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=200, learning_rate=0.05, max_depth=4	0.0483
CatBoost	iterations=1000, learning_rate=0.05, depth=6, l2_leaf_reg=3	0.3445
Neural Network	[128, 64], epochs=100, batch_size=16	2.5329
Stacking Ensemble	Default base models + CatBoost final estimator	0.7889
Extra Trees	n_estimators=200	0.1127
Deep Neural Network	[256, 128, 64], epochs=150, batch_size=16	2.3055

4. Evaluation Metrics

Model	MSE	RMSE	MAE	R^2 Score	Adjusted R^2
XGBoost	0.0031	0.0554	0.0311	0.9417	0.9407
CatBoost	0.0028	0.0525	0.0295	0.9476	0.9467
Neural Network	0.0036	0.0600	0.0382	0.9318	0.9306
Stacking Ensemble	0.0029	0.0543	0.0289	0.9441	0.9431
Extra Trees	0.0032	0.0563	0.0295	0.9398	0.9388
Deep Neural Network	0.0037	0.0608	0.0353	0.9299	0.9287

5. Cross-Validation Summary (5-Fold)

Model	RMSE Mean	RMSE Std	MAE Mean	MAE Std	R^2 Mean	R^2 Std
Stacking Ensemble	0.0668	0.0213	0.0311	0.0059	0.9381	0.0189
CatBoost	0.0668	0.0253	0.0315	0.0077	0.9381	0.0256
Extra Trees Regressor	0.0684	0.0212	0.0317	0.0064	0.9349	0.0196
XGBoost	0.0724	0.0293	0.0339	0.0086	0.9276	0.0337
Neural Network	0.2229	0.0316	0.1641	0.0266	0.2816	0.1071
Deep Neural Network	0.2230	0.0235	0.1692	0.0173	0.2400	0.2437

