Gentle Introduction to Blockchains

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Outline

- Why it works
- Smart contracts
- Types, ideas and the future

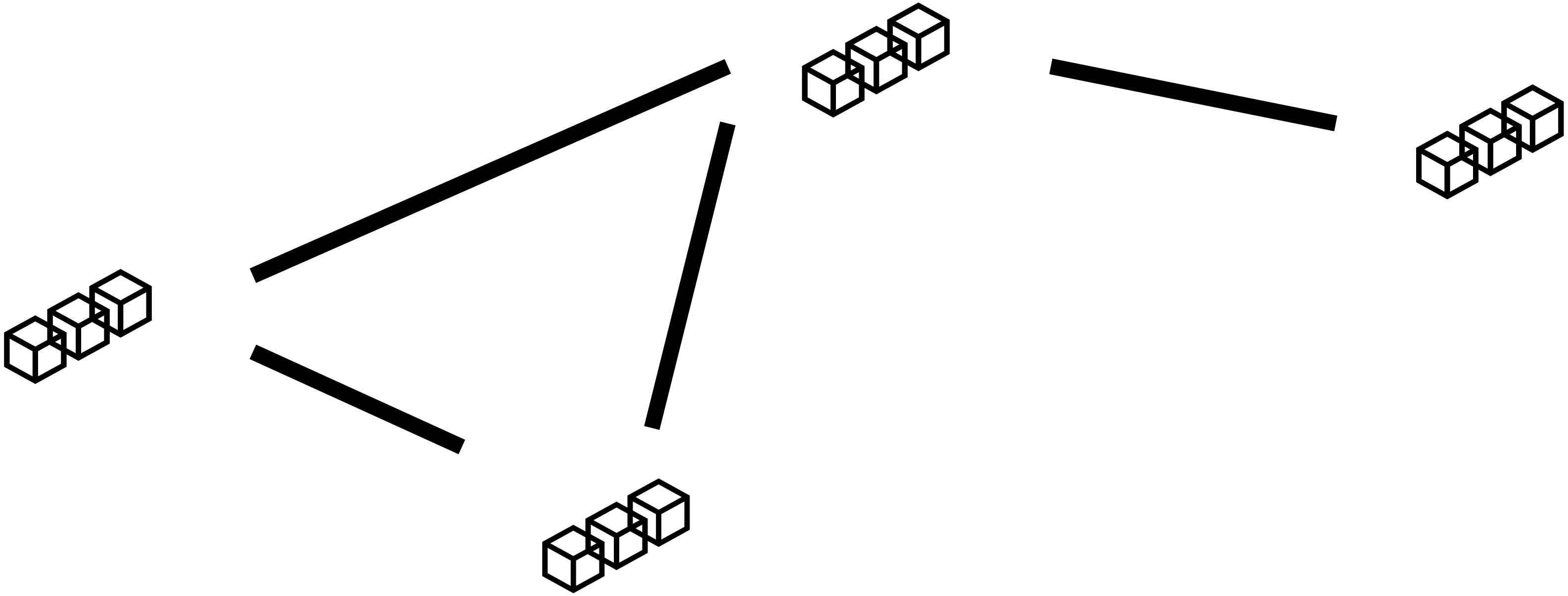
Part I

Why it works, or a Bitcoin primer

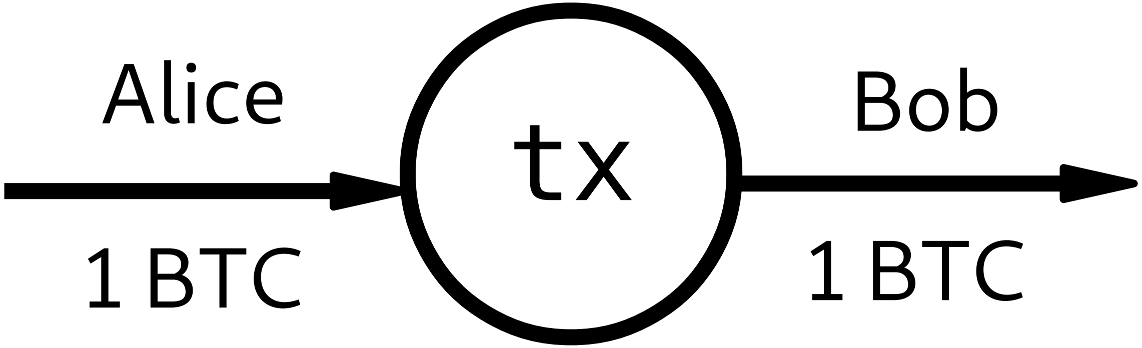
What is a Blockchain?

- distributed,
- append-only,
- transaction ledger

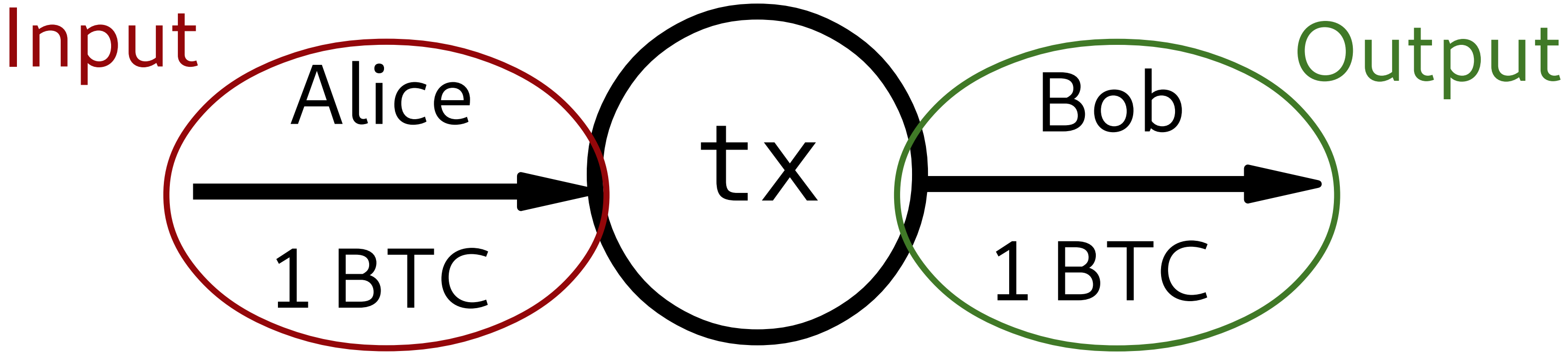
What is a Blockchain?



