Algo-Trading System with Machine Learning & Automation

Sri Tarunika G P
sritarunikagunasekaran@gmail.com

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PROBLEM STATEMENT

In today's dynamic and fast-paced stock markets, traders and investors are overwhelmed by large volumes of real-time data. Making informed decisions quickly is crucial to capitalize on market opportunities. However, manual analysis of stock movements using traditional technical indicators can be time-consuming, error-prone, and inconsistent.

Most existing retail tools provide static charts and lagging analytics, failing to offer intelligent, real-time decision-making support. There is a growing need for a lightweight, intelligent, and automated system that can:

- Monitor multiple stocks continuously
- Apply proven technical indicators (like RSI, 20-DMA, 50-DMA)
- Predict next-day price direction using ML algorithms
- Log all trade activities and analytics systematically
- Send real-time alerts via messaging platforms like Telegram

Solution:
To create a mini prototype that combines rule-based strategy and machine learning to generate **automated buy signals**, track stock behavior, and assist decision-making through **Google Sheets logging** and **Telegram alerts**.

OBJECTIVES

The main objective of this project is to develop an **end-to-end automated trading assistant** that leverages both **technical analysis** and **machine learning** to assist in making informed, timely, and consistent buy decisions in the stock market. Below are the detailed goals:

Primary Objectives

1. **Automated Data Acquisition**
    - Integrate with a free market data API (Yahoo Finance via yfinance) to fetch daily historical data (Open, High, Low, Close, Volume) for selected NIFTY 50 stocks.
    - Enable data refresh without manual intervention, keeping the system ready for daily execution.
2. **Implementation of Rule-Based Trading Strategy**
    - Calculate technical indicators such as:
        - **Relative Strength Index (RSI)** to identify overbought/oversold zones.
        - **Moving Averages (20-DMA and 50-DMA)** to identify momentum and crossover patterns.
    - Generate **BUY signals** based on:
        - RSI < 30 (oversold condition)
        - 20-DMA crossing above 50-DMA (bullish crossover)

3. **Machine Learning Integration**

    ○ Train a **Logistic Regression** model to predict the next-day stock movement using technical indicators.

    ○ Provide real-time feedback on model performance by displaying **prediction accuracy** in the UI.

    ○ Help users validate or strengthen the confidence in generated signals.

4. **Trade Signal Logging & Analytics**

    ○ Automate logging of trade signals into **Google Sheets** using gspread, including:

        ■ Stock Name, Date, Signal, Close Price

        ■ A separate sheet for **Profit & Loss (PnL)** summary

        ■ Another sheet to track **Win Ratio**

5. **User Notification via Telegram**

    ○ Integrate **Telegram Bot API** to deliver daily signal alerts to users in a preformatted message.

    ○ Notify users even if no trades are detected to improve transparency and reliability.

6. **User Interface for Visualization**
    - Create a **Streamlit dashboard** that displays:
        - Stock price charts overlaid with 20-DMA and 50-DMA
        - RSI trend line
        - Buy signals and ML accuracy metrics
    - Provide interactive stock selection and one-click strategy execution.

Secondary Objectives

- Ensure **scalability and modularity** so that additional strategies or indicators can be easily plugged in.
- Maintain a **clean, informative, and visually appealing dashboard** that's beginner-friendly yet detailed enough for analysts.
- Keep the codebase **well-documented** with comments, error handling, and logs for maintainability.

SCOPE OF THE PROJECT

The scope of this algo-trading system is deliberately defined to ensure **clarity of objectives**, **simplicity in execution**, and **relevance to real-world financial scenarios**. The project is designed for educational, analytical, and experimental use by individual traders and AI/data science practitioners.

Users

- **Retail Traders:** Individuals looking for basic guidance in equity trading based on technical indicators.

- **Beginners in Trading:** Newcomers who wish to explore algorithmic trading without the complexity of full-fledged platforms.

- **Data Science Students/Practitioners:** Learners who want to understand the integration of machine learning with financial time series and automation tools.

Stocks

- Focused exclusively on **large-cap Indian stocks** listed on the **Nifty 50 index**.

