StudentsExamsScoreAnalysis

November 20, 2025

The program performs exploratory data analysis and predictive modeling on a dataset of students' exam scores. It loads the data from student_exam_scores.csv into a pandas DataFrame, creates a derived categorical variable isPassed, and computes descriptive statistics for the main features. Relationships between study habits and performance are explored using scatter plots with a pass/fail hue, linear regression plots, correlation heatmaps, and histograms of key variables. The data is then split into training and test sets, and two regression models (Linear Regression and Random Forest) are trained to predict exam_score. Their performance is evaluated using MSE and R^2 on both train and test sets, the results are summarized in a comparison table, and an additional scatter plot compares predicted vs. actual exam scores for the linear model.

Importing libraries.

[28]:

```
import pandas as pd
import seaborn as sns
import numpy as np
from matplotlib import pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score
from sklearn.ensemble import RandomForestRegressor
```

Loading data.

[29]:

```
scores = pd.read_csv("student_exam_scores.csv", delimiter=",")
```

```
  student_id  hours_studied  sleep_hours  attendance_percent  previous_scores  \
0       S001            8.0          8.8                72.1               45
1       S002            1.3          8.6                60.7               55
2       S003            4.0          8.2                73.7               86
3       S004            3.5          4.8                95.1               66
4       S005            9.1          6.4                89.8               71

   exam_score
0        30.2
1        25.0
2        35.8
3        34.0
4        40.3
```

Printing information about dataframe.

[54]:

```
scores.dtypes
```

[54]:

```
student_id              object
hours_studied          float64
sleep_hours            float64
attendance_percent     float64
previous_scores          int64
exam_score             float64
isPassed                object
dtype: object
```

[55]:

```
scores.head()
```

[55]:

```
  student_id  hours_studied  sleep_hours  attendance_percent  previous_scores  \
0       S001            8.0          8.8                72.1               45
1       S002            1.3          8.6                60.7               55
2       S003            4.0          8.2                73.7               86
3       S004            3.5          4.8                95.1               66
4       S005            9.1          6.4                89.8               71

   exam_score isPassed
0        30.2   Passed
1        25.0   Failed
2        35.8   Passed
3        34.0   Passed
4        40.3   Passed
```

Printing basic statistics of dataset.

[30]:

```
scores.describe()
```

[30]:

```
       hours_studied  sleep_hours  attendance_percent  previous_scores  \
count     200.000000   200.000000          200.000000       200.000000
mean        6.325500     6.622000           74.830000        66.800000
std         3.227317     1.497138           14.249905        15.663869
min         1.000000     4.000000           50.300000        40.000000
25%         3.500000     5.300000           62.200000        54.000000
50%         6.150000     6.700000           75.250000        67.500000
75%         9.000000     8.025000           87.425000        80.000000
max        12.000000     9.000000          100.000000        95.000000

       exam_score
count  200.000000
mean    33.955000
std      6.789548
min     17.100000
```

```
25%      29.500000
50%      34.050000
75%      38.750000
max      51.300000
```

Checking dataset for null values and dropping duplicates.

[32]:
```
scores.isna().sum()
scores.drop_duplicates()
```

[32]:
```
    student_id  hours_studied  sleep_hours  attendance_percent  \
0         S001            8.0          8.8                72.1
1         S002            1.3          8.6                60.7
2         S003            4.0          8.2                73.7
3         S004            3.5          4.8                95.1
4         S005            9.1          6.4                89.8
..         …              …            …                  …
195       S196           10.5          5.4                94.0
196       S197            7.1          6.1                85.1
197       S198            1.6          6.9                63.8
198       S199           12.0          7.3                50.5
199       S200           10.2          6.3                97.4

     previous_scores  exam_score
0                 45        30.2
1                 55        25.0
2                 86        35.8
3                 66        34.0
4                 71        40.3
..               …          …
195               87        42.7
196               92        40.4
197               76        28.2
198               58        42.0
199               68        37.8

[200 rows x 6 columns]
```

