Artificial Intelligence and Expert Systems

CT-361

Complex Computing Project (CCP)

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Project Title

Financial Sentiment & Forecast Analyzer

Overview

The Financial Sentiment & Forecast Analyzer is a comprehensive stock analysis tool that combines advanced sentiment analysis, technical indicators, and machine learning-based price forecasting to provide users with detailed investment recommendations. Designed for both individual investors and financial professionals, this application bridges the gap between traditional financial analysis and cutting-edge artificial intelligence techniques. The system processes multiple data streams - historical price data, technical indicators, news sentiment, and market trends - to generate informed investment recommendations with specified confidence levels.

The application offers an intuitive Gradio-based interface that visualizes historical data alongside forecasts and presents technical indicators through an interactive dashboard. Users can analyze stocks across various timeframes, from short-term (3 months) to long-term (10 years), making it versatile for different investment strategies. By leveraging both statistical approaches (Prophet) and neural networks (LSTM), the system provides robust price forecasts that complement the sentiment analysis derived from news sources. This multi-faceted approach aims to reduce investment uncertainty by providing a more complete picture of a stock's potential performance.

Introduction

In today's volatile financial markets, investors face an overwhelming amount of information from diverse sources, making it increasingly difficult to make sound investment decisions. Traditional analysis methods often focus on either technical indicators or fundamental data, rarely integrating news sentiment or applying machine learning forecasting. This siloed approach can lead to incomplete views of market conditions and missed opportunities.

The Financial Sentiment & Forecast Analyzer addresses these challenges by creating an integrated platform that combines multiple analysis dimensions into a cohesive system. By analyzing news sentiment, investors gain insights into market perception and emerging trends that might not yet be reflected in price movements. The machine learning forecasting models provide data-driven predictions based on historical patterns, while technical analysis offers context on current market conditions and momentum.

What sets this application apart is its ability to synthesize these diverse analyses into actionable recommendations. Rather than presenting disconnected metrics that the user must interpret, the system leverages artificial intelligence to weigh different factors and generate clear investment guidance. The recommendation engine considers short-term sentiment shifts alongside long-term technical trends, providing nuanced advice that accounts for various time horizons.

Moreover, the system is designed with transparency in mind, allowing users to examine the underlying data and analyses that inform each recommendation. This transparency builds trust and enables investors to incorporate their own expertise and risk tolerance into final decisions. By democratizing access to sophisticated financial analysis tools, the application empowers investors of all experience levels to make more informed decisions in increasingly complex markets.

Tech Stack

Programming Language

- **Python**: Core programming language used for all aspects of the application

Data Manipulation & Analysis

- **Pandas**: For structured data manipulation and analysis
- **NumPy**: For numerical computing operations
- **Matplotlib**: For creating visualizations and charts

Financial Data

- **yfinance**: For retrieving historical stock data and company information

Machine Learning & Forecasting

- **Prophet**: Facebook's time series forecasting tool
- **Keras/TensorFlow**: For building and training LSTM neural networks
- **scikit-learn**: For data preprocessing (MinMaxScaler)

Natural Language Processing

- **NLTK (Natural Language Toolkit)**: For sentiment analysis with VADER
- **TextBlob**: For additional sentiment analysis capabilities

AI Integration

- **Phi Assistant & Groq**: For LLM-based sentiment analysis and recommendation generation

Web Interface

- **Gradio**: For creating the interactive web interface

Models

1. Sentiment Analysis Models

- **VADER (Valence Aware Dictionary and sEntiment Reasoner)**: Specifically attuned to sentiments expressed in social media
- **TextBlob**: Provides polarity and subjectivity measures
- **LLM (Groq's llama3-70b-8192)**: For deeper context-aware sentiment analysis of news

2. Forecasting Models

- **Prophet**: Designed for business forecasting, handling seasonality and trend
- **LSTM (Long Short-Term Memory)**: Neural network approach specialized for time series prediction

3. Technical Analysis

- Moving Averages (SMA, EMA)
- MACD (Moving Average Convergence Divergence)
- RSI (Relative Strength Index)
- Bollinger Bands

Working of the Application

1. Data Collection Process

- The application starts by accepting a stock ticker symbol and analysis period from the user
- Historical price data is retrieved using yfinance
- Recent news about the stock is gathered using Google search

