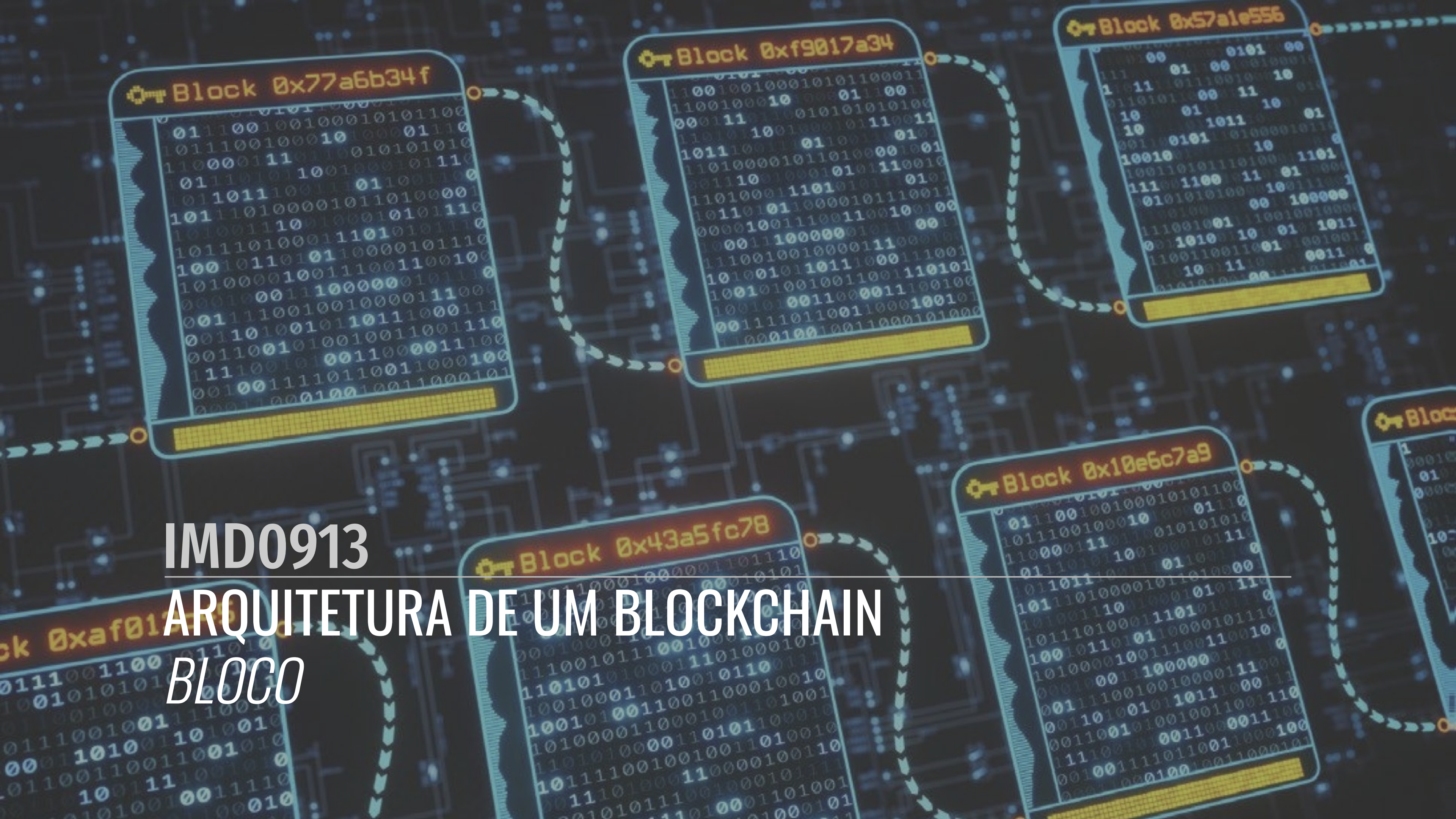
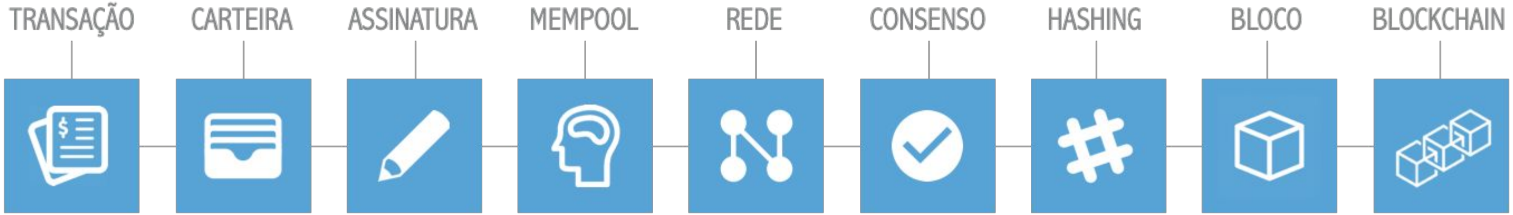


IMD0913

ARQUITETURA DE UM BLOCKCHAIN

BLOCO

Arquitetura de um Blockchain



TRANSAÇÃO

CARTEIRA

ASSINATURA

MEMPOOL

REDE

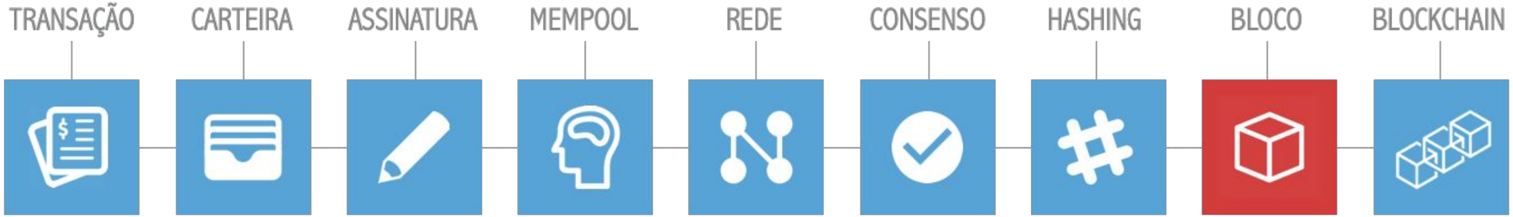
CONSENSO

HASHING

BLOCO

BLOCKCHAIN

Arquitetura de um Blockchain



TRANSAÇÃO

CARTEIRA

ASSINATURA

MEMPOOL

REDE

CONSENSO

HASHING

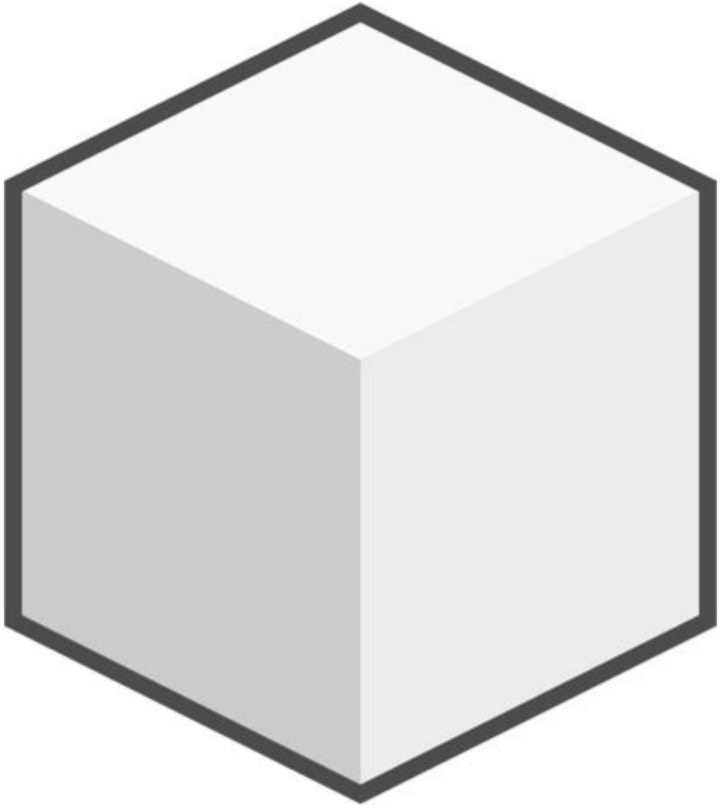
BLOCO

BLOCKCHAIN

Bloco

Componente elementar do *blockchain*

Segmentação do *blockchain* em unidades mais elementares



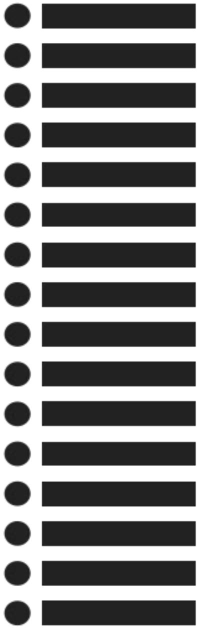
Bloco

Um *container* que armazena uma lista de transações para serem adicionadas ao *blockchain*.

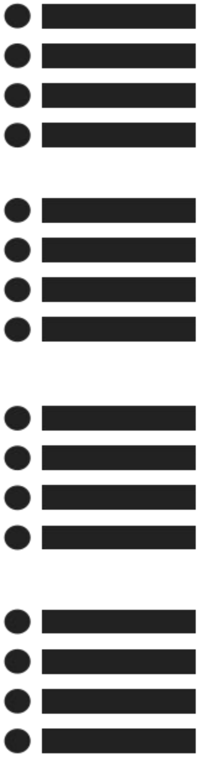
Blockchain

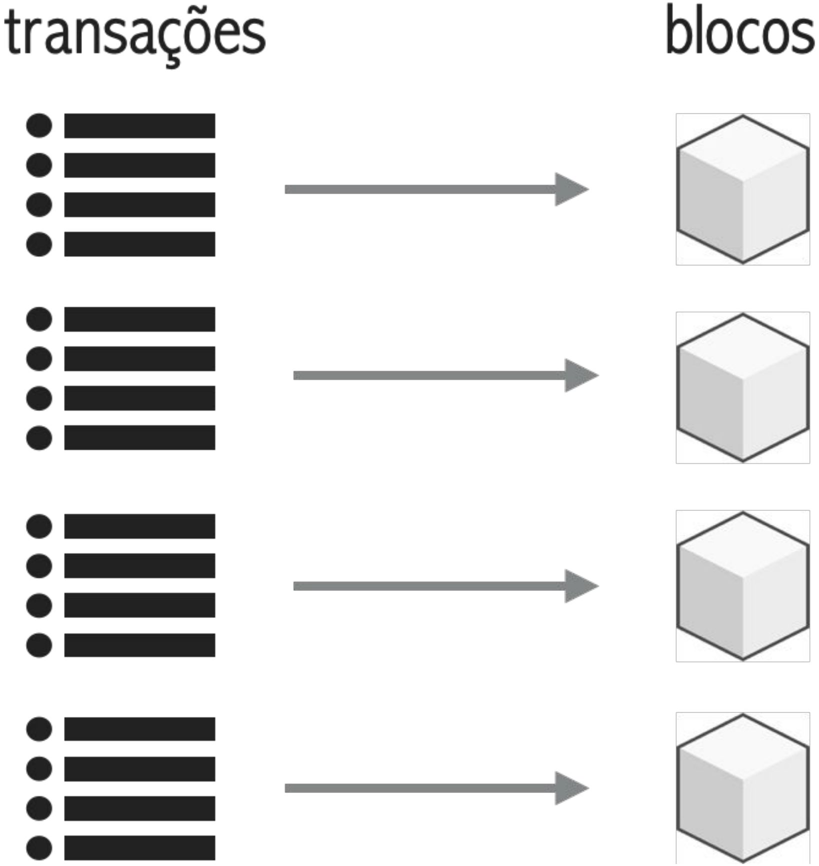
Um livro-razão digital e compartilhado que registra uma lista de transações no formato de uma sequência de blocos.

