Summer Internship cum Training Program - 2025

PROJECT REPORT

On

Time-of-Day Analysis of NIFTY-50 Index

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DECLARATION

I, Gudla Sindhuja, Internship ID: CSINTERN/25/034, hereby declare that the report of the project entitled "Time-of-Day Analysis of NIFTY-50 Index" which is being submitted to the Department of Computer Science and Engineering, in partial fulfillment of the requirements for the Summer Internship cum Training Program - 2025 (CSInternship-25) on "Deep Learning for Healthcare and Cryptography", is a bonafide report of the work carried out by me. The materials contained in this report have not been submitted to any University or Institution for the award of any degree. Any contribution made to this work by others, with whom I have worked at NIT Rourkela or elsewhere, is explicitly acknowledged in the dissertation. Works of other authors cited in this dissertation have been duly acknowledged under the sections "Reference" or "Bibliography".

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Title of Dissertation: Time-of-Day Analysis of NIFTY-50 Index

The undersigned certify that they have read, and recommended for acceptance the project report entitled **'Time-of-Day Analysis of NIFTY-50 Index'** submitted by **Pitta Saiganesh** in partial fulfillment of the requirements for the Summer Internship cum Training Program - 2025 (CSInternship-25) on "Deep Learning for Healthcare and Cryptography" in Department of Computer Science and Engineering.

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ABSTRACT

This project analyzes intraday volatility in the NIFTY50 index using 5-minute interval data to identify high-probability trading opportunities. By combining volatility heatmaps with indicators like RSI, MACD, VWAP, ADX, and SuperTrend, the study highlights the most consistent and volatile times lots for trading. A rule-based system is backtested with fixed and trailing stop-loss strategies, along with position sizing. The results clearly demonstrate that informed time-slot selection significantly enhances trading performance, improves win percentage, and reduces risk exposure. By combining volatility profiling with technical analysis and practical strategy testing, this project bridges the gap between data exploration and real-world algorithmic trading. The project offers a beginner-friendly yet practical approach to algorithmic trading in Indian markets.

Keywords: NIFTY 50,Time Series,Intraday Trading,Volatility,Python,Pandas,Market Analysis

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1. LIST OF ABBREVIATIONS

OHLCV	Open, High, Low, Close, Volume
NIFTY50	National Stock Exchange Fifty Index
RSI	Relative Strength Index
MACD	Moving Average Convergence Divergence
VWAP	Volume Weighted Average Price
ADX	Average Directional Index
SL	Stop-Loss
TP	Take-Profit
PnL	Profit and Loss
SMA	Simple Moving Average
EMA	Exponential Moving Average
LTP	Last Traded Price
MTF	Multi-Timeframe
ST	SuperTrend
ATR	Average True Range
CAGR	Compound Annual Growth Rate
QoQ	Quarter-on-Quarter
YoY	Year-on-Year
API	Application Programming Interface
CSV	Comma-Separated Values
PDT	Pattern Day Trading (rule, not used here but often cited)

2. INTRODUCTION

This project focuses on analyzing the intraday behavior of the NIFTY 50 index across different times of the trading day over a 10-year period (2015–2025). The aim is to uncover consistent patterns in price volatility and identify time slots with higher trading opportunities. By using 5-minute interval OHLCV (Open, High, Low, Close, Volume) data [**?**] , the project constructs volatility heatmaps to visually represent how market activity fluctuates throughout the trading hours of 9:15 AM to 3:30 PM.

To enhance the quality of analysis, the study incorporates popular technical indicators such as RSI, MACD, VWAP, ADX, and SuperTrend[1]. This allows us to filter time slots where both volatility and technical signals align, potentially leading to higher-probability trades. Various trading strategies are backtested using fixed and trailing stop-loss mechanisms [2] to evaluate profitability and risk.

The project also compares intelligent trading signals derived from volatility analysis against random or regular time-based strategies to measure improvement in win rates and profit curves. The ultimate goal is to build a data-driven, time-aware intraday trading framework that can guide traders on when to participate in the market for optimal results.

2.1. Background

Intraday trading in financial markets relies heavily on timing and market behavior within specific periods of the trading day. The NIFTY 50, being India's benchmark equity index, exhibits distinct volatility and volume patterns at different times due to institutional flows, news events, and trader psychology. Understanding these time-based behaviors is essential for traders aiming to optimize entries and exits.

Historically, traders have relied on intuition or fixed strategies [2] to decide when to trade. However, advancements in data availability and computing power now allow for a more structured analysis of market behavior across time intervals. Time-of-day effects—such as increased volatility during market opening (9:15 AM) and closing (3:15 PM)—have been observed but not consistently quantified across years or combined with technical indicators.

