Blockchain 101

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ODTÜ BLOCKCHAIN
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You are doing it wrong

Cryptocurrencies

Cryptographers are not happy with how you're using the word 'crypto'

The renamed Crypto.com Arena is a win for cryptocurrency fans but strikes a blow against the word's original meaning

Matthew Cantor
@CantorMatthew

Thu 18 Nov 2021 16.14 GMT

Construction workers put the finishing touches on the Staples Center sign outside the arena in downtown Los Angeles on 16 September 1999. Photograph: Xerro Ryan Covarrubias/AP

The stadium that is home to the Los Angeles Lakers is getting a new name: the Crypto.com Arena. The name reflects the arena's new sponsorship agreement with a Singapore-based cryptocurrency trading platform. That may be good news for cryptocurrency fanatics - but perhaps not so much for another faction within the digital landscape: cryptographers.

Look up the word "crypto" in Webster's dictionary, and you'll see it refers to cryptography, which in turn is defined as "the computerized encoding and decoding of information". Search "crypto" on Google, however, and you'll see a host of top results pointing to cryptocurrencies like bitcoin and ethereum.

https://www.theguardian.com/technology/2021/nov/18/crypto-cryptocurrency-cryptographers

Short History

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- Almost every e-cash company failed until the invention of Bitcoin

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- Pseudo-anonymity: Account numbers are cryptographically obtained values and do no contain personal information

Cryptographic Hash Functions

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Actually we want a hash function to behave like a **random** function

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3. Collision Resistance

It should be hard to find two inputs x_1 and x_2 such that $H(x_1) = H(x_2)$

Hash Functions

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Bitcoin script allows the use of **SHA-1**, **RIPEMD-160**, and **SHA-2**

Discrete Logarithm Problem (DLP)

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Warning

Hardness (intractability) of the discrete logarithm problem depends on the group! (e.g. DLP on an elliptic curve $y^2 = x^3 + ax + b$)

Digital Signature Algorithm/Standard (DSA/DSS)

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1. **Randomly** choose a secret key x where $0 < x < q$
2. Calculate the public key $y = g^x \pmod p$

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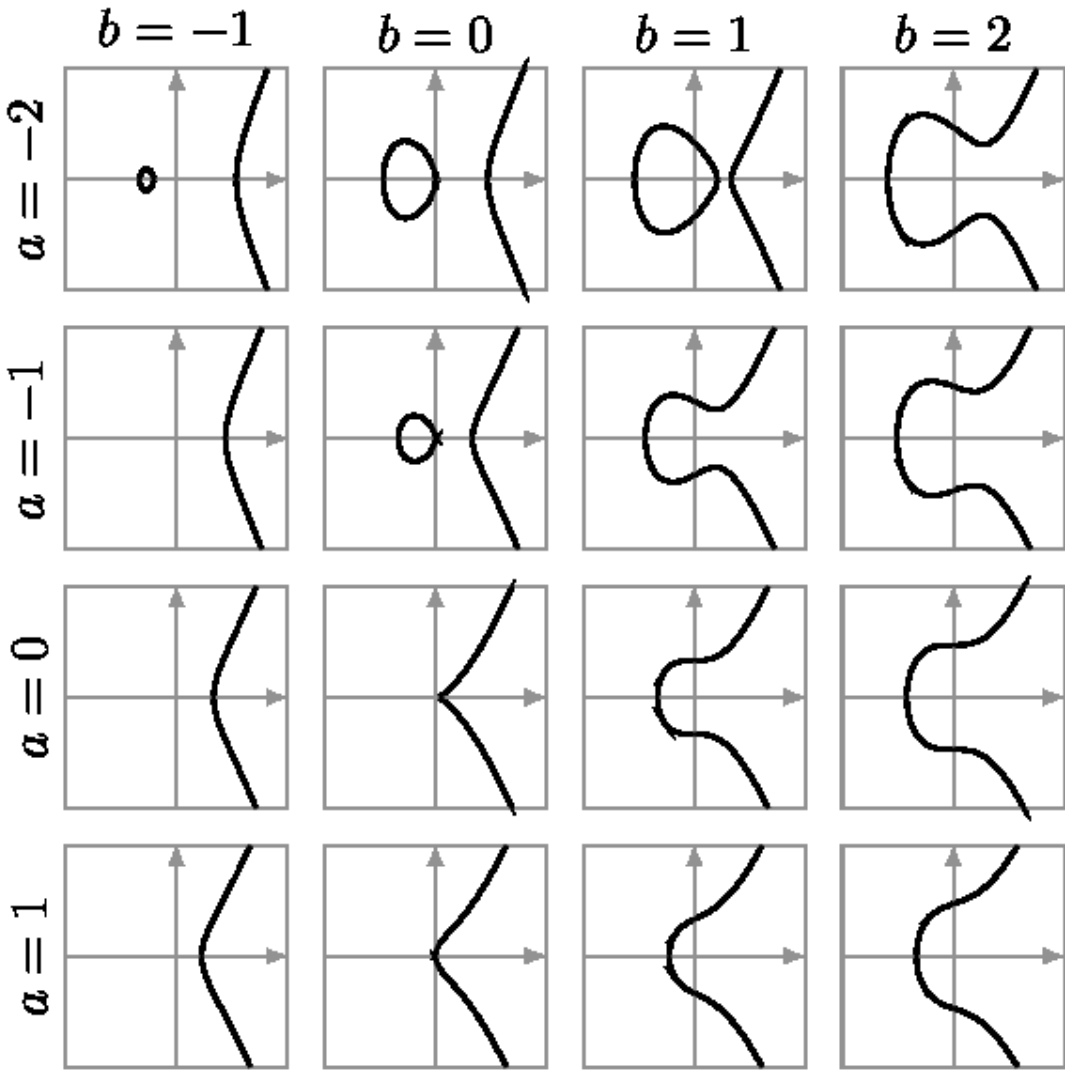
The signature is valid if $v = r$