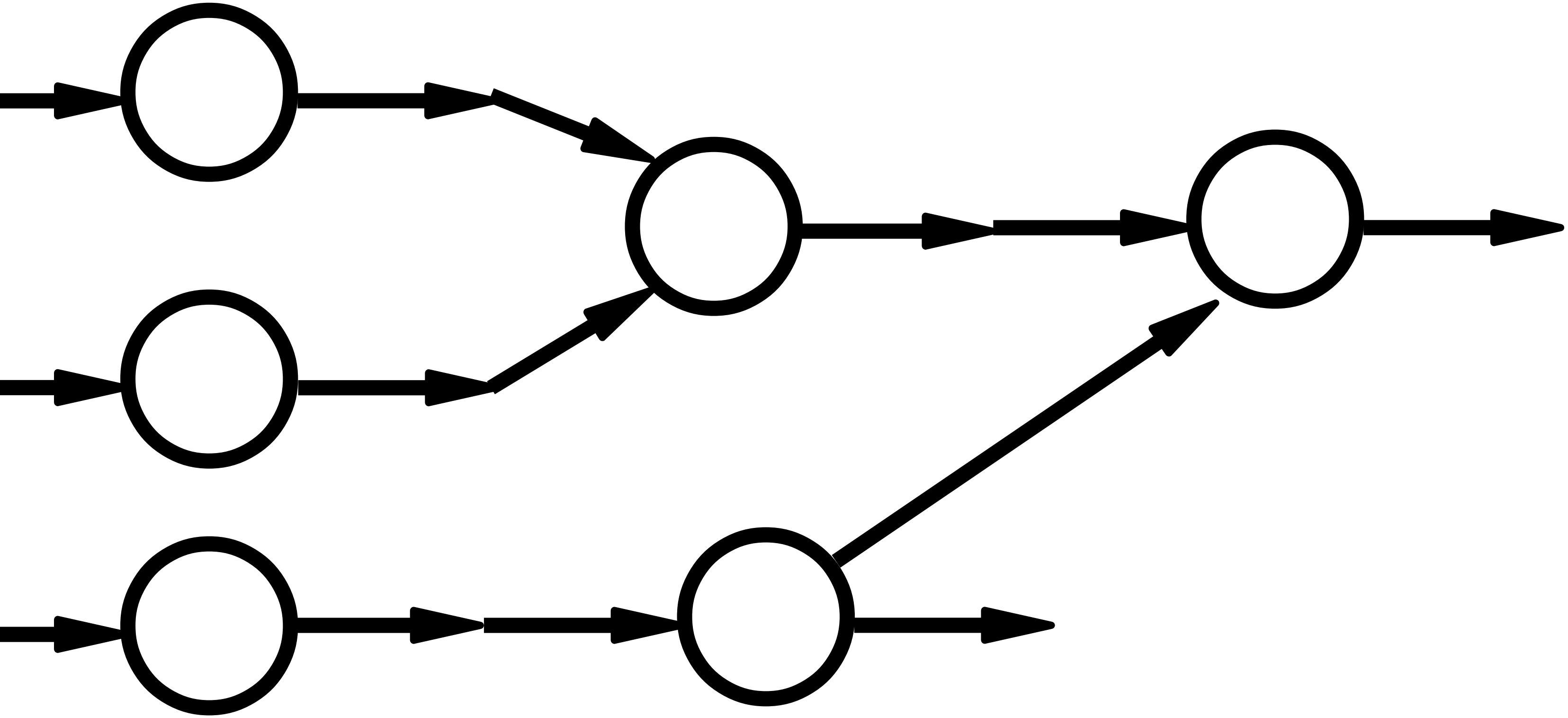
Transactions



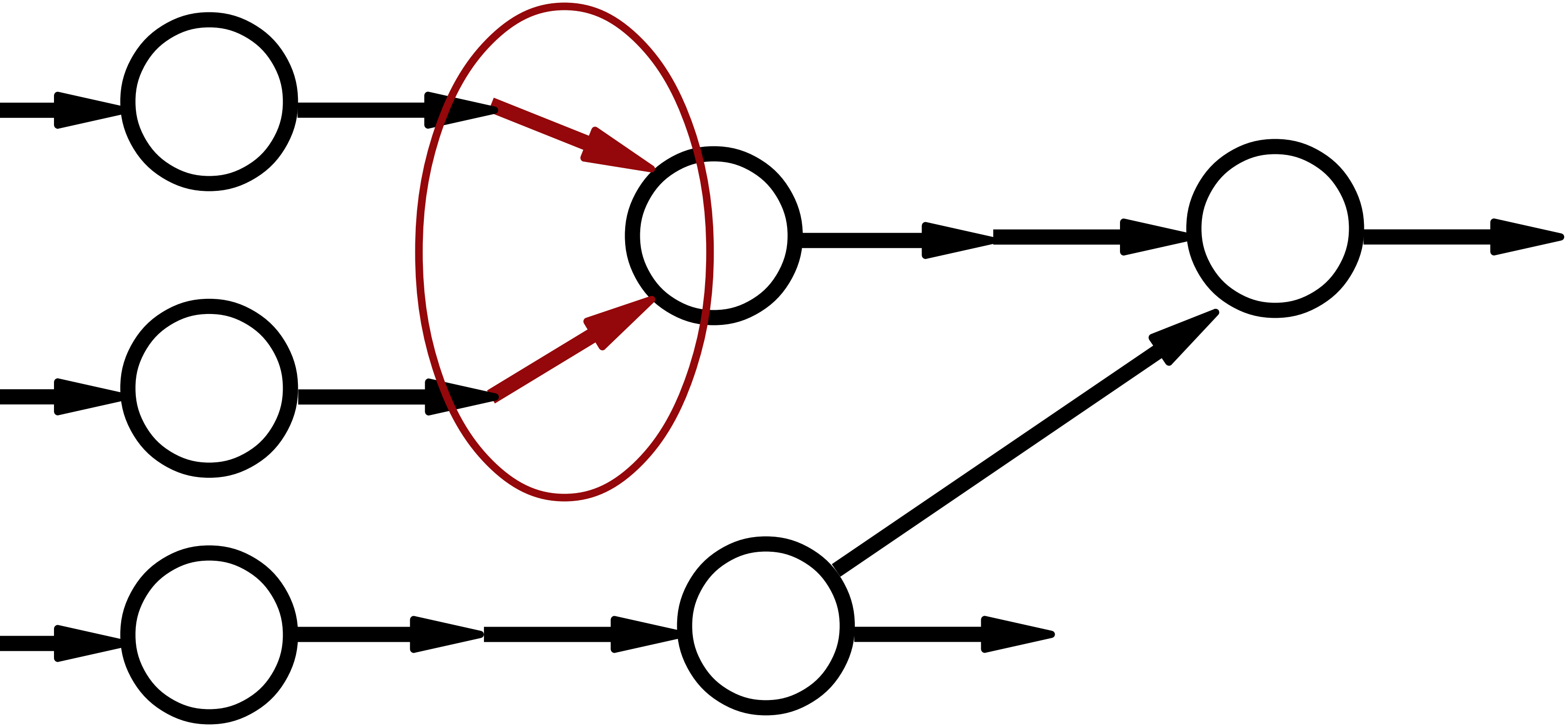
Transactions



