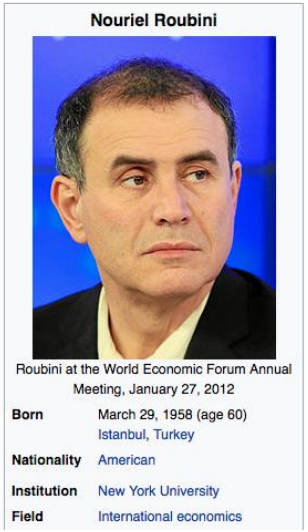
Bitcoin Mechanics

Blockchain on the news

Blok Zinciri Mühendislerine Talep Yüzde 400 Arttı!

Maaşları 15 Bin Dolara Çıktı

https://www.haberler.com/blok-zinciri-muhendislerine-talep-yuzde-400-artti-11357793-h



The Big Blockchain Lie

Roubini's predictions have earned him the nicknames "Dr. Doom”

https://www.project-syndicate.org/commentary/blockchain-big-lie-by-nouriel-roubini-2018-10

CRYPTOGRAPHIC HASH FUNCTIONS

INTEGRITY OF INFORMATION

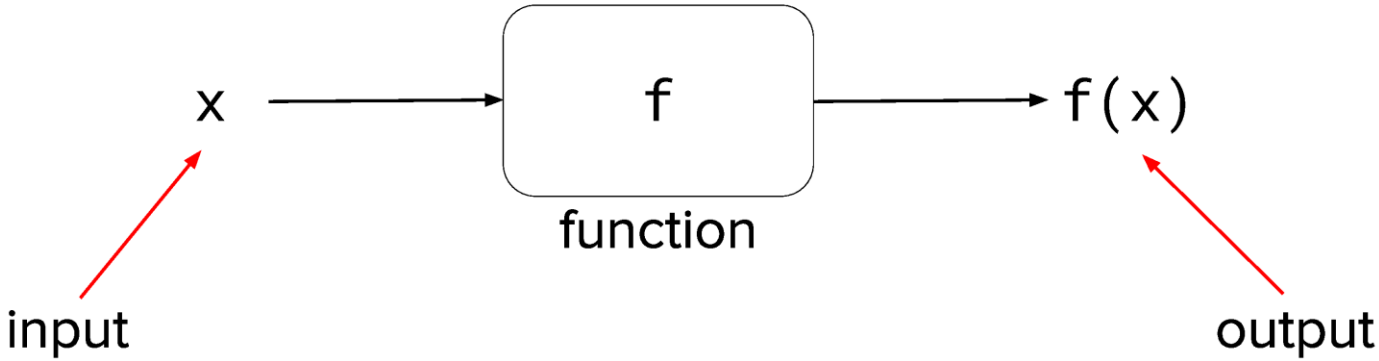
How do we ensure trust in communication in a trustless environment?

⇒ With **cryptographic hash functions**

Image source: https://spiritegg.com/wp-content/uploads/2016/03/63180952_fingerprint_types624.jpg

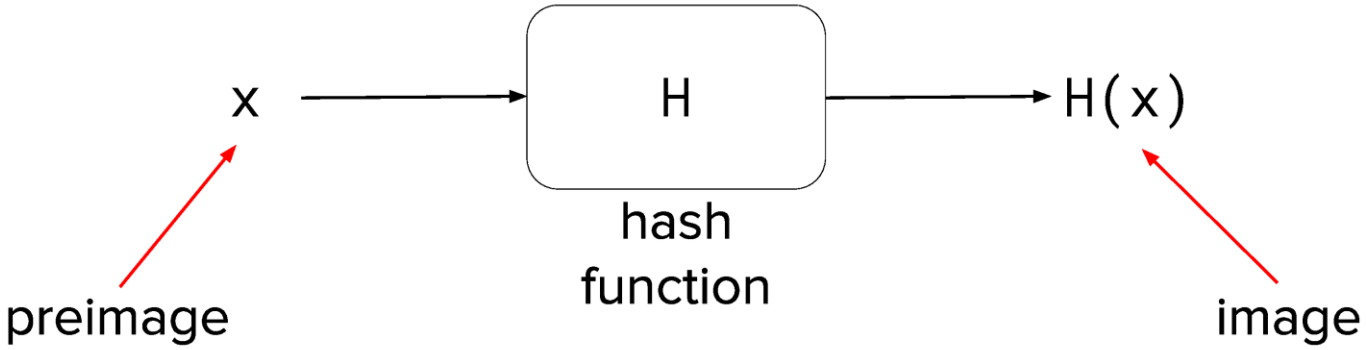
CRYPTOGRAPHIC HASH FUNCTIONS

WHAT IS A HASH FUNCTION?



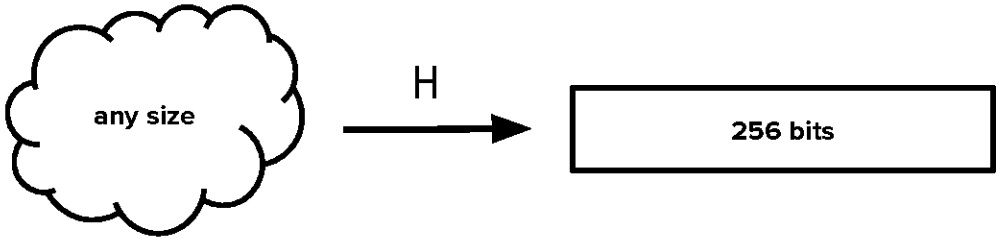
CRYPTOGRAPHIC HASH FUNCTIONS

WHAT IS A HASH FUNCTION?



CRYPTOGRAPHIC HASH FUNCTIONS

WHAT IS A HASH FUNCTION?



CRYPTOGRAPHIC HASH FUNCTIONS

#CRYPTOGRAPHY

Cryptographic hash function:

A hash function with three special properties:

- Preimage resistance
- Second preimage resistance
- Collision resistance

The equivalent of **mathematical fingerprints/identifiers**

Image source: http://chimera.labs.oreilly.com/books/1234000001802/ch08.html#_proof_of_work_algorithm

```
I am Satoshi Nakamoto0 => a80a81401765c8eddee25df36728d732...
I am Satoshi Nakamoto1 => f7bc9a6304a4647bb41241a677b5345f...
I am Satoshi Nakamoto2 => ea758a8134b115298a1583ffb80ae629...
I am Satoshi Nakamoto3 => bfa9779618ff072c903d773de30c99bd...
I am Satoshi Nakamoto4 => bce8564de9a83c18c31944a66bde992f...
I am Satoshi Nakamoto5 => eb362c3cf3479be0a97a20163589038e...
I am Satoshi Nakamoto6 => 4a2fd48e3be420d0d28e202360cfbaba...
I am Satoshi Nakamoto7 => 790b5a1349a5f2b909bf74d0d166b17a...
I am Satoshi Nakamoto8 => 702c45e5b15aa54b625d68dd947f1597...
I am Satoshi Nakamoto9 => 7007cf7dd40f5e933cd89fff5b791ff0...
I am Satoshi Nakamoto10 => c2f38c81992f4614206a21537bd634a...
I am Satoshi Nakamoto11 => 7045da6ed8a914690f087690e1e8d66...
I am Satoshi Nakamoto12 => 60f01db30c1a0d4cbce2b4b22e88b9b...
I am Satoshi Nakamoto13 => 0ebc56d59a34f5082aaef3d66b37a66...
I am Satoshi Nakamoto14 => 27ead1ca85da66981fd9da01a8c6816...
I am Satoshi Nakamoto15 => 394809fb809c5f83ce97ab554a2812c...
I am Satoshi Nakamoto16 => 8fa4992219df33f50834465d3047429...
I am Satoshi Nakamoto17 => dca9b8b4f8d8e1521fa4eaa46f4f0cd...
I am Satoshi Nakamoto18 => 9989a401b2a3a318b01e9ca9a22b0f3...
I am Satoshi Nakamoto19 => cda56022ecb5b67b2bc93a2d764e75f...
```

CRYPTOGRAPHIC HASH FUNCTIONS

PREIMAGE RESISTANCE

Preimage resistance:

Given $H(x)$, it is computationally difficult to determine x

Fingerprint analogy:

Whose fingerprint is this?

CRYPTOGRAPHIC HASH FUNCTIONS

SECOND PREIMAGE RESISTANCE

Second preimage resistance:

Given x, it is computationally difficult to find some value x' such that `H(x) == H(x')`

Fingerprint analogy:

Can you find someone with the same fingerprint as you?

CRYPTOGRAPHIC HASH FUNCTIONS

COLLISION RESISTANCE

Collision resistance:

It is computationally difficult to find x and y such that `H(x) == H(y)`

Fingerprint analogy:

Can you find two random people with the same fingerprint?

CRYPTOGRAPHIC HASH FUNCTIONS

AVALANCHE EFFECT

Avalanche effect: a small change in the input produces a pseudorandom change in the output

- Often a significant difference from the first output
- Prevents “hot or cold” game with inputs to produce or predict outputs

```
I am Satoshi Nakamoto0 => a80a81401765c8eddee25df36728d732...
I am Satoshi Nakamoto1 => f7bc9a6304a4647bb41241a677b5345f...
I am Satoshi Nakamoto2 => ea758a8134b115298a1583ffb80ae629...
I am Satoshi Nakamoto3 => bfa9779618ff072c903d773de30c99bd...
I am Satoshi Nakamoto4 => bce8564de9a83c18c31944a66bde992f...
I am Satoshi Nakamoto5 => eb362c3cf3479be0a97a20163589038e...
I am Satoshi Nakamoto6 => 4a2fd48e3be420d0d28e202360cfbaba...
I am Satoshi Nakamoto7 => 790b5a1349a5f2b909bf74d0d166b17a...
I am Satoshi Nakamoto8 => 702c45e5b15aa54b625d68dd947f1597...
I am Satoshi Nakamoto9 => 7007cf7dd40f5e933cd89fff5b791ff0...
I am Satoshi Nakamoto10 => c2f38c81992f4614206a21537bd634a...
I am Satoshi Nakamoto11 => 7045da6ed8a914690f087690e1e8d66...
I am Satoshi Nakamoto12 => 60f01db30c1a0d4cbce2b4b22e88b9b...
I am Satoshi Nakamoto13 => 0ebc56d59a34f5082aaef3d66b37a66...
I am Satoshi Nakamoto14 => 27ead1ca85da66981fd9da01a8c6816...
I am Satoshi Nakamoto15 => 394809fb809c5f83ce97ab554a2812c...
I am Satoshi Nakamoto16 => 8fa4992219df33f50834465d3047429...
I am Satoshi Nakamoto17 => dca9b8b4f8d8e1521fa4eaa46f4f0cd...
I am Satoshi Nakamoto18 => 9989a401b2a3a318b01e9ca9a22b0f3...
I am Satoshi Nakamoto19 => cda56022ecb5b67b2bc93a2d764e75f...
```

CRYPTOGRAPHIC HASH FUNCTIONS

SHA-256^2

SHA-256: A cryptographic hash function designed by the NSA

Bitcoin uses **SHA-256^2** (“`SHA-256 squared`”), meaning that `H(x)` actually means `SHA256(SHA256(x))`

