# Kirin: An Interactive Visualization for Decentralized Finance Applications in Ethereum Blockchain

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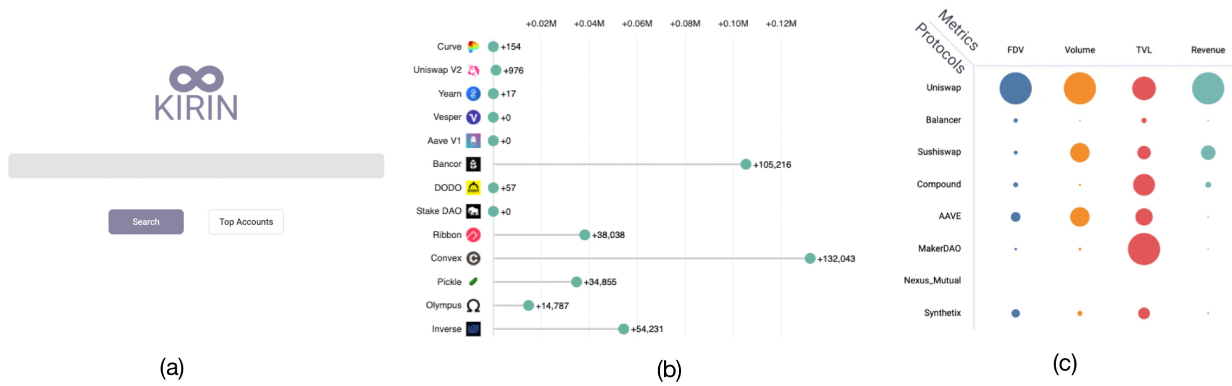


Fig. 1: Kirin visualizes on-chain metric values for DeFi applications : (a) search interface; (b) lollipop plot of assets in different protocols of an account; (c) different metrics for different protocols.

**Abstract**—Ethereum is a popular blockchain-based software platform that supports transacting values and interacting between users and decentralized finance (Defi) applications securely. Tons of anonymous transactions and smart contract interactions happen in Ethereum, thus creating a large amount of data each day. Our goal is to find out how users interact with DeFi applications in a period. However, limited research focused on using visualizations to understand this issue. In this paper, We propose Kirin, a tool that first retrieves and preprocesses data from Ethereum and then visualizes the data interactively in two different views: the User Account View and the Project Metric view. The User Account View shows the user's detailed information, including his asset distribution on Defi protocols. The Project Metric View presents different metric values of various DeFi applications in a period. We showcased how novice users can utilize Kirin to make investment decisions. We also evaluated Kirin using a user study to verify that our tool is approachable and helpful.

**Index Terms**—Ethereum, Information Visualization, Blockchain, Visual Analytics.

## 1 Introduction

Bitcoin, invented by Satoshi Nakamoto [24], has revolutionized digital money transactions and exchanges by creating a decentralized form of currency along with the blockchain technology. Inspired by Bitcoin, Ethereum was proposed in 2013 and brought to life in 2014 by Vitalik Buterin [21], which is a blockchain-based network infrastructure aiming to support decentralized applications (Dapps) such as financial transactions, specifically decentralized finance (DeFi), directly without the need of an intermediary. Equipped with autonomous but cryptographically-secure mechanisms, Ethereum attracts numerous active users to transfer money and interact with the smart contracts globally, which also creates multitudinous data that is worthwhile to study to better understand the user activity regulations as well as mechanisms in blockchain systems.

Blockchain data is stored and maintained across peer-to-peer networks, so any single transaction activity will be recorded. In Ethereum, such stored activities also include users' interactions with smart contracts, which is a piece of executable code. To better explore the blockchain technology in a wider domain, a large number of blockchain-related researches have been conducted from the aspects of algorithms, software systems, computer security, and cryptography. Despite the increasing acknowledgement of the importance of blockchain technology, from a perspective of better supporting visual analytics of these complex data, there is limited research combining visualization and blockchain, especially Ethereum. For example, there are attempts [28] trying to visualize blockchain data based on bitcoin addressing two criteria: visual representation and implementation. Later, researchers presented systematic reviews [30,31] of online visualizations for blockchain. But the majority of the previous work focused on bitcoin instead of Ethereum and did not address enough observations to understand the interactions between users and DeFi applications.

In this paper, we present a visualization system, Kirin, that allows users to explore the user account and on-chain metrics of some notable decentralized finance applications on Ethereum in a period. Kirin collects user activities on the following decentralized finance applications, including the decentralized banking platform (MakerDAO), decentralized lending and borrowing platforms (Compound and AAVE), decentralized exchange platforms (Uniswap, Balancer, and Sushiswap), and decentralized derivative trading platform (Synthetix). The user account analyzed by Kirin includes user account value and user asset allocation in DeFi protocols; the on-chain metrics analysis has total value locked (TVL), protocol revenue, trading volume, and fully diluted valuation (FDV).

