CHI23

NFTDisk: Visual Detection of Wash Trading in NFT Markets





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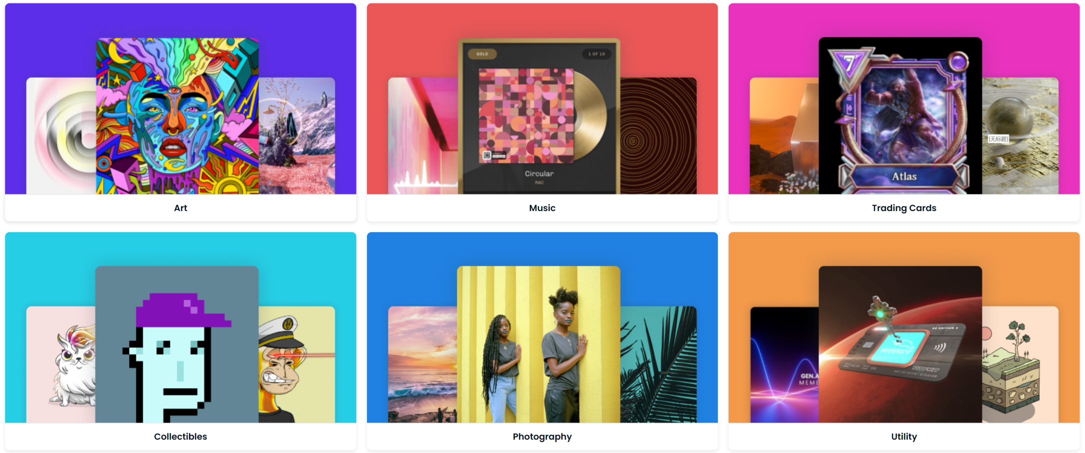
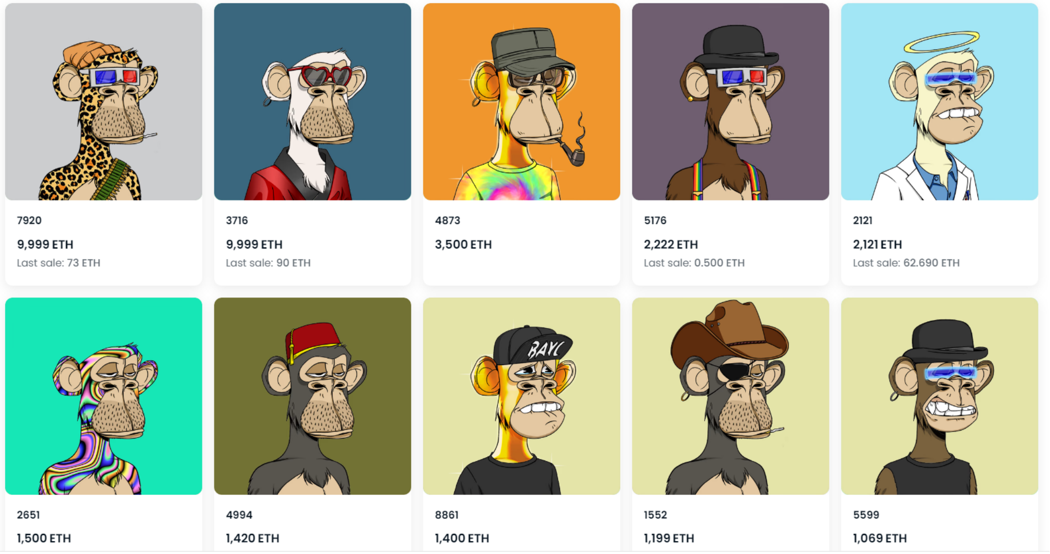
Background

NFT (Non-Fungible Token)





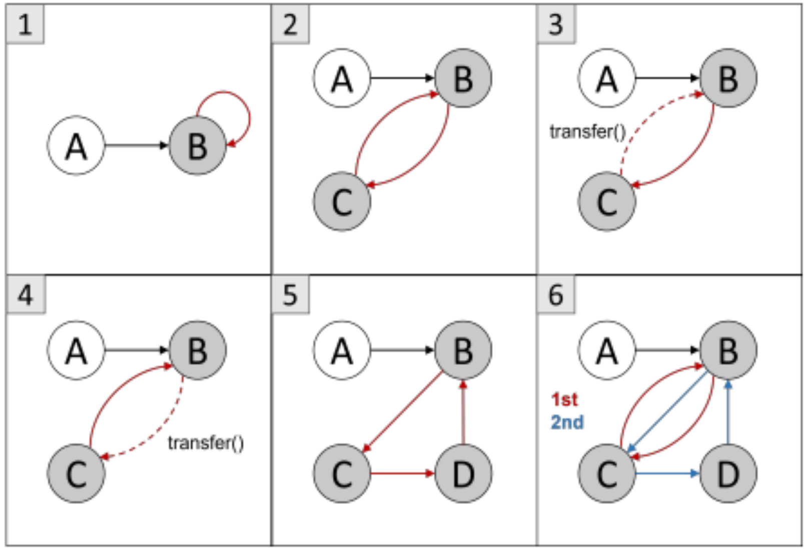
NFT Investors → NFT Markets ← Fraudulent Activities

Background

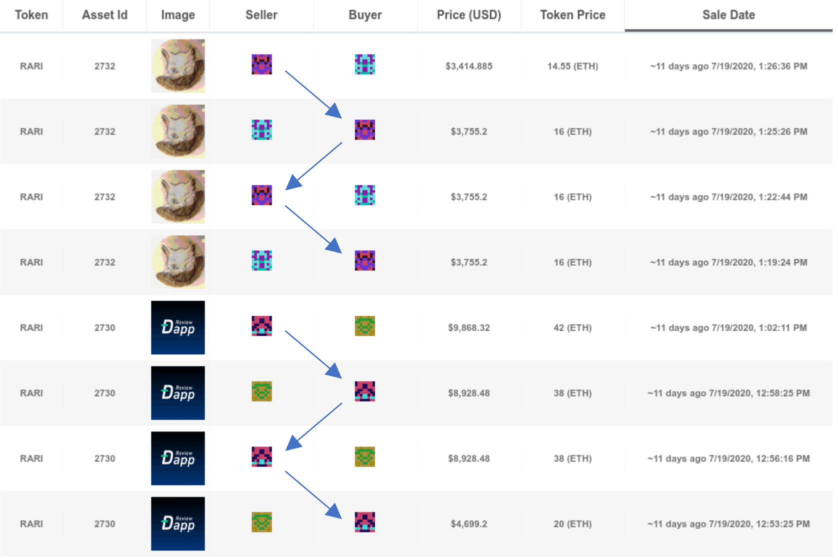
Wash Trading

Motivation

Automatic Detection[1]



Manual Inspection

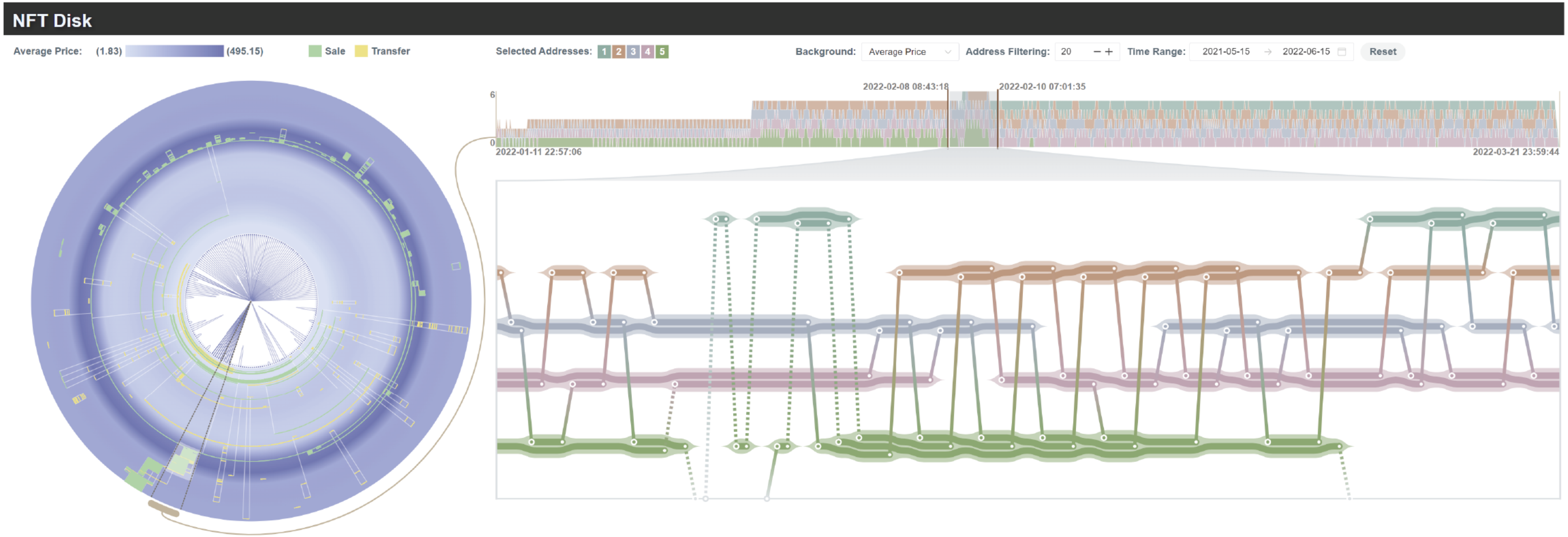


Token	Asset Id	Image	Seller	Buyer	Price (USD)	Token Price	Sale Date
RARI	2732				$3,414.885	14.55 (ETH)	~11 days ago 7/19/2020, 1:26:36 PM
RARI	2732				$3,755.2	16 (ETH)	~11 days ago 7/19/2020, 1:25:26 PM
RARI	2732				$3,755.2	16 (ETH)	~11 days ago 7/19/2020, 1:22:44 PM
RARI	2732				$3,755.2	16 (ETH)	~11 days ago 7/19/2020, 1:19:24 PM
RARI	2730	Dapp			$9,868.32	42 (ETH)	~11 days ago 7/19/2020, 1:02:11 PM
RARI	2730	Dapp			$8,928.48	38 (ETH)	~11 days ago 7/19/2020, 12:58:25 PM
RARI	2730	Dapp			$8,928.48	38 (ETH)	~11 days ago 7/19/2020, 12:56:16 PM
RARI	2730	Dapp			$4,699.2	20 (ETH)	~11 days ago 7/19/2020, 12:53:25 PM

- **Automatic Detection** can only find a subset of wash trading due to their sophisticated patterns.
- **Manual Inspection** is usually required, but it is hard to get useful information directly from the original transactions.

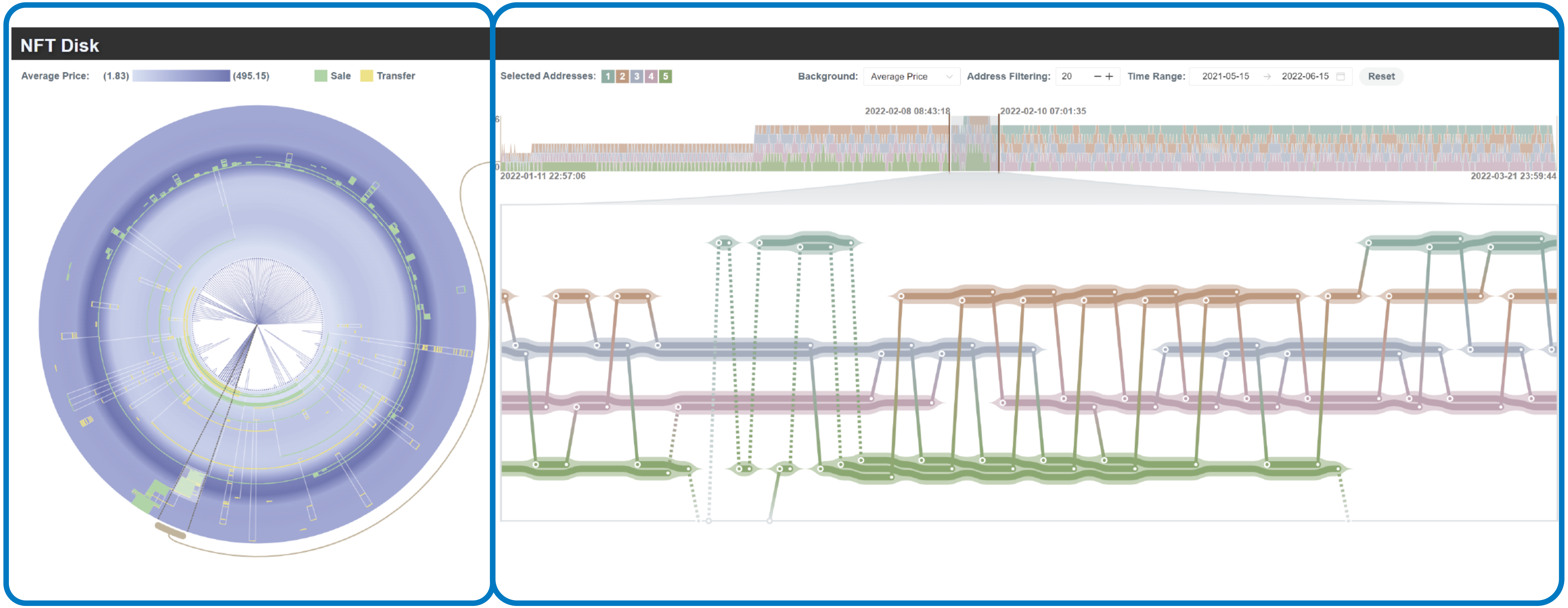
[1] von Wachter V, Jensen J R, Regner F, et al. NFT Wash Trading: Quantifying suspicious behaviour in NFT markets[J]. arXiv preprint arXiv:2202.03866, 2022.

