BitTorrent

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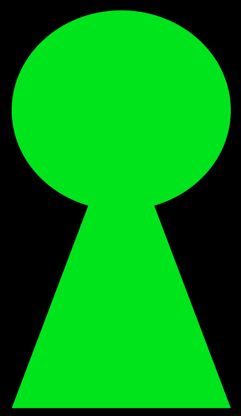
(much content borrowed from Dave Levin, dml@cs.umd.edu)

BitTorrent Overview

peer



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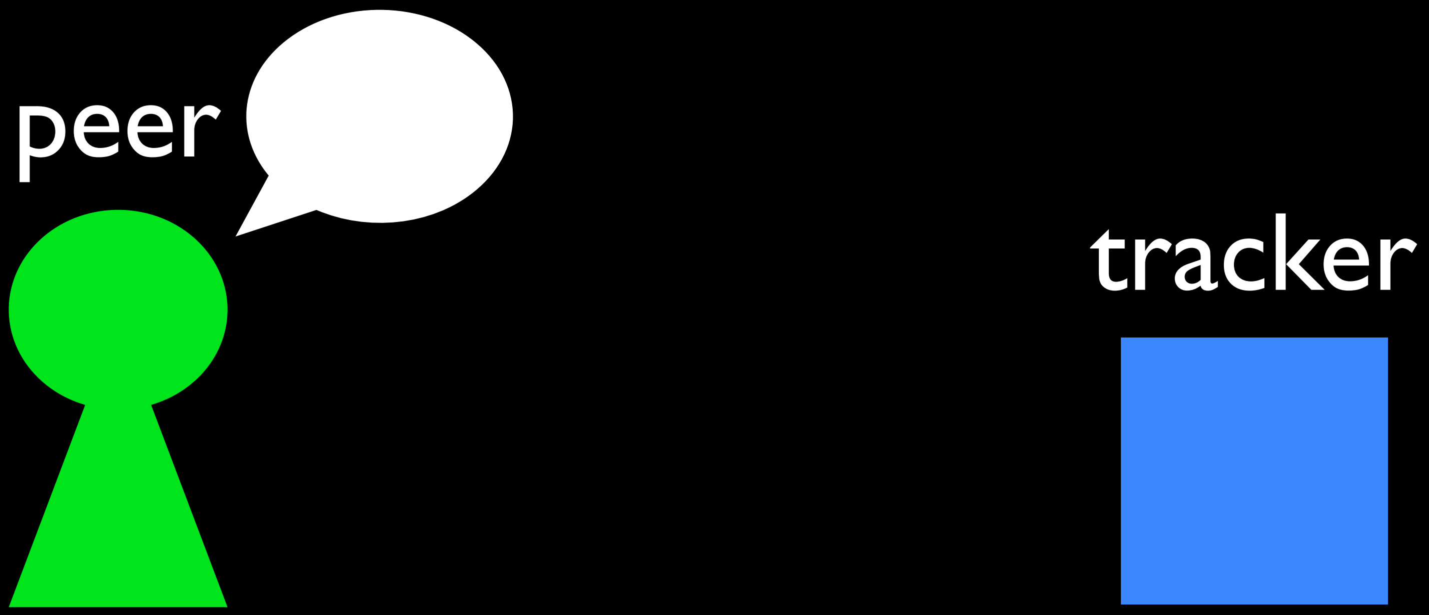

peer

tracker

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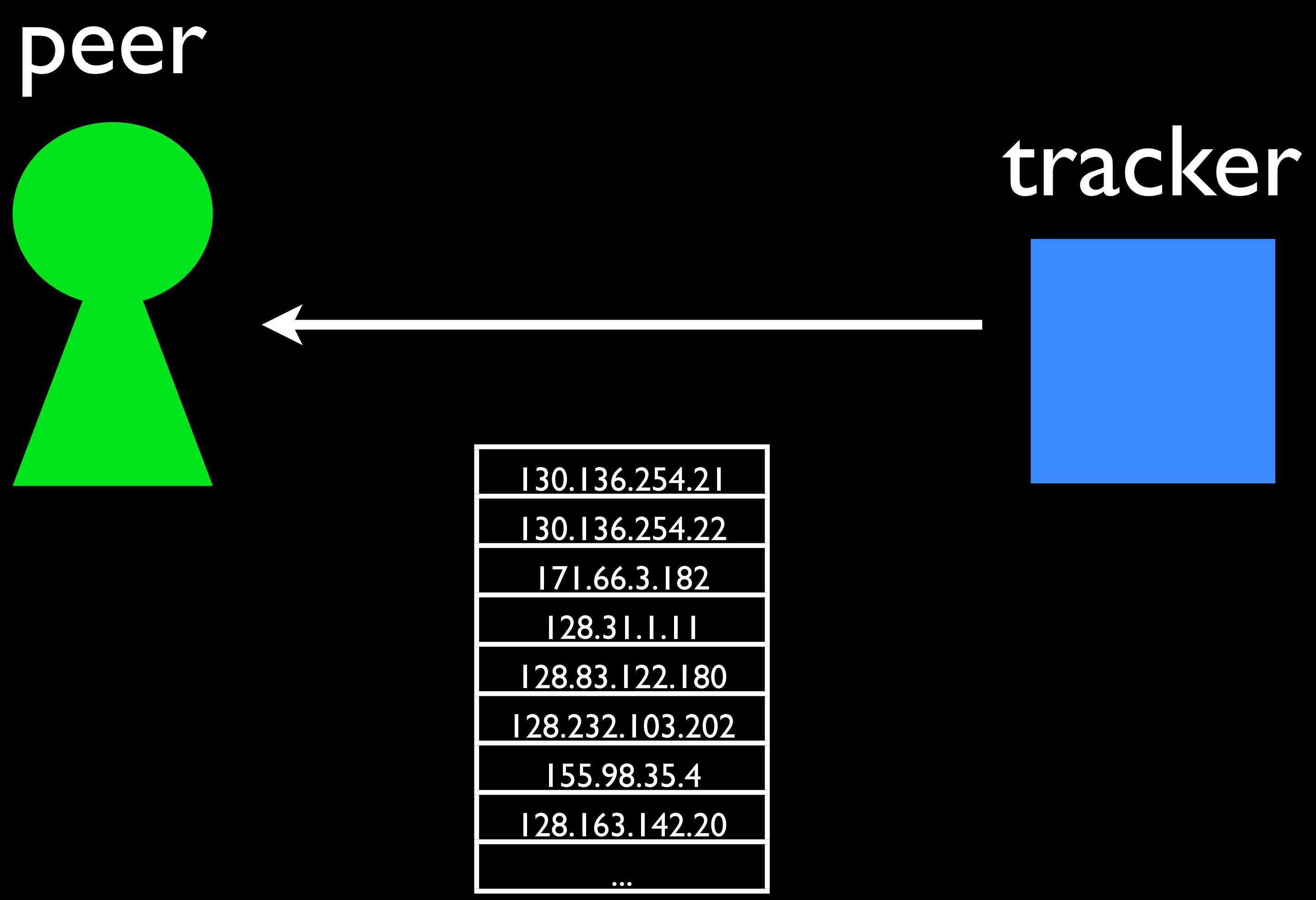

peer

tracker

130.136.254.21
130.136.254.22
171.66.3.182
128.31.1.11
128.83.122.180
128.232.103.202
155.98.35.4
128.163.142.20
...

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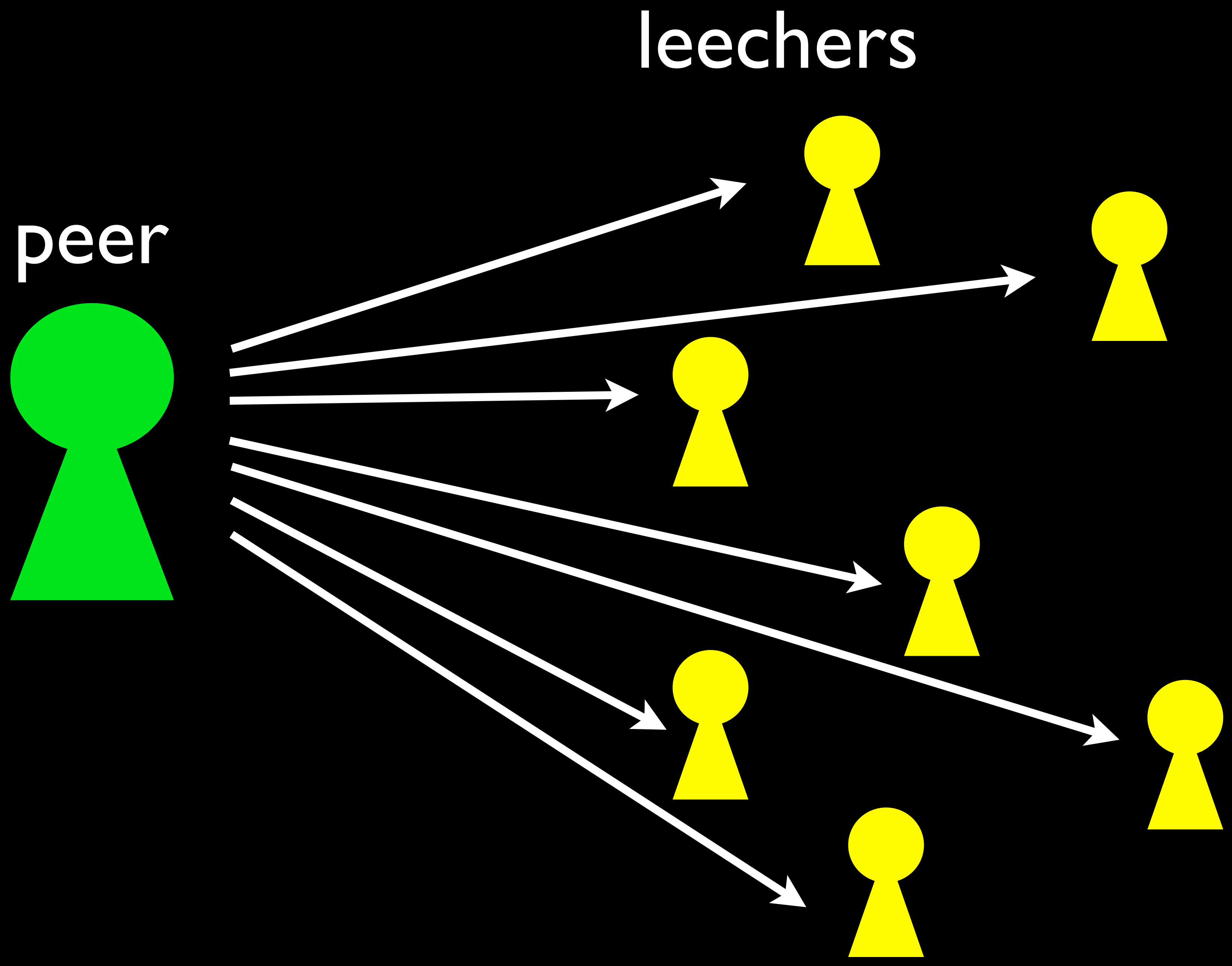

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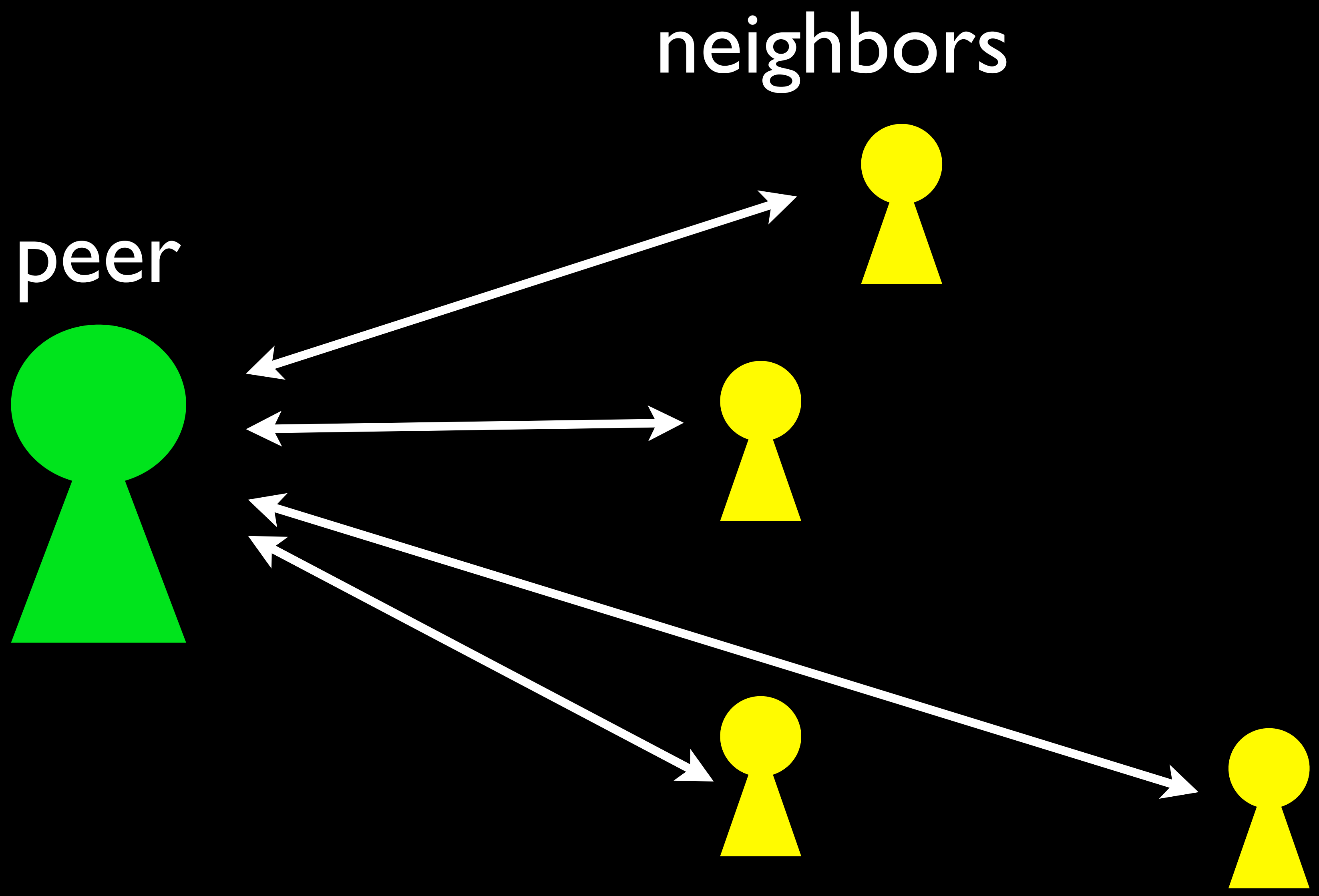

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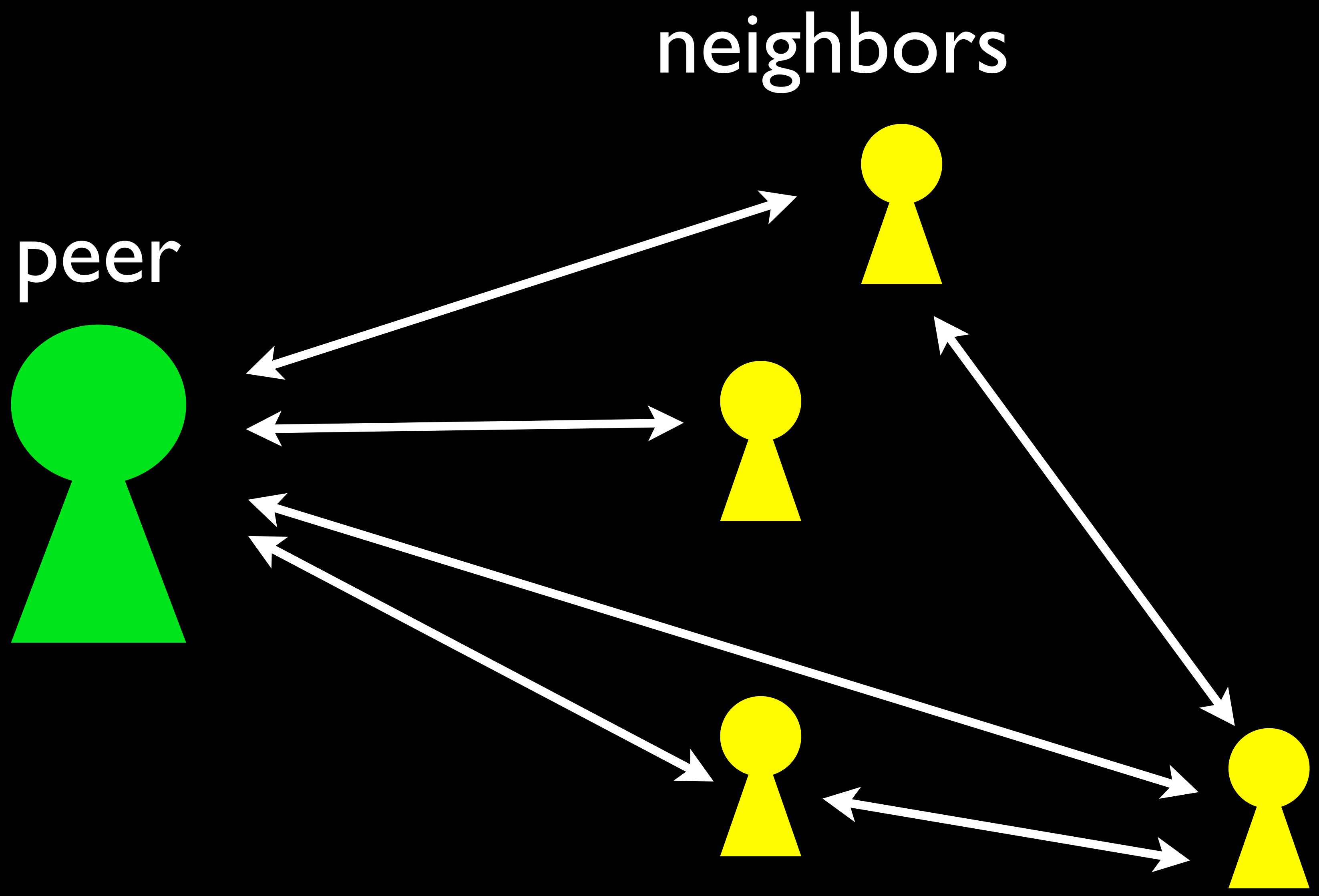

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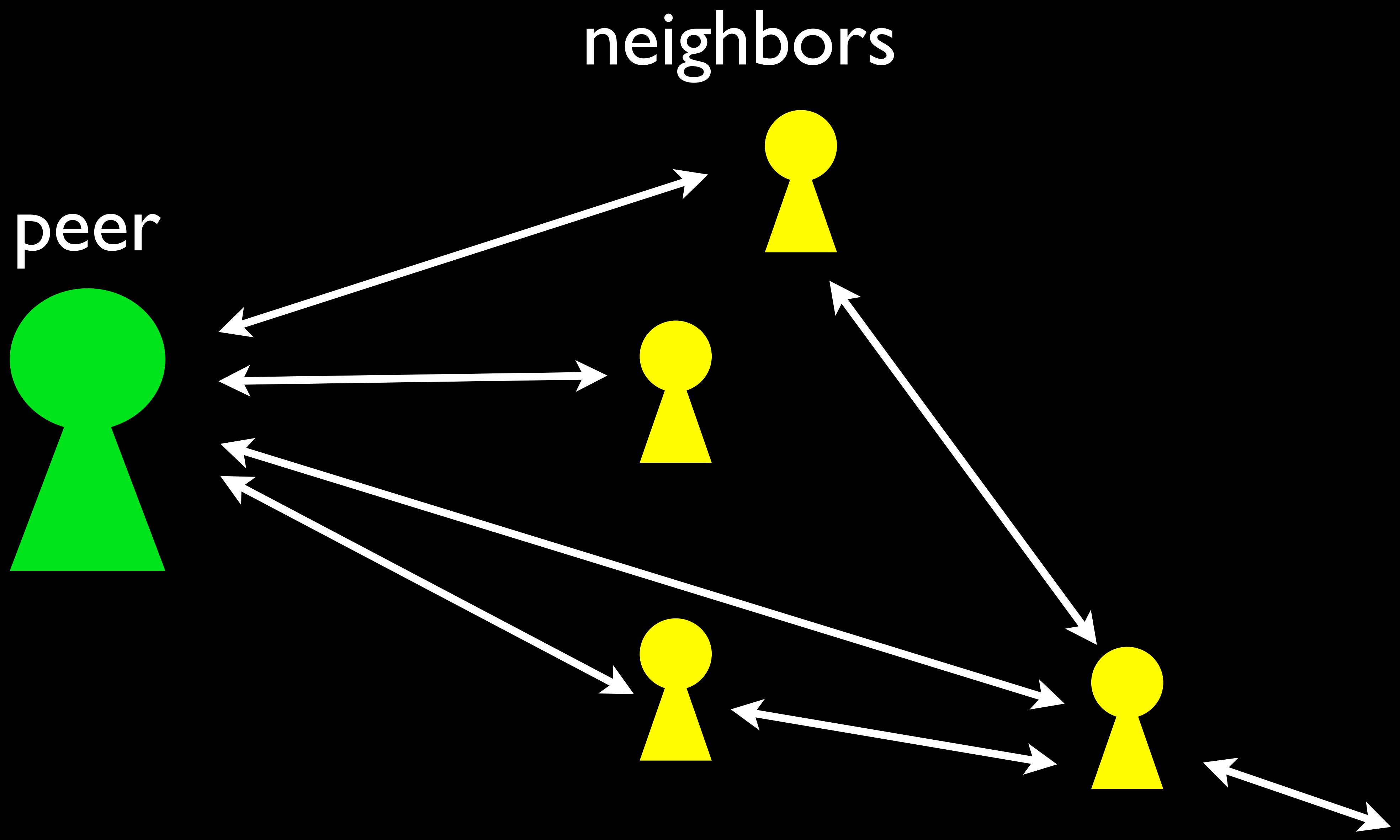

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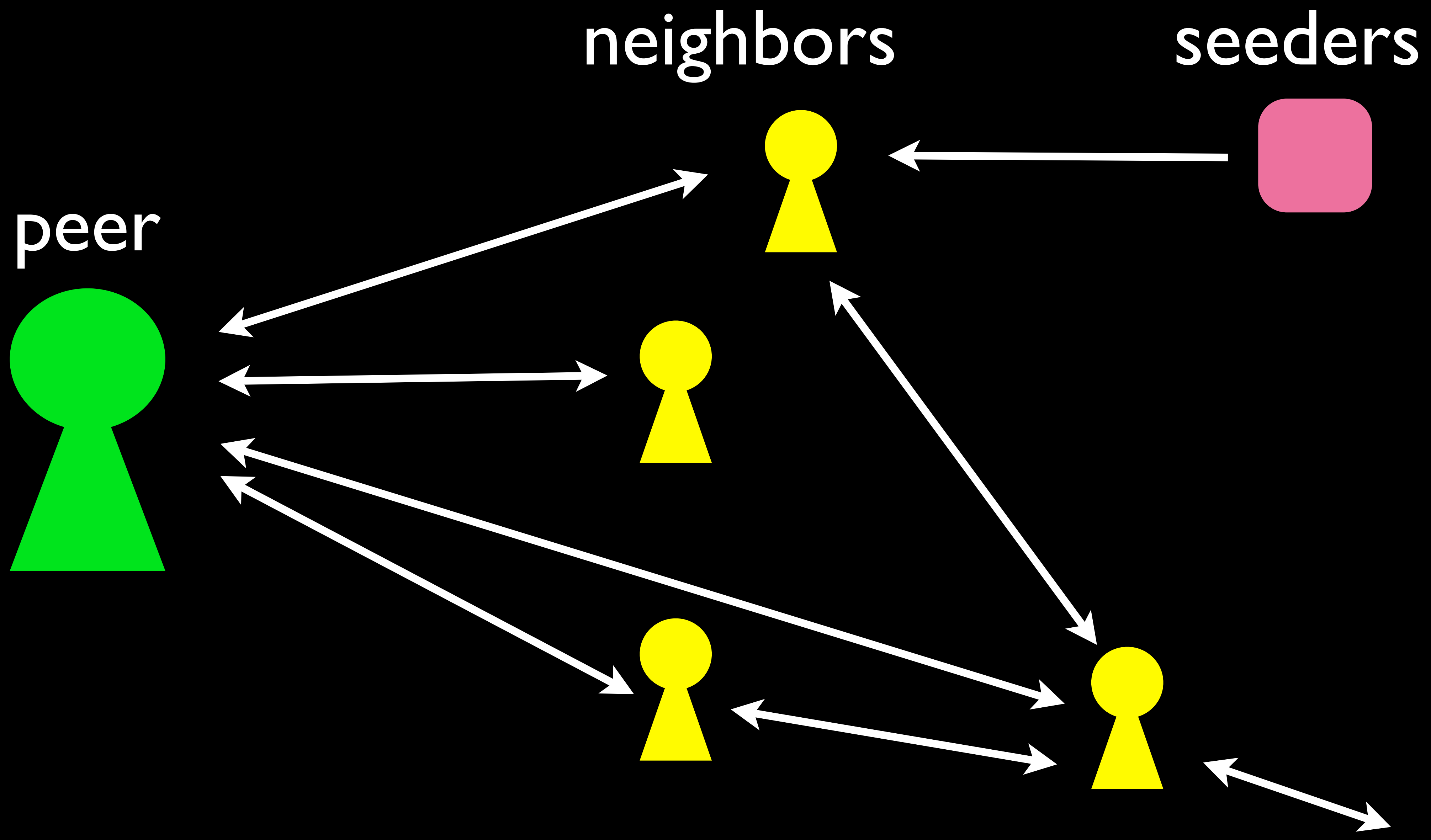
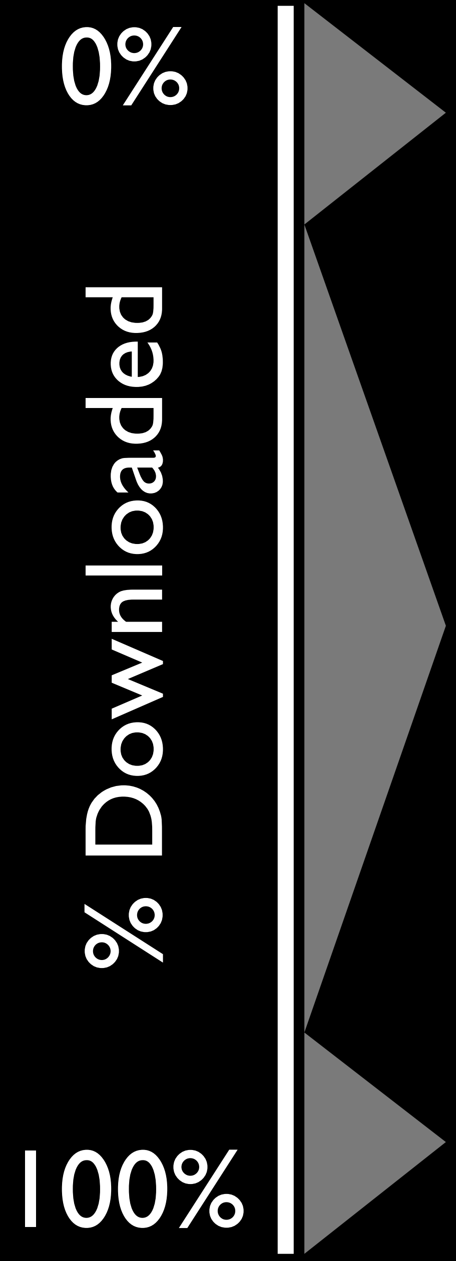


Phases of BitTorrent

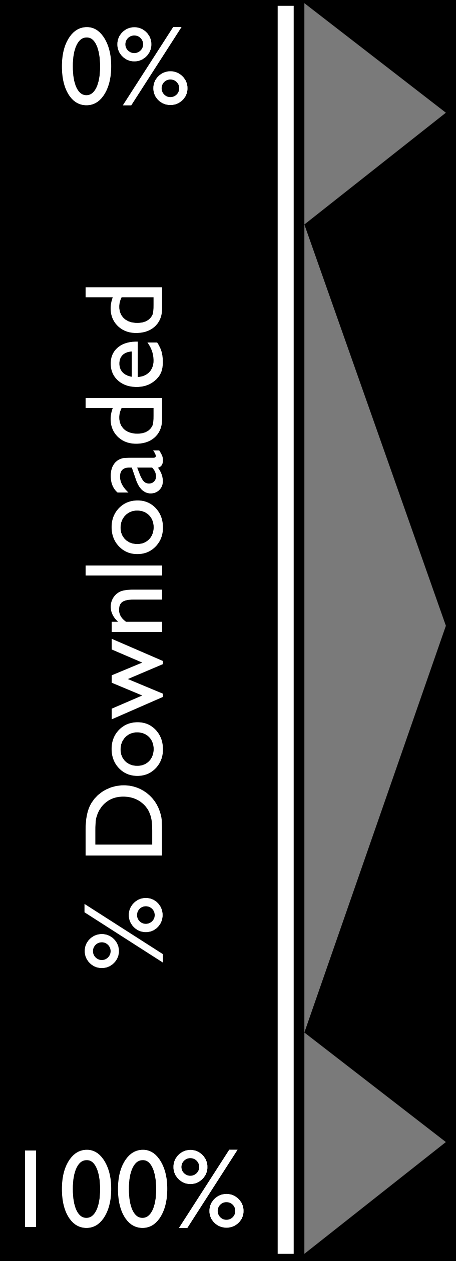


Bootstrapping: Getting the first pieces

Steady-state: Trading with peers

End-game: Getting the last pieces

Phases of BitTorrent



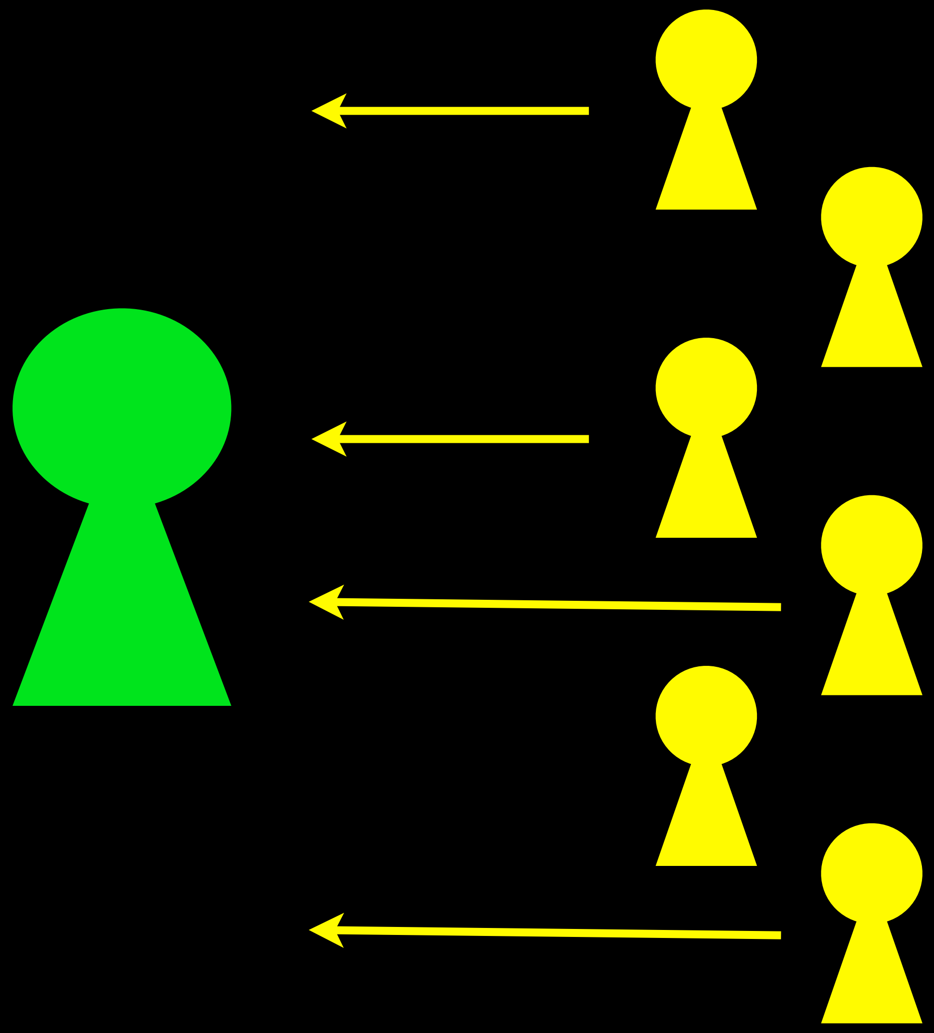
Bootstrapping: Getting the first pieces

Steady-state: Trading with peers

assumption: peers have pieces to trade with other peers

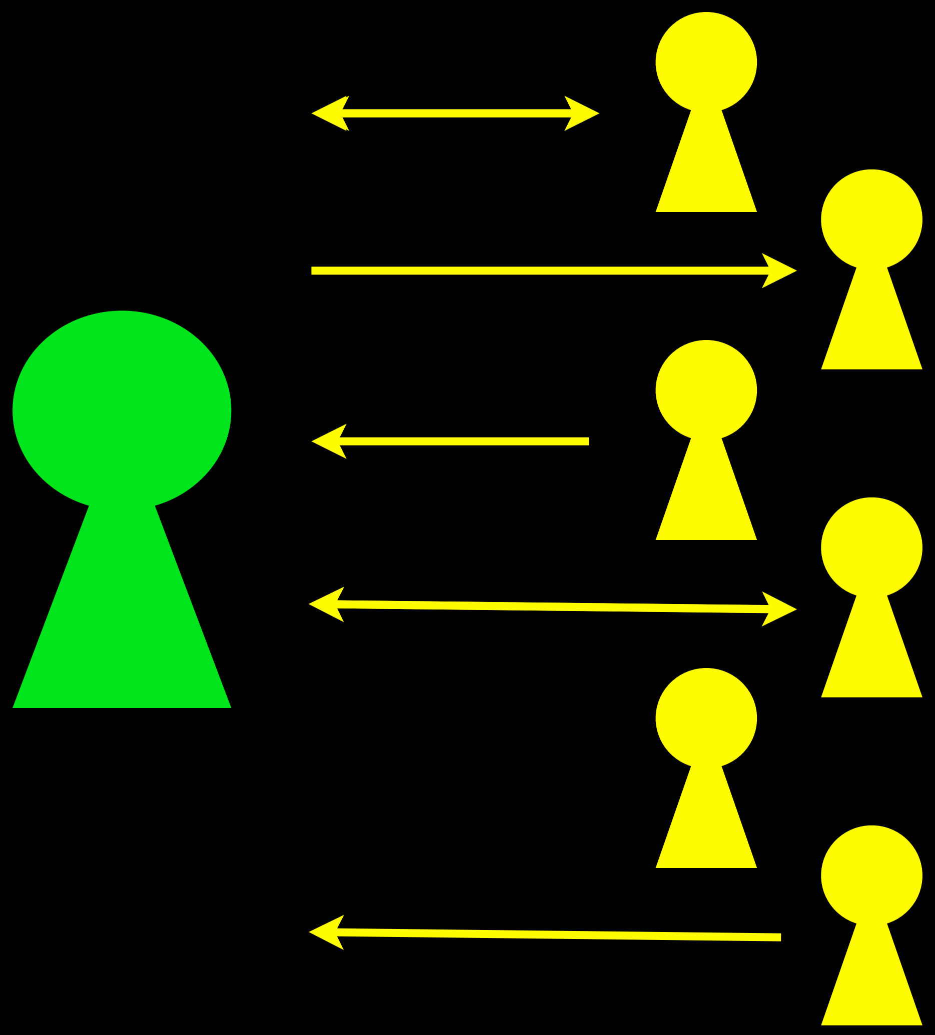
End-game: Getting the last pieces

Steady-state



in steady-state, a BitTorrent peer uploads to and downloads from different neighbors

Steady-state



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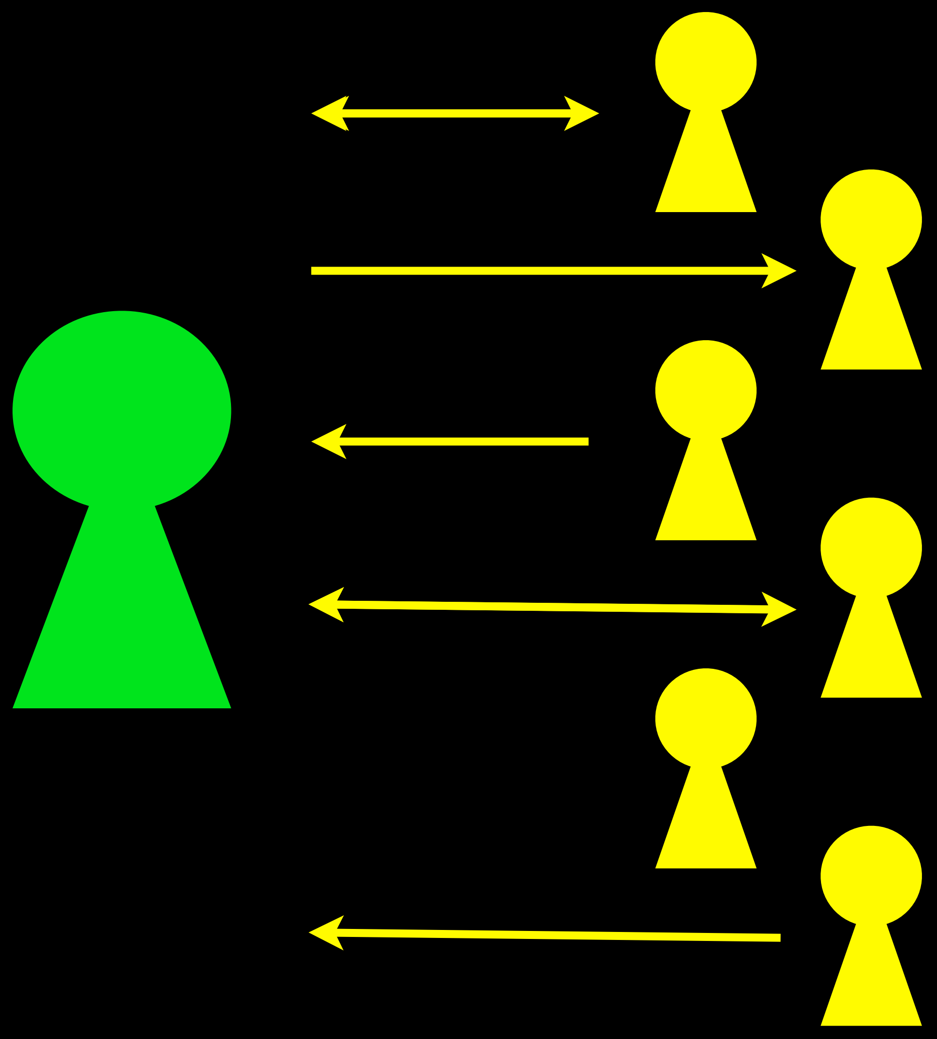
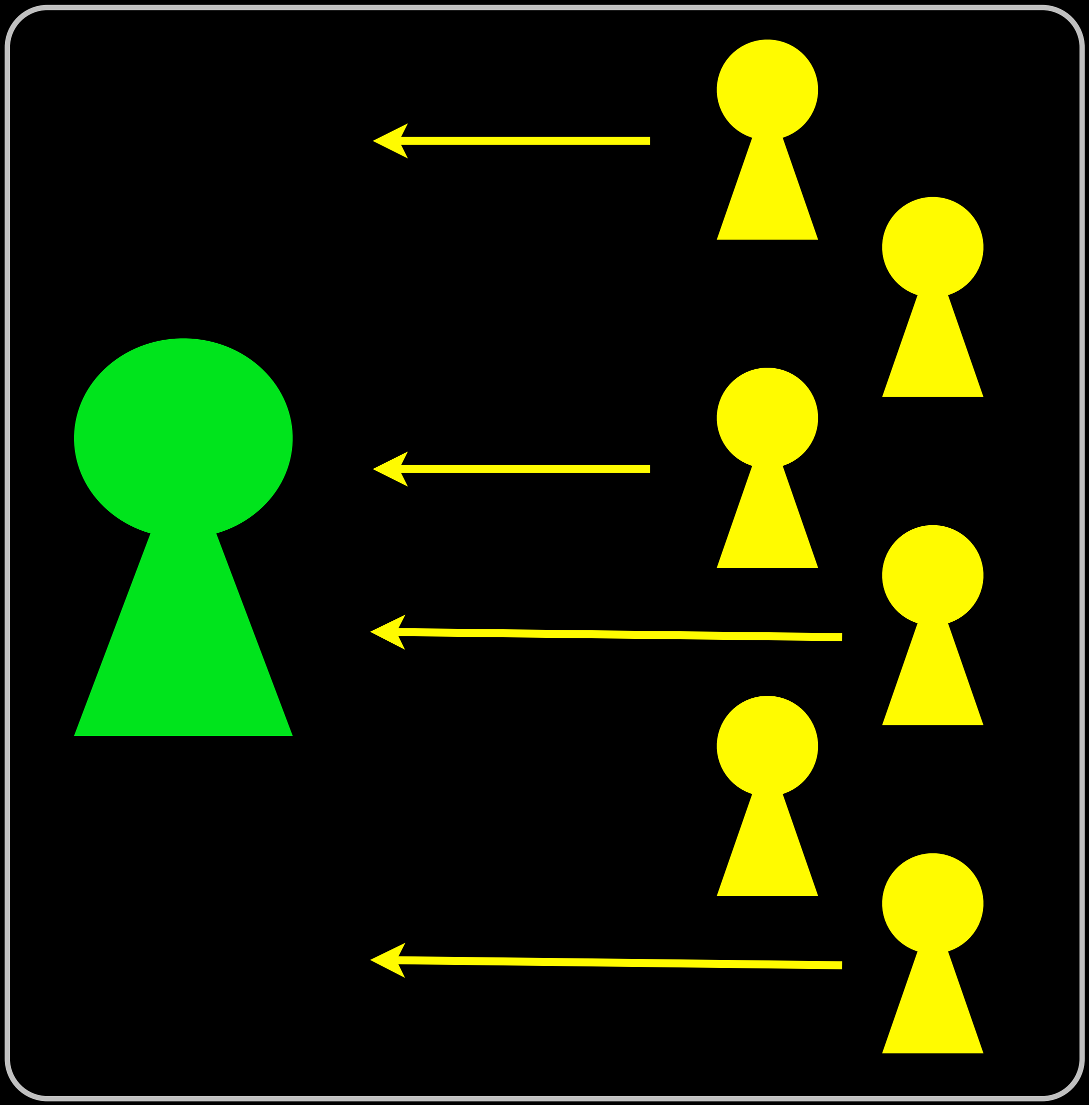


in steady-state, a BitTorrent peer uploads to and downloads from different neighbors

how does he decide who to upload to, how much to upload, etc.?

