OPTIMIZING CRYPTOCURRENCY PORTFOLIO FOR RISK

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OUTLINE

Background

Objective & Methodologies

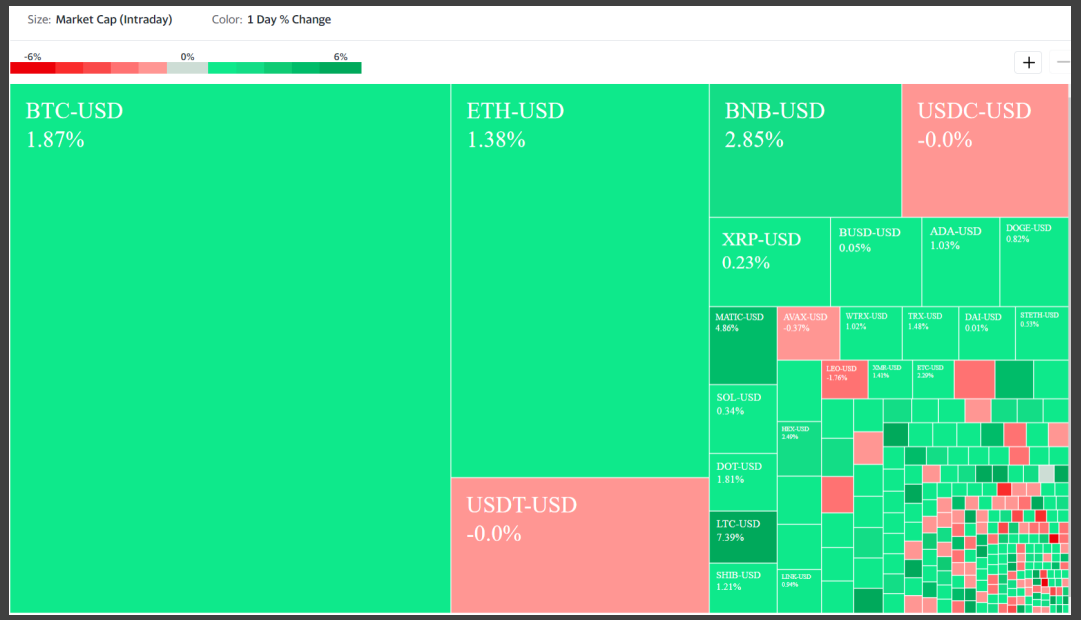
Approach

Challenges & Assumptions

Results

Background

- More than 18,000 different cryptocurrencies and counting [1]
- Cryptocurrencies decoupled from mainstream financial markets [2]
- High volatility, low transaction fees [3]
- Not controlled by central institution [4]
- Market capitalization of few cryptocurrencies accounts for majority of total market [5]



Depiction of market capitalization of major cryptocurrencies as of January 29, 2023. [6]

1. Gupta & Chaudhary, 2022
2. Caferra & Vidal-Tomás, 2021
3. Kim, Chulhee, & Lee 2021
4. Cafera & Vida-Tomás. 2021
5. Gupta & Chaudhary, 2022
6. Yahoo Finance, 2023

Objective & Methodologies

Objective:

- Minimize Risk Maximize returns

Requirements:

- Cryptocurrencies not normally distributed
- Substantial liquidity
- Different currency categories

Considered:

- Binary Integer Programming
- Mixed-Integer Linear Programming [7]
- Convex Optimization [8]
- Mean-Variance [9]
- Black-Litterman Allocation [10]
- Genetic Heuristic Algorithm [11]
- Monte Carlo Simulation [12, 13, 14]
- Mean Conditional Value at Risk (M-CVaR) [15]
- Liquidity Bounded Risk-Return Optimization (LIBRO)[16]

7. Mansini & Ogryczak, 2015
8. Markowitz, 1952
9. Markowitz, 1994
10. Black & Litterman, 1991
11. Grazia Speranza, 1996
12. Detemple, 2003
13. Pedersen, 2014
14. Cong & Oosterlee, 2016
15. Petukhina et.al., 2021
16. Trimborn, Lee, and Härdle, 2020

APPROACH

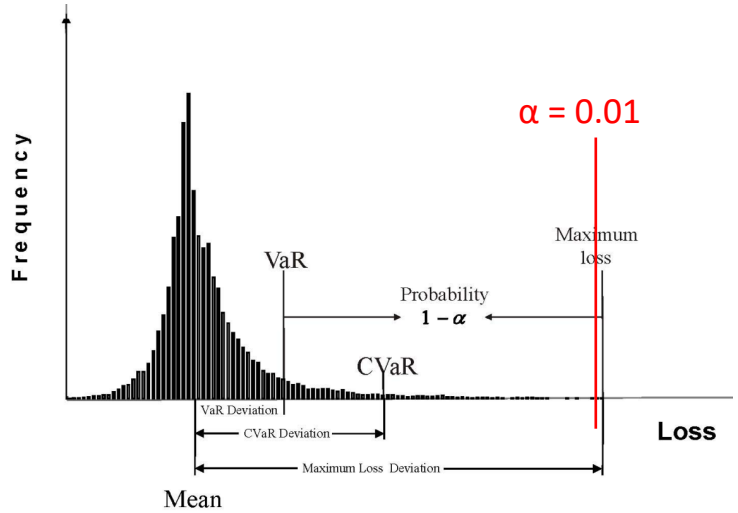
Methodology

M-CVaR [17]

$$\mathrm{CVaR}\alpha(w) = \frac{1}{1-\alpha}\int_{y(w)\leq VaR(w)} y\, f(y|w)dy$$

