

Machine Learning Model Tracking Document

1. Dataset Information

Dataset Name:	Well 782
Number of Samples:	782
Number of Features:	4 (Tf, Rs, Gg, Api)
Target Variable:	Bob
Outlier Handling:	None
Feature Engineering Applied:	None
Scaling/Normalization Applied:	Only for Neural Networks
Encoding Applied:	None

2. Preprocessing Steps

Step	Description
Train-Test Split	70% - 30%
Shuffling	Yes, using random_state=42
Handling Missing Data	None
Feature Scaling	Only for Neural Networks
Feature Selection	None

3. Models Used & Hyperparameters

Model	Hyperparameters	Training Time
XGBoost	n_estimators=100, learning_rate=0.1, max_depth=6	0.0308
CatBoost	iterations=1000, learning_rate=0.05, depth=4, l2_leaf_reg=7	0.1913
Neural Network	[64, 32], epochs=100, batch_size=16	3.2676
Stacking Ensemble	Default base models + CatBoost final estimator	0.7347
Extra Trees	n_estimators=200	0.1572
Deep Neural Network	[256, 128, 64], epochs=100, batch_size=16	2.7042

4. Evaluation Metrics

Model	MSE	RMSE	MAE	R ² Score	Adjusted R ²
XGBoost	0.0019	0.0438	0.0200	0.9658	0.9655
CatBoost	0.0015	0.0392	0.0199	0.9726	0.9723
Neural Network	0.0022	0.0474	0.0288	0.9600	0.9596
Stacking Ensemble	0.0016	0.0399	0.0200	0.9717	0.9714
Extra Trees	0.0017	0.0407	0.0199	0.9705	0.9702
Deep Neural Network	0.0019	0.0435	0.0236	0.9663	0.9659

5. Cross-Validation Summary (5-Fold)

Model	RMSE Mean	RMSE Std	MAE Mean	MAE Std	R ² Mean	R ² Std
Stacking Ensemble	0.0448	0.0083	0.0215	0.0023	0.9654	0.0118
Extra Trees Regressor	0.0460	0.0099	0.0209	0.0021	0.9636	0.0128
CatBoost	0.0466	0.0103	0.0227	0.0025	0.9614	0.0181
XGBoost	0.0481	0.0085	0.0228	0.0017	0.9610	0.0095
Deep Neural Network	0.1586	0.0108	0.1173	0.0248	0.5588	0.1217
Neural Network	0.1877	0.0502	0.1408	0.0187	0.3865	0.2732