Elliptic Curve Cryptography



$$y^2 = x^3 + a \cdot x + b$$

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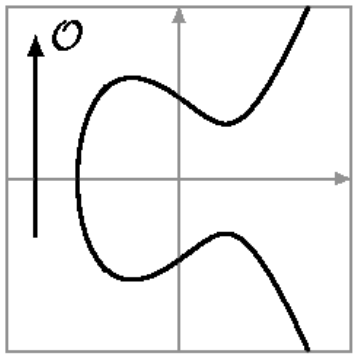
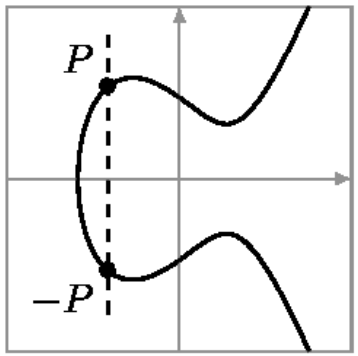
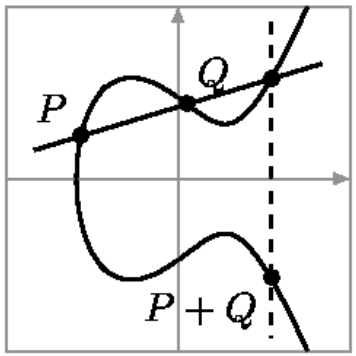


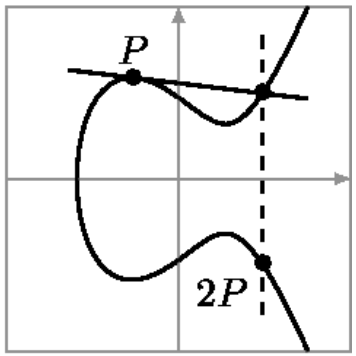
Neutral element $\mathcal{O}$



Inverse element $-P$



Addition $P + Q$
"Chord rule"



Doubling $P + P$
"Tangent rule"

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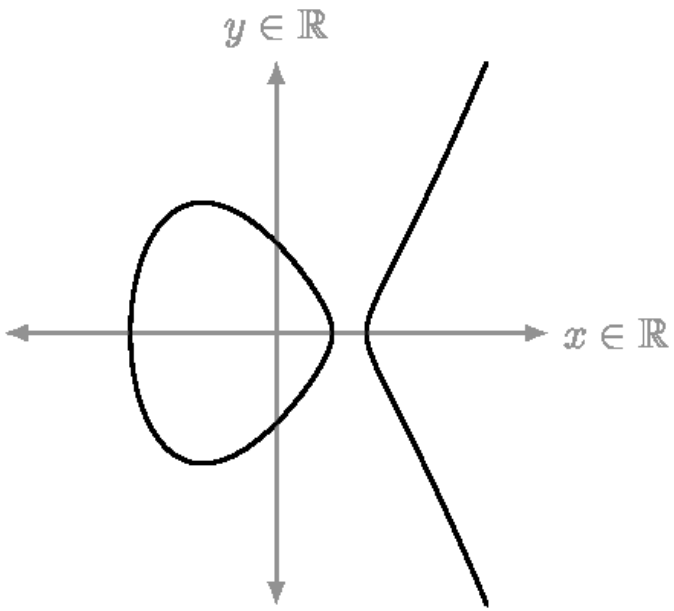
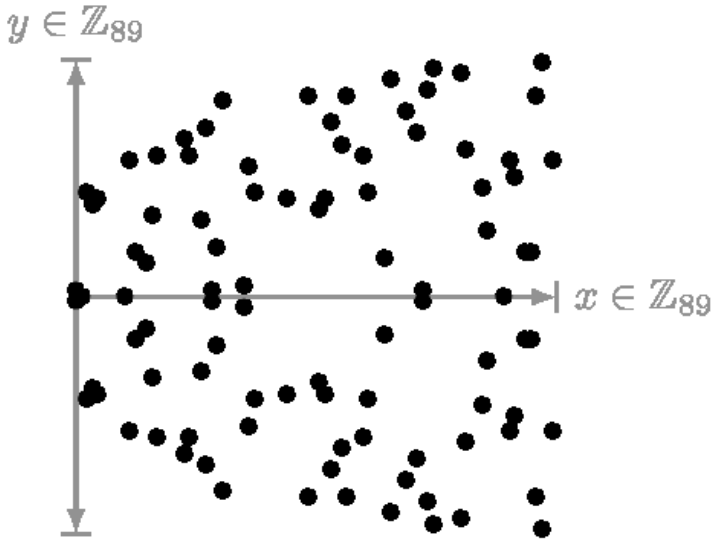


$y^2 = x^3 - 2x + 1$ over $\mathbb{R}$



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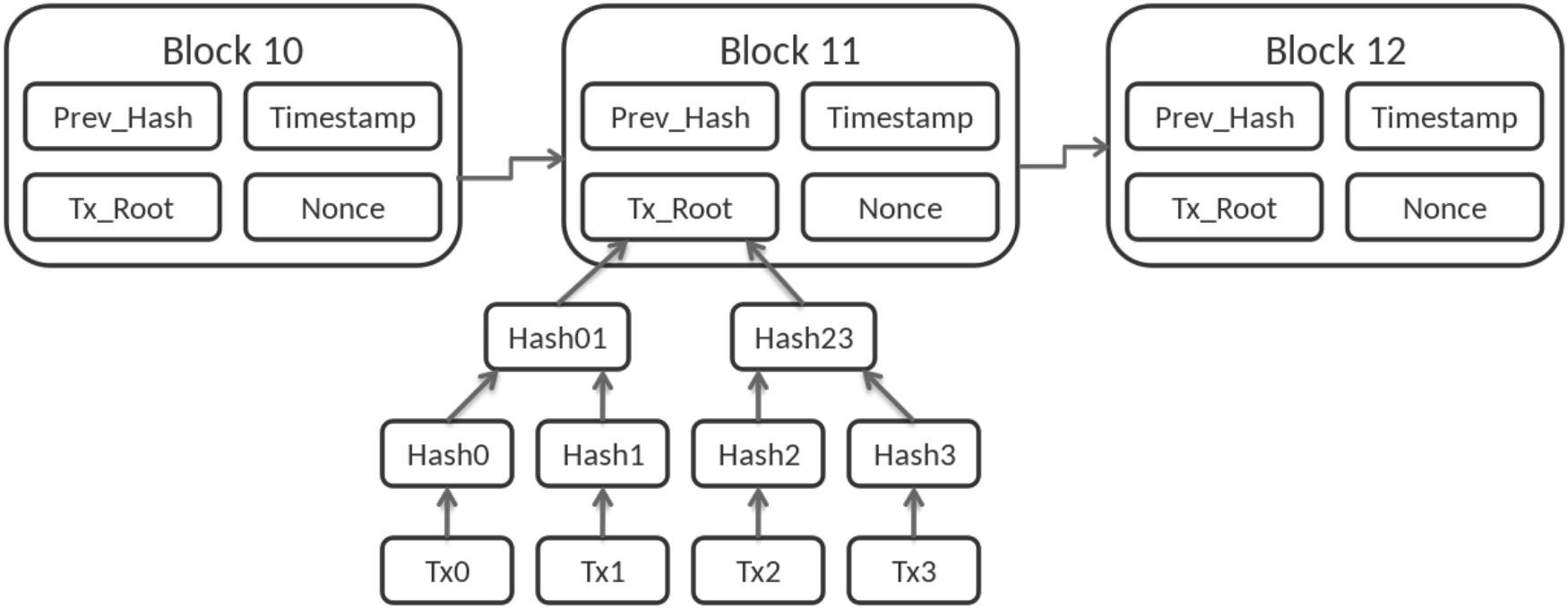
Blockchain



