

BitTorrent is an Auction: Analyzing and Improving BitTorrent's Incentives

Dave Levin

Katrina LaCurts

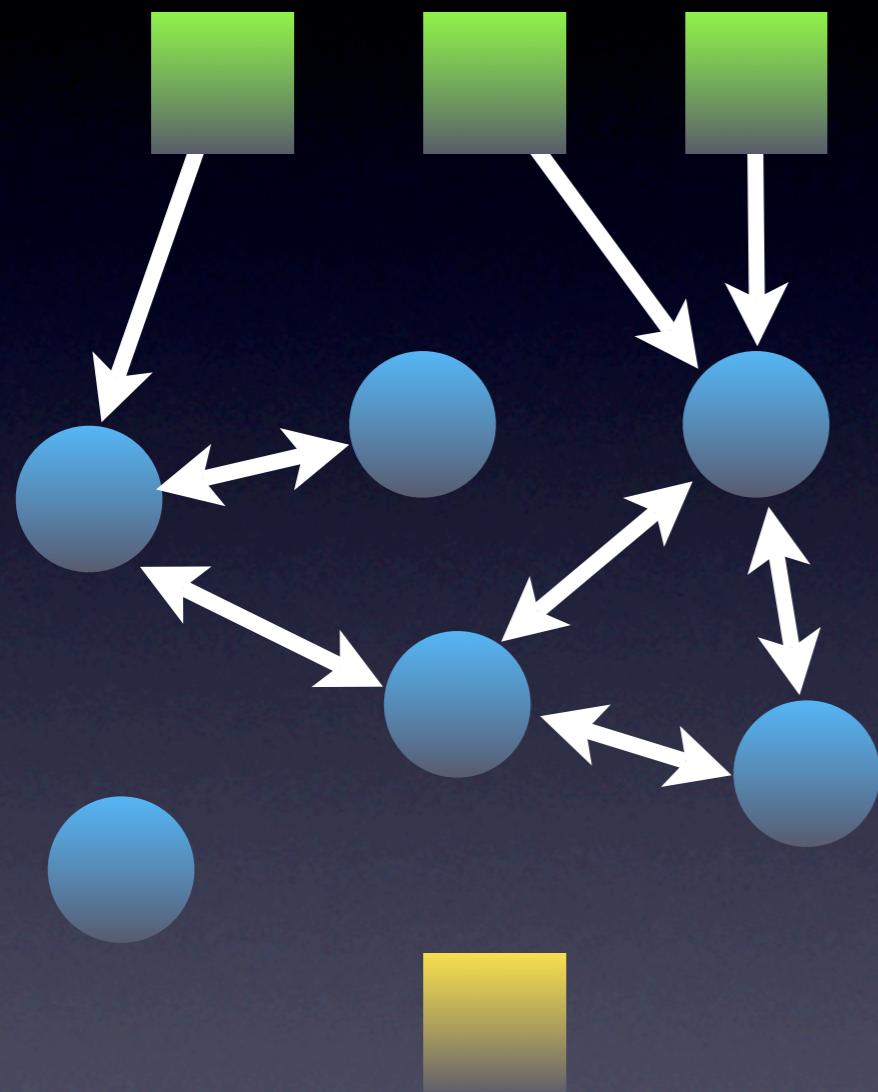
Neil Spring

Bobby Bhattacharjee

University of Maryland



BitTorrent Primer

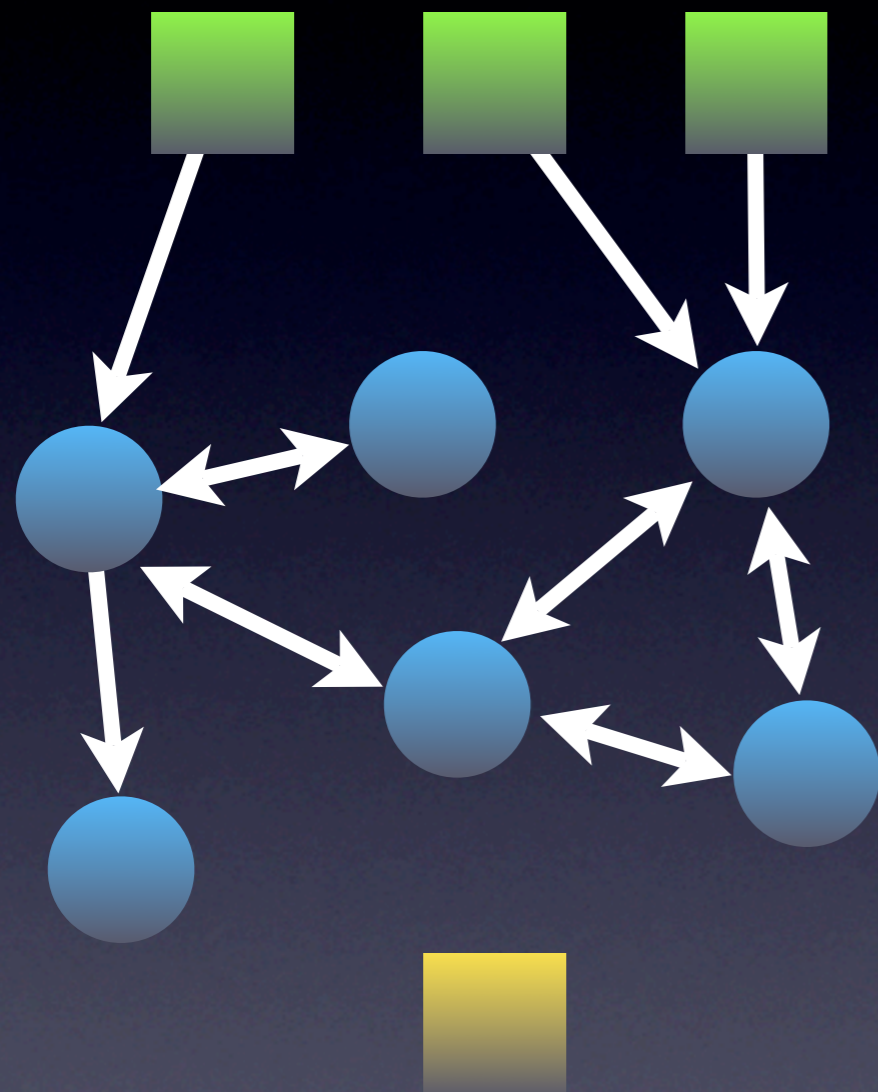


Seeders upload

Leechers trade

Trackers introduce

BitTorrent Primer

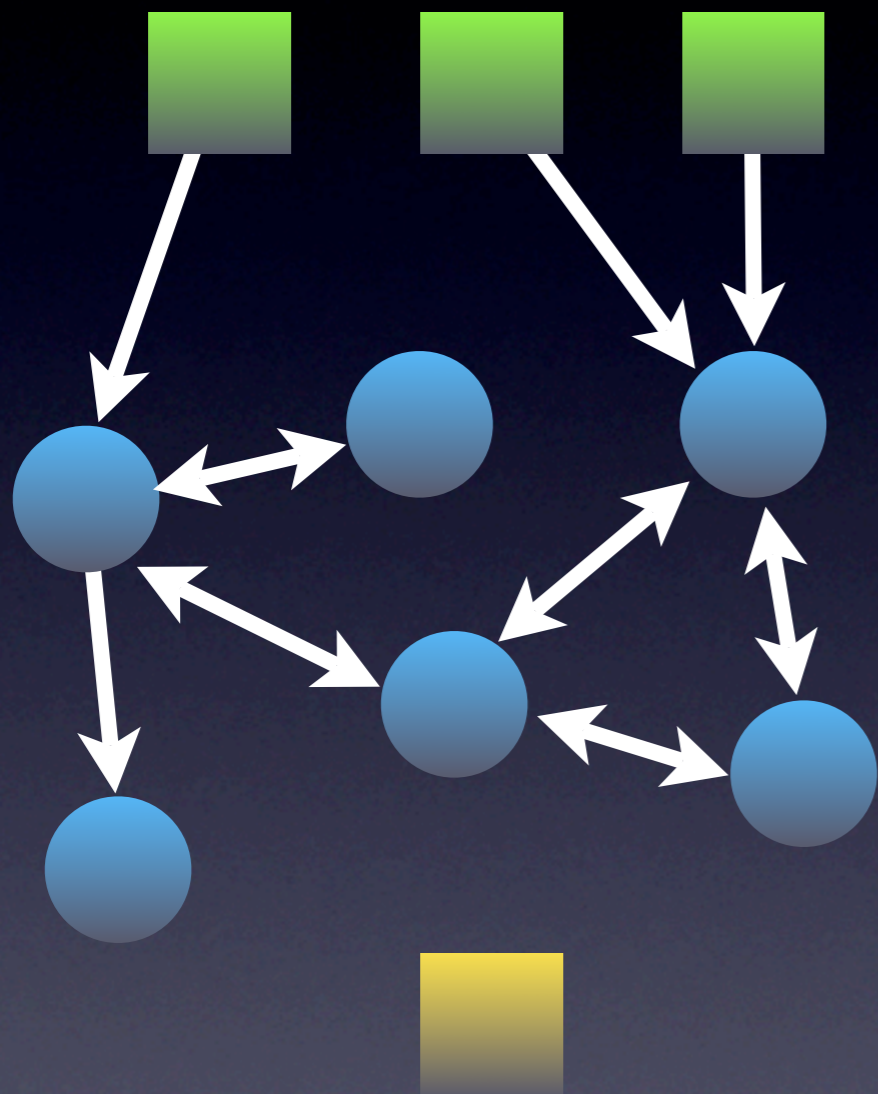


Seeders upload

Leechers trade

Trackers introduce

BitTorrent Primer



Seeders upload

Leechers trade

Selfish

Trackers introduce

Lifecycle of a Leecher



Lifecycle of a Leecher

Steady-state

Trade with others

Leechers' Local Policy

Steady-state

Trade with others

What to download

- Estimate **block rarity**
- Download **rarest blocks first**

To whom
to upload

- Determined by an **unchoking algorithm**

What to upload

- State everything you have
- Determined by a **block revelation strategy**

Leechers' Local Policy

Steady-state

Trade with others

What to download

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Contributions

①

Modeling and improving BitTorrent's
unchoking algorithm

②

Strategic **block revelation**

③

Minimizing altruism in **bootstrapping**

[In the paper]

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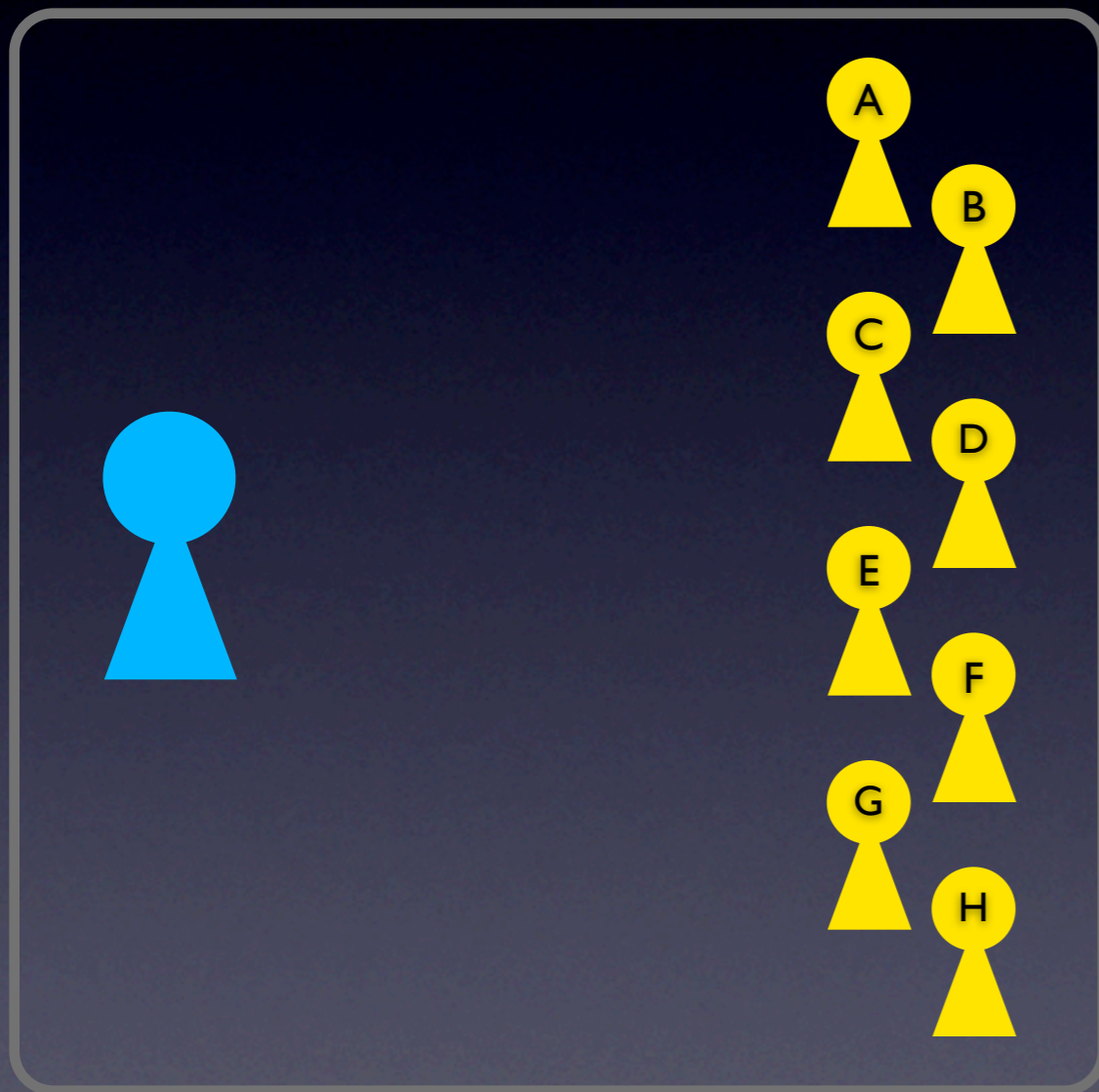
③

Minimizing altruism in **bootstrapping**

[In the paper]

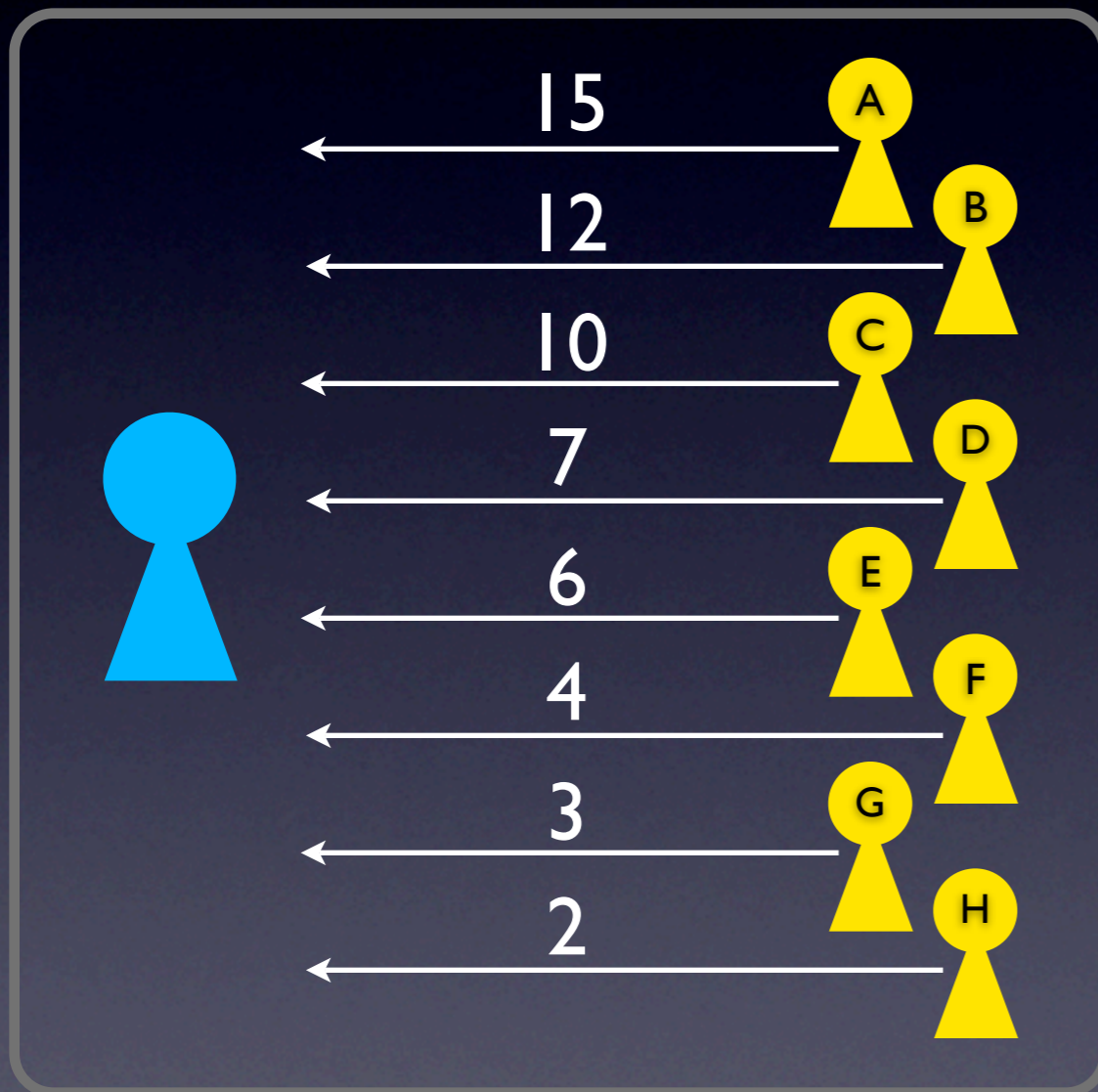
BitTorrent's Unchoker

Round t



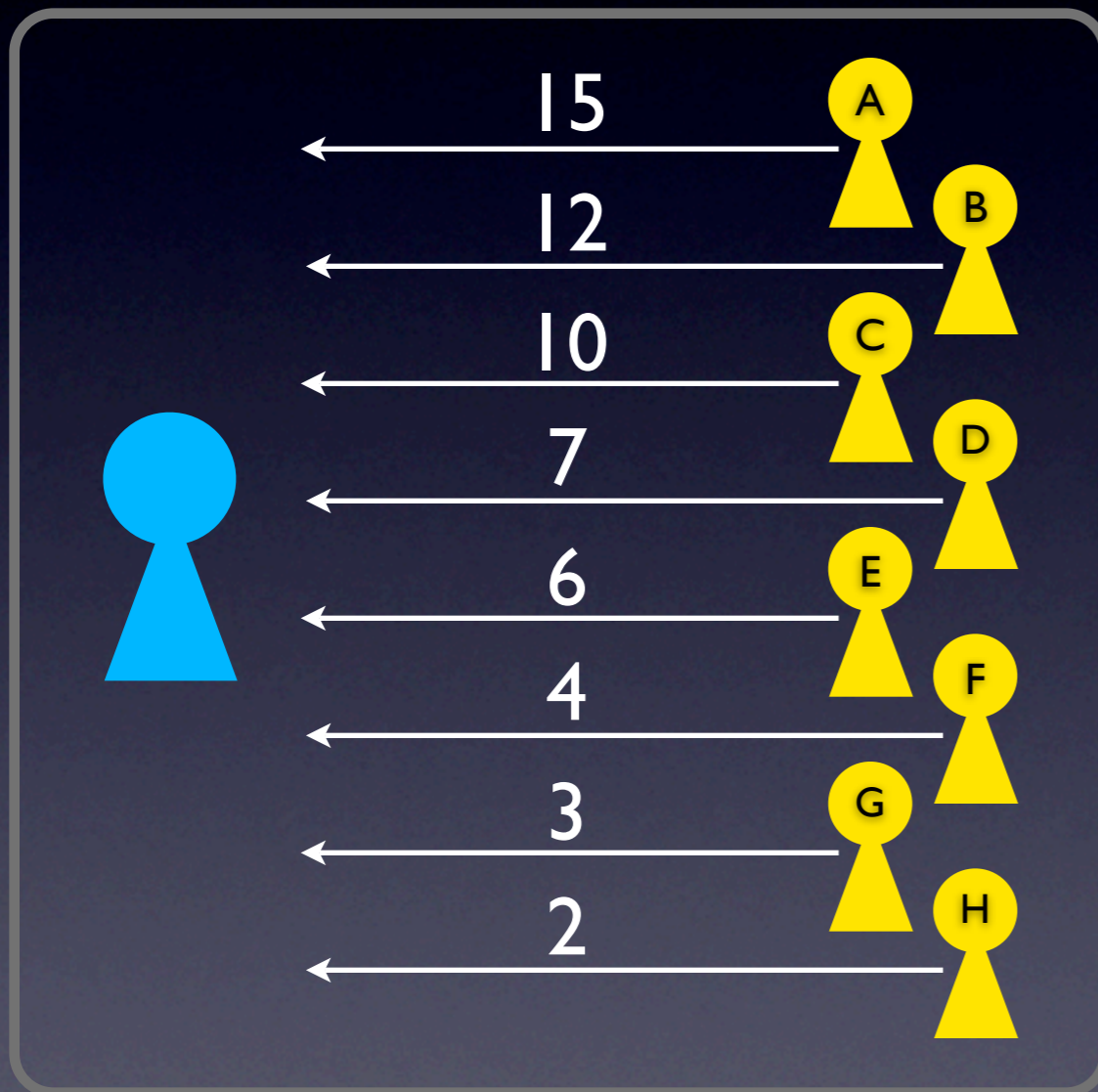
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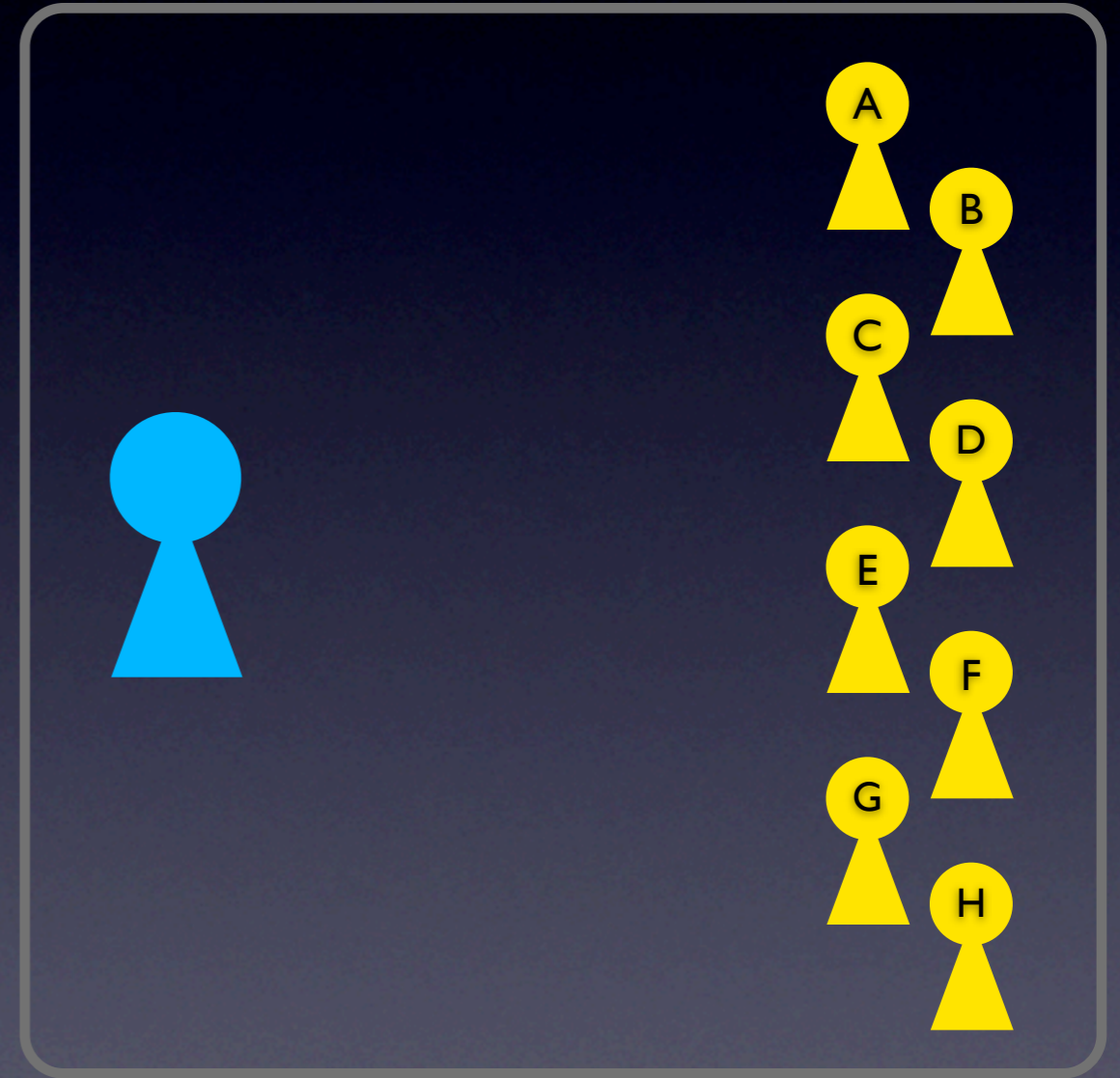


