Bitcoin Blockchain Visualization

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I. INTRODUCTION

BLOCKCHAIN and bitcoin are both hot topics these days. Bitcoin is a distributed, decentralized crypto-currency. A blockchain is a distributed database that is used to maintain a continuously growing list of records, called blocks. Bitcoin uses the blockchain protocol to serialize transactions of the bitcoin currency among its users. Figure 1 is an image briefly introducing how blockchain works for bitcoin.
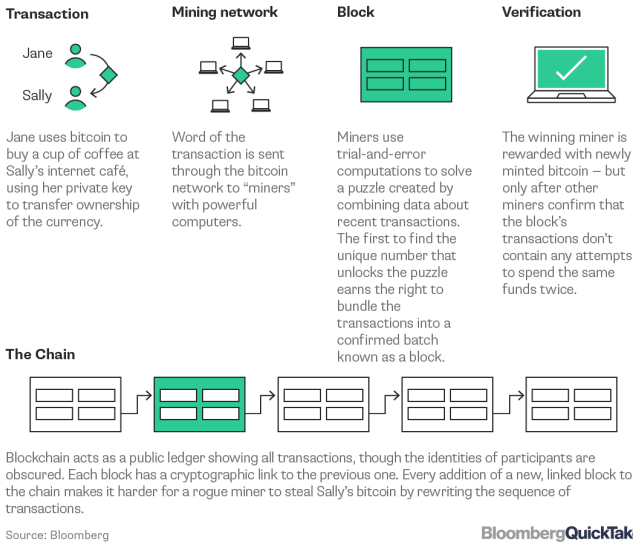

Fig. 1. an image briefly introducing how blockchain works for bitcoin

II. MOTIVATION

Blockchain is a hot topic these days. Even though there are a huge number of video and blog tutorials for blockchain beginners on the internet, people are still asking "what is blockchain ?", meaning that blockchain could be a very abstract concept and takes a relatively longer time for people to understand. In this case, the use of visualization could be very helpful. So we want to do a learning project in which we mock and visualize the bitcoin blockchain. We aim to study the concept of bitcoin and blockchain thoroughly and deeply.

III. GAP

Since we want to build a visualization, the first and biggest challenge is the overall design of the visualization. Some existing visualizations focus on how transactions are generated and how them are added into blocks, then we'll lose an overall view of how the whole blockchain works. Other existing visualizations focus more on how blocks are added by miners and how blockchain is generated, then we'll lose a detailed view of transaction fees, why some transactions are recorded into the blocks while others are not. Other challenges would be how to get the data and how to design the data structure.

IV. PROBLEM STATEMENT

Design and build a bitcoin blockchain visualization that demonstrates both overall and detailed view of how bitcoin blockchain works, helping others to study the concept of bitcoin and blockchain thoroughly and deeply. This is our project's Github link:https://github.com/LTZX/BitCoin-Visualization. To view the visualization, please open index.html file with Firefox to ensure it's working.

V. OVERALL DESIGN

Figure 2 is the initial state of the overall design of our bitcoin blockchain visualization.

- Time slider: the time range within which transactions and blocks are generated. It can be used to choose the time point by dragging it to the point. You can also use the "Play" button to make it move automatically. And "Pause" it with the same button.
- Right panel: all the bitcoin addresses in the system and the transactions were made by those addresses. Nodes that have transactions happening between them will form subgraphs and be dragged closer.
- Left panel's upper layer: the blockchain
- Left panel's middle layer: detailed information of selected transaction
- Left panel's lower layer: all transactions happening at present time point

Fig. 2. Initial state of bitcoin blockchain visualization

Figure 3 is the state of bitcoin blockchain visualization at some time point.

- Time slider: the smallest time interval is 5 minutes.
- Right panel: the color of the nodes demonstrates if it is active at the time
  - grey: inactive, not involved in any transactions
  - orange: active, involved in transactions