6. Visualizations

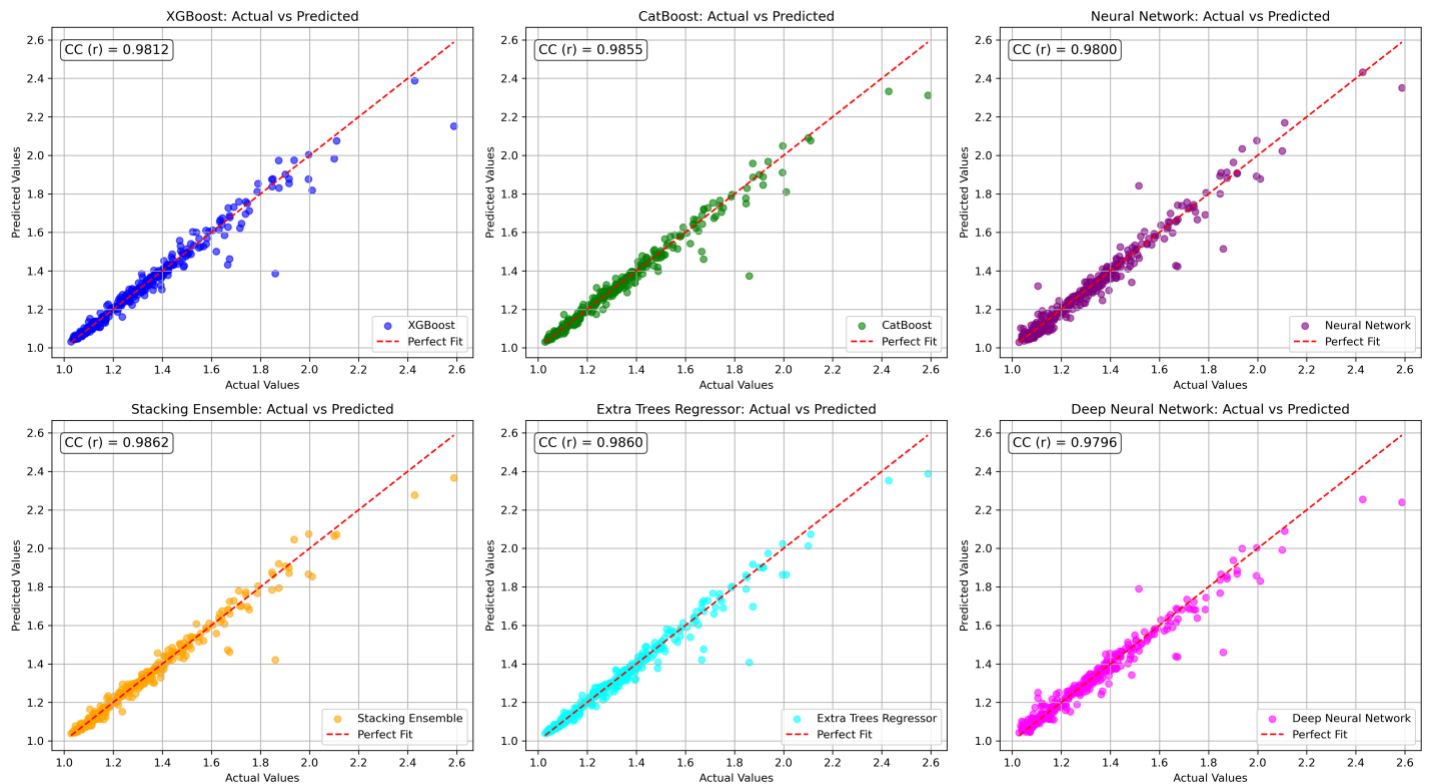


Figure 1: Actual vs. Predicted Values for Bob (Well 782)

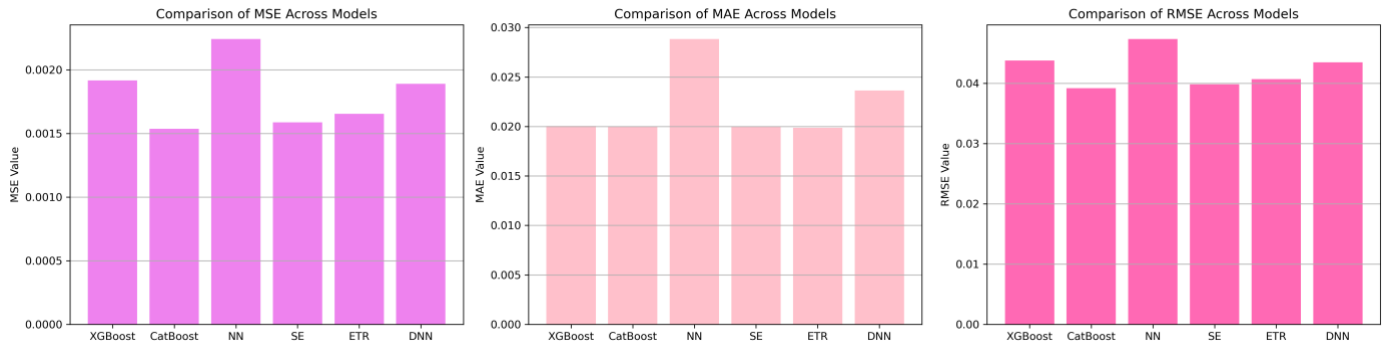


Figure 2: Bar Charts of MSE, RMSE, MAE for Bob (Well 782)