- See readings for clarifications and reasoning

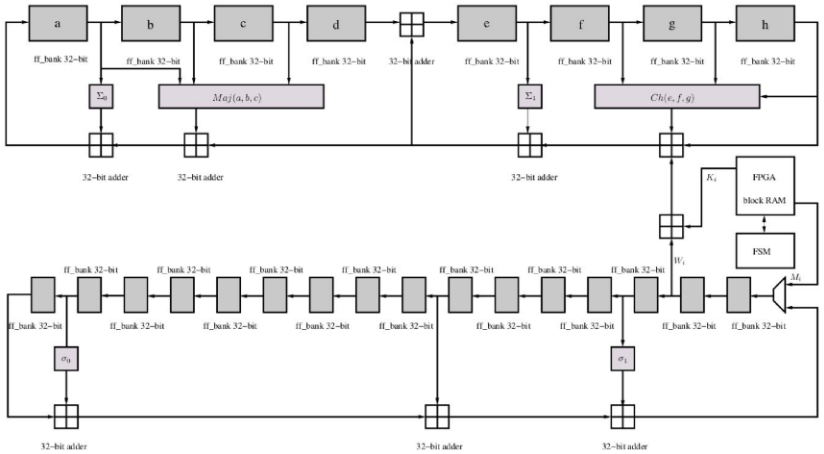


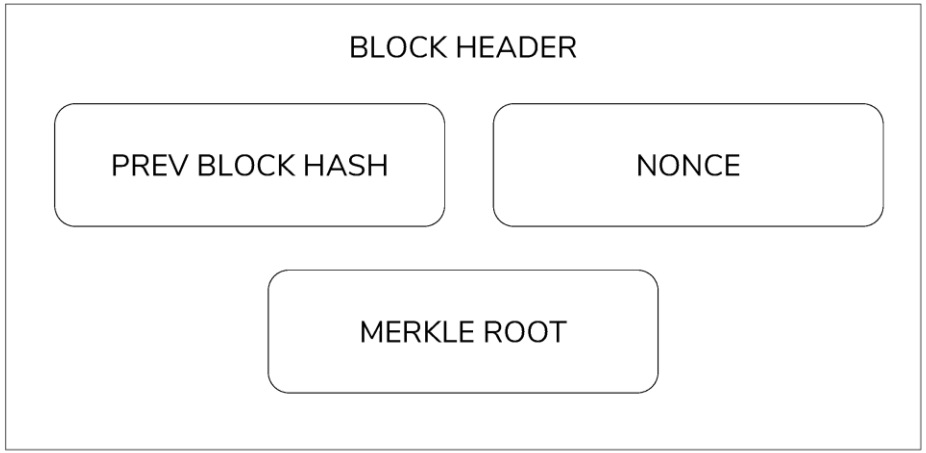
Image source:
https://opencores.org/usercontent,img,1375985843

2

A TAMPER-EVIDENT DATABASE

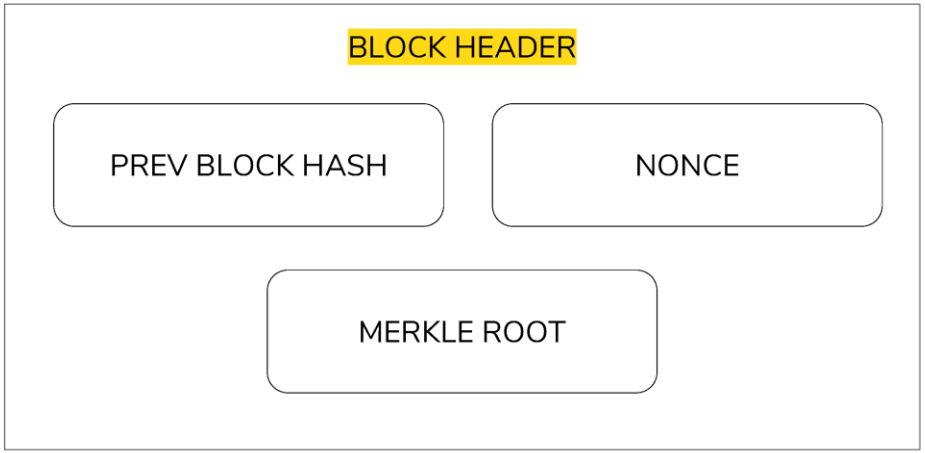
A TAMPER-EVIDENT DATABASE

DISSECTING THE BLOCKCHAIN



A TAMPER-EVIDENT DATABASE

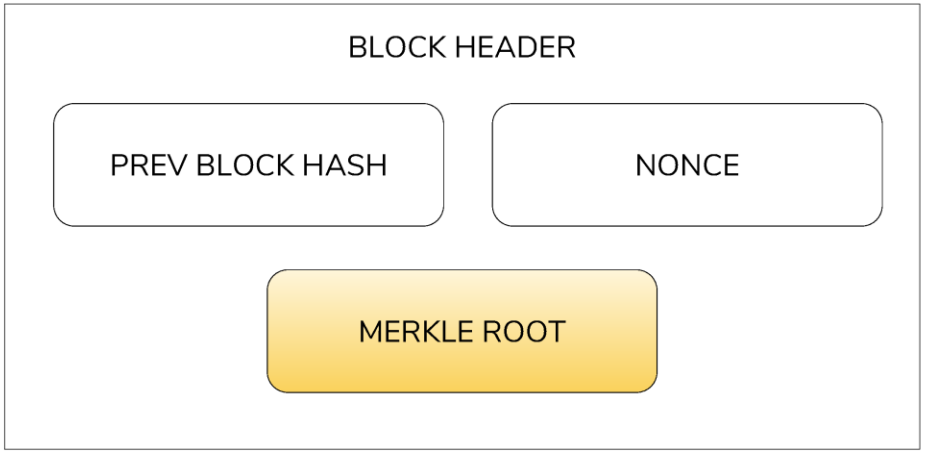
BLOCK HEADER

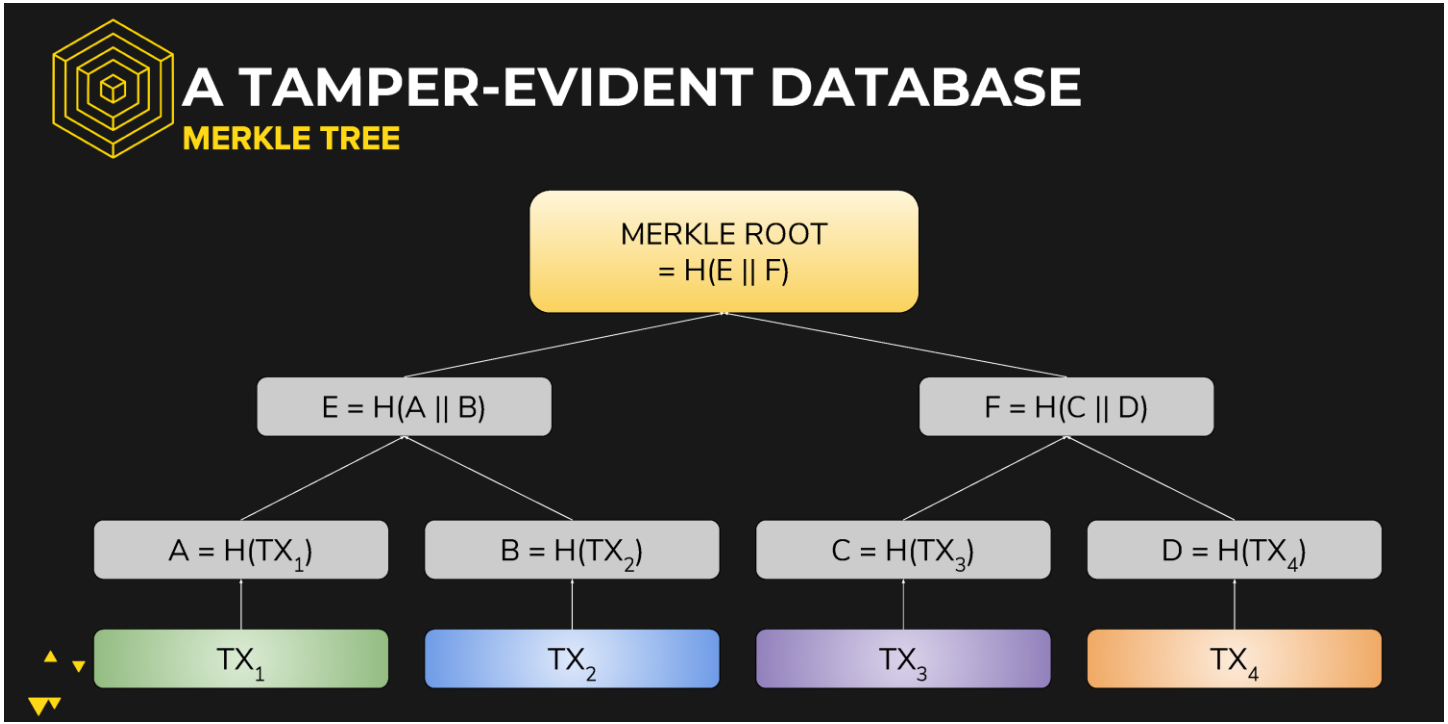


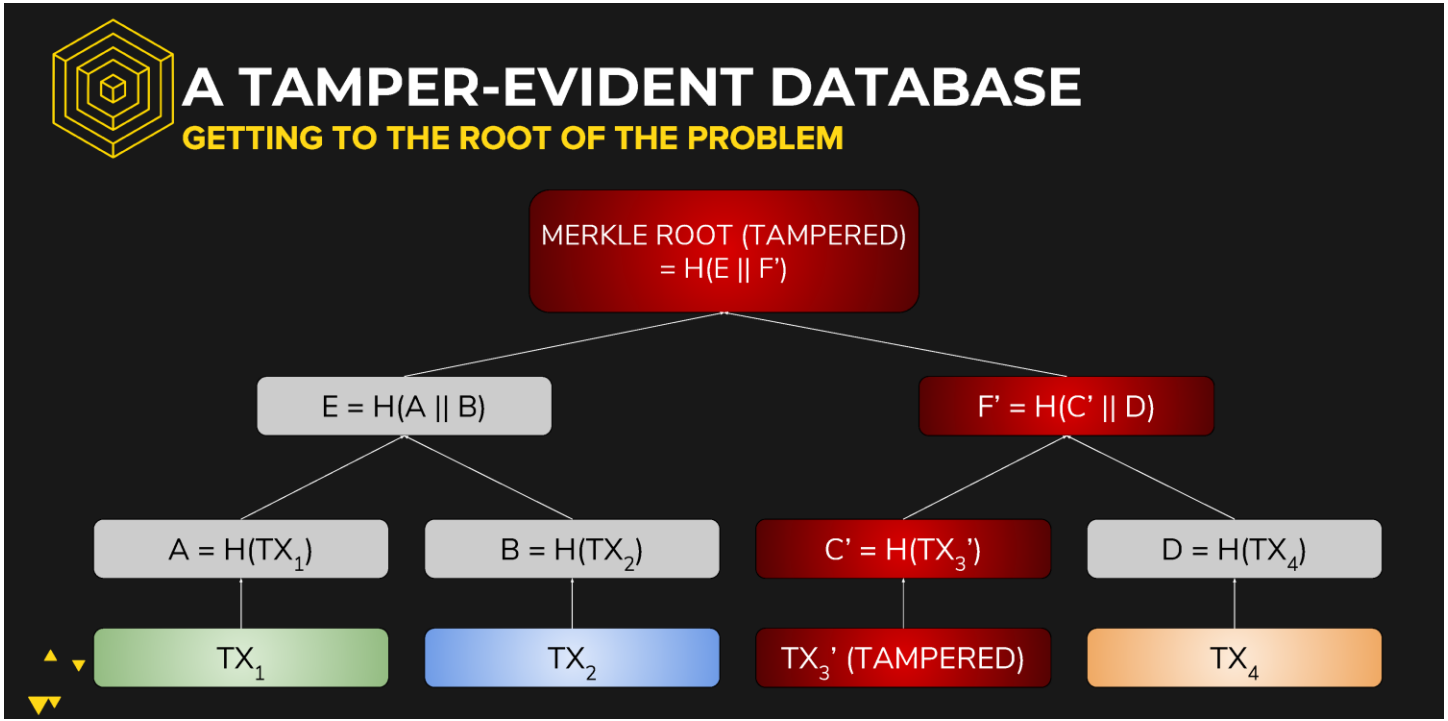
blockID = **H(blockHeader)** = H(prevBlockHash || merkleRoot || nonce)