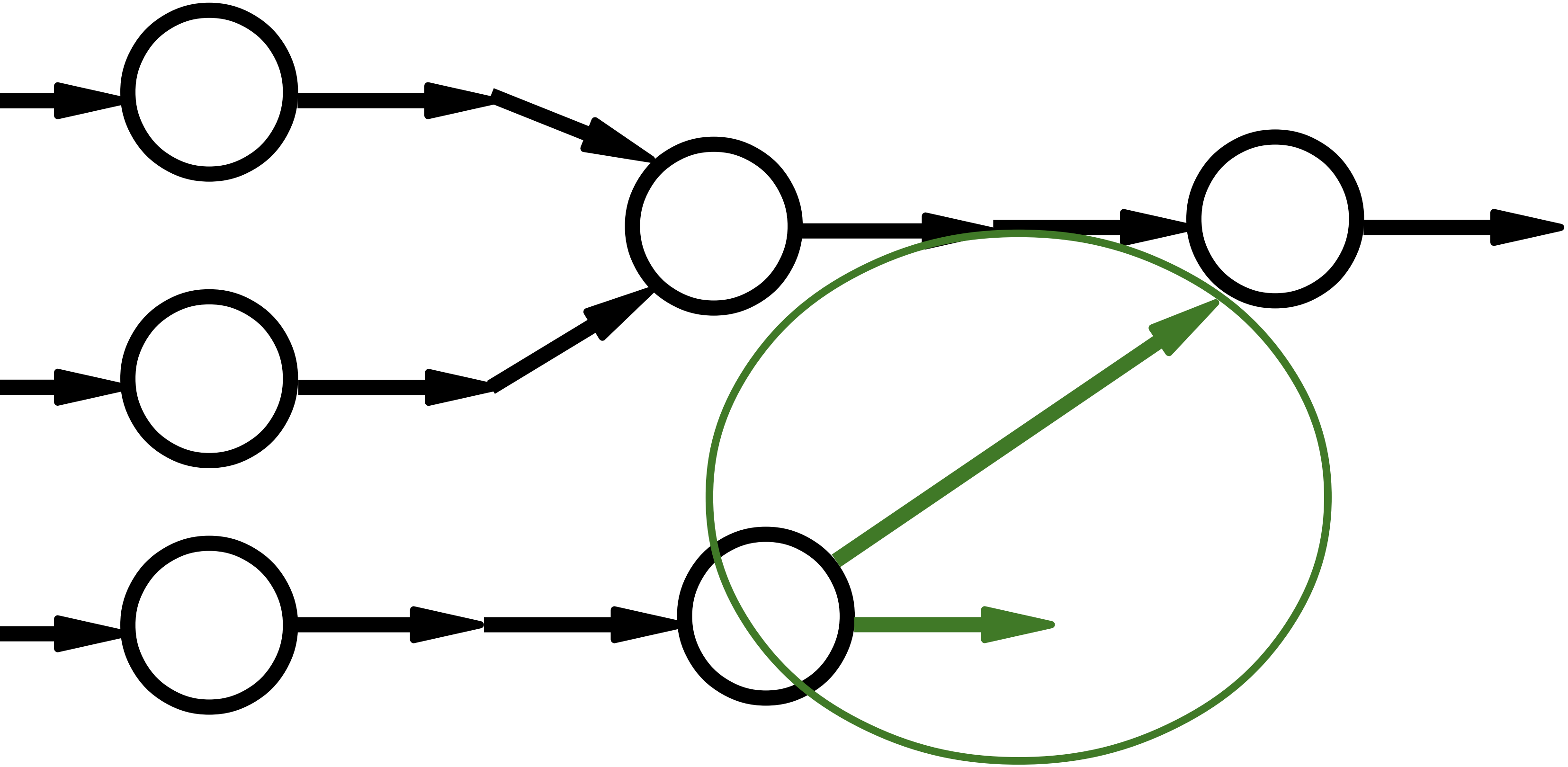
Transaction Graph



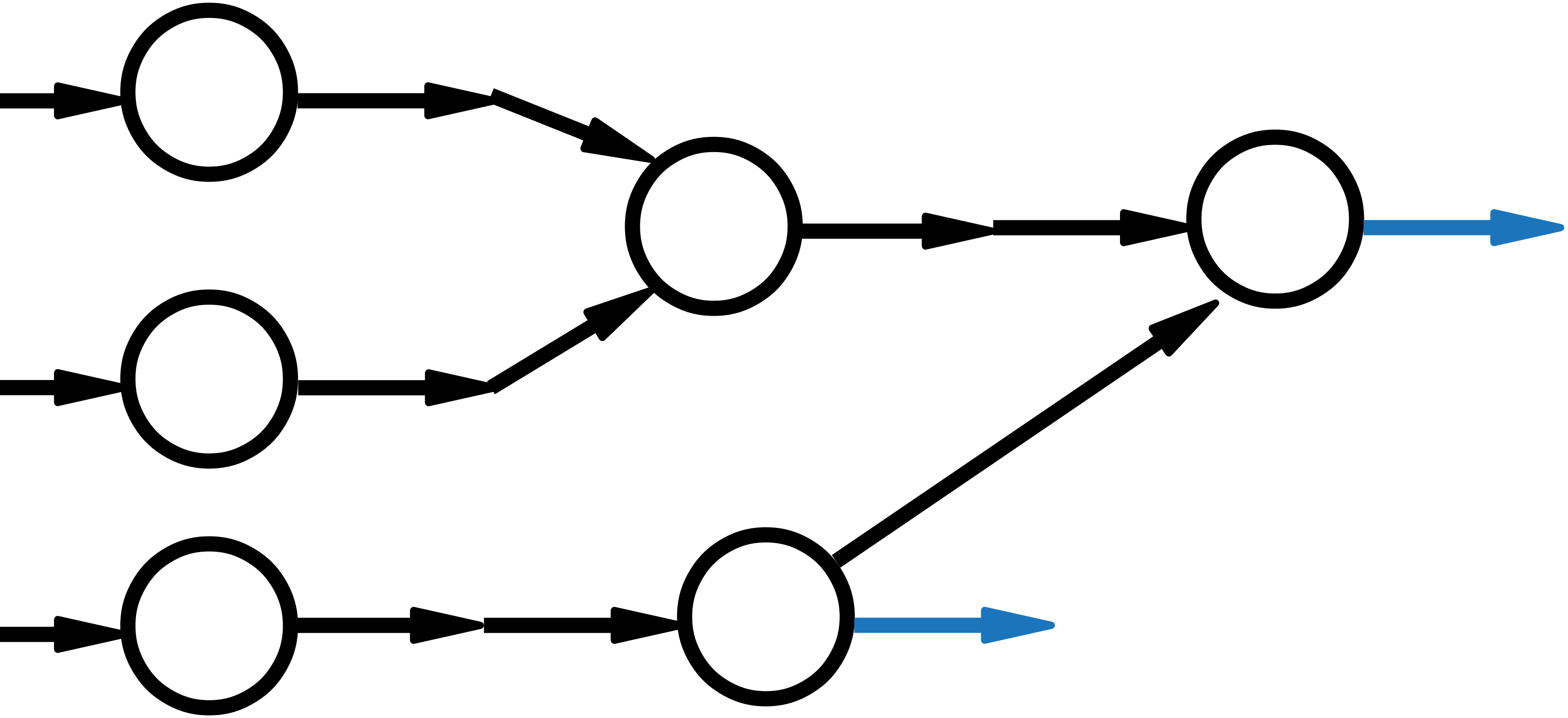
Many inputs



