AI-POWERED STOCK AND ETF SIGNAL GENERATION PLATFORM

Problem Statement

The Challenge We Face

Investors and analysts face significant barriers in efficiently analyzing market data

Time-Consuming Analysis
Manual analysis of large volumes of stock and ETF data is slow and inefficient

Error-Prone Decisions
Human error in interpreting complex market indicators leads to poor trading decisions

Complex Metrics
Users struggle to interpret technical metrics and backtesting results effectively

Lack of Real-Time Response
No automated system to validate strategies and deliver timely trading alerts

Strategy Validation Gap
Difficulty in backtesting and validating trading strategies before actual deployment

No intelligent Insights
Absence of AI-driven explanations to help users understand why specific signals are generated

End-to-End Solution

Platform Architecture

Modular Python-based platform using FastAPI backend for scalable communication between modules

Data Ingestion
yfinance API
60+ Indian stock tickers

Data Pipeline
Medallion Architecture
Bronze >> Silver >>Gold

Storage
Supabase PostgreSQL
Ticker & feature storage

ML Models
RF,XGBoost, LSTM
Buy/Sell/Hold Signals

Backtesting
VectorBT
5-year validation

Gen AI
LLM Explanations
Signal insights

Alerts
Gmail/SMTP
Confidence-based

Dashboard
Streamlit
Visual analytics

Signal Prediction
ML models

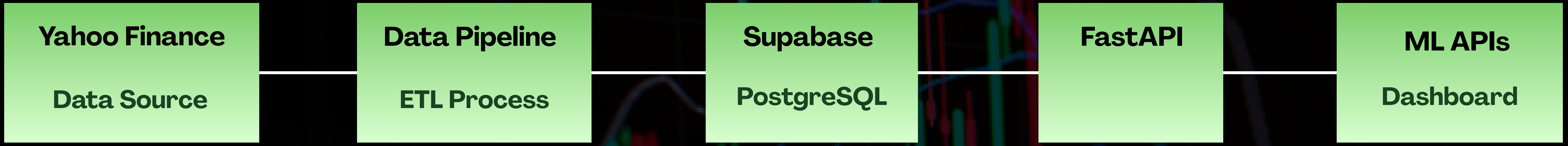
Strategy Validation
Backtesting confidence

Real-Time Alerts
Email notifications

Python FastAPI Streamlit Supabase VectorBT yfinance GenAI Gmail SMTP

Data Ingestion & API Layer

Automated backend infrastructure for real-time stock market analysis with 60+ Indian stock tickers



Data Pipeline Process

Fetch Data
OHLCV from yfinance

Clean and Validate
Remove nulls and Duplicate

Add Features
RSI, SMA, MACD, etc.

60+ Indian Tickers

5 Years Historical

6+ ML Features

Tech Stack

yfinance	Python	Supabase
numpy	pandas	FastAPI

Medallion Architecture

- ● Bronze Layer: Raw OHLCV data ingestion
- ● Silver Layer: Cleaned and validated data
- ● Gold Layer: Feature-enriched ML data

Data Pipeline Flowchart

● Data Ingestion ● Storage ● API Layer ● ML Pipeline

1 Fetch OHLCV data

2 Clean & validate data

3 Feature engineering (RSI, SMA, Volatility, MACD etc.)

4 Sync processed data to Supabase

5 Update available data

6 Request training data via FastAPI

7 Query features from database

8 Return data to ML models

9 Deliver features for prediction

10 Train/Predict signals

MLOps & Drift Detection Flow

Fetch Baseline
Last 30 days data

Compare Window
Last 7 days data

Calculate Z-scores
KS test p-value

Alert & Retrain
If drift detected

Key Engineering Highlights

Core technical decisions powering the data pipeline

Incremental Loading

Pipeline checks existing records and only fetches missing date ranges, optimizing data transfer

Parallel Processing

Uses ThreadPool Executor to process multiple tickers concurrently, reducing execution time

Dual Persistence

Data stored locally as Apache Parquet for speed and in Cloud (Supabase) for accessibility

Drift Detection

Implements Kolmogorov-Smirnov (KS) tests to monitor feature distribution shifts

Technical Indicators

RSI, SMA (20/50), Rolling Volatility, MACD, Volume MA for comprehensive ML features