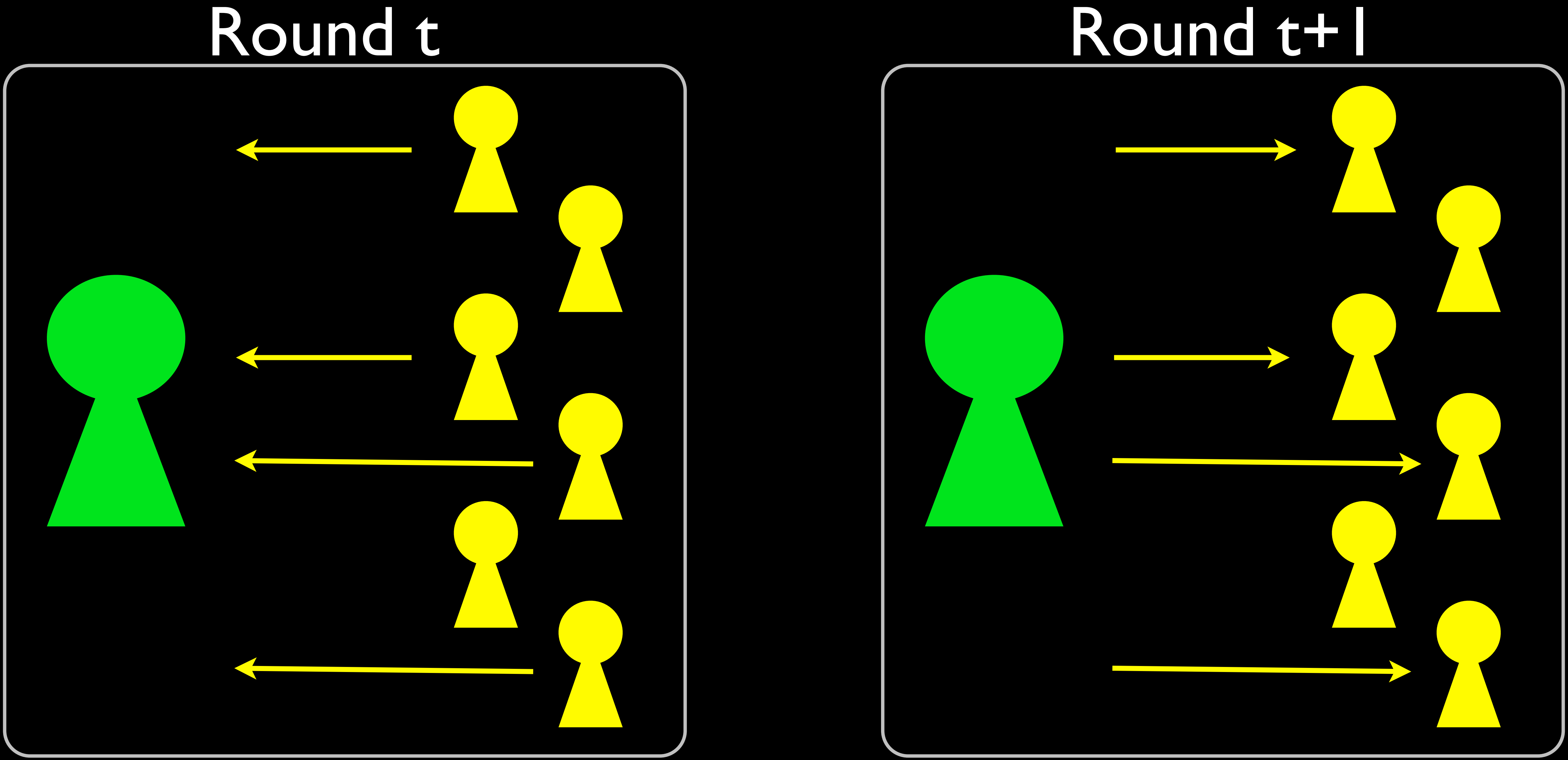
Steady-state

Round t



divide protocol into *rounds*. peers that upload the most to us in round t get uploaded to in round t+1

Steady-state



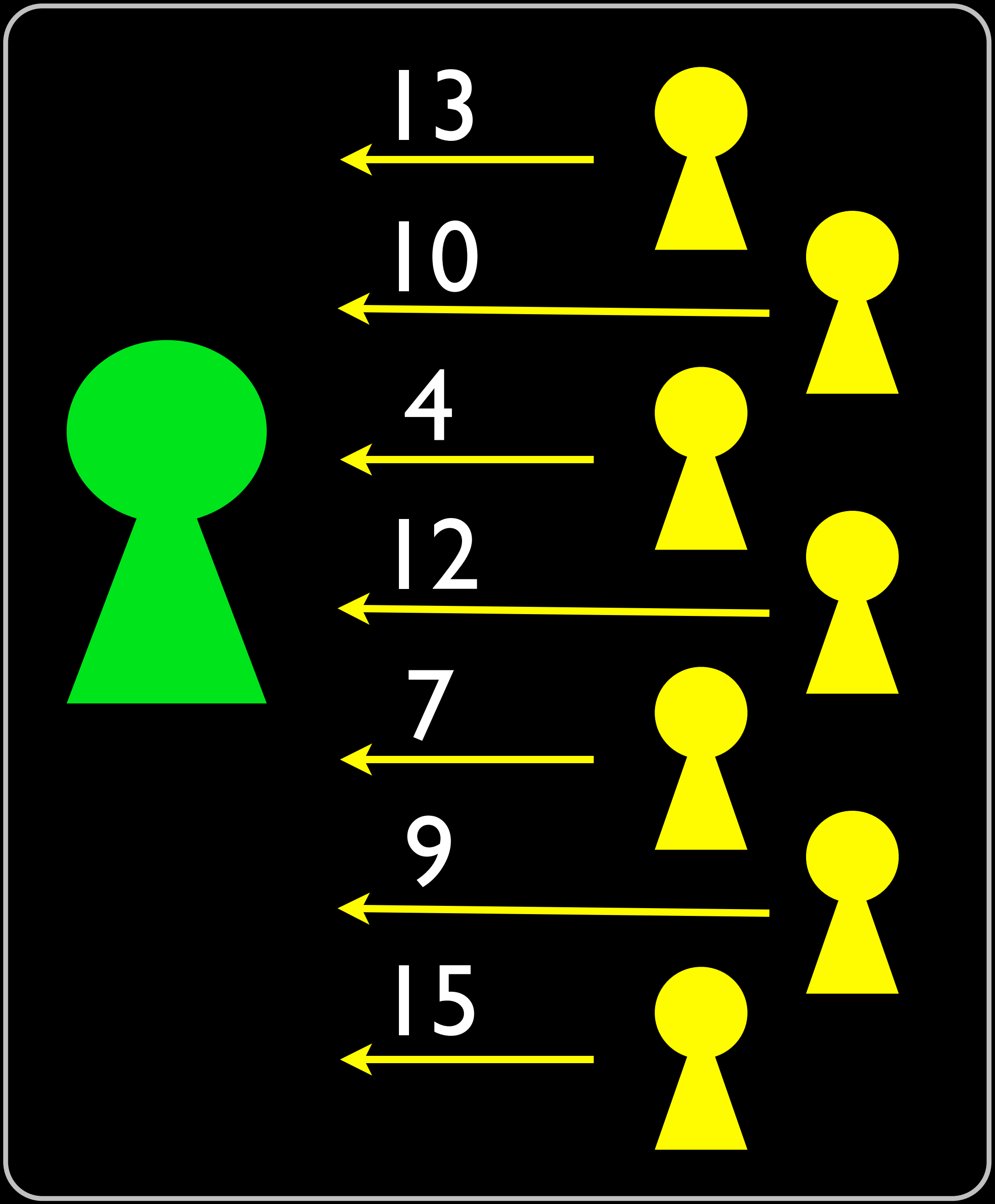
Round t

Round t+1

divide protocol into *rounds*. peers that upload the most to us in round t get uploaded to in round t+1

BitTorrent's Unchoker

Round t



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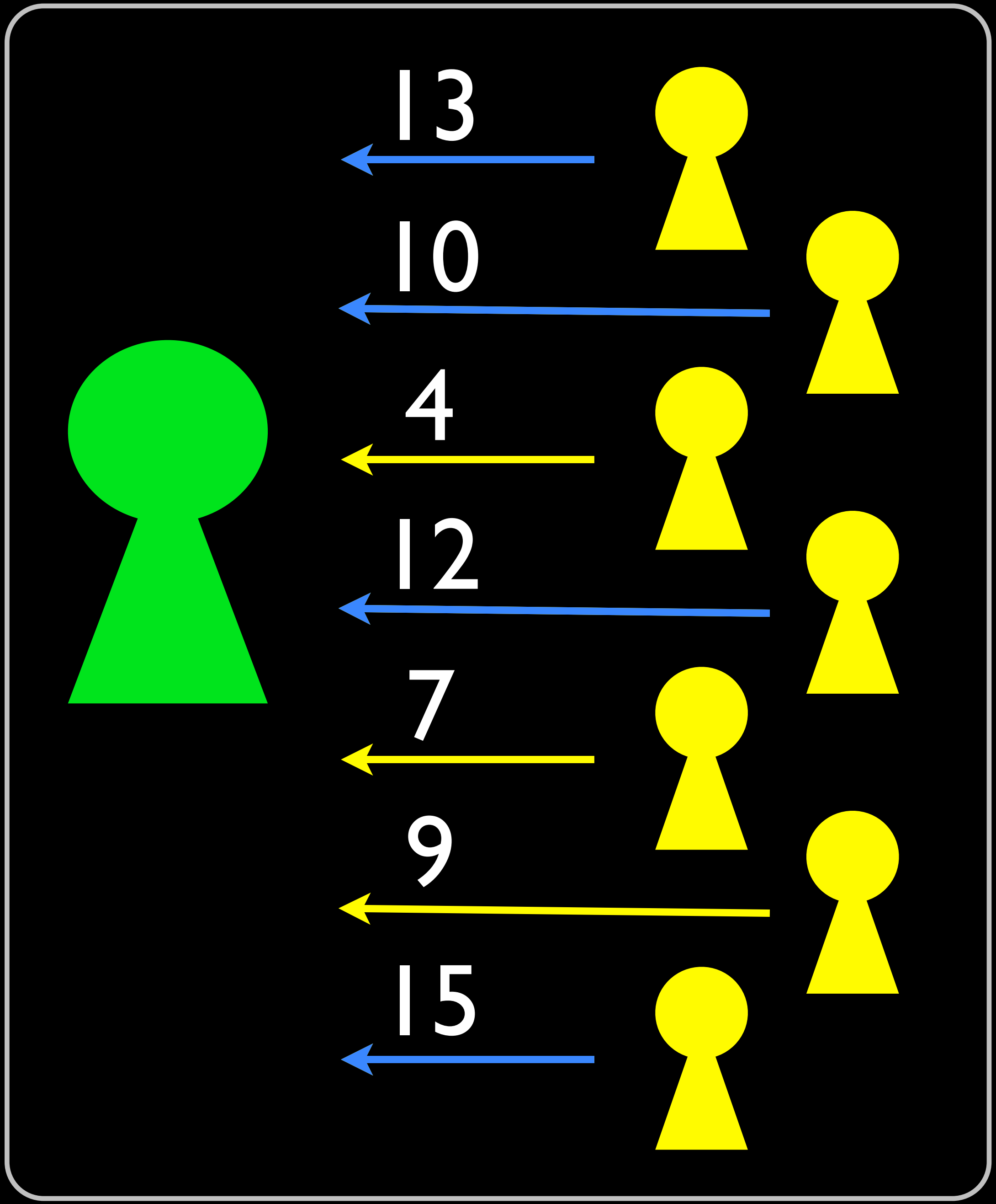
Round t



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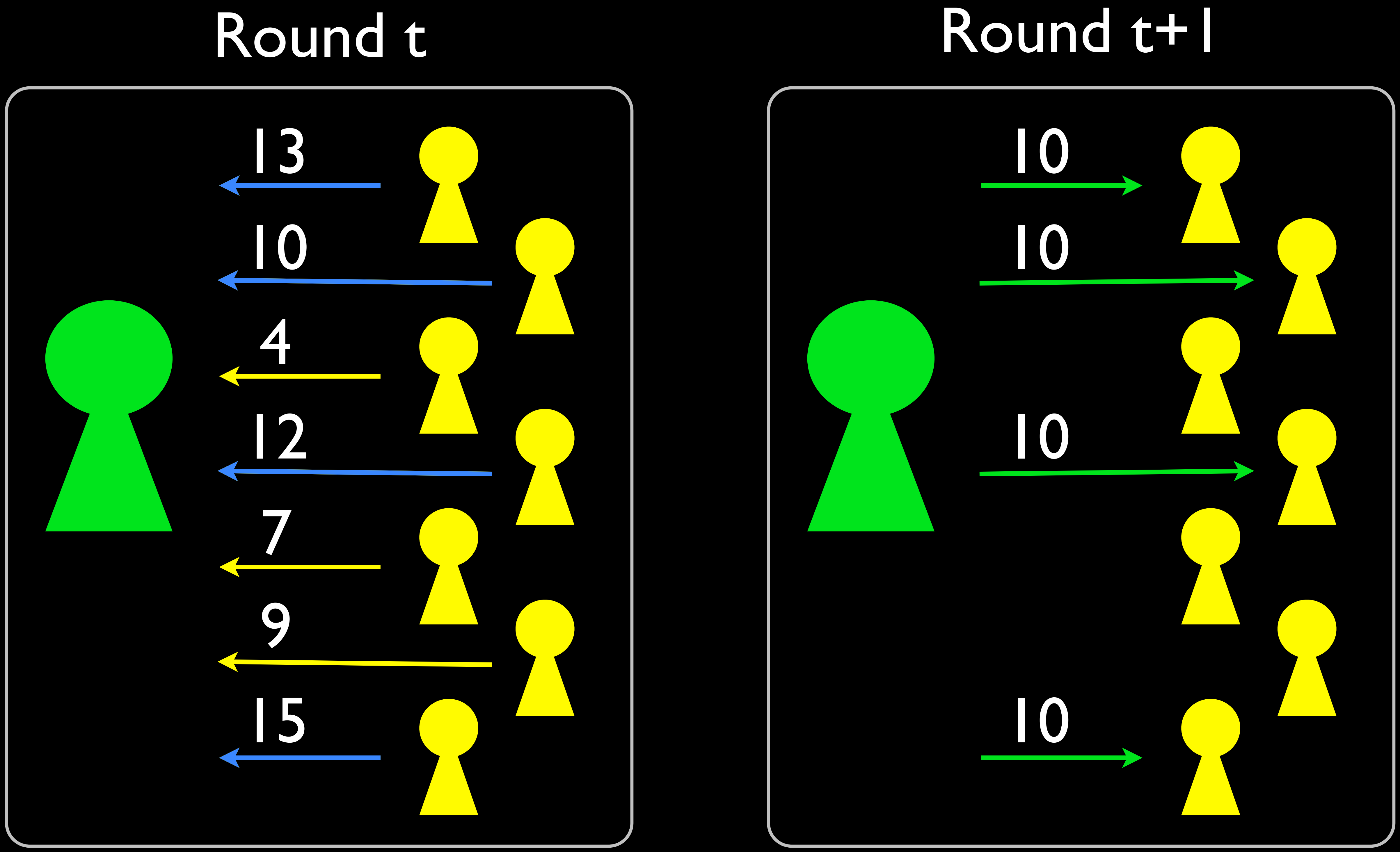

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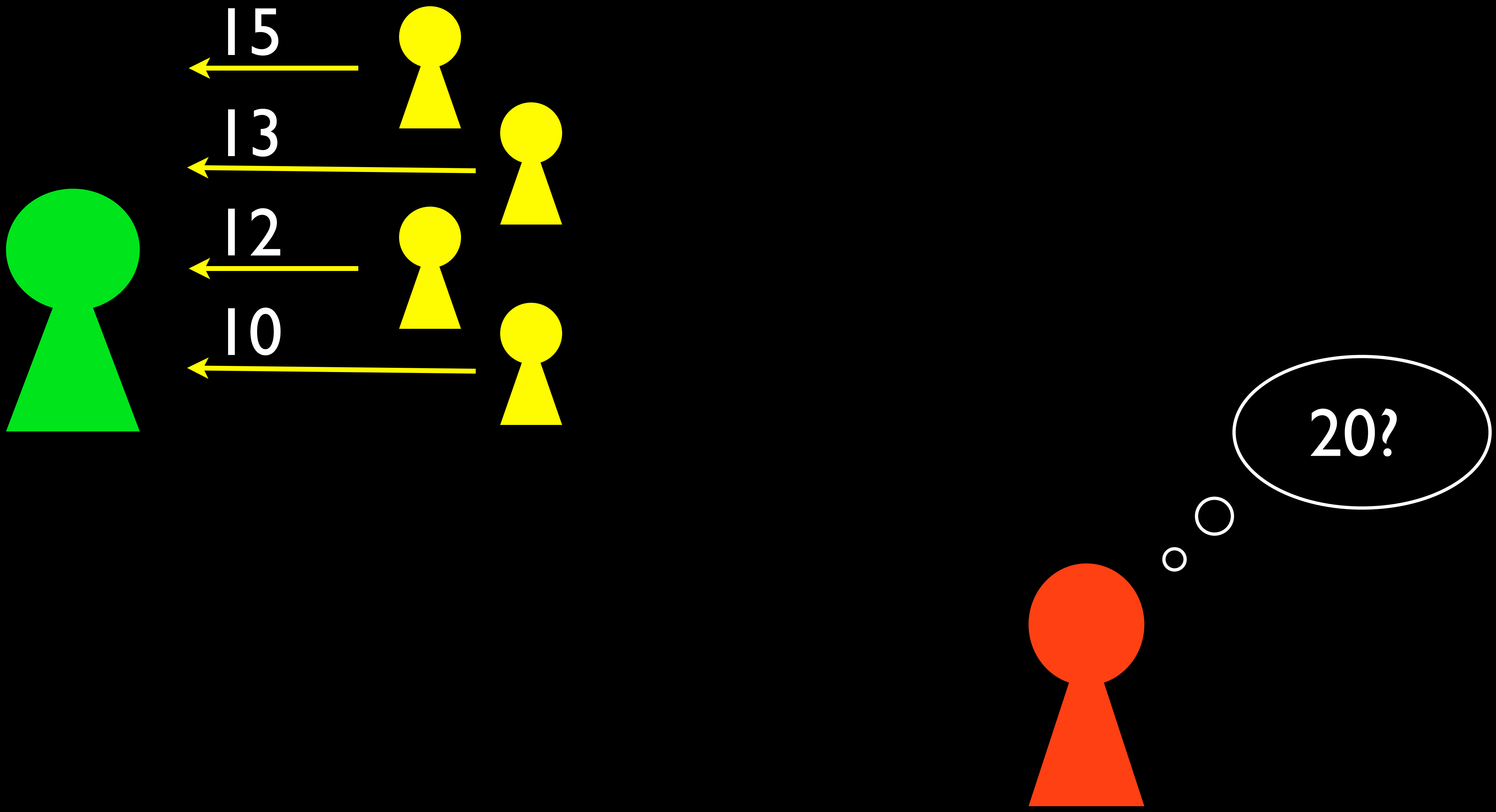

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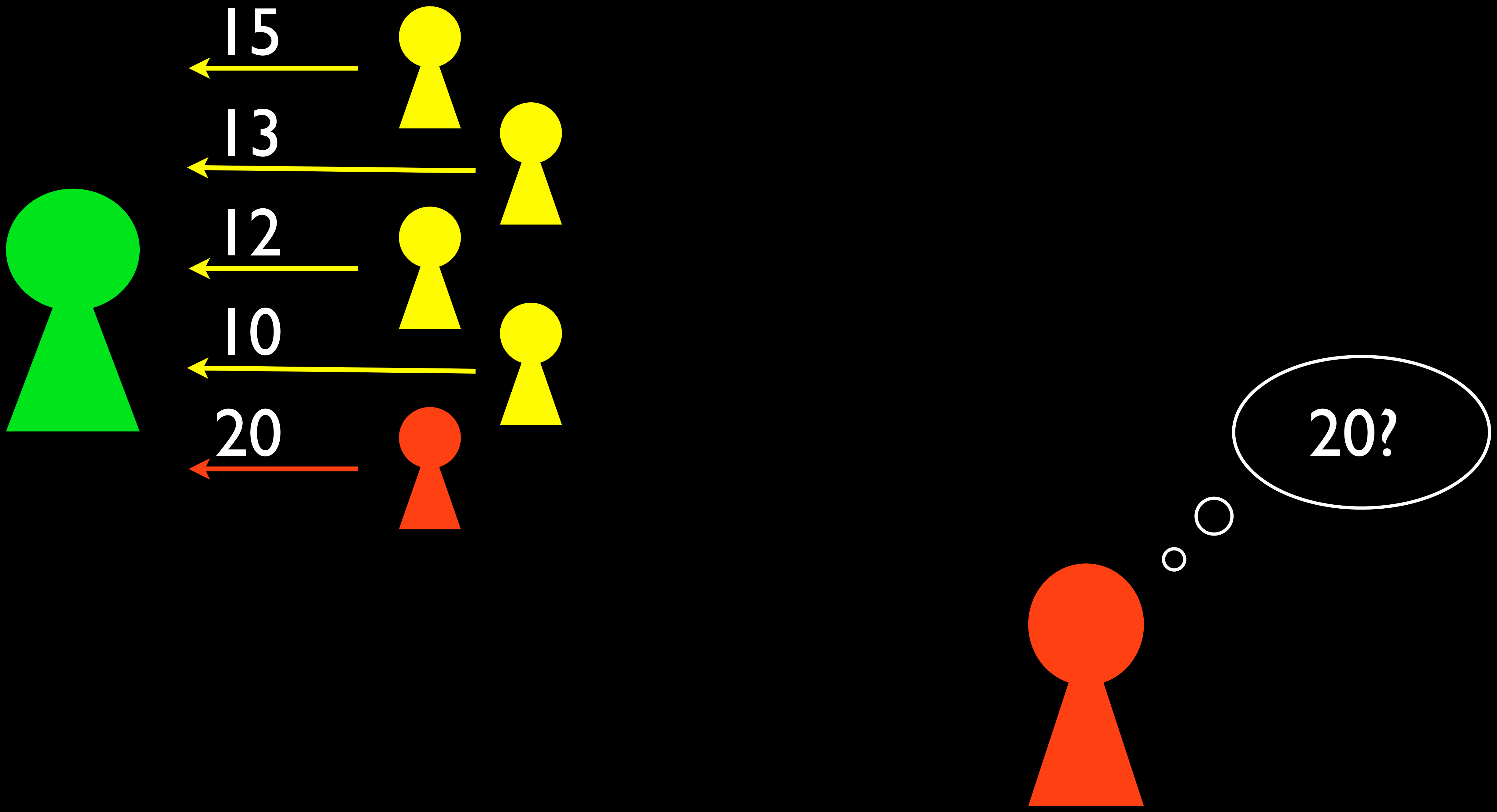

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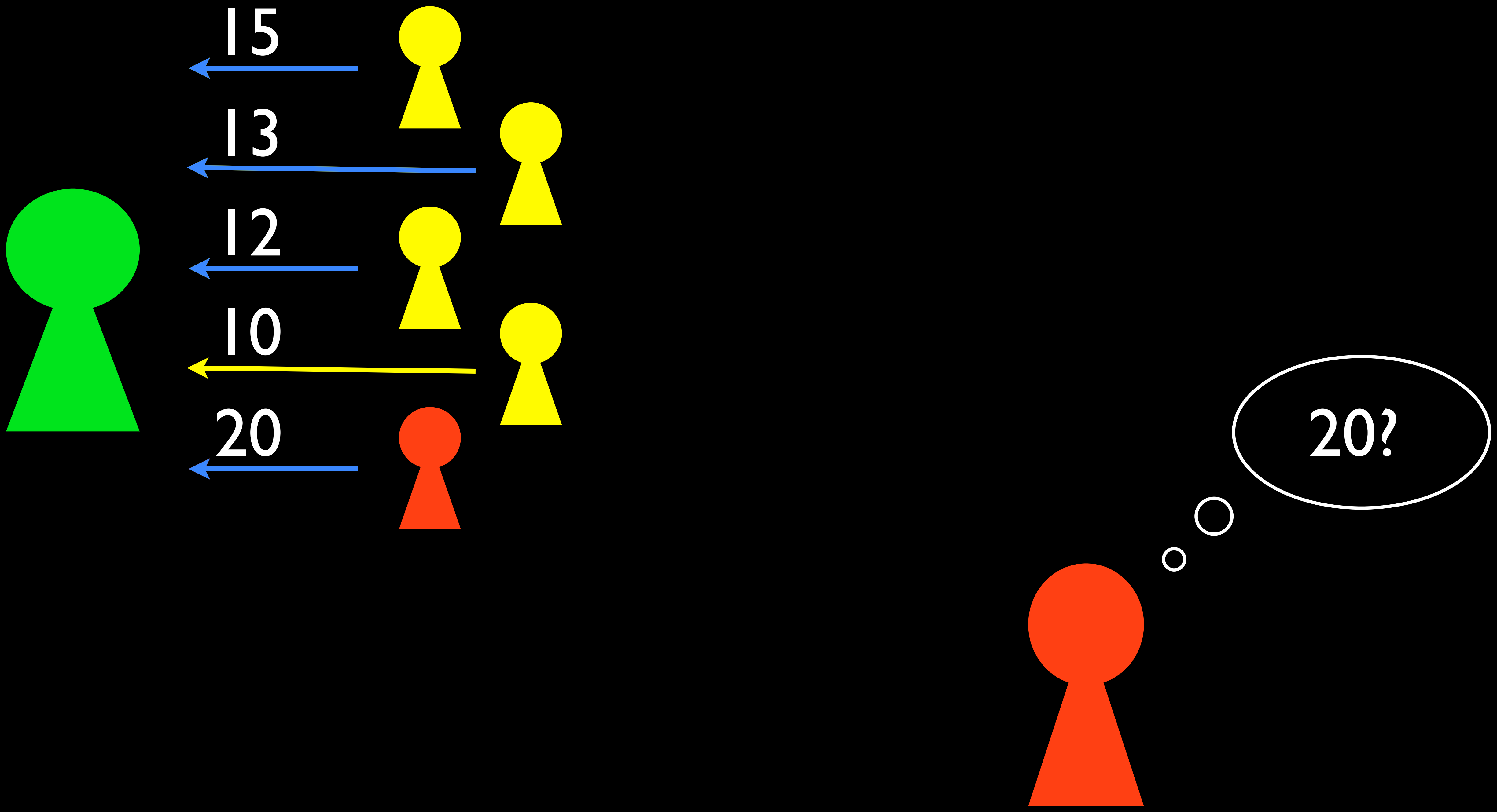

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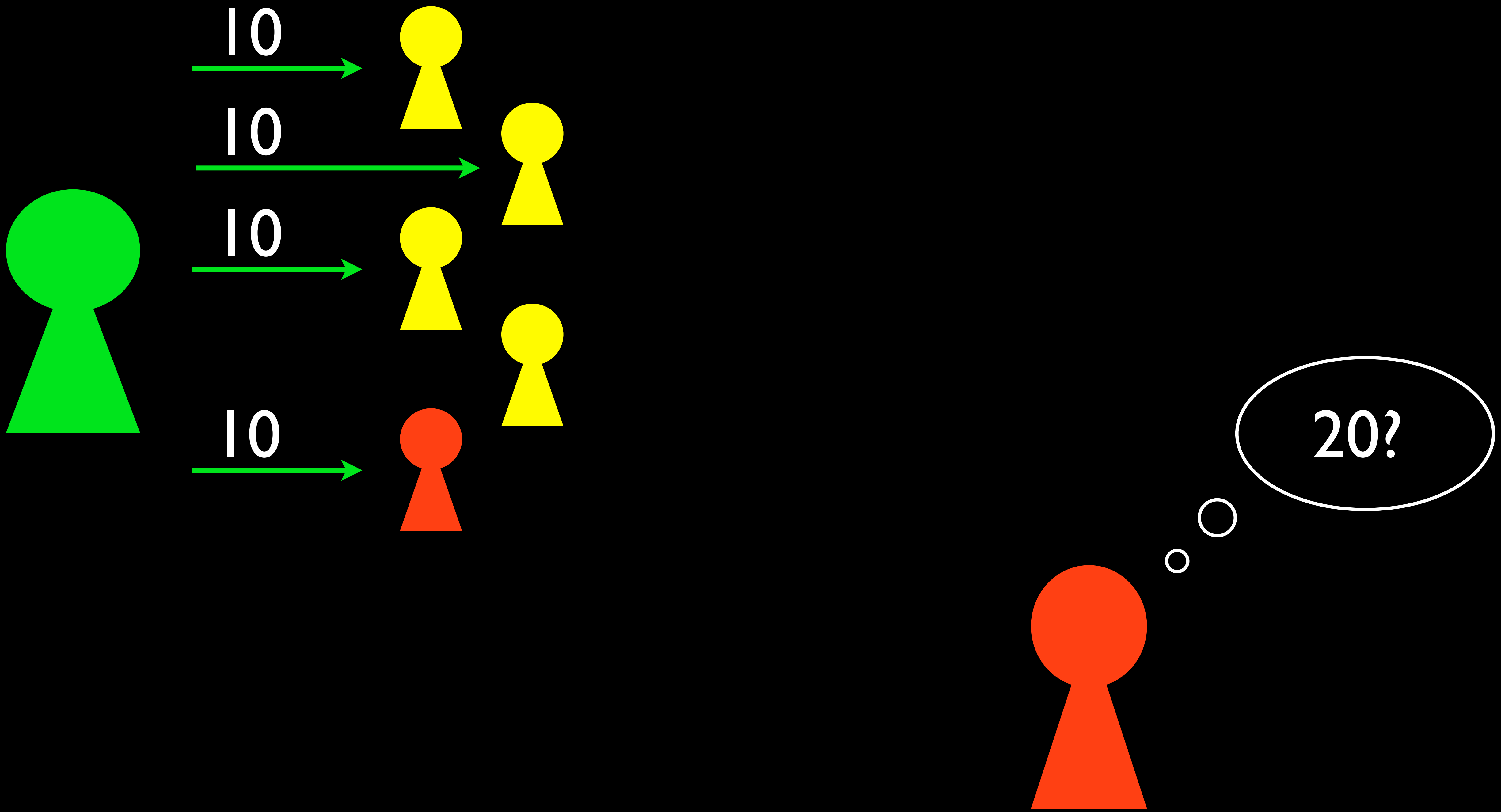

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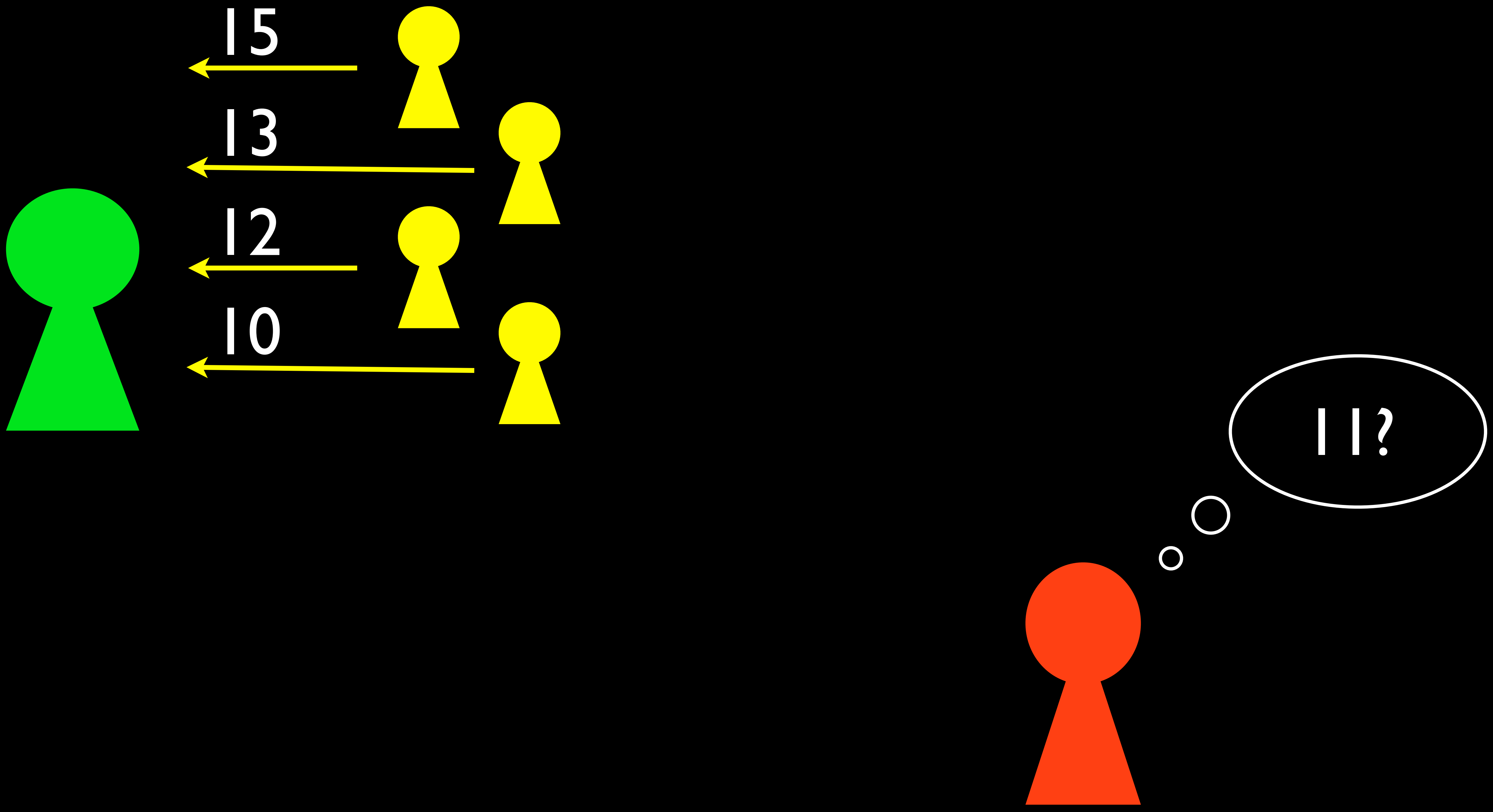

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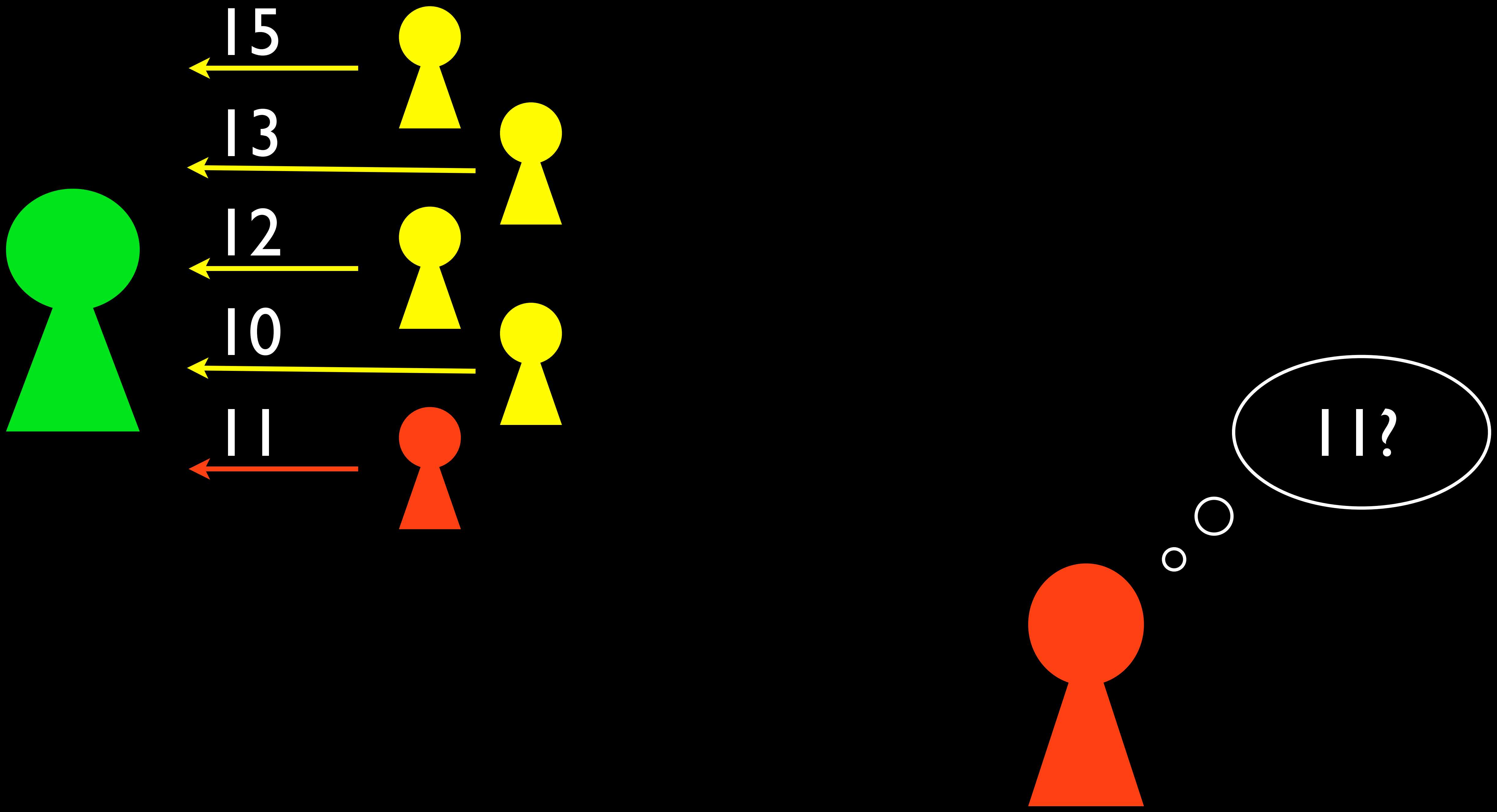

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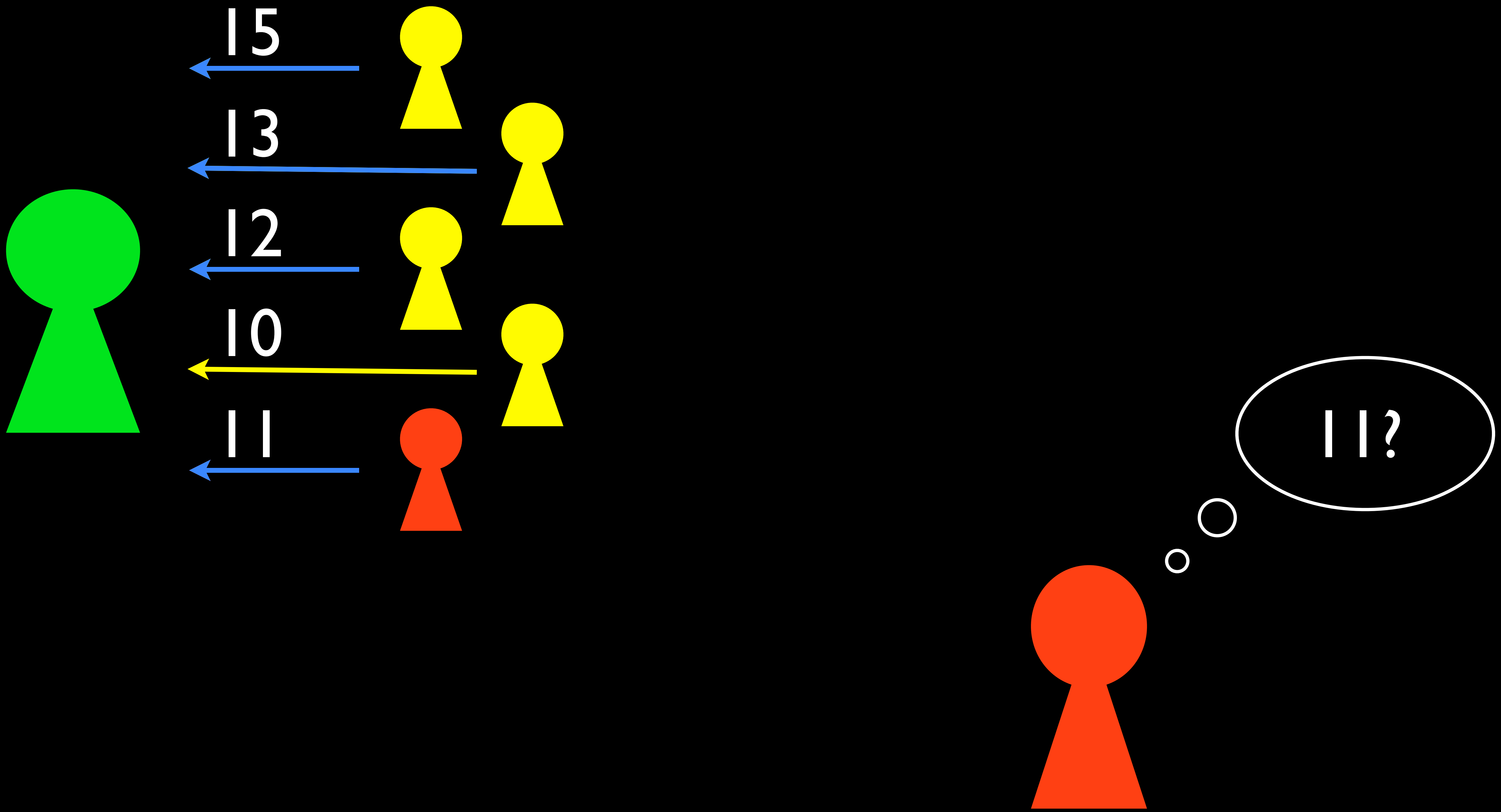

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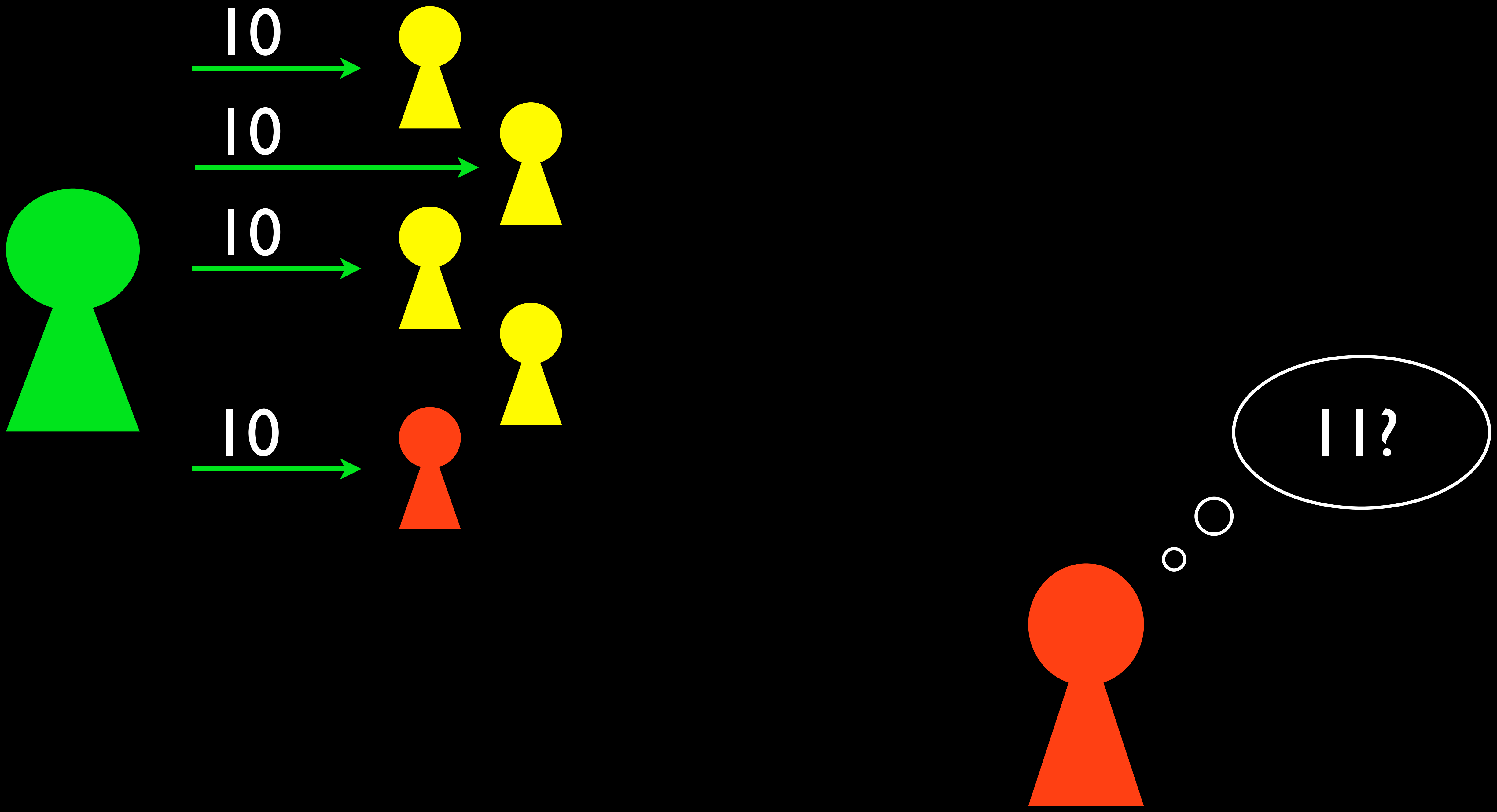