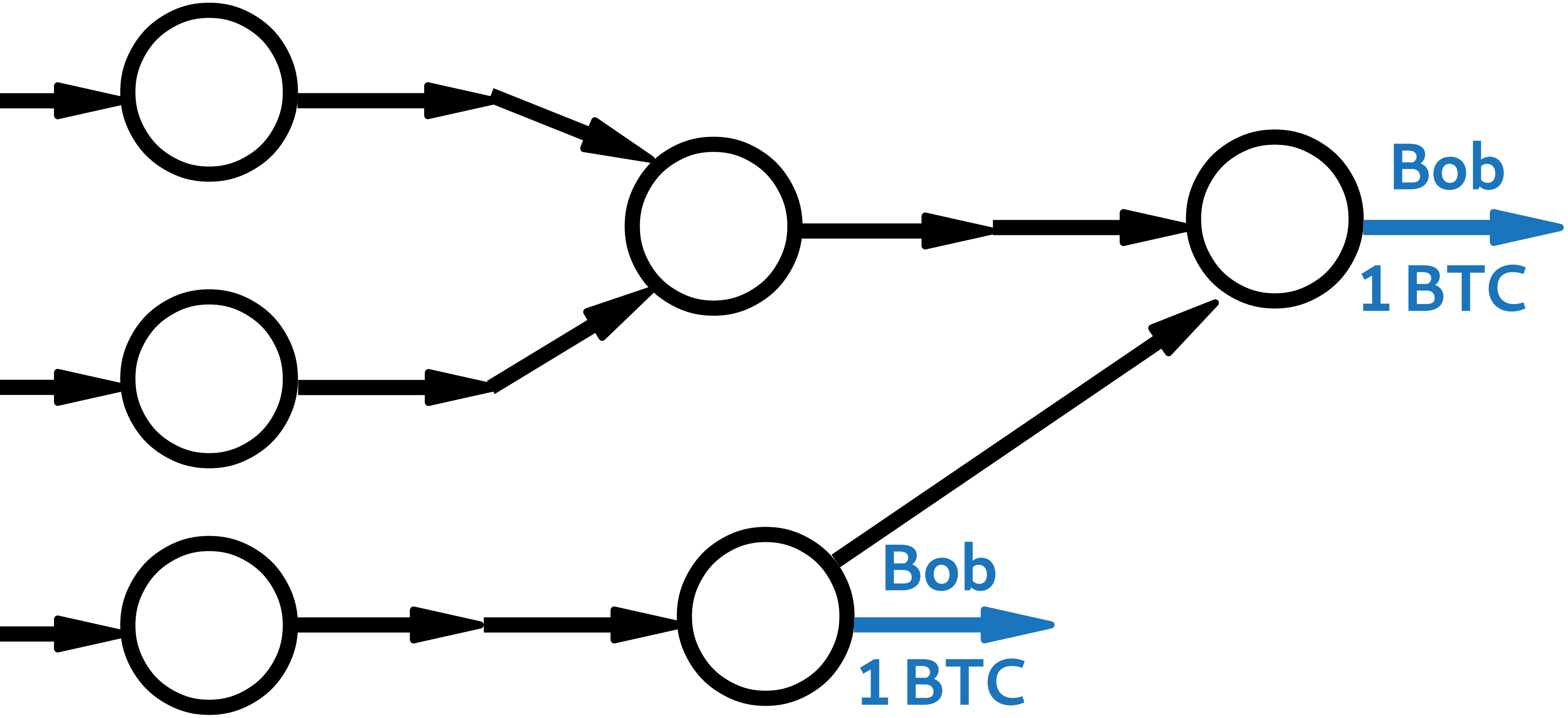
Many outputs



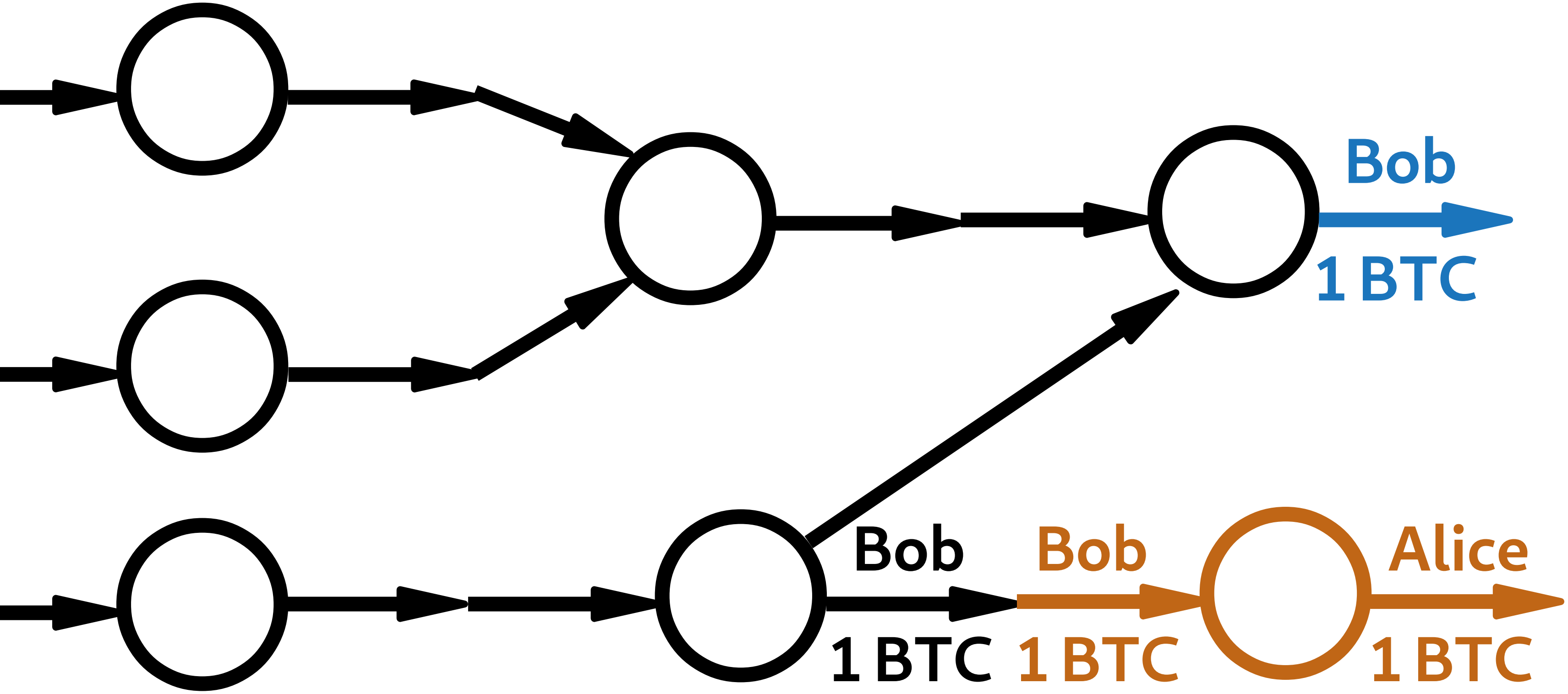
Unspent Transaction Outputs (UTXO)



