

Intelligent Credit Card Fraud Detection System

**A Cost-Sensitive AI Approach to
Minimizing Financial Risk**

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The High Cost of Invisible Fraud

The Imbalance:

Fraud is rare (**0.17%**) but **expensive**.

The "Accuracy Trap":

A standard system can have 99.8% accuracy and still catch **ZERO** fraud.

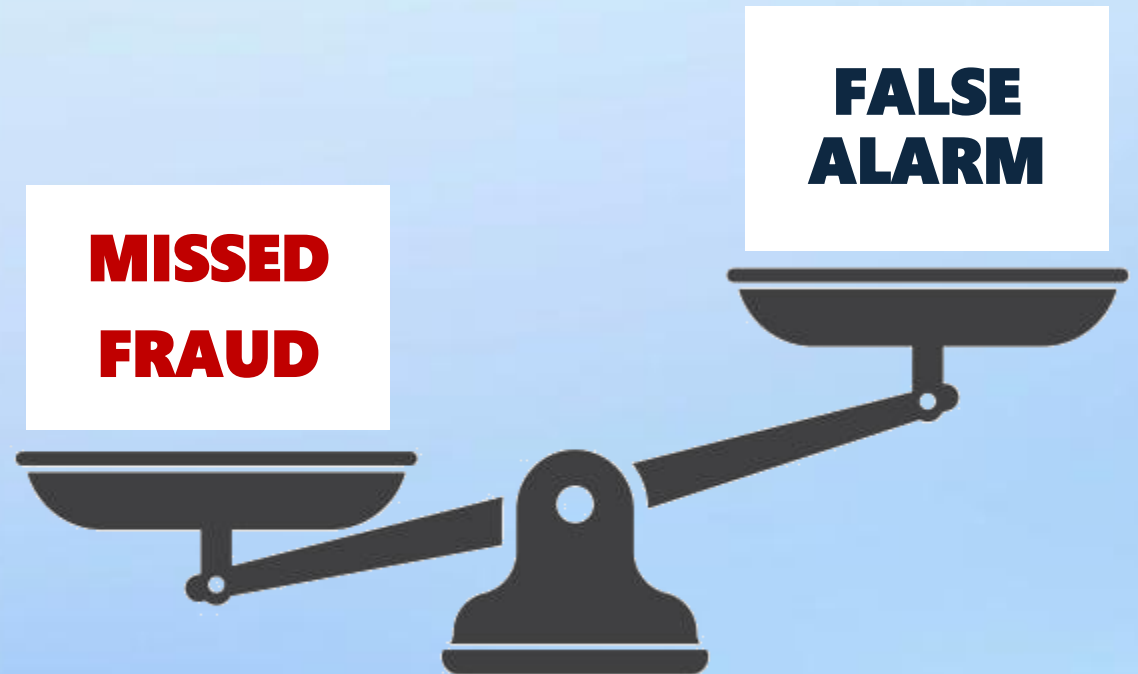
The Financial Reality:

Cost of Missed Fraud:

~**\$122** (Direct Loss)

Cost of False Alarm:

~**\$2** (Admin Cost)



