SCOPE OF WORK

Multi-Agent Stock Market Price Prediction System

Project Name: Multi-Agent Price Prediction & Trading Signal System

Client: Tory Neal

Vendor: Mouaaz Farrukh

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Project Duration: 10-14 weeks (2-3 months)

Team Size: 3 people (1 Tech Lead + 2 Developers)

Total Project Value: **$6,000**

1. Executive Summary

This Scope of Work defines the development of a comprehensive multi-agent stock market price prediction system that delivers actionable trading signals through an ensemble of specialized AI agents. The system will predict prices, classify trends, identify support/resistance levels, analyze news sentiment, and generate fused trading signals with backtesting capabilities.

Project Objective: Build a production-ready (Minimum Viable Product) that demonstrates end-to-end functionality with prediction efficiency, serving as the foundation for future enhancements and scaling.

2. Project Scope

2.1 What We Will Build

The system will consist of the following core components:

2.1.1 Multi-Agent Architecture

- **Data Agent:** Ingests and manages historical and real-time OHLCV data
- **Feature Agent:** Computes technical indicators and engineered features
- **Price Forecast Agent:** Multi-horizon price prediction (1h, 4h, 1d, 1w)
- **Trend Classification Agent:** Directional signals (BUY/SELL/HOLD) with confidence scores
- **Support/Resistance Agent:** Identifies key price levels with strength scores
- **News Fetch Agent:** Collects financial news from multiple sources
- **LLM Sentiment Agent:** Processes news using GPT-4 for sentiment scoring
- **Sentiment Aggregator:** Combines multiple sentiment outputs
- **Fusion Agent:** Combines all predictions into unified trading signals
- **Backtesting Agent:** Simulates historical performance with PnL metrics

2.1.2 Data Infrastructure

- Historical data pipeline (2+ years of OHLCV data)
- Real-time data ingestion (5-minute, 1-hour, daily bars)
- News data aggregation pipeline
- Feature engineering pipeline
- Data validation and quality checks
- Caching layer for performance optimization

2.1.3 Model Implementation

- **Price Prediction Models:** Prophet (baseline) + LSTM (primary) for multi-horizon forecasting
- **Trend Classification:** LightGBM/XGBoost classifier for directional signals
- **Support/Resistance:** DBSCAN clustering + local extrema detection
- **Sentiment Analysis:** GPT-4 API integration with semantic caching
- **Signal Fusion:** Rule-based weighted combination of all signals

2.1.4 Backend API

- RESTful API (FastAPI) for prediction endpoints
- WebSocket support for real-time updates
- Model serving infrastructure
- Authentication and rate limiting
- API documentation (OpenAPI/Swagger)

2.1.5 Backtesting System

- Historical simulation engine
- Performance metrics calculation (PnL, Sharpe ratio, drawdown, hit rate)
- Walk-forward validation framework
- Results visualization and reporting

2.1.6 Frontend Dashboard (Basic MVP)

- Ticker selection interface

- Price chart with predictions overlay
- Support/resistance levels visualization
- Signal display panel
- Basic performance metrics dashboard

2.2 What We Will NOT Build (Out of Scope)

The following features are explicitly excluded from this scope:

- **Advanced Personalization:** User-specific risk profiles and customization (V2+)
- **Options Intelligence:** Options contract recommendations and Greeks analysis (V3+)
- **Mobile Applications:** Native iOS/Android apps
- **Automated Trading Execution:** Direct broker integration for trade execution
- **Multi-Asset Support:** Crypto, forex, or commodities (stocks only)
- **Advanced ML Models:** Transformer-based models, reinforcement learning agents (V2+)
- **Social Trading Features:** User communities, sharing, social signals
- **Third-Party API Integrations:** External platform integrations beyond data sources
- **Advanced Analytics:** Portfolio-level analysis, correlation matrices
- **Production Deployment:** Cloud infrastructure setup, CI/CD pipelines (development environment only)