Bitcoin blockchain structure by Matthäus Wander (CC BY-SA 3.0)

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Bitcoin (Specs)

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- Any change in these specs causes a **hard fork**
- Adding a cryptographic algorithm causes a **soft fork**

P2SH Example: SHA1 Collision Bounty

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- A disassembly of its script is
  1. *OP_2DUP*
  2. *OP_EQUAL*
  3. *OP_NOT*
  4. *OP_VERIFY*
  5. *OP_SHA*1
  6. *OP_SWAP*
  7. *OP_SHA*1
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8. Full anonymity

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Ethereum Classic

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- This resulted in the network splitting into two blockchains

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Is a Blockchain Temper-Proof?

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- After the hard fork, Ethereum subsequently forked twice in the fourth quarter of 2016 to deal with other attacks

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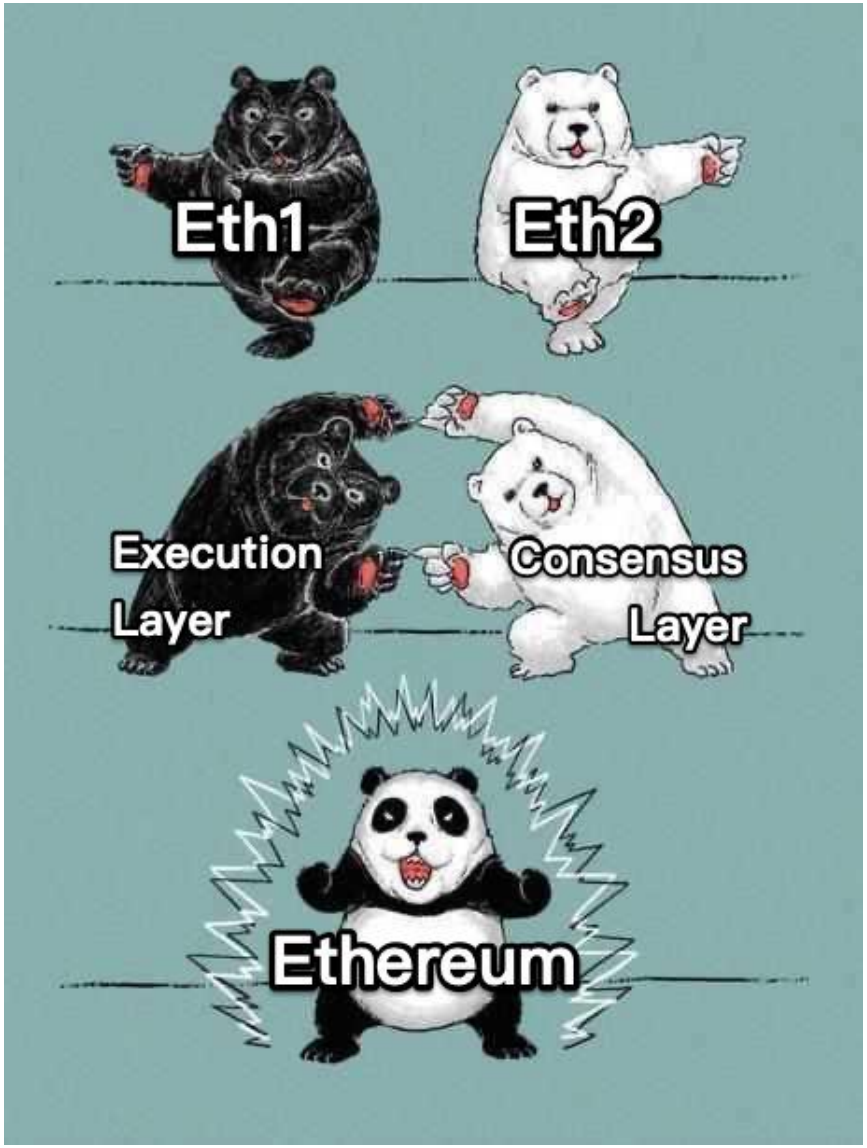
Electricity Consumption

- Bitcoin mining's yearly electricity consumption is around 200 TWh
- Norway's yearly electricity consumption is around 120 TWh
- Ethereum mining's yearly electricity consumption is around 100 TWh

Ethereum Merge



https://blog.ethereum.org/2022/01/24/the-great-eth2-renaming/

A Bitcoin Block

Block 714108

USD BTC

This block was mined on December 14, 2021 at 2:49 PM GMT+3 by AntPool. It currently has 1 confirmations on the Bitcoin blockchain.

The miner(s) of this block earned a total reward of 6.25000000 BTC ($299,190.81). The reward consisted of a base reward of 6.25000000 BTC ($299,190.81) with an additional 0.07192409 BTC ($3,443.04) reward paid as fees of the 3561 transactions which were included in the block. The Block rewards, also known as the Coinbase reward, were sent to this address.

A total of 27,890.66393872 BTC ($1,335,140,864.80) were sent in the block with the average transaction being 7.83225609 BTC ($374,934.25). Learn more about how blocks work.

