

区块链技术

Course Overview

上次课程内容



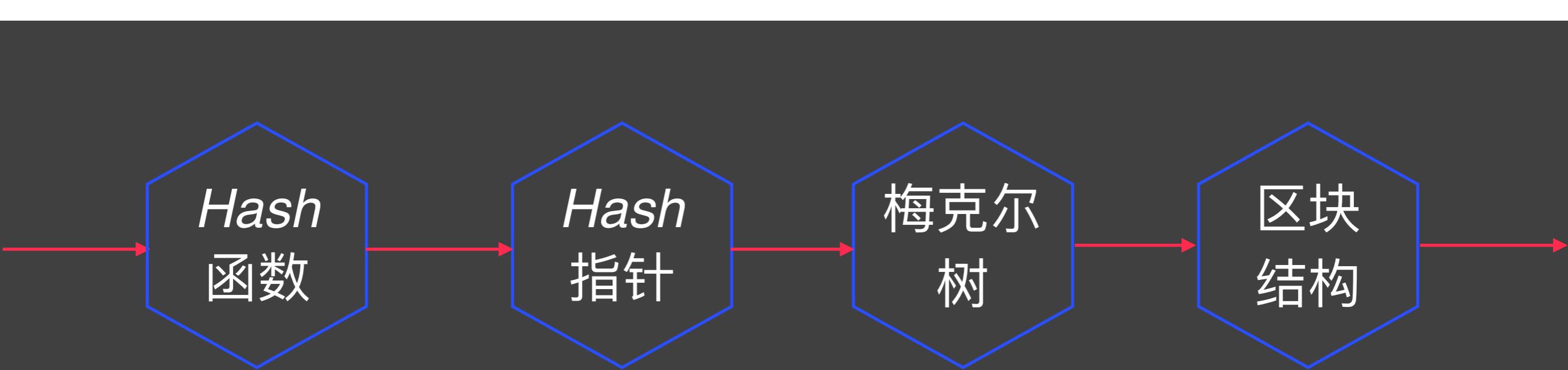
- 交易
- 交易历史
- 金融创新
- 记账历史

- 区块链定义
- 账本集vs. 分
- 区块链结构
- 租车例子

- 区块链起源
- 比特币
- 区块链发展
- 智能合约
- ICO

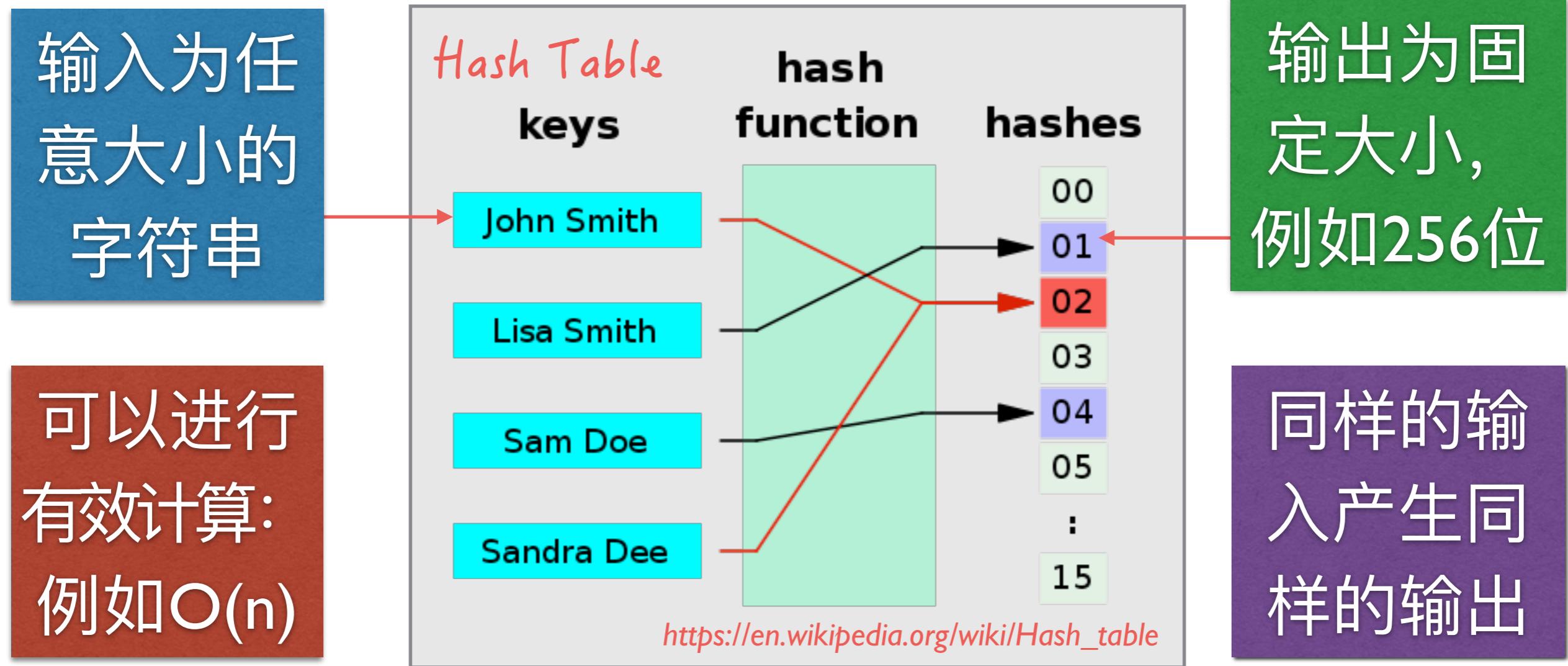
- 计算视角
- 网络视角
- 是否使用
- 面临挑战

区块



Hash函数

https://en.wikipedia.org/wiki/Hash_function



可以进行有效计算：
例如 $O(n)$

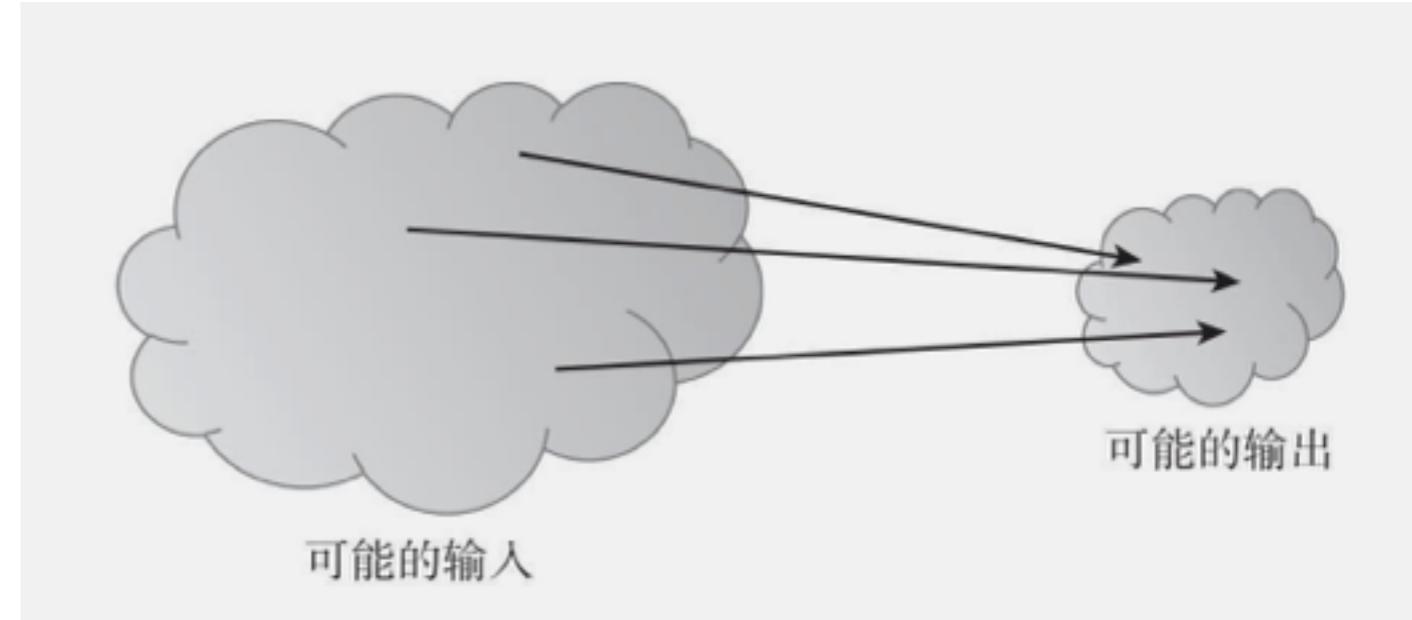
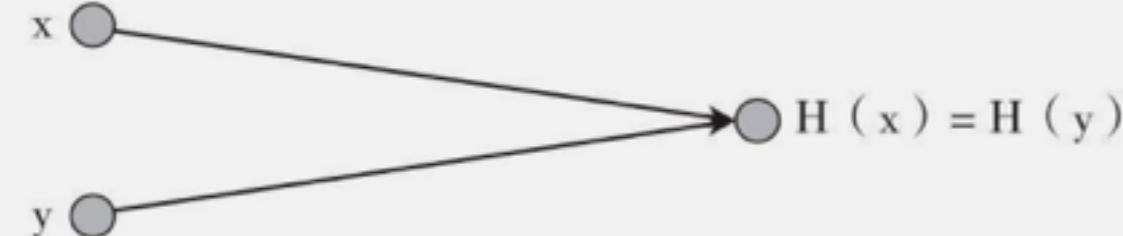
同样的输入产生同样的输出



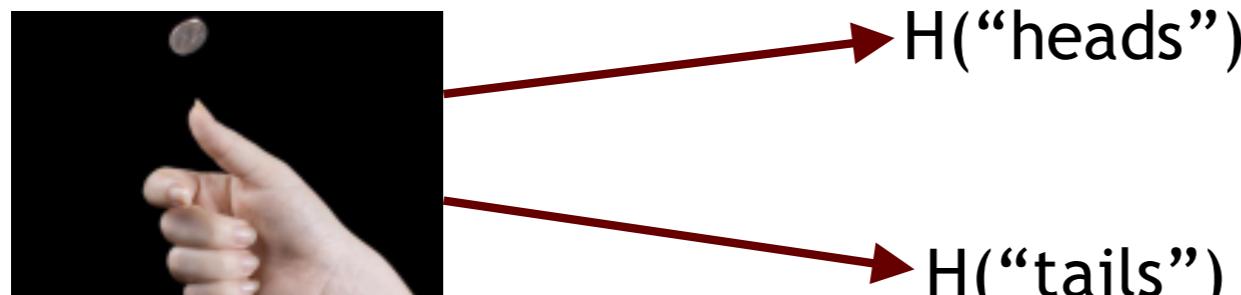
<http://www.fileformat.info/tool/hash.htm>