LIBRO [18]

$$w_i \leq \frac{TV_{i,m} \cdot \mathrm{f_i}}{M}$$



Depiction of market distribution, VaR, CVaR, loss and the role of α [19]

Monte Carlo Simulation

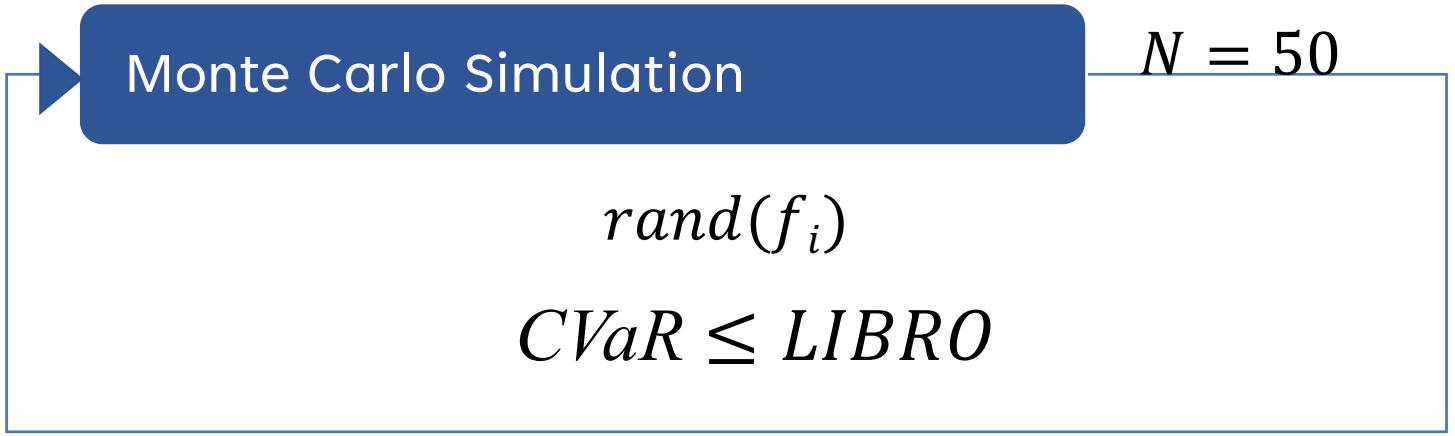
17. Rockafellar & Uryasev, 2000 18. Triborn, Lee and Härdle, 2020 19. Uryasev, 2008

Data Handling

- Binance Market API
  - Daily trading data
  - 293 currencies
- CoinMarketCap API
  - 17 Categories
  - 10+ currencies

Category	Min Controlling Factor	Max Controlling Factor
Fiat	0.8	1.0
Defi	0.7	0.9
Sports	0.6	0.7
Enterprise Solutions	0.5	0.7
Yield Aggregator	0.5	0.7
Gamification	0.6	0.7
Data Handling	0.3	0.5
Dex Token	0.3	0.5
Analytics	0.2	0.4
Media	0.1	0.3
Other	0.1	0.3
Web3	0.1	0.3
Distributed Computing	0.1	0.3
Cybersecurity	0.1	0.3
IoT	0.1	0.3
Privacy	0.1	0.3
Metaverse	0.1	0.3

Optimization



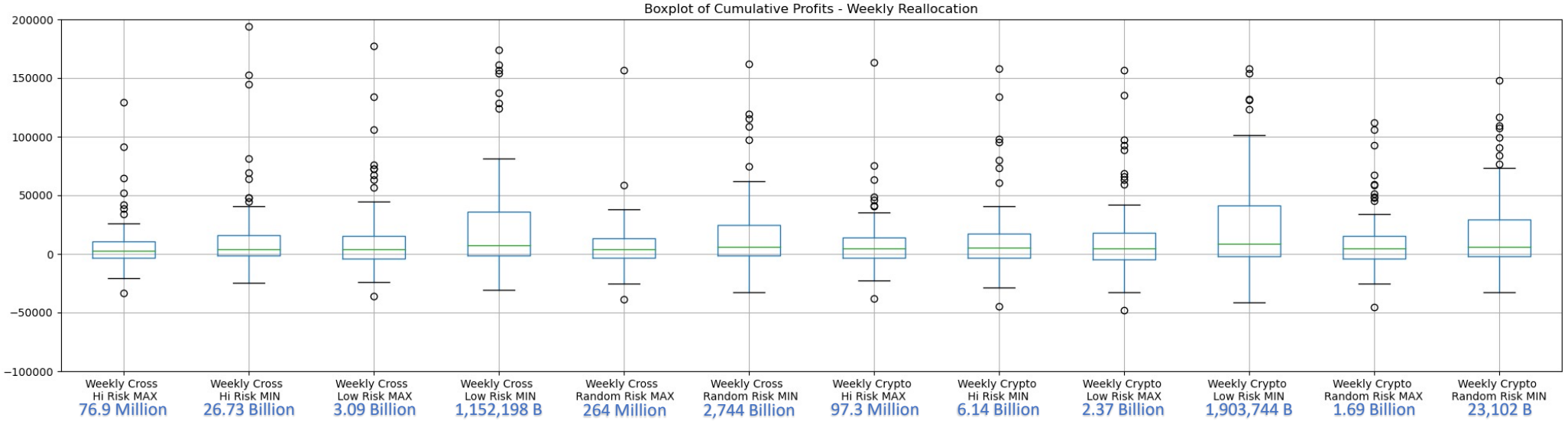
- Consider weekly & monthly reallocation
- Consider high, low & random risk tolerances
- Compare against including fiat currencies (+ tokenized gold)