2.3 Supported Assets & Timeframes

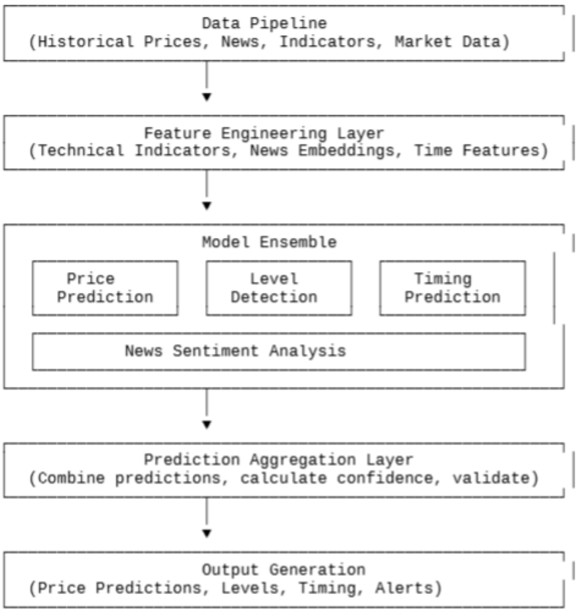
Initial Scope:

- **Assets:** 3-5 major liquid stocks (e.g., AAPL, TSLA, MSFT, GOOGL, SPY)
- **Timeframes:** 1-hour and 1-day predictions (5-minute optional if data permits)
- **Data Sources:** Free tier APIs (yfinance, Alpha Vantage) with fallback options)

Note: *Expansion to more tickers and additional timeframes will be considered for future phases.*

2.4 System Architecture

The following diagram illustrates the high-level architecture and data flow of the system:


Data Pipeline
(Historical Prices, News, Indicators, Market Data)
Feature Engineering Layer
(Technical Indicators, News Embeddings, Time Features)
Model Ensemble
Price Prediction
Level Detection
Timing Prediction
News Sentiment Analysis
Prediction Aggregation Layer
(Combine predictions, calculate confidence, validate)
Output Generation
(Price Predictions, Levels, Timing, Alerts)

Architecture Components:

- **Data Pipeline:** Ingests historical and real-time price data, news, and market indicators
- **Feature Engineering Layer:** Transforms raw data into ML-ready features (technical indicators, news embeddings, time-based features)
- **Model Ensemble:** Multiple specialized models working in parallel including Price Prediction Agent (Prophet + LSTM), Level Detection Agent, Timing Prediction Agent, and News Sentiment Analysis
- **Prediction Aggregation Layer (Fusion Agent):** Combines all model outputs, calculates confidence scores, and validates predictions
- **Output Generation:** Produces final trading signals, price predictions, levels, and timing recommendations

3. Project Timeline

3.1 Overall Duration

Total Project Duration: 14 weeks (3 months Approx)

Start Date: [To be determined]
Target Completion Date: [Start Date + 13 weeks]

3.2 Milestone Breakdown

Milestone	Duration	Start Week	End Week	Payment %	Payment Amount
M0: Rapid Prototyping	1 week	Week 1	Week 2	**10%**	**$600**
M1: Foundation & Data Pipeline	2 weeks	Week 1	Week 2	**15%**	**$900**
M2: Core Prediction Models	3 weeks	Week 3	Week 5	**20%**	**$1,200**
M3: Sentiment & Fusion	2 weeks	Week 6	Week 7	**20%**	**$1,200**
M4: Backtesting & Integration	2 weeks	Week 8	Week 9	**15%**	**$900**
M5: Frontend & Testing	2 weeks	Week 10	Week 11	**15%**	**$900**
M6: Documentation & Delivery	1 week	Week 12	Week 12	**5%**	**$300**
Total	**12 weeks**			**100%**	**$6,000**

4. Detailed Milestones

This section provides comprehensive details for each project milestone, including deliverables, definition of done criteria, and acceptance requirements.

Milestone 0: Rapid Prototyping (Phase 0) – Weeks 1–2

Payment: $600 (10% of $6,000)

Purpose: This phase focuses on building the complete frontend layout and UI components with mock data to provide the client with a visual representation of the final product. This allows for early feedback, design lock-in, and ensures alignment before backend development begins.

