Strategic Stock Trading with Deep Reinforcement Learning Models

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Problem Definition

Problem Statement:
Traditional trading models rely heavily on historical data, making them rigid and slow to respond to real-time market fluctuations. This gap often leads to missed opportunities and increased risk for traders.

Literature Review Highlights:

- Deep Reinforcement Learning (DRL) has shown potential in enabling real-time adaptability and improving decision-making in volatile environments.
- Studies suggest DRL can integrate real-time data and sentiment analysis, providing more robust, dynamic trading strategies.

Datasets for Model Training

Primary Dataset:

- Dhaka Stock Exchange Dataset (DSEBD): Daily stock price data from the Dhaka Stock Exchange, providing insights into a growing emerging market.

Additional International Datasets:

- SP 500 Stock Data: Covers daily prices for SP 500 stocks, offering a view into a mature market.
- US Stocks and ETFs Price and Volume Data: Includes comprehensive price and volume data across all US stocks and ETFs.
- Brazilian Stock Market - Daily Updated
- Indian Stock Market Index Intraday Data(2008-2020)

Reference Papers :

- FinRL: A Deep Reinforcement Learning Library for Automated Stock Trading in Quantitative Finance
- Practical Deep Reinforcement Learning Approach for Stock Trading

Proposed Solution (Architecture)

Solution Approach:

- Develop a DRL-based trading model that dynamically adapts to real-time market conditions by employing an optimal reward function.
- This function not only maximizes profits but also carefully considers the level of risk taken, ensuring a balanced strategy that prioritizes sustainable growth while minimizing potential losses.

Key Techniques:

- **Proximal Policy Optimization (PPO)** for stability in decision-making.
- **Twin Delayed DDPG (TD3)** to manage volatility and improve accuracy.
- **Trust Region Policy Optimization (TRPO)** for stable and conservative policy updates.
- **Ensemble of DRL models** for robust adaptability across market conditions.

Performance Metrics

- **Initial and Final Portfolio Value**
- **Annualized Return**
- **Annualized Standard Deviation**
- **Sharpe Ratio:** Defined as:

$$\text{Sharpe Ratio} = \frac{\mathbb{E}[R_p - R_f]}{\sigma_p}$$

where R_p is the portfolio return, R_f is the risk-free rate, and σ_p is the standard deviation of the portfolio returns.

- **Max Drawdown:** Calculated as the maximum observed loss from a peak to a trough:

$$\text{Max Drawdown} = \max_{t \in [0,T]} \left(\frac{V_{\text{peak}} - V_{\text{trough}}}{V_{\text{peak}}} \right)$$

- **Sortino Ratio:** Focuses on downside risk, defined as:

$$\text{Sortino Ratio} = \frac{\mathbb{E}[R_p - R_f]}{\sigma_d}$$

where σ_d is the standard deviation of negative (downside) returns only.