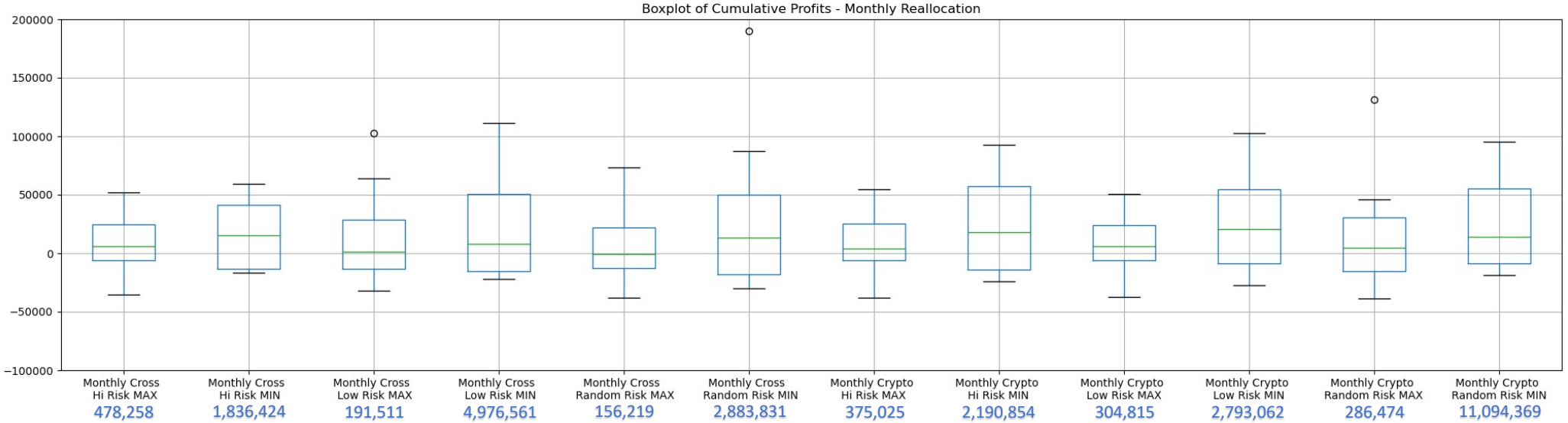
Challenges & Assumptions

- Only Currencies, mainly crypto
- Timeframe: Jan 2021 – Dec 2022
- Not all currencies traded for entire period, so had to impute data
- Reduced currencies considered based on most popular categories
- Divided market capitalization into large and small
- Multiprocessing required (60+ GHz used)
- Only 50 iterations due to run time
- $100,000 initial investment

