Analyzing the Role of Bridges in Cross-Chain MEV Extraction

Danut Ilisei

10.06.2024, Master's Thesis Final Presentation

Chair of Software Engineering for Business Information Systems (sebis)
Department of Computer Science
School of Computation, Information and Technology (CIT)
Technical University of Munich (TUM)
wwwmatthes.in.tum.de

Outline

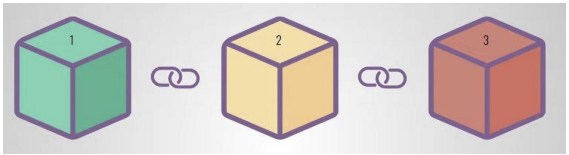
- Background & Motivation
- Problem Statement
- Research Questions
- Methodology
- Results
- Evaluation & Future Work

Background & Motivation

Blockchains

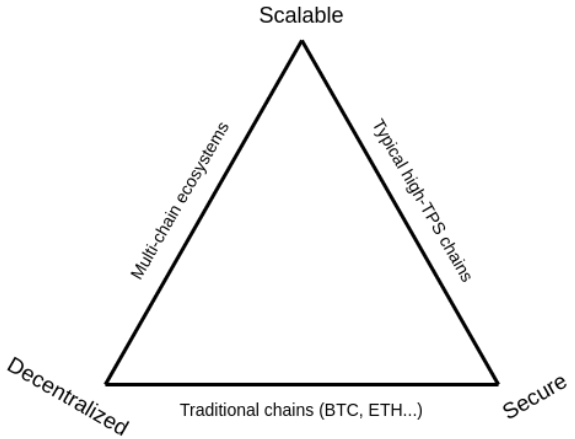
The three pillars of blockchain technology:

- Decentralization
- Transparency
- Immutability



Why do multiple blockchains exist instead of a single unified blockchain?

- Various use cases
- Blockchain trilemma



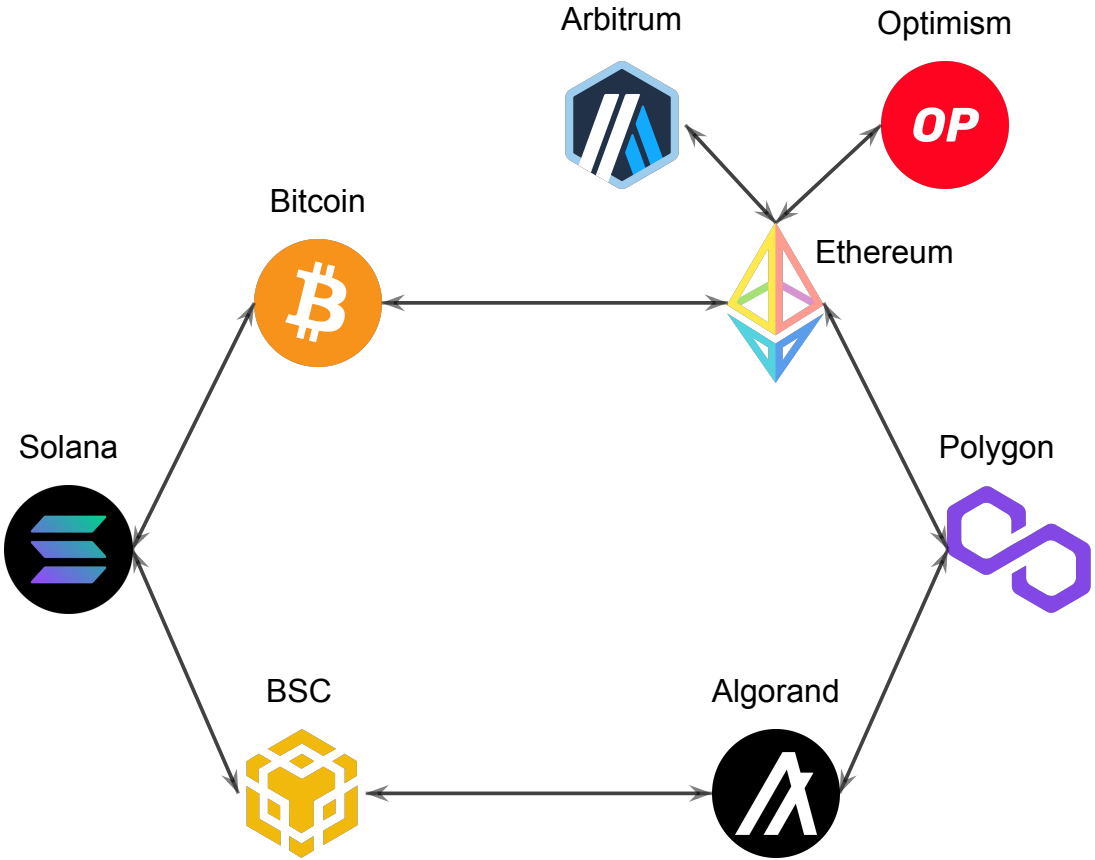
[Blockchain] Simply Explained, How does a Blockchain work on YouTube