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The main target user of Kirin is the new user for Ethereum and DeFi Protocols. Kirin provides the tool to let new users explore the activities of the experienced users and learn the necessary metrics for investment and DeFi farming.

In summary, our main contributions include:

- A novel data-driven approach that analyzes the user interaction with decentralized finance on Ethereum applications from various aspects.
- An interactive tool, Kirin, summarizes the critical on-chain metrics following time series and supports data exploration for different user behaviours.

## 2 Background

With the advent of blockchain technology and the rapid development of the internet, bitcoin was proposed in 2008 by Satoshi Nakamoto [24], before which, the only way that people can use money digitally was through an intermediary along with currency controlled by a government. Bitcoin, as a decentralized form of currency, changed the situation by allowing users to trade directly under pseudonyms and ensuring the transaction validation by the entire network.

***DeFi (Decentralized Finance).*** Inspired by bitcoin, a decentralized form of money, the concept of a decentralized form of finance is proposed. DeFi utilizes smart contracts to ensure that financial products and services are accessible to anyone who can use Ethereum, i.e. anyone with an internet connection. To be more specific, built on transparency, DeFi guarantees the markets are always open without a centralized intermediary and any financial action will be confirmed by the whole network through Ethereum.

***Ethereum Accounts and DeFi Protocols.*** The most basic type of account in Ethereum is called an *Externally Owned Account (EOA)*, which has an Ethereum address along with a private key. Each EOA can send or receive cryptocurrencies, create contracts or trigger contracts. And Ethereum transactions are used not only for transferring values but also for creating or triggering smart contracts. There are many different DeFi protocols that are used by users or EOAs for exchanging cryptocurrencies and tokens, for example, *Uniswap, Balancer, Sushiswap* etc. These protocols smooth the automatic transactions between cryptocurrency tokens on the Ethereum blockchain through the interactions with the smart contracts. There are other DeFi protocols to let conduct other financial activities, for example, *Compound* and *AAVE* provide a non-custodial protocol for earning interest on deposits and borrowing assets; *MakerDAO* builds a decentralized stable cryptocurrency which pegs the value to fiat currency; *Synthetix* provides a platform for decentralized derivatives trading and *Nexus Mutual* is decentralized insurance protocol.

***On-chain Metrics.*** There are a number of metrics on-chain that can help crypto investors to better analyze the cryptocurrency markets and understand the tokenomics of the chain. For example, *Total Value Locked (TVL)*, one of the most commonly considered metrics, represents the total amount of assets that are secured or staked in a specific protocol. Another notable metric is *Fully Diluted Valuation (FDV)*, which can be computed as the multiple of the maximum supply of a token and the current market price of the token, in other words, FDV represents the future market capacity of a project. And similarly, in capital markets, *Trading Volume* is the total value of assets that was traded during a given period of time (24 hours), which can be a sign of users' general interest in the crypto market since high trading volume is likely to drive more on-chain activities. *Revenue* refers to the total fees paid by end-users to take the services of a project, and high revenue will also motivate more potential on-chain action. In the following of this paper, we will focus on these four on-chain metrics to provide insights about the crypto markets through visualizations.

## 3 Related Work

### 3.1 Blockchain Technology and Ethereum

The blockchain technology [24] has addressed its practicalities and vitality along with a cryptographically-secured transaction ledger system via the Bitcoin project. With the decentralized mechanisms, Ethereum [21, 33] emerged from the blockchain technology attempting to build up a platform to allow any transaction-based state machine concepts with security, anonymity and data integrity.

***Blockchain Technology.*** Due to its diverse potential in security, cryptography, finance and etc, blockchain technology has also attracted researcher's attention. Yli-Huumo et al. [34] collected 41 primary papers from scientific databases about blockchain technology. Grounded on the extracted data, they observed that 80% of the current research focused on Bitcoin and the rest explored blockchain applications such as smart contracts. They recommended several future research directions for blockchain technology as: continuing to identify limitations and propose possible solutions, more studies on scalability, more applications based on blockchain beyond bitcoin, and more effective evaluation of the proposed solutions.

***Recent Advances and Future Trends.*** Zheng et al. [35] investigated the recent advances and possible future trends of blockchain technology comprehensively. They interpreted typical consensus algorithms and several blockchain applications thoroughly. Besides, the authors discussed the main challenges of the blockchain technology despite its great potential for the construction of internet information systems. On account of the limited size of each block, the limited time of every mining procedure and the trade-off between storage propagation in the network, high-frequency trading is quite circumscribed. Moreover, selfish mining strategy and privacy leakage also need to be addressed in future development.

These researches emphasized the limitations of blockchain technology in terms of privacy, security and performance, however, prior studies have failed to leverage data visualization.