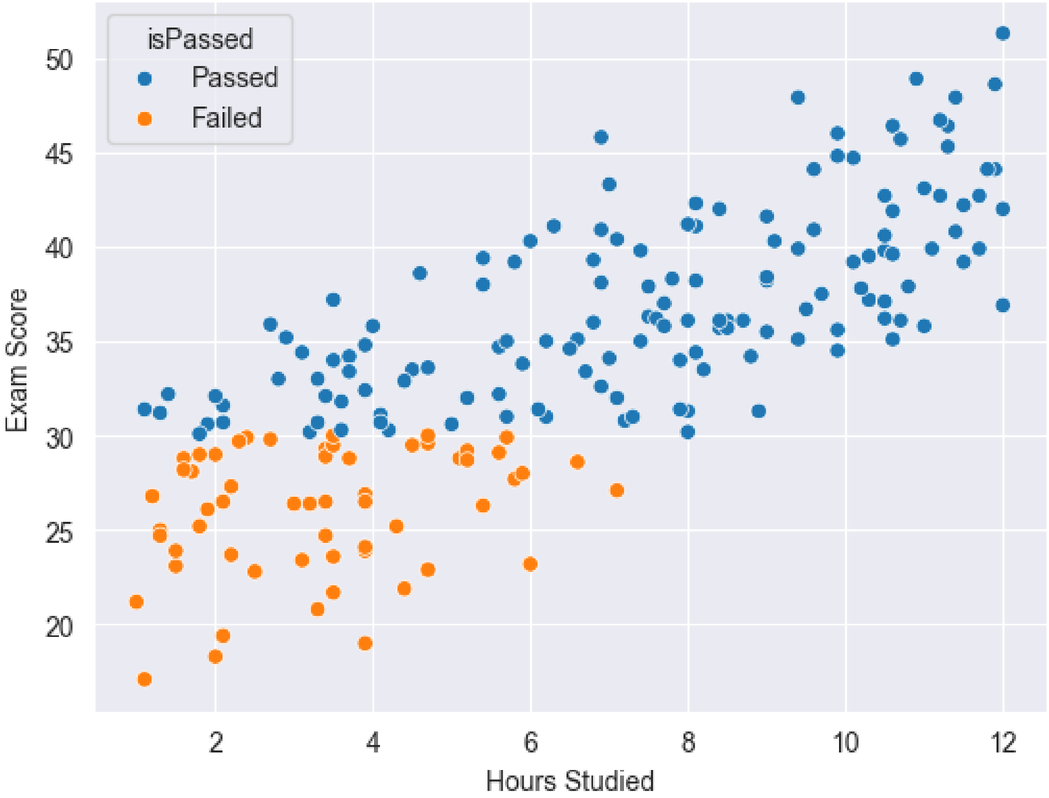
Creating a new categorical column "isPassed".

[56]:
```
scores["isPassed"] = np.where(scores["exam_score"] > 30.0, "Passed", "Failed")
```

Visualization of the relationship between hours studied and exam score.

[57]:
```
plot = sns.scatterplot(scores, x="hours_studied", y="exam_score",␣
  ↪hue="isPassed")
plot.set(xlabel = "Hours Studied", ylabel = "Exam Score")
```

