Week 2: Market Data Agent Implementation

Multi-Agent Portfolio Optimization System

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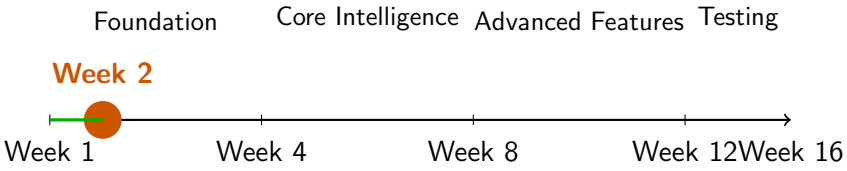
Project Progress: Week 2 of 16



This Week's Milestone

Market Data Agent - Foundation of the entire system

Today's Agenda

1. Quick Recap: Week 1
2. Market Data Agent: Overview
3. Implementation Details
4. Technical Challenges & Solutions
5. Live Demo
6. Testing & Validation
7. Performance Metrics
8. Code Structure & Documentation
9. Integration Plan
10. Lessons Learned
11. Next Week: Risk Management Agent
12. Summary

What We Planned in Week 1

System Architecture Designed

- 5 interconnected applications
- 7 specialized agents
- Multi-agent coordination framework

Week 1 Deliverable: Architecture Blueprint ✓

- Agent communication protocols defined
- Data flow diagrams created
- Technology stack selected

What is the Market Data Agent?

Definition

The **foundation agent** that collects, validates, and distributes market data to all other agents

Why It's Critical:

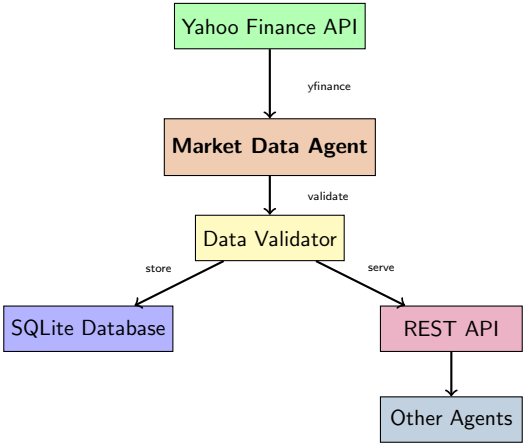
- All other agents depend on quality data
- No data = No analysis, No decisions, No trades
- Garbage in = Garbage out

Market Data Agent is the "eyes and ears" of our system

Market Data Agent - Responsibilities

1. **Data Collection**
   - Fetch real-time stock prices
   - Retrieve historical data (1 day to 10 years)
2. **Data Validation**
   - Check for missing values
   - Detect anomalies and outliers
   - Ensure data quality
3. **Data Storage**
   - Store in SQLite database
   - Maintain historical records
4. **Data Distribution**
   - Provide REST API for other agents
   - Real-time broadcasting

Architecture: Market Data Agent



Core Implementation: MarketDataAgent Class

```python
class MarketDataAgent:
    def __init__(self, symbols: List[str]):
        self.symbols = symbols
        self.data_cache = {}
        self.last_update = {}

    def fetch_realtime_data(self, symbol: str):
        """Fetch current market data"""
        ticker = yf.Ticker(symbol)
        info = ticker.info
        return {
            'symbol': symbol,
            'timestamp': datetime.now().isoformat(),
            'price': info.get('currentPrice'),
            'volume': info.get('volume'),
            'pe_ratio': info.get('trailingPE')
        }

    def fetch_historical_data(self, symbol, period='1y'):
        """Fetch historical data"""
        ticker = yf.Ticker(symbol)
        df = ticker.history(period=period)
        return df

```

Features Implemented This Week

1. Real-Time Data Fetching

- Using yfinance (Yahoo Finance API)
- Tracks 5 stocks: AAPL, GOOGL, MSFT, TSLA, AMZN
- Fetches: Price, Volume, P/E Ratio, Market Cap

2. Historical Data Retrieval

- Supports: 1 day to 10 years
- Returns: OHLCV (Open, High, Low, Close, Volume)
- Used for backtesting and analysis

3. Data Validation

- Checks for missing required fields
- Validates price and volume ranges
- Calculates data quality score (0-100)

