# Exercise 7

Compare the effectiveness of two teaching methods, A and B, in helping students pass a test. Analyse the proportions of passing students, calculate confidence intervals for the difference in proportions, conduct significance tests, and evaluate the area under the ROC curve for predictive accuracy.

In [126…

```
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.metrics import roc_curve, roc_auc_score
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.preprocessing import LabelEncoder
```

In [127…

```
df = pd.read_csv("teaching_methods.csv")
df.head()
```

Out[127…

| | Method | Outcome | Study Time |
|---|---|---|---|
| **0** | A | Pass | 10 |
| **1** | B | Pass | 12 |
| **2** | A | Pass | 8 |
| **3** | A | Pass | 6 |
| **4** | A | Pass | 9 |

In [128…

```
encoder = LabelEncoder()
```

In [129…

```
df["Method"] = encoder.fit_transform(df["Method"])
df["Outcome"] = encoder.fit_transform(df["Outcome"])

df.head()
```

Out[129…

| | Method | Outcome | Study Time |
|---|---|---|---|
| **0** | 0 | 1 | 10 |
| **1** | 1 | 1 | 12 |
| **2** | 0 | 1 | 8 |
| **3** | 0 | 1 | 6 |
| **4** | 0 | 1 | 9 |

In [130…

```
X = df[["Method", "Study Time"]]
Y = df["Outcome"]
```

In [131…

```
n_A = len(df[df["Method"] == 0])
```

```
n_B = len(df[df["Method"] == 1])

x_A = len(df[(df["Method"] == 0) & (df["Outcome"] == 1)])
x_B = len(df[(df["Method"] == 1) & (df["Outcome"] == 1)])

p_A = x_A / n_A
p_B = x_B / n_B

print(f"Sample size of students taught by Method A: {n_A}")
print(f"Sample size of students taught by Method B: {n_B}")

print(f"Number of passing students taught by Method A: {x_A}")
print(f"Number of passing students taught by Method B: {x_B}")

print(f"Student Pass Rate with Method A: {p_A}")
print(f"Student Pass Rate with Method B: {p_B}")
```

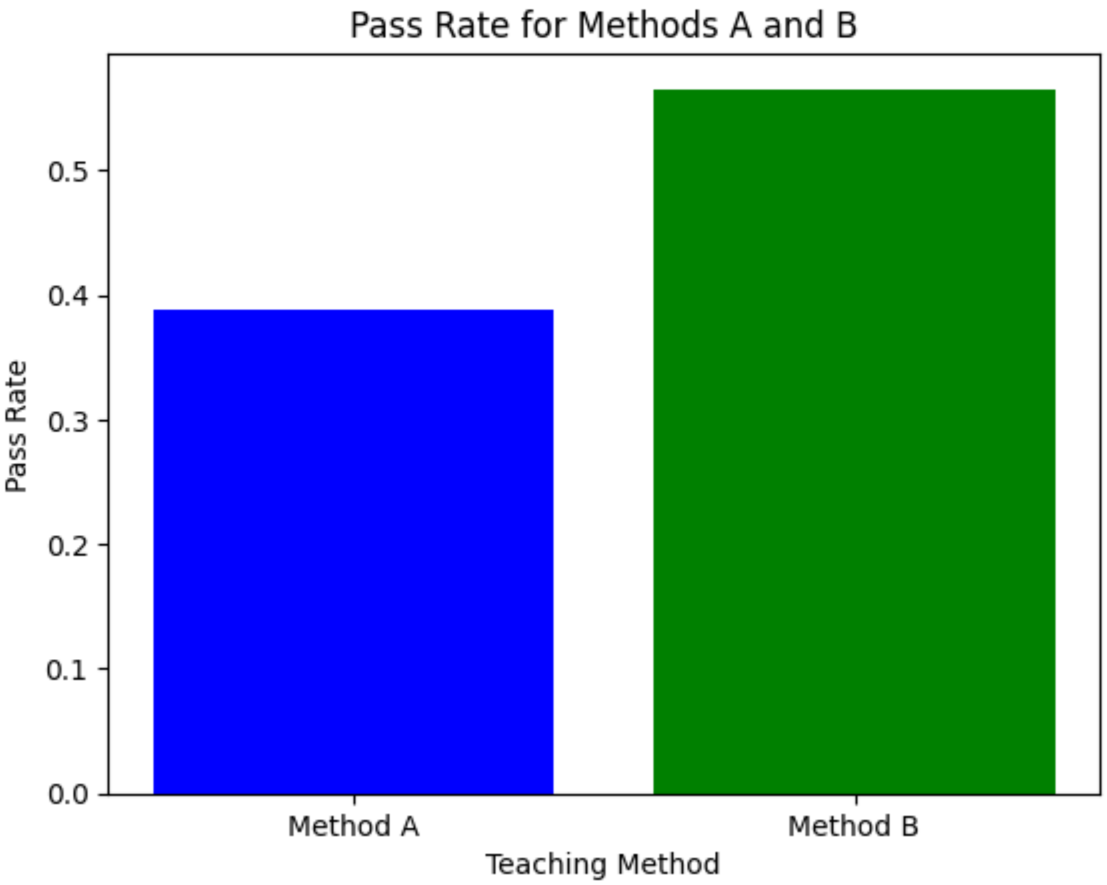
```
Sample size of students taught by Method A: 54
Sample size of students taught by Method B: 46
Number of passing students taught by Method A: 21
Number of passing students taught by Method B: 26
Student Pass Rate with Method A: 0.3888888888888889
Student Pass Rate with Method B: 0.5652173913043478
```