[57]:
```
[Text(0.5, 0, 'Hours Studied'), Text(0, 0.5, 'Exam Score')]
```

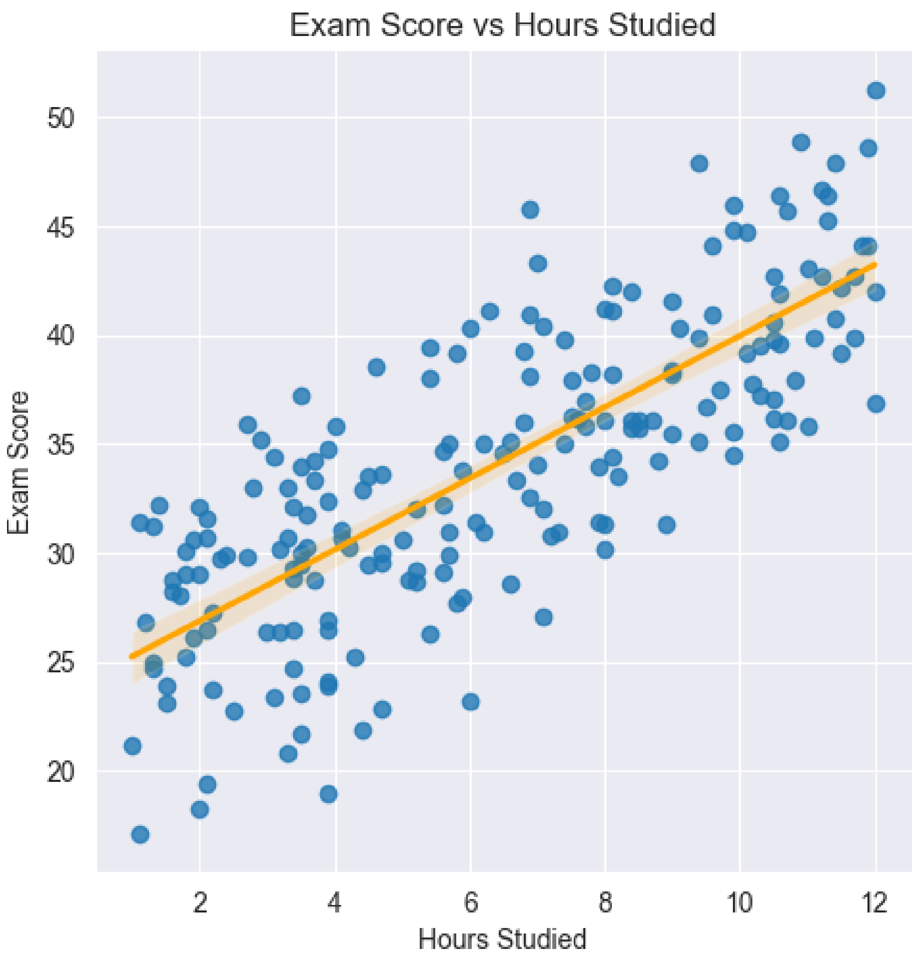


Visualization of the relationship between hours studied and exam score using linear regression plot.

```
[58]: plt.figure(figsize = (6,4))
      plot = sns.lmplot(scores, x="hours_studied", y="exam_score", line_kws={"color":␣
       ↪"orange"})
      plot.set(xlabel = "Hours Studied", ylabel = "Exam Score", title="Exam Score vs␣
       ↪Hours Studied")
```

```
[58]: <seaborn.axisgrid.FacetGrid at 0x1bcc2abb9d0>

<Figure size 600x400 with 0 Axes>
```