NFTDisk



NFTDisk: a novel visualization for investors to visually identify wash trading activities in NFT markets.

NFTDisk



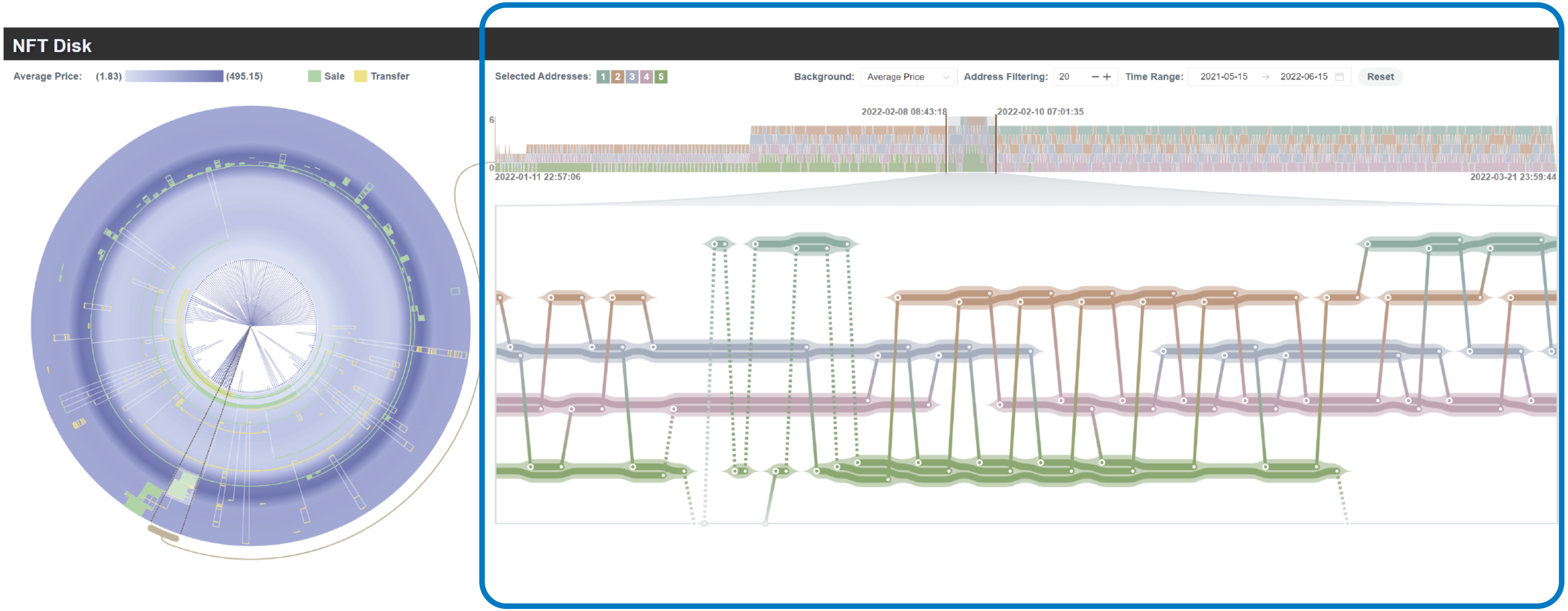
Disk Module **Flow Module**

NFTDisk

Disk Module

Overview Transactions → Suspicious addresses

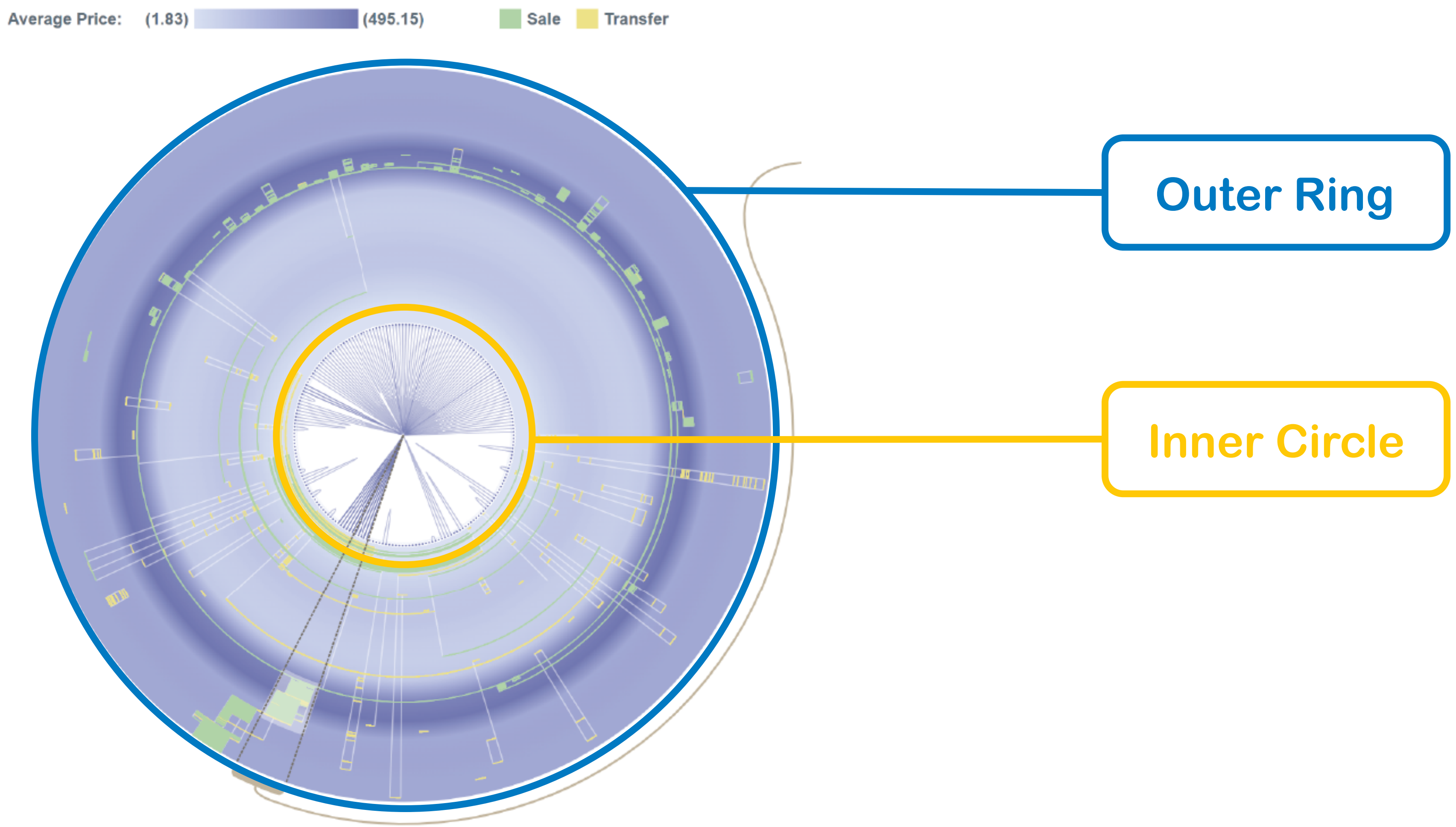
NFTDisk



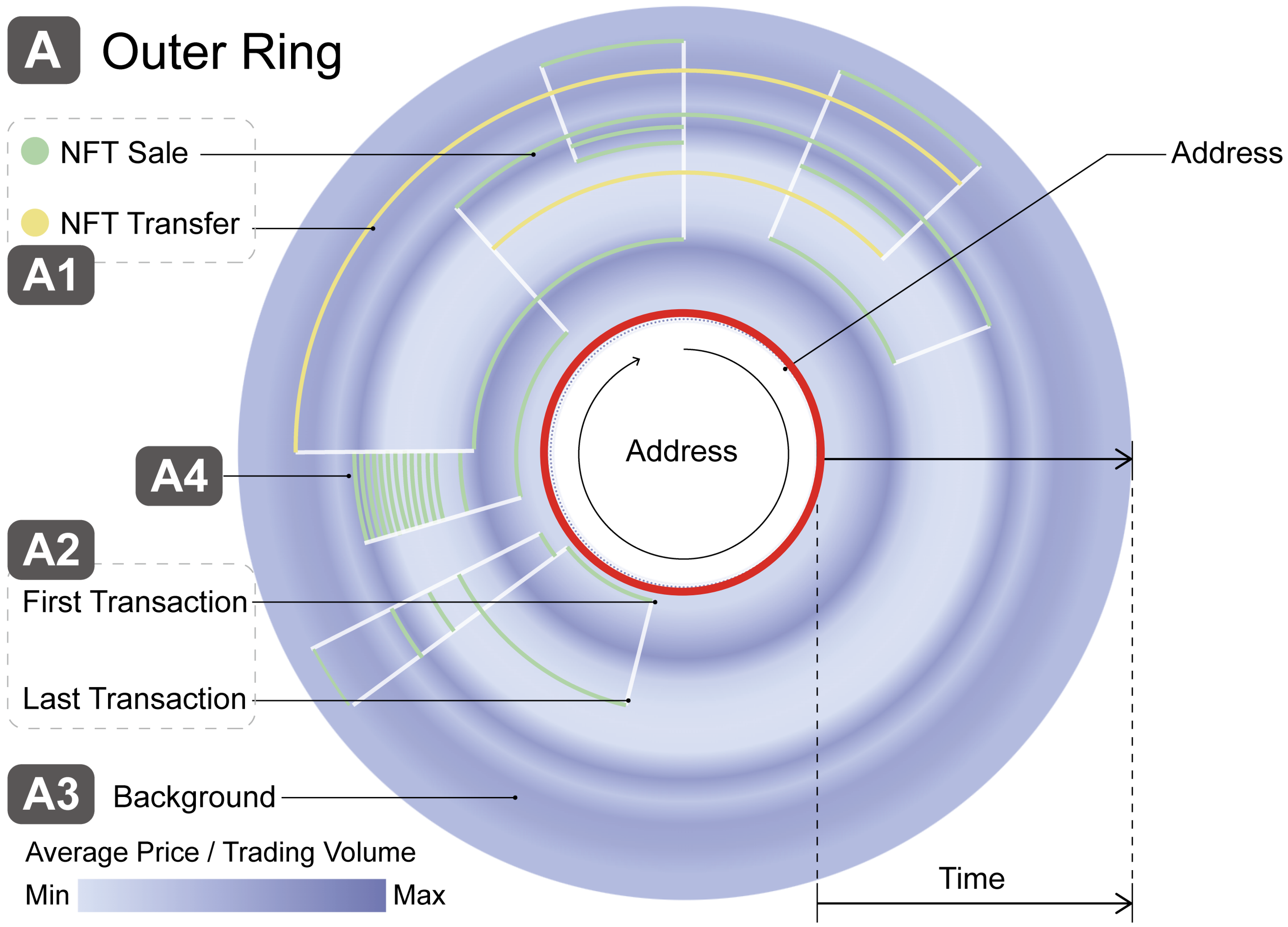
Show NFT flows among suspicious addresses at multiple levels.