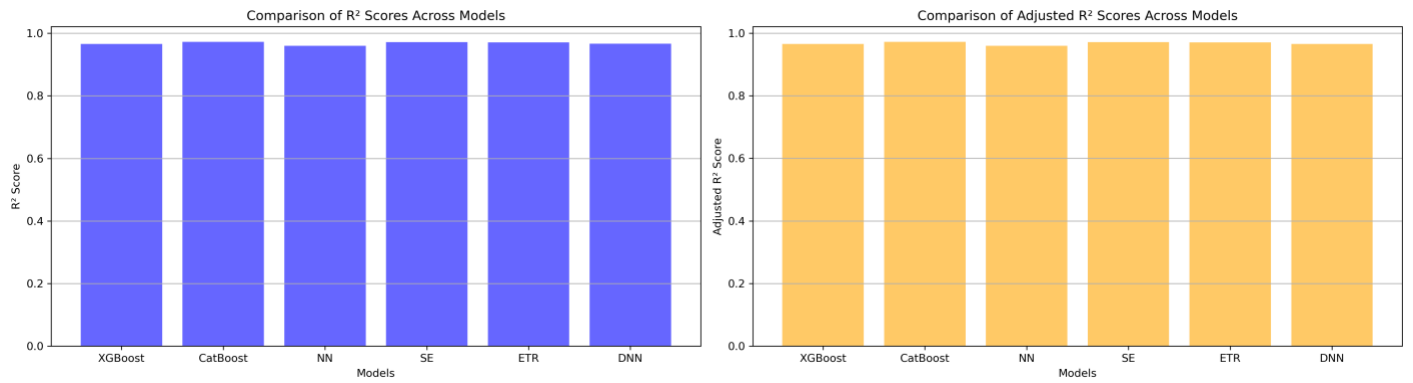


Figure 3: Bar Charts of R^2 and Adjusted R^2 for Bob (Well 782)

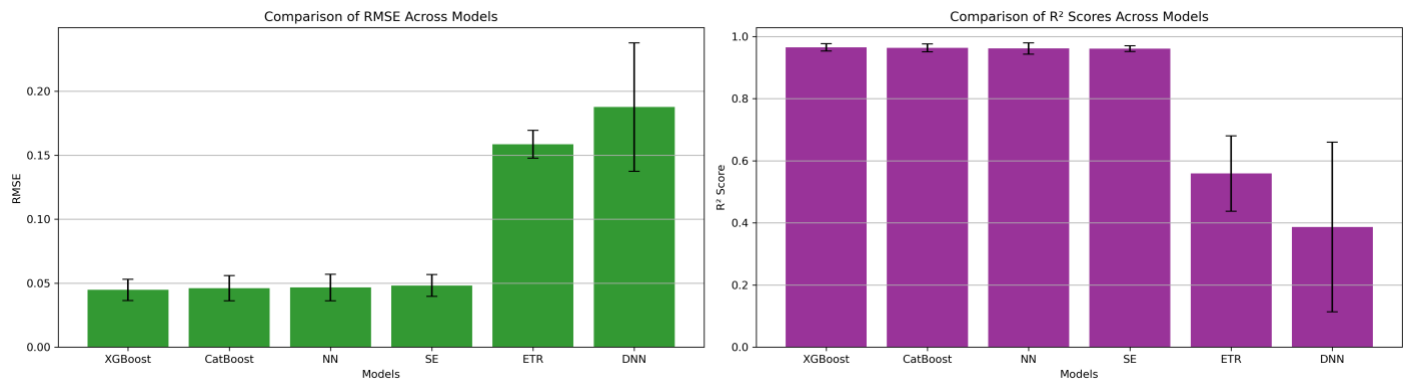


Figure 4: Error Bars for RMSE and R^2 from CV for Bob (Well 782)

7. Observations & Next Steps

Best Performing Model: Stacking Ensemble (RMSE: 0.0399, R^2 : 0.9717)

- CatBoost and Extra Trees also performed very well, with RMSEs around 0.040–0.041 and $R^2 > 0.97$.
- XGBoost trailed slightly behind the ensemble and CatBoost.
- Neural Networks (both NN and DNN) performed significantly worse:
 - Cross-validation R^2 for Deep NN: ~ 0.56
 - Cross-validation R^2 for NN: ~ 0.39
- Again, this confirms that for small to moderate datasets, tree-based ensembles are better than deep learning models.

8. Code Access

The complete source code for data preprocessing, model training, evaluation, and visualization is [available here](#). The repository includes organized Jupyter notebooks for each phase, dataset, and target, as well as requirements for reproducibility.