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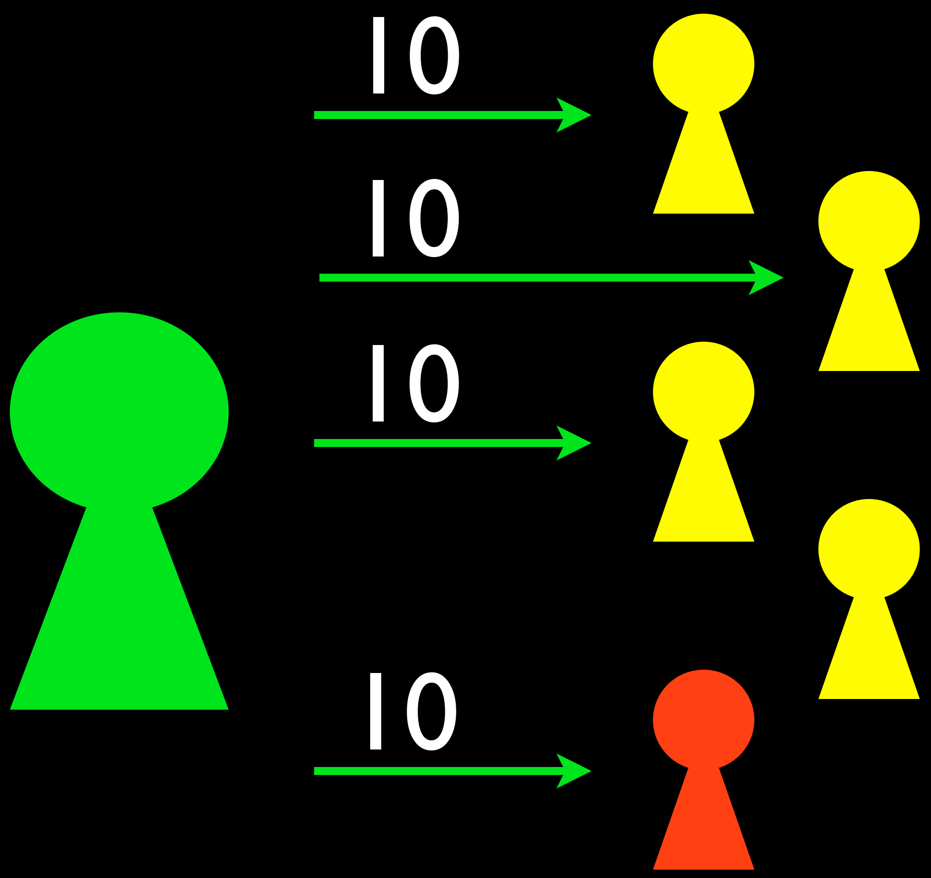
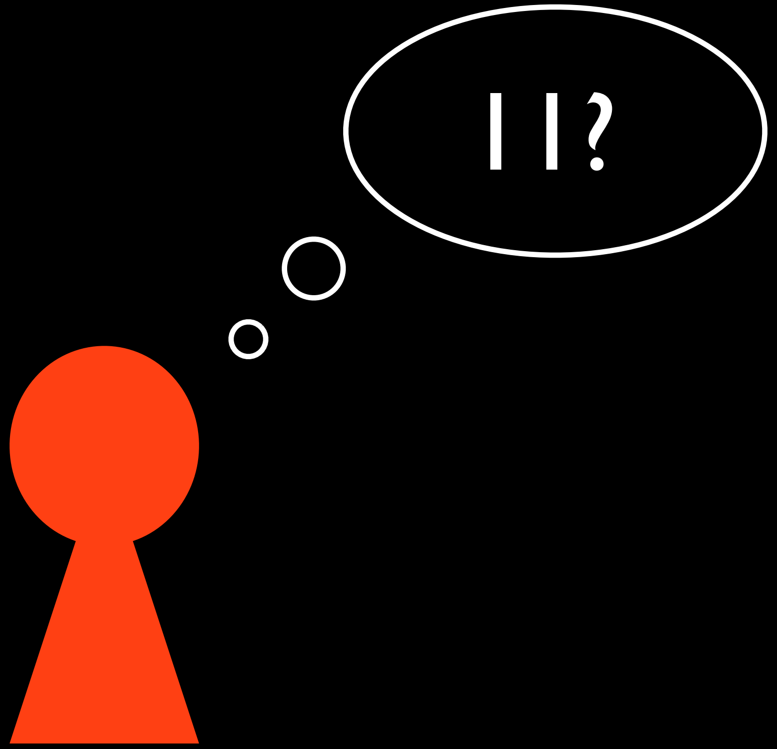


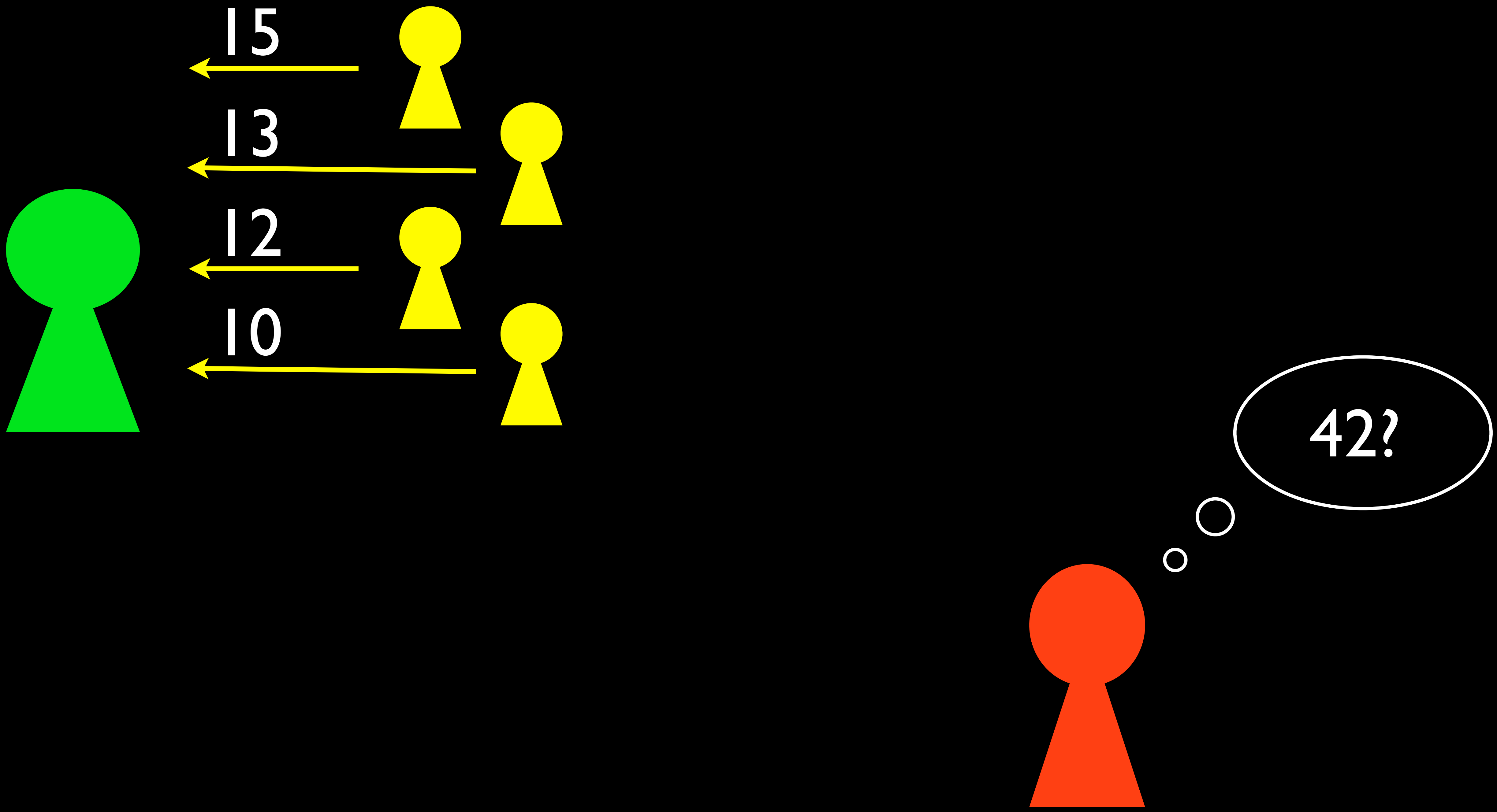
Best strategy: Come in last

peers do *not* have incentive to give as much as possible



Piatek, et al. "Do Incentives Build Robustness in BitTorrent?". NSDI 2007

BitTorrent's Unchoker



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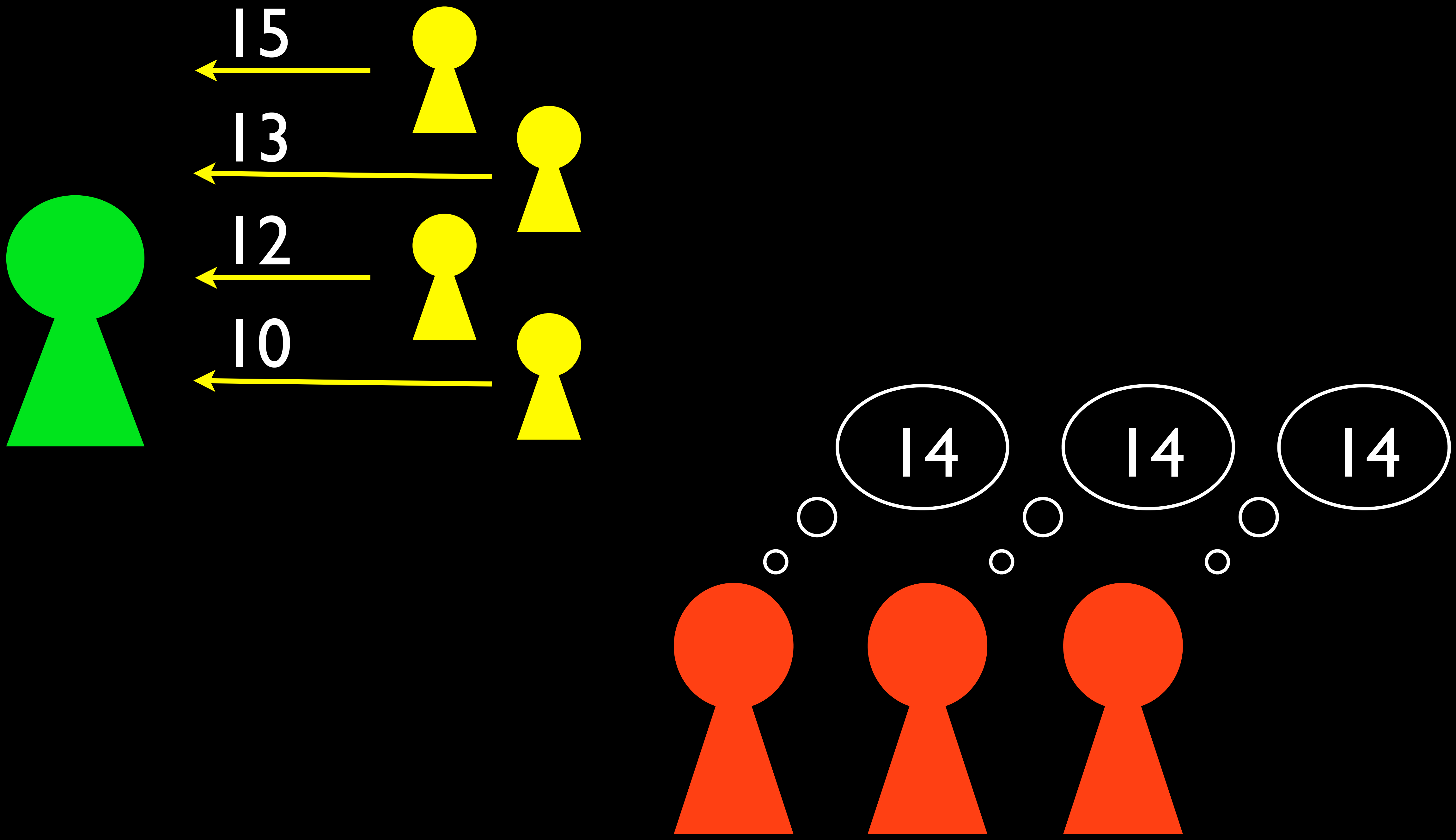

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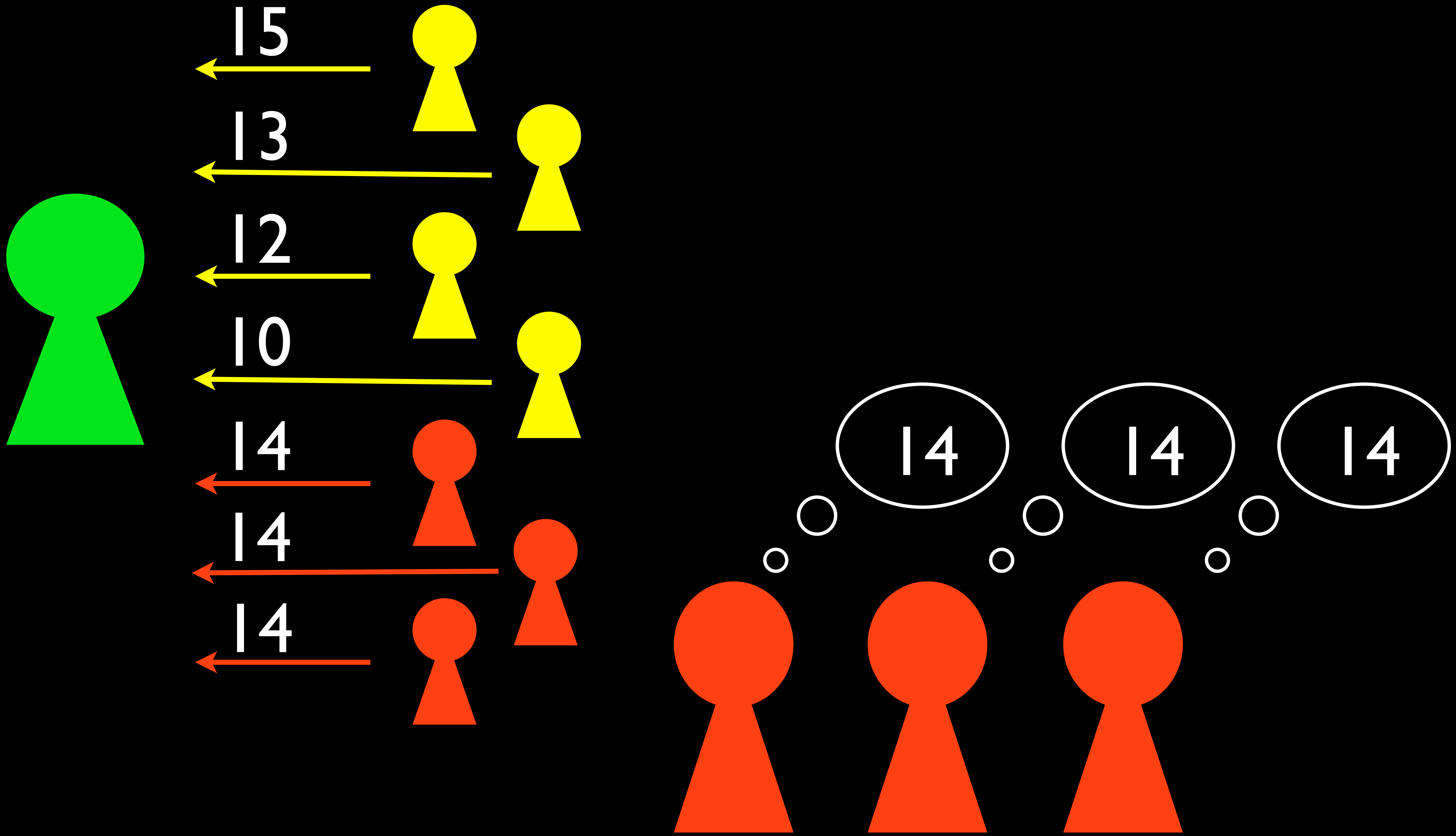

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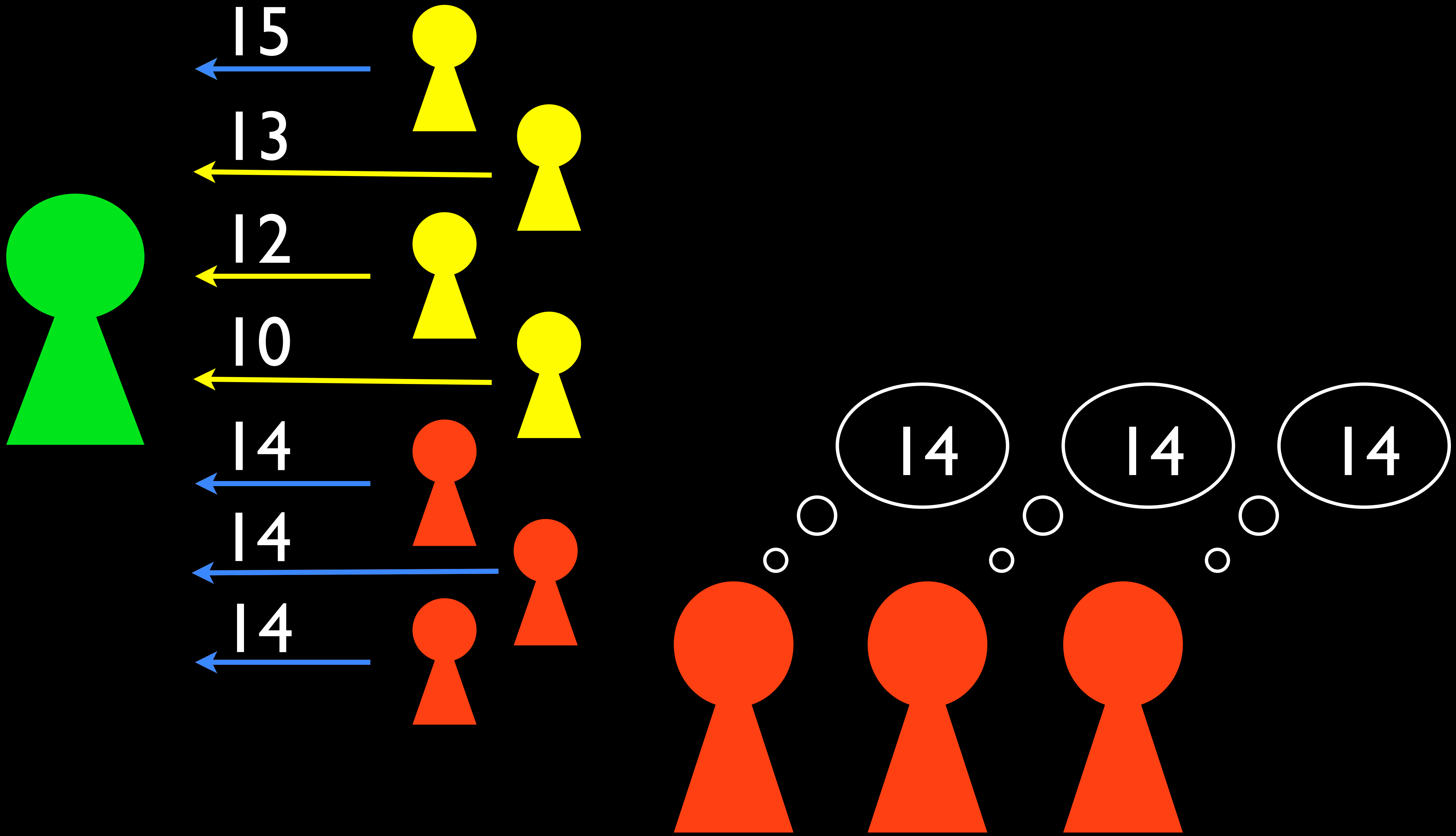

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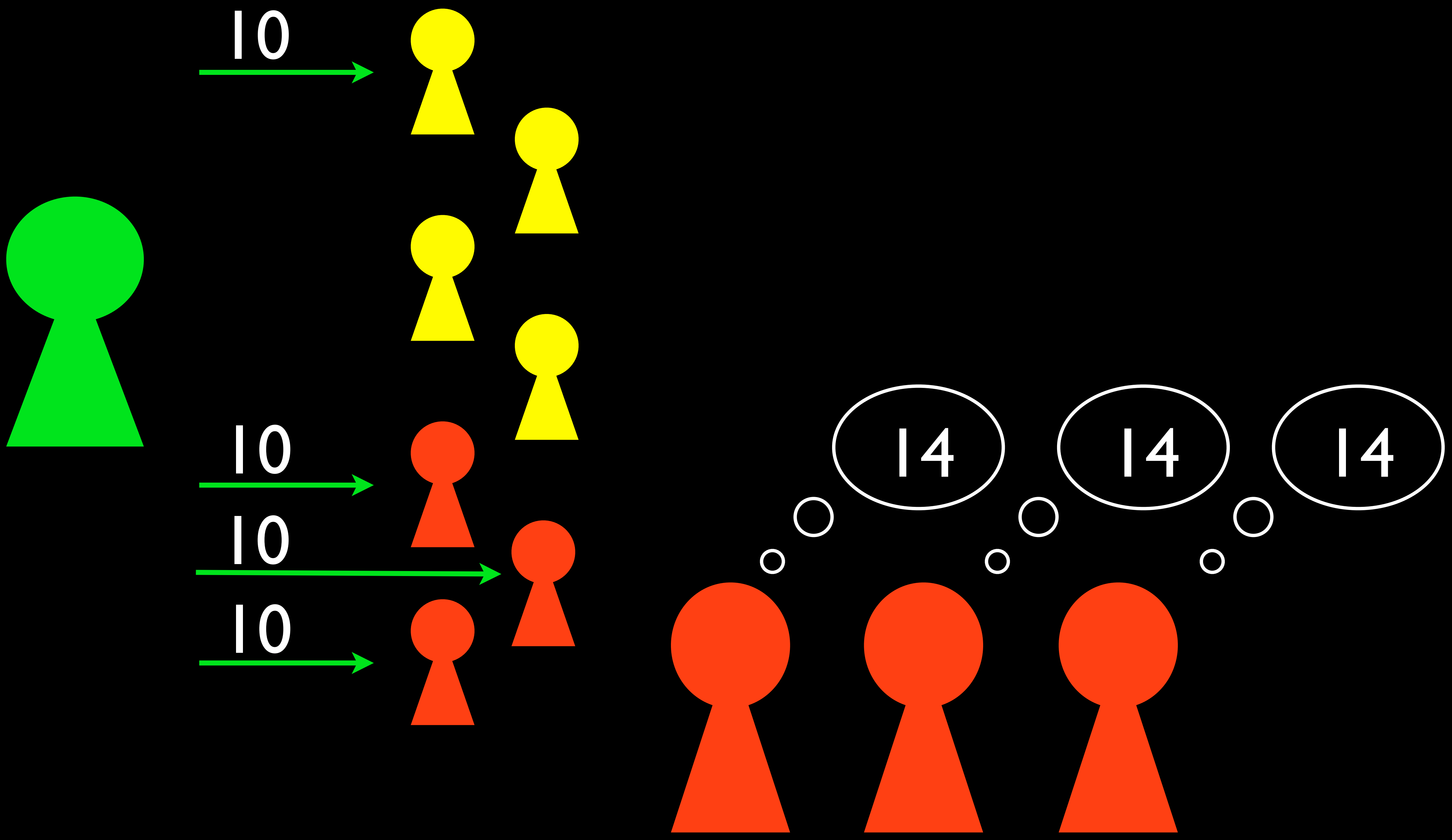
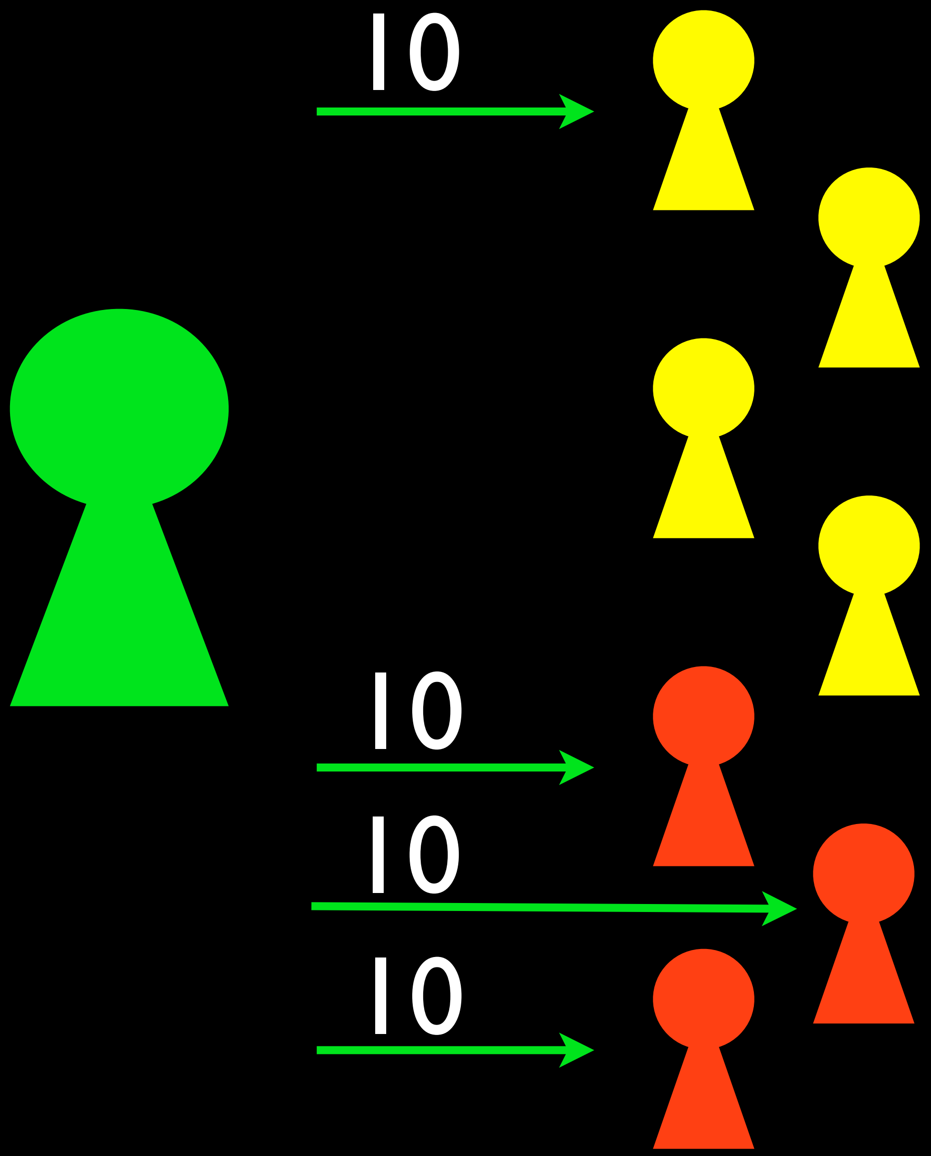
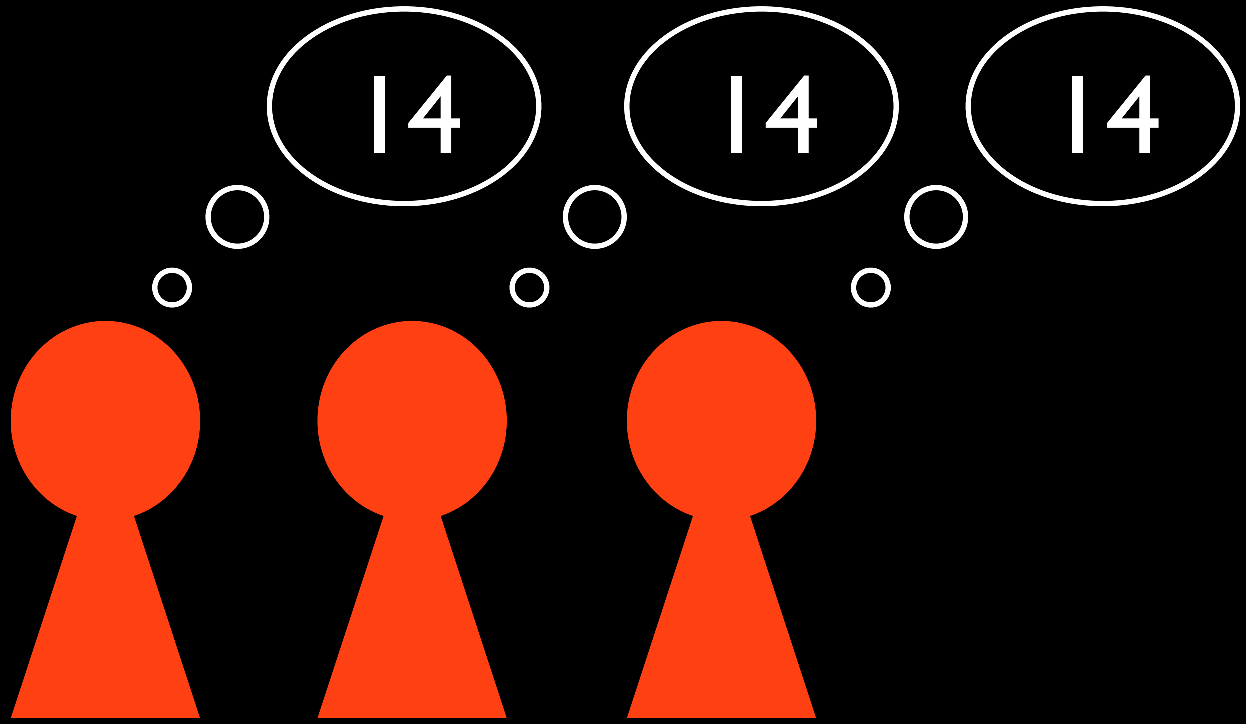


BitTorrent's Unchoker

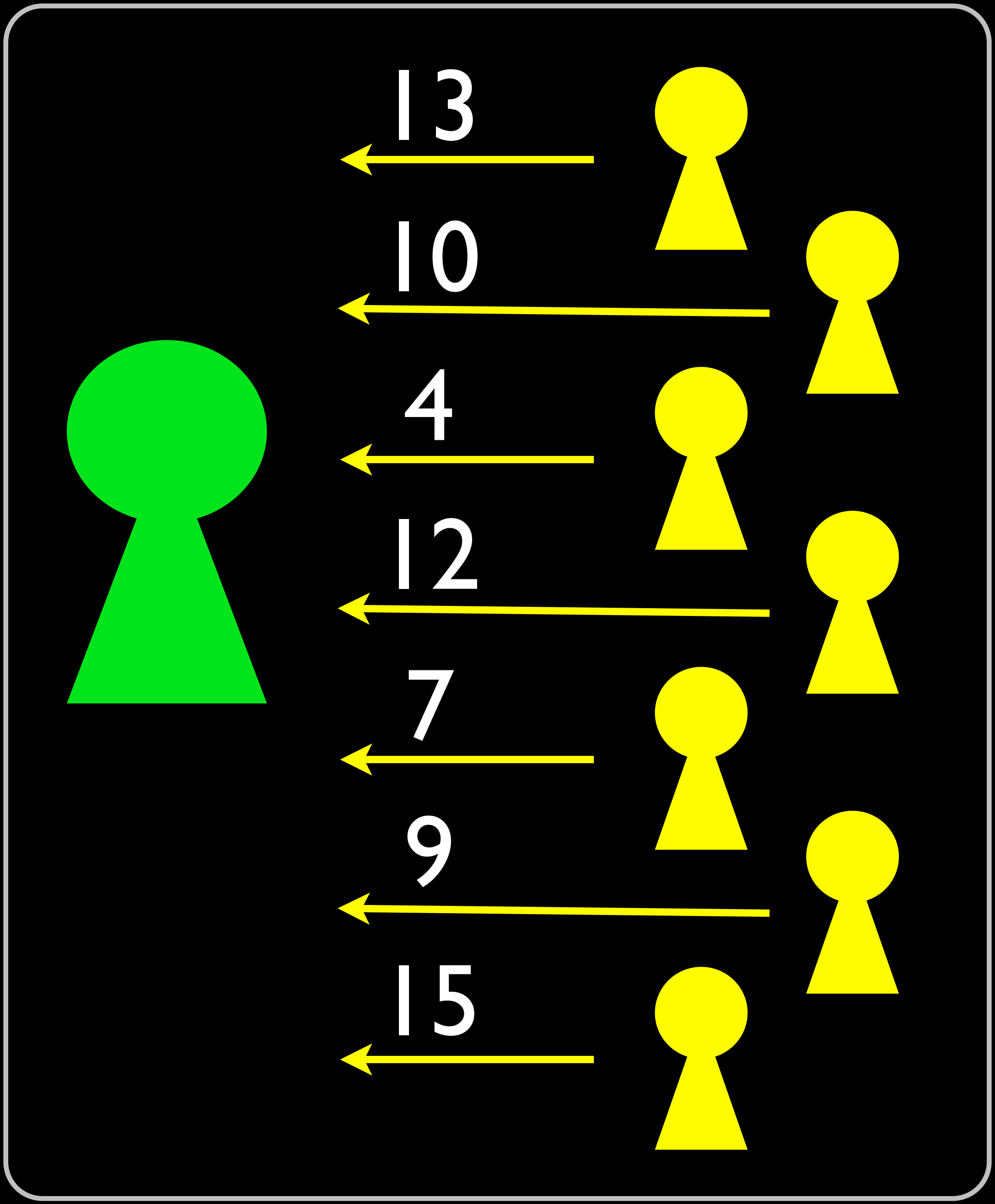
Sybil Attack: Create additional identities to subvert the system





PropShare Unchoker

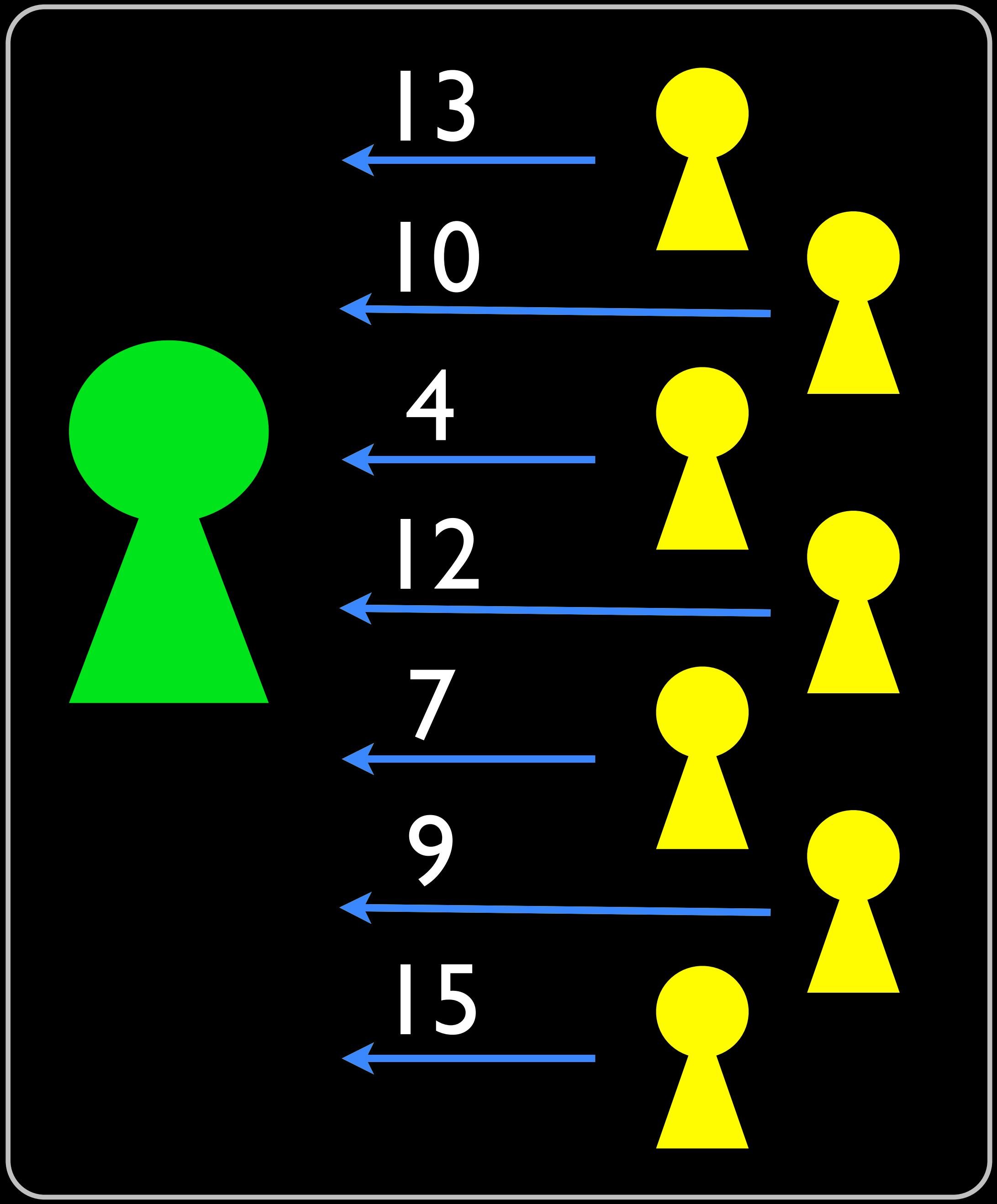
Round t



Levin, et al. "BitTorrent is an Auction: Analyzing and Improving BitTorrent's Incentives". SIGCOMM 2008

PropShare Unchoker

Round t



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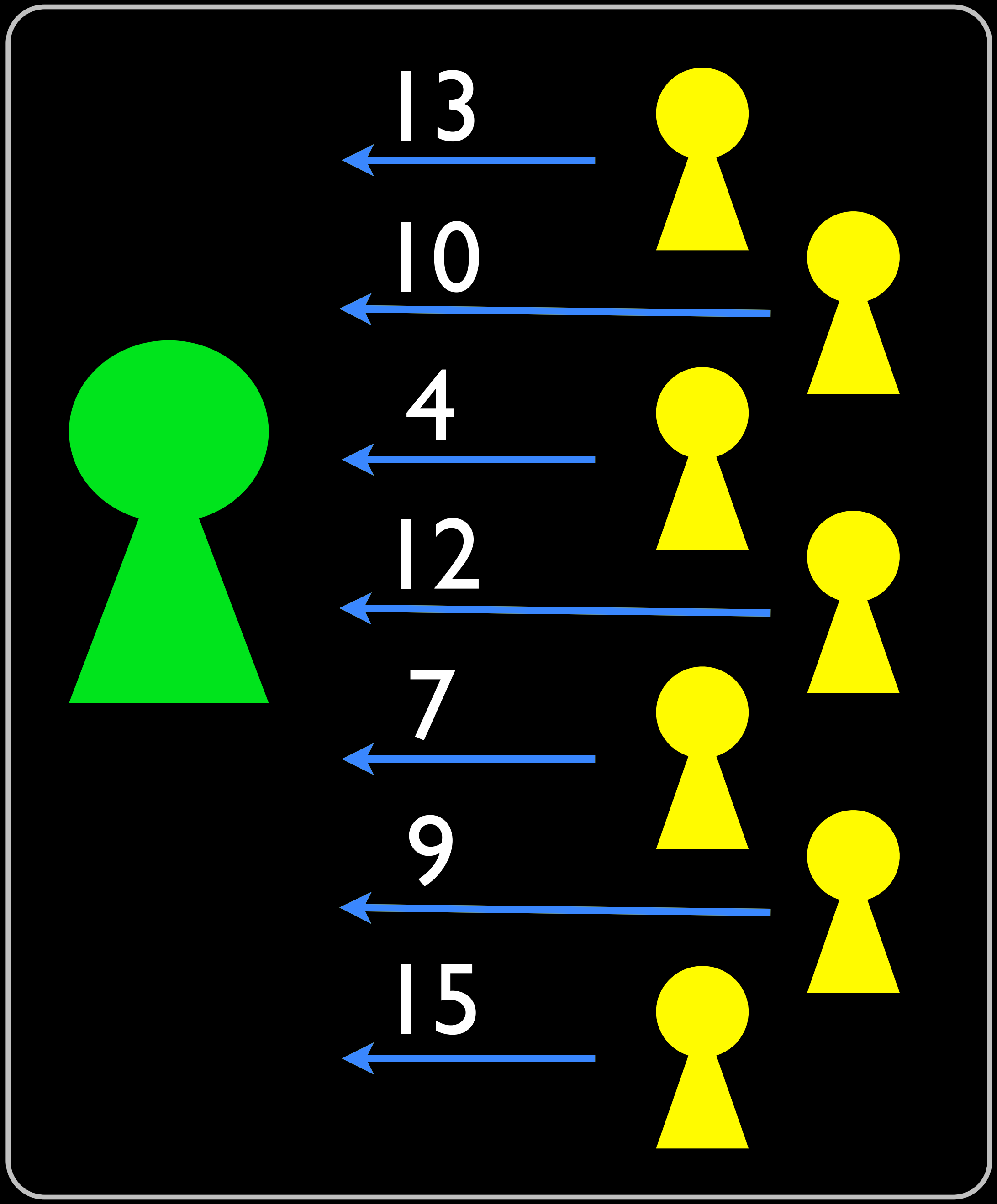
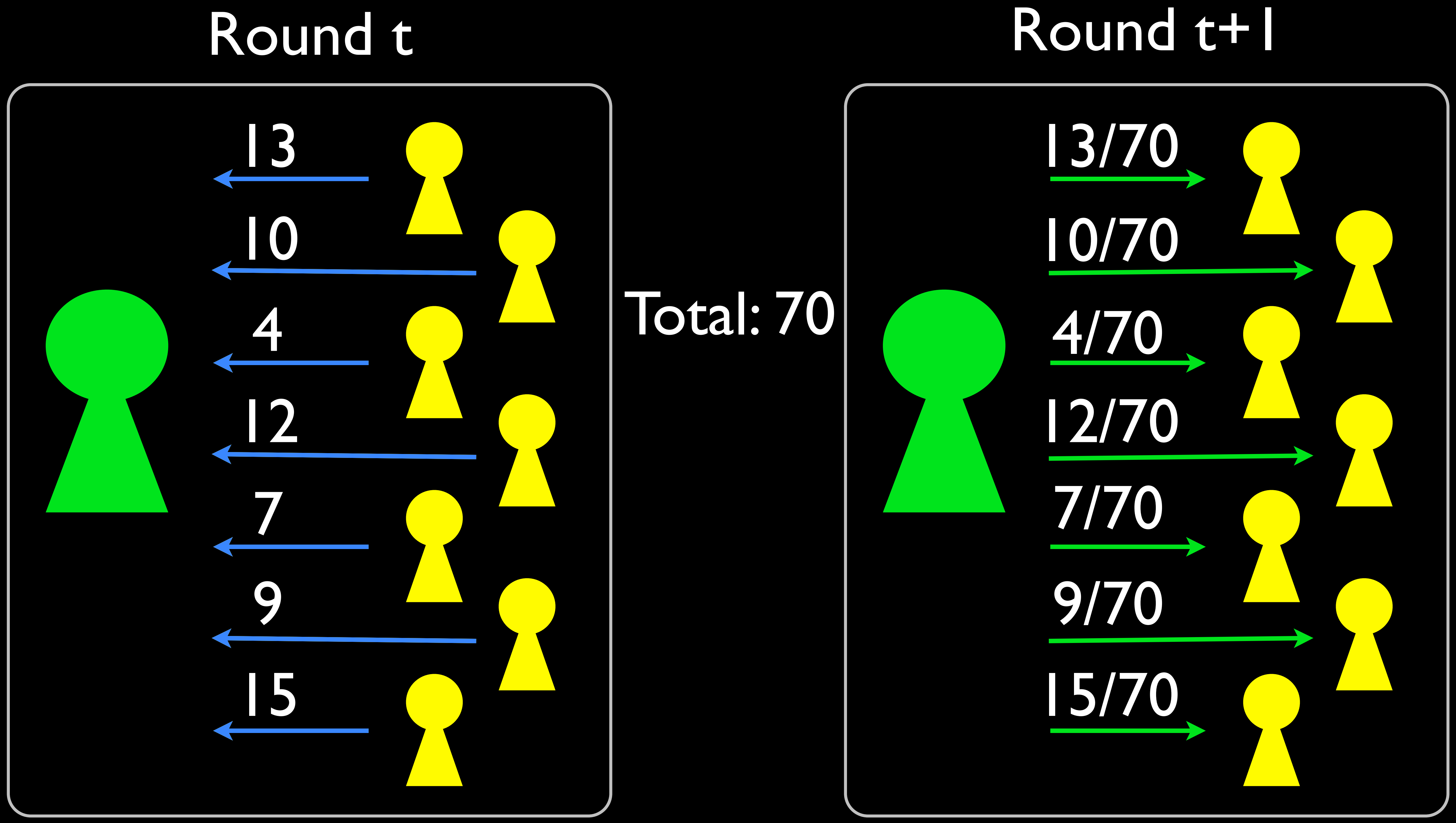
Round t