BitTorrent's Unchoker

Round t

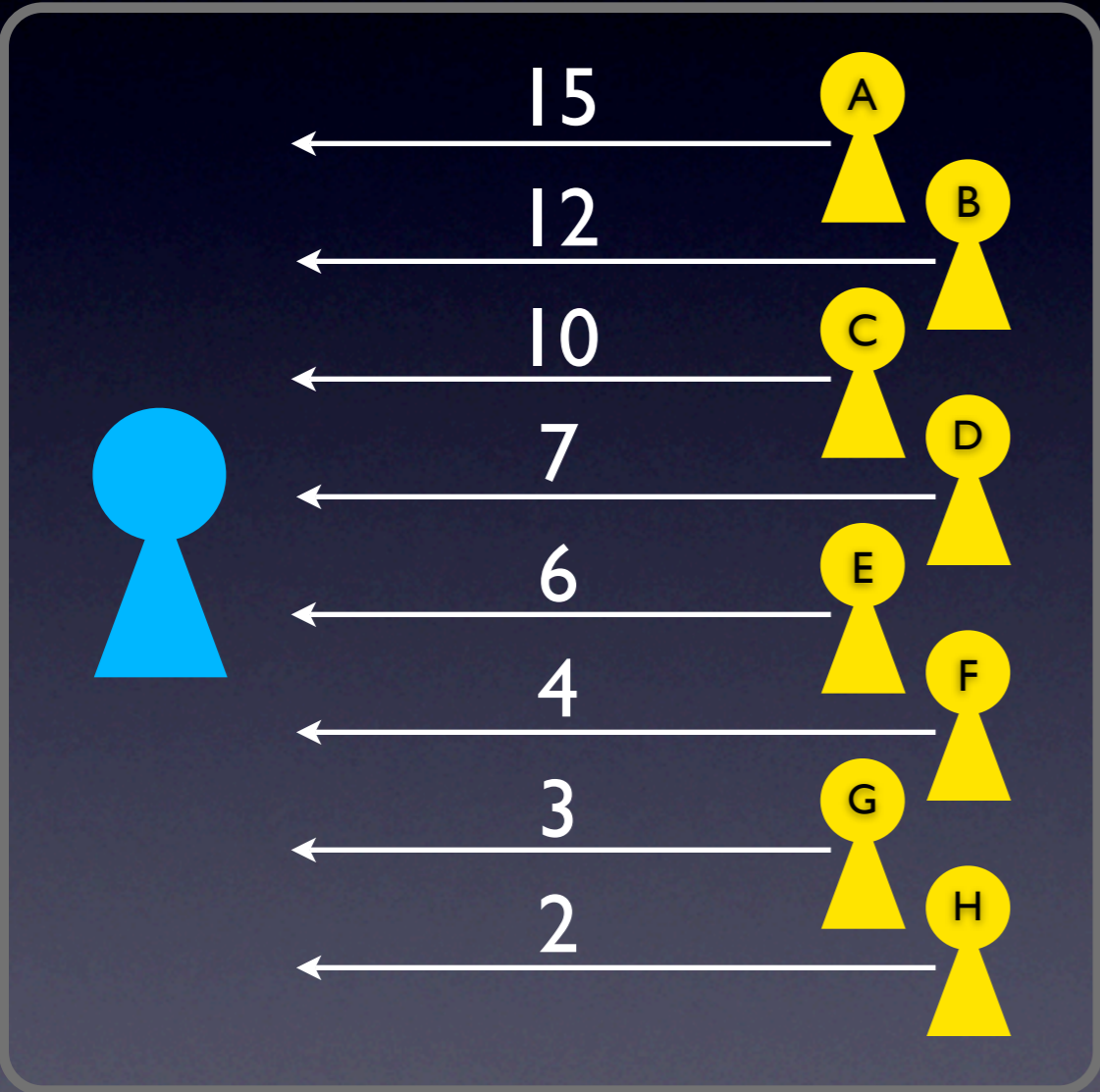


Round $t+1$

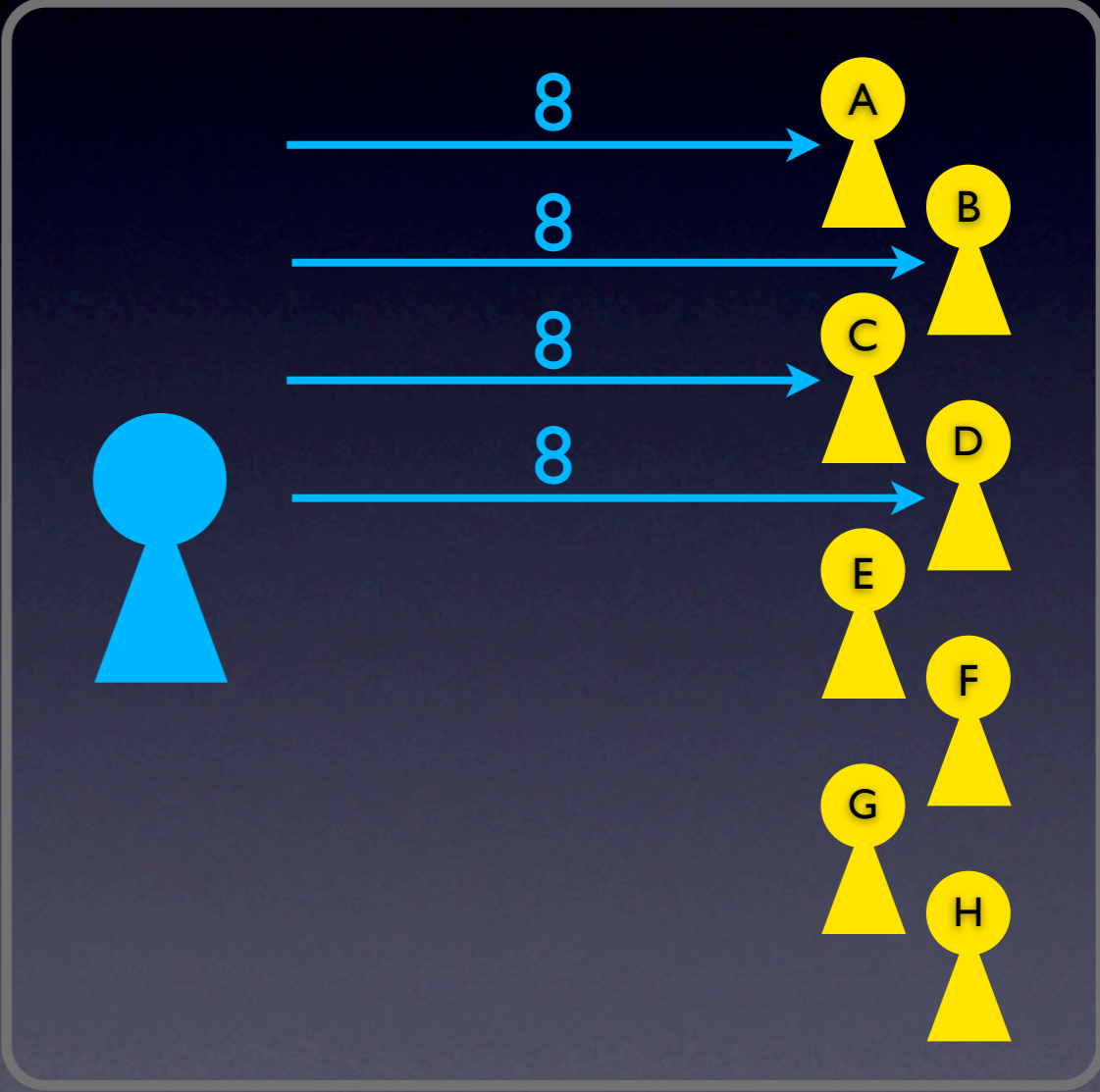


BitTorrent's Unchoker

Round t



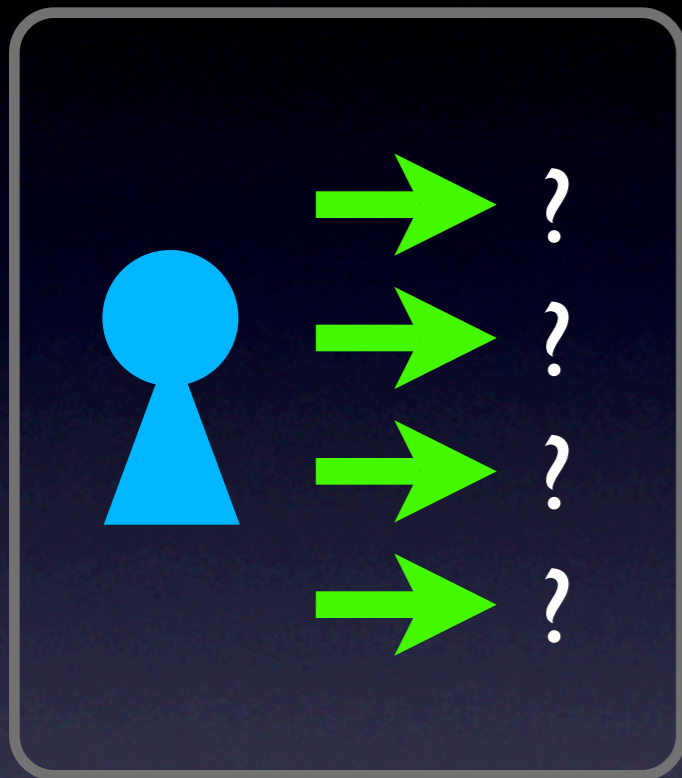
Round t+1



BitTorrent is an Auction

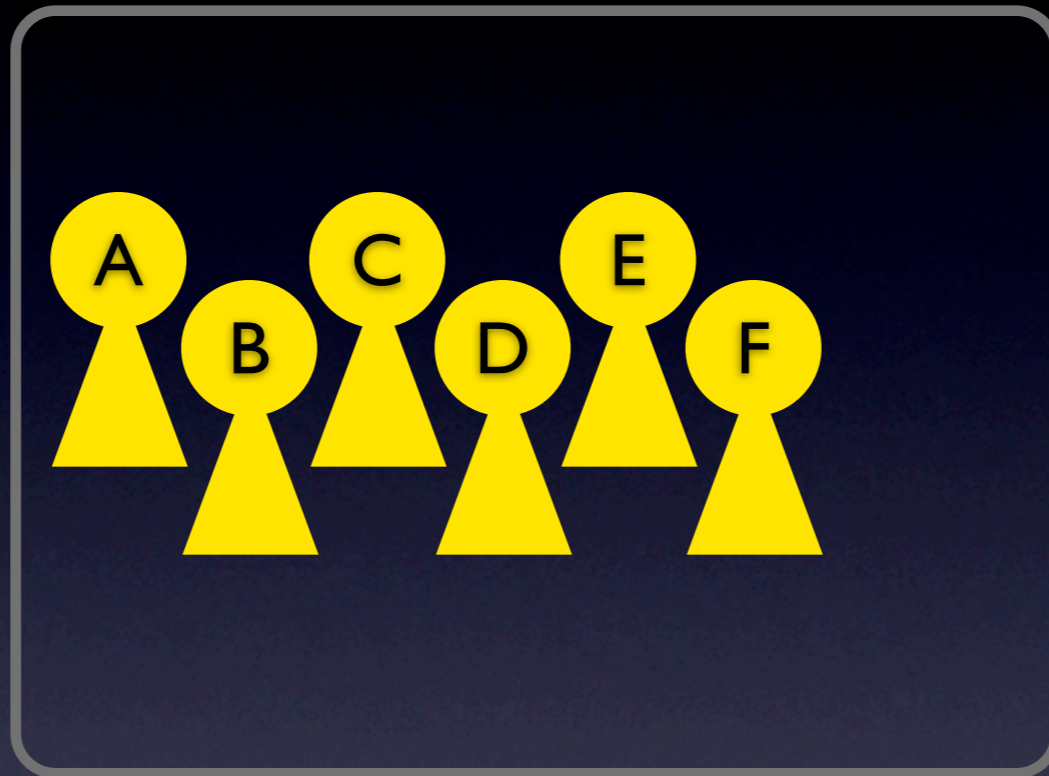
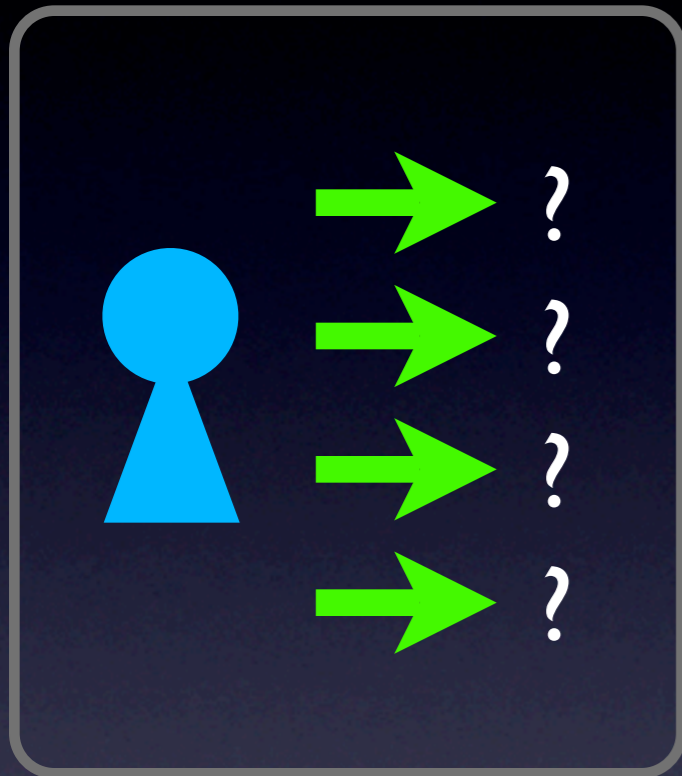


BitTorrent is an Auction



Fixed number of
equal goods

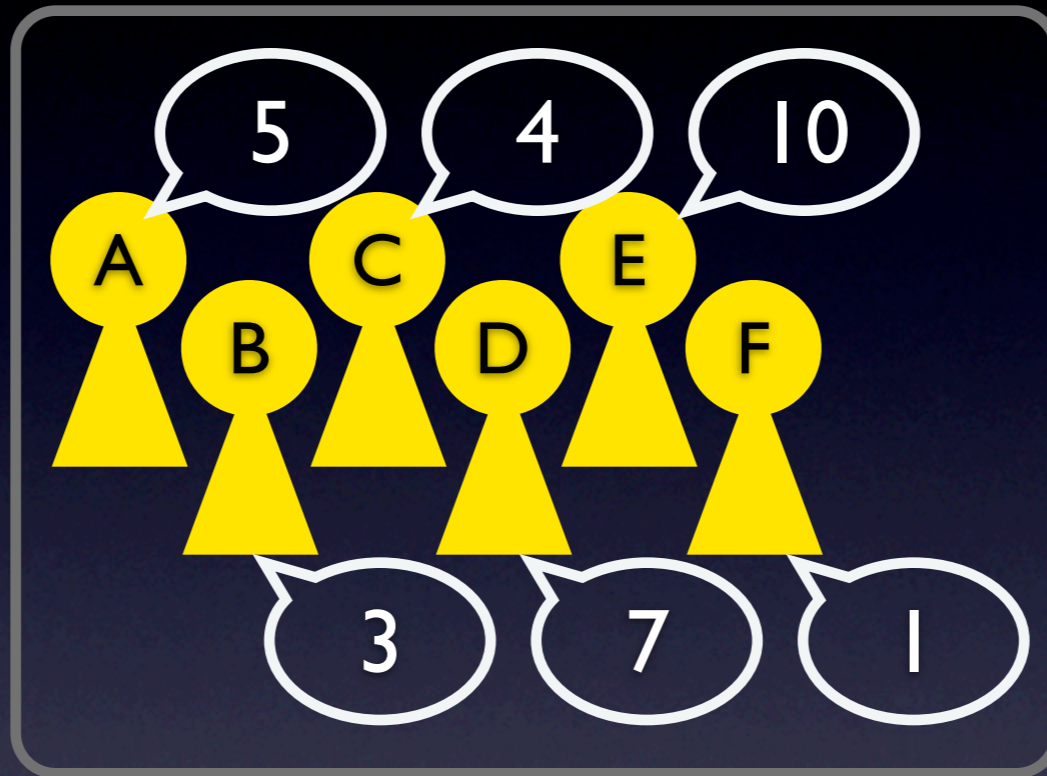
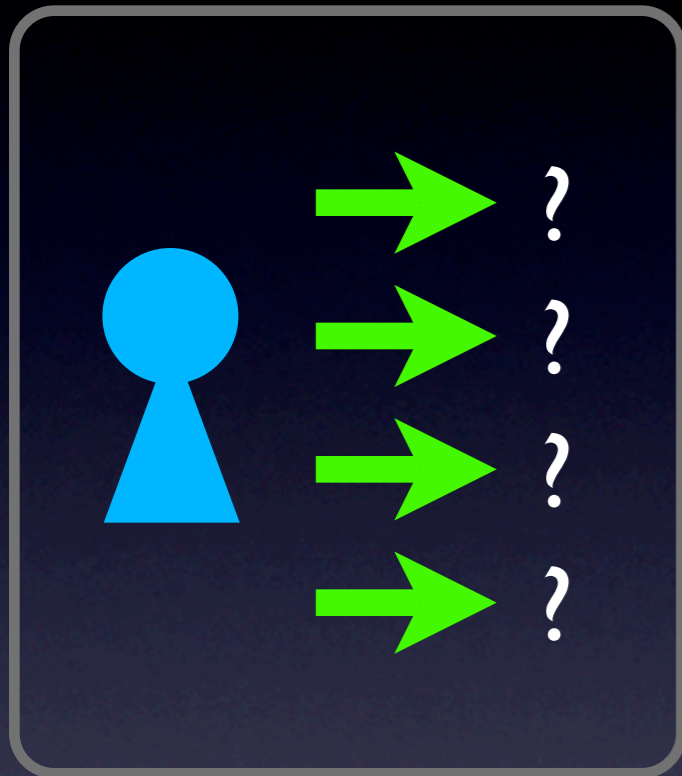
BitTorrent is an Auction



Fixed number of equal goods

Bids are prior round's uploads

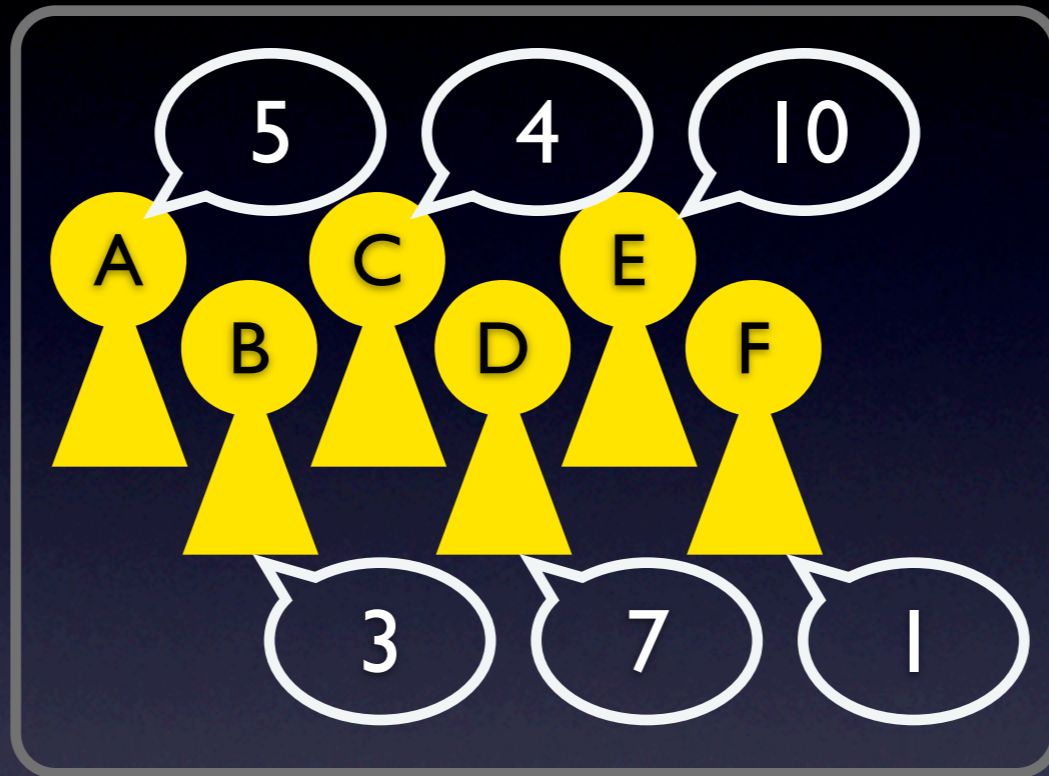
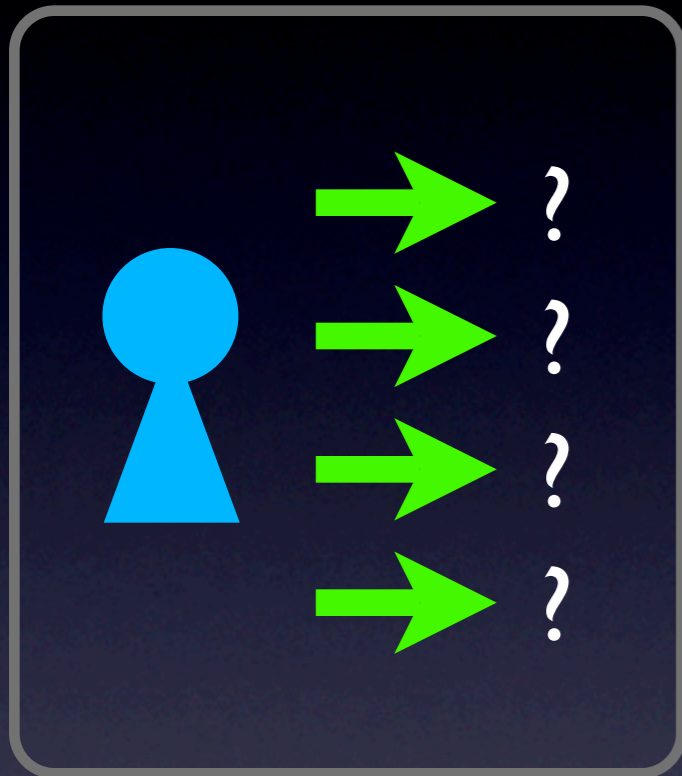
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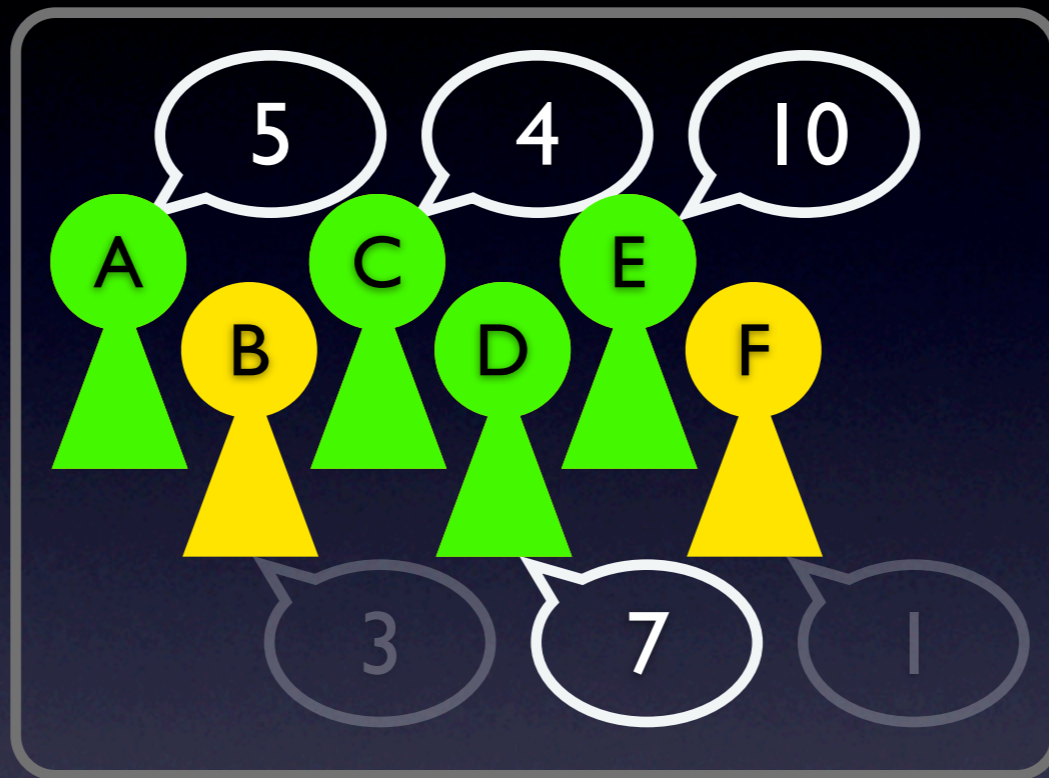
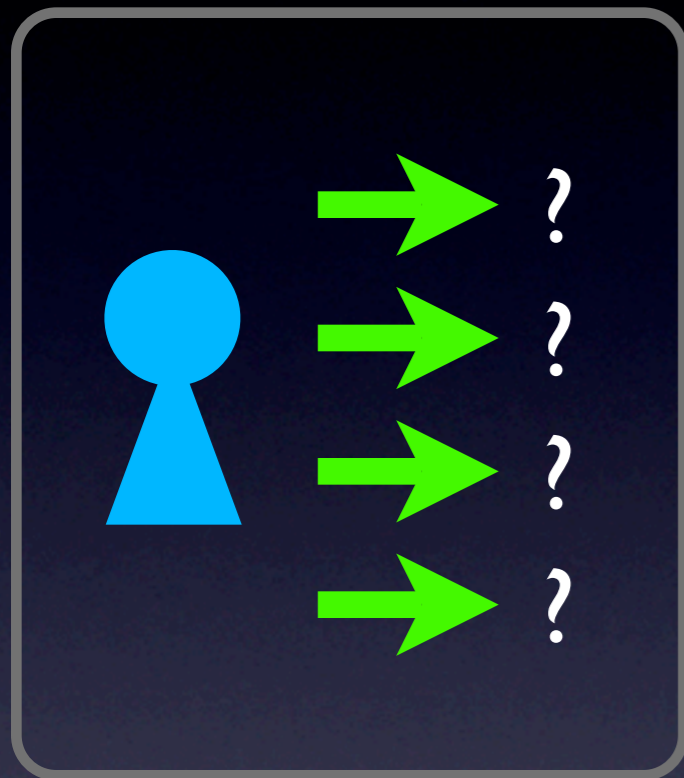


Fixed number of equal goods

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Auction clearing is "top 4"

BitTorrent is an Auction

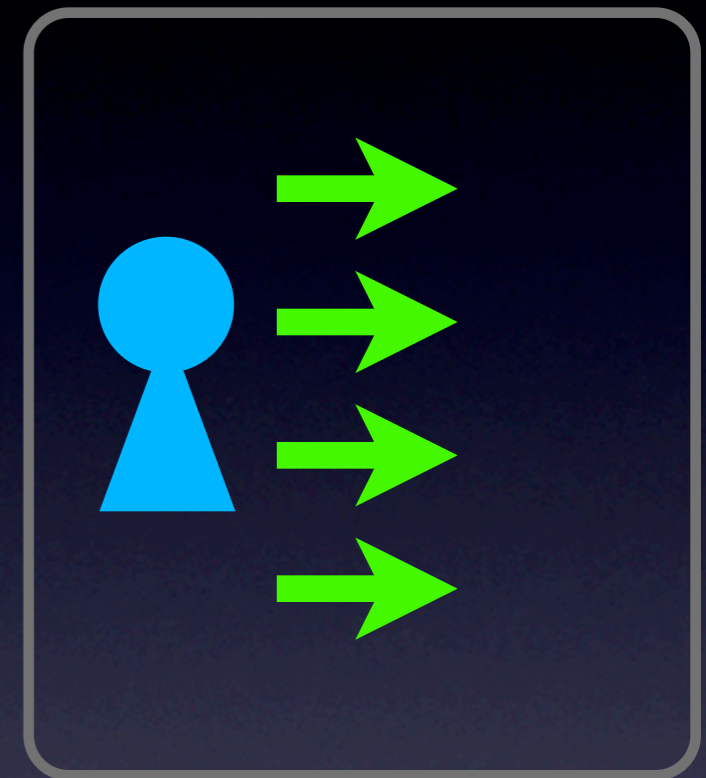
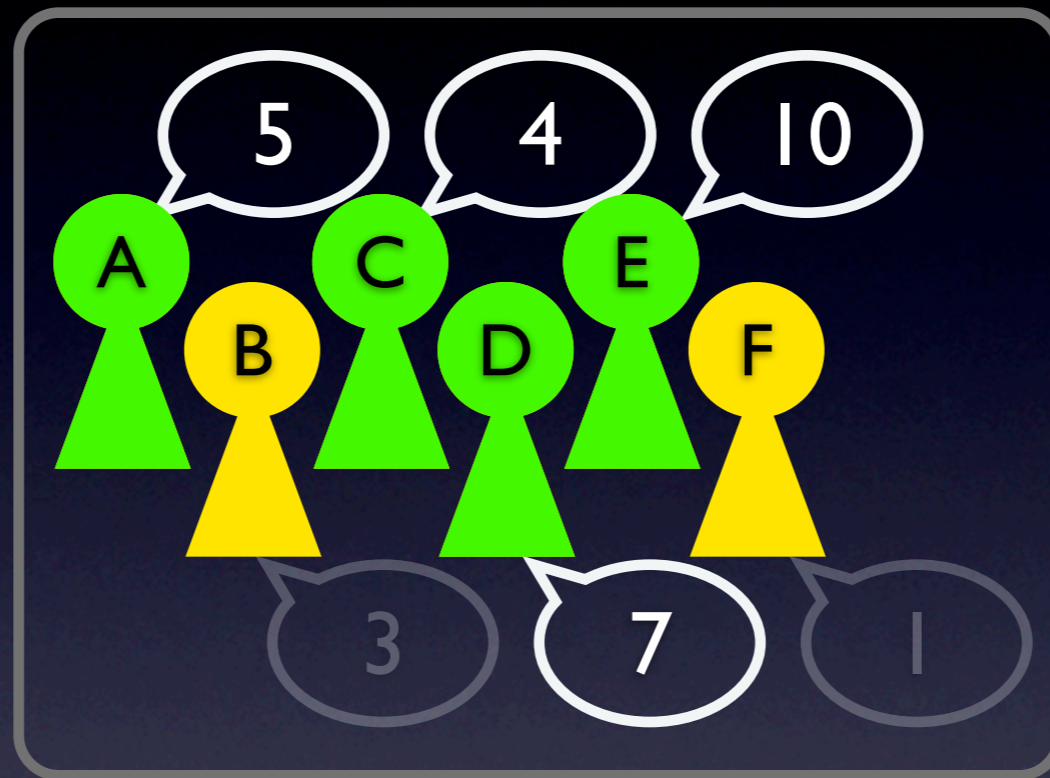
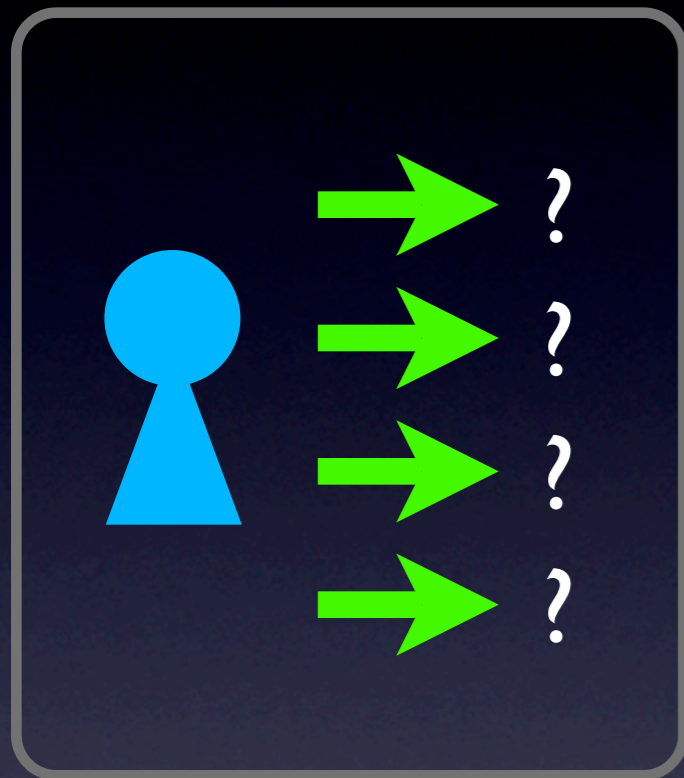