RESULTS

Cumulative Profit Comparison

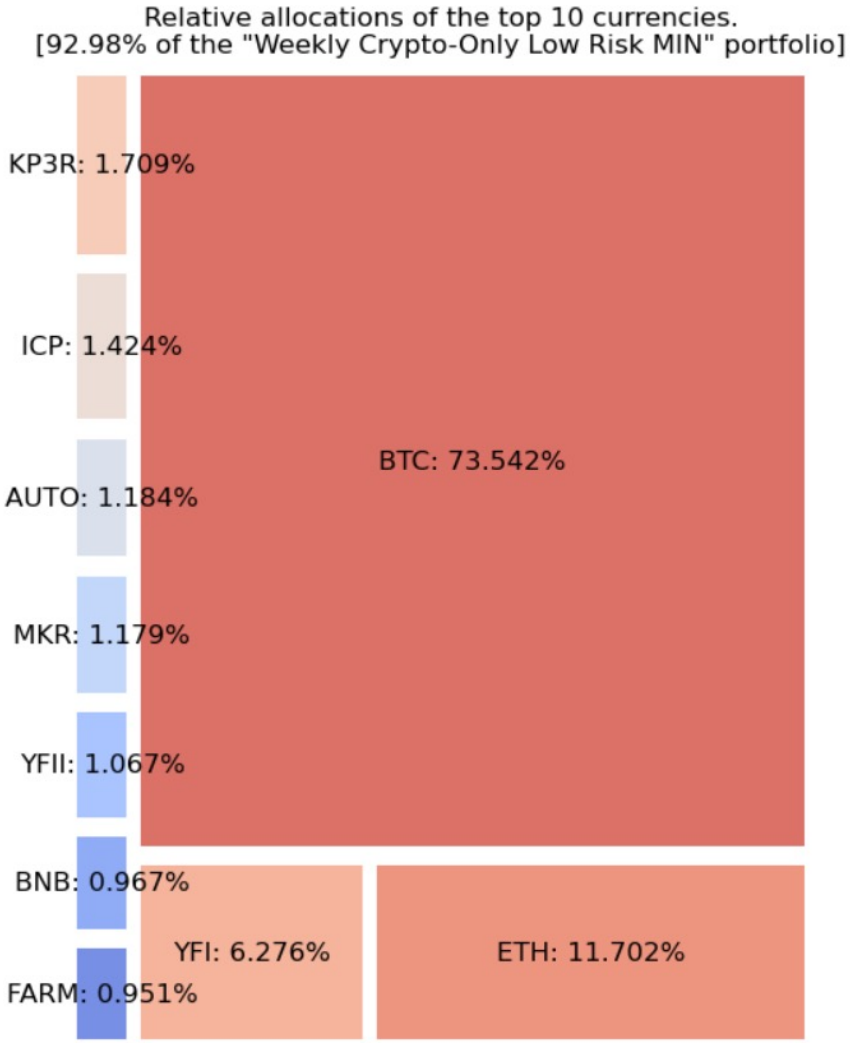


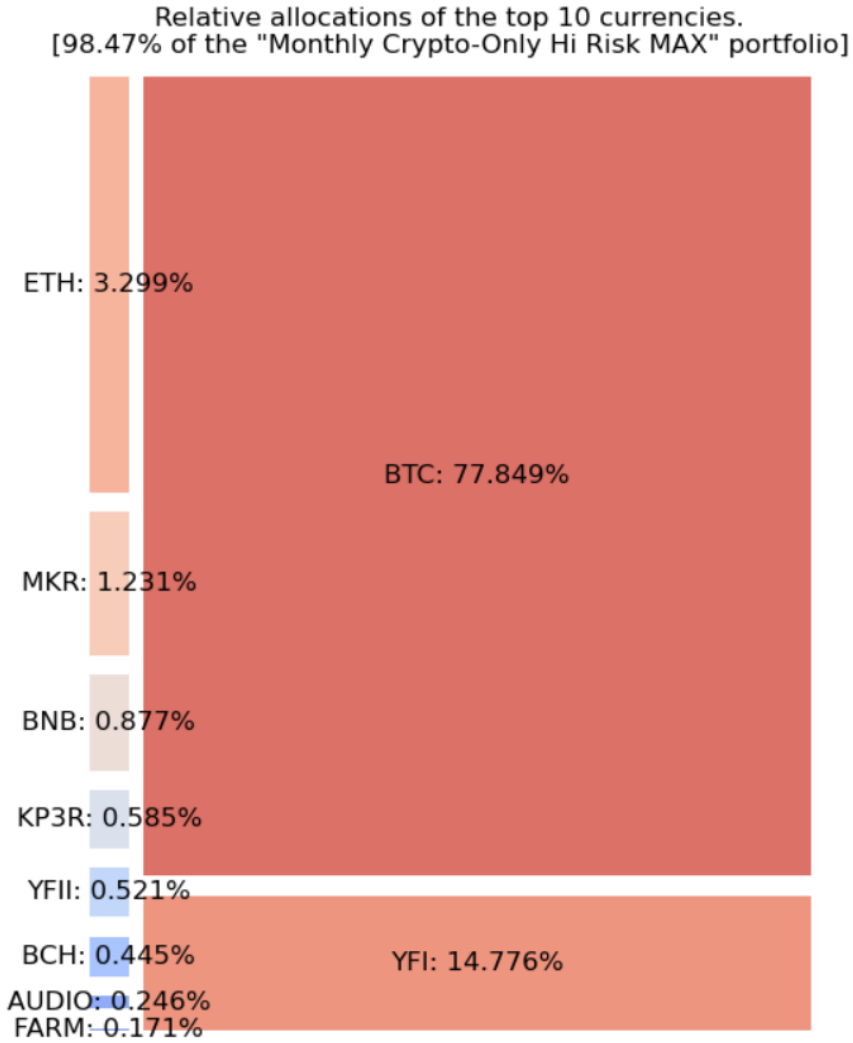


Summary of Best & Worst Portfolios

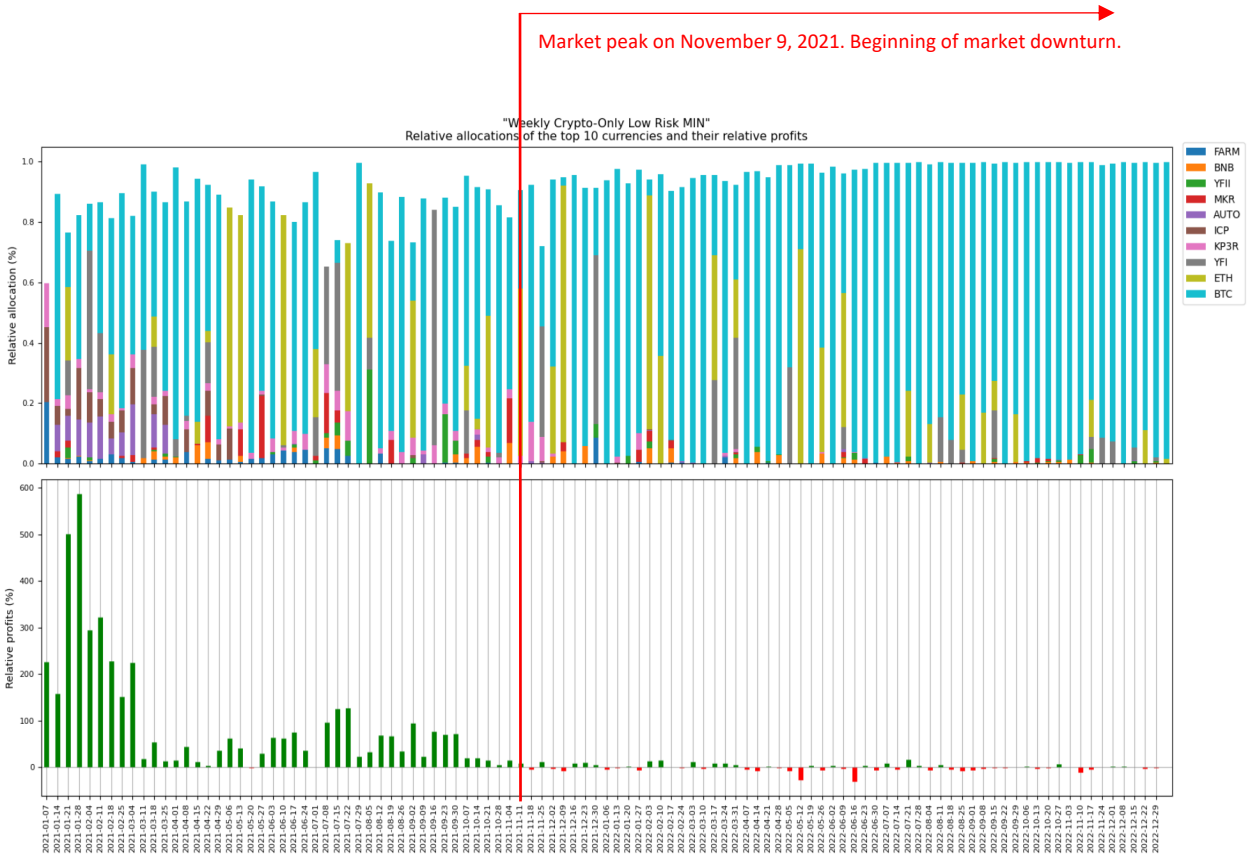
Portfolio	λ	Allocation	CVaR	Assets	Total Profit	Normalized Profit
Weekly Crypto-Only Low Risk MIN	0.1	Weekly	Minimum	Crypto	1.093744E15	1.0
Weekly Low Risk MIN	0.1	Weekly	Minimum	Cross-Asset	1.152199E15	0.6052276
Monthly Crypto-Only Low Risk MAX	0.1	Monthly	Maximum	Crypto	3.048150E05	1.60113E-10
Monthly Low Risk MAX	0.1	Monthly	Maximum	Cross-Asset	1.915110E05	1.00597E-10

