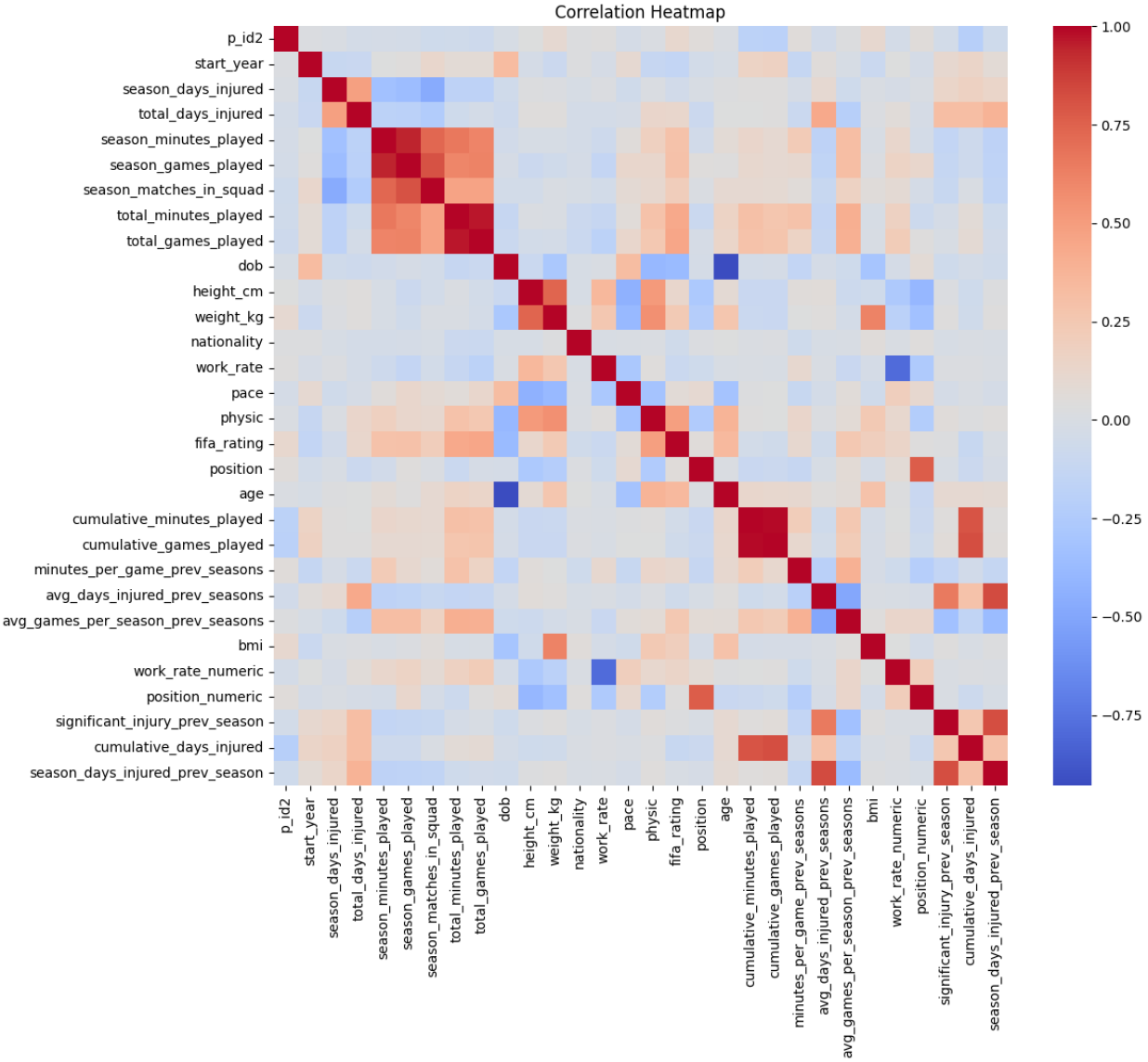
```
Problem Type: Classification
```

```
from sklearn.impute import SimpleImputer
from sklearn.preprocessing import StandardScaler, LabelEncoder

# Separate numerical and categorical columns
num_cols = data.select_dtypes(include=['float64', 'int64']).columns
cat_cols = data.select_dtypes(include=['object']).columns

# Impute missing values for numerical columns with median
imputer_num = SimpleImputer(strategy='median')
data[num_cols] = imputer_num.fit_transform(data[num_cols])

# For categorical columns, check for empty columns and remove them
empty_cats = [col for col in cat_cols if data[col].nunique() == 0]
if empty_cats:
    print(f"Removing empty categorical columns: {empty_cats}")
    cat_cols = [col for col in cat_cols if col not in empty_cats]

# Ensure categorical columns have valid data and impute missing values
if len(cat_cols) > 0:
    imputer_cat = SimpleImputer(strategy='most_frequent')
    data[cat_cols] = data[cat_cols].astype(str)  # Convert to strings
for consistency
    data[cat_cols] = imputer_cat.fit_transform(data[cat_cols])

    # Encode categorical features using LabelEncoder
    encoder = LabelEncoder()
    for col in cat_cols:
        data[col] = encoder.fit_transform(data[col])

# Normalize numerical columns
scaler = StandardScaler()
data[num_cols] = scaler.fit_transform(data[num_cols])
```

```
print("Data preprocessing completed.")