Hash	00000000000000000008247d658dbb5502b4ad00087adc0823ddd34f4dce5b79
Confirmations	1
Timestamp	2021-12-14 14:49
Height	714108
Miner	AntPool
Number of Transactions	3,561
Difficulty	24,195,286,980,613.62
Merkle root	b716d73ff930a5fe5ca70a573734bbe6fc9506d4c1953438543f22224dcbdcbf
Version	0x20400004
Bits	386,638,367
Weight	3,993,549 WU
Size	1,538,685 bytes
Nonce	4,170,003,327
Transaction Volume	27890.66393872 BTC
Block Reward	6.25000000 BTC
Fee Reward	0.07192409 BTC

From www.blockchain.com

Digital Signatures

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- Some Bitcoin users used the same **k** for signing two different transactions due to a Java bug in the Java SecureRandom class on Android and attackers stole their bitcoins by obtaining secret keys from these transactions

Elliptic Curve DSA (ECDSA)

How to Choose an Elliptic Curve?

- Bitcoin uses the elliptic curve $y^2 = x^3 + 7$ (secp256k1) over F_p where $p = 2^{256} - 2^{32} - 2^9 - 2^8 - 2^7 - 2^6 - 2^4 - 1$

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- *Inside Information:* NIST is planning to add *secp256k1* to its standards for interoperability

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- Recall that adding new cryptographic algorithms to a blockchain requires soft forks

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- STARKS are quantum secure but proof sizes are larger (45-200 KB)

Lightweight Cryptography

Blockchains for IoT Devices

- Lightweight cryptography focuses on resource-constrained devices and tries to provide solutions that are tailored for them
  - require less energy
  - require less power
  - have small latency
  - provide better throughput
  - have side-channel resistance

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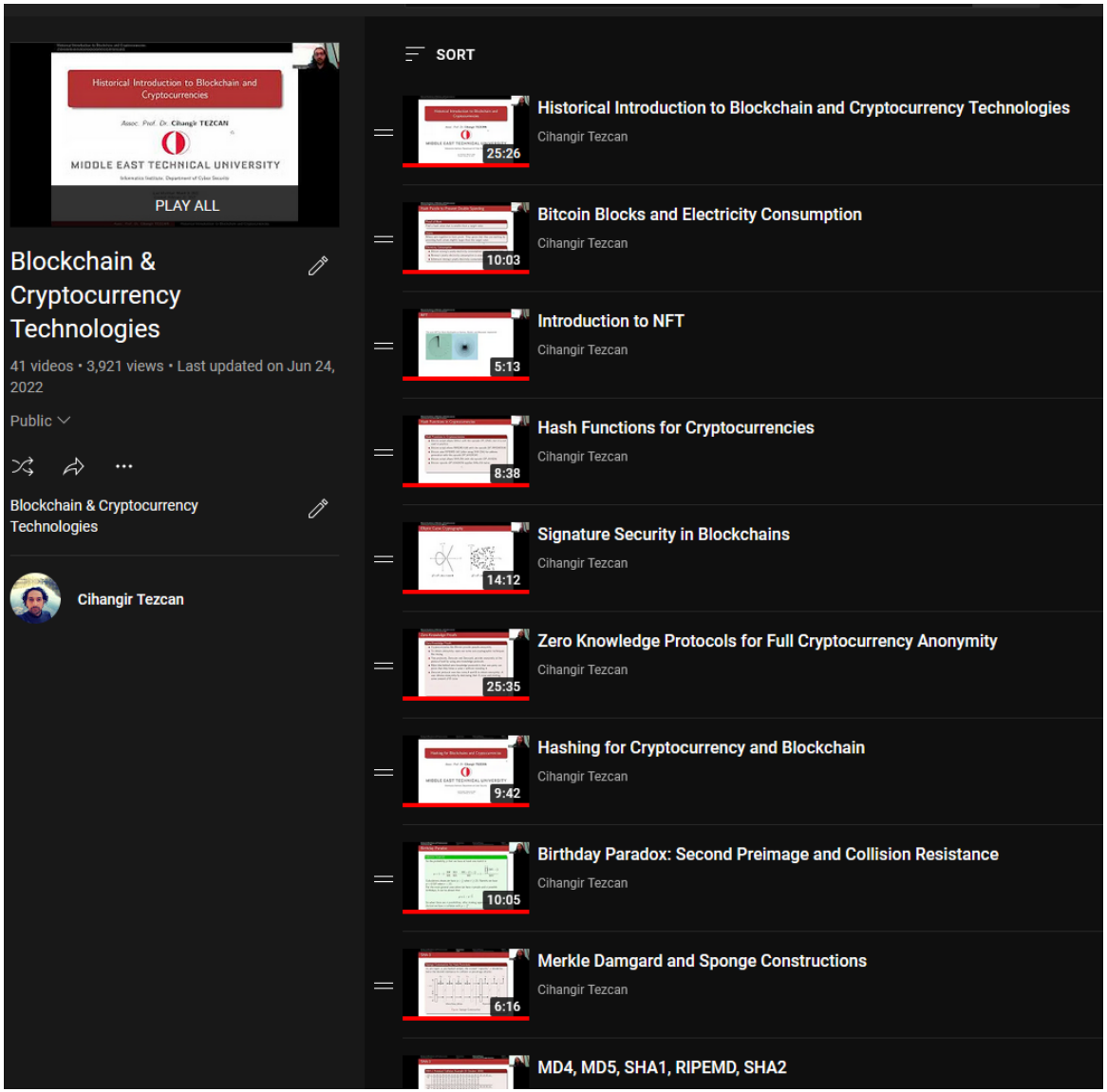
CSEC 519



youtube.com/CihangirTezcan

Flu TV

youtube.com/c/ilkercanikligilflutv

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2. Non-fungible tokens are unique and each token represents someone's ownership of a specific digital asset (ERC-721)

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- ERC-721 standard does NOT record the hash of the file!!!