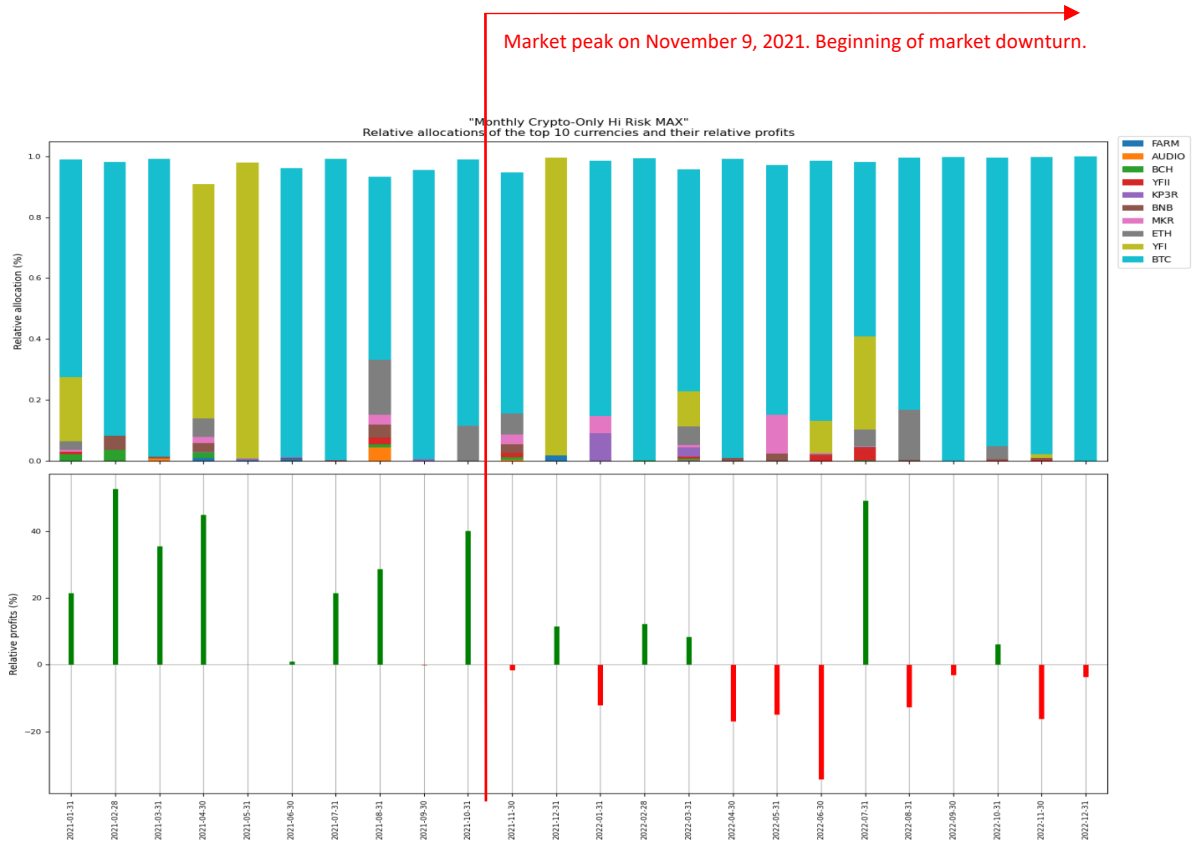
Relative Allocation Comparison



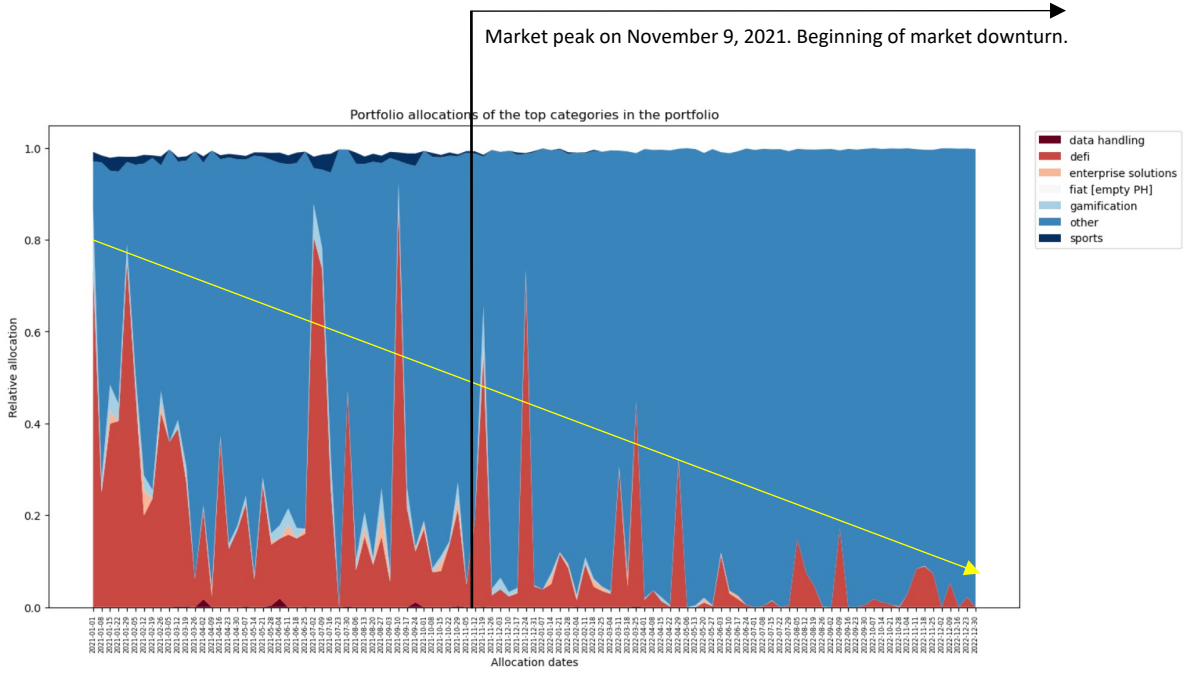


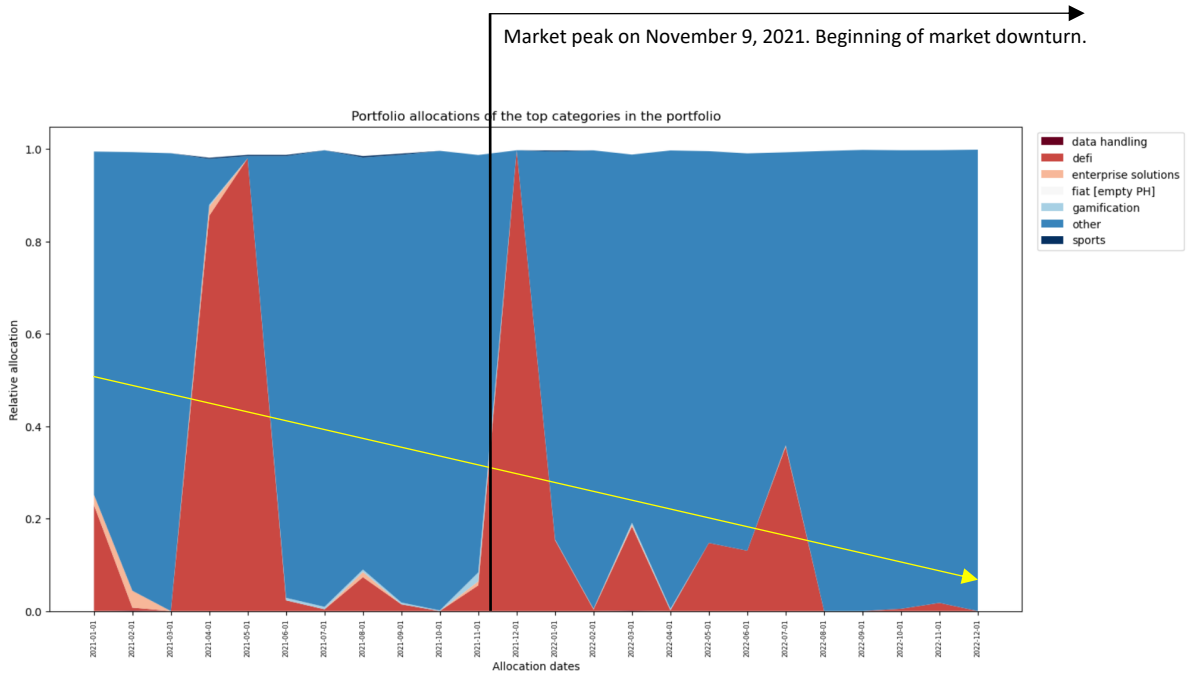
