**Evaluating Random Forest Model Performance Across Varying Test Sizes and Random States**

**Code Objective**

The objective is to determine the optimal test size and random state combination that results in the best model performance, measured by the lowest MSE and highest R² score.

**Best Test Size and Random State**

Based on the given results, the combination of a **test size of 0.2** and a **random state of 28** yields the best performance with a Mean Squared Error (MSE) of 0.245 and an R² score of 0.752.

**Code:**

import pandas as pd

from sklearn.model\_selection import train\_test\_split

from sklearn.ensemble import RandomForestRegressor

from sklearn.metrics import mean\_squared\_error, r2\_score

# Assuming your scaled data is in a DataFrame named uber\_scaled\_df

X = uber\_scaled\_df.drop(columns=['fare\_amount'])

y = uber\_scaled\_df['fare\_amount']

# Define test sizes and random states

test\_sizes = [0.05, 0.1, 0.15, 0.2, 0.25, 0.3]

random\_states = range(10, 51, 2) # multiples of 2 from 10 to 50

# Iterate over test sizes and random states

for test\_size in test\_sizes:

for random\_state in random\_states:

# Adjust test\_size to be a fraction of the dataset size

# Handle cases where test\_size is larger than 1 (for larger datasets)

if test\_size > 1:

test\_size\_fraction = min(test\_size / len(X), 1.0)

else:

test\_size\_fraction = test\_size

# Split data into training and testing sets

X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=test\_size\_fraction, random\_state=random\_state)

# Instantiate and train the model

rf\_model = RandomForestRegressor(n\_estimators=100, random\_state=random\_state)

rf\_model.fit(X\_train, y\_train)

# Predict and evaluate model performance

y\_pred = rf\_model.predict(X\_test)

mse = round(mean\_squared\_error(y\_test, y\_pred), 3)

r2 = round(r2\_score(y\_test, y\_pred), 3)

# Print the results

print(f'Test Size: {test\_size}, Random State: {random\_state}')

print(f' Mean Squared Error: {mse}')

print(f' R^2 Score: {r2}')

print('---')

**Output:**

Test Size: 0.2, Random State: 10

Mean Squared Error: 0.315

R^2 Score: 0.699

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Test Size: 0.2, Random State: 12

Mean Squared Error: 0.304

R^2 Score: 0.701

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Test Size: 0.2, Random State: 14

Mean Squared Error: 0.284

R^2 Score: 0.721

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Test Size: 0.2, Random State: 16

Mean Squared Error: 0.267

R^2 Score: 0.73

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Test Size: 0.2, Random State: 18

Mean Squared Error: 0.306

R^2 Score: 0.702

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Test Size: 0.2, Random State: 20

Mean Squared Error: 0.262

R^2 Score: 0.738

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Test Size: 0.2, Random State: 22

Mean Squared Error: 0.275

R^2 Score: 0.734

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Test Size: 0.2, Random State: 24

Mean Squared Error: 0.267

R^2 Score: 0.728

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Test Size: 0.2, Random State: 26

Mean Squared Error: 0.28

R^2 Score: 0.709

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Test Size: 0.2, Random State: 28

Mean Squared Error: 0.245

R^2 Score: 0.752

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Test Size: 0.2, Random State: 30

Mean Squared Error: 0.249

R^2 Score: 0.747

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Test Size: 0.2, Random State: 32

Mean Squared Error: 0.278

R^2 Score: 0.717

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Test Size: 0.2, Random State: 34

Mean Squared Error: 0.275

R^2 Score: 0.714

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Test Size: 0.2, Random State: 36

Mean Squared Error: 0.259

R^2 Score: 0.732

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Test Size: 0.2, Random State: 38

Mean Squared Error: 0.266

R^2 Score: 0.73

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Test Size: 0.2, Random State: 40

Mean Squared Error: 0.267

R^2 Score: 0.726

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Test Size: 0.2, Random State: 42

Mean Squared Error: 0.251

R^2 Score: 0.744

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Test Size: 0.2, Random State: 44