Flow Module

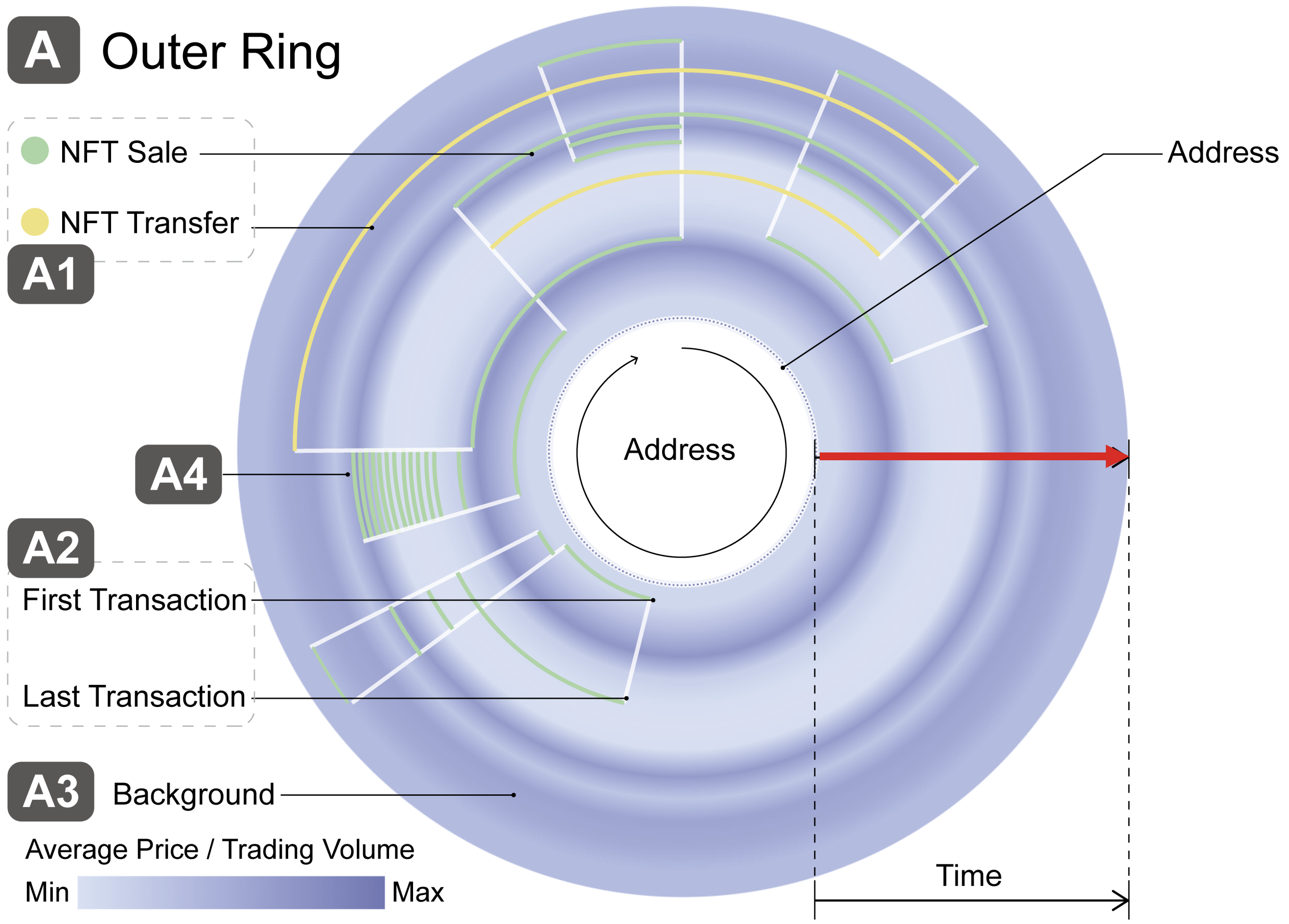
Disk Module


Average Price: (1.83) (495.15)
Sale
Transfer
Outer Ring
Inner Circle

Disk Module

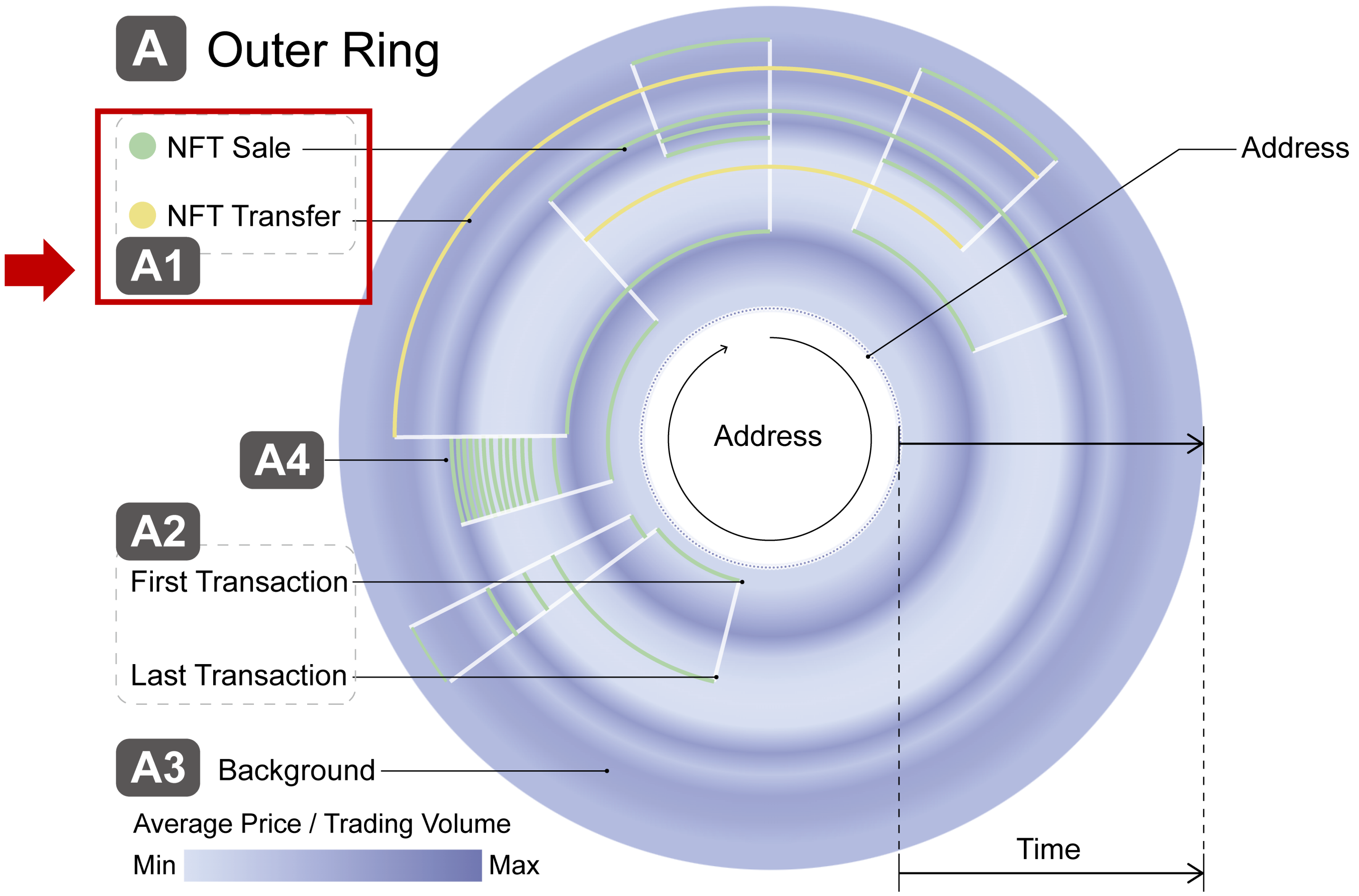

A
Outer Ring
NFT Sale
NFT Transfer
A1
A4
A2
First Transaction
Last Transaction
A3
Background
Average Price / Trading Volume
Min
Max
Address
Address
Time

Disk Module



A Outer Ring
NFT Sale
NFT Transfer
A1
A4
A2
First Transaction
Last Transaction
A3 Background
Average Price / Trading Volume
Min
Max
Address
Address
Time

Disk Module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Outer Ring
NFT Sale
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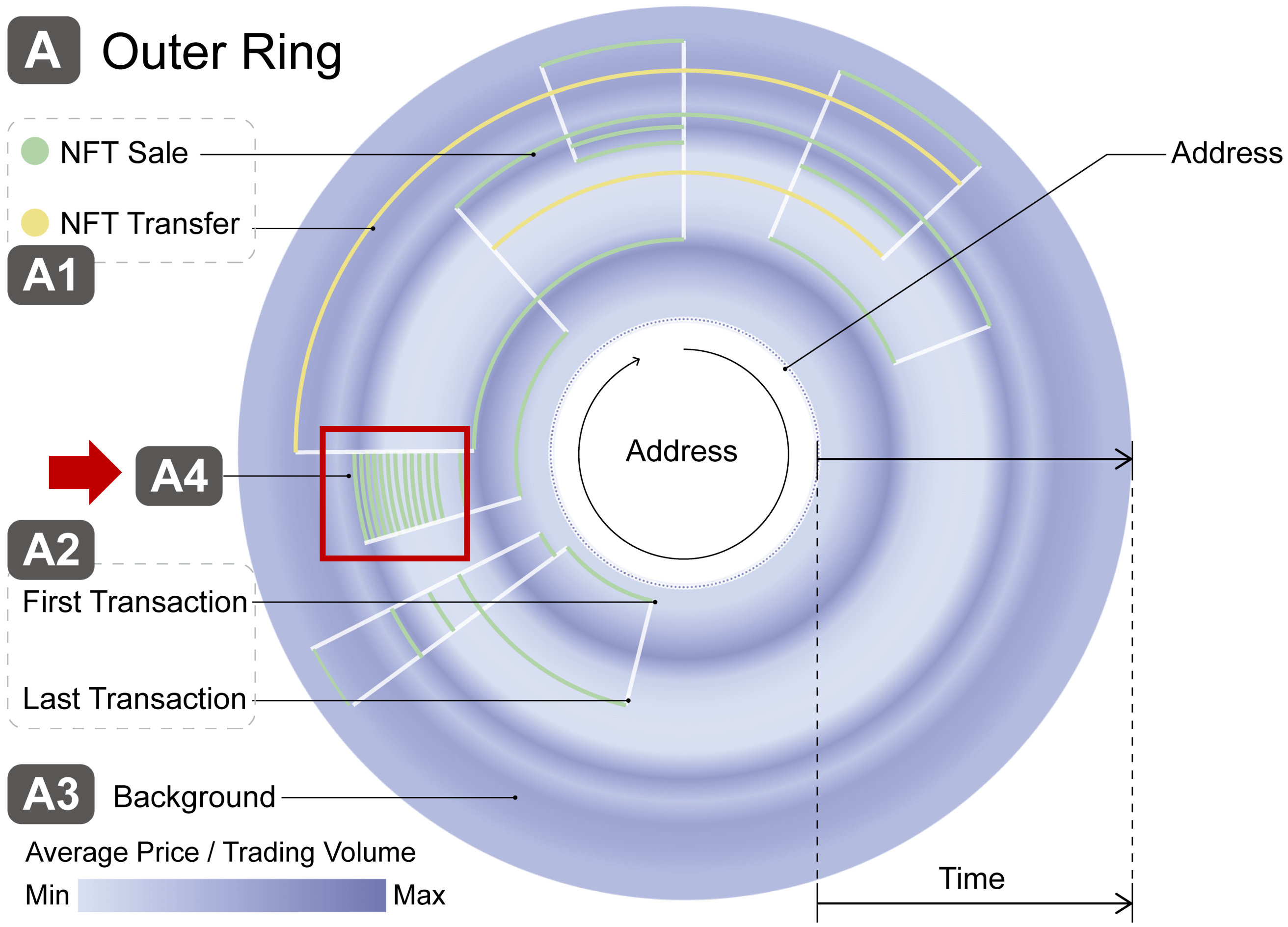

