

# DeFi Analytics & Risk Assessment

## Milestone 1 Report

Course 460/560 - Data Models and Query Languages

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## Introduction

### 1.1. Project Overview:

The DeFi Analytics & Risk Assessment tool analyzes decentralized finance (DeFi) activities on the Ethereum blockchain, by collecting on the chain data in a relational database. The goal is to identify suspicious activities, large-volume transfers, and token changes that could suggest problems like rug pulls, flash loan exploits, and liquidity shortages

### 1.2 The project involves:

- Obtaining and preparing Ethereum blockchain data Designing a normalized database schema
- Creating a normalized database schema
- Executing SQL queries for transaction analysis and risk evaluation
- Formulating risk management techniques for DeFi protocols

### 1.3 Importance of Relational Databases for DeFi Analytics:

Relational databases are necessary for DeFi analytics because they enable efficient querying, systematic data management, and scalability. They use main and foreign keys to ensure data integrity while also providing security features such as encryption and access control. They enable reliable financial tracking, risk identification, and data-driven decision-making in decentralized finance thanks to their ACID compliance and ability to model complicated relationships.

### 1.4 Problem Statement:

Because of a lack of broad transaction tracking, decentralized finance DeFi companies frequently encounter difficulties like include fraud, manipulation of the markets, or crisis of liquidity. Traditional Excel file methods suffer with capacity issues, inability to manage complicated relationships, and a lack of real-time searching capabilities. A system of relational databases overcomes these restrictions by providing efficient keeping, real-time querying, advanced analytics, and scalability.

# DeFi Analytics & Risk Assessment

## 1.5 Target Users:

- Researchers and Risk Control Teams may utilize the database to analyze transaction patterns, detect problematic steps, and make informed decisions.
- DBAs handle database performance, integrity, indexing, and backups.

## Real-Life

A DeFi structure, including the or Aava, use the above database to continuously monitor big or unusual token actions, allowing for instant risk reduction measures like, blocking specific operations, notifying lenders, or starting security processes.

## Dataset Acquisition and Preprocessing

- Google Big Query dataset on Ethereum blockchain (bigquery-public-data.crypto\_ethereum) concentrates on ERC-20 and ERC-721 token transfers..
- A SQL-based filtration extract found 20,000 related tokens exchange data between January to February 2025.
- The extracted data was uploaded into PostgreSQL in the form of a CSV, first placed in a staging database (staging\_deploy), before being normalized into structural records (Block, Transaction, Token).
- Performance optimizations, such as table separation, query the sorting, and batch processing of data have been implemented.
- Cloud methods, like Google Cloud Dataflow and Apache Beam, were evaluated for increased scalability..