6. Visualizations

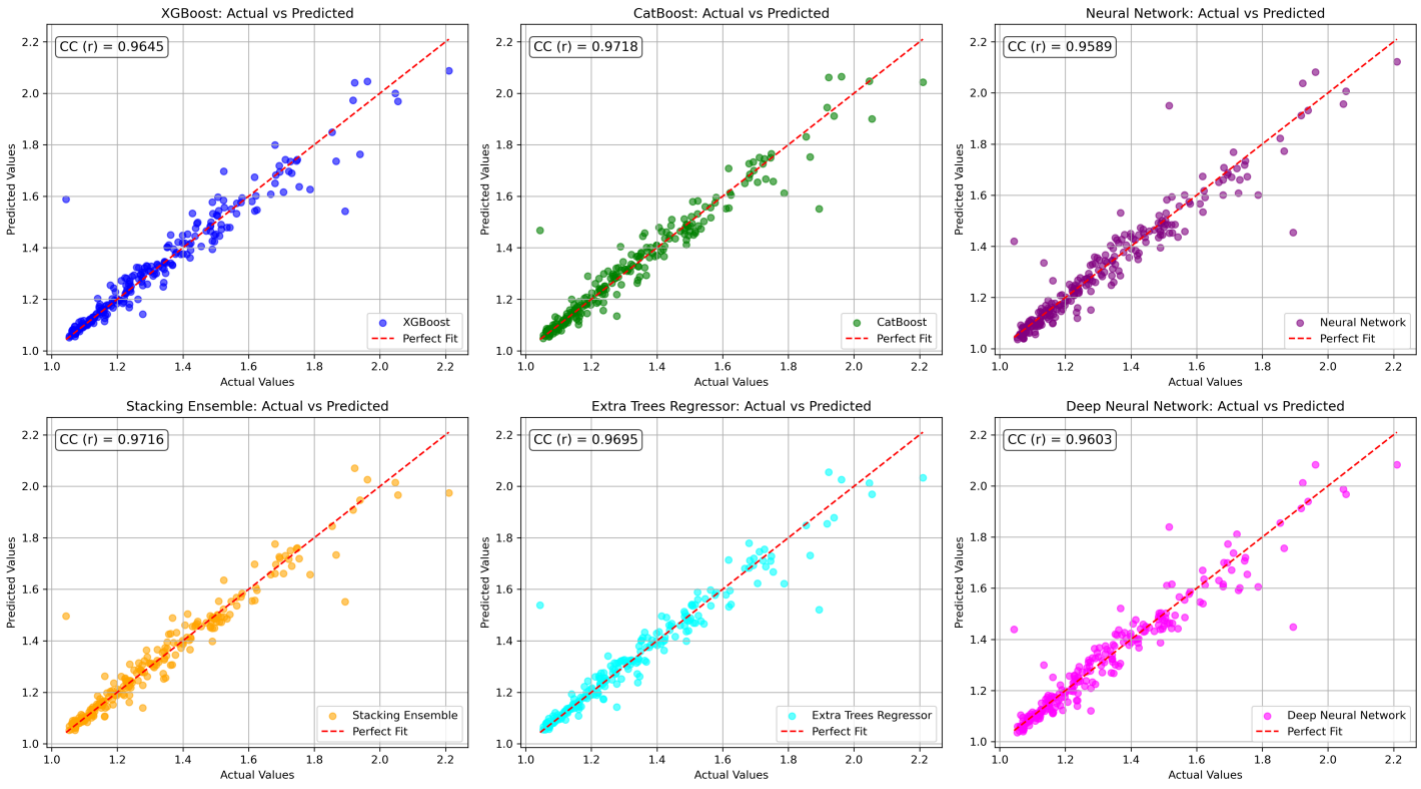

Figure 1: Actual vs. Predicted Values for Bob (Well 782)

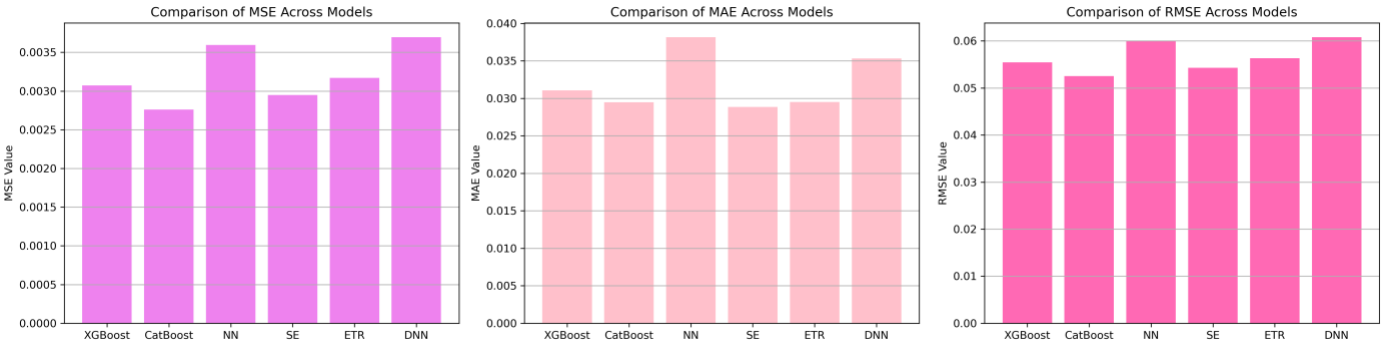

Figure 2: Bar Charts of MSE, RMSE, MAE for Bob (Well 782)

