

Assessment 4: Uniswap v3 LP Rebalancing

Overview

You are tasked with building a Python-based backtesting framework to simulate Uniswap v3 liquidity provision on the ETH/USDC pool. The simulation should start with an initial balance of **100 ETH** on January 1st, 2024, and use historical price data from CoinMarketCap (CMC) for the previous year.

Key Components

1. LP Position Setup:

- **Liquidity Range:** For a given spot price P , Equal amounts of ETH and USDC should be provided in a fixed range of $[P/(1+x\%), P*(1+x\%)]$ where x is a configurable parameter.
- **Example:** If $x=0.5$ (or 50%), and the current price P is \$1,000, 50 ETH will be swapped for 50,000 USDC and deployed in $[1000/1.5, 1000*1.5]$ or $[666, 1500]$

2. Rebalancing Logic:

- **Monitoring:** Continuously monitor the market.
- **Trigger:** When the market price exits the active liquidity range, you must "remove" the current LP position.
- **Action:** Record the impermanent loss (or gain) from that position.
- **Re-entry:** Immediately swap to maintain equal amounts of ETH and USDC and open a new LP position centered at the current price using the same logic.

3. Alternative Ranges:

- **Testing:** The framework should allow you to experiment with different values of x . Specifically, calculate for round figures of **5%, 10%, 15%, and 20%**.

- **Optimization:** Additionally, try to determine the optimal x value (i.e., the range that provides the best risk-adjusted returns) by analyzing performance across these scenarios.

Performance Evaluation

Your strategy's performance should be compared against a simple **HODL** (buy-and-hold) strategy using the following metrics:

- **Total Returns:** Compare the final portfolio value of the LP strategy with that of HODL.
- **Sharpe Ratio:** Calculate the Sharpe ratio based on daily returns to understand the risk-adjusted performance.
- **Maximum Drawdown:** Identify the maximum drawdown during the simulation.
- **Impermanent Loss:** Quantify the impermanent loss (or gain) incurred each time a position is rebalanced.
- **Time-Based Returns:** Compute returns on a daily, weekly, and monthly basis.
- **Position Value Over Time:** Track how the value of the LP strategy evolves over the simulation period.

Visualization Requirements

Include visualizations to help interpret the results and support your analysis:

- **Equity Curves:** Plot the cumulative returns of both the LP strategy and the HODL strategy over time.
- **Price & Range Visualization:** Overlay the historical price data with the active LP ranges. Mark the points at which rebalancing occurs.
- **Risk Metrics:** Visualize trends for risk metrics such as drawdown and the Sharpe ratio.

Submission Requirements

- **Jupyter Notebook:** Your complete analysis should be delivered as a Jupyter Notebook. This notebook should contain:
 - Your backtesting framework code.

- Visualizations.
 - Detailed commentary explaining your approach, assumptions, and any challenges you encountered.
 - **requirements.txt:** Include a file listing all the Python packages used.
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Conclusion

This assignment is designed to evaluate your ability to integrate market data, implement a trading strategy simulation, and perform a thorough quantitative analysis. We encourage you to be creative in your analysis and to think critically about the risk-return trade-offs of providing liquidity on Uniswap v3.

Good luck, and we look forward to seeing your solution!