Hash函数

抗碰撞



隐匿性



给出 $H(x)$, 不能找到 x

单向性

已知 x , 计算 $H(x)$ 容易

已知 $H(x)$, 求 x 困难

难题友好

Hash指针

Hash指针：
是一个指向存储数据
及其数据Hash的指针

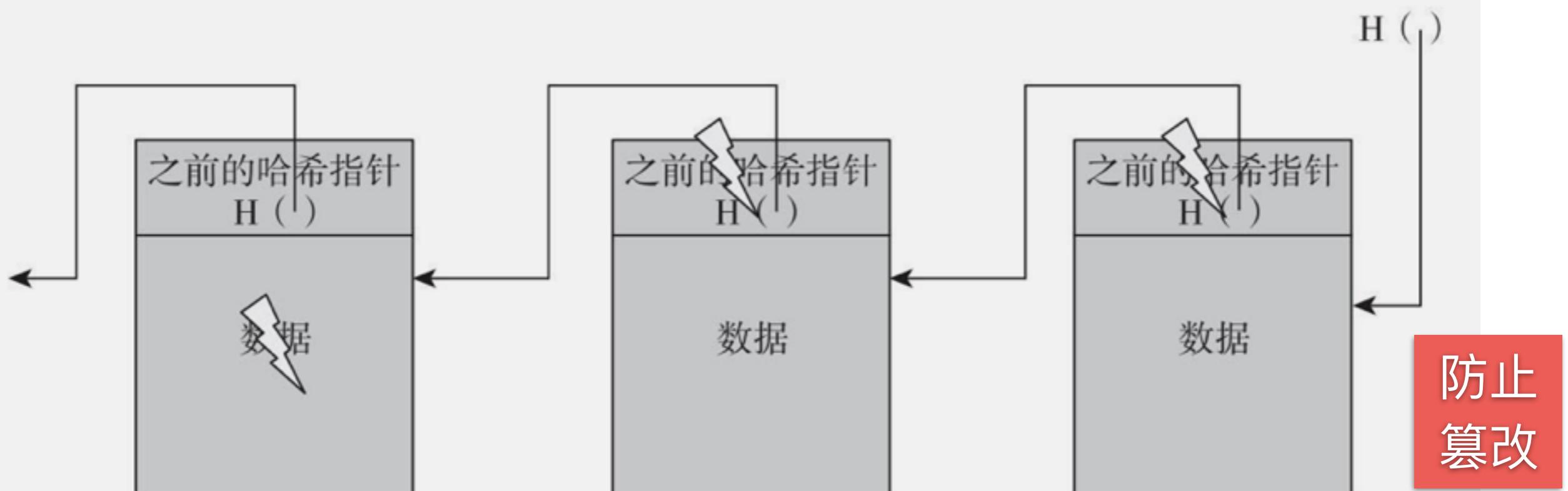
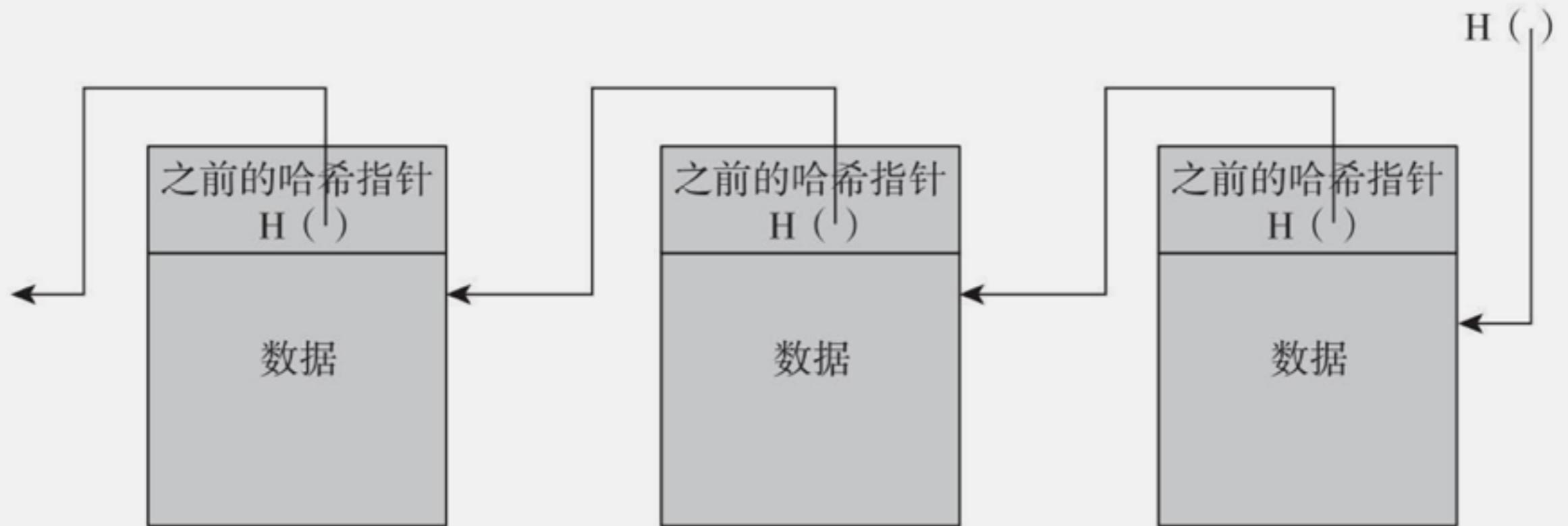
取回数据
验证数据是否改变

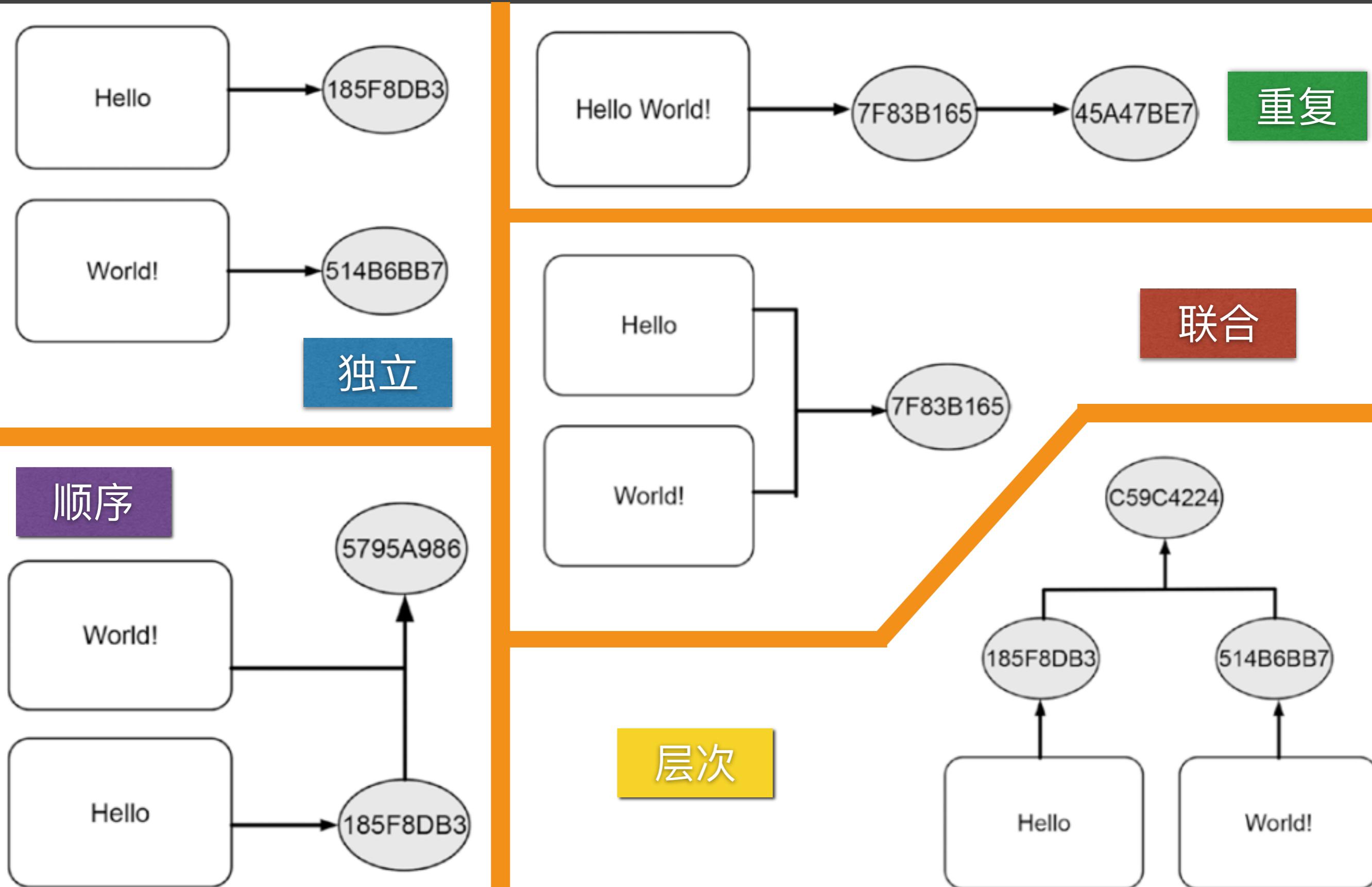
区块链的关键思想



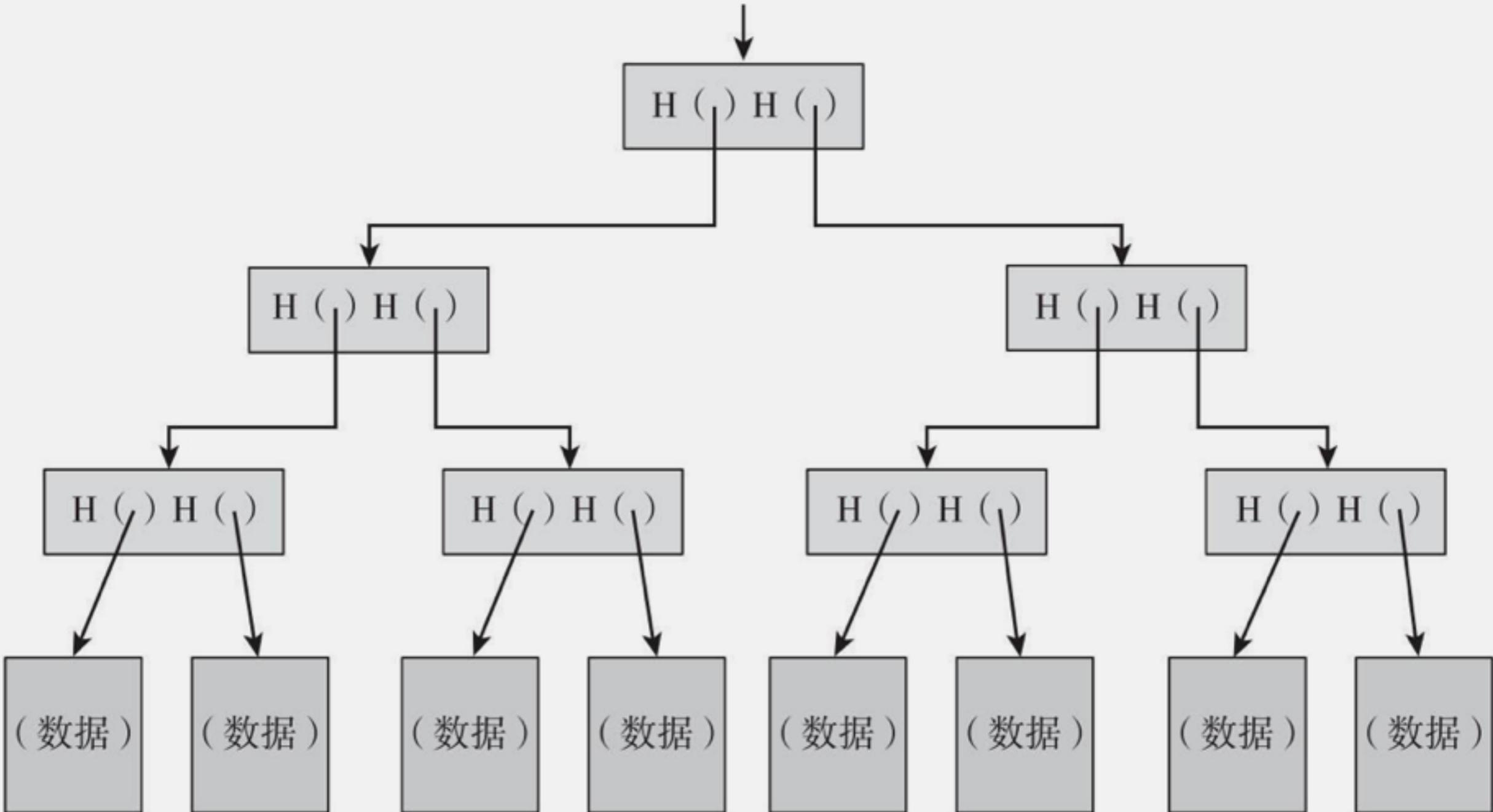
(数据)

区块链



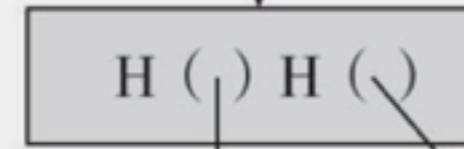
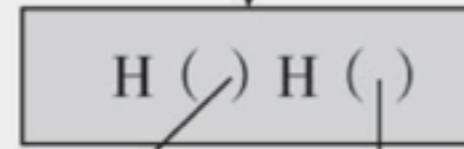
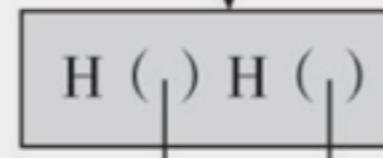
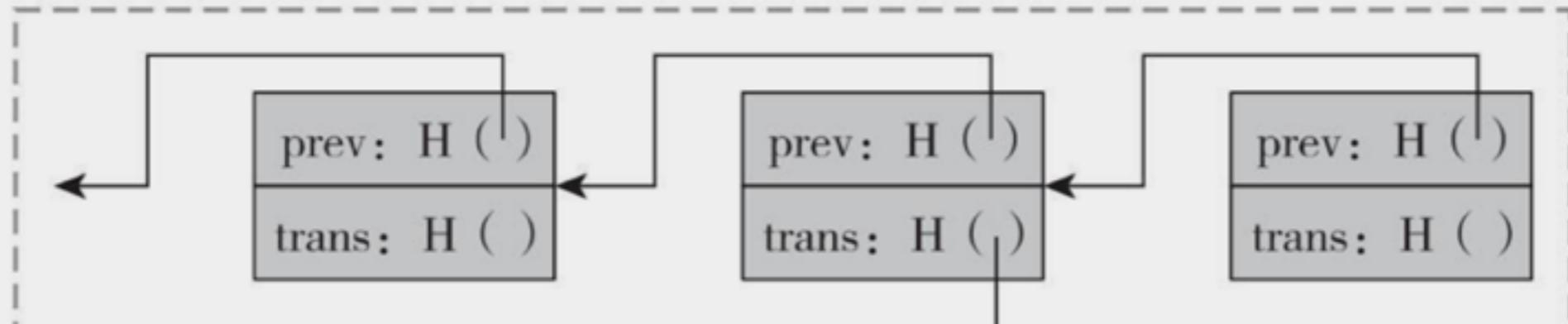