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Outer Ring
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Average Price / Trading Volume
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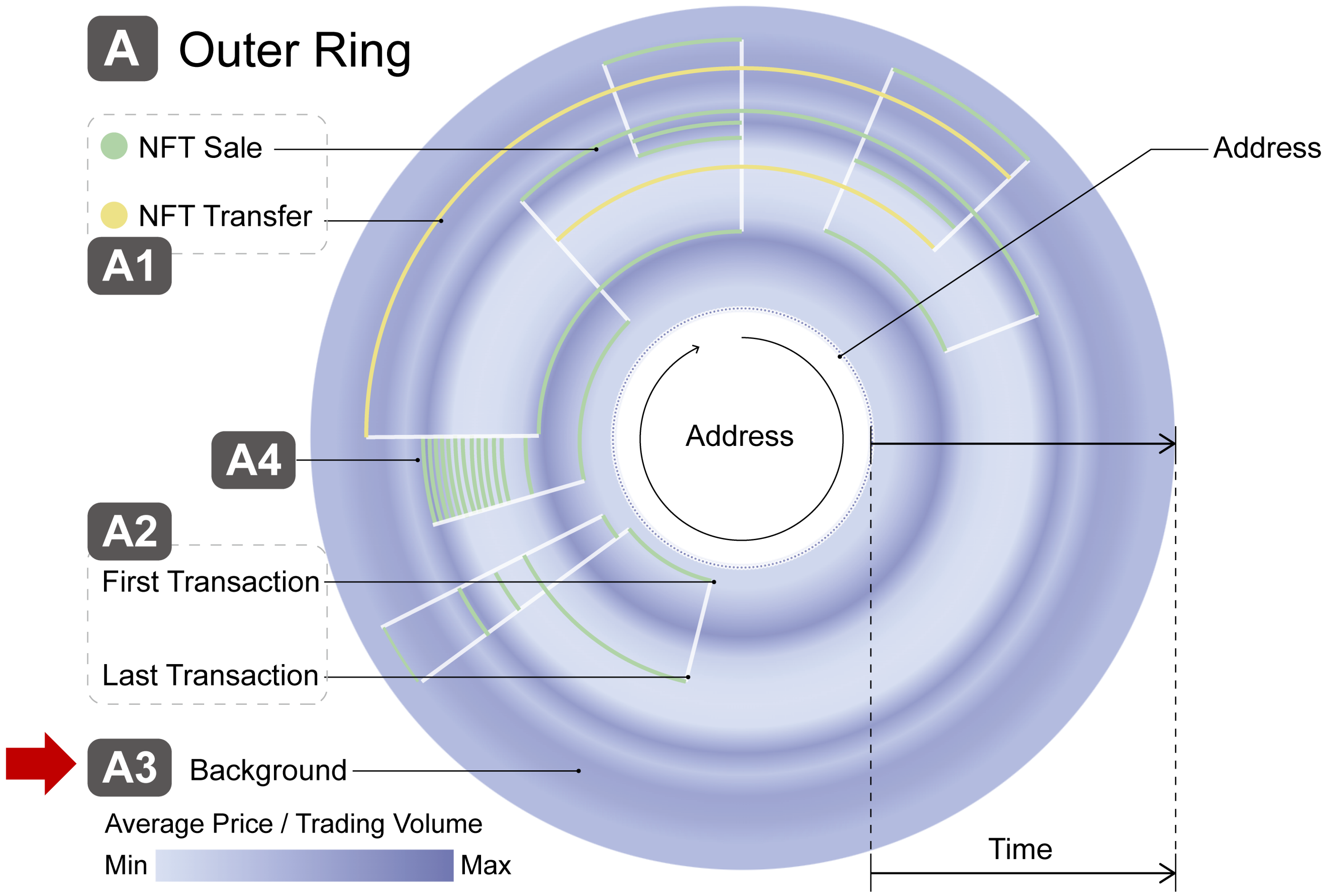
Time

Disk Module



A
Outer Ring
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First Transaction
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Average Price / Trading Volume
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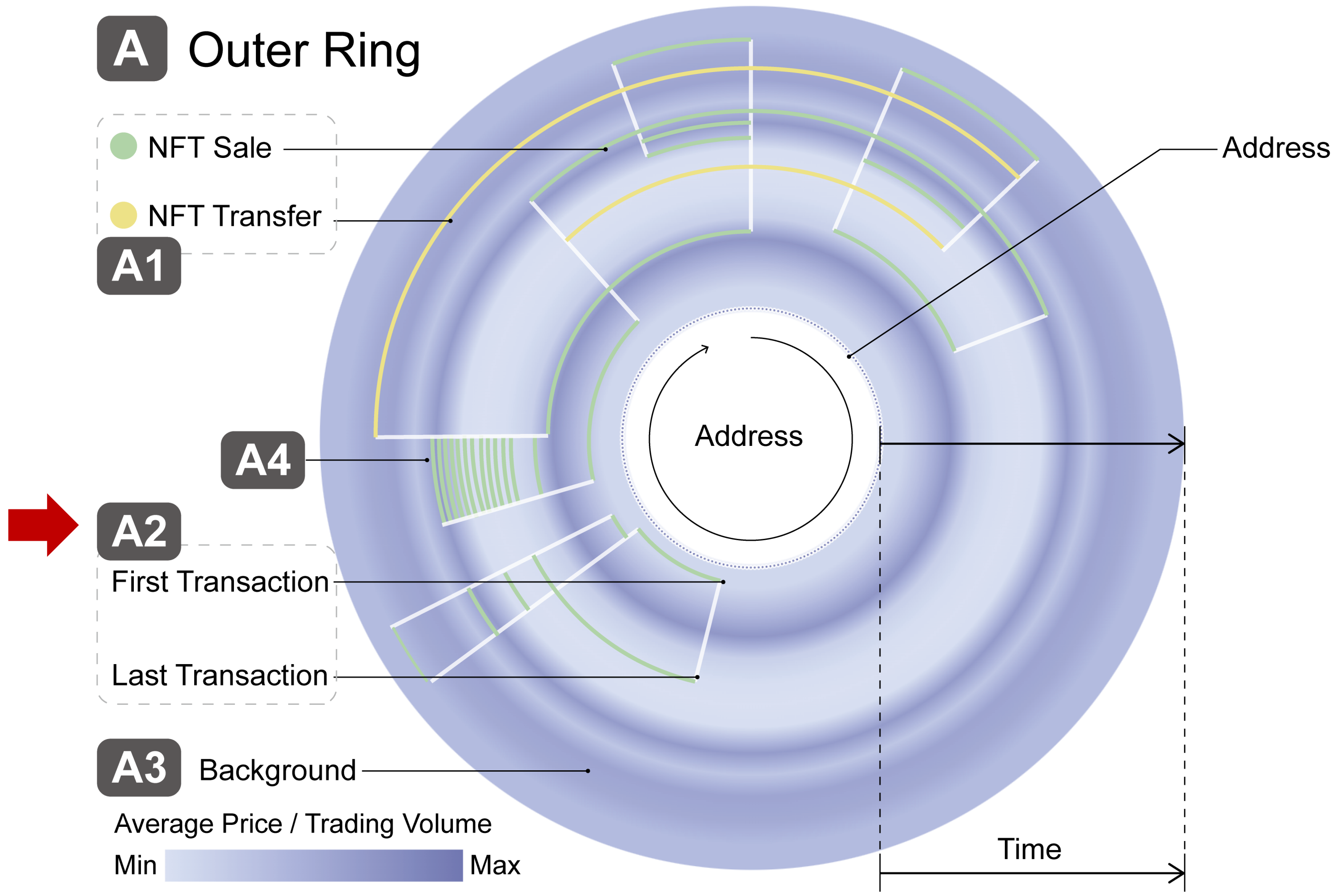
Address
Address
Time

Disk Module



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Average Price / Trading Volume
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Max
Address
Address
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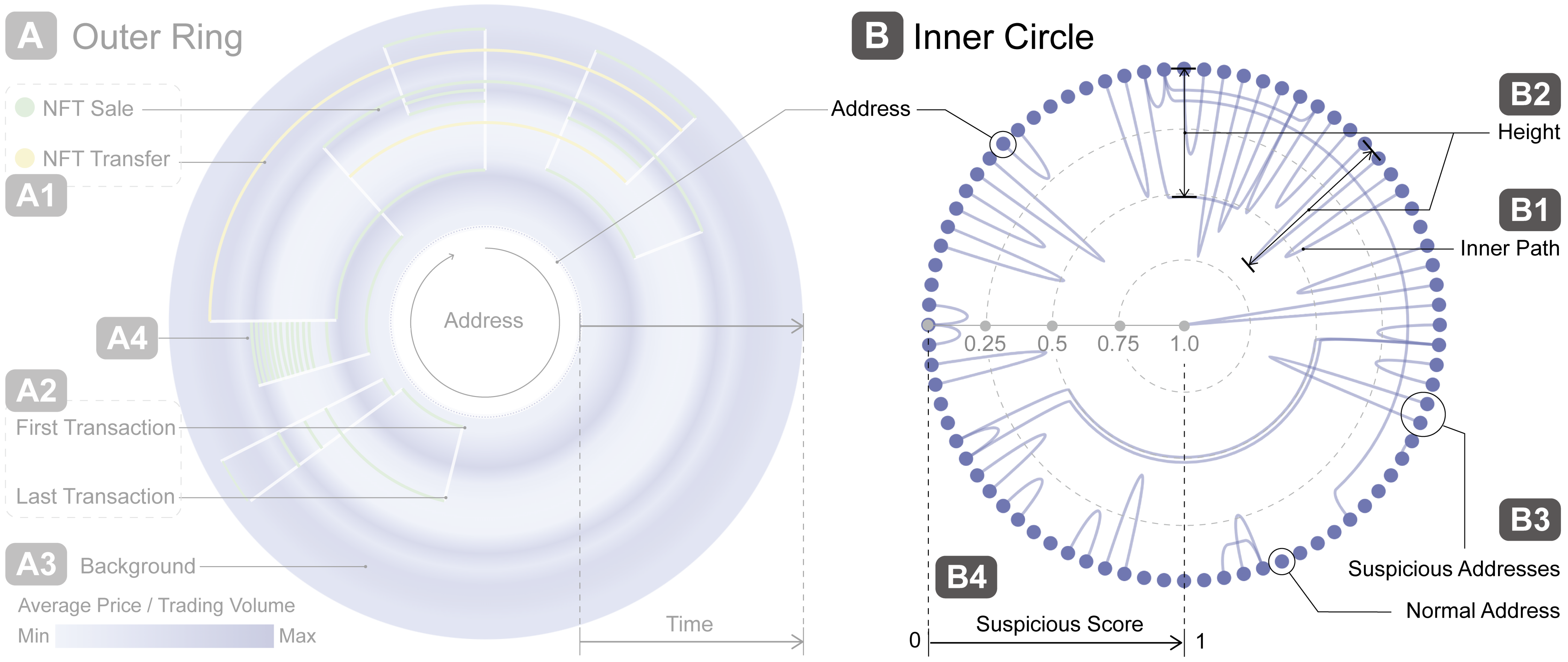
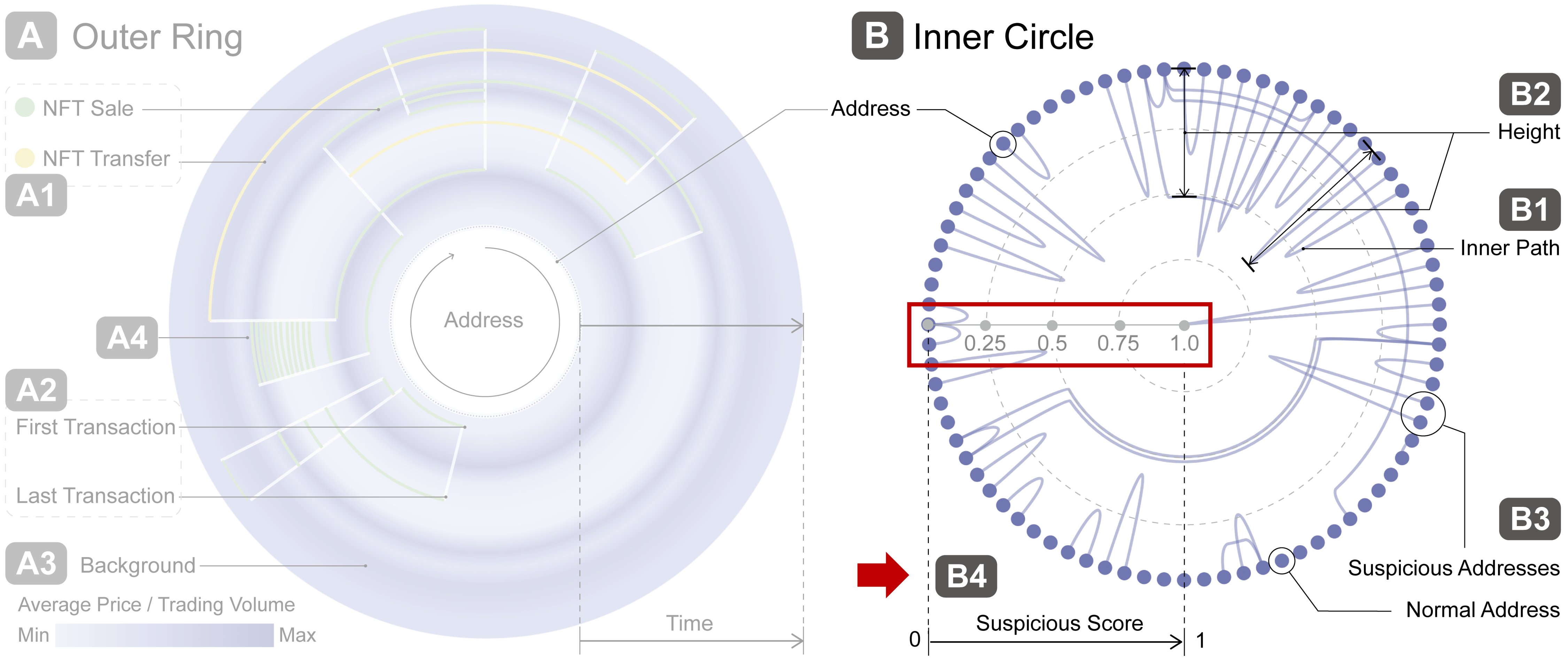
Disk Module