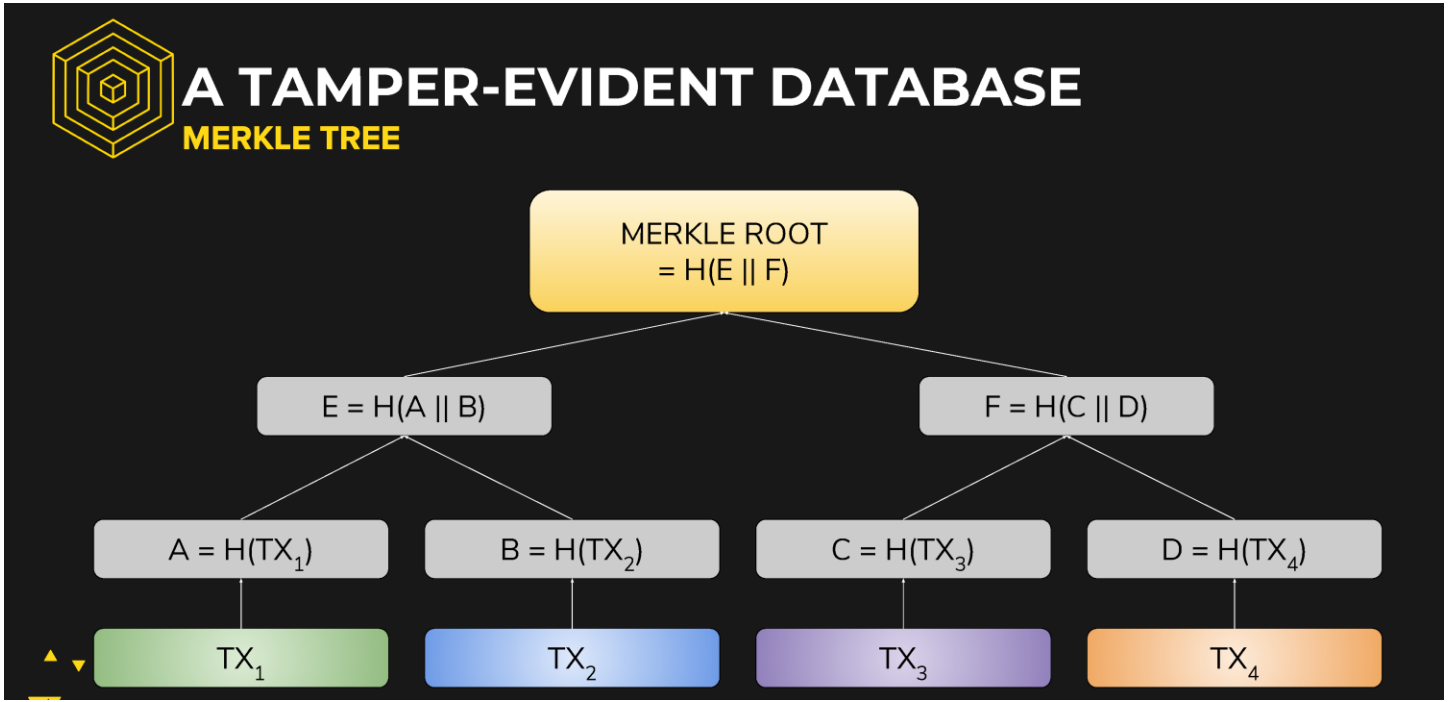
A TAMPER-EVIDENT DATABASE

MERKLE ROOT

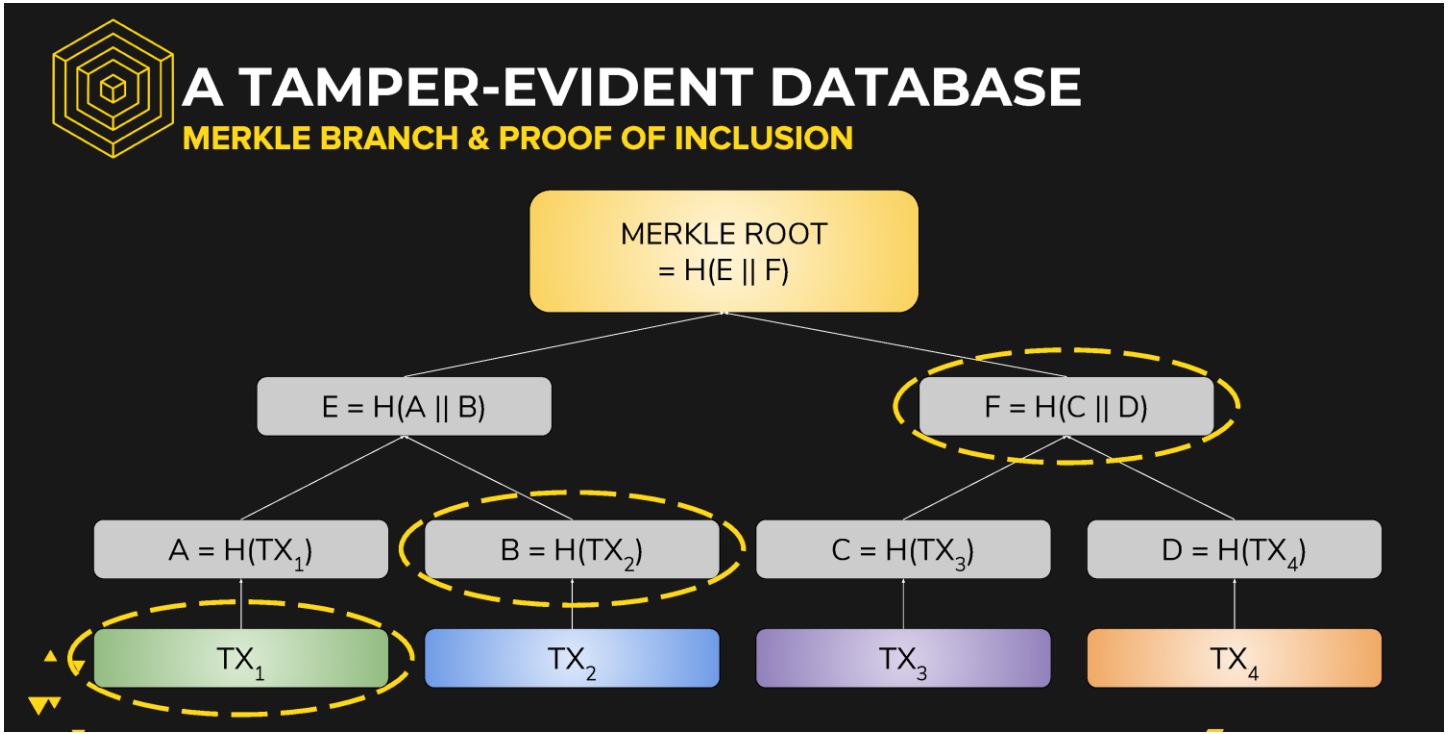



A TAMPER-EVIDENT DATABASE
MERKLE TREE
MERKLE ROOT
= H(E || F)
E = H(A || B)
F = H(C || D)
A = H(TX1)
B = H(TX2)
C = H(TX3)
D = H(TX4)
TX1
TX2
TX3
TX4


A TAMPER-EVIDENT DATABASE
GETTING TO THE ROOT OF THE PROBLEM
MERKLE ROOT (TAMPERED)
= H(E || F')
E = H(A || B)
F' = H(C' || D)
A = H(TX1)
B = H(TX2)
C' = H(TX3')
D = H(TX4)
TX1
TX2
TX3' (TAMPERED)
TX4

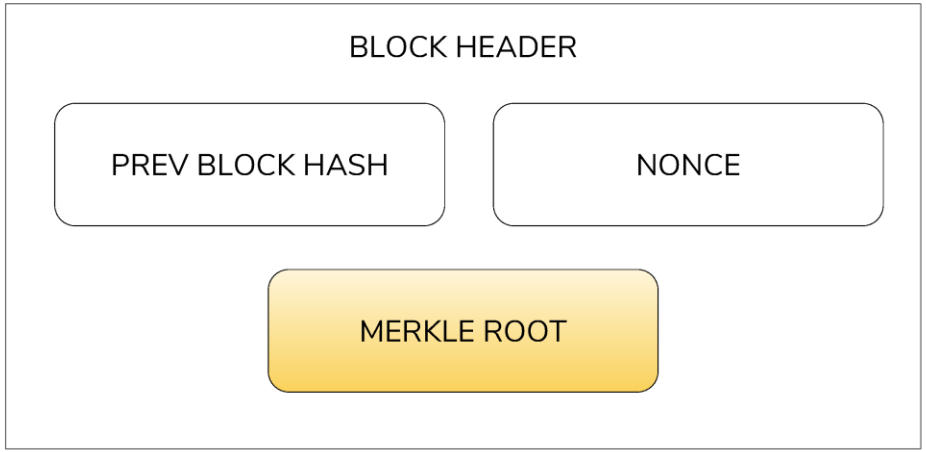


What do we need to validate a transaction?


A TAMPER-EVIDENT DATABASE
MERKLE BRANCH & PROOF OF INCLUSION
MERKLE ROOT
= H(E || F)
E = H(A || B)
F = H(C || D)
A = H(TX1)
B = H(TX2)
C = H(TX3)
D = H(TX4)
TX1
TX2
TX3
TX4