  The links connect to the nodes that are related to transactions and their thickness demonstrate the transaction amount. The color of the links demonstrates the transaction status
  - red: confirmed to be invalid transaction and should not been recorded in any block
  - green: confirmed to be valid transaction and has been recorded in the latest block
  - blue: unconfirmed and unrecorded in any block yet
- Left panel's upper layer: the blocks in blockchain
  - block#: its rank in the blockchain by the time it is generated
  - size: number of transactions recorded in this block
  - color: dark grey is the color at the time point a block is generated. It will stay light grey after that.
- Left panel's middle layer: hover the circles below and detail information of selected transaction will show up here. The transaction of selected nodes will also be highlighted in the right panel.
- Left panel's lower layer: circles represent transactions happening at this time point. The size of the circles demonstrates the transaction amount. The color of the circles demonstrates the status of the transactions.
  - red: confirmed to be invalid transaction and should not been recorded in any block
  - green: confirmed to be valid transaction and has been recorded in the latest block
  - blue: unconfirmed and unrecorded in any block yet

  you can also choose to sort or group the circles with the buttons that offered.
  - By Status: circles will be grouped by status in order of red(invalid), blue(unrecorded) and green(valid).
  - By Amount: circles will be sorted by amount in order of small to large.
  - By Time: circles will be sorted by amount In chronological order.
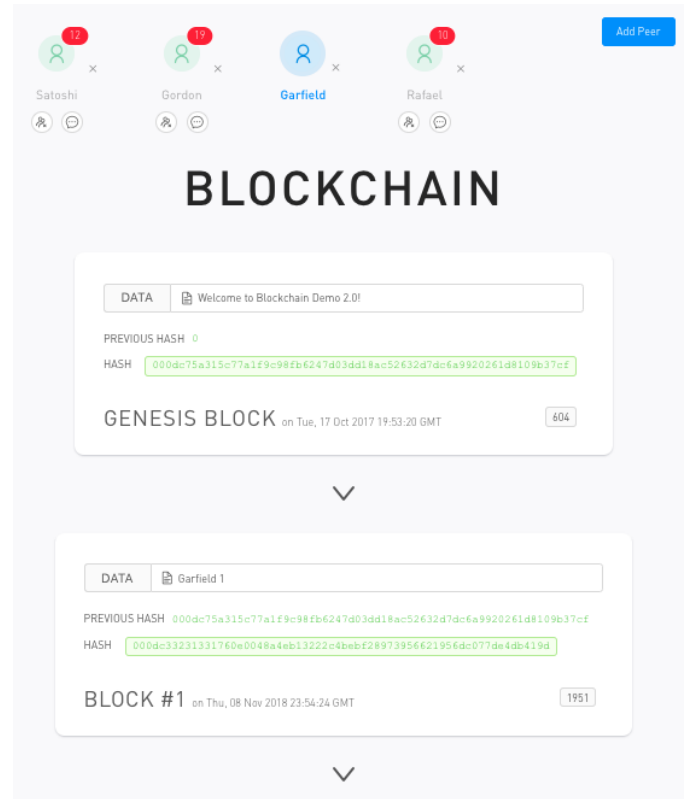
VI. Key intuitions behind our proposed design

A. Blockchain Demo

We found an implementation of blockchain in JavaScript(Figure 4). Using this implementation as a base, we are going to mock and visualize the bitcoin blockchain by ourselves. Right now, this implementation required users to enter data, create new blocks and setup for different peers. Its in details but the data and blocks are added by users themselves, which means that the data size is small. And it cannot offer users a detailed view behind the blockchain, such as what transactions are being generated now. We plan to change it to a format that take in a database and automatically go through all the steps.

Fig. 3. no-real time monitoring of bitcoin blockchain

Fig. 4. Blockchain Demo, Link: https://blockchaindemo.io

B. Ethereum blockchain visualization

We found another live application for bitcoin that is implemented in Javascript(Figure 5). Its nice real-time visualization but the data size is very big and the information is not in details. Besides, Users cannot stop it to learn details by themselves because it's real-time. It offers users a board view of the transactions and blockchain, but give users little detail information which makes it hard to understand what is going on.

VII. Key benefits of our proposed design

We decide to combine the advantages of the two visualizations mentioned above.
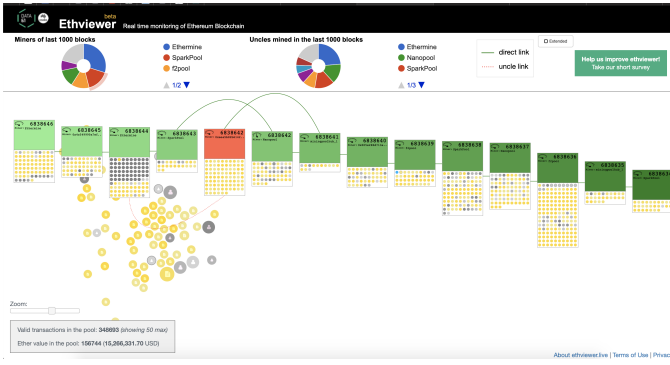
Fig. 5. Ethereum blockchain visualization, Link: http://www.ethviewer.live

- Instead of letting users adding data or using real-time data, we will use our own non-real-time dataset, so the size of data would not be too big or too small for users to accept.
- Instead of having only one view, we will have two panels, one showing transactions and detail information, the other showing the blockchain and detail information.