A
Outer Ring
NFT Sale
NFT Transfer
A1
A4
A2
First Transaction
Last Transaction
A3
Background
Average Price / Trading Volume
Min
Max
Address
Time
B
Inner Circle
Address
B2
Height
B1
Inner Path
0.25
0.5
0.75
1.0
B3
Suspicious Addresses
Normal Address
B4
Suspicious Score
0
1

Disk Module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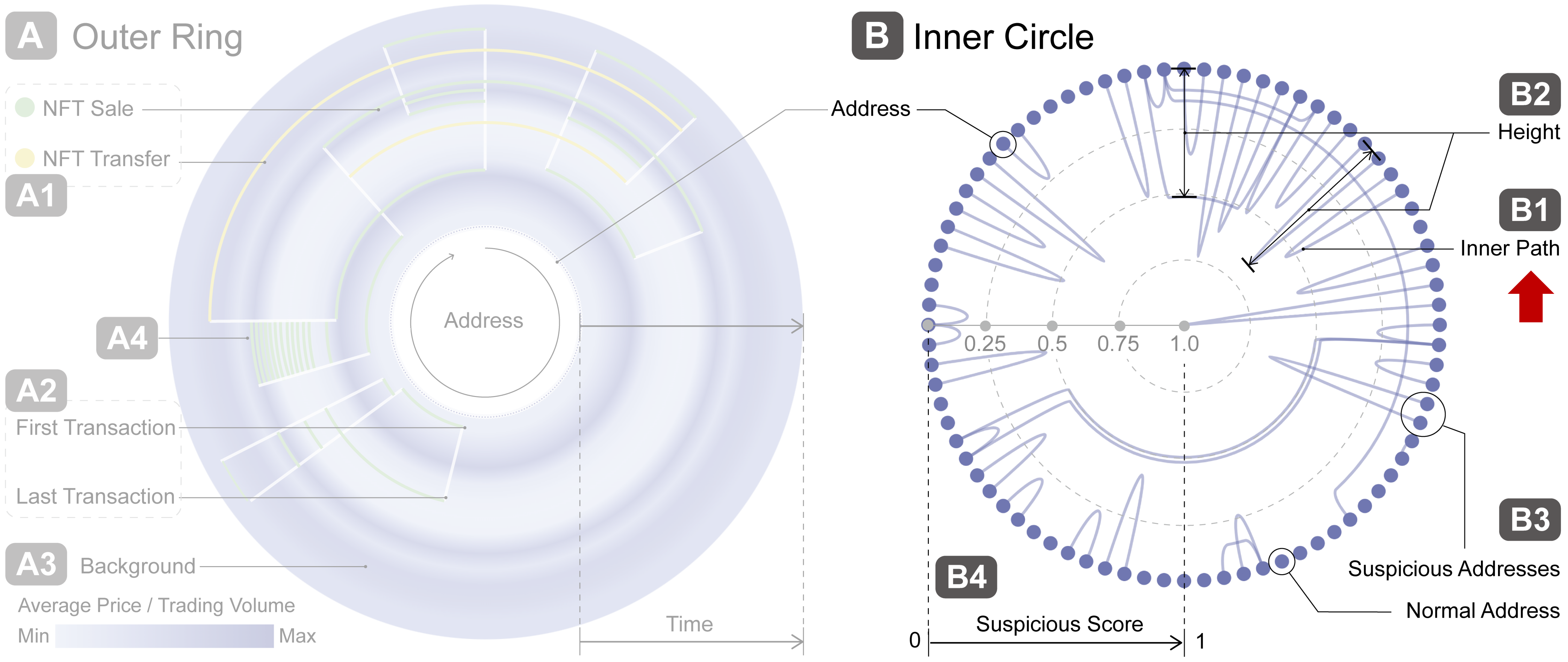
Disk Module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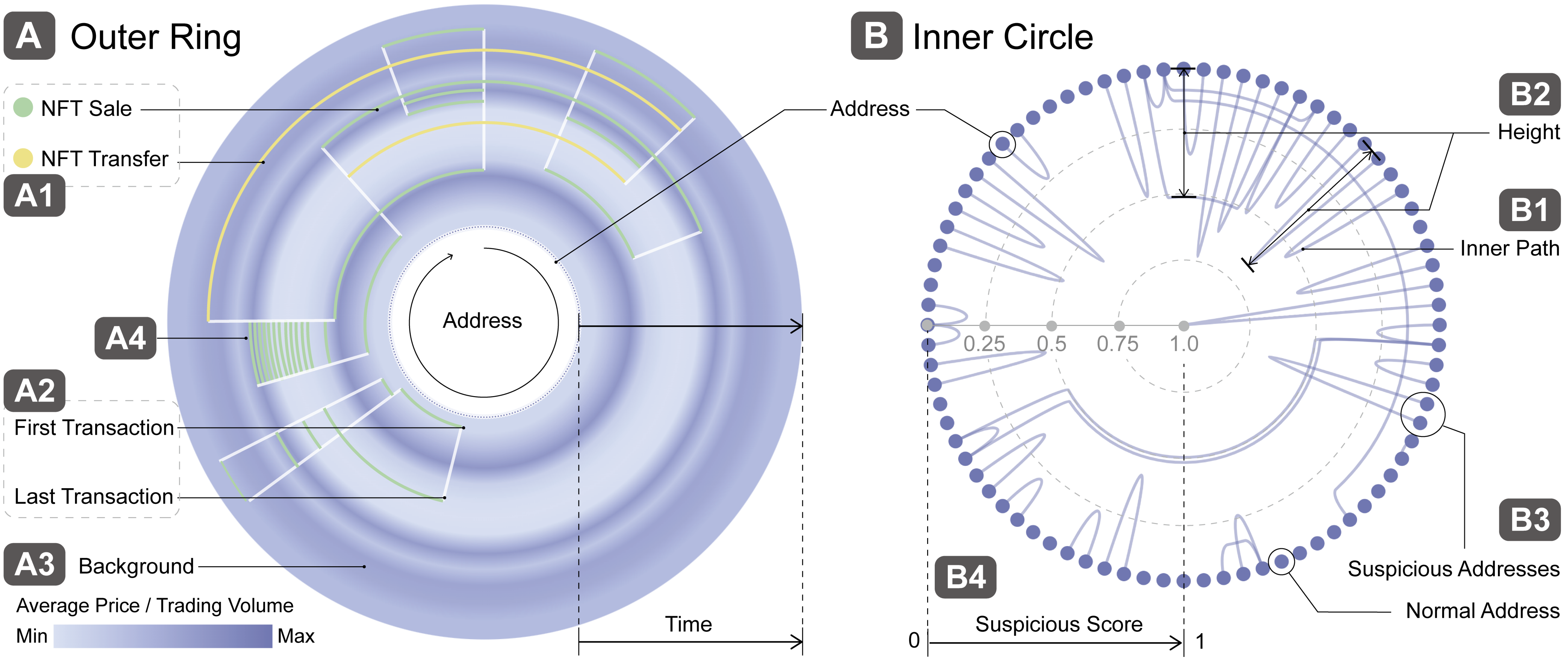
Disk Module



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Suspicious Score
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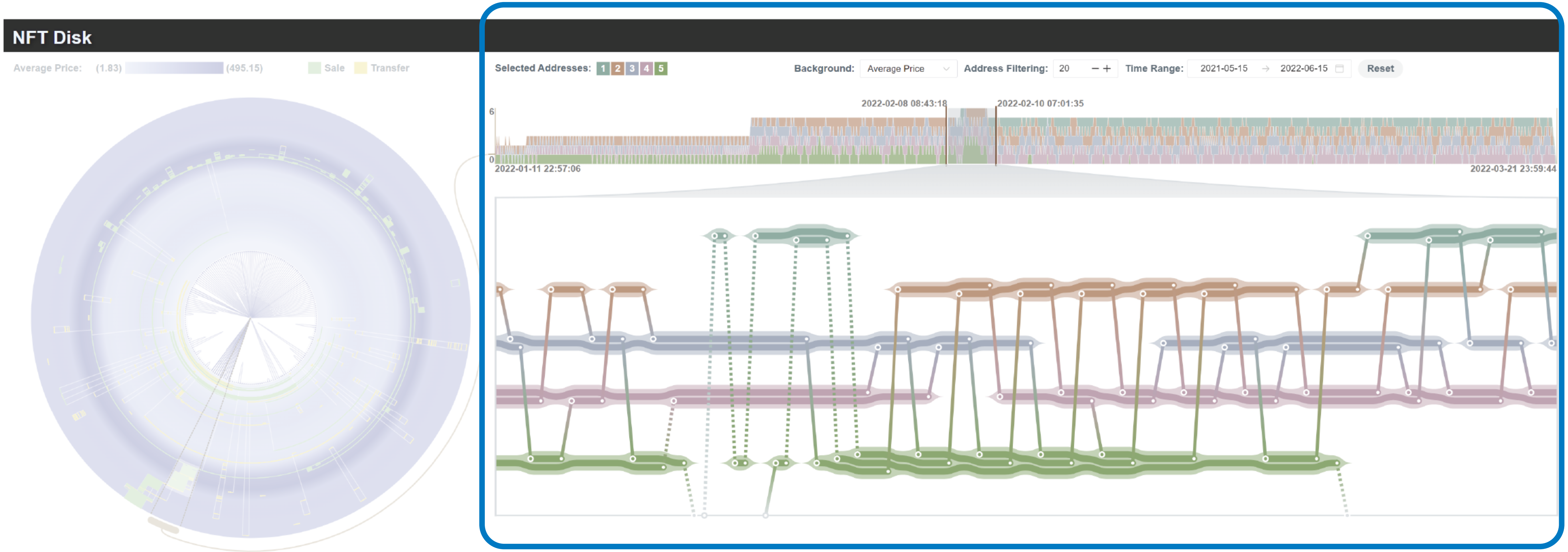
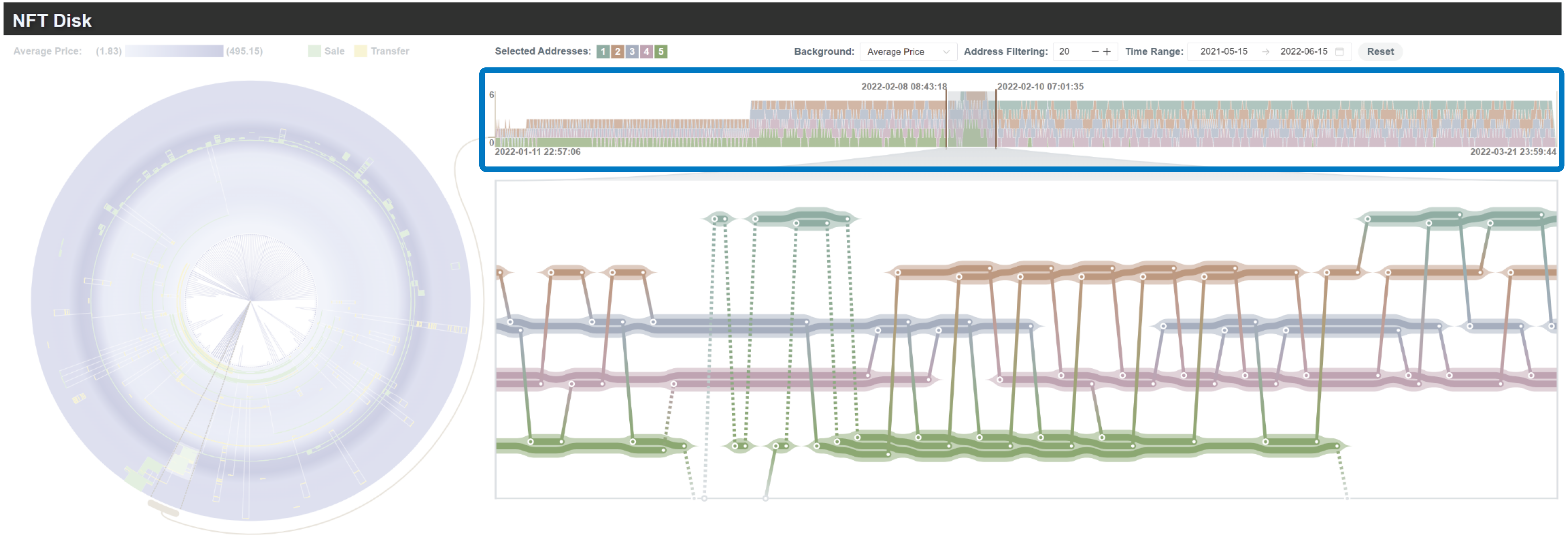
1