梅克尔树



区块结构

区块的哈希链



交易

交易

交易

交易

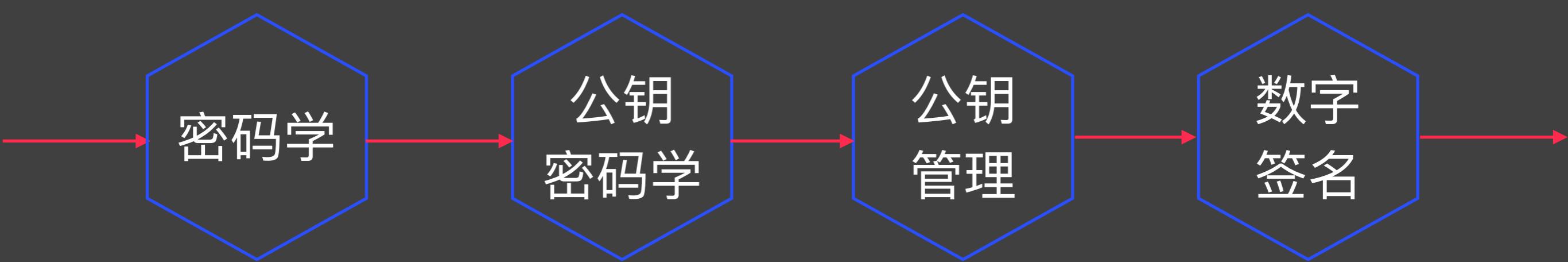
比特币

每个区块中各笔交易的哈希树（梅克尔树）

图3.7 比特币的区块链有两个哈希结构

注：一个就是把区块联结在一起的哈希链，另一个就是区块内部的交易哈希值梅克尔树。

密码



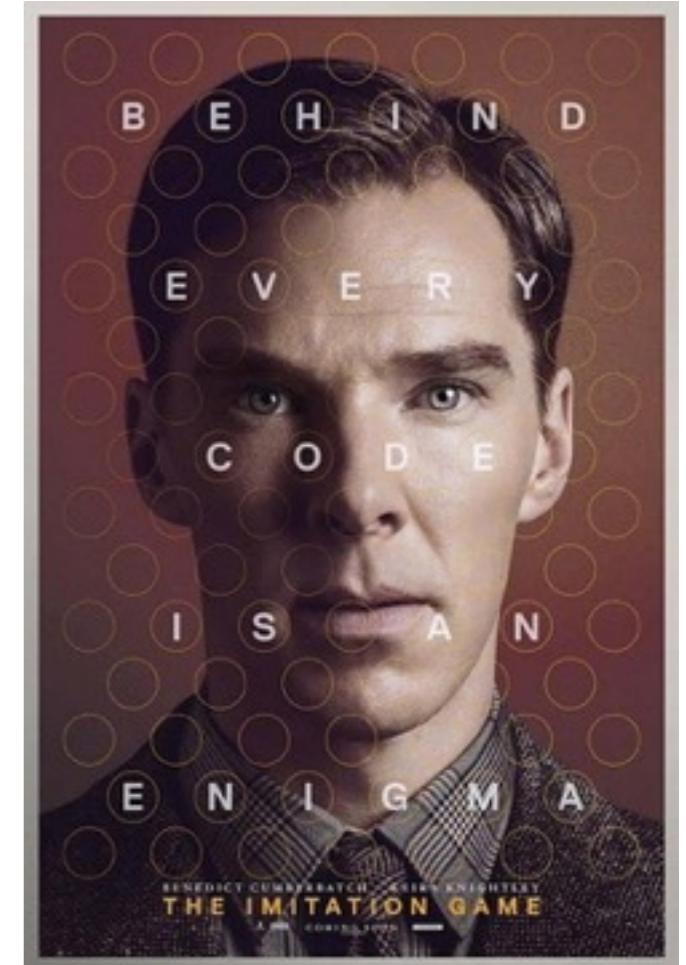
图灵



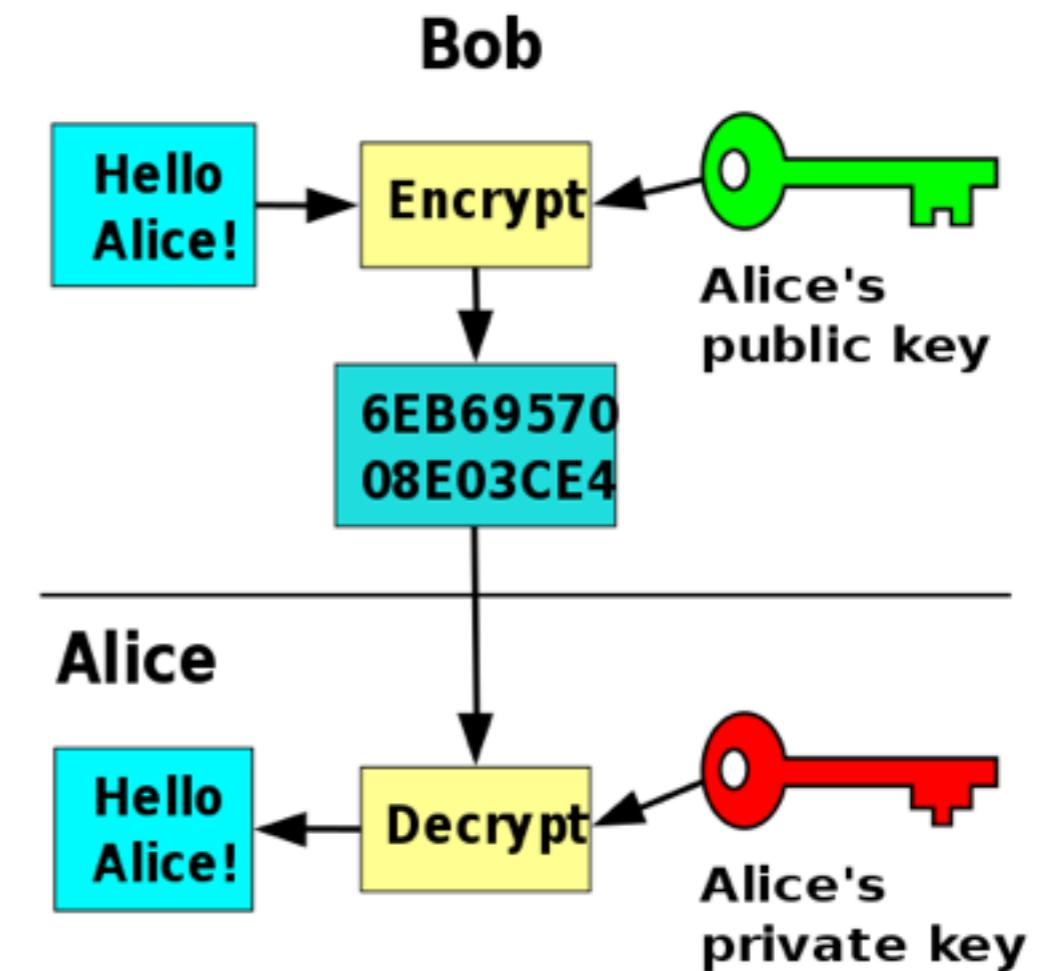
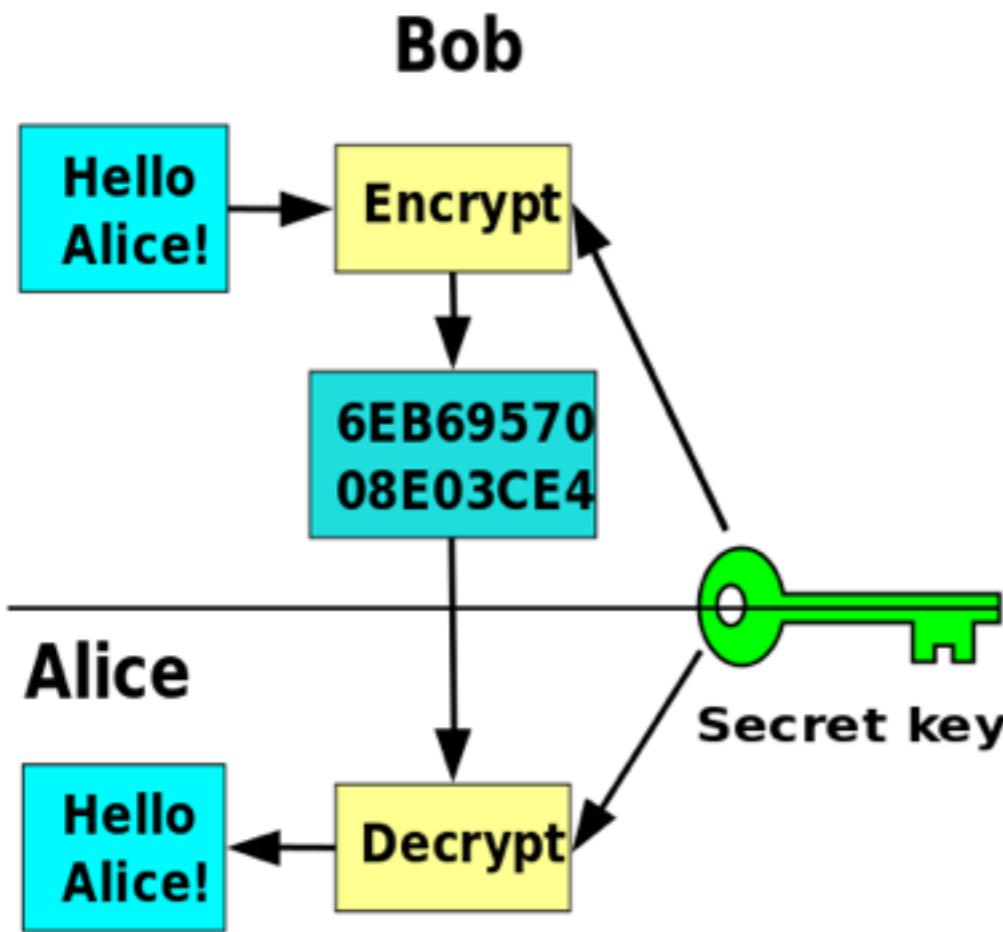
恩尼格玛密码机



