A Retrospective Analysis of Public and Private Order Flow on the Ethereum Blockchain

Deniz Yüksel

Start Date: 15.02.2024, Kick-off for Master's Thesis in Informatics

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

Motivation – Public Order Flow

Order Flow

- **Traditional Finance:** Stream of orders on protocols that facilitate crypto trading, matching buy & sell orders

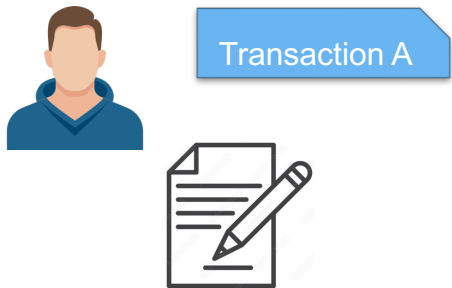- **Blockchain context:** All transactions entering into the blockchain network

Ethereum is a **public & permissionless blockchain:** open to public, join, participate in consensus, monitor, and validate without permission
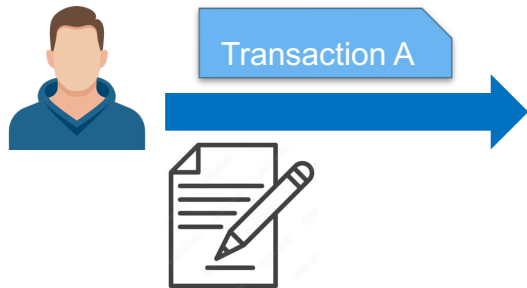
Motivation – Public Order Flow

Order Flow

- **Traditional Finance:** Stream of orders on protocols that facilitate crypto trading, matching buy & sell orders

- **Blockchain context:** All transactions entering into the blockchain network

Ethereum is a **public & permissionless blockchain:** open to public, join, participate in consensus, monitor, and validate without permission
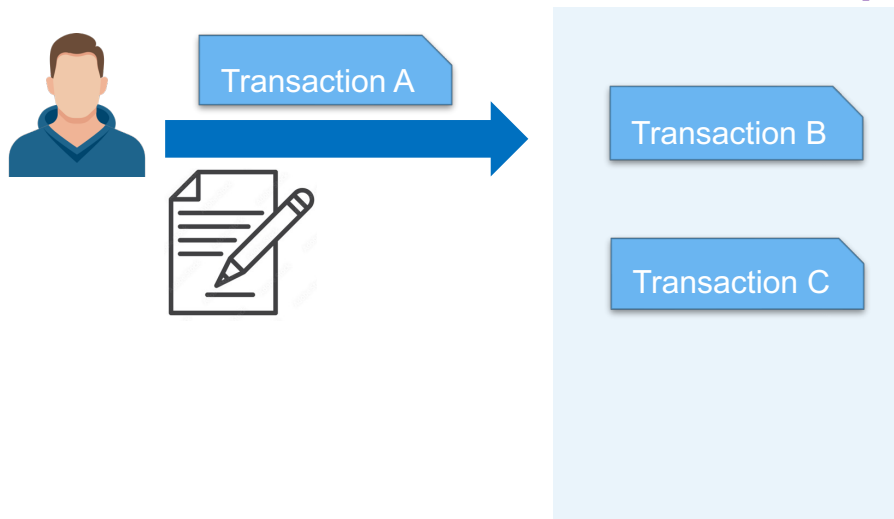
Transaction A

Motivation – Public Order Flow

Order Flow

- **Traditional Finance:** Stream of orders on protocols that facilitate crypto trading, matching buy & sell orders

- **Blockchain context:** All transactions entering into the blockchain network

Ethereum is a **public & permissionless blockchain:** open to public, join, participate in consensus, monitor, and validate without permission

Transaction A

Motivation – Public Order Flow

Order Flow

- **Traditional Finance:** Stream of orders on protocols that facilitate crypto trading, matching buy & sell orders

- **Blockchain context:** All transactions entering into the blockchain network

Ethereum is a **public & permissionless blockchain:** open to public, join, participate in consensus, monitor, and validate without permission
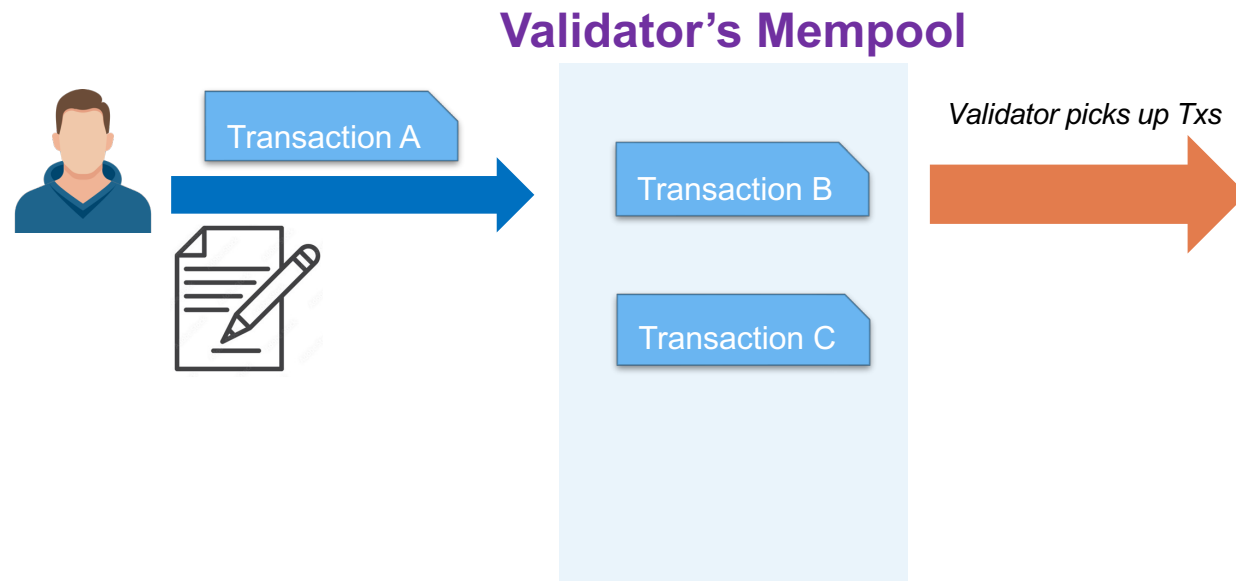
Validator's Mempool