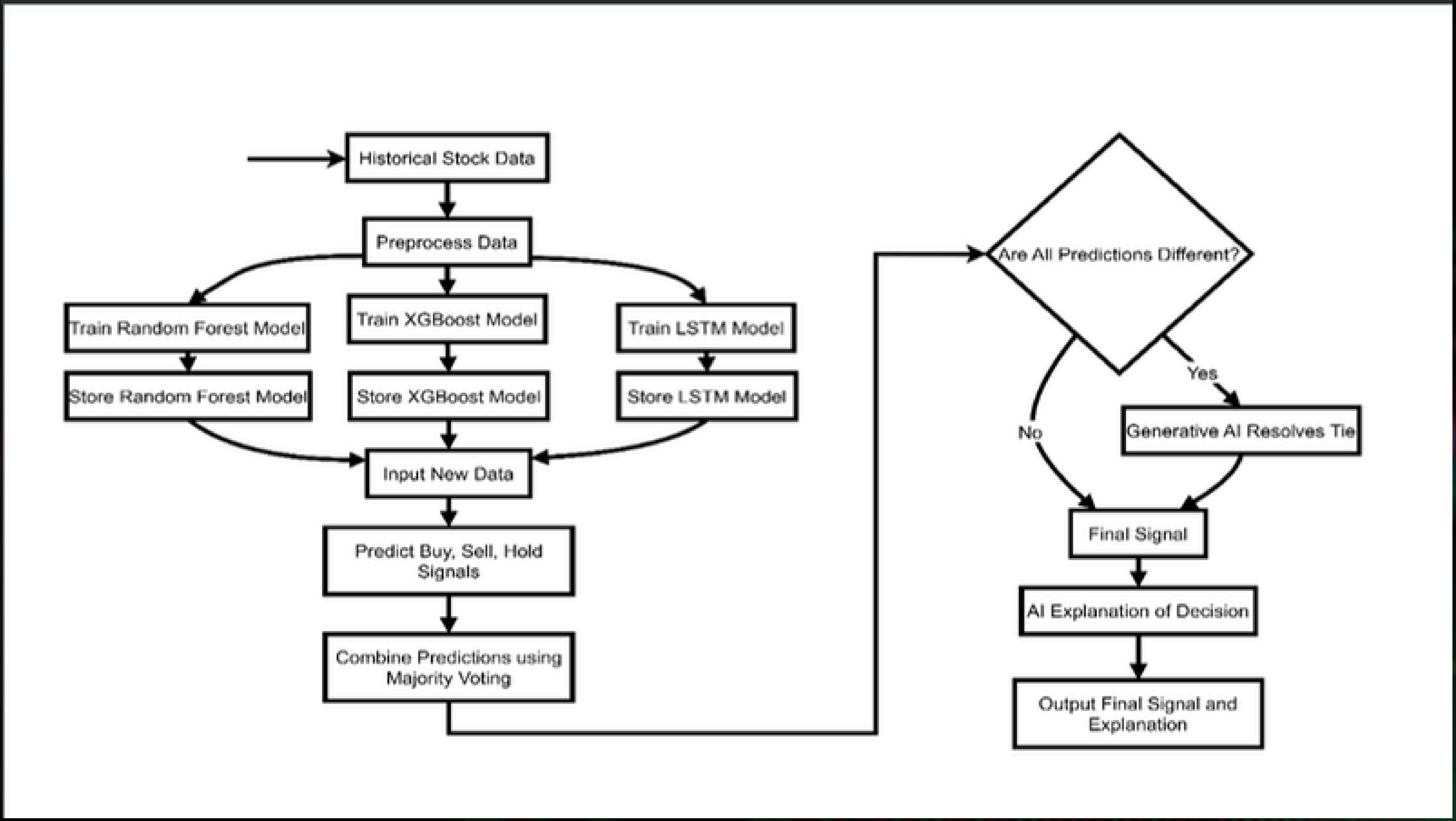
Automated Alerts

If data drift detected (p-value < 0.05), system logs alert for model retraining

PostgreSQL Data Model

Stock features table with composite key (ticker, date) + B-Tree indexing

ML SIGNAL GENERATION ENGINE


Historical Stock Data
Preprocess Data
Train Random Forest Model
Train XGBoost Model
Train LSTM Model
Store Random Forest Model
Store XGBoost Model
Store LSTM Model
Input New Data
Predict Buy, Sell, Hold Signals
Combine Predictions using Majority Voting
Are All Predictions Different?
Yes
No
Generative AI Resolves Tie
Final Signal
AI Explanation of Decision
Output Final Signal and Explanation

ML Models

Market Condition / Topic	Random Forest	XGBoost	LSTM
Sideways / Noisy Market	✅ Robust to noise via bagging	❌ Overreacts to false momentum	✅ Avoids trend confirmation without temporal strength
Strong Trending Market	❌ Conservative averaging weakens trend signal	✅ Captures nonlinear momentum	✅ Confirms trend persistence over time
Sudden Price Breakout	❌ Slow to react due to averaging	✅ Detects sharp nonlinear moves	✅ Captures early momentum sequence
Long-Term Trend Continuation	❌ Lacks temporal memory	❌ Feature-based, no sequence awareness	✅ Learns long-range dependencies
High Volatility / Whipsaw	✅ Variance reduction stabilizes signal	✅ Adapts quickly to changing interactions	❌ Sequence confusion due to abrupt reversals
Regime Change (Trend → Range)	✅ Quickly adapts via re-sampling	❌ Overfits previous regime patterns	❌ Temporal memory tied to old regime
Conflicting Technical Indicators	✅ Averages out indicator conflicts	❌ Sensitive to misleading feature importance	✅ Confirms using price-action sequence
Low Liquidity / Sparse Data	❌ Performance degrades with sparse splits	✅ Handles imbalance with boosting	✅ Uses temporal continuity instead of raw density

Model Architecture	Parameters & Configuration
XGBoost	Depth: 6, LR: 0.05, 300 Estimators
Random Forest	Depth: 5, 100 Estimators
Bidirectional LSTM	10-day lookback, Dropout layers

Hybrid Reliability Strategy

Eliminates **Single Point of Failure** by balancing XGBoost speed with Random Forest stability.

Explainable AI (XAI)

Bridges the **Contextual Gap**, allowing users to understand the 'Why' behind every numeric score.