transações

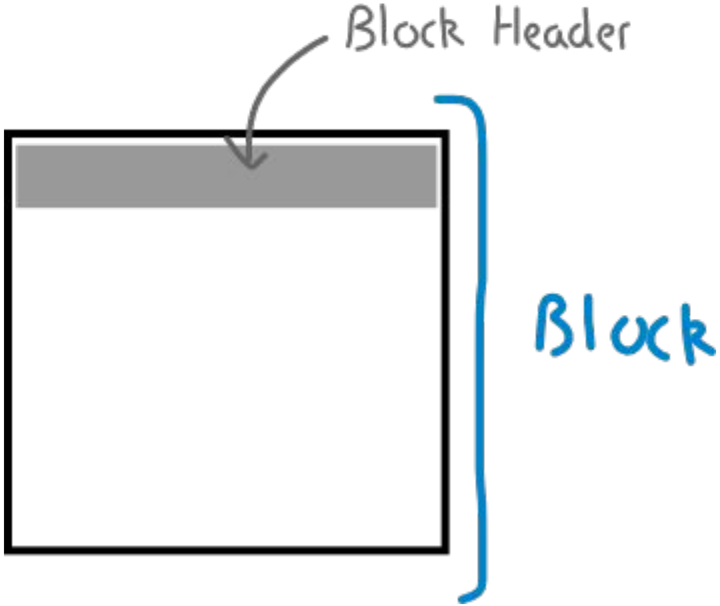


transações




transações
blocos

Cabeçalho (*header*) de um bloco



Cabeçalho (*header*) de um bloco

O **número de versão** do bloco

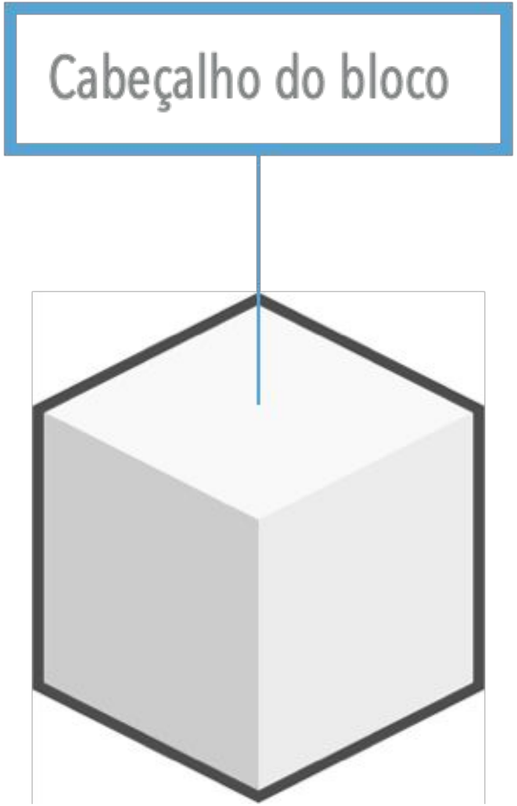
O ***hash* do bloco anterior** (*prevBlockHash*) na cadeia

Um código gerado pelos dados transacionais (***merkle root***)

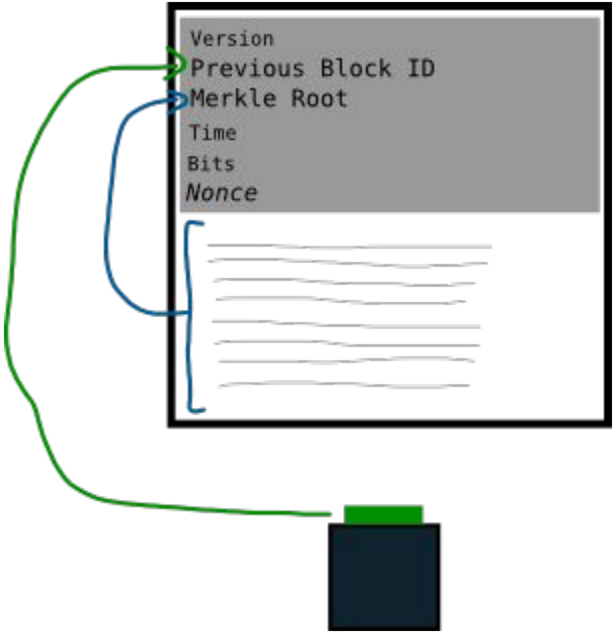
Um ***timestamp*** de quando o bloco foi criado

O alvo de **dificuldade** do bloco (*bits*)

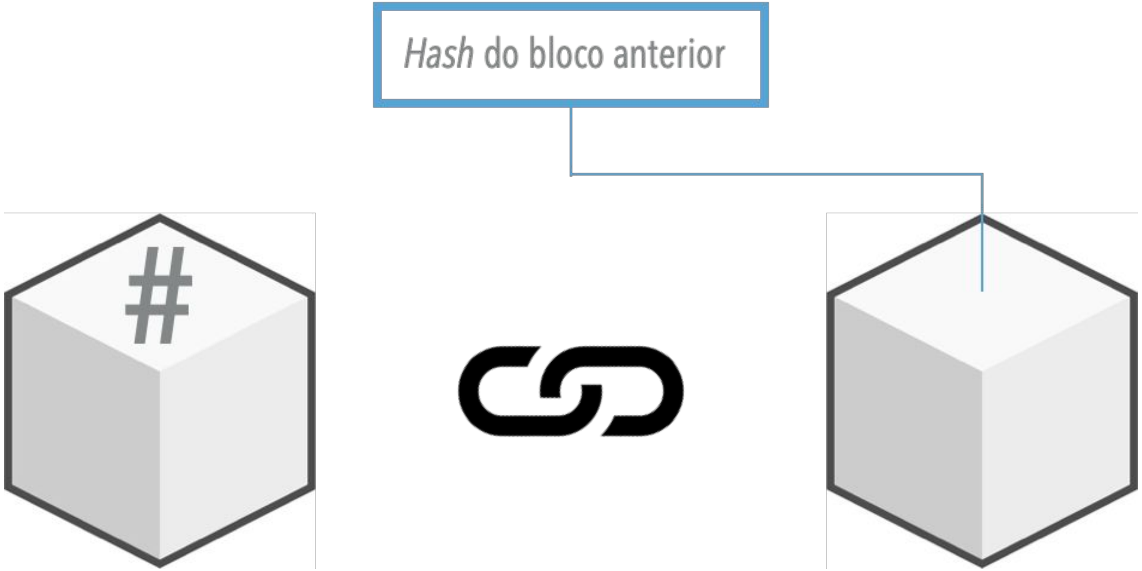
Um valor aleatório chamado ***nonce***



Cabeçalho (*header*) de um bloco

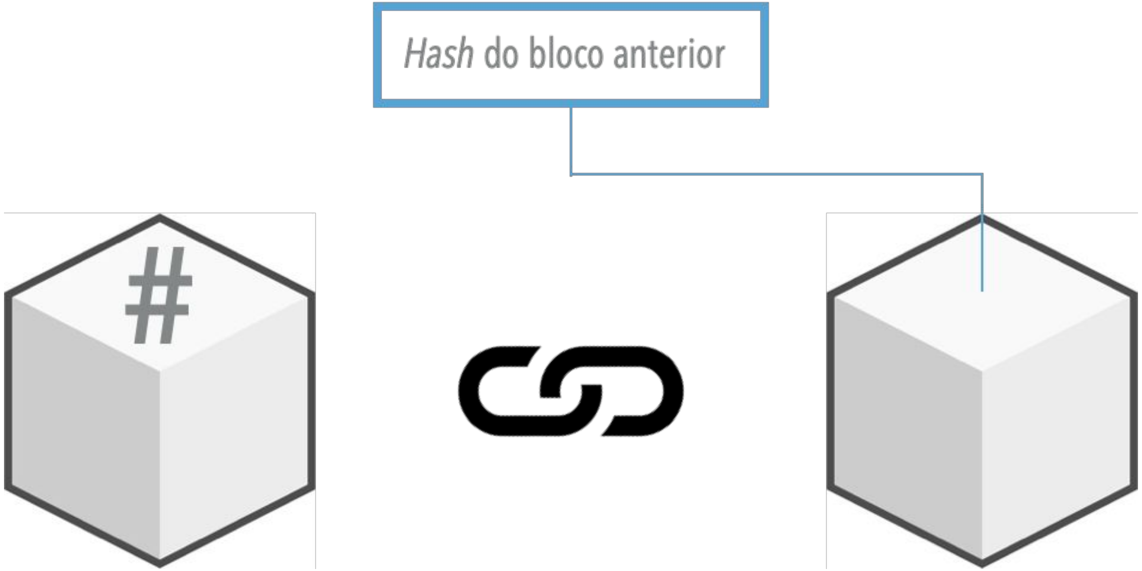


Cabeçalho (*header*) de um bloco



```
blockID = H(blockHeader) = H(prevBlockHash || merkleRoot || time || nonce || …)
```

Cabeçalho (*header*) de um bloco

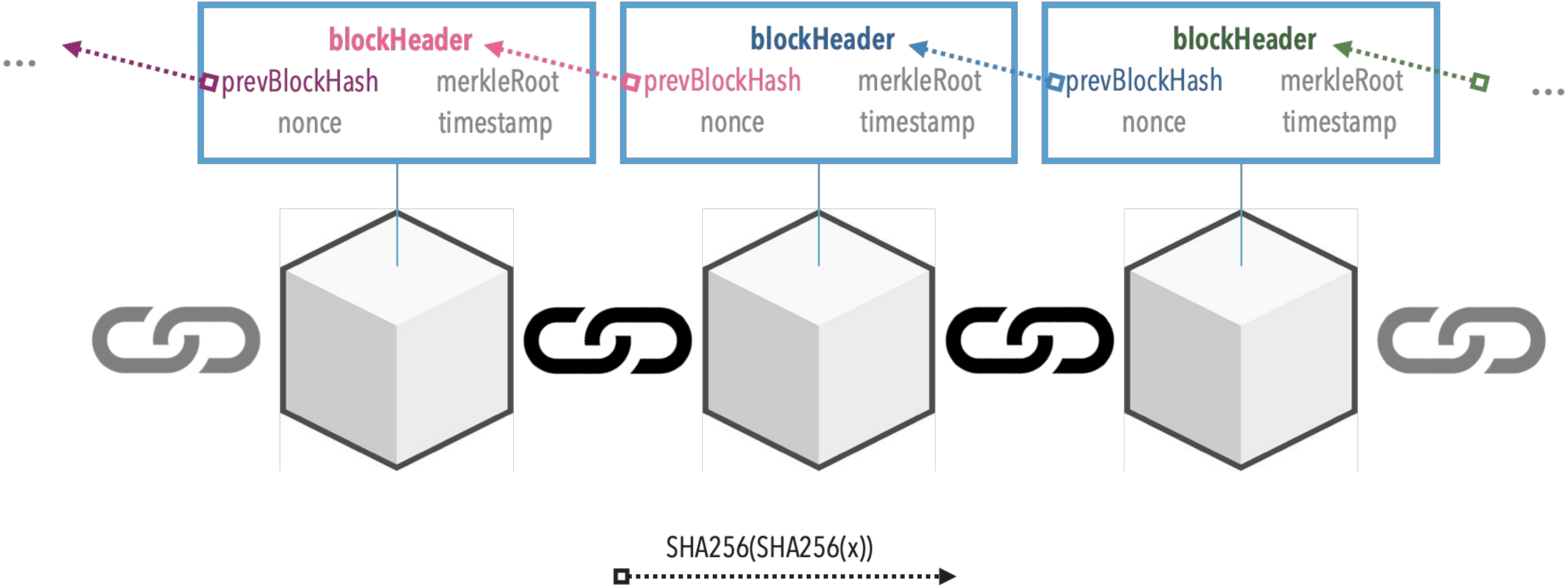


Bloco 123.456 do Bitcoin:

bytes do cabeçalho do bloco!