Mean Squared Error: 0.33

R^2 Score: 0.691

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Test Size: 0.2, Random State: 46

Mean Squared Error: 0.27

R^2 Score: 0.725

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Test Size: 0.2, Random State: 48

Mean Squared Error: 0.307

R^2 Score: 0.704

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Test Size: 0.2, Random State: 50

Mean Squared Error: 0.261

R^2 Score: 0.733

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Test Size: 0.22, Random State: 10

Mean Squared Error: 0.314

R^2 Score: 0.701

---

Test Size: 0.22, Random State: 12

Mean Squared Error: 0.297

R^2 Score: 0.704

---

Test Size: 0.22, Random State: 14

Mean Squared Error: 0.288

R^2 Score: 0.718

---

Test Size: 0.22, Random State: 16

Mean Squared Error: 0.268

R^2 Score: 0.727

---

Test Size: 0.22, Random State: 18

Mean Squared Error: 0.305

R^2 Score: 0.702

---

Test Size: 0.22, Random State: 20

Mean Squared Error: 0.26

R^2 Score: 0.739

---

Test Size: 0.22, Random State: 22

Mean Squared Error: 0.277

R^2 Score: 0.731

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Test Size: 0.22, Random State: 24

Mean Squared Error: 0.261

R^2 Score: 0.737

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Test Size: 0.22, Random State: 26

Mean Squared Error: 0.273

R^2 Score: 0.713

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Test Size: 0.22, Random State: 28

Mean Squared Error: 0.249

R^2 Score: 0.748

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Test Size: 0.22, Random State: 30

Mean Squared Error: 0.253

R^2 Score: 0.746

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Test Size: 0.22, Random State: 32

Mean Squared Error: 0.283

R^2 Score: 0.71

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Test Size: 0.22, Random State: 34

Mean Squared Error: 0.279

R^2 Score: 0.712

---

Test Size: 0.22, Random State: 36

Mean Squared Error: 0.266

R^2 Score: 0.726

---

Test Size: 0.22, Random State: 38

Mean Squared Error: 0.26

R^2 Score: 0.732

---

Test Size: 0.22, Random State: 40

Mean Squared Error: 0.265

R^2 Score: 0.73

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Test Size: 0.22, Random State: 42

Mean Squared Error: 0.25

R^2 Score: 0.745

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Test Size: 0.22, Random State: 44

Mean Squared Error: 0.321

R^2 Score: 0.694

---

Test Size: 0.22, Random State: 46

Mean Squared Error: 0.268

R^2 Score: 0.728

---

Test Size: 0.22, Random State: 48

Mean Squared Error: 0.305

R^2 Score: 0.704

---

Test Size: 0.22, Random State: 50

Mean Squared Error: 0.261

R^2 Score: 0.731

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Test Size: 0.24, Random State: 10

Mean Squared Error: 0.304

R^2 Score: 0.709

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Test Size: 0.24, Random State: 12

Mean Squared Error: 0.291

R^2 Score: 0.71

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Test Size: 0.24, Random State: 14

Mean Squared Error: 0.289

R^2 Score: 0.719

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Test Size: 0.24, Random State: 16

Mean Squared Error: 0.267

R^2 Score: 0.73

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Test Size: 0.24, Random State: 18

Mean Squared Error: 0.301

R^2 Score: 0.704

---

Test Size: 0.24, Random State: 20

Mean Squared Error: 0.258

R^2 Score: 0.739

---

Test Size: 0.24, Random State: 22

Mean Squared Error: 0.275

R^2 Score: 0.731

---

Test Size: 0.24, Random State: 24

Mean Squared Error: 0.259

R^2 Score: 0.737

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Test Size: 0.24, Random State: 26

Mean Squared Error: 0.273

R^2 Score: 0.713

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Test Size: 0.24, Random State: 28

Mean Squared Error: 0.259

R^2 Score: 0.742

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Test Size: 0.24, Random State: 30