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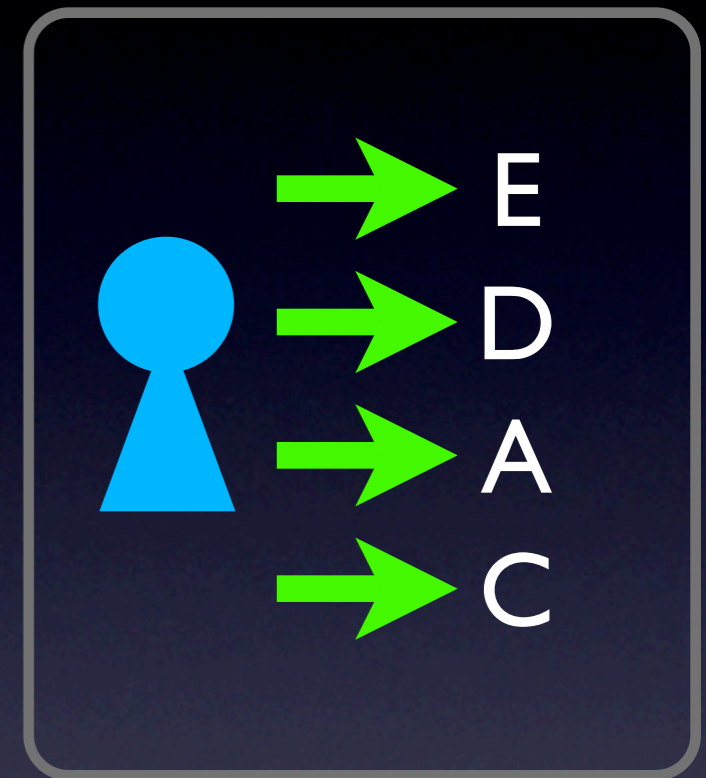
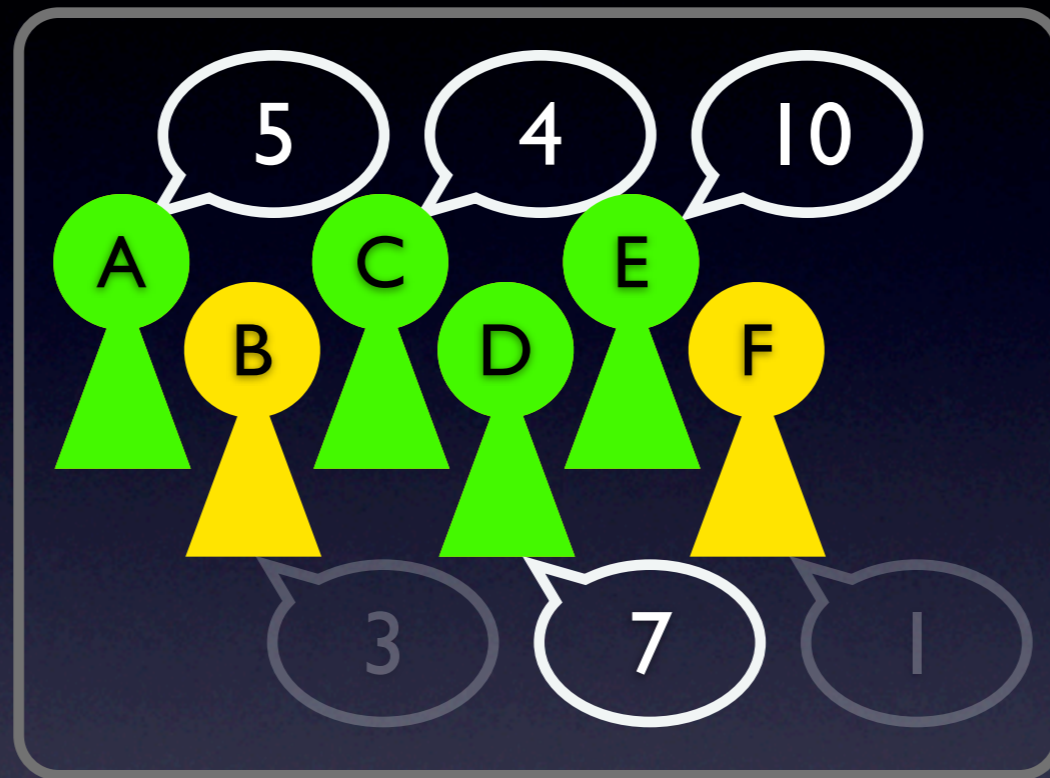
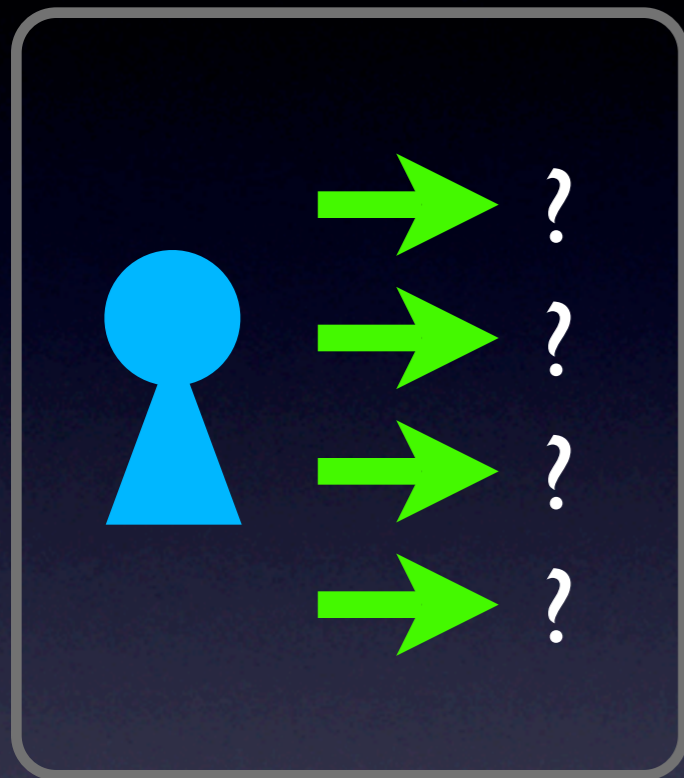


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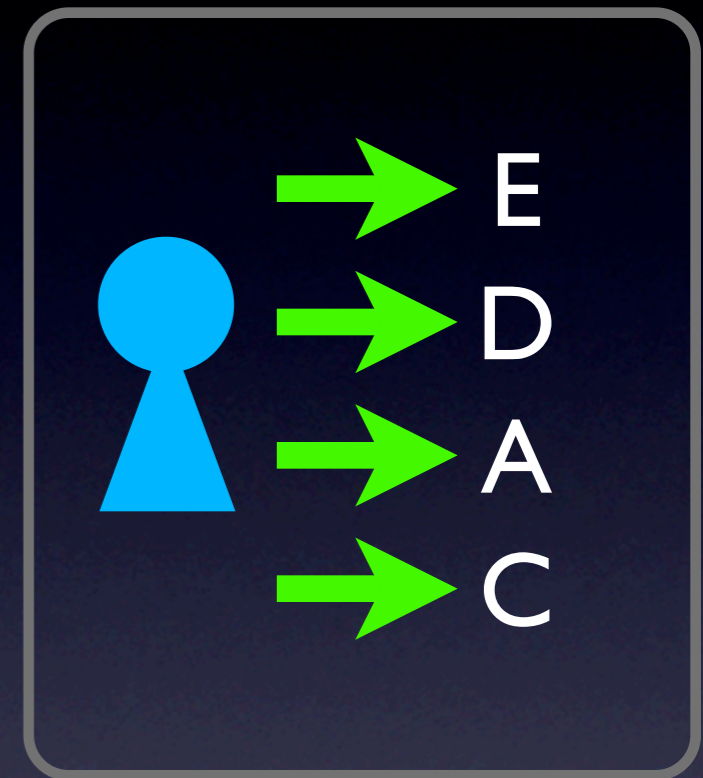
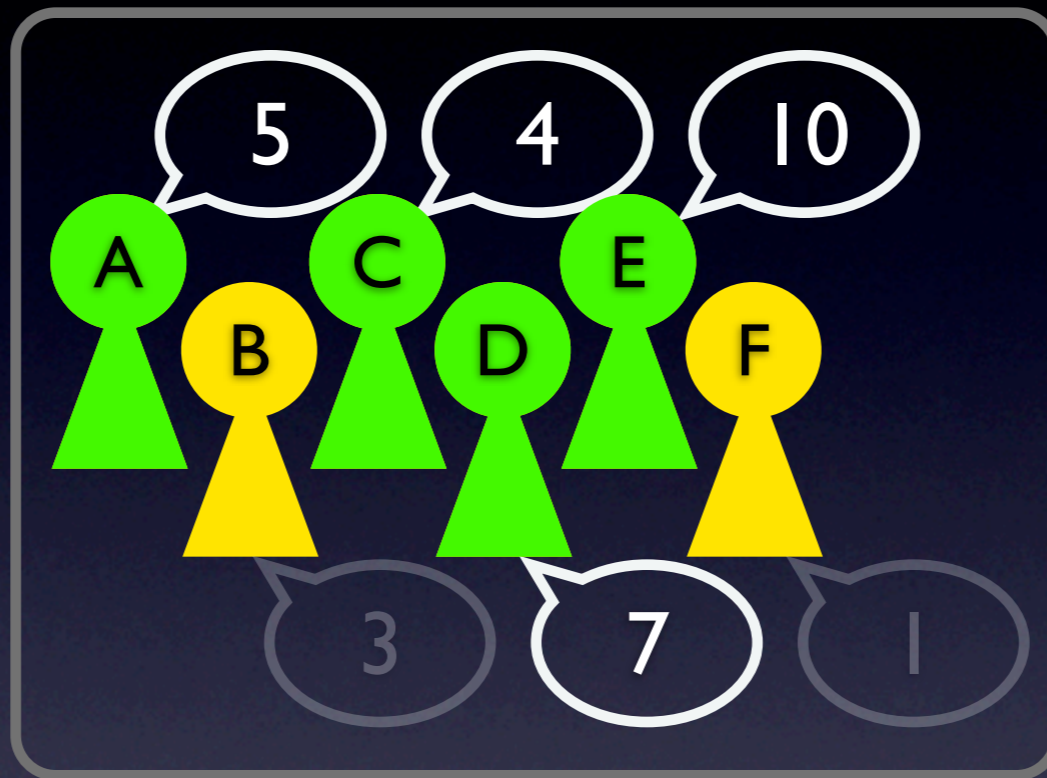
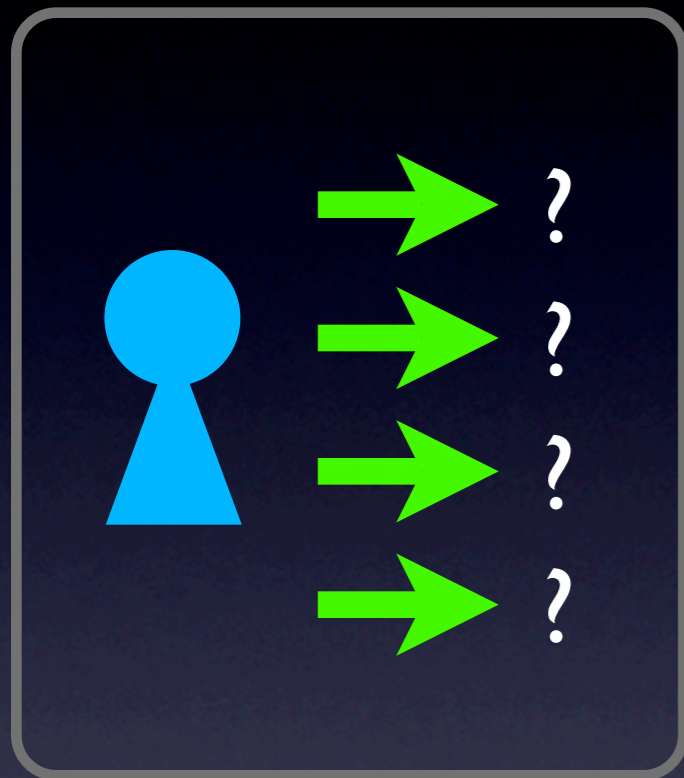


Fixed number of equal goods

Bids are prior round's uploads

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BitTorrent is an Auction

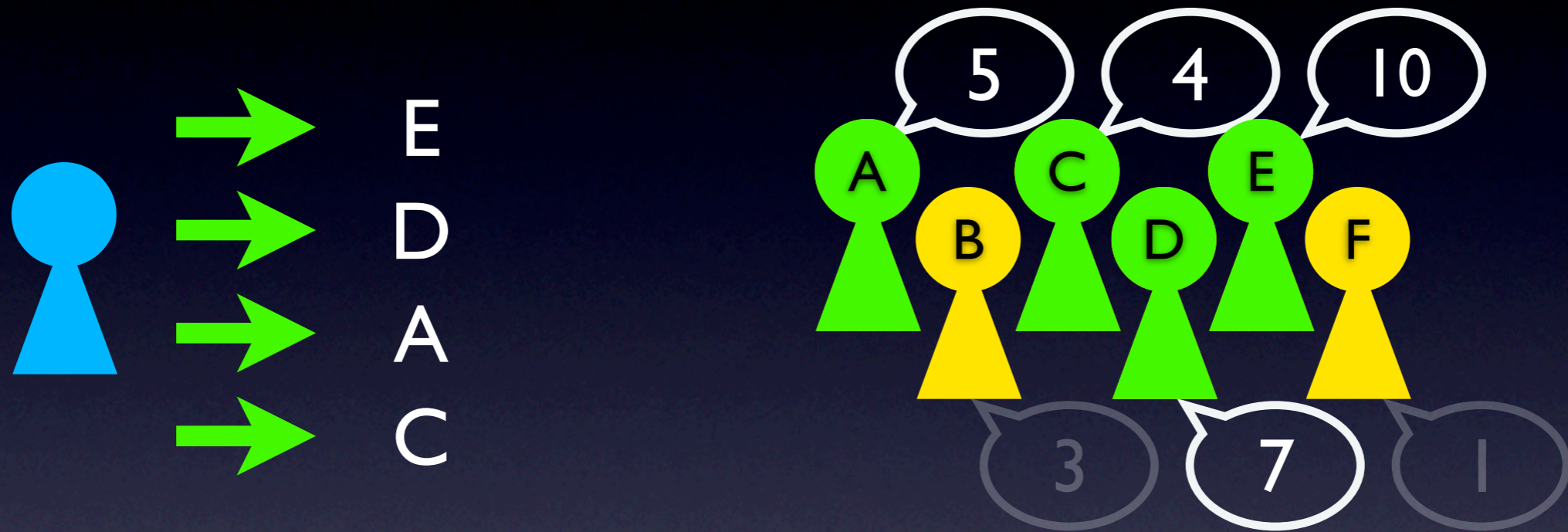


Fixed number of equal goods

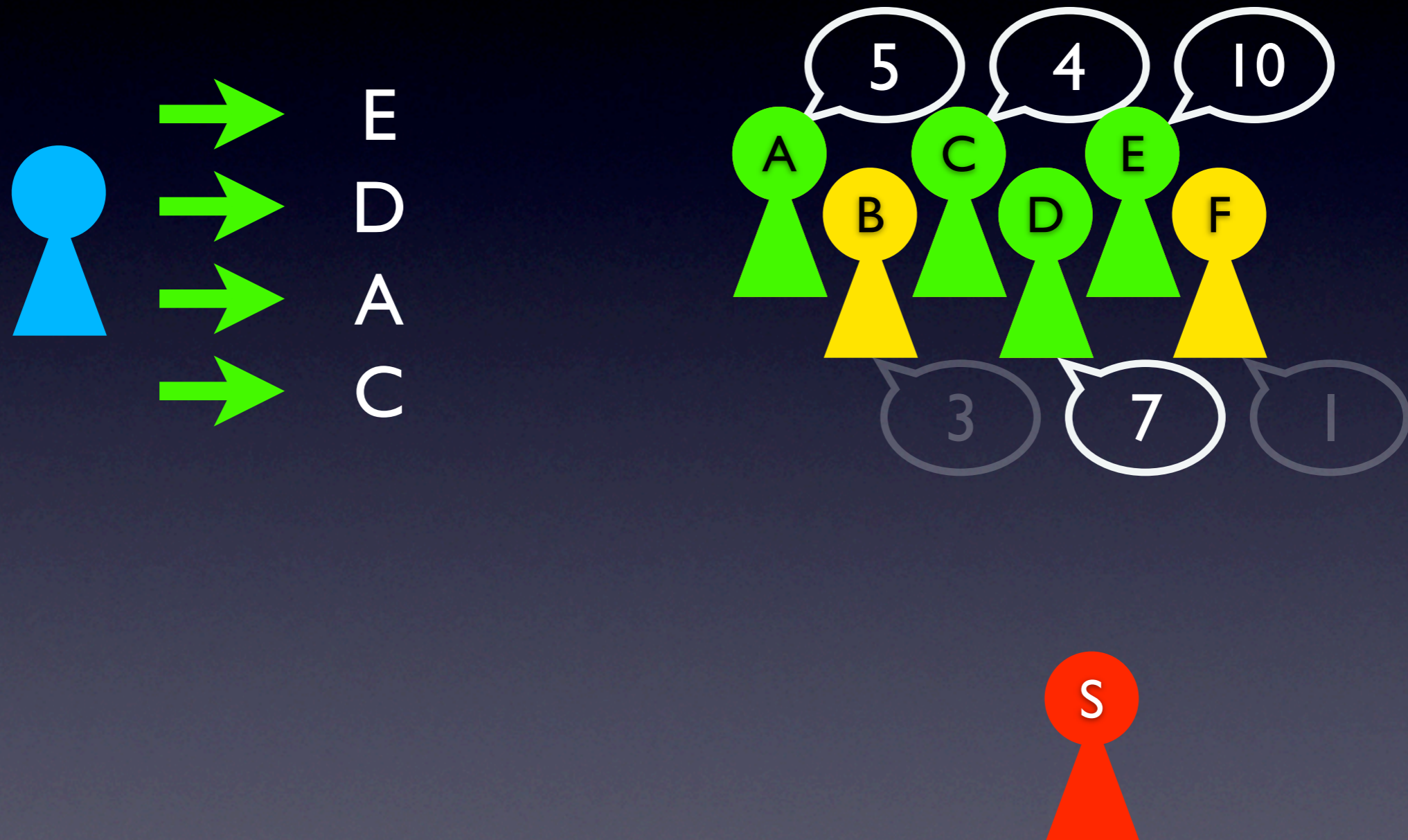
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Auction clearing is "top 4"

