

Technical Report AI Trading Signal Prediction of Final Model (Target_Hit)

1. Model Choice Justification

We approached the trading- signal classification problem as a **binary time- series event- prediction task**.

After benchmarking several algorithms — **Logistic Regression, Random Forest, LightGBM, and XGBoost** — the **XGBoost Tuned** model was selected as the final one based on both statistical and practical criteria:

Model	Validation F1	Test F1	F1 Gap	Comment
Logistic Regression	0.848	0.848	0.00	Stable but underfits non- linearities
Random Forest Tuned	1.00	0.885	−0.11	Strong overfitting
LightGBM Tuned	0.97	0.882	−0.09	Similar to XGB but less stable
XGB Tuned (final)	0.876	0.871	−0.007	Best balance of accuracy and generalization

Why XGBoost:

After benchmarking multiple classifiers, the tuned **XGBoost** achieved the most stable results for the target_hit class, with strong precision-recall balance, realistic win rate, and robust performance under realistic backtesting constraints. Its ensemble nature makes it well-suited for noisy financial time-series features.

- Handles non- linear market patterns and interaction effects.
- Robust to outliers, missing data, and unscaled features (we still scaled for production consistency anyway).
- Easily calibrated via isotonic mapping → well- behaved probabilities.
- Generalizes stably across time- based splits ($\Delta F1 \approx 0.007$ only).

Validation F1 = 0.8783, AUC = 0.83, Test F1 = 0.8714, AUC = 0.81
→ Excellent temporal stability and realistic performance.

2. Feature Importance (Explainability)

Explainability was performed using **SHAP (TreeExplainer)** on the test set. The top drivers are technical momentum and volatility features — intuitively consistent with trading logic.

Top 10 Features (by SHAP):

Feature	Economic meaning	Importance Rank
rsi_3d	Short- term momentum over 3 days	1
rsi_1d	Daily momentum reversal signal	2
volume	Market participation intensity	3
RSI	Overall momentum oscillator	4
atr_1h	1- hour volatility (average true range)	5
close	Price level reference	6
ratio_high_low	Intra- candle volatility compression	7
ratio_close_high	Relative close position within candle	8
wick_ratio	Buying/selling pressure balance	9
candle_body	Candle strength (impulse size)	10

All top features make economic sense — the model is learning **momentum + volatility structures** rather than temporal leakage.

Visual outputs:

reports/shap_summary_beeswarm.png and reports/shap_feature_importance_bar.png

3. Risks & Limitations

Category	Description	Impact / Mitigation
Data Bias & Coverage	Trained on a limited historical window	Retrain periodically and validate on multi- symbol data.
Class Imbalance	Only ~30 % of samples are positive ("trade hit").	Mitigated using class_weight='balanced' instead of artificial resampling.
Temporal Leakage Risk	Mitigated by removing time_bin, created_at, and future targets.	Continuous monitoring on live feed ensures data integrity.
Market Regime Shift	Model may degrade under new volatility regimes.	Deploy with rolling retraining & retrieval- augmented tests.
Backtest Over- optimism	68 K % ROI is statistical (ideal compounding).	Interpret as relative metric, not cash return.

Summary Statement

The final *target_hit* model (XGB Tuned v1.5 calibrated) achieved stable, out-of-sample performance with $F1 \approx 0.87$ and $AUC \approx 0.81$, aligning with market drivers (momentum + volatility). The model is fully production-ready under controlled risk, with periodic retraining and monitoring recommended.