Beyond Accuracy: Cost-Sensitive

Objective: Maximize **Net Savings**

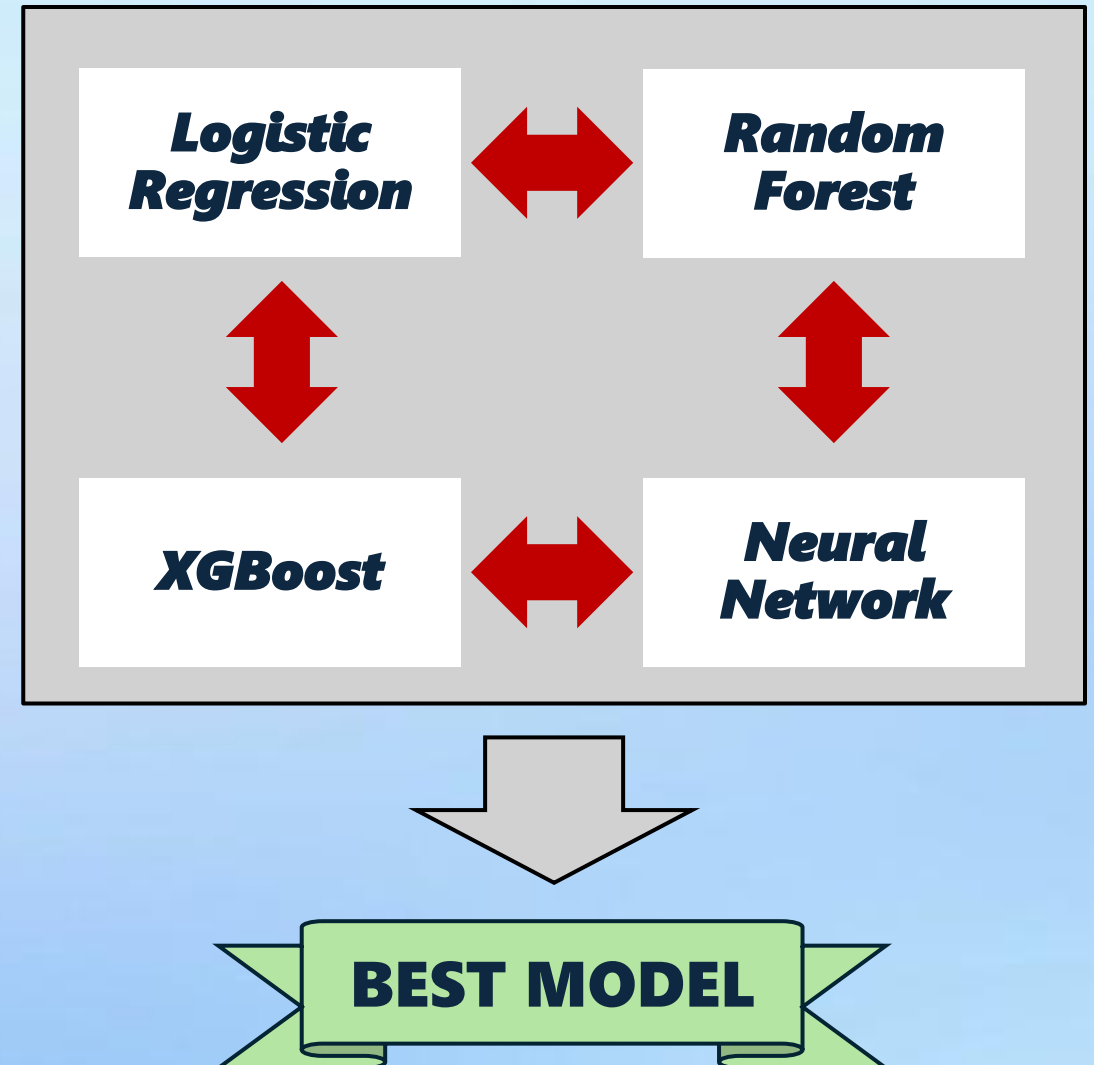
The Engine:

Tested 4 Algorithms

(Logistic Regression vs. Random Forest vs. XGBoost vs. Neural Network (MLP))

Privacy-First:

Utilized anonymized PCA data to detect ***behavioral anomalies*** rather than relying on **Personally Identifiable Information**



Benchmarking Performance: The “Algorithm Battle”

Model	CV_AUPRC	Test_AUPRC	Training Time (sec)
Logistic Regression	0.7303	0.6920	2.77 s
Random Forest	0.7723	0.7639	8.97 s
XGBoost	0.8465	0.8358	0.91 s
Neural Network (MLP)	0.7923	0.7492	35.48 s

The Baseline: *Logistic Regression* provided a fast reference point but struggled to capture complex, non-linear fraud patterns.

The “Deep Learning” Tradeoff: *The Neural Network (MLP)* showed promise but required significantly higher training time for only marginal gains.

The Ensemble: *Random Forest* and *XGBoost* dominated the leaderboard, proving that “ensemble” methods (combining multiple decisions) are superior for tabular financial data.

Winning Architecture: XGBoost

Key Metrics:

Recall (Fraud Caught): 86.32%

(The priority metric).