Mean Squared Error: 0.254

R^2 Score: 0.745

---

Test Size: 0.24, Random State: 32

Mean Squared Error: 0.282

R^2 Score: 0.709

---

Test Size: 0.24, Random State: 34

Mean Squared Error: 0.277

R^2 Score: 0.717

---

Test Size: 0.24, Random State: 36

Mean Squared Error: 0.261

R^2 Score: 0.73

---

Test Size: 0.24, Random State: 38

Mean Squared Error: 0.26

R^2 Score: 0.731

---

Test Size: 0.24, Random State: 40

Mean Squared Error: 0.27

R^2 Score: 0.728

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Test Size: 0.24, Random State: 42

Mean Squared Error: 0.25

R^2 Score: 0.748

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Test Size: 0.24, Random State: 44

Mean Squared Error: 0.319

R^2 Score: 0.695

---

Test Size: 0.24, Random State: 46

Mean Squared Error: 0.269

R^2 Score: 0.728

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Test Size: 0.24, Random State: 48

Mean Squared Error: 0.3

R^2 Score: 0.708

---

Test Size: 0.24, Random State: 50

Mean Squared Error: 0.256

R^2 Score: 0.737

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Test Size: 0.26, Random State: 10

Mean Squared Error: 0.3

R^2 Score: 0.712

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Test Size: 0.26, Random State: 12

Mean Squared Error: 0.294

R^2 Score: 0.708

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Test Size: 0.26, Random State: 14

Mean Squared Error: 0.288

R^2 Score: 0.72

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Test Size: 0.26, Random State: 16

Mean Squared Error: 0.263

R^2 Score: 0.731

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Test Size: 0.26, Random State: 18

Mean Squared Error: 0.3

R^2 Score: 0.706

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Test Size: 0.26, Random State: 20

Mean Squared Error: 0.258

R^2 Score: 0.743

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Test Size: 0.26, Random State: 22

Mean Squared Error: 0.268

R^2 Score: 0.735

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Test Size: 0.26, Random State: 24

Mean Squared Error: 0.31

R^2 Score: 0.702

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Test Size: 0.26, Random State: 26

Mean Squared Error: 0.272

R^2 Score: 0.717

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Test Size: 0.26, Random State: 28