### 3.2 Blockchain and Ethereum Analytics

***Blockchain Analytics.*** Bartoletti et al. [18] surveyed analytic tools for Bitcoin and Ethereum and categorized these tools based on their purposes: anonymity, market analytics, cyber-crime, metadata and transaction fees. The authors further listed the type of data collected for each analytic goal with their sources. Based on the survey, they created a general-purpose analytic tool on the blockchains of Bitcoin and Ethereum. Balaskas and Franqueira [17] examined a set of blockchain analytic tools in terms of their effectiveness in cybercrime investigations and analysis. They proposed a thematic taxonomy to categorize blockchain analytic tools based on their applications: entity relationships, metadata, money flows, user behaviour, transaction fees, and market/wallets. One limitation they found is that current analytics tools focus on too narrow features, so the suggested future work is to create a more generic and real-time analytic tool to process a wider range of blockchain data.

***Ethereum Analytics.*** Rouhani and Deters [27] presented the Ethereum transactions and evaluated the two most popular Ethereum clients, Geth and Parity, on a private blockchain, and investigated how different clients affect Ethereum performance. Results show that Parity is faster than Geth on transaction speed. Tikhomirov et al. [29] classified the code issues in Solidity where Solidity is the most mature high-level smart contract language and implemented SmartChack for detecting such vulnerabilities. Voulgari [32] presented in-depth analyses for Ethereum usability and Ethereum price via comparison of the number of transactions and the value of ether transferred. The author highlighted that the number of transactions has an exponential growth while the value transferred fluctuates every day. Li et al. [23] offered perspectives on the relationships between transaction graph properties and crypto price dynamics via the topological data analysis tools into Ethereum data analytics. Based on the topology and geometry of the Ethereum graph, the Ethereum network can lead to critical comprehension of the price changes of the crypto-token, which are not observed using traditional analytic methods.

All these works discussed tools for analyzing blockchain data with specific purposes. However, they do not provide ideas on utilizing visualizations to analyze blockchain data, which is the aim of our work.

### 3.3 Ethereum Visualization

***Research on Ethereum Visualization.*** Tovanich et al. [31] presented a systematic review for the visual analytics tools, blockchain data, task domains, and visualization types across different blockchains. The author assessed 76 analytics tools created by researchers and blockchain developers. There are 19 of them focusing on Ethereum, and the transaction detail analysis is one of the main tasks in blockchain visualization. Norvill et al. [25] presented E-EVM, an interactive tool to emulate and visualize smart contract execution in Ethereum Virtual Machine environment. The tool could read the bytecode of the smart contract and display the smart contract's opcode, stack, and execution flow.

***Ethereum Visualization Products.*** Etherscan [8] is a widely used product doing Ethereum transactions visualizations. It syncs with the Ethereum network and shows the latest block and transaction details in text and table. Besides that, it provides some additional visualization for tokens, accounts in Ethereum in text and table. DeFi Pulse focuses on the Total locked value (TVL) metrics for many decentralized finance smart contracts. It uses a linear chart to demonstrate the Total locked value for a protocol over a period. Txstreet [16] is a cartoon visualizer for Ethereum network blocks and transactions. It uses the school bus representing the block, a cartoon student representing the transaction, and some houses representing the decentralized finance smart contracts.

Txstreet shows the top two smart contracts for each Ethereum block and the traffic status of the Ethereum network. E-EVM and Etherscan visualized the primary raw data from Ethereum blockchain, including Ethereum Virtual Machine, blocks and transactions. DeFi Pulse and Txstreet emphasized a few metrics, such as Total locked value for limited decentralized finance smart contracts. These researches and products can not visualize more metrics for a wide range of decentralized finance protocols in a more extended period, nor provide interactive visualization for user interaction, which are the aim of our work.

### 3.4 Visualization of interactions

Tovanich et al. [31] categorized the blockchain visualization into six task domain types of visualization. Any subset of these tasks can describe an interaction between different parts of the blockchain. In this paper, our focus is on the users' interaction with Decentralized Finance Applications in Ethereum Blockchain. Thus, it can be defined as Transaction Detail and Network Analysis, Peer-to-Peer Network Activity Analysis, and Cryptocurrency Exchanges Analysis based on Tovanich et al.'s categorization. In the rest of this section, we will focus on the visualization and techniques used in these three task domains.

