```
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report

# Load the dataset
df = pd.read_csv('Social_Network_Ads.csv')
print("Original Dataset:")
print(df)
print(f"Dataset shape: {df.shape}")

print("\nDataset Head:")
print(df.head())

# Extract features (Age and EstimatedSalary) and labels
features = df.iloc[:, [2, 3]].values  # Age and EstimatedSalary
columns
label = df.iloc[:, 4].values  # Purchased column

print("\nFeatures (Age, EstimatedSalary):")
print(features)

print("\nLabels (Purchased):")
print(label)

# Find the best random state where test score >= train score
print("\nSearching for best random state...")
best_random_state = None
best_test_score = 0

for i in range(1, 401):
    x_train, x_test, y_train, y_test = train_test_split(features,
label, test_size=0.2, random_state=i)
    model = LogisticRegression()
    model.fit(x_train, y_train)
    train_score = model.score(x_train, y_train)
    test_score = model.score(x_test, y_test)

    if test_score >= train_score:
        print(f"Test: {test_score:.4f} Train: {train_score:.4f} Random
State: {i}")

        if test_score > best_test_score:
            best_test_score = test_score
            best_random_state = i

print(f"\nBest Random State: {best_random_state} with Test Score:
{best_test_score:.4f}")
```

```python
# Train final model with the best random state
x_train, x_test, y_train, y_test = train_test_split(features, label,
test_size=0.2, random_state=best_random_state)
finalModel = LogisticRegression()
finalModel.fit(x_train, y_train)

print(f"\nFinal Model Training Score: {finalModel.score(x_train,
y_train):.4f}")
print(f"Final Model Test Score: {finalModel.score(x_test,
y_test):.4f}")

# Generate classification report
print("\nClassification Report:")
print(classification_report(label, finalModel.predict(features)))

# Additional: Display model coefficients and intercept
print("\nModel Coefficients:")
print(f"Age Coefficient: {finalModel.coef_[0][0]:.4f}")
print(f"Salary Coefficient: {finalModel.coef_[0][1]:.4f}")
print(f"Intercept: {finalModel.intercept_[0]:.4f}")

# Predict probabilities for first 10 samples
print("\nPrediction Probabilities for first 10 samples:")
probabilities = finalModel.predict_proba(features[:10])
for i, prob in enumerate(probabilities):
    print(f"Sample {i+1}: Not Purchased: {prob[0]:.4f}, Purchased:
{prob[1]:.4f}")

# Additional: Confusion Matrix
from sklearn.metrics import confusion_matrix
import seaborn as sns
import matplotlib.pyplot as plt

y_pred = finalModel.predict(features)
cm = confusion_matrix(label, y_pred)

print("\nConfusion Matrix:")
print(cm)

# Plot confusion matrix
plt.figure(figsize=(8, 6))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues',
           xticklabels=['Not Purchased', 'Purchased'],
           yticklabels=['Not Purchased', 'Purchased'])
plt.title('Confusion Matrix')
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.show()

# Feature importance
```

```
feature_importance = pd.DataFrame({
    'Feature': ['Age', 'EstimatedSalary'],
    'Coefficient': finalModel.coef_[0]
}).sort_values('Coefficient', key=abs, ascending=False)

print("\nFeature Importance (by absolute coefficient value):")
print(feature_importance)
```

```
Original Dataset:
      User ID  Gender  Age  EstimatedSalary  Purchased
0    15624510    Male   19            19000          0
1    15810944    Male   35            20000          0
2    15668575  Female   26            43000          0
3    15603246  Female   27            57000          0
4    15804002    Male   19            76000          0
..        ...     ...  ...              ...        ...
