

Coinviz

Visualizing Bitcoin

University of California, Berkeley
School of Information
I247 - Information Visualization and Presentation



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Live Demo:

<http://people.ischool.berkeley.edu/~shaun/infoviz/bitcoin/index.html>

Goals & Tasks

In this project we aimed to build a source of Bitcoin information that could serve as an interesting introduction for people who have little knowledge of the system. In order to do this we presented a number of views into the bitcoin ecosystem that visualize physical make-up, activity, size, global participation, price, and address usage.

Since we are building a collection of visualizations, we laid out some more refined goals for each individual view:

- Define important vocabulary used in the Bitcoin network, such as “blockchain”, “block”, “transaction” and “address”
- Communicate the byte-wise makeup of a block’s components
- Portray the size and frequency of real-time transaction broadcasts
- Understand the global distribution of peers (nodes) participating in the network
- Understand how bitcoins have been valued against other currencies since the technology’s invention. Show the relationships between price history, number of transactions and size of the blockchain.
- Provide a ‘recent usage’ view in order to see which addresses are hoarding coins, and which are spending more frequently

Tasks on our interface would have an educational feel, wherein users would be asked to define key terms, explain their understanding of blockchain elements, find the top 5 countries for bitcoin nodes, and understand price history. We would test their understanding by asking a few detailed questions, such as “define the four important terms: blockchain, block, transaction and address.”

Data used to accomplish the goals

Information for technical definitions, anatomy of a block, and other context was derived from the Bitcoin wiki (https://en.bitcoin.it/wiki/Main_Page).

Data for the live transactions is being pulled in directly using the web sockets API at <https://blockchain.info/api>.

Global distribution of the P2P network, used for the choropleth, was collected manually from <https://getaddr.bitnodes.io/> and populated directly into the script object of that page.

Historical price information was retrieved via csv export from <https://blockchain.info/charts> and is saved at <http://people.ischool.berkeley.edu/~shaun/infviz/bitcoin/vis-price/price.csv>

Data on address balances and transaction timestamps was gathered via a custom python script that pulled historical information from the blockchain, and then iterated over found addresses to calculate their most recent usage.

Script:

<http://people.ischool.berkeley.edu/~shaun/infviz/bitcoin/vis-balances/balanceExplorerer.py>

Data: <http://people.ischool.berkeley.edu/~shaun/infviz/bitcoin/vis-balances/10000.csv>

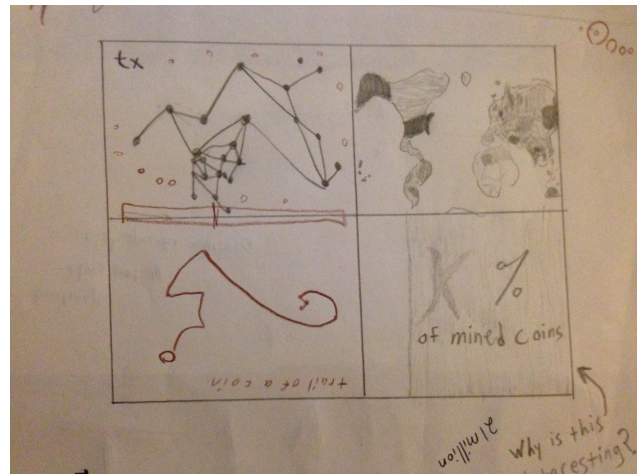
Tools used to accomplish the goals

- Blockchain.info: JSON and Websocket APIs
- Blockcypher API
- Adobe Illustrator
- Gephi and Pygexf (a python library for creating gephi files)
- Sigma.js
- d3
- Microsoft Excel
- getaddr.bitnodes.io
- ColorBlender

What steps were required to accomplish goals

Determining our user base and understanding what questions they may have about bitcoin played a large part in driving the direction of this project. Through conversations with people outside of class, and following our in-class mid-project critique, we hypothesized that more context and introductory content would improve the experience of first-time viewers unfamiliar with bitcoin.

We began with an exploratory approach that involved assessing the data we could gain access to, and the forms that this data might make sense in. After a weekend hackathon of familiarizing ourselves with bitcoin APIs, many sketches, and peer-critiques, we created an initial set of four visualizations. These visualizations



went over quite well with the hackathon judges, all from prominent positions in the bitcoin world, who were likely most happy to see new design ideas that lower the barrier to entry of understanding - and getting involved with - bitcoin. Our classmates were significantly less impressed, with due cause, and we were glad to get their feedback. Here are some of the notable quotes we received:

- *“the changing shape didn’t seem to add meaning. was a little hard to figure out.”*
- *“needs some explanatory text--what is blockchain? what is the significance of an address?”*
- *“Map is working. Animations: totally incomprehensible”*
- *“Is your audience people who already know what you’re talking about? If not, an infographic would be good”*

Following this feedback on our initial iteration, we returned to the drawing board and focused primarily on the story that we would tell. We mapped out a “tour of bitcoin” as a series of modules that focus on core aspects: blocks, transactions, addresses, and value. Once we crafted an outline for the story, we worked independently to develop the various modules, often returning to the group for peer-feedback and discussion.