***Transaction Detail and Network Analysis.*** Most of the work in this area focuses on aggregated details of transactions [22] or representing the network based on the transactions in a node-link diagram [19]. For example, Ethstat [9] provides a dashboard to explore metrics related to transactions like block mining time and difficulty in Ethereum network, BitInfoCharts [1] has a set of visualizations and tabular data of transactions on different blockchains, and BlockChainVis [19] visualizes the BitCoin transaction network in real-time. Although most visualizations in this domain are based on aggregated data, Schretlen et al. [26] proposed an interactive visualization using a large-scale tile map for transaction exploration on the blockchain. However, all these previous researches are focused on the visualization of transactions and the network either as an overview of the whole blockchain or a specific address. We aim to make this visualization more specific and concentrate on the transactions between users and DeFi apps. Also, as mentioned in [31] most of the visualizations are designed and developed for expert users, but with the current rise in cryptocurrencies, more novice users are involved with blockchain daily. Thus, the visualizations should be more descriptive.

***Cryptocurrency Exchanges Analysis.*** Blockchain technology is designed to make the transactions pseudonymous, which means you can track the source and destination for a transaction, but it is impossible or rather hard to know the identity of a person or organization behind each address only using the blockchain data. Therefore, most tools in this area focus on visualizing conversion rates [1,3,7] or statistics [3,8] like the market cap. However, our research is focused on the Ethereum and DeFi apps, which means if we find correct external data connected to DeFi apps one exploratory direction for our research may be to provide more metadata in our visualization.

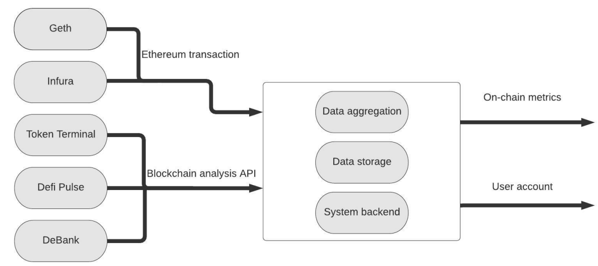



Fig. 2: Data processing pipeline

***Peer-to-Peer Network Activity Analysis.*** Blockchain is active on peer-to-peer networks. The visualization task here is not related to blockchain, and it is more related to the visualization of p2p networks, which is possible through node-link graphs or map-based visualizations [2]. However, the blockchain data provides another temporal dimension to this task. Time series visualizations are implemented in several tools [3,20] to represent processed p2p network data. However, to the best of our knowledge, they did not focus on implementing temporal navigation to better support the exploration tasks.

## 4 Proposed Solution

This section demonstrates the data processing pipeline, the interface and user interaction of Kirin.

### 4.1 Data Processing Pipeline

Kirin depends on the DeFi transaction activity data in Ethereum for both protocol and individual users. After researching the current datasets, we found that none of them provide the DeFi transaction data in a period or complete DeFi activities for a particular user. Thus, Kirin's data processing pipeline will utilize different data sources to collect the DeFi transaction activity data.

As presented in Figure 5, the data comes from two primary sources: Ethereum transaction and blockchain analysis API. Ethereum transaction is loaded from running a local Ethereum client (Geth [11]) and a third-party Ethereum client (Infura [12]) through JSON-RPC call. Utilizing the Ethereum transaction data, all related transactions for an address in the period are retrieved. We will filter the transactions between the address and target DeFi application contract address to get the user history data, including usage frequency, usage time, and assets exchange history.

On-chain metrics and other user information are derived from the blockchain analysis API. Token Terminal [15] and DeFi Pulse [6] are two blockchain analytical data providers. We used their APIs to query and store the on-chain metrics, including total value locked, token trading volume, revenue, and fully diluted market cap for Uniswap, Balancer, Sushiswap, Compound, AAVE, MakerDAO, and Synthetix protocols. Debank [5] is a DeFi wallet service provider, and we used their APIs to query the real-time statistics data for the account, including account portfolio and account asset allocation.

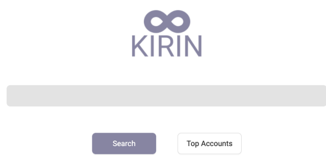
### 4.2 User Account View

The user account view as in Figure 3 shows the portfolio of a chosen Ethereum user. Users can switch to the metric view by selecting "Metrics" on the top left of the page.

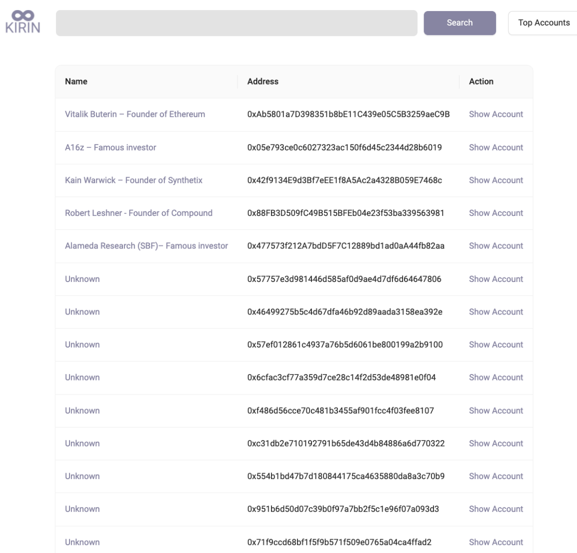
#### 4.2.1 Visualization Design

As presented in Figure 3, the user account view includes a search interface, a top users list and a personal data view with text and visualizations.