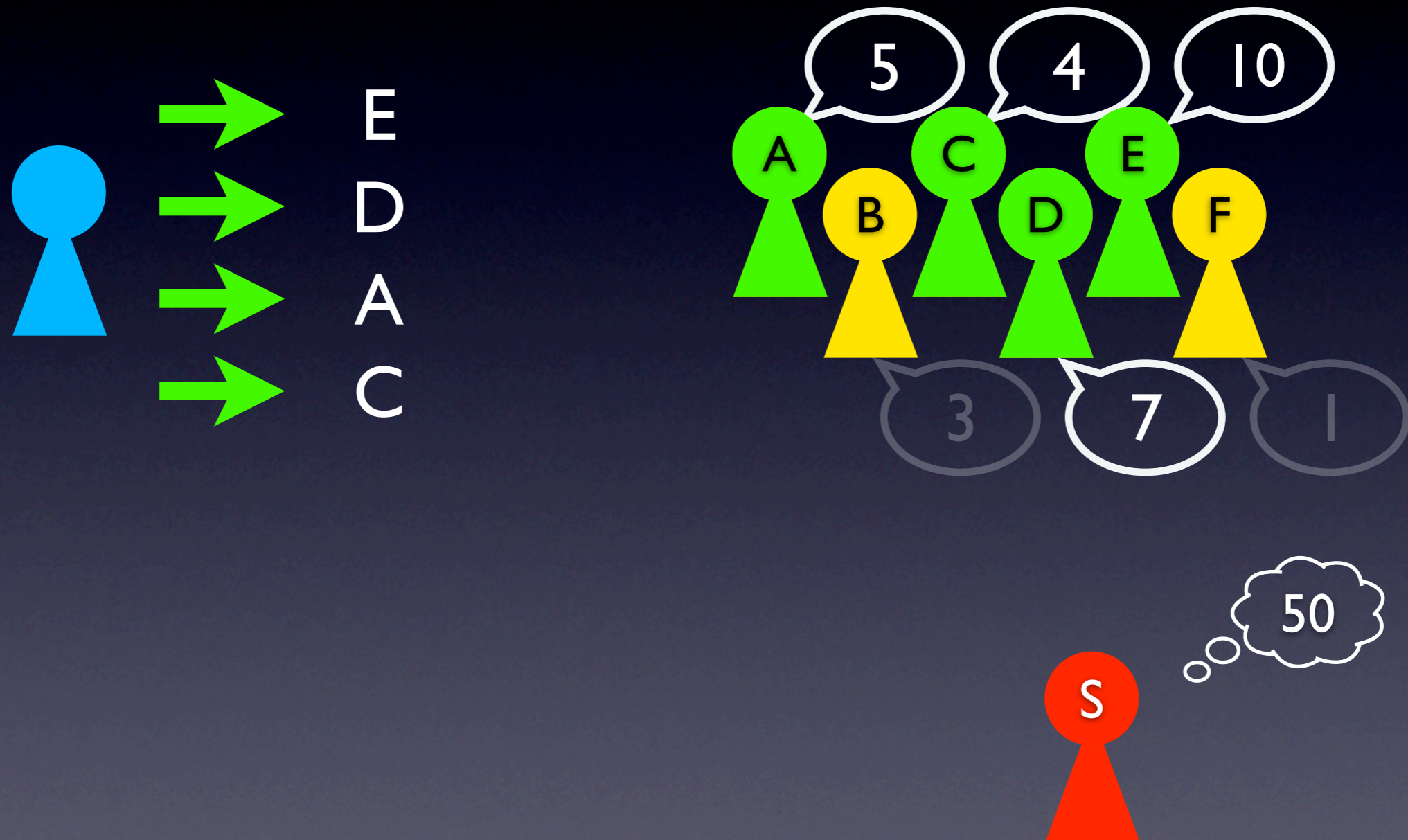
Gaming BitTorrent's Auction



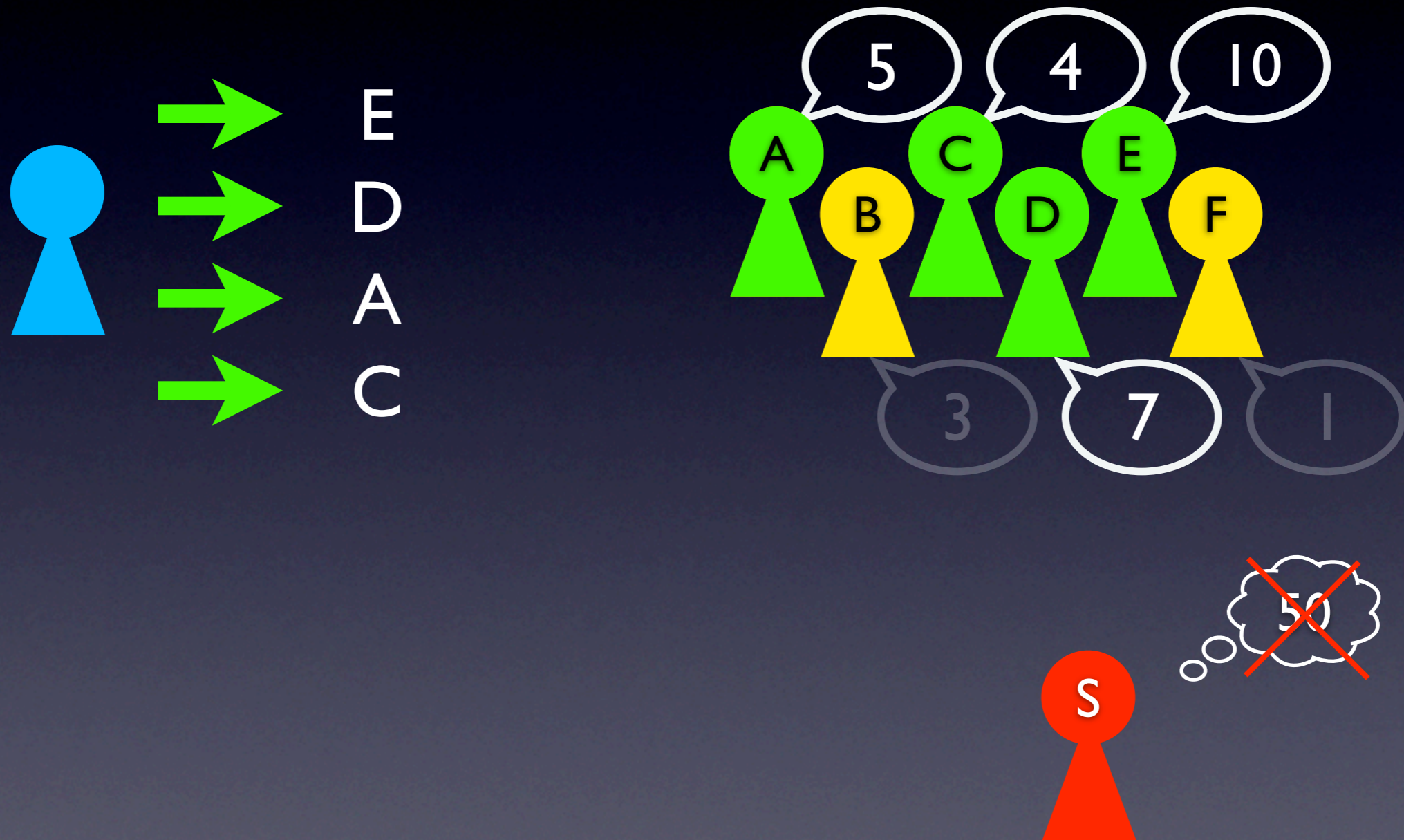
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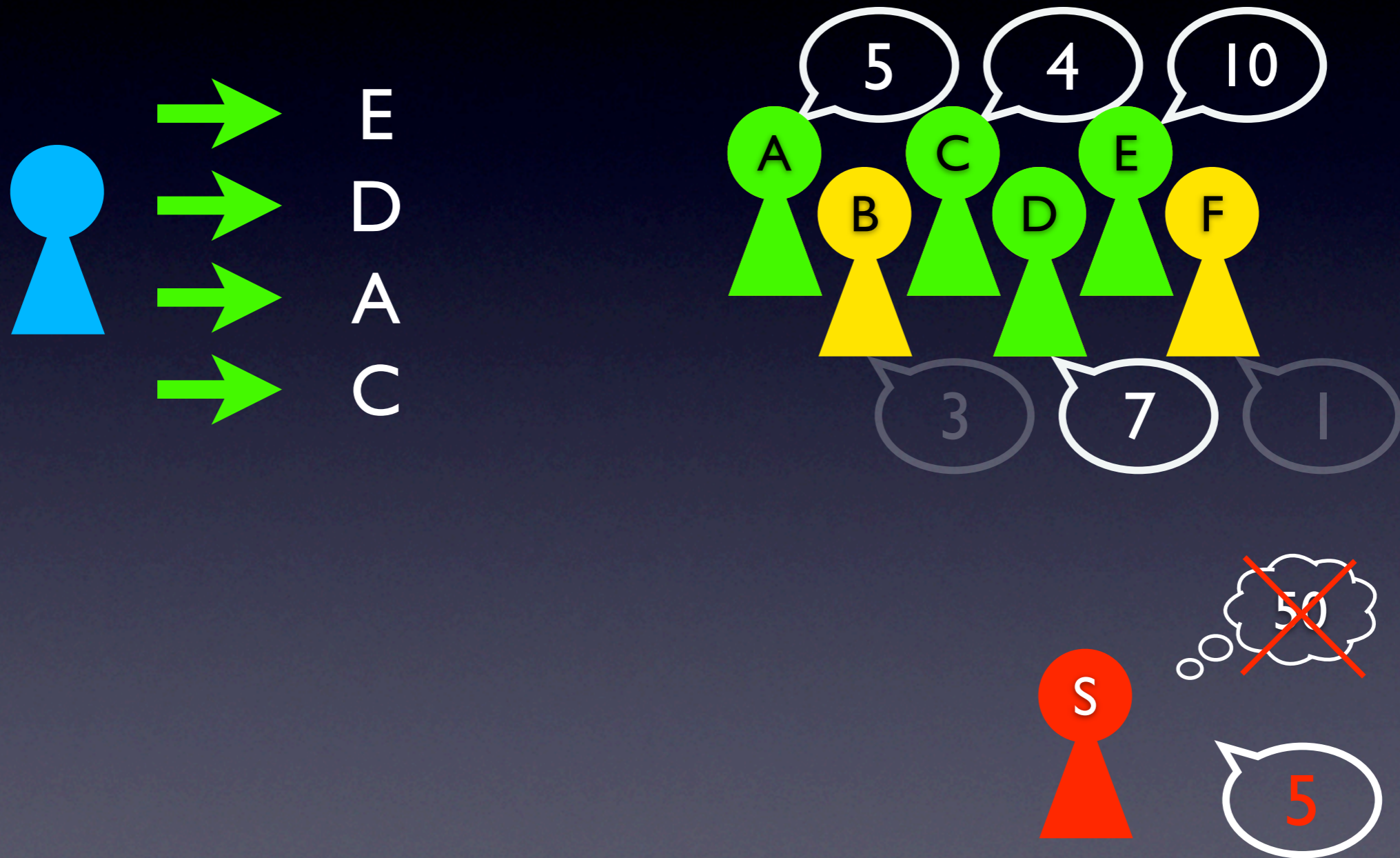
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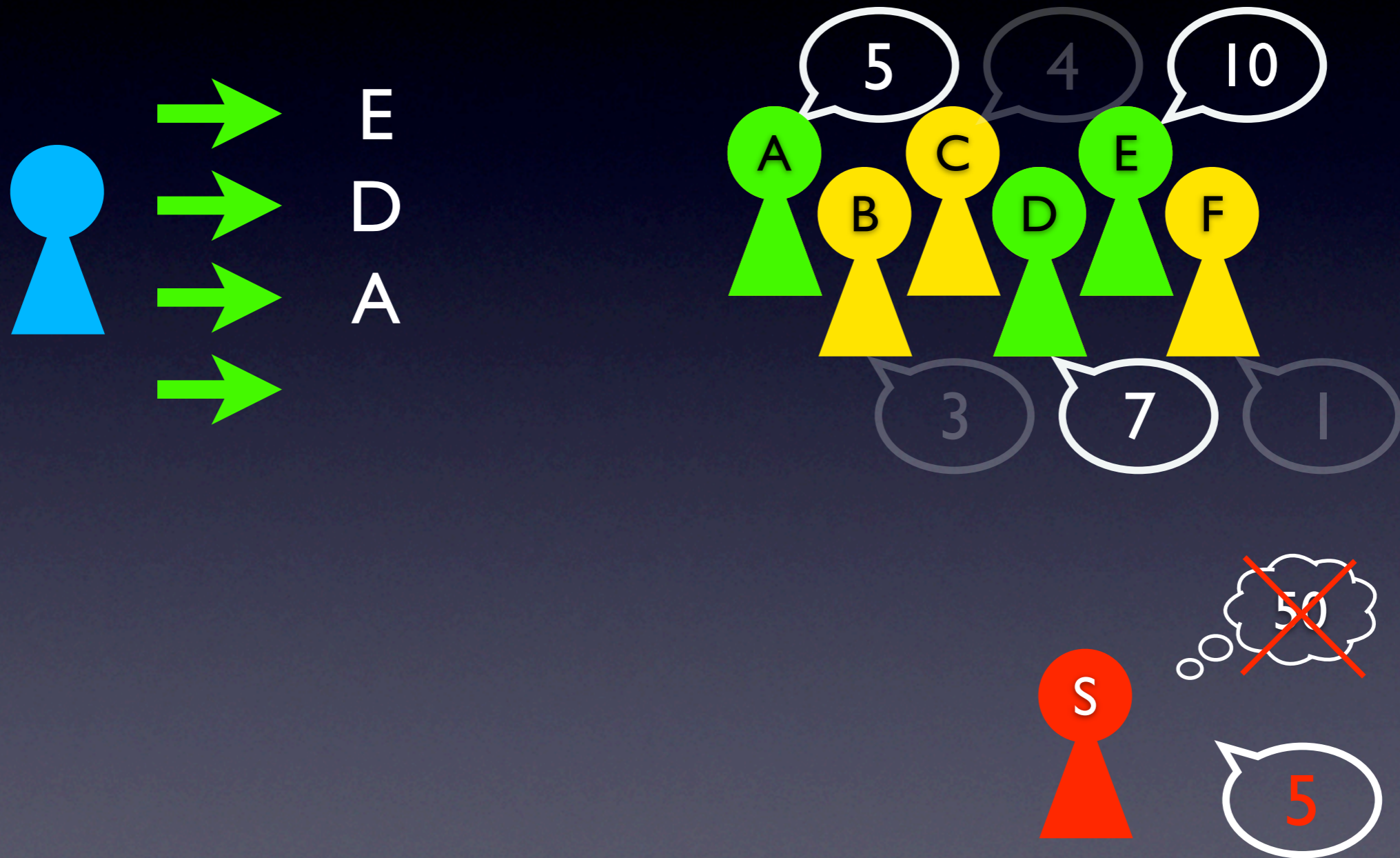
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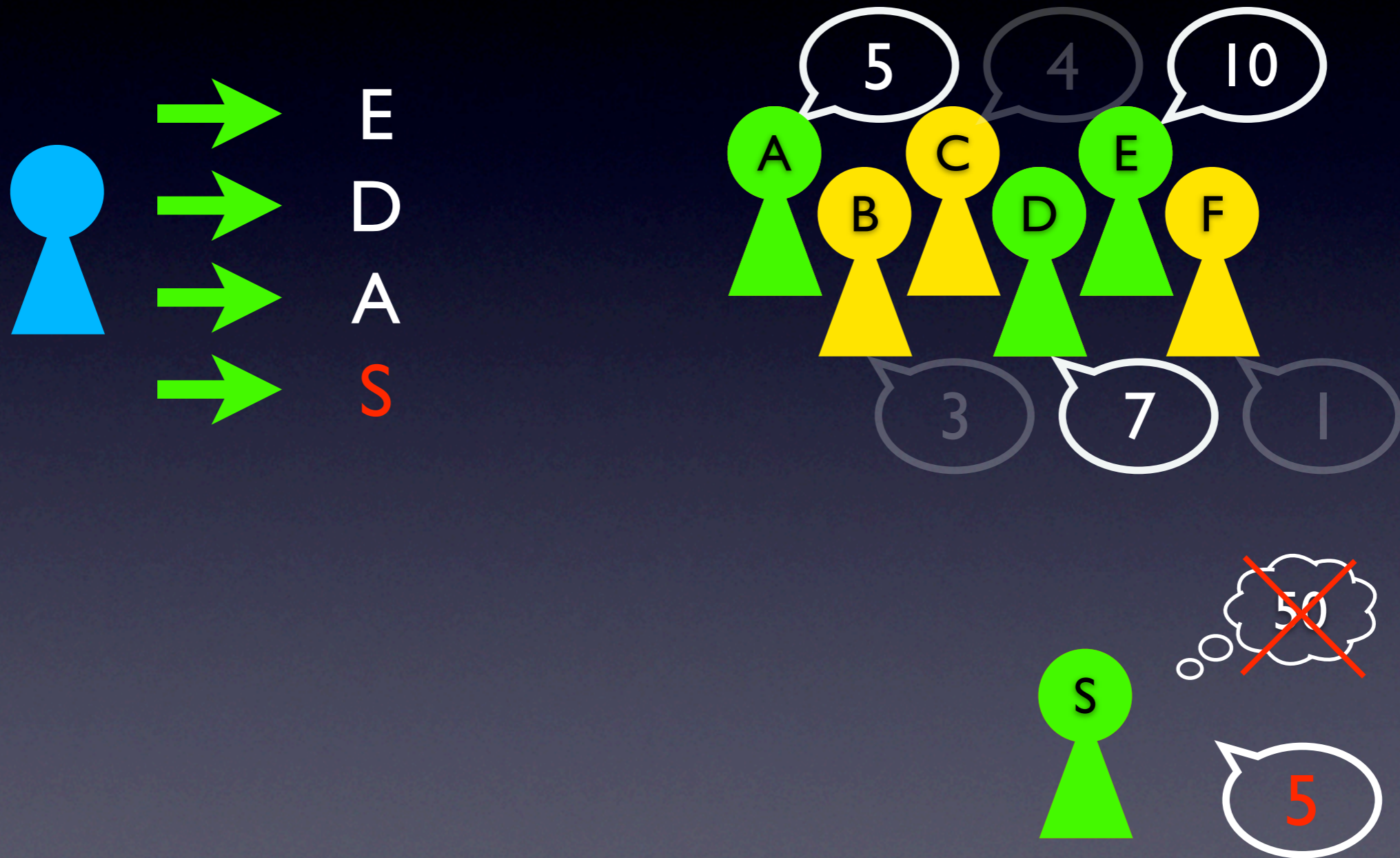
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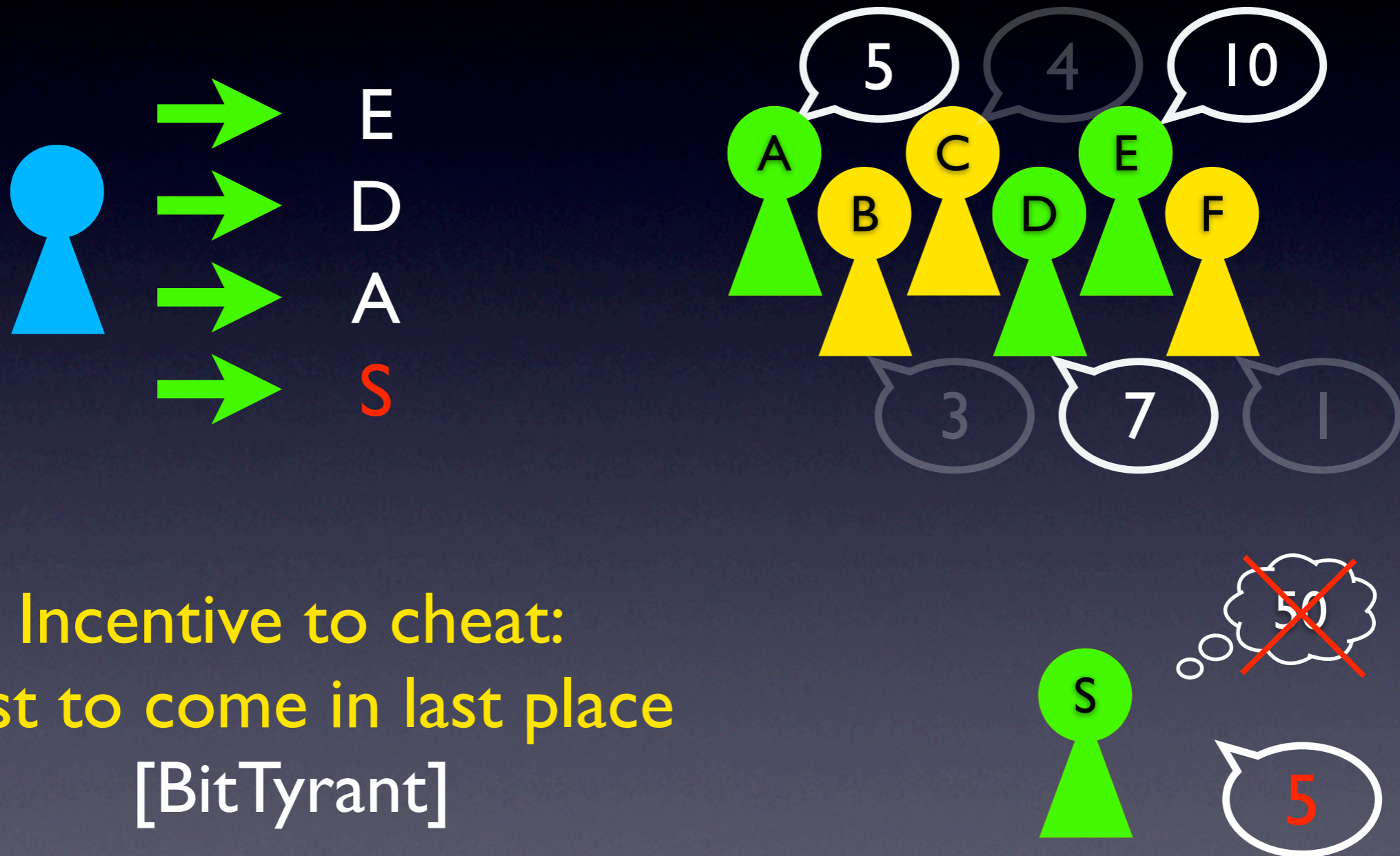
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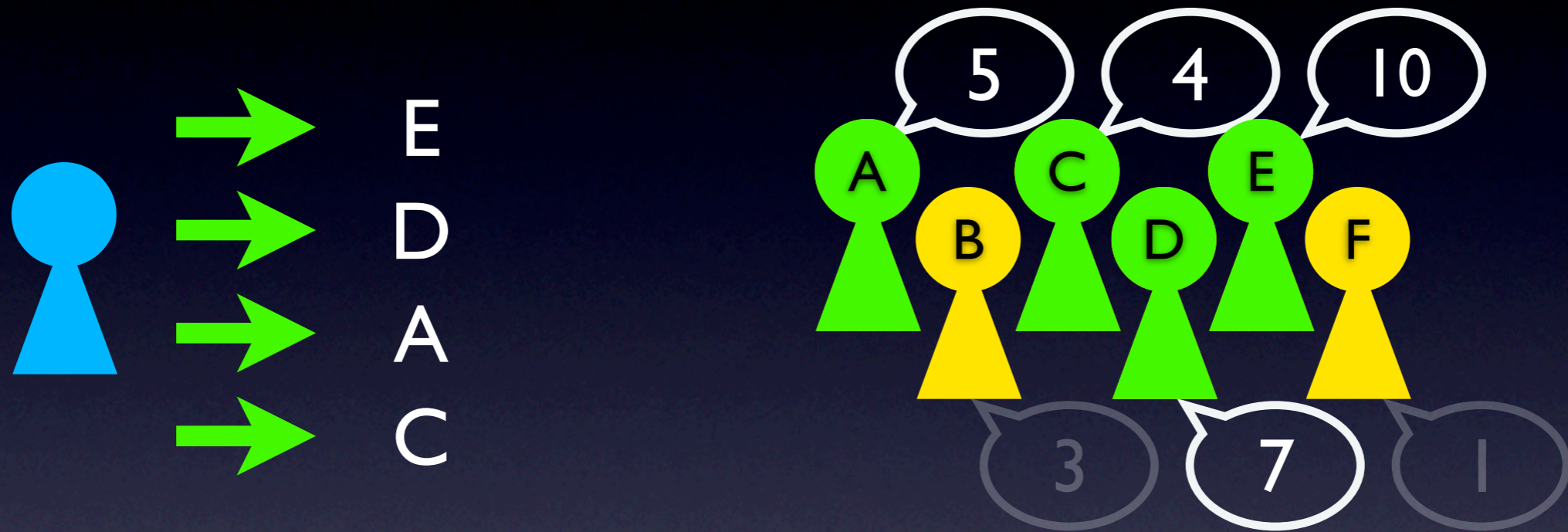
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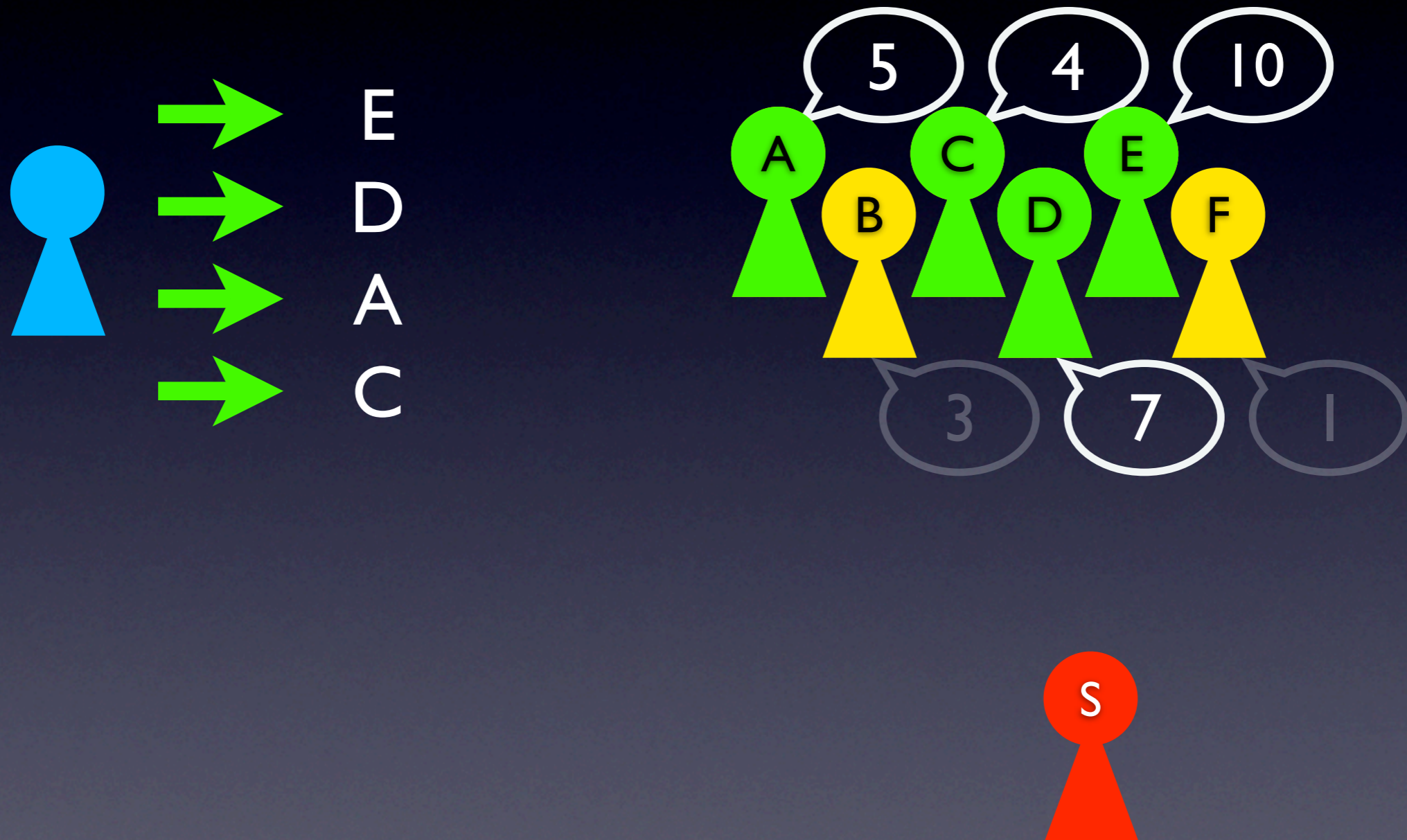
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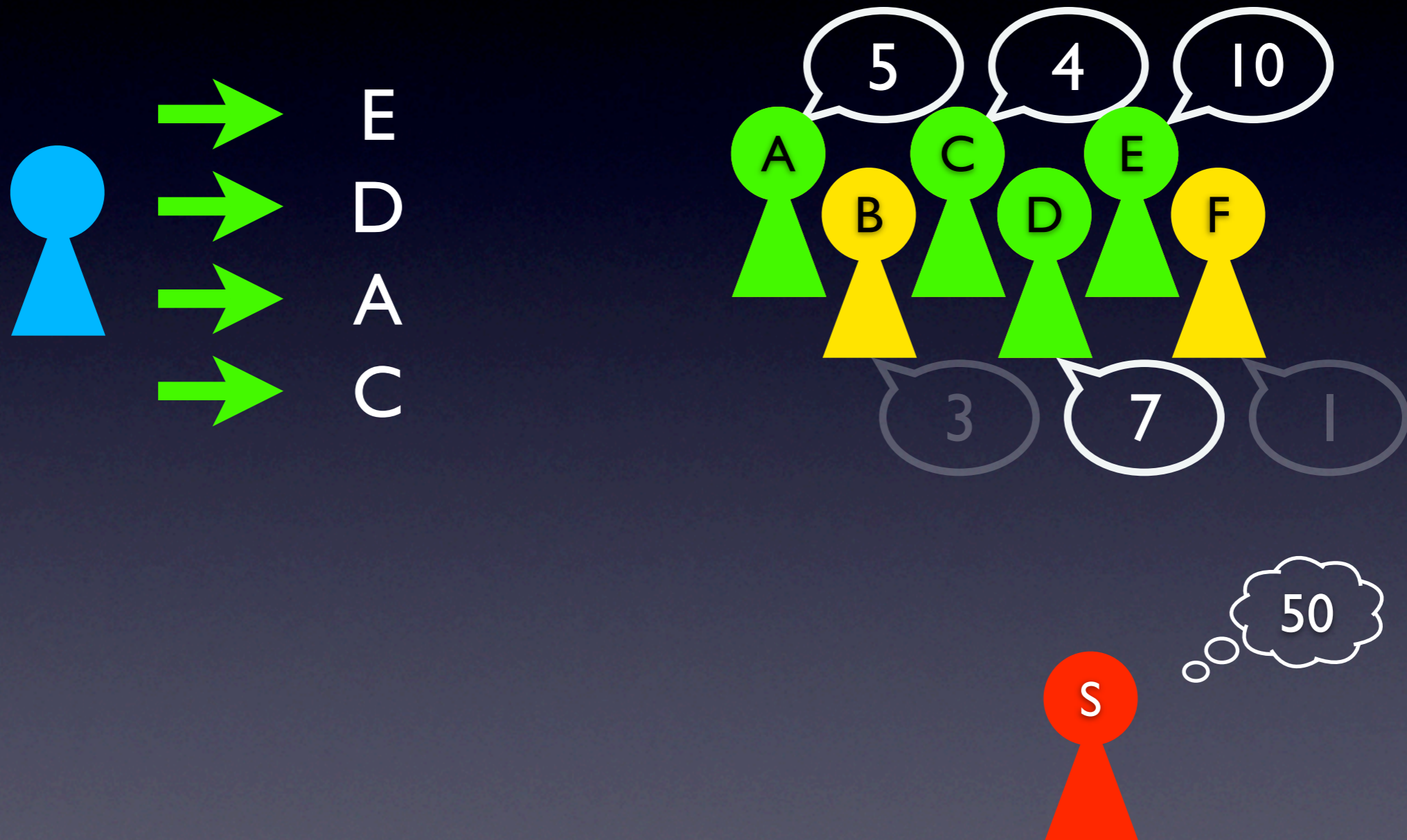
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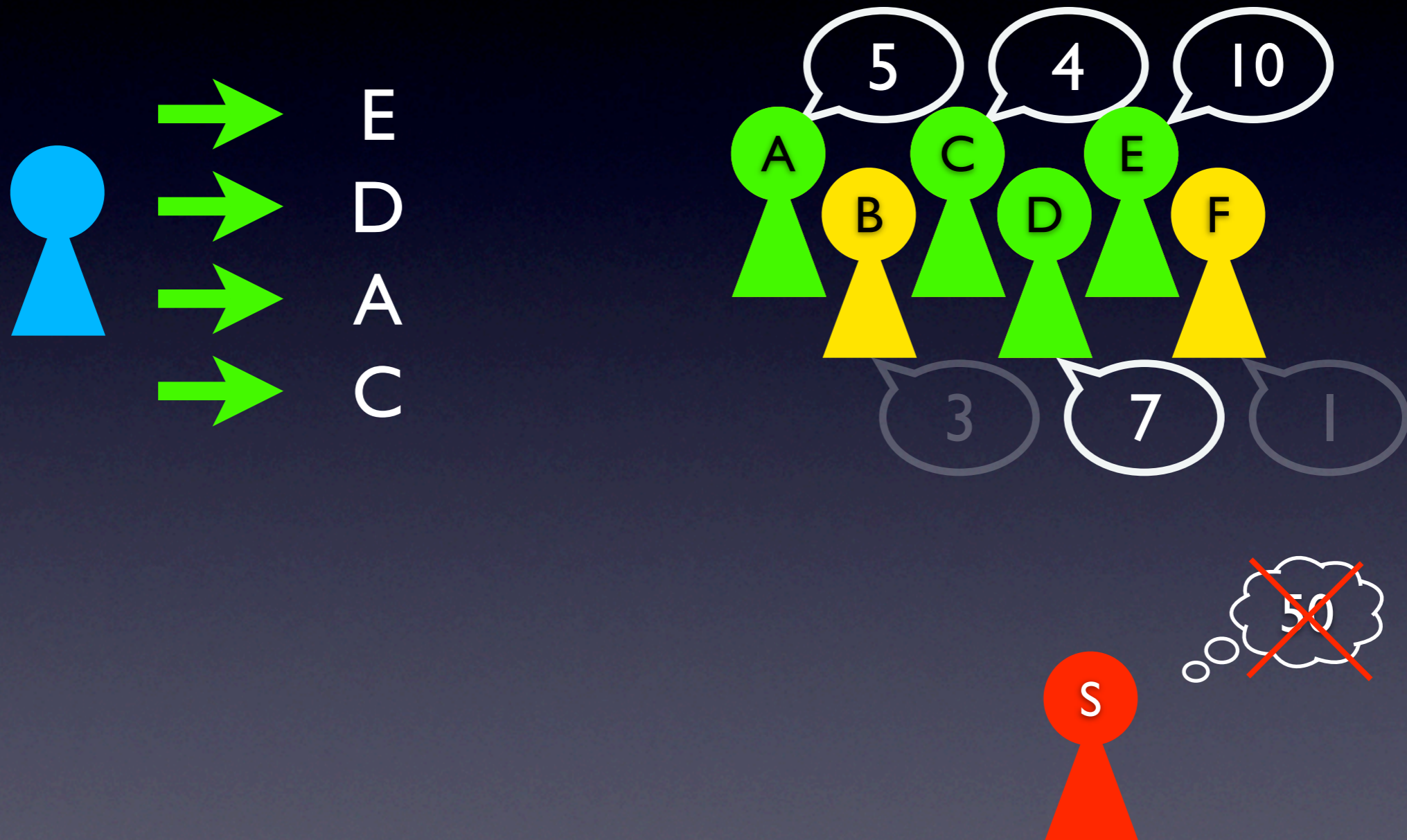
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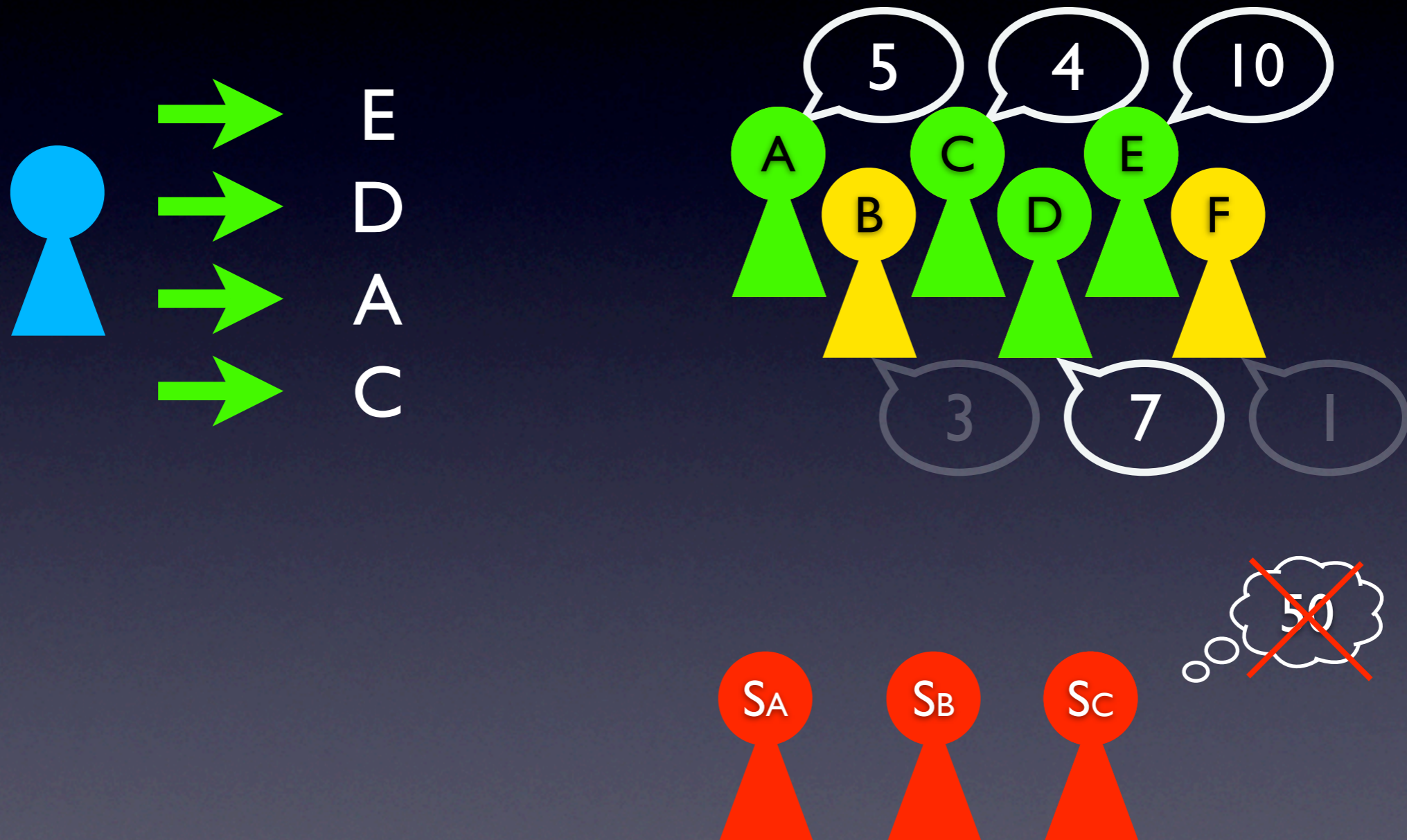
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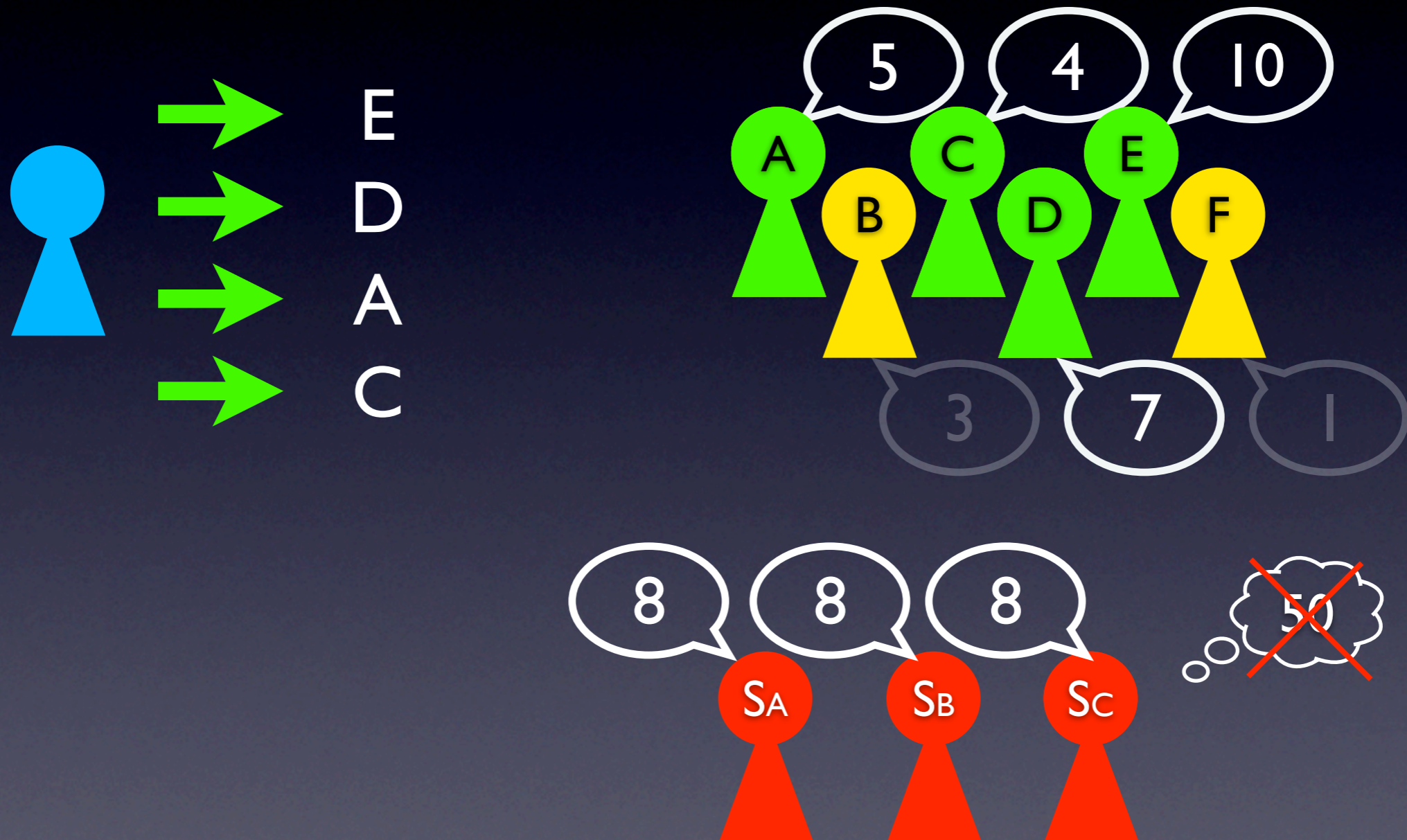
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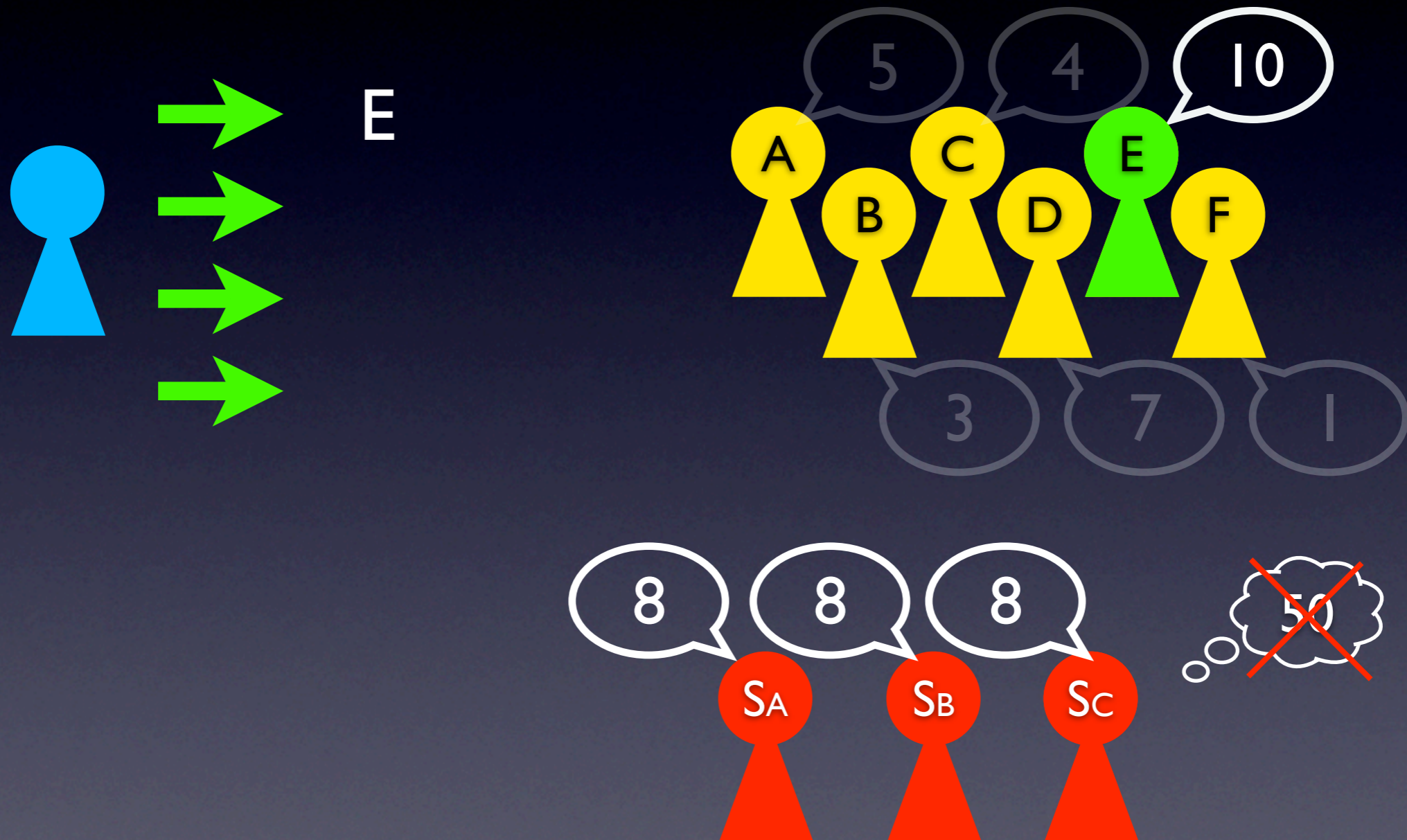
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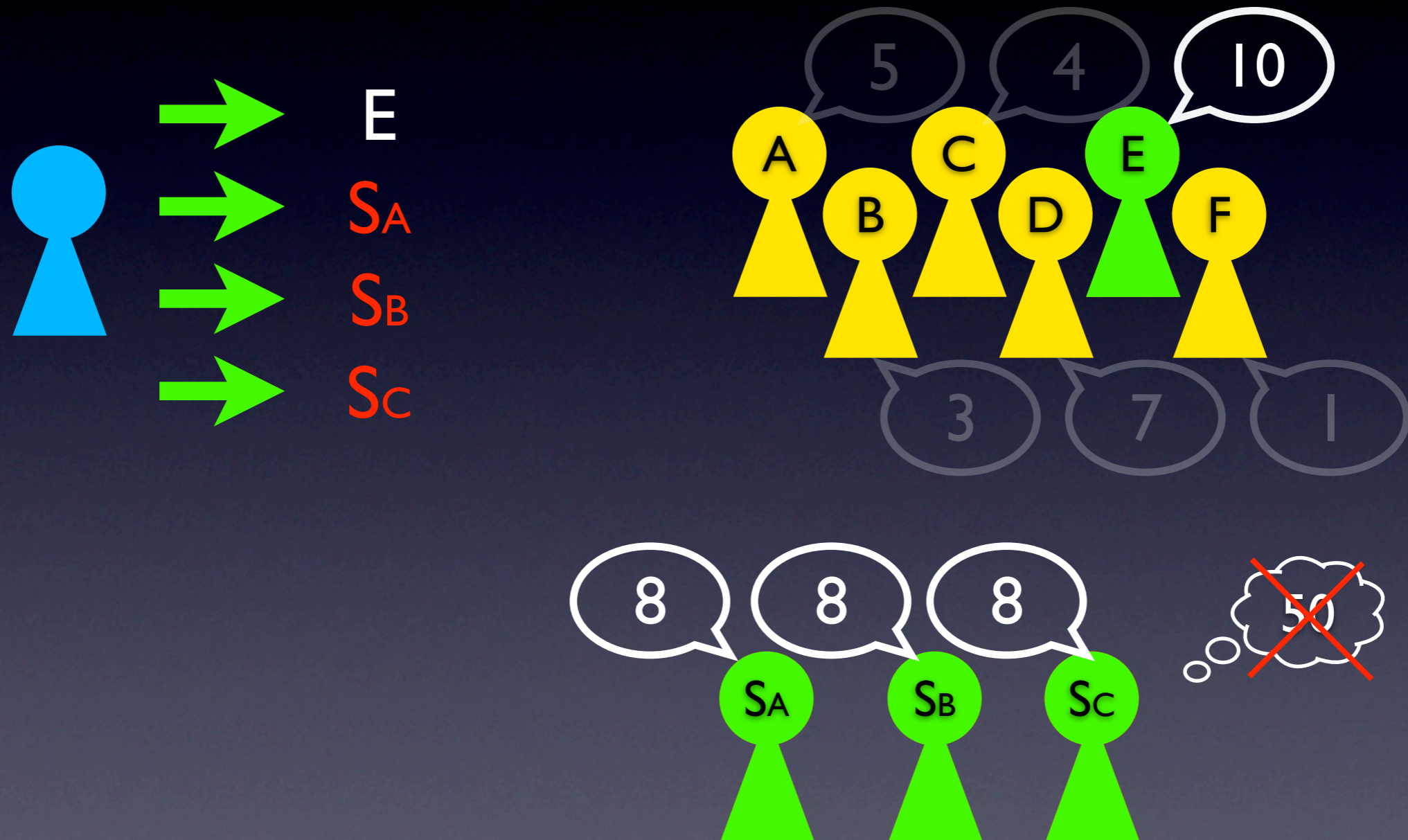
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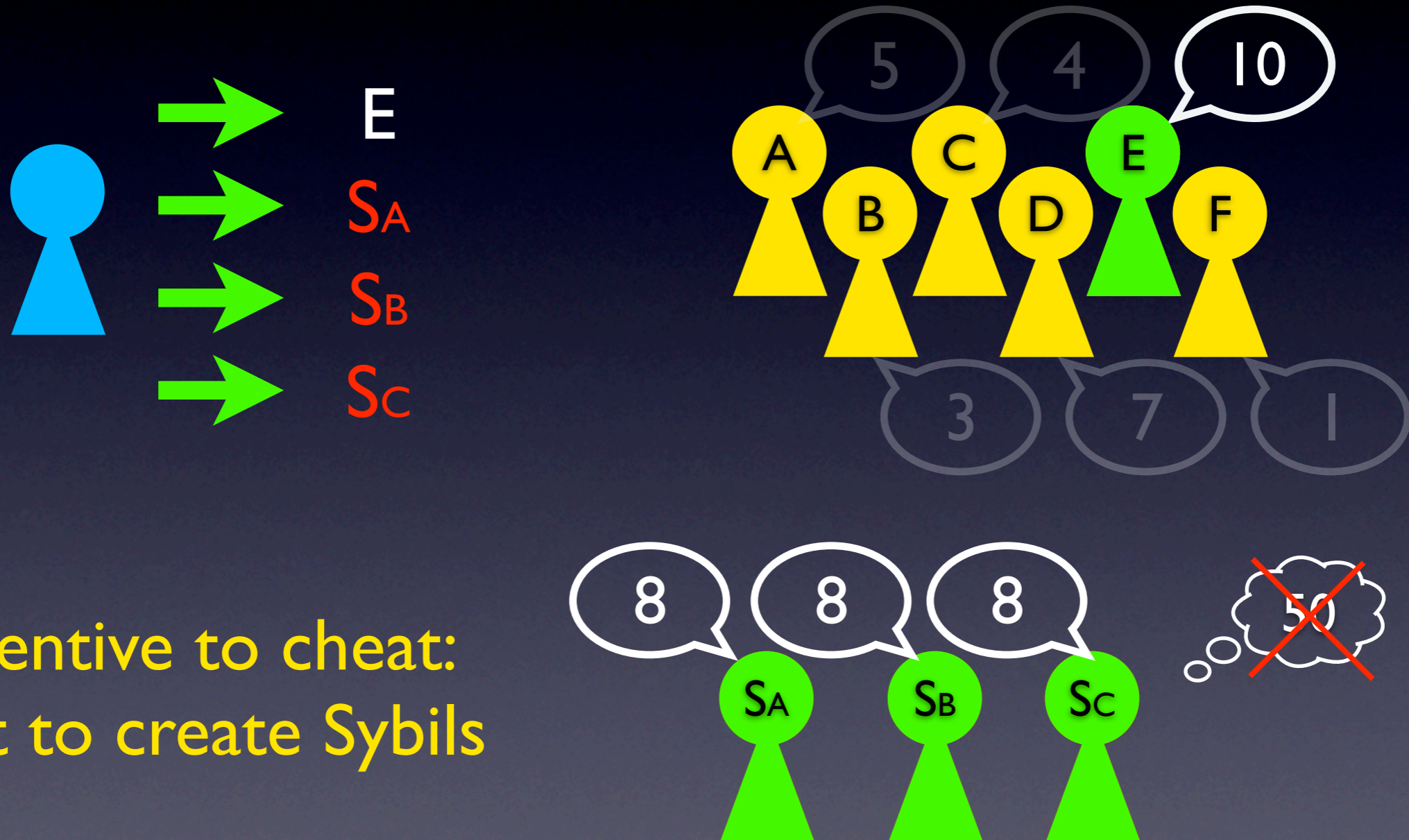
Gaming BitTorrent's Auction