## Entity-Relationship Diagram (ERD)

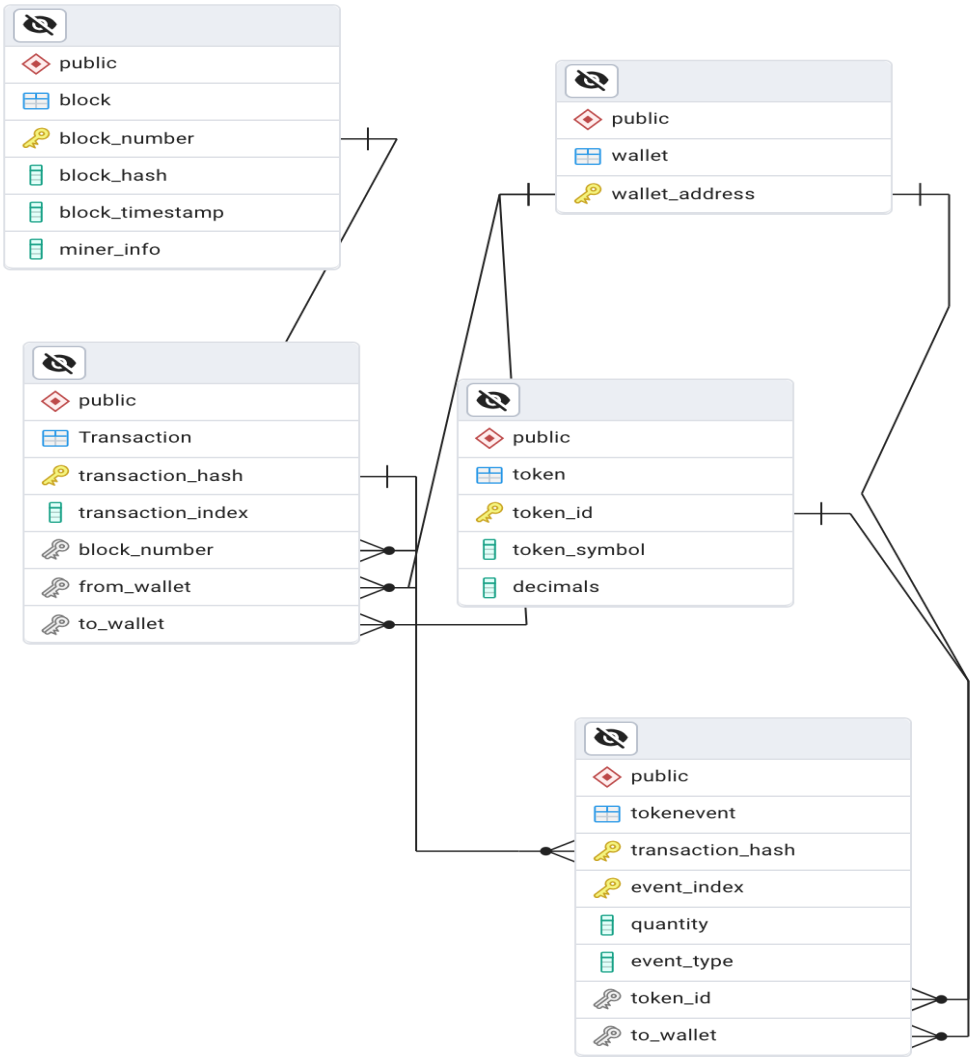
### Schema Design

This section includes a list of SQL queries run using the DeFi analytics database, as well as the outcomes and analysis. These queries show the ability of the relational database to deal with complex DeFi transaction data.

# DeFi Analytics & Risk Assessment

## Entity Descriptions

Entity	Description
Block	Stores block metadata, including block_number, block_hash, and block_timestamp.
Wallet	Tracks unique wallet addresses involved in transactions.
Token	Stores details of different tokens (token_id, token_symbol).
Transaction	Links from_wallet and to_wallet to block_number for each transaction.
TokenEvent	Tracks token transfers within transactions (includes token_id, quantity, and to_wallet).



# DeFi Analytics & Risk Assessment

## Relationships:

1. Block → Transaction (one-to-many)
2. Wallet → Transaction (one-to-many)
3. Transaction → TokenEvent (one-to-many)
4. Token → TokenEvent (one-to-many)

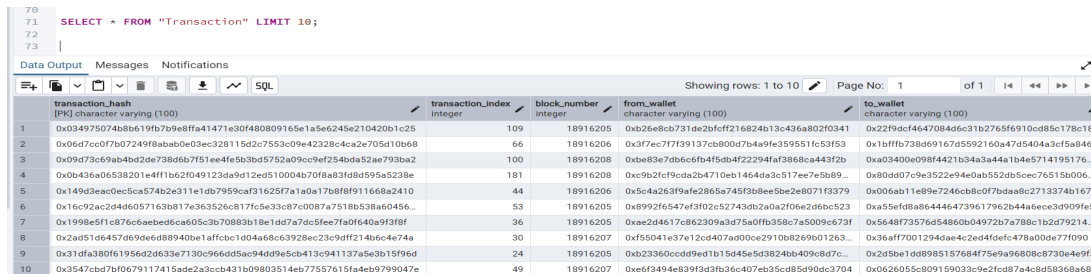
The relationships between these items allow proper organization and allow sophisticated searches to be run via JOIN procedures without duplication. , The layout has been adjusted to the BCNF to improve speed and regularity.