Automated Data Integrity

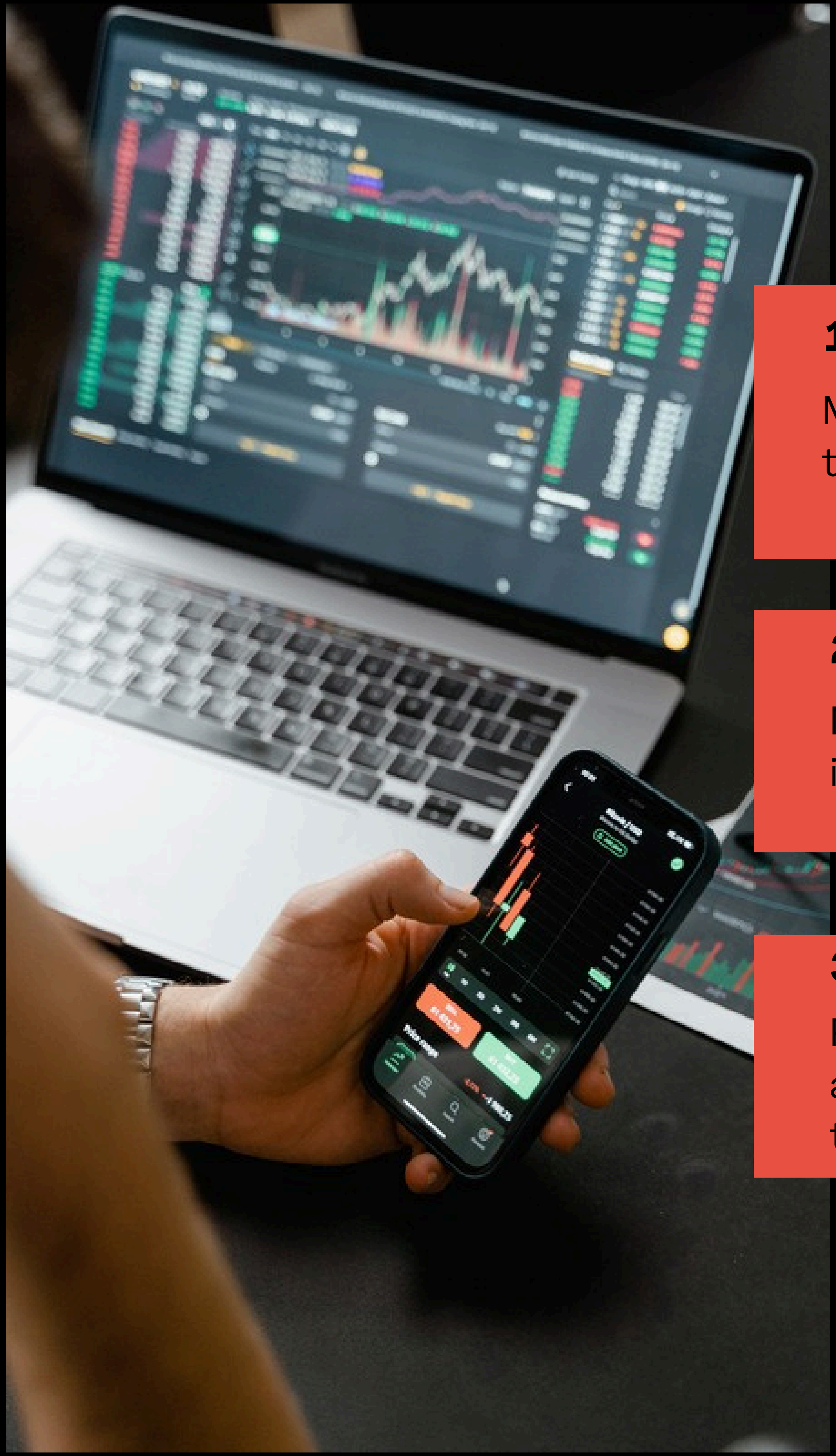
Handles m[illegible]sing data points com[illegible]on in volatile financial feeds to ensure model input integrity.