Related Work

We discovered twenty-two other Bitcoin visualizations while performing initial research for this project, and there are likely more out there. (See Appendix C for full list). The majority of Bitcoin-related visualizations are line graphs that communicate changes in specific variables

over time, including statistics related to the network itself (hashing power, number of nodes, volume of transactions), financial information (bitcoin price in USD), and the ecosystem (number of merchants, Wikipedia “Bitcoin” article daily views, tweets).

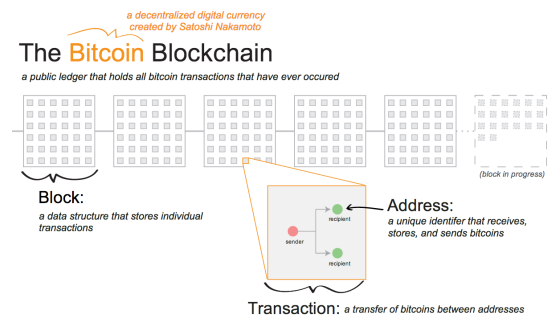
Two particularly creative visualizations were FiatLeak, which displays the flow of value from fiat currencies into bitcoin in real-time, and Listen to Bitcoin, which visualizations live transactions as bubbles and generates audio cues for every new transaction. Listen To Bitcoin does not reveal any additional data about a transaction beyond how much bitcoin was transferred, so our visualization that includes the addresses involved in each transaction communicates data Listen To Bitcoin does not.

There were a number of attempts to visualize a chain of transactions; these were similar to the network visualizations we created early on in our exploratory data analysis, but did not include in the final project (Appendix B). The more effective visualizations in this category included a horizontal axis representing time. This is the direction we intend to go with as we revise our gephi network visualizations.

Description of Visualizations

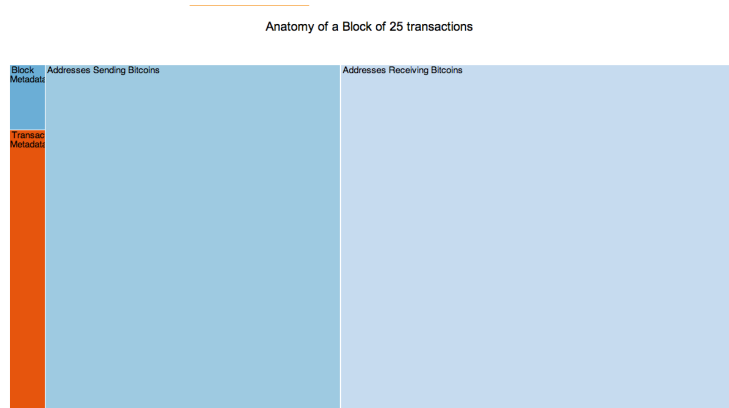
Infographic of the Bitcoin Blockchain

This infographic defines key terms that have special meaning within the scope of bitcoin. We decided to draw an interpretation of the blockchain with the goal of visually communicating that it is constructed in the form of a linked-list. Using concepts of zoom to show the inner makeup of a transaction, and provided relevant definitions at the position in the graphic where the element first appears. See Appendix A for full-size screenshots.



Anatomy of Block

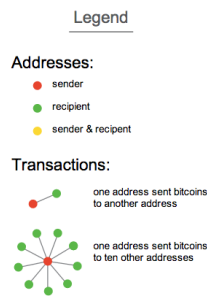
We chose to implement a treemap to show the byte-wise makeup of an average block that contains 25 transactions. After building it out to include all the sub-components of a block, the view became quite obscure and filled with . We decided to limit this to a very high-level view of four major components.



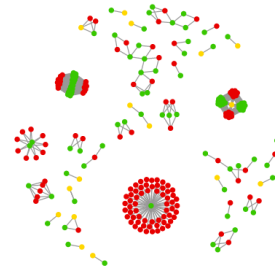
Realtime Bitcoin Transactions

A force-directed graph of nodes representing addresses and edges representing the transfer of bitcoins between addresses. Updated in realtime.

 [Video of the graph in action](#) 