## SQL Queries & Results

- This section includes a list of SQL queries run on our DeFi analytics database, as well as their results and analysis. These operations demonstrate the ability of our MySQL database to handle complex DeFi transactions with ease.

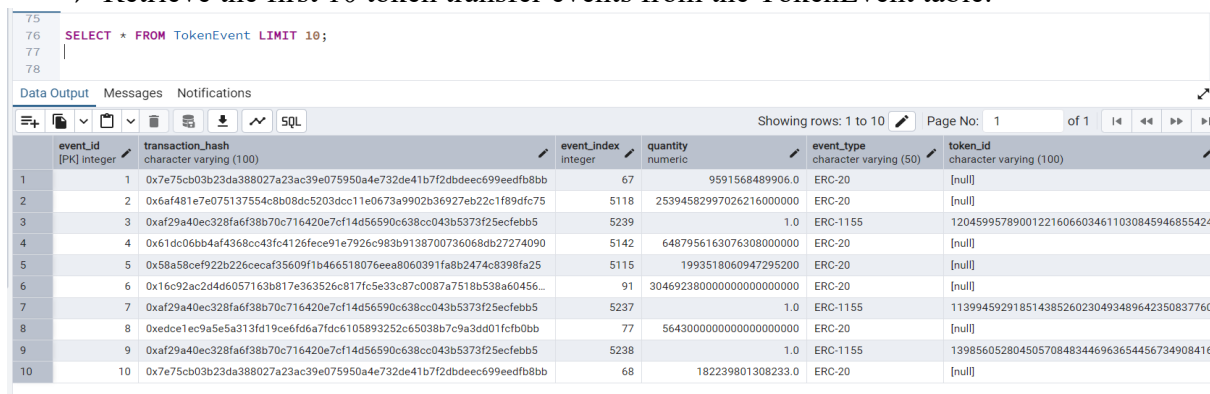
### Data Verification Queries

→ Retrieve the first 10 transactions from the Transaction table



transaction_hash	transaction_index	block_number	from_wallet	to_wallet
0x034975074b8b619fb7b9e8ffa41471e30f480809165e1a5e245e210420b1c25	109	18916205	0xb26e8cb731de2bfcff216824b13c436a802f0341	0x22f9dc4647084dc631b2765f910cd85c178c18
0x06d7cc0f7b07249f8abab0e03ec32b115d2c7553c09e42328c4ca2e705d10b68	66	18916206	0x3f7ec77f39137cb800d7b4a9fe359551fc53f53	0x1bfff6738d69167d5592160a47d5404a3cf5a846
0x09d73ce9ab4bd2de738d6b7f51ee4fe5b3bd5752a09cc9ef254bda52ae793ba2	100	18916208	0xb683e7db6c6fb4f5db4f22294fa3868ca443f2b	0xa03400e098f4421b34a3a44a1b4e5714195176...
0x0b436a06538201e4ff1b62f049123da9d12ed510004b70f8a83fdd595a5238e	181	18916208	0x9b2f9cda2b4710eb1464da3c517ee7e5b89...	0x80dd07c9e3522e94e0ab552db5ec76515b006...
0x149d3eac0ec5ca574b2e311e1db7959caf31625f7a1a0a17b8f8f911668a2410	44	18916206	0x5c4a263f9af2865a745f3b8ee5be2e8071f3379	0x006ab11e89e7246cb8c0f7bdaa8c2713374b1676
0x16c92acc2d4d6057163b817e363526c871fc53c87c0087a7518b538a60456...	53	18916205	0x8992f6547ef3f02c52743db2a0a2f06e2d6bc523	0xa55fd8a86444647396179b2644a6ece3d909fe5
0x1998e5f1c76c6aebd6ca605c3b0883b18e1dd7a7dc5ee7fa0f640a9f8f8f	36	18916205	0xae2d4617c862309a3d75a0ffb358c7a5009c673f	0x5648f73576d54860b04972b7a788c1b2d79214...
0x2ad51d6457d69ded88940be1affbce1dd4a68c63928ec23c9dff214b6c4e74a	30	18916207	0xf55041e37e12cd407ad00ce2910b8269b01263...	0x36aff7001294dae4c2ed4dfefc478a00de77f090
0x31dfa380f61956d2d633e7130c966dd5ac94dd95cb413c941137a5e3b15f96d	24	18916205	0xb23360cdd9ed1b15445e5d3824bb409c8d7c...	0x2d5be1dd8985157684f75e9a96808c8730e4e9f3
0x3547cbd7bf0679117415ade2a3ccb431b09803514eb77557615fa4eb9799047e	49	18916207	0xe6f3494e839f3d3fb36c407eb35cd85d90dc3704	0x0626055c809159033c9e2fcd87a4c8d58368a683

