AI CRYPTO TRADING SYSTEM

MASTER TECHNICAL ARCHITECTURE & PRODUCTION SPECIFICATION (QUANTITATIVE CORE - ALL MODELS ACTIVE)

1. Executive Overview

This document defines the complete production-grade quantitative architecture for the AI Crypto Trading System.

This version excludes all LLM and news-based components and operates purely on quantitative market data.

All predictive model classes (tree-based and deep learning) are active from initial deployment.

Primary objective: Generate consistent risk-adjusted returns while maintaining strict capital preservation and a maximum portfolio drawdown of 20%.

2. Trading Environment & Constraints

Exchange: Kraken Spot only.

No leverage, no margin, no borrowing. Long-only spot positions.

Order Execution: Limit-first logic with controlled fallback to market orders.

Trading Fee: 0.4% per trade (0.8% round trip).

Maximum Concurrent Positions: 10.

Maximum Portfolio Drawdown: 20% hard stop.

3. Asset Universe Selection

Tradable assets must be listed on Kraken.

Exclude stablecoins, meme coins, and low-liquidity tokens.

Liquidity Filters: minimum daily volume threshold and maximum bid-ask spread threshold.

Cross-asset control: 30-day rolling correlation matrix with cluster-based exposure caps.

4. Infrastructure & DevOps

Cloud Provider: Microsoft Azure.

Containerization: Docker for all services.

Version Control: GitHub.

CI/CD: GitHub Actions deploying to Azure.

Primary Database: PostgreSQL with TimescaleDB extension.

Blob Storage: Azure Blob Storage for raw market data and model artifacts.

Model Registry: MLflow.

API keys stored securely via environment variables and Azure configuration.

5. Data Sources

Market Data: Kraken API (primary).

Supplementary Reference Data: Binance and Coinbase for cross-exchange price comparison.

All data strictly timestamp-aligned to prevent lookahead bias.

Minimum historical data window: 1 year (preferred 3 years).

6. Feature Engineering Framework

Momentum Features: 1h, 4h, 24h returns; rolling momentum slope.

Volatility Features: ATR (14), rolling standard deviation, volatility regime flags.

Liquidity Features: volume surge ratio, spread widening indicator.

Market Structure: breakout detection, mean reversion distance metrics.

Cross-Asset Metrics: BTC beta, rolling correlation to BTC, market breadth signals.

All features timestamped and validated to eliminate lookahead bias.

7. Model Architecture (All Models Active)

Tree-Based Models: XGBoost, LightGBM, Random Forest (tabular feature prediction).

Deep Learning Models: LSTM and Transformer (sequence-based pattern recognition).

Regime Classifier: Identifies trend, range, high-volatility, and crash regimes.

Meta-Learner: Stacking ensemble combining outputs from all predictive models and regime state.

All models trained using walk-forward validation with rolling retraining.

8. Prediction Framework

Prediction Horizons: 1 hour, 4 hours, and 24 hours.

Primary Execution Cycle: Hourly.

Outputs per asset: Probability of upward movement and expected return.

Final trade decisions derived exclusively from meta-learner output.

9. Strategy Engine Logic

Entry Conditions: Meta-learner confidence above threshold and expected return exceeds fee-adjusted threshold.

Exit Conditions: Stop-loss, take-profit, time-based exit, or signal reversal.

Position Sizing: Volatility-adjusted using ATR scaling.

Cluster-based exposure caps enforced.

10. Risk Management Framework

10% drawdown: Reduce position size.

15% drawdown: Reduce trading frequency.

20% drawdown: Immediate trading halt.

Emergency kill switch triggered by extreme spreads, volatility spikes, or exchange downtime.

11. Backtesting Engine

Hourly historical simulation.

Exact Kraken fee modeling.

Slippage modeling: spread + volatility-based impact.

Walk-forward validation with rolling retraining.

Strict timestamp validation to eliminate lookahead bias.

12. Execution Engine

Pre-trade risk validation.

Limit-first order submission.

Fallback to market order under urgency conditions.

Order fill monitoring and retry logic.

Full event logging for audit and commercialization readiness.

13. Monitoring & Dashboard

Backend: FastAPI.

Frontend: Next.js (production-grade React stack).

Real-time monitoring of portfolio value, PnL, drawdown, open positions, and AI signals.

Full logging of features, predictions, and model confidence distributions.

14. Performance Targets

Target Sharpe Ratio: 1.2 – 1.8.

Target Annual Return: 20% – 60%.

Maximum Monthly Drawdown: <10%.

Hard Stop Drawdown: 20%.

15. Commercialization Roadmap

Phase 1: Proprietary quantitative trading with verified performance logs.

Phase 2: Multi-user architecture and authentication layer.

Phase 3: SaaS subscription system.

Full regulatory compliance and audit preparation before public offering.

END OF QUANTITATIVE MASTER SPECIFICATION