```

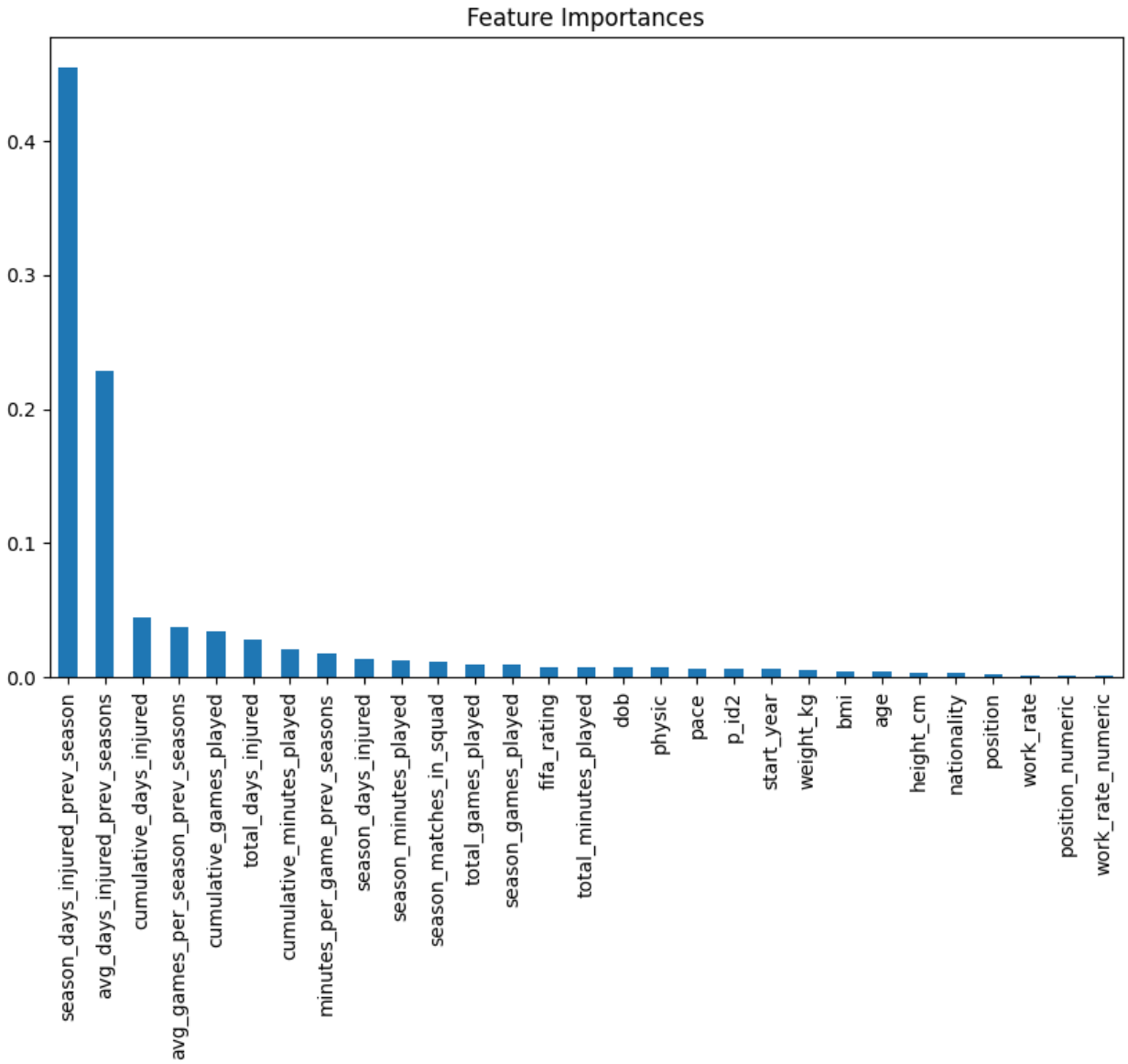
```
Data preprocessing completed.