In [132…

```
methods = ['Method A', 'Method B']
pass_rates = [p_A, p_B]

plt.bar(methods, pass_rates, color=['blue', 'green'])
plt.xlabel('Teaching Method')
plt.ylabel('Pass Rate')
plt.title('Pass Rate for Methods A and B')
```

Out[132…

```
Text(0.5, 1.0, 'Pass Rate for Methods A and B')
```

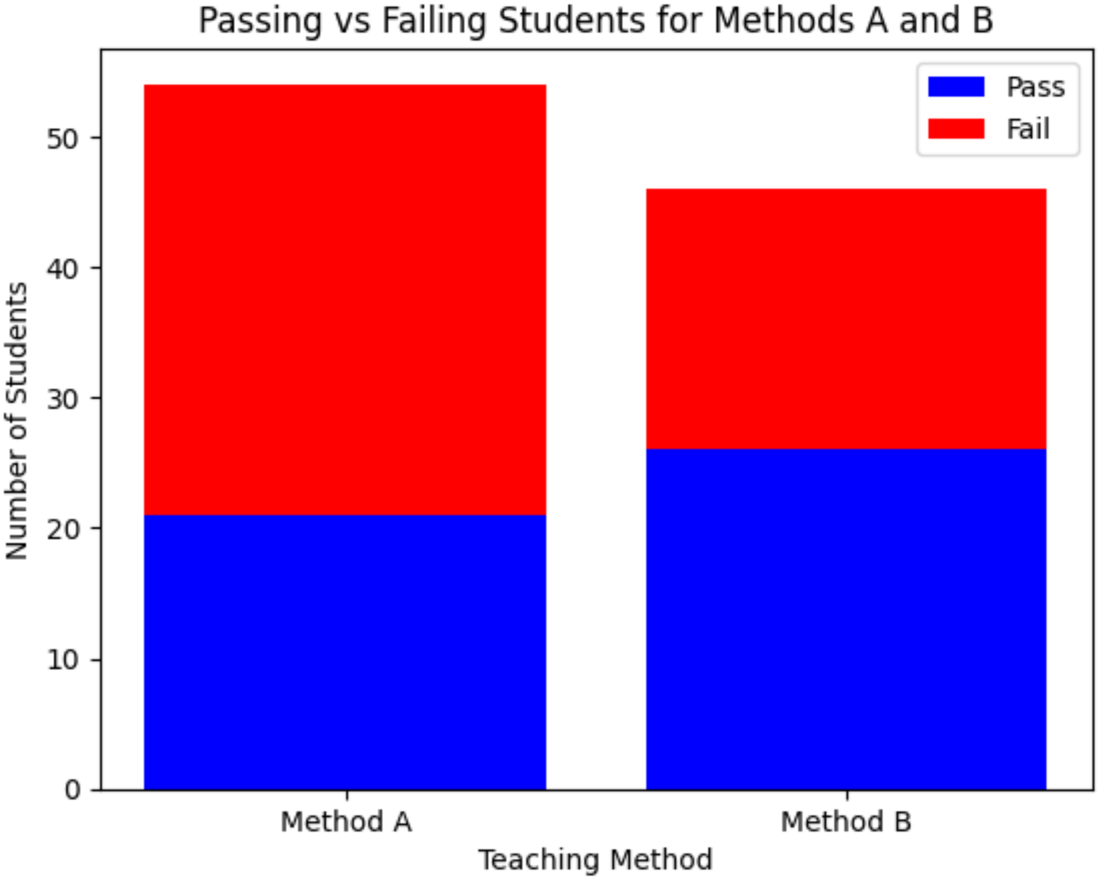


In [133…

```python
pass_fail_counts_A = [x_A, n_A - x_A]
pass_fail_counts_B = [x_B, n_B - x_B]

plt.bar(methods[0], pass_fail_counts_A[0], label='Pass', color='blue')
plt.bar(methods[0], pass_fail_counts_A[1], bottom=pass_fail_counts_A[0], label='Fail',
color='red')

plt.bar(methods[1], pass_fail_counts_B[0], color='blue')
plt.bar(methods[1], pass_fail_counts_B[1], bottom=pass_fail_counts_B[0], color='red')

plt.xlabel('Teaching Method')
plt.ylabel('Number of Students')
plt.title('Passing vs Failing Students for Methods A and B')

plt.legend()
```

Out[133…

```
<matplotlib.legend.Legend at 0x7ea662c32990>
```



In [134…

```
from statsmodels.stats.proportion import proportions_ztest, confint_proportions_2indep

ci_low, ci_high = confint_proportions_2indep(x_A, n_A, x_B, n_B)

print(f"The Confidence Interval for difference in proportions is [{ci_low},
{ci_high}]")
```

```
The Confidence Interval for difference in proportions is [-0.35420954540253474, 0.0189285
411289222]
```

In [135…

```
successes = [x_A, x_B]
n_obs = [n_A, n_B]

z_statistic, p_value = proportions_ztest(successes, n_obs)

print(f"z-statistic: {z_statistic}")

if p_value < 0.05:
    print("The proportions are significantly different.")
else:
    print("The proportions are not significantly different.")
```

```
z-statistic: -1.7608057630771965
The proportions are not significantly different.
```

In [136…

```
X = df[["Method", "Study Time"]]
Y = df["Outcome"]
```

In [137…

```
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, random_state=42,
test_size=0.25)
```

In [138…

```
model = LogisticRegression()

model.fit(X_train, Y_train)
```

Out[138…

```
▾ LogisticRegression  i  ?

LogisticRegression()
```

In [139…

```
Y_prob = model.predict_proba(X_test)[:, 1]

Y_pred = model.predict(X_test)
```

In [140…

```
auc = roc_auc_score(Y_test, Y_prob)

print(f"AUC: {auc:.2f}")
```

```
AUC: 1.00
```