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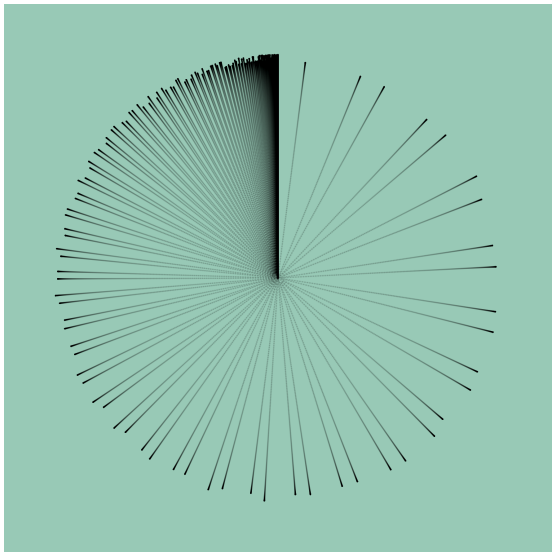
3. NFT files may be lost or changed in the future

NFT Example 1

The same NFT by Moxie Marlinspike on Opensea, Rarible, and Metamask, respectively



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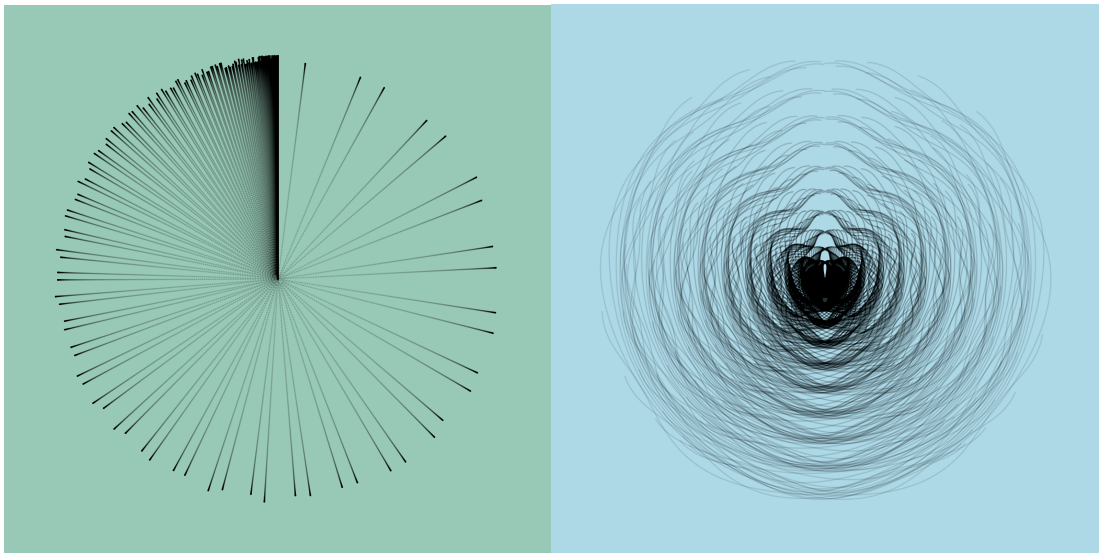

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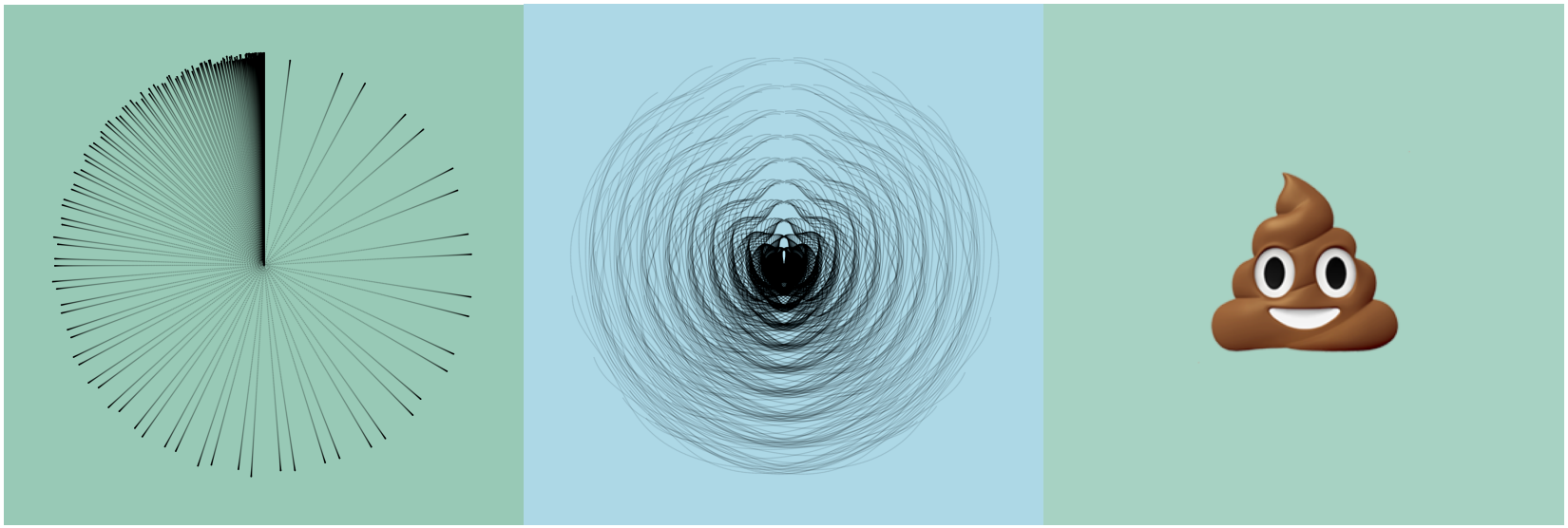

Storing an NFT at a regular webpage (HTTP) is NOT a good idea

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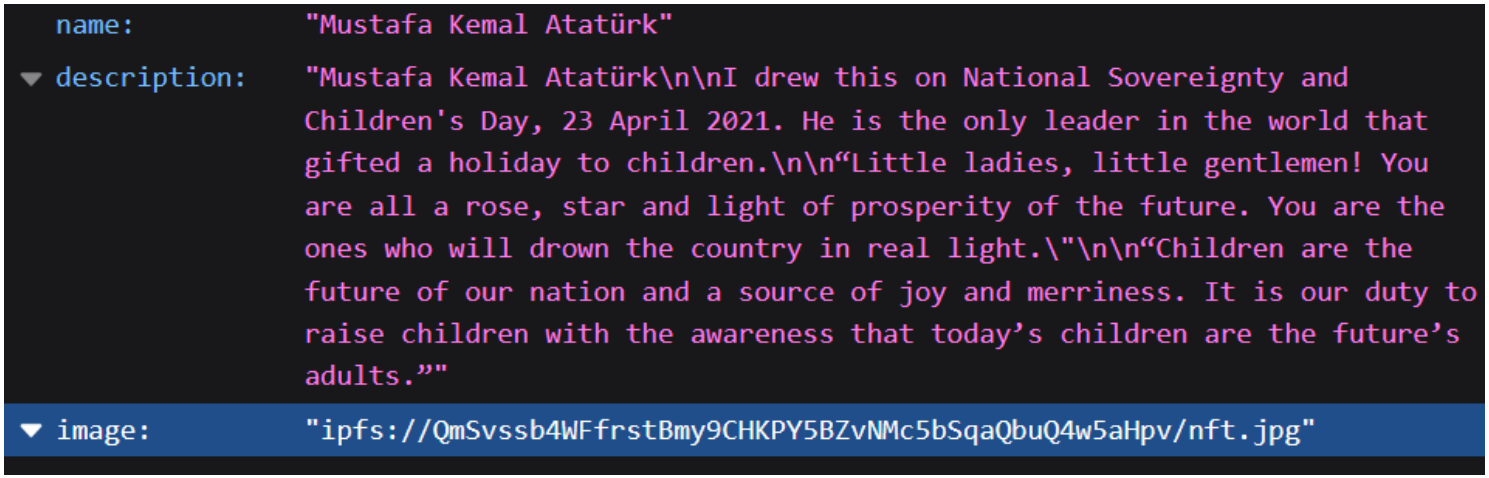