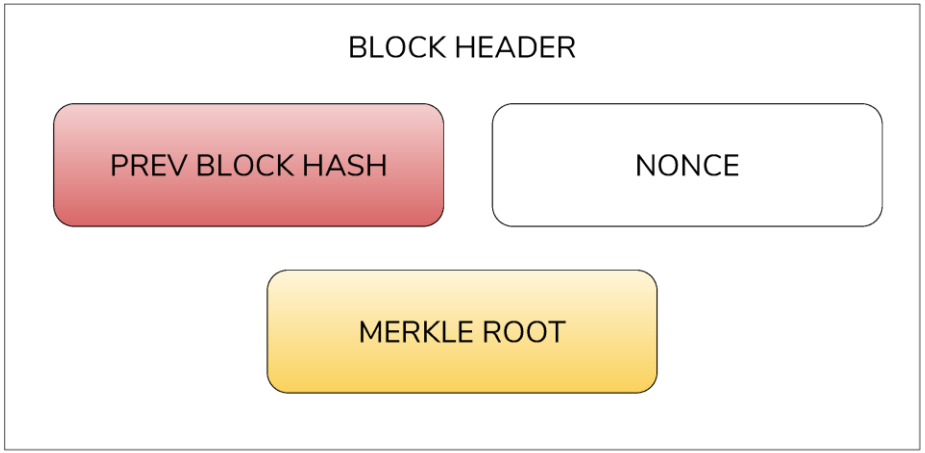
A TAMPER-EVIDENT DATABASE

MERKLE ROOT



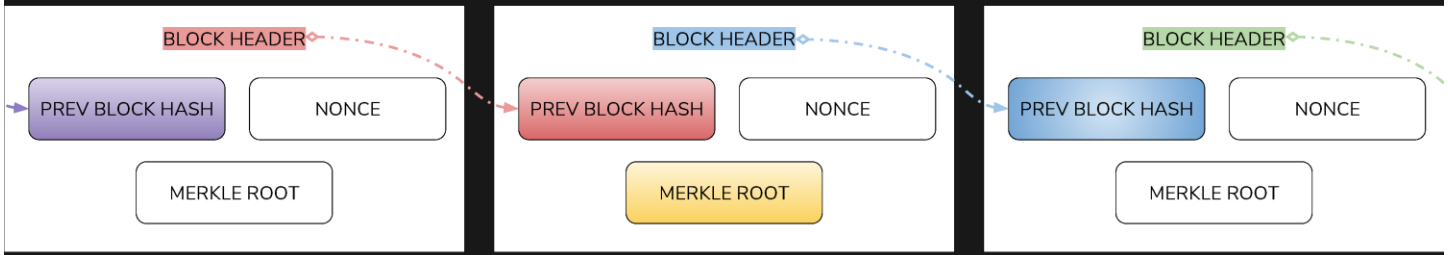
A TAMPER-EVIDENT DATABASE

PREV BLOCK HASH



A TAMPER-EVIDENT DATABASE

PROTECTING THE CHAIN

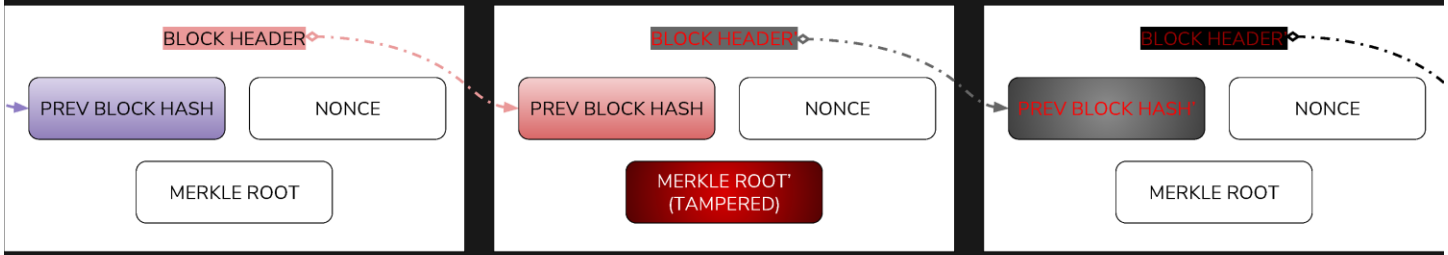


SHA256(SHA256(x))

```
prevBlockHash = H(prevBlockHash || merkleRoot || nonce)
```

A TAMPER-EVIDENT DATABASE

PROTECTING THE CHAIN

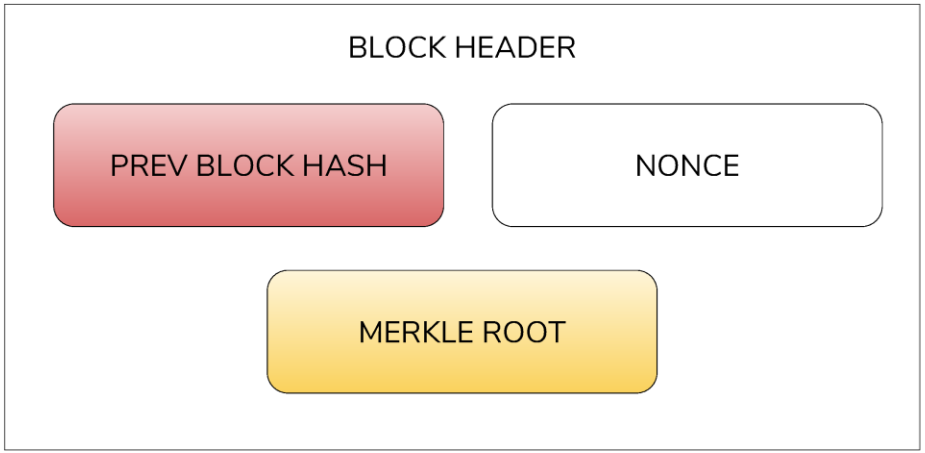


SHA256(SHA256(x))

```
prevBlockHash = H(prevBlockHash || merkleRoot || nonce)
```

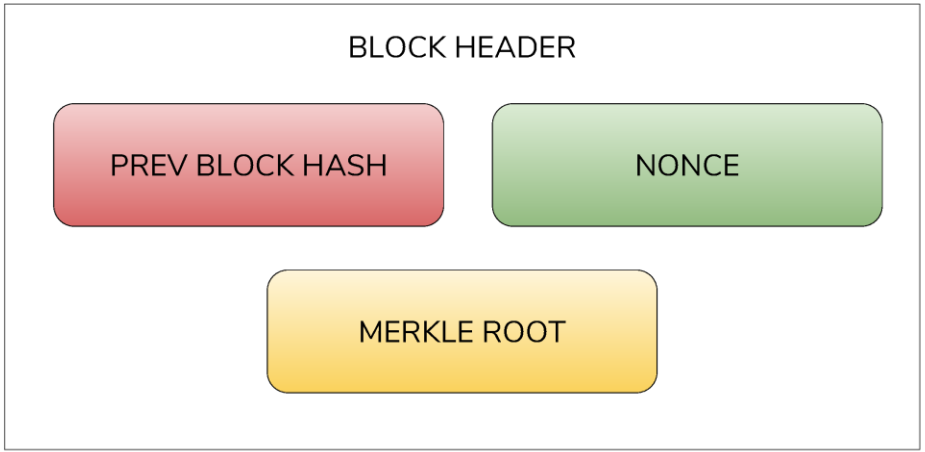
A TAMPER-EVIDENT DATABASE

PREV BLOCK HASH



A TAMPER-EVIDENT DATABASE

NONCE



A TAMPER-EVIDENT DATABASE

PARTIAL PREIMAGE HASH PUZZLE

Bitcoin's partial preimage hash puzzle: A problem with a requirement to find a nonce that satisfies the following inequality:

```
H(prevBlockHash || merkleRoot || nonce) < target
```

- Used to implement Proof-of-Work in Bitcoin (and every other PoW cryptocurrency)

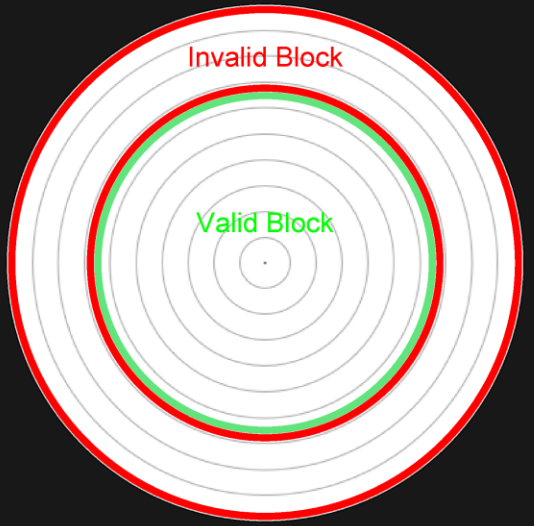
Hash puzzles need to be:

1. Computationally difficult.
2. Parameterizable.
3. Easily verifiable.

A TAMPER-EVIDENT DATABASE

MINING

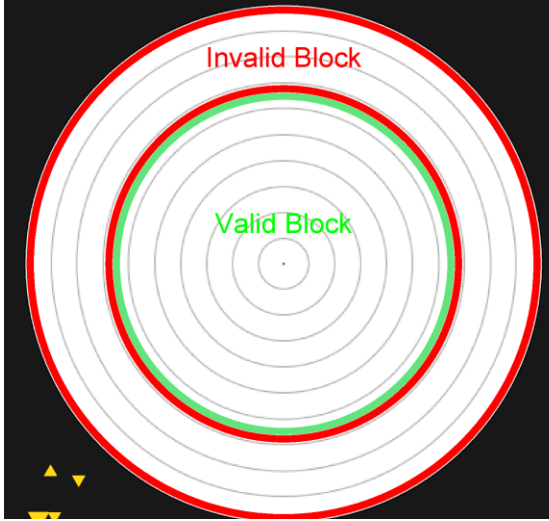
- **Mining** is like throwing darts at a target while blindfolded:
  - Equal likelihood of hitting any part of the target
  - Faster throwers ⇒ more hits / second
- Miners look for a hash below an algorithmically decided target




```
H(prevBlockHash || merkleRoot || nonce) < target
```

A TAMPER-EVIDENT DATABASE

BLOCK DIFFICULTY



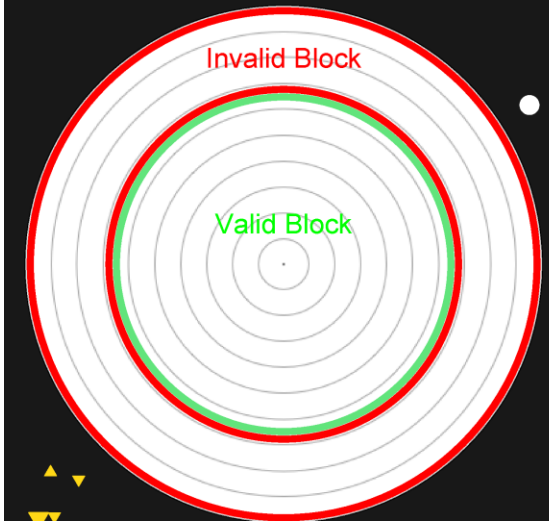
Difficulty: A representation of the expected number of computations required to find a block

- Implemented as requirement of leading number of 0s
- Adjusts with global hashrate
- `difficulty *= two_weeks / time_to_mine_prev_2016_blocks`
  - Technically every 2015 blocks

```
H(prevBlockHash || merkleRoot || nonce) < target
```

A TAMPER-EVIDENT DATABASE

BLOCK DIFFICULTY

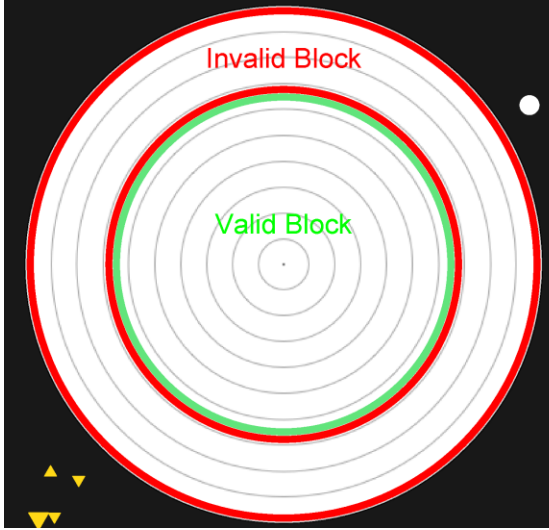


- **Sanity check** (difficulty = 10):
  - What is the new difficulty when `two_weeks = time_to_mine_prev_2016_blocks`?

```
difficulty *= two_weeks / time_to_mine_prev_2016_blocks
```

A TAMPER-EVIDENT DATABASE

BLOCK DIFFICULTY

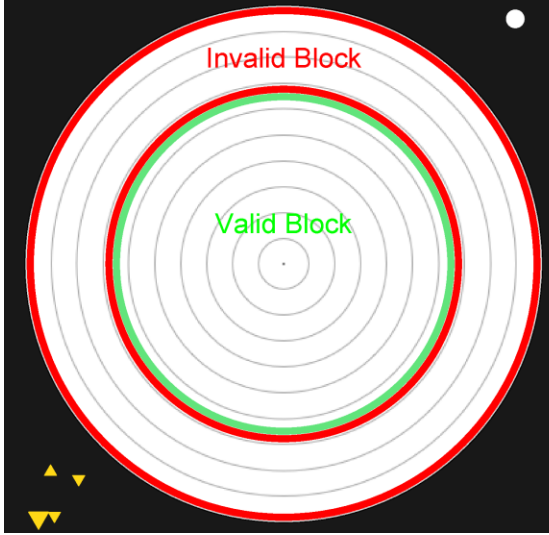


- **Sanity check** (difficulty = 10):
  - What is the new difficulty when `two_weeks = time_to_mine_prev_2016_blocks`?
    (Answer: 10. Difficulty stays the same!)

```
difficulty *= two_weeks / time_to_mine_prev_2016_blocks
```