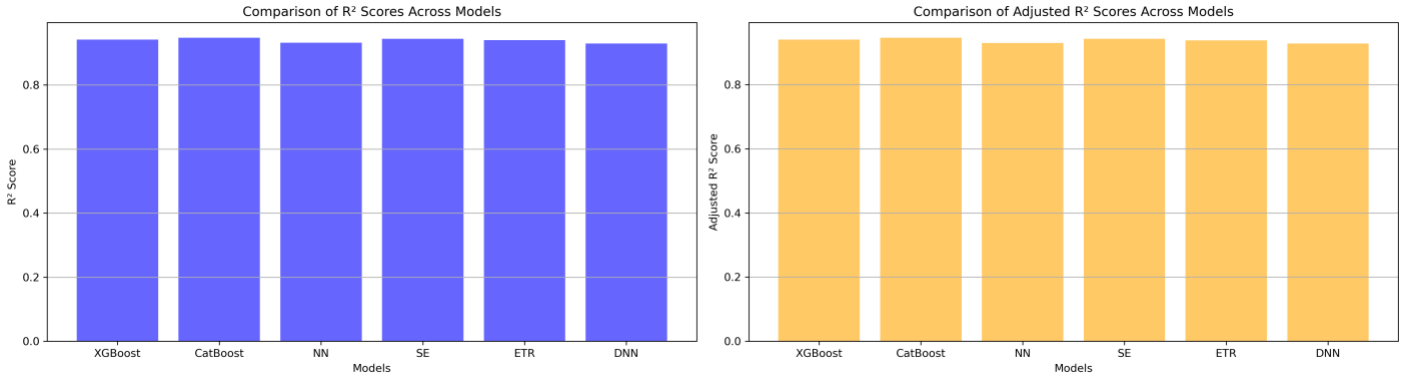

Figure 3: Bar Charts of R^2 and Adjusted R^2 for Bob (Well 782)

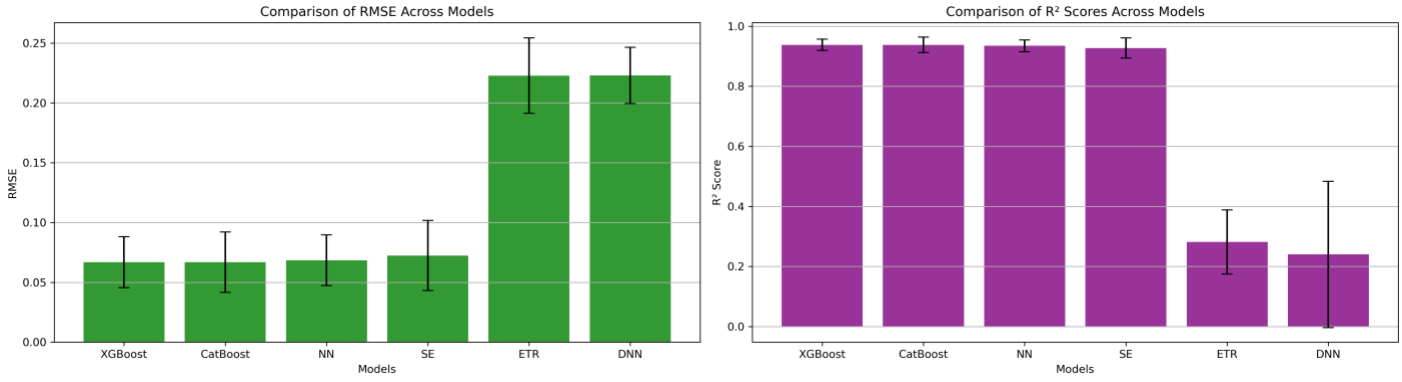

Figure 4: Error Bars for RMSE and R^2 from CV for Bob (Well 782)

7. Observations & Next Steps

Best Performing Models: CatBoost and **Stacking Ensemble** — both with RMSE around 0.052–0.054 and R^2 above 0.944.

- Extra Trees and XGBoost also performed competitively but slightly behind.
- **Neural Networks (NN and DNN)** underperformed heavily:
  - **NN R^2 during CV:** ~0.28
  - **DNN R^2 during CV:** ~0.24
- **Reason:** Deep learning requires larger datasets and more complex feature interactions, while boosting and ensemble trees generalize better on medium datasets like 782 samples.

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.