模仿游戏



对称密码学 vs. 非对称密码学



对称密码学

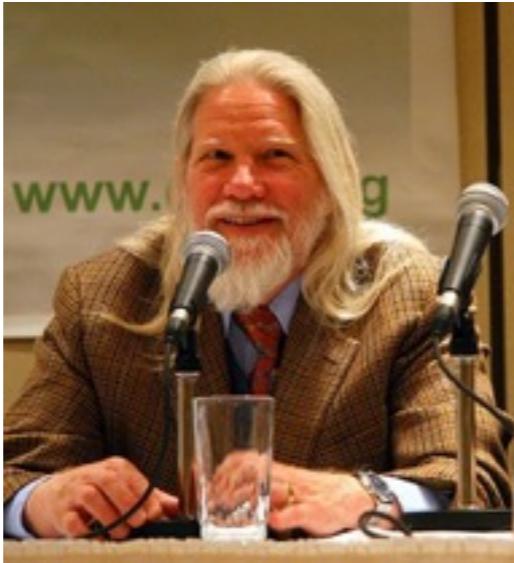
非对称密码学

Blockchain Technology

DH vs. RSA

2015年
图灵奖

1976



Whitfield Diffie



Martin Hellman



Ralph Merkle

1978

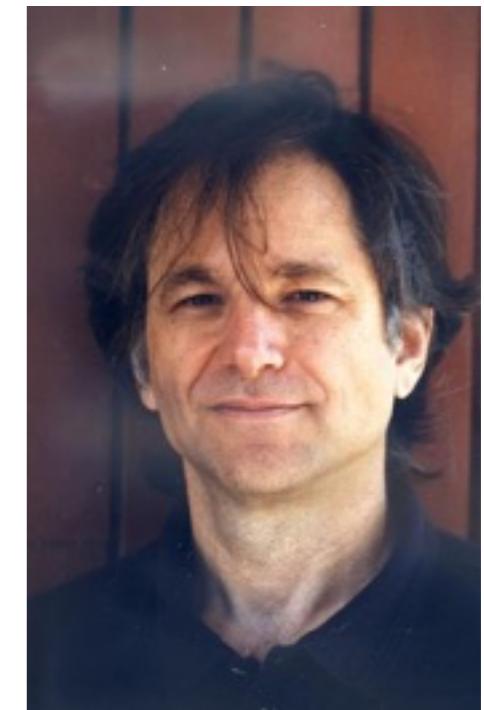
2002年
图灵奖



Ronald L. Rivest



Adi Shamir



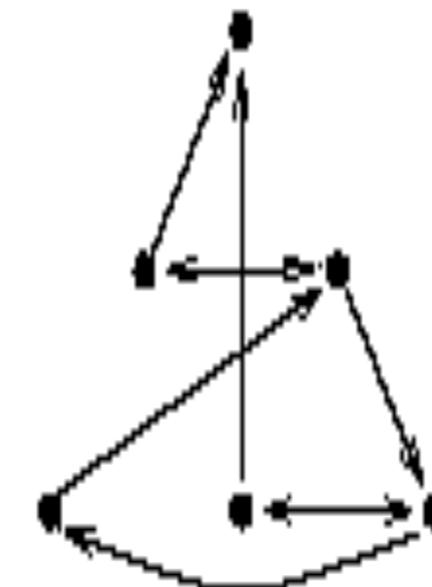
Leonard Max Adleman

公钥管理: PKI vs. PGP

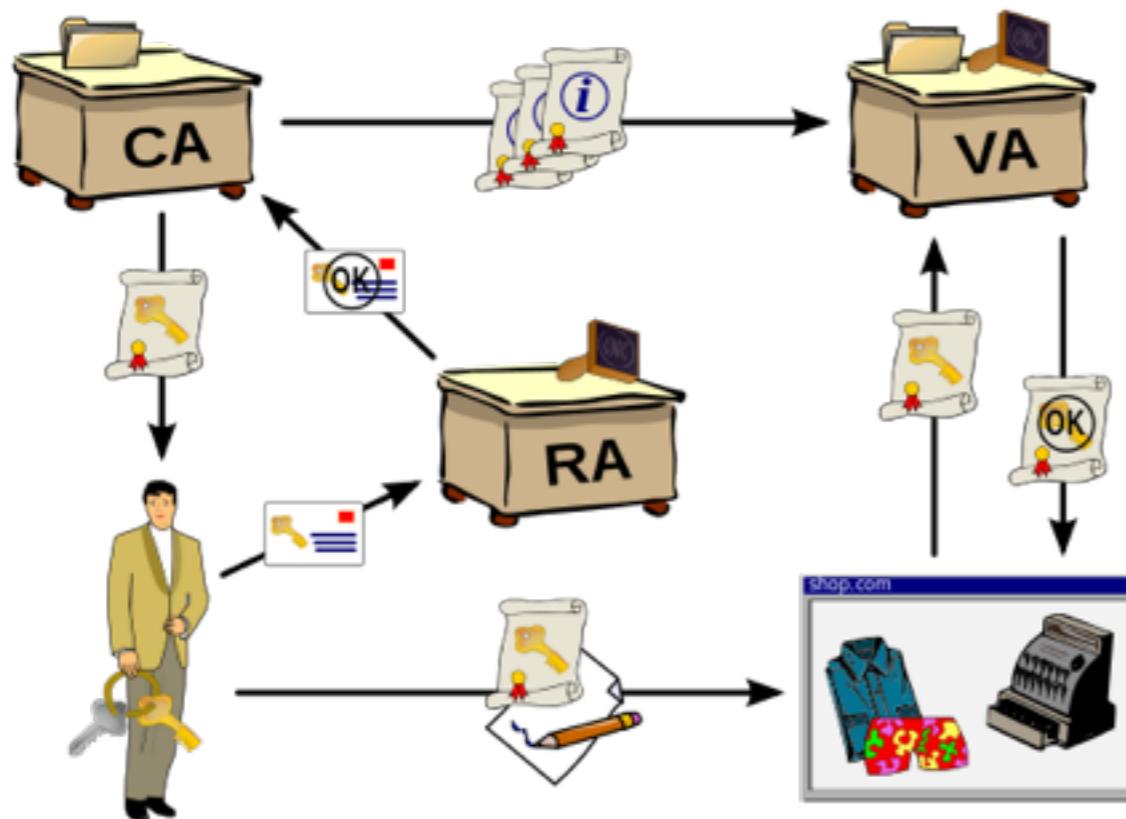
RSA



VERISIGN™



公钥管理
的P2P版本



P G P®

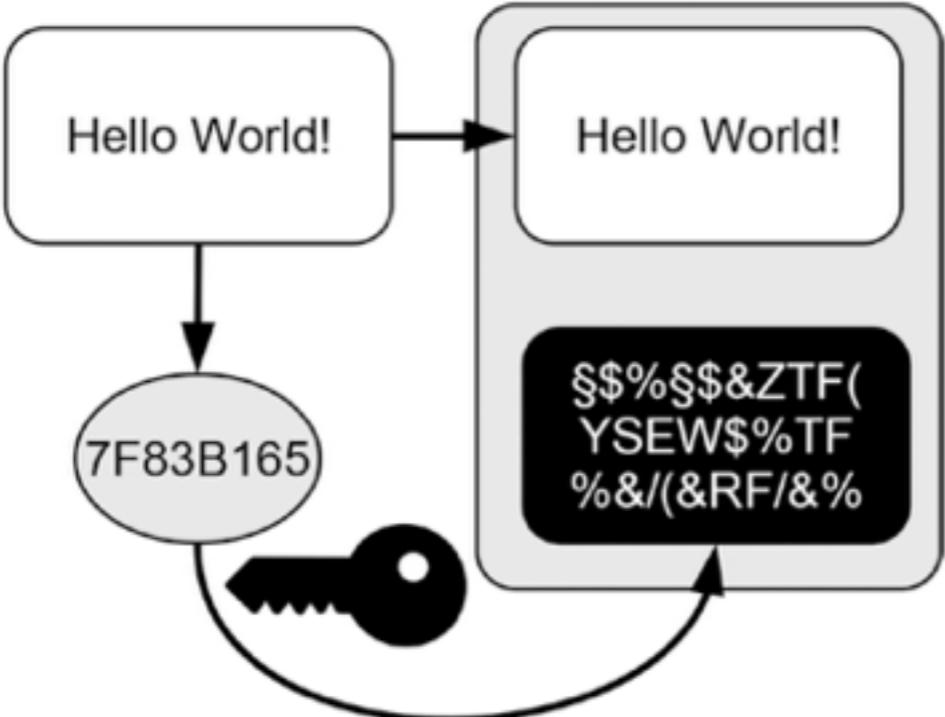
1991

GnuPG
1999

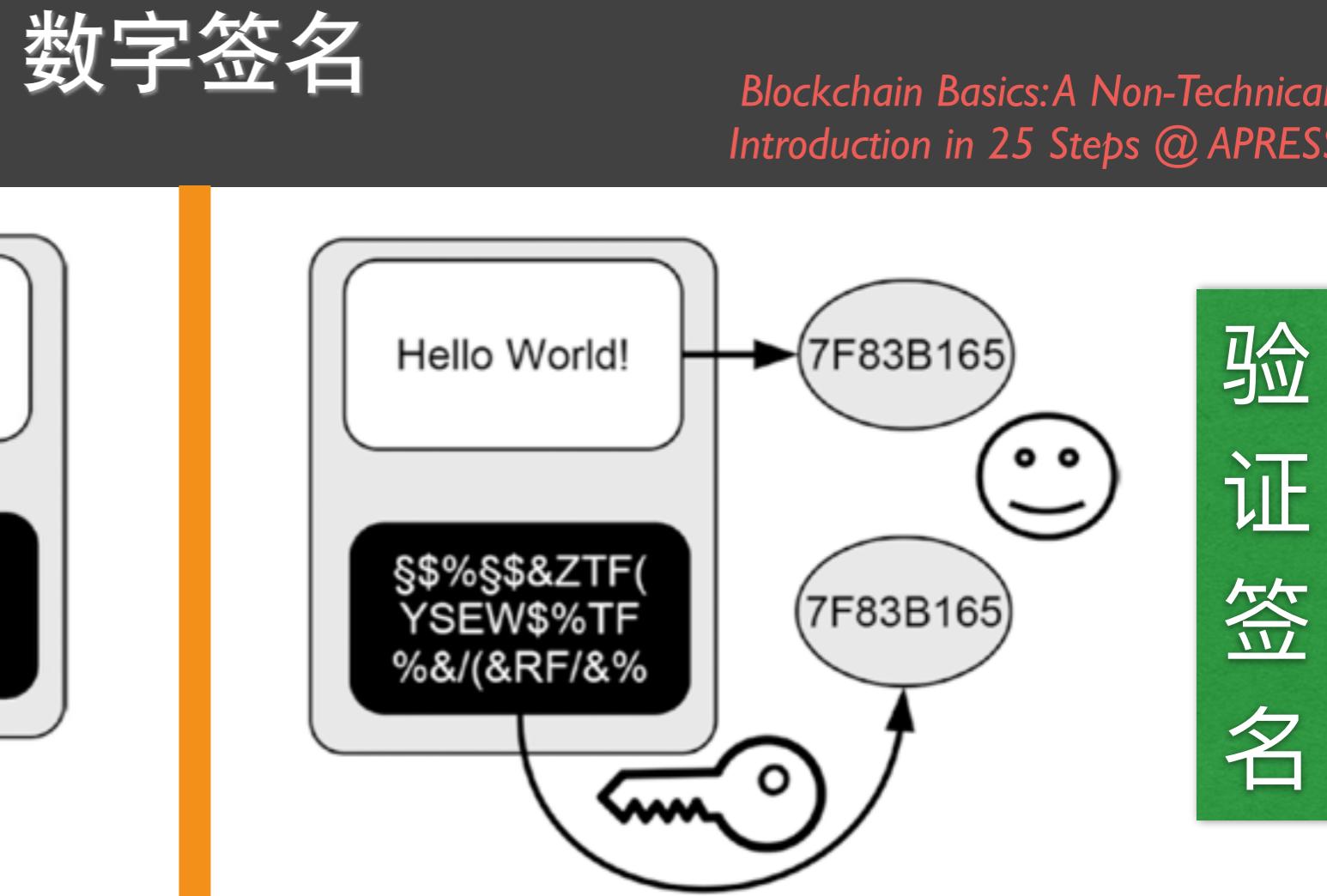
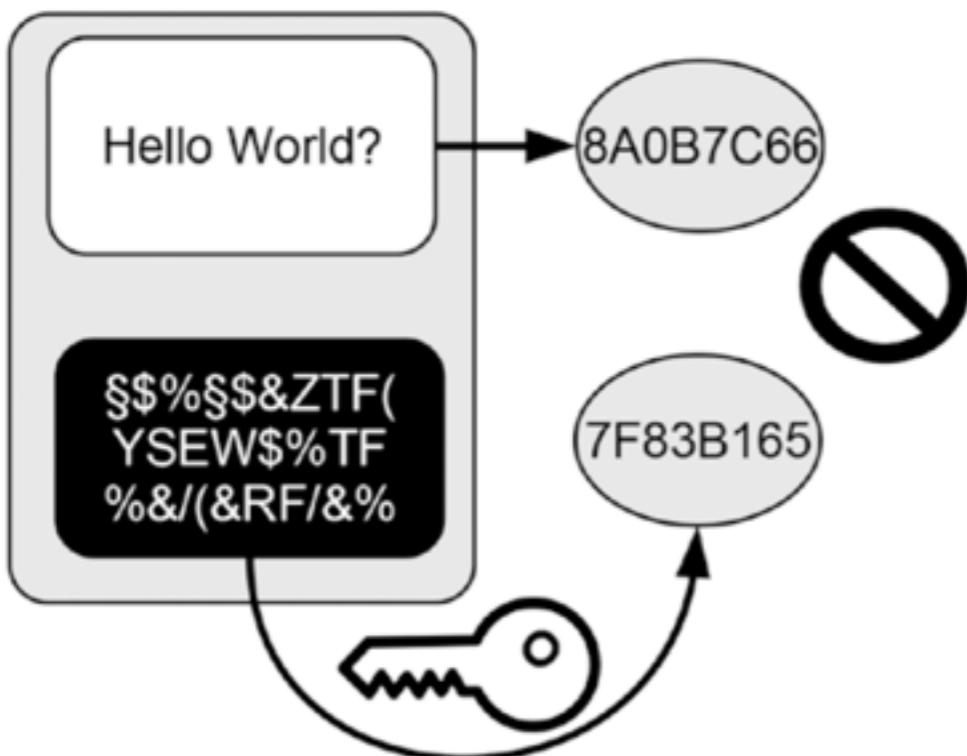