Relative Profit Comparison



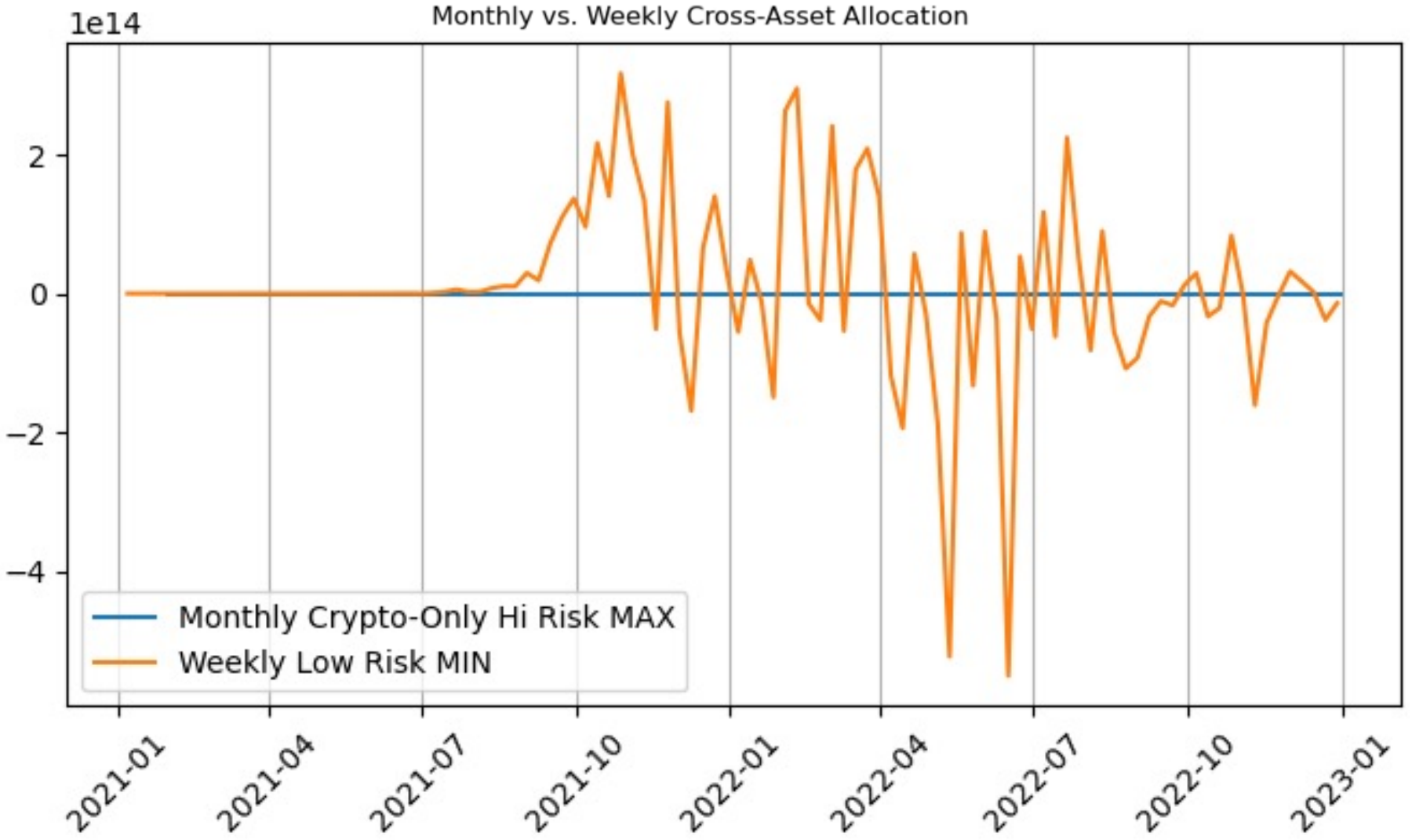


Trend in Allocation

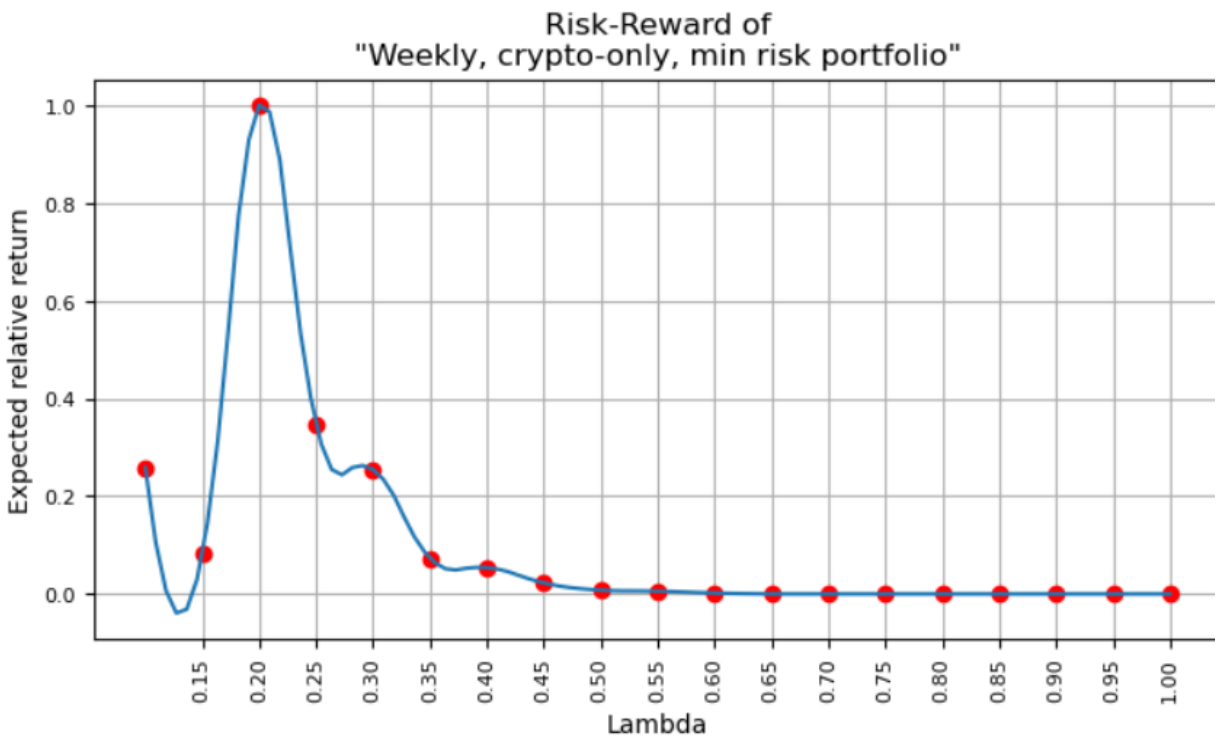