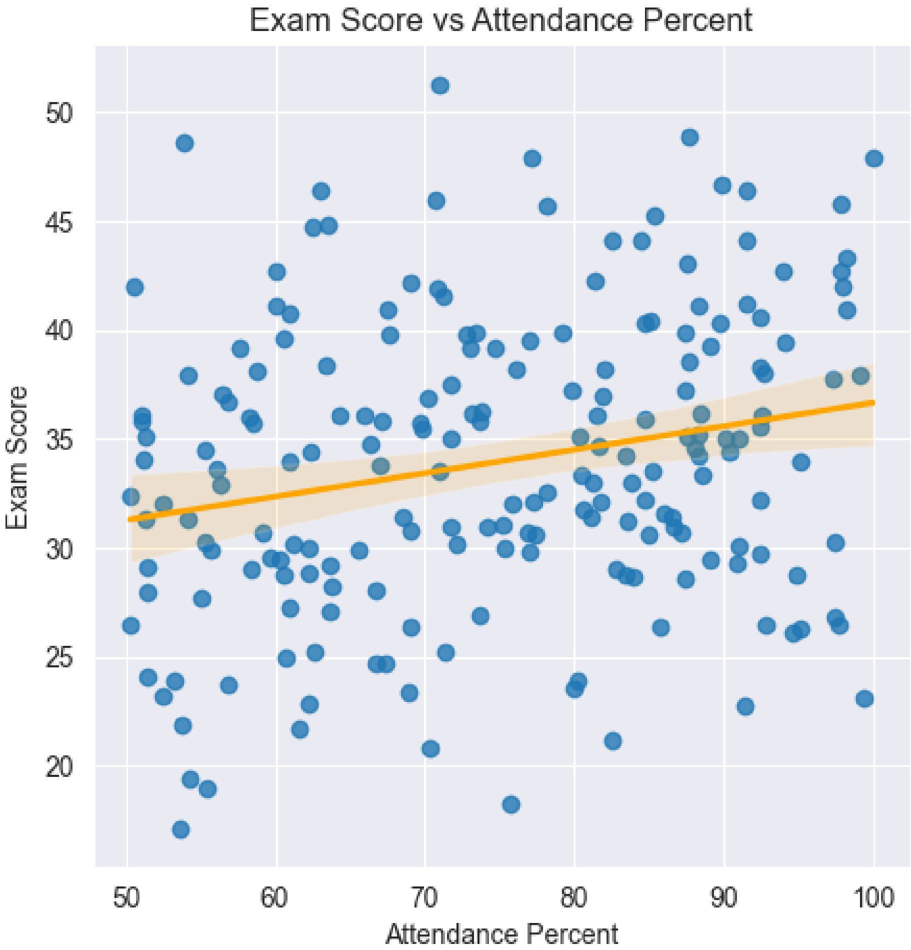


Visualization of the relationship between attendance percent and exam score using linear regression plot.

[35]:
```
plt.figure(figsize = (6,4))
plot = sns.lmplot(scores, x="attendance_percent", y="exam_score",␣
  ↪line_kws={"color": "orange"})
plot.set(xlabel = "Attendance Percent", ylabel = "Exam Score", title="Exam␣
  ↪Score vs Attendance Percent")
```

[35]:
```
<seaborn.axisgrid.FacetGrid at 0x1bcc16e4690>
```

```
<Figure size 600x400 with 0 Axes>
```



Creating a correlation matrix out of numeric values.

```
[61]: corr = scores[["hours_studied", "sleep_hours", "exam_score",␣
        ↪"attendance_percent"]].corr()
      print(corr)
```

```
                    hours_studied  sleep_hours  exam_score  attendance_percent
hours_studied            1.000000     0.077864    0.776751           -0.031311
sleep_hours              0.077864     1.000000    0.188222            0.000572
exam_score               0.776751     0.188222    1.000000            0.225713
attendance_percent      -0.031311     0.000572    0.225713            1.000000
```