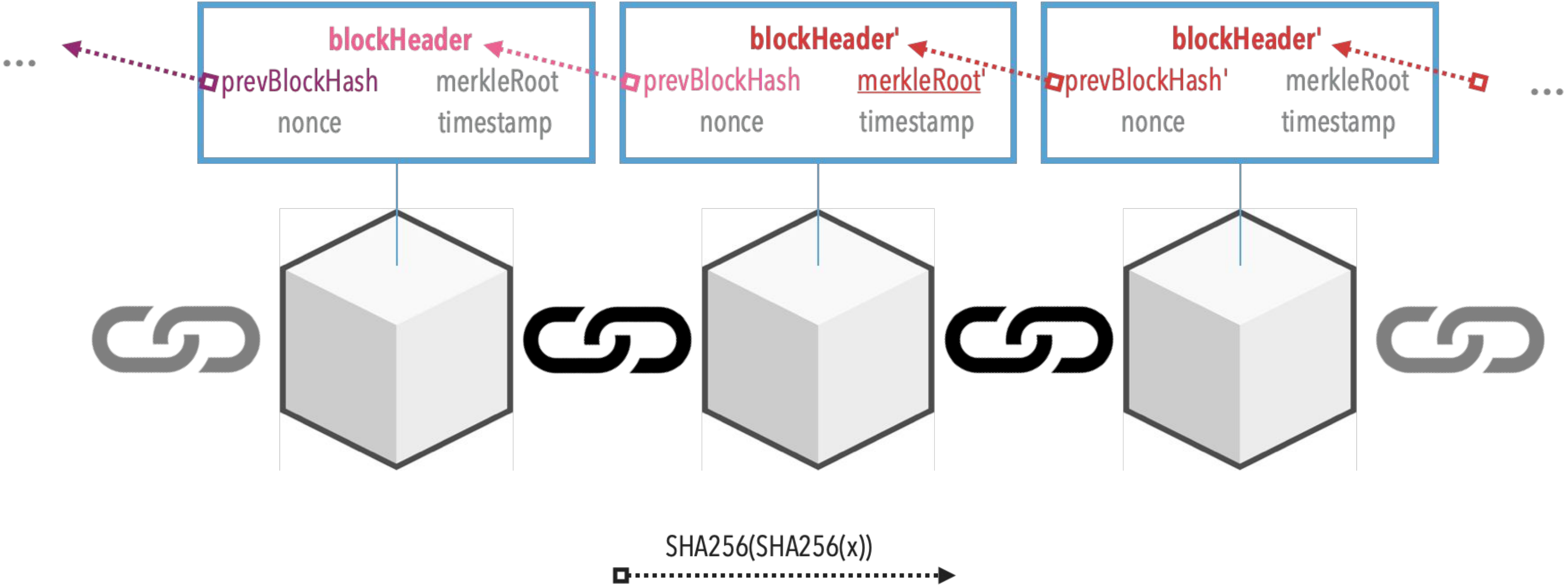
```
blockID = SHA256(SHA256( 010000009500c43a25c624520b5100adf82cb9f9da72fd2447a496bc600b0000000000006cd86237
                         0395dedf1da2841ccda0fc489e3039de5f1ccddef0e834991a65600ea6c8cb4db3936a1ae3143991 ))
=
00000000000002917ED80650C6174AAC8DFC46F5FE36480AAEF682FF6CD83C3CA
```

Cabeçalho (*header*) de um bloco



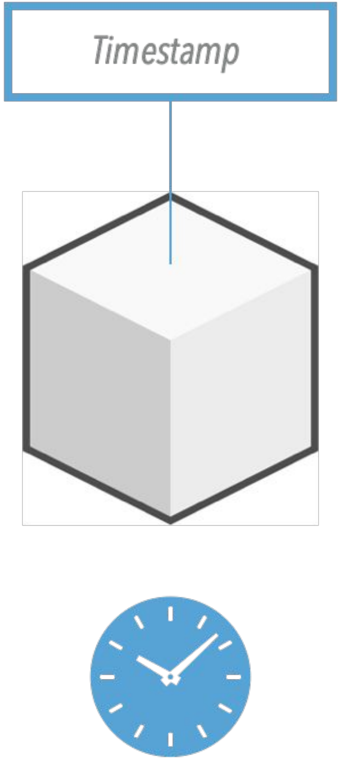
`prevBlockHash = H(prevBlockHash || merkleRoot || time || nonce)`

Cabeçalho (*header*) de um bloco

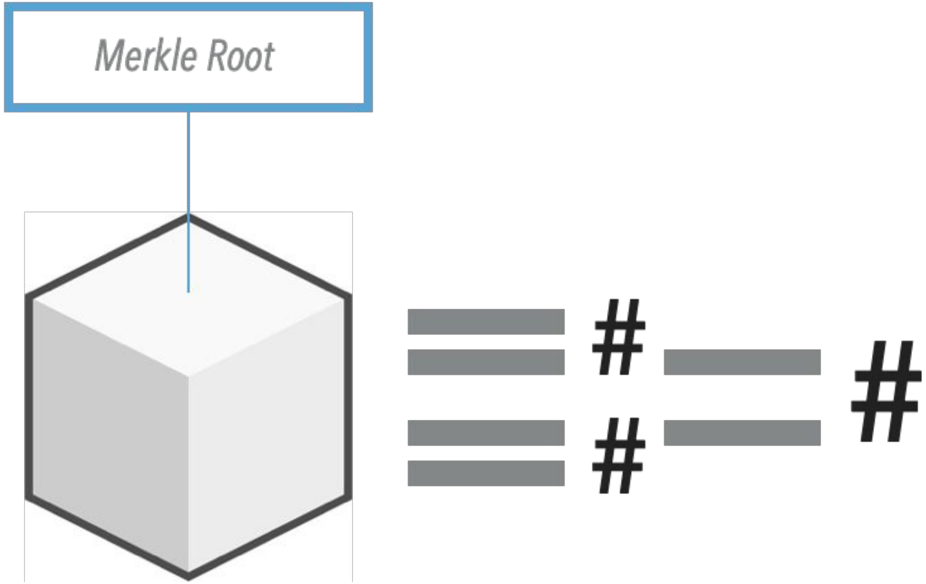


```
prevBlockHash = H(prevBlockHash || merkleRoot || time || nonce)
```