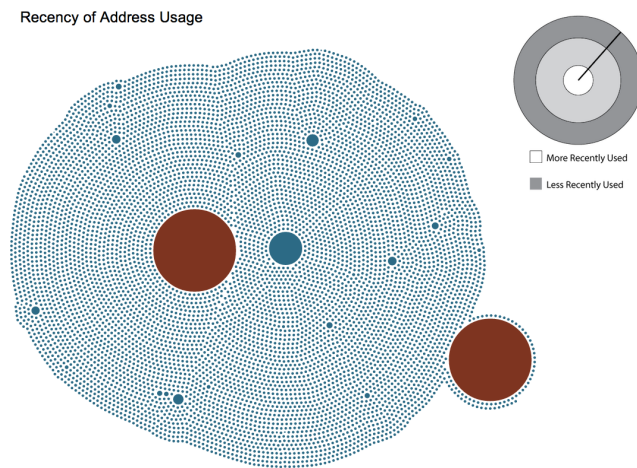


Realtime Transactions



Bitcoin Hoarding

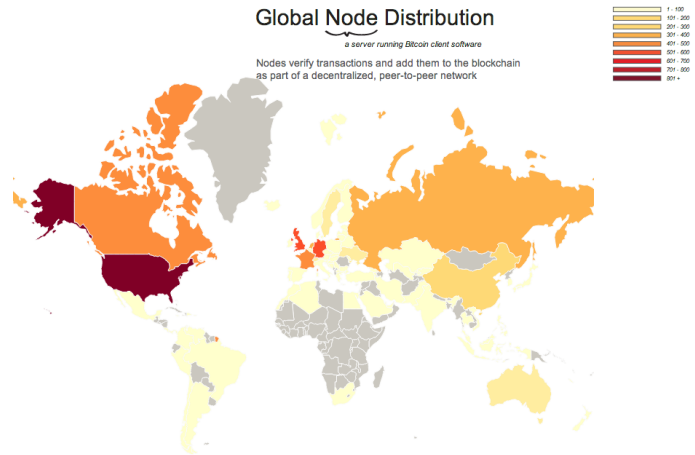
Visualization of the addresses used in the first 10,000 blocks and the recency of their usage. More recently used addresses are closer to the center of the visualization, while the most dormant addresses are on the periphery. The amount of bitcoins stored at an address is visualized by the size of the circle representing the



address. Addresses with exceptionally large amounts of bitcoins are differentiated by color as well.

Global Node Distribution

A choropleth illustrating the global distribution of nodes in the Bitcoin ecosystem and context as to what a node is to assist the viewer on how it relates to the Blockchain with respect to allow transactions to take place. The heatmap of the choropleth lets the viewer understand where the node distribution is greatest based on the density of the color.

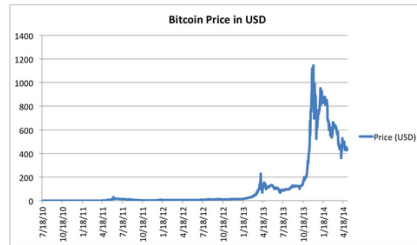


Bitcoin Pricing

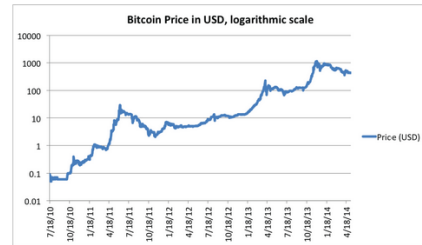
Two line graphs visualizing the price of a bitcoin in USD from Q4 2010 to the present. Price is represented linearly and logarithmically.

The Price of a Bitcoin

The price of a bitcoin has rapidly appreciated since the digital currency was created five years ago.

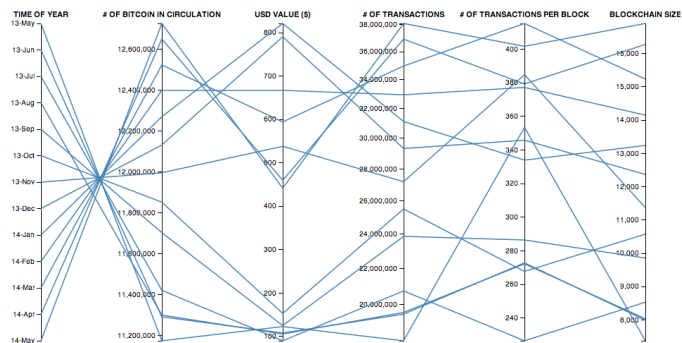


The exponential nature of the price appreciation is apparent when plotted on logarithmic scale.



Map Projection Distortion

A parallel coordinates visualization for May 2013-May 2014 was implemented to show how other variables have been affected with respect to time in addition to the USD Market price of the bitcoin. These additional variables include



number of bitcoin in circulation, number of transactions, number of transactions per block, and size of block chain. Decision was made to use a map projection distortion because this allowed us to use different nominal variables with their respective units. Shown below: User selects January 2014 to understand the average values for the variables discussed earlier.

Feedback from real users

As mentioned above, early feedback from our classmates indicated a clear need for more context around our visualizations. Because Bitcoin is a relatively new technology, the terminology used in the network is unfamiliar to most viewers. We incorporated more educational content and context of Bitcoin concepts in our second iteration.

We observed users as they viewed our visualizations, and asked questions to gather whether they gained some new understanding given the available context. We learned the importance of ordering and progressively disclosing context, making information available when it is most relevant to the visualization, and minimizing the user's need to switch back and forth between the visualization and the legend/context in order to understand its meaning. Users provided positive feedback to the vocabulary and definitions we provided, and some even confirmed that their understanding of the Bitcoin network increased.