[Trilemma] Vitalik Buterin: Why sharding is great: demystifying the technical properties

Background & Motivation

Blockchain interoperability

- Blockchain networks can communicate with each other through interoperability protocols
- These are mechanisms that enable different blockchain networks to share data



Background & Motivation

Blockchain Bridges

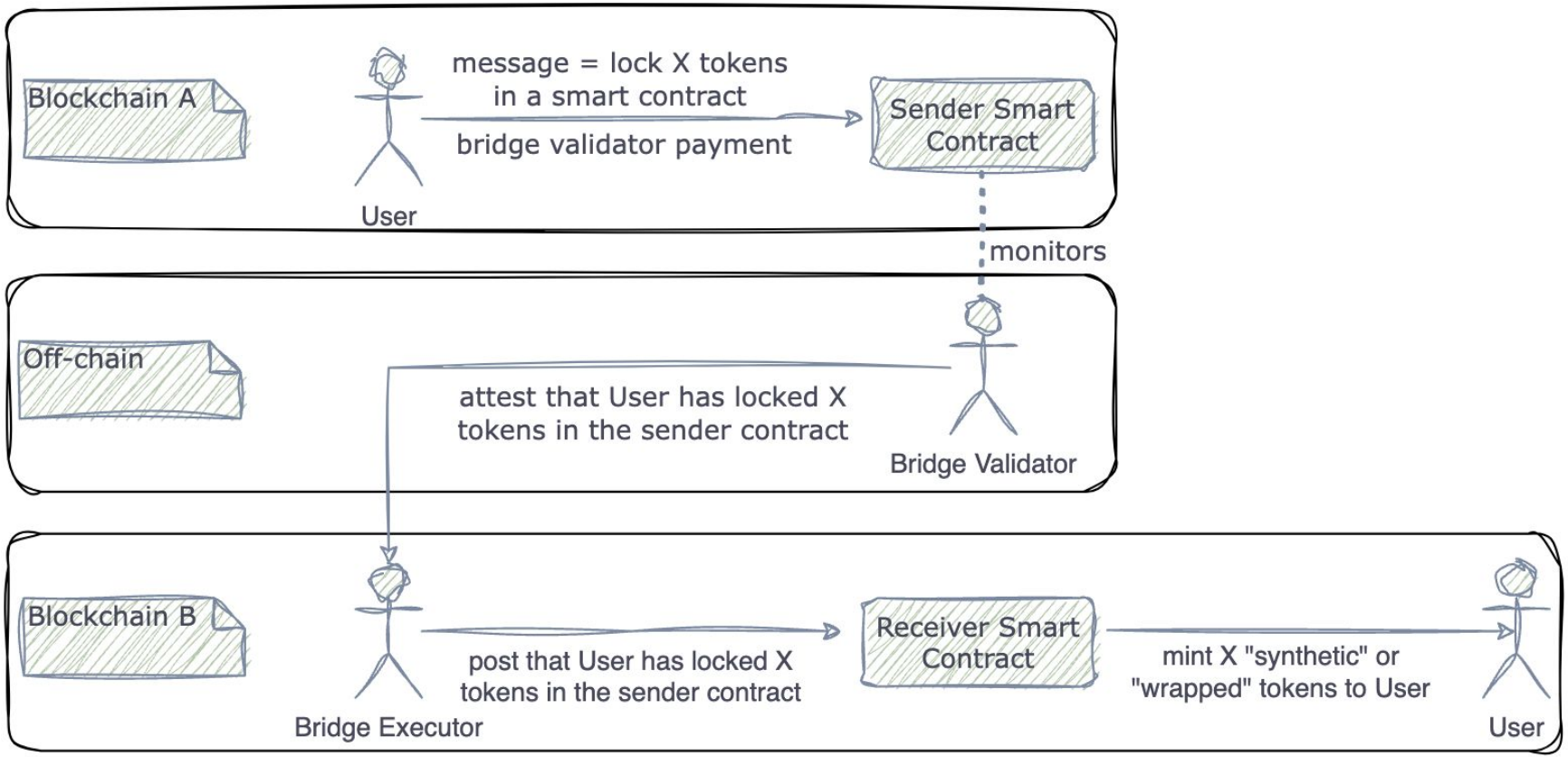
- Bridges facilitate communication between blockchains through the transfer of information and assets
- The demand to move assets across blockchains increases in proportion to the number of blockchains
- Bridges break the interoperability barrier!

