

```

In [26]: # Define features (X) and target (y)
X = df[["Matter Description", "Responsible Attorney", "Practice Area"]]
y = df["Total Hours"]

# Split the 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)

# Define the model
model = RandomForestRegressor(random_state=42)

# Define the parameter grid
param_grid = {
    'n_estimators': [50, 100, 200],
    'max_features': ['auto', 'sqrt', 'log2'],
    'max_depth': [None, 10, 20, 30],
    'min_samples_split': [2, 5, 10],
    'min_samples_leaf': [1, 2, 4]
}

# Perform Grid Search with cross-validation
grid_search = GridSearchCV(estimator=model, param_grid=param_grid,
                           cv=3, n_jobs=-1, verbose=2, scoring='neg_mean_squared_error')

grid_search.fit(X_train, y_train)

# Get the best model
best_model = grid_search.best_estimator_

```

```

In [27]: # Evaluate the best model
y_pred = best_model.predict(X_test)
rmse = np.sqrt(mean_squared_error(y_test, y_pred))
r2 = r2_score(y_test, y_pred)

print(f"Best Model RMSE: {rmse}")
print(f"Best Model R2: {r2}")

```

```

Best Model RMSE: 15.87377000902211
Best Model R2: 0.8573611351913836

```

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In [28]: # Save the best model
joblib.dump(best_model, 'random_forest_best_model.pkl')
joblib.dump(label_encoders, 'label_encoders.pkl')

```

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Out[28]: ['label_encoders.pkl']

```

```

1  from flask import Flask, request, jsonify, render_template, url_for
2  import joblib
3  import pandas as pd
4  import json
5
6  app = Flask(__name__)
7
8  # Load the trained model and label encoders
9  model = joblib.load('random_forest_best_model.pkl')
10 label_encoders = joblib.load('label_encoders.pkl')
11
12 # Load the unique values from JSON files
13 with open('unique_matter_descriptions.json', 'r') as f:
14     unique_matter_descriptions = json.load(f)
15 with open('unique_responsible_attorneys.json', 'r') as f:
16     unique_responsible_attorneys = json.load(f)
17 with open('unique_practice_areas.json', 'r') as f:
18     unique_practice_areas = json.load(f)
19
20 @app.route('/')
21 def home():
22     return render_template('index.html',
23                             matter_descriptions=unique_matter_descriptions,
24                             responsible_attorneys=unique_responsible_attorneys,
25                             practice_areas=unique_practice_areas)
26
27 @app.route('/predict', methods=['POST'])
28 def predict():
29     data = request.get_json()
30
31     # Convert data to DataFrame
32     df = pd.DataFrame(data, index=[0])
33
34     # Encode categorical variables
35     for column in ["Matter Description", "Responsible Attorney", "Practice Area"]:
36         le = label_encoders[column]
37         df[column] = le.transform(df[column])
38
39     # Predict using the loaded model
40     prediction = model.predict(df)
41
42     return jsonify({'prediction': prediction[0], 'rmse': rmse, 'r2': r2})
43
44 if __name__ == '__main__':
45     app.run(debug=True)
46

```

```

1 <!DOCTYPE html>
2 <html lang="en">
3 <head>
4   <meta charset="UTF-8">
5   <meta name="viewport" content="width=device-width, initial-scale=1.0">
6   <title>Random Forest Prediction</title>
7   <link href="https://stackpath.bootstrapcdn.com/bootstrap/4.5.2/css/bootstrap.min.css" rel="stylesheet">
8   <style>
9     body {
10       padding-top: 50px;
11       background-color: #f8f9fa;
12     }
13     .container {
14       max-width: 600px;
15       margin: auto;
16     }
17     .logo {
18       display: block;
19       margin: 0 auto 20px;
20     }
21     .form-label {
22       font-weight: bold;
23     }
24     .form-control {
25       margin-bottom: 15px;
26     }
27     .btn-primary {
28       width: 100%;
29     }
30     #result, #metrics {
31       margin-top: 20px;
32     }
33   </style>
34 </head>
35 <body>
36   <div class="container">
37     
38     <h1 class="text-center">Random Forest Model Prediction</h1>
39     <form id="predictionForm">
40       <div class="form-group">
41         <label for="matter_description" class="form-label">Matter Description:</label>
42         <select id="matter_description" name="Matter Description" class="form-control">
43           {% for description in matter_descriptions %}
44             <option value="{{ description }}">{{ description }}</option>
45           {% endfor %}
46         </select>
47       </div>
48       <div class="form-group">