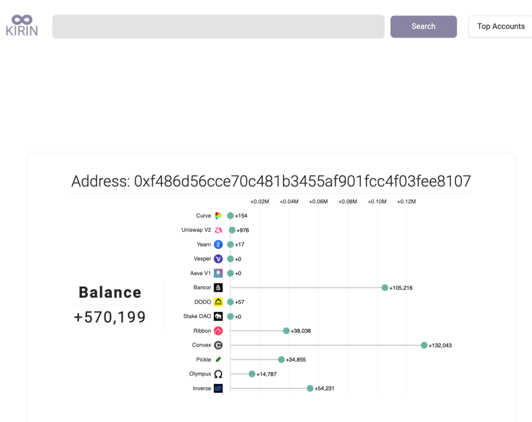
***Search interface.*** Kirin provides a search interface as in Figure 3a such that users can enter an account address to view more detailed




(a) Search Interface



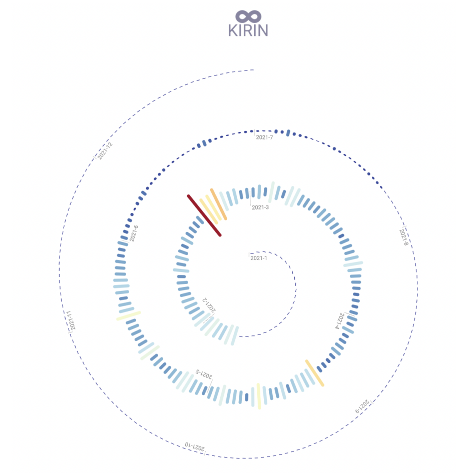

(b) Top users




(c) Personal data view

Fig. 3: User account view


(a) Bubble plot view




(b) Spiral plot view

Fig. 4: Metric view

context for this account, or users can also click the "top account" button to get some alternatives and choose one to view.

***Top users list.*** Kirin suggests users with a list of top accounts, which are the richest in Ethereum, as shown in Figure 3b after the users click the "Top Accounts" button in the search interface in Figure 3a. Users can select the account that they are interested in to view its portfolio in the personal data view which we will soon introduce. There are two types of users here, one type is the address that link the real identity of a well-known person, such as Vitalik Buterin - the founder of Ethereum. Another type is the anonymous wealthy address, which is called "Degen".

***Personal data view.*** Kirin returns basic contexts and corresponding visualizations of the input account as illustrated in Figure 3c. Some basic portfolios of the current account such as account address, account balance are presented. At the bottom right, there is a lollipop chart showing the user's staked or deposited asset values in different DeFi applications.

Note that some asset values might be "+0" which means a small positive value that is close to zero. We had intended to use a pie chart but ended up choosing a lollipop chart since some values could be too small to be recognized in a pie chart, and the percentages represented by different portions of a pie chart are more difficult to distinguish than a lollipop chart.

### 4.3 Project Metric View

The project metric view as in Figure 4 shows various metrics for different DeFi protocols in a period. Users can switch to the user account view by selecting "Account" on the top left of the page.

#### 4.3.1 Visualization Design

We designed a bubble plot view and a spiral plot view as in Figure 4 for different purposes.

***Bubble plot.*** The main visualization is a bubble plot in the center of Figure 4a which takes different projects and metrics as variables. The size of the bubble is defined by the metric value of the project. The bubble plot shows the metric values of different projects for a specific date that is chosen by the time control panel below it, thus, the bubble plot helps compare different metrics of different protocols at different times. The date for the bubble plot is shown on the top right of the page. We prefer a bubble plot than a heat map since different bubble sizes are more distinguishable than different color densities.

***Time control panel.*** There is a time control panel at the bottom of Figure 4a such that users can select a specific date for the bubble plot. The range of the panel is for 6 months, and each time tick represents a day. There is also a play button on the left to trigger the animation of the bubble plot that shows the changes of the metric data through time.

***Spiral plot.*** A more detailed spiral plot is illustrated in Figure 4b to show the value percentages of the selected metric of a project in a year with respect to the largest value of that year on a spiral curve. The information for the selected metric and project is shown on the top right of the page. The height and color of each bar represent the corresponding percentage of the metric value of the project of a specific date. Two advantages of using a spiral plot to represent value percentages of a period are that it is efficient in space usage and is easy to compare different values.

#### 4.3.2 Interaction Design

Kirin supports several user interactions for the two plots in the Metric view in Figure 4 to create a comprehensive understanding for users.