[Ethereum] *Ethereum: Blockchain bridges*

[Bitnovo] *Bitnovo: What are blockchain bridges?*

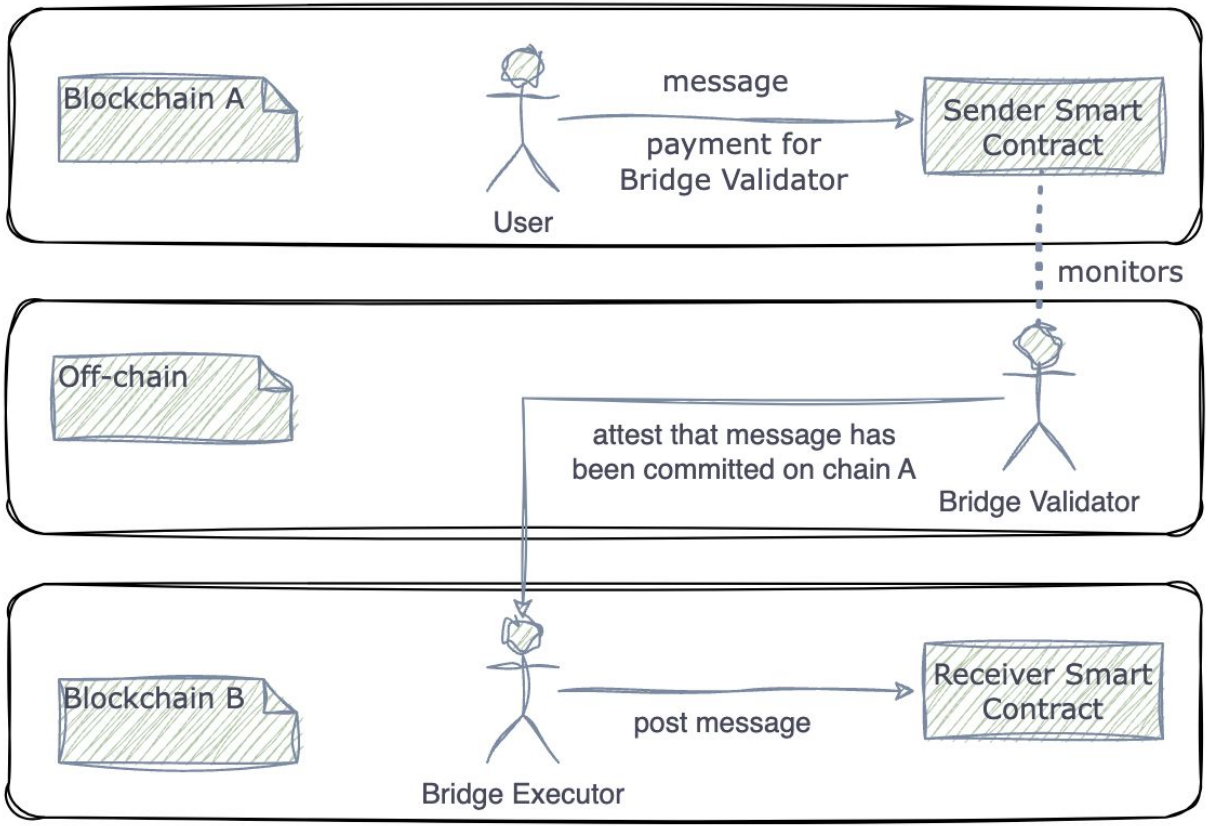
Background & Motivation

Blockchain Bridges



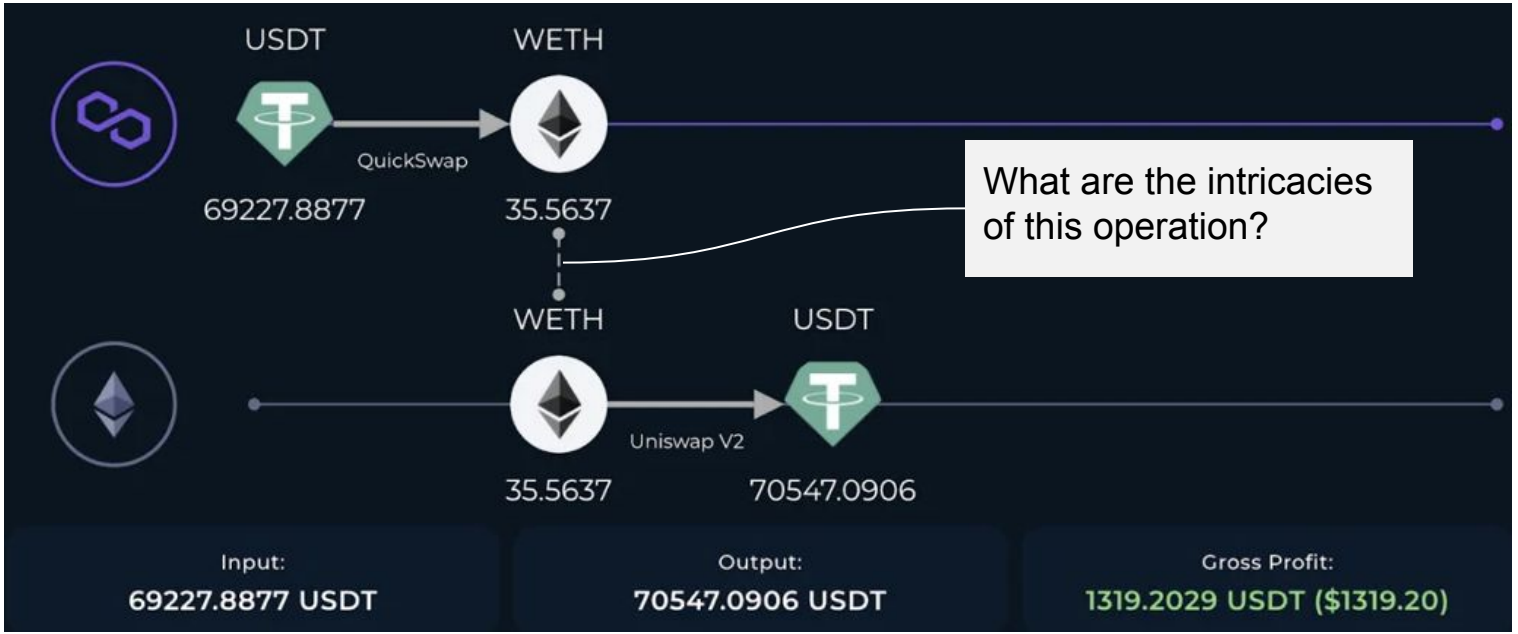
Background & Motivation

Blockchain Bridges



Problem Statement

Cross-Chain Maximal Extractable Value



[Blocknative] *Blocknative: The Fundamentals of Cross-Chain MEV*

Research Questions

RQ1	What are the existing interoperability solutions for connecting different blockchain networks?
RQ2	What does the existing literature reveal about the current state of MEV in the context of cross-chain operations?
RQ3	How can we quantify cross-chain MEV extraction enabled by a selected blockchain bridge?
RQ4	What are the risks of cross-domain MEV?

Research Questions

Interoperability solutions

Type			Protocol	Message Verification
Arbitrary Messaging Bridges			LayerZero	External
			Wormhole	External
			Axelar	External
Token Bridges	Liquidity Networks	Pool Based	Across	Optimistic
			Hop	Optimistic
			Connext	Optimistic
			cBridge	External
			Stargate	External
		Order Flow Based	deBridge	External
			UniswapX	External
	Burn and mint	Stable Coins	Circle CCTP	External
			Maker Teleport	External
		Bridge Standards	Connext xERC20	Optimistic
			LayerZero OFT	External
			Polygon Bridge	Native
	Lock and mint		wBTC	External

[LayerZero] LayerZero: GitBook documentation

[Wormhole] Wormhole: GitBook documentation

[Axelar] Axelar: What is Aexlar?