GenAI: Translating Quantitative Logic

Top Evidence Headlines extracted from sources for verification

Clear Sentiment Categories providing instant visibility into market posture

Detailed Reasoning Narratives that explain the logic behind every signal



1.ML Score Input

Meric scores and headlines are fed into the LLM synthesis engine

2.LLM Processing

Mistral and llama3 categorize the data into high confidence market vibes

3.StrategOutput

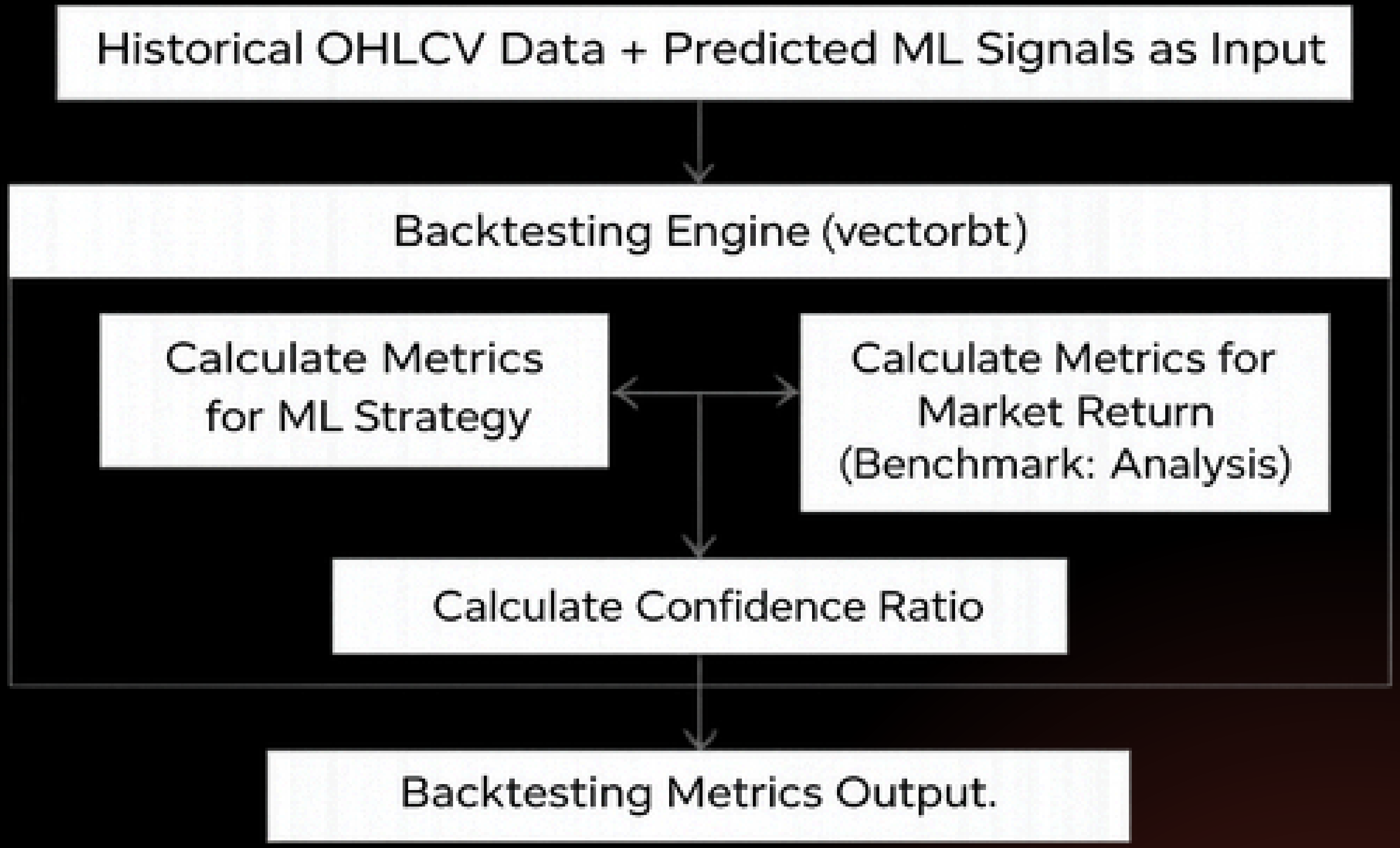
Plain English reasoning with an evidence based auidit trail

What is **Backtesting?**

- Applying a trading strategy to historical market data to see how it would have performed
- It is the validation and evaluation layer of the platform
- Its objective is to test ML-generated trading signals on historical market data and determine whether those signals are profitable, stable, and risk-aware

“High ML accuracy does not guarantee profits. Backtesting ensures strategies are financially viable and risk-aware before deployment“

Flow Chart


Historical OHLCV Data + Predicted ML Signals as Input
Backtesting Engine (vectorbt)
Calculate Metrics for ML Strategy
Calculate Metrics for Market Return (Benchmark: Analysis)
Calculate Confidence Ratio
Backtesting Metrics Output.

- Historical OHLCV data along with predicted ML signals are given as input
- The engine runs the trading strategies against the historical timeline using Vectorbt
- This step simulates account balance, transaction costs, and trade execution as if they were happening in real-time
- Metrics are calculated for both ML strategy and Market return
- Confidence ratio is calculated using metrics and sent to dashboard
- This provides validation to the predicted signals and enhances user trust

Outputs

The system generates the following key outputs

- **Total Return**
- **CAGR**
- **Volatility**
- **Sharpe Ratio**
- **Max Drawdown**
- **Win Rate**
- **Profit Factor**
- **Market Benchmark Metrics (Buy & Hold)**
- **Confidence Score**
- **Equity Curve & Trade Statistics**

"Only validated, confidence-backed, and risk-aware signals are shown to users and used for alerts"