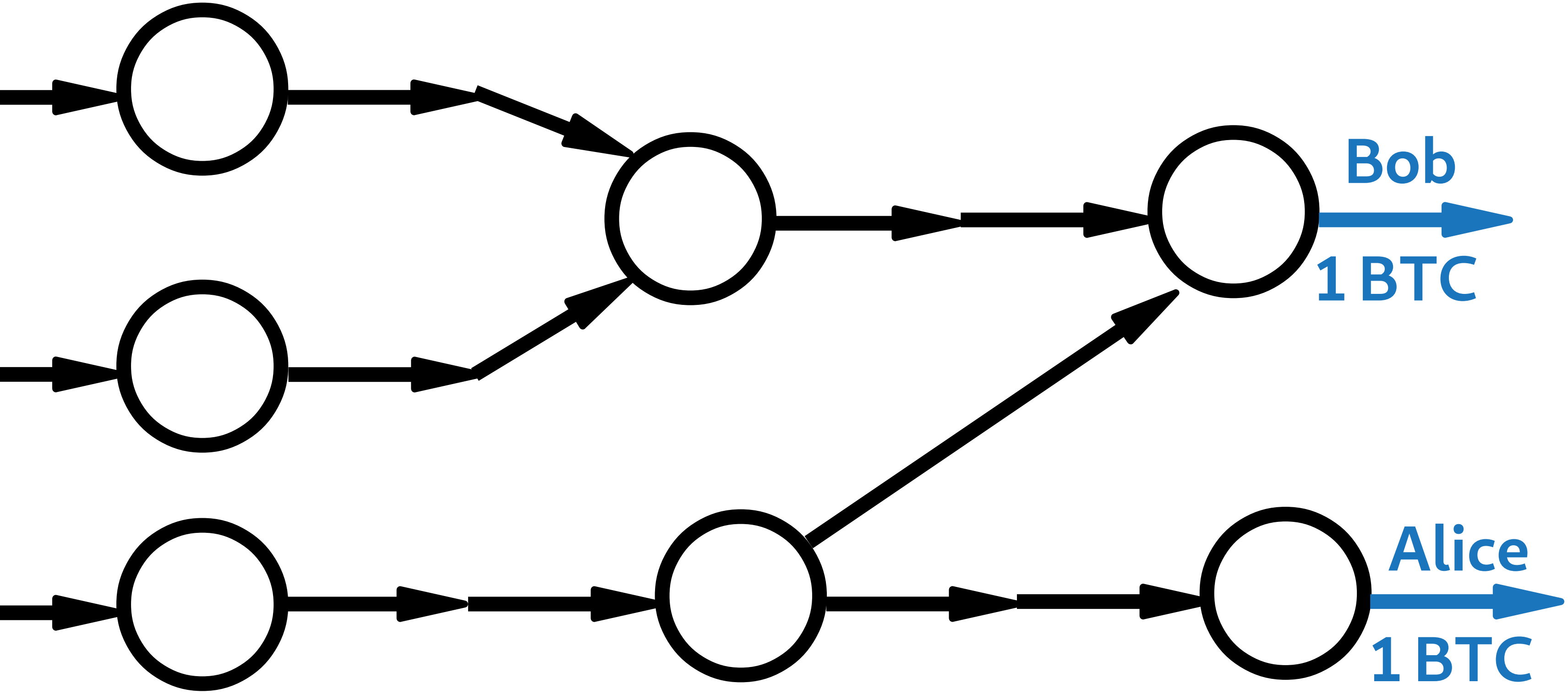
Bob has 2 BTC



Bob pays 1 BTC to Alice



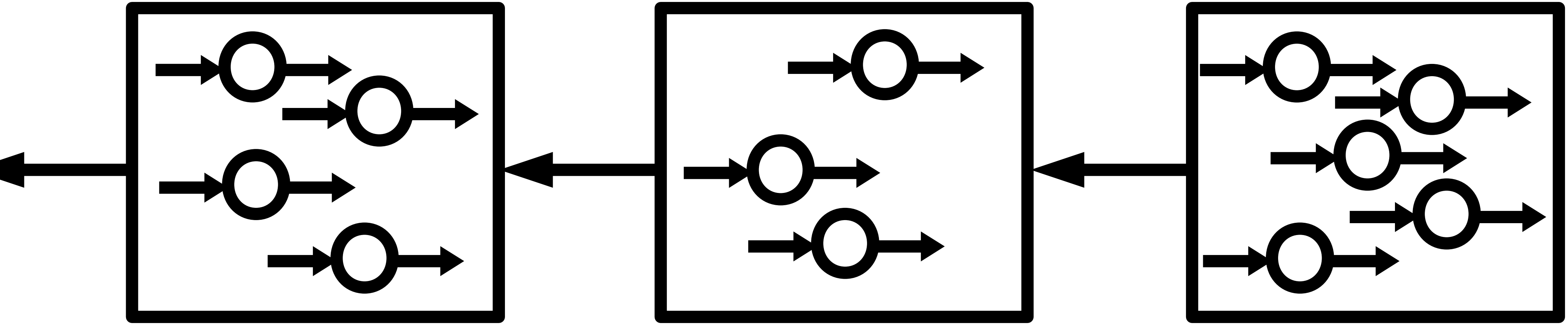
New UTXO



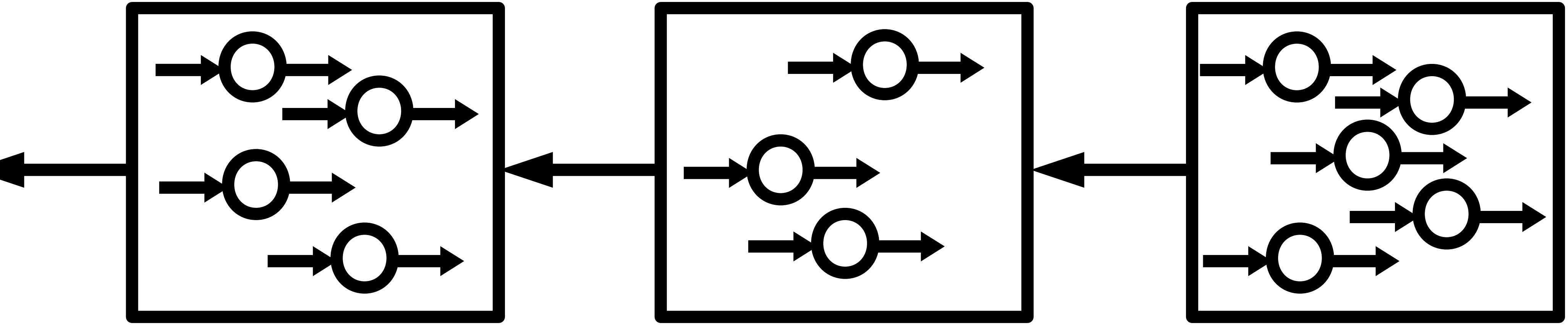
Block

- Contains
  - ▪ transactions
  - ▪ metadata
- Has unique parent

Blockchain

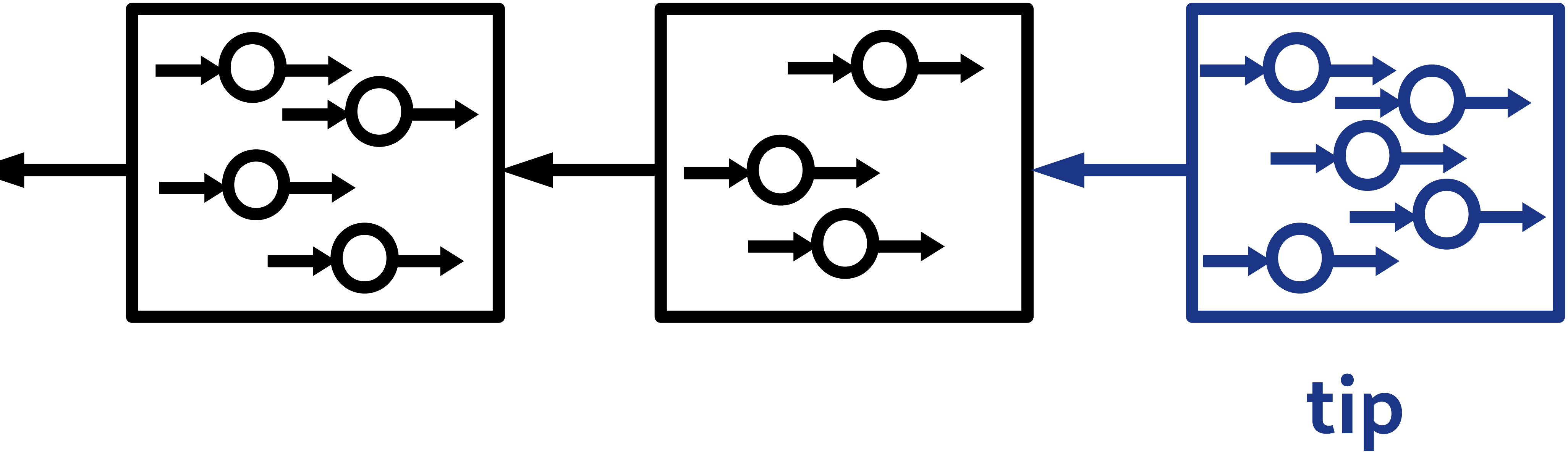


Blockchain

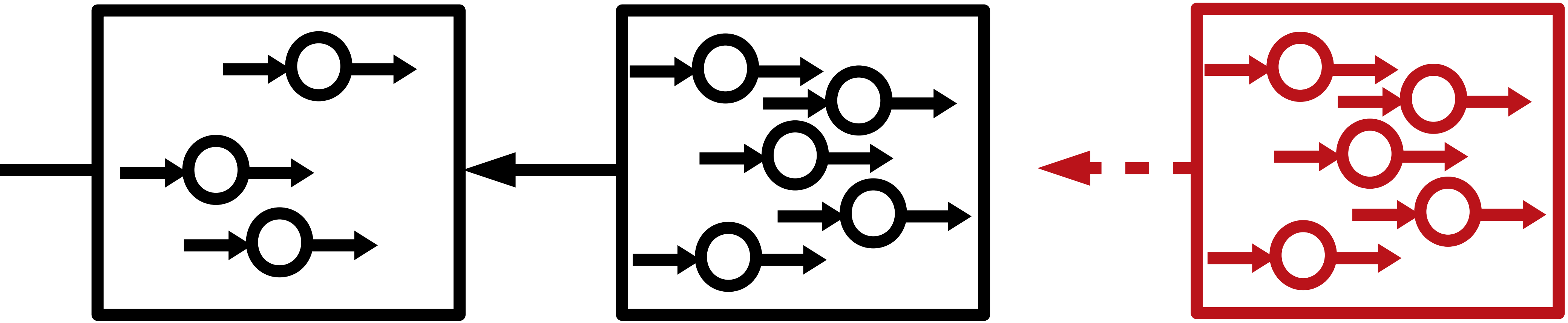


History of all transactions

Blockchain

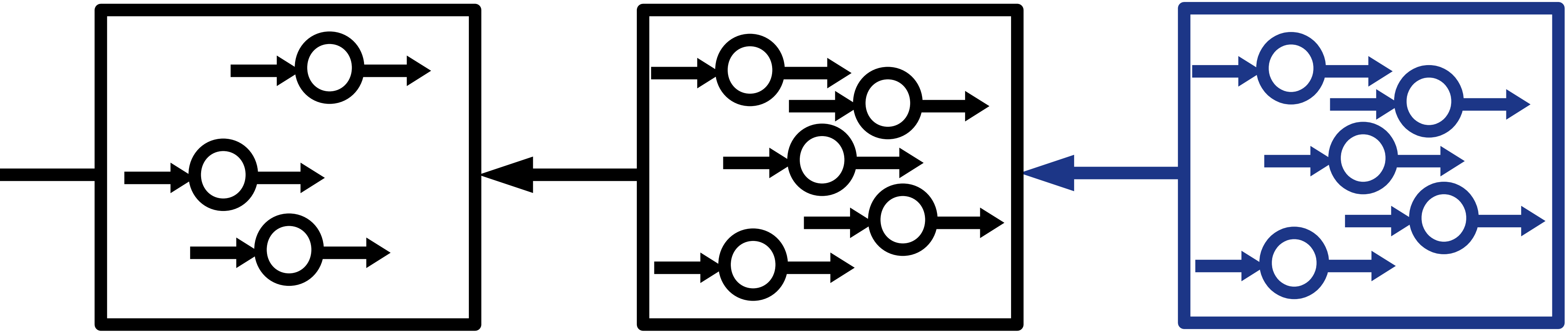


Mining (a.k.a. writing history)



- Only valid transactions?
- Proof of Work?