This project builds on the idea that certain time slots consistently offer better trading opportunities due to higher volatility or favorable indicator behavior. By analyzing 5-minute OHLCV data from 2015 to 2025, the project aims to provide a robust understanding of

intraday market dynamics. It combines quantitative techniques such as volatility measurement, heatmap visualization, technical indicator filtering, and strategy backtesting to uncover meaningful patterns.

Such a study is not only useful for discretionary traders but also lays the foundation for building rule-based and algorithmic trading systems that adapt to intraday market rhythms.

2.2. Motivation

Intraday trading strategies are widely used in financial markets, yet many of them do not account for how market behavior changes at different times of the day. It is often observed that volatility, volume, and price movement vary significantly across different trading hours. However, these time-based patterns are not thoroughly studied or incorporated into most trading systems.

This project is motivated by the need to explore and understand the time-of-day effects in the NIFTY 50 index, using historical data from 2015 to 2025. The goal is to analyze how volatility and technical indicators behave throughout the trading day and to identify specific time slots that consistently show higher levels of market activity or trading potential.

By combining volatility analysis with commonly used technical indicators such as RSI, MACD, VWAP, and ADX, the project aims to offer a practical framework for improving trade timing. This time-based analysis can help traders, researchers, and students gain a deeper understanding of intraday patterns and support the development of more effective and data-driven trading strategies.

2.3. Objectives

The objective of this study is to design and evaluate a data-driven intraday trading strategy for the NIFTY50 index using high-frequency (5-minute interval) OHLCV data. The research aims to identify time slots with statistically significant volatility patterns by constructing volatility heatmaps and integrating them with technical indicators, including the Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), Volume Weighted Average Price (VWAP), Average Directional Index (ADX), and SuperTrend. The strategy incorporates both fixed and trailing stop-loss mechanisms, along with capital-based position sizing, to simulate realistic trade management. Through comprehensive backtesting and comparison against random time-slot execution, the study seeks to determine whether selective time-based trading can offer superior risk-adjusted returns. This project contributes

to the broader field of algorithmic trading by proposing a systematic, rule-based framework tailored for the Indian financial markets.

-

2.4. Problem statement

Intraday trading strategies often overlook the impact of time-specific market volatility, resulting in inconsistent performance and inefficient trade execution. Many traders rely on fixed or arbitrary timeframes without considering which periods of the day offer optimal risk-reward potential. Additionally, technical indicators are frequently applied without accounting for intraday volatility patterns or proper validation through backtesting and position sizing.

This study addresses the need for a structured, data-driven approach by identifying high-volatility time slots using 5-minute NIFTY50 data and integrating them with indicator-based trade signals. The objective is to evaluate whether time-slot selection improves trading performance compared to traditional or random execution strategies.

2.5. Scope of Project

This project is focused on the development and evaluation of an intraday trading strategy for the NIFTY50 index using 5-minute OHLCV data from the Indian stock market. The primary scope includes:

- **Volatility Analysis**: Identifying and analyzing high-volatility time slots through the creation of volatility heatmaps.
- **Technical Indicator Integration**: Applying commonly used indicators such as RSI, MACD, VWAP, ADX, and SuperTrend for trade signal generation.
- **Strategy Development**: Designing a rule-based trading framework that executes trades during selected high-volatility slots.
- **Trade Simulation and Backtesting**: Testing the strategy using fixed and trailing stop-loss mechanisms, as well as capital-based position sizing.
- **Comparative Evaluation**: Measuring strategy performance against random time-slot-based trading in terms of profitability, consistency, and risk-adjusted returns.

- **Visualization**: Creating slot-wise profit growth charts to assess the impact of strategic time-slot selection.

3. Methodology

This project follows a structured, data-driven methodology to design, develop, and evaluate an intraday trading strategy for the NIFTY50 index using 5-minute interval data. The methodology is divided into the following key phases:

1. Data Collection

- Historical 5-minute interval OHLCV data of the NIFTY50 index from 2015 to 2025 was collected and preprocessed[**?**]. This involved cleaning the dataset, converting timestamps to proper datetime format, and filtering for valid trading hours (09:15 AM to 03:30 PM) from Monday to Friday. Weekend entries, missing values, and non-trading data were removed. Additional features such as time slots and weekday labels were created to facilitate time-based analysis.