AUPRC Score: 0.8358

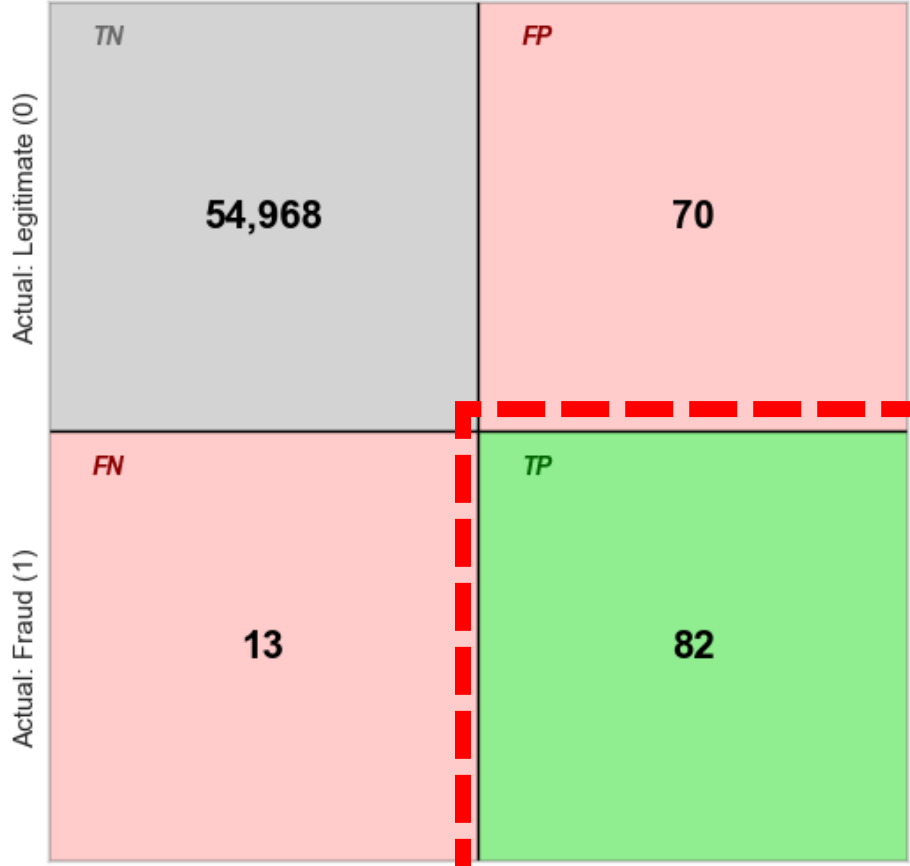
(High reliability on rare events).