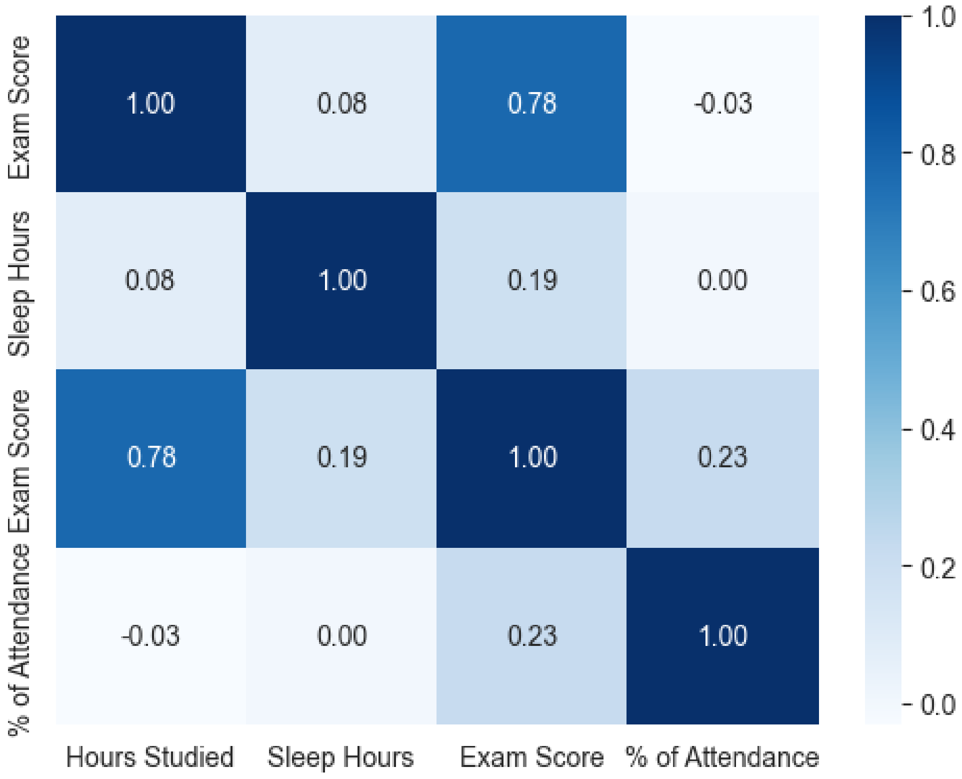
A positive correlation can be observed between hours_studied and exam score, implying that the number of hours studied is associated with the score of exam.

There is a direct relationship between hours studied and exam score.

Creating a correlation heatmap.

```
[65]: x_labels = ["Hours Studied", "Sleep Hours", "Exam Score", "% of Attendance"]
      y_labels = ["Exam Score", "Sleep Hours", "Exam Score", "% of Attendance"]
      sns.heatmap(corr, annot=True, fmt=".2f", cmap="Blues", xticklabels=x_labels,␣
        ↪yticklabels=y_labels)
```