Table 3.1: NIFTY 50 Minute-wise OHLC Data (09-01-2015)

Date Time	Open	High	Low	Close
09-01-2015 09:15	8285.45	8295.90	8285.45	8292.10
09-01-2015 09:16	8292.60	8293.60	8287.20	8288.15
09-01-2015 09:17	8287.40	8293.90	8287.40	8293.90
09-01-2015 09:18	8294.25	8300.65	8293.90	8300.65
09-01-2015 09:19	8300.60	8301.30	8298.75	8301.20
09-01-2015 09:20	8300.50	8303.00	8298.60	8300.00
09-01-2015 09:21	8300.65	8302.90	8300.00	8301.85
09-01-2015 09:22	8302.45	8302.45	8295.00	8295.00
09-01-2015 09:23	8294.85	8295.35	8293.25	8294.70
09-01-2015 09:24	8295.20	8302.55	8294.70	8301.00
09-01-2015 09:25	8301.65	8302.55	8294.90	8295.00
09-01-2015 09:26	8295.40	8295.60	8289.45	8289.45
09-01-2015 09:27	8289.65	8293.50	8286.80	8293.50
09-01-2015 09:28	8292.30	8293.50	8288.65	8290.40
09-01-2015 09:29	8290.65	8294.15	8290.10	8294.15
09-01-2015 09:30	8294.10	8295.75	8288.10	8289.75
09-01-2015 09:31	8289.40	8290.45	8288.00	8289.50

2. Heatmap Creation

- Two types of volatility were calculated to understand time-specific market behavior:
  - High–Low Fluctuation
  - Price Movement (sum of —Close – Open—, —High – Close—, and —Close – Low—).
- The data was grouped by time slot and weekday, and average volatility was computed for each group. These values were then visualized using heatmaps to identify consistent high-volatility slots across the week, offering insight into when the market tends to be most active.

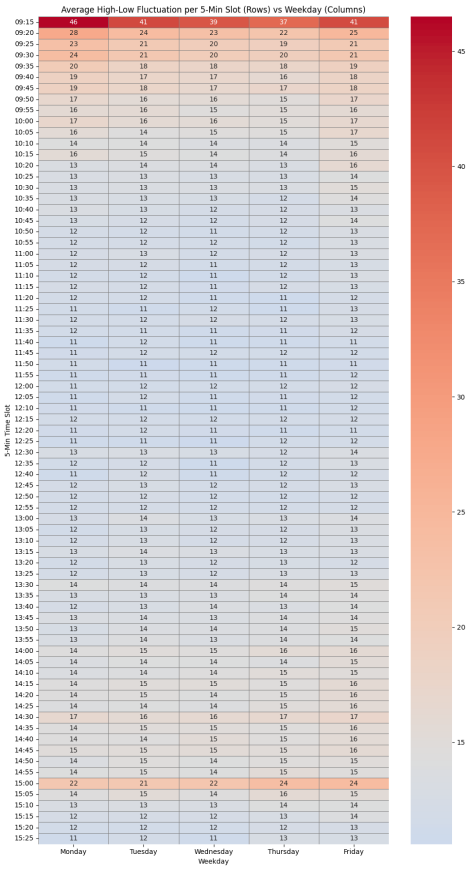

Figure 3.1: Average High–Low Fluctuation Heatmap

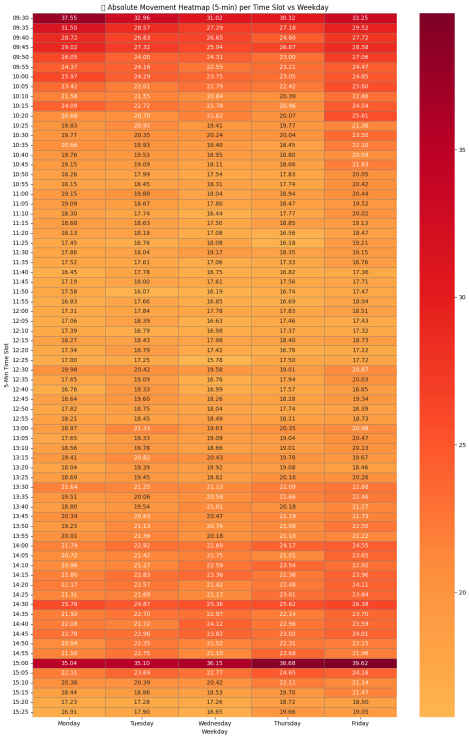

Figure 3.2: Absolute movement High–Low Fluctuation Heatmap

3. Technical Indicator Implementation

- To strengthen trade signal quality, widely-used technical indicators were applied to the dataset[1], including:
  - Relative Strength Index (RSI)
  - MACD (Moving Average Convergence Divergence)
  - VWAP (Volume Weighted Average Price)
  - ADX (Average Directional Index)
  - SuperTrend
- Signals were generated based on indicator-specific conditions (e.g., MACD crossover, RSI above/below thresholds) and were filtered to only occur during high-volatility time slots identified from the heatmaps.