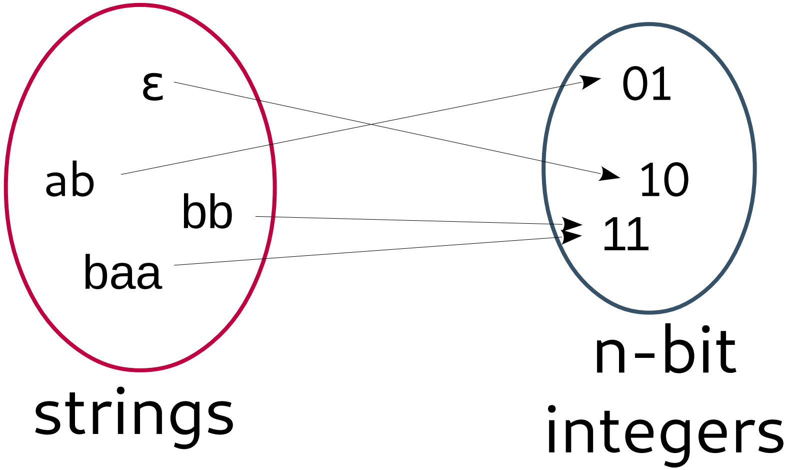
Mining (a.k.a. writing history)



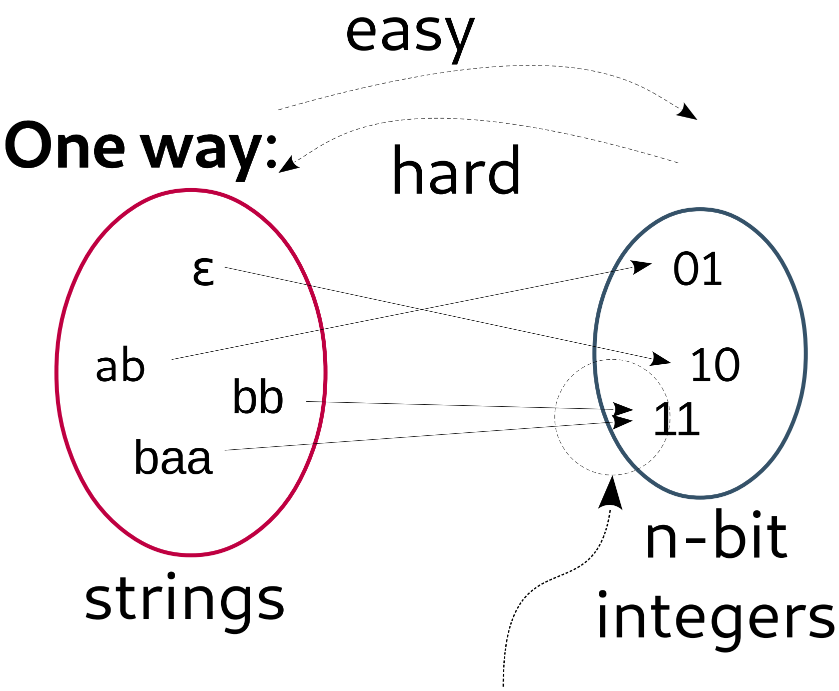
- Only valid transactions!
- Proof of Work!

new tip

Hash function



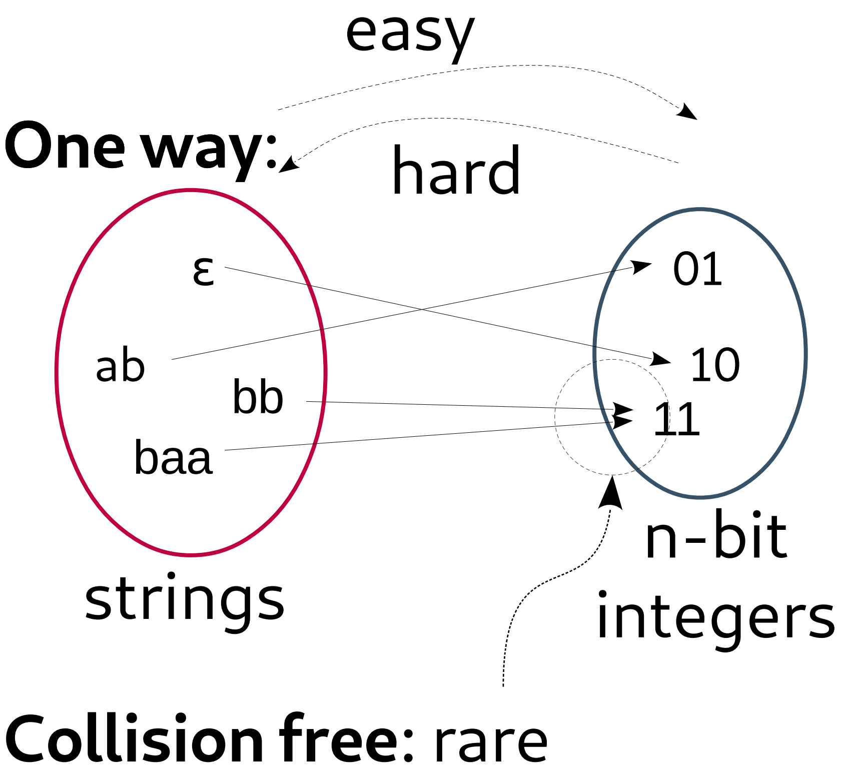
Hash function



One way:

Collision free: rare

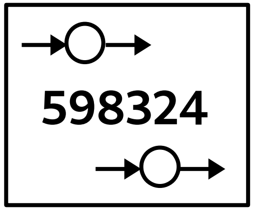
Hash function



One way:

Collision free: rare

Bitcoin uses SHA256, e.g.:

SHA256() =

0000000000000000000
d7819fc59c65ca6f3e8f73c
6eeadf538aa874a31341fb

Proof of work

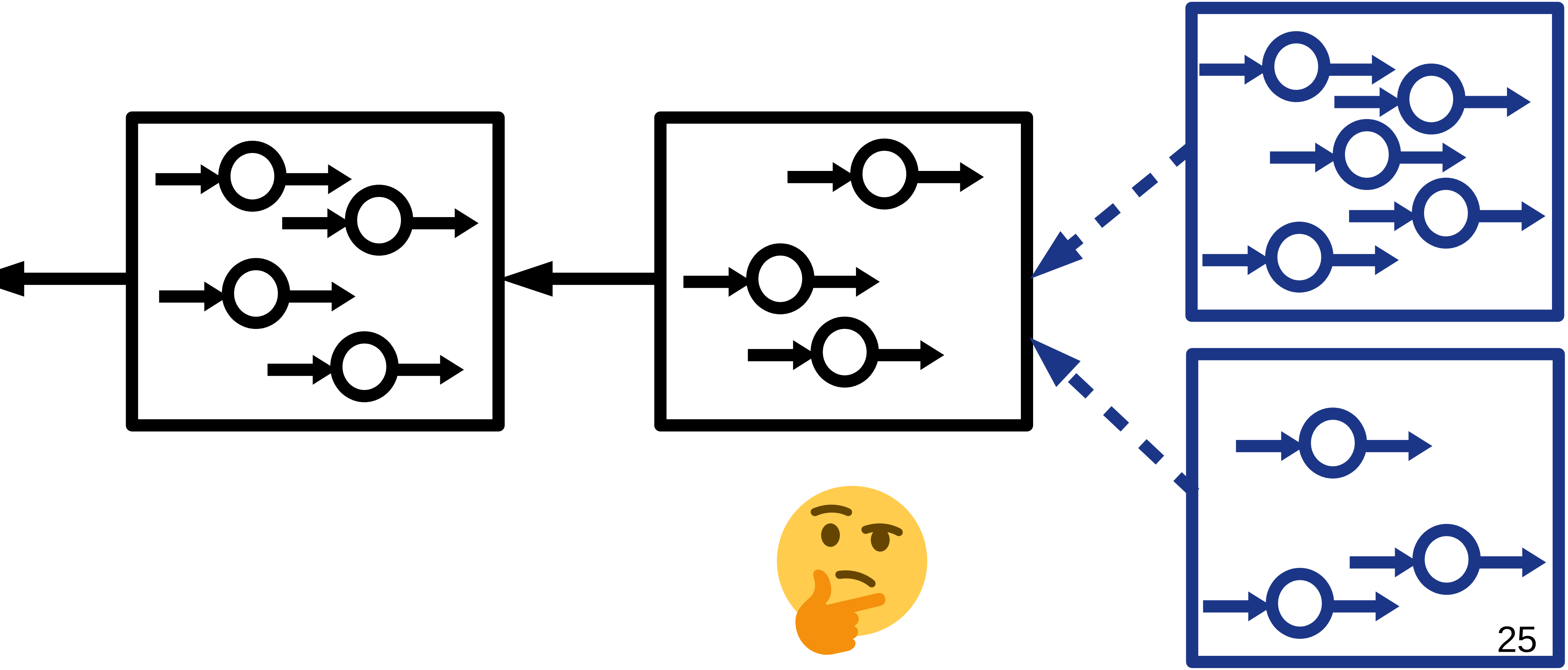
```
def hasProofOfWork(block):
  if hasManyLeadingZeroes(SHA256(block)):
    return True
  return False
```