- Sample stocks include: `RELIANCE.NS`, `INFY.NS`, `TCS.NS`, `HDFCBANK.NS`, `ICICIBANK.NS`, `WIPRO.NS`, `SBIN.NS`, `LT.NS`, `AXISBANK.NS`.

- Stocks are selectable via the Streamlit UI for dynamic inclusion.

Market

- **Indian Stock Market** (National Stock Exchange - NSE).

- Stocks are fetched using ticker symbols compatible with Yahoo Finance (`.NS` suffix for NSE).

Timeframe

- Backtest and ML model training are performed over **the past 6 months** of daily data (approx. 120–130 trading sessions).

- This provides a sufficient window to test the effectiveness of both the rule-based strategy and the ML model.

Signal Type

- **Buy-Only Signals:**

  - The current version focuses on identifying **bullish entry opportunities**.

  - Short selling, stop-loss, exit logic, or trailing mechanisms are **not included** in this scope.

- This simplification allows users to focus on **entry timing and signal validation**.

TOOLS AND TECHNOLOGIES

To build a robust, automated, and user-friendly algo-trading system, the following tools and technologies were utilized,

- Python (py):
  The core language used for all backend logic, machine learning, data handling, and integration tasks due to its simplicity and vast ecosystem for finance and AI.

- **Frontend**

  Streamlit: Used to build an intuitive, web-based UI for interaction, visualization of charts, and dynamic stock selection. It enables rapid prototyping and live data display.

- **APIs & Libraries**
  - **yfinance**: Used to fetch historical stock data (daily price, volume) directly from Yahoo Finance.
  - **gspread** + **oauth2client**: For authenticating and interacting with Google Sheets to log trade signals, track P&L, and maintain trading history.
  - **Telegram Bot API**: For sending real-time trade alerts to the user via Telegram, enhancing responsiveness and automation.

- **Machine Learning**
  - **scikit-learn**: Used for building and training a Logistic Regression model to predict next-day price movements based on technical indicators (RSI, Volume, etc.).
  - **Model Evaluation**: Accuracy metrics are computed and displayed for each stock to assess model performance.

- **Automation & Cloud Storage**

  Google Sheets: Acts as a lightweight backend database to store:

  - Trade logs
  - P&L calculations
  - Win/Loss ratio

- **Development Environment**
  - **Visual Studio Code (VS Code)**: The primary IDE used for coding, debugging, and modularizing the application.
  - **Python virtual environment**: Used to isolate dependencies and keep the project environment clean and reproducible.

FUNCTIONAL COMPONENTS

The system is designed in a modular fashion, ensuring separation of concerns, easier debugging, and scalability. Each component performs a distinct function in the algo-trading pipeline.

1. Data Ingestion (`fetch_data.py`)

- **Purpose**: Fetches historical stock data (6 months daily data) for selected NIFTY stocks.
- **Source**: Yahoo Finance via `yfinance` API.
- **Functionality**:
    - Automatically removes invalid or missing data.
    - Ensures each DataFrame contains essential columns like `Close`, `Volume`, `Open`, etc.
    - Handles multi-index and standardizes column names for uniform processing.

2. Technical Strategy (`strategy.py`)

- **Purpose**: Applies a rule-based trading strategy using technical indicators.
- **Indicators Used**:
    - RSI (Relative Strength Index)
    - 20-Day Moving Average (20-DMA)
    - 50-Day Moving Average (50-DMA)
- **Signal Generation**:
    - A **BUY** signal is triggered when:
        - RSI < 30 (oversold)
        - 20-DMA crosses above 50-DMA (bullish crossover)
- **Output**: List of signal dictionaries containing Date, Stock, Close price, and Signal.