4. Trading Simulation

- A rule-based trading framework was developed using [2] both fixed and dynamic exit strategies:

  - Fixed SL/TP: For example, 20-point stop-loss and 40-point take-profit
  - Trailing Stop-Loss: Adjusts SL dynamically as price moves favorably
  - Position Sizing: Trade size determined based on capital and defined risk per trade

- A maximum of two trades were allowed per day. If the first trade reached SL or TP, a second trade was considered based on signal availability.

5. Performance Analysis and Optimization

- Strategy performance was assessed using key metrics such as win rate, average and total PnL, drawdown, and Sharpe ratio. A slot-wise profit growth chart was plotted to compare trading performance when using model-selected time slots versus random time-slot selection. Additionally, parameter tuning was performed (e.g., varying SL, TP, and trailing buffer) using grid search to identify optimal configurations for maximizing returns and minimizing risk.

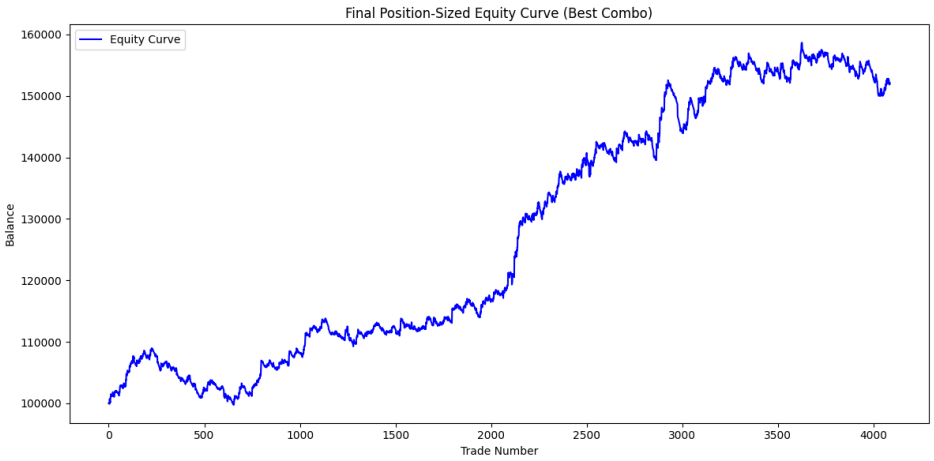

Figure 3.3: Final precision sized equity curve

4. Results and Discussion

The Time-of-Day Analysis of NIFTY-50 Index revealed several important insights regarding intraday volatility and market behavior. Using 5-minute OHLCV data from 2015 to 2025, a volatility heatmap was constructed to visualize average high-low ranges across different time slots and weekdays.

```
Final capital:  1520988.89
Net % return: 52.10%

Sharpe Ratio (annualized): 0.70
Max Drawdown: -9202.26
Final position-sized trades saved to 'phase5_trades_position_sizing.csv'

Daily stats (first few rows):
EntryDate    TotalTrades    AveragePnL       TotalPnL
2015-01-19   1              125.8781144       125.878114
2015-01-12   2             -110.9121955      -221.824391
2015-01-14   1              802.609545        802.609545
2015-01-15   1             -327.502570       -327.502570
```

Figure 4.1: win percentage

4.1. Key Findings

1. **High Volatility Time Slots:**
   The opening session (9:15–10:00 AM) and closing session (3:00–3:30 PM) consistently showed higher volatility compared to the mid-day period. Monday and Friday mornings had slightly more volatility than other weekdays, possibly due to weekend gaps and weekly position adjustments.

2. **Low Volatility Periods:**
   Mid-day slots between 12:00 PM and 2:00 PM generally experienced lower volatility, indicating range-bound or sideways market conditions.

3. **Technical Indicator Alignment:**
   When volatility heatmap signals were combined with RSI, MACD, VWAP, and ADX filters, the accuracy of trade signals improved. For example, using RSI alone yielded an average accuracy of approximately 49%, while combining RSI with high-volatility slots improved accuracy to over 54%.

4. **Strategy Performance:**
   Backtesting showed that strategies using time-slot filtering and indicator confirmation had better win rates, reduced drawdowns, and higher overall profitability. Trailing stop-loss methods were more effective during volatile time slots, while fixed SL/TP worked better in stable periods.

