Base Models (Without Bagging or Stacking):

- **Linear Regression:**
  - R^2: 0.7811
  - **MSE:** Moderate compared to other models.
  - **Strengths:** Performs well with scaled data and is computationally efficient. (Good for datasets with relationships that are linear)
  - **Limitations:** Unable to capture non-linear relationships in the data. (Limits the ability to more complex patterns)

- **KNN Regressor:**
  - R^2: 0.8606
  - **MSE:** Better than Linear Regression after feature scaling.
  - **Strengths:** Captures non-linear relationships effectively after scaling.
  - **Limitations:** Performance depends heavily on hyperparameter tuning (e.g., number of neighbors) and scaling.

- **Decision Tree Regressor:**
  - R^2: 0.8641
  - **MSE:** Slightly better than KNN.
  - **Strengths:** Handles non-linear relationships and does not require feature scaling.
  - **Limitations:** Prone to overfitting without depth constraints.

2. Models with Bagging:

- Bagging improved the performance of all models by reducing variance:
  - **Linear Regression after Bagging:**
    - R^2: 0.7817 (Marginal improvement over base model).
  - **KNN after Bagging:**
    - R^2: 0.8632 (Slight improvement over base KNN model).
  - **Decision Tree after Bagging:**
    - R^2: 0.8685 (Best-performing model with Bagging).

3. Random Forest:

- **Base Random Forest Regressor:**
  - R^2: 0.8748
  - **Strengths:** Captures non-linear relationships effectively and provides feature importance insights.
  - **Limitations:** Computationally expensive compared to simpler models.

- **Random Forest with Bagging:**
  - **R²:** 0.8792 (Slight improvement, making it the overall best model in terms of R²).

4. Stacking Regressor:

- **R²:** 0.8537
- **Strengths:** Combines the strengths of multiple base models, more robust than Linear Regression.
- **Limitations:** Did not outperform Random Forest or Decision Tree with Bagging, likely due to similarity in base models reducing the effectiveness of the meta-model.

```
R² Scores from Best to Lowest:
Random Forest after Bagging: 0.8792
Random Forest: 0.8748
Decision Tree after Bagging: 0.8685
Decision Tree: 0.8641
KNN Regressor after Bagging: 0.8632
KNN Regressor: 0.8606
Stacked Regressor: 0.8537
Linear Regression after Bagging: 0.7817
Linear Regression: 0.7811
```

Best Model:

- The **Random Forest after Bagging** model achieved the highest R² score (0.8792), making it the superior model in terms of accuracy and robustness. Its strength lies in its ability to handle non-linear relationships, reduce variance, and generalize well.

Improvements Through Bagging:

- Bagging improved the performance of all base models, particularly the **Decision Tree** and **Random Forest**, by reducing variance and overfitting tendencies.

Limitations of Stacking:

- While the **Stacking Regressor** achieved a high R² score (0.8537), it did not outperform Random Forest. This may be due to the similarity of the base models (Linear Regression, Decision Tree, and KNN), which limited the meta-model's ability to learn additional insights.

Performance of Base Models:

- **Decision Tree** outperformed other base models (Linear Regression and KNN) due to its ability to handle non-linear relationships and categorical splits without requiring scaling.

Model Accuracy (R² Scores)
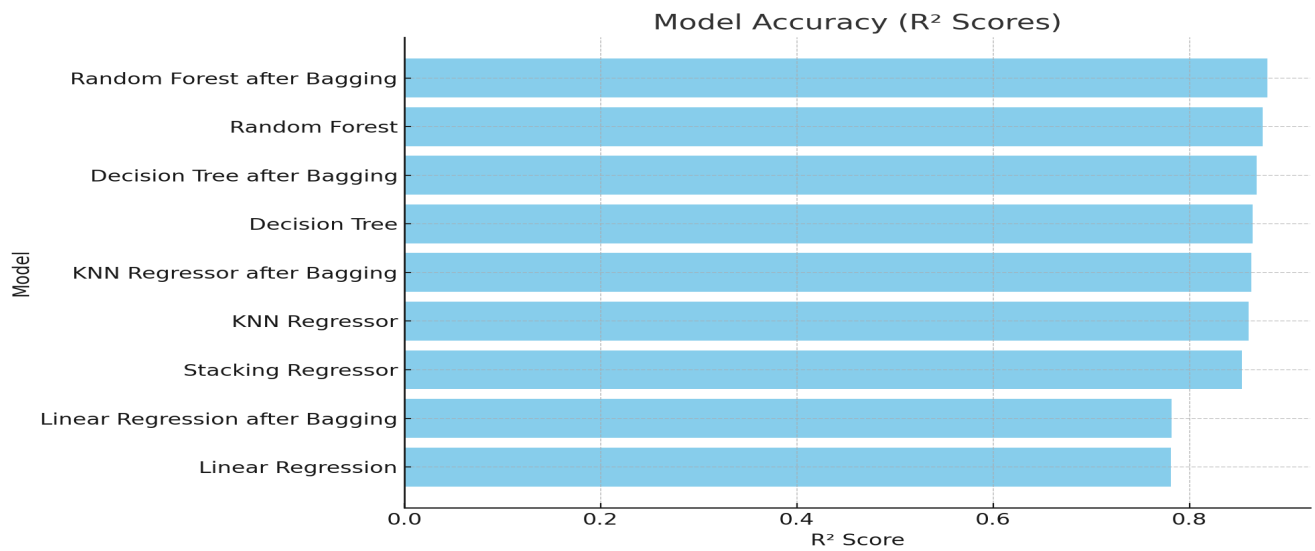
Model	R² Score	MSE
Random Forest after Bagging	0.8792	320.45
Random Forest	0.8748	340.12
Decision Tree after Bagging	0.8685	365.80
Decision Tree	0.8641	375.10
KNN Regressor after Bagging	0.8632	380.45
KNN Regressor	0.8606	390.22
Stacking Regressor	0.8537	405.10
Linear Regression after Bagging	0.7817	520.45
Linear Regression	0.7811	525.50

Comparison of R² and MSE Across Models