ipfs://QmbGNG3wes9tk7ori7Gu6mRcV9fwWvrzyJutqVQ3sCje99/metadata.json

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IPFS SHA-256 (CID): 9772F58B3EA7BD44DB28A93DED464D6A46027B602B8C298F597FE7A9CC5B594B

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5. OpenSea and Rarible allow the creator to modify royalty after the sale
   - Around 9% of OpenSea royalty fees were modified after the 1st sale

Blockchain Use Cases

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- Many academic papers that propose blockchain solutions are wrong or redundant

Why You Do NOT Need a Blockchain

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6. Tamper-proof log of all data store writes is wanted

WEB2 vs WEB3

WEB3

- Current internet (Web2) is dominated by companies that provide *free* services in exchange for your personal data

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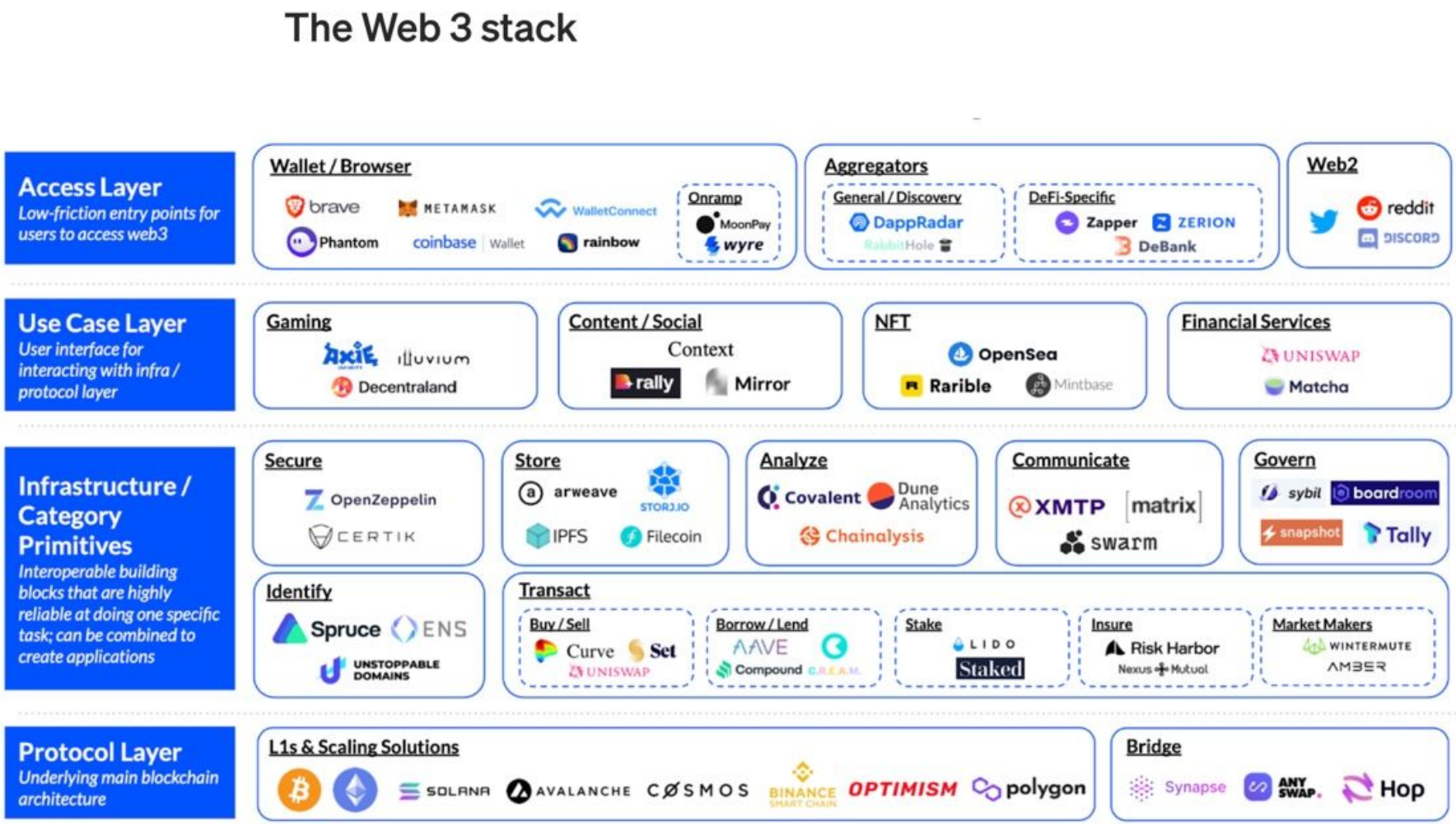
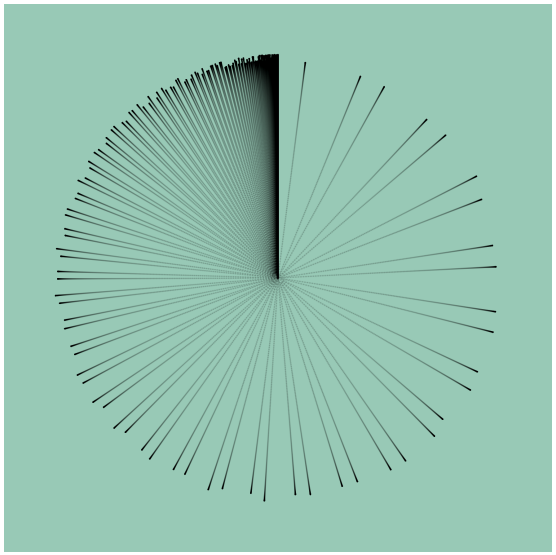
WEB3