***Bubble hovering.*** Hovering on a bubble in Figure 4a will highlight this bubble and display its metric value.

***Bubble selecting.*** Selecting a bubble in Figure 4a will trigger a spiral plot as shown in Figure 4b. The spiral plot will show the metric value percentages for the project of the selected bubble in a year w.r.t the largest metric value of that year.

***Time hovering and selecting.*** Hovering on the ticks in the timeline n Figure 4a will highlight this tick and display the date represented by this tick. Users can specify the time for the bubble plot view by clicking a time tick on the timeline. After the time selection, the bubble plot will be updated with the metric data from the chosen date.

***Animation of the bubble plot.*** When users click on the "play" button located on the left of the time control panel in Figure 4a, they will see an animation of the bubble plot that presents the changes of all metric values starting from the time chosen by the user. Users can also click on the "pause" button anytime during the animation to pause. This animation feature is helpful for users to see the trend of different metrics of different projects during a period.

***Spiral plot hovering.*** Users can hover on any bar to view the metric value percentage w.r.t the largest metric value of a year represented by that bar and the corresponding date. Moreover, all other bars will fade out when users hover on one bar.

### 4.4 Implementation

Our implementation of Kirin is divided into two sections: front-end and back-end.

***Front-end*** is implemented based on React [14] and D3 [4]. We use React to build the structure of the application and use D3 to create the data visualization. We use React to handle all the API calls and manage the states. Also, it helps with routing that moves through different pages. After fetching and processing the data in React, we pass all the visualization-related data to D3 to handle the visualization. Although React's main task is to render the front-end, we use D3 as the main renderer for visualizations so that we can have more control over visualizations, interactions, and animations.

***Back-end*** is implemented with Nodejs [13] with Express framework [10]. It has an API for fetching real-time Ethereum account data that is used in the user account view. The data for the metric view is fetched and process through the data processing pipeline and stored as a JSON file in the back-end directory.

## 5 Example Use Case

Kirin can help novice users and experts to discover the relationship between Ethereum users and DeFi applications. Since Kirin has easy-to-use and straightforward properties, we believe it is better to showcase a use case from a novice user's perspective.

Let's consider a scenario where a novice user Emma wants to invest some money in DeFi protocols but is not sure which DeFi application to choose. Our tool Kirin can help Emma to better invest her money in two different ways: following the wealthiest user's choice and analyzing the earning power of each DeFi application.

### 5.1 Following the wealthiest user's choice

The easiest way for Emma to select DeFi protocols with large potentials is to follow the wealthiest user's choice since those rich accounts know better the strengths of different protocols and invest their money in the DeFi applications that they trust.

To begin with, Emma goes to the Search Interface inside the User Account View as shown in Figure 3a. Then she selects the "top Accounts" button and a list of "top Accounts" will appear on the page as in Figure 3b. Some top accounts are known while most others are anonymous. Emma chooses the Top Degen 5's account as shown in Figure 3c. The information such as the total balance of the account and the distribution of assets for this account is visualized. She finds out that this account holds mostly Convex, Bancor and Inverse assets, which can be a good hint for a novice user. Emma then continues using the tool and views more top accounts. Finally, she chooses those DeFi apps that the top accounts prefer to invest money on.

However, there is a potential risk if Emma simply follows what the rich do as she does not know the condition of each DeFi app. Therefore, this method can be used as a reference when choosing DeFi apps. Proper analysis is still needed which we will discuss in the following method.

### 5.2 Evaluating the earning power of each DeFi application

Another way to invest money in DeFi protocols that is more trustworthy is by evaluating the earning power of each DeFi apps. This is done by analyzing different metrics of each DeFi apps over a period.

Emma starts with visiting the Bubble Plot Metric View page as shown in Figure 4a to analyze different protocols. In the bubble plot metric view, she sees a matrix of protocols and metrics within which circles with different sizes and colors represent the values. Below that, she sees a timeline that each tick represents a day, and next to the timeline, there is a play button to animate the visualization.

Emma wants to compare different protocols and metrics in a period. First, she checks the time label on the top right corner of the screen to understand the visualization date. Then she finds the two-month period from February to April on the timeline as her focus. Emma wants to know how the value of trading volume for the Sushiswap and Uniswap protocols has changed over this time window. She checks some of the data points by clicking on the time tick inside the timeline and understands that this metric rose during February and then decreased during March for Sushiswap. However, the visualization shows no significant change for Uniswap. To better understand these changes she selects February 1st as the starting point and clicks on the play button. While watching the animation, Emma notices that it seems like there is a relation between these two protocols and their trading volume values. On the first two or three days of March, a decrease in the Uniswap trading volume value results in a rise in the value of not only Sushiswap but also most of the other protocols.