VIII. DETAILS OF OUR DESIGN

A. Transactions

Figure 6 is a live updating graph of addresses and bitcoin transactions between nodes.
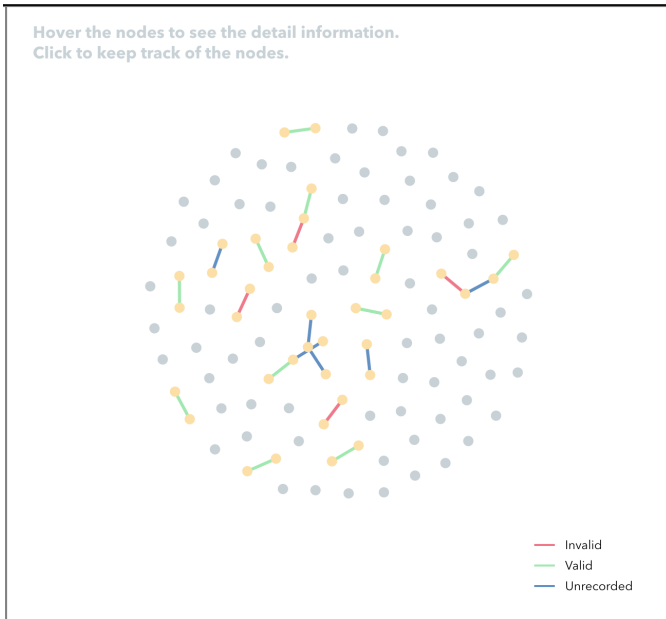

Fig. 6. bitcoin transactions

Figure 7 shows detail information of the node when you hover it.

- Address: public bitcoin address, identifiers which you use to send bitcoins to another person
- Hash: the hash of a public key, to shorten it.
- Nickname: we add this name to easily represent nodes

- Balance: we add this balance to show how many bitcoins one address owns at present, so the results of transactions can be visible.
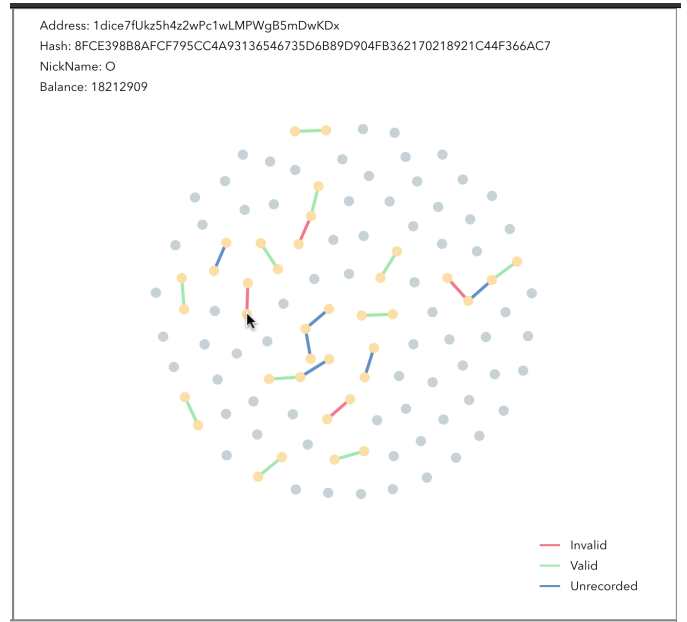

Fig. 7. Hover the nodes to see the detail information

B. Blocks

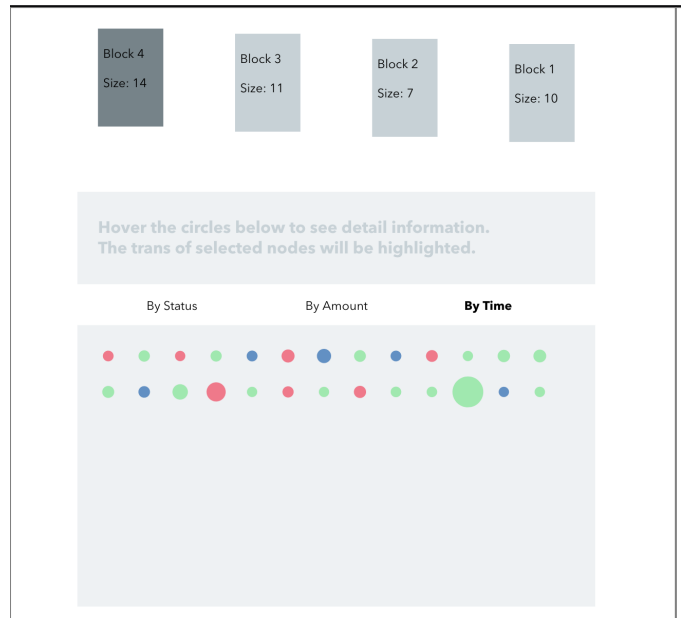Figure 8 is a live updating left panel of bitcoin transactions between nodes.