2. Analysis Pipeline

- **Sentiment Analysis**: News articles are processed through VADER, TextBlob, and the LLM to extract sentiment
- **Technical Analysis**: Various technical indicators are calculated from historical price data
- **Price Forecasting**: Both Prophet and LSTM models generate price predictions

- **Investment Recommendation**: All analyses are combined to generate a comprehensive recommendation

3. Visualization

- The application creates a multi-panel visualization showing:
  - Historical prices with moving averages and forecasts
  - RSI with overbought/oversold regions
  - MACD indicator with signal line and histogram
  - Investment recommendation summary

Key Functions

From FinancialSentimentForecaster Class

1. **__init__()**
   - **Purpose**: Initializes the Financial Sentiment Forecaster system
   - **Process**: Sets up API keys, initializes sentiment analyzers, configures the LLM, and creates necessary tools
   - **Parameters**: Optional Groq API key for LLM services
   - **Returns**: Initialized forecaster object
   - **Key Features**: Establishes the assistant with specialized financial analysis system prompt
2. **search_news()**
   - **Purpose**: Gathers recent news and information about a specific asset
   - **Process**: Creates multiple targeted search queries and executes them via GoogleSearch
   - **Parameters**: Asset name/ticker and number of desired results
   - **Returns**: List of dictionaries containing search results with titles, snippets, and sources
   - **Key Features**: Uses diversified queries to capture different aspects of asset news
3. **analyze_news_sentiment()**
   - **Purpose**: Processes news content to determine market sentiment
   - **Process**: Extracts text from results, applies multiple sentiment analysis techniques
   - **Parameters**: List of news search results

- **Returns**: Comprehensive sentiment analysis with scores and categorization
- **Key Features**: Combines VADER, TextBlob, and LLM-based sentiment analysis for robust results

4. **get_stock_data()**
   - **Purpose**: Retrieves historical price data for a stock
   - **Process**: Uses yfinance to fetch OHLC data, volume, and dividends
   - **Parameters**: Stock ticker symbol and time period (e.g., "2y" for 2 years)
   - **Returns**: DataFrame with historical stock data
   - **Key Features**: Flexible time periods for different analysis needs
5. **get_stock_info()**
   - **Purpose**: Obtains fundamental information about a company
   - **Process**: Queries yfinance for company profile and financial metrics
   - **Parameters**: Stock ticker symbol
   - **Returns**: Dictionary of company information (sector, industry, financials, etc.)
   - **Key Features**: Provides context for technical analysis with fundamentals
6. **forecast_with_prophet()**
   - **Purpose**: Creates time series forecasts using Facebook's Prophet model
   - **Process**: Prepares data, fits Prophet model, generates future predictions
   - **Parameters**: Historical price data and number of periods to forecast
   - **Returns**: Dictionary with forecast results and visualization components
   - **Key Features**: Handles seasonality and trends in time series data
7. **forecast_with_lstm()**
   - **Purpose**: Forecasts prices using deep learning neural networks
   - **Process**: Scales data, creates sequences, builds and trains LSTM model, predicts future values
   - **Parameters**: Historical data, training window size, and forecast horizon
   - **Returns**: Dictionary with forecast results and model components

- **Key Features**: Captures complex non-linear patterns in price movements

8. **identify_trends()**
    - **Purpose**: Analyzes technical indicators to identify market trends
    - **Process**: Calculates moving averages, MACD, RSI, and Bollinger Bands; identifies trend directions
    - **Parameters**: DataFrame with historical stock data
    - **Returns**: Dictionary with trend analysis and technical indicators
    - **Key Features**: Identifies short, medium, and long-term trends; detects pattern formations
9. **get_investment_recommendation()**
    - **Purpose**: Generates comprehensive investment guidance
    - **Process**: Compiles all analyses, prompts LLM for recommendation, extracts key details
    - **Parameters**: Stock ticker and results from all previous analyses
    - **Returns**: Dictionary with recommendation text, summary, type (BUY/SELL/HOLD), and confidence
    - **Key Features**: AI-generated insights that balance technical, fundamental, and sentiment factors
10. **analyze_asset()**
    - **Purpose**: Orchestrates complete analysis process from start to finish
    - **Process**: Calls all analysis methods in sequence, handles potential errors
    - **Parameters**: Stock ticker and analysis period
    - **Returns**: Comprehensive results dictionary with all analyses
    - **Key Features**: Error handling to ensure partial results even if some components fail