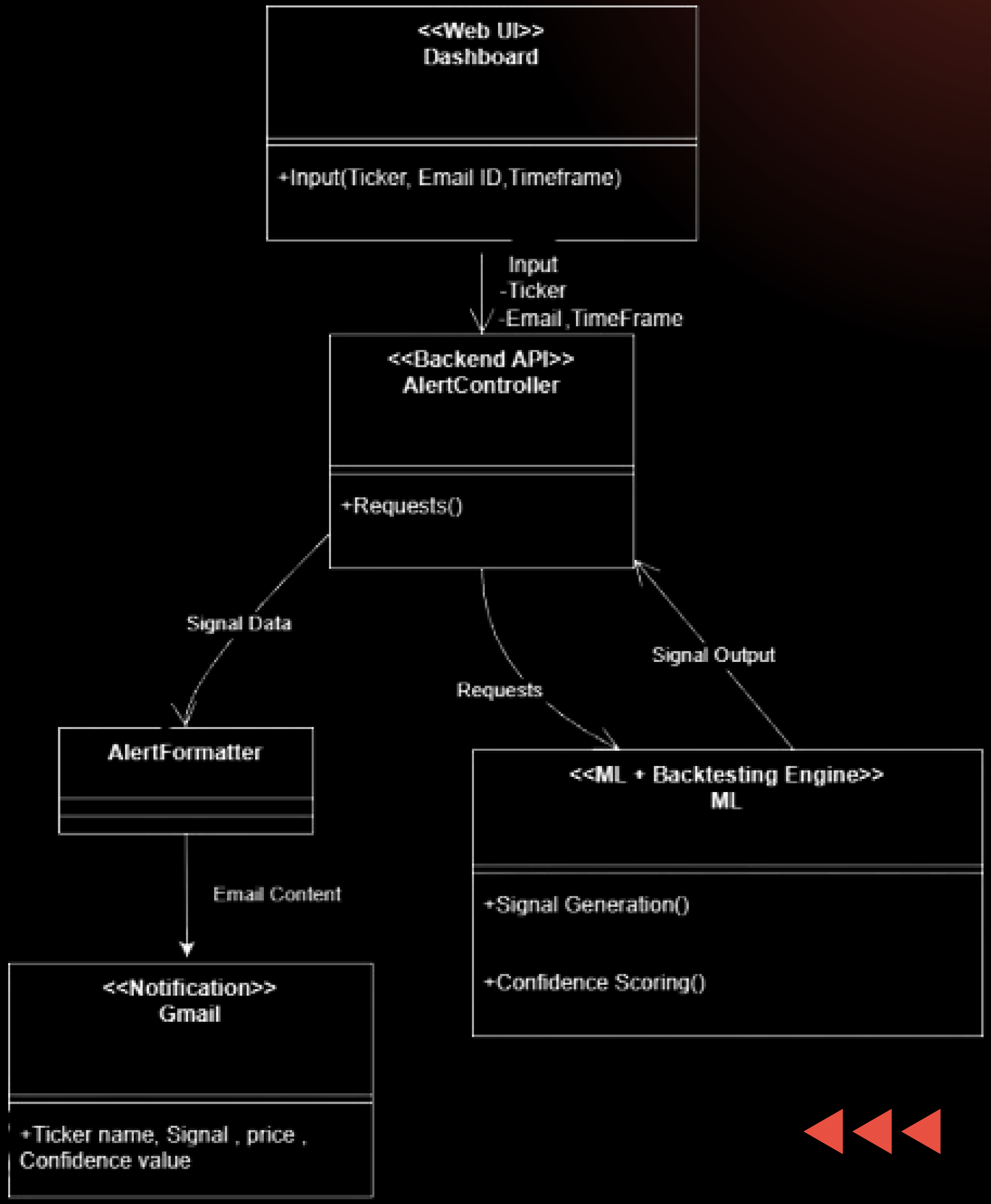
Real-Time Alerts System

- The Alerts Service is responsible for notifying users when a strong and reliable BUY or SELL signal is detected for a stock
- Since raw ML signals can be noisy and risky, this service ensures that alerts are sent only when the ML signal is validated using historical performance and meets a confidence threshold
- User configures alert preferences via dashboard by providing ticker, email, timeframe
- Notifications are delivered via email for the selected ticker in given timeframe

Flowchart

- The user provides ticker, email ID and timeframe and registers for alerts via dashboard
- The alert controller automatically runs the alert pipeline during the specified timeframe
- The pipeline triggers ML and backtesting API to predict the signal and validate it
- Upon validation the following Alert Content is sent via email

  - Ticker symbol
  - Signal type
  - Current price
  - Confidence score



<<Web UI>> Dashboard
+Input(Ticker, Email ID,Timeframe)
Input -Ticker -Email ,TimeFrame
<<Backend API>> AlertController
+Requests()
Signal Data
Requests
Signal Output
AlertFormatter
<<ML + Backtesting Engine>> ML
+Signal Generation()
+Confidence Scoring()
Email Content
<<Notification>> Gmail
+Ticker name, Signal , price , Confidence value

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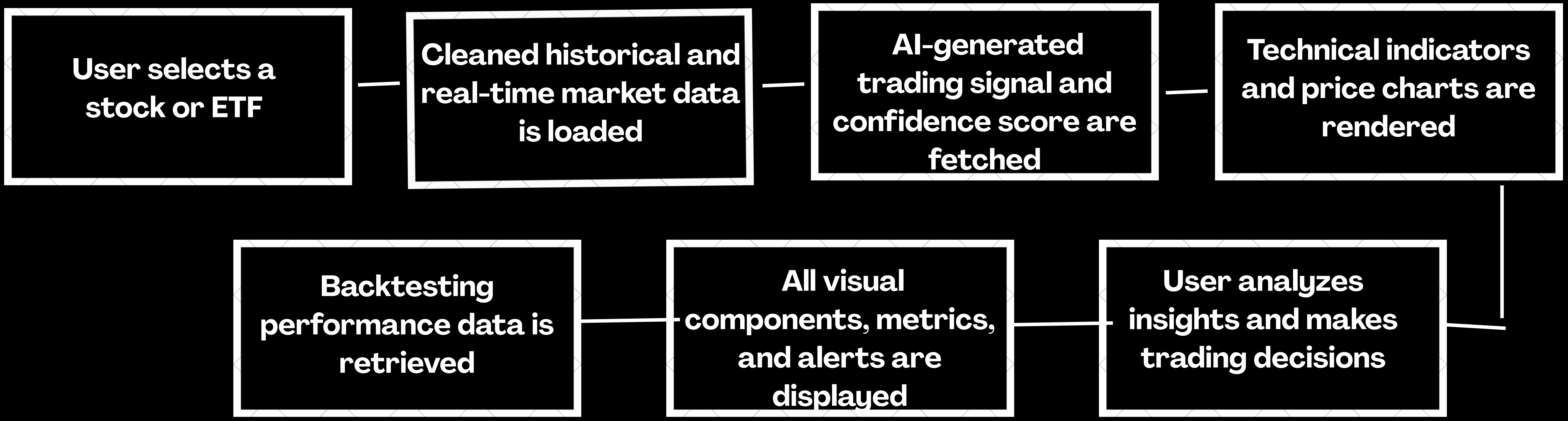
What is Dashboard & Visualization Hub?