Fig. 8. bitcoin transactions

Figure 9 shows detail information of the circles below when you hover it.

- Status: VALID (green), INVALID (red) and UN-RECORDED (blue)
- Trans: from Nickname to Nickname with amount of bitcoin transacted
- Time: the time point when this transaction is generated
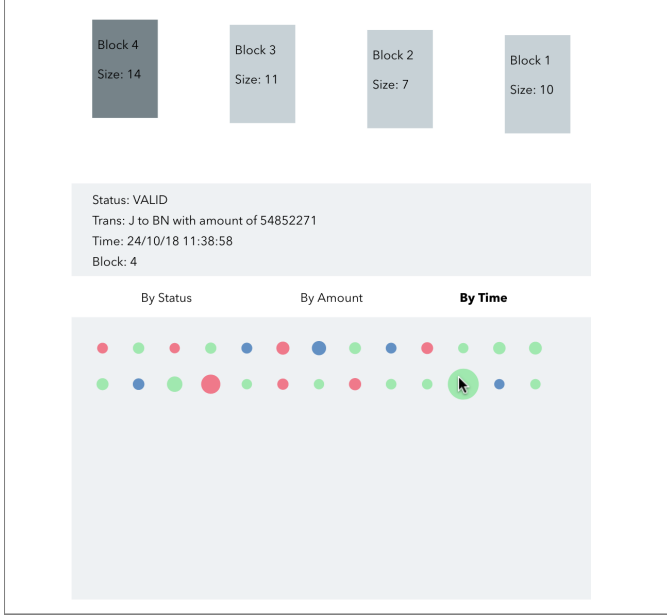- Block: the # of block to which this transaction belongs

Fig. 9. Hove the circle to see the detail information

C. Interaction of left and right panels

Figure 10 shows the interaction of left and right panels. The nodes you select on the right panel will be highlighted on the right panel. All transactions related to the selected nodes will be highlighted on both left and right panels.

Fig. 10. Interaction of left and right panels

IX. CONTRIBUTIONS

Zhiyi contributed in design, data organization, front end construction; Ruolan contributed in writing progress and final report, collecting and organizing back end data, such as data for nodes, transaction and blocks.

X. CONCLUSIONS

The concept of blockchain is abstract and hard to understand only with words and graphs. Our visualization tool will help people who are interested in bitcoin and blockchain get a both detailed and board view of how transactions are collected and finally form blockchains. The version we provide now is naive, later we could add more features such math puzzle miners actually solve and transaction fee.

XI. FUTURE DIRECTIONS

Despite Bitcoins potential, blockchain protocols face a significant scalability barrier. The maximum rate at which these systems can process transactions is capped by the choice of two parameters: block size and block interval.

- Increasing block size improves throughput, but the resulting bigger blocks take longer to propagate in the network.
- Reducing the block interval reduces latency, but leads to instability where the system is in disagreement and the blockchain is subject to reorganization.

We want to learn and try to implement Bitcoin-NG (Next Generation), a new blockchain protocol designed to scale, presented in Bitcoin-NG: A Scalable Blockchain Protocol[1]. It is a Byzantine fault tolerant blockchain protocol that is robust to extreme churn and shares the same trust model as Bitcoin. Finally, we want to compare the transaction frequency, consensus latency, fairness, mining power utilization, time to win and time to prune of Bitcoin and Bitcoin-NG at the same block frequency or block size to see if Bitcoin-NG can reduce latency and increase throughput, and whether it is possible to improve the scalability of blockchain protocols to the point where the consensus latency is limited solely by the network diameter and the throughput bottleneck lies only in node processing power.

REFERENCES

[1] Ittay Eyal, Adem Efe Gencer, Emin Gün Sirer, and Robbert Van Renesse. Bitcoin-ng: A scalable blockchain protocol. In *NSDI*, pages 45–59, 2016.