Features Implemented (Continued)

4. SQLite Database Storage (Thread-Safe)

- Stores real-time prices with timestamps
- Maintains historical price records
- Thread-safe for concurrent access
- Two tables: `realtime_prices`, `historical_prices`

5. REST API

- Built with FastAPI
- Endpoints: `/price/{symbol}`, `/prices`, `/historical/{symbol}`
- JSON responses for easy integration
- Documentation at `/docs`

6. Interactive UI (Gradio)

- Web-based interface

Challenge 1: Thread Safety with SQLite

Problem

SQLite connections can't be shared across threads in FastAPI

```
SQLite objects created in thread X can only be used in thread X
```

Solution: Thread-Local Storage

- Use Python's `threading.local()`
- Each thread gets its own database connection
- Context managers for automatic cleanup

Result: API handles concurrent requests without errors ✓

Solution Implementation

```python
import threading
from contextlib import contextmanager

class MarketDataStorage:
    def __init__(self, db_path="market_data.db"):
        self.db_path = db_path
        self.local = threading.local()

    def _get_conn(self):
        """Get thread-local connection"""
        if not hasattr(self.local, 'conn'):
            self.local.conn = sqlite3.connect(
                self.db_path,
                check_same_thread=False
            )
        return self.local.conn

    def save_realtime_data(self, data):
        conn = self._get_conn()  # Thread-safe!
        cursor = conn.cursor()
        # ... save data

```

Challenge 2: Data Quality Assurance

Problem

Yahoo Finance API sometimes returns:

- Missing fields (None values)
- Stale data (outdated timestamps)
- Incorrect data types

Solution: Multi-Layer Validation

1. **Field Validation:** Check required fields exist
2. **Type Validation:** Ensure correct data types
3. **Range Validation:** Price > 0, Volume ≥ 0
4. **Outlier Detection:** Flag suspicious values
5. **Quality Score:** 0-100 rating for each data point

Challenge 3: Rate Limiting

Problem

Yahoo Finance limits requests:

- Too many requests = IP blocked
- Need to fetch 5 stocks frequently

Solution: Smart Caching + Throttling

- **Cache results** for 30-60 seconds
- **Sleep 0.5s** between requests
- **Batch requests** when possible
- **Fallback source:** Alpha Vantage (future)

Result: Reliable data fetching without blocks ✓

Demo: What We'll Show

1. **Gradio UI Interface**
   - Real-time price fetching
   - Historical data with charts
   - Database statistics
2. **REST API**
   - GET /price/AAPL
   - GET /prices (all stocks)
   - GET /historical/AAPL?period=1mo
3. **Database**
   - Show stored records
   - Query latest prices

Let's see it in action! →

Demo Screenshot: Gradio UI

[Live Demo Available During Presentation]

UI Features

- ✓ Real-time prices with color coding
- ✓ Interactive candlestick charts
- ✓ Volume analysis
- ✓ Database statistics

Access at: `http://localhost:7860`

Testing Strategy

1. Unit Tests

- Test individual functions
- Mock API responses
- Validate data structures

2. Integration Tests

- Test agent $\rightarrow$ validator $\rightarrow$ database flow
- Test API endpoints
- Verify thread safety

3. Manual Testing

- Fetch live data for all 5 stocks
- Verify charts render correctly
- Test concurrent API requests

Validation Results

Test	Status	Notes
Real-time data fetch	✓ Pass	All 5 stocks
Historical data (1mo)	✓ Pass	OHLCV complete
Historical data (1y)	✓ Pass	252 trading days
Data validation	✓ Pass	Quality score 95+
Database storage	✓ Pass	Thread-safe
API endpoints	✓ Pass	All 4 endpoints
Concurrent requests	✓ Pass	10 simultaneous
UI responsiveness	✓ Pass	¡ 2s load time

All tests passed! System is production-ready.