```

```
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.ensemble import RandomForestClassifier

# Correlation heatmap
plt.figure(figsize=(12, 10))
sns.heatmap(data.corr(), annot=False, cmap='coolwarm')
plt.title('Correlation Heatmap')
plt.show()
```



```
X = data.drop(columns=[target])
y = data[target] # Convert target to categorical if it's not already
if y.dtype.kind in 'iufc':
    y = pd.cut(y, bins=3, labels=["low", "medium", "high"]) # Example
for continuous targets, adjust bins and labels as needed
model = RandomForestClassifier(random_state=42)
model.fit(X, y)
importances = pd.Series(model.feature_importances_,
index=X.columns).sort_values(ascending=False)
plt.figure(figsize=(10, 6))
importances.plot(kind='bar')
plt.title('Feature Importances')
```

```
Text(0.5, 1.0, 'Feature Importances')
```



```
from sklearn.model_selection import train_test_split

# Split 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)

print("Data split into training and testing sets.")
```

```
Data split into training and testing sets.
```

```
from sklearn.ensemble import RandomForestClassifier

# Initialize the model
model = RandomForestClassifier(random_state=42)
print("Model initialized.")
```

```
Model initialized.
```

```
# Train the model
model.fit(X_train, y_train)
print("Model training completed.")
```

```
Model training completed.
```

```
# Make predictions
y_pred = model.predict(X_test)
print("Model testing completed.")
```

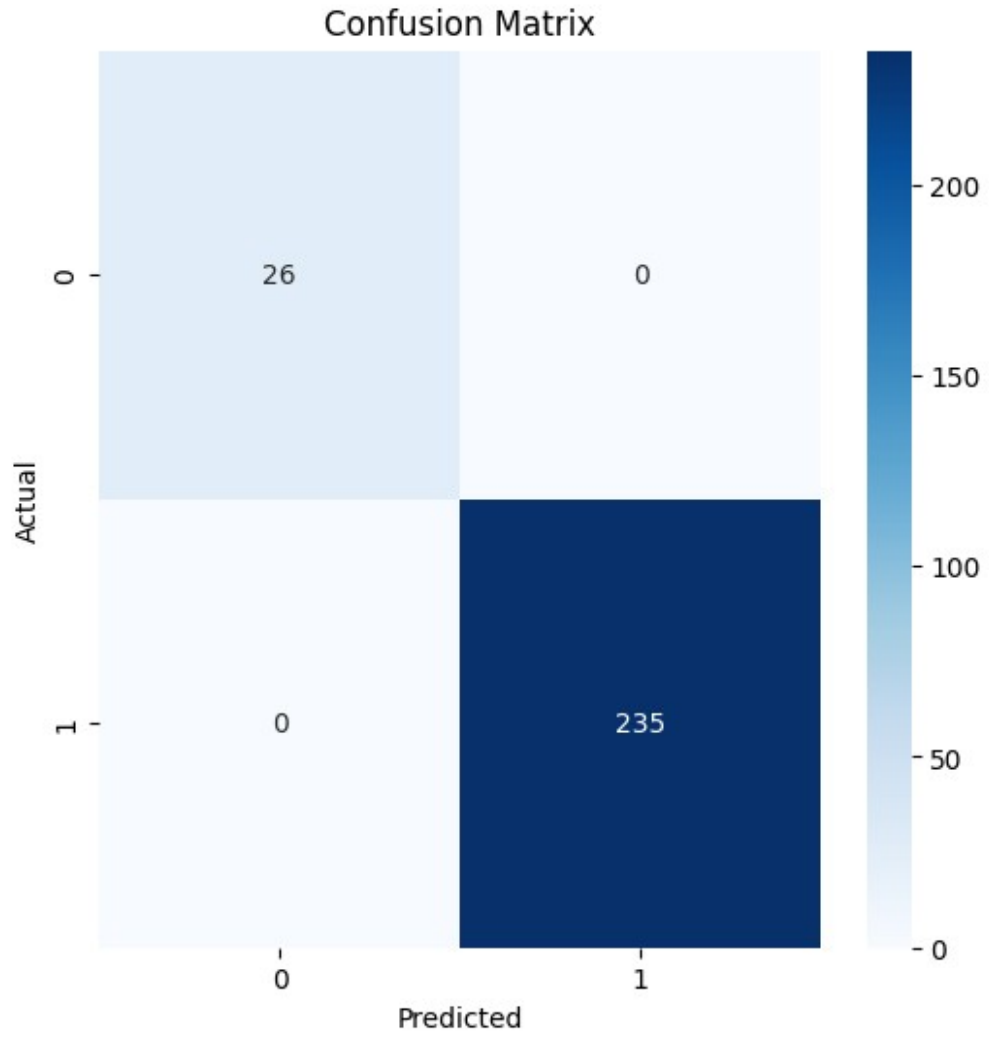
```
Model testing completed.
```

```
from sklearn.metrics import accuracy_score

# Calculate accuracy
accuracy = accuracy_score(y_test, y_pred)
print(f"Accuracy: {accuracy:.2f}")
```

```
Accuracy: 1.00
```

```
from sklearn.metrics import classification_report, confusion_matrix

# Print classification report
print("Classification Report:")