Transaction A

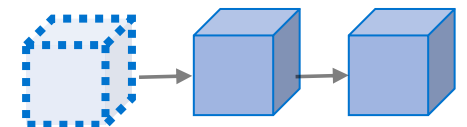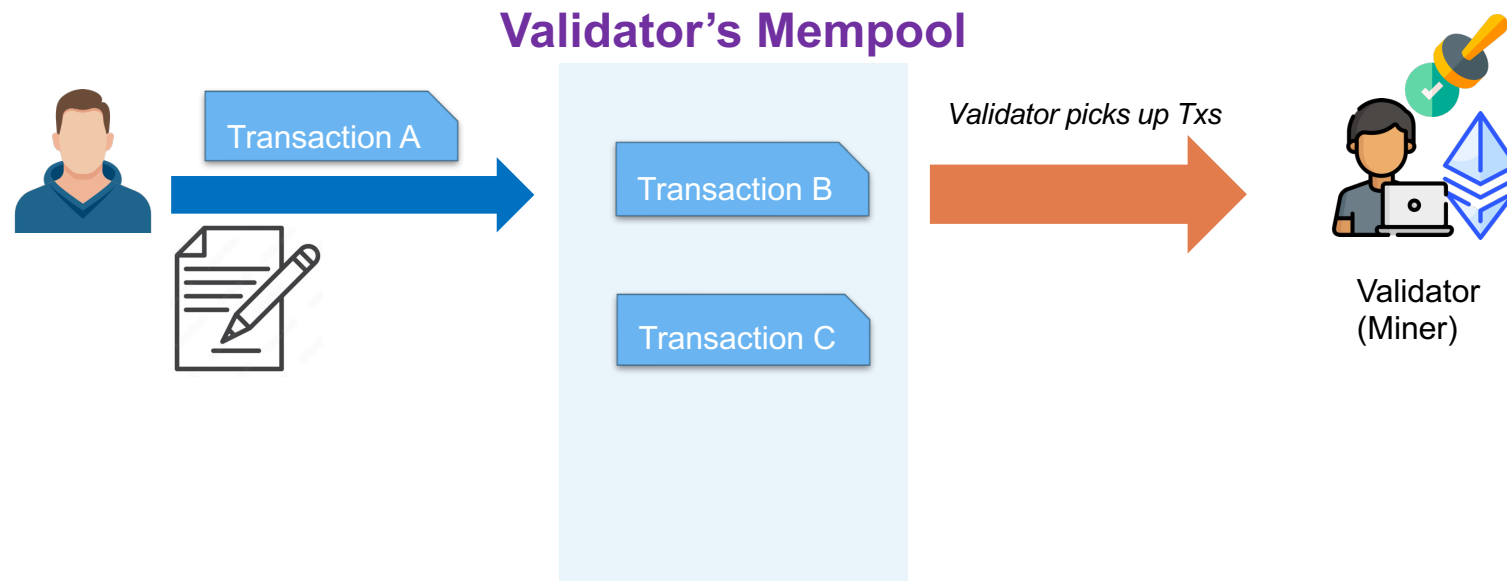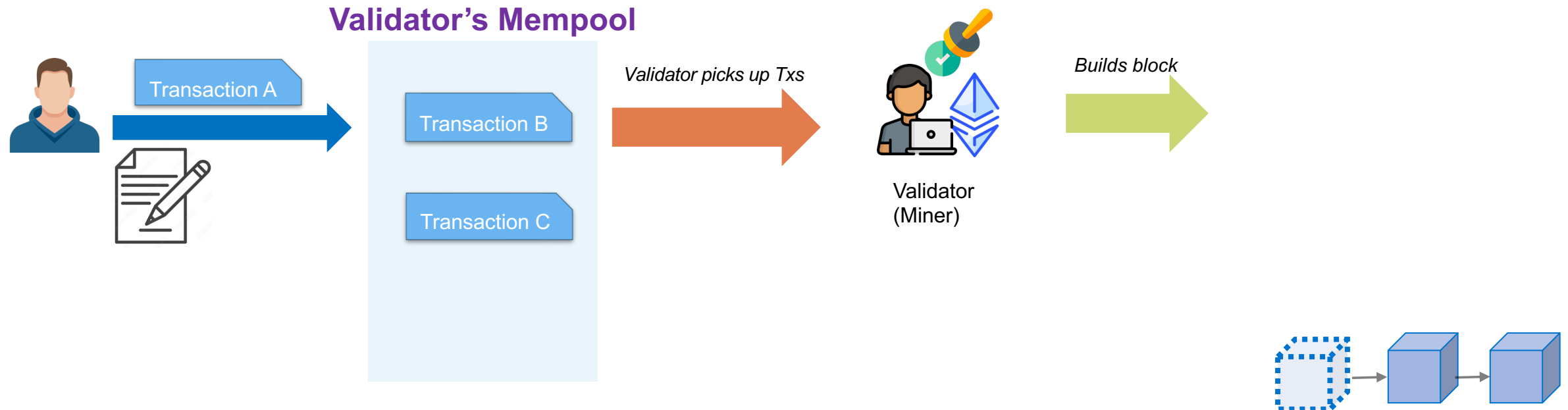Transaction B

Transaction C

Motivation – Public Order Flow

Order Flow

- **Traditional Finance:** Stream of orders on protocols that facilitate crypto trading, matching buy & sell orders

- **Blockchain context:** All transactions entering into the blockchain network

Ethereum is a **public & permissionless blockchain:** open to public, join, participate in consensus, monitor, and validate without permission

Validator's Mempool

Transaction A

Transaction B

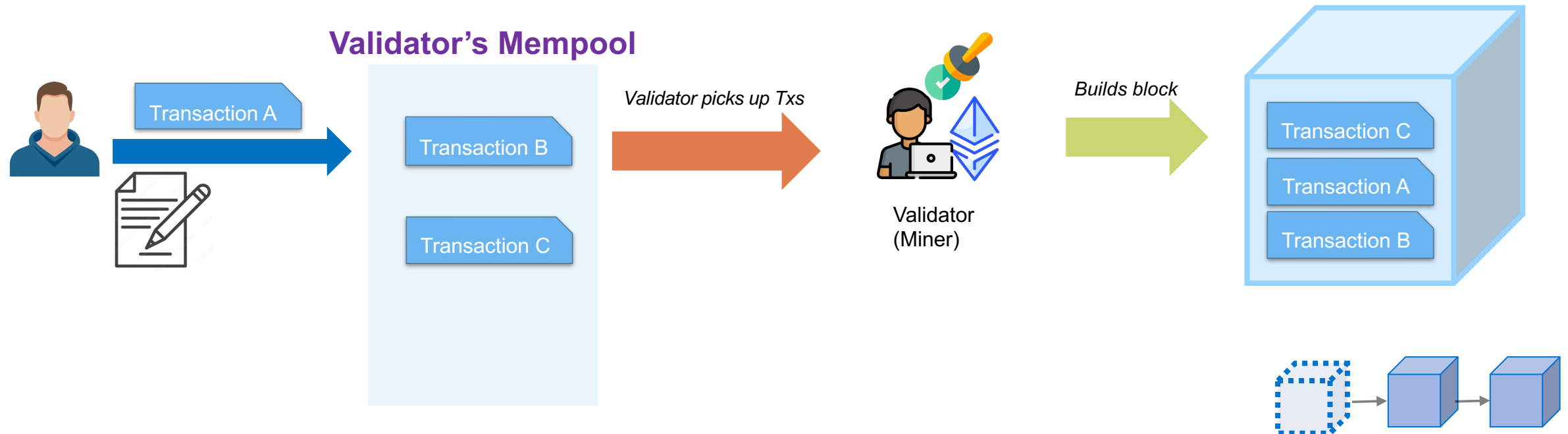Transaction C

Validator picks up Txs

Motivation – Public Order Flow
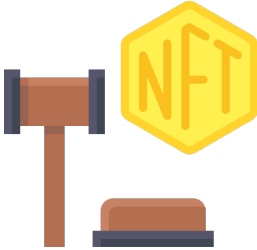
Order Flow

- **Traditional Finance:** Stream of orders on protocols that facilitate crypto trading, matching buy & sell orders

- **Blockchain context:** All transactions entering into the blockchain network

Ethereum is a **public & permissionless blockchain:** open to public, join, participate in consensus, monitor, and validate without permission

Validator's Mempool

Transaction A

Transaction B

Transaction C

Validator picks up Txs

Validator
(Miner)

Motivation – Public Order Flow

Order Flow

- **Traditional Finance:** Stream of orders on protocols that facilitate crypto trading, matching buy & sell orders

- **Blockchain context:** All transactions entering into the blockchain network

Ethereum is a **public & permissionless blockchain:** open to public, join, participate in consensus, monitor, and validate without permission
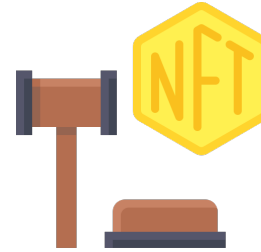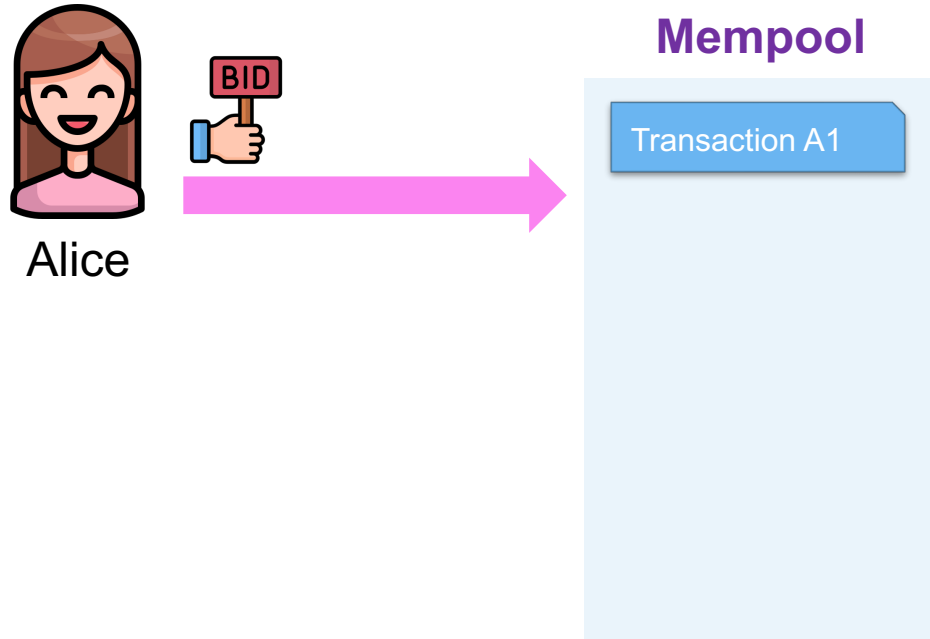