From UI Interface

1. **initialize_analyzer()**
    - **Purpose**: Sets up the FinancialSentimentForecaster with credentials
    - **Process**: Retrieves API key from environment or uses default, initializes forecaster
    - **Parameters**: None

- **Returns**: Configured FinancialSentimentForecaster instance
- **Key Features**: Environment variable support for secure API key management

2. **clear_outputs()**
    - **Purpose**: Resets the interface between analyses
    - **Process**: Closes any open matplotlib plots and returns empty values
    - **Parameters**: None
    - **Returns**: Empty values for all output components
    - **Key Features**: Ensures clean state before new analysis begins
3. **analyze_stock(ticker, period)**
    - **Purpose**: Processes user input to generate analysis
    - **Process**: Validates input, maps period selection, calls analyze_asset, creates visualizations
    - **Parameters**: Stock ticker and analysis period
    - **Returns**: Visualization figure, recommendation text, summary, sentiment details, trend details
    - **Key Features**: Comprehensive error handling with user-friendly messages; creates multi-panel visualization
4. **create_stock_analysis_interface()**
    - **Purpose**: Builds the Gradio interface components
    - **Process**: Defines interface layout, components, tabs, and event handlers
    - **Parameters**: None
    - **Returns**: Configured Gradio Blocks interface
    - **Key Features**: Organized tab structure for different analysis aspects; reactive error display

Features

1. Comprehensive Stock Analysis

- Technical indicators (SMA, EMA, MACD, RSI, Bollinger Bands)
- News sentiment analysis
- Short, medium, and long-term trend identification
- Detection of patterns like Golden Cross and Death Cross

2. Advanced Forecasting

- Dual forecasting approaches (statistical and neural network-based)
- Visual comparison of different forecast methods

3. Intelligent Recommendations

- AI-generated investment recommendations
- Clear BUY/SELL/HOLD guidance with confidence levels
- Analysis of supporting factors and potential risks

4. Flexible Analysis Timeframes

- Options ranging from 3 months to 10 years of historical data

5. Rich Visualizations

- Multi-panel visualization of historical data, forecasts, and indicators
- Color-coded recommendation display

User Interface

The application provides a clean, intuitive interface organized into the following components:

Input Section

- Stock ticker input field
- Time period selection dropdown
- "Analyze Stock" button

Output Tabs

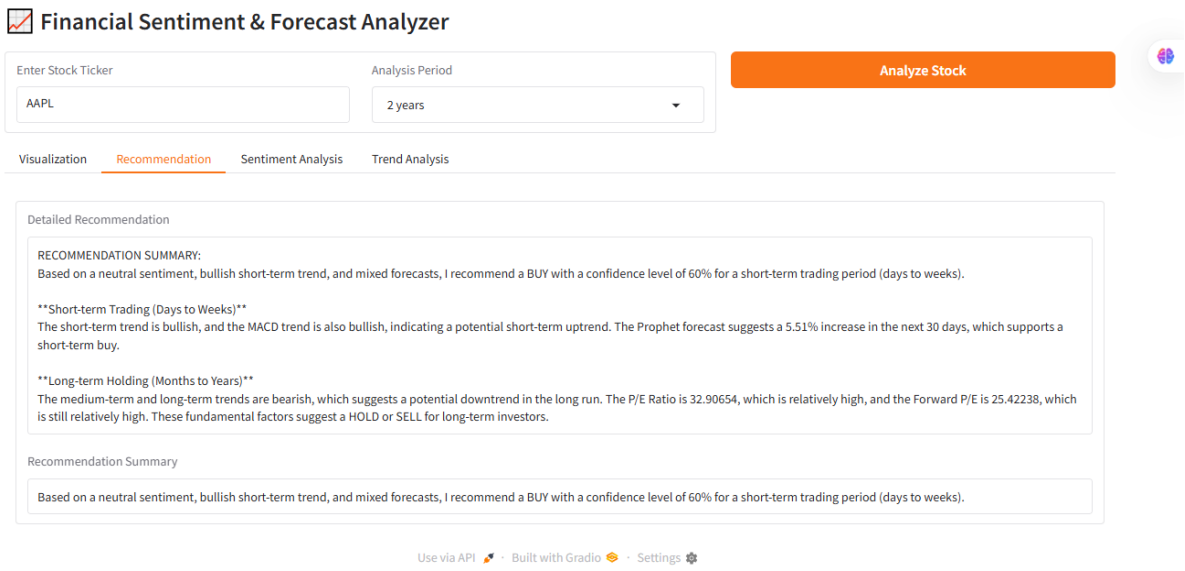
1. **Visualization Tab**: Shows the main chart with historical prices, moving averages, and forecasts
2. **Recommendation Tab**: Displays detailed investment recommendation and summary
3. **Sentiment Analysis Tab**: Shows sentiment metrics from different analysis methods
4. **Trend Analysis Tab**: Displays technical trend indicators and conditions