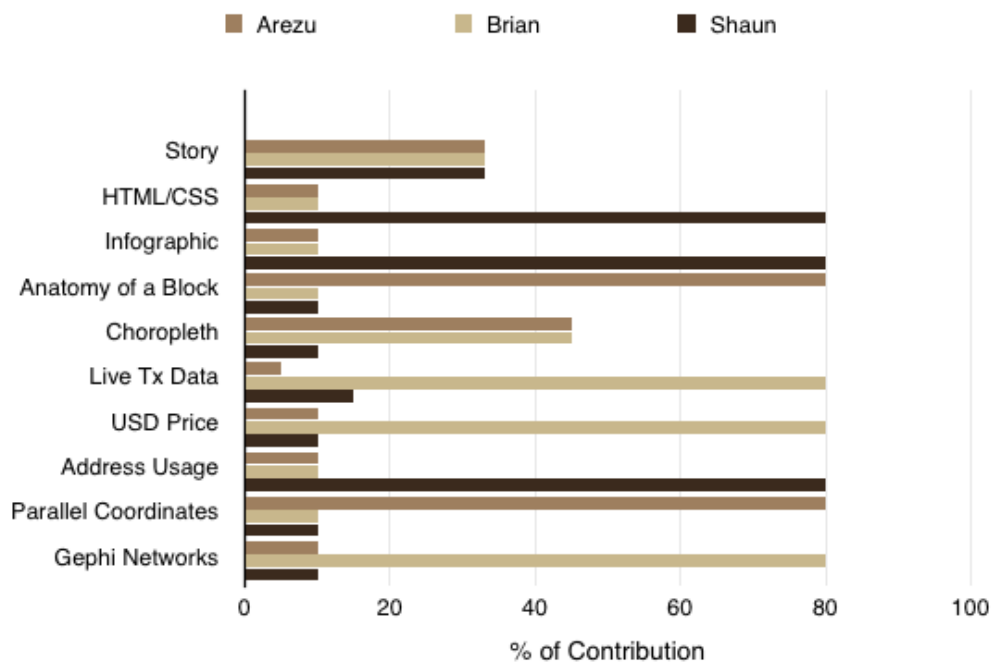
Although our user base consisted of individuals that were unaware of Bitcoin or had little knowledge about this digital currency, we also worked with experts in the Bitcoin industry. This enabled us to ensure that our process was intuitive, and use of vocabulary was accurate. The project was initiated at the BoostVC Hackathon, where we executed the first iteration of the project, and presented to a panel and audience of experts in the area. Outside of the hackathon, we followed up with expert advice by presenting our latest work to the Coinbase team. They provided valuable feedback for our live transactions view, and followed up with more ideas and questions about what future visualizations could answer.

Following the final project showcase, we had the opportunity to conduct an in-depth usability test and think-aloud with another student from class. We received a lot of good comments and impressions over the 20-minute session, then spliced together the highlights into this 6.5 minute video: [Coinviz Usability Test](#) (warning: shoddy camera work).



Coinviz starts first iteration of “Visualizing the Blockchain” at BoostVC Hackathon, April 25th 2014.