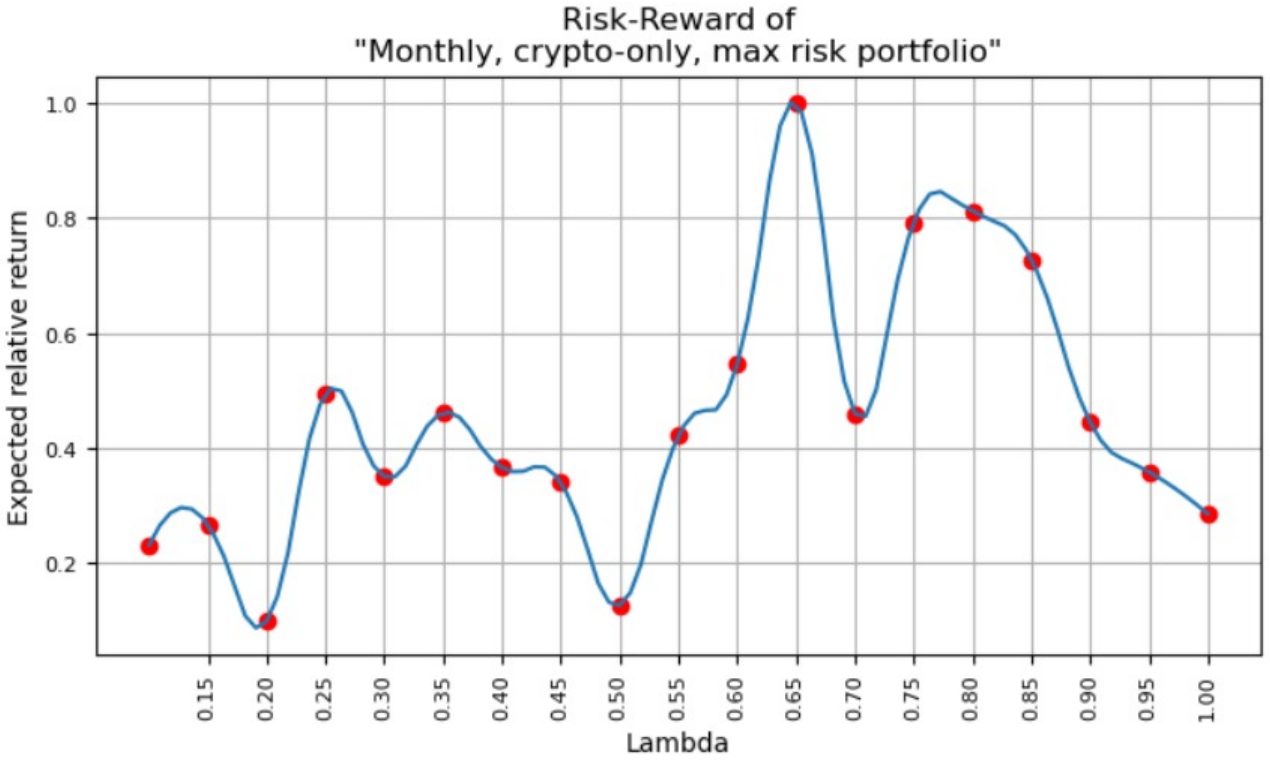


Profit Comparison



Efficient Frontier Comparison





CONCLUSION

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