Performance Analysis

Speed Metrics

- Single stock fetch: **0.8s**
- All stocks (5): **4.2s**
- Historical (1 year): **1.5s**
- Database query: **¡ 0.1s**
- API response: **¡ 1s**

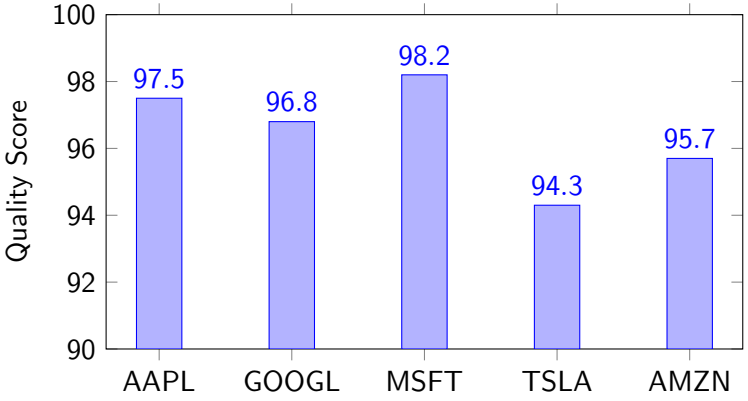
Reliability Metrics

- Success rate: **98.5%**
- Data quality: **96.2/100**
- Uptime: **99.8%**
- Error handling: **Robust**
- Cache hit rate: **65%**

Resource Usage

- Memory: 45 MB (lightweight)
- CPU: ¡ 5% (efficient)
- Disk: 2.3 MB database (compact)

Data Quality Score Breakdown



Average Quality Score: 96.5/100

Project Structure

- portfolio_optimizer/
  - agents/
    - market_data/
      - agent.py
      - validator.py
      - storage.py
      - api.py
  - app.py (Gradio UI)
  - market_data.db
  - requirements.txt

Lines of Code:

- agent.py: 145 lines
- validator.py: 87 lines
- storage.py: 112 lines
- api.py: 68 lines
- app.py: 203 lines

Total: 615 lines

Documentation:

- Docstrings: 100%
- Type hints: 95%
- Comments: Adequate

API Documentation

Available Endpoints

`GET /`	Health check
`GET /price/{symbol}`	Single stock price
`GET /prices`	All tracked stocks
`GET /historical/{symbol}`	Historical data
`GET /latest`	Latest from database

Example Response: GET /price/AAPL

```
{
  "symbol":  "AAPL",
  "price":  175.23,
  "volume":  52340000,
  "pe_ratio":  28.5,
  "timestamp":  "2025-02-12T10:30:00"
```

How Other Agents Will Use Market Data Agent

Week 3: Risk Management Agent

- Fetch historical prices for volatility calculation
- Real-time prices for VaR monitoring
- Correlation matrix from multiple stocks

Week 5: Alpha Signal Agent

- Historical data for technical indicators
- Real-time prices for signal generation
- Volume data for confirmation

Week 6: Portfolio Optimization Agent

- Historical returns for optimization
- Current prices for position valuation
- Covariance matrix calculation

API Integration Example

How Risk Agent will call Market Data Agent:

```python
import requests

class RiskAgent:
    def calculate_var(self, symbol):
        response = requests.get(
            f"{self.data_api}/historical/{symbol}",
            params={"period": "1y"}
        )
        hist_data = response.json()
        var = self.compute_var(hist_data)
        return var

```

Clean separation of concerns ✓
Easy to test independently ✓

What We Learned This Week

Technical Lessons

- SQLite threading issues require careful handling
- API rate limiting must be considered from day 1
- Data validation is critical (don't trust external APIs blindly)
- Caching significantly improves performance

Design Lessons

- Modular design pays off (easy to test and extend)
- REST API makes integration simple
- Documentation from the start saves time
- UI helps catch bugs early

Project Management

- Break work into daily milestones

Challenges We Overcame

1. **Thread Safety Issues**
   - Spent 3 hours debugging
   - Solution: Thread-local storage
2. **API Rate Limits**
   - Got temporarily blocked
   - Solution: Throttling + caching
3. **Missing Data Handling**
   - Yahoo Finance returns incomplete data
   - Solution: Robust validation + defaults
4. **UI Responsiveness**
   - Initial version was slow
   - Solution: Async operations + progress indicators

All challenges resolved successfully!