A TAMPER-EVIDENT DATABASE

BLOCK DIFFICULTY

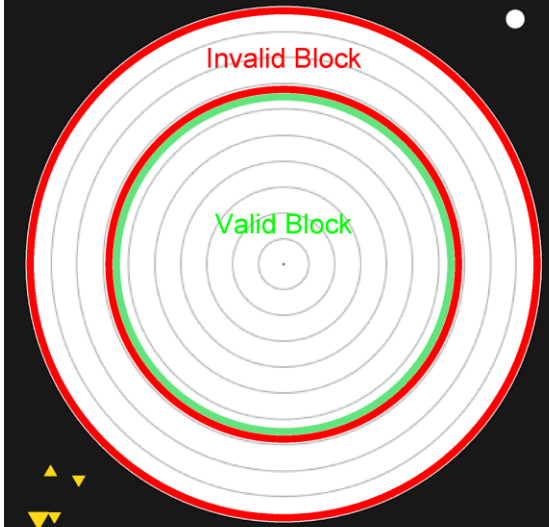


- **Sanity check** (difficulty = 10):
  - What does difficulty equal when:
    - `time_to_mine = one_week`?
    - `time_to_mine = four_weeks`?

```
difficulty *= two_weeks / time_to_mine_prev_2016_blocks
```

A TAMPER-EVIDENT DATABASE

BLOCK DIFFICULTY

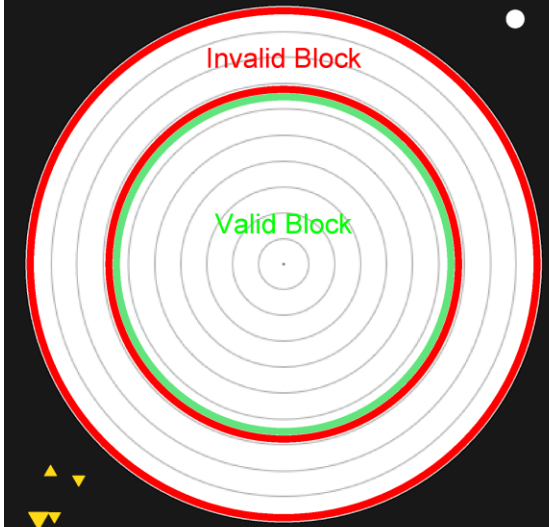


- **Sanity check** (difficulty = 10):
  - What does difficulty equal when:
    - `time_to_mine = one_week?`
      (Answer: 20)
    - `time_to_mine = four_weeks?`

```
difficulty *= two_weeks / time_to_mine_prev_2016_blocks
```

A TAMPER-EVIDENT DATABASE

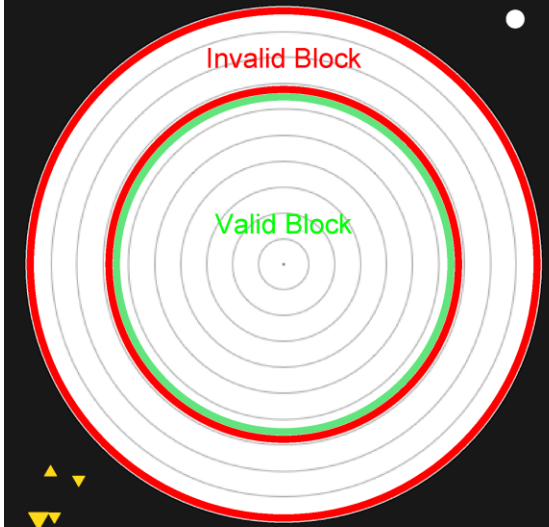
BLOCK DIFFICULTY



- **Sanity check** (difficulty = 10):
  - What does difficulty equal when:
    - `time_to_mine = one_week`?
      (Answer: 20)
    - `time_to_mine = four_weeks`?
      (Answer: 5)

A TAMPER-EVIDENT DATABASE

BLOCK DIFFICULTY



- **Sanity check** (difficulty = 10):
  - What does difficulty equal when:
    - `time_to_mine = one_week`?
      (Answer: 20)
    - `time_to_mine = four_weeks`?
      (Answer: 5)
  - Difficulty is inversely proportional to `time_to_mine`.)

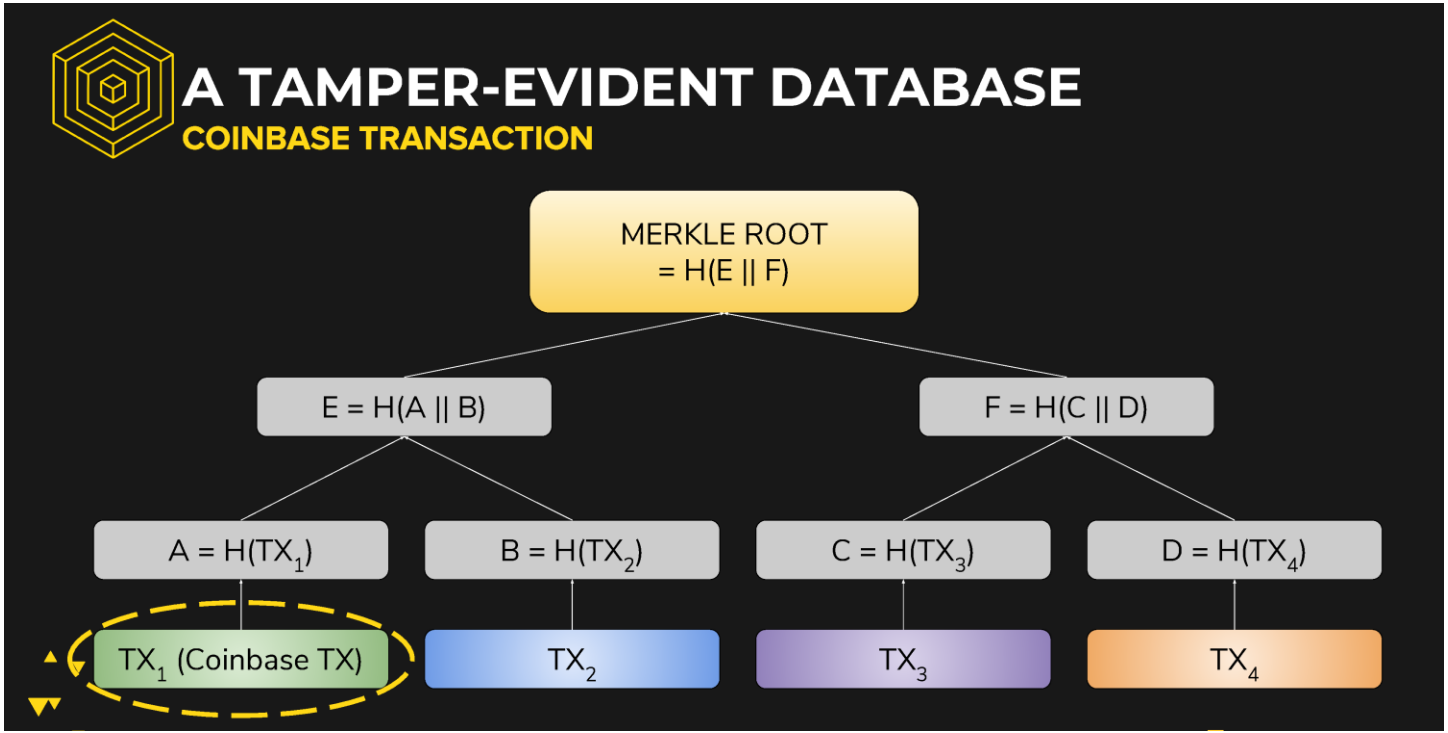
A TAMPER-EVIDENT DATABASE

MINING PSEUDOCODE

```
TARGET = (65535 << 208) / DIFFICULTY;
coinbase_nonce = 0;
while (1) {
      header = makeBlockHeader(transactions, coinbase_nonce);
      for (header_nonce = 0; header_nonce < (1 << 32); header_nonce++){
            if (SHA256(SHA256(makeBlock(header, header_nonce))) <
      TARGET)
                  break; //block found!
      }
      coinbase_nonce++;
}
```

Figure 5.6 : CPU mining pseudocode.

Source: (from Princeton Textbook, 5.2)


A TAMPER-EVIDENT DATABASE
COINBASE TRANSACTION
MERKLE ROOT
= H(E || F)
E = H(A || B)
F = H(C || D)
A = H(TX1)
B = H(TX2)
C = H(TX3)
D = H(TX4)
TX1 (Coinbase TX)
TX2
TX3
TX4

A TAMPER-EVIDENT DATABASE

EXAMPLE BLOCK

Block #485963

Summary	
Number Of Transactions	2055
Output Total	4,819.27194588 BTC
Estimated Transaction Volume	1,770.2727223 BTC
Transaction Fees	1.05055103 BTC
Height	485963 (Main Chain)
Timestamp	2017-09-19 02:11:37
Received Time	2017-09-19 02:11:37
Relayed By	BTC.TOP
Difficulty	1,103,400,932,964.29

Hashes	
Hash	00000000000000000013942c4215cd92306bbce769cfcb349d0b42f031c994eb
Previous Block	00000000000000000004a5b64638b5d96d367a6d4e0a435fd460f972f1fb8f56b
Next Block(s)	
Merkle Root	ddb4970913d63bcb0c32a6d26fb9e792f8cd332ddf9c830a23c3e191608ce51a

Sponsored Link

3

SIGS, ECDSA, AND ADDRESSES

DIGITAL SIGNATURE SCHEMES (DSS)

EXAMPLE

private key:

public key:

message:

Alice uses ECDSA to generate private and public keys

DIGITAL SIGNATURE SCHEMES (DSS)

EXAMPLE

DIGITAL SIGNATURE SCHEMES (DSS)

EXAMPLE

DIGITAL SIGNATURE SCHEMES (DSS)

EXAMPLE

DIGITAL SIGNATURE SCHEMES (DSS)

EXAMPLE

ALICE

BOB

private key: 

public key: 

message: 

signature: 

Bob can easily verify if Alice signed

DIGITAL SIGNATURE SCHEMES (DSS)

EXAMPLE

ALICE

BOB

private key: 

public key: 

message: 

signature: 

Bob cannot easily guess
Alice's private key

DIGITAL SIGNATURE SCHEMES (DSS)

EXAMPLE

ALICE

EVE

BOB

private key: 

public key: 

message: 

signature: 

private key + message = signature

public key + signature = message

DIGITAL SIGNATURE SCHEMES (DSS)

EXAMPLE

ALICE

private key:

public key:

message:

signature:

EVE

private key:

public key:

private key + message = signature

BOB

public key + signature = BAD

DIGITAL SIGNATURE SCHEMES (DSS)

DSS SECURITY DEFINITION

Recipients given the (message, signature) pair should be able to verify:

- **Message Origin**: original sender (owner of private key) has authorized this message/transaction
- **Non-repudiation**: original sender (owner of private key) cannot backtrack
- **Message Integrity**: message cannot have been modified since sending

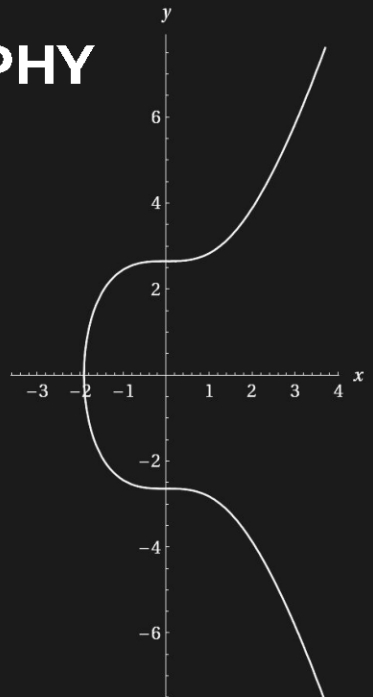
ELLIPTIC CURVE CRYPTOGRAPHY

PART 1: ELLIPTIC CURVE

- Bitcoin uses **ECDSA** (Elliptic Curve Digital Signature Algorithm) to produce private and public keys
- The Elliptic Curve is defined by some mathematical function
  - **Bitcoin's Elliptic Curve**:

