DefAIAgent: An Autonomous AI Agent for DeFi Trading with Aptos Integration

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March 7, 2025

Abstract

This document presents the design and implementation of **DefAIAgent**, an autonomous AI agent for decentralized finance (DeFi) trading. DefAIAgent optimizes yield, calculates risk indices, and triggers rebalancing actions based on market data. When the computed rebalancing signal is triggered, the agent integrates with the Aptos blockchain via the official Aptos SDK to submit on-chain transactions. We detail the mathematical formulation, provide pseudo-code, include a flowchart for visualization, and describe the overall architecture.

1 Introduction

Decentralized finance (DeFi) demands adaptive and automated systems to efficiently manage portfolio allocation and mitigate risks in volatile markets. The **DefAIAgent** is designed to:

- Fetch market data using CCXT.
- Compute a novel **Yield Score** and **Risk Index** from historical price returns.
- Determine a dynamic allocation and trigger a rebalancing signal if the deviation from the target exceeds a specified threshold.
- Execute on-chain transactions on the Aptos blockchain using the official Aptos SDK.
- Provide interactive visualizations of the computed metrics.

2 Mathematical Formulation

2.1 Yield Score

Let $r(t)$ be the return at time t. Over a window of N periods, define the rolling average and standard deviation as:

$$\mu_r(t) = \frac{1}{N}\sum_{i=0}^{N-1} r(t-i), \quad \sigma_r(t) = \sqrt{\frac{1}{N}\sum_{i=0}^{N-1}\big(r(t-i)-\mu_r(t)\big)^2}.$$

The **Yield Score** is computed as:

$$\text{Yield Score}(t) = \frac{\mu_r(t)}{\sigma_r(t)+\epsilon},$$

where ϵ is a small constant (e.g., 10^{-8}) to avoid division by zero.

2.2 Risk Index

The **Risk Index** is defined by the volatility (standard deviation) scaled to a percentage:

$$\text{Risk Index}(t) = \sigma_r(t) \times 100.$$

2.3 Rebalancing Signal

The agent computes a dynamic allocation $a(t)$ as follows:

$$a(t) = \min\left(1, \max\left(0, a_0 + \frac{\text{Yield Score}(t) - \text{Risk Index}(t)}{1000}\right)\right),$$

with a target allocation $a_0 = 0.5$. A rebalancing signal is triggered when:

$$\text{Rebalance Signal} = \begin{cases} \text{True} & \text{if } |a(t) - a_0| > 0.1, \\ \text{False} & \text{otherwise.} \end{cases}$$