print(classification_report(y_test, y_pred))

# Confusion matrix
plt.figure(figsize=(6, 6))
sns.heatmap(confusion_matrix(y_test, y_pred), annot=True, fmt='d',
cmap='Blues')
plt.title('Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()
```

```
Classification Report:
              precision    recall  f1-score   support

        high       1.00      1.00      1.00        26
         low       1.00      1.00      1.00       235

    accuracy                           1.00       261
   macro avg       1.00      1.00      1.00       261
weighted avg       1.00      1.00      1.00       261
```




```python
train_score = model.score(X_train, y_train)
test_score = model.score(X_test, y_test)

print(f"Training Accuracy: {train_score:.2f}")
print(f"Testing Accuracy: {test_score:.2f}")
```

```
if abs(train_score - test_score) > 0.1:
    print("The model may be overfitting or underfitting.")
else:
    print("The model has good generalization.")
```

```
Training Accuracy: 1.00
Testing Accuracy: 1.00
The model has good generalization.
```

```
from sklearn.model_selection import GridSearchCV

# Define parameter grid
param_grid = {
    'n_estimators': [50, 100, 200],
    'max_depth': [None, 10, 20],
    'min_samples_split': [2, 5, 10]
}

# Perform grid search
grid_search = GridSearchCV(estimator=model, param_grid=param_grid,
cv=5, scoring='accuracy')
grid_search.fit(X_train, y_train)

# Best parameters and retrain
print(f"Best Parameters: {grid_search.best_params_}")
best_model = grid_search.best_estimator_

# Evaluate final model
final_accuracy = best_model.score(X_test, y_test)
print(f"Final Accuracy after Hyperparameter Tuning:
{final_accuracy:.2f}")
```

```
Best Parameters: {'max_depth': None, 'min_samples_split': 5,
'n_estimators': 50}
Final Accuracy after Hyperparameter Tuning: 1.00
```