Enhancing Q-Learning for Intraday Financial Trading: Dynamic State Modeling with Attention LSTM and Physics-Informed Neural Networks

Muktinath Vishwakarma[a], Jagdish Chakole[b], Manish Kurhekar[a]

[a] *Visvesvaraya National Institute of Technology, Nagpur, 440010, Maharashtra, India*
[b] *Indian Institute of Information Technology, Nagpur, 441108, Maharashtra, India*

Abstract

Data-driven trading is particularly well-suited for short-term trading, as stock prices are influenced by numerous factors, many of which are unknown or unpredictable. When the time window for trading is large, the likelihood of price movements being affected by external factors increases, making predictions less reliable. Intraday trading, on the other hand, relies heavily on recent trading activity and is inherently data-driven. Given that stock price data exhibits both temporal and spatial characteristics, effective trading strategies must account for these dynamics while addressing the market's ever-changing nature.

In this research, we propose a novel Reinforcement Learning (RL) framework for intraday trading, where the RL agent refines its trading strategy through interactions with the stock market environment. A critical aspect of RL is the representation of the state space, as it directly impacts the agent's learning efficiency and decision-making capabilities. To this end, we introduce a unique method for state-space representation that leverages Long Short-Term Memory (LSTM) networks, Deep Neural Networks (DNN), and k-Means clustering.

The LSTM component captures long-term temporal dependencies in the time-

series data, while the DNN extracts spatial features, capturing complex patterns and relationships within the data. The k-Means clustering algorithm is then employed to discretize and combine these features into a finite, manageable state space for Q-learning. By integrating these components, our approach effectively models the intricate dynamics of the stock market, enabling the RL agent to make informed trading decisions.

Our methodology is specifically tailored to the dynamic and high-frequency nature of intraday trading and represents a significant advancement in applying RL to financial markets. This novel state-space representation bridges the gap between the complexity of stock market data and the computational demands of traditional Q-learning methods, paving the way for more effective and efficient data-driven trading strategies.

Keywords: Reinforcement Learning, LSTM, Deep Learning, Intraday Trading

---

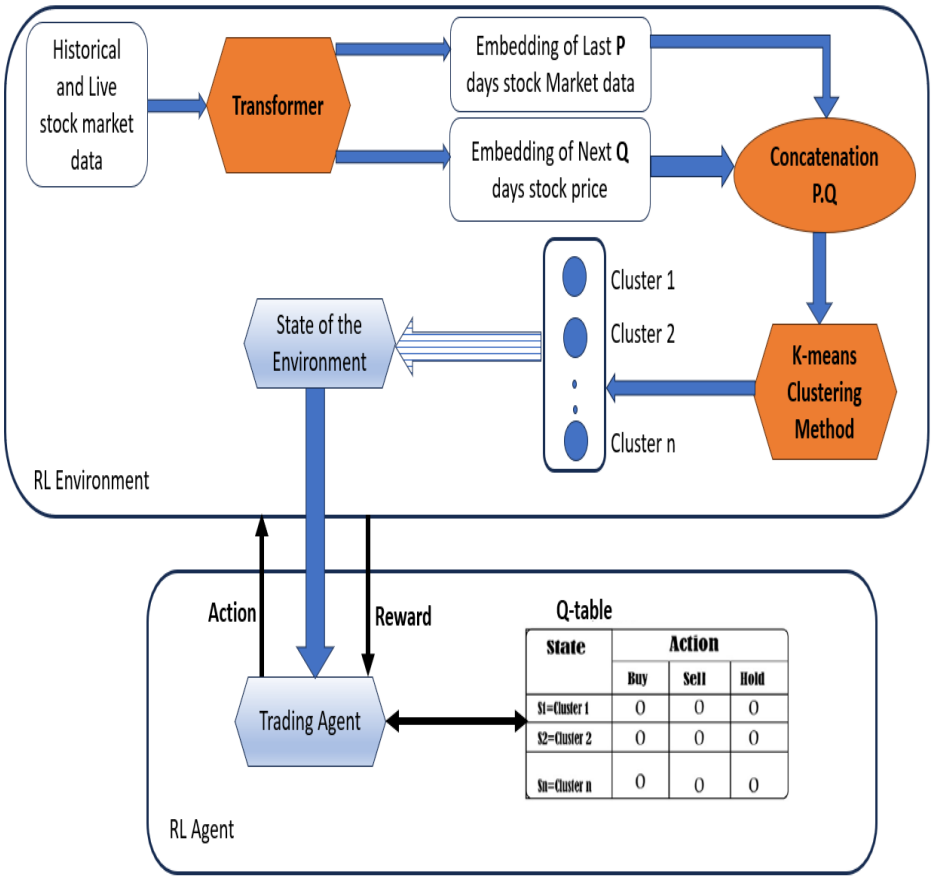

Figure 1: Proposed model of the trading strategy.