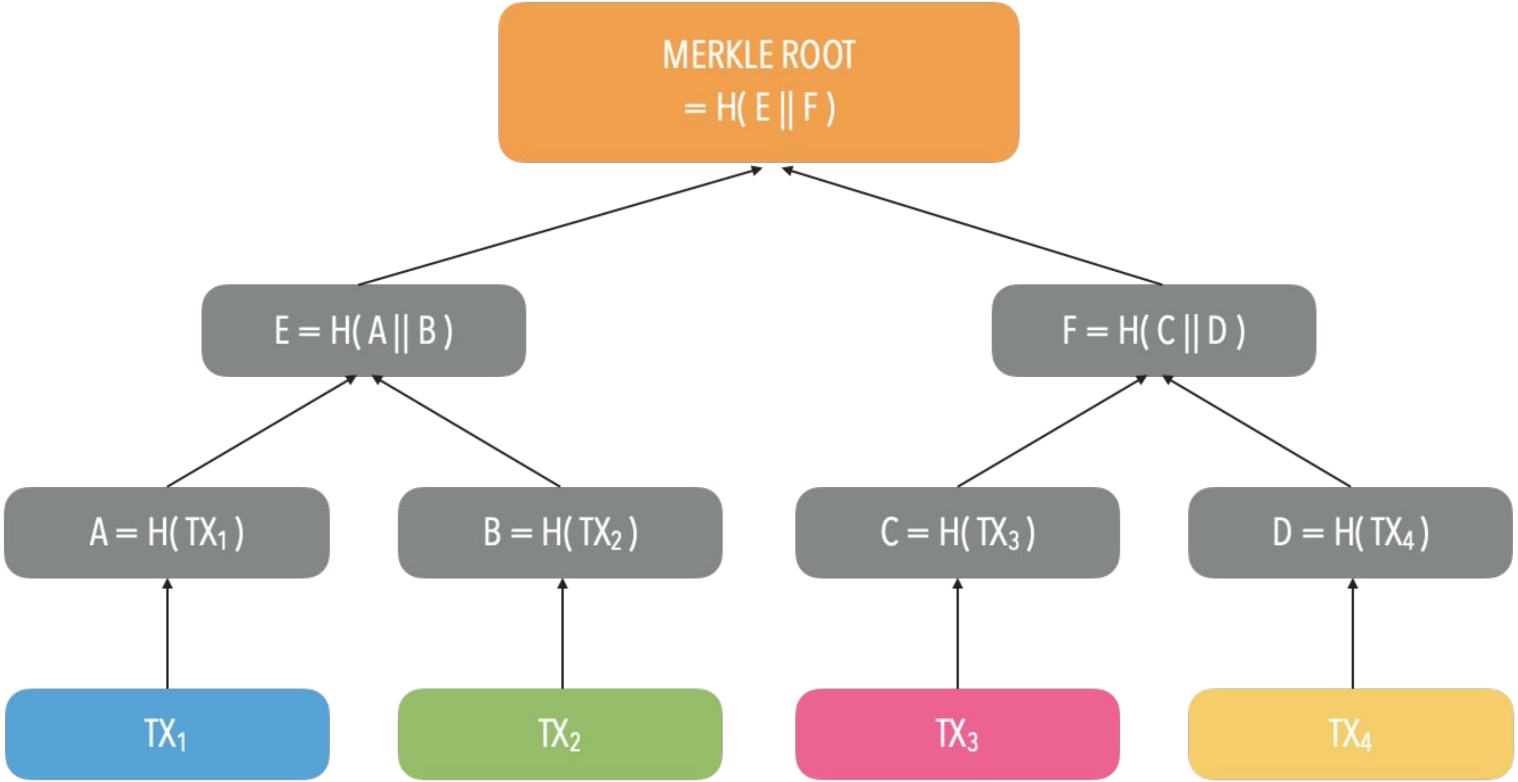
Cabeçalho (*header*) de um bloco



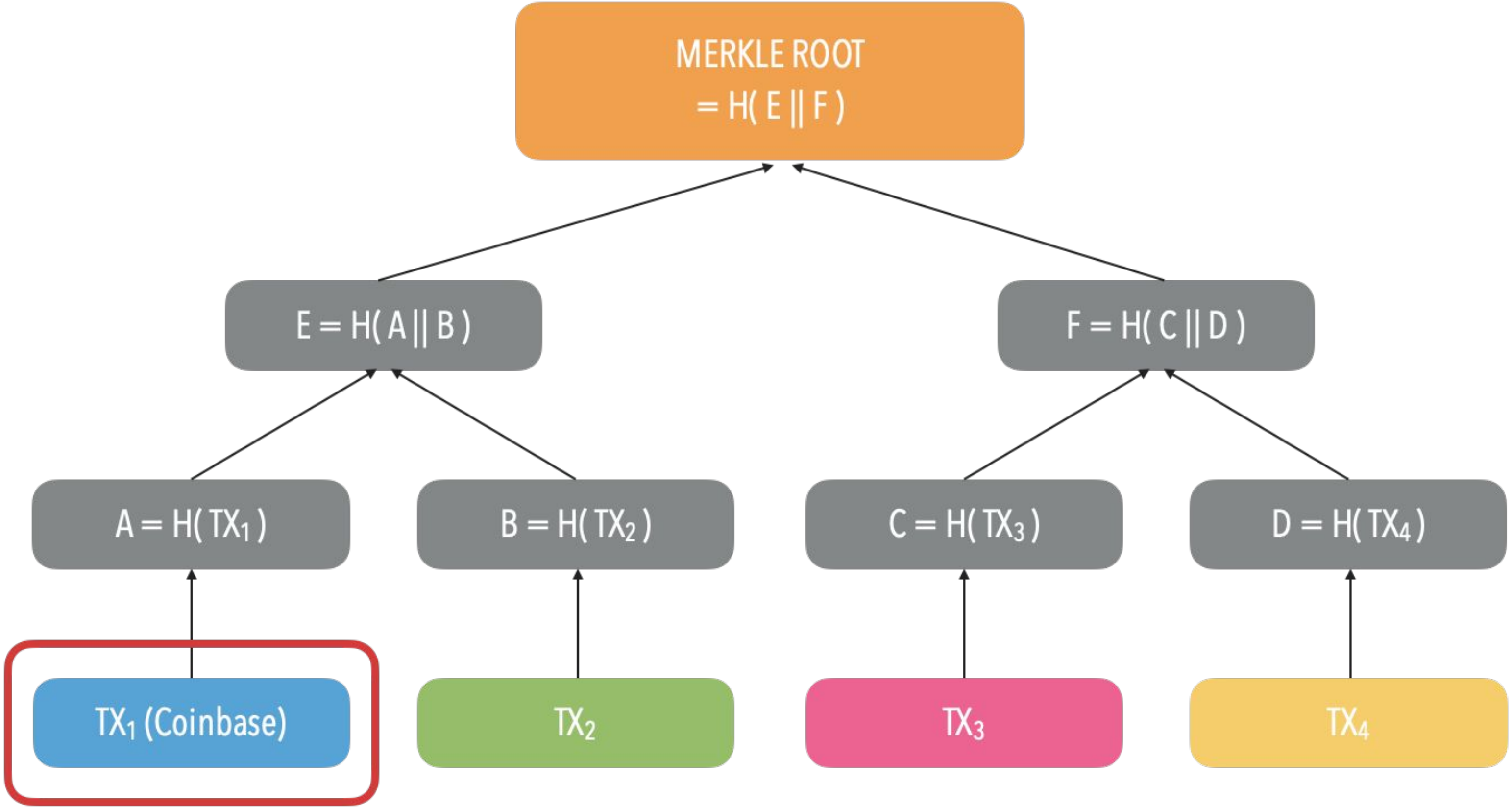
Cabeçalho (*header*) de um bloco



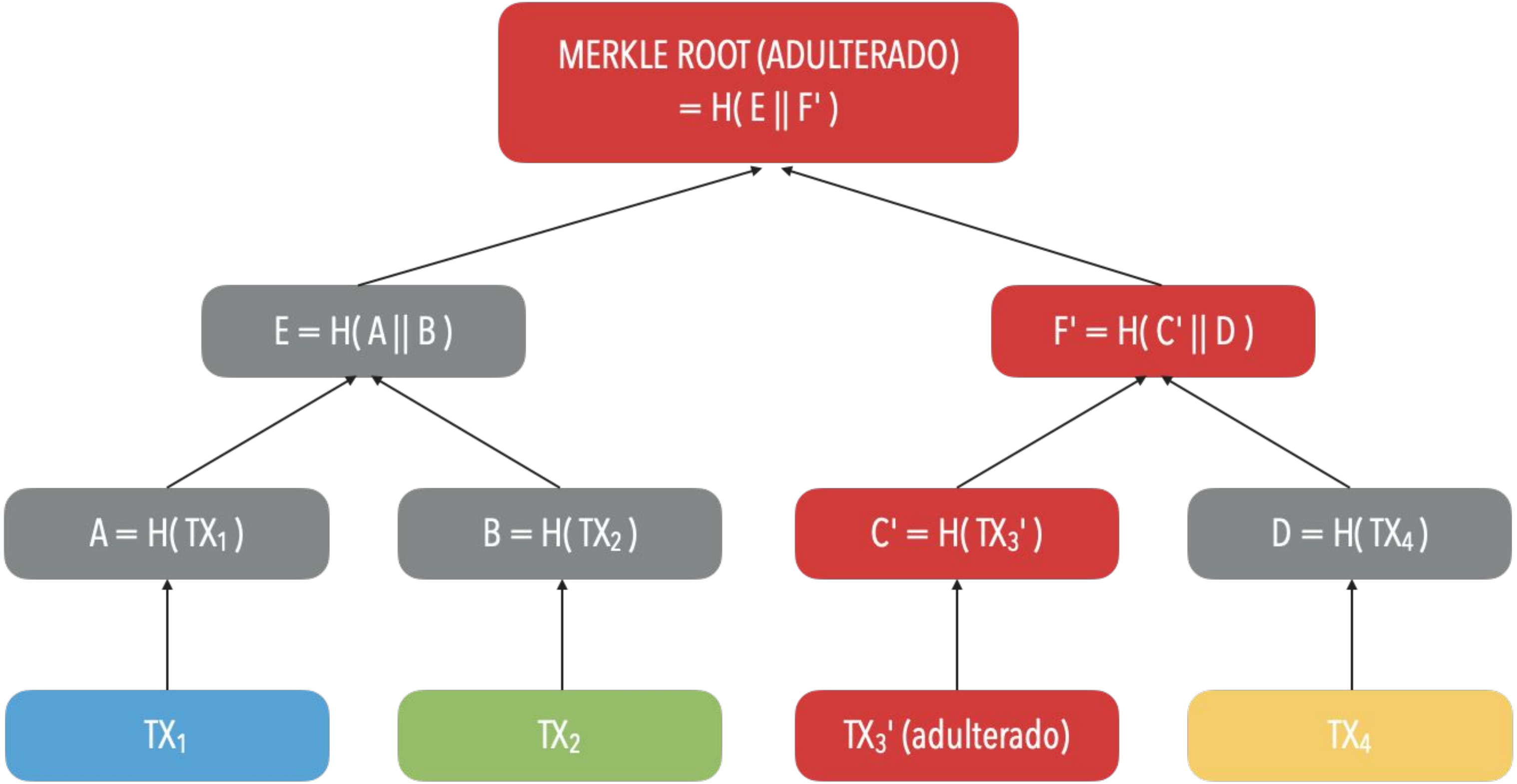
Merkle Root


MERKLE ROOT
= H(E || F)
E = H(A || B)
F = H(C || D)
A = H(TX_1)
B = H(TX_2)
C = H(TX_3)
D = H(TX_4)
TX_1
TX_2
TX_3
TX_4

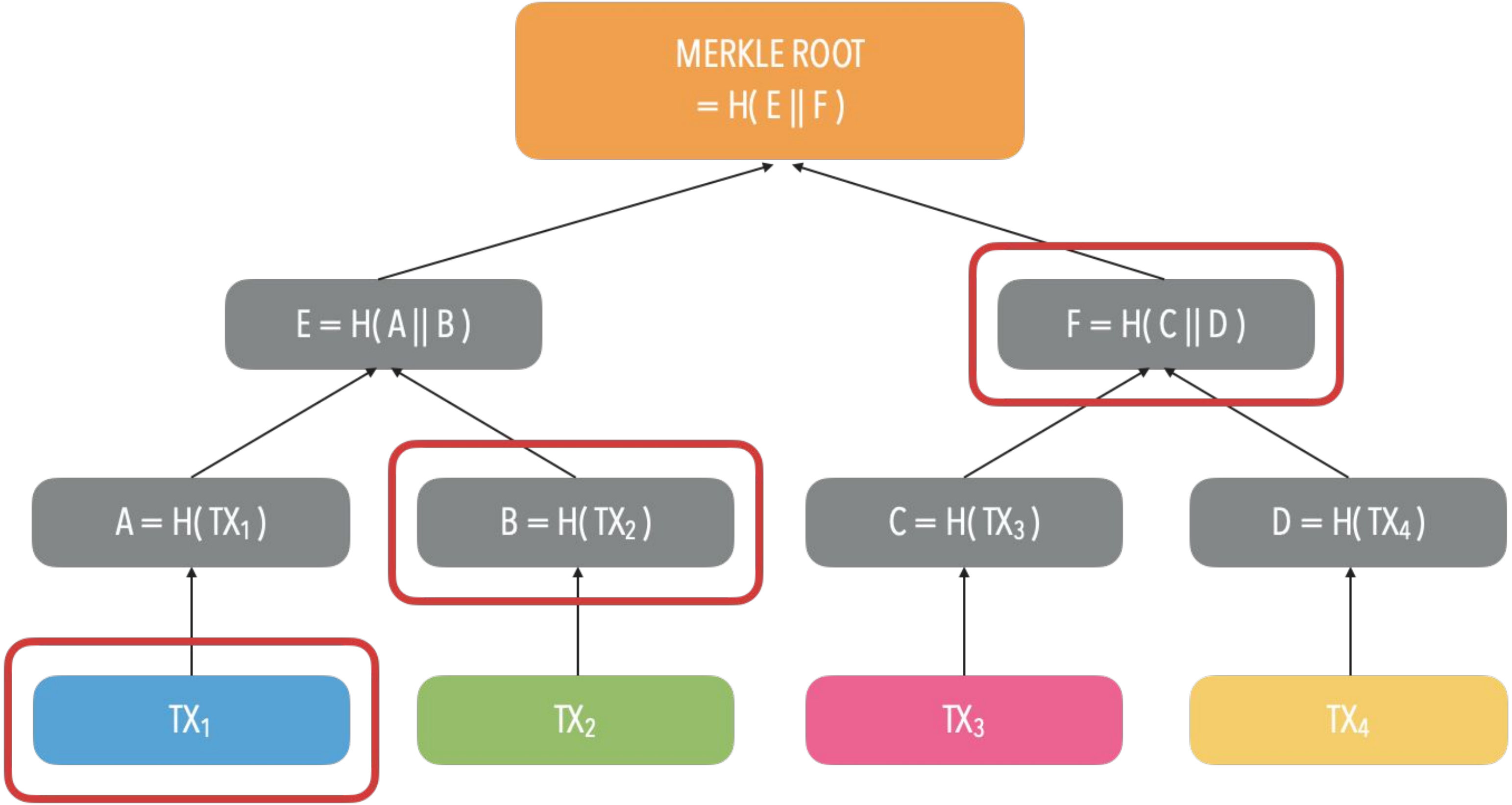
Merkle Root


MERKLE ROOT
= H(E || F)
E = H(A || B)
F = H(C || D)
A = H(TX_1)
B = H(TX_2)
C = H(TX_3)
D = H(TX_4)
TX_1 (Coinbase)
TX_2
TX_3
TX_4

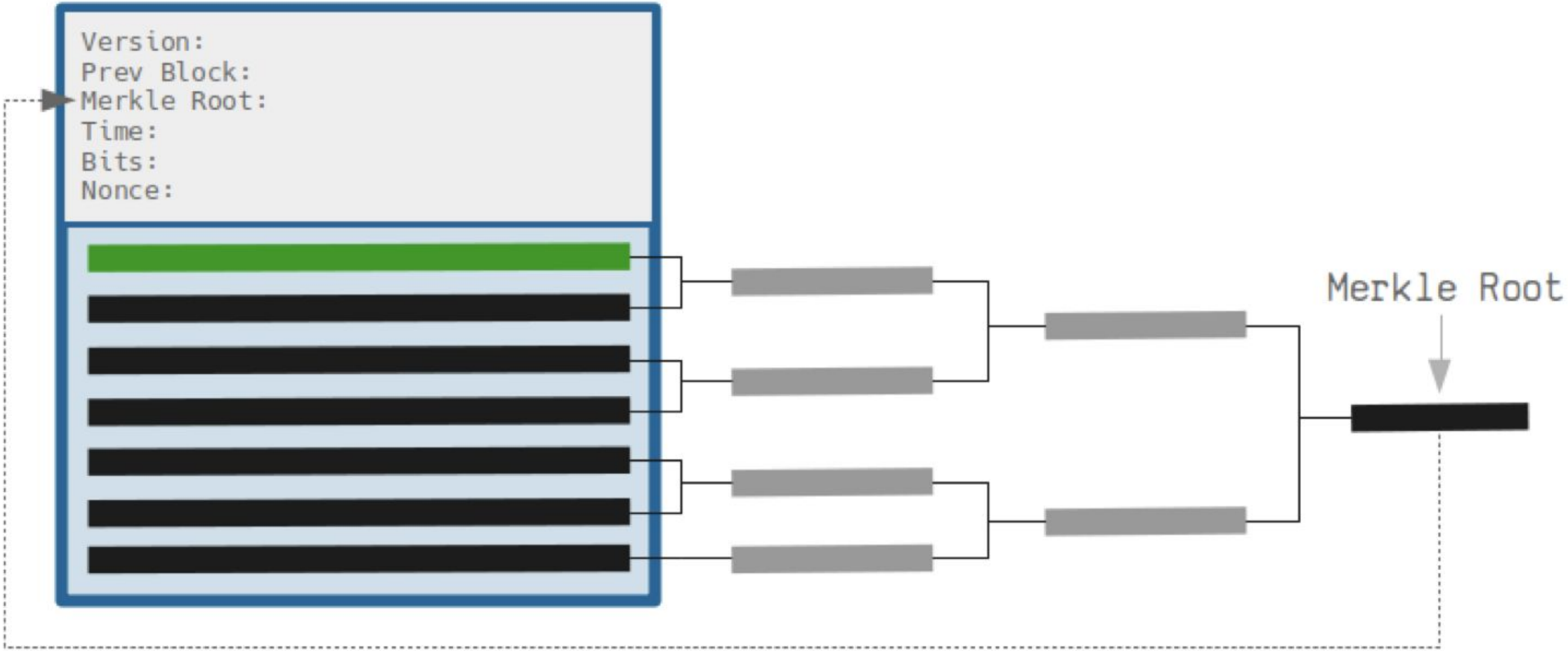
Merkle Root


MERKLE ROOT (ADULTERADO)
= H(E || F')
E = H(A || B)
F' = H(C' || D)
A = H(TX_1)
B = H(TX_2)
C' = H(TX_3')
D = H(TX_4)
TX_1
TX_2
TX_3' (adulterado)
TX_4