Flow Module



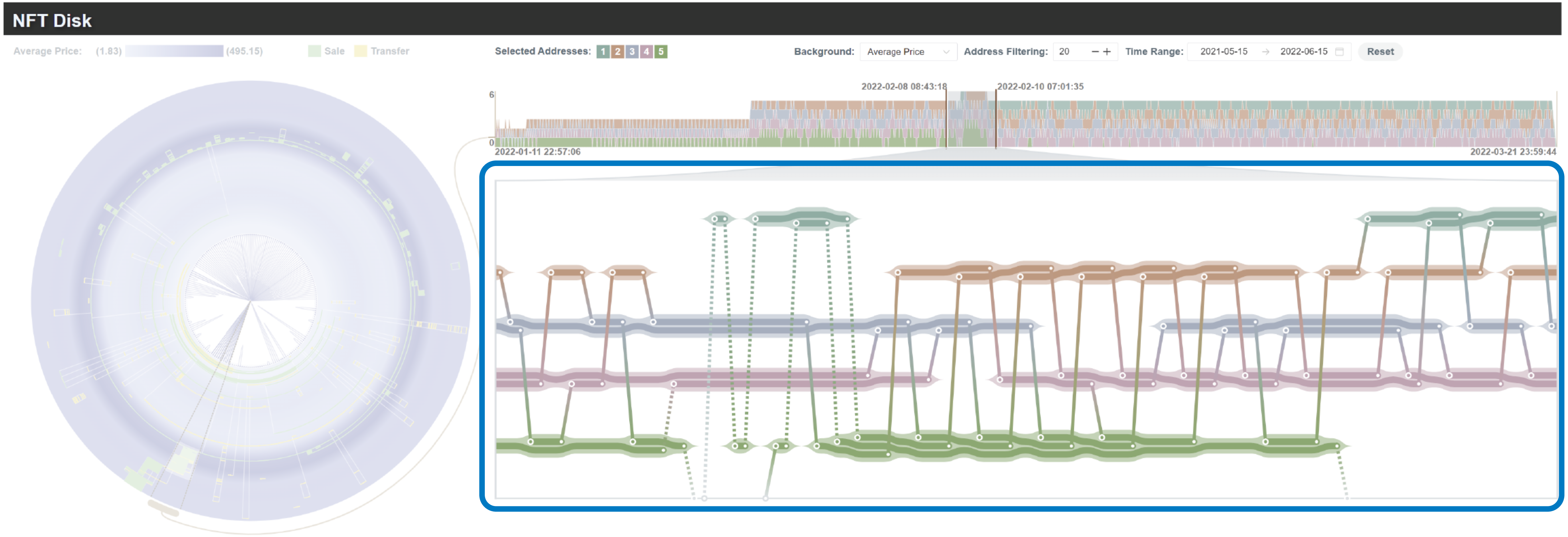
Flow Module

Flow Module



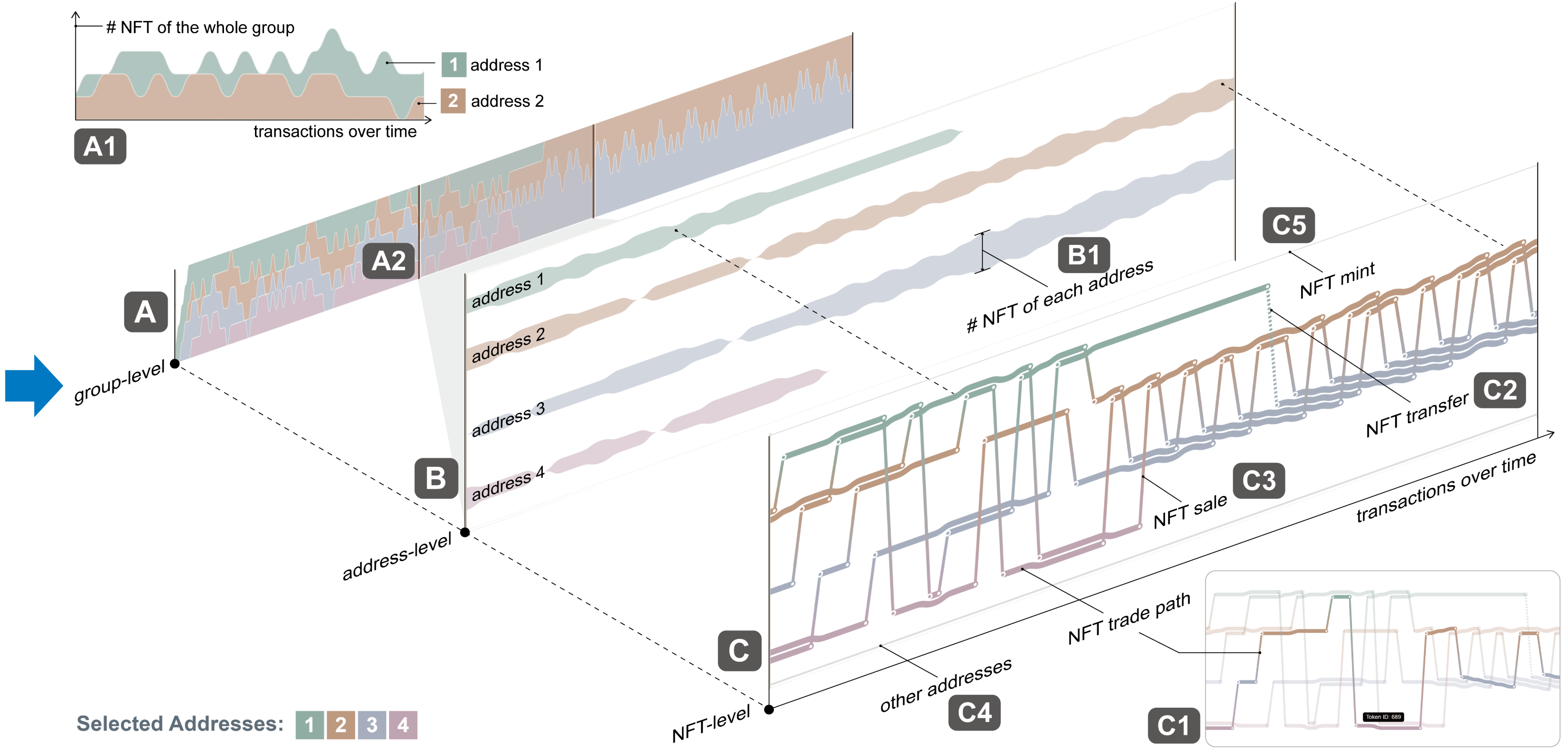
Stacked Area Chart

Flow Module



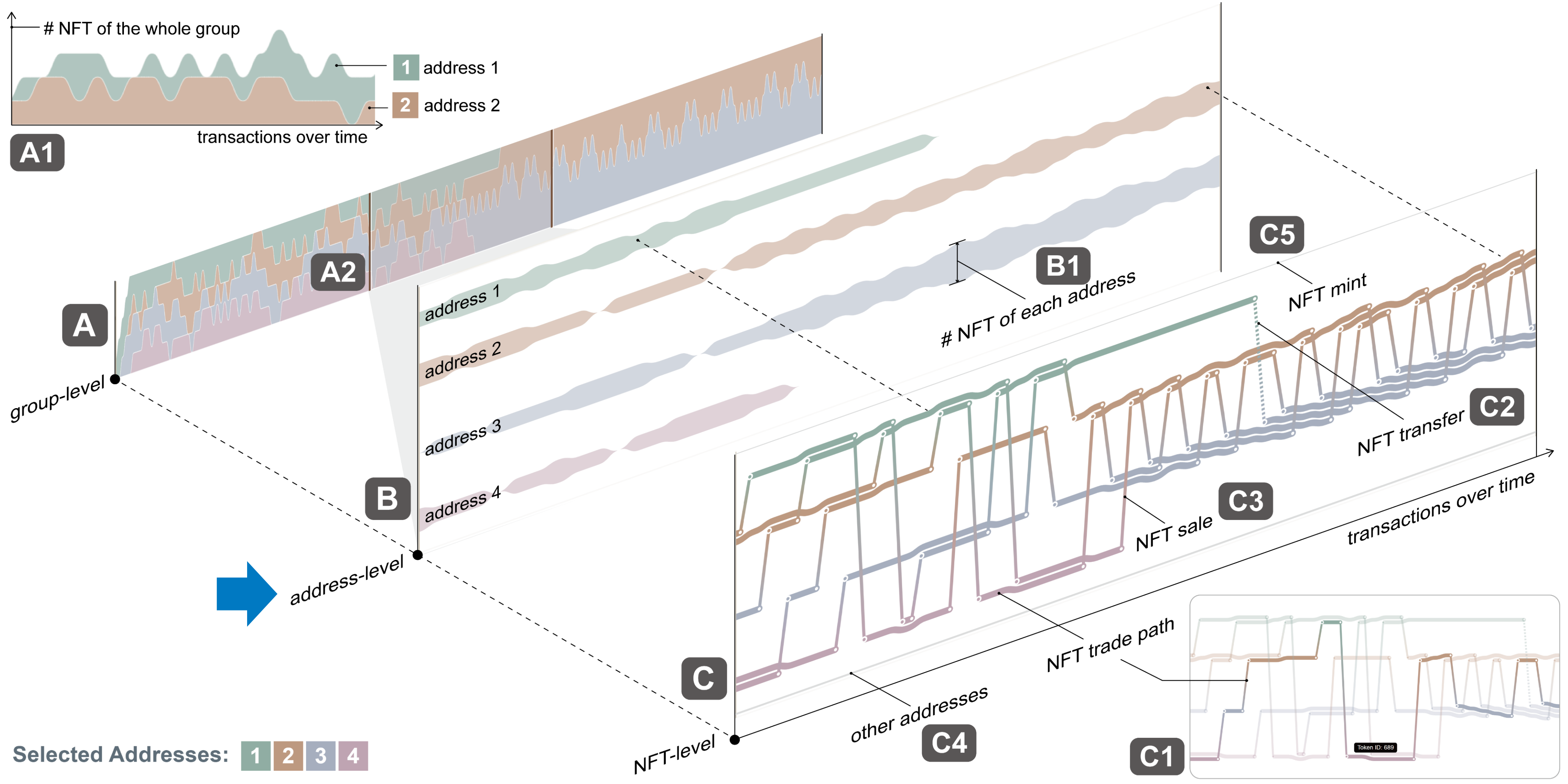
Flow-based Chart

Flow Module



NFT of the whole group
1 address 1
2 address 2
transactions over time
A1
A2
A
group-level
address 1
address 2
address 3
address 4
B
address-level
B1
NFT of each address
C5
NFT mint
C2
NFT transfer
C3
NFT sale
transactions over time
NFT trade path
C
NFT-level
other addresses
C4
C1
Token ID: 689
Selected Addresses: 1 2 3 4