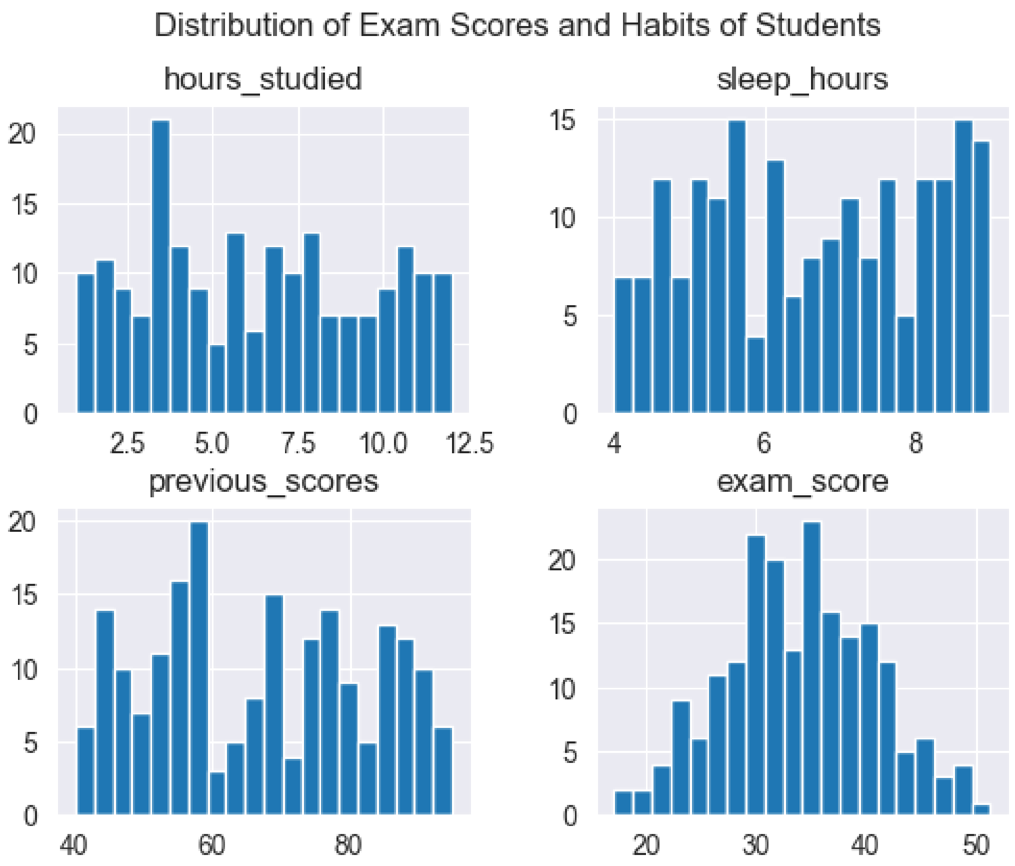
```
[65]: <Axes: >
```



Creating plots showing distributions of study habits and performance.

```
[66]: plot = scores[["hours_studied", "sleep_hours", "previous_scores",␣
        ↪"exam_score"]].hist(bins=20)
      plt.suptitle("Distribution of Exam Scores and Habits of Students")
```

```
[66]: Text(0.5, 0.98, 'Distribution of Exam Scores and Habits of Students')
```



Splitting numeric data to train and test sets.

```
[39]: y = scores[["exam_score"]]
      x = scores.drop(["exam_score", "student_id", "isPassed"], axis=1)

      x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.2,␣
       ↪random_state=100)
```

A linear regression model was fitted on the training data.

```
[40]: lr = LinearRegression()
      lr.fit(x_train, y_train)
```

```
[40]: LinearRegression()
```

Generating predictions for both training and test set.

```
[72]: y_lr_train_pred = lr.predict(x_train)
      y_lr_test_pred = lr.predict(x_test)
      print(y_lr_train_pred[:5])
```

[72]:
```
array([[27.88123664],
       [36.15845932],
       [33.77975984],
       [34.72220155],
       [22.62250902]])
```

[73]:
```
print(y_lr_test_pred[:5])
```

```
[[28.96606215]
 [20.85361165]
 [36.39543205]
 [39.73621892]
 [31.87043094]]
```

Model performance was evaluated using MSE and R2 for both training and test set.

[43]:
```
lr_train_mse = mean_squared_error(y_train, y_lr_train_pred)
lr_train_r2 = r2_score(y_train, y_lr_train_pred)

lr_test_mse = mean_squared_error(y_test, y_lr_test_pred)
lr_test_r2 = r2_score(y_test, y_lr_test_pred)
```

[44]:
```
print("LS MSE (Train): ", lr_train_mse)
print("LS R2 (Train): ", lr_train_r2)
print("LS MSE (Test): ", lr_test_mse)
print("LS R2 (Test): ", lr_test_r2)
```

```
LS MSE (Train):  7.167182016317801
LS R2 (Train):  0.8412909628396832
LS MSE (Test):  8.37137635264973
LS R2 (Test):  0.8205275135283744
```

[45]:
```
lr_results = pd.DataFrame(["Linear Regression", lr_train_mse, lr_train_r2,␣
  ↪lr_test_mse, lr_test_r2]).transpose()
lr_results.columns = ["Method", "Training MSE", "Training R2", "Test MSE",␣
  ↪"Test R2"]
lr_results
```

[45]:
```
              Method Training MSE Training R2  Test MSE   Test R2
0  Linear Regression     7.167182    0.841291  8.371376  0.820528
```

A random forest regressor model was fitted on the training data.