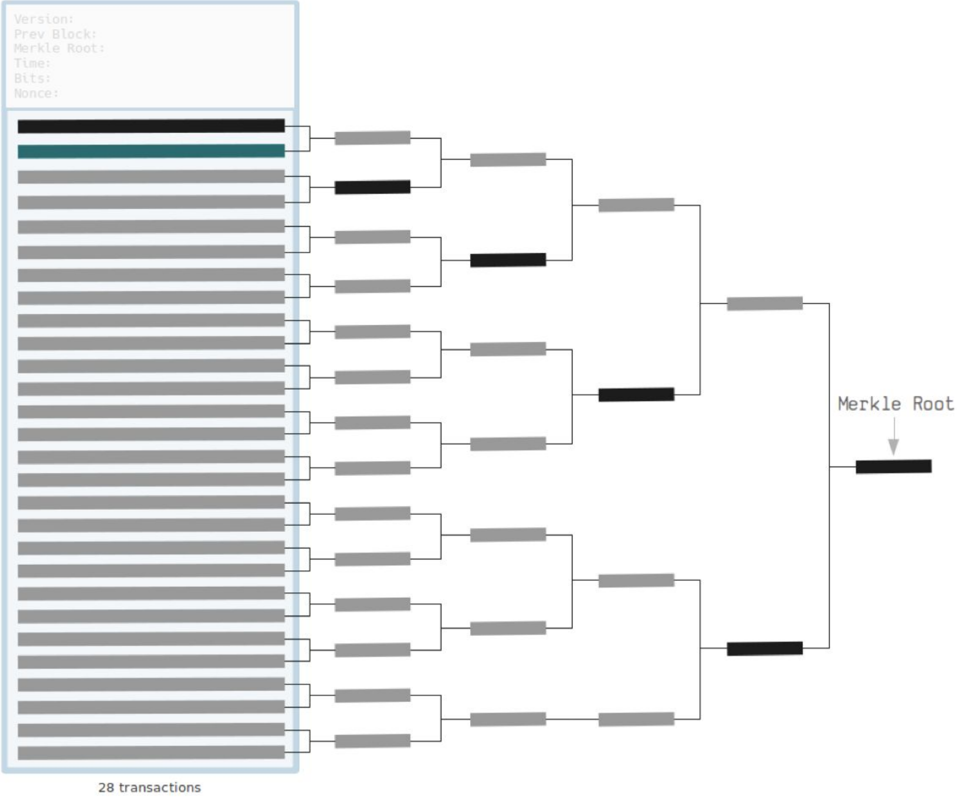
Merkle Root e *proof-of-inclusion*



Merkle Root

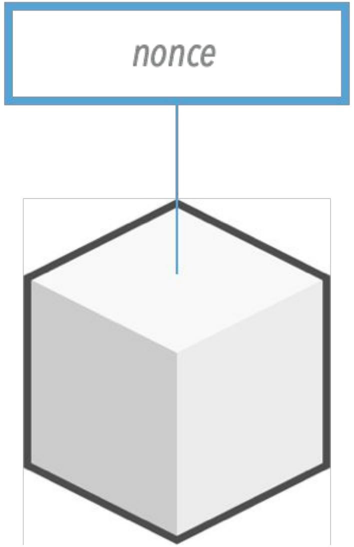


Merkle Root


Version:
Prev Block:
Merkle Root:
Time:
Bits:
Nonce:
28 transactions
Merkle Root

Cabeçalho (*header*) de um bloco

32 bits

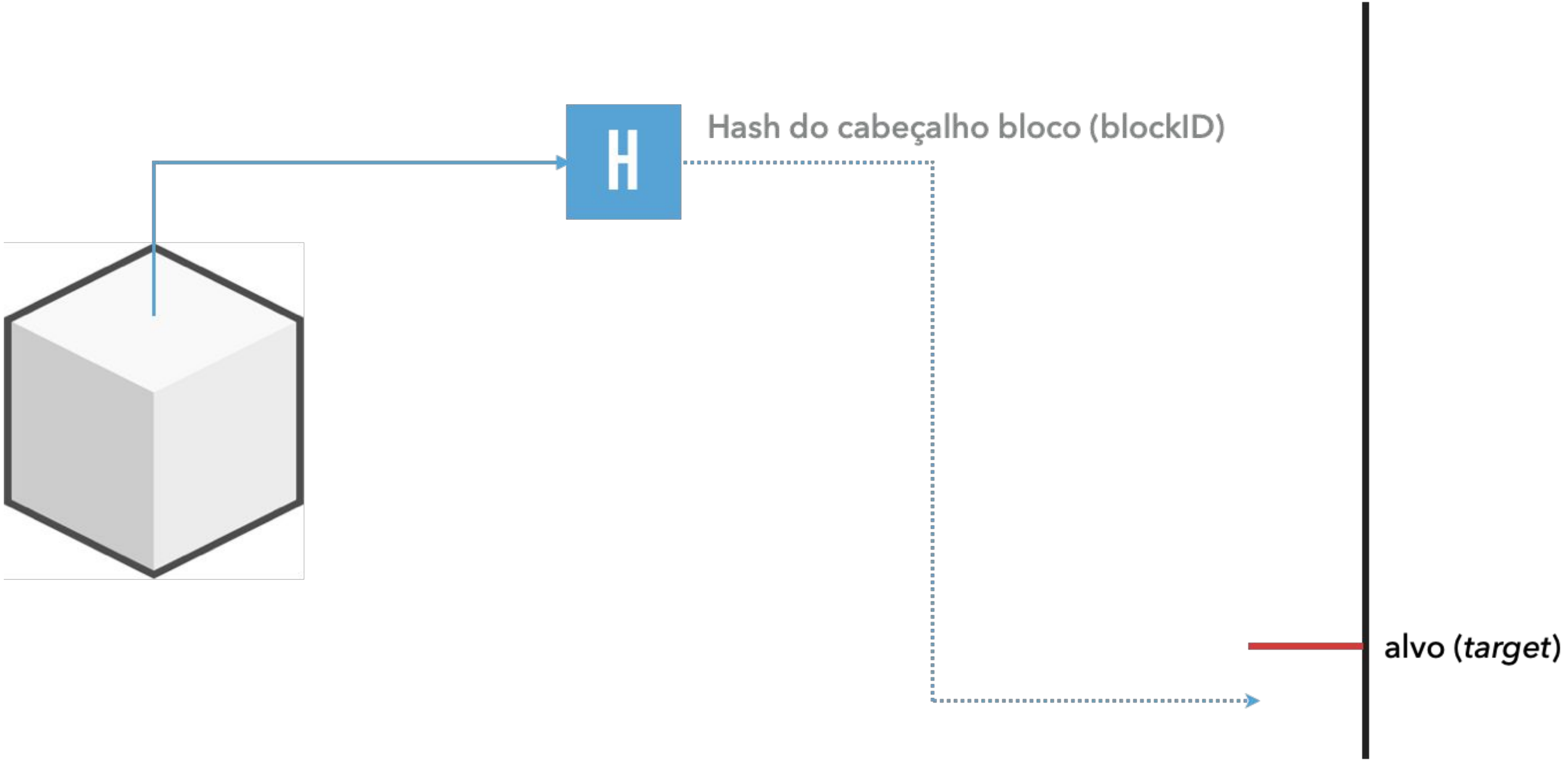


PROOF-OF-WORK!

Enigma criptográfico *hash*: Encontrar um **nonce** que satisfaça a seguinte inequação:

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

Puzzle criptográfico baseado em *hash*



Puzzle criptográfico baseado em *hash*

```
H(prevBlockHash || merkleRoot || time || nonce) <
0x0000ffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff
```

Puzzle criptográfico baseado em *hash*

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

H("Hello, World!0")
0x1312af178c253f84028d480a6adc1e25e81caa44c749ec81976192e2ec934c64
<
0x0000ffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff
```

Puzzle criptográfico baseado em *hash*

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

H("Hello, World!1")
0xe9afc424b79e4f6ab42d99c81156d3a17228d6e1eef4139be78e948a9332a7d8
<
0x0000ffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff
```