[Across] Across: The Bridge Ethereum Deserves

[Hop] Hop: GitBook documentation

[Connext] Connext: GitBook documentation

[cBridge] cBridge: GitBook documentation

[Stargate] Stargate: GitBook documentation

[deBridge] deBridge: GitBook documentation

[uniswapX] uniswapX: Uniswap documentation

[Circle CCTP] Circle CCTP: Cross-Chain Transfer Protocol

[Maker Teleport] Maker Teleport: DAI Teleport

[Connext xERC20] xERC20: Technical documentation

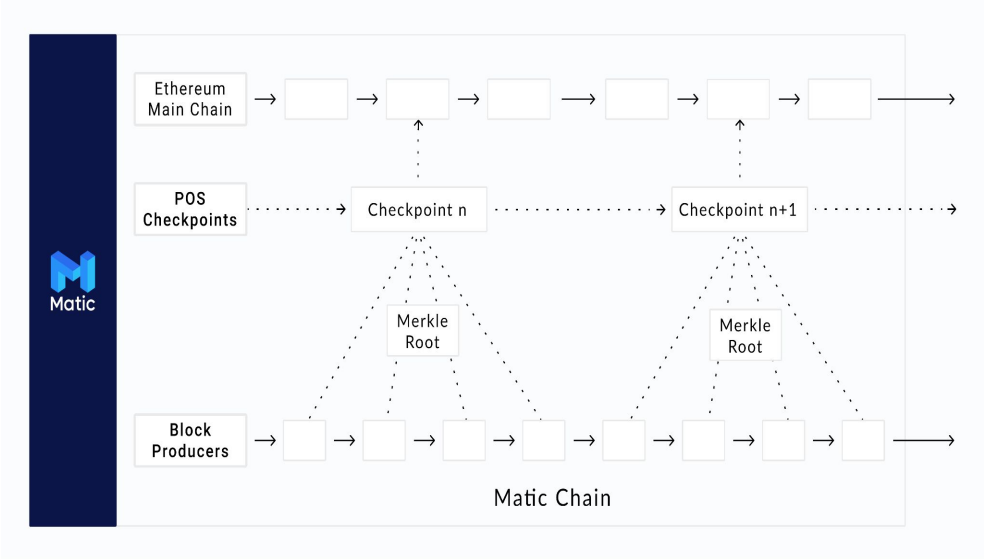
[LayerZero OFT] LayerZero OFT: Technical documentation

[Polygon Bridge] Polygon Bridge: Bridge Layers

[Wrapped Bitcoin] Wrapped Bitcoin: Whitepaper

Methodology

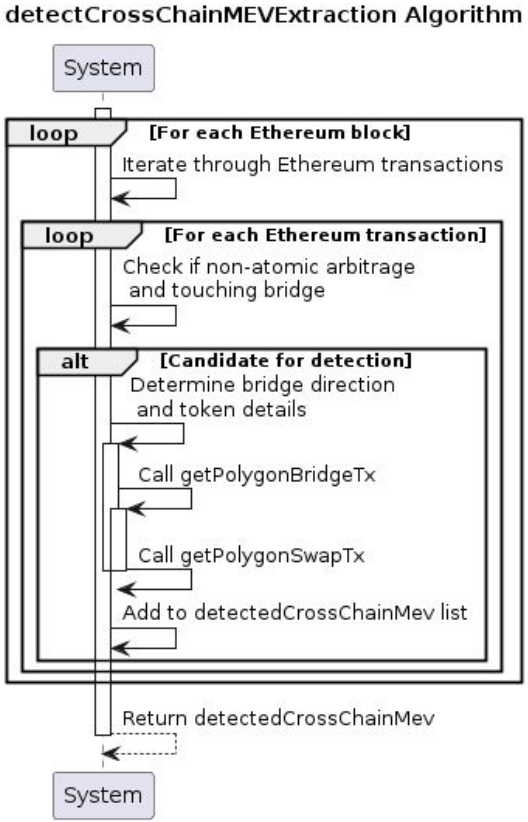
Case Study: Polygon Bridge



- Native mechanism for transferring assets between Ethereum and Polygon and vice versa
- Validators need time to process the cross-chain transfers
- Transparency exists for both legs of the cross-chain transactions