Now to verify these findings, Emma wants to focus on a specific protocol (Uniswap) and metric (Trading Volume). She clicks on the bubble at the intersection of the two parameters. Then the page changes to the spiral view as in Figure 4b, which is designed to visualize a metric in a protocol over a year. In this view, each bar represents the relative value of the specific metric at that time point. She is interested to see what was the reason behind her earlier findings. Emma notices that the trading volume value of Uniswap had an extreme rise in late February, which might be because of specific news or events in those days. And eventually, the value gets back to normal, which could be the reason behind the rise of other metrics.

Emma performs similar explorations and analyses several times using Kirin and uses the summary of her findings to evaluate each DeFi application. The time selection feature, the animation and the spiral plot view are great boosters during the exploration process. The DeFi application evaluation process is similar to that of evaluating a stock since both DeFi protocols and stocks have revenue and trading

Table 1: Participants' ratings in the interview study.

| | P1 | P2 | P3 |
|---|---|---|---|
| **Q1** Tool is easy to use | 6 | 5 | 6 |
| **Q2** Tool is easy to learn | 6 | 7 | 6 |
| **Q3** Metric view is useful | 7 | 6 | 6 |
| **Q4** Account view is useful | 5 | 4 | 3 |
| **Q5** Tool makes new user learn DeFi easier | 6 | 6 | 6 |

volume as their metrics. Thus, if Emma has prior knowledge of stock investment, she will learn how to analyze DeFi apps easily.

## 6 EVALUATION

To investigate if the tool is useful from the eyes of experts, we conducted an interview study to collect in-depth qualitative feedback from blockchain practitioners.

### 6.1 Study Setup

We recruited three experts (one female and two males), served as engineer, director, and co-founder of different DeFi protocols. Each study session started with exploring Kirin and asked questions after a short tutorial (3 minutes). Next, they completed three tasks: finding the FDV of a protocol on a specific date, exploring the trend for the revenue of a protocol in the past 180 days, and searching for one address (10 minutes). Last, they filled a questionnaire contains 5 questions to rate the system's functionality (5 minutes). The rating for each question is from 1(worst) to 7(best). We encouraged them to express their feelings and thoughts during the study and took their comments in notes.

### 6.2 Results and Analysis

All participants completed the task and their ratings are shown in Table 1.

***Ease of Learning and Use (Q1, Q2)***

All participants found Kirin easy to learn, as mentioned by P2 *"I could understand the tool without a tutorial."* and P3 *"I think I know how to use it after the introduction."*

The responses for ease to use were generally positive, P1 explained *"The UI is very intuitive."* and P3 said *"This will be a useful tool in some cases."*

***Metric View (Q3)***

All participants found the metric view is useful. P2 liked the novelty of time navigation option, as P2 said *"Time navigation functionality is very interesting, and I have never seen it in other products. It gives me an insight about how each protocol develops and evolves."* The spiral plot is recommended by P3 *"I can see a different visualization method other than the existing products."* The bubble plot is mentioned by P1 *"It is very easy to compare different metrics for our competitors."*

***User Account View (Q4)***

The responses for user account view are mixed and there are several limitations mentioned by participants. One limitation is *"lack of user assets details"* mentioned by P3. P2 suggested that the personal data view *"is better to have a sort functionality and cryptocurrency base.* P1 thought *"It might be useful for new users, but for experienced users, there are many other options in the market."*

***Usefulness for new users (Q5)***

As Kirin is mainly for new users in the DeFi space, all participants answered the question about its usefulness for new users. Overall, the result is positive for this question. P1 explained that *"I would recommend the people who are new to DeFi have a look at this."*. P2 even mentioned Kirin could be used in the production environment: *"If it is possible, I want to integrate Kirin to our analytics dashboard for all users."* P3 commented that *I believe it is useful for new users since it provides a data visualization in another perspective."*

## 7 CONCLUSION AND DISCUSSION

In this paper, we have proposed Kirin, a visualization analysis tool to help users explore Ethereum data and understand DeFi processes, thus better interact with DeFi applications. Compared with previous visual systems for blockchain, our system has proffered its significance in four aspects. First, previous blockchain systems focused on analytics instead of visualization, and most of the previous systems are targeting at bitcoin instead of Ethereum. Kirin, as a tool aiming at visualizing Ethereum transactions, fills this gap. Second, it supports the users to search accounts in the search dashboard, which will encourage more explorations. In the meantime, it also provides accounts suggestion for users to get some basic sense. Then, it reorganizes the data obtained from different sources and different protocols to visualize the overall analysis result for the users without any required background knowledge, which is also time-saving to help the practitioners and competitors to better discover the cryptocurrency markets. What's more, the intuitive user interface designs facilitate the use of this tool for new users without any tutorial, and the time navigation functionality adds more freedom, which can assist users to better understand the tokenomics based on the period they want. Through the use case along with the evaluation, we have demonstrated the usability and uniqueness of our tool in promoting users to analyze and further interact with DeFi applications.