Gaming BitTorrent's Auction



Gaming BitTorrent's Auction



Incentive to cheat:
Best to create Sybils

Gaming BitTorrent's Auction


Truthful bidding

50 = 

Come in last place

5 = 

Sybil attack

24 = 

Proportional Share Auction

$$\text{Proportional Share} \sim \frac{\text{Amount he gave to me}}{\text{Total amount I received}}$$

Round t

Round t-1

Variable number of unequal goods

PropShare Properties



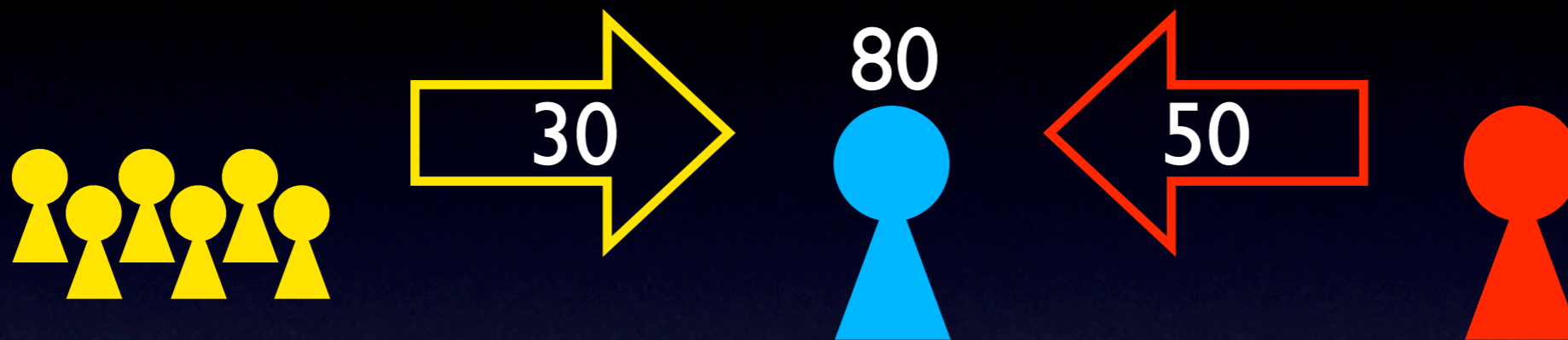
PropShare Properties



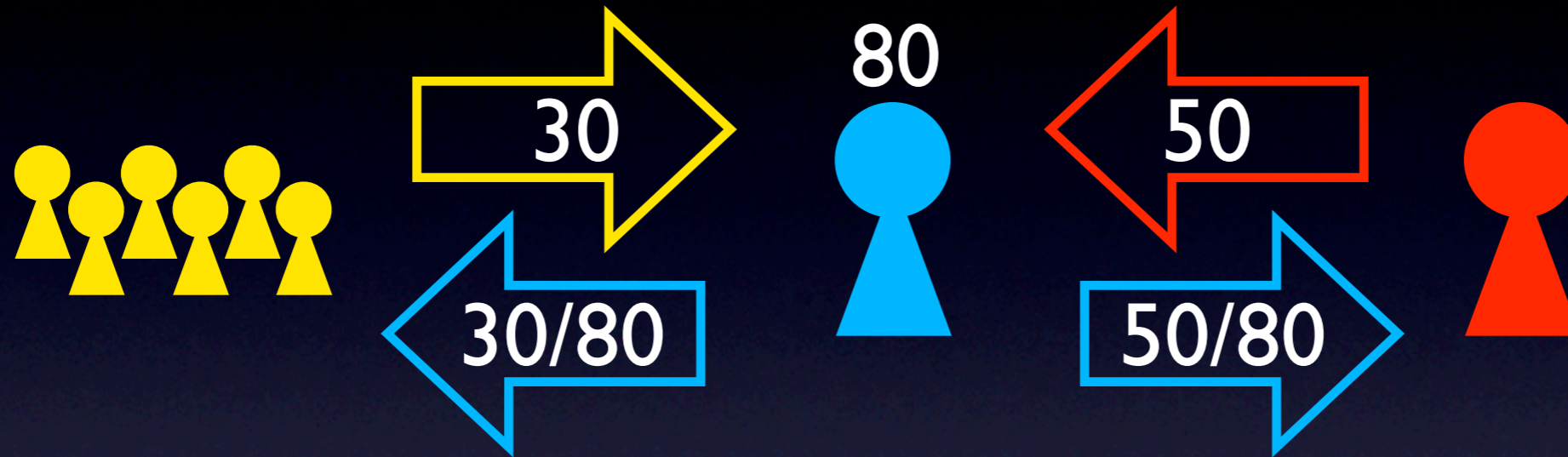
PropShare Properties



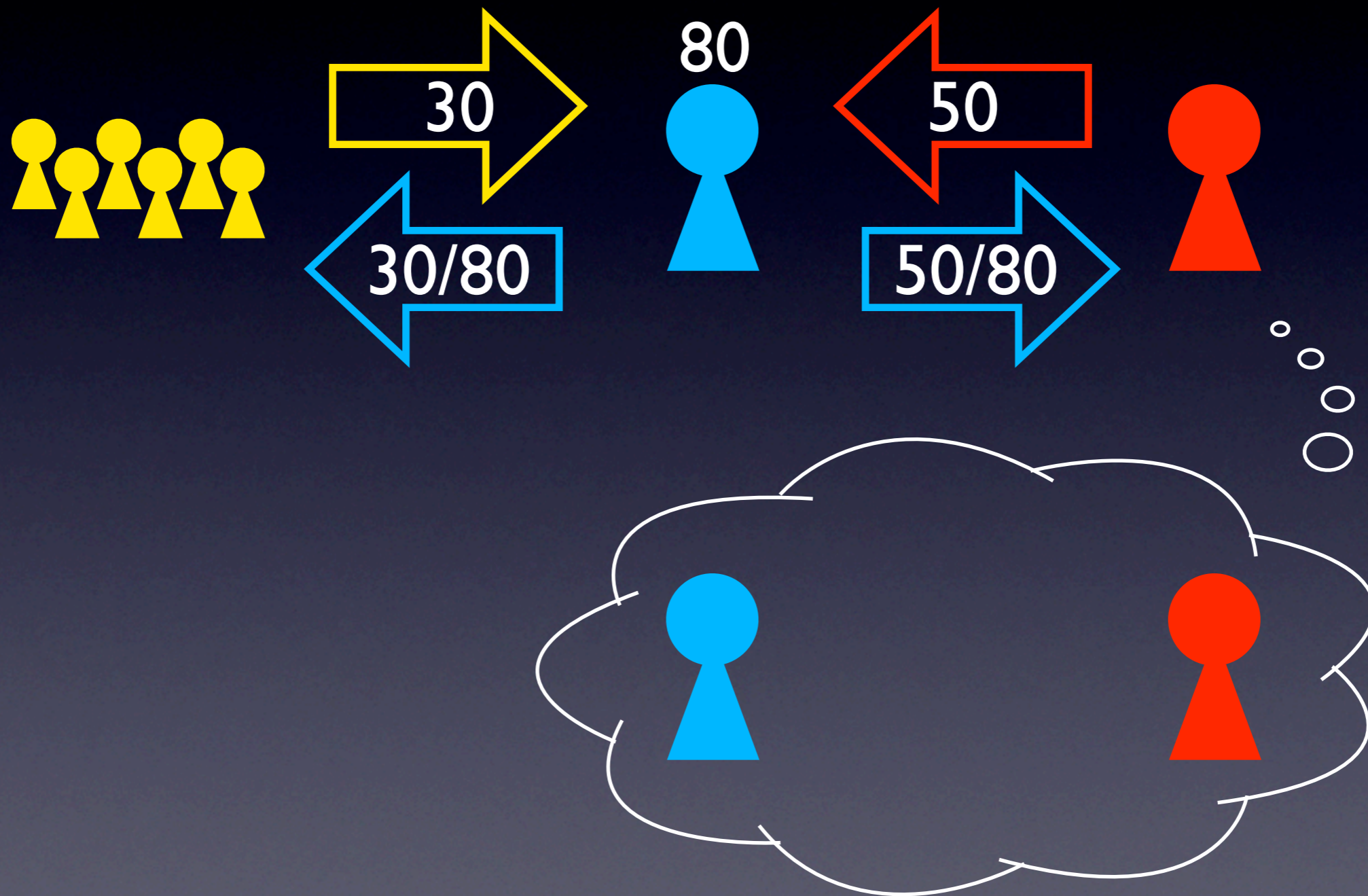
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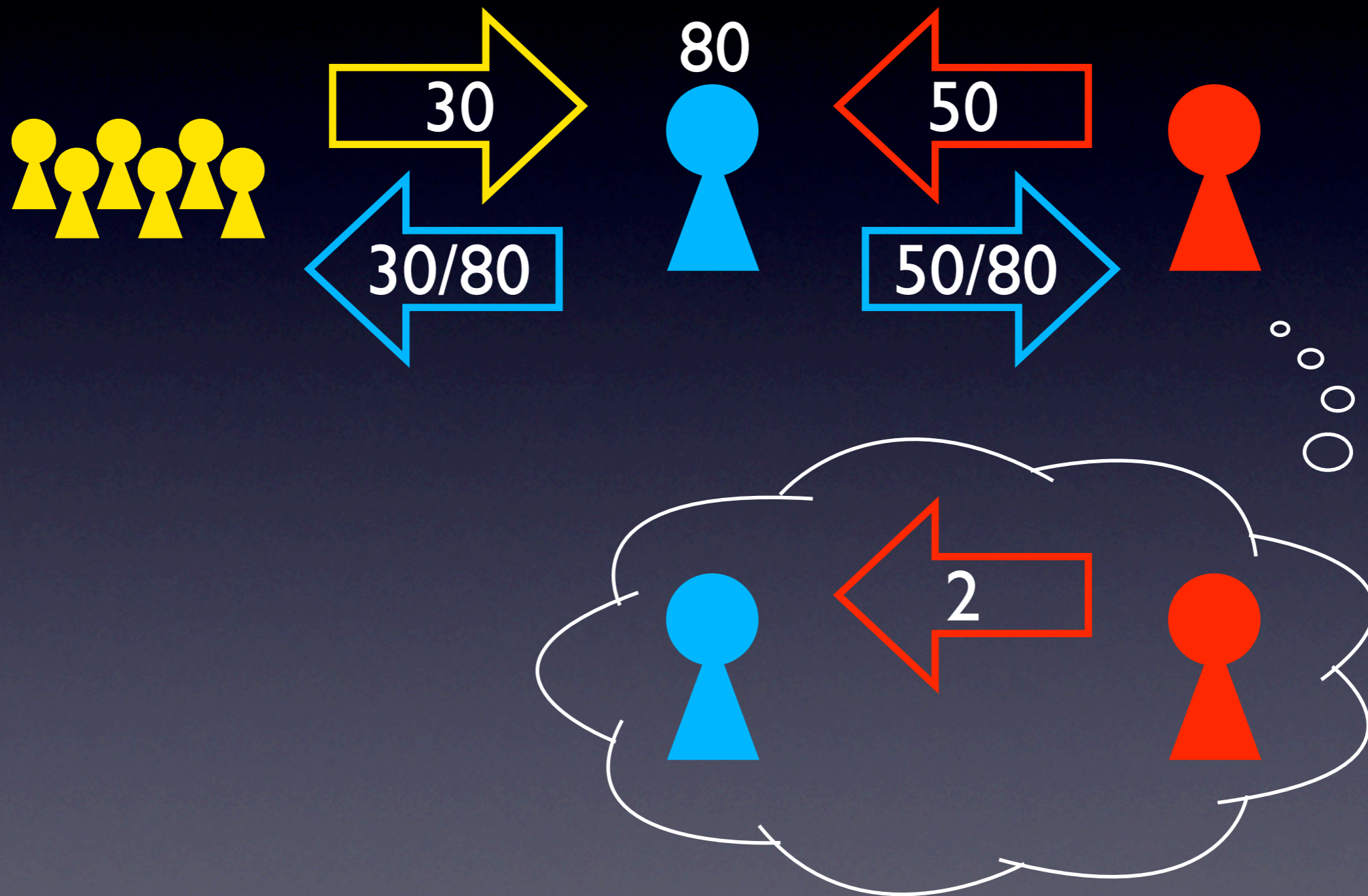
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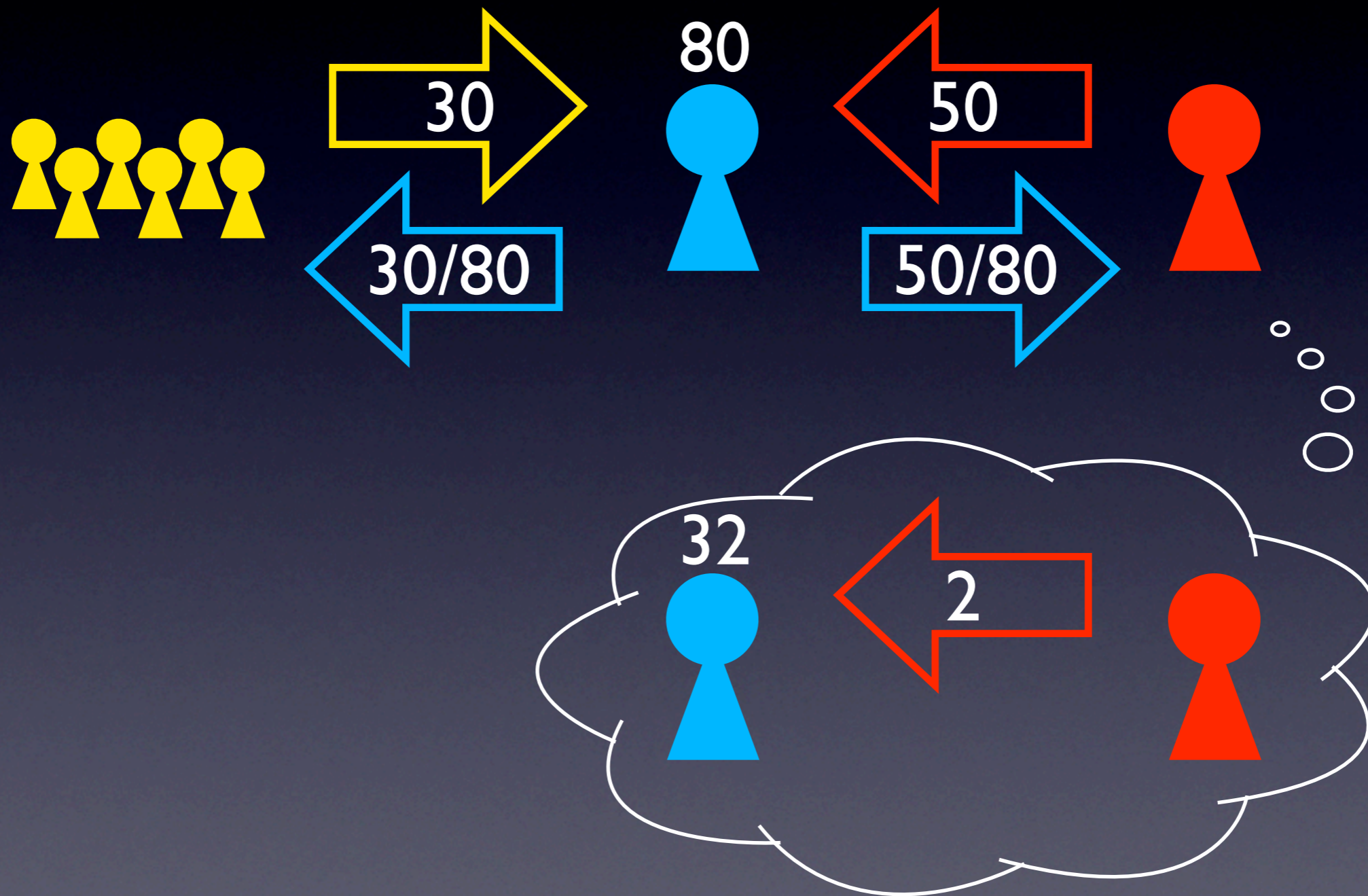
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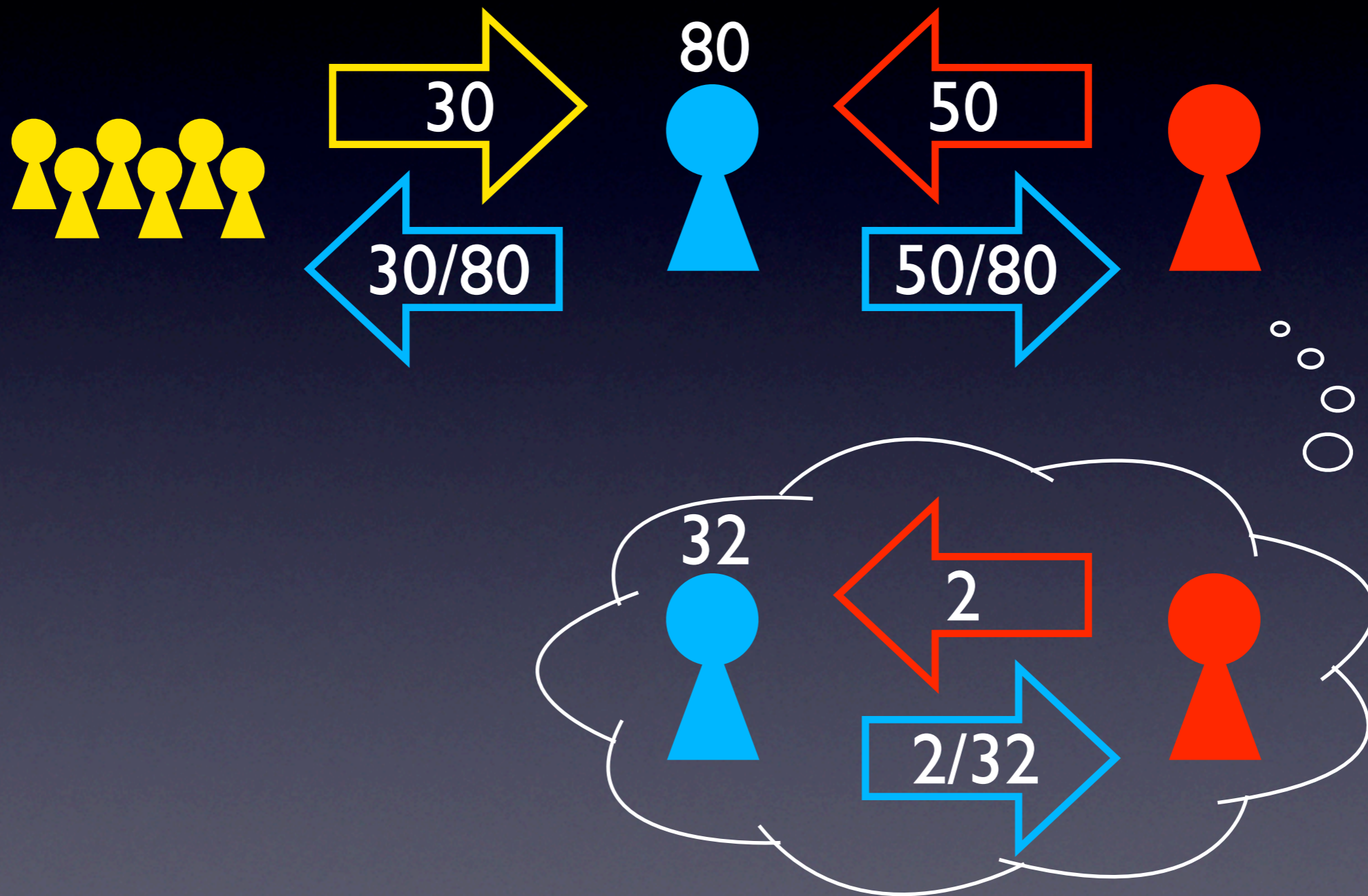
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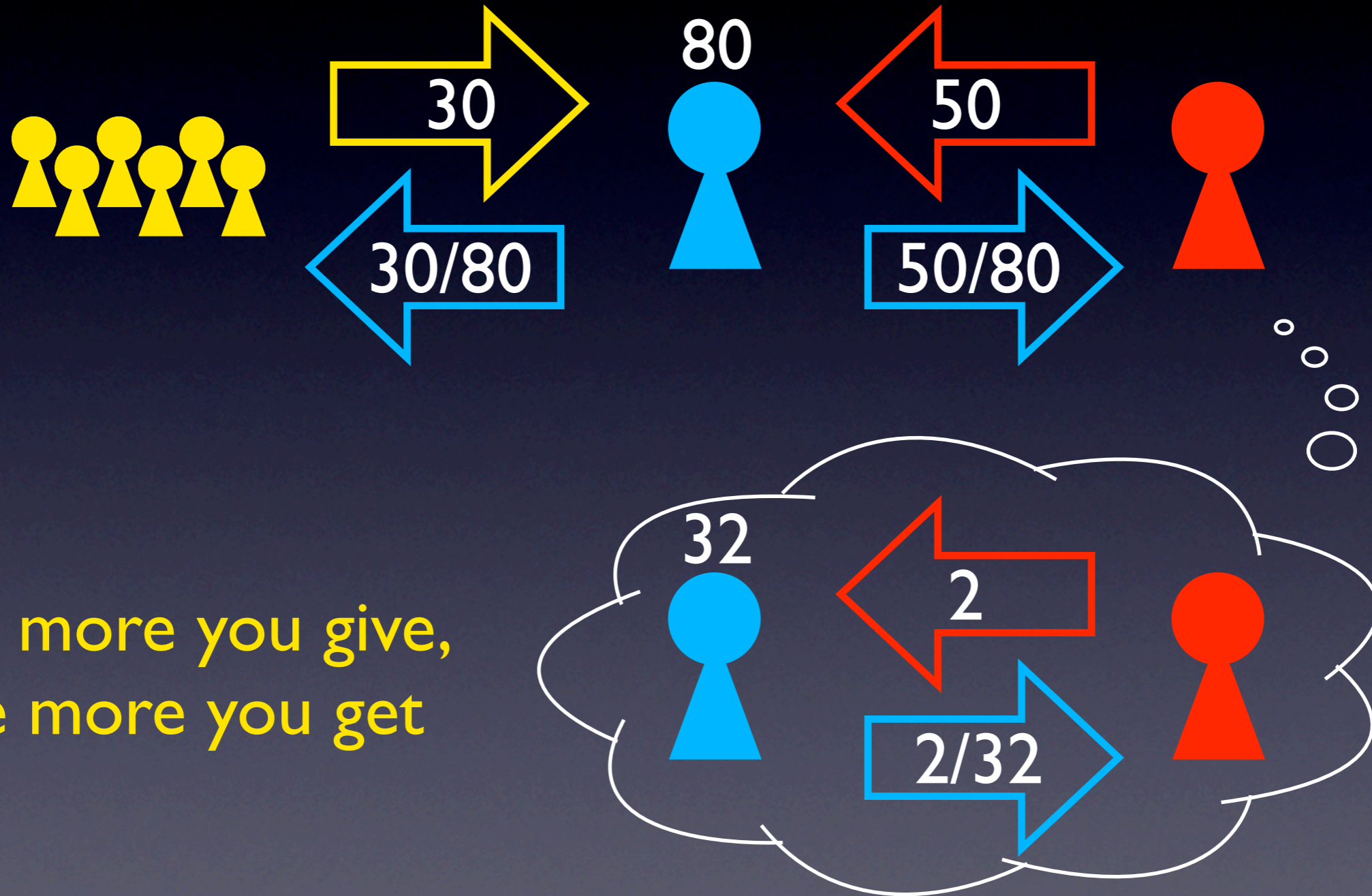
PropShare Properties