Total: 70

Levin, et al. "BitTorrent is an Auction: Analyzing and Improving BitTorrent's Incentives". SIGCOMM 2008

PropShare Unchoker



Round t

13

10

4

12

7

9

15

Total: 70

Round t+1

13/70

10/70

4/70

12/70

7/70

9/70

15/70

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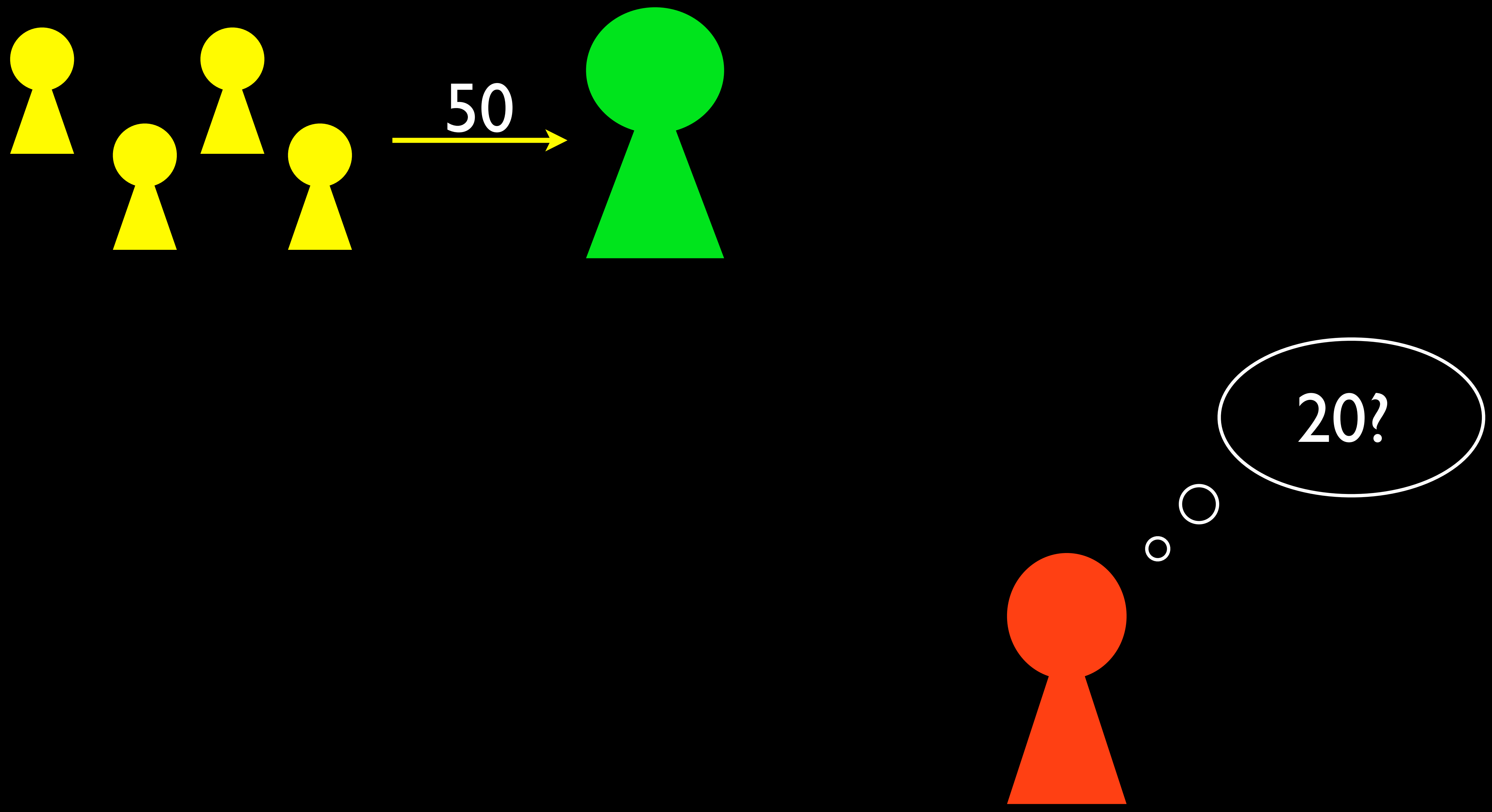

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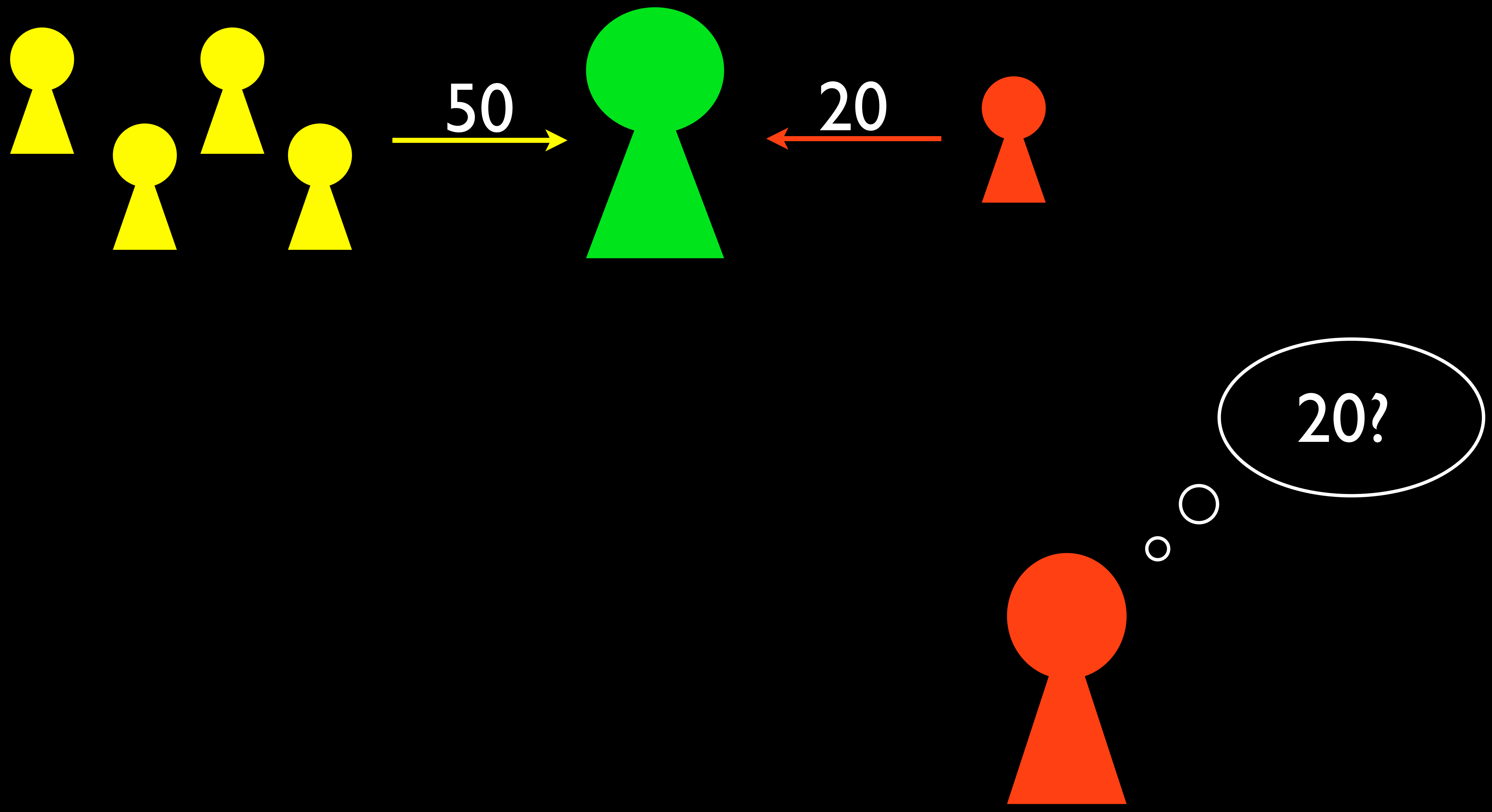

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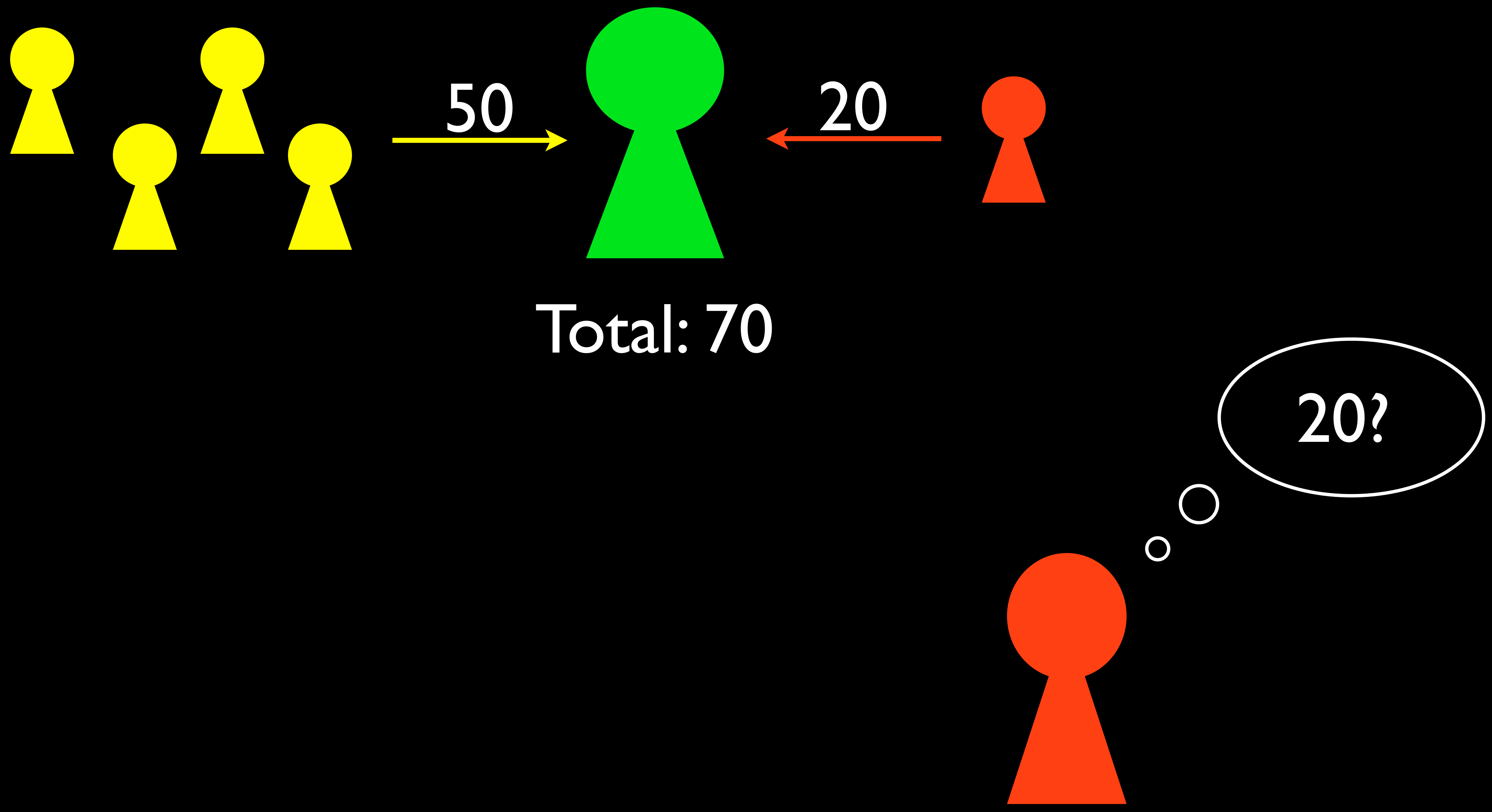

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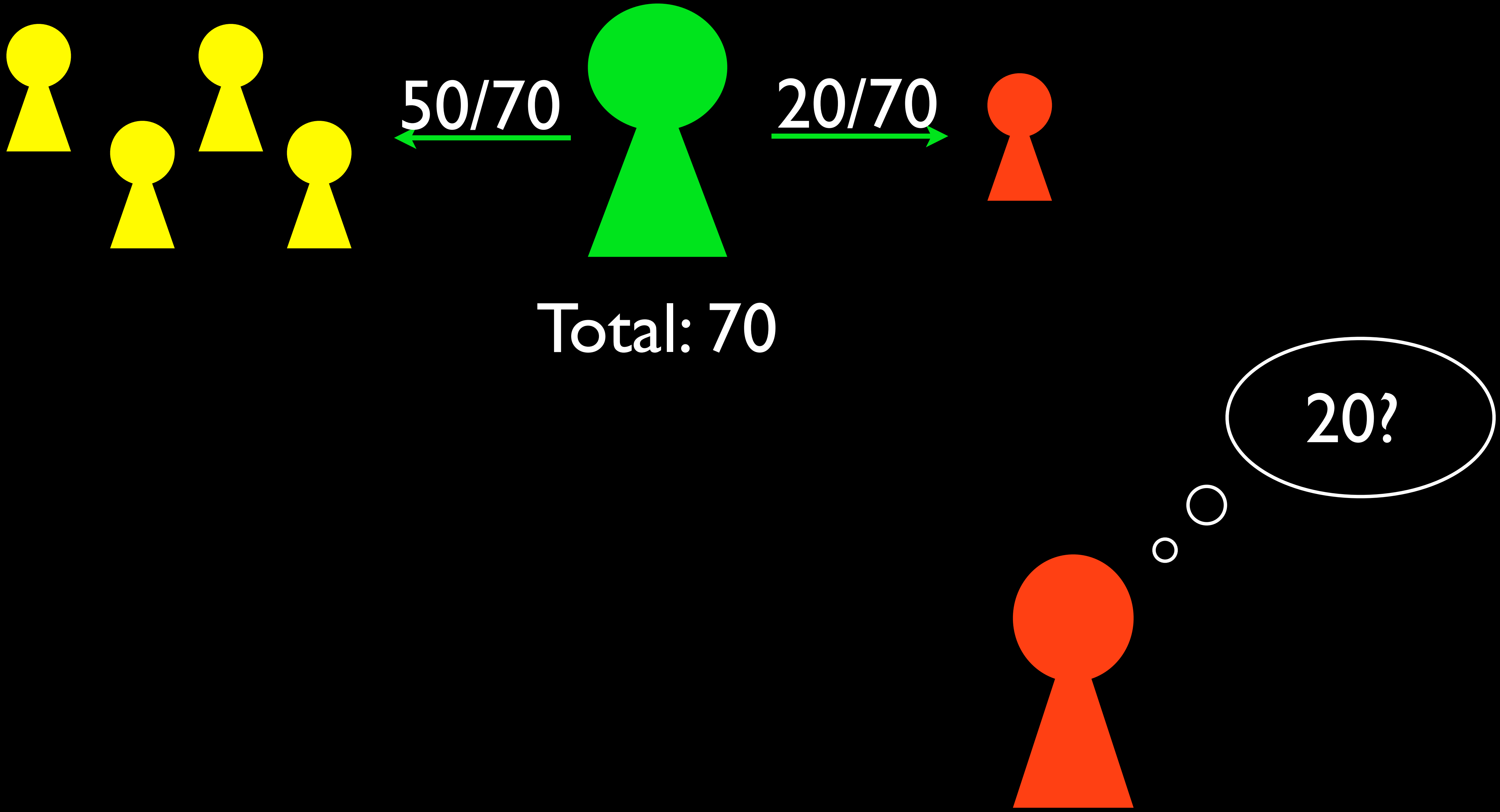

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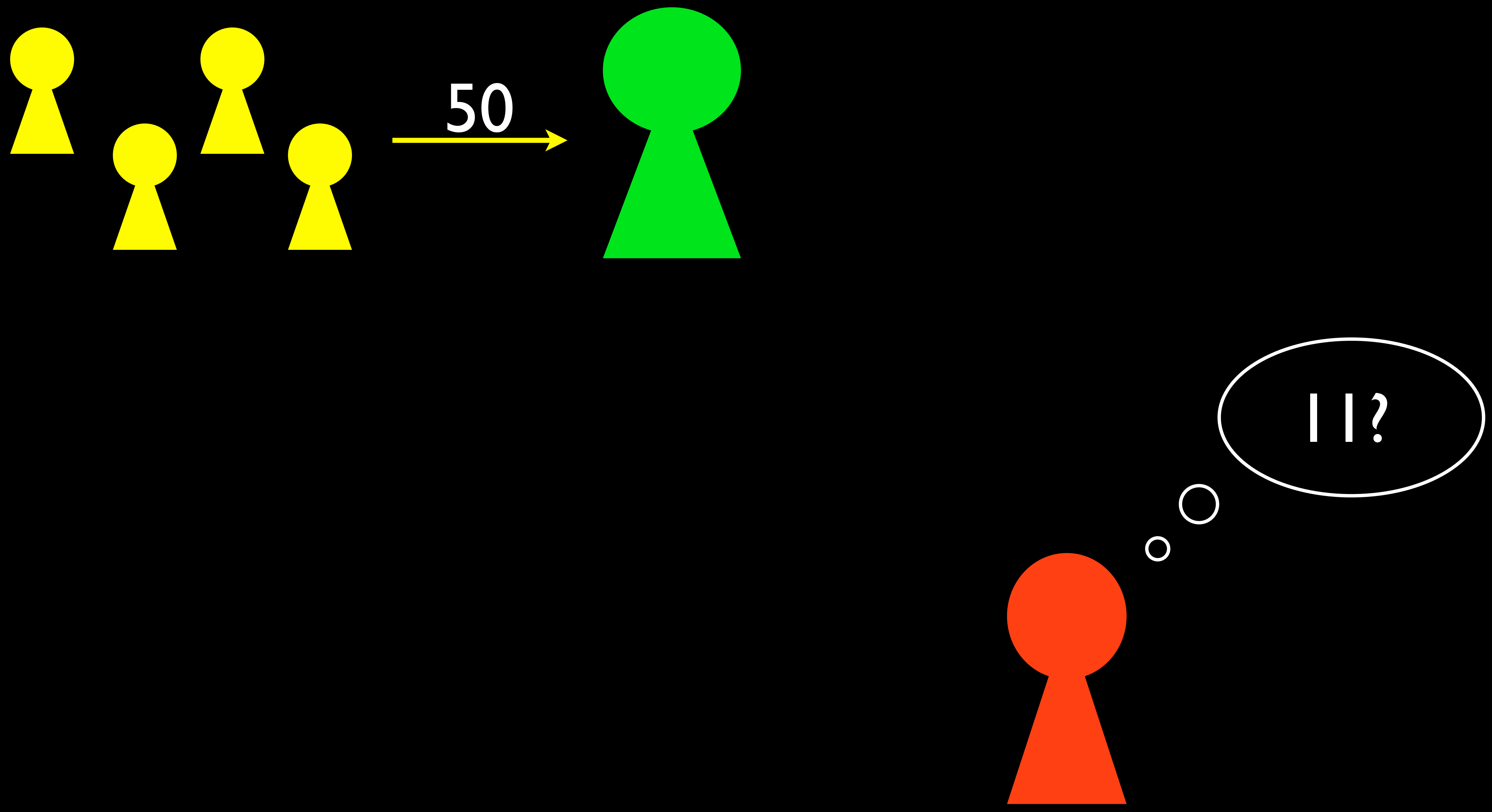

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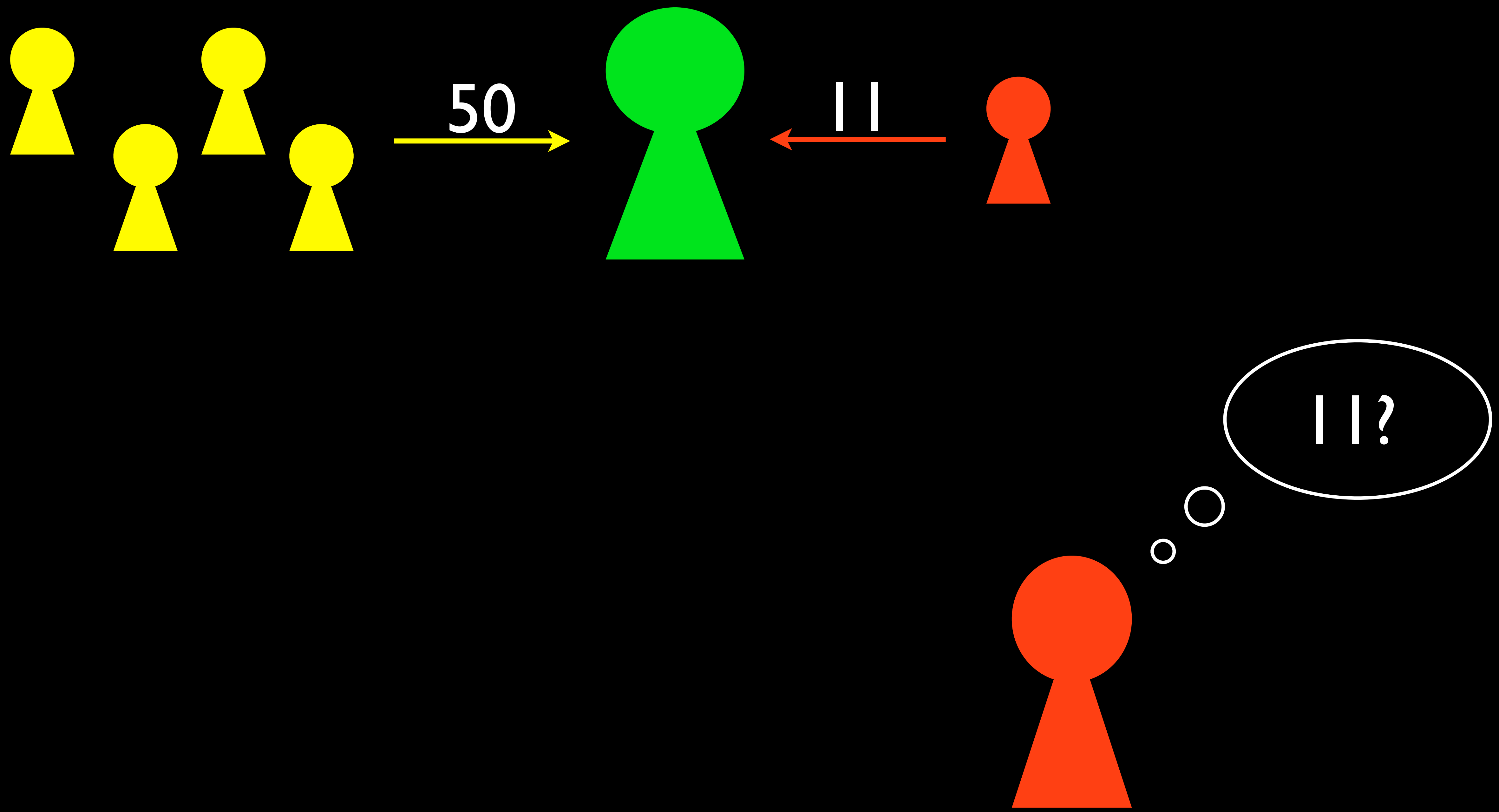

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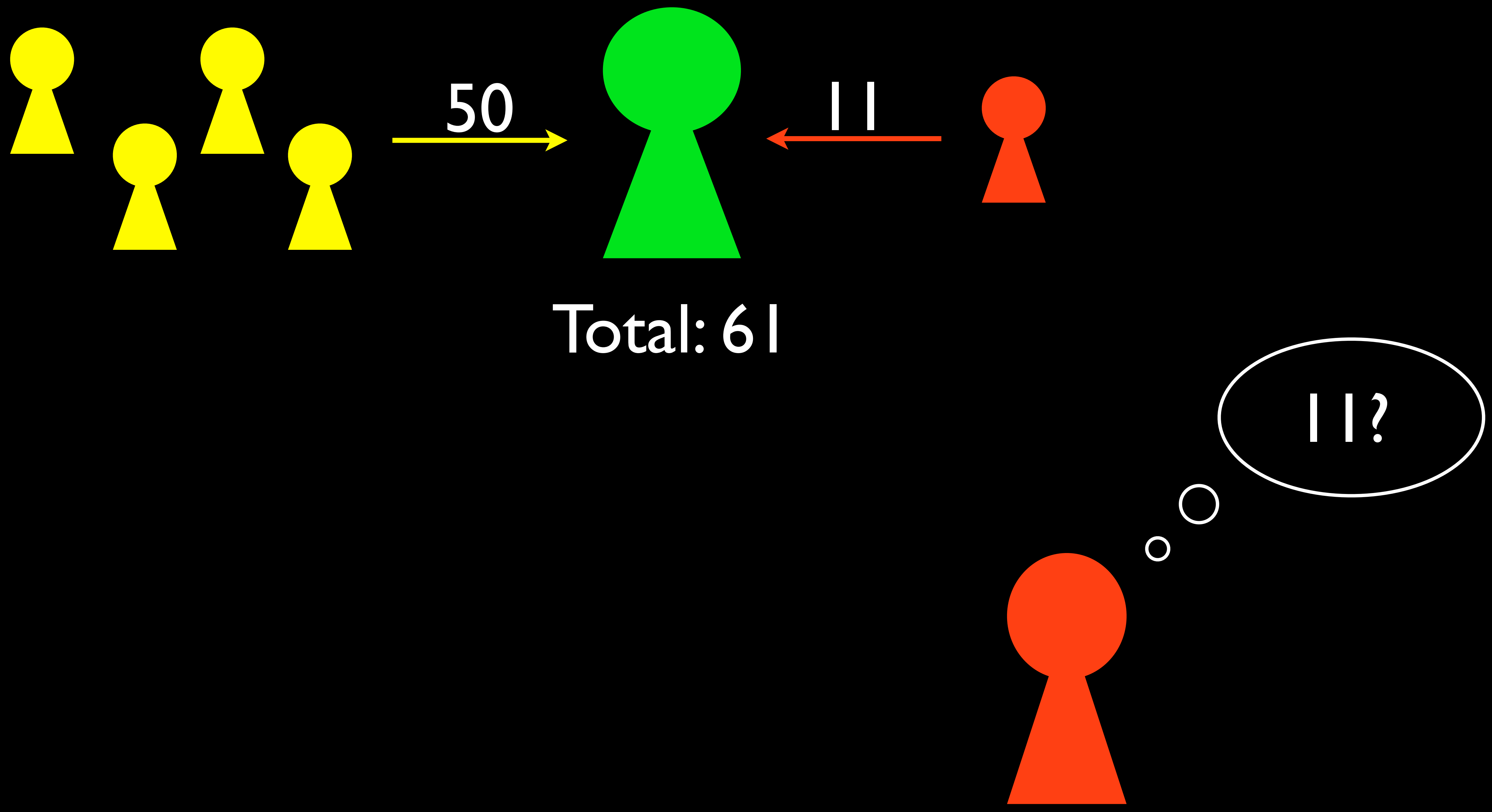

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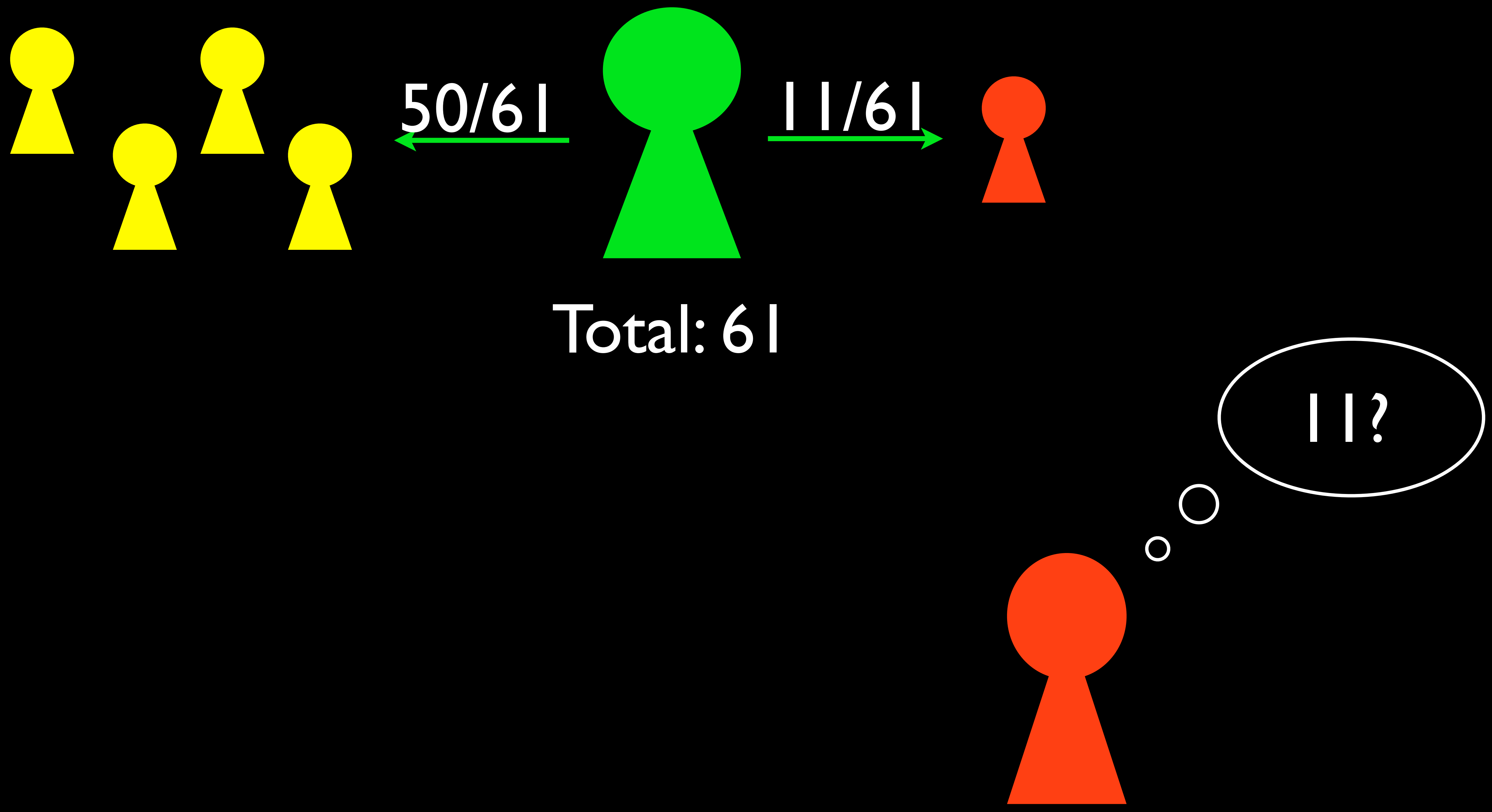

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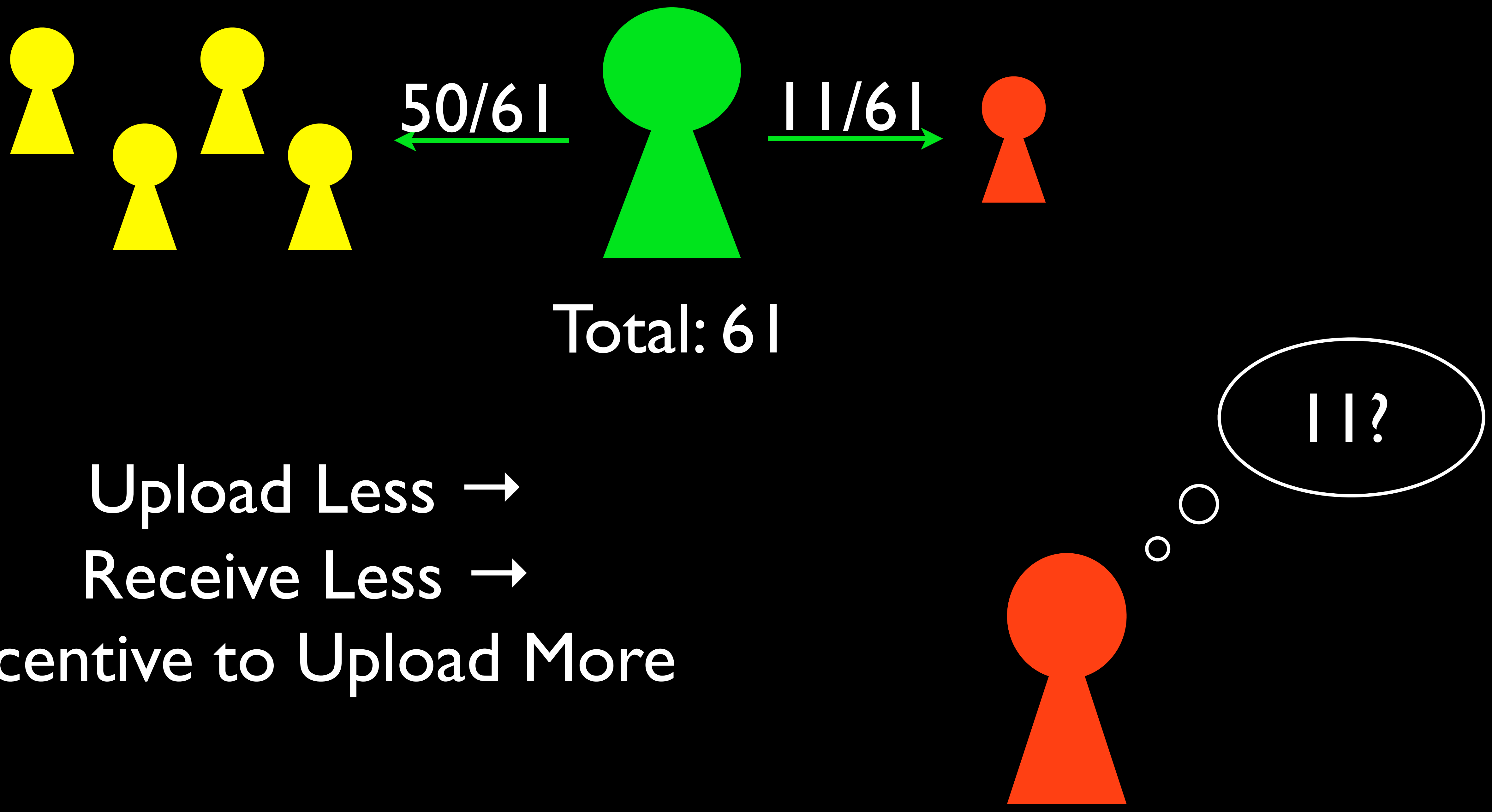
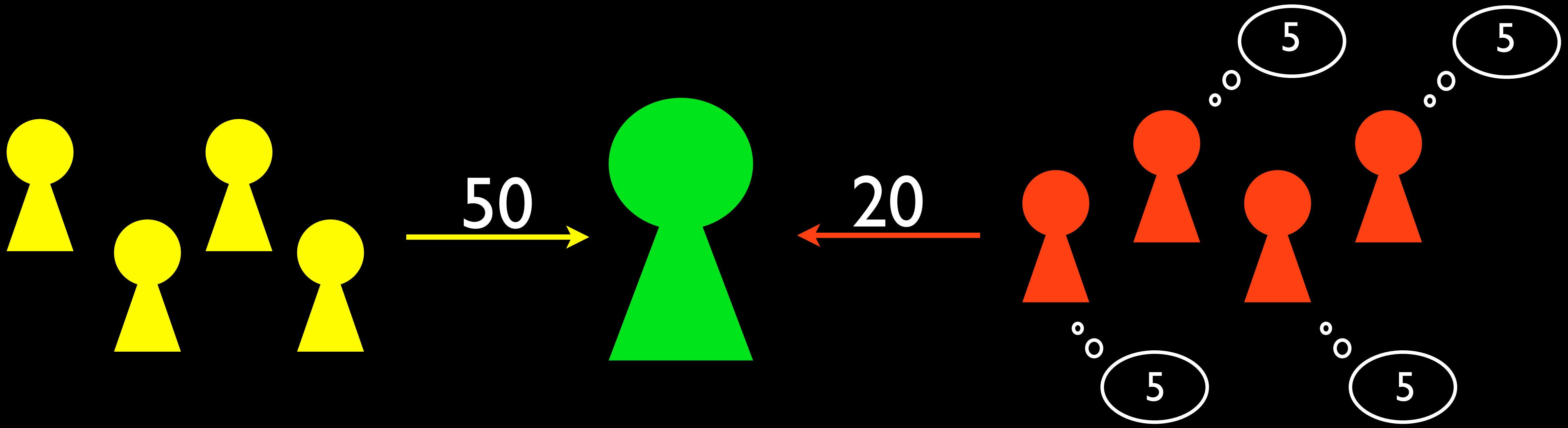


Upload Less →
Receive Less →
Incentive to Upload More

PropShare Unchoker



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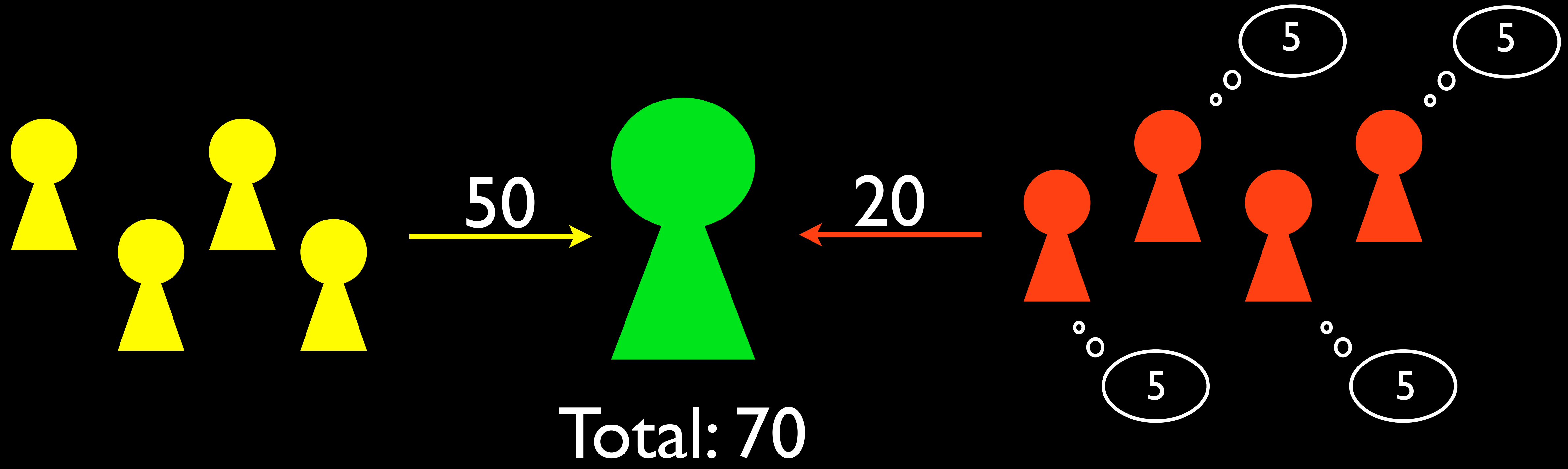