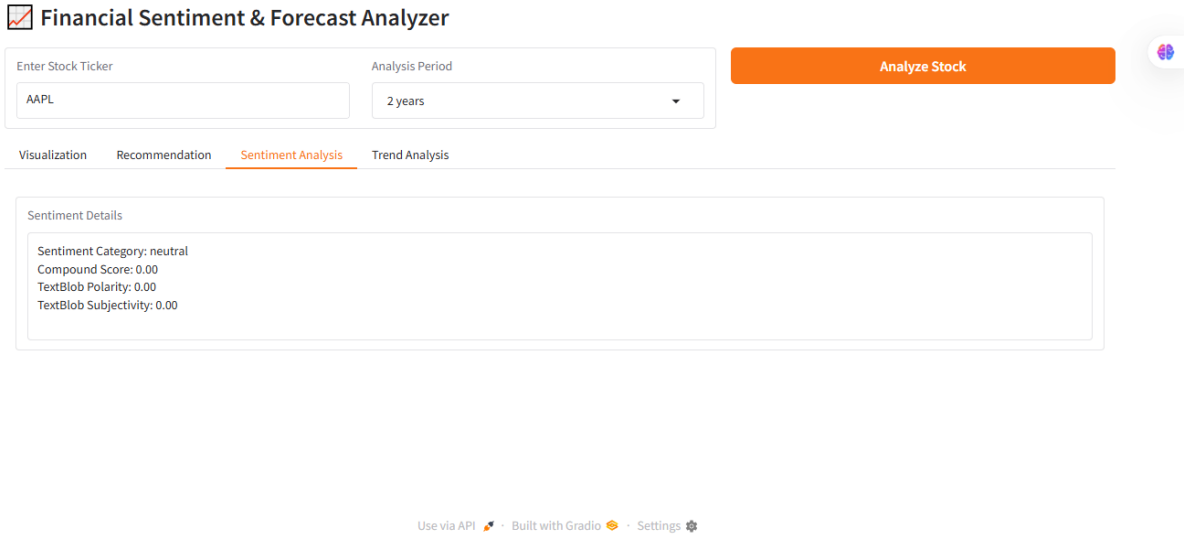
Error Handling

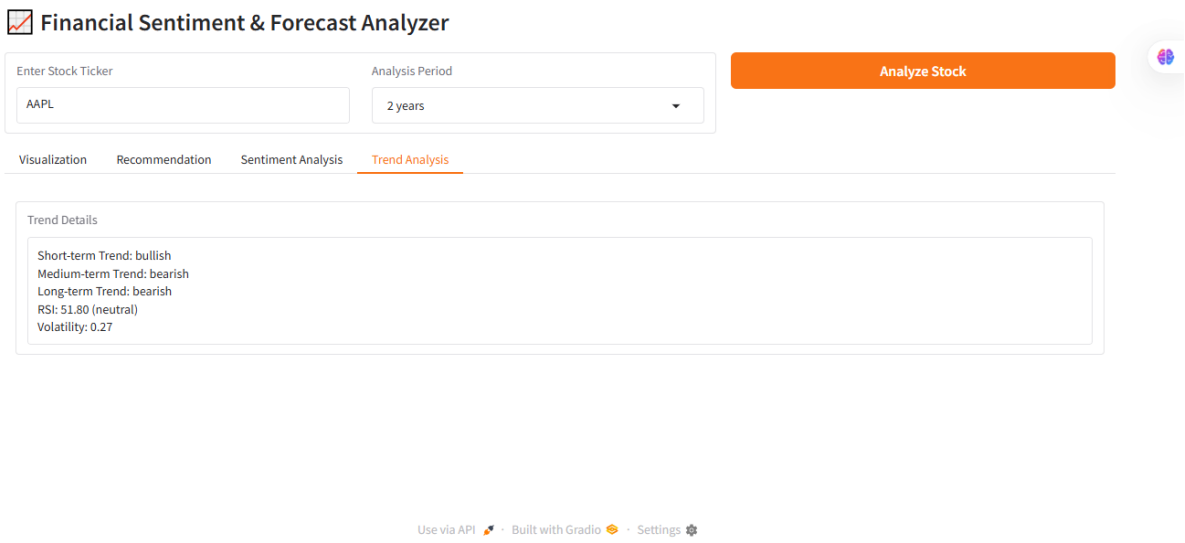
- Clear error messaging when issues arise
- Automatic visibility toggling for error messages