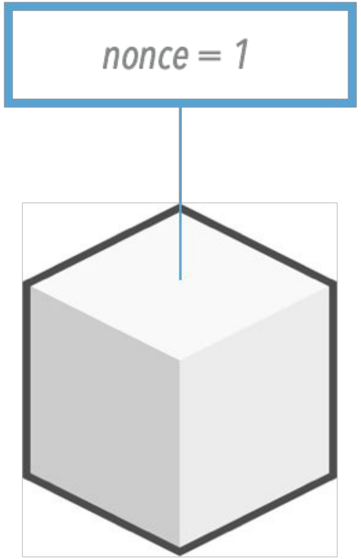
Puzzle criptográfico baseado em *hash*

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

H("Hello, World!4250")
0x0000c3af42fc31103f1fdc0151fa747ff87349a4714df7cc52ea464e12dcd4e9
<
0x0000ffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff
```

resolvido!

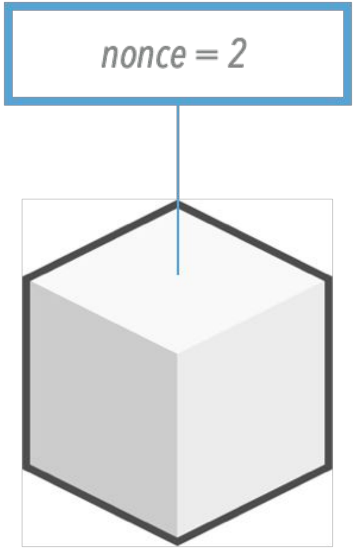
Cabeçalho (*header*) de um bloco



4c47c2d47712cc266c3b7ed7e9a0bcda2e6786f7455b9af3e9df3c5a2b26ddbf

✗

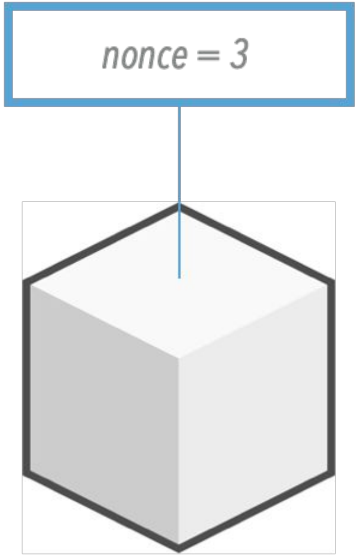
Cabeçalho (*header*) de um bloco



6bbe9136c059738eaaf237c995a78971788ee87119d82ef640a7288b43928017

✗

Cabeçalho (*header*) de um bloco

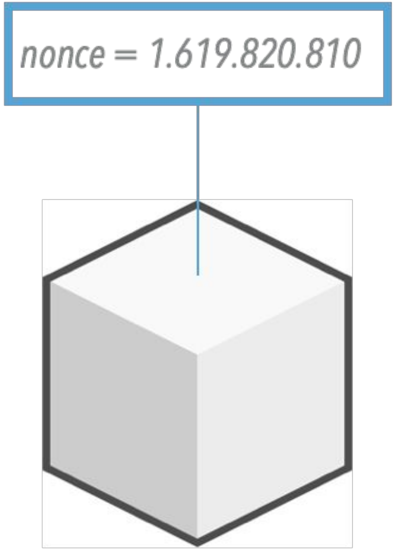


nonce = 3

000004bb7c4d63435e1fa5595986fab643490560699bf35c43bdc6ecfd3ea721

✗

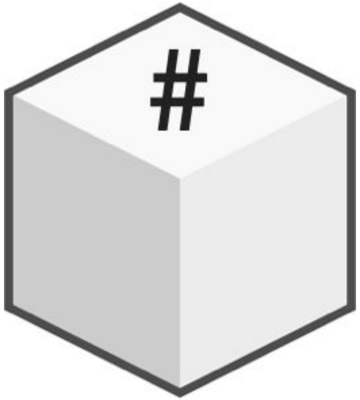
Cabeçalho (*header*) de um bloco



00000000000000000274cb1a04c382475310f70cee3776af06414f22f8337044

✓

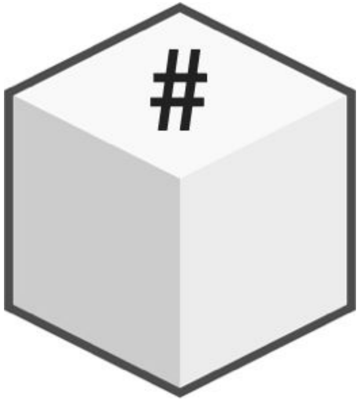
Dificuldade de um bloco



Dificuldade do bloco:

0000000HASHVALUE

Dificuldade de um bloco



2.016 blocos

≃

2 semanas

Dificuldade do bloco:

0000000HASHVALUE

Dificuldade de um bloco

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

0x0000ffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff

0x000000000000ffffffffffffffffffffffffffffffffffffffffffffffffffff

0x00000000ffffffffffffffffffffffffffffffffffffffffffffffffffffffff
```

```
010000009500c43a25c624520b5100adf82cb9f9da72fd2447a496bc600b0000000000006cd862370395dedf1da2841ccda0fc489e3039de5f1ccddef0e834991a65600ea6c8cb4db3936a1ae31439910d0100000001000000000000
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b11f8b360f4e88ac887f680af7fde035295939145d868011e0b37e077cc5e5aa2b699f6030ffffffff1b1887532137b5c7ec5c141f5cb88dbf1465c578fb6491acc4d9ffade969bdbb010000008b4830450220630795aefe55d8be9
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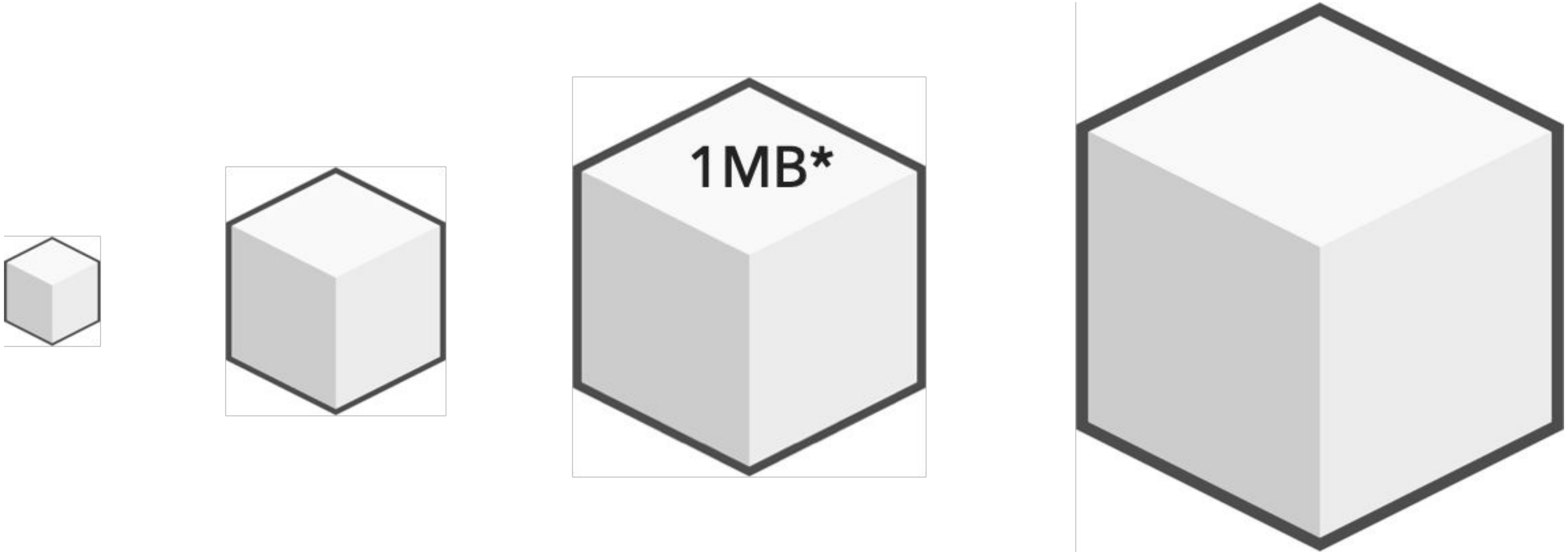
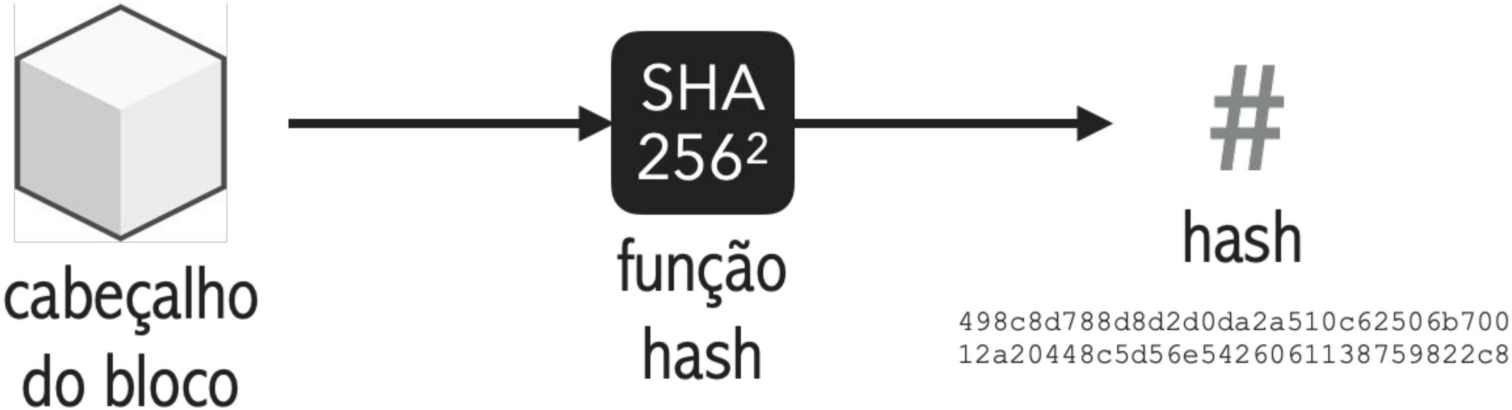
```

Campo	Tamanho	Codificação
Version *	4 bytes	Little-Endian
Previous Block Hash	32 bytes	Little-Endian
Merkle Root	32 bytes	Little-Endian
Time	4 bytes	Little-Endian
Bits	4 bytes	Little-Endian
Nonce	4 bytes	Little-Endian

Tamanho de um bloco



Hash de um bloco



cabeçalho do bloco

SHA 256^2

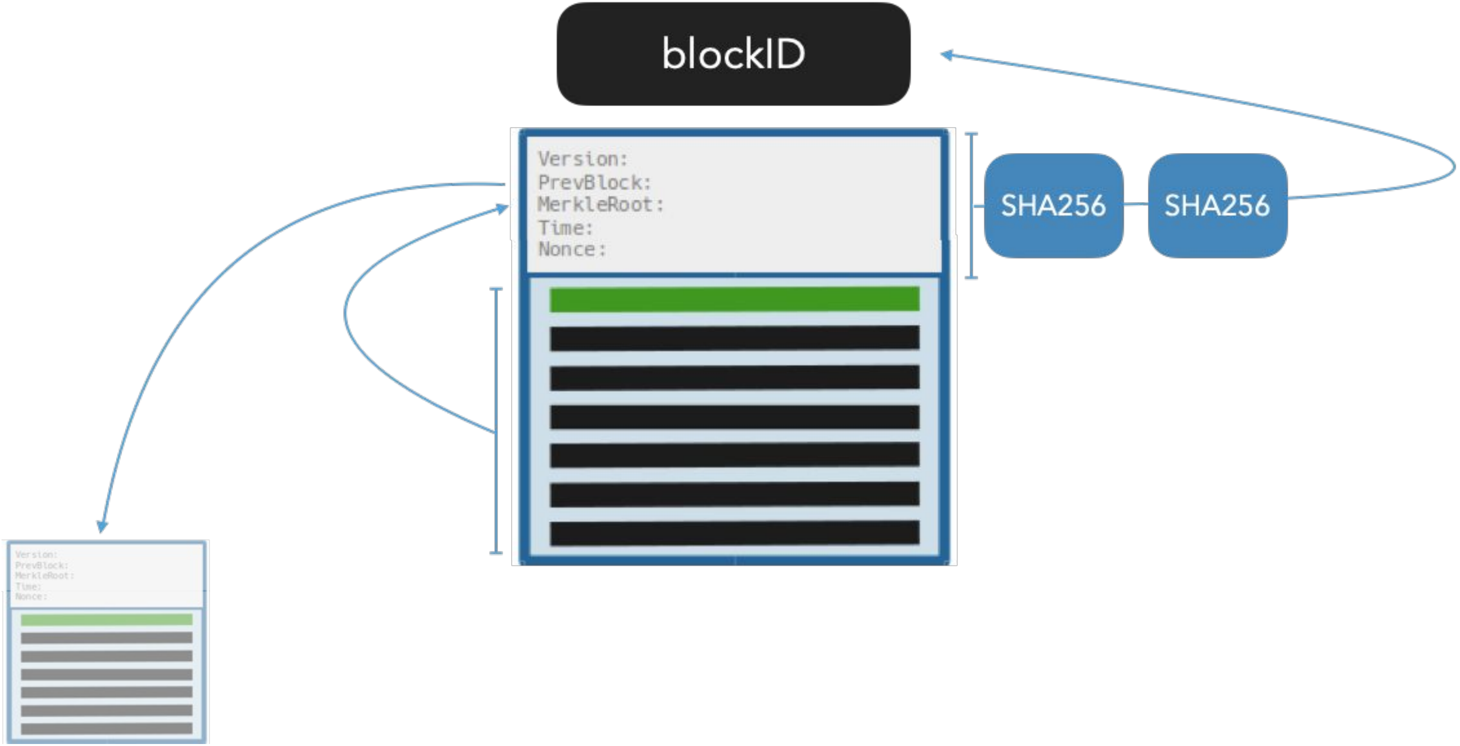
função hash

#

hash

498c8d788d8d2d0da2a510c62506b700
12a20448c5d56e54260611387598 22c8

ID de um bloco



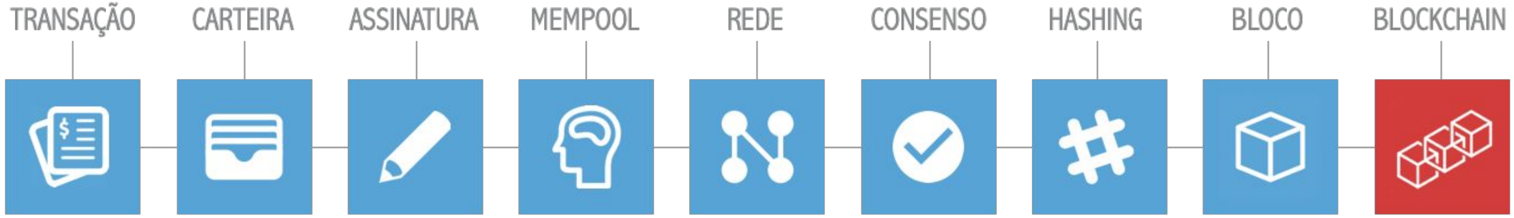
Exemplo: bloco #123456

https://www.blockchain.com/explorer/blocks/btc/0000000000002917ed80650c6174aac8dfc46f5fe36480aaef682ff6cd83c3ca