Deliverables

1. Frontend Project Setup

- Next.js 14+ project initialization with TypeScript
- Tailwind CSS configuration
- Project structure and component architecture
- Development environment setup

2. Complete UI Layout & Components

- Dashboard Layout: Main navigation, sidebar, header structure
- Ticker Selection Interface: Search, dropdown, multi-select functionality
- Price Chart Component: Chart container with TradingView Lightweight Charts or Recharts integration (with mock data)
- Prediction Display Panels: Price predictions, direction indicators, entry/exit timing etc
- Mock Data Integration for all UI components

Definition of Done

- Complete frontend layout built and functional
- All UI components implemented with mock data
- Responsive design for desktop, tablet, and mobile
- Interactive prototype demonstrates all features
- Client review session conducted
- Design approved and locked in
- All components documented with expected data structures

Acceptance Criteria

- Dashboard loads and displays all components correctly
- All UI elements are functional
- Design is consistent and professional
- Responsive layout works across screen sizes

- Client can navigate and understand all features
- Design approval obtained from client
- Component data structures documented for backend integration

Milestone 1: Foundation & Data Pipeline (Weeks 1-2)

Payment: $900 (15% of $6,000)

Deliverables:

- Development Environment Setup: Docker containerization, PostgreSQL + TimescaleDB, Redis cache setup, Version control repository structure
- Data Agent Implementation: Historical data ingestion from yfinance/Alpha Vantage, Real-time data streaming capability (5-minute, 1-hour bars), Data validation and quality checks, Storage in TimescaleDB with proper schema
- Feature Agent Foundation: Technical indicator calculation pipeline (TA-Lib integration), Basic feature engineering (returns, volatility, moving averages), Feature caching mechanism
- API Foundation: FastAPI project structure, Basic health check endpoints, Database connection management, Error handling framework

Definition of Done:

✓ Data Agent successfully ingests 2+ years of historical data for 3-5 tickers
✓ Real-time data stream operational (updates every 5 minutes)
✓ Feature Agent calculates 20+ technical indicators
✓ API responds to basic requests with <500ms latency
✓ All code committed to repository with documentation
✓ Development environment documented and reproducible

Acceptance Criteria:

- Historical data available for at least 2 years per ticker
- Data quality validation shows >98% accuracy
- Feature calculations complete in <2 seconds per ticker
- API endpoints return valid JSON responses
- No critical bugs in data pipeline

Milestone 2: Core Prediction Models (Weeks 3-5)

Payment: $1,200 (20% of $6,000)

Deliverables:

- Price Forecast Agent: Prophet model implementation (baseline), LSTM model implementation (primary), Multi-horizon prediction (1h, 4h, 1d, 1w), Confidence interval calculation, Model training pipeline with walk-forward validation
- Trend Classification Agent: LightGBM/XGBoost classifier implementation, Feature engineering for trend classification, BUY/SELL/HOLD prediction with probability scores, Multi-timeframe support (1h, 1d)
- Support/Resistance Agent: DBSCAN clustering implementation for level detection, Local extrema detection algorithm, Level strength scoring (0-100), Historical validation of levels

- Model Serving Infrastructure: Model registry (MLflow or custom), Model versioning and deployment, Inference API endpoints, Model performance monitoring

Definition of Done:

- ✓ Price Forecast Agent generates predictions for all timeframes with confidence intervals
- ✓ Trend Classification Agent achieves >55% directional accuracy on validation set
- ✓ Support/Resistance Agent identifies 3-5 key levels per ticker with strength scores
- ✓ All models can be trained and deployed via API
- ✓ Model inference completes in <3 seconds per ticker
- ✓ Walk-forward validation framework operational

Acceptance Criteria:

- Price predictions within 10% of actual price for 1-day horizon (50% of test cases)
- Trend classification accuracy >55% on out-of-sample data
- Support/resistance levels validated: >60% of identified levels show price reactions
- Model training pipeline runs without errors
- API endpoints return predictions in expected format

Milestone 3: Sentiment & Fusion (Weeks 6-7)

Payment: $1,200 (20% of $6,000)

Deliverables:

- News Fetch Agent: Integration with financial news APIs (Finnhub, NewsAPI, Alpha Vantage), News filtering and relevance scoring, Historical news data collection, Real-time news monitoring
- LLM Sentiment Agent: GPT-4 API integration, Sentiment scoring pipeline (-1 to +1 scale), Semantic caching implementation (60%+ cache hit rate target), Cost optimization strategies
- Sentiment Aggregator: Multi-source sentiment combination, Time-weighted sentiment aggregation, Impact scoring (High/Medium/Low)
- Fusion Agent: Rule-based signal fusion logic, Weighted combination of all signals, Final BUY/SELL/HOLD signal generation, Confidence score calculation