Flow Module



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address 3
address 4
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NFT of each address
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NFT trade path
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C1
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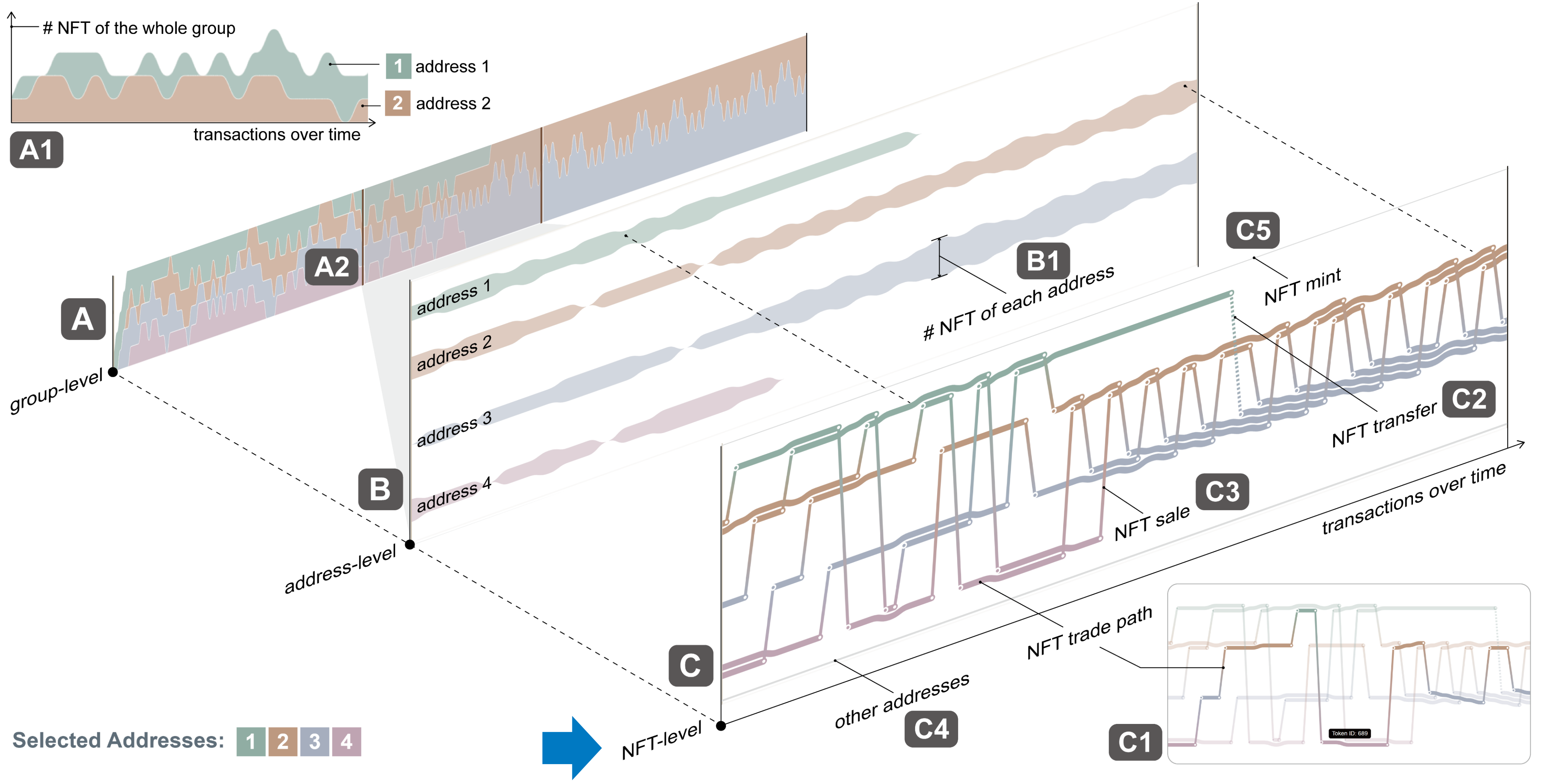
Flow Module



NFT of the whole group
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A1
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address 1
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B
B1
NFT of each address
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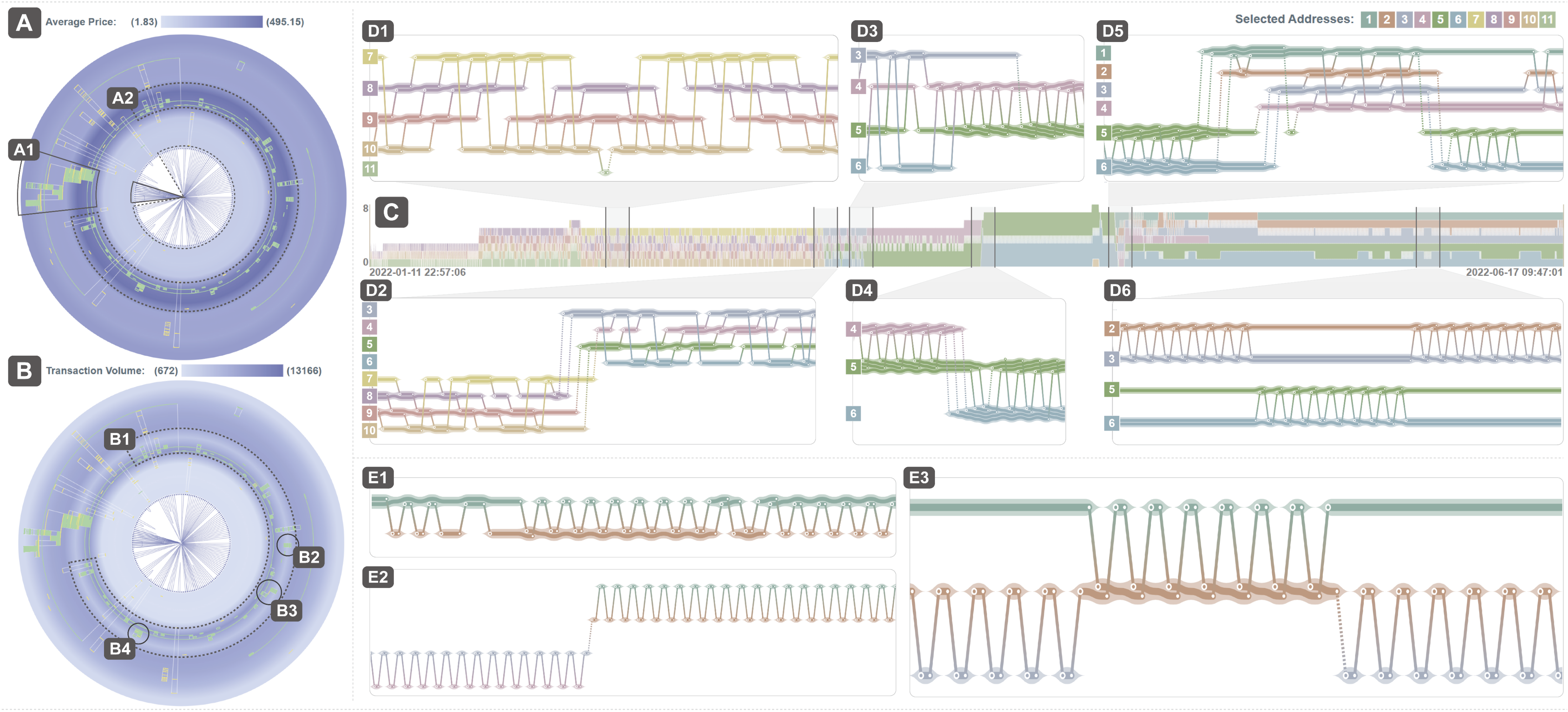
NFT sale
transactions over time
NFT trade path
C
other addresses
C4
C1
NFT-level
Selected Addresses: 1 2 3 4

Evaluation

- Two case studies
- User interview with 14 real NFT investors

Case Study


A
Average Price:
(1.83)
(495.15)
A1
A2
B
Transaction Volume:
(672)
(13166)
B1
B2
B3
B4
C
8
0
2022-01-11 22:57:06
2022-06-17 09:47:01
Selected Addresses:
1 2 3 4 5 6 7 8 9 10 11
D1
D2
D3
D4
D5
D6
E1
E2
E3

Case Study

[redacted]

User Interview

Online study with 14 NFT investors (4 females, 10 males, age_{mean} = 28)

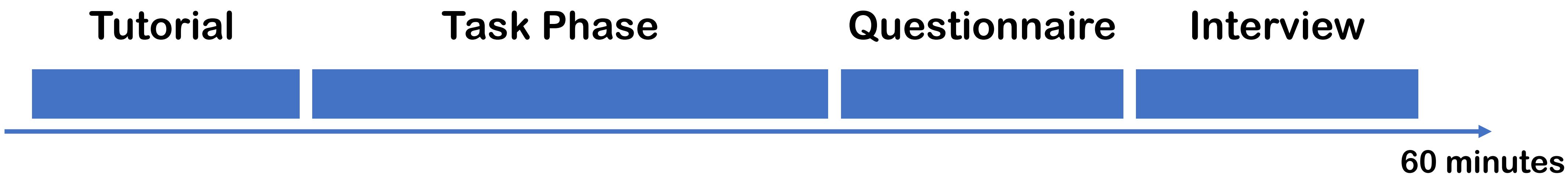
Task:

T1. Initialize the visualization by using interactions components to filter out undesired information.

T2. Observe the Disk Module to find suspicious addresses and time periods and brush to select them.

T3. Analyze the NFT flows at the group level by the stacked area chart of the Flow Module.

T4. Brush a period in the stacked area chart and check the detailed NFT flows in the flow-based chart.

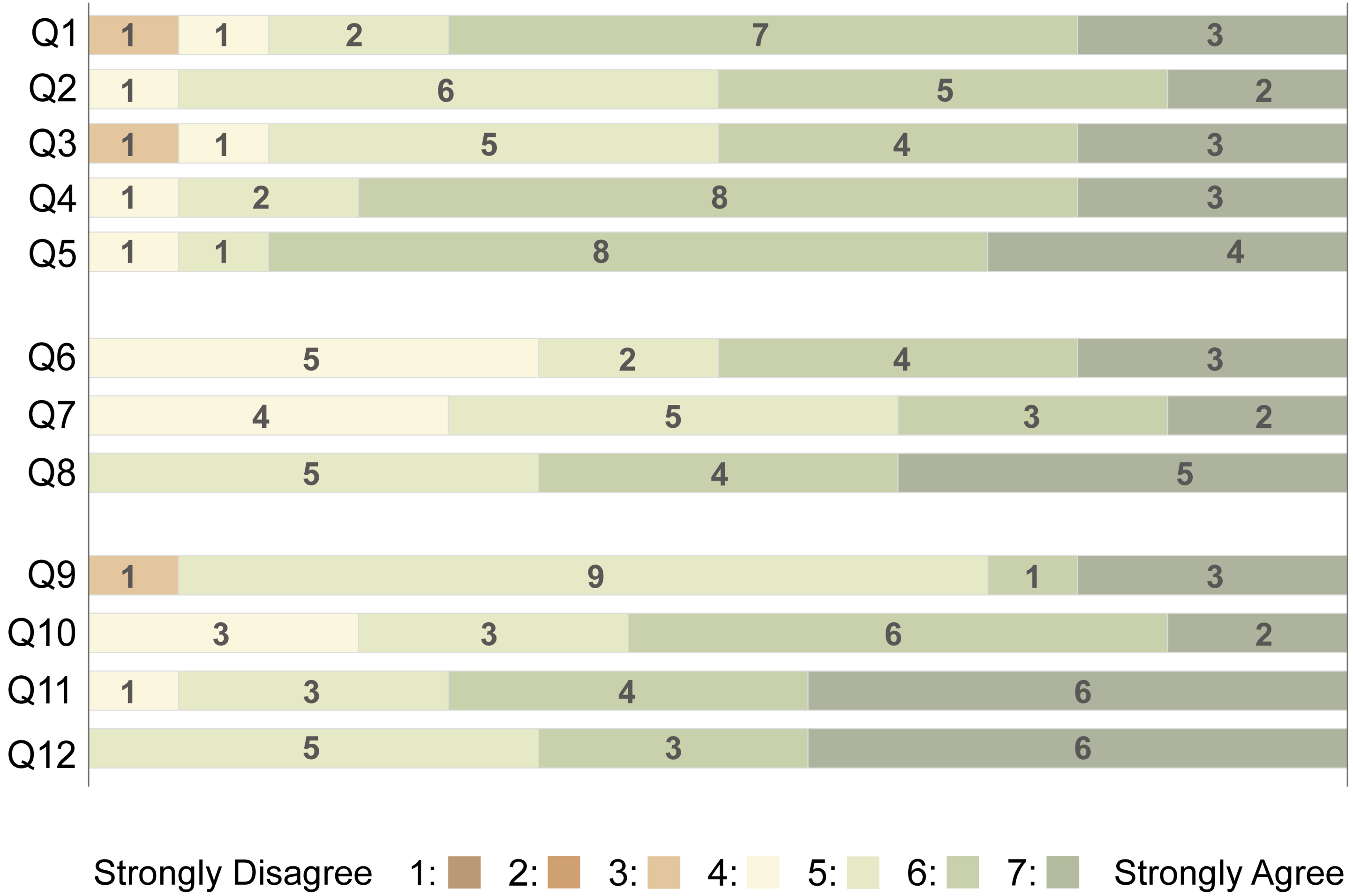


User Interview

Workflow Effectiveness

Visual Design and Interactions

Usability



Summary

- Cooperated with NFT investors to collect design requirements;
- Proposed NFTDisk to help investors detect and analyze wash trading;
- Conducted case studies and user interview to evaluate NFTDisk;