[Polygon] *Matic Whitepaper*

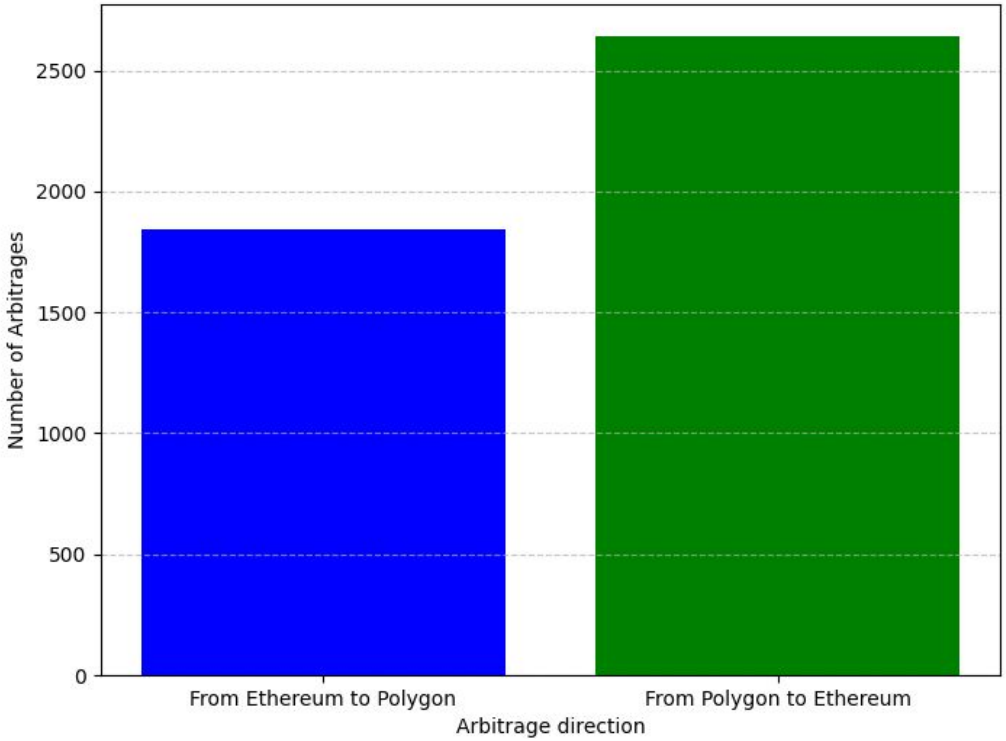
Methodology



- We collected and analyzed data from **1,000,000 blocks ≈ 140 days**
- We attempt to find **matching transactions** on the other side of the arbitrage for each candidate
- Once we identify the matching pairs, we can **reconstruct the arbitrage** and analyze the tokens and resulting profits

Results

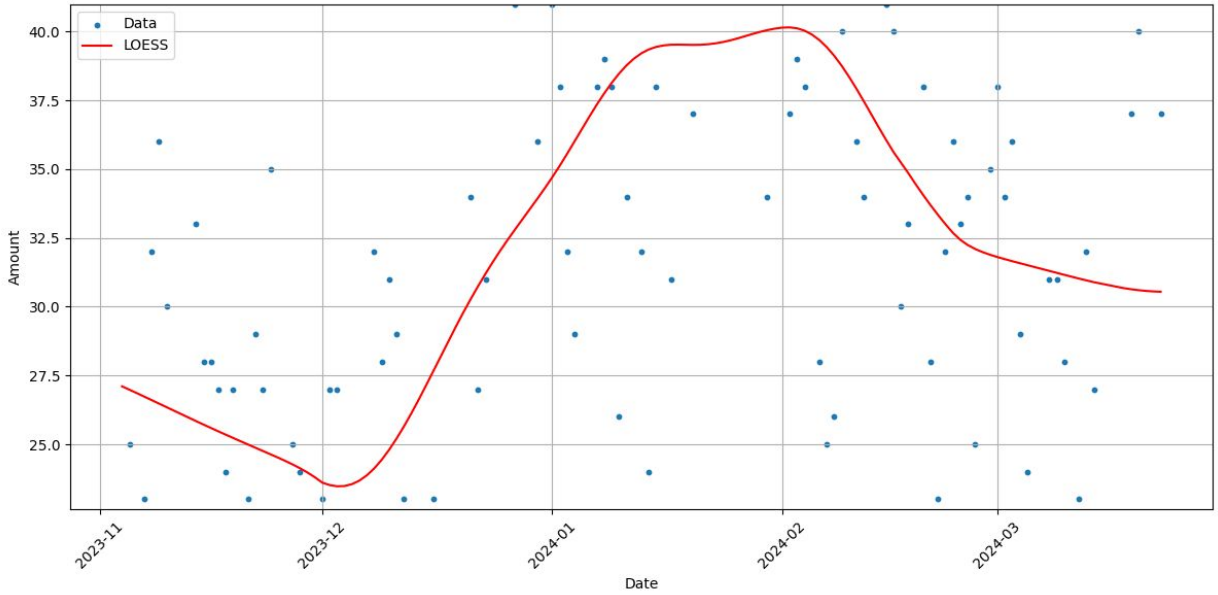
Frequency



- 4,488 instances of cross-chain MEV extraction
- 3,901 of these extractions to be cyclic arbitrages
- 3,311 transactions yielded a positive revenue