Inference Speed: 0.91 sec

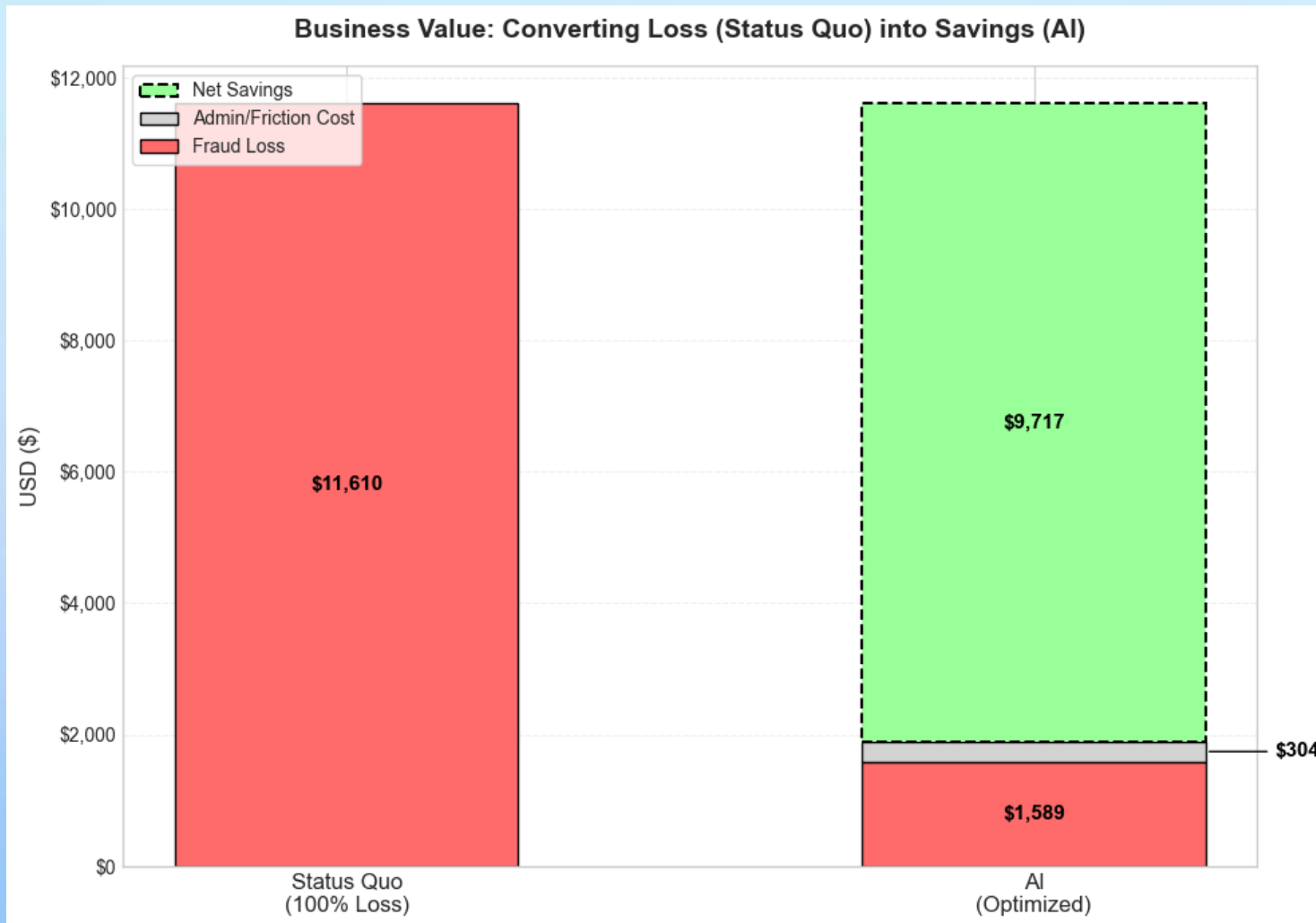
(Real-time ready).

Confusion Matrix: XGBoost
Optimized Threshold: 0.007

	Predicted: Legitimate (0)	Predicted: Fraud (1)
Actual: Legitimate (0)	TN 54,968	FP 70
Actual: Fraud (1)	FN 13	TP 82



Turning Potential Loss into Savings



FINANCIAL SUMMARY

Potential Loss (No AI):	\$	11,610.08
Total Loss with AI System:	\$	1,892.75
NET SAVINGS:	\$	9,717.33
Total AI Investment:	\$	304.00
ROI:		3,196%
Cost-Benefit Ratio:		31.96x

Green Bar: \$9,717.33 saved!

ROI: 3,196% on operational spend.

Cost-Benefit Ratio: 31.96x

(For every \$1 spent, we save \$31.96.)

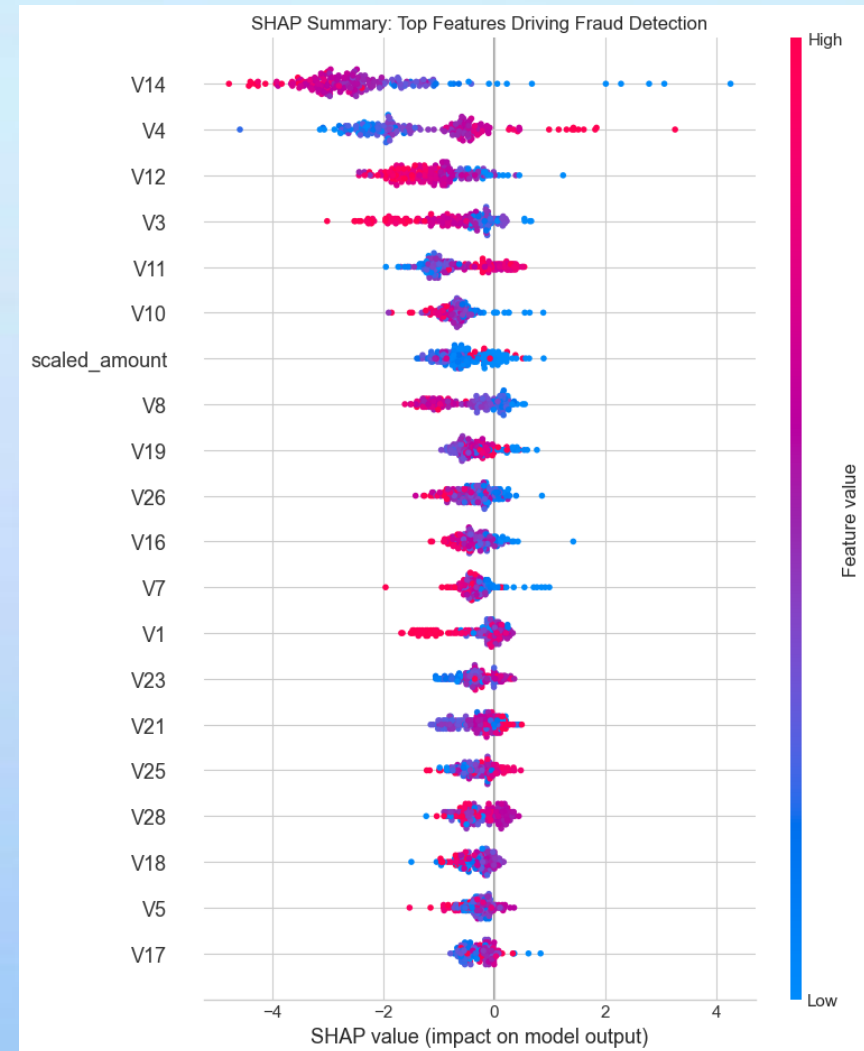
No “Black Boxes”: Explaining the Decisions