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NFTDisk: Visual Detection of Wash Trading in NFT Markets

Paper Link


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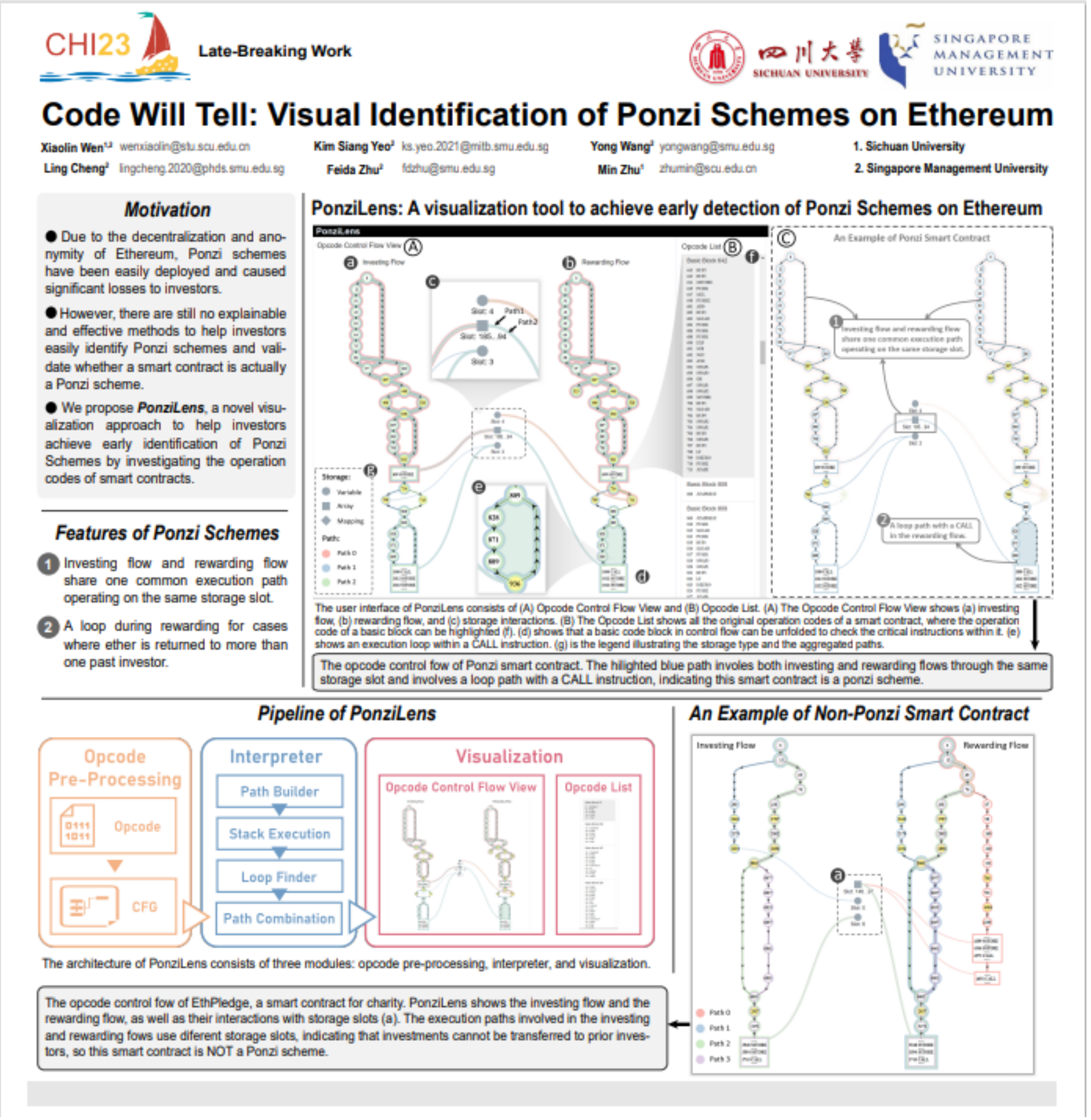

LBW-B044

Code Will Tell: Visual Identification of Ponzi Schemes on Ethereum

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Yong Wang

yongwang@smu.edu.sg

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Design Requirements

- R1 Analyze wash trading in the scope of NFT collection;
- R2 Recognize suspicious transactions and addresses from the overview;
- R3 Reveal wash trading features at multiple levels;
- R4 Display the detailed transaction patterns of wash trading;
- R5 Enable the evaluation of wash trading influence.

Participants

ID	Gender	Age	NFT Experience	Description
U1	Male	23	13 months	A creator of an NFT community and a key opinion leader on Twitter.
U2	Female	25	8 months	A product manager for multiple NFT projects.
U3	Male	30	12 months	An NFT investor who is good at using NFT analysis tools.
U4	Female	26	12 months	A creator of an NFT community and a key opinion leader on Twitter.
U5	Male	29	10 months	A creator of an NFT community and a leader of an NFT project.
U6	Male	25	12 months	A creator of an NFT community and a leader of three NFT projects.
U7	Female	23	7 months	An NFT investor engaged in the issuance of NFT projects.
U8	Male	27	10 months	An NFT investor engaged in the issuance of NFT projects.
U9	Male	27	6 months	An NFT investor who is good at using NFT analysis tools.
U10	Male	30	12 months	An NFT investor investing in cryptocurrencies for five years.
U11	Male	25	7 months	An NFT investor investing in cryptocurrencies for two years.
U12	Male	28	5 months	An NFT investor investing in cryptocurrencies for two years.
U13	Male	46	4 months	A professor whose research focus is digital economy.
U14	Female	28	5 months	A PhD student with two-year research experience in cryptocurrencies.

Implications

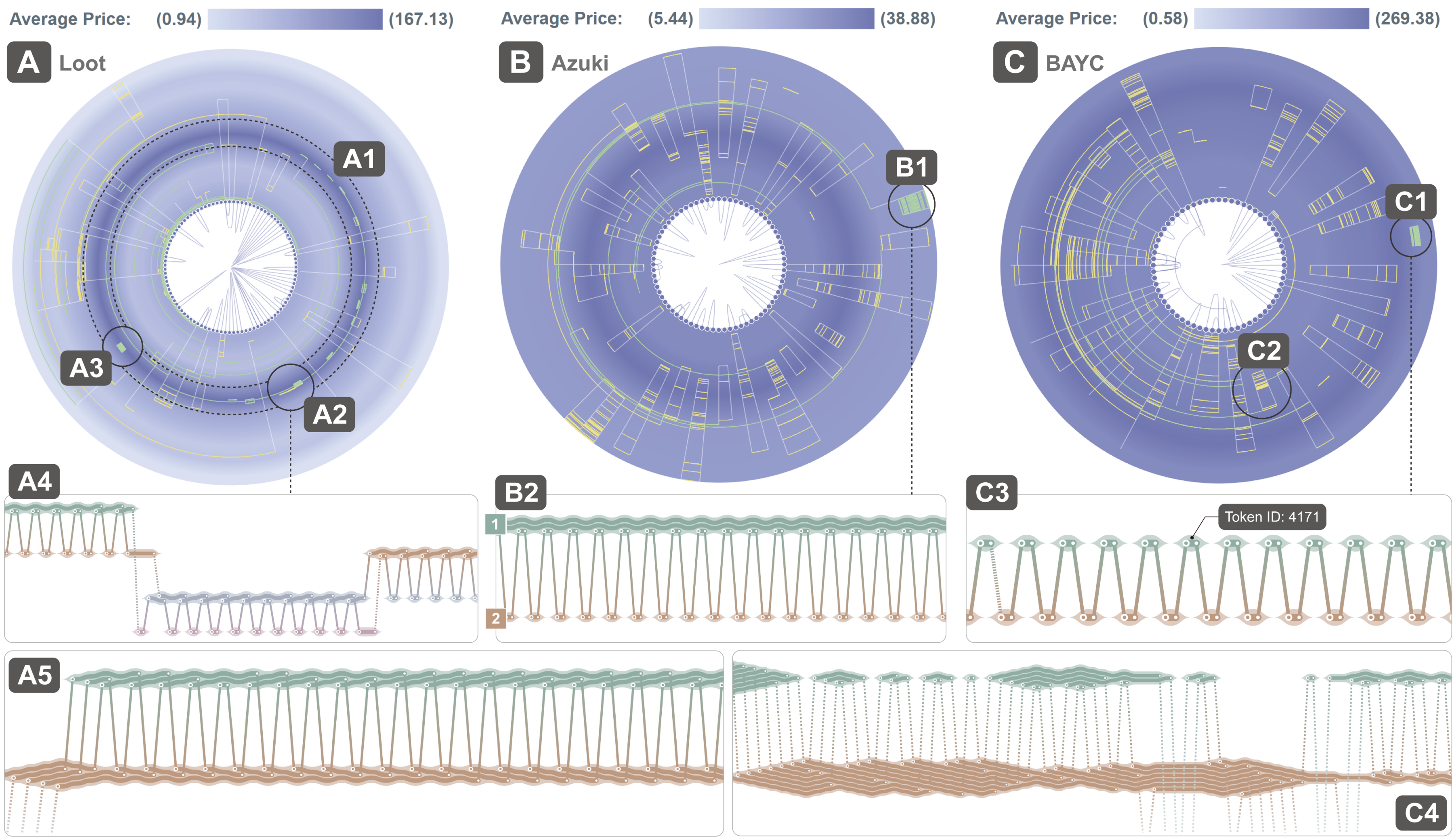
- Lessons learned:
  - Group of addresses > Individual addresses.
  - Different addresses have different tasks.
  - Not all wash trading are “harmful”.
- Design considerations for novices users:
  - Straightforward visual design (market risk -> height of flows);
  - Overview first, Details on demand;

Generalization

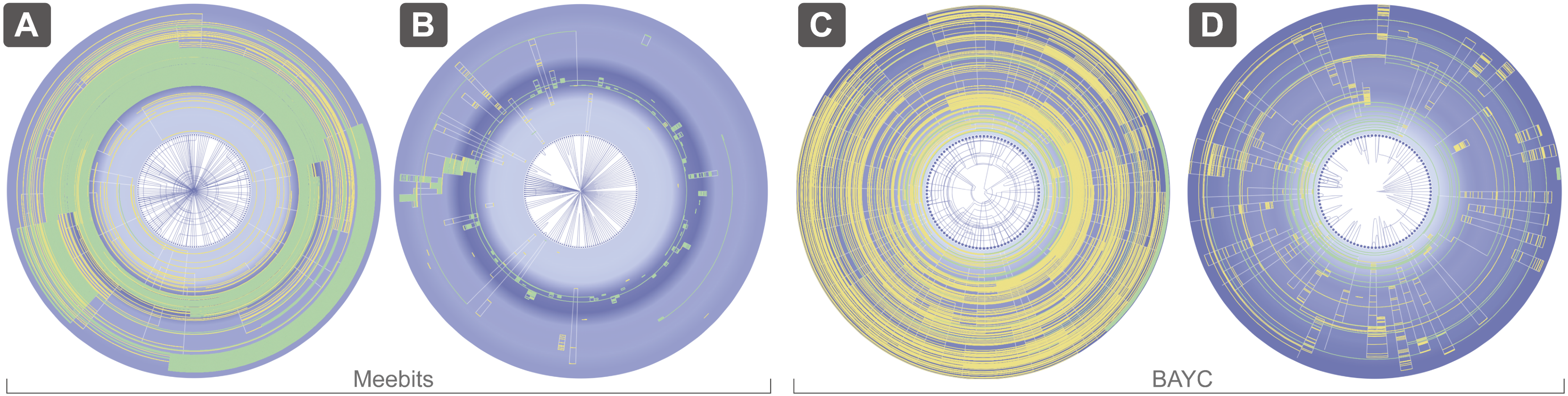
- Workflow => Other frauds in cryptocurrency markets:
  - e.g. money laundering
- NFTDisk => Traditional financial market:
  - e.g. stocks and bonds
- NFTDisk => Other abnormal online activities involving different participants:
  - e.g. Political Astroturfing

Case 2

Wash Trading Enhanced by Trading Rewards but Discouraged by Royalties



Address Reordering



Amount of transactions => distance matrix of addresses

Hierarchy clustering => clustering tree => optimal leaf ordering algorithm

Suspicious Score

$$S = 1 - \frac{N}{M}$$

where M is the number of transactions between the two addresses, and N is the number of unique NFTs involved in these transactions. The higher the suspicious score, the more likely the address pair is to collude. If each transaction from a pair of addresses includes a different NFT, then their suspicious score is zero.