395  15691863  Female   46            41000          1
396  15706071    Male   51            23000          1
397  15654296  Female   50            20000          1
398  15755018    Male   36            33000          0
399  15594041  Female   49            36000          1

[400 rows x 5 columns]
Dataset shape: (400, 5)

Dataset Head:
    User ID  Gender  Age  EstimatedSalary  Purchased
0  15624510    Male   19            19000          0
1  15810944    Male   35            20000          0
2  15668575  Female   26            43000          0
3  15603246  Female   27            57000          0
4  15804002    Male   19            76000          0

Features (Age, EstimatedSalary):
[[    19  19000]
 [    35  20000]
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Labels (Purchased):
[0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 1 0 0 0
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Searching for best random state...
Test: 0.9000 Train: 0.8406 Random State: 4
Test: 0.8625 Train: 0.8500 Random State: 5
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Test: 0.8625 Train: 0.8375 Random State: 9
Test: 0.9000 Train: 0.8406 Random State: 10
Test: 0.8375 Train: 0.8375 Random State: 13
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Test: 0.8500 Train: 0.8438 Random State: 15
Test: 0.8625 Train: 0.8562 Random State: 16
Test: 0.8750 Train: 0.8344 Random State: 18
Test: 0.8500 Train: 0.8438 Random State: 19
Test: 0.8750 Train: 0.8438 Random State: 20
Test: 0.8625 Train: 0.8344 Random State: 21
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Test: 0.8750 Train: 0.8406 Random State: 24
Test: 0.8500 Train: 0.8344 Random State: 26
Test: 0.8500 Train: 0.8406 Random State: 27
Test: 0.8625 Train: 0.8344 Random State: 30
Test: 0.8625 Train: 0.8562 Random State: 31
Test: 0.8750 Train: 0.8531 Random State: 32
Test: 0.8625 Train: 0.8438 Random State: 33
Test: 0.8750 Train: 0.8313 Random State: 35
Test: 0.8625 Train: 0.8531 Random State: 36
Test: 0.8875 Train: 0.8406 Random State: 38
Test: 0.8750 Train: 0.8375 Random State: 39
Test: 0.8875 Train: 0.8375 Random State: 42
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Test: 0.9125 Train: 0.8313 Random State: 47
Test: 0.8750 Train: 0.8313 Random State: 51
Test: 0.9000 Train: 0.8438 Random State: 54
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Test: 0.8750 Train: 0.8438 Random State: 58
Test: 0.9250 Train: 0.8375 Random State: 61
Test: 0.8875 Train: 0.8344 Random State: 65
Test: 0.8875 Train: 0.8406 Random State: 68
Test: 0.9000 Train: 0.8313 Random State: 72
Test: 0.8875 Train: 0.8375 Random State: 75
Test: 0.9250 Train: 0.8250 Random State: 76
Test: 0.8625 Train: 0.8406 Random State: 77
Test: 0.8625 Train: 0.8594 Random State: 81
Test: 0.8750 Train: 0.8375 Random State: 82
Test: 0.8875 Train: 0.8375 Random State: 83
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Test: 0.8625 Train: 0.8406 Random State: 85
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Test: 0.8625 Train: 0.8500 Random State: 95
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Test: 0.8750 Train: 0.8281 Random State: 159
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Test: 0.9625 Train: 0.8187 Random State: 220
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Test: 0.8500 Train: 0.8469 Random State: 283
Test: 0.8500 Train: 0.8438 Random State: 285
Test: 0.9125 Train: 0.8344 Random State: 286
Test: 0.8500 Train: 0.8406 Random State: 290
Test: 0.8500 Train: 0.8406 Random State: 291