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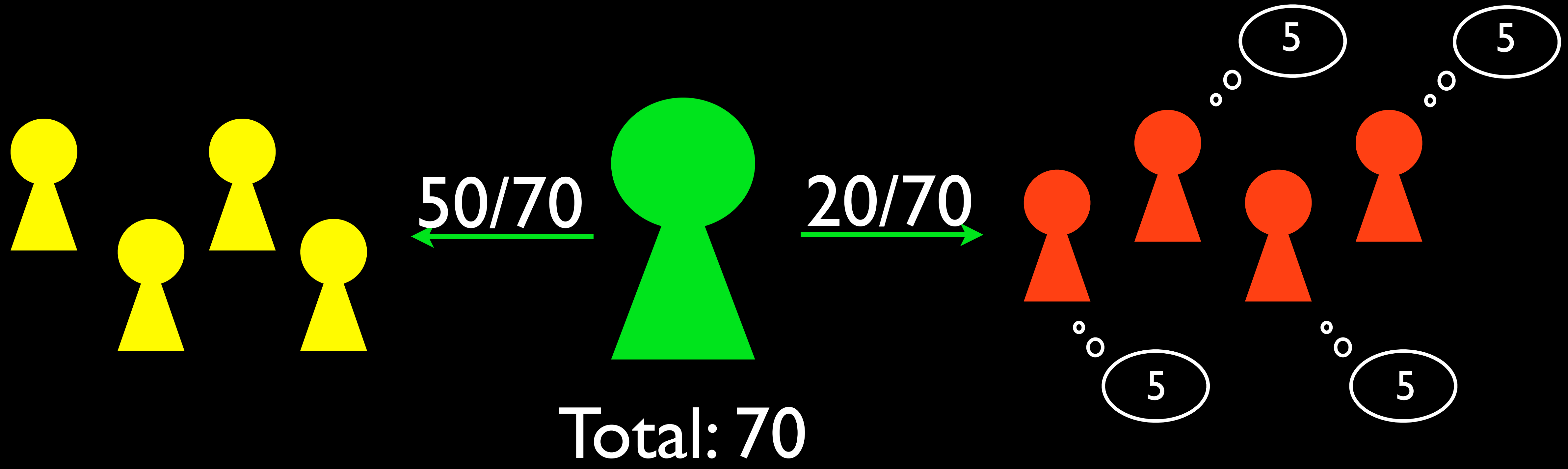

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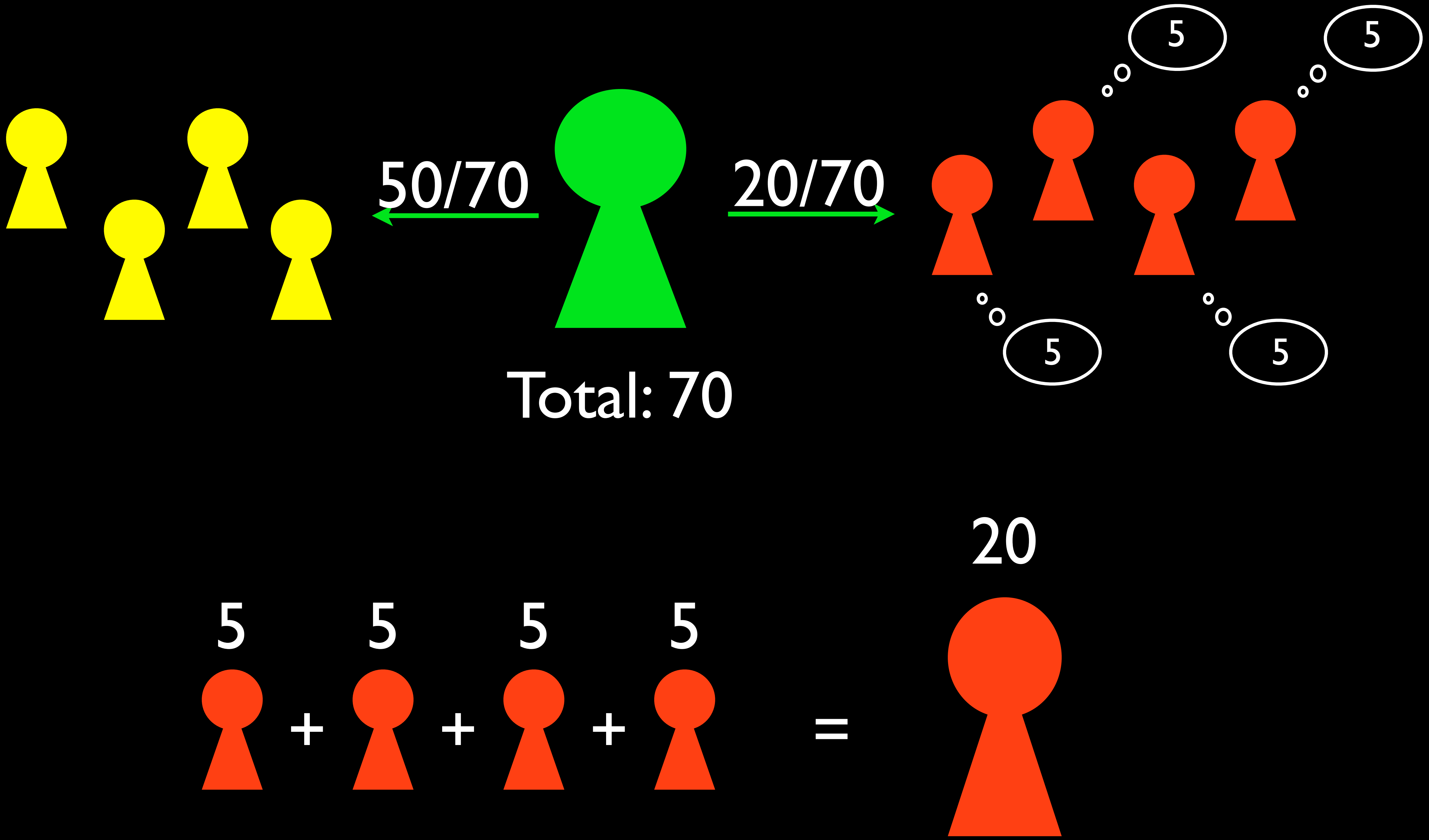

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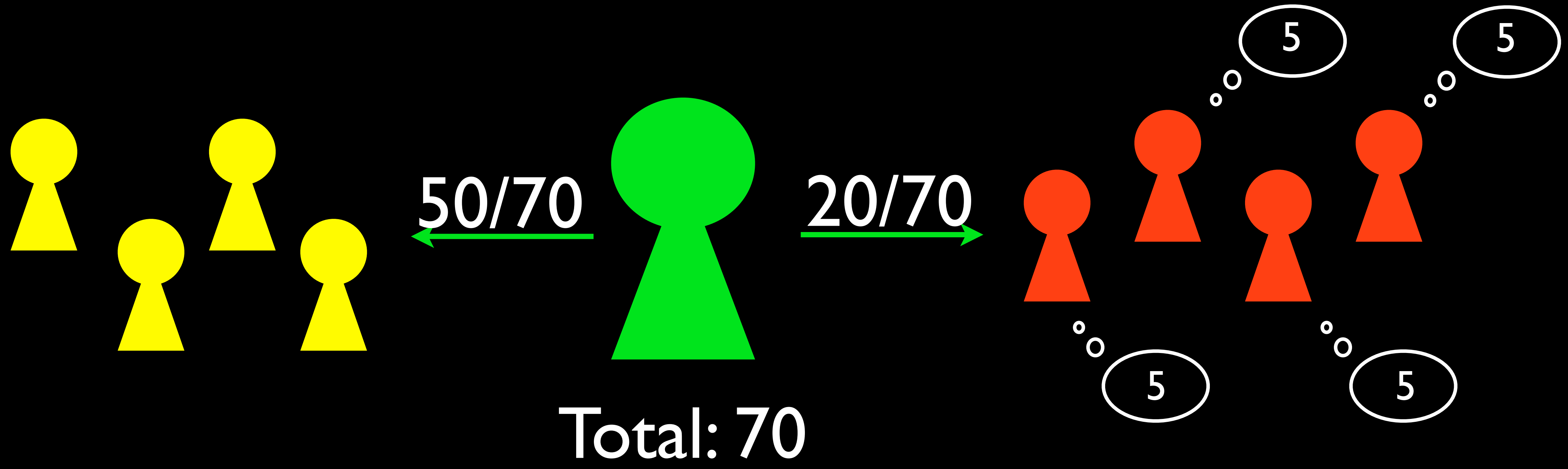
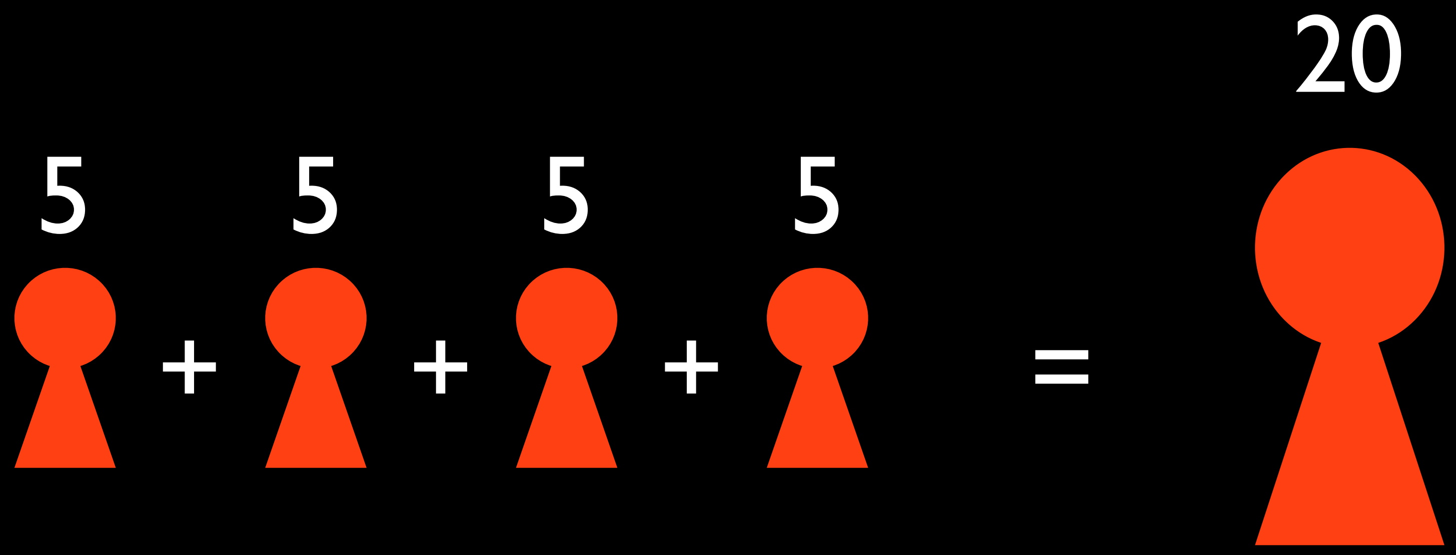


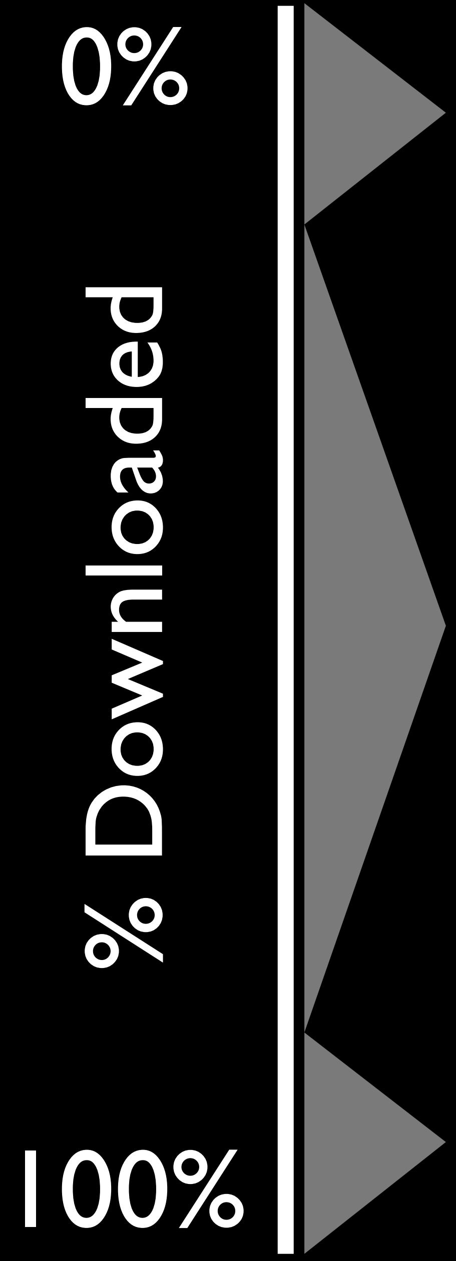


PropShare is Sybil-proof

Steady-state Results

- BitTyrant and PropShare are both faster than BitTorrent
  - For different reasons
- PropShare performs comparably to BitTyrant
- PropShare does *not* suffer from a tragedy of the commons
  - BitTyrant does

Phases of BitTorrent



0%

% Downloaded

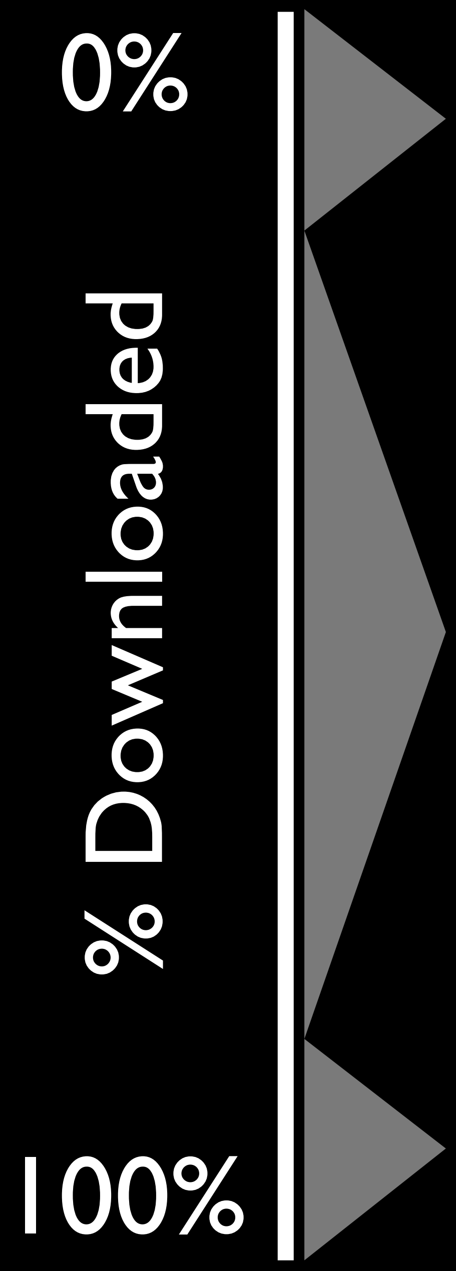
100%

Bootstrapping: Getting the first pieces

Steady-state: Trading with peers

End-game: Getting the last pieces

Phases of BitTorrent



Bootstrapping: Getting the first pieces

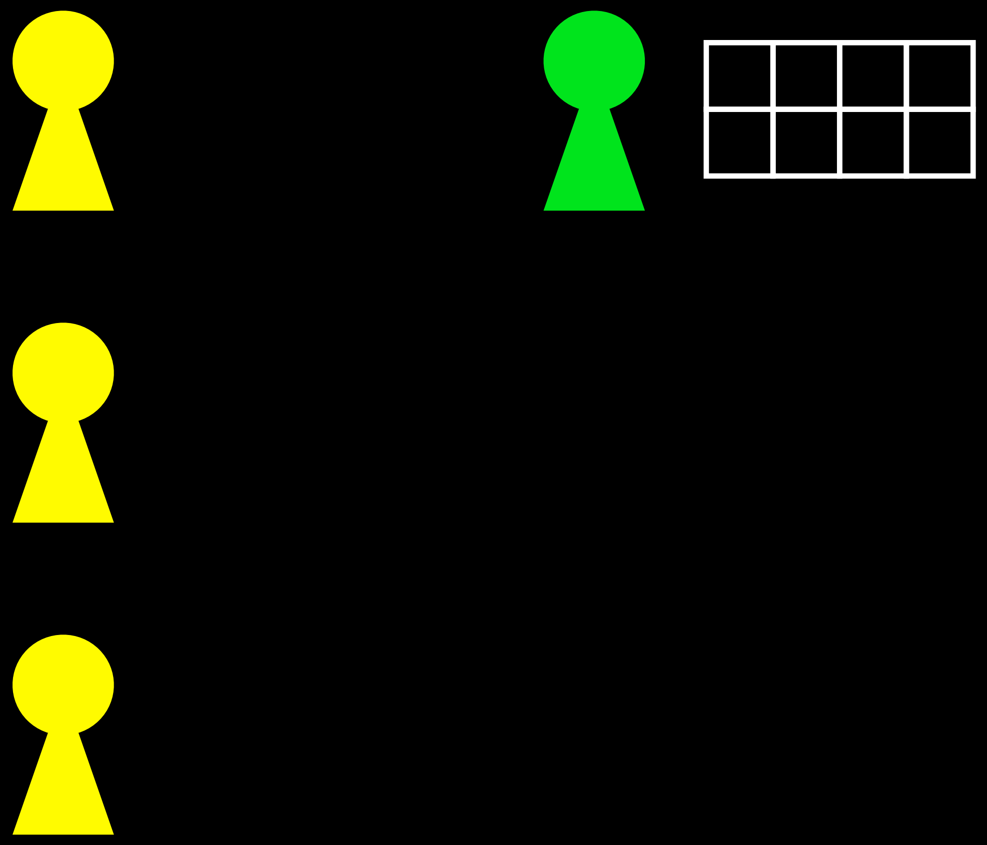
assumption: peers have *nothing* to give to other peers

Steady-state: Trading with peers

End-game: Getting the last pieces

Optimistic Unchoking

reserve a portion of bandwidth to give *freely* to other peers (presumably new peers)



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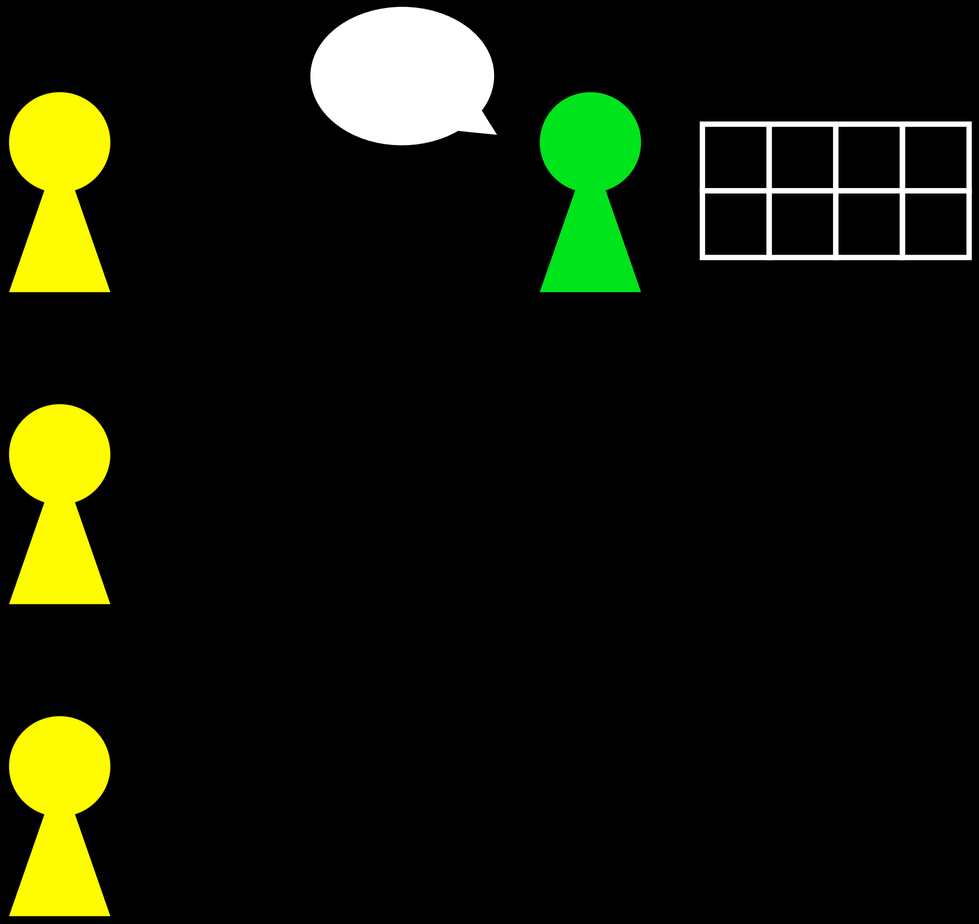

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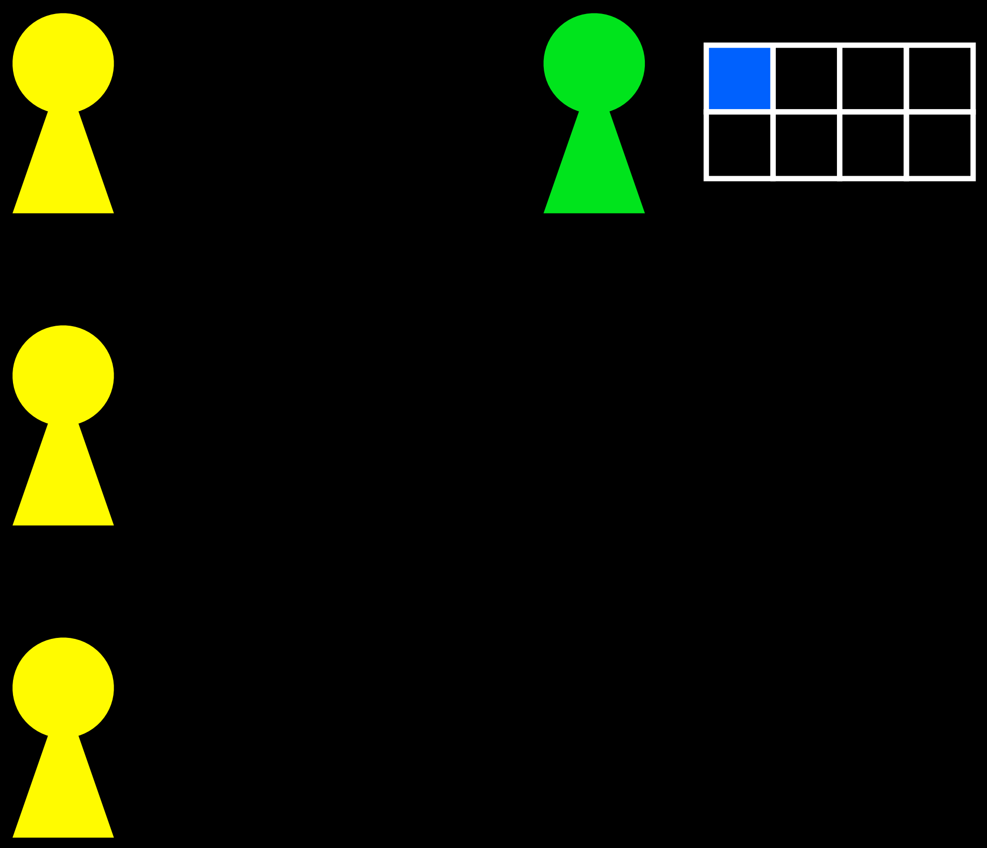

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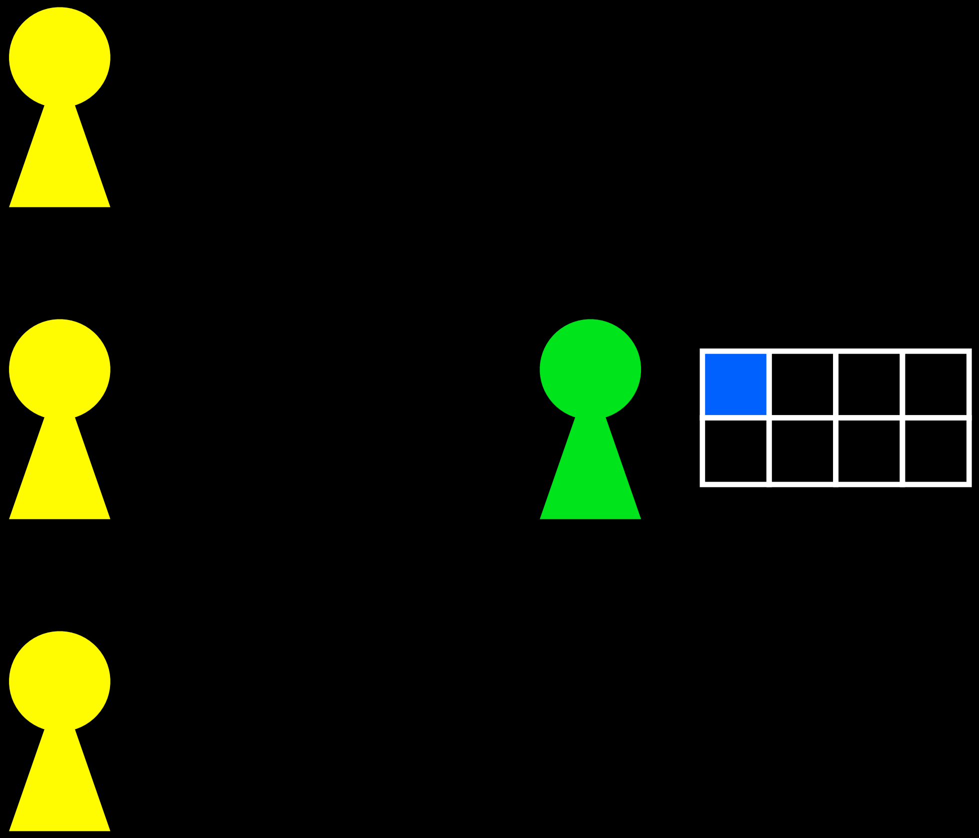

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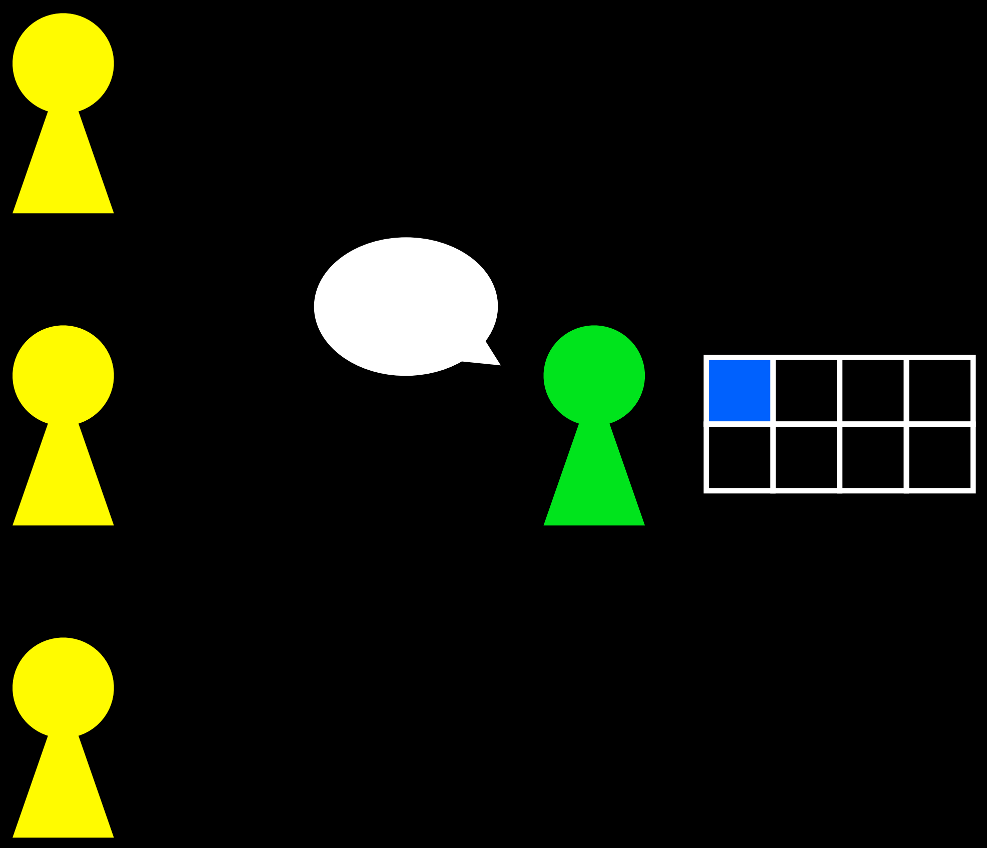

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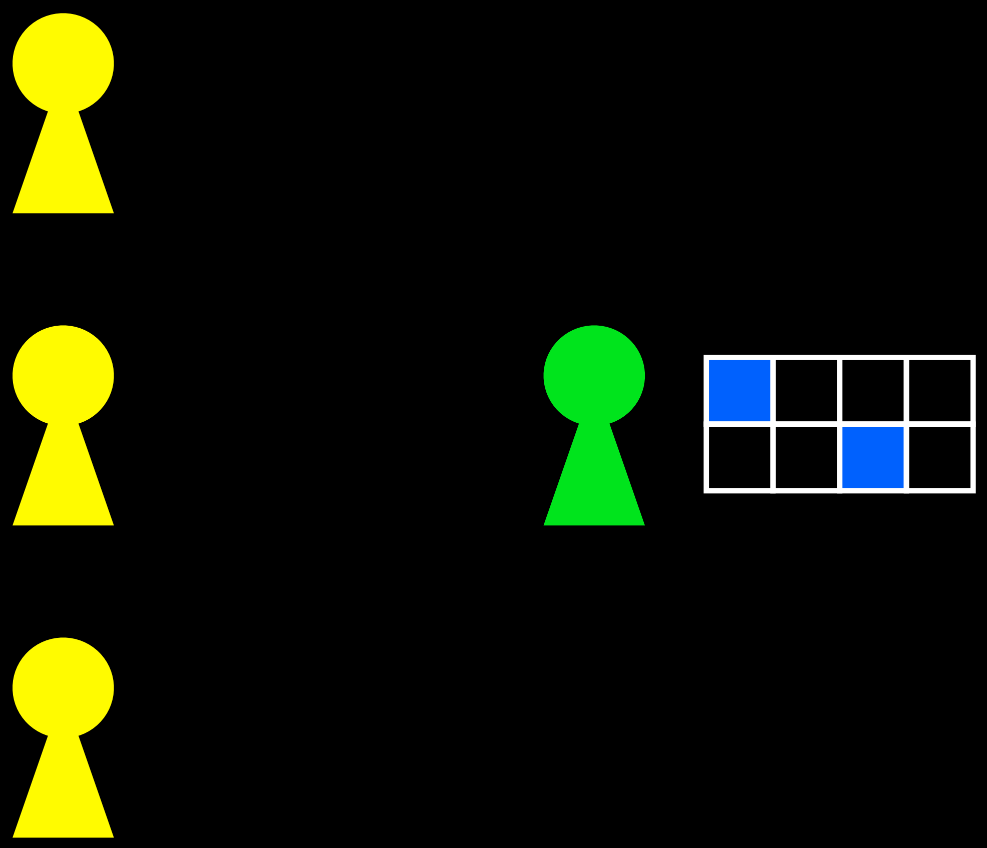

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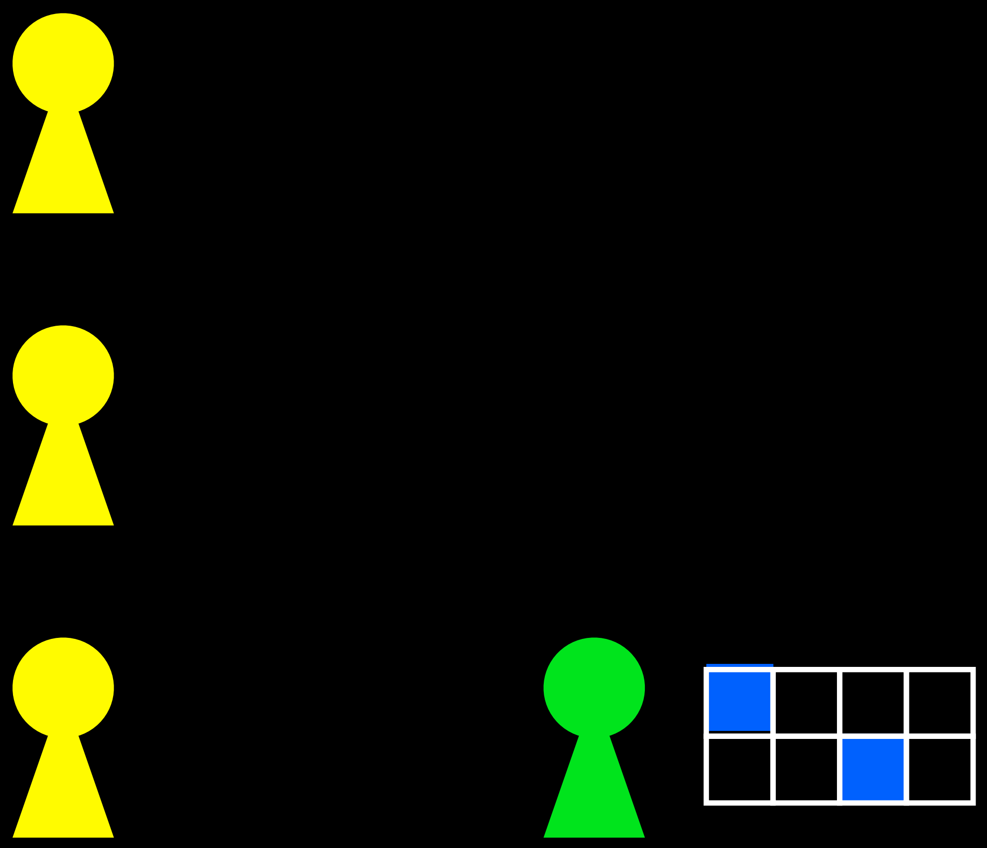

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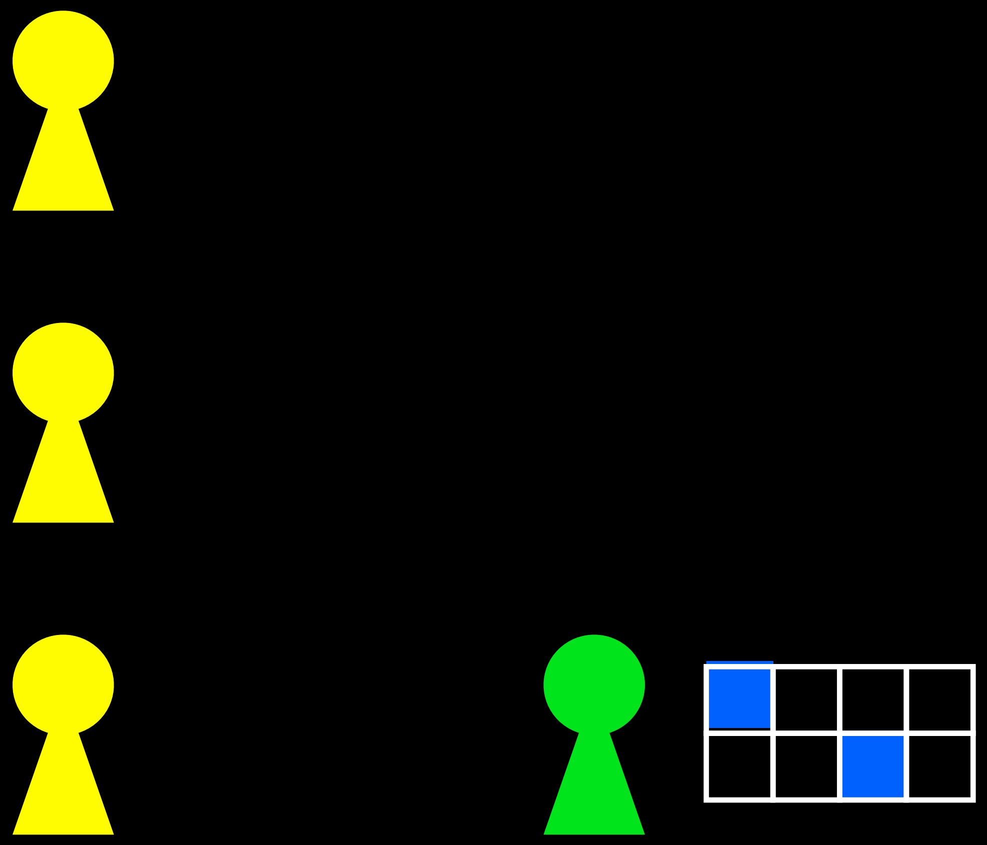
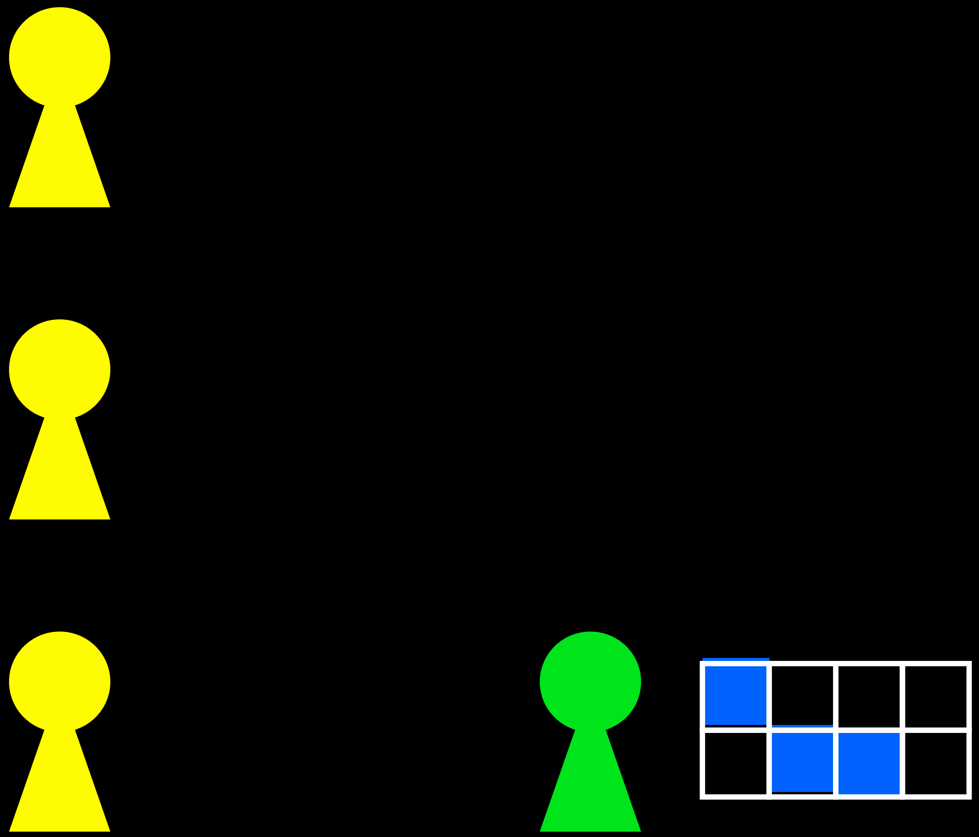


Optimistic Unchoking

reserve a portion of bandwidth to give *freely* to other peers
(presumably new peers)



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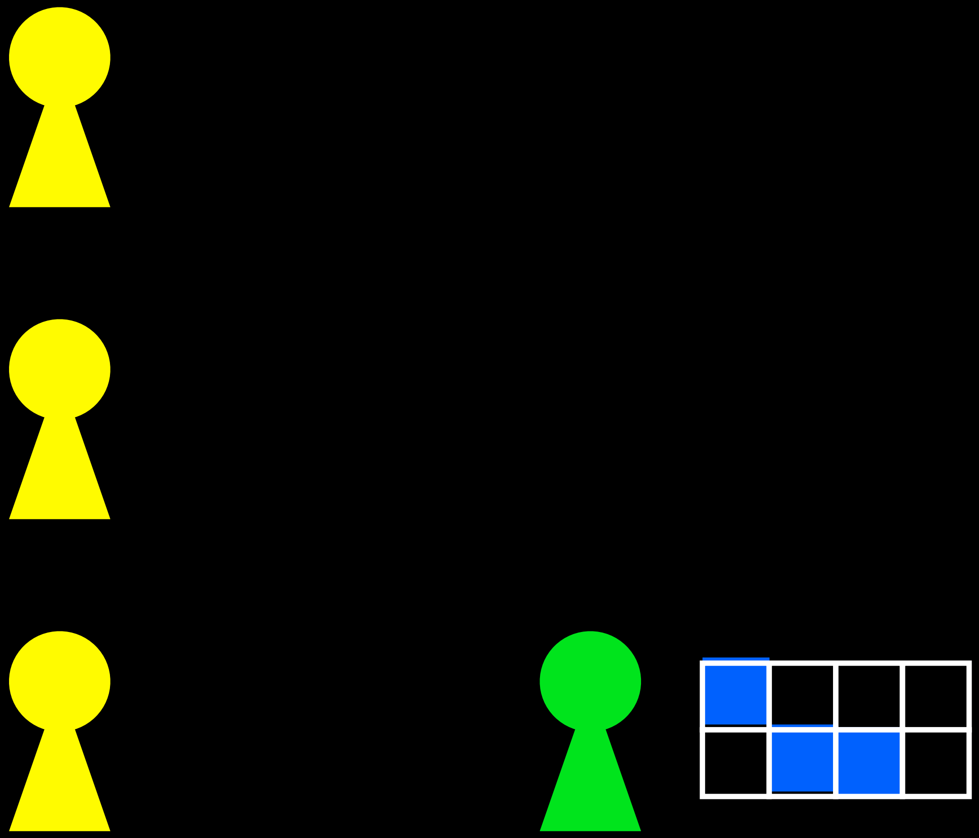

exploit: always asked to be optimistically unchoked (i.e., never upload)

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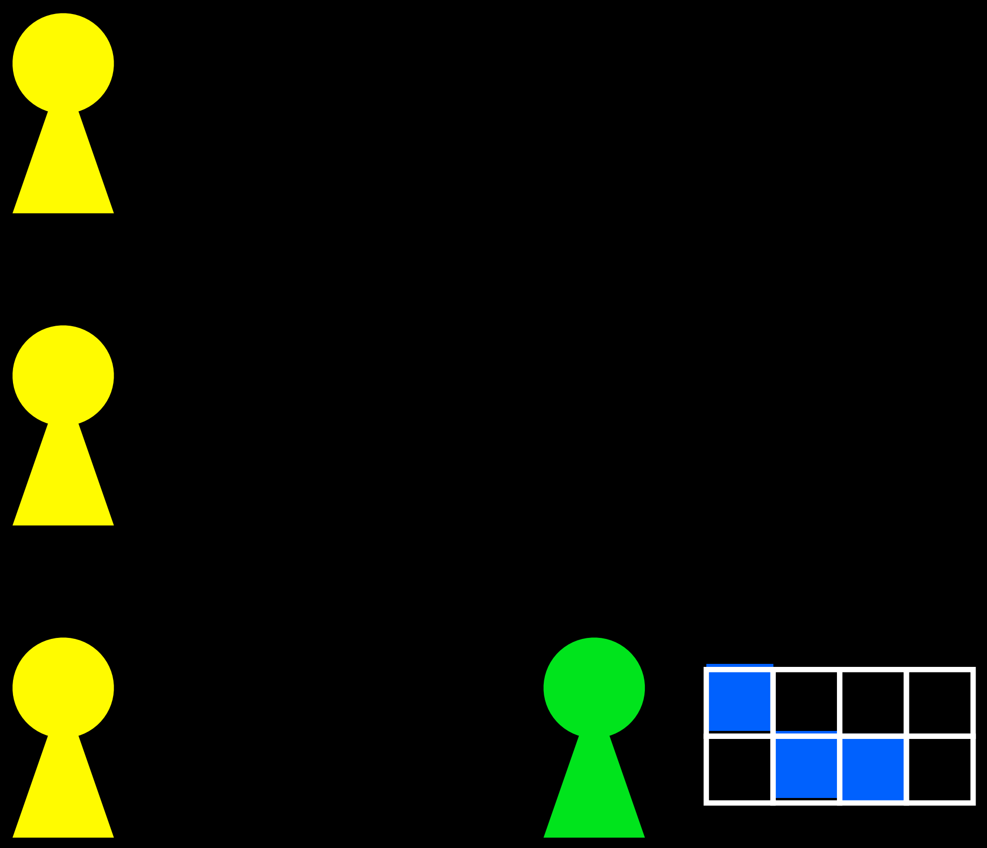


exploit: always asked to be optimistically unchoked (i.e., never upload)