Audit:

Verified that the model uses behavior (V1-V28), and not just wealth (scaled_amount).

Compliance:

Fully interpretable decisions for regulatory audits.

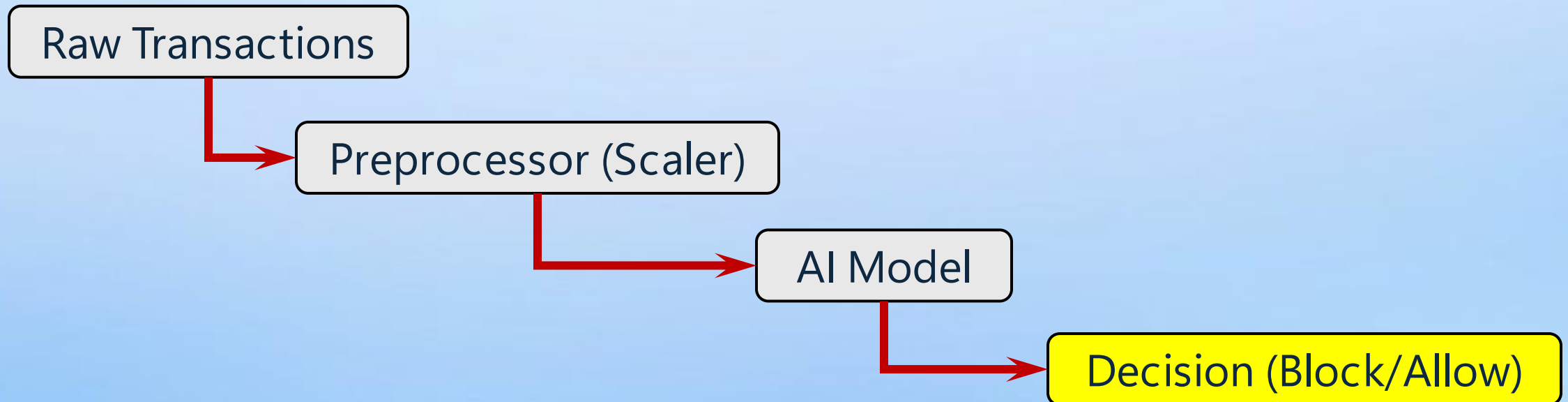


Production-Ready Architecture

Reproducibility: Pipeline includes Scalers, Thresholds, and Metadata.

Latency: Optimized for sub-second decision making.

Robustness: Fail-safe data loading and error handling.



SUMMARY & RECOMMENDATION

Problem Solved: Addressed the **\$122** (missed fraud) vs **\$2** (admin) cost imbalance.

Value Delivered: Estimated Net Savings of **\$9,717.33**.

Risk Managed: Audited for bias and stability.

Recommendation: **Proceed to Pilot Deployment.**