3. Machine Learning Module (`ml_model.py`)

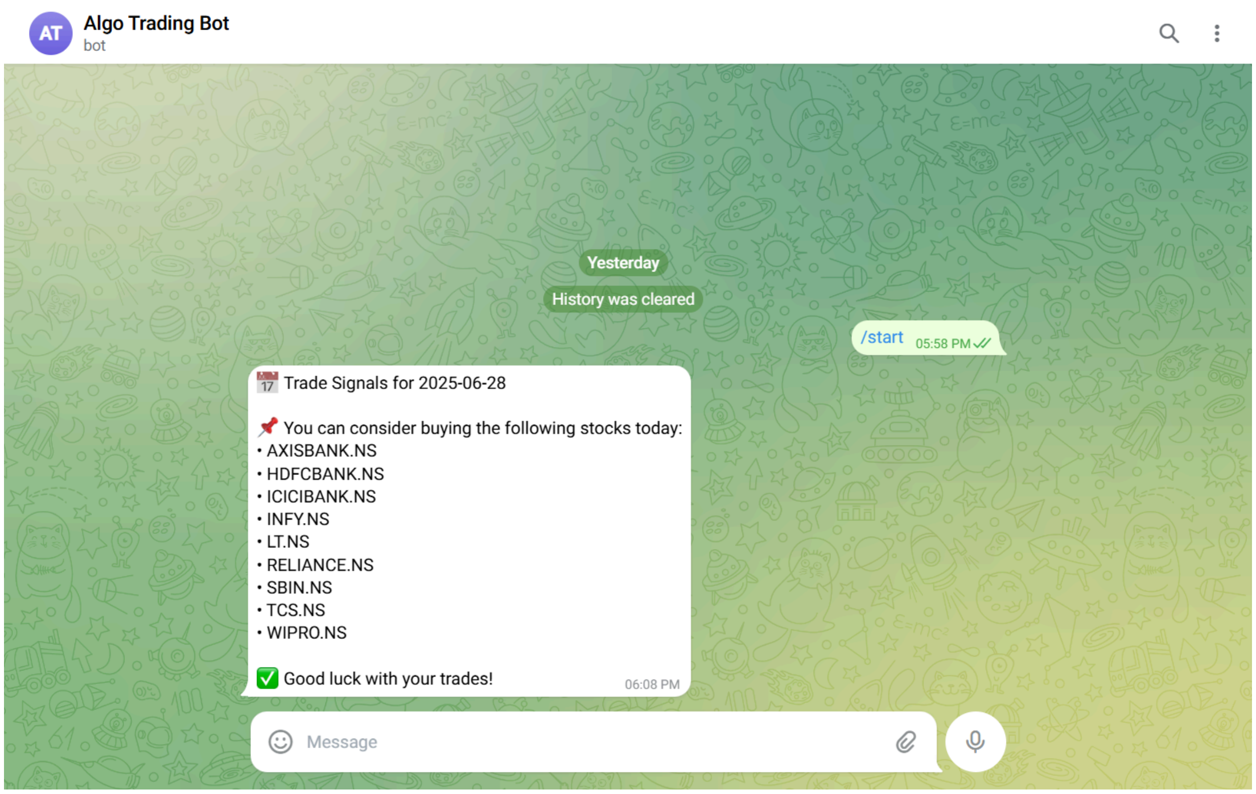
- **Purpose**: Automates the prediction of next-day stock movement.
- **Model Used**: Logistic Regression (from scikit-learn).
- **Features Used**:
  - RSI
  - Volume
  - Moving Averages
- **Label**: Binary (1 if next-day price is higher, else 0).
- **Output**: Accuracy score (%) and trained model for each stock.

4. Google Sheets Logger (`gsheet_logger.py`)

- **Purpose**: Logs trade signals and P&L data automatically to Google Sheets.
- **Sheets Handled**:
  - **Trade Log**: Entry of stock name, signal, date, and close price.
  - **P&L Summary**: Daily profit/loss based on hypothetical trades.
  - **Win Ratio Tab**: Calculates percentage of successful signals.
- **Tech Used**: `gspread` with OAuth2 credentials.

5. Telegram Bot Alerts (`telegram_bot.py`)

- **Purpose**: Sends a summary message of buy signals to the user via Telegram.
- **Message Format**:



📅 Trade Signals for 2025-06-28

📌 You can consider buying the following stocks today:
• AXISBANK.NS
• HDFCBANK.NS
• ICICIBANK.NS
• INFY.NS
• LT.NS
• RELIANCE.NS
• SBIN.NS
• TCS.NS
• WIPRO.NS

✅ Good luck with your trades! 06:08 PM

6. Streamlit Frontend (`app.py`)

- **Purpose**: Provides a user-friendly interface for:
  - Selecting stocks
  - Viewing ML metrics and charts
  - Triggering analysis
  - Displaying output signals
- **Visualizations**:
  - Line Chart: Close, 20DMA, 50DMA
  - RSI Trend
- **User Interaction**:
  - Sidebar for configuration
  - Button to trigger complete strategy
  - Result panel for metrics and charts
  - Summary alerts and logs

IMPLEMENTATION

Step 1: Combines both **rule-based strategy** and **machine learning-based predictions** for generating signals.