Work Breakdown

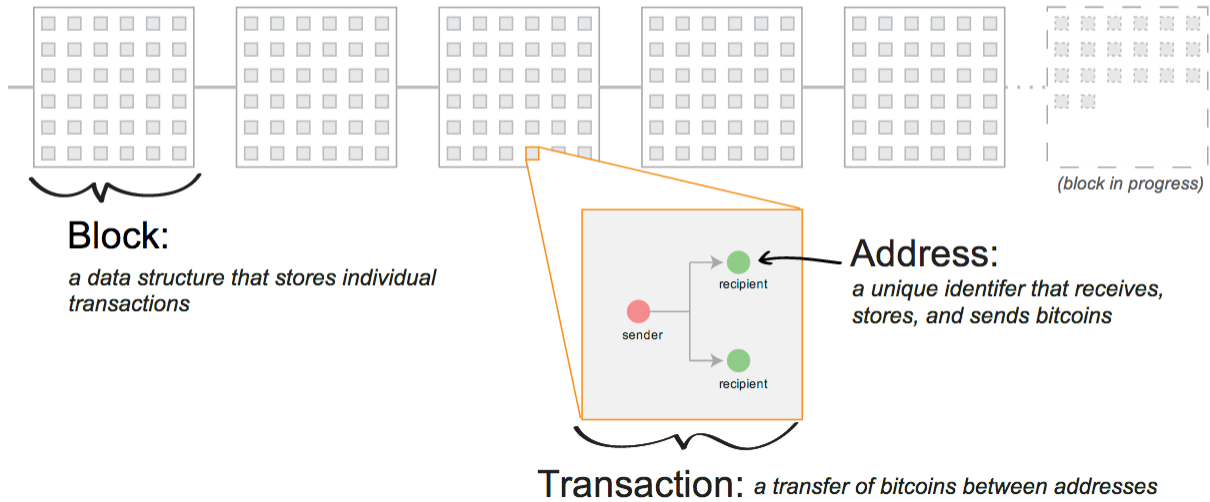


Appendix A: Full Size Visualizations

a decentralized digital currency
created by Satoshi Nakamoto

The Bitcoin Blockchain

a public ledger that holds all bitcoin transactions that have ever occurred



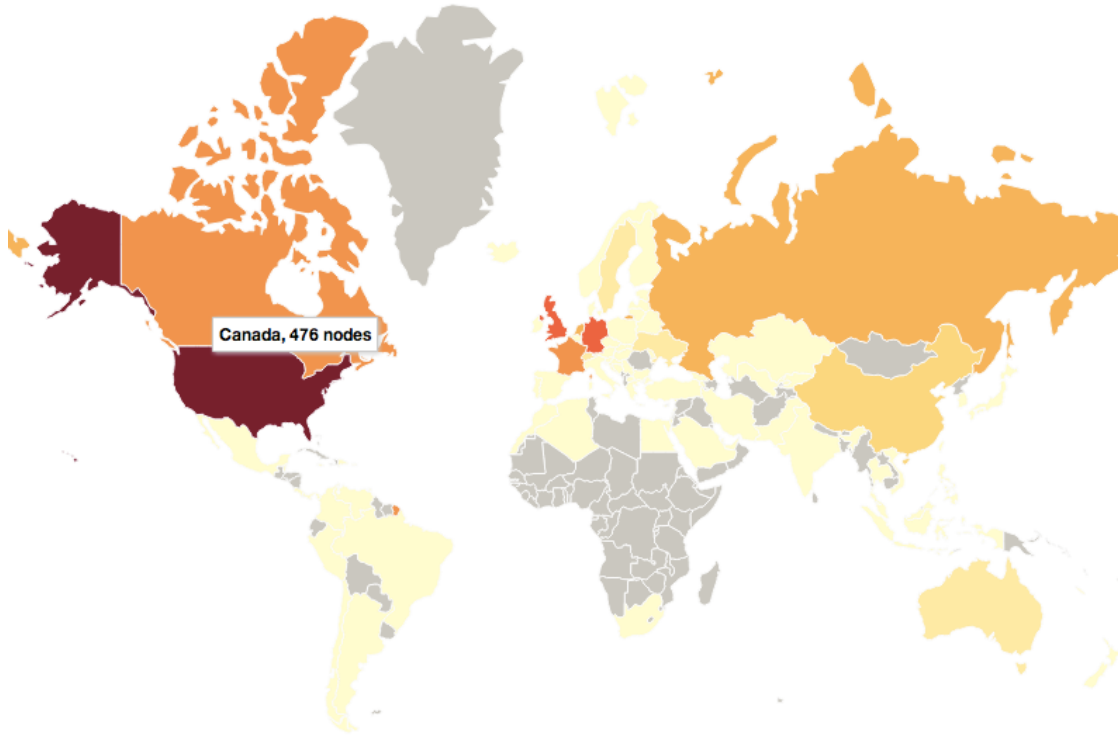
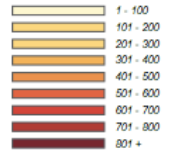
Anatomy of a Block of 25 transactions



Global Node Distribution

a server running Bitcoin client software

Nodes verify transactions and add them to the blockchain
as part of a decentralized, peer-to-peer network



Realtime Transactions

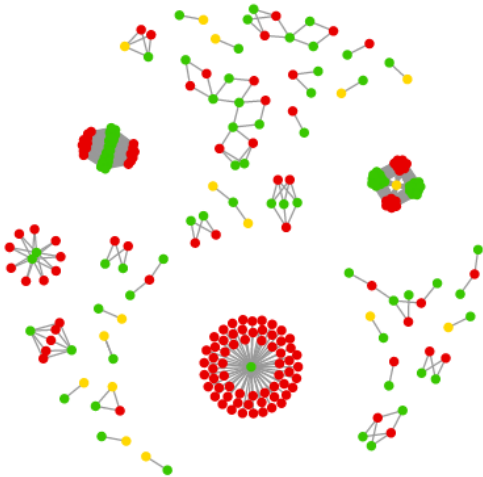
Legend

Addresses:

- sender
- recipient
- sender & recipient

Transactions:

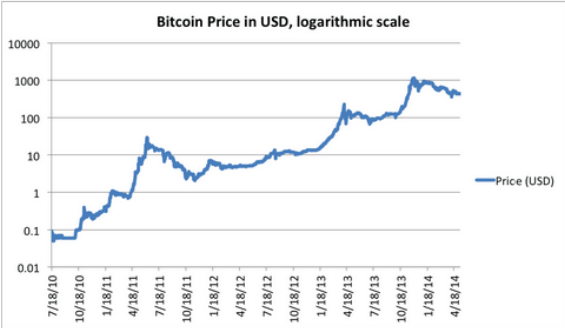
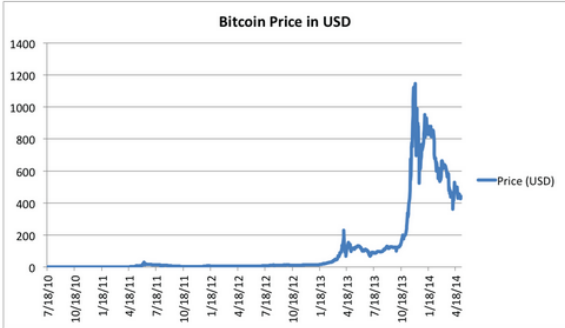
- — ● one address sent bitcoins to another address
- — ● — ● — ● — ● — ● one address sent bitcoins to ten other addresses