→ Retrieve the first 10 token transfer events from the TokenEvent table.



event_id	transaction_hash	event_index	quantity	event_type	token_id
1	0x7e75cb03b23da388027a23ac39e075950a4e732de41b7f2dbdec699eedf8bb	67	9591568489906.0	ERC-20	[null]
2	0x6af481e7e075137554c8b08dc5203dca11e0673a9902b36927eb22c1f89dfc75	5118	25394582997026216000000	ERC-20	[null]
3	0xaf29a40ec328fa6f38b70c716420e7cf14d56590c638cc043b5373f25ecfbb5	5239	1.0	ERC-1155	120459957890012216066034611030845946855424
4	0x61dc06bb4af4368cc43fc4126fcec91e7926c983b9138700736068db27274090	5142	6487956163076308000000	ERC-20	[null]
5	0x58a58cef922b226cecaf35609f1b466518076eea8060391fa8b2474c8398fa25	5115	1993518060947295200	ERC-20	[null]
6	0x16c92acc2d4d6057163b817e363526c871fc53c87c0087a7518b538a60456...	91	3046923800000000000000000	ERC-20	[null]
7	0xaf29a40ec328fa6f38b70c716420e7cf14d56590c638cc043b5373f25ecfbb5	5237	1.0	ERC-1155	113994592918514385260230493489642350837760
8	0xedce1ec9a5e5a313fd19ce6fda7fde6105893252c65038b7c9a3dd01cfb0bb	77	564300000000000000000000	ERC-20	[null]
9	0xaf29a40ec328fa6f38b70c716420e7cf14d56590c638cc043b5373f25ecfbb5	5238	1.0	ERC-1155	139856052804505708483446963654456734908416
10	0x7e75cb03b23da388027a23ac39e075950a4e732de41b7f2dbdec699eedf8bb	68	1822398013082323	ERC-20	[null]

# DeFi Analytics & Risk Assessment

→ Count unique transactions in the staging table to verify initial data extraction.

The screenshot shows a SQL IDE interface with a query editor and a data output table. The query editor contains the following SQL code:

```
-- Unique transaction count in staging table:
SELECT COUNT(DISTINCT transaction_hash) AS unique_transactions_in_staging
FROM staging_deploy;
```

The data output table shows the result of the query:

unique_transactions_in_staging
105

→ Confirm total transactions inserted into the Transaction table.

The screenshot shows a SQL IDE interface with a query editor and a data output table. The query editor contains the following SQL code:

```
-- Total transactions inserted into Transaction table:
SELECT COUNT(*) AS transactions_in_transaction_table
FROM "Transaction";
```

The data output table shows the result of the query:

transactions_in_transaction_table
105

→ Verify total rows loaded into staging\_deploy for data completeness.

The screenshot shows a SQL IDE interface with a query editor and a data output table. The query editor contains the following SQL code:

```
SELECT t.block_number
FROM "Transaction" t
LEFT JOIN Block b ON t.block_number = b.block_number
WHERE b.block_number IS NULL;
```

The data output table shows the result of the query:

block_number
integer

# DeFi Analytics & Risk Assessment

→ Verify total number of token events stored in the TokenEvent table.