- It is the user-friendly interface of the AI-Powered Stock & ETF Signal Generation Platform that acts as the final presentation layer, converting complex ML, data engineering, and backtesting outputs into clear and actionable visual insights.
- The dashboard ensures transparency and informed decision-making by visually presenting BUY/SELL/HOLD signals, confidence scores, technical indicators, and performance metrics in a professional trading interface.

"Even accurate ML models are ineffective if users cannot interpret or trust their outputs. The dashboard ensures transparency, clarity, and informed decision-making."

Flow Chart

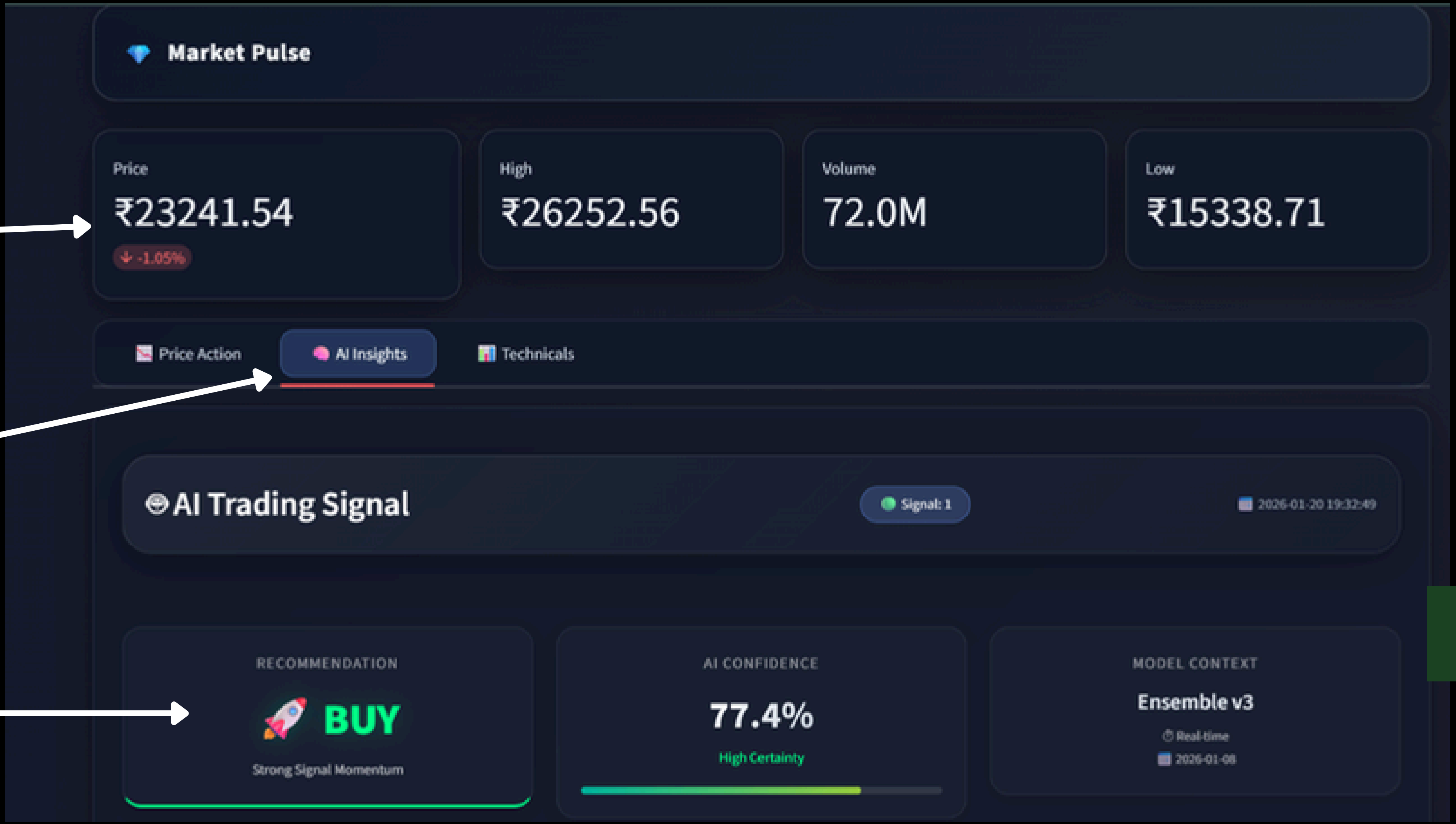

User selects a stock or ETF
Cleaned historical and real-time market data is loaded
AI-generated trading signal and confidence score are fetched
Technical indicators and price charts are rendered
User analyzes insights and makes trading decisions
All visual components, metrics, and alerts are displayed
Backtesting performance data is retrieved

- Shows end-to-end user interaction with the dashboard
- Data is loaded automatically from backend APIs
- AI signals and confidence are visualized, not calculated here
- Technical indicators support signal understanding