Validator's Mempool

Transaction A

Transaction B

Transaction C

Validator picks up Txs

Validator (Miner)

Builds block

Motivation – Public Order Flow

Order Flow

- **Traditional Finance:** Stream of orders on protocols that facilitate crypto trading, matching buy & sell orders

- **Blockchain context:** All transactions entering into the blockchain network

Ethereum is a **public & permissionless blockchain:** open to public, join, participate in consensus, monitor, and validate without permission

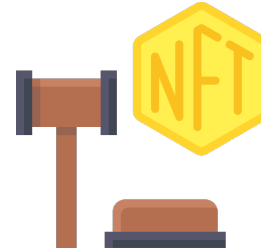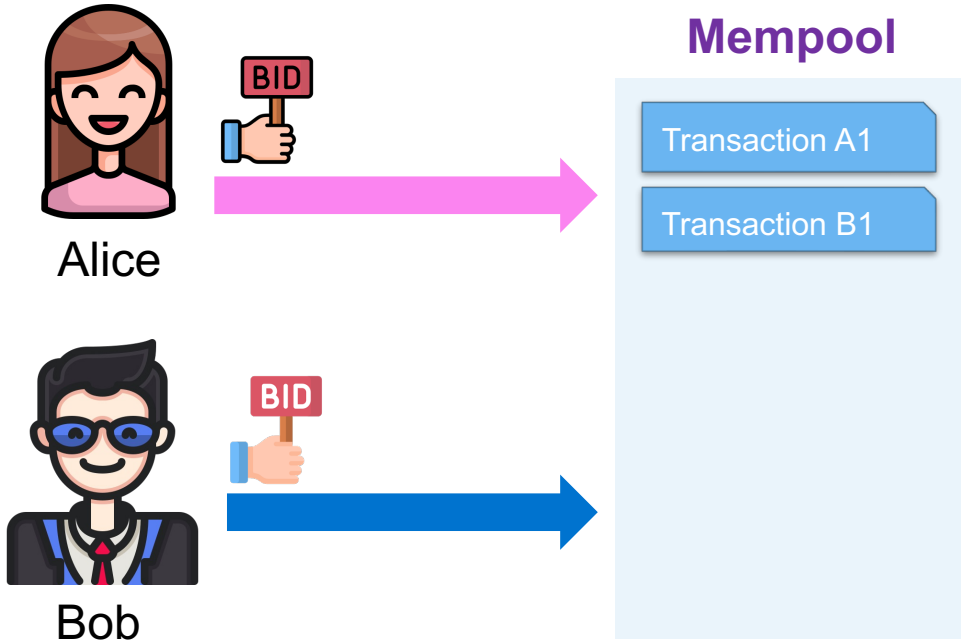# Motivation – Is There a Problem?

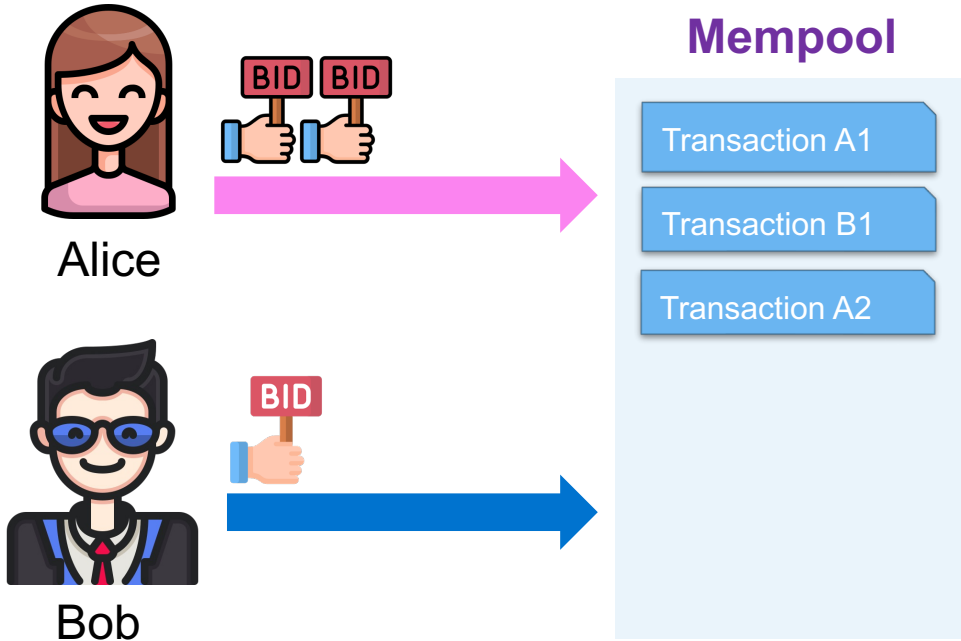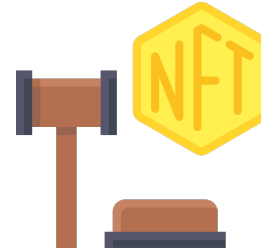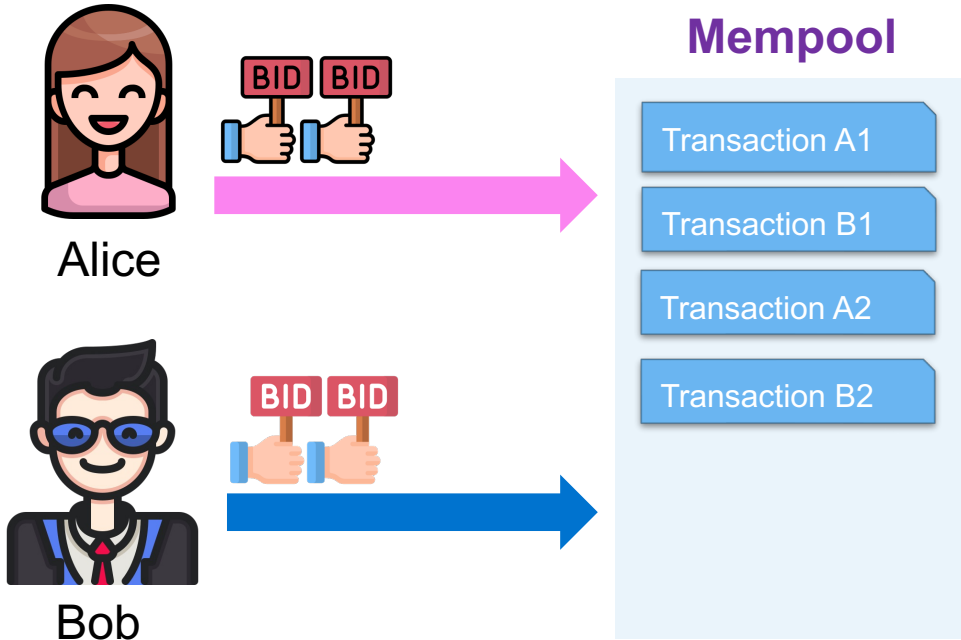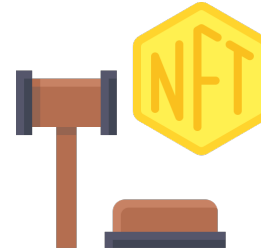# Motivation – Is There a Problem?


0.1490   ETH

Motivation – Is There a Problem?

Mempool

Transaction A1

Alice

0.1491   ETH

Motivation – Is There a Problem?