Snapshots


Financial Sentiment & Forecast Analyzer
Enter Stock Ticker
AAPL
Analysis Period
2 years
Analyze Stock
Visualization
Recommendation
Sentiment Analysis
Trend Analysis
Stock Analysis Visualization
AAPL Price History and Forecasts (2 years)
Close Price
20-Day SMA
50-Day SMA
200-Day SMA
Prophet Forecast
LSTM Forecast
Price (USD)
Date
Relative Strength Index (RSI)
RSI
MACD
Signal Line
Histogram
Investment Recommendation
RECOMMENDATION: BUY (MEDIUM CONFIDENCE)
Based on a neutral sentiment, bullish short-term trend, and mixed forecasts, I recommend a BUY with a confidence level of 60% for a short-term trading period (days to weeks).
Use via API
Built with Gradio
Settings


Financial Sentiment & Forecast Analyzer
Enter Stock Ticker
AAPL
Analysis Period
2 years
Analyze Stock
Visualization
Recommendation
Sentiment Analysis
Trend Analysis
Detailed Recommendation
RECOMMENDATION SUMMARY:
Based on a neutral sentiment, bullish short-term trend, and mixed forecasts, I recommend a BUY with a confidence level of 60% for a short-term trading period (days to weeks).
Short-term Trading (Days to Weeks)
The short-term trend is bullish, and the MACD trend is also bullish, indicating a potential short-term uptrend. The Prophet forecast suggests a 5.51% increase in the next 30 days, which supports a short-term buy.
Long-term Holding (Months to Years)
The medium-term and long-term trends are bearish, which suggests a potential downtrend in the long run. The P/E Ratio is 32.90654, which is relatively high, and the Forward P/E is 25.42238, which is still relatively high. These fundamental factors suggest a HOLD or SELL for long-term investors.
Recommendation Summary
Based on a neutral sentiment, bullish short-term trend, and mixed forecasts, I recommend a BUY with a confidence level of 60% for a short-term trading period (days to weeks).
Use via API · Built with Gradio · Settings


Financial Sentiment & Forecast Analyzer
Enter Stock Ticker
AAPL
Analysis Period
2 years
Analyze Stock
Visualization
Recommendation
Sentiment Analysis
Trend Analysis
Sentiment Details
Sentiment Category: neutral
Compound Score: 0.00
TextBlob Polarity: 0.00
TextBlob Subjectivity: 0.00
Use via API · Built with Gradio · Settings



Future Enhancements

This project has strong industrialization potential and can be transformed into a commercial product by:

- **Subscription-based SaaS Platform:** Providing insights to traders and investors.
- **Integration with Brokerage & Trading Platforms:** Offering automated trading strategies.
- **Enterprise-Level Financial Intelligence Tool:** Used by hedge funds, banks, and analysts.
- **Retail Investor Application:** Empowering individual investors with AI-driven market insights.

Conclusion

The Financial Sentiment & Forecast Analyzer represents a sophisticated approach to stock analysis by combining traditional technical analysis with modern AI and machine learning techniques. By integrating news sentiment analysis with price forecasting models, the application provides a more holistic view than conventional technical analysis tools alone.

The user-friendly Gradio interface makes complex financial analysis accessible to investors of various experience levels. The visual presentation of data alongside AI-generated recommendations helps users quickly understand market trends and potential investment opportunities.

Future enhancements could include portfolio analysis capabilities, real-time data integration, and expanded asset classes beyond stocks. The modular architecture of the application makes it well-suited for continued development and feature expansion.

This project demonstrates the power of combining multiple analysis techniques and leveraging AI to provide nuanced investment insights in an accessible format.