Bloco: demonstração

https://andersbrownworth.com/blockchain/block

Arquitetura de um Blockchain



TRANSAÇÃO

CARTEIRA

ASSINATURA

MEMPOOL

REDE

CONSENSO

HASHING

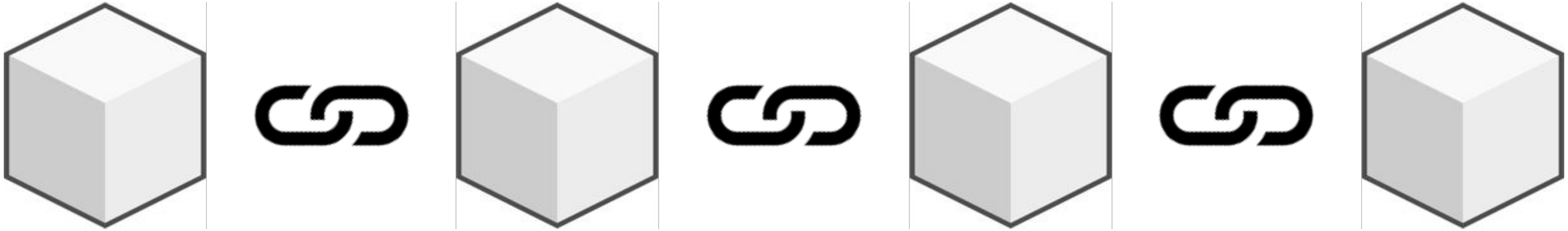
BLOCO

BLOCKCHAIN

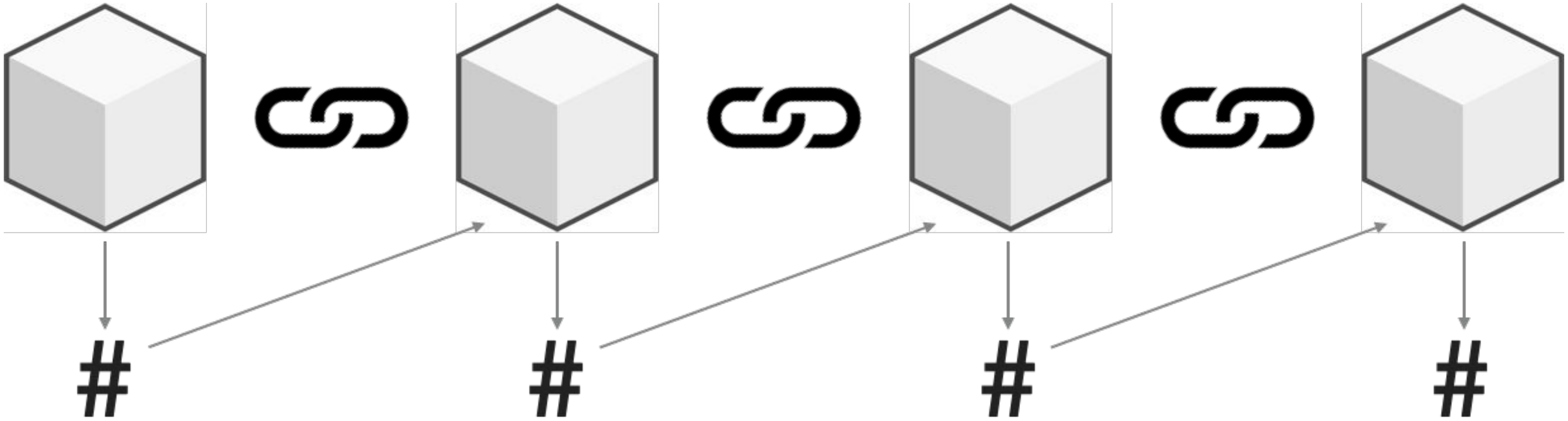
Blockchain

Um livro-razão digital e compartilhado que registra uma lista de transações no formato de uma sequência de blocos.

