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:	Pb
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=4	0.0415
CatBoost	iterations=1000, learning_rate=0.01, depth=6, l2_leaf_reg=3	0.3064
Neural Network	[128, 64, 32], epochs=150, batch_size=32	3.1060
Stacking Ensemble	Default base models + CatBoost final estimator	0.8214
Extra Trees	n_estimators=200	0.1158
Deep Neural Network	[256, 128, 64], epochs=100, batch_size=16	3.7269

4. Evaluation Metrics

Model	MSE	RMSE	MAE	R^2 Score	Adjusted R^2
XGBoost	88242.176	297.056	207.900	0.9326	0.9315
CatBoost	89964.778	299.941	214.514	0.9313	0.9301
Neural Network	152226.257	390.162	292.070	0.8838	0.8817
Stacking Ensemble	109131.806	330.351	217.044	0.9167	0.9152
Extra Trees	98353.398	313.614	210.681	0.9249	0.9236
Deep Neural Network	142519.201	377.517	290.717	0.8912	0.8893

5. Cross-Validation Summary (5-Fold)

Model	RMSE Mean	RMSE Std	MAE Mean	MAE Std	R^2 Mean	R^2 Std
CatBoost	348.176	70.255	234.746	25.258	0.9249	0.0186
Extra Trees Regressor	351.781	75.700	227.877	32.070	0.9235	0.0204
Stacking Ensemble	352.655	67.819	232.352	27.937	0.9216	0.0218
XGBoost	366.470	80.905	246.418	37.622	0.9165	0.0243
Deep Neural Network	528.849	50.928	375.089	24.855	0.8269	0.0157
Neural Network	531.050	52.696	381.294	20.825	0.8258	0.0135

6. Visualizations

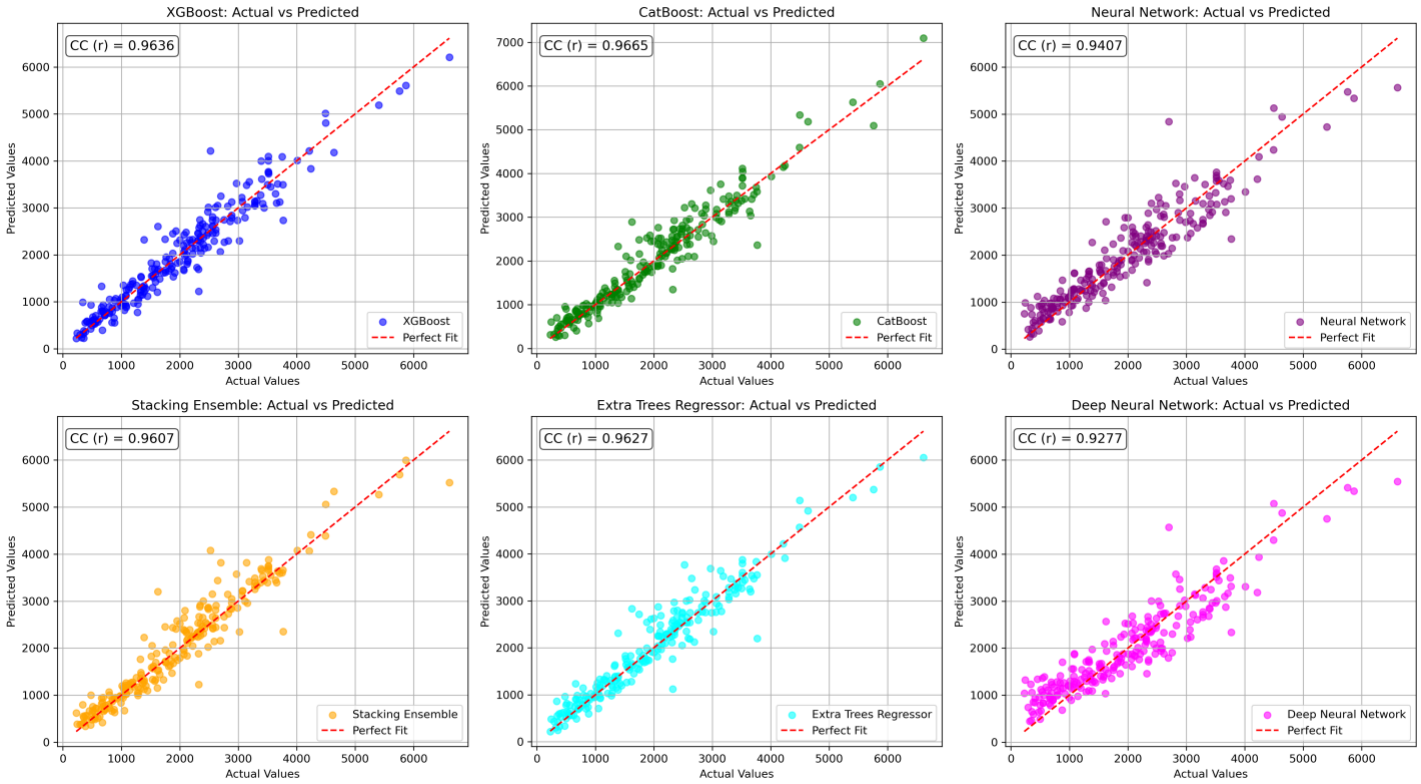

Figure 1: Actual vs. Predicted Values for Pb (Well 782)