Here we discuss several limitations of Kirin.

***Dataset Limitation***

Our data obtained from the Ethereum transaction and blockchain analysis API only covers the time from January 2021 until July 2021, it may require a more complex processing procedure to scale this up. Also, some related designs such as the time panel may need further modification if we want to support a longer period. Moreover, Kirin focuses on the four main on-chain metrics, but there are still some other purposeful metrics such as *market cap* and *price to sales ratio* since the crypto markets have evolved into a more diverse ecosystem of protocols, therefore it is worthwhile to try to dig more data for dissection thus improving Kirin to better serve as a solid indicator. Obtaining data from Ethereum is extremely time-consuming for a wider time range, thus we chose to preprocess data instead of fetching data per request, which limited the flexibility of the system.

***Lack of Interaction***

Our initial design involves different kinds of functionalities such as merging bubbles for the same metrics of different protocols and selecting time in hours in the time panel, but due to the difficulty of data extraction from the chain, the smallest time unit we can obtain is one day instead of one hour, which also affects the performance of the merging operation since sometimes the results do not make too much difference when one selected metric value is small within a long period.

***Visualization Limitation***

In addition, our initial idea as illustrated in Figure 5, is to use a pie chart to show the percentages of the assets in different protocols, but there could be many small values that are indistinguishable in the pie chart, so we changed to a lollipop chart, and dealing with these small values may need a furthermore careful design. Moreover, we also thought about including visualization that can help to cluster addresses for pseudonymous users, however, this requires much work to derive the entity information from the entity labeling datasets and apply heuristics to group-related addresses. Similar functionalities such as transaction network analysis and cybercrime detection can be a large amount of work and also require deep prior knowledge, so we will leave these functionalities for future work.

Although the current performance of Kirin is promising, polishing the system regarding the above limitations can boost user experience and encourage more insight, we are hoping to work further in these directions.

## 8 FUTURE WORK

In the future we are interested in enhancing our system with respect to these possible directions :

***Scale up***

As discussed above, more work can be done to gain more data on chain and enable Kirin to cope with these data thus allowing smaller time unit comparison along with a more user-friendly interface design.

***Add more features***


Fig. 5: initial design of user account view

More features can be added with careful treatment such that more general users and expert users will be attracted to utilize Kirin to acquire insights of tokenmics, therefore interact with DeFi applications more effectively and efficiently. Such possible features, as discussed earlier, can be modifying the time panel that allows more flexible time selection, enriching the user account view by adding more basic portfolios of the account (similarly to our initial design in Figure 5), merging the selected metric bubbles of different protocols and allowing reset, involving more on-chain metrics, etc.

***Deal with smart contracts***

Each Ethereum account can not only proceed with financial transactions but also interact with smart contracts. Smart contracts, as another major part of the Ethereum world, also need further investigations. Currently, Kirin explored financial visualizations of Ethereum accounts, with further knowledge of Solidity, which is the language for implementing smart contracts, researches related to smart contract interaction visualization are also worth taking a look at.

***Explore more complicated functionalities***

Although blockchain has been a rising technology to maintain data with integrity in the decentralized network, blockchains do not contain much information to cluster pseudonymous users, which can be an inevitable part of user analysis. It will be interesting to leverage network analysis techniques to support Ethereum pseudonymous user addresses clustering visualization. Besides, due to the pseudonymous characteristic of the Ethereum society, cybercrime detection visualization can be a future research direction.

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**Proposal :** Abstract is written by Xiaoyu Wen, Background and Related Work are written by Saiyue Lyu, Approach and Key Contribution are written by Ziqi Zhou, and Propsed Solution is written by Ziqi Zhou.
**Related Work :** Blockchain Technology and Ethereum reviews are written by Saiyue Lyu, Blockchain and Ethereum Analytics reviews are written by Xiaoyu Wen and Saiyue Lyu, Ethrereum Visualization reviews are written by Ziqi Zhou, Visualization of Interactions reviews are written by Ehsan Jahangirzadeh Soure.
**Proposed Design :** Data preprocessing, section 3.1 and Figure 5 are done by Ziqi Zhou; Figure 3 and Figure 4 are done by Ehsan Jahangirzadeh Soure; section 3.2 and section 3.3.1 are done by Saiyue Lyu; section 3.3.2 is done by Xiaoyu Wen.
**Final Paper :** Kirin is implemented by Ehsan Jahangirzadeh Soure; Evaluation is conducted and written by Ziqi Zhou; Background, conclusion and discussion, future work are written by Saiyue Lyu; Abstract, implementation and example use case are written by Xiaoyu Wen.
**Demo Video :** Ehsan Jahangirzadeh Soure.

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