The Web 3 stack
Access Layer
Low-friction entry points for users to access web3
Wallet / Browser
brave
METAMASK
WalletConnect
Phantom
coinbase Wallet
rainbow
Onramp
MoonPay
wyre
Aggregators
General / Discovery
DappRadar
RabbitHole
DeFi-Specific
Zapper
ZERION
DeBank
Web2
reddit
DISCORD
Use Case Layer
User interface for interacting with infra / protocol layer
Gaming
Axie
illuvium
Decentraland
Content / Social
Context
rally
Mirror
NFT
OpenSea
Rarible
Mintbase
Financial Services
UNISWAP
Matcha
Infrastructure / Category Primitives
Interoperable building blocks that are highly reliable at doing one specific task; can be combined to create applications
Secure
OpenZeppelin
CERTIK
Store
arweave
STORJ.IO
IPFS
Filecoin
Analyze
Covalent
Dune Analytics
Chainalysis
Communicate
XMTP
matrix
swarm
Govern
sybil
boardroom
snapshot
Tally
Identify
Spruce
ENS
UNSTOPPABLE DOMAINS
Transact
Buy / Sell
Curve
Set
UNISWAP
Borrow / Lend
AAVE
Compound
Stake
LIDO
Staked
Insure
Risk Harbor
Nexus Mutual
Market Makers
WINTERMUTE
AMBER
Protocol Layer
Underlying main blockchain architecture
L1s & Scaling Solutions
SOLANA
AVALANCHE
COSMOS
BINANCE SMART CHAIN
OPTIMISM
polygon
Bridge
Synapse
ANY SWAP
Hop

Back to NFT Example

The same NFT by Moxie Marlinspike on OpenSea, Rarible, and Metamask, respectively



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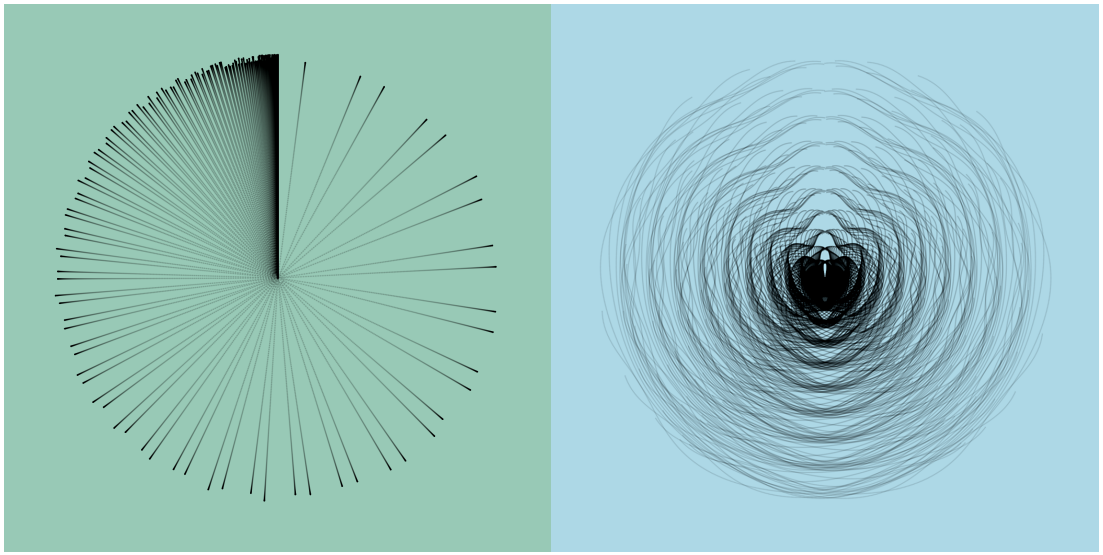

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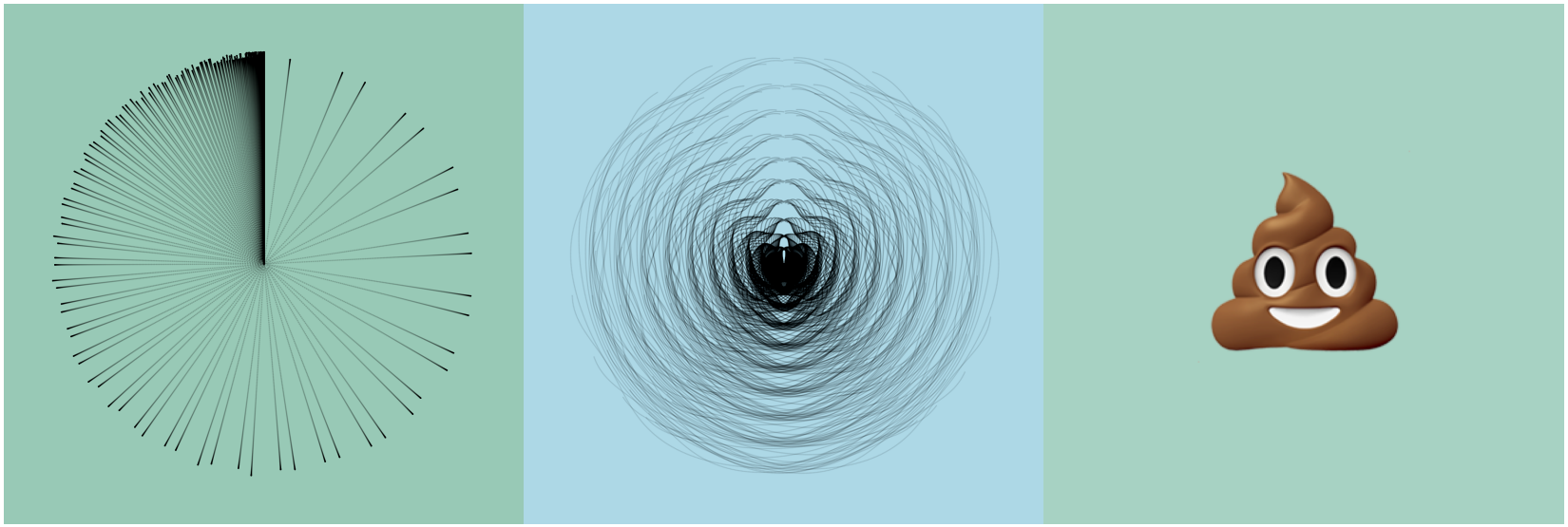