Mempool

Transaction A1

Transaction B1

Alice

Bob

0.1492   ETH

Motivation – Is There a Problem?

Mempool

| Alice | | Transaction A1 |
| Transaction B1 |
| Transaction A2 |

Bob

0.1493   ETH

Motivation – Is There a Problem?

Mempool

- Transaction A1
- Transaction B1
- Transaction A2
- Transaction B2

Alice

Bob

0.1494   ETH

Motivation – Is There a Problem?

Motivation – Is There a Problem?

Mempool

- Transaction A1
- Transaction B1
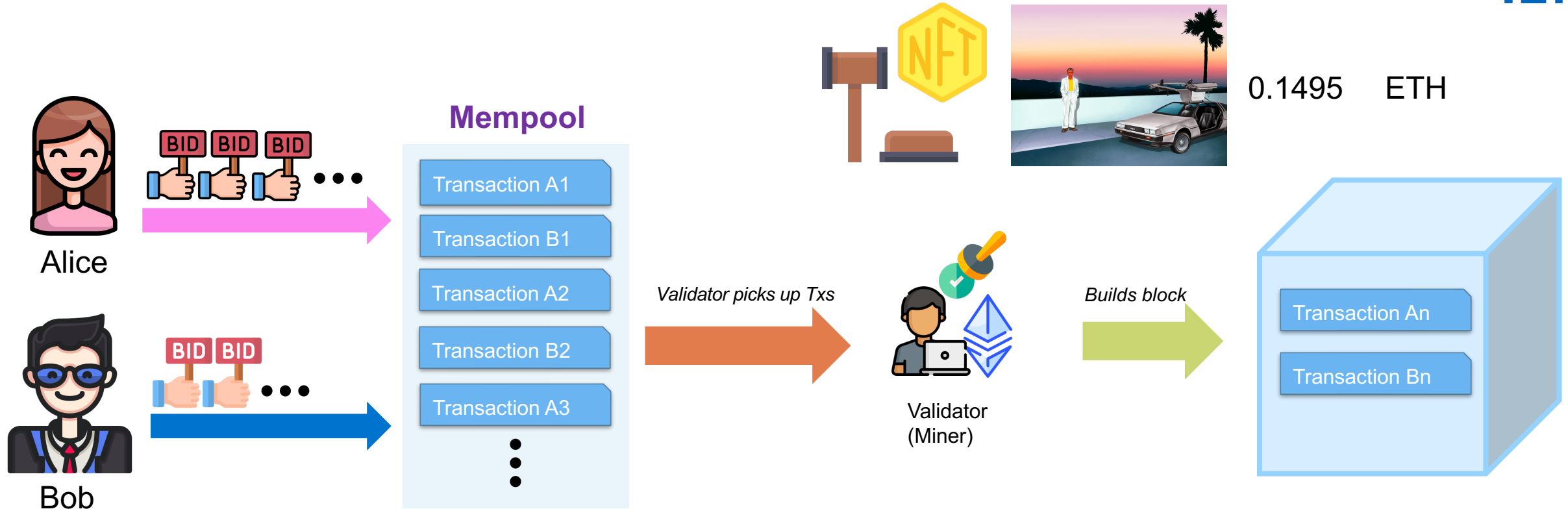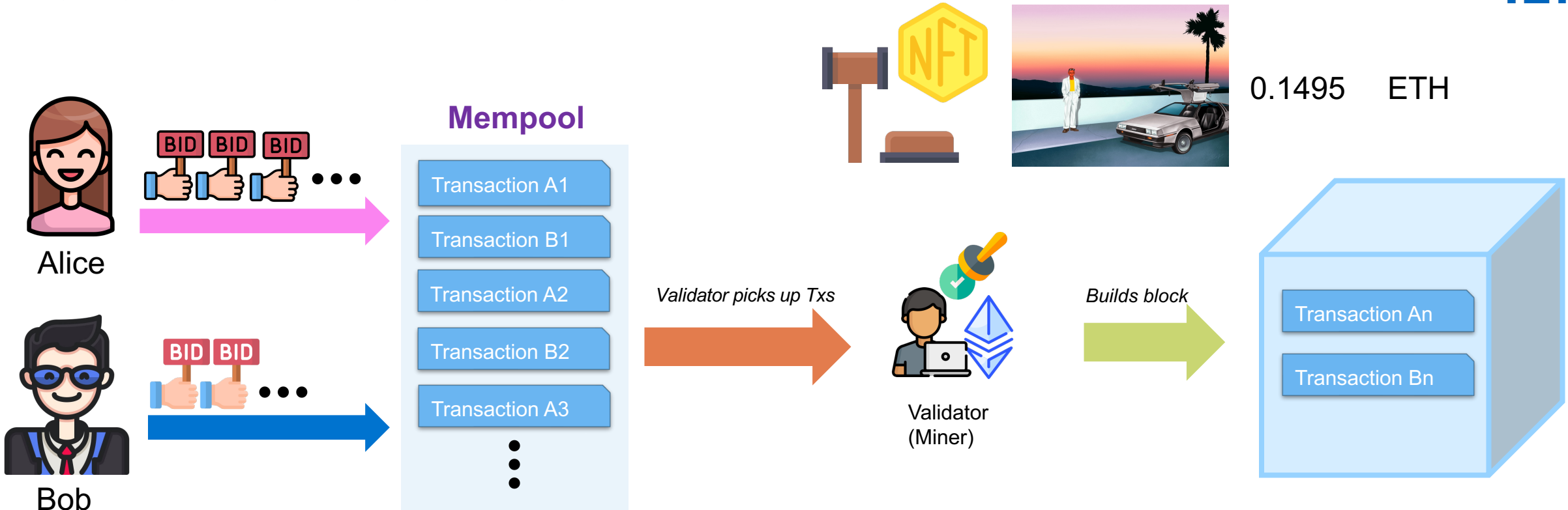- Transaction A2
- Transaction B2
- Transaction A3

Alice

Bob
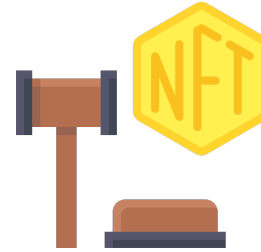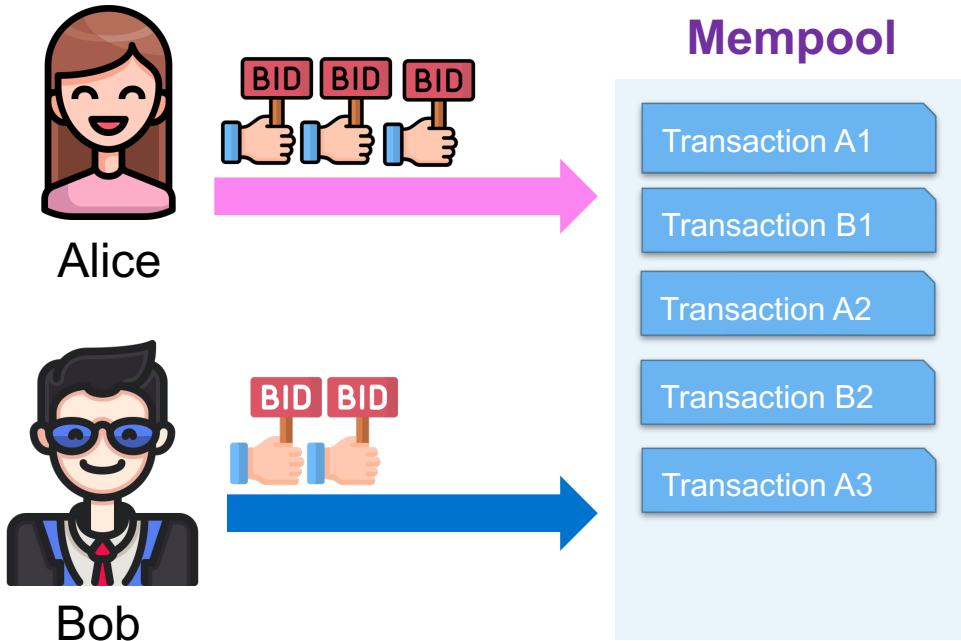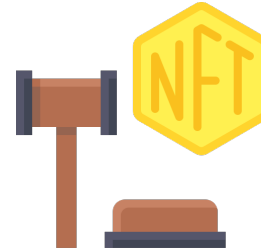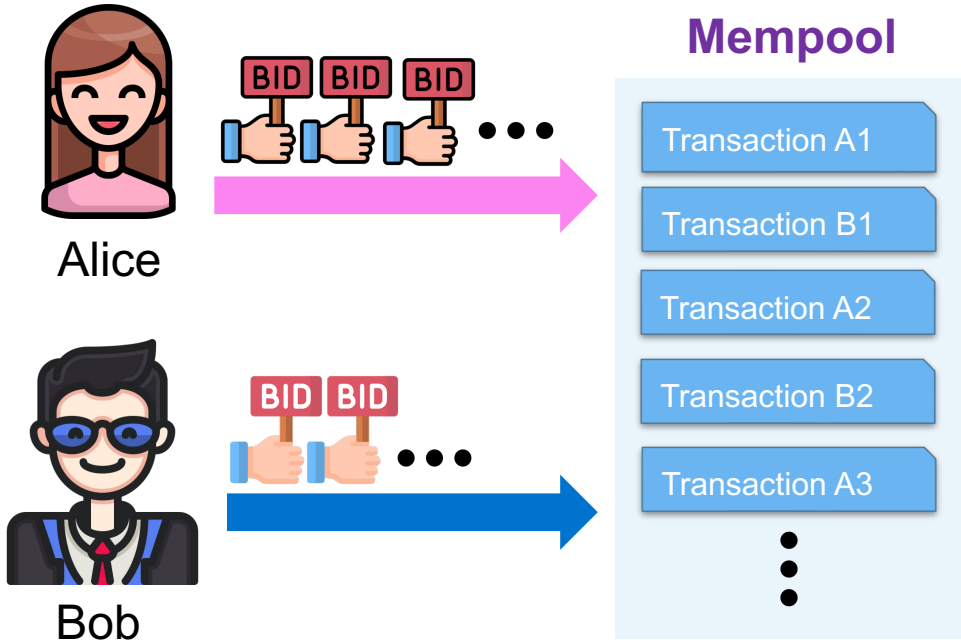
0.1495   ETH