Price Action

Ai Insights

AI Suggestion


Market Pulse

Price	High	Volume	Low
₹23241.54 ↓ -1.05%	₹26252.56	72.0M	₹15338.71

AI Trading Signal Signal: 1 2026-01-20 19:32:49

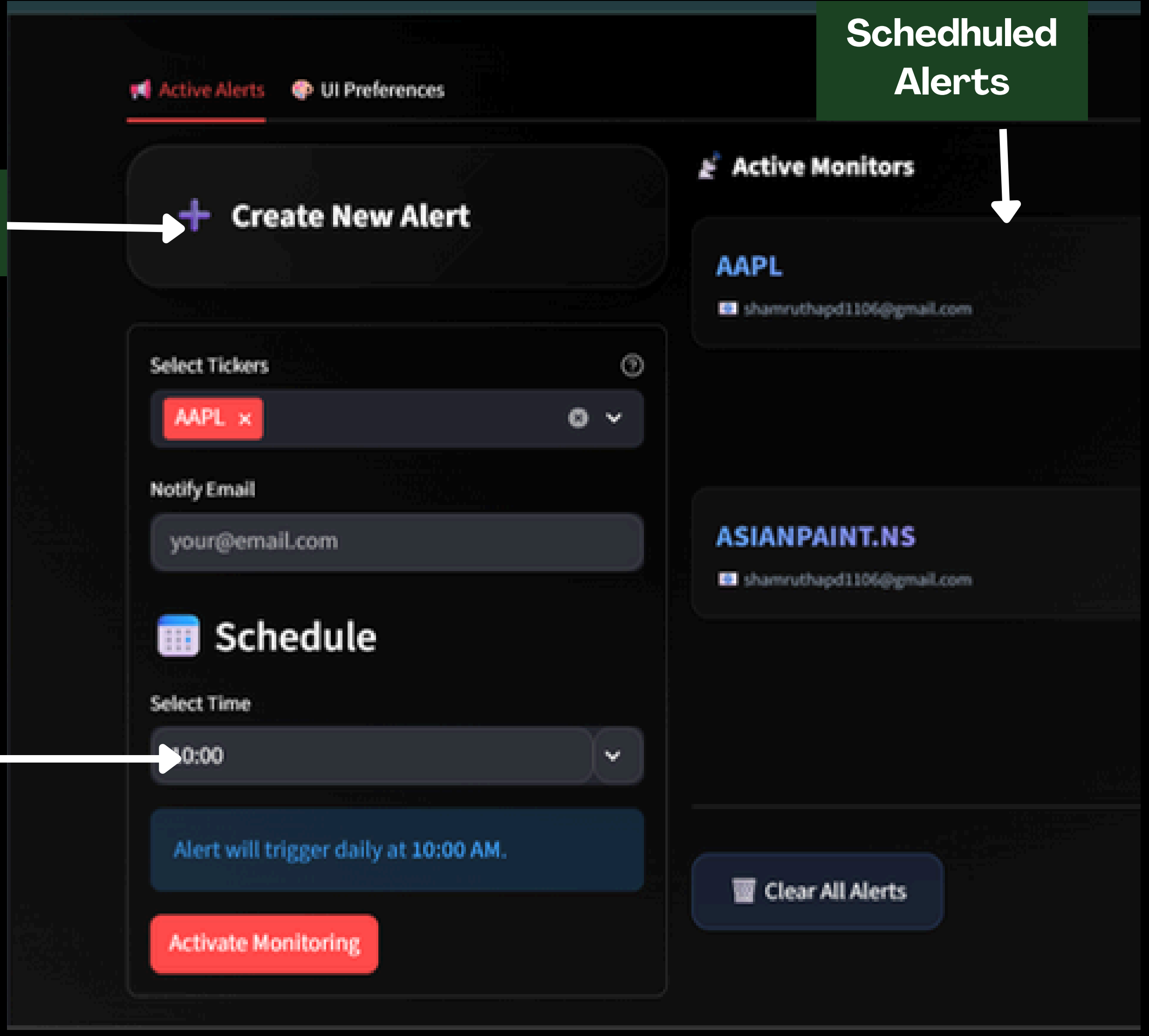
RECOMMENDATION	AI CONFIDENCE	MODEL CONTEXT
BUY Strong Signal Momentum	77.4% High Certainty	Ensemble v3 Real-time 2026-01-08

