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Franky: An Intelligent Agent for Stock Portfolio Management Using Large Language Models and Deep Reinforcement Learning

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I. INTRODUCTION

This paper introduces an innovative intelligent trading agent designed for autonomous stock portfolio management, integrating Large Language Models (LLMs) and Deep Reinforcement Learning (DRL). The core objective was to develop a trading agent capable of effectively managing a diversified stock portfolio by synthesizing quantitative market data with qualitative insights derived from real-time financial news and corporate reports.

The motivation behind this approach arises from limitations observed in conventional trading algorithms, which predominantly rely on historical price data and technical indicators while frequently neglecting critical qualitative information. Existing market solutions typically separate numerical analysis and text-driven sentiment analysis, thus failing to fully exploit the synergistic potential of these data sources. By contrast, the proposed method uniquely integrates these elements through a combined architecture inspired by FINMEM [1] and FinRL [2] frameworks.

The proposed system operates through a multi-layered approach, employing DRL agents trained on historical numerical data and stock-specific memory module that prioritize and manage textual information. Memory module continuously captures, processes, and contextualizes incoming data streams into structured, actionable insights. Data is being scraped and processed in real-time from predefined and trusted sources on the Internet, allowing a rapid reaction to ever changing market environment. LLM serve as an advanced interpretative engine, conducting sentiment and contextual analyses of news articles to anticipate market reactions. DRL Agent is responsible for

a quantitative analysis of portfolio assets and suggesting an optimized resources allocation. It considers how assets move relative to each other, risks associated with each asset, technical indicators and historical data. Agent is using the Advantage Actor-Critic [3] algorithm that, after a series of backtesting, outperformed DDPG, PPO, TD3 and SAC [4] by around 5%-20%. Ultimately, stock-level recommendations are integrated by a dedicated portfolio-level LLM, considering portfolio constraints, diversification, risk tolerance, and available funds to formulate cohesive and strategic trading decisions. As many LLMs of various architectures are currently available, such a selection of them was taken into consideration which enabled verification of the difference between reasoning and non-reasoning models.

Validation of the system's performance was conducted through rigorous backtesting across diverse historical market conditions, employing metrics such as cumulative returns and risk-adjusted returns against benchmark trading strategies. Initial results (return of around 36%) demonstrate the superior performance and adaptability of the proposed system, outperforming conventional DRL-based and purely sentiment-based methods, particularly in volatile market conditions.

Future development will concentrate on optimizing the portfolio manager component, exploring dynamic rebalancing strategies and refining its scalability and adaptability to real-time trading environments. This work not only enhances autonomous trading technologies but also provides valuable insights into how hybrid AI architectures can revolutionize financial market analysis and decision-making.

Index Terms—Large Language Models, Deep Reinforcement Learning, Stock Trading, Portfolio Management

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