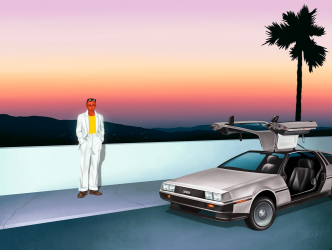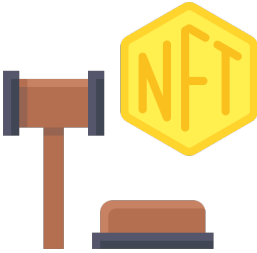# Motivation – Is There a Problem?
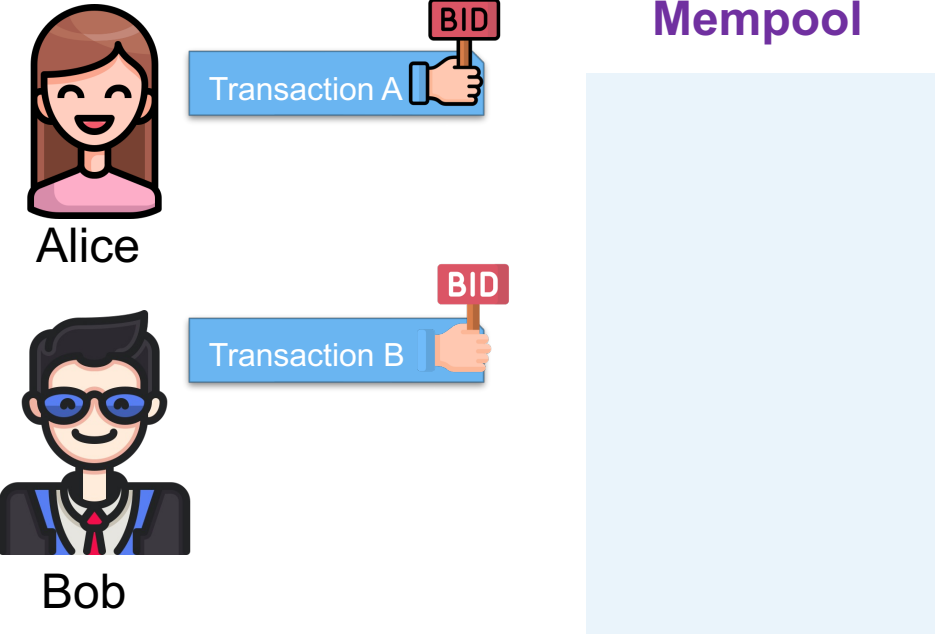
Motivation – Is There a Problem?

- The **availability of public information** in public permissionless blockchains can have **negative externalities!**

  - Network usage, meaningless transactions congesting mempool, fees & inclusion time for other participants [1]

- Other examples include **DeFi** (Decentralized Finance), **voting** …

- In this thesis we will concentrate on **DeFi** use cases

An Emerging Solution: Private Mempools

0.1490 ETH

Alice

Transaction A

Bob

Transaction B

Mempool

An Emerging Solution: Private Mempools
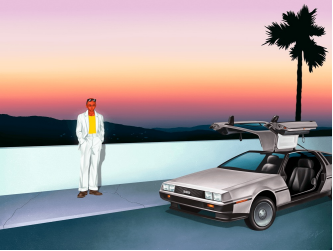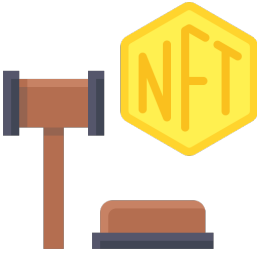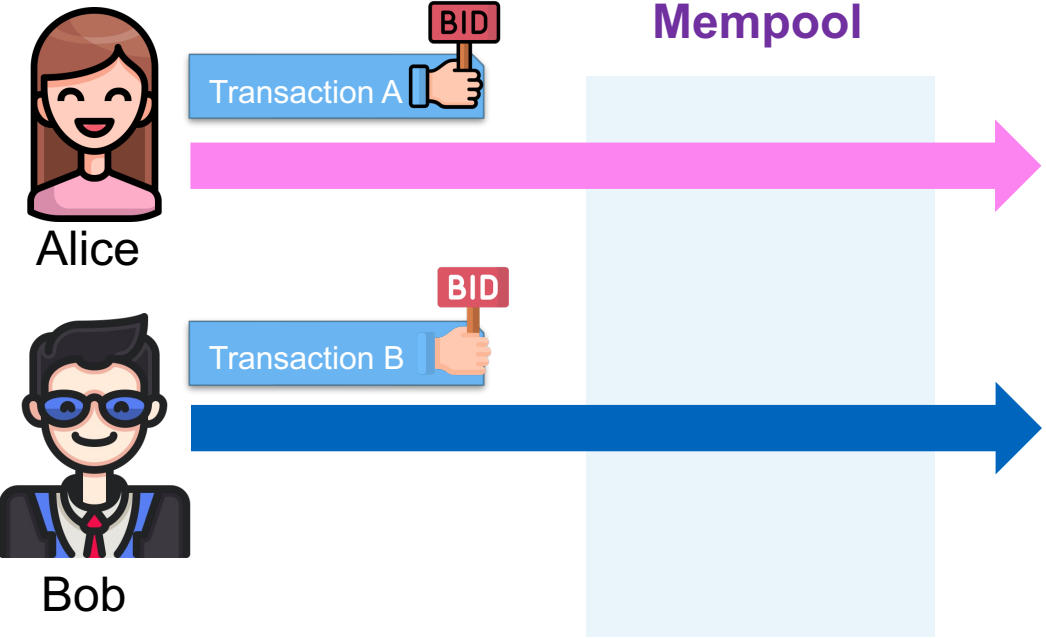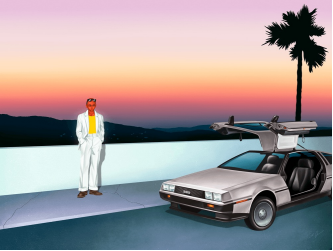
An Emerging Solution: Private Mempools