Alerts and notification

Set Alerts

Pick Alert Time

Schedhuled Alerts



Select Tickers: AAPL ×

Notify Email: your@email.com

Schedule

Select Time: 10:00

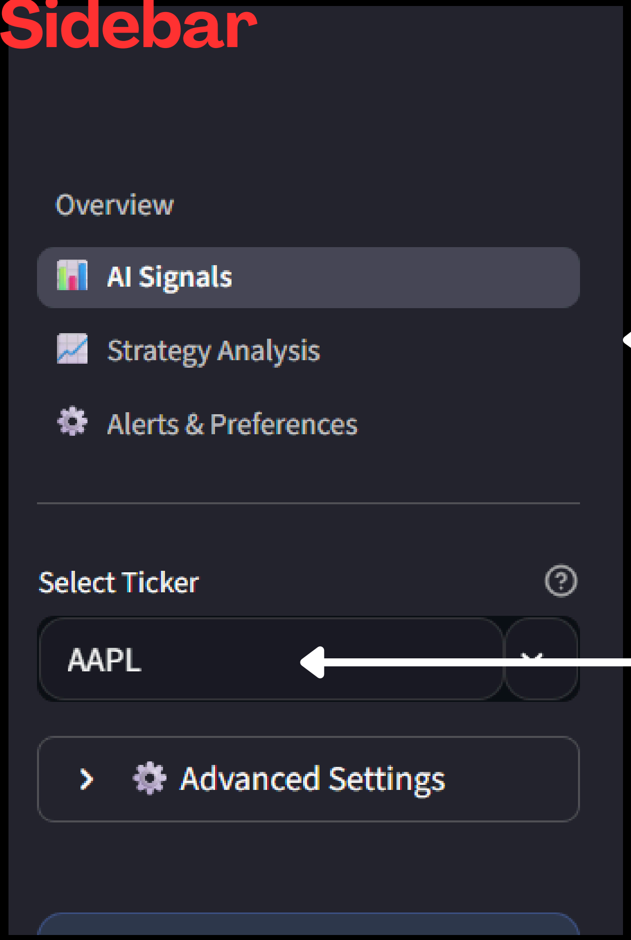
Alert will trigger daily at 10:00 AM.

Active Monitors

AAPL
shamruthapd1106@gmail.com

ASIANPAINT.NS
shamruthapd1106@gmail.com

Sidebar



Select Ticker: AAPL

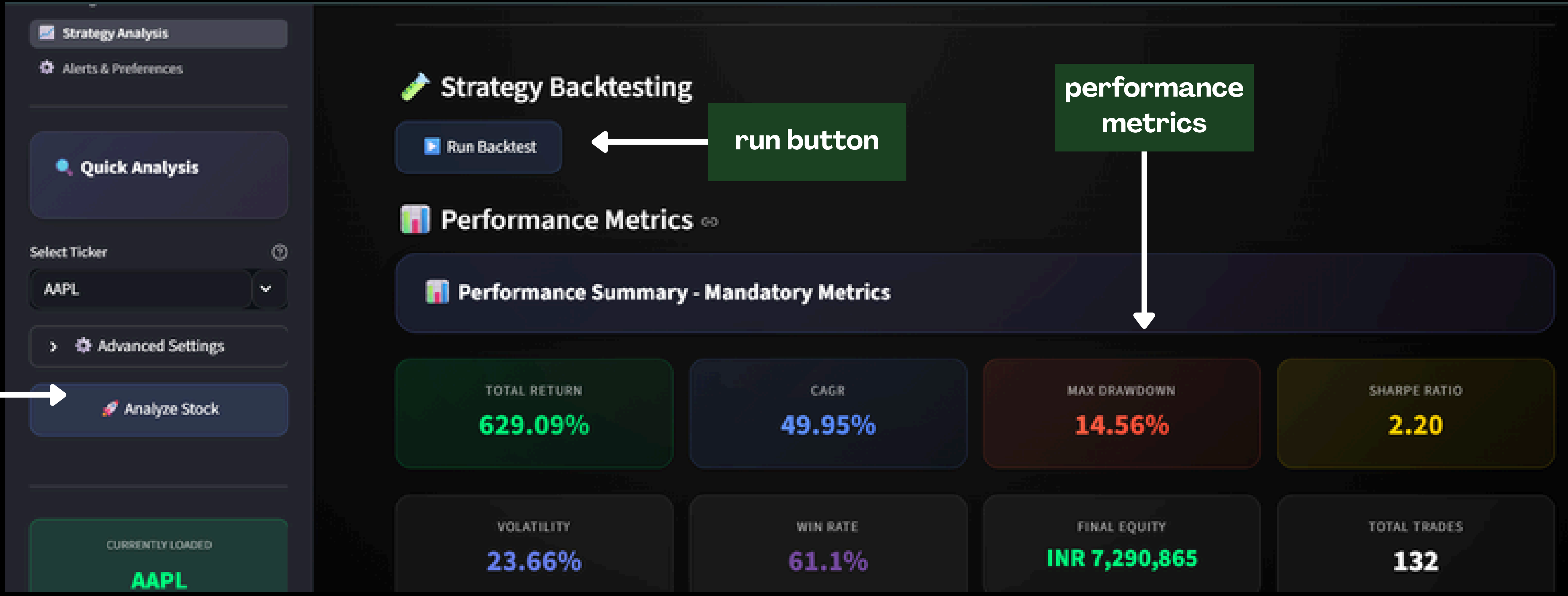
Sidebar Pages

All Tickers

Analyze stock

run button

performance metrics



Select Ticker: AAPL

CURRENTLY LOADED AAPL

Strategy Backtesting

Performance Metrics

Performance Summary - Mandatory Metrics

TOTAL RETURN	CAGR	MAX DRAWDOWN	SHARPE RATIO
629.09%	49.95%	14.56%	2.20

VOLATILITY	WIN RATE	FINAL EQUITY	TOTAL TRADES
23.66%	61.1%	INR 7,290,865	132

Dashboard System Output & Tools Used

Dashboard System Output & Data Presentation

- Selected ticker symbol
- AI-generated signal (BUY / SELL / HOLD)
- Current market price
- Confidence score
- Risk & volatility indicators
- Backtesting performance summary
- Data is fetched via APIs
- Data can be exported for reporting

Tools Used

- Streamlit – UI development
- Plotly – interactive charts
- Python – backend logic
- Pandas & NumPy – data handling
- Figma – UI design planning