PropShare Properties



PropShare Properties



The more you give,
the more you get

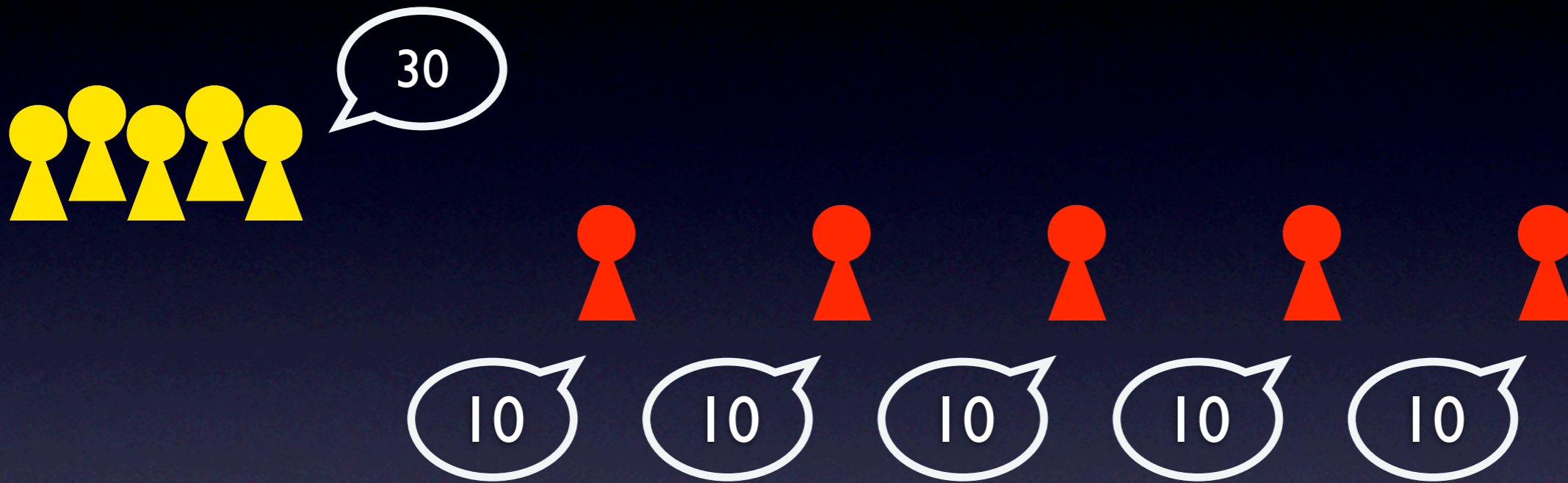
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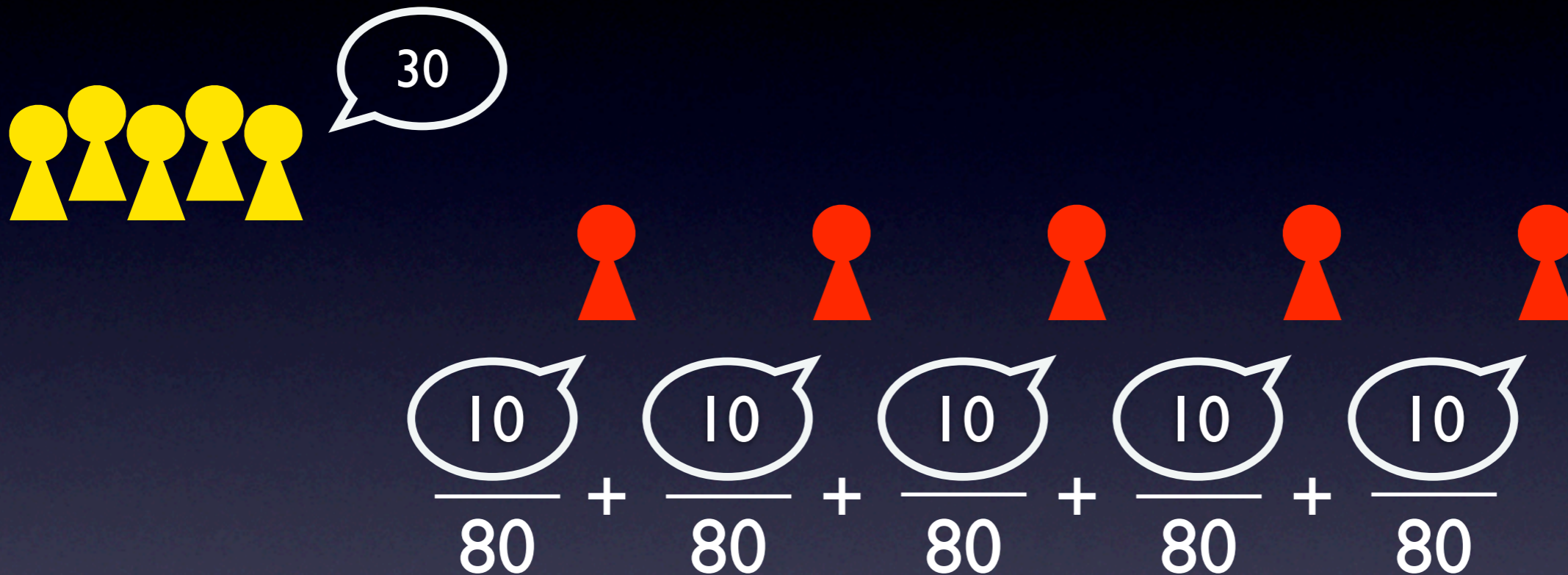
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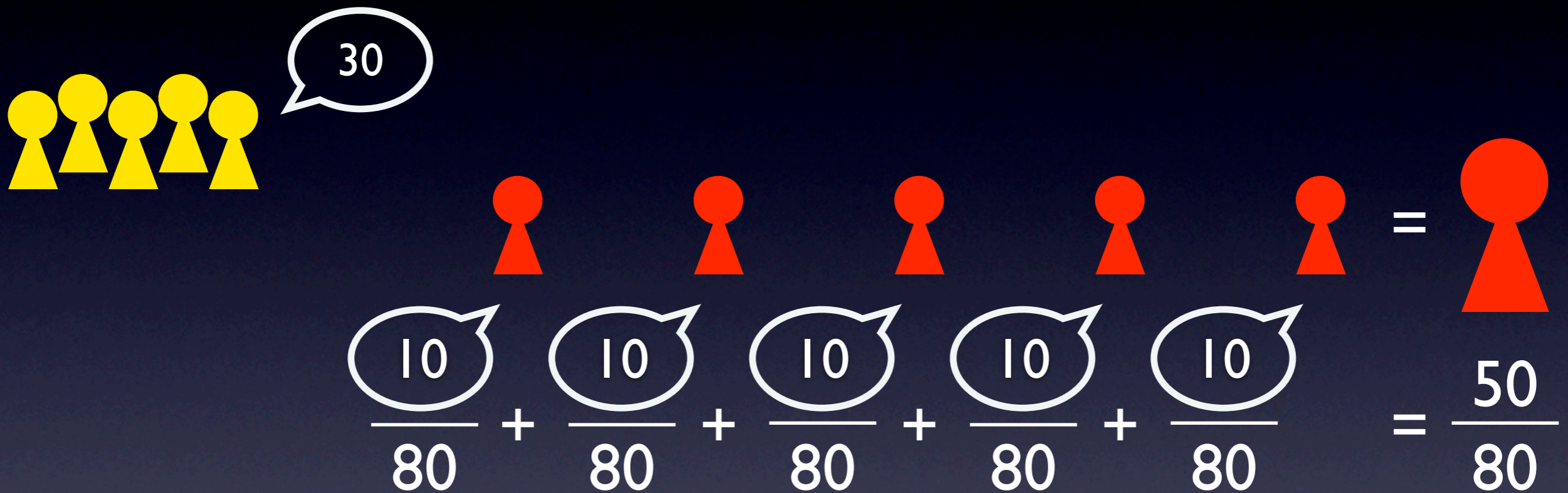
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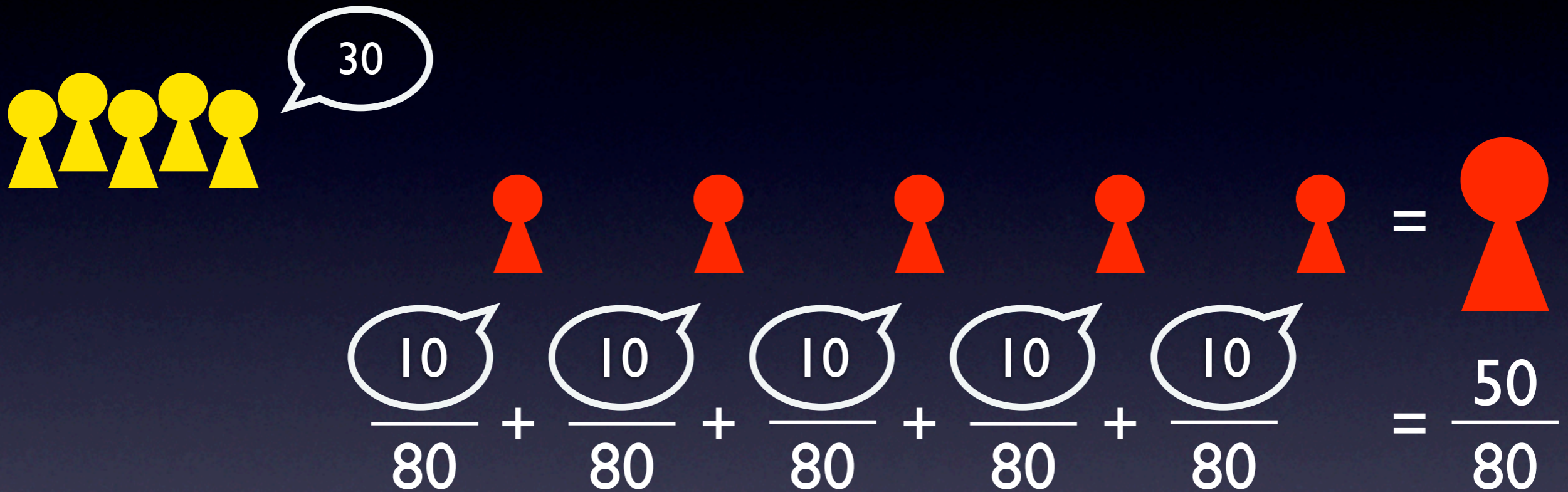
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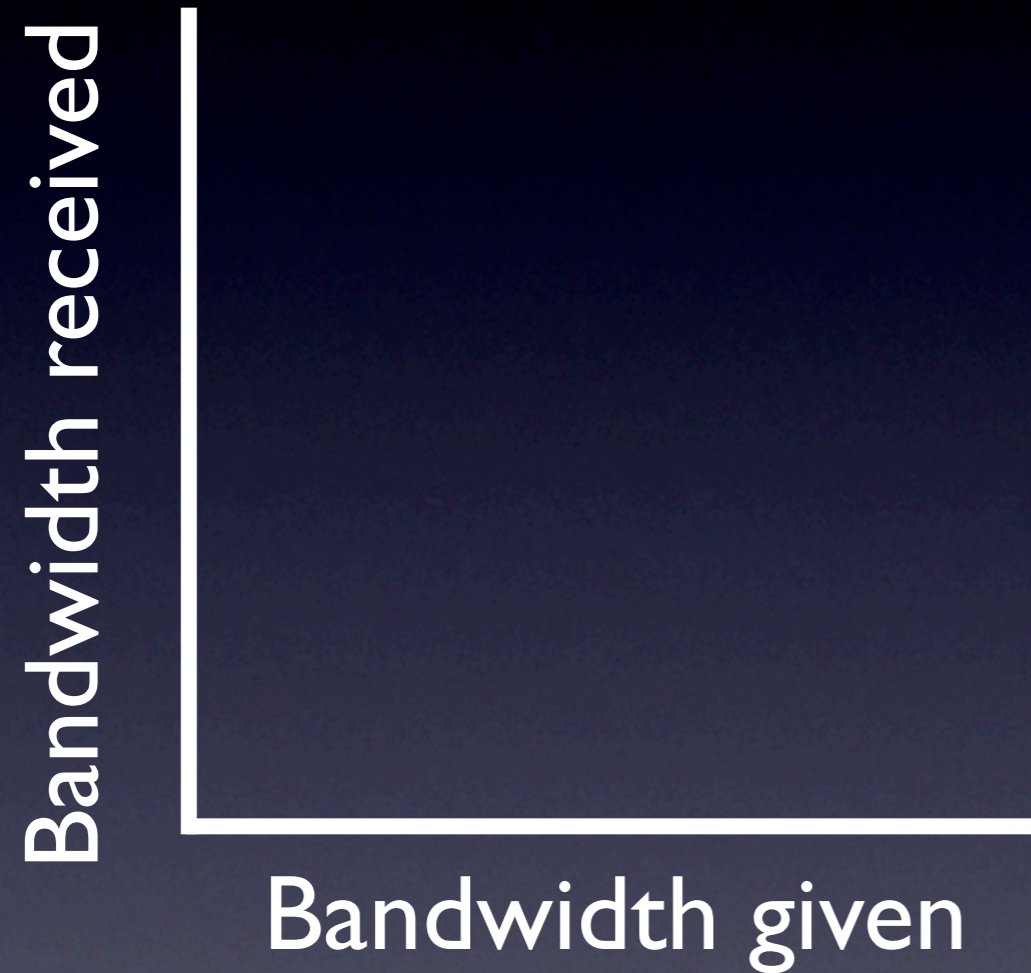