Phil Zimmermann

产生签名



发现欺骗



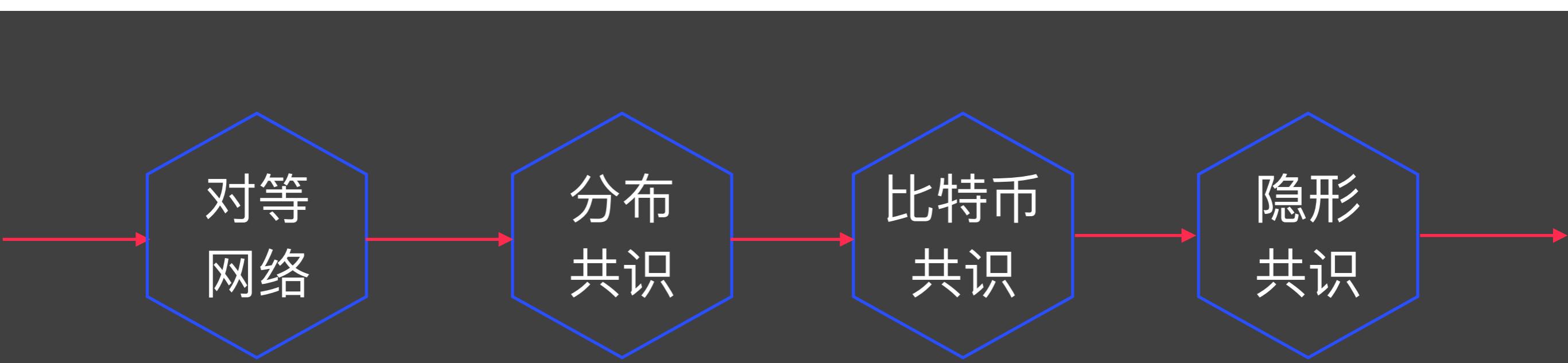
自己签名，任何人都可以验证（公钥分发）

不可伪造，公钥私钥

签名信息的大小

验证签名

共识



Blockchain Technology

Peer to Peer

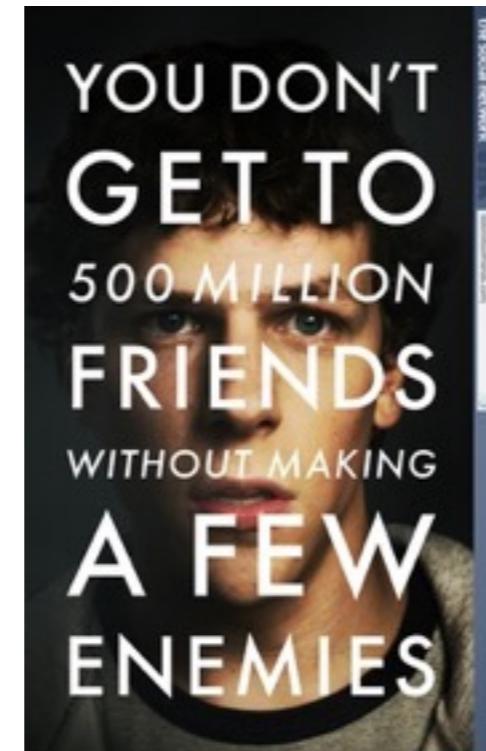


napster™

1999



Sean Parker



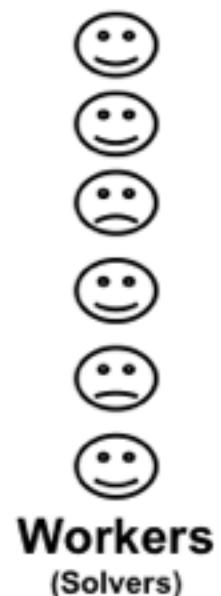
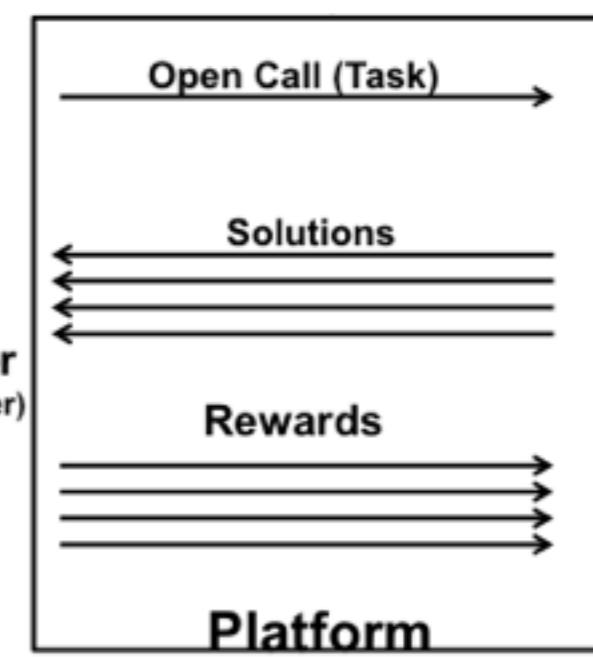
The Social Network



2003



众包



**Workers
(Solvers)**

Blockchain Technology

BitTorrent

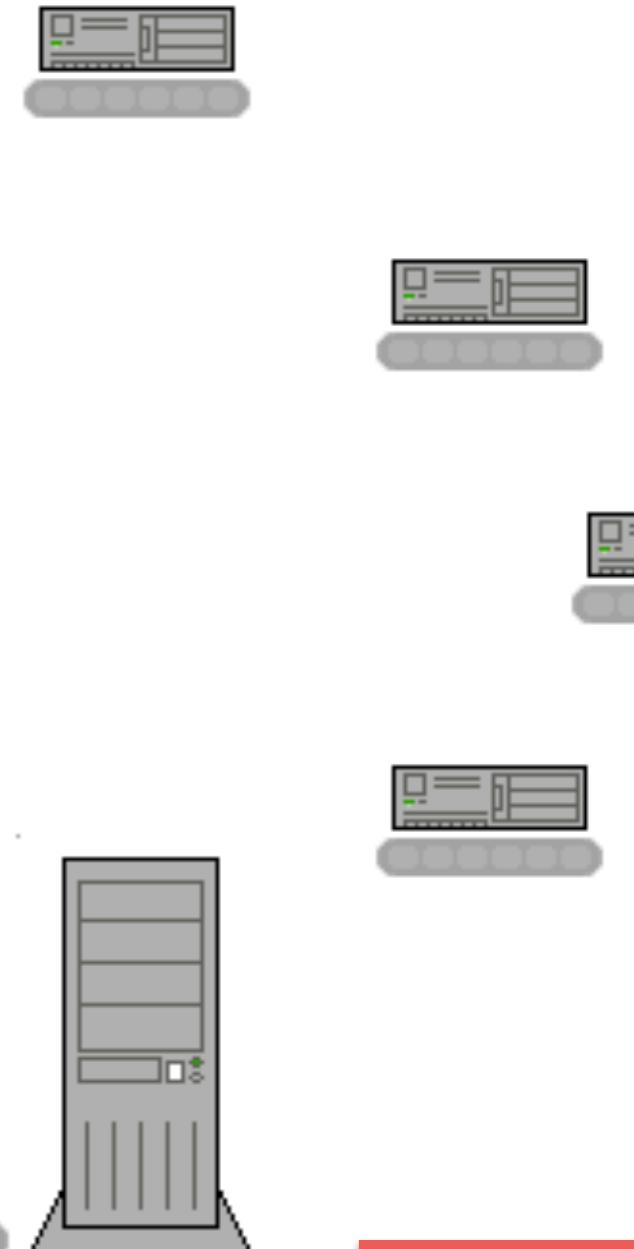
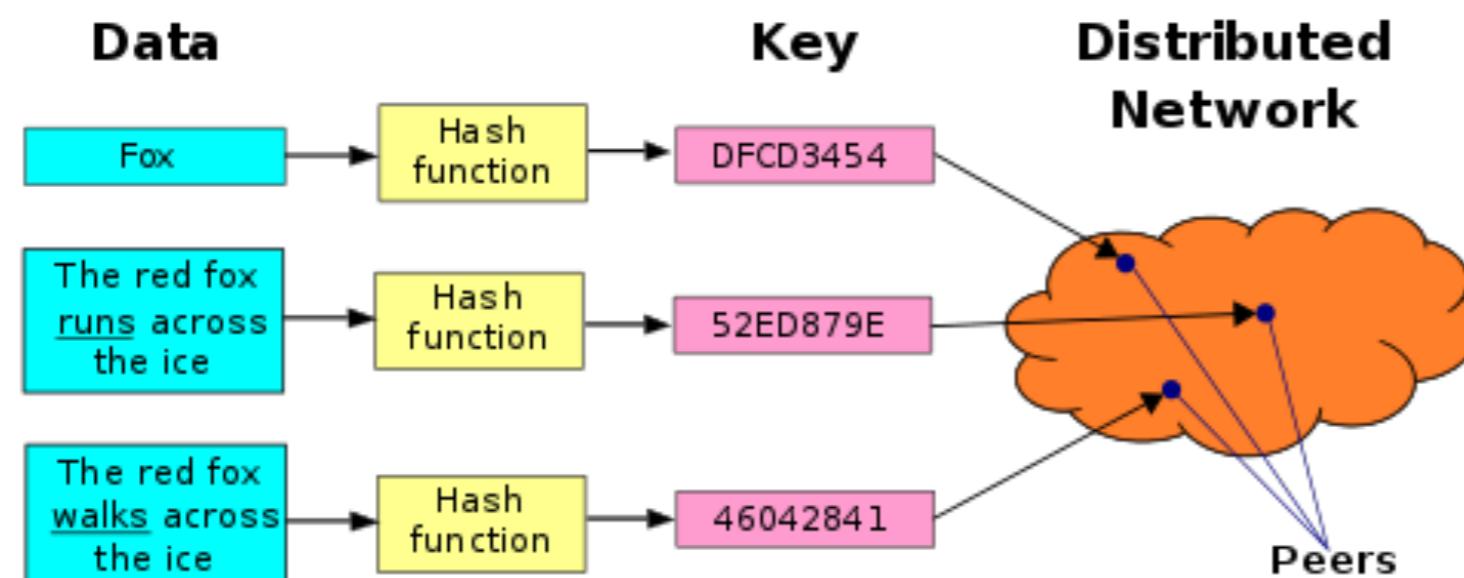


2001

Bram Cohen

BitTorrent

Distributed Hash Table



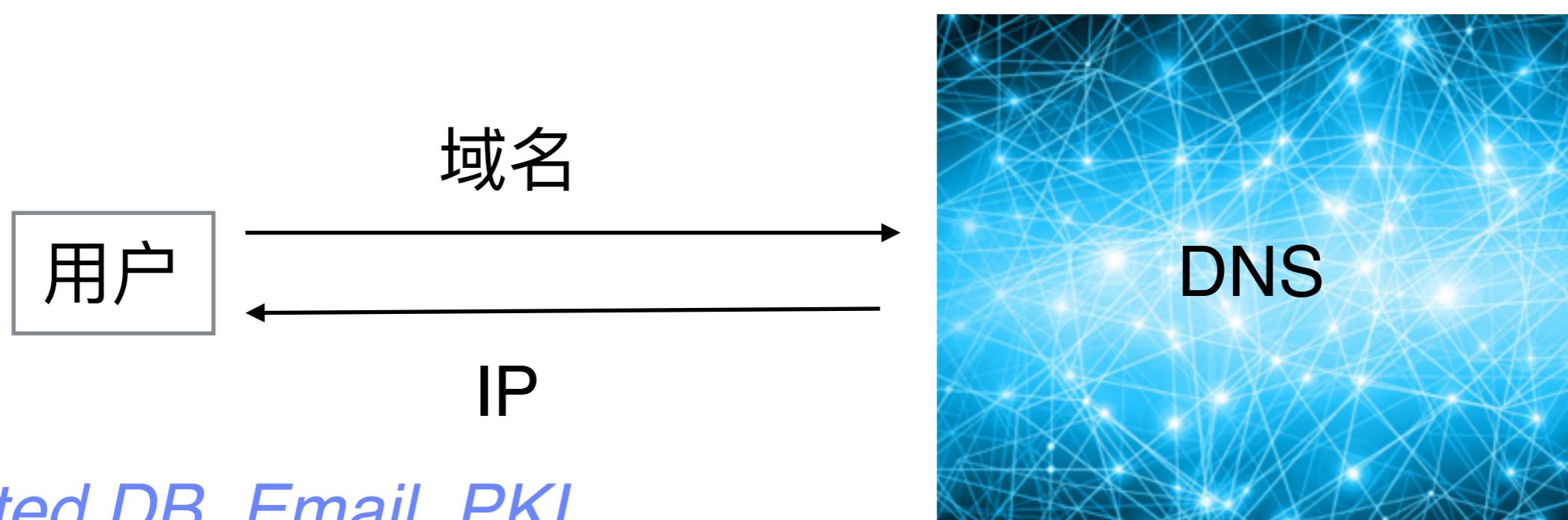
激励

[https://en.wikipedia.org/
wiki/BitTorrent](https://en.wikipedia.org/wiki/BitTorrent)