Results

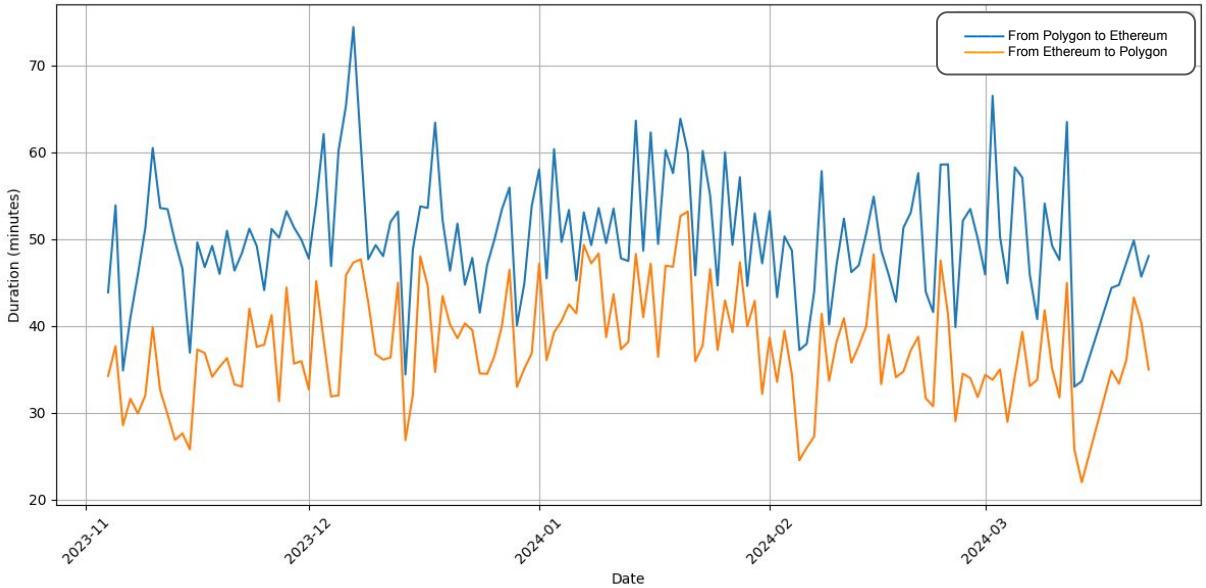
Frequency



- 32 arbitrages per day on average

Results

Duration



- Strong positive association between the durations of arbitrage in both directions (0.67)
- On average, extracting MEV
  - From Polygon to Ethereum: 50 minutes and 17 seconds
  - From Ethereum to Polygon: 20 minutes and 8 seconds