PropShare Properties

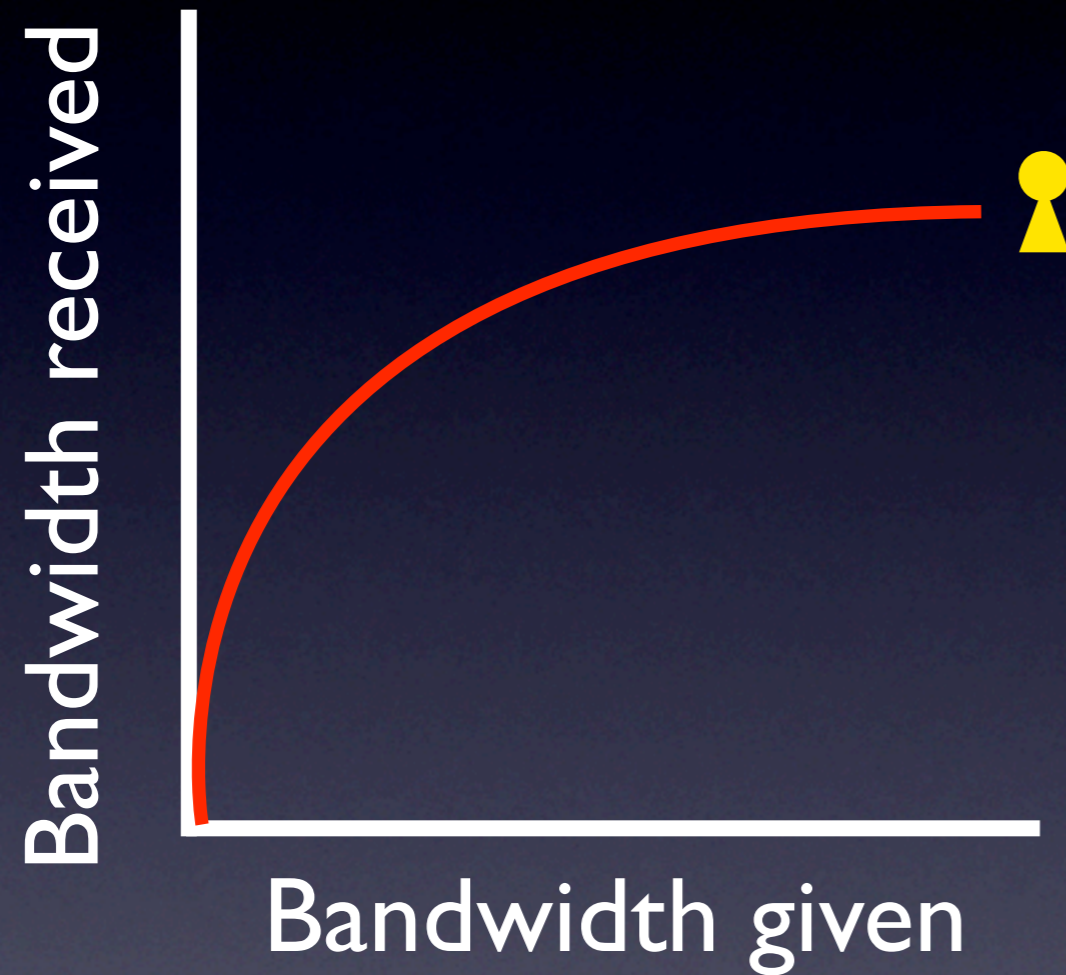


PropShare is Sybil-proof

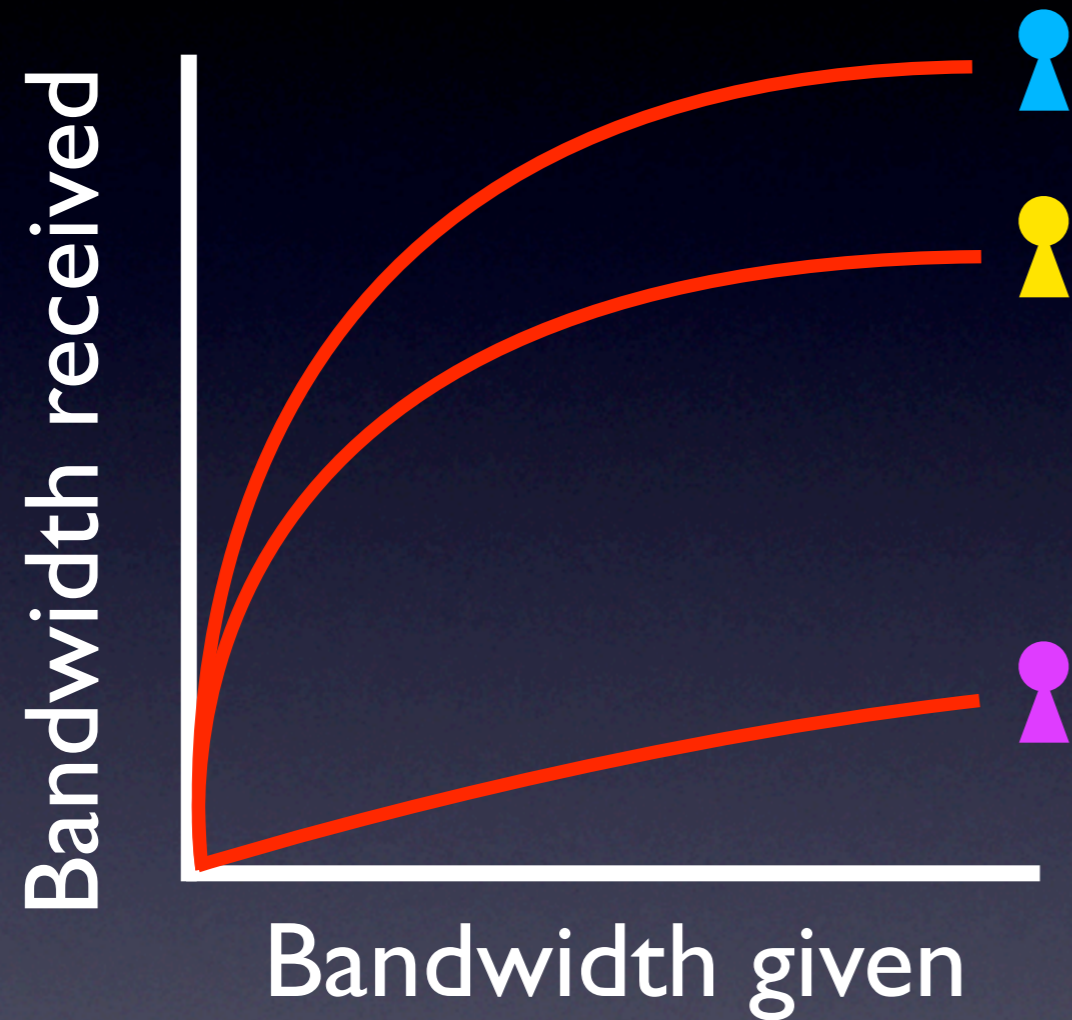
PropShare Response



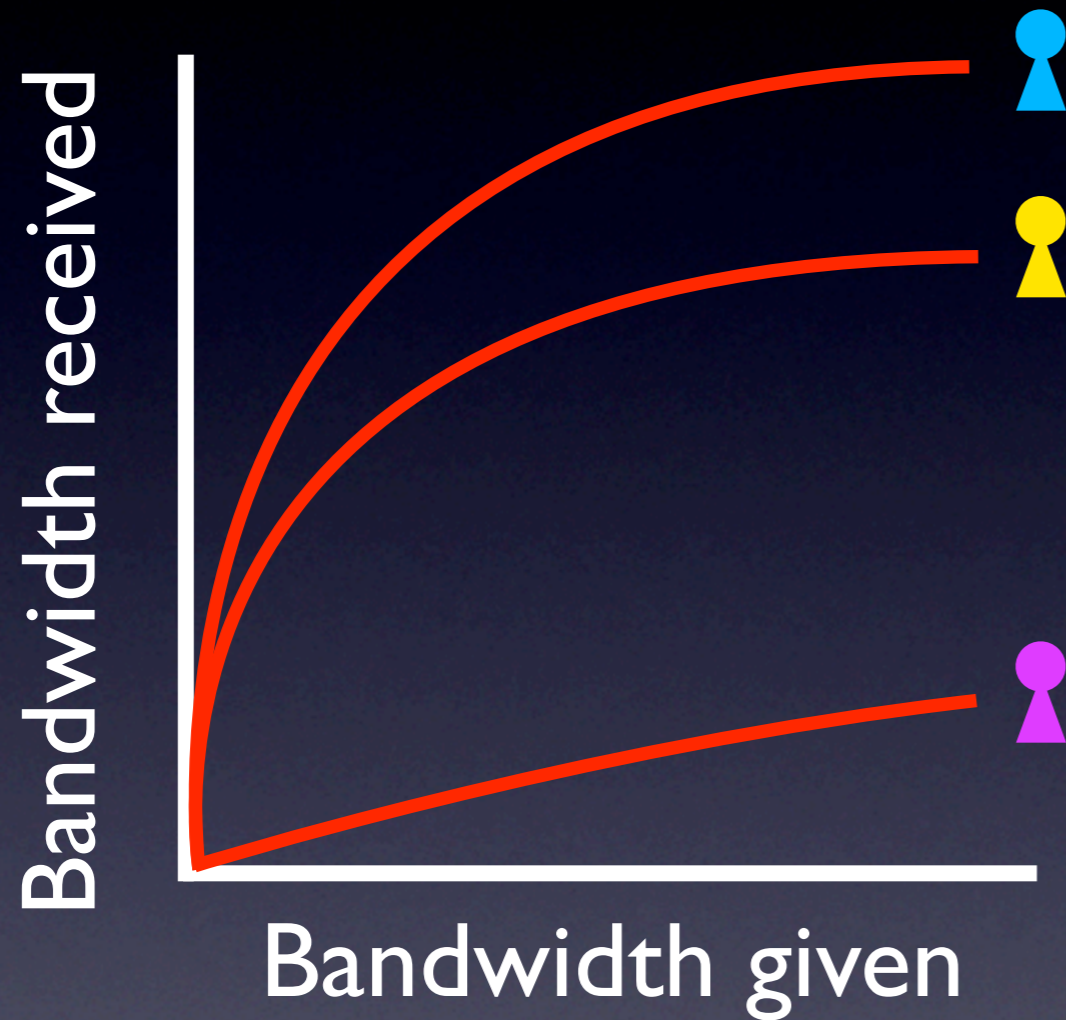
PropShare Response



PropShare Response

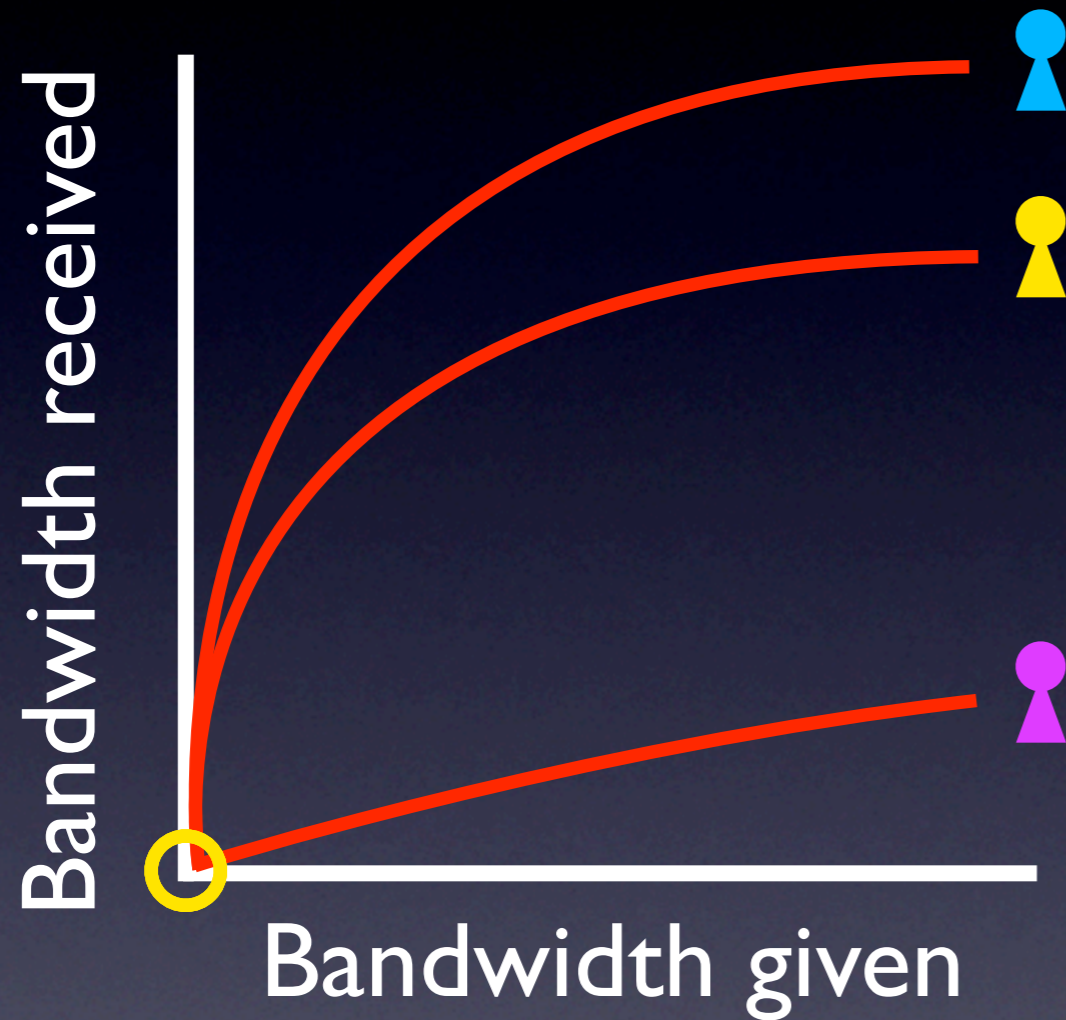


PropShare Response



- Maximize received bandwidth
- Within a fixed budget

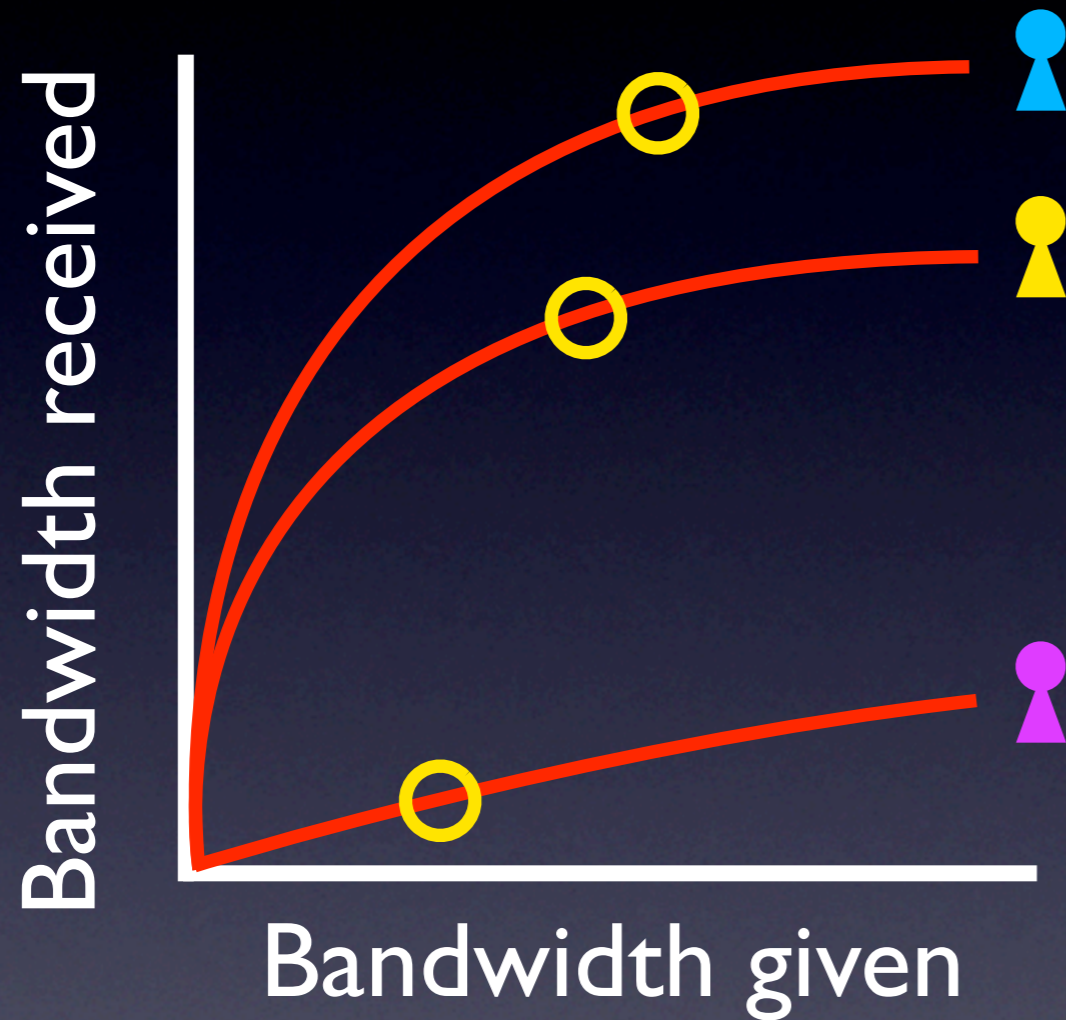
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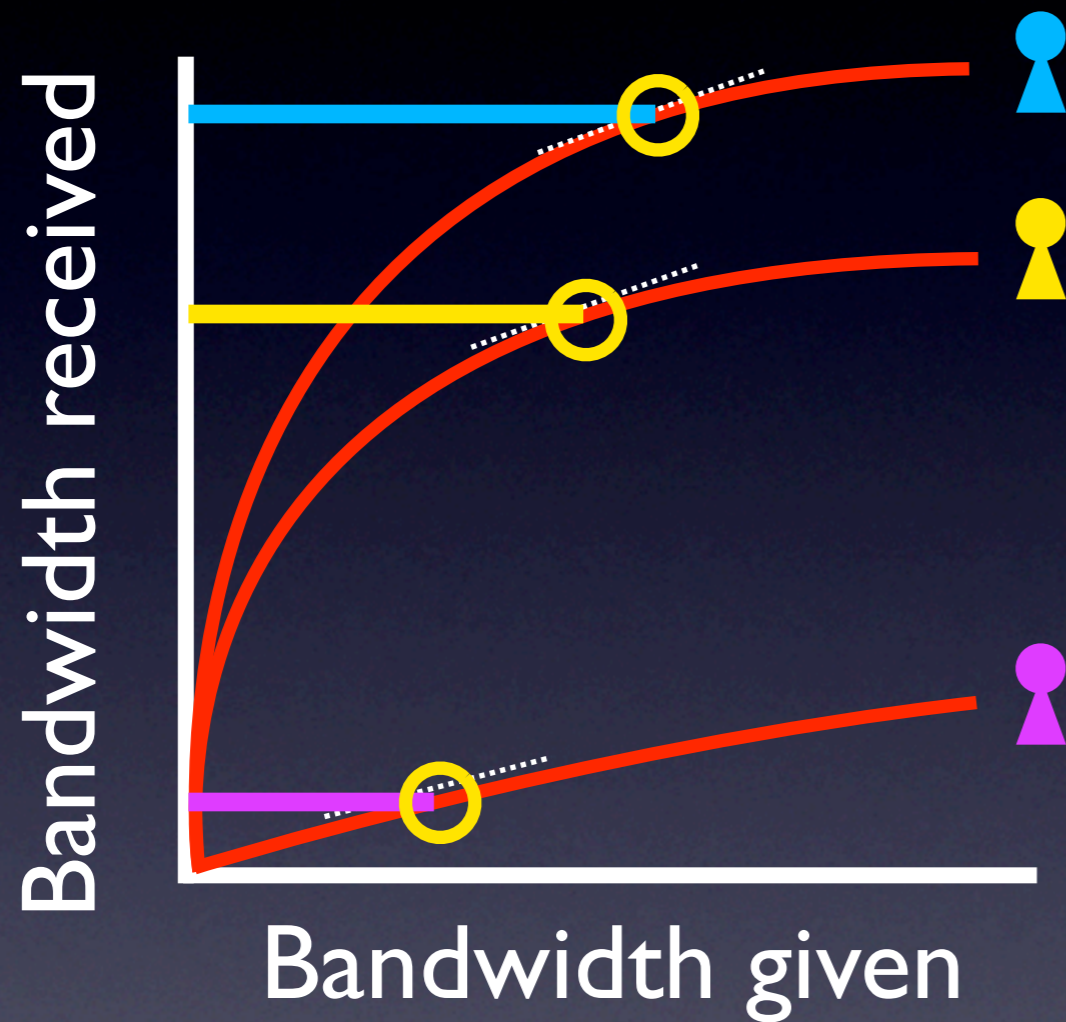
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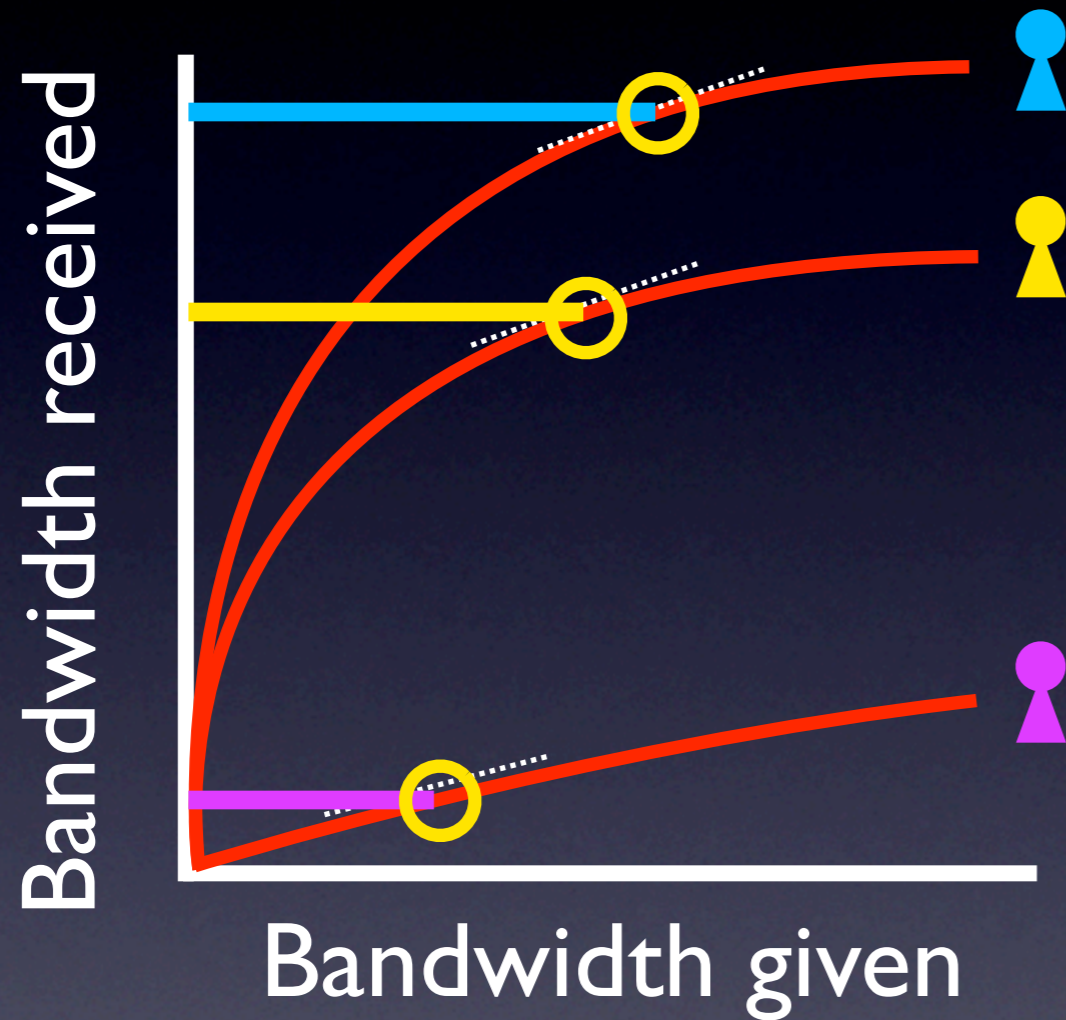
PropShare Response



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PropShare Response



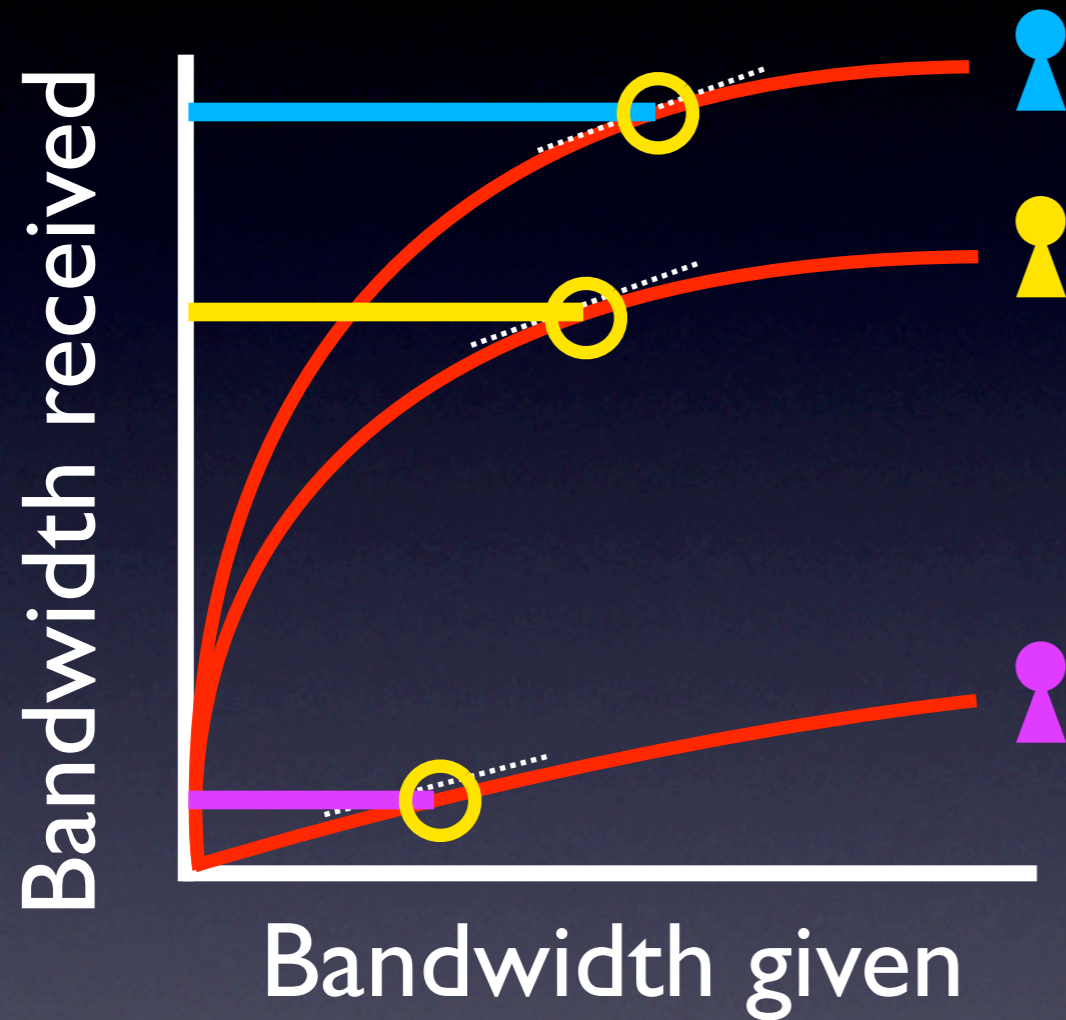
- Maximize received bandwidth

- Within a fixed budget



- Use only local information

PropShare Response



- Maximize received bandwidth
- Within a fixed budget



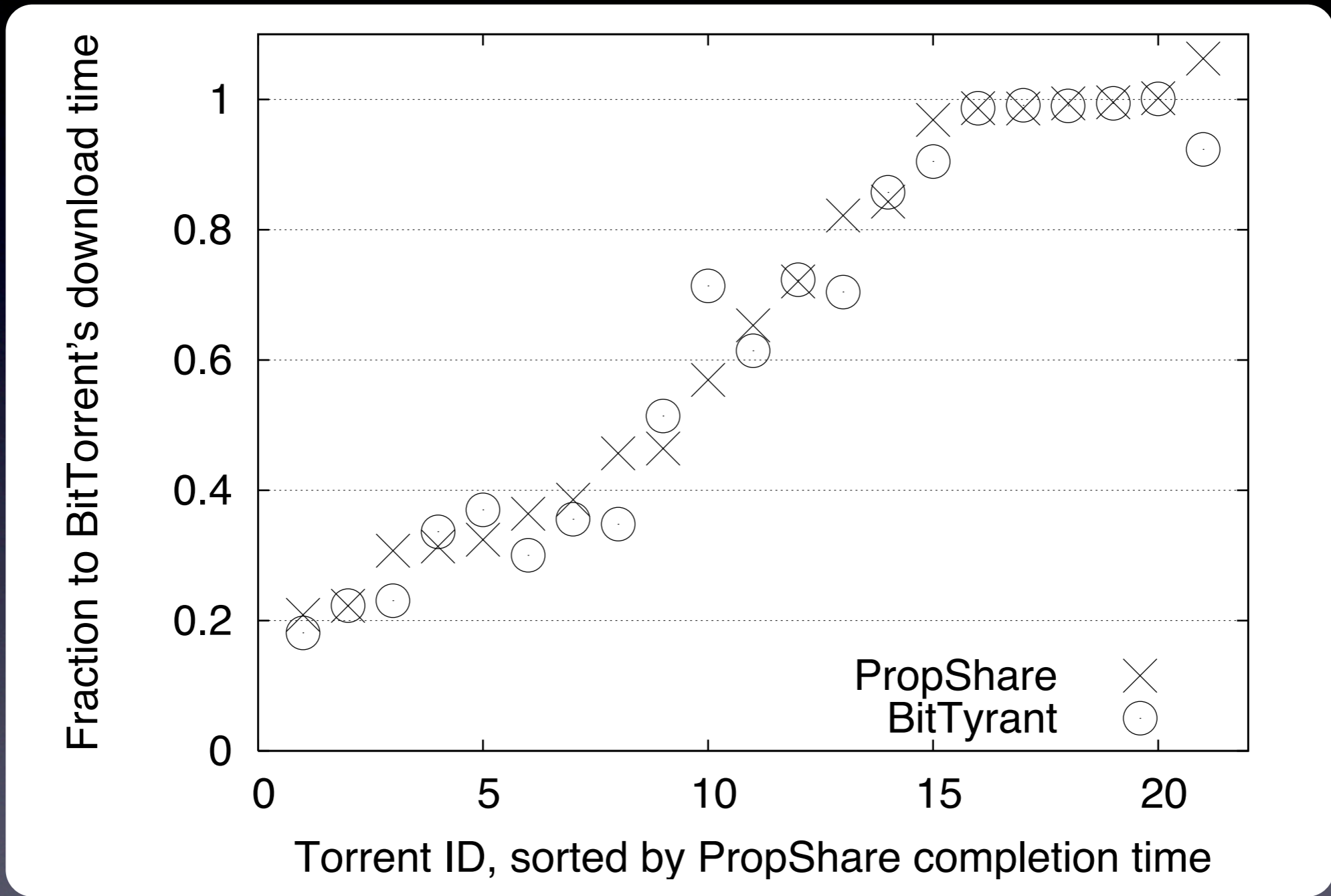
- Use only local information

PropShare yields nearly as much return as best response

Does PropShare work in practice?

- Experiments on **live downloads** and **controlled populations**
- How does it play with BitTorrent?
- Can strategic clients cheat PropShare?

Live Downloads



PropShare's performance is comparable to BitTyrant

Summary of PropShare Results

- ✓ Single-client PropShare performance comparable to BitTyrant
- PropShare is **resistant to manipulation**
 - Not sensitive to (a mix of) other clients' strategies
- All-PropShare performance better than all-BitTorrent

Contributions

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Minimizing altruism in **bootstrapping**

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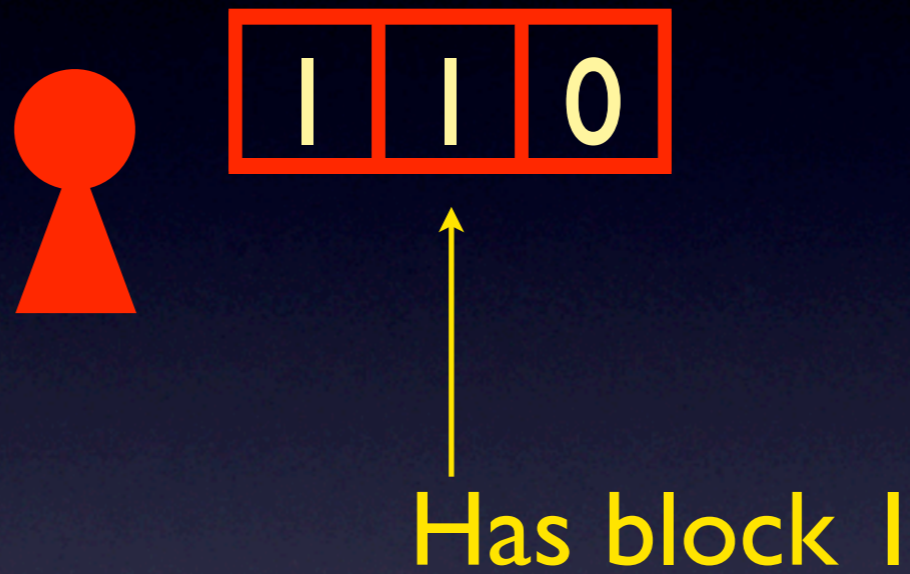
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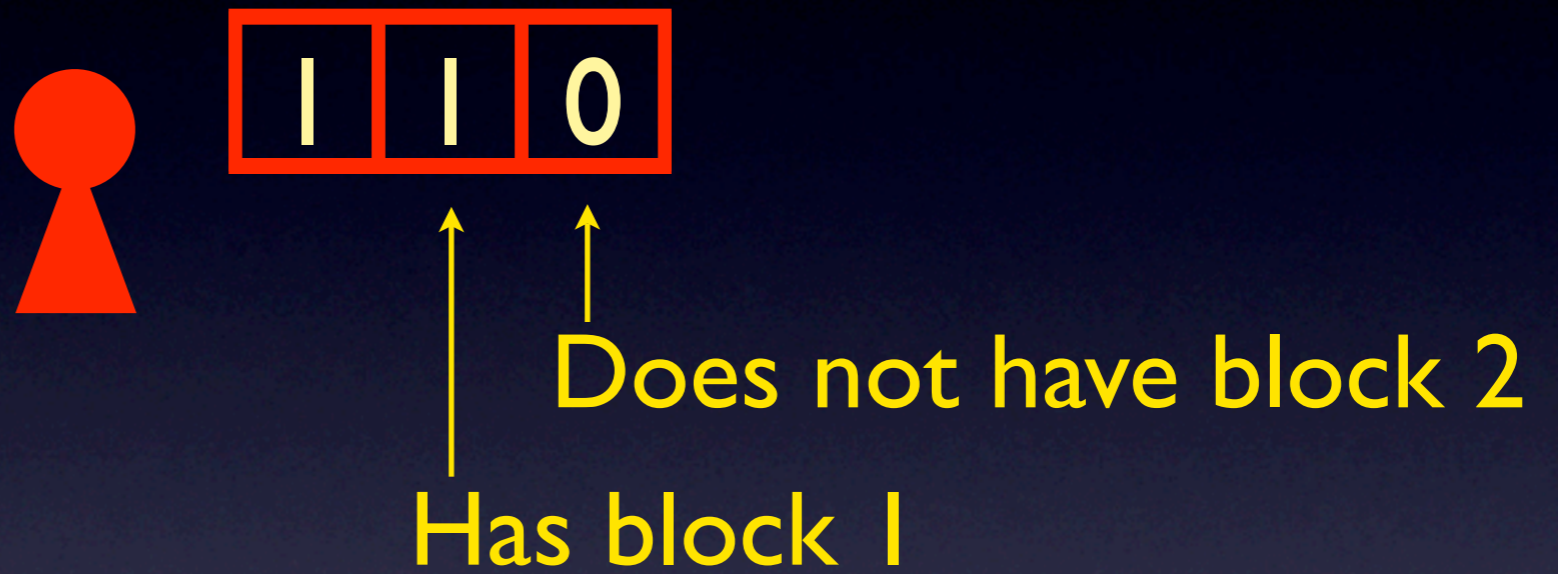
Block Revelation