0.1490

ETH

Mempool

Transaction A

Alice

BID

Transaction B

Bob

BID

Private
RPC
Endpoint

Whitelisted
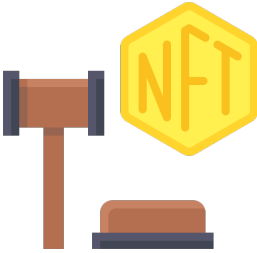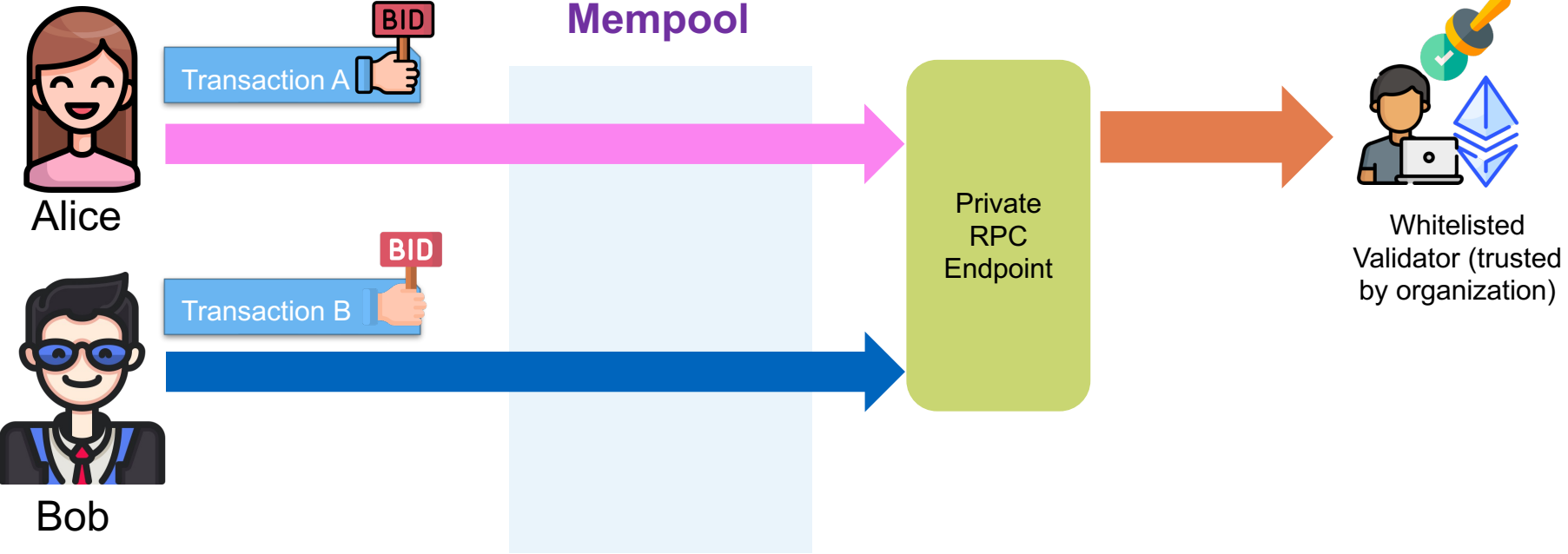Validator (trusted
by organization)

An Emerging Solution: Private Mempools

0.1490 ETH

Alice — Transaction A [BID]

Bob — Transaction B [BID]

Mempool

Private RPC Endpoint

Whitelisted Validator (trusted by organization)

Builds block

An Emerging Solution: Private Mempools

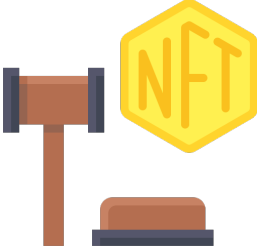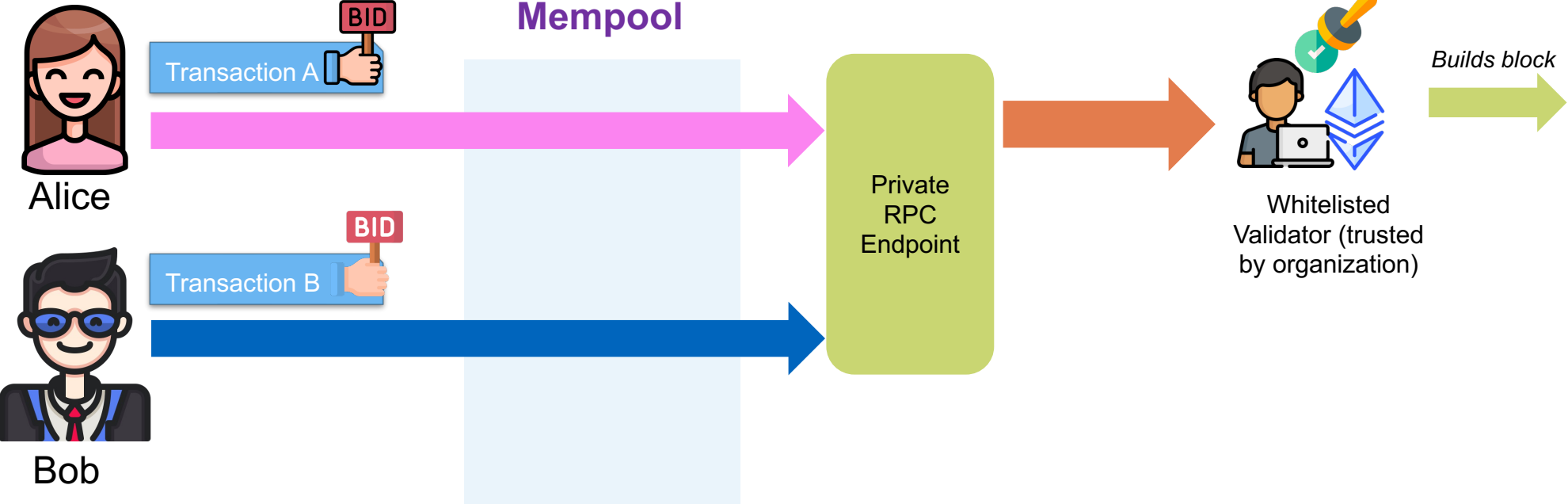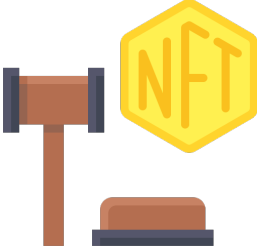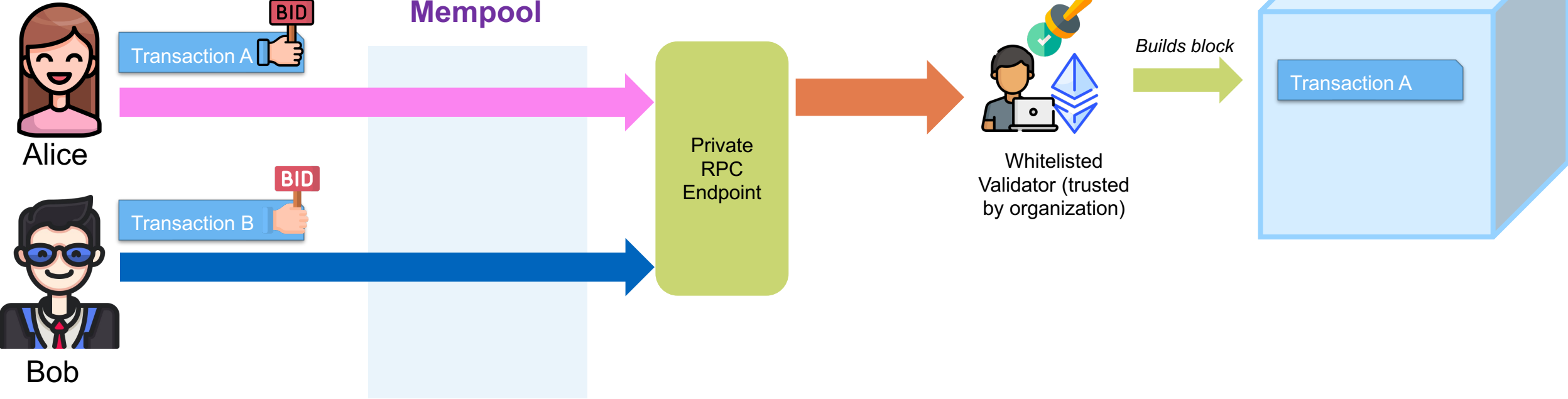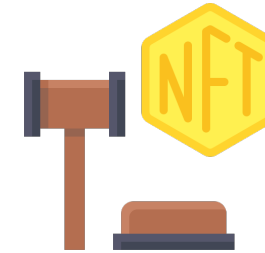# An Emerging Solution: Private Mempools

