Machine Learning Model Tracking Document

1. Dataset Information

Dataset Name:	Well 283
Number of Samples:	283
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=0.05, max_depth=6	0.0225
CatBoost	iterations=1000, learning_rate=0.05, depth=4, l2_leaf_reg=5	0.1251
Neural Network	[64, 32], epochs=100, batch_size=16	2.6758
Stacking Ensemble	Default base models + CatBoost final estimator	0.5619
Extra Trees	n_estimators=200	0.0708
Deep Neural Network	[256, 128, 64], epochs=150, batch_size=32	2.8945

4. Evaluation Metrics

Model	MSE	RMSE	MAE	R^2 Score	Adjusted R^2
XGBoost	0.0003	0.0186	0.0135	0.9845	0.9837
CatBoost	0.0002	0.0124	0.0076	0.9931	0.9928
Neural Network	0.0043	0.0654	0.0392	0.8071	0.7975
Stacking Ensemble	0.0001	0.0118	0.0078	0.9937	0.9934
Extra Trees	0.0002	0.0125	0.0083	0.9929	0.9926
Deep Neural Network	0.0045	0.0671	0.0323	0.7972	0.7870

5. Cross-Validation Summary (5-Fold)

Model	RMSE Mean	RMSE Std	MAE Mean	MAE Std	R^2 Mean	R^2 Std
Stacking Ensemble	0.0107	0.0016	0.0069	0.0009	0.9953	0.0011
Extra Trees	0.0118	0.0015	0.0078	0.0008	0.9942	0.0012
CatBoost	0.0138	0.0061	0.0075	0.0026	0.9915	0.0063
XGBoost	0.0170	0.0029	0.0116	0.0014	0.9882	0.0020
Deep Neural Network	0.1366	0.0279	0.1027	0.0253	0.2138	0.2457
Neural Network	0.1633	0.0397	0.1195	0.0250	-0.1857	0.5130

6. Visualizations

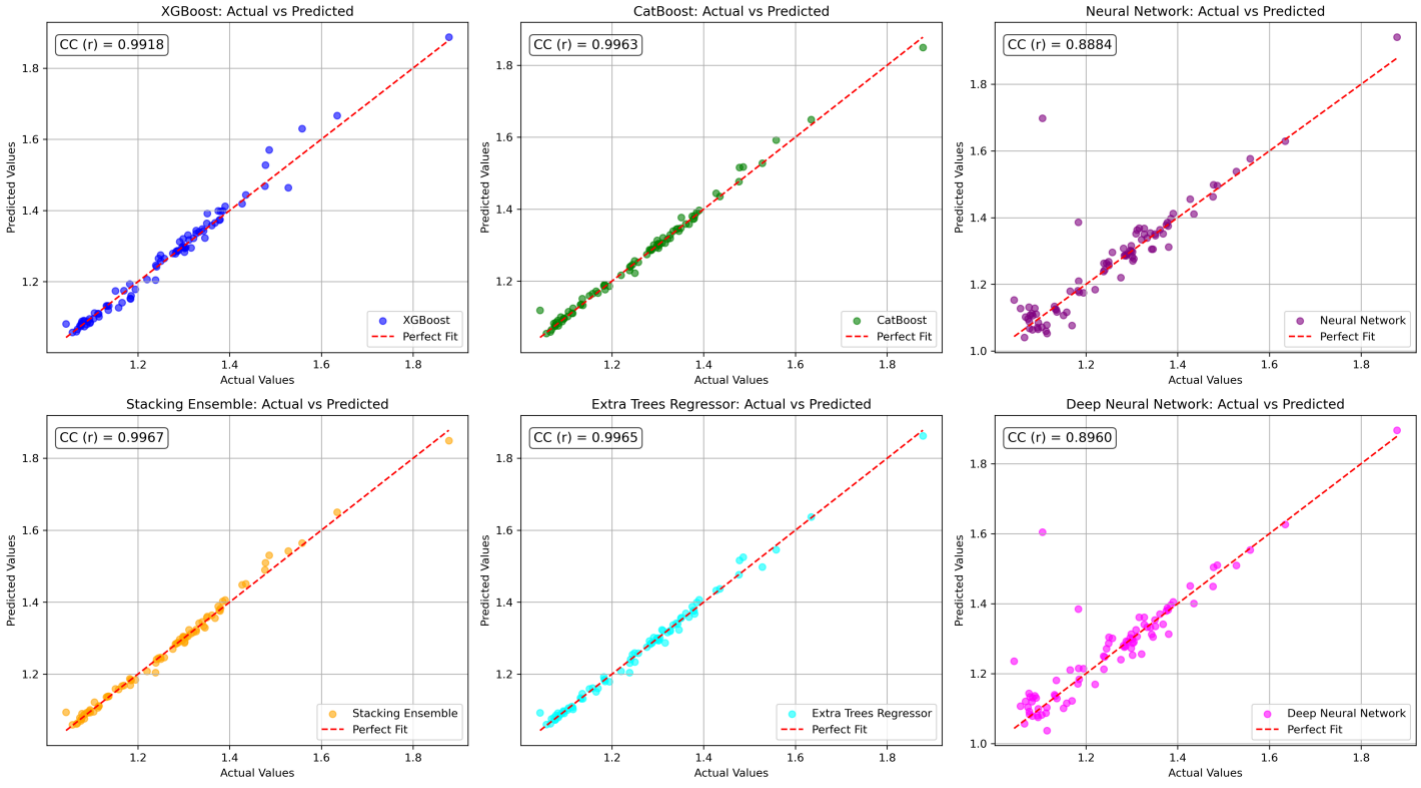

Figure 1: Actual vs. Predicted Values for Bob (Well 283)