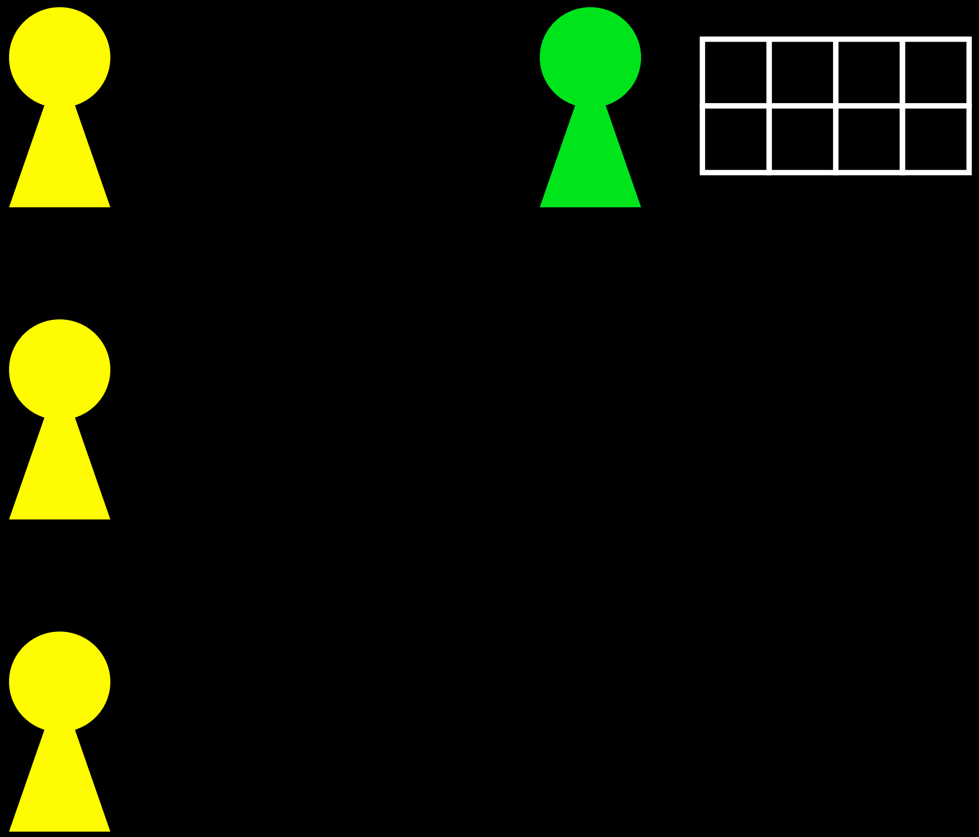
tragedy of the commons: system will collapse if everyone does this

Locher, et al. "Free Riding in BitTorrent is Cheap". HotNets, 2006

Junk Updates

force peers to upload useless data

Li, et al. "BAR Gossip". OSDI 2006



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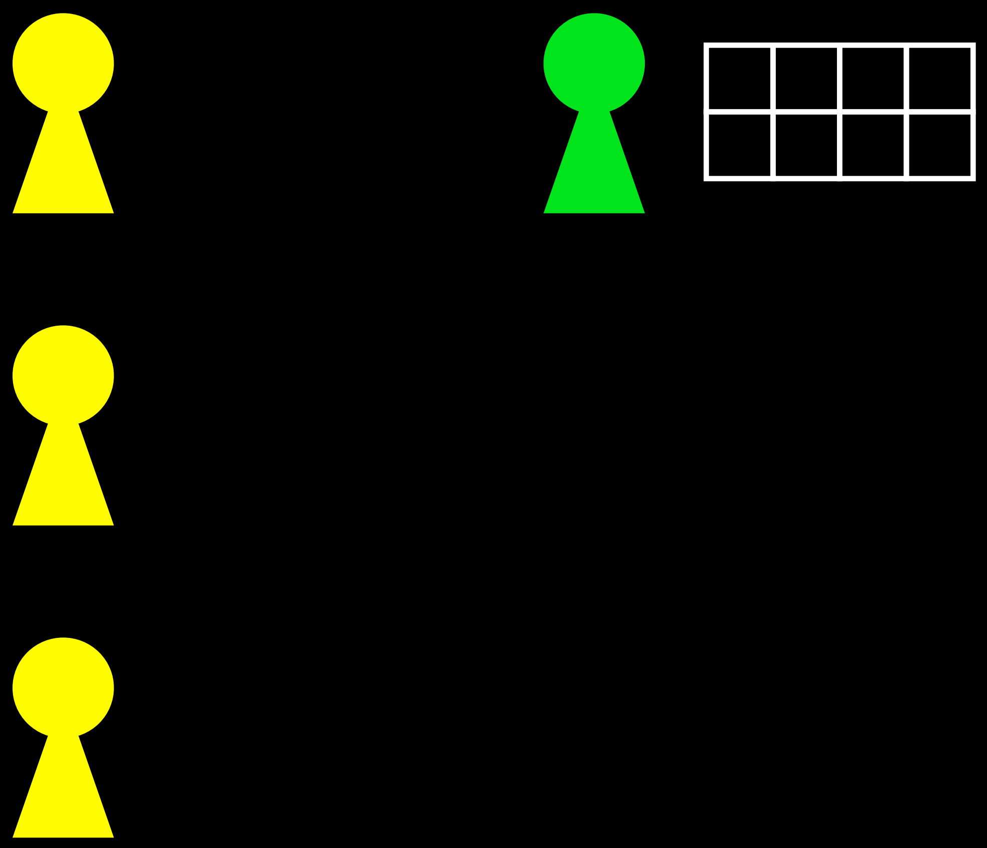

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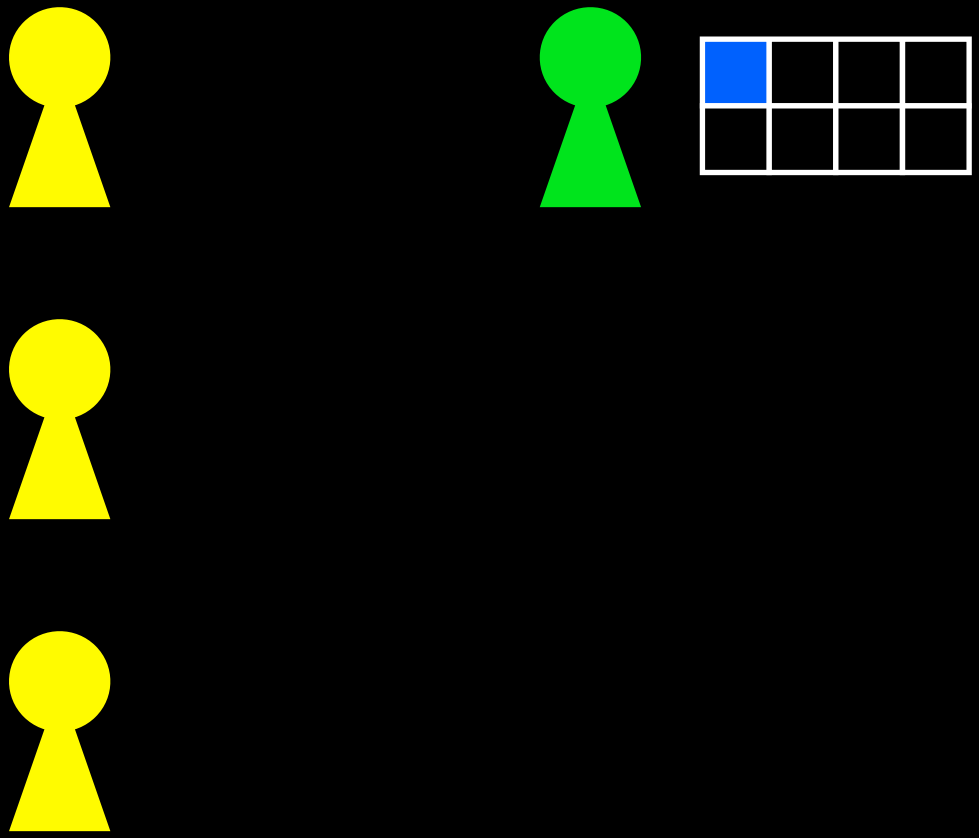

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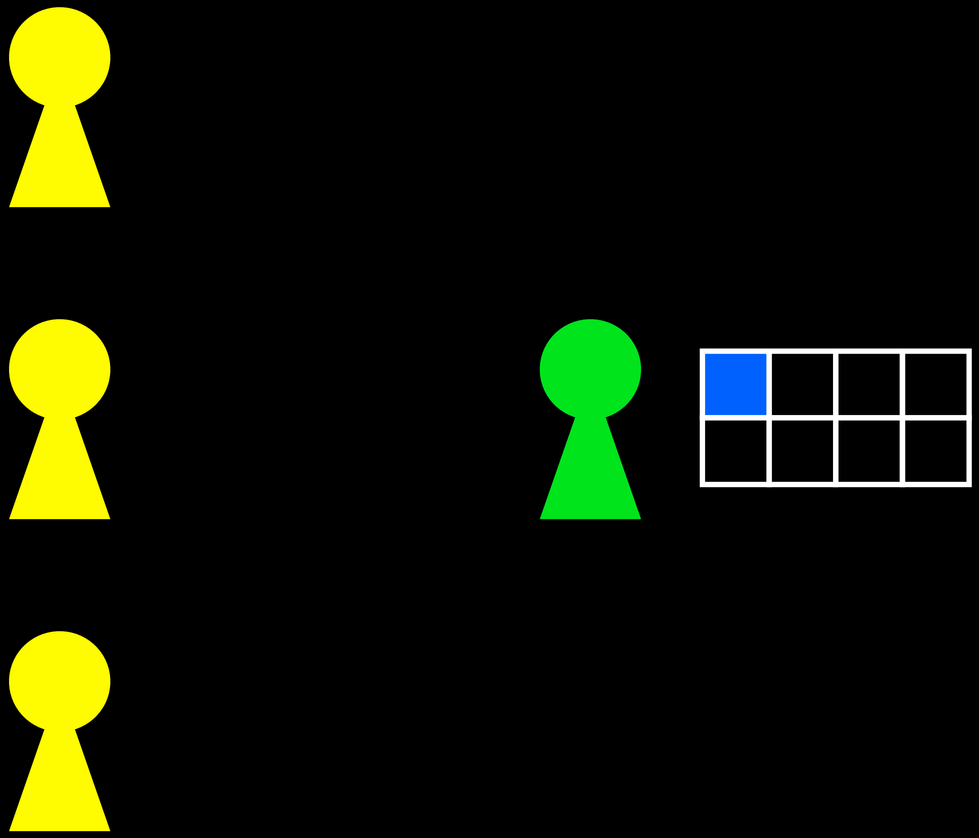

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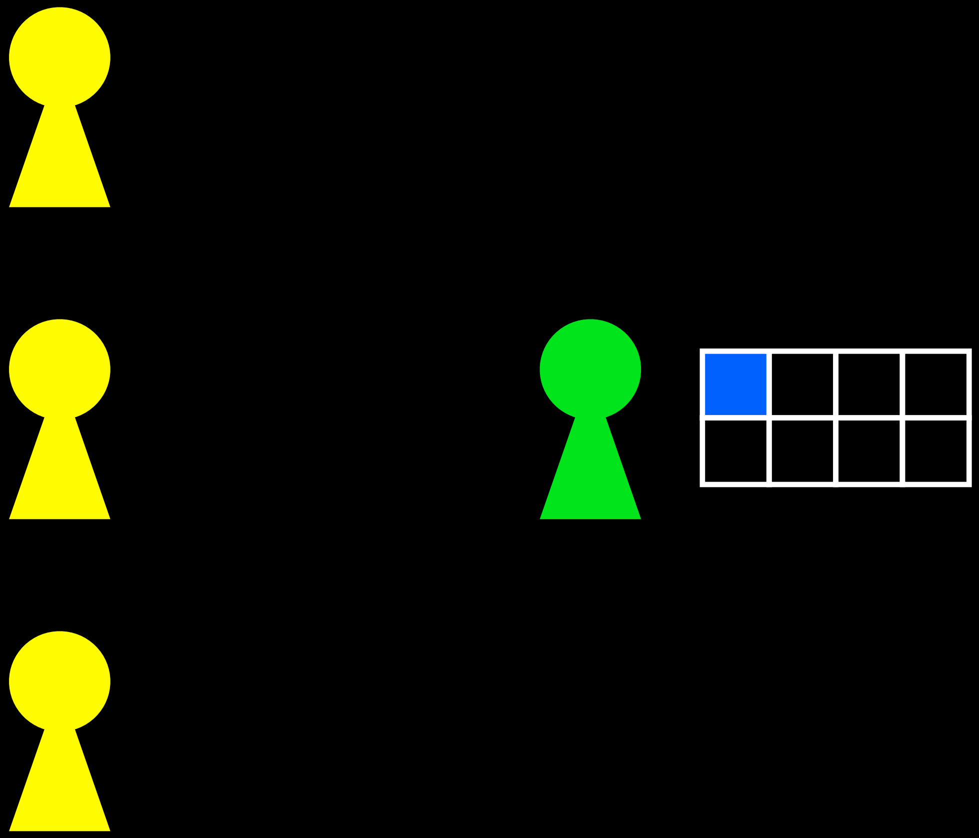

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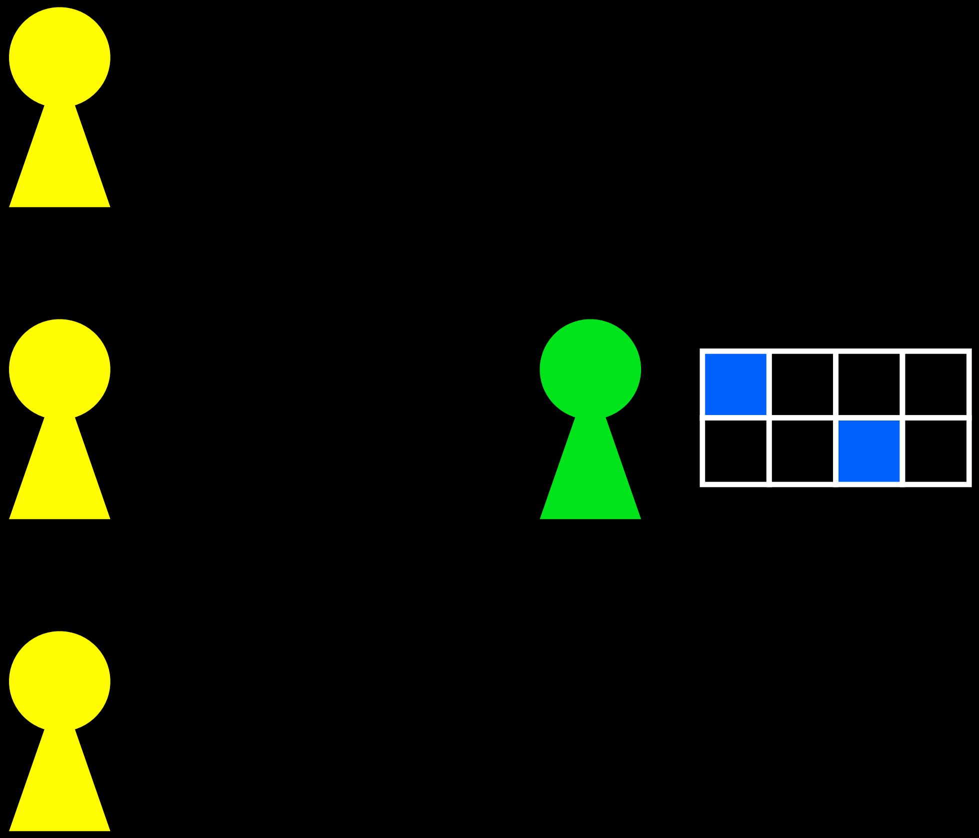

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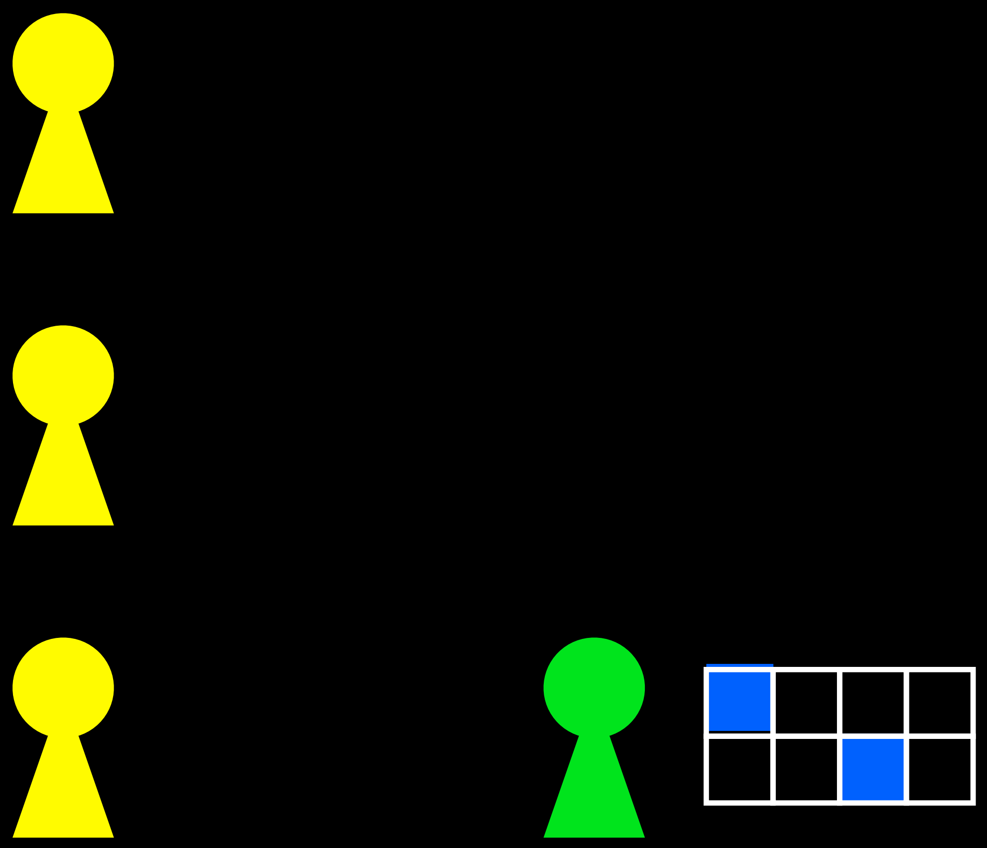

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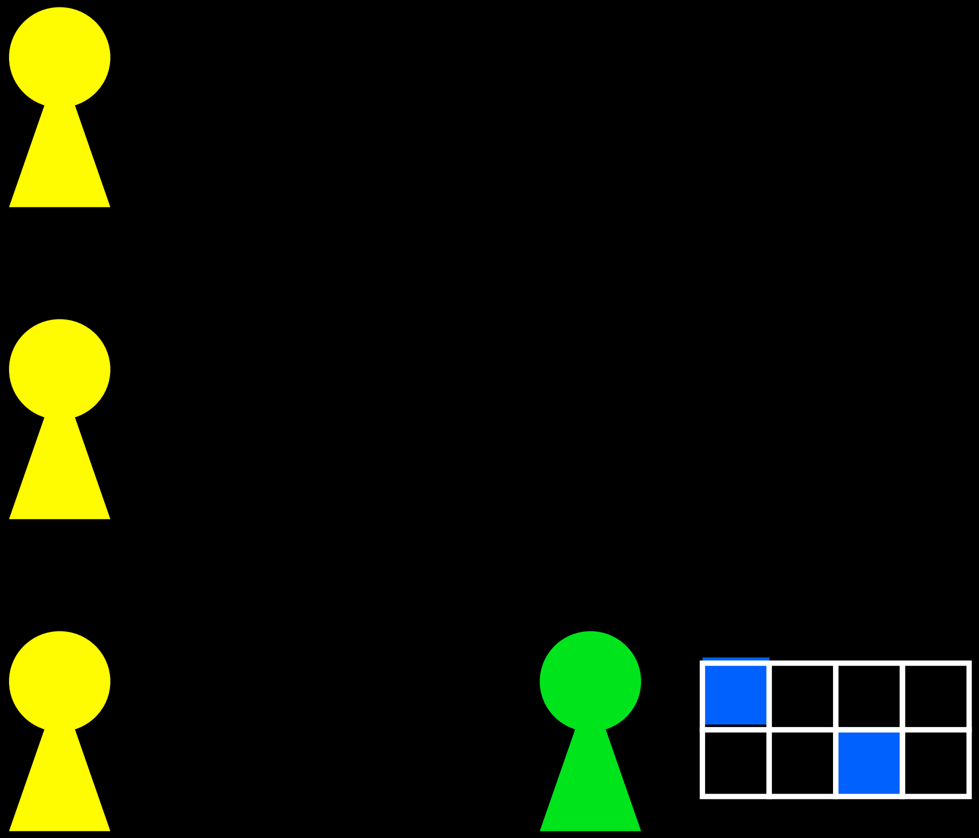

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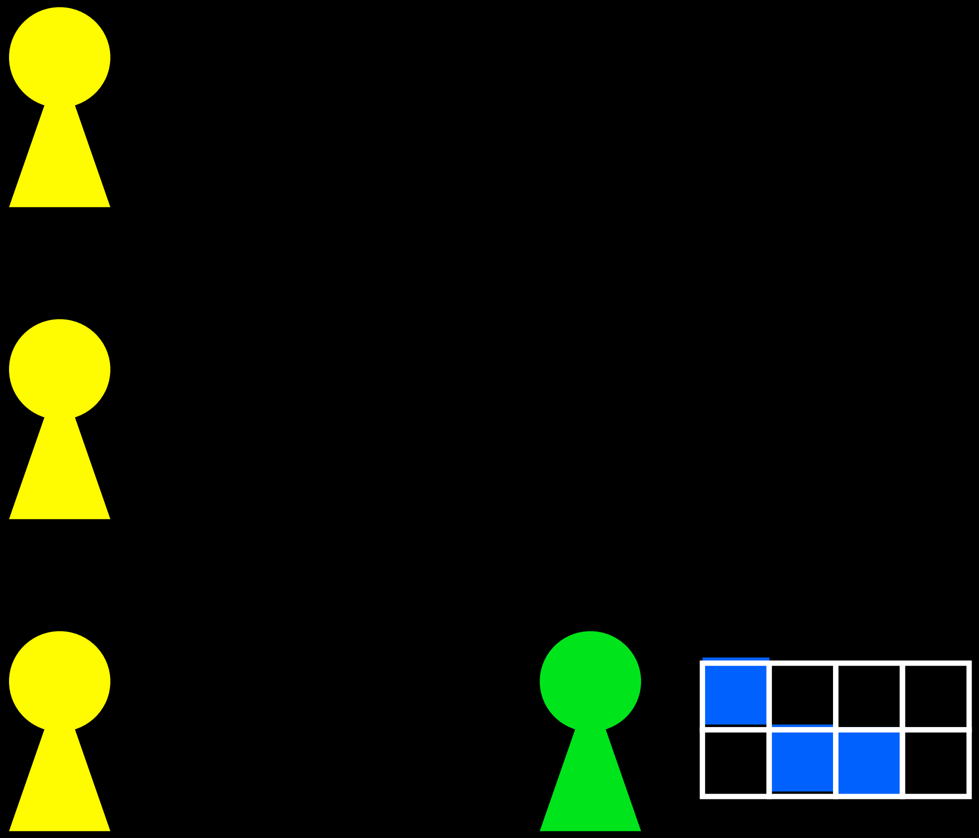

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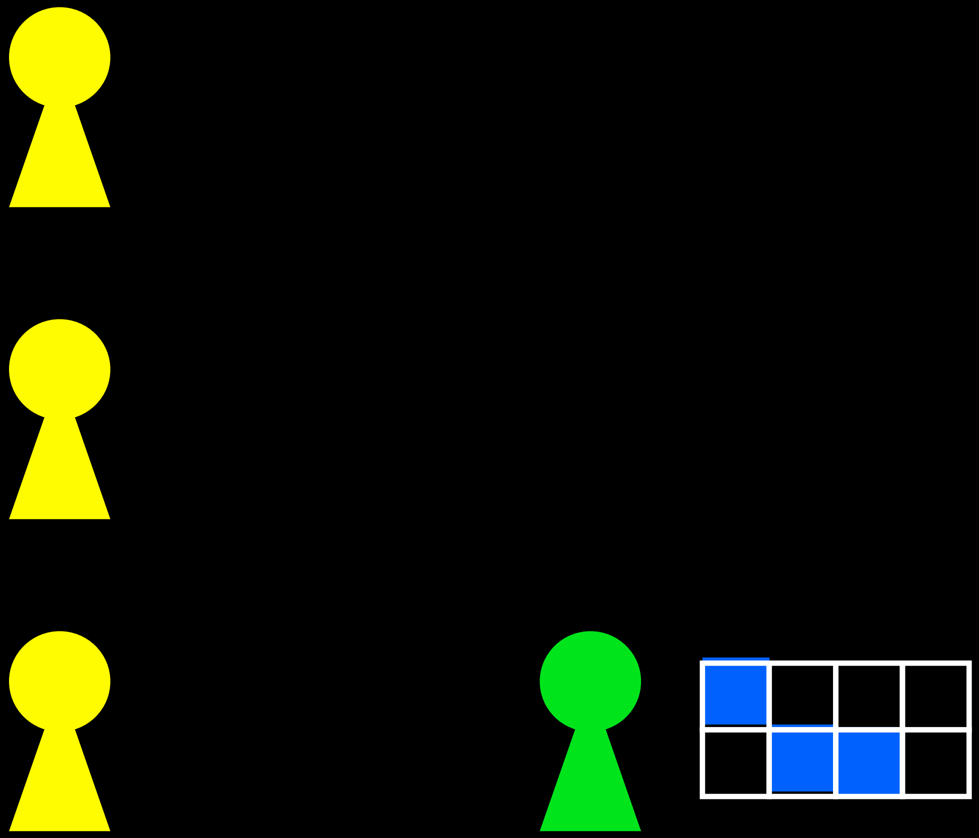

no incentive to repeatedly ask for unchoking, but wastes system resources

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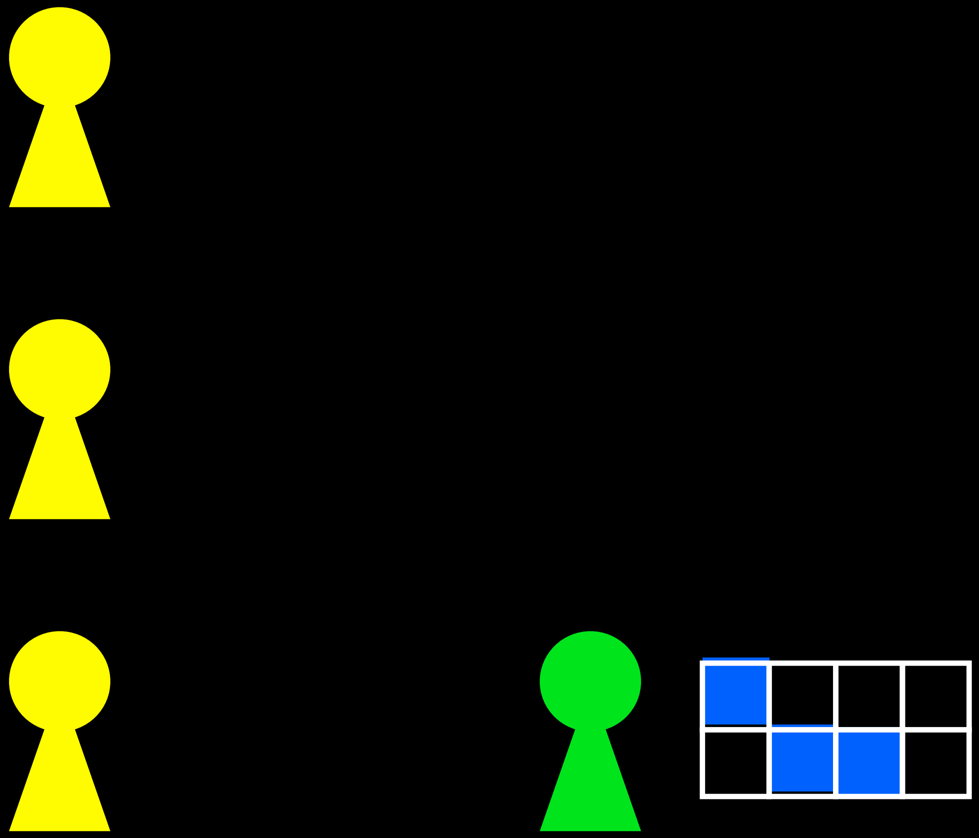
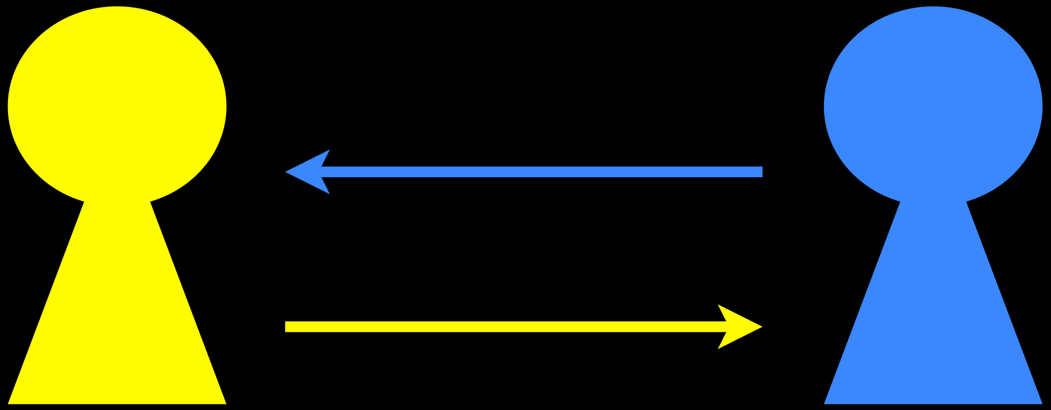


no incentive to repeatedly ask for unchoking, but wastes system resources

can we put new peers to work doing something useful?

TBS

Levin, et al.



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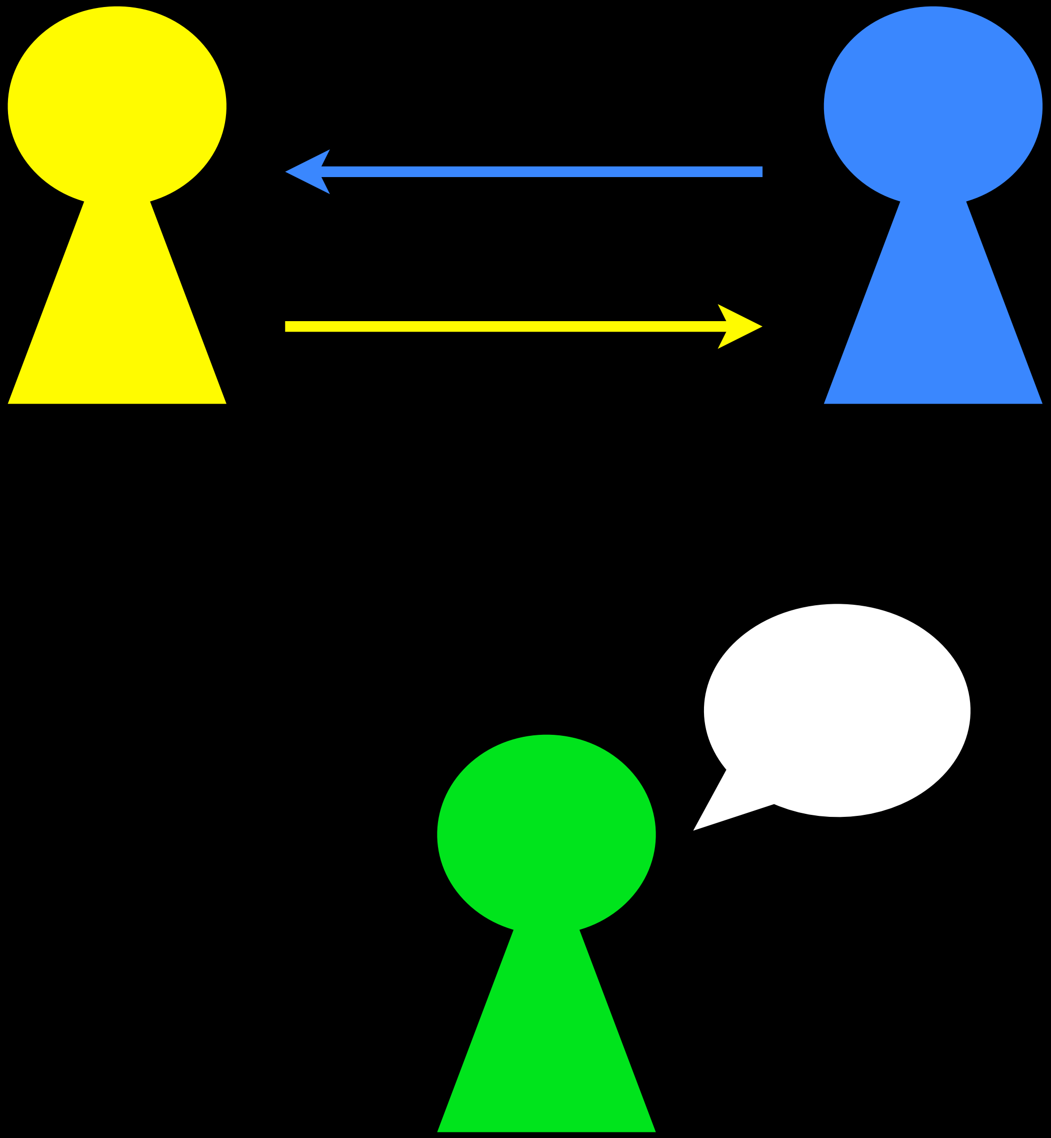

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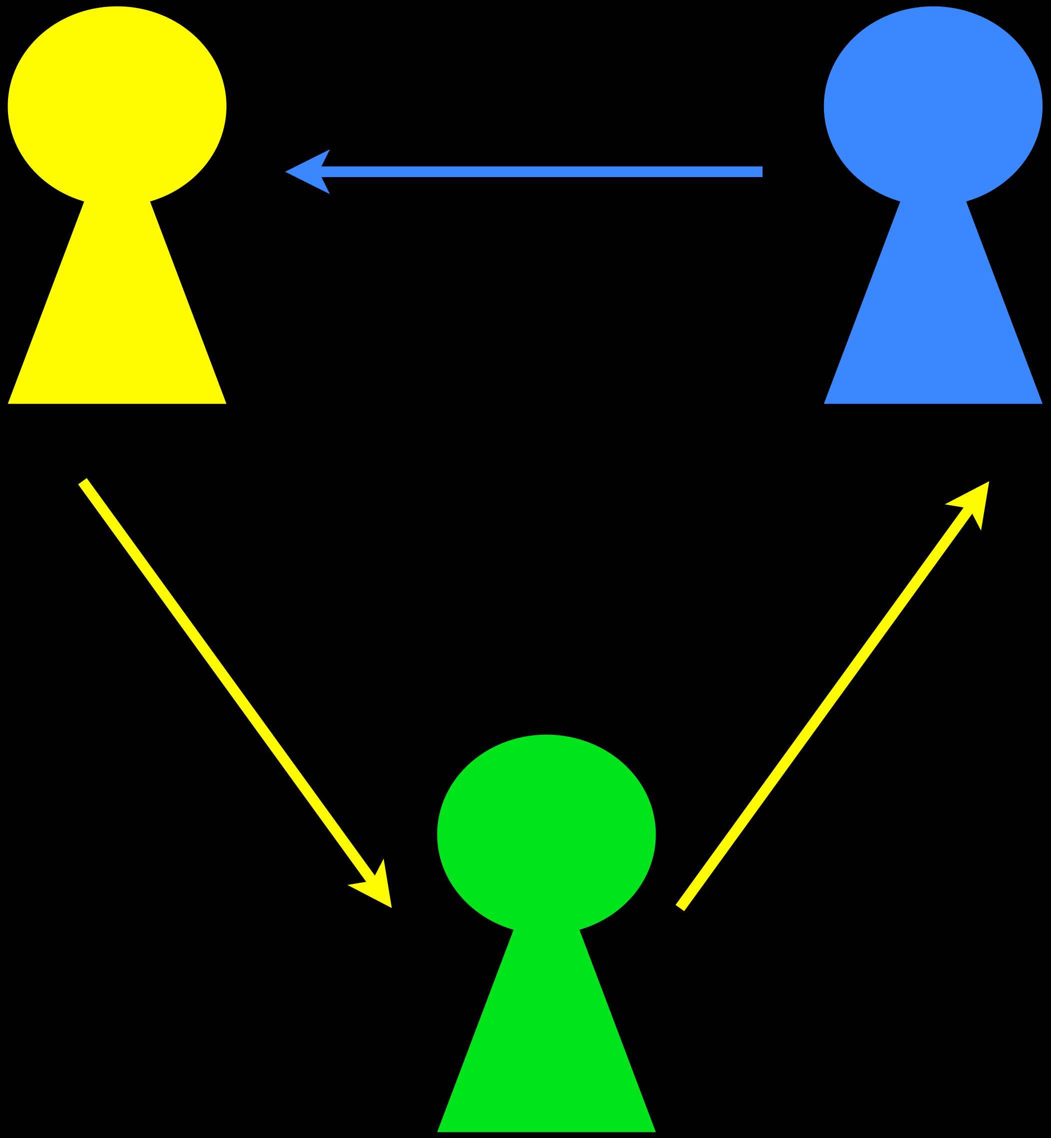

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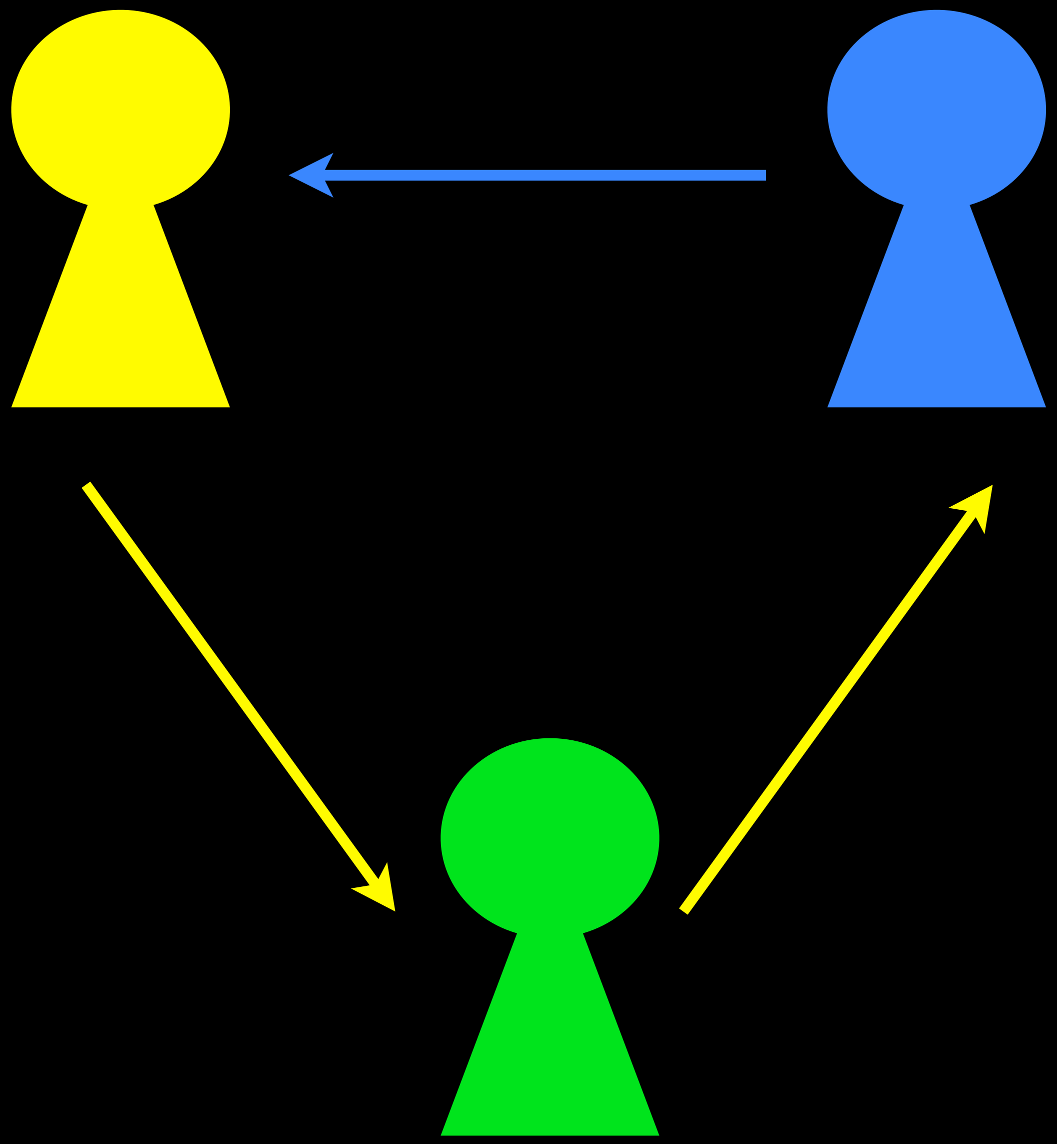
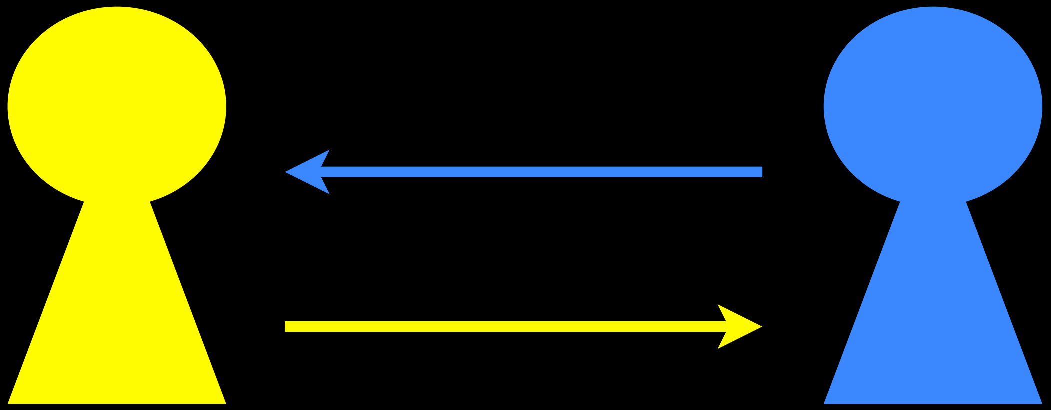


both 🔵 and 🟢
get pieces from 🟡

TBS

Levin, et al.