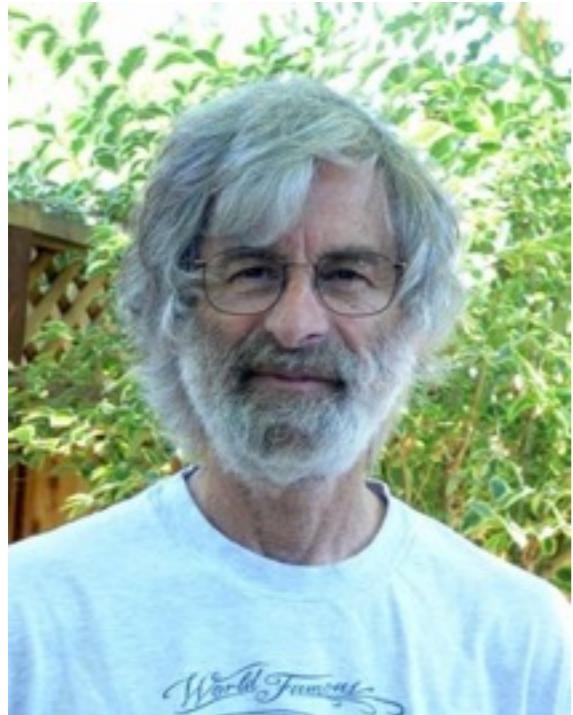
[https://en.wikipedia.org/
wiki/Distributed_hash_table](https://en.wikipedia.org/wiki/Distributed_hash_table)

分布共识

- 在一个有 n 个节点的系统中，每一个节点都有一个输入值，其中有一些节点是错误的或者恶意的。一个分布式共识协议具有如下两个属性：
 - * 结束时所有诚实的节点均认同该值；
 - * 该值由诚实节点产生



拜占庭将军问题和Paxos



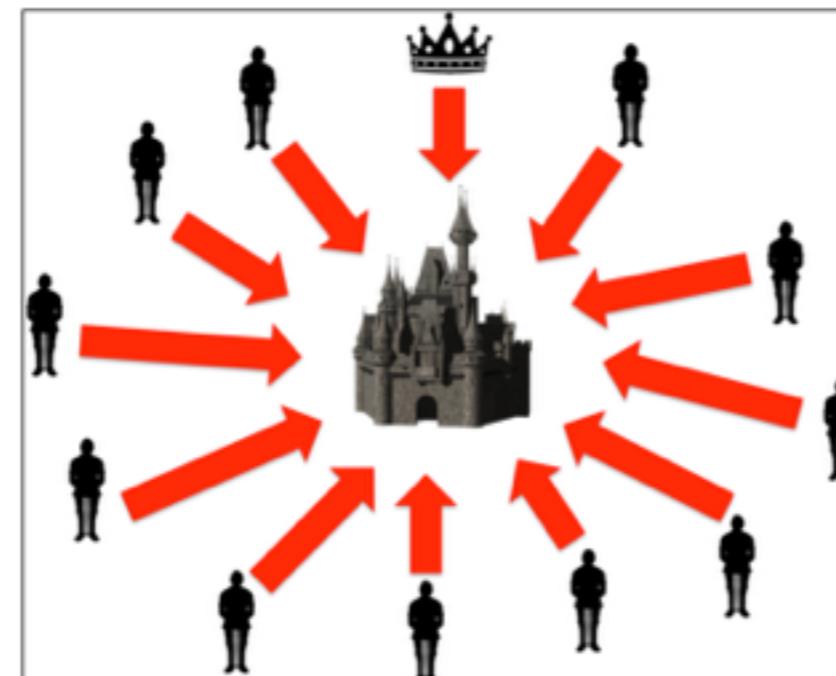
LESLIE LAMPORT

2013图灵奖

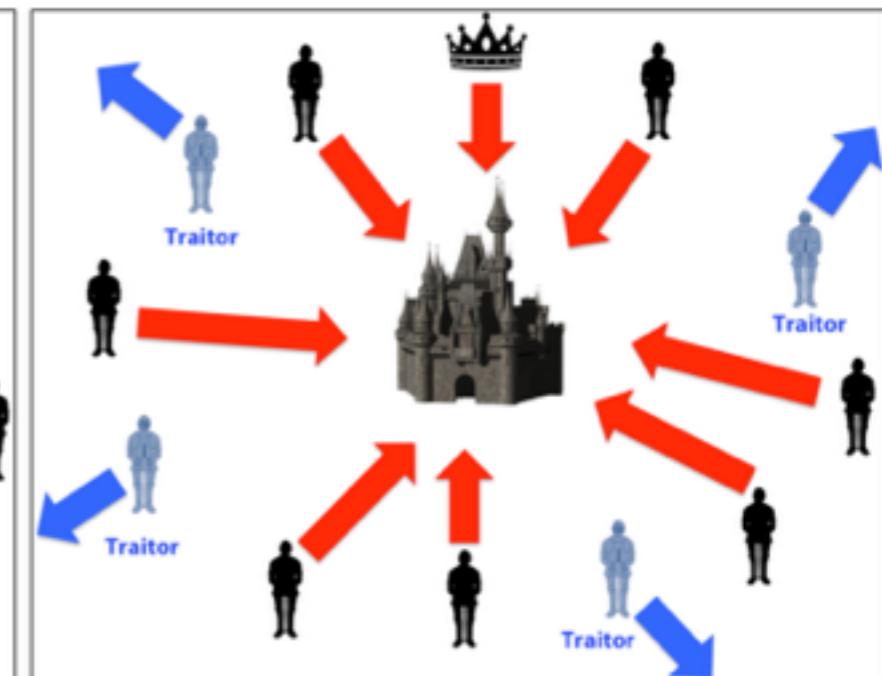
The Byzantine Generals Problem

1982

LESLIE LAMPORT, ROBERT SHOSTAK, and MARSHALL PEASE
SRI International



Coordinated Attack Leading to Victory



Uncoordinated Attack Leading to Defeat

Paxos Made Simple

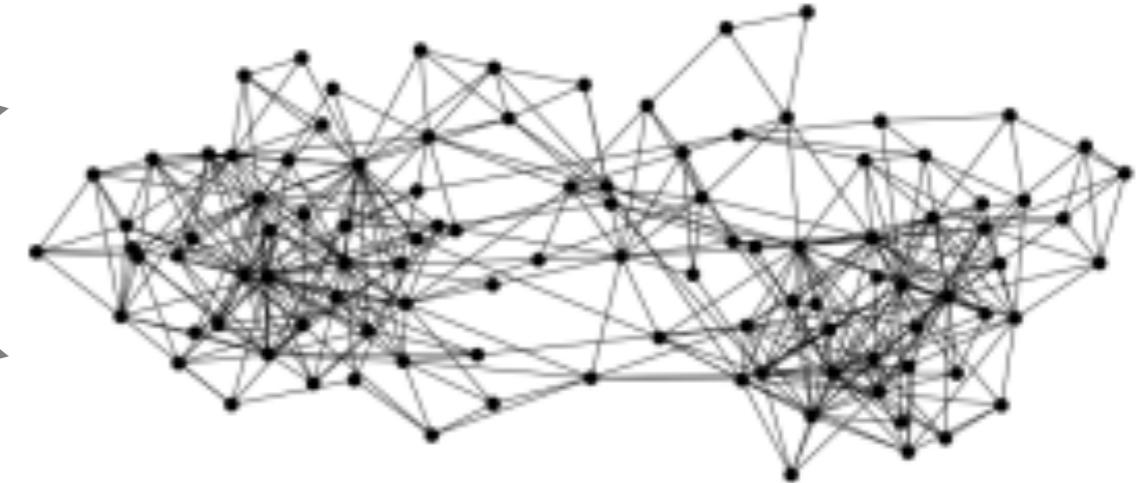
2001

The Paxos algorithm, when presented in plain English, is very simple.

比特币的交易传播



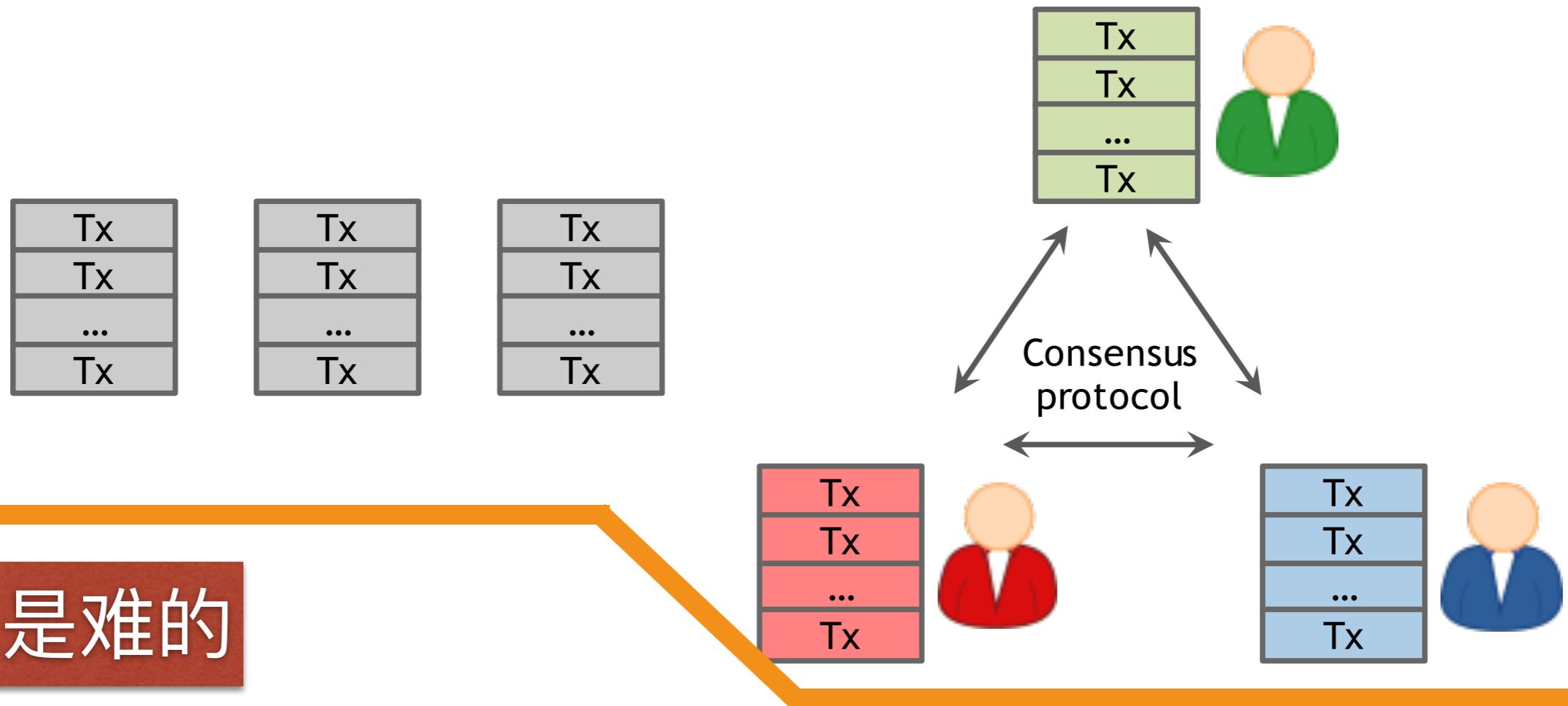
signed by Alice
Pay to $pk_{Bob} : H()$



- 比特币是一个P2P网络
- Alice 需要广播她完成的交易給所有的节点
- Bob计算机当时可以不在P2P网络中
- *A single, global ledger for the system*
- 等待共识的业务、已共识的业务

比特币的分布共识

每一个节点输出它的未共识的业务竞争下一个Block



→ *Node: crash, malicious*

→ *Network: Imperfect (online, latency)*

Global Time

比特币和身份

- 比特币节点需要身份 (*ID*)
- 比特币假设恶意节点小于 50%
- 但是 P2P 系统中，*ID* 面临很大问题
 - * *Sybil Attack*
- *Pseudonymity* 是比特币的目的
- 比特币跟踪和验证 *ID* 是困难的
- 比特币采用的应对方法：随机的选择节点