Valid blocks need energy

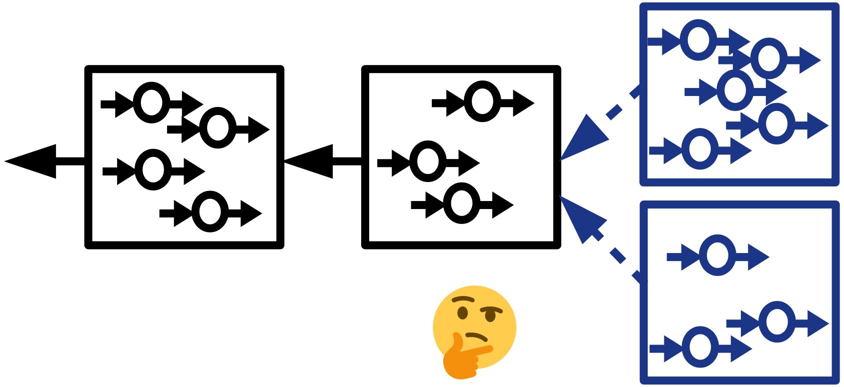
→

can’t spam blocks

Forks



Forks



Protocol says:

- Choose longest fork
- If equal, choose random

Nice properties

if *honest* mining power > 50%,

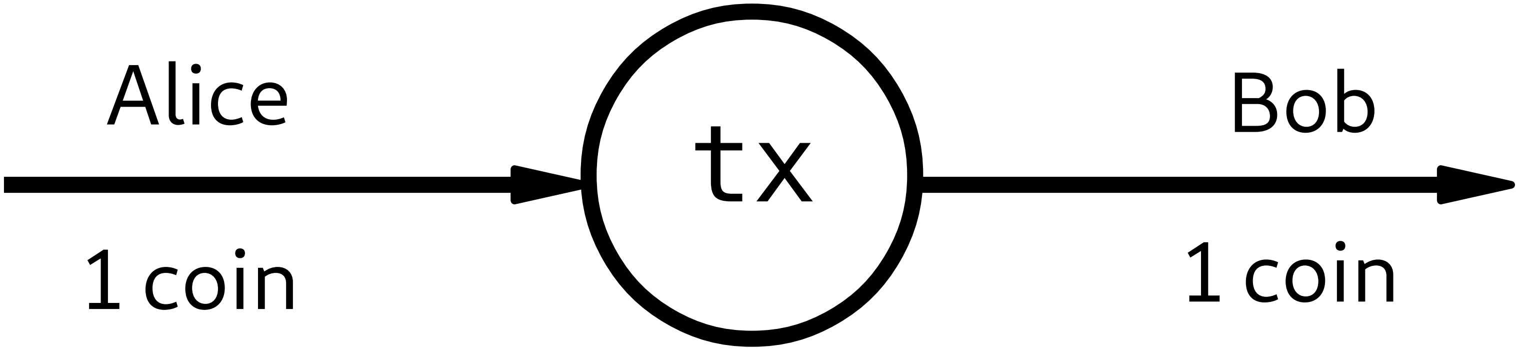
- **Liveness**: a new tx *will enter* the chain
- **Persistence**: Old blocks *won't change*

Garay, Kiayias, Leonardos. "The bitcoin backbone protocol: Analysis and applications." Annual International Conference on the Theory and Applications of Cryptographic Techniques. Springer, Berlin, Heidelberg, 2015.

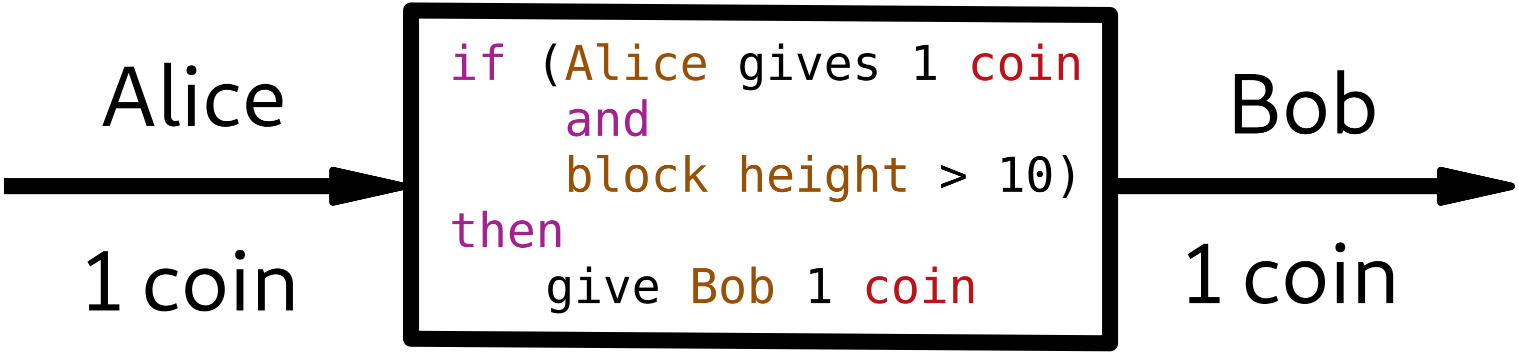
Part II

Smart Contracts: Programmable money

Remember transactions?



Now add some code!



Alice

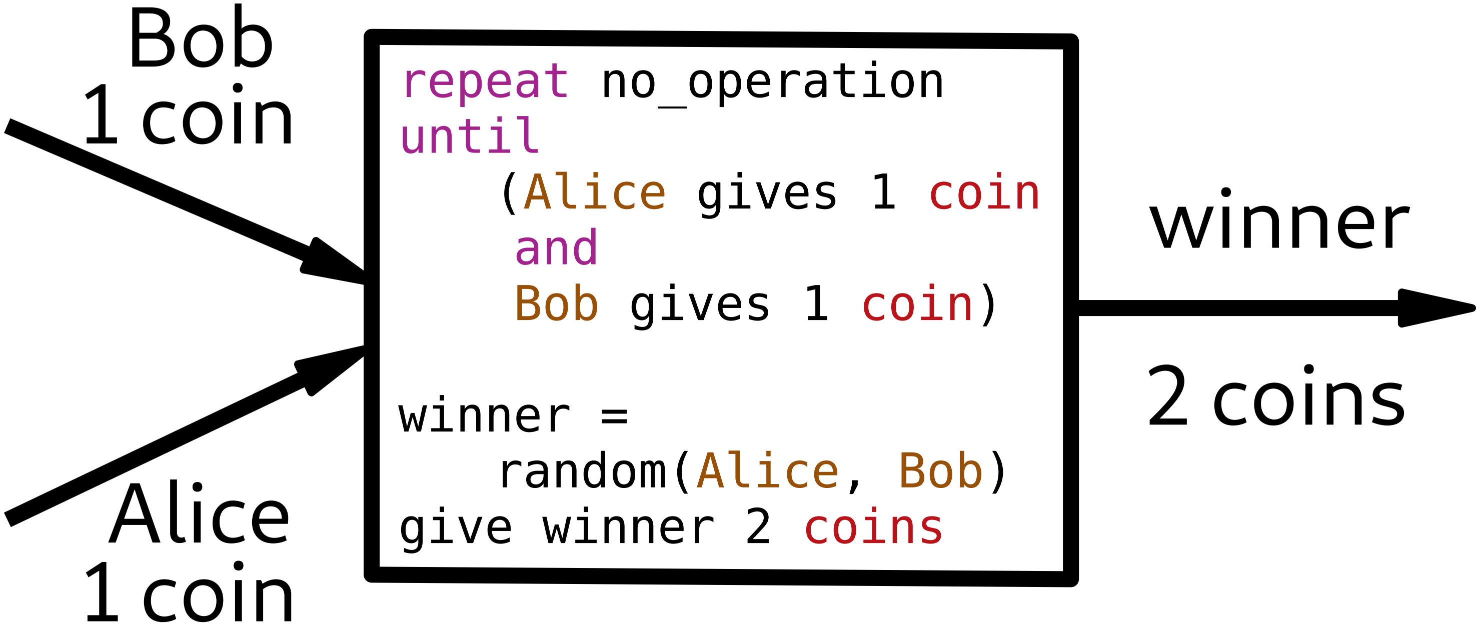
1 coin

```
if (Alice gives 1 coin
    and
    block height > 10)
then
   give Bob 1 coin
```