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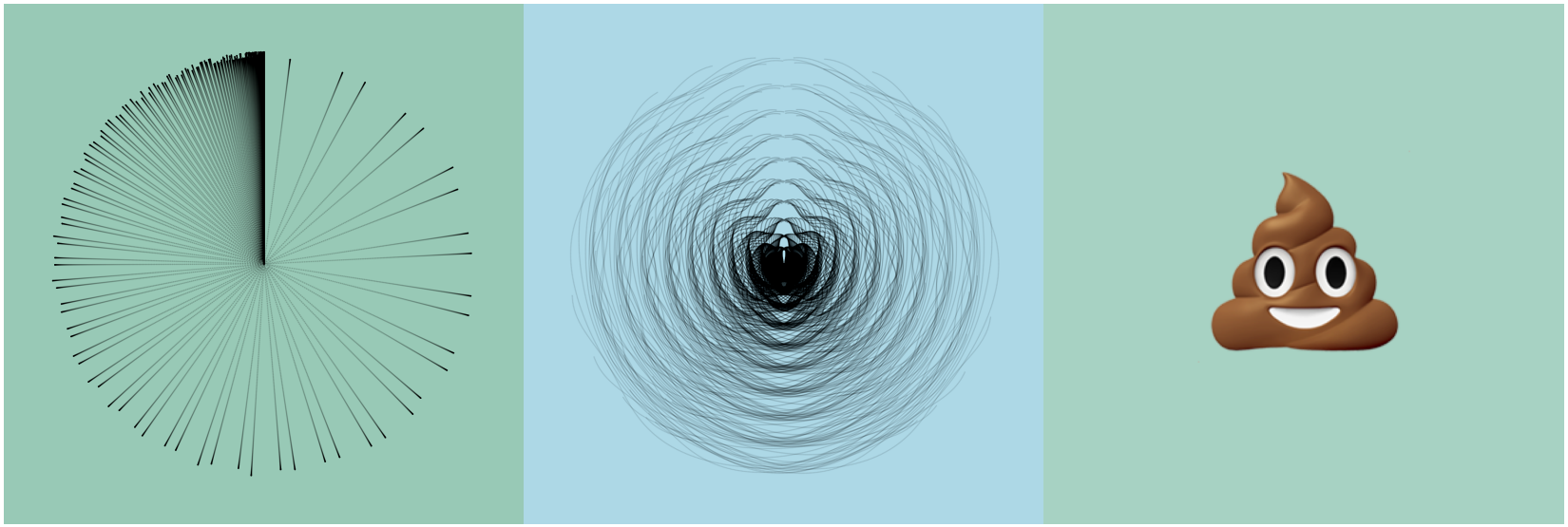

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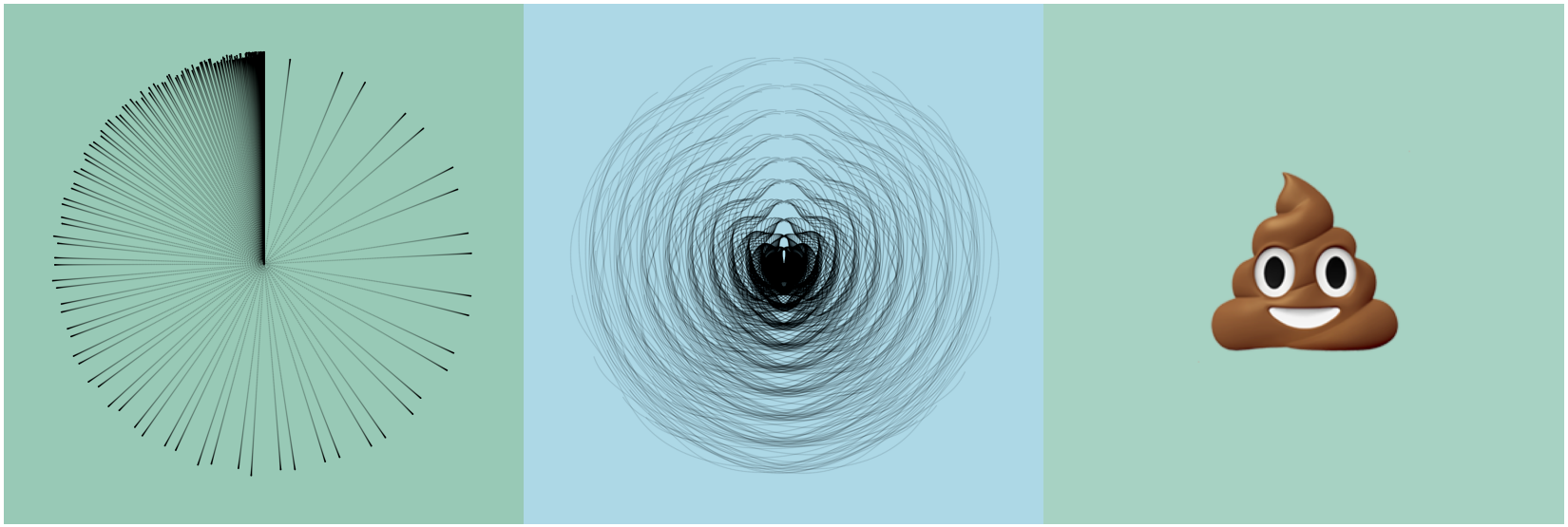

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- Instead of looking at the blockchain, using a library/API of others result in centralized systems

WEB3 Challenges

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3. Considering that hundreds of cryptocurrencies died in the last 10 years, assuming that a blockchain will live forever might be a huge assumption

Metaverse

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The metaverse refers to digital worlds in which people will gather to work, play and hang out where you can own digital assets like NFTs and transact using cryptocurrencies

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4. Metaverse does NOT mean VR/AR

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2. Legal system is not ready for Metaverse
3. Services that do not provide convenience will not be preferred
4. Some technologies emerge untimely and leave the scene

Thanks

Thank You for Your Attention