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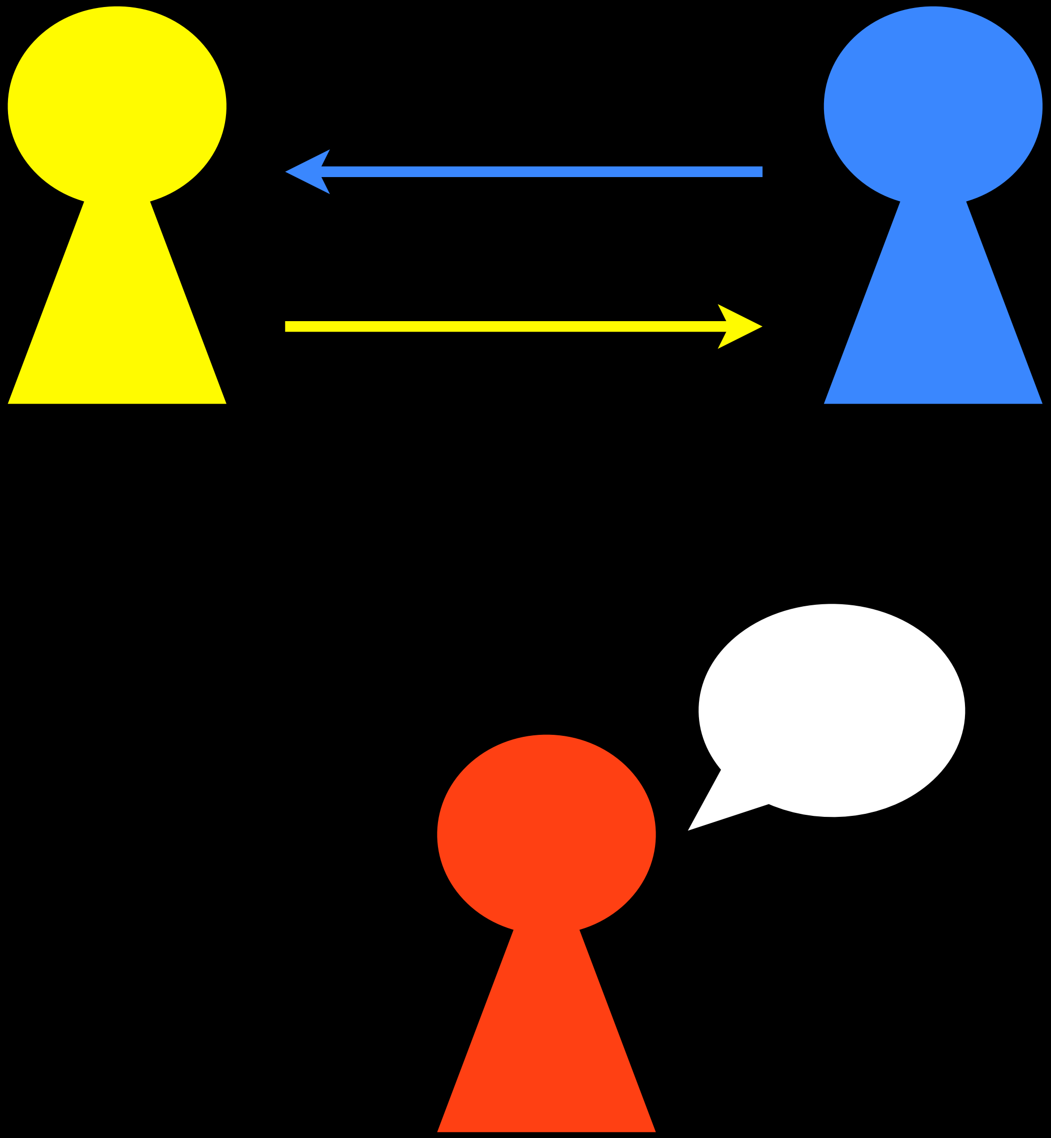

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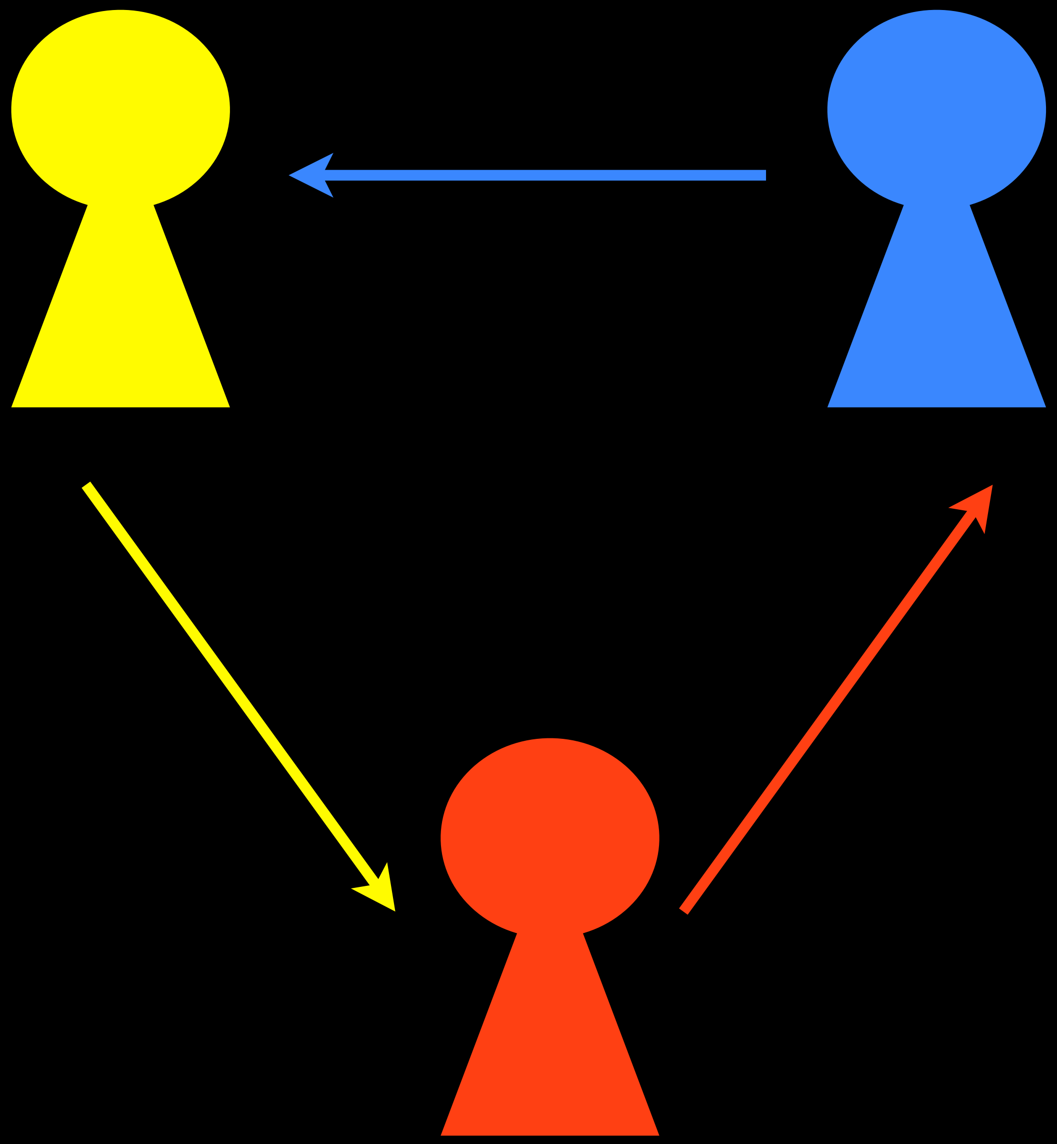

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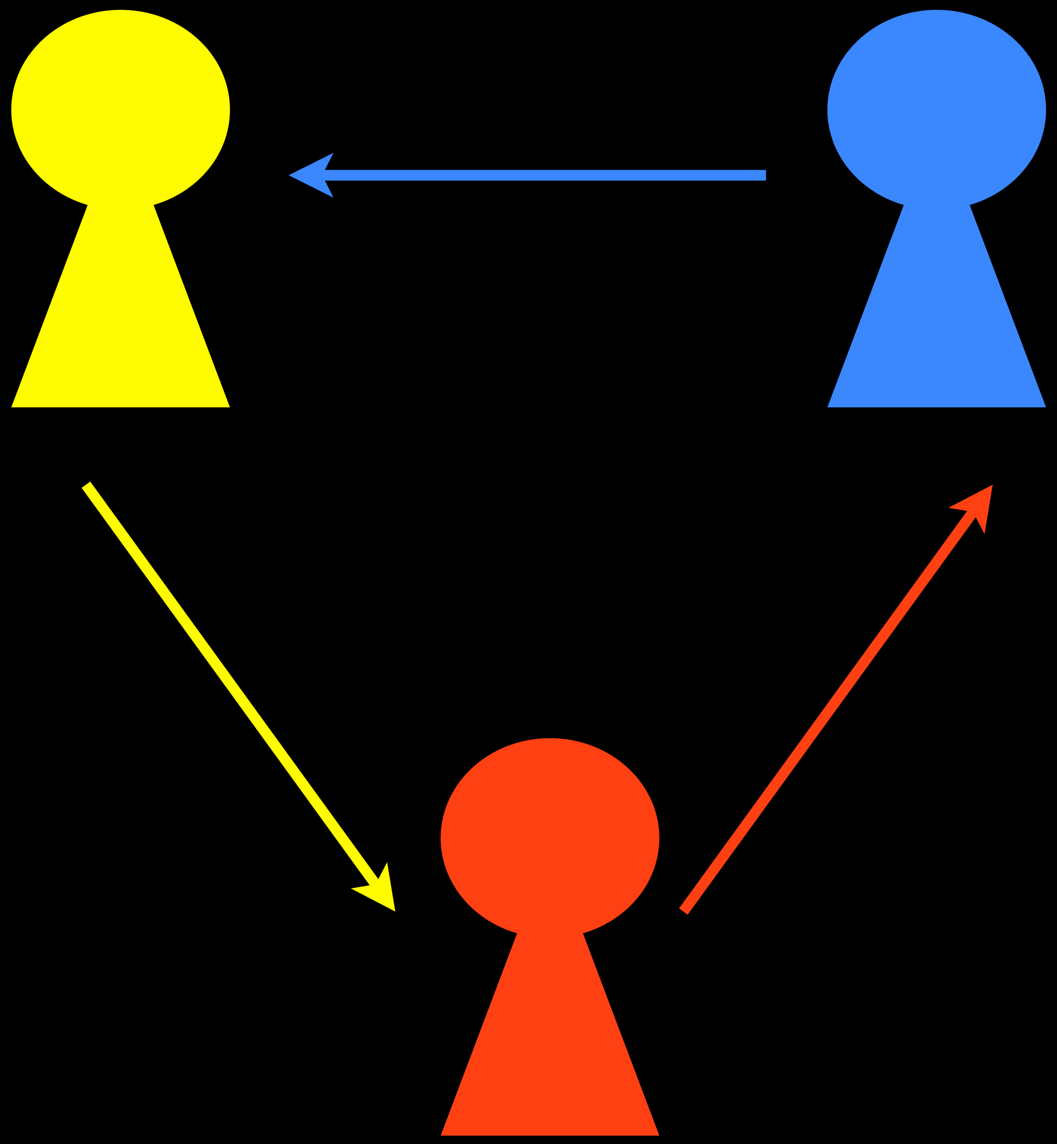
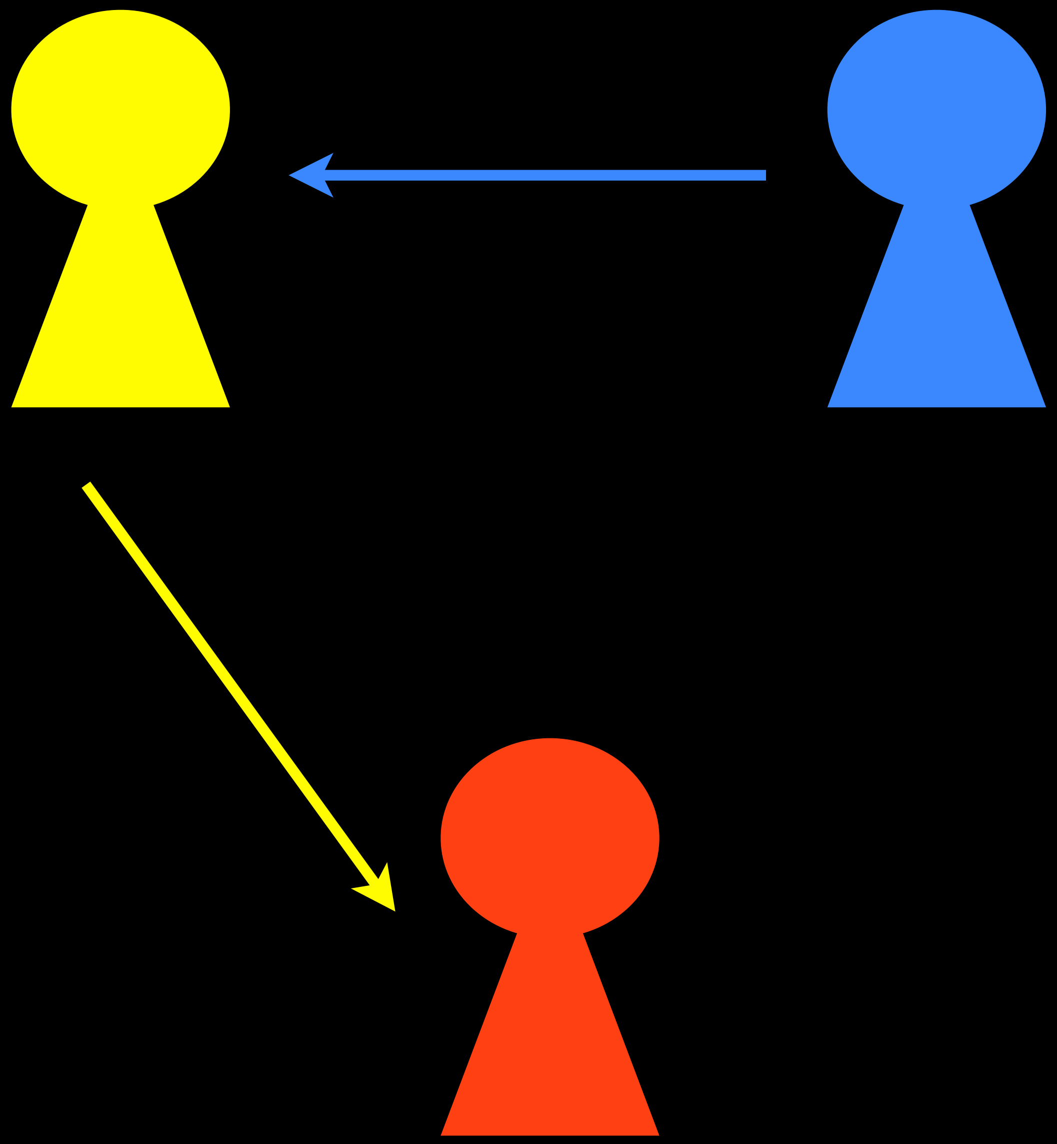


problem: ♟

can send junk

TBS

Levin, et al.



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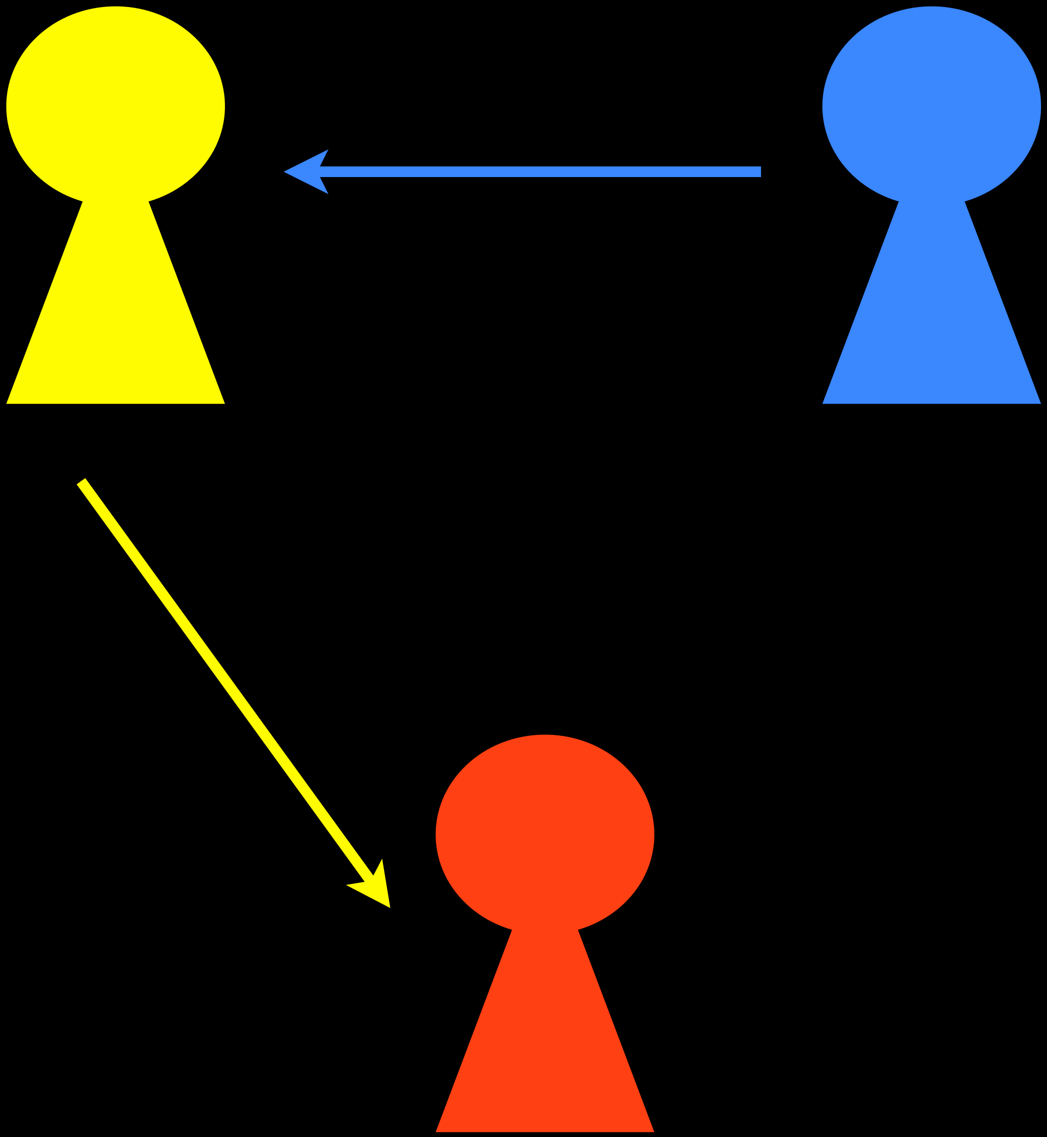

problem:

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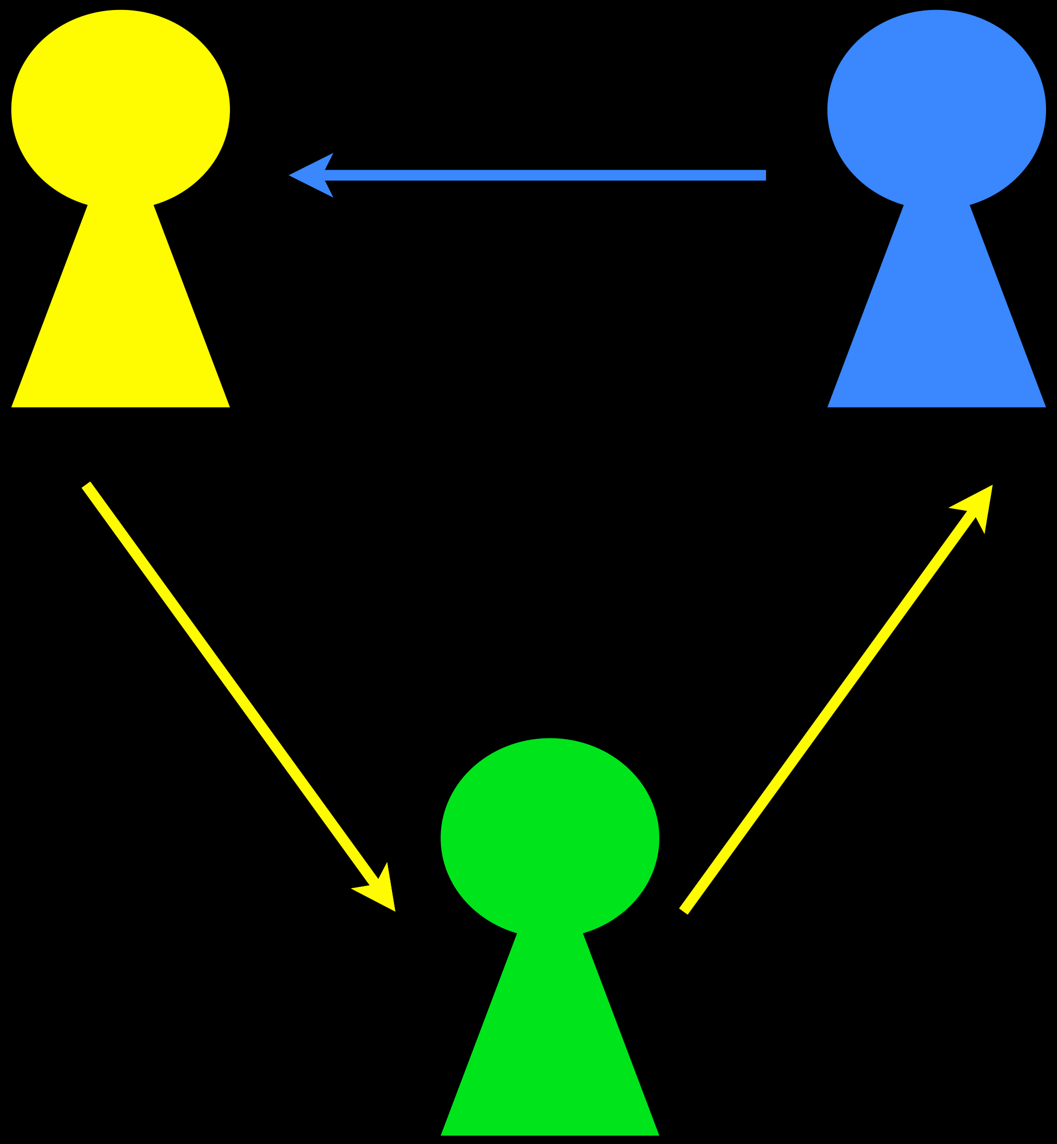
or nothing at all

Solution: Encryption

TBS

Levin, et al.



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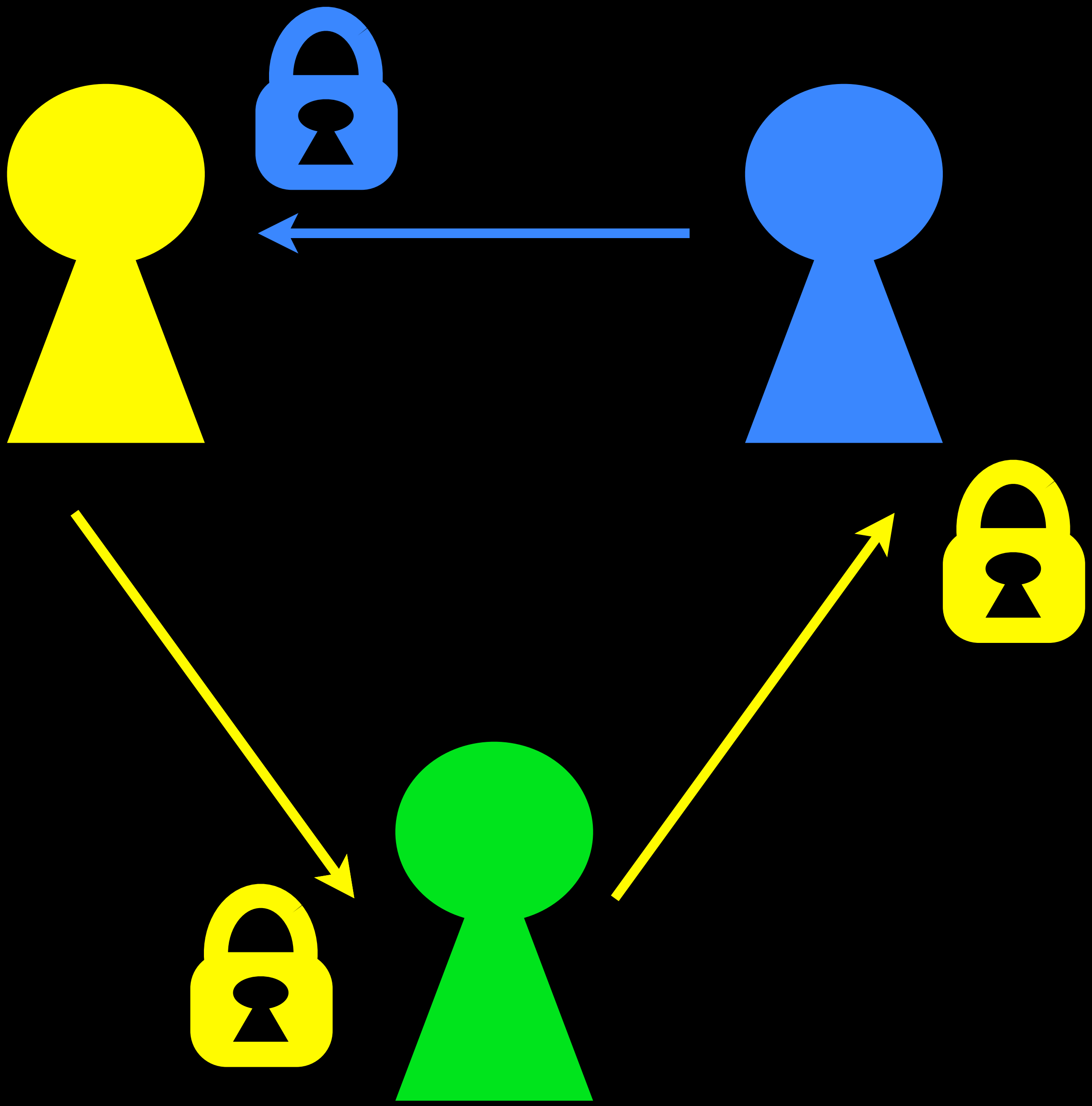

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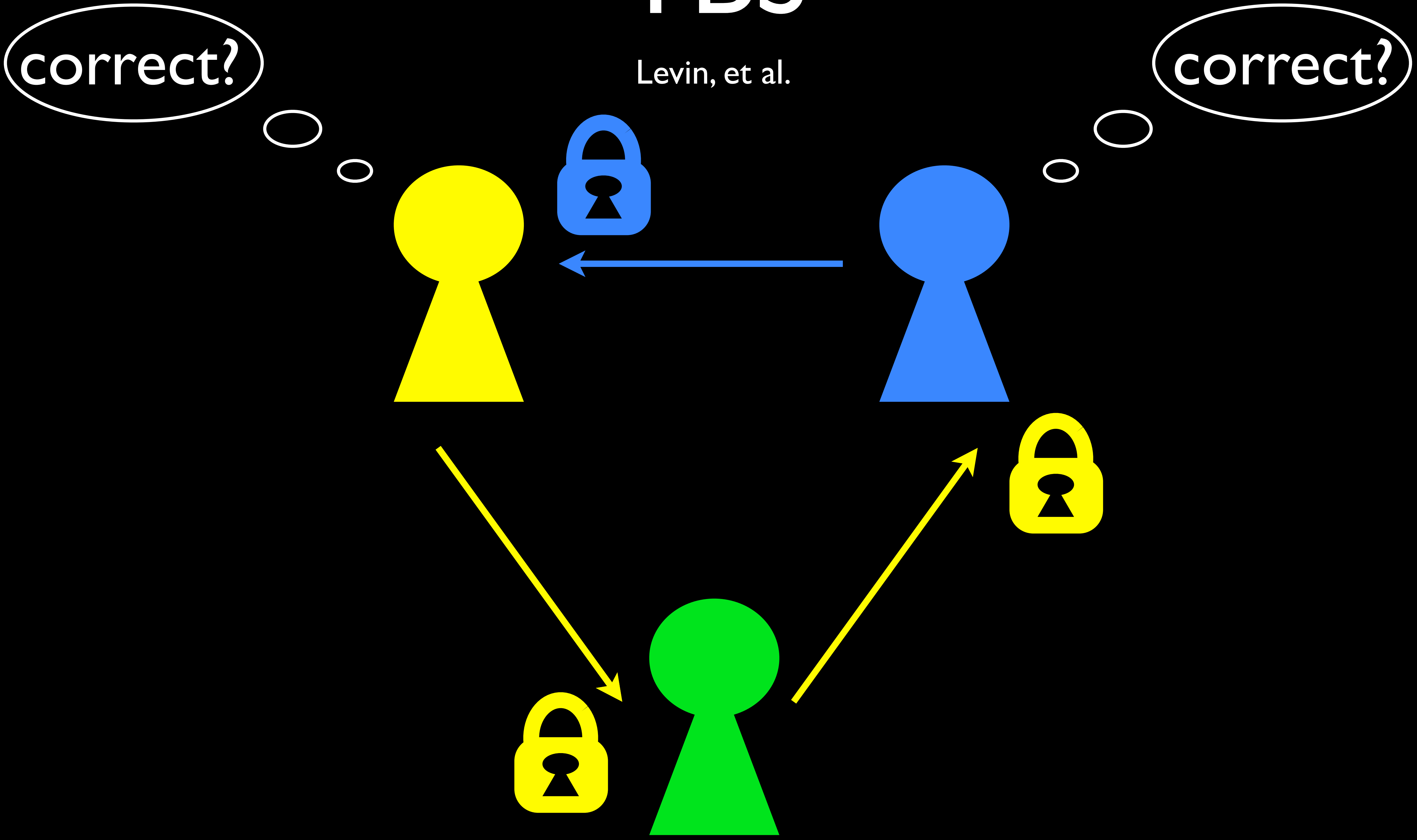

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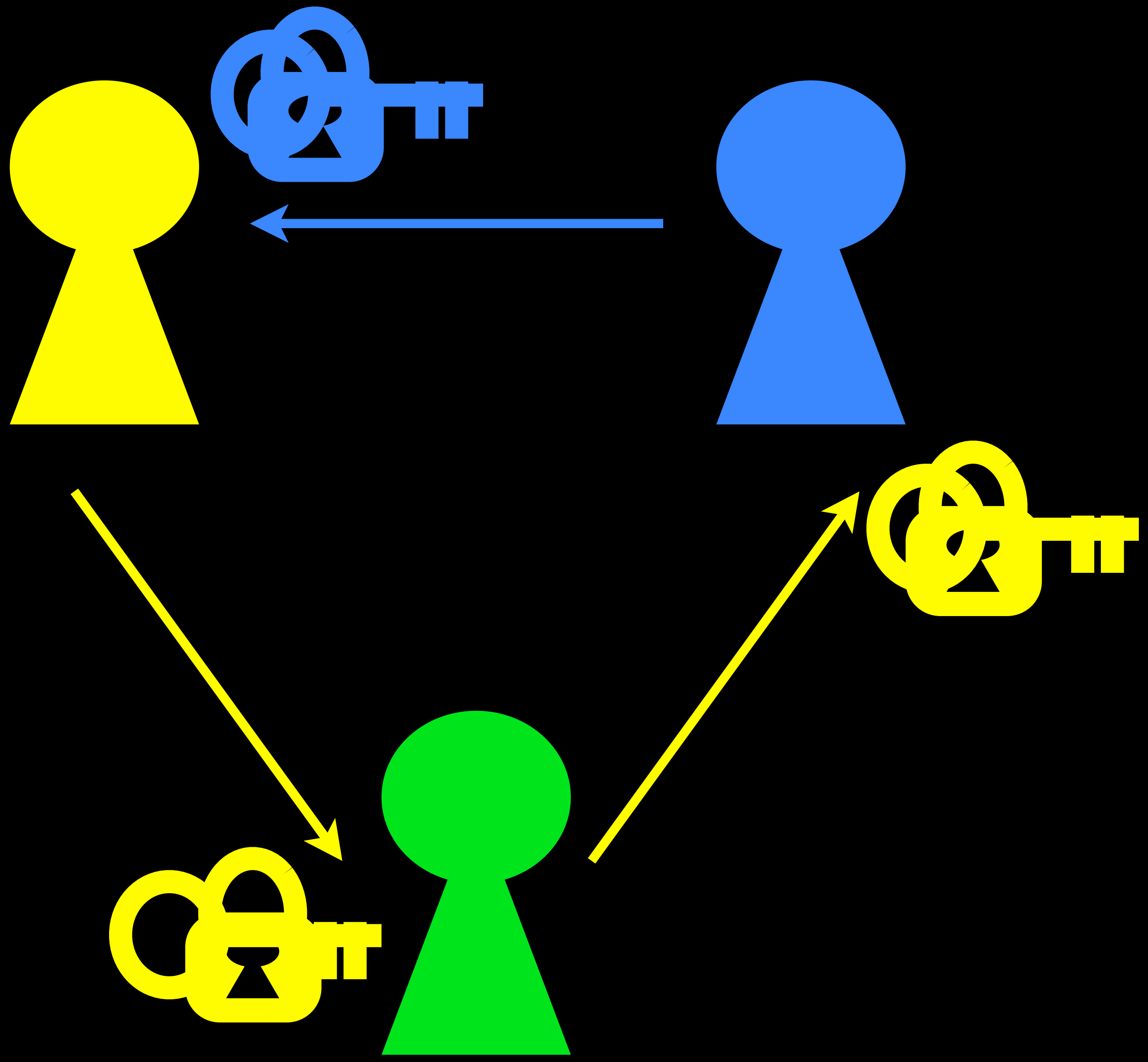
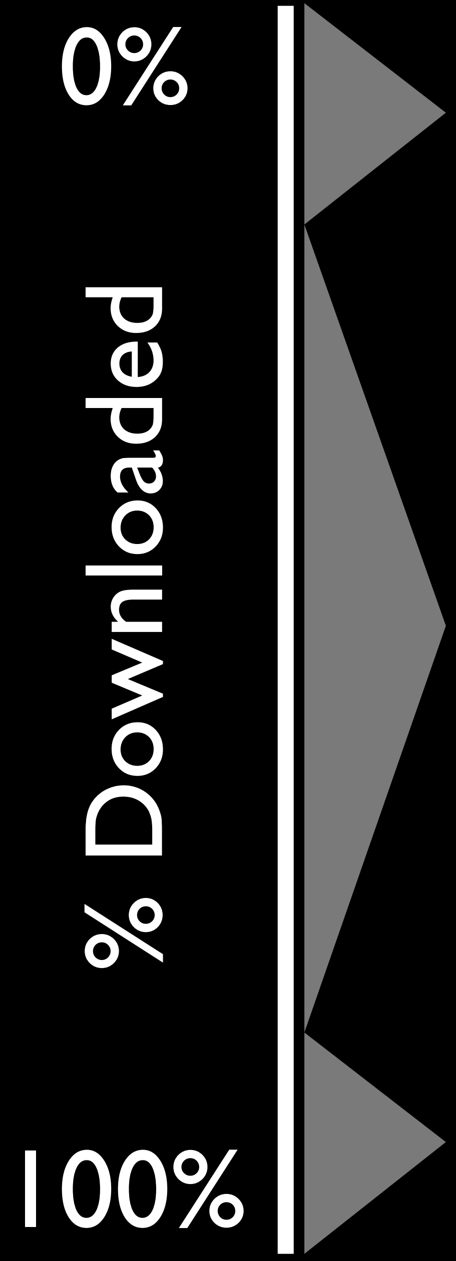


Bootstrapping Summary

- Bootstrapping is not a very large part of the download. Even so, it can be exploited
- A better bootstrapping mechanism has potential to yield better performance *throughout* the download
    - Moreover, it can be used whenever a peer becomes uninteresting, not just in the bootstrapping phase

Phases of BitTorrent

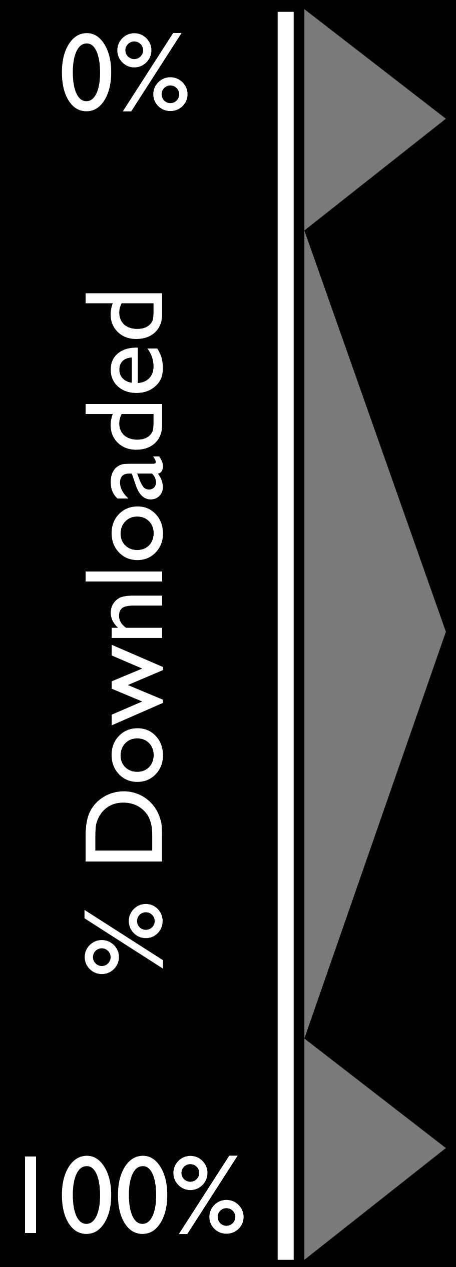


Bootstrapping: Getting the first pieces

Steady-state: Trading with peers

End-game: Getting the last pieces

Phases of BitTorrent



Bootstrapping: Getting the first pieces

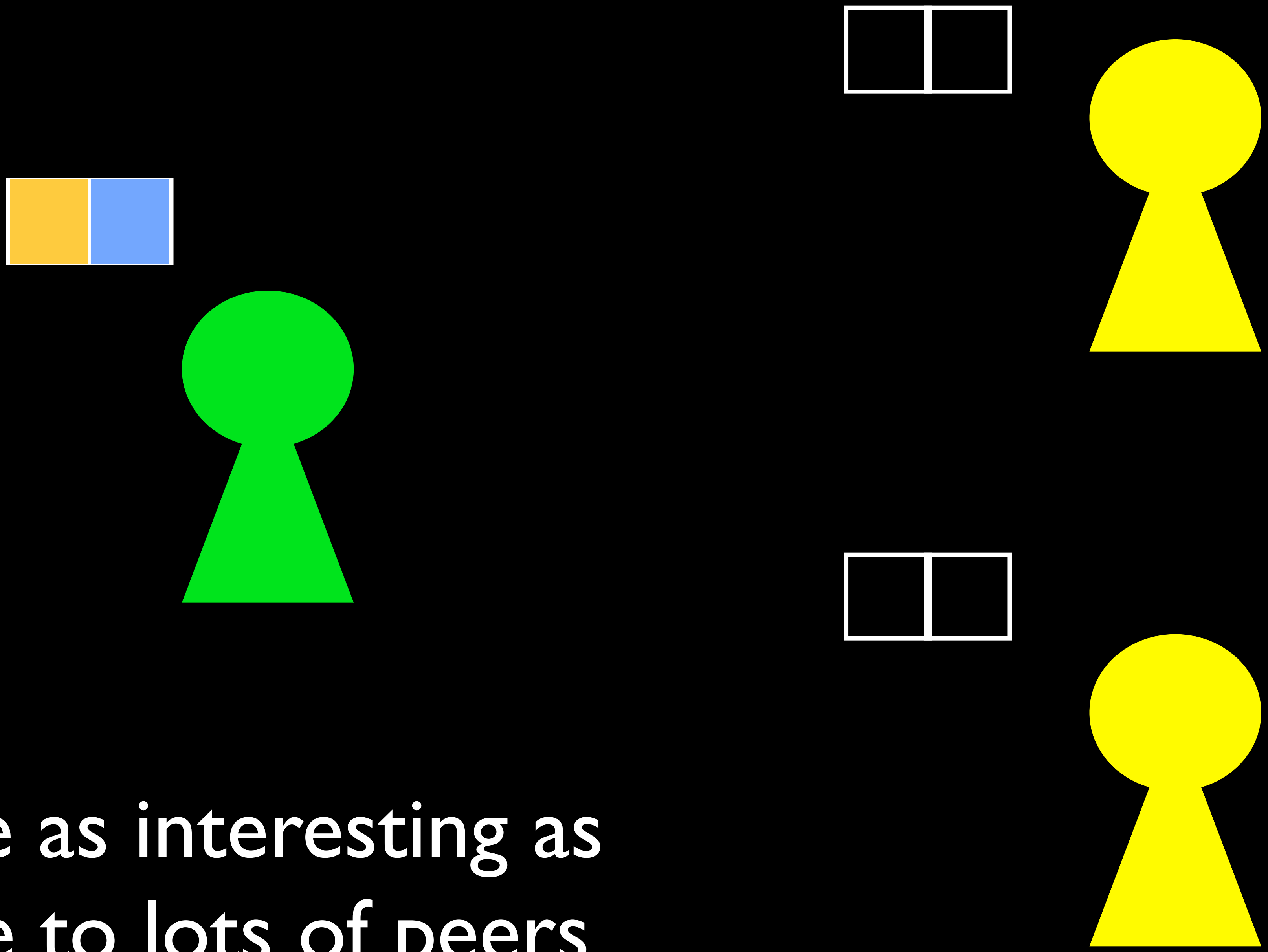
Steady-state: Trading with peers

End-game: Getting the last pieces

assumption: not many peers are mutually interesting

Strategic Piece Revelation

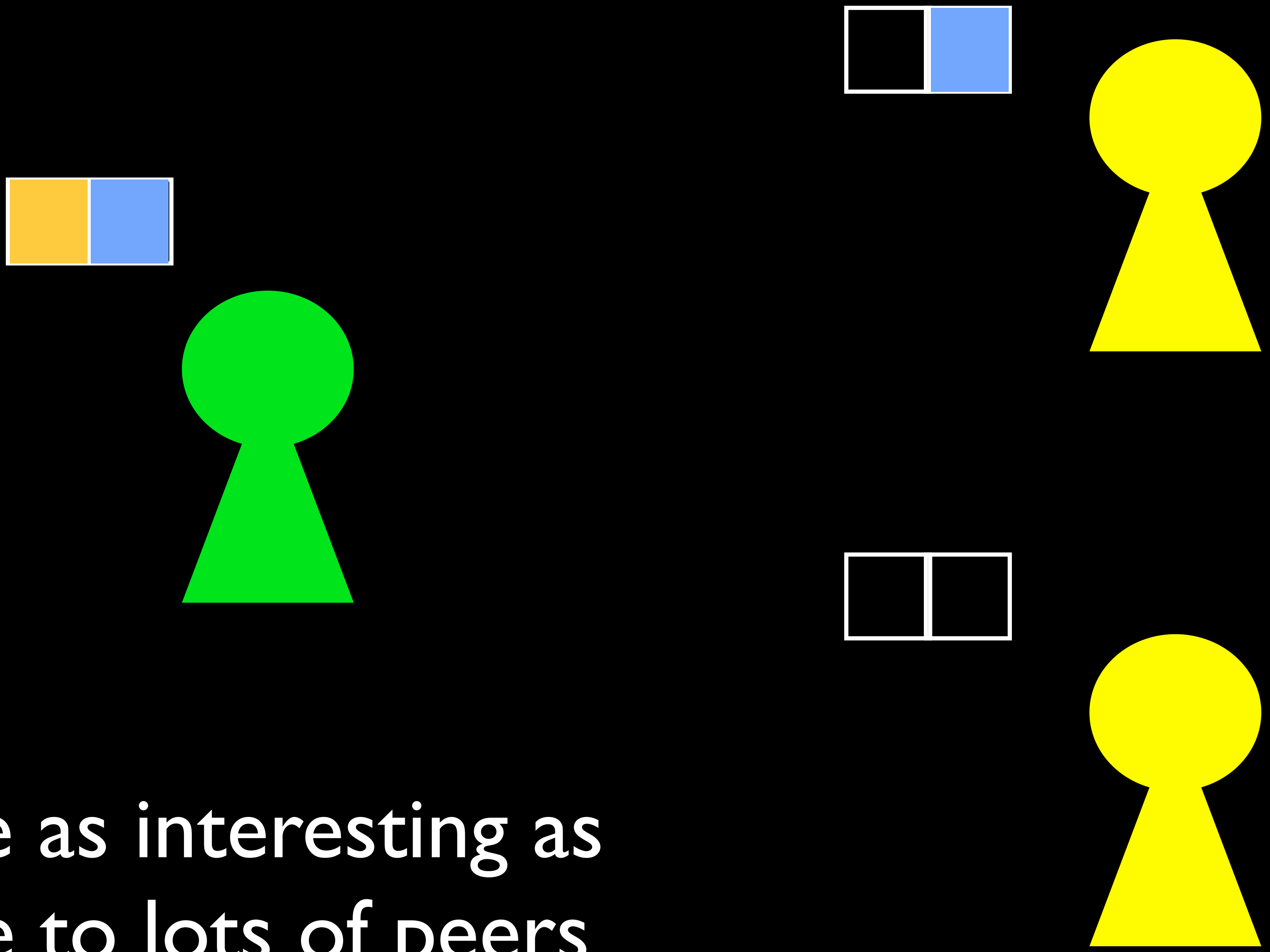
Round t



Goal: Be as interesting as possible to lots of peers

Strategic Piece Revelation

Round t



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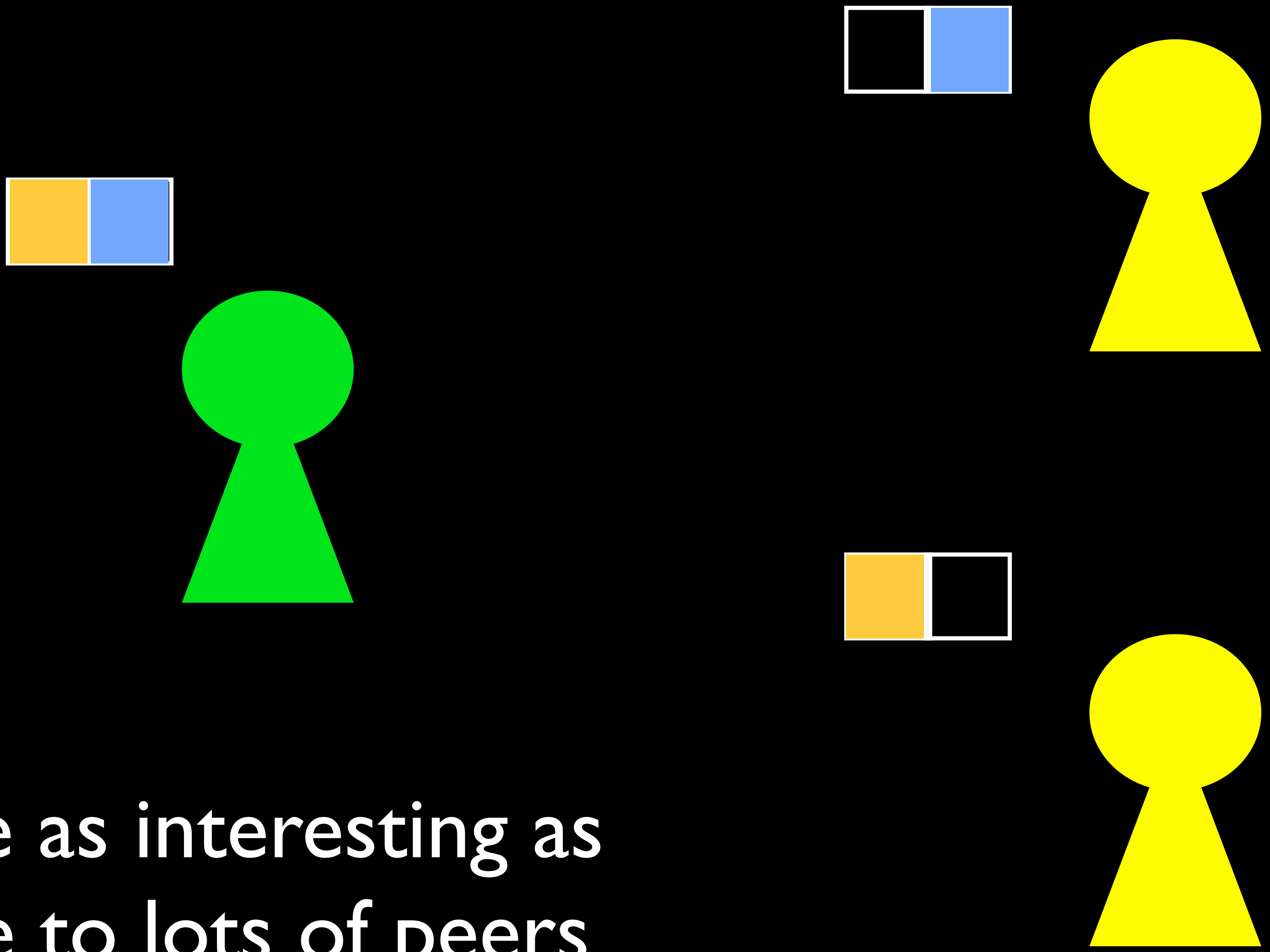