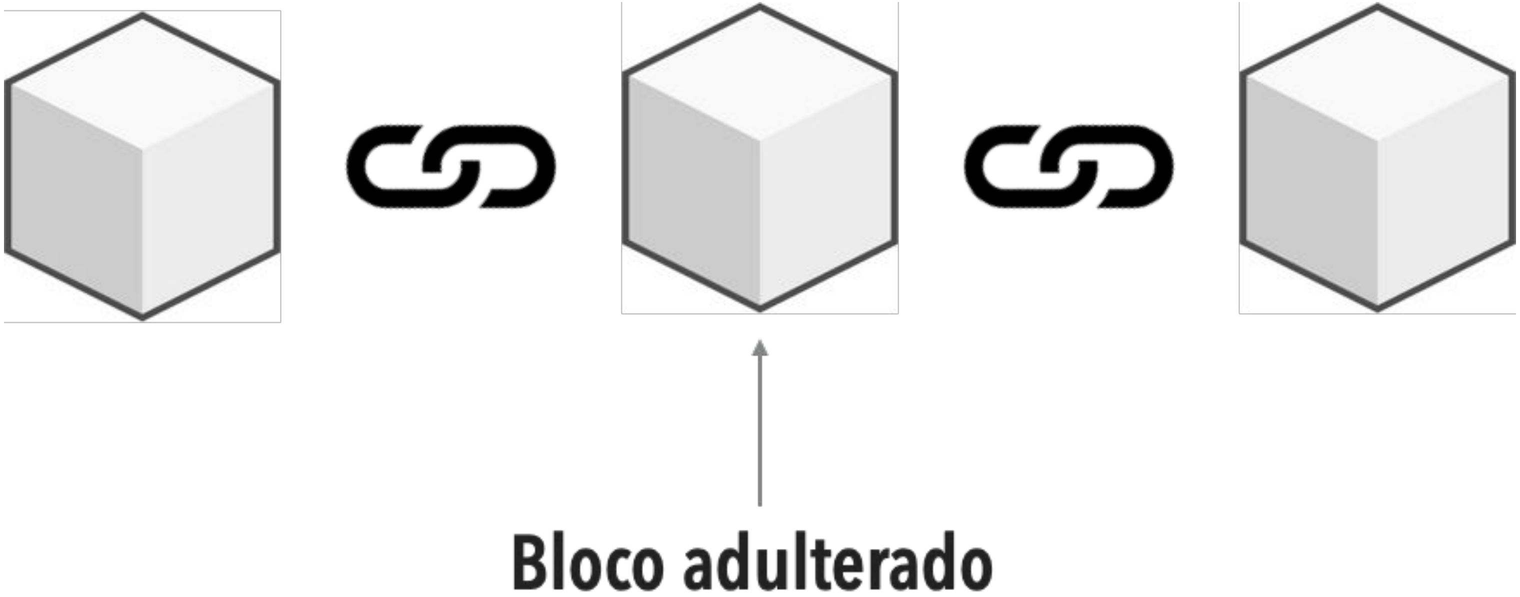
"Corrente" de blocos



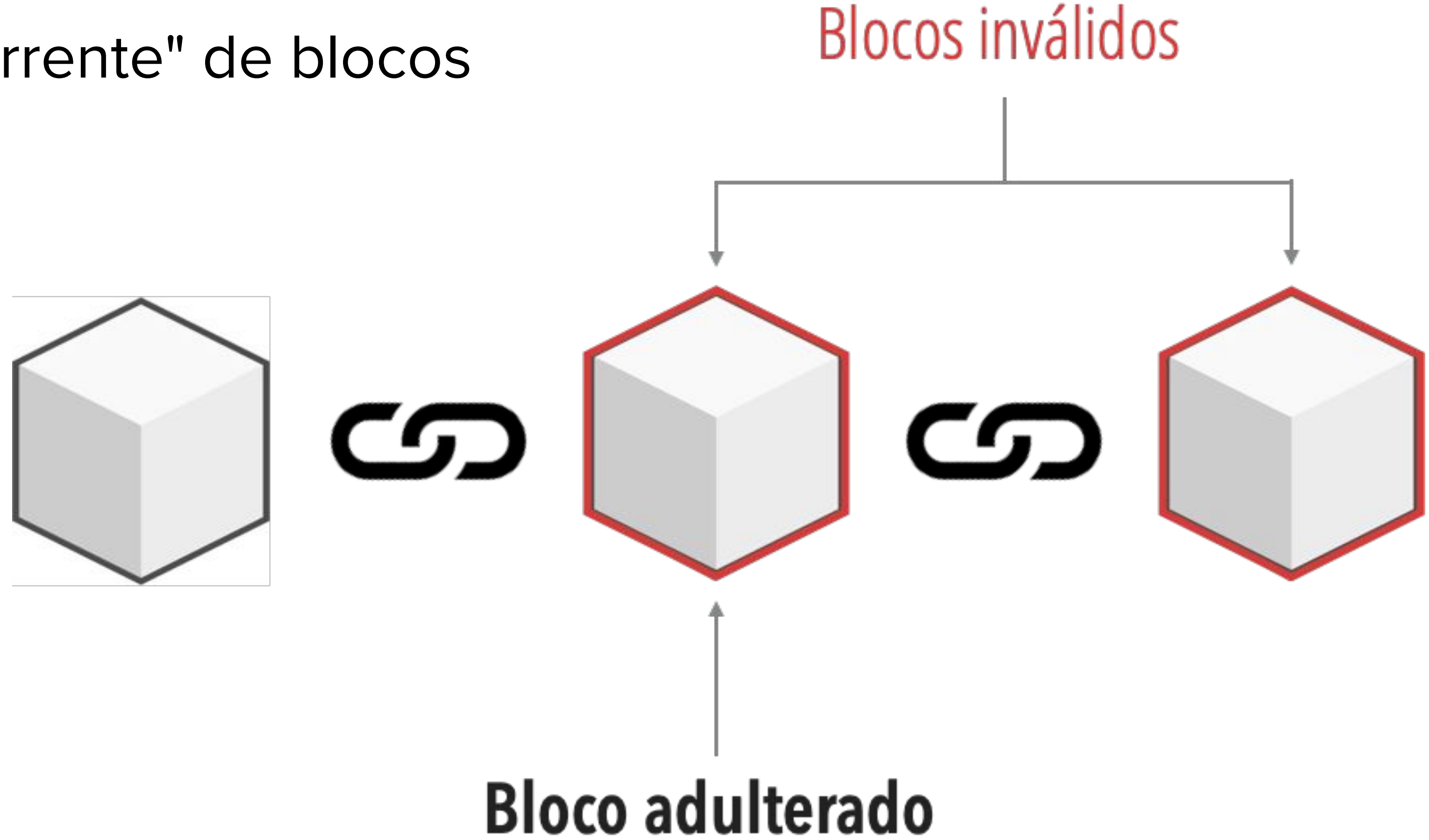
"Corrente" de blocos



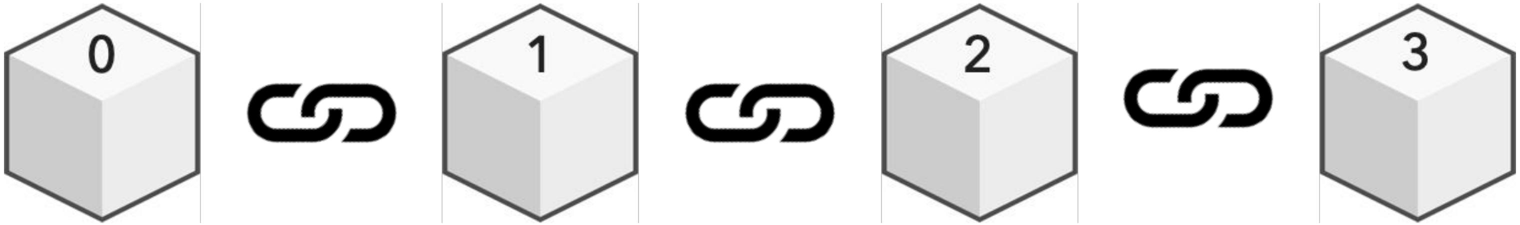
"Corrente" de blocos



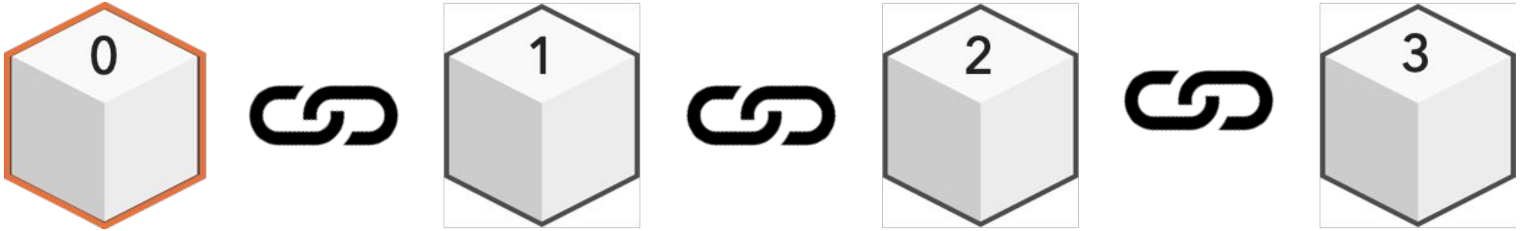
"Corrente" de blocos



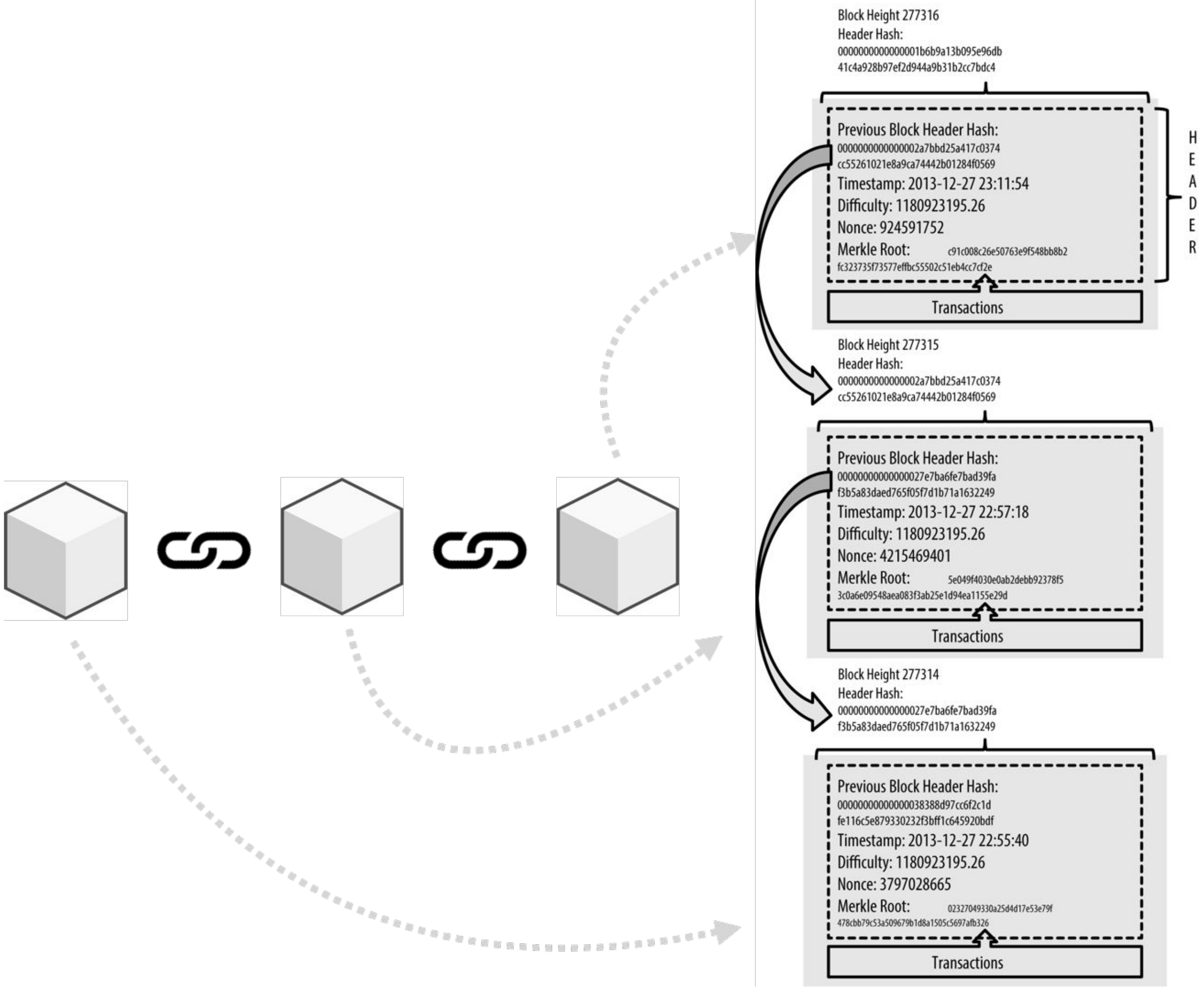
Número do bloco



Bloco "gênesis"



https://www.blockchain.com/btc/block/000000000019d6689c085ae165831e934ff763ae46a2a6c172b3f1b60a8ce26f



Block Height 277316
Header Hash:
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41c4a928b97ef2d944a9b31b2cc7bdc4

Previous Block Header Hash:
0000000000000002a7bbd25a417c0374
cc55261021e8a9ca74442b01284f0569
Timestamp: 2013-12-27 23:11:54
Difficulty: 1180923195.26
Nonce: 924591752
Merkle Root: c91c008c26e50763e9f548bb8b2
fc323735f73577effbc55502c51eb4cc7cf2e

Transactions

Block Height 277315
Header Hash:
0000000000000002a7bbd25a417c0374
cc55261021e8a9ca74442b01284f0569

Previous Block Header Hash:
00000000000000027e7ba6fe7bad39fa
f3b5a83daed765f05f7d1b71a1632249
Timestamp: 2013-12-27 22:57:18
Difficulty: 1180923195.26
Nonce: 4215469401
Merkle Root: 5e049f4030e0ab2debb92378f5
3c0a6e09548aea083f3ab25e1d94ea1155e29d

Transactions

Block Height 277314
Header Hash:
00000000000000027e7ba6fe7bad39fa
f3b5a83daed765f05f7d1b71a1632249

Previous Block Header Hash:
000000000000000038388d97cc6f2c1d
fe116c5e879330232f3bff1c645920bdf
Timestamp: 2013-12-27 22:55:40
Difficulty: 1180923195.26
Nonce: 3797028665
Merkle Root: 02327049330a25d4d17e53e79f
478cbb79c53a509679b1d8a1505c5697afb326

Transactions

Blockchain: demonstração

https://andersbrownworth.com/blockchain/blockchain

```
010000009500c43a25c624520b5100adf82cb9f9da72fd2447a496bc600b0000000000006cd862370395dedf1da2841ccda0fc489e3039de5f1ccddef0e834991a65600ea6c8cb4db3936a1ae31439910d010000000100000000000
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BLOCO 123.456 DO BITCOIN

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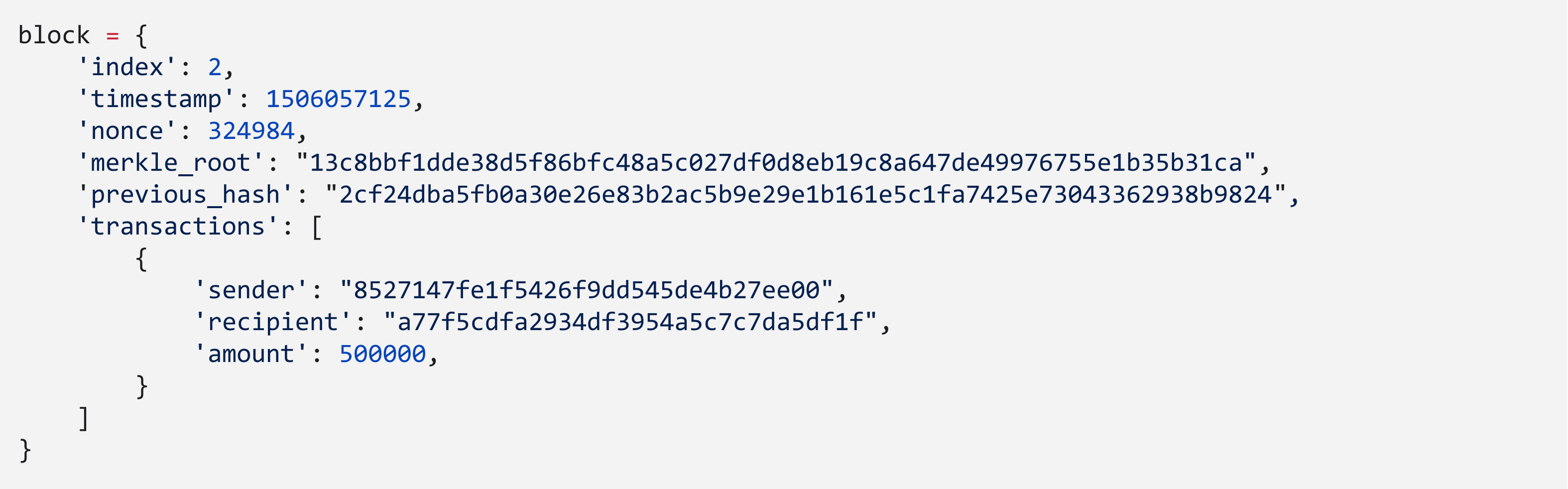
```

Blocos em Python

https://docs.python.org/3/tutorial/datastructures.html#dictionaries



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block = {
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    'nonce': 324984,
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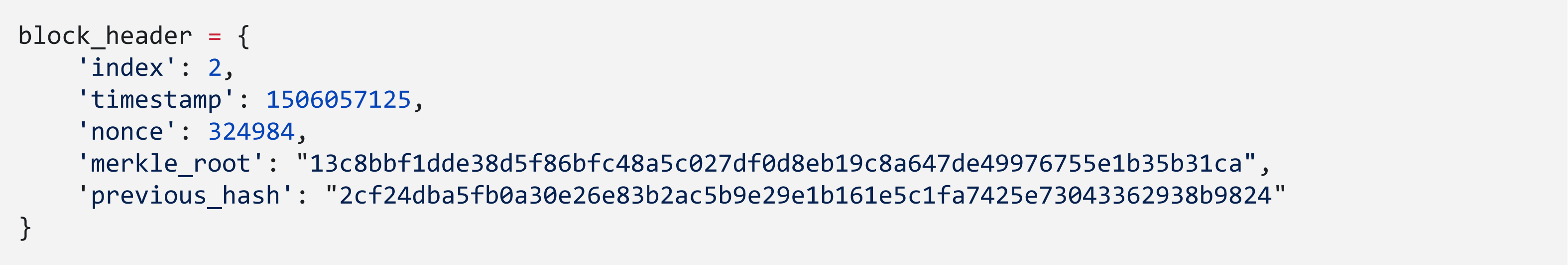

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}
```

Atividade avaliativa #02

GitHub Classroom

/02-blocks/

?