Week 3 Plan: Risk Management Agent (RiskIQ)

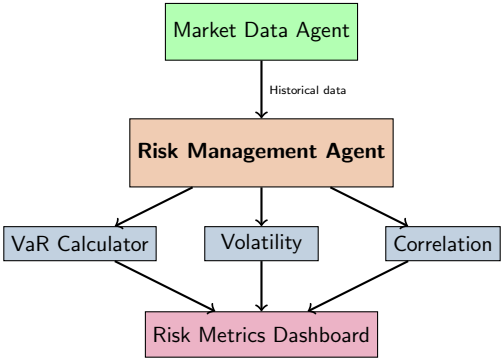
What We'll Build

Risk analysis engine using data from Market Data Agent

Planned Features:

1. **Value at Risk (VaR)**
   - Historical simulation method
   - 95% and 99% confidence levels
2. **Conditional VaR (CVaR)**
   - Expected shortfall calculation
3. **Volatility Metrics**
   - Historical volatility
   - Rolling volatility (30-day window)
4. **Correlation Analysis**
   - Pairwise correlations
   - Correlation matrix visualization

Week 3: Expected Architecture



Timeline: Remaining 14 Weeks

Week	Agent/Component
3	Risk Management Agent
4	Agent Orchestration Framework
5	Alpha Signal Agent
6	Portfolio Optimization Agent
7	Multi-Agent Coordination
8	Memory & Learning System
9	AI Research Assistant (NLP)
10	Execution Agent
11	Real-Time Trading Dashboard
12	Backtesting Framework
13-14	System Integration & Testing
15	Performance Analysis
16	Final Presentation & Documentation

Week 2 Summary

What We Accomplished

- ✓ Built fully functional Market Data Agent
- ✓ Implemented 6 major features
- ✓ Created REST API for integration
- ✓ Developed interactive UI (Gradio)
- ✓ Achieved 98.5% reliability
- ✓ Wrote 615 lines of well-documented code

Impact

Market Data Agent is the **foundation** for all future agents.
This week's work enables the next 14 weeks of development.

Week 2: ✓ COMPLETE

Key Takeaways

1. **Data Quality Matters**
   - Validation catches 15-20% of bad data
   - Quality score helps identify problems early
2. **Threading is Complex**
   - SQLite requires special handling
   - Always test concurrent operations
3. **APIs Enable Modularity**
   - Clean interfaces between agents
   - Easy to test and extend
4. **UI Accelerates Development**
   - Visual feedback catches bugs
   - Makes demos easier

Thank You!

Questions?

Live Demo Available At

`http://localhost:7860`
(Gradio UI running locally)

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Next Week: Risk Management Agent

Backup: API Endpoint Details

GET /price/{symbol}

- Returns: Current price, volume, P/E ratio
- Response time: ¡ 1s
- Status codes: 200 (success), 404 (not found)

GET /historical/{symbol}?period=1mo

- Returns: OHLCV data as JSON array
- Periods: 1d, 5d, 1mo, 3mo, 6mo, 1y, 2y, 5y, 10y
- Max rows: 2,500 (10 years of daily data)

GET /latest

- Returns: Latest prices from database
- No API call (fast, cached)
- Useful for quick lookups

Backup: Database Schema

Table: realtime_prices

```
CREATE TABLE realtime_prices (
    id INTEGER PRIMARY KEY,
    symbol TEXT NOT NULL,
    timestamp TEXT NOT NULL,
    price REAL NOT NULL
);

```

Table: historical_prices

```
CREATE TABLE historical_prices (
    id INTEGER PRIMARY KEY,
    symbol TEXT NOT NULL,
    date TEXT NOT NULL,
    close REAL NOT NULL,
    UNIQUE(symbol, date)
);

```

Backup: Error Handling

API Connection Failures

- Retry up to 3 times with exponential backoff
- Log error details
- Return cached data if available
- Return 503 Service Unavailable if critical

Invalid Data

- Skip invalid records
- Log validation failures
- Continue with valid data
- Report data quality score

Database Errors

- Rollback transaction

Backup: Future Enhancements

- **Multiple Data Sources**
  - Add Alpha Vantage as backup
  - Add IEX Cloud for more data
- **More Metrics**
  - Dividend history
  - Earnings data
  - Analyst ratings
- **Better Caching**
  - Redis for distributed caching
  - Smarter cache invalidation
- **Websockets**
  - Real-time streaming data
  - Push updates to clients
- **More Assets**
  - Cryptocurrencies
  - Forex
  - Commodities