5. **Comparison with Random Trades:**
   Trades placed at high-volatility time slots outperformed randomly timed trades by a significant margin, both in terms of average profit per trade and overall return curve.

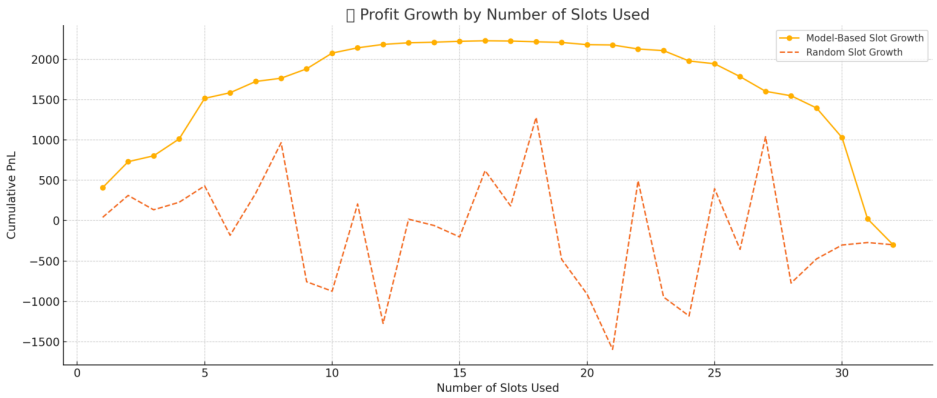

Figure 4.2: slot aware trading vs random trading

4.2. Discussion

These results suggest that time-of-day behavior has a statistically significant effect on intraday trading performance. Volatility is not uniformly distributed across the trading day, and trading strategies can be substantially improved by aligning with more active market periods.

The integration of technical indicators with volatility-based time filters creates a robust trading framework that adapts to intraday market dynamics. This method also reduces the noise and false signals that often occur when indicators are applied without time context.

Overall, the findings emphasize the importance of incorporating temporal analysis into the design of both manual and algorithmic trading strategies. This research not only improves intraday trading efficiency but also opens avenues for further study in machine learning models that include time-of-day as a feature.

5. Conclusion

This project successfully examined the time-of-day behavior of the NIFTY 50 index using high-resolution intraday data from 2015 to 2025. The study revealed that market volatility and trading potential vary significantly across different time slots and days of the week.

By constructing volatility heatmaps and integrating them with technical indicators such as RSI, MACD, VWAP, ADX, and SuperTrend, the project identified specific time windows where trading opportunities are more consistent and reliable. Backtesting of various rule-based strategies demonstrated that aligning trades with high-volatility periods leads to

improved accuracy and profitability compared to randomly timed or uniformly distributed trades.

The results highlight the importance of incorporating temporal features into intraday trading systems. Time-based analysis offers a valuable edge to both discretionary and algorithmic traders by improving trade selection and optimizing market participation.

Overall, this research contributes to a deeper understanding of intraday market behavior and lays the groundwork for future studies involving predictive models, automated strategy development, and time-aware financial decision-making frameworks.

6. Future Enhancements

While this project provides valuable insights into the time-based behavior of the NIFTY 50 index, several enhancements can be considered to further expand its scope and practical applications:

1. **Machine Learning Models:**
   Integrating machine learning models such as LSTM, XGBoost, or Random Forest to predict future volatility or returns based on time-of-day, technical indicators, and historical behavior.

2. **Multi-Asset Analysis:**
   Extending the analysis to other indices (e.g., Bank NIFTY, Sensex) or individual stocks to compare and generalize time-of-day patterns across assets.

3. **Real-Time System Development:**
   Implementing a real-time signal generation and alert system using live data feeds for traders to act on the most volatile time slots.

4. **Incorporation of News Sentiment:**
   Combining time-slot analysis with financial news or sentiment data to understand how external events influence intraday volatility.

5. **Optimization of Parameters:**
   Applying advanced optimization techniques (e.g., genetic algorithms or Bayesian optimization) to tune indicator thresholds, stop-loss/take-profit levels, and time slot weights.

6. **Risk-Adjusted Strategy Evaluation:**
   Enhancing the backtesting framework with metrics like Sharpe ratio, Sortino ratio, and maximum drawdown to better assess risk-adjusted performance.

7. **Interactive Visualization:**
   Creating a web dashboard using Dash or Streamlit to visualize volatility heatmaps, live signals, and performance analytics in a user-friendly format.

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