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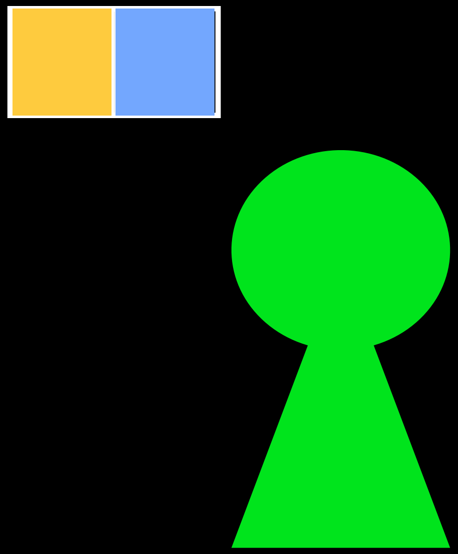
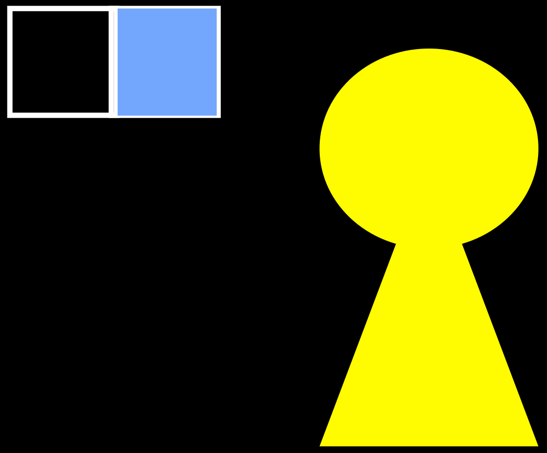
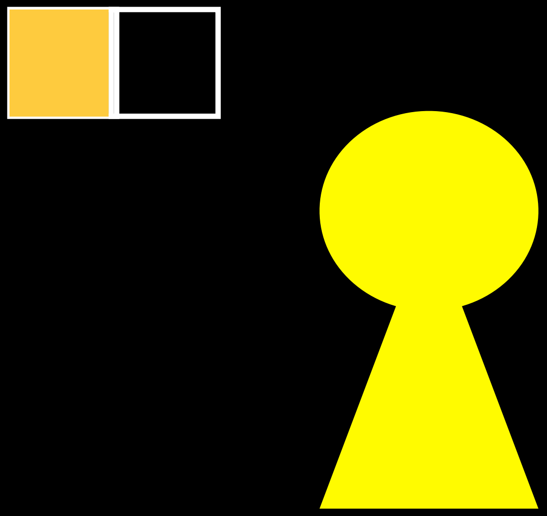
Strategic Piece Revelation

Round t+1







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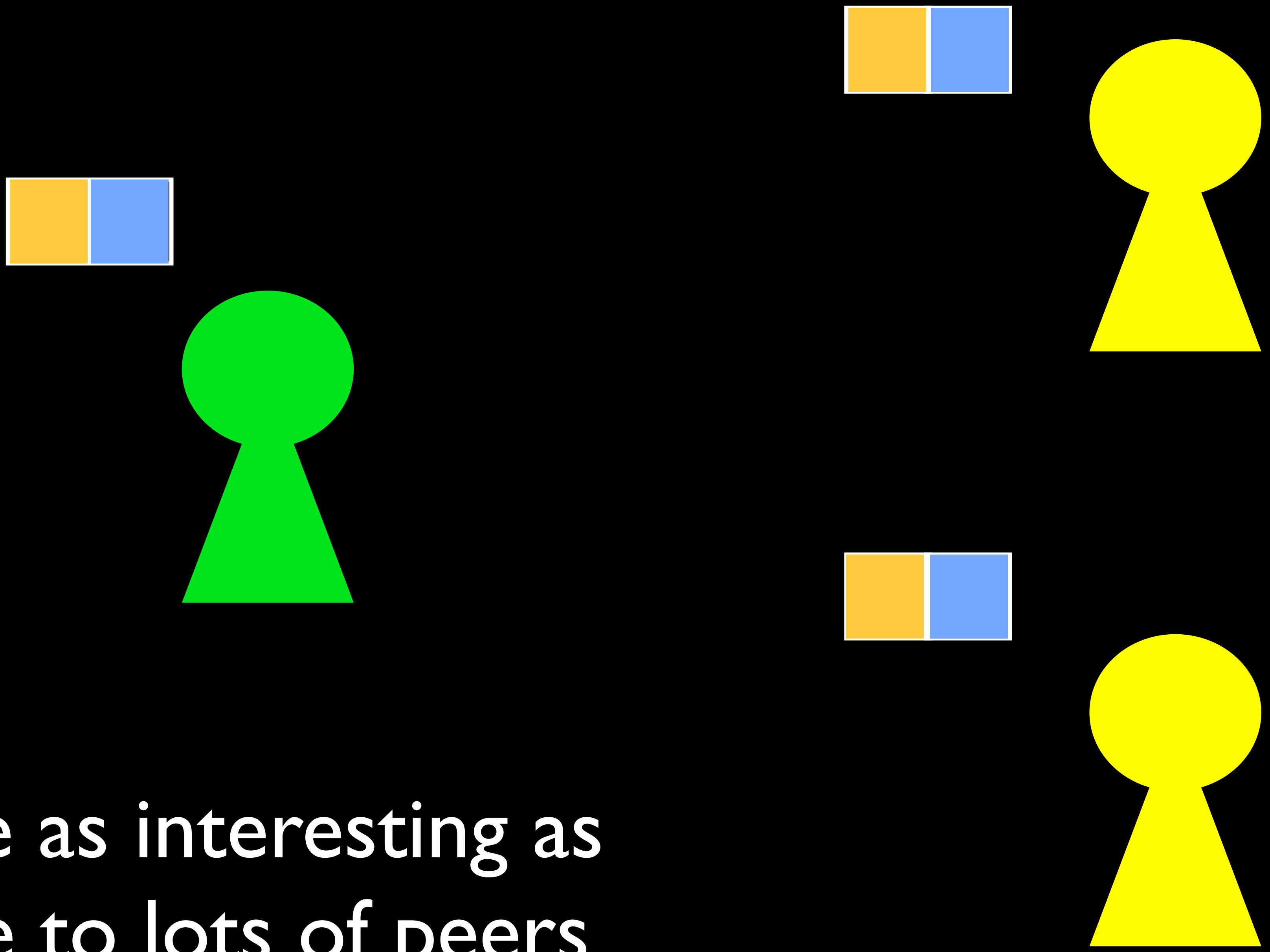

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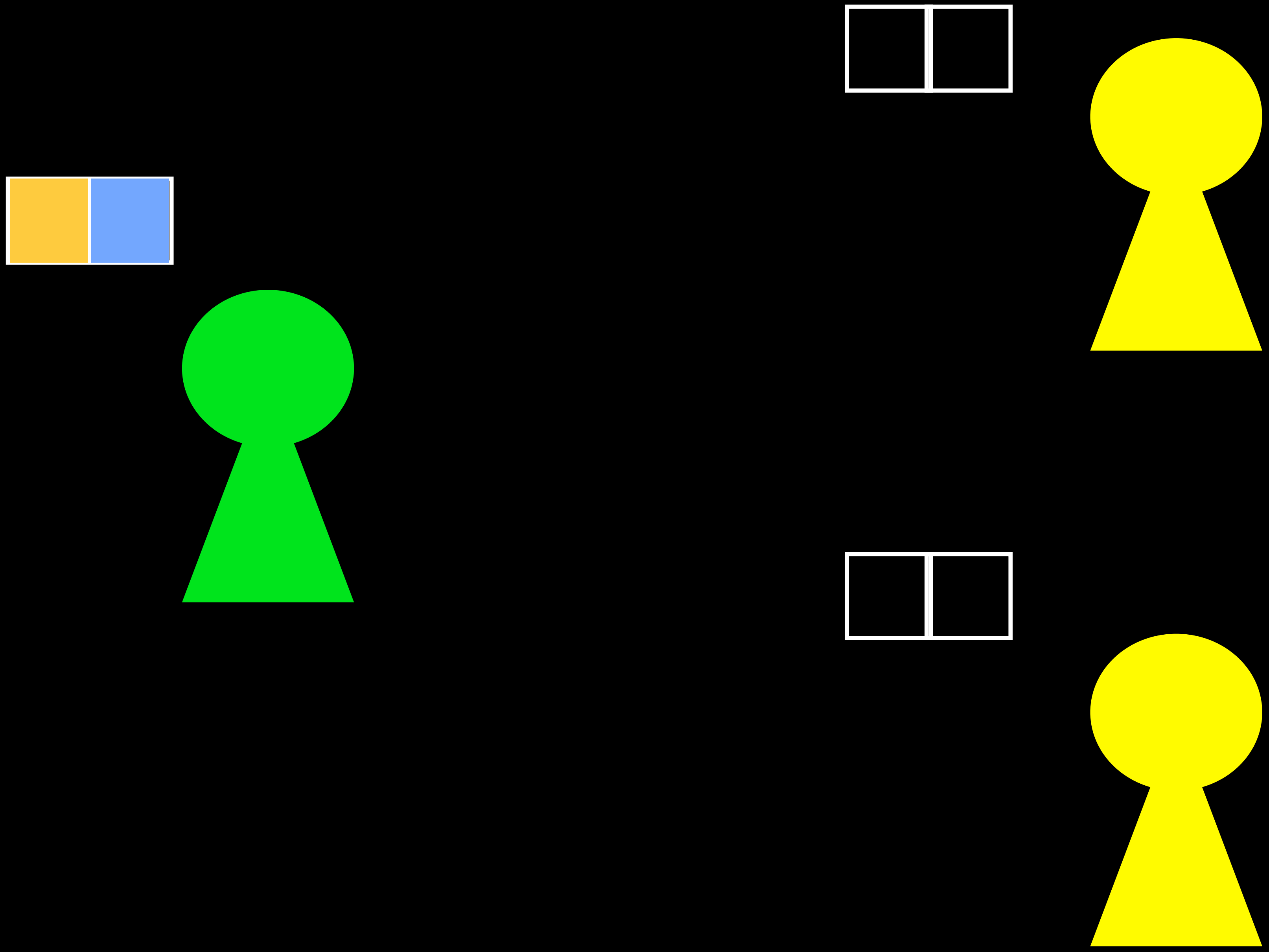

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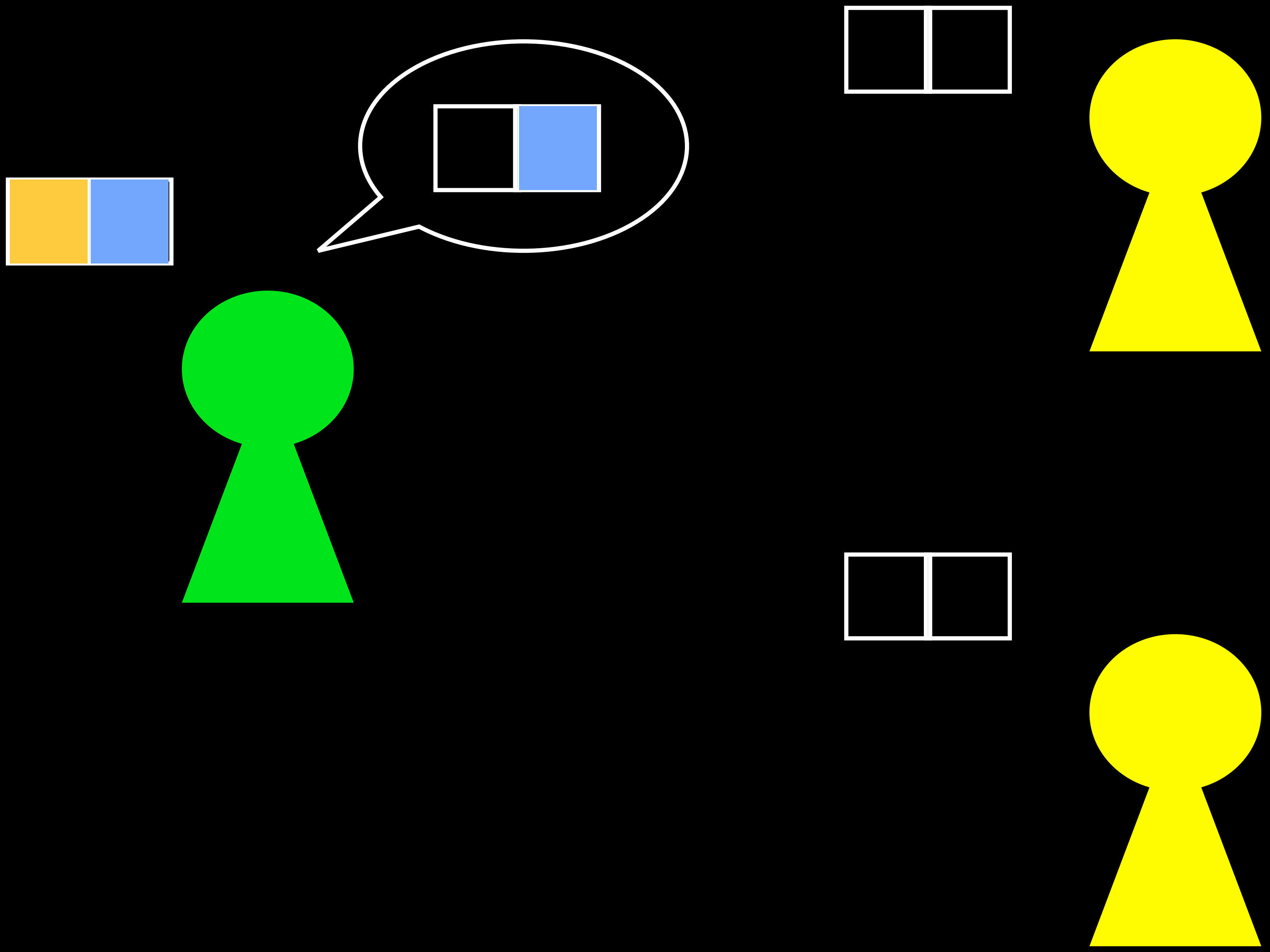

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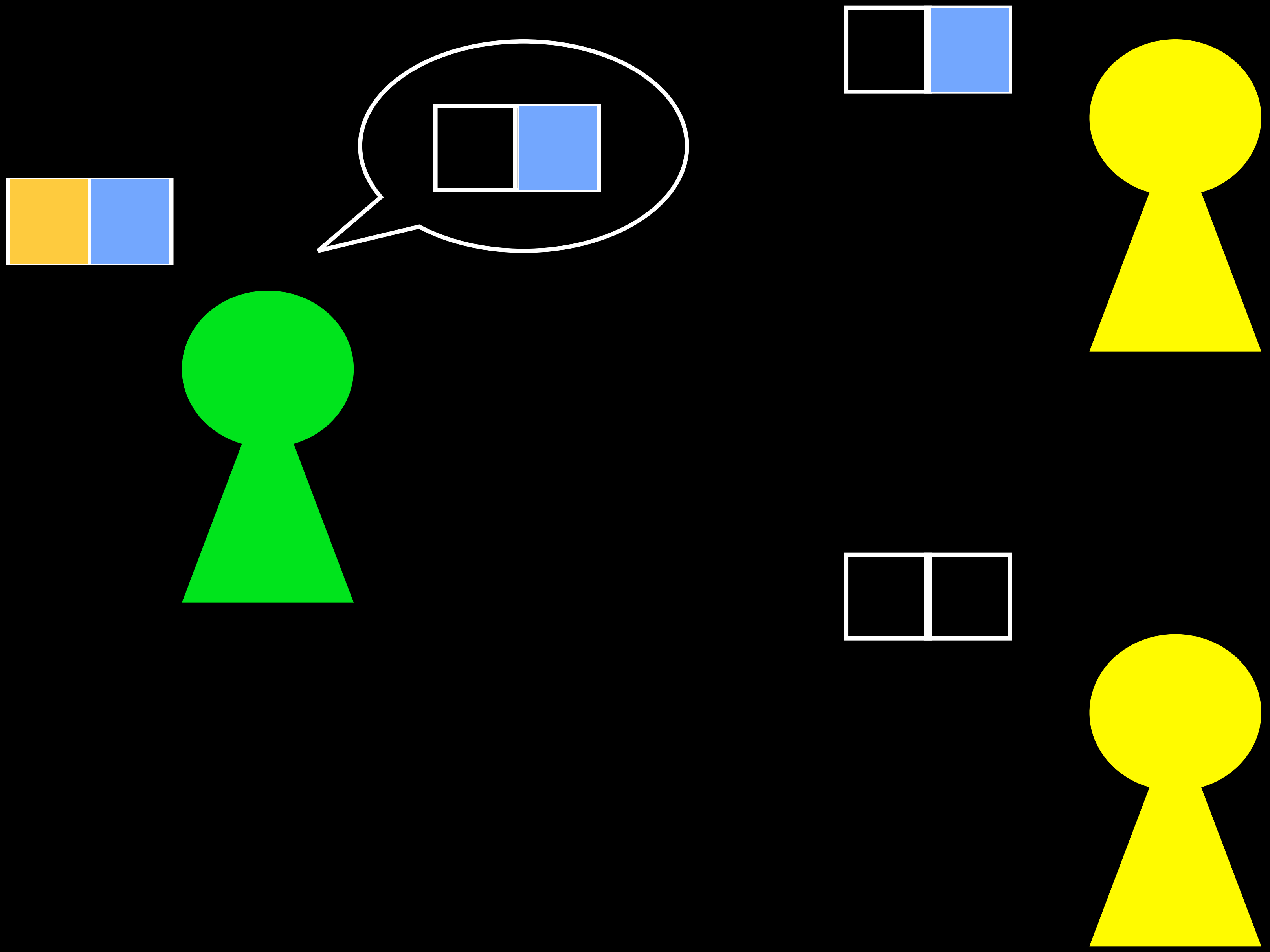

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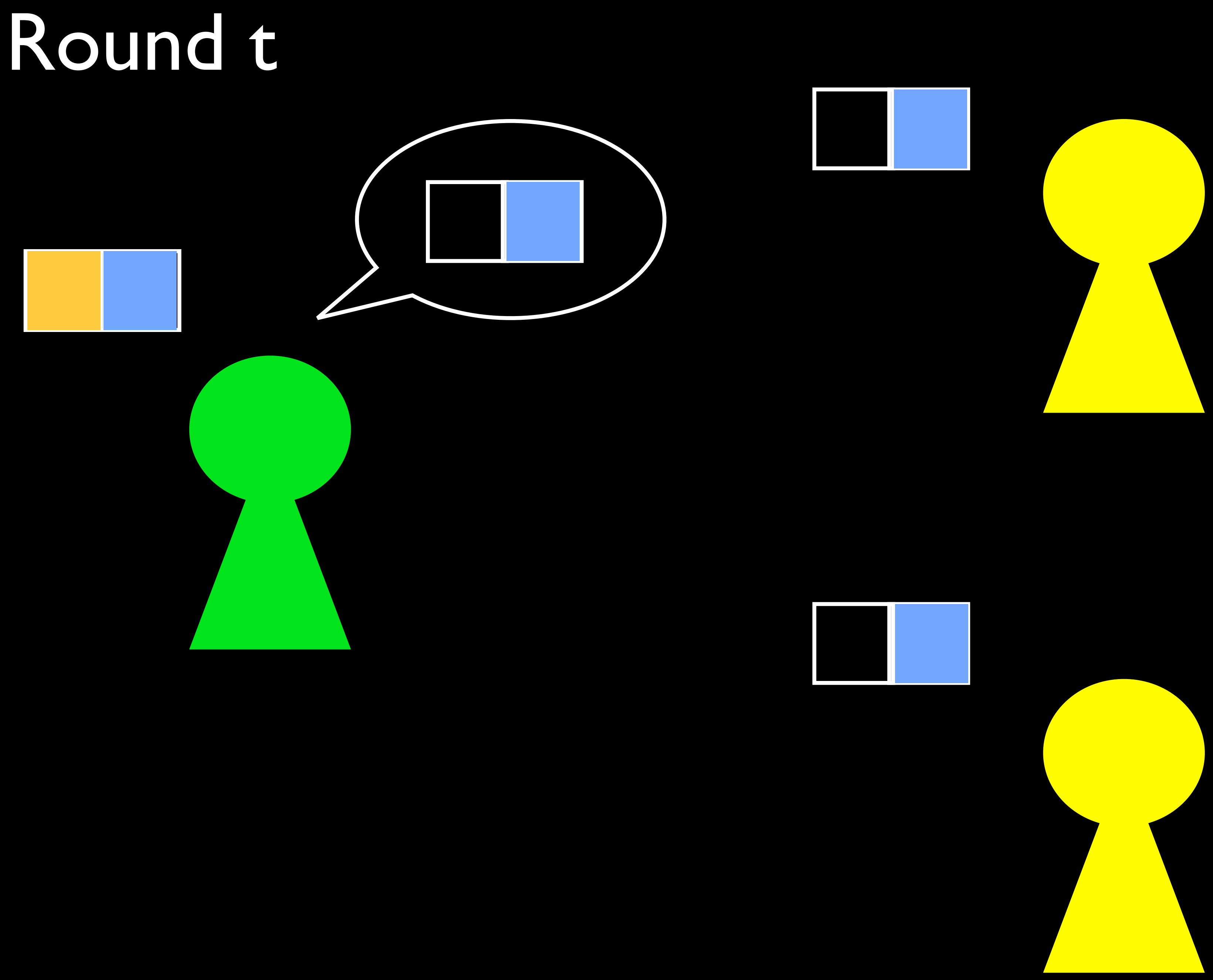

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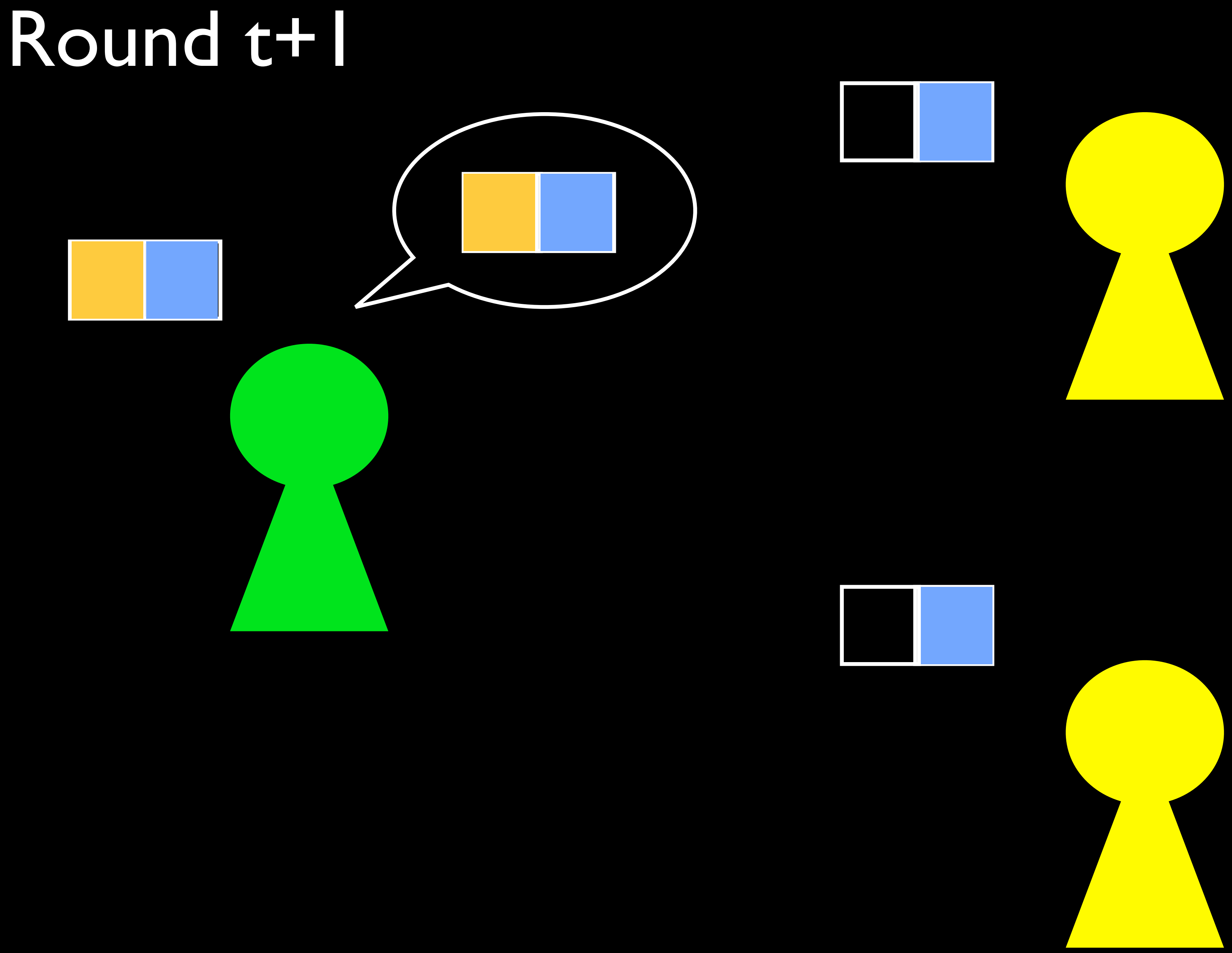

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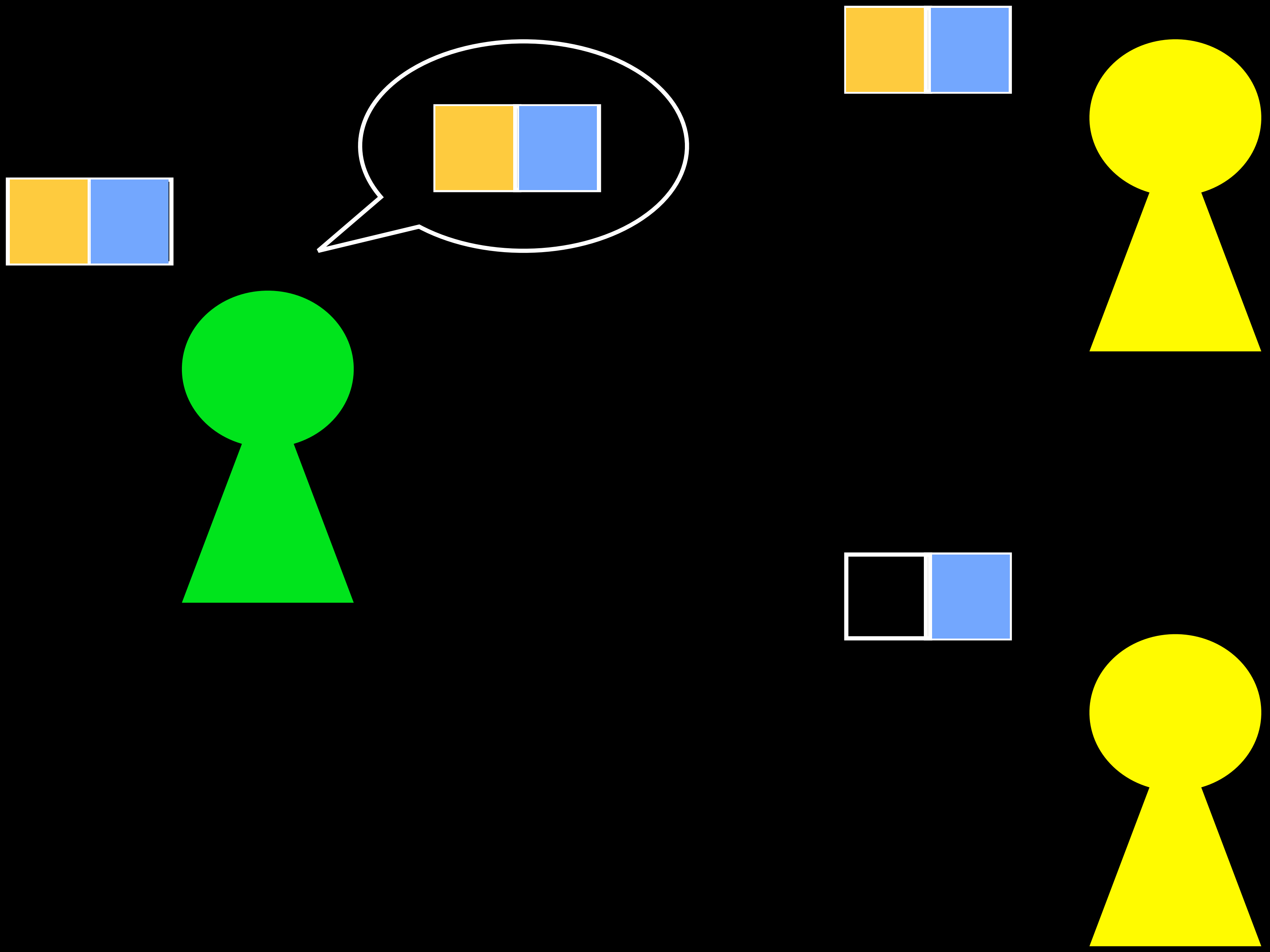

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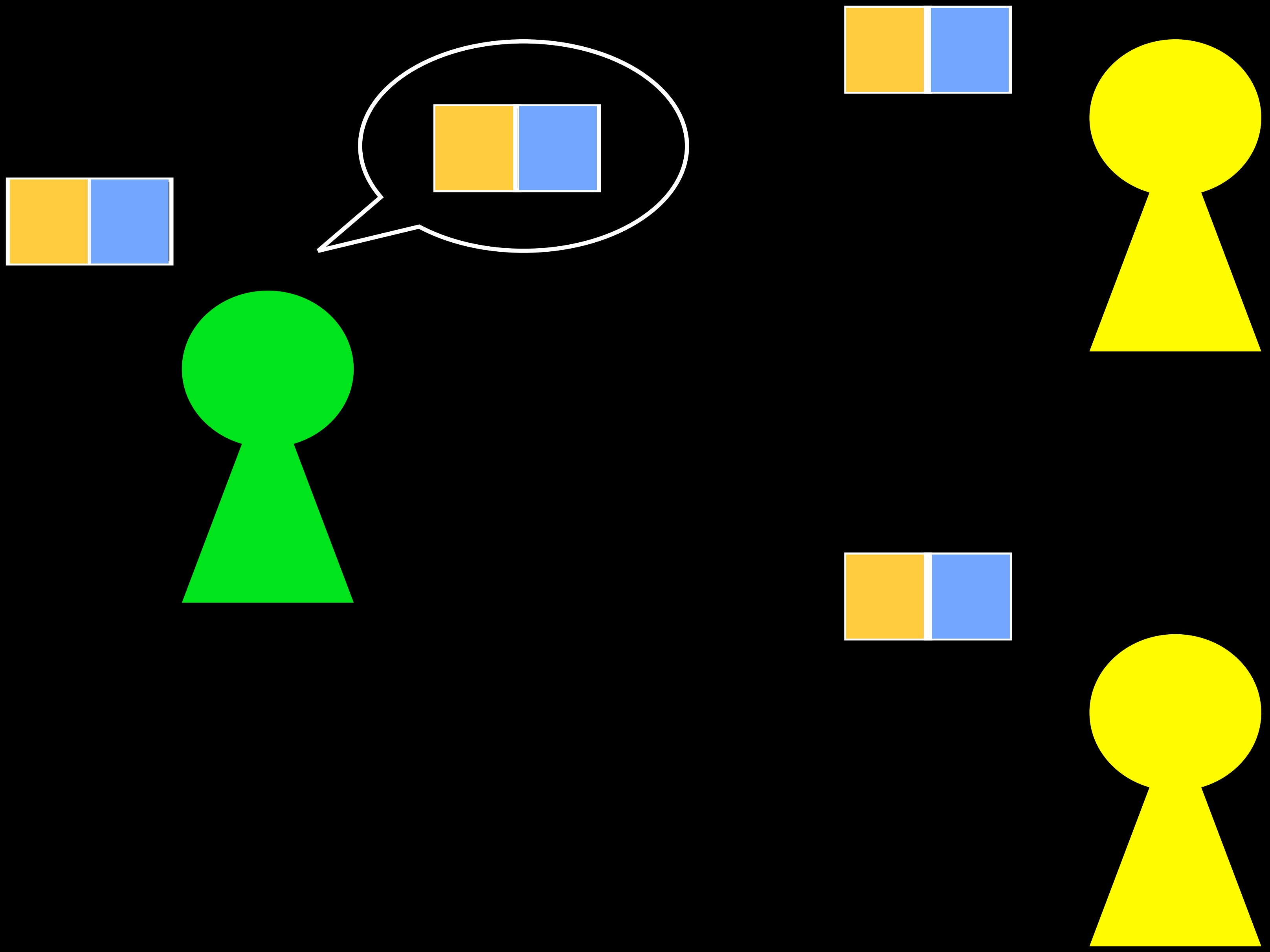

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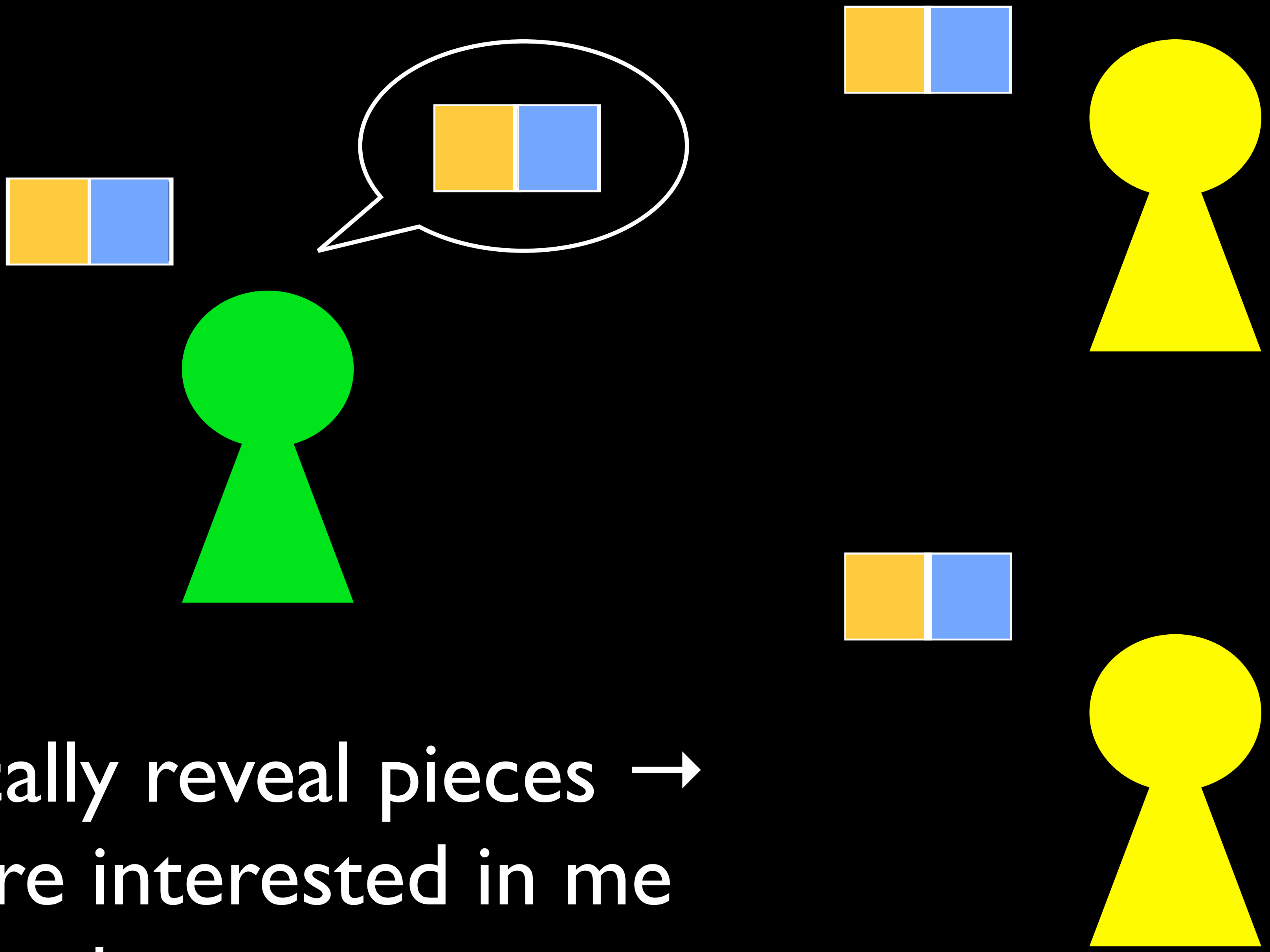

Strategically reveal pieces → Peers are interested in me longer

Peer Selection

- Before our download even starts, a BitTorrent client gets a set of peers from the tracker.
- During the download, the peer figures out the “best” of this set
- What if we could decide which peers would be best without trading with them first?

Peer Selection

- Measuring link characteristics is sometimes seen as a threat, and doesn’t scale
- Many measurement systems require a “map” of the Internet, which is hard to obtain
- Network coordinate systems don’t require a map, but are complicated and don’t always work
- Could try simple things (use peers in our ISP, e.g.), but it’s not clear that these work either

Summary

- BitTorrent is a large system; lots of things to tweak
  - Bootstrapping, steady-state, end-game phases
  - Peer selection
- Not all strategies are fair
- A combination of techniques (from various phases) would probably result in an extremely fast client