In [141…

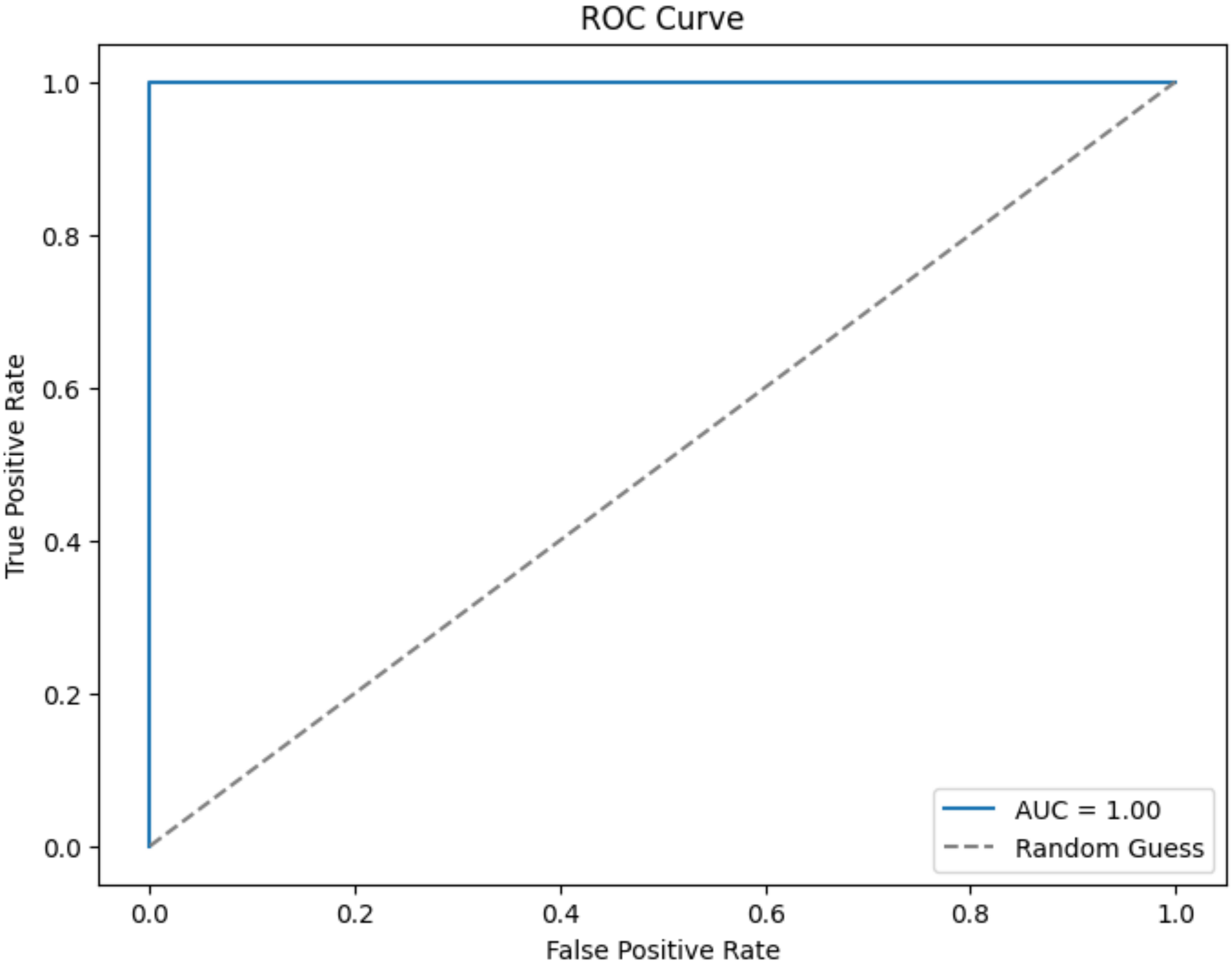
```
fpr, tpr, thresholds = roc_curve(Y_test, Y_prob)
```

In [142…

```
plt.figure(figsize=(8, 6))
plt.plot(fpr, tpr, label=f"AUC = {auc:.2f}")
plt.plot([0, 1], [0, 1], linestyle="--", color="gray", label="Random Guess")
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title("ROC Curve")
plt.legend(loc="lower right")
```

Out[142…

```
<matplotlib.legend.Legend at 0x7ea662c92e90>
```


ROC Curve
True Positive Rate
False Positive Rate
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
AUC = 1.00
Random Guess