An Emerging Solution: Private Mempools

- Being forced to trust 3rd parties – movement towards centralization

- Loss of transparency and traceability

0.1490

ETH

Mempool

Transaction A

Alice

Transaction B

Bob

Private
RPC
Endpoint

Whitelisted
Validator (trusted
by organization)

Builds block

Transaction A

Flashbots
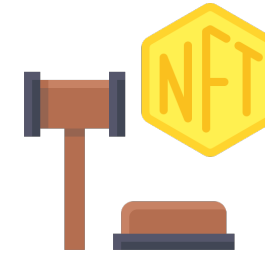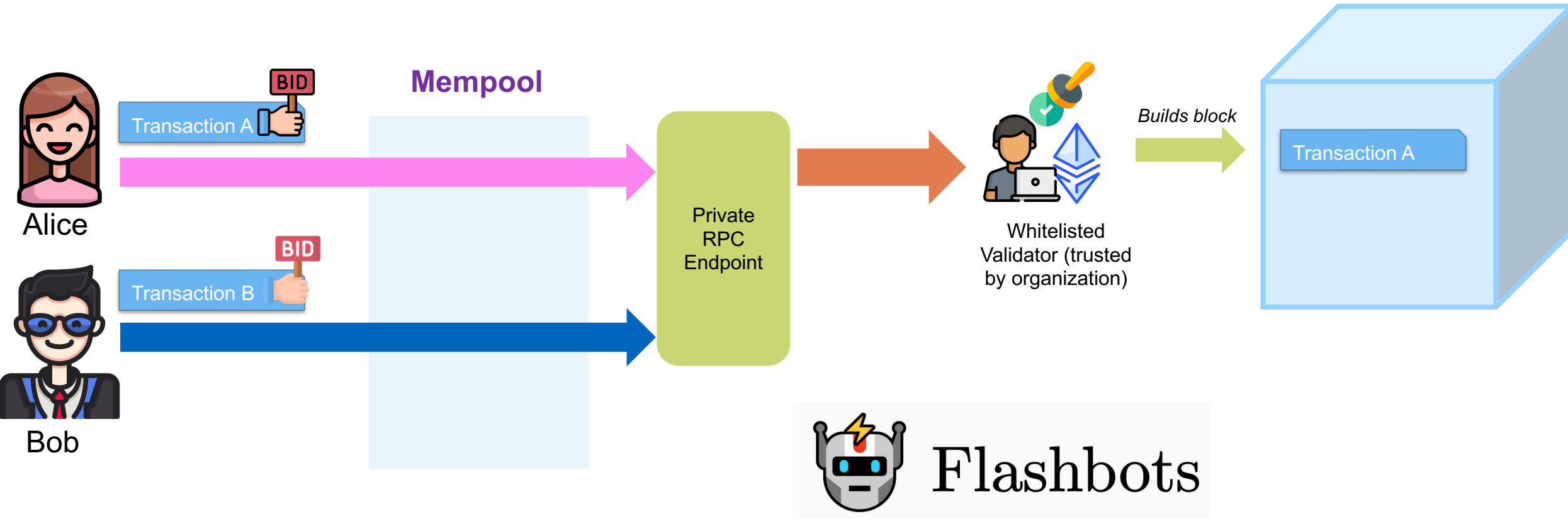
An Emerging Solution: Private Mempools

- Being forced to trust 3rd parties – movement towards centralization

- Loss of transparency and traceability

0.1490

ETH

Mempool

Transaction A

Alice

Transaction B

Bob

SUAVE

Whitelisted
Validator (trusted
by organization)

Builds block

Transaction A

Flashbots
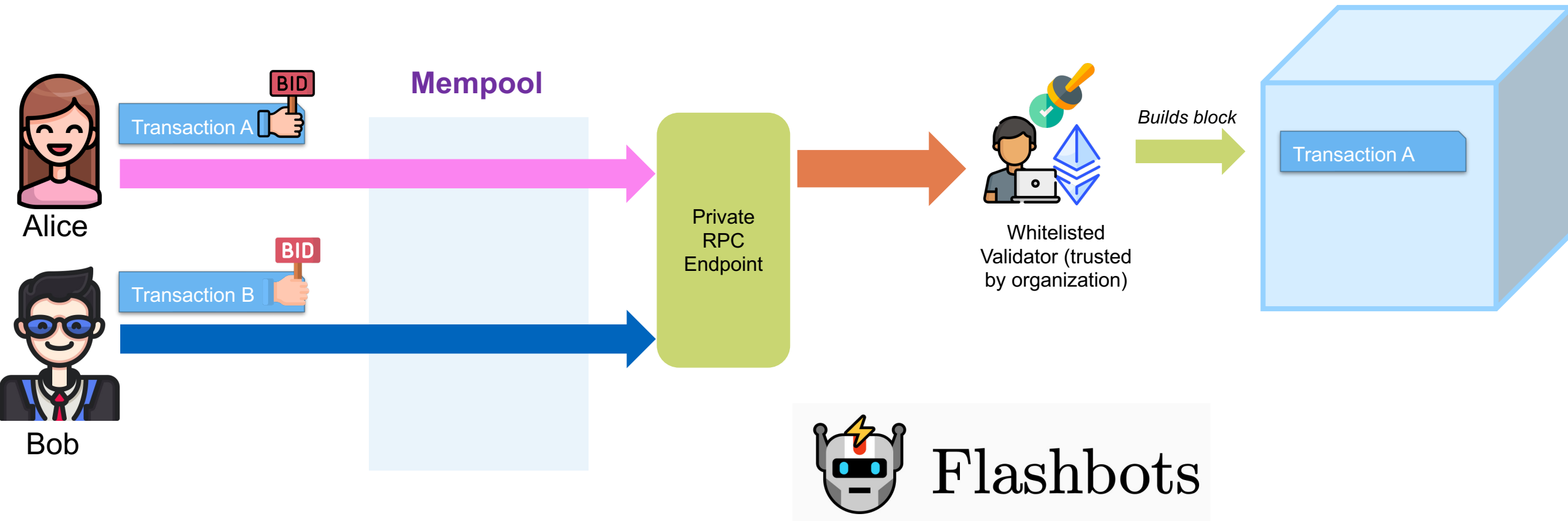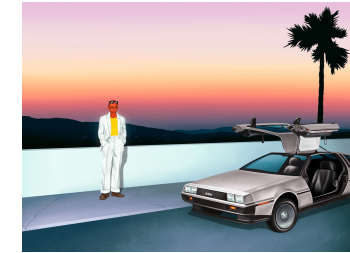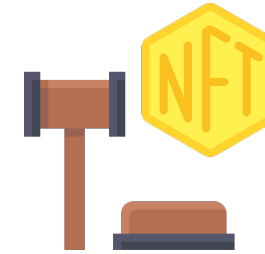
Problem – Private Order Flow Increase Over Time

Problem – Private Order Flow Increase Over Time

- From the merge until July 2023, private transactions made up 9.6% of the transactions on Ethereum. [1]

- Reasons for the increase - why did user behavior change?

- What problems occur while transacting publicly?

Daily Proportion of Private Transactions Since The Merge

blocknative

[3]

RQ 1
- What are the risks of submitting transactions to the public mempool of the Ethereum blockchain?
  - What solutions are available to mitigate these risks?
  - Can a taxonomy be built to classify these solutions?