比特币的隐形共识机制

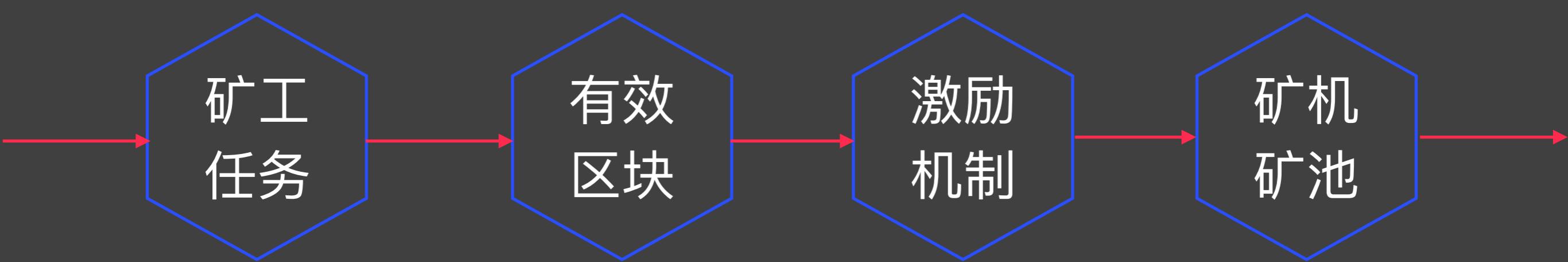
- 新的交易被广播到所有节点
- 每个节点将新的交易放进一个区块
- 在每一轮中，一个随机的节点被选择可以广播它的区块
- 其余节点可以选择接受这个区块，前提是区块的交易是可验证的
- 节点将以上区块的Hash放进自己的区块，表示它认可这个新区块

隐形共识：接受该块并扩展 vs. 拒绝该块，扩展前面的块

比特币的共识总结

- 理论落后于实践
- 引入了 *Incentive*
 - * 是电子货币
- 利用了随机性
 - * 很长时间后才取得共识，1小时
 - * 随着时间的增加，对某一块的共识的概率越来越大

挖矿

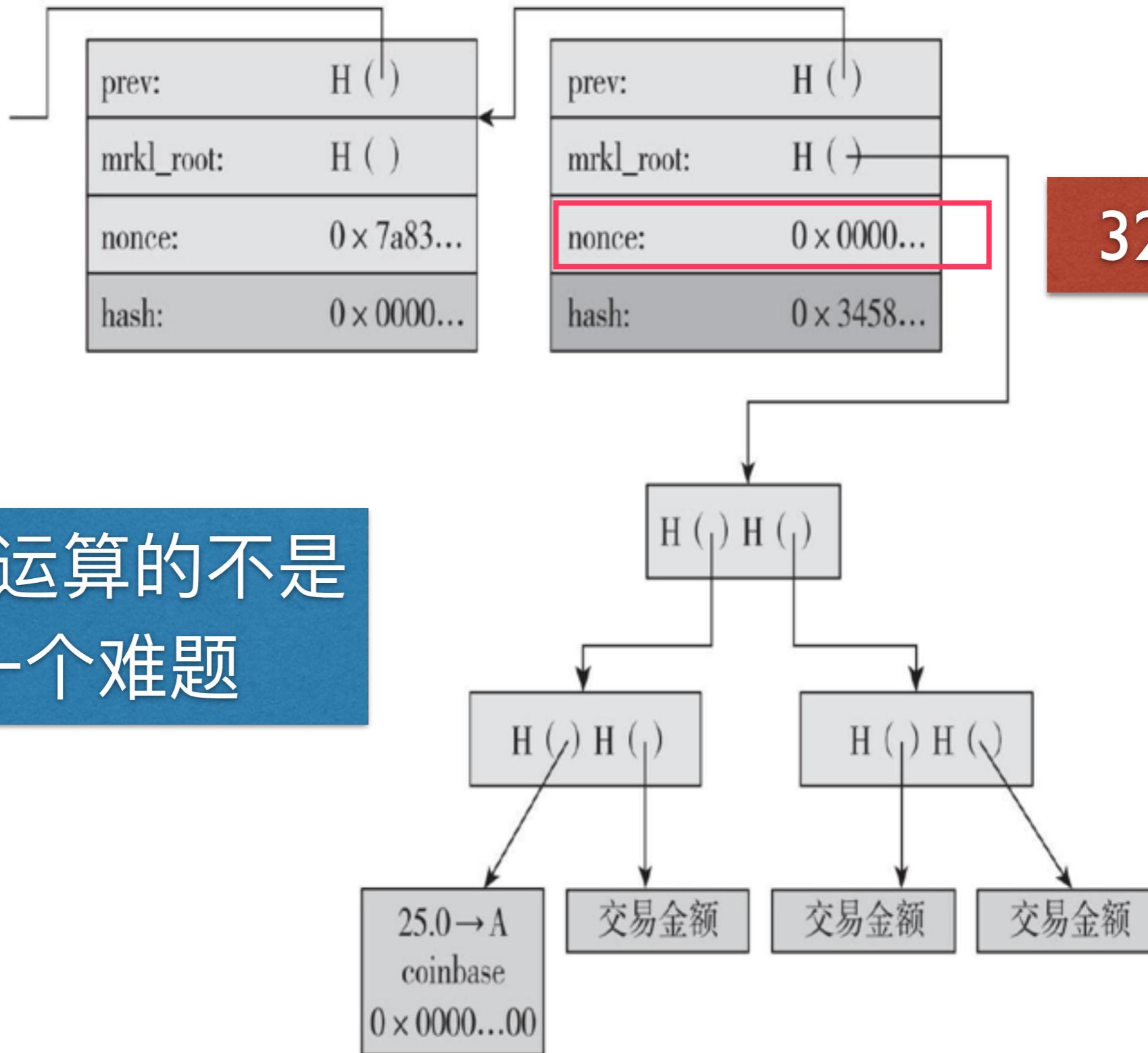


矿工的任务

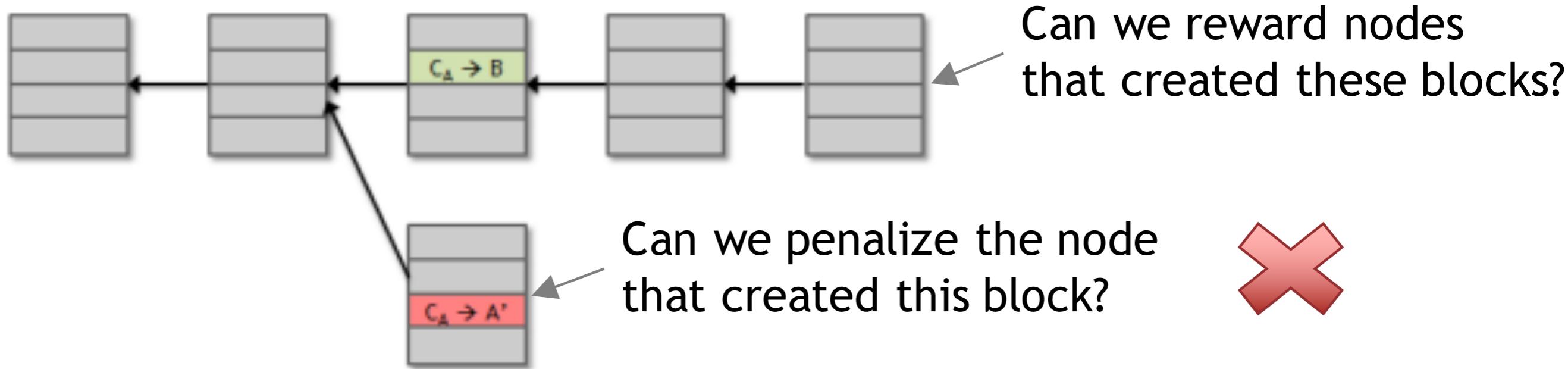
- 监听交易广播
- 维护区块链网络和监听新的区块
- 组装一个备选区块
- 找到一个让你的区块有效的随机数
- 希望你的区块被全网接受
- 利润