3 Pseudo-code

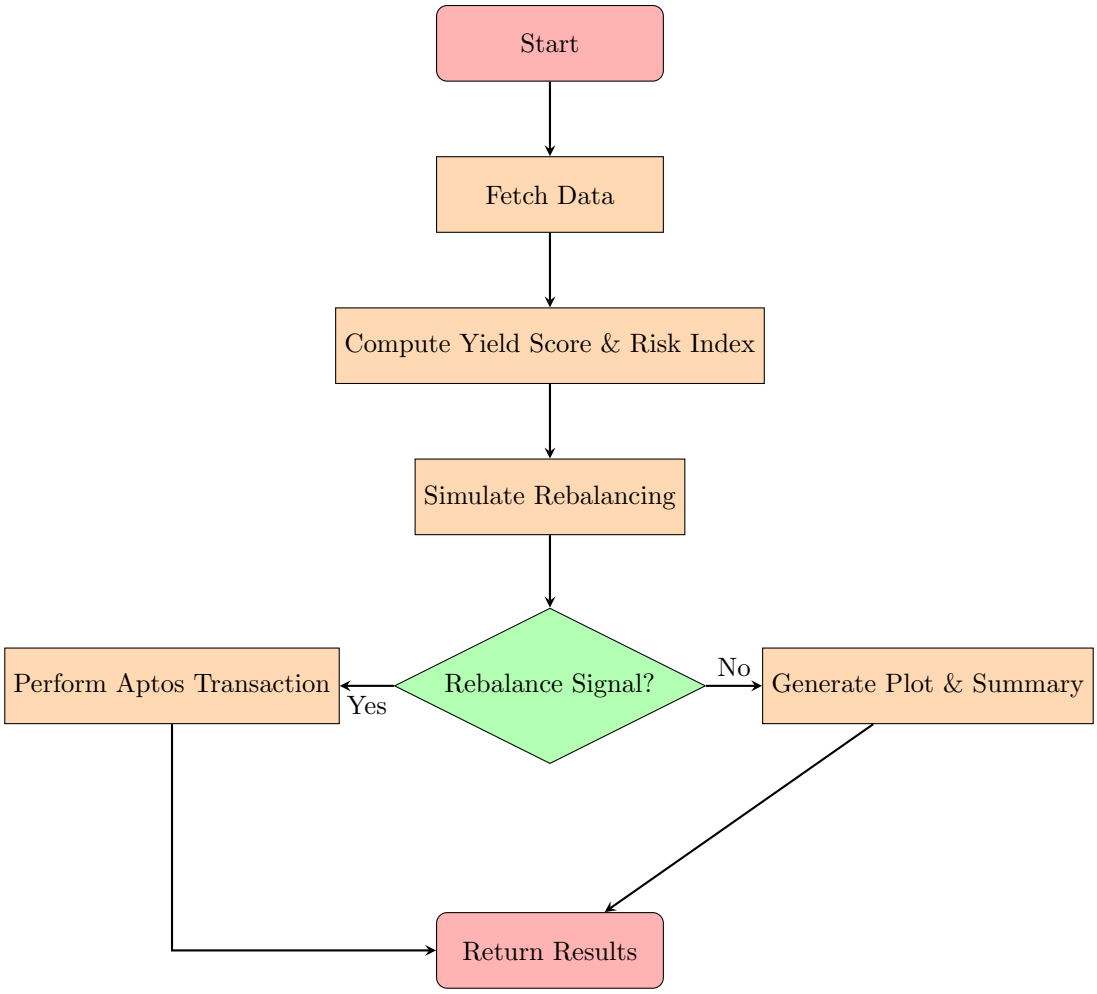
The following pseudo-code summarizes the main operations of the DefAIAgent:

Algorithm 1 DefAIAgent Execution

```
procedure ExecuteDefAI(symbol, use_csv)
    data ← FetchData(symbol, use_csv)
    if data is None or empty then
        return error message
    end if
    yield_score ← CalculateYieldScore(data)
    risk_index ← CalculateRiskIndex(data)
    rebalancing_info ← SimulateRebalancing(data)
    plot ← GenerateDefAIPlot(data, rebalancing_info)
    if rebalancing_info.rebalance_signal is True then
        aptos_result ← PerformAptosTransaction("rebalance")
        Append trade with aptos_result to trades
    end if
    return {trades, plot, summary}
end procedure
```

4 Flowchart

The flowchart below illustrates the main workflow of DefAIAgent:



5 Detailed Description

The **DefAIAgent** class is implemented to autonomously manage a DeFi trading strategy with the following steps:

1. **Data Retrieval:** The agent uses CCXT to fetch market data (OHLCV data) for a given trading symbol. It can also load data from a local CSV file.

2. **Yield and Risk Calculation:** - The *Yield Score* is computed as the ratio of the rolling average return to the rolling volatility. - The *Risk Index* is derived from the rolling standard deviation of returns.

3. **Rebalancing Signal:** The agent calculates a dynamic allocation based on a target (e.g., 50%). If the deviation from the target allocation exceeds 10%, a rebalancing signal is triggered.

4. **Aptos Blockchain Integration:** Using the official `aptos-sdk`, the agent creates an `AptosClient` and a new account (for demonstration). Depending on the transaction type (e.g., "rebalance"), it builds a transaction payload and executes the transaction on the Aptos blockchain.

5. **Visualization:** The agent generates interactive Plotly charts to display the computed yield score and risk index over time.

6. **Output:** The agent returns a JSON object containing trade details (if a rebalance was triggered), the interactive plot (as a JSON string), and a summary of the computed metrics.

6 Conclusion

This document has presented an in-depth explanation of the **DefAIAgent** module. We discussed the mathematical formulation for yield score and risk index, provided pseudo-code and a flowchart to illustrate the process, and described how the agent integrates with the Aptos blockchain via the official Aptos SDK. This autonomous agent offers a novel approach to managing DeFi trading strategies by combining advanced statistical metrics with on-chain execution capabilities.

References