Definition of Done:

- ✓ News Fetch Agent collects news from 2+ sources for target tickers
- ✓ LLM Sentiment Agent processes news with GPT-4 and returns sentiment scores
- ✓ Semantic caching reduces API calls by >60%
- ✓ Sentiment Aggregator combines multiple sentiment sources
- ✓ Fusion Agent generates unified trading signals from all inputs
- ✓ All agents integrated and communicating via defined interfaces

Acceptance Criteria:

- News collection operational for all target tickers
- Sentiment scores generated within 5 seconds per news item (with caching)
- Cache hit rate >60% for repeated or similar news queries
- Fusion Agent produces signals that align with individual agent outputs
- End-to-end pipeline from news to fused signal operational

Milestone 4: Backtesting & Integration (Weeks 8-9)

Payment: $900 (15% of $6,000)

Deliverables:

- Backtesting Agent: Historical simulation engine, Trade execution logic (entry/exit based on signals), Performance metrics calculation (Cumulative PnL, Sharpe ratio, Maximum drawdown, Win rate / Hit rate, Average profit per trade), Walk-forward backtesting framework
- System Integration: All agents integrated into unified pipeline, End-to-end data flow validation, Error handling and recovery mechanisms, Performance optimization
- API Completion: All prediction endpoints implemented, WebSocket support for real-time updates, Authentication and authorization, Rate limiting and request validation
- Performance Optimization: Caching layer optimization, Database query optimization, Model inference optimization, API response time optimization

Definition of Done:

- ✓ Backtesting Agent runs historical simulations on 6+ months of data
- ✓ Performance metrics calculated and reported accurately
- ✓ All agents integrated and working together
- ✓ API endpoints functional for all system outputs
- ✓ System processes predictions for 3-5 tickers in <30 seconds total
- ✓ Walk-forward backtesting shows consistent performance

Acceptance Criteria:

- Backtesting completes on 6 months of data in <10 minutes
- Performance metrics match expected calculations (validated manually)
- End-to-end pipeline processes all tickers without errors
- API response times <500ms for single ticker predictions
- System handles errors gracefully without crashing

Milestone 5: Frontend & Testing (Weeks 10-11)

Payment: $900 (15% of $6,000)

Deliverables:

- Frontend Dashboard (Basic MVP): Next.js project setup, Ticker selection interface, Price chart with predictions overlay (using Recharts or TradingView Lightweight Charts), Support/resistance levels visualization, Signal display panel, Basic performance metrics display
- Testing Suite: Unit tests for core models (>70% coverage), Integration tests for API endpoints, End-to-end tests for critical user flows, Performance tests
- Bug Fixes & Refinements: Address identified issues, UI/UX improvements, Performance optimizations

Definition of Done:

- ✓ Frontend dashboard displays all core predictions
- ✓ Charts render correctly with predictions and levels
- ✓ Real-time updates functional via WebSocket

- ✓ Unit test coverage >70% for critical components
- ✓ Integration tests pass for all API endpoints
- ✓ No critical bugs in production-ready code

Acceptance Criteria:

- Dashboard loads and displays data for all tickers
- Charts update correctly when new predictions arrive
- All UI components responsive and functional
- Test suite passes with >70% code coverage
- User can navigate and use all features without errors

Milestone 6: Documentation & Delivery (Week 12)

Payment: $300 (5% of $6,000)

Deliverables:

- Technical Documentation: System architecture documentation, API documentation (OpenAPI/Swagger), Model documentation (training, inference, performance), Database schema documentation, Deployment guide
- User Documentation: User guide for frontend dashboard, API usage guide, Troubleshooting guide
- Project Handover: Code repository with complete documentation, Environment setup instructions, Training session (2-3 hours), Knowledge transfer materials
- Final Report: Project summary, Performance metrics and benchmarks, Known limitations and future recommendations, Maintenance and support guidelines

Definition of Done:

- ✓ All documentation complete and reviewed
- ✓ Code repository fully documented
- ✓ Handover session conducted
- ✓ Final report delivered
- ✓ All deliverables accepted by client

Acceptance Criteria:

- Documentation is clear, complete, and accurate
- Code is well-commented and follows best practices
- Handover session covers all critical aspects
- Client can independently run and maintain the system