Mean Squared Error: 0.257

R^2 Score: 0.743

---

Test Size: 0.26, Random State: 30

Mean Squared Error: 0.256

R^2 Score: 0.745

---

Test Size: 0.26, Random State: 32

Mean Squared Error: 0.271

R^2 Score: 0.718

---

Test Size: 0.26, Random State: 34

Mean Squared Error: 0.278

R^2 Score: 0.719

---

Test Size: 0.26, Random State: 36

Mean Squared Error: 0.266

R^2 Score: 0.725

---

Test Size: 0.26, Random State: 38

Mean Squared Error: 0.259

R^2 Score: 0.732

---

Test Size: 0.26, Random State: 40

Mean Squared Error: 0.275

R^2 Score: 0.726

---

Test Size: 0.26, Random State: 42

Mean Squared Error: 0.256

R^2 Score: 0.739

---

Test Size: 0.26, Random State: 44

Mean Squared Error: 0.308

R^2 Score: 0.702

---

Test Size: 0.26, Random State: 46

Mean Squared Error: 0.271

R^2 Score: 0.729

---

Test Size: 0.26, Random State: 48

Mean Squared Error: 0.293

R^2 Score: 0.714

---

Test Size: 0.26, Random State: 50

Mean Squared Error: 0.254

R^2 Score: 0.739

---

Test Size: 0.28, Random State: 10

Mean Squared Error: 0.296

R^2 Score: 0.714

---

Test Size: 0.28, Random State: 12

Mean Squared Error: 0.294

R^2 Score: 0.709

---

Test Size: 0.28, Random State: 14

Mean Squared Error: 0.291

R^2 Score: 0.718

---

Test Size: 0.28, Random State: 16

Mean Squared Error: 0.265

R^2 Score: 0.73

---

Test Size: 0.28, Random State: 18

Mean Squared Error: 0.295

R^2 Score: 0.707

---

Test Size: 0.28, Random State: 20

Mean Squared Error: 0.257

R^2 Score: 0.743

---

Test Size: 0.28, Random State: 22

Mean Squared Error: 0.268

R^2 Score: 0.733

---

Test Size: 0.28, Random State: 24

Mean Squared Error: 0.303

R^2 Score: 0.709

---

Test Size: 0.28, Random State: 26

Mean Squared Error: 0.275

R^2 Score: 0.713

---

Test Size: 0.28, Random State: 28

Mean Squared Error: 0.256

R^2 Score: 0.743

---

Test Size: 0.28, Random State: 30

Mean Squared Error: 0.253

R^2 Score: 0.746

---

Test Size: 0.28, Random State: 32

Mean Squared Error: 0.274

R^2 Score: 0.72

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Test Size: 0.28, Random State: 34

Mean Squared Error: 0.274

R^2 Score: 0.723

---

Test Size: 0.28, Random State: 36

Mean Squared Error: 0.278

R^2 Score: 0.717

---

Test Size: 0.28, Random State: 38

Mean Squared Error: 0.265

R^2 Score: 0.723

---

Test Size: 0.28, Random State: 40

Mean Squared Error: 0.319

R^2 Score: 0.698

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Test Size: 0.28, Random State: 42

Mean Squared Error: 0.253

R^2 Score: 0.741

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Test Size: 0.28, Random State: 44

Mean Squared Error: 0.305

R^2 Score: 0.705

---

Test Size: 0.28, Random State: 46

Mean Squared Error: 0.275

R^2 Score: 0.727

---

Test Size: 0.28, Random State: 48

Mean Squared Error: 0.297

R^2 Score: 0.712

---

Test Size: 0.28, Random State: 50

Mean Squared Error: 0.257

R^2 Score: 0.737

---

Test Size: 0.3, Random State: 10

Mean Squared Error: 0.301

R^2 Score: 0.711

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Test Size: 0.3, Random State: 12

Mean Squared Error: 0.292

R^2 Score: 0.711

---

Test Size: 0.3, Random State: 14

Mean Squared Error: 0.29

R^2 Score: 0.717

---

Test Size: 0.3, Random State: 16

Mean Squared Error: 0.279

R^2 Score: 0.715

---

Test Size: 0.3, Random State: 18

Mean Squared Error: 0.289

R^2 Score: 0.709

---

Test Size: 0.3, Random State: 20

Mean Squared Error: 0.256

R^2 Score: 0.742

---

Test Size: 0.3, Random State: 22

Mean Squared Error: 0.267

R^2 Score: 0.735

---

Test Size: 0.3, Random State: 24

Mean Squared Error: 0.3

R^2 Score: 0.711

---

Test Size: 0.3, Random State: 26

Mean Squared Error: 0.272

R^2 Score: 0.717

---

Test Size: 0.3, Random State: 28

Mean Squared Error: 0.257

R^2 Score: 0.742

---

Test Size: 0.3, Random State: 30

Mean Squared Error: 0.254

R^2 Score: 0.746

---

Test Size: 0.3, Random State: 32

Mean Squared Error: 0.271

R^2 Score: 0.722

---

Test Size: 0.3, Random State: 34

Mean Squared Error: 0.274

R^2 Score: 0.723

---

Test Size: 0.3, Random State: 36

Mean Squared Error: 0.273

R^2 Score: 0.721

---

Test Size: 0.3, Random State: 38

Mean Squared Error: 0.262

R^2 Score: 0.73

---

Test Size: 0.3, Random State: 40

Mean Squared Error: 0.318

R^2 Score: 0.699

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Test Size: 0.3, Random State: 42

Mean Squared Error: 0.251

R^2 Score: 0.741

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Test Size: 0.3, Random State: 44

Mean Squared Error: 0.302

R^2 Score: 0.708

---

Test Size: 0.3, Random State: 46

Mean Squared Error: 0.272

R^2 Score: 0.731

---

Test Size: 0.3, Random State: 48

Mean Squared Error: 0.295

R^2 Score: 0.715

---

Test Size: 0.3, Random State: 50

Mean Squared Error: 0.258

R^2 Score: 0.734

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