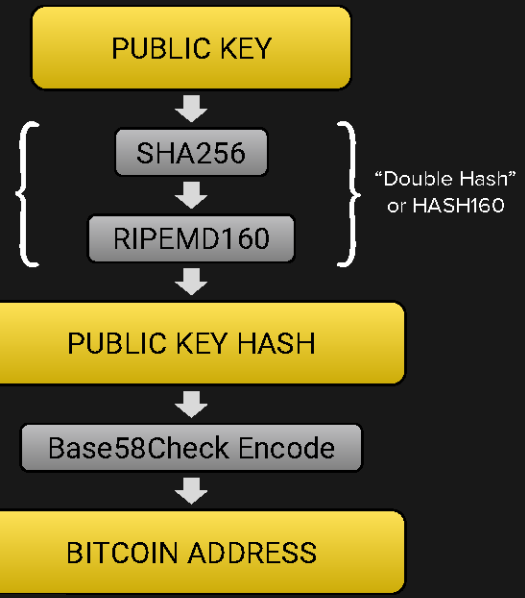
    secp256k1 : $Y^2 = (X^3 + 7)$ over $(\mathbf{F}_p)$
- For cryptographic purposes, we use elliptic curves over a **finite field** (for key size)

Trapdoor function – difficult to invert



PUBLIC KEY TO BITCOIN ADDRESS

PUBLIC KEY TO PUBKEYHASH



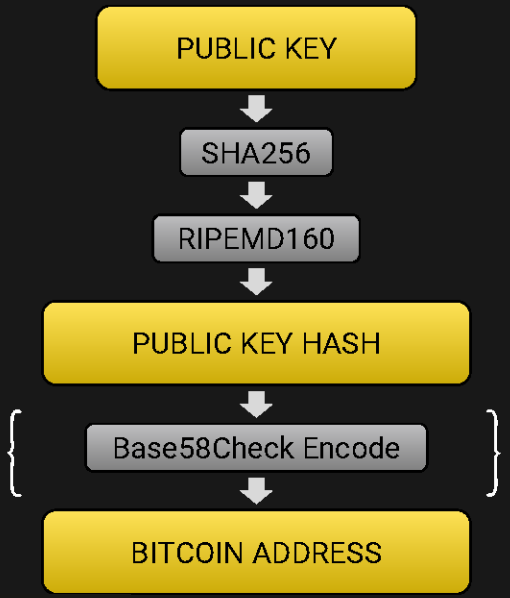
`PUBKEYHASH = RIPEMD160(SHA256(K))`

- SHA-256 (Secure Hashing Algorithm)
  - Used extensively in bitcoin scripts and mining
- RIPEMD (RACE Integrity Primitives Evaluation Message Digest)
  - Produces 160-bit (20-byte) number

The name of the game is TAMPER EVIDENT

PUBLIC KEY TO BITCOIN ADDRESS

PUBLIC KEY HASH TO ADDRESS



- Bitcoin Addresses are Base58Check Encoded
  - Base-58 alphabet:
    123456789ABCDEFGHJKLMNPQRSTUVW
    XYZabcdefghijkmnopqrstuvwxyz
  - 58 characters (omits 0, O, I, l)

- prefix: “version byte” based on type of data
  - makes it easy for people to read address
- checksum: 4-byte error-checking code
  appended to the end of an address
  - `checksum = SHA256(SHA256(prefix + data)`, first 4 bytes

4 BITCOIN SCRIPT

BITCOIN SCRIPTS

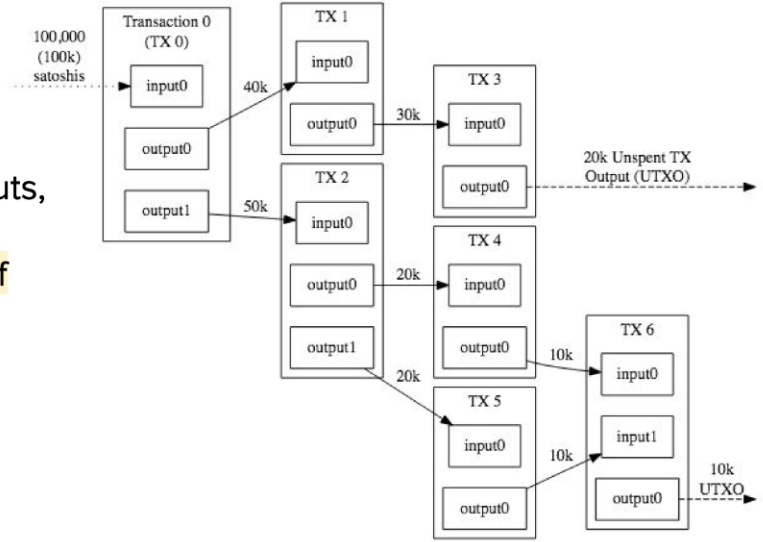
REMEMBER THE UTXO MODEL?

Reminders:

- Bitcoin uses a UTXO model
- Transactions map inputs to outputs,

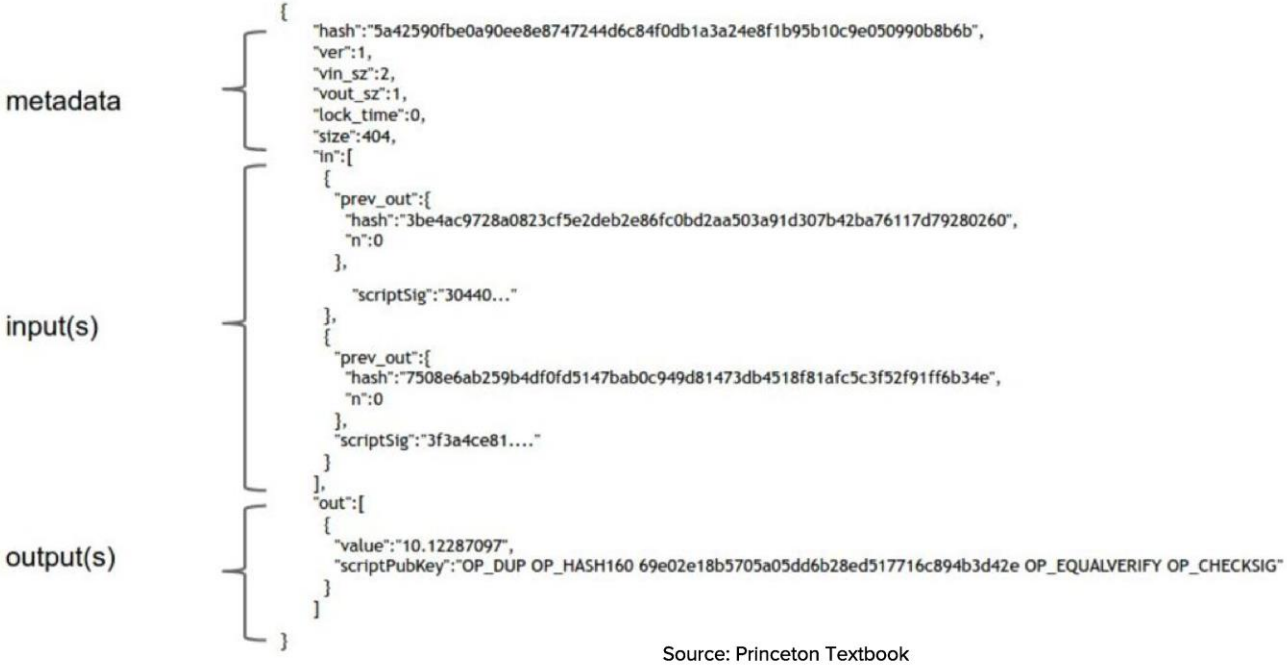
- Transactions contain signature of owner of funds
- Spending Bitcoin is **redeeming** previous transaction outputs

Source: Bitcoin Developer Guide



Triple-Entry Bookkeeping (Transaction-To-Transaction Payments) As Used By Bitcoin

CONTENTS OF A TRANSACTION



Source: Princeton Textbook

CONTENTS OF A TRANSACTION - METADATA


```
{
  “hash”: “5a42590fbe0a90ee8e8747244d6c84f0db1a3a24e8f1b95b10c9e050990b8b6b”,
  “ver”: 1,
  “vin_sz”: 2,
  “vout_sz”: 1,
  “lock_time”: 0,
  “size”: 404,
  “in”: [
      {
          “prev_out”: {
              “hash”: “3be4ac9728a0823cf5e2deb2e86fc0bd2aa503a91d307b42ba76117d79280260”,
              “n”: 0
          },
              “scriptSig”: “30440…”
      },
      {
          “prev_out”: {
              “hash”: “7508e6ab259b4df0fd5147bab0c949d81473db4518f8afc5c3f52f91ff6b34e”,
              “n”: 0
          },
          “scriptSig”: “3f3a4ce81….”
      }
  ],
  “out”: [
      {
          “value”: 10.12287097”,
          “scriptPubKey”: “OP_DUP OP_HASH160 69e02e18b5705a05dd6b28ed517716c894b3d42e OP_EQUALVERIFY OP_CHECKSIG”
      }
  ]
}
```


hash or “ID”
of this transaction

CONTENTS OF A TRANSACTION - METADATA


```
{
  “hash”: “5a42590fbe0a90ee8e8747244d6c84f0db1a3a24e8f1b95b10c9e050990b8b6b”,
  “ver”: 1,
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      }
  ]
}
```


size (number) of inputs

size (number) of outputs

hash or “ID” of this transaction

CONTENTS OF A TRANSACTION - METADATA


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    }
  ]
}
```


version

size (number) of inputs

size (number) of outputs

lock time (useful for scripting)

size of transaction

hash or "ID" of this transaction

CONTENTS OF A TRANSACTION - INPUTS

{
"hash": "5a42590fbe0a90ee8e8747244d6c84f0db1a3a24e8f1b95b10c9e050990b8b6b",
"ver": 1,
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}

remember these?

CONTENTS OF A TRANSACTION - INPUTS

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}

remember these?

input 1:

input 2:

ID of previous transactions being referenced

CONTENTS OF A TRANSACTION - INPUTS

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}

index of input in previous transaction

input 1:

ID of previous transactions being referenced

index of input in previous transaction

input 2:

CONTENTS OF A TRANSACTION - INPUTS

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"scriptPubKey": "OP_DUP OP_HASH160 69e02e18b5705a05dd6b28ed517716c894b3d42e OP_EQUALVERIFY OP_CHECKSIG"

index of input in previous transaction

input 1: signature used to redeem previous transaction output

index of input in previous transaction

input 2: signature used to redeem previous transaction output

CONTENTS OF A TRANSACTION - OUTPUTS