验证交易和区块 vs. 和其余矿工竞争

寻找有效区块



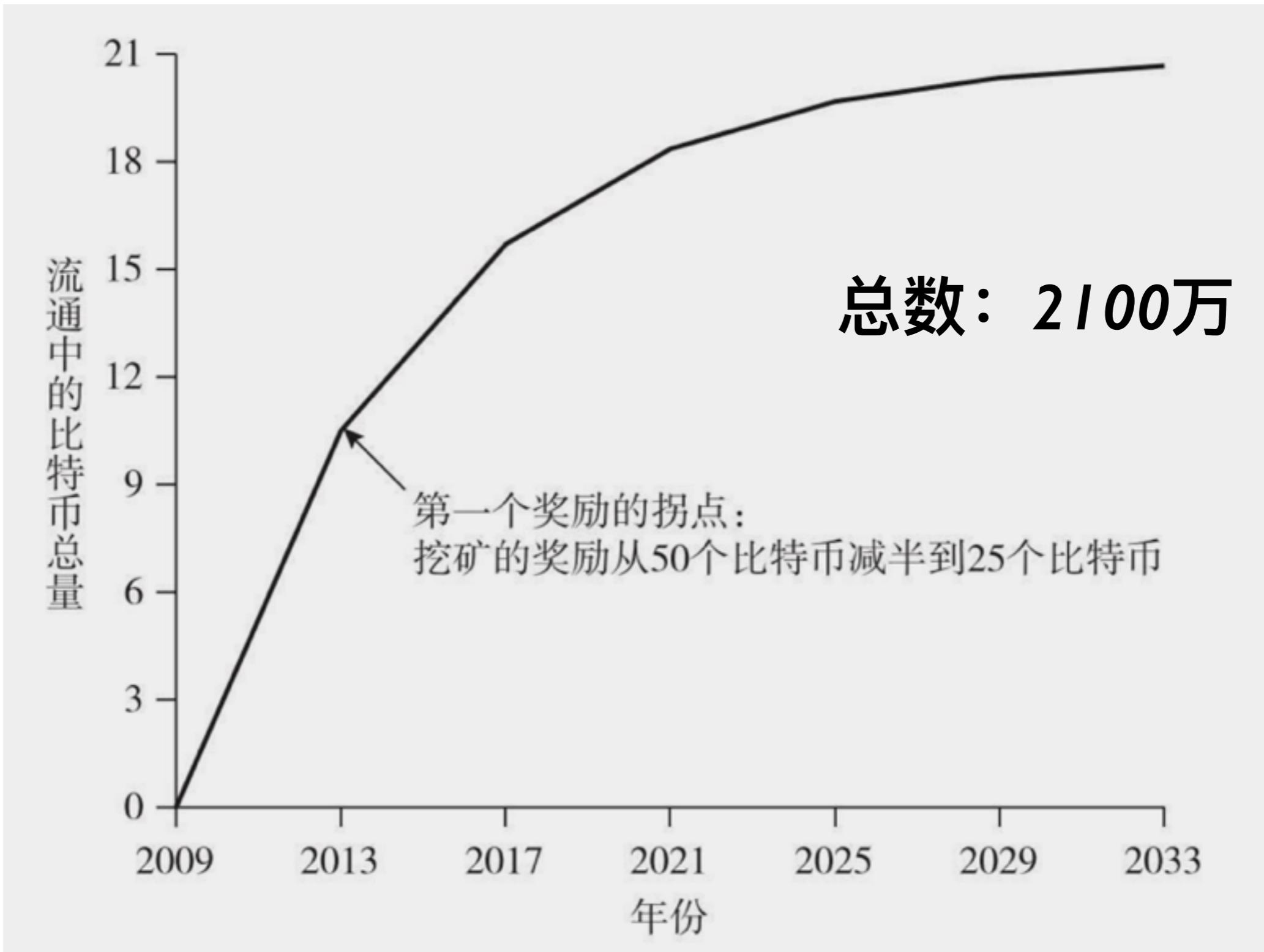
激励节点诚实



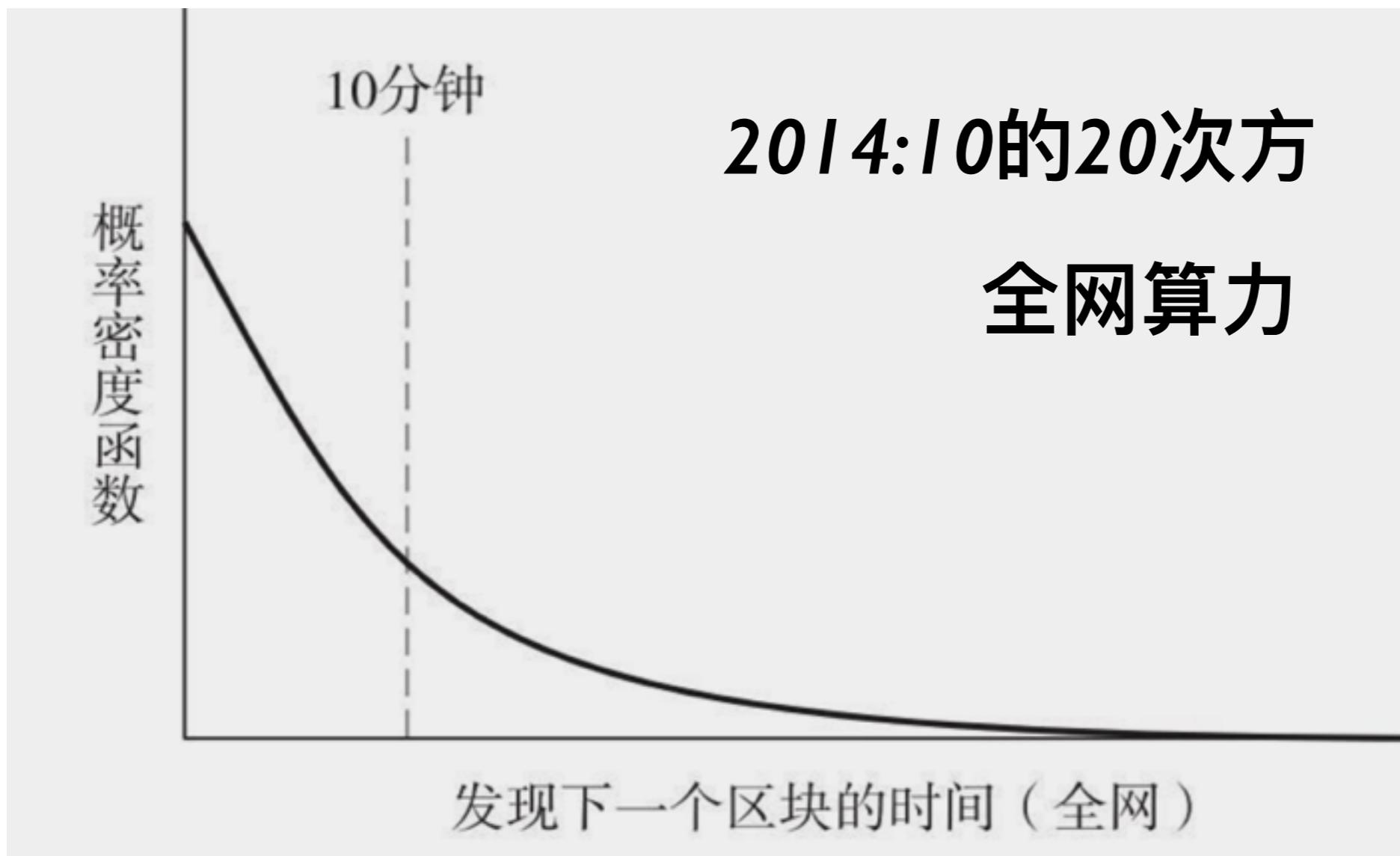
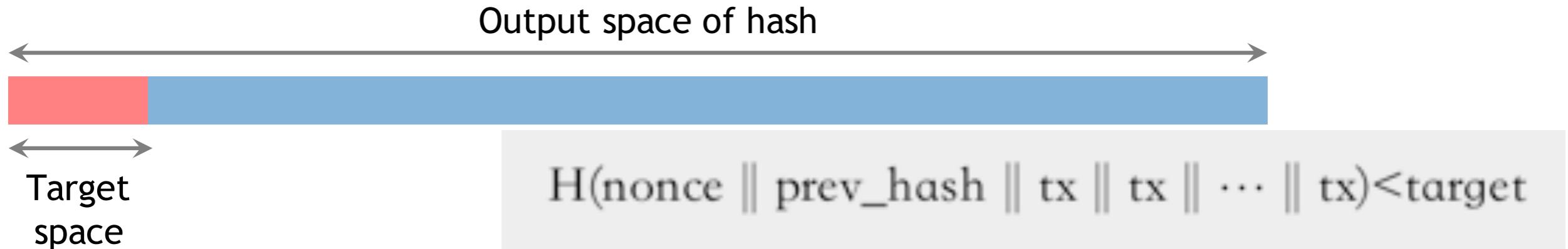
区块奖励 vs. 交易费奖励

交易费：输入和输出不等

比特币奖励



工作量证明



限定Hash的
输出范围

临时随机数

PoW:
工作量证明

PoS:
权益证明

挖矿发展



CPU



GPU



FPGA



ASIC



gold pan



placer mining



pit mining

Blockchain
Technology

专业矿场

温度

电费

网速

中国

Blockchain Technology

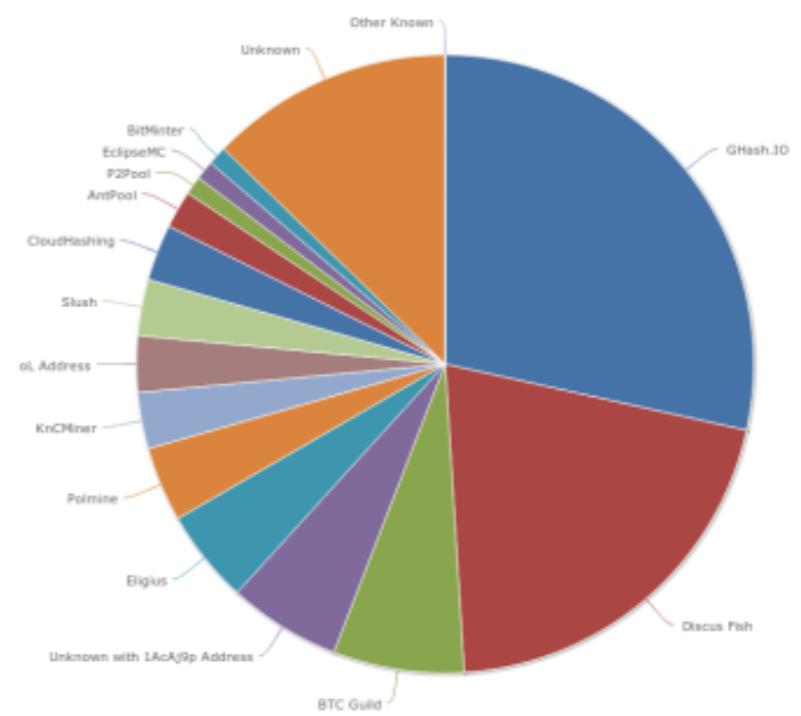
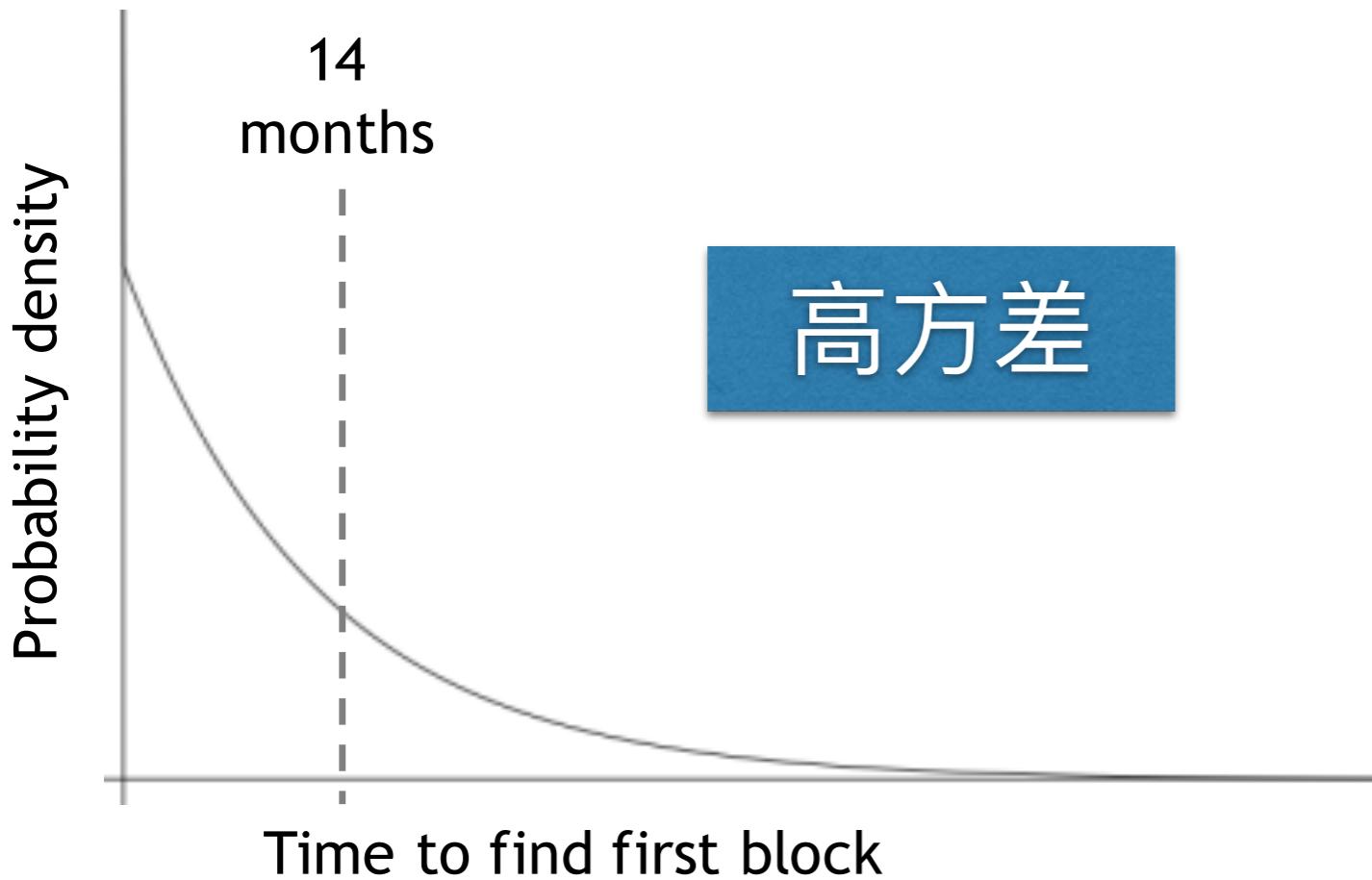
矿池



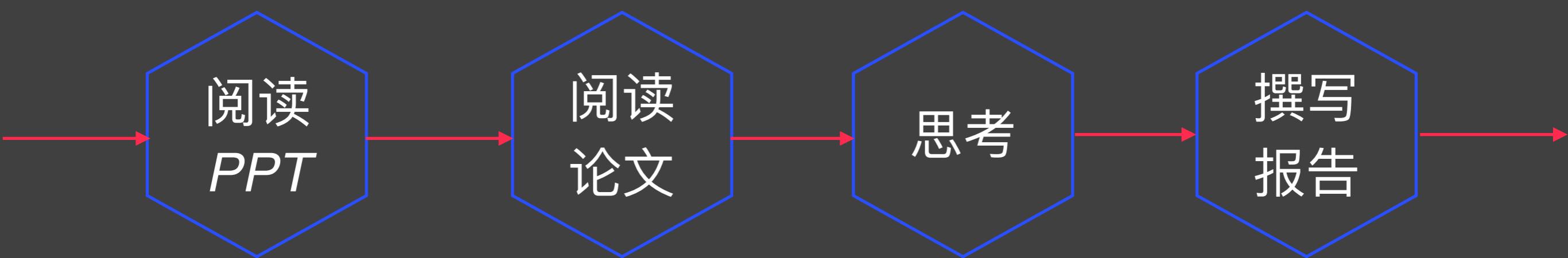
TerraMiner IV

Cost: ≈US\$6,000
Expected time to find a block: ≈14 months
Expected revenue: ≈\$1,000/month

# blocks found in one year	probability (Poisson dist.)
0	42.4%
1	36.4%
2	15.6%
3+	5.6%



课后作业



课后作业

要求阅读如下资料，写阅读报告

Bitcoin Developer Guide

Find detailed information about the Bitcoin protocol and related specifications.

<https://bitcoin.org/en/developer-guide#block-chain-overview>

- 1、资料概述
- 2、主要收获

- 3、存在疑问
- 4、所思所感

11月16日晚上12
点前提交给助教

謝謝 !

Huijing Sun

sunhp@ss.pku.edu.cn

<https://huijingsun.github.io>