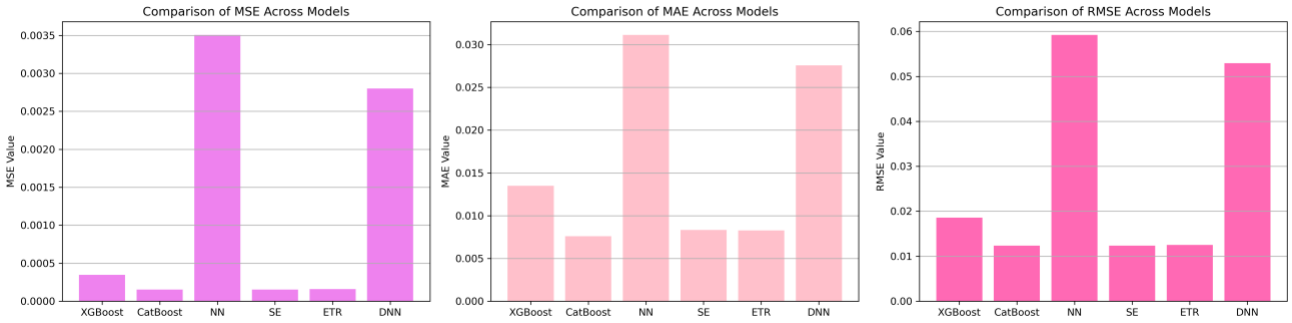

Figure 2: Bar Charts of MSE, RMSE, MAE for Bob (Well 283)

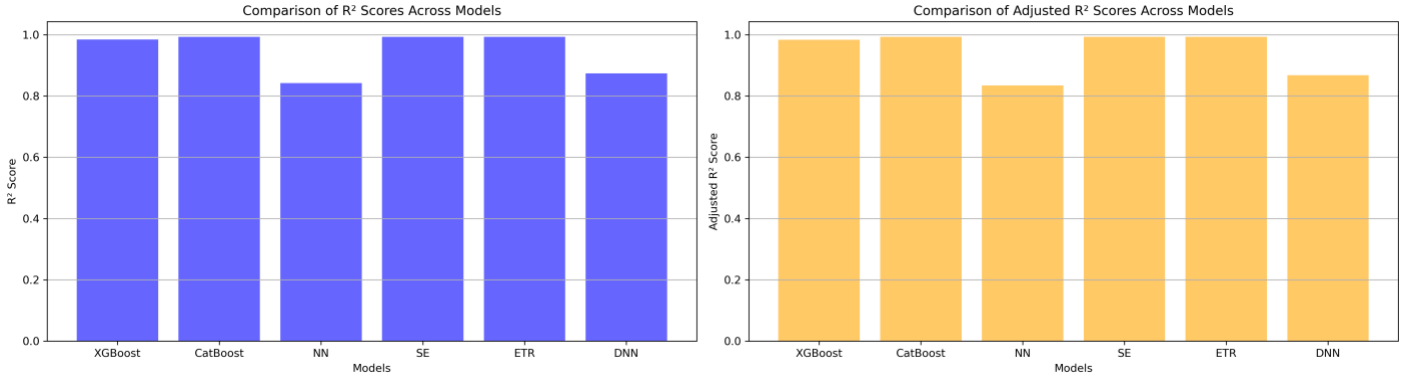

Figure 3: Bar Charts of R^2 and Adjusted R^2 for Bob (Well 283)

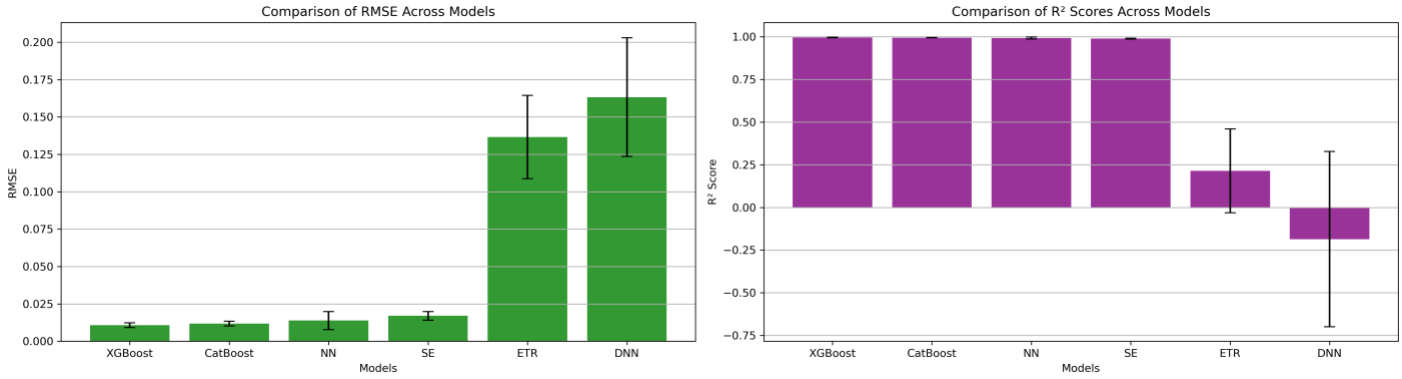

Figure 4: Error Bars for RMSE and R^2 from CV for Bob (Well 283)

7. Observations & Next Steps

Best Performing Model: Stacking Ensemble (RMSE: 0.0118, R^2: 0.9937)

- CatBoost and Extra Trees also performed competitively with RMSEs below 0.013.
- Neural-based models underperformed, with R^2 below 0.81.
- All models except the neural-based ones achieved **$R^2 > 0.98$**.

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.