```
{
    “hash”: “5a42590fbe0a90ee8e8747244d6c84f0db1a3a24e8f1b95b10c9e050990b8b6b”,
    “ver”: 1,
    “vin_sz”: 2,
    “vout_sz”: 1,
    “lock_time”: 0,
    “size”: 404,
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        {
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            “scriptPubKey”: “OP_DUP OP_HASH160 69e02e18b5705a05dd6b28ed517716c894b3d42e OP_EQUALVERIFY OP_CHECKSIG”
        }
    ]
}
```


output amount (how much BTC is being sent)

type of script

output script

BITCOIN SCRIPTS

REMINDERS

Output “addresses” are actually scripts.

“scriptPubKey”: “OP_DUP OP_HASH160 69e02e18b5705a05dd6b28ed517716c894b3d42e OP_EQUALVERIFY OP_CHECKSIG”

➔ This particular Output Script: “This amount can be redeemed by the **public key** that hashes to address X, plus a **signature** from the owner of that public key”

- Inputs and outputs through scripting allows for future extensibility of Bitcoin.
- **Script or “Bitcoin Scripting Language”**: Language built specifically for Bitcoin
  - Stack based
  - Native support for cryptography
  - Simple, not turing complete (no loops)

BITCOIN SCRIPTS

P2PKH EXAMPLE

"scriptPubKey": "OP_DUP OP_HASH160 69e02e18b5705a05dd6b28ed517716c894b3d42e OP_EQUALVERIFY OP_CHECKSIG"

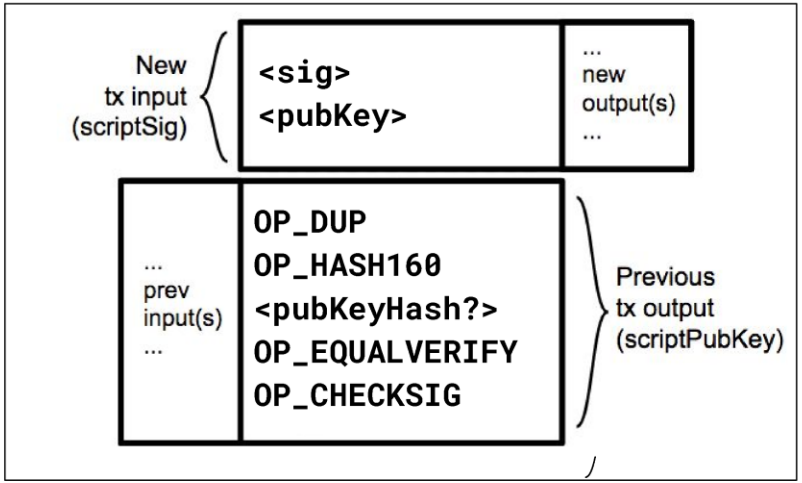


Figure: Two transactions along with their input and output scripts

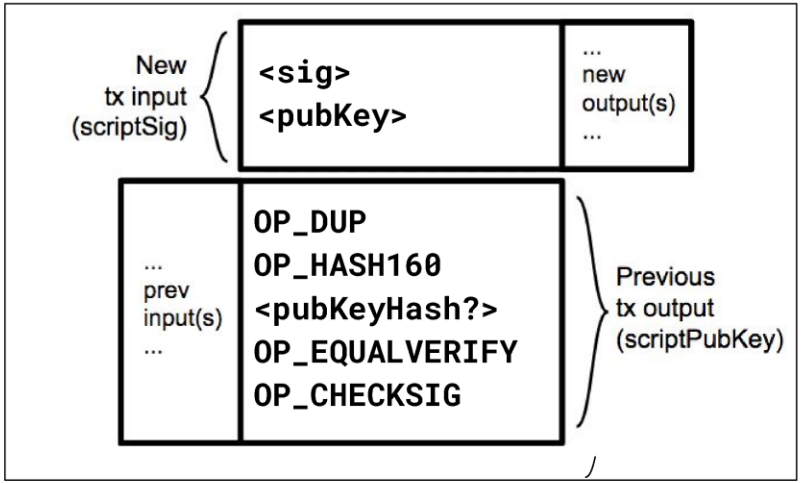
Source: Princeton textbook

- **locking script:** found in previous transaction output, specifies requirements for redeeming transaction
- **unlocking script (scriptSig):** found in transaction input, redeems the output of a previous transaction
- bitcoin validating node will execute the locking and unlocking scripts in sequence

BITCOIN SCRIPTS

P2PKH EXAMPLE

“scriptPubKey”: “OP_DUP OP_HASH160 69e02e18b5705a05dd6b28ed517716c894b3d42e OP_EQUALVERIFY OP_CHECKSIG”



Code Execution

“scriptPubKey”: “

OP_DUP

OP_HASH160

69e02e18b5705a05dd6b28ed5

17716c894b3d42e

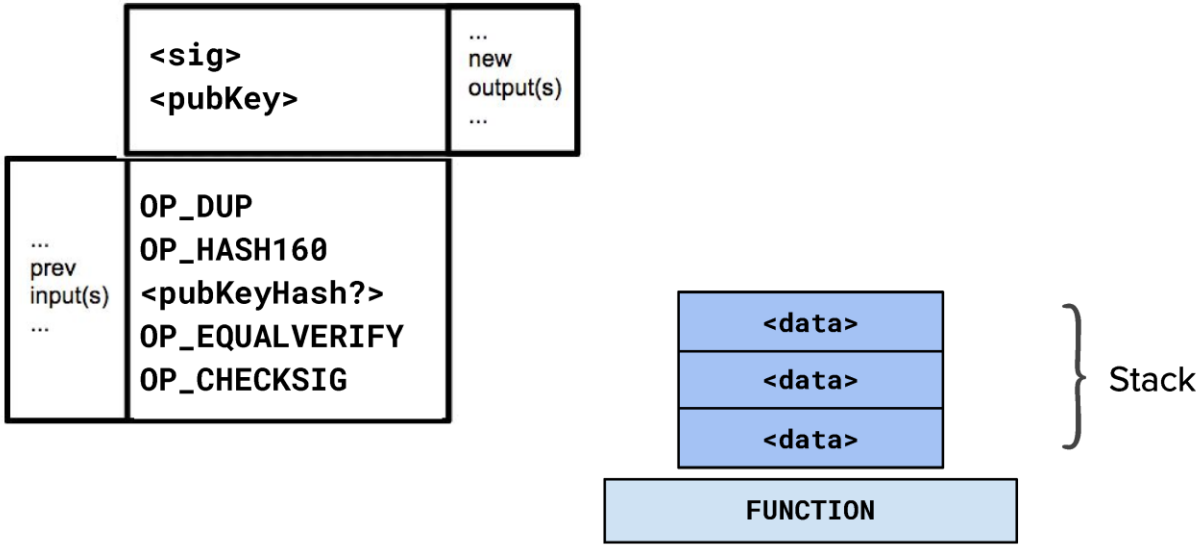
OP_EQUALVERIFY

OP_CHECKSIG”

Figure: Two transactions along with their input and output scripts

BITCOIN SCRIPTS

P2PKH EXAMPLE EXECUTION



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BITCOIN SCRIPTS

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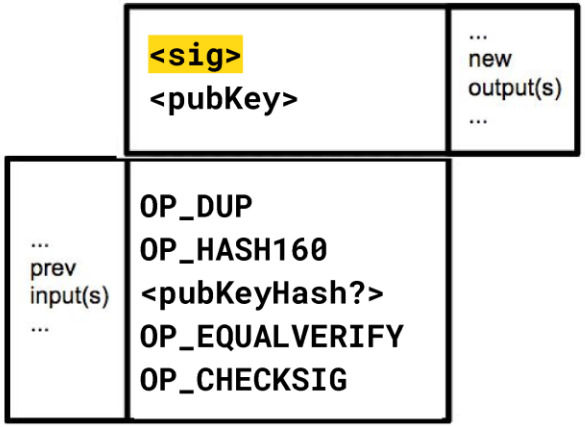

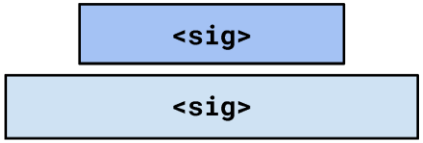

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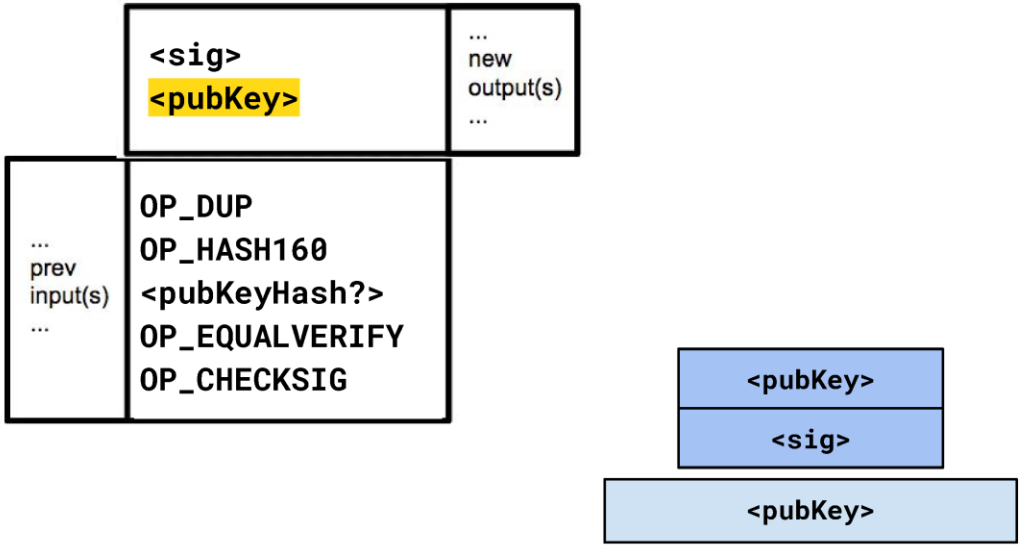
BITCOIN SCRIPTS

P2PKH EXAMPLE EXECUTION



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BITCOIN SCRIPTS

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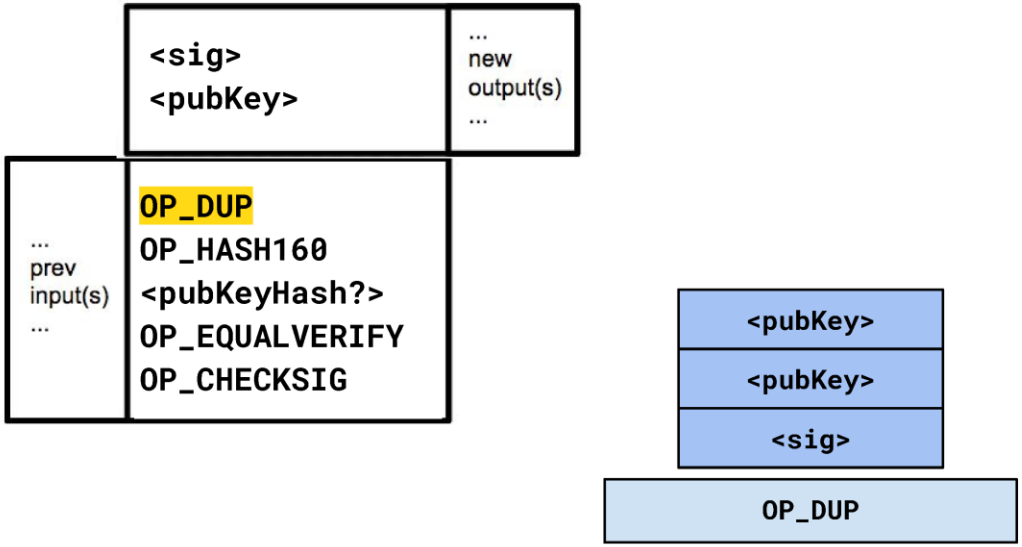

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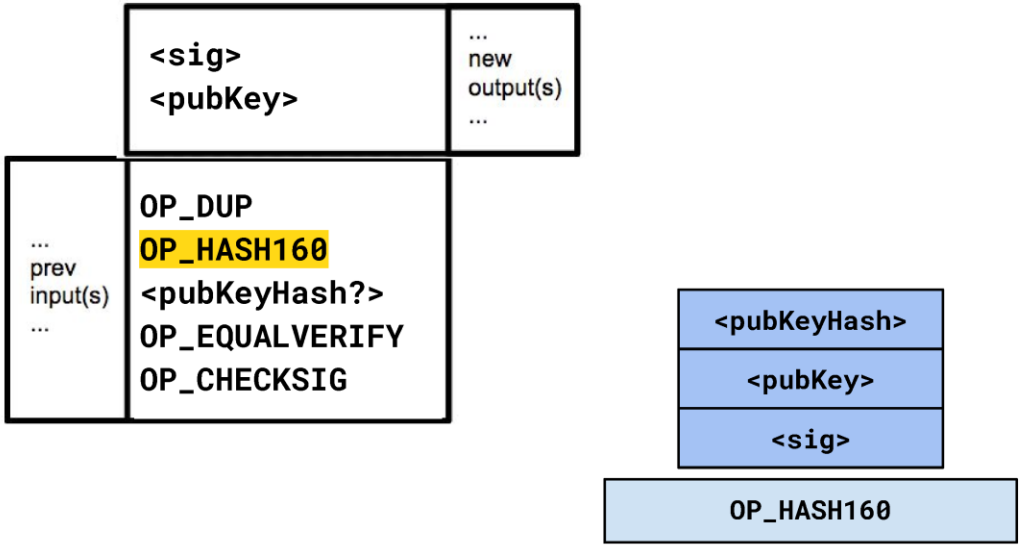
BITCOIN SCRIPTS