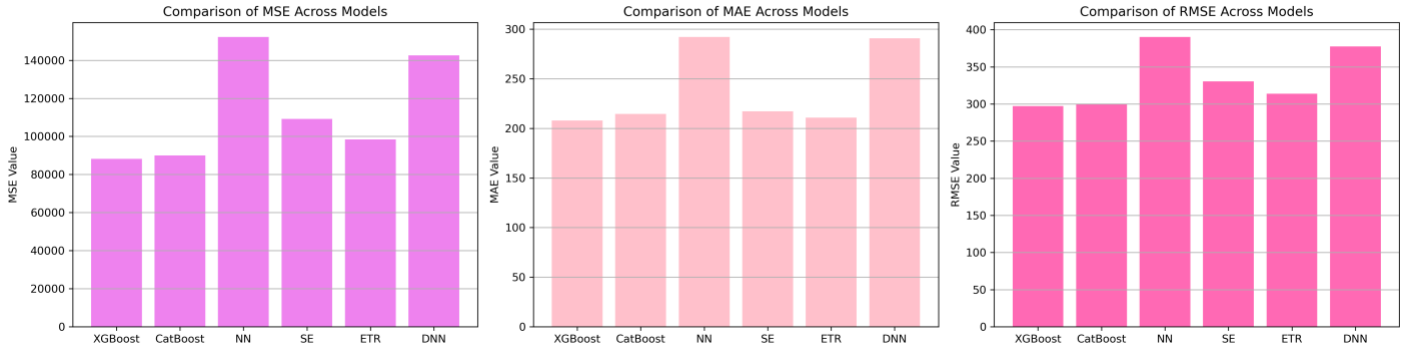

Figure 2: Bar Charts of MSE, RMSE, MAE for Pb (Well 782)

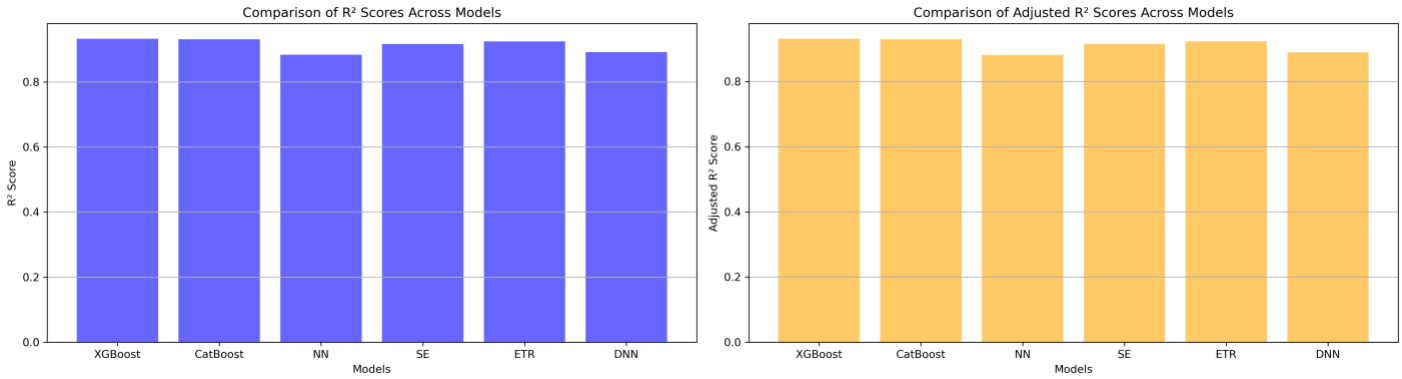

Figure 3: Bar Charts of R^2 and Adjusted R^2 for Pb (Well 782)

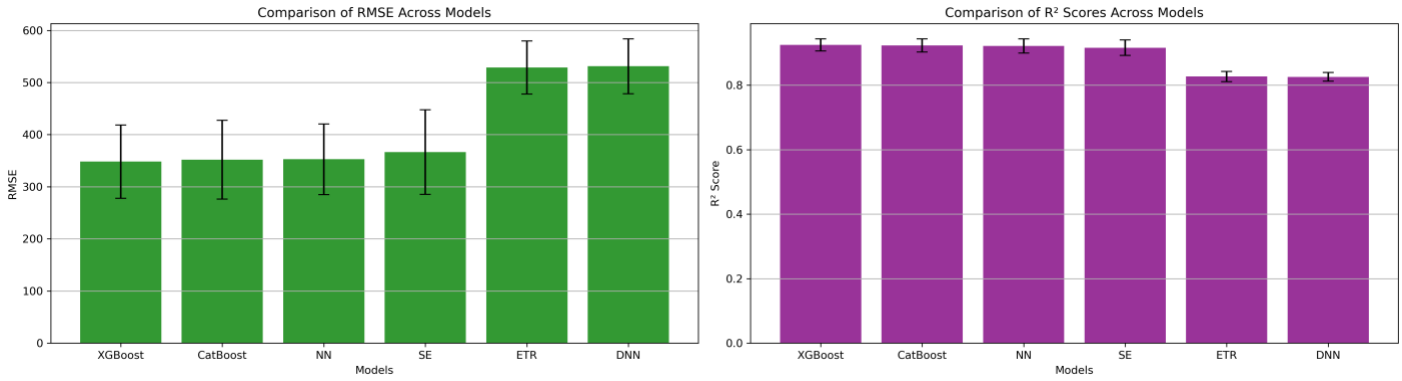

Figure 4: Error Bars for RMSE and R^2 from CV for Pb (Well 782)

7. Observations & Next Steps

Best Performing Model: CatBoost (RMSE: ~299, R^2: ~0.9313)

- Extra Trees and Stacking Ensemble models also showed good performance but slightly lower R^2.
- Neural networks (both NN and DNN) performed poorly with R^2 around ~0.83 during cross-validation.
- Ensemble-based models clearly outperform deep learning architectures on this dataset.

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.