# Blockchain and Cryptocurrencies

Week 7 — Chapter 9: Bitcoin as a Platform

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SS 2020

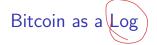
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#### Non monetary uses

Bitcoin as a Log

Colored Coins

3 Lotteries



#### Blockchain

- tamperproof ledger
- append-only
- history preserved

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## Bitcoin as a Log

#### Blockchain

- tamperproof ledger
- append-only
- history preserved

## Log File (wikipedia, excerpt)

[...] a log file is a file that records either events that occur in an operating system or other software runs, or messages between different users of a communication software.

A transaction log is a [...] data collection method that automatically captures the type, content, or time of transactions made [...] with that system.

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# Secure Timestamping

#### Goal

prove knowledge of value x at time T

#### Method

- choose random *r* with high min-entropy
- publish H(r||x) at time T on the blockchain
- (e.g., using OP\_RETURN or coin burn)

(c.g., using of \_italional of/com burn)

 $\bullet$  if challenged later, we can produce r and x and point to the record on the blockchain

MIni transaction in which you can put an address

• Prior knowledge of ideas

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- Proof of submission

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- Digital signature schemes (Guy Fawkes signature scheme)

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## Overlay Currency

- uses Bitcoin as the transport and consensus layer
- (standard) Bitcoin nodes and miners are not aware of the overlay's transactions
- special nodes verify the overlay transaction, e.g., from OP\_RETURN instructions
- example: counterparty

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1 Bitcoin as a Log

Colored Coins

# **Fungibility**

## Definition (wikipedia)

In economics, fungibility is the property of a good or a commodity whose individual units are essentially interchangeable, and each of its parts is indistinguishable from another part.

• Are bitcoins fungible?

#### Colored Coins

- Bitcoins with additional metadata
- Implemented using special scripts
- Examples: tickets, shares, collectibles, subscriptions

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3 Lotteries

## Secure Multiparty Lotteries in Bitcoin

## The offline version: Coin Flip

- Alice and Bob want to bet on the outcome of a coin flip
- They agree on the amount and the method to determine the winner
- Bob throws the coin, Alice shouts "heads" or "tails" while the coin is in the air
- When the coin lands, Alice wins if she correctly predicted the coin top

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- All participants have to be physically present
- They need to trust each other

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## Building block for other applications

- Sealed bid auctions without trusted auctioneer
- Randomization (e.g., to break ties)
- Transfer of the auctioned (digital) asset

## Three party coin flip

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## Simultaneity

- cannot be guaranteed on the Internet
- if A publishes last, she can affect the outcome . . .

# Three Party Fair Coin Flip

#### Round One

- A, B, and C each pick a (large) random number a, b, ane c
- Everyone publishes the hashes H(a), H(b), H(c)
- Abort the protocol if two of the hashes are equal

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#### Remark

It is sufficient that one participant picks a number at random!

#### Fairness and Commitment

#### Drawback of the coin flip protocoll

- Once C sees values a and b in round three, she can figure out whether she won
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#### What's needed

- a commitment to the stake
- automatic loss of the stake if c leaves the protocol (i.e., no reaction inside a time limit)

#### Timed Commitment in Bitcoin

#### Timed commitment between Alice and Bob

- Alice puts up a **bond** that vouches for value *x*:
- a bitcoin transaction with an output that can be spent in two ways
  - 1 transaction signed by both Alice and Bob
  - 2 transaction that includes the value x, but only needs Alice's signature

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#### Possible Outcomes

- Alice reveals x before time t and her bond is returned
- Alice fails to reveal x before t and her bonds falls to Bob

## Bitcoin script for timed commitment

#### Locking script for the output

```
OP_IF
     <AlicePubKey> OP_CHECKSIGVERIFY <BobPubKey> OP_CHECKSIG
OP_ELSE
     <AlicePubKey> OP_CHECKSIGVERIFY OP_HASH <H(x)> OP_EQUAL
OP_ENDIF
```

## Bitcoin script for timed commitment

## Locking script for the output

## Unlocking script; bond forfeited

<BobSignature> <AliceSignature> 1

# Bitcoin script for timed commitment

## Locking script for the output

## Unlocking script; bond forfeited

<BobSignature> <AliceSignature> 1

## Unlocking script; bond returned

<x> <AliceSignature> 0

# Application to Secure Lottery

#### *n*-party lottery protocol

- timed hash commitments
- n parties  $\rightarrow n^2 n$  commitments required
- to be effective, players have to escrow more than they are betting

# Thanks!