Test: 0.8500 Train: 0.8469 Random State: 292
Test: 0.8625 Train: 0.8375 Random State: 294
Test: 0.8875 Train: 0.8281 Random State: 297
Test: 0.8625 Train: 0.8344 Random State: 300
Test: 0.8625 Train: 0.8500 Random State: 301
Test: 0.8875 Train: 0.8500 Random State: 302
Test: 0.8750 Train: 0.8469 Random State: 303
Test: 0.8625 Train: 0.8344 Random State: 305
Test: 0.9125 Train: 0.8375 Random State: 306
Test: 0.8750 Train: 0.8469 Random State: 308
Test: 0.9000 Train: 0.8438 Random State: 311
Test: 0.8625 Train: 0.8344 Random State: 313
Test: 0.9125 Train: 0.8344 Random State: 314
Test: 0.8750 Train: 0.8375 Random State: 315
Test: 0.9000 Train: 0.8469 Random State: 317
Test: 0.9125 Train: 0.8219 Random State: 319
Test: 0.8625 Train: 0.8500 Random State: 321
Test: 0.9125 Train: 0.8281 Random State: 322
Test: 0.8500 Train: 0.8469 Random State: 328
Test: 0.8500 Train: 0.8375 Random State: 332
Test: 0.8875 Train: 0.8531 Random State: 336
Test: 0.8500 Train: 0.8375 Random State: 337
Test: 0.8750 Train: 0.8406 Random State: 343
Test: 0.8625 Train: 0.8438 Random State: 346
Test: 0.8875 Train: 0.8313 Random State: 351
Test: 0.8625 Train: 0.8500 Random State: 352
Test: 0.9500 Train: 0.8187 Random State: 354
Test: 0.8625 Train: 0.8500 Random State: 356
Test: 0.9125 Train: 0.8406 Random State: 357
Test: 0.8625 Train: 0.8375 Random State: 358
Test: 0.8500 Train: 0.8406 Random State: 362
Test: 0.9000 Train: 0.8438 Random State: 363
Test: 0.8625 Train: 0.8531 Random State: 364
```

```
Test: 0.9375 Train: 0.8219 Random State: 366
Test: 0.9125 Train: 0.8406 Random State: 369
Test: 0.8625 Train: 0.8531 Random State: 371
Test: 0.9250 Train: 0.8344 Random State: 376
Test: 0.9125 Train: 0.8281 Random State: 377
Test: 0.8875 Train: 0.8500 Random State: 378
Test: 0.8875 Train: 0.8500 Random State: 379
Test: 0.8625 Train: 0.8406 Random State: 382
Test: 0.8500 Train: 0.8500 Random State: 385
Test: 0.8625 Train: 0.8594 Random State: 386
Test: 0.8500 Train: 0.8375 Random State: 387
Test: 0.8750 Train: 0.8281 Random State: 388
Test: 0.8500 Train: 0.8438 Random State: 394
Test: 0.8625 Train: 0.8375 Random State: 395
Test: 0.9000 Train: 0.8438 Random State: 397
Test: 0.8625 Train: 0.8438 Random State: 400

Best Random State: 220 with Test Score: 0.9625

Final Model Training Score: 0.8187
Final Model Test Score: 0.9625

Classification Report:
              precision    recall  f1-score   support

           0       0.85      0.92      0.89       257
           1       0.84      0.71      0.77       143

    accuracy                           0.85       400
   macro avg       0.84      0.82      0.83       400
weighted avg       0.85      0.85      0.84       400


Model Coefficients:
Age Coefficient: 0.2105
Salary Coefficient: 0.0000
Intercept: -11.1836

Prediction Probabilities for first 10 samples:
Sample 1: Not Purchased: 0.9986, Purchased: 0.0014
Sample 2: Not Purchased: 0.9601, Purchased: 0.0399
Sample 3: Not Purchased: 0.9872, Purchased: 0.0128
Sample 4: Not Purchased: 0.9756, Purchased: 0.0244
Sample 5: Not Purchased: 0.9916, Purchased: 0.0084
Sample 6: Not Purchased: 0.9749, Purchased: 0.0251
Sample 7: Not Purchased: 0.9444, Purchased: 0.0556
Sample 8: Not Purchased: 0.4216, Purchased: 0.5784
Sample 9: Not Purchased: 0.9924, Purchased: 0.0076
Sample 10: Not Purchased: 0.8521, Purchased: 0.1479
```

```
Confusion Matrix:
[[237  20]
 [ 41 102]]
```


```
Feature Importance (by absolute coefficient value):
           Feature  Coefficient
0              Age     0.210540
1  EstimatedSalary     0.000032
```