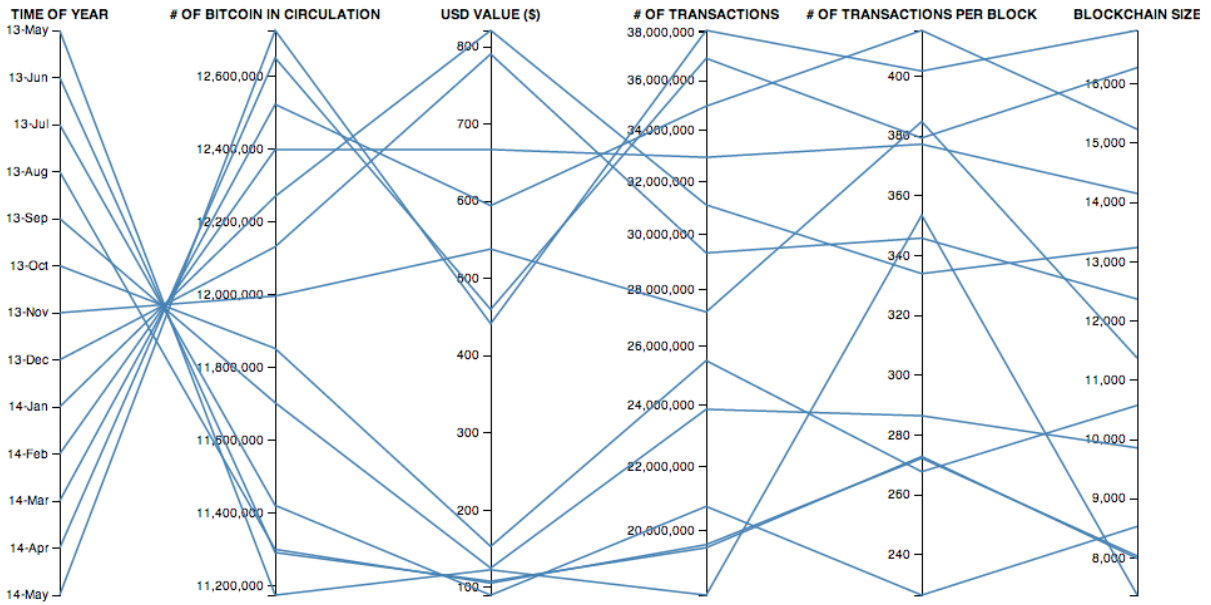
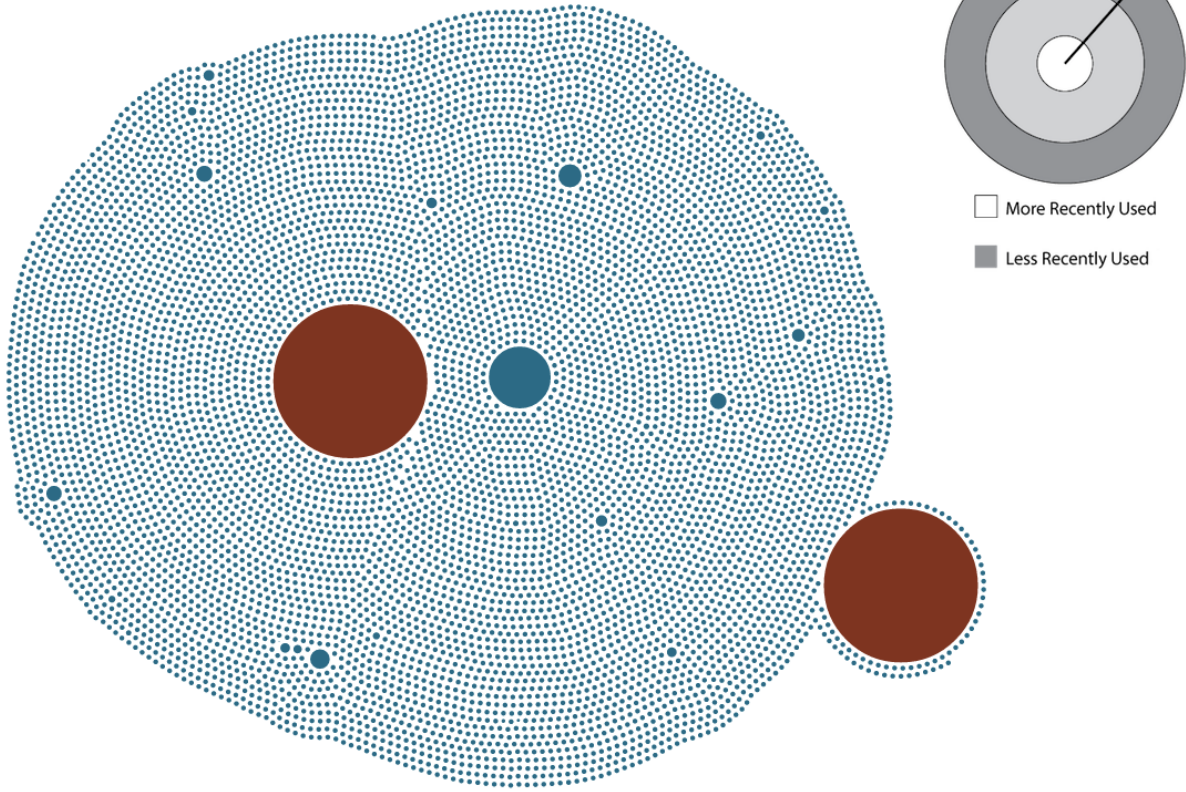
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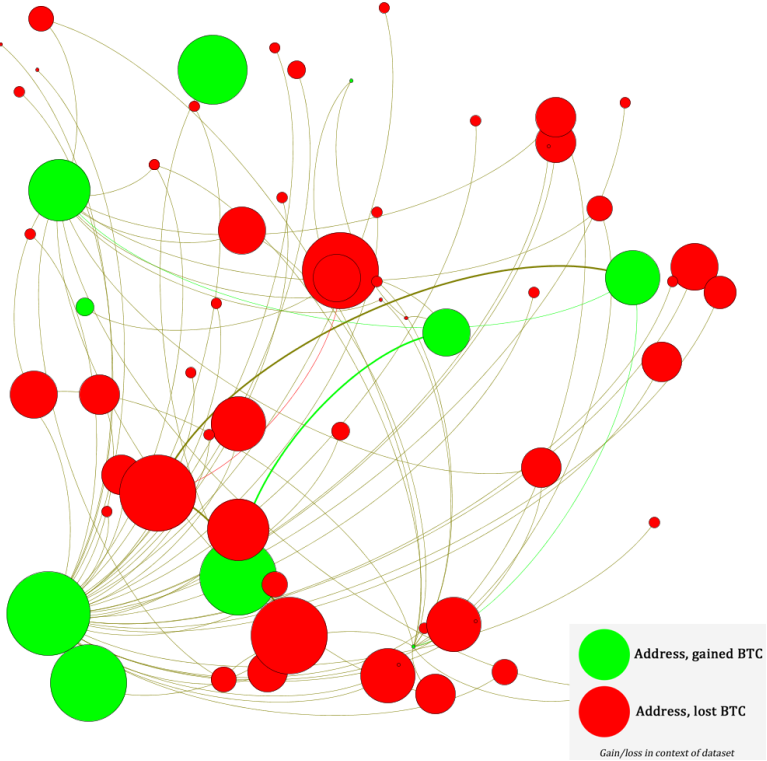