Dashboard × Properties × SQL × Statistics × Dependencies × Dependents × Processes × dmql.sql\* ×

defi\_project/postgres@PostgreSQL 17

Query Query History

```

92
93
94 -- Total rows in staging_deploy:
95 SELECT COUNT(*) AS staging_rows_count FROM staging_deploy;
96
97
98

```

Data Output Messages Notifications

Showing rows: 1 to 1 Page No: 1 of 1

staging_rows_count bigint
200

- **Transaction and Wallet Analytics**

→ Identify top 10 wallets by transaction count (most active wallets).

Dashboard x Properties x SQL x Statistics x Dependencies x Dependents x Processes x **dml.sql** x

defi\_project/postgres@PostgreSQL 17

No limit

Query Query History

```
-- Total rows in TokenEvent:
SELECT COUNT(*) AS token_events_count FROM TokenEvent;
-----
```

Data Output Messages Notifications

Showing rows: 1 to 1 Page No: 1 of 1

	token_events_count bigint
1	200

→ Analyze daily transaction trends (volume by date).

Dashboard
Properties
SQL
Statistics
Dependencies
Depends
Processes
dml.sql

defi\_project/postgres@PostgreSQL 17

No limit

Query
Query History

```

103
104
105 SELECT w.wallet_address, COUNT(*) AS transaction_count
106 FROM Wallet w
107 JOIN "Transaction" t ON w.wallet_address = t.from_wallet
108 GROUP BY w.wallet_address
109 ORDER BY transaction_count DESC
110 LIMIT 10;
111
112

```

Data Output
Messages
Notifications

Showing rows: 1 to 10
Page No: 1
of 1

	wallet_address [PK] character varying (100)	transaction_count bigint
1	0x00...	10
2	0x3fc91a34fd70395cd496c647d5a6cc9d4b2b7fad	7
3	0xddef1c0db6e6c7f1a1670819b32340021625efff	2
4	0xaa2d4617c6d2309a3d75ad0fb358c7a5009e673f	2
5	0xcc6f5fbc373392c4e1c26cd9fbc0f421dfca13b	2
6	0x55935d5188077514dfad3051d19c148c5f5101...	2
7	0x1063181dc986f76f7ea2dd109e16fc596d0f522a	1
8	0x48c1d08d7e43a0ab8597a52c2bfed280c111c3d	1
9	0x8992f6547ef3f02c52743db2a0a2f06e2d6bc523	1
10	0x89e51fa8ca5d66cd220baed62ed01e8951aa7c40	1

Total rows: 10
Query complete 00:00:00.129

# DeFi Analytics & Risk Assessment

→ Retrieve transactions with unusually large token transfers (potential risk).

The screenshot shows a PostgreSQL query editor interface. The query is as follows:

```
111
112
113
114 SELECT DATE(b.block_timestamp) AS transaction_date, COUNT(*) AS total_transactions
115 FROM "Transaction" t
116 JOIN Block b ON t.block_number = b.block_number
117 GROUP BY DATE(b.block_timestamp)
118 ORDER BY transaction_date;
119
120
```

The Data Output tab shows the following results:

transaction_date	total_transactions
2024-01-02	105

- **Insert, Update, and Delete Queries (Data Management)**

→ Insert a new wallet address into the Wallet table.

The screenshot shows a PostgreSQL query editor interface. The query is as follows:

```
133
134 INSERT INTO Wallet (wallet_address)
135 VALUES ('0xNewWalletAddress123');
136
137 SELECT * FROM Wallet
138 WHERE wallet_address = '0xNewWalletAddress123';
139
140
141
```

The Data Output tab shows the following results:

wallet_address
0xNewWalletAddress123

→ Update miner information in the Block table for a specific block.