Block Revelation



Block Revelation



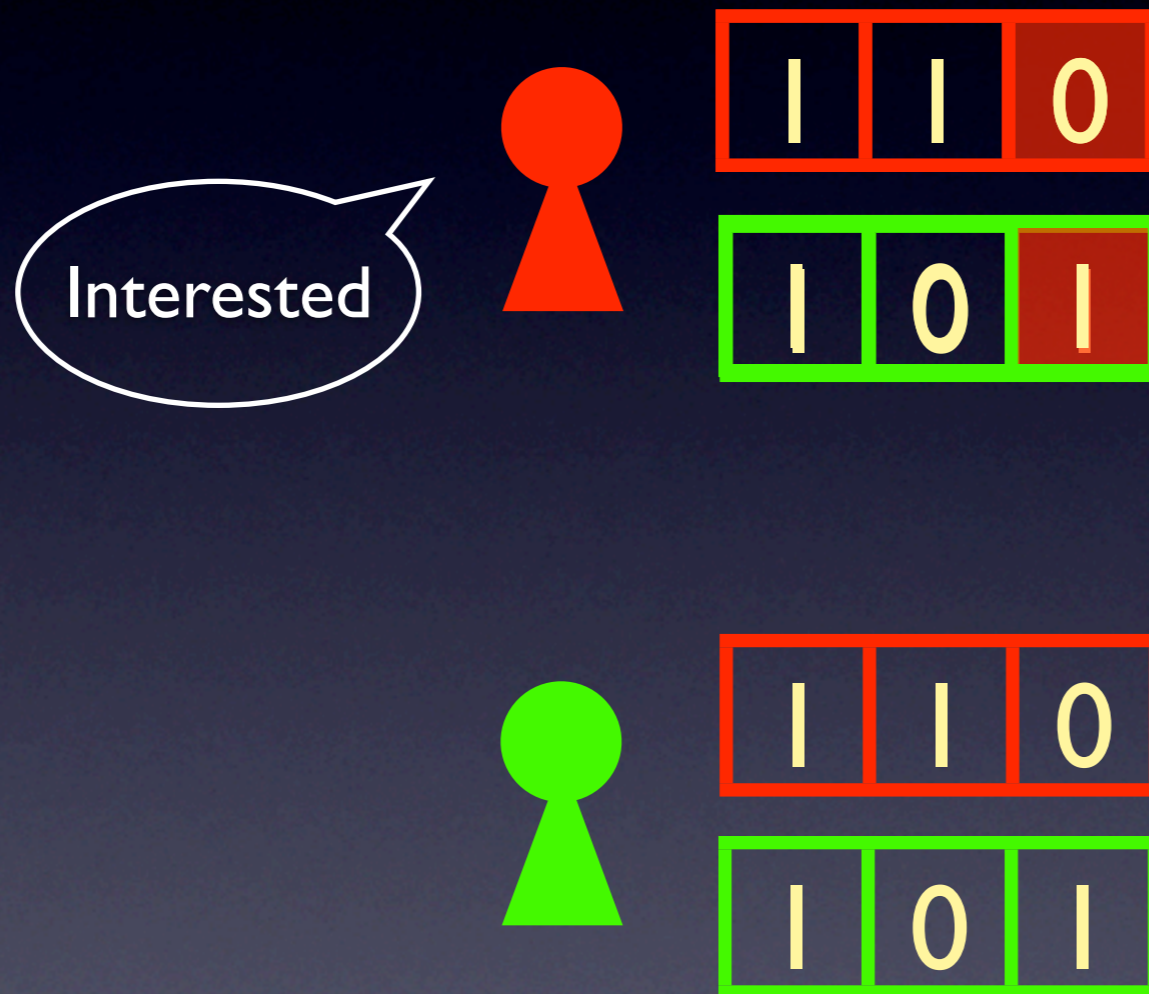
Block Revelation



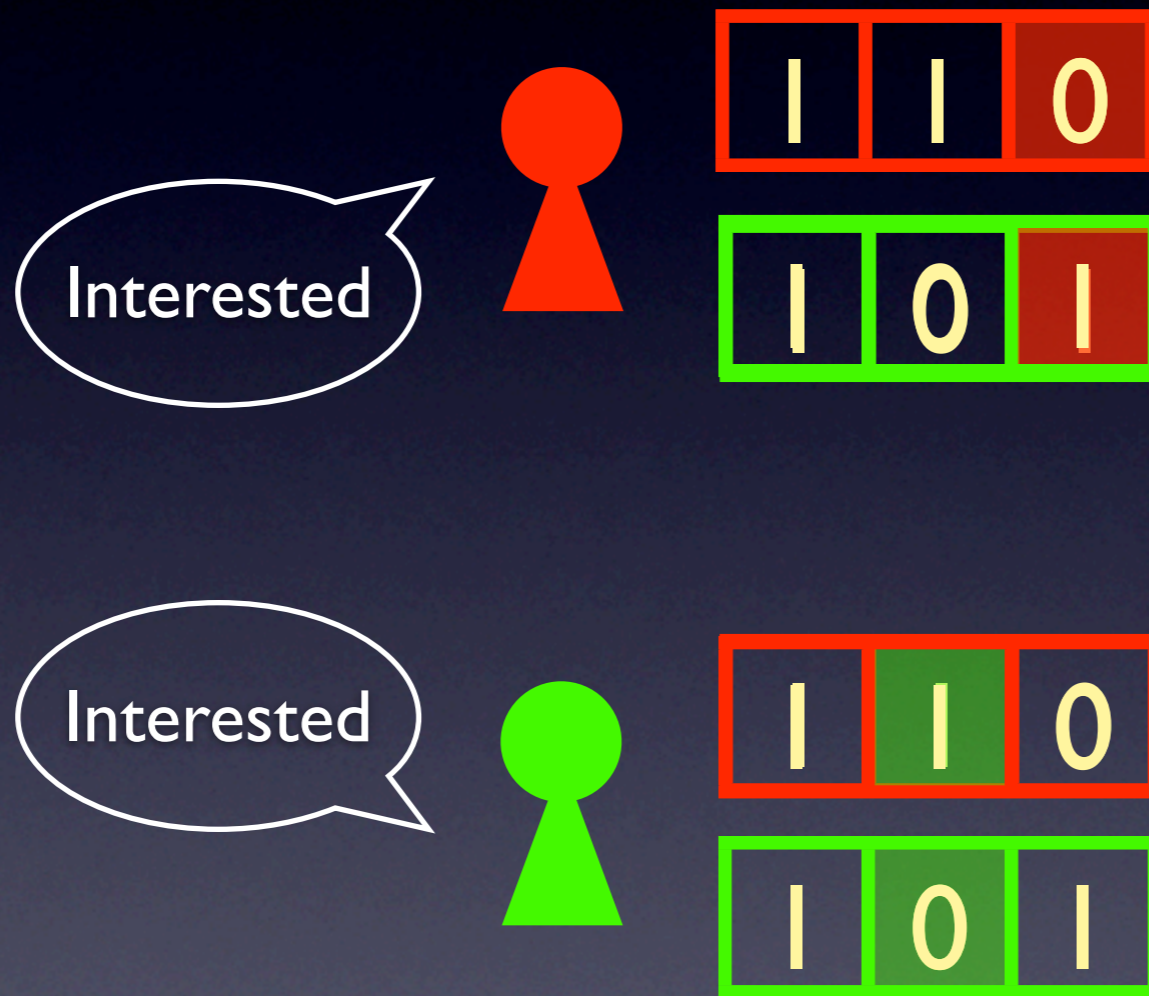
Block Revelation



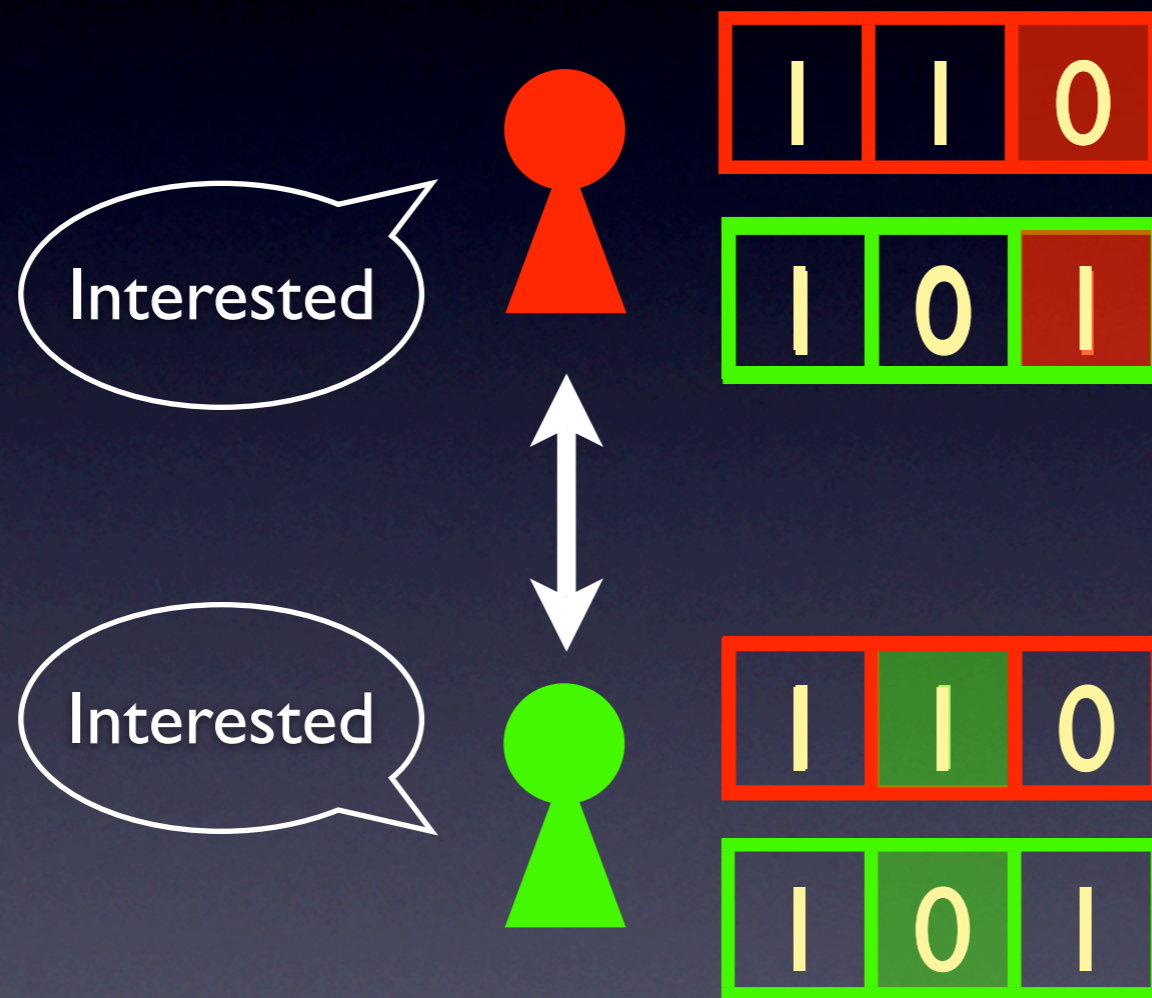
Block Revelation



Block Revelation



Block Revelation



Interest



Interest



Interest

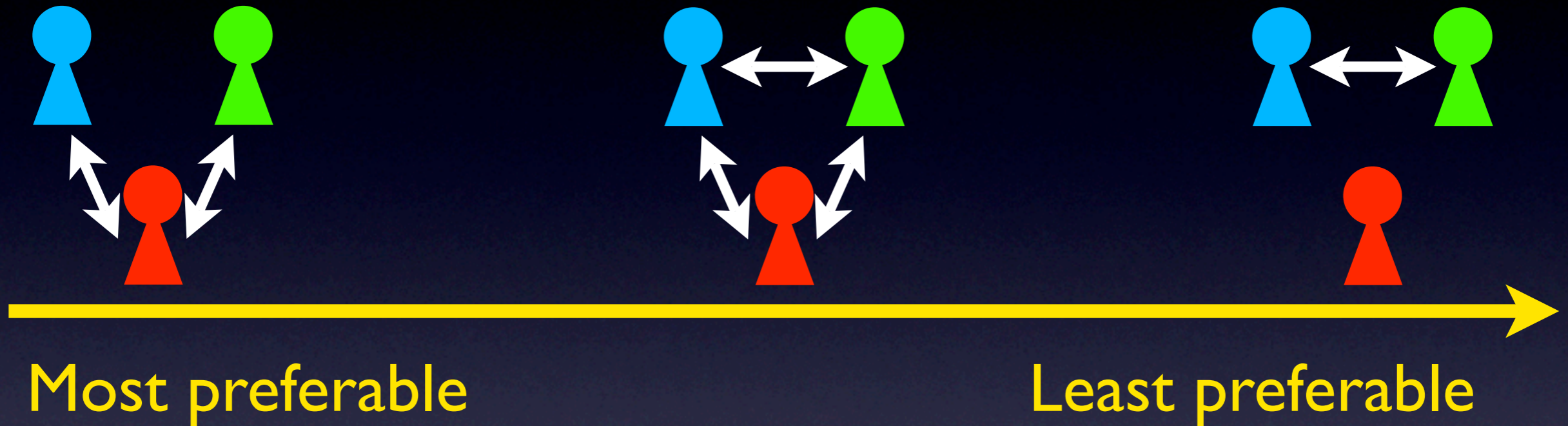


Interest



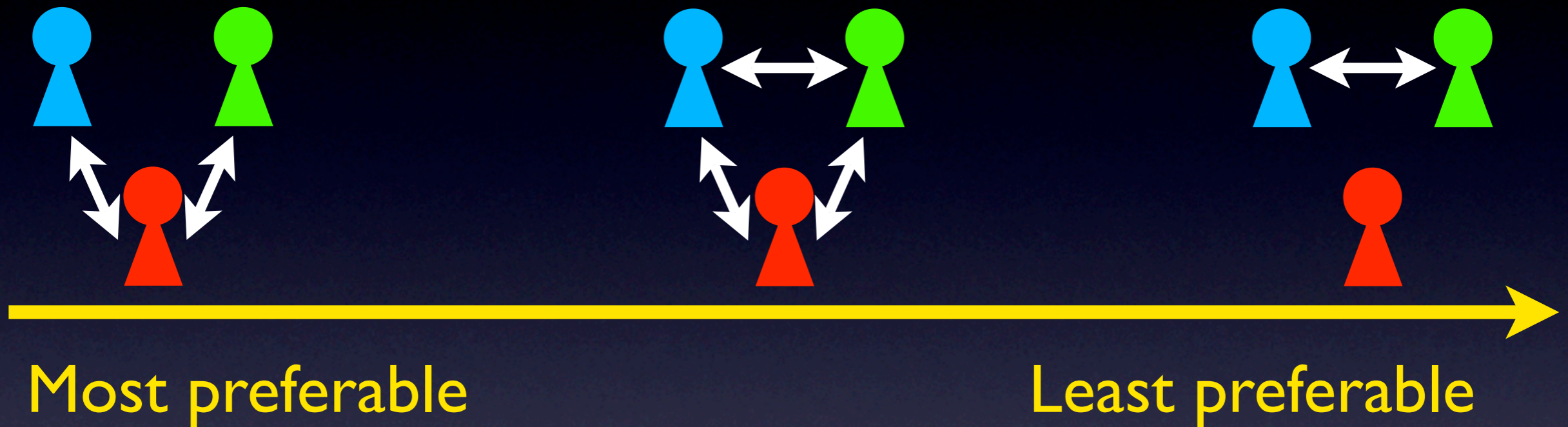
Goal 1: Be interesting for as long as possible

Interest



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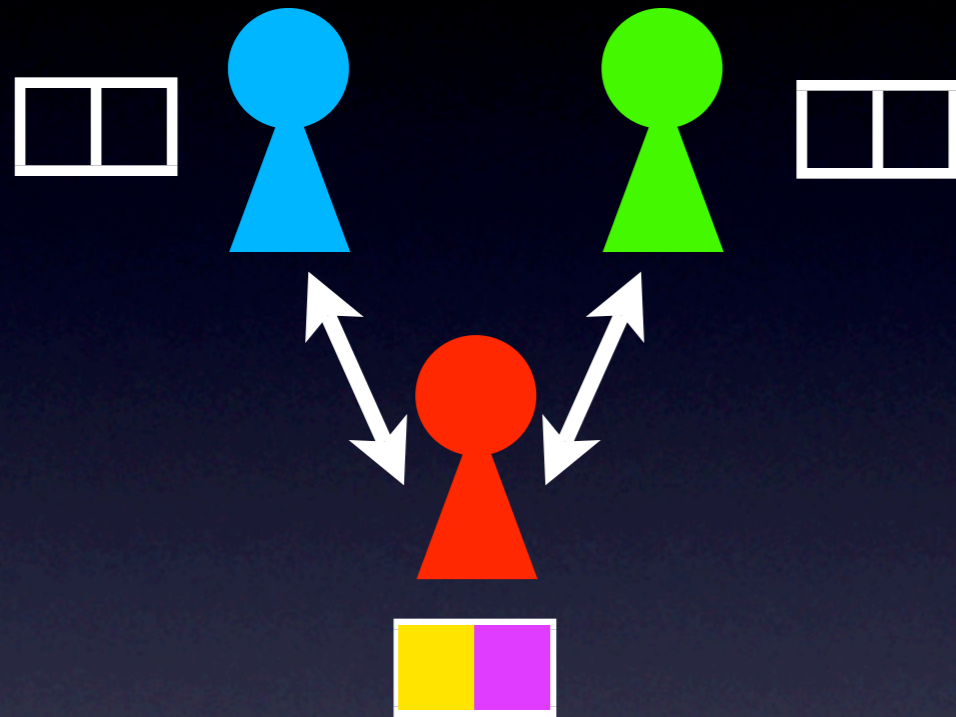
Interest



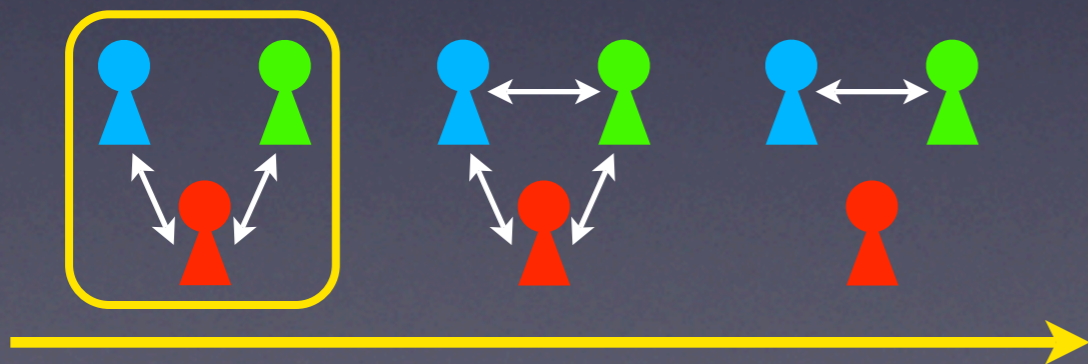
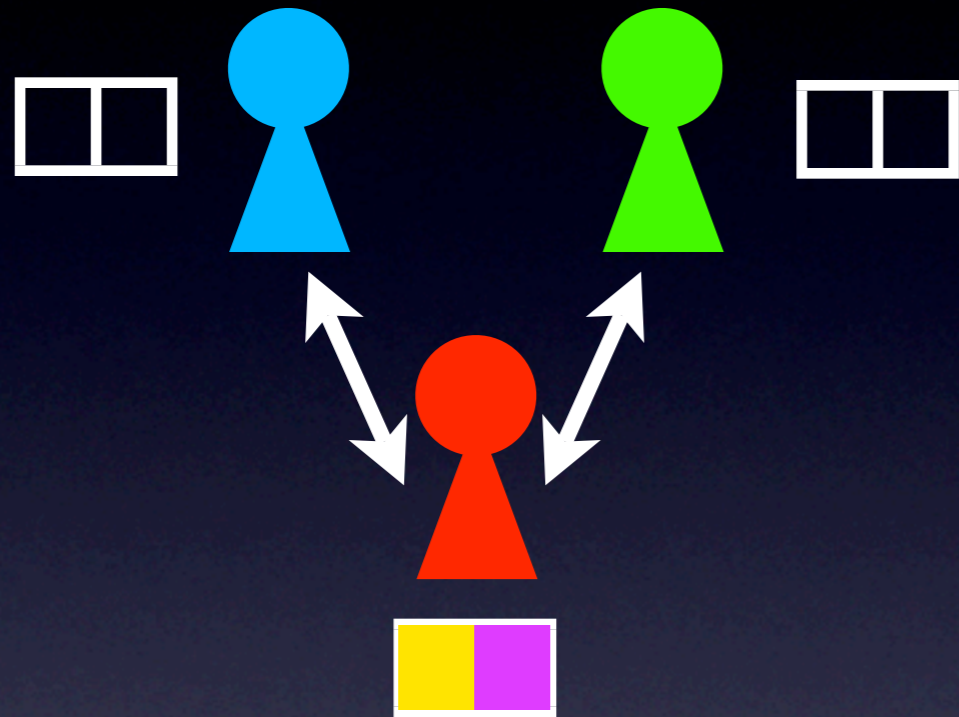
Goal 1: Be interesting for as long as possible

Goal 2: Add as little to others' interest as possible

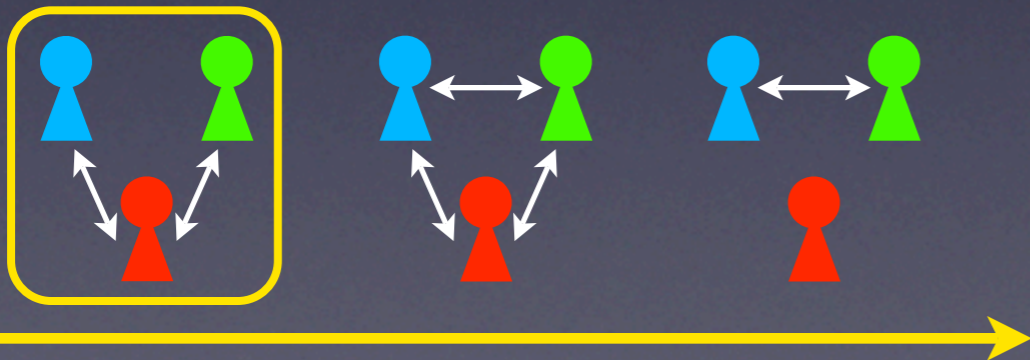
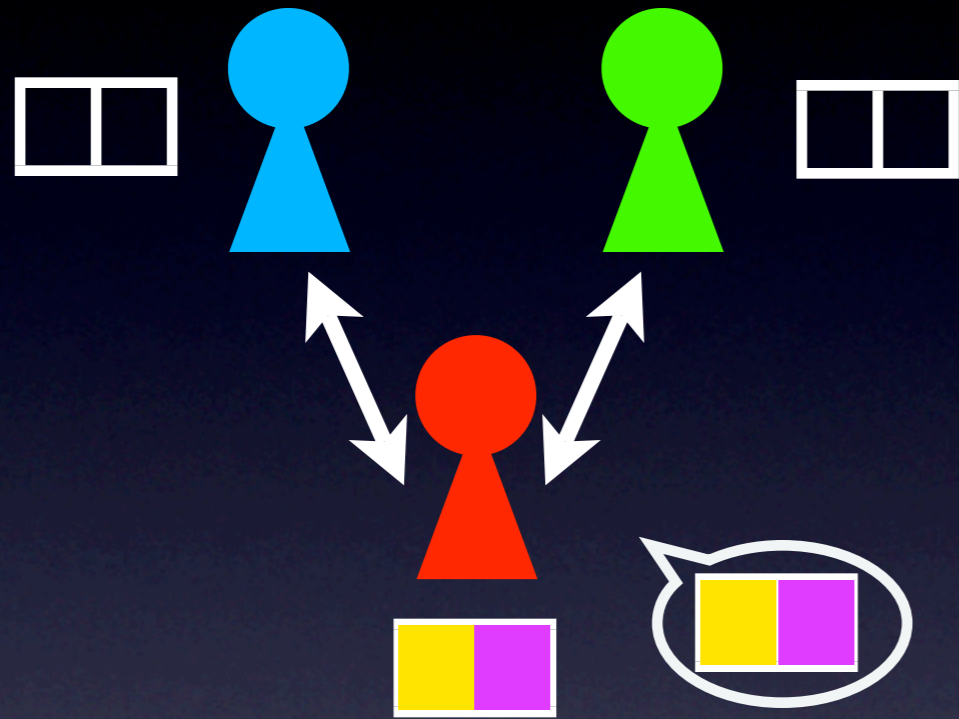
Block Revelation



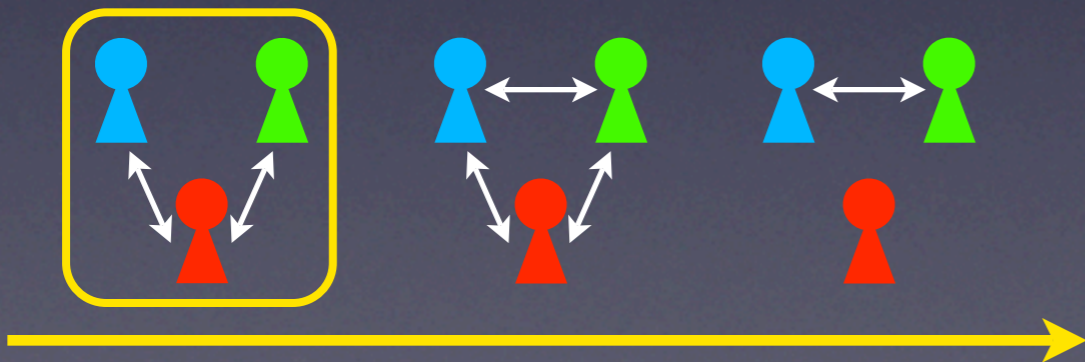
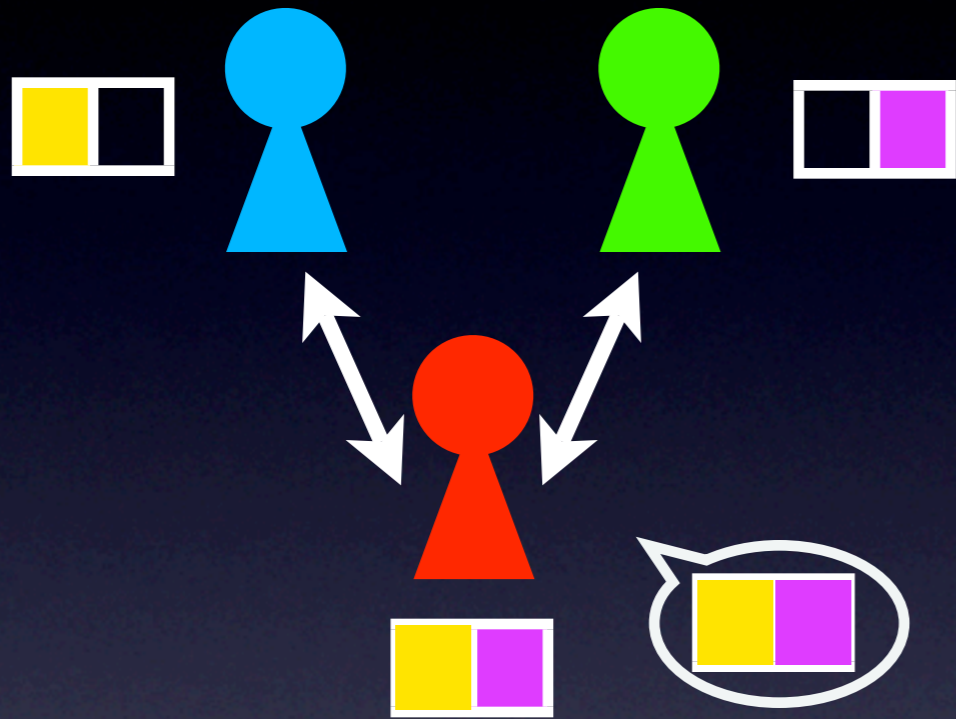
Block Revelation



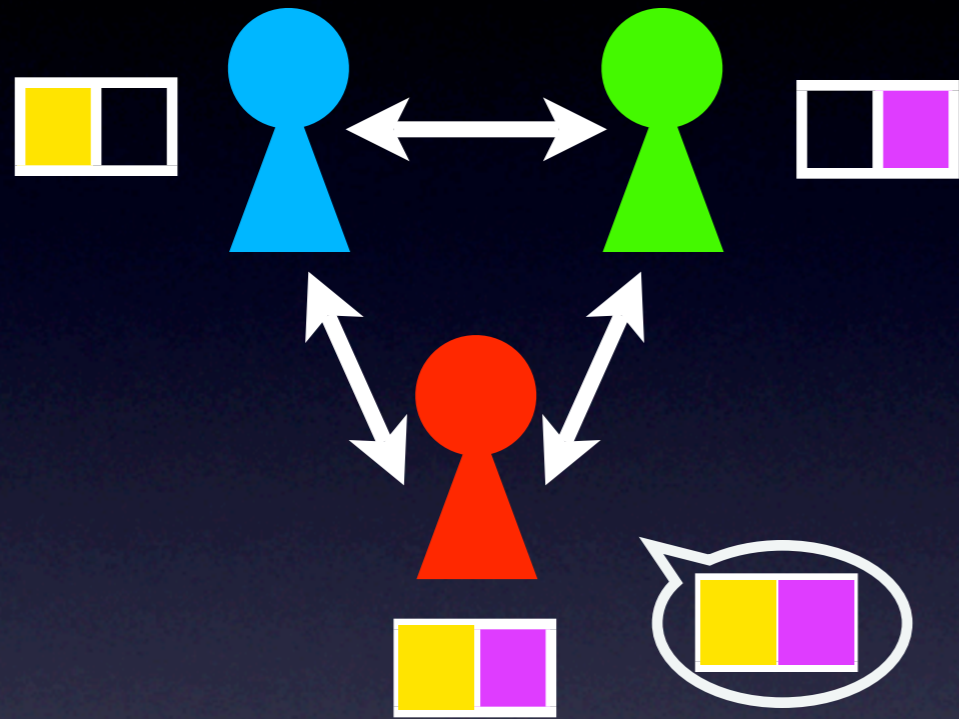
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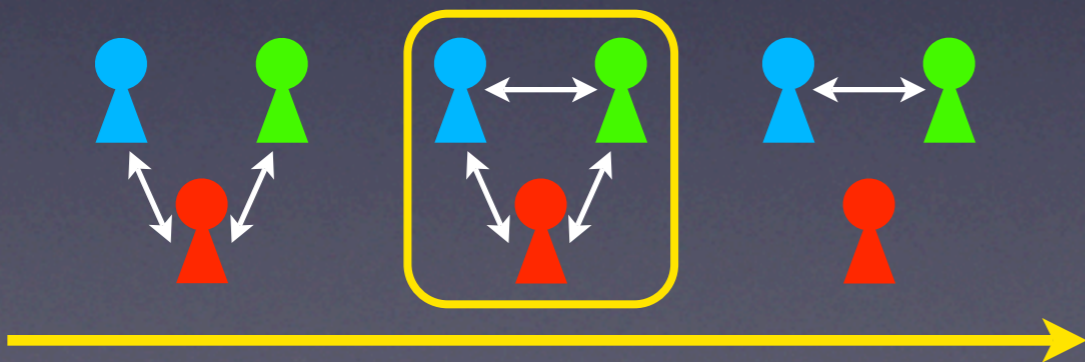
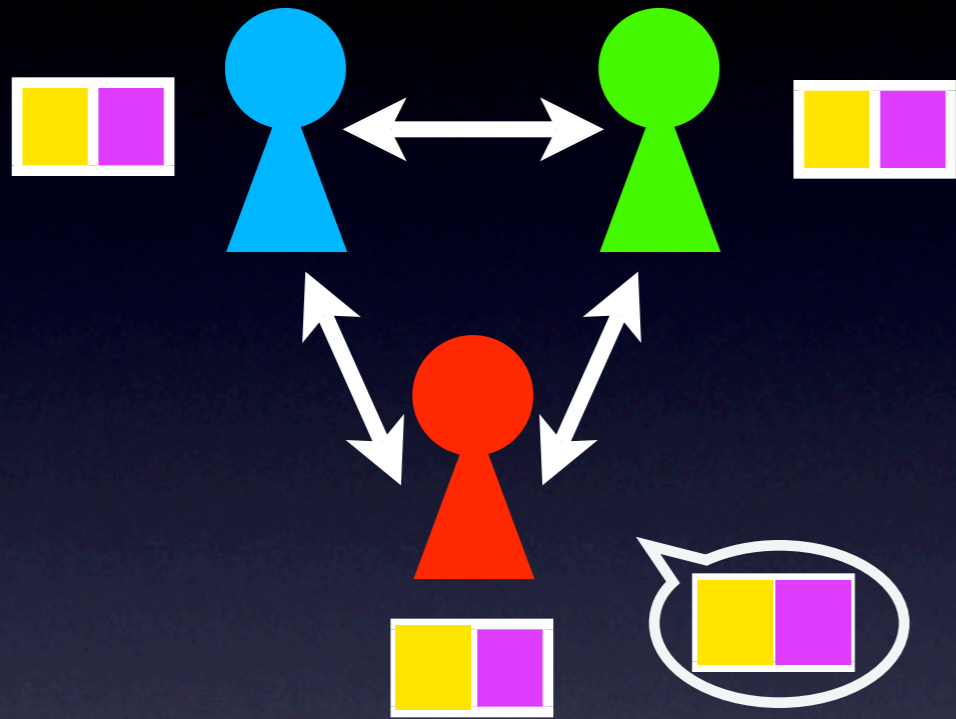
Block Revelation



Block Revelation