```

```


48     <div class="form-group">
49         <label for="responsible_attorney" class="form-label">Responsible Attorney:</label>
50         <select id="responsible_attorney" name="Responsible Attorney" class="form-control">
51             {% for attorney in responsible_attorneys %}
52             <option value="{{ attorney }}">{{ attorney }}</option>
53             {% endfor %}
54         </select>
55     </div>
56     <div class="form-group">
57         <label for="practice_area" class="form-label">Practice Area:</label>
58         <select id="practice_area" name="Practice Area" class="form-control">
59             {% for area in practice_areas %}
60             <option value="{{ area }}">{{ area }}</option>
61             {% endfor %}
62         </select>
63     </div>
64     <button type="submit" class="btn btn-primary">Predict</button>
65 </form>
66 <div id="result" class="alert alert-info" role="alert" style="display: none;"></div>
67 <div id="metrics" class="alert alert-secondary" role="alert" style="display: none;"></div>
68 </div>
69
70 <script>
71     const form = document.getElementById('predictionForm');
72     const result = document.getElementById('result');
73     const metrics = document.getElementById('metrics');
74
75     form.addEventListener('submit', async (e) => {
76         e.preventDefault();
77
78         const formData = new FormData(form);
79         const data = Object.fromEntries(formData);
80
81         const response = await fetch('/predict', {
82             method: 'POST',
83             headers: {
84                 'Content-Type': 'application/json',
85             },
86             body: JSON.stringify(data),
87         });
88

```

```

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50         <select id="responsible_attorney" name="Responsible Attorney" class="form-control">
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52             <option value="{{ attorney }}">{{ attorney }}</option>
53             {% endfor %}
54         </select>
55     </div>
56     <div class="form-group">
57         <label for="practice_area" class="form-label">Practice Area:</label>
58         <select id="practice_area" name="Practice Area" class="form-control">
59             {% for area in practice_areas %}
60             <option value="{{ area }}">{{ area }}</option>
61             {% endfor %}
62         </select>
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84                 'Content-Type': 'application/json',
85             },
86             body: JSON.stringify(data),
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88

```

 app.py 5

 index.html

 Procfile.txt ×

Users > keith > Library > CloudStorage > OneDrive-ProdStudentNU >

1 web: gunicorn app:app

2

```

Last login: Tue Jun  4 19:38:09 on ttys013
(base) keith@Keiths-Mac-Studio Billable Hours App % python -m venv venv

(base) keith@Keiths-Mac-Studio Billable Hours App % source venv/bin/activate

(venv) (base) keith@Keiths-Mac-Studio Billable Hours App % pip install Flask joblib

Requirement already satisfied: Flask in ./venv/lib/python3.11/site-packages (3.0.3)
Requirement already satisfied: joblib in ./venv/lib/python3.11/site-packages (1.4.2)
Requirement already satisfied: pandas in ./venv/lib/python3.11/site-packages (2.2.2)
Requirement already satisfied: scikit-learn in ./venv/lib/python3.11/site-packages
Requirement already satisfied: Werkzeug>=3.0.0 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: Jinja2>=3.1.2 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: itsdangerous>=2.1.2 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: click>=8.1.3 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: blinker>=1.6.2 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: numpy>=1.23.2 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: python-dateutil>=2.8.2 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: pytz>=2020.1 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: tzdata>=2022.7 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: scipy>=1.6.0 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: threadpoolctl>=3.1.0 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: MarkupSafe>=2.0 in ./venv/lib/python3.11/site-packages
Requirement already satisfied: six>=1.5 in ./venv/lib/python3.11/site-packages (from Werkzeug>=3.0.0)

[notice] A new release of pip is available: 23.1.2 -> 24.0
[notice] To update, run: pip install --upgrade pip
(venv) (base) keith@Keiths-Mac-Studio Billable Hours App % pip freeze > requirement

(venv) (base) keith@Keiths-Mac-Studio Billable Hours App % python app.py

/Users/keith/Library/CloudStorage/OneDrive-ProdStudentNU/Verum Analytica/Clients/G...
rsion 1.3.0 when using version 1.5.0. This might lead to breaking code or invalid r...
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-lir...
warnings.warn(
/Users/keith/Library/CloudStorage/OneDrive-ProdStudentNU/Verum Analytica/Clients/G...
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/Users/keith/Library/CloudStorage/OneDrive-ProdStudentNU/Verum Analytica/Clients/G...
.0 when using version 1.5.0. This might lead to breaking code or invalid results. l...
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-lir...
warnings.warn(
* Serving Flask app 'app'
* Debug mode: on
WARNING: This is a development server. Do not use it in a production deployment. Us...
* Running on http://127.0.0.1:5000
Press CTRL+C to quit
* Restarting with stat
/Users/keith/Library/CloudStorage/OneDrive-ProdStudentNU/Verum Analytica/Clients/G...
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https://scikit-learn.org/stable/model_persistence.html#security-maintainability-lir...
warnings.warn(
* Debugger is active!
* Debugger PIN: 119-422-581
127.0.0.1 - - [04/Jun/2024 19:54:31] "GET / HTTP/1.1" 200 -
127.0.0.1 - - [04/Jun/2024 19:54:31] "GET /static/images/logo.png HTTP/1.1" 404 -
127.0.0.1 - - [04/Jun/2024 19:54:32] "GET /favicon.ico HTTP/1.1" 404 -

```



```

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