The screenshot shows a PostgreSQL query editor interface. The query is as follows:

```
142
143
144 UPDATE Block
145 SET miner_info = 'Updated Miner'
146 WHERE block_number = 18916205;
147
148 select * from block
149 WHERE block_number = 18916205;
150
```

The Data Output tab shows the following results:

block_number	block_hash	block_timestamp	miner_info
18916205	0x9d5f03464709683f46eb09460403c6826bb499834b7a23a5bf6ee63c19954975	2024-01-02 00:41:35	Updated Miner

# DeFi Analytics & Risk Assessment

## Performance Optimization

Handling and query large blockchain datasets depend on database optimization efficiency. The search strategies listed below were used to cater for the vast quantity and variety of Ethereum blockchain data. To boost query speed for faster DeFi transactions statistics, certain indexing algorithms were implemented:

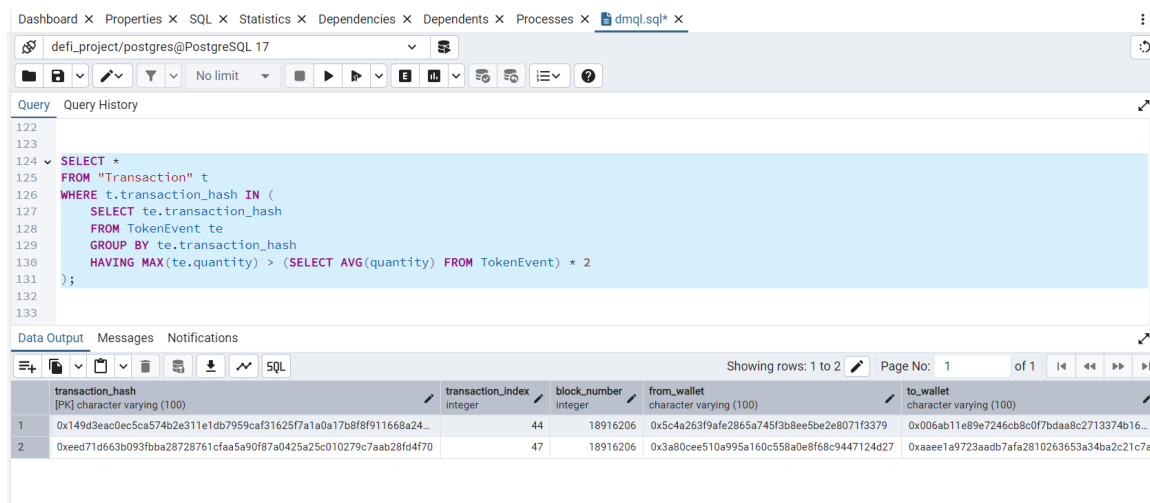
- Single-column indexing improves search time by creating indexes on frequently searched columns like transaction\_hash and block\_number.
- Used multi-column indexing to optimize queries with numerous conditions or JOIN actions.
- Covering indexes allow queries to retrieve data directly from the index, reducing the need for table lookups.

These methods reduced db efficiency, which is critical for actual time DeFi analytics and assessment of risks.

## Risk Assessment Metrics

Queries are run to find token transfers that are abnormally large much larger than usual which could be dangerous.

To find transactions involving token transfers that were abnormally huge and far more than the typical transfer amount—possibly indicating fraudulent or high-risk activity the following query was run:



The screenshot shows a database query interface with a SQL query editor and a results table. The query is designed to find transactions where the transferred token amount is more than twice the average.

```
SELECT *
FROM "Transaction" t
WHERE t.transaction_hash IN (
  SELECT te.transaction_hash
  FROM TokenEvent te
  GROUP BY te.transaction_hash
  HAVING MAX(te.quantity) > (SELECT AVG(quantity) FROM TokenEvent) * 2
);
```

The results table displays the following data:

transaction_hash [PK] character varying (100)	transaction_index integer	block_number integer	from_wallet character varying (100)	to_wallet character varying (100)
0x149d3eac0ec5ca574b2e311e1db7959caf31625f7a1a0a17b8f8f911668a24...	44	18916206	0x5c4a263f9afe2865a745f3b8ee5be2e8071f3379	0x006ab11e89e7246cb8c0f7bdaa8c2713374b16...
0xeed71d663b093fba28728761cfaa5a90f87a0425a25c010279c7aab28fd4f70	47	18916206	0x3a80cee510a995a160c558a0e8f68c9447124d27	0xaeee1a9723aadb7afa2810263653a34ba2c21c7a

This query helps identify vulnerabilities like market manipulation, liquidity attacks, or fraudulent schemes early on by flagging transactions when the transferred token amount is more than twice the average.