Bob

1 coin

Example 1: Flip a coin



Bob
1 coin

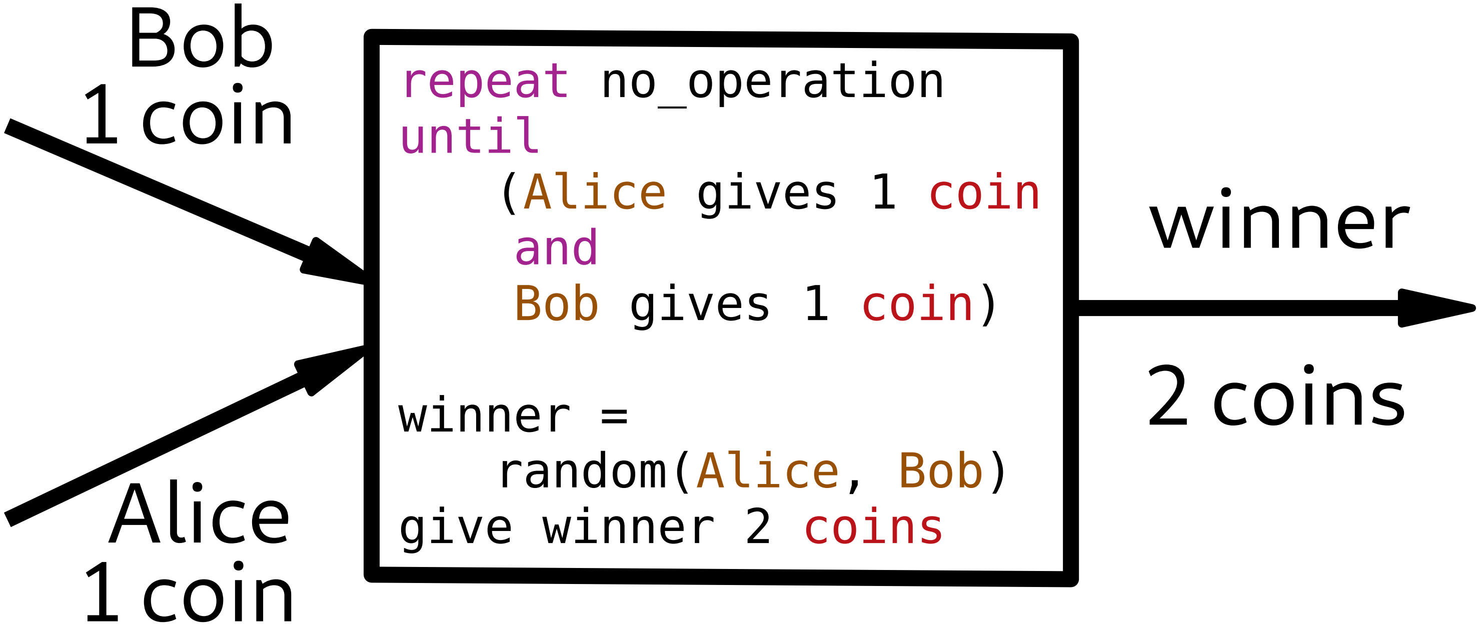
```
repeat no_operation
until
    (Alice gives 1 coin
     and
     Bob gives 1 coin)

winner =
    random(Alice, Bob)
give winner 2 coins
```

Alice
1 coin

winner

2 coins

Example 1: Flip a coin



Bob
1 coin

Alice
1 coin

```
repeat no_operation
until
    (Alice gives 1 coin
     and
     Bob gives 1 coin)

winner =
    random(Alice, Bob)
give winner 2 coins
```

winner

2 coins

Don’t use this contract in real life!

Example 2: King of the Hill

```
top = 0
king = null
while (true)
  if (user gives x coins
      and
      x > top)
     give king top coins
     king = user
     top = x
```

Don’t use this contract in real life!

Still too hard

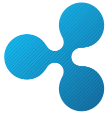
A fast way to lose your (and others')

Smart Contracts: ~~Programmable~~ money

- Very easy to make mistakes
  - TheDAO
  - Parity wallet
- Smart contract languages not (yet) safe

Part III

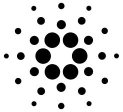
LND

 v

Types of blockchains, applications and the future

DASH

v

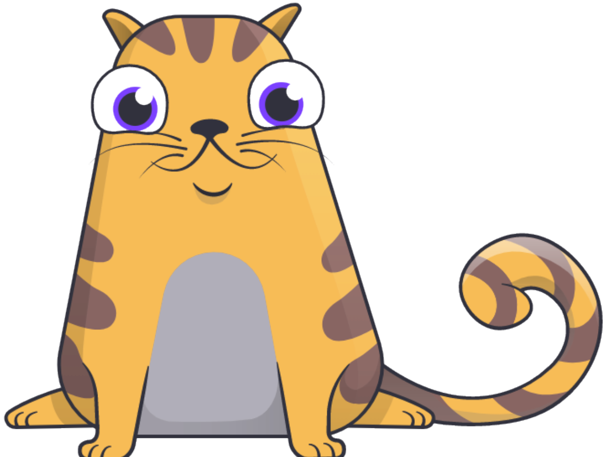


Xchain

v

Cryptokitties

Cute kitties that live on Ethereum!



MakerDao

- Decentralised stablecoin
  - On Ethereum
- 1 Dai = 1 USD
- Overcollateralised by floating “Maker”

Types of blockchains

- Permissioned vs Permissionless

v

- Proof of Work vs Proof of Stake

DASH

v

- Private vs Transparent

v

Scalability issue

₿: 7 txs/sec

VISA: 20,000 txs/sec

Problem: too much redundancy

Candidate Solution

Payment Channels! (e.g. Lightning, LND)

- 1 tx on-chain to open channel
- Unlimited off-chain txs
- 1 tx on-chain to close channel

Crosschain transactions

Move coins to another chain

E.g. use bitcoins in Ethereum contracts

Interconnected blockchains

Specialised blockchains

Separation of duties

Related: Sharding

Questions?

Credits:

- Blockchain by Pablo Rozenberg from the Noun Project

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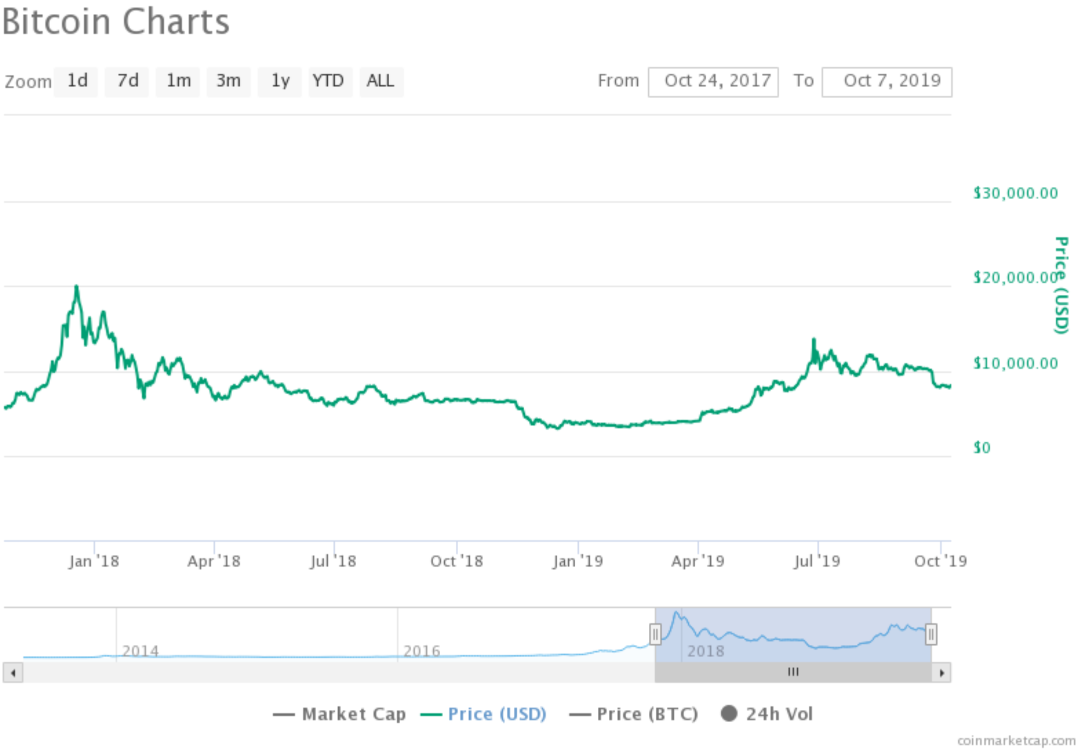
Bitcoin Charts

Zoom 1d 7d 1m 3m 1y YTD ALL

From Oct 24, 2017 To Oct 7, 2019