P2PKH EXAMPLE EXECUTION



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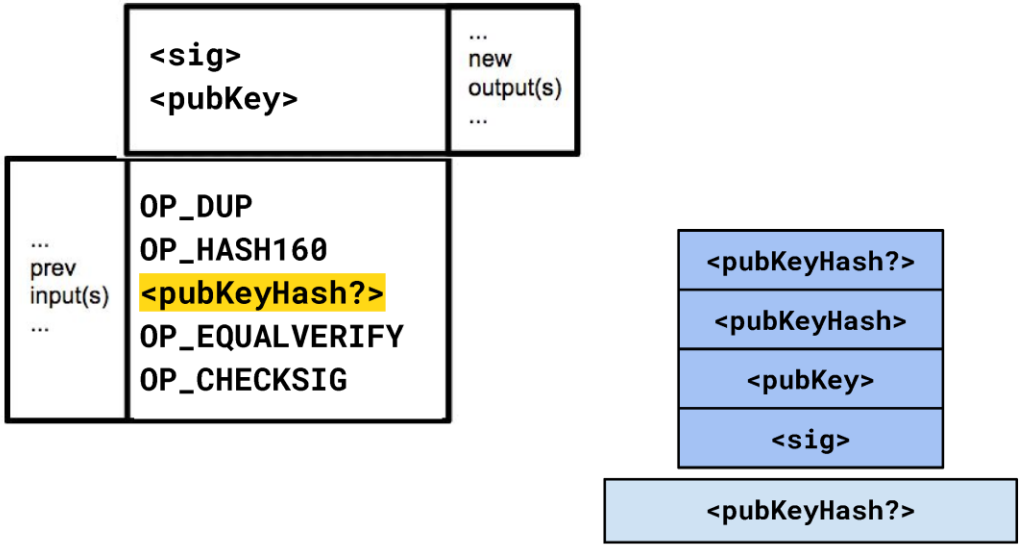
BITCOIN SCRIPTS

P2PKH EXAMPLE EXECUTION



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BITCOIN SCRIPTS

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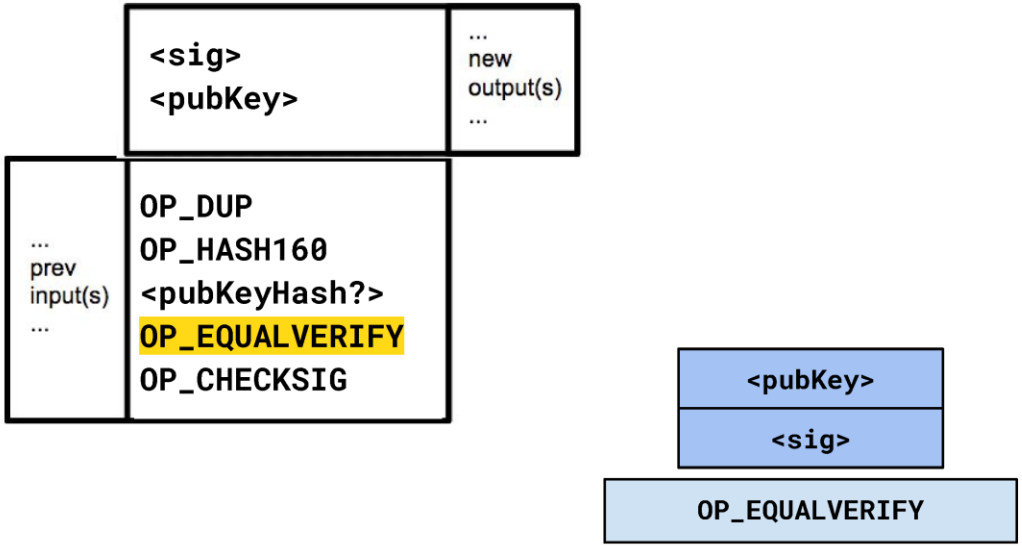

Source: Princeton textbook

BITCOIN SCRIPTS

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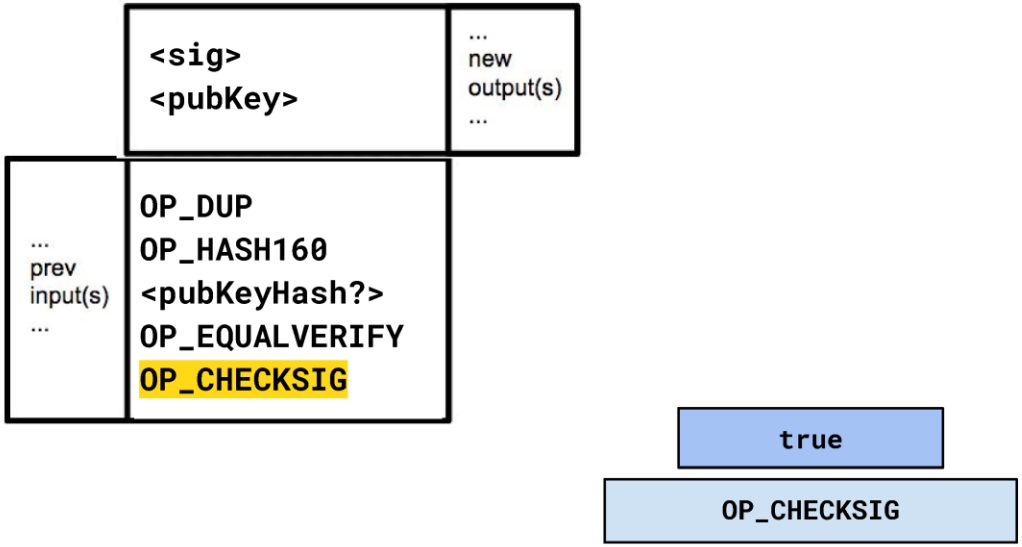
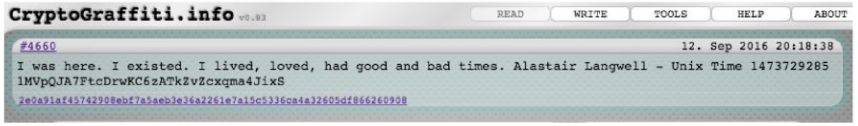


Source: Princeton textbook

EXTRA: BITCOIN SCRIPTS

PROOF OF BURN



Output script:

OP_RETURN

<arbitrary data>

How to write arbitrary data into the Bitcoin blockchain?

Proof of Burn

- OP_RETURN throws an error if reached
- Output script can't be spent - you prove that you destroyed some currency
- Anything after OP_RETURN is not processed, so arbitrary data can be entered

Use cases

- Prove existence of something at a particular point in time
  - Ex. A word you coined, hash of a document/music/creative works
- Bootstrap CalCoin by requiring that you destroy some Bitcoin to get CalCoin

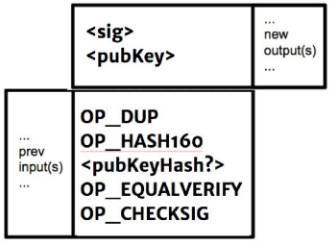
5

P2PKH & P2SH

P2PKH VS P2SH

WHO SPECIFIES THE SCRIPT?

- In Bitcoin, senders specify a locking script, recipients provide an unlocking script
- **Pay-to-Pub-Key-Hash (P2PKH):** Vendor (recipient of transaction) says “Send your coins to the hash of this Public Key.”
  - Simplest case
  - By far the most common case
- **Pay-to-Script-Hash (P2SH):** Vendor says “Send your coins to the hash of this Script; I will provide the script and the data to make the script evaluate to true when I redeem the coins.”
  - A vendor cannot say, “To pay me, write a complicated output script that will allow me to spend using multiple signatures.”



Simple P2PKH script - recipient only has to provide signature and public key

P2PKH VS P2SH

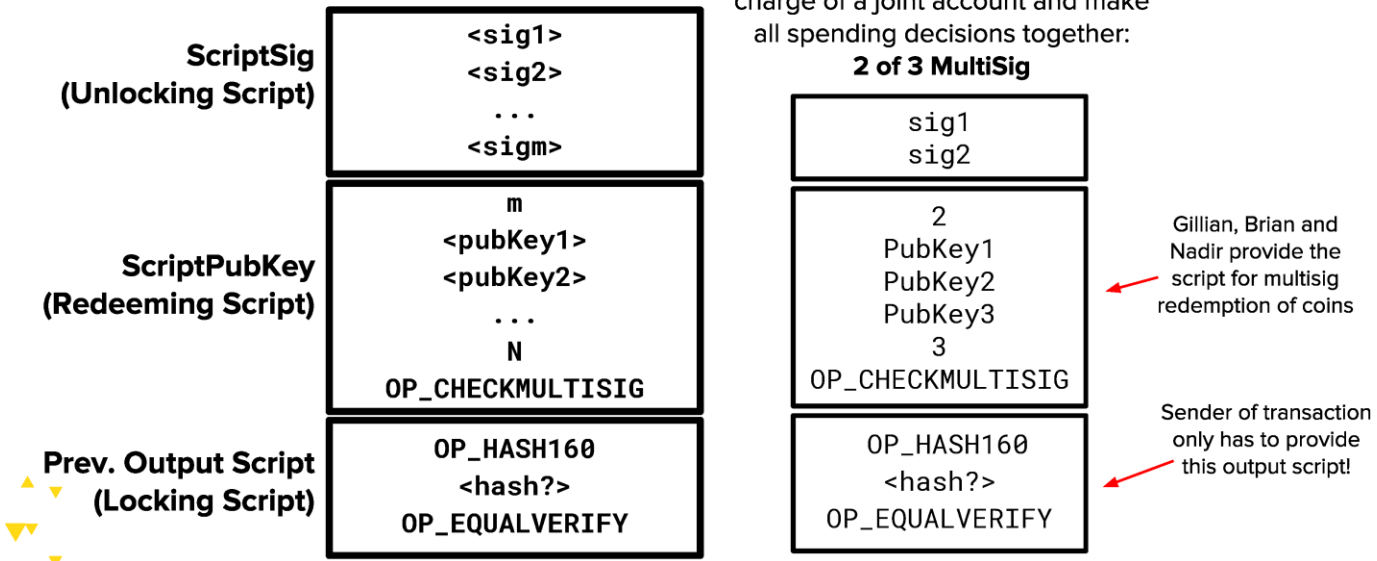
WHY P2SH?

Why Pay-to-Script-Hash?

- Offloads complicated script writing to recipients
- Makes more sense from a payer-payee standpoint
  - Merchant (rather than customer) is responsible for writing correct and secure script
  - Customer doesn't care what the script actually is
- P2SH is the most important improvement to Bitcoin since inception
- Example: **MultiSig**
  - *M* of *N* specified signatures can redeem and spend the output of this transaction

P2PKH VS P2SH

MULTISIG EXAMPLE



Demo

- https://anders.com/blockchain/public-private-keys/keys.html

Next class – Bitcoin Mechanics

Recommended Readings:

- Public / Private Keys & Signing Demo: https://www.youtube.com/watch?v=xIDL_akeras

References

Slides mainly adopted from

- Blockchain @ Berkeley : https://blockchain.berkeley.edu/
- Blockchain @ Princeton : http://bitcoinbook.cs.princeton.edu/