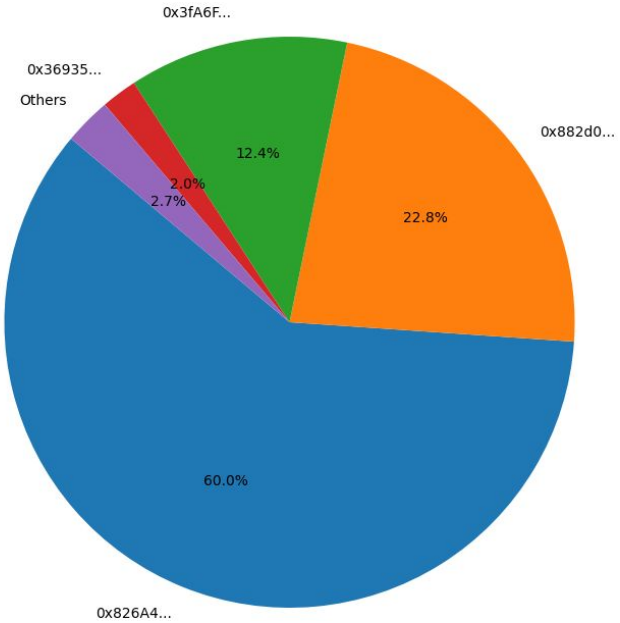
Results

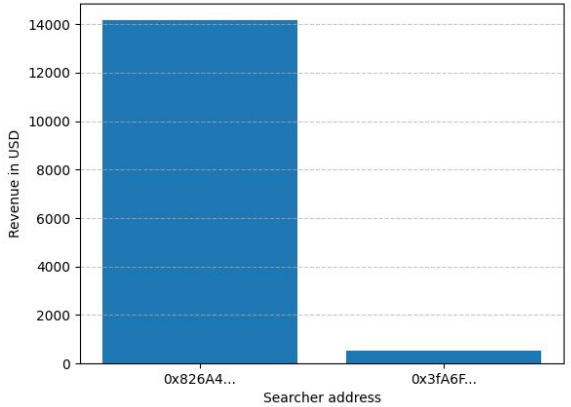
Bridged Tokens

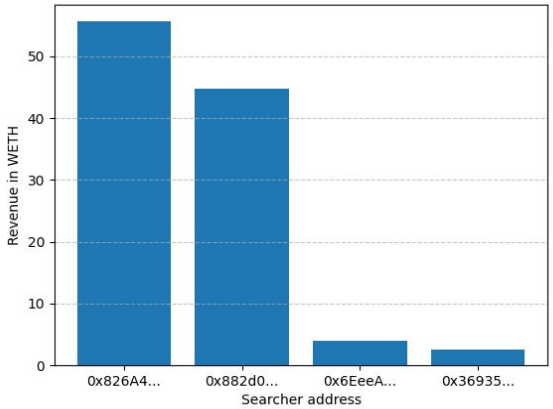
- Significant number of tokens
- Mostly unknown tokens
- Low-liquidity tokens

Results

Searchers Domination



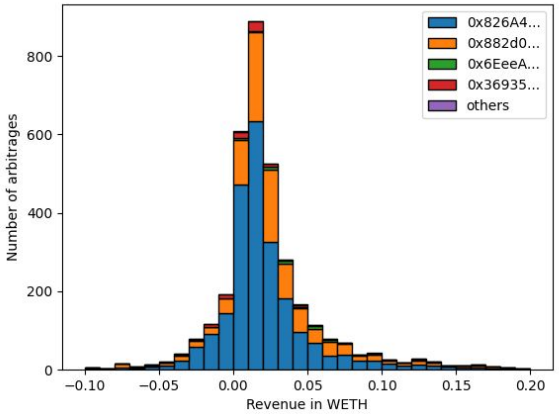


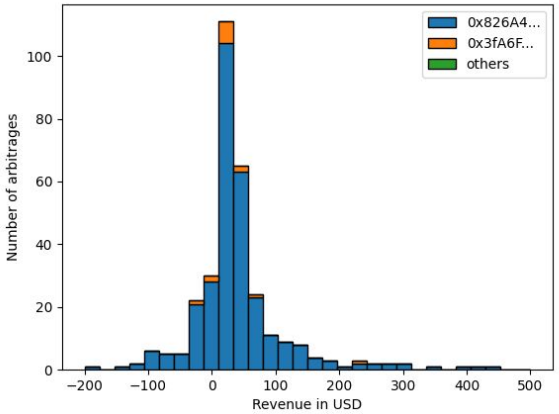


- Only a few searchers consistently succeed in extracting MEV
- Three searchers realized 95% of the arbitrages
- They can use the gained value to improve their algorithms and infrastructure, thereby consolidating further their dominance in the space

Results

Searchers Revenue Distribution





- WETH:
  - Average revenue: 0.02
  - Highest revenue: 1.83
  - Biggest loss: 0.61
- USD stable coin:
  - Average revenue: 45
  - Highest revenue: 708
  - Biggest loss: 443

Evaluation & Future Work

Evaluation & Limitations

We observed that these arbitrages do occur, albeit infrequently due to the extended bridging time

The tokens involved in these arbitrages are often unknown

Only a few arbitrageurs are able to profit from this situation

Future work should focus on enhancing the heuristic, as we maintained strict criteria in some aspects, and on evaluating the profitability of these strategies

BSc
Danut Ilisei
danut.ilisei@tum.de

Technical University of Munich (TUM)
TUM School of CIT
Department of Computer Science (CS)
Chair of Software Engineering for
Business Information Systems (sebis)

Boltzmannstraße 3
85748 Garching bei München

+49.89.289.17132
matthes@in.tum.de
wwwmatthes.in.tum.de