RQ 2
- How did the public mempool usage change over time and what were the factors affecting this change?
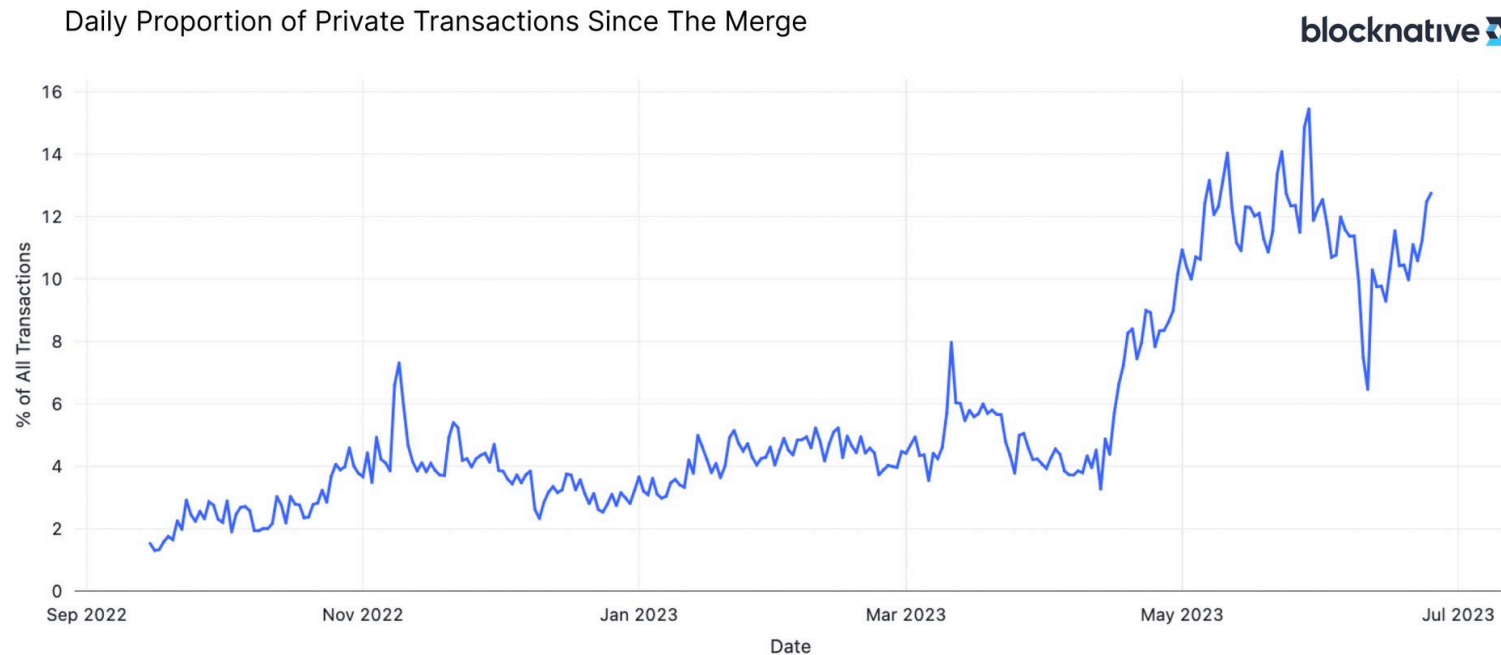 - How prominent was Flashbots' private endpoint in the pre-merge era?
 - What is the source of the private order flow in post-merge Ethereum?

RQ 3
- What is the impact of increased usage of private endpoints to the users that transact publicly?
  - How do the paid fees change?
  - How does the inclusion time change?

Methodology

Literature Review	Data Collection	Data Analysis & Interpretation
RQ 1	**RQ 2** **RQ 3**	**RQ 2** **RQ 3**

- Up-to-date literature review

- Descriptive & quantitative data analysis

- Interpretation of macro events with empirical data – what is behind event X? (e.g the Merge)

- Correlation with change of public/private transaction volume

- Impact assessment on users who transact publicly

Time Plan

References
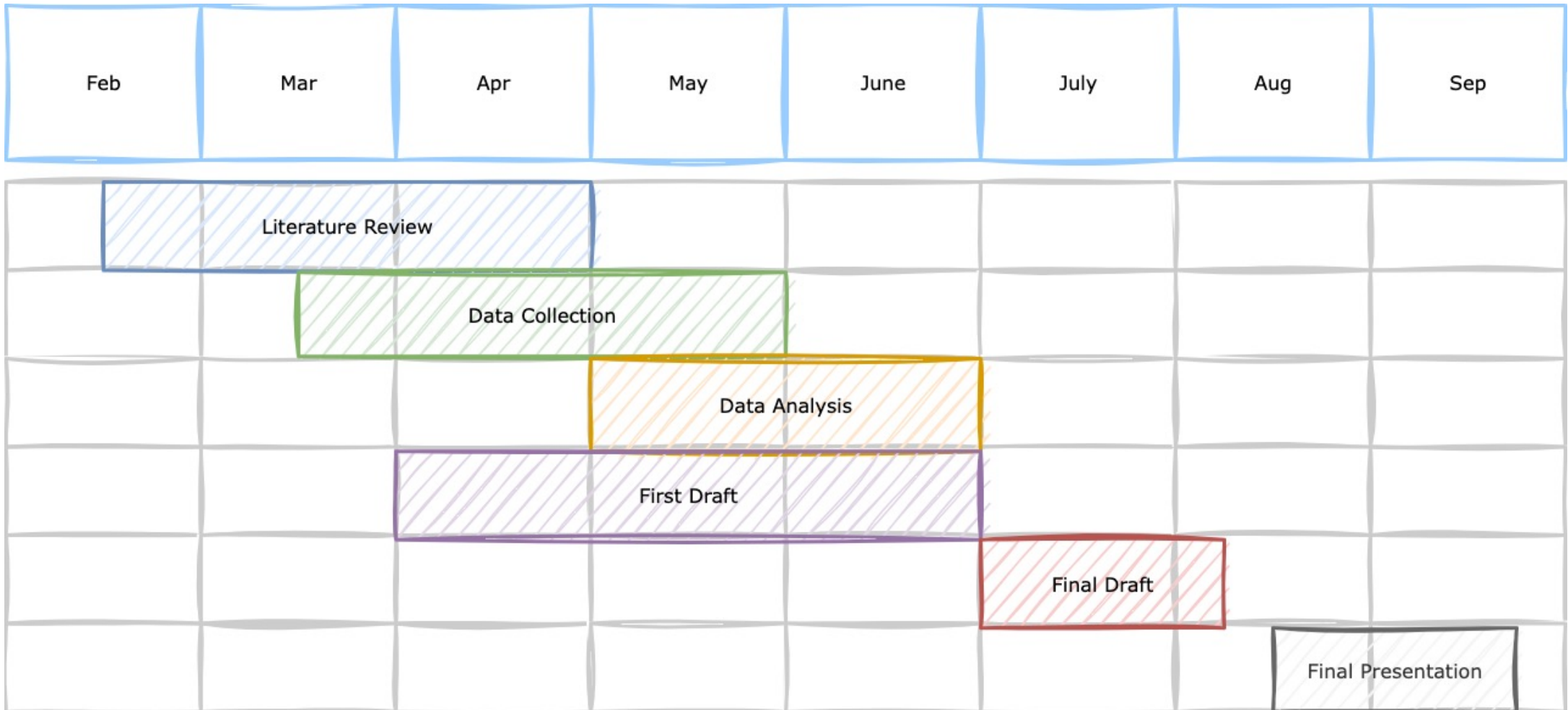
[1] P. Daian *et al.*, "Flash Boys 2.0: Frontrunning, Transaction Reordering, and Consensus Instability in Decentralized Exchanges." arXiv, Apr. 10, 2019. doi: 10.48550/arXiv.1904.05234.

[2] "(21) Blocknative | mempool.eth 🔮 on X: 'This quarter, private transactions made up 9.6% of the transactions on Ethereum. That's nearly 1 out of every 10 transactions. This is more than a 2x increase from last quarter, where only about 4.5% were private. The reason? MEV and OFAs. 🧵 👇 https://t.co/dhqITMPoSq' / X," X (formerly Twitter). Accessed: Feb. 25, 2024. [Online]. Available:

https://twitter.com/blocknative/status/1674155468909060098

[3] "The Number of Private Transactions on Ethereum Doubles in Last Quarter." Accessed: Feb. 25, 2024. [Online]. Available: https://www.blocknative.com/blog/private-transactions-on-ethereum-doubles-in-last-quarter