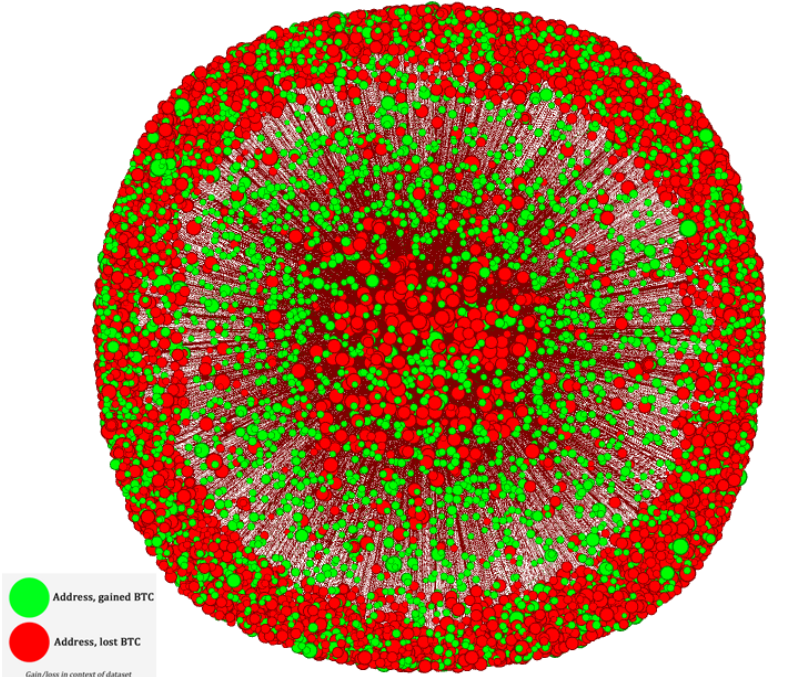
The exponential nature of the price appreciation is apparent when plotted on logarithmic scale.