[46]:
```
rf = RandomForestRegressor(max_depth=2, random_state=100)
y_train_1d = y_train.values.ravel()
rf.fit(x_train, y_train_1d)
```

[46]:
```
RandomForestRegressor(max_depth=2, random_state=100)
```

```
[47]: y_rf_train_pred = rf.predict(x_train)
      y_rf_test_pred = rf.predict(x_test)
```

Generating predictions for both data sets.

```
[48]: rf_train_mse = mean_squared_error(y_train, y_rf_train_pred)
      rf_train_r2 = r2_score(y_train, y_rf_train_pred)

      rf_test_mse = mean_squared_error(y_test, y_rf_test_pred)
      rf_test_r2 = r2_score(y_test, y_rf_test_pred)
```

```
[49]: rf_results = pd.DataFrame(["Random Forest", rf_train_mse, rf_train_r2,␣
       ↪rf_test_mse, rf_test_r2]).transpose()
      rf_results.columns = ["Method", "Training MSE", "Training R2", "Test MSE",␣
       ↪"Test R2"]
      rf_results
```

```
[49]:           Method Training MSE Training R2   Test MSE   Test R2
      0  Random Forest    14.004342     0.68989  17.062459  0.634201
```

Comparison of two used models (linear regression and random forest).

```
[50]: df_models = pd.concat([lr_results, rf_results], axis=0).reset_index(drop=True)
      df_models
```

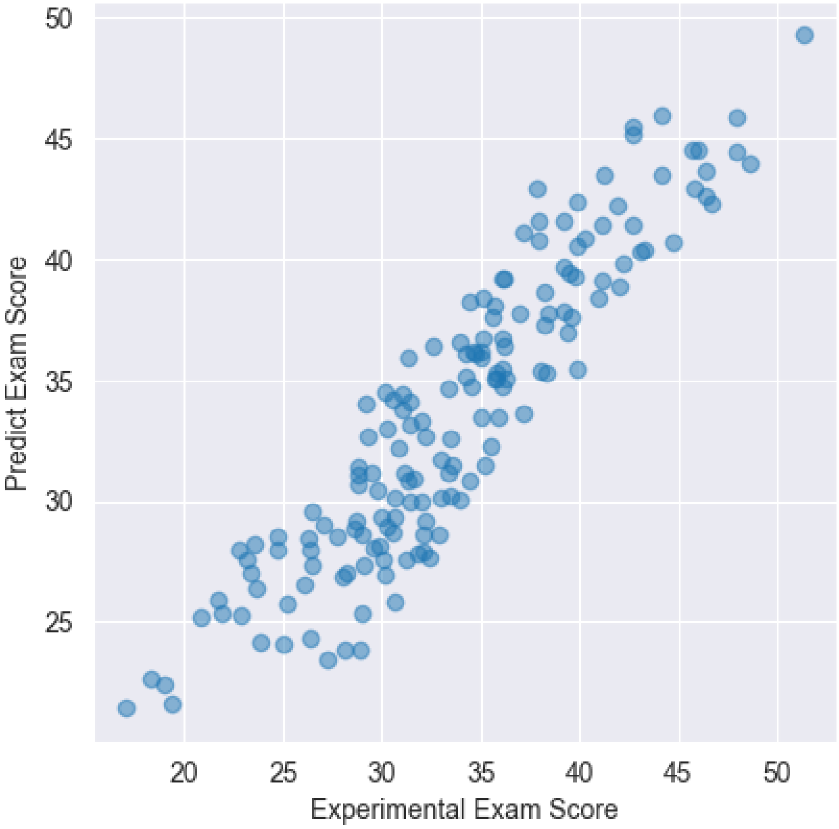
```
[50]:               Method Training MSE Training R2   Test MSE   Test R2
      0  Linear Regression     7.167182    0.841291   8.371376  0.820528
      1      Random Forest    14.004342     0.68989  17.062459  0.634201
```

Visualization of predictions.

```
[51]: plt.figure(figsize=[5,5])
      plt.scatter(x=y_train, y=y_lr_train_pred, alpha=0.5)

      plt.ylabel("Predict Exam Score")
      plt.xlabel("Experimental Exam Score")
      plt.plot()
```

```
[51]: []
```


50
45
40
35
30
25
Predict Exam Score
20
25
30
35
40
45
50
Experimental Exam Score