Step 2: Processes multiple NIFTY stocks including:

- `RELIANCE.NS`, `TCS.NS`, `INFY.NS`, `ICICIBANK.NS`, `WIPRO.NS`, `SBIN.NS`, etc.

Step 3: Signals are generated and stored as a list of dictionaries containing:

- `Stock`, `Signal`, `Close Price`, and `Date`

Step 4: Charts plotted for each stock include:

- 📈 Price with 20-DMA and 50-DMA overlays
- 📉 RSI trend

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MACHINE LEARNING MODEL

Objective: Predict whether the stock price will go up the next trading day based on technical indicators.

Model Used: DecisionTreeClassifier from scikit-learn

Input Features:

- RSI (Relative Strength Index)
- Volume
- Current Close Price

Target Label:

- 1 → If next day's closing price is **greater** than today's
- 0 → Otherwise

Evaluation Metric: Accuracy (displayed in Streamlit for each stock)

Purpose: Supports the technical strategy by offering an ML-based signal confidence boost

GOOGLE SHEETS LOGGING

- **Libraries Used:**

  gspread with oauth2client for authentication

- **Automation:**

  After trade signals are generated, they are instantly pushed to Google Sheets

- **Sheets Maintained:**
  - **Trade Log:** Records date, stock, signal type, and price
  - **P&L Tracker:** Tracks hypothetical profit/loss based on signals
  - **Win Ratio Tab:** Shows the percentage of successful signal outcomes

- **Purpose:**

  Enables transparent tracking, strategy validation, and analytics

TELEGRAM BOT INTEGRATION

- **Libraries Used:**

  Python's `asyncio` + `python-telegram-bot` package

- **Functionality:**

  Sends an alert message once trade signals are available

Use Case: Keeps the trader informed in real time—even without accessing the Streamlit app

STREAMLIT DASHBOARD

- **Framework Used:** `Streamlit`
- **Modules Linked:**
  - Strategy execution (`strategy.py`)
  - ML model accuracy (`ml_model.py`)
  - Google Sheets logging (`gsheet_logger.py`)
  - Telegram messaging (`telegram_bot.py`)
- **UI Features:**
  - Stock selector sidebar
  - "Run Strategy" button to execute the pipeline
  - Graphs:
    - Moving Averages (Close, 20DMA, 50DMA)
    - RSI trend line
  - ML Accuracy for each stock
  - Buy signals table with date and price
  - Warnings for invalid/missing data
- **UX Focus:** Clean, responsive layout using columns and containers

CONCLUSION

This project successfully delivers a mini algo-trading assistant capable of:

- Real-time data ingestion from Yahoo Finance
- Technical strategy screening using RSI and Moving Averages
- ML-based prediction using a Decision Tree classifier
- Logging trade data in Google Sheets
- Instant trade alerts via Telegram bot

The system is modular, scalable, and built for retail traders, students, and fintech learners looking to automate and validate trade decisions.

FUTURE ENHANCEMENTS

- Add exit signal logic (e.g., RSI > 70 or MA cross-down)
- Build a full-fledged backtesting module to visualize P&L over time
- Integrate intraday time frames (e.g., 15min/1hr)
- Replace ML model with:
  - `RandomForestClassifier`
  - `XGBoost`
  - `LSTM` for sequence-based learning
- Upgrade Telegram bot to support:
  - Interactive responses (e.g., “Track”, “Buy Now”, “Ignore”)
  - Weekly summaries or visual charts via bot

REFERENCES

- *Yahoo Finance via yfinance*
- *scikit-learn Documentation*
- *Google Sheets API using gspread*
- *Telegram Bot API*
- *Streamlit Framework*