Recency of Address Usage



Appendix B: Visualizations from Exploratory Data Analysis



Appendix C: Existing Visualizations

<http://fiatleak.com/>

- Reveals flow of international currencies into bitcoin (not out) using a world map and animated coin graphics. Keep track of total number of bitcoins that have been purchased beginning with the loading of the visualization. Ticker along the bottom visualizes each individual currency move into bitcoin, uses height of ticker bar to indicate transaction size. Likely pulling data from Bitcoin exchange APIs

<http://www.bitcoinpulse.com/>

Visualizes via line graph a wide area of metric related to Bitcoin

- Current price at most popular exchanges
- Growth in wallet ownership
- Investors interested in Bitcoin & other metrics from Angellist
- Downloads of BTC client
- # of posts & other metrics from bitcointalk forums
- Number of EC2 nodes purchased with bitcoin via Bitnodes
- Stackexchange posts
- Tweets
- Wikipedia daily views
- subreddit subscribers
- google hits
- Github repos created/updated
- itBit price & volume (exchange)
- ebay listings
- craigslist merchants
- cointerest/coinmap venues
- coinbase wallets/merchants/price
- campbx members/price
- btce price/volume
- btcchina price/volume
- bitstamp volume/liquidity/price
- Blockchain:
 - est. tx volume
 - avg tx confirmation time
 - btc in circulation
 - # of tx's
 - total tx fees
 - wallet tx volume
 - wallet # of tx's per day
 - total output volume (?)
 - trade volume vs tx volume ratio
 - hash rate
 - wallet users
 - # of tx's EXCLUDING popular addresses
 - # of unique BTC addresses used

- cost % of tx volume
- bitcoin days destroyed
(<http://bitcoin.stackexchange.com/questions/845/what-are-bitcoin-days-destroyed>)

<http://bitcoin.stamen.com/> - the Mt. Gox 500

- visualizations of trading histories of Mt Gox users between 4/2011 to 11/2013. analyzes the behavior of top 500 highest volume Mt Gox users
- uses dot graphs to visualize each use
- segments users into four groups: Bitcoin Barons, Greater Fools, Dueling Bots, Glitch in the System

<http://www.listentobitcoin.com/>

- Realtime viz; Each BTC tx on the network is visualized as a bubble accompanied by an audio chime

http://www.zerohedge.com/sites/default/files/images/user3303/imageroot/2013/05/20130512_BT_C.jpg

- infographic showing how a Bitcoin transaction works

<http://www.bitcoinmonitor.com/>

- visualizes currency trades, tx's, and block creation on a dot graph that is constantly moving horizontally to represent movement in time

<http://bitcoin.interaqt.nl/>

- Visualizes tx's as cluster of circles (no visible edges though)
- size of circle indicates tx size
- mouseover a circle to see tx details

<http://blocks.wizb.it/>

- Shows tx's and mined blocks on a 3d globe in realtime (uses IP to deduce location)

<http://mapofcoins.com/>

- Visualization of the cryptocurrency ecosystem over time -- shows creation of new currencies added to ecosystem and how the currencies are related to one another

<https://bitcointalk.org/index.php?topic=103609.0>

- Visualizes a chain of tx's , attempting to associate identity ownership with addresses.
- website no longer working, screengrabs in the link

<http://youtu.be/3ujUlz9hQ7c>

- 3d visualization of blocks being added to the blockchain over time

<http://public.tableausoftware.com/profile/#!/vizhome/WorldofBitcoin/AccordingtoGoogle>

- Visualizes google trends in Tableau (searches, locations)
- Visualizes price, volume, and supply in Tableau

Bconomy <http://charts.bconomy.com/>

- price
- fee
- tx's
- blocks
- avg txs/block
- avg fees/block
- avg block size
- distributions
- *all line graphs except some bar graphs in distribution*

<http://www.wired.com/2014/03/james-clar/#slide-id-631432>

- Artistic neon spiral sculpture somehow utilizing Mt Gox data

<http://visual.ly/realtime-bitcoin>

- A slew of infographics

<https://blockchain.info/charts>

- line graphs of various network statistics and trading stats

<http://www.fastcoexist.com/3020559/visualized/visualizing-bitcoins-amazingly-fast-spread-around-the-world#4>

- Choropleths of Bitcoin downloads across the world

<http://thinkdifferent.ly/stuff/sheep-bitcoin/>

- Intricate & complex network graph of a Bitcoin heist (blackmarket robbing its customers)
- addresses are nodes
- edges are tx'a
- edges are color-coded

<http://blockexplorer.com>

- Data on the blockchain

<http://bitcoinrichlist.com>

- Visualizations of addresses & associated bitcoin amounts

<http://coinmap.org/>

- Shows where merchants accept bitcoin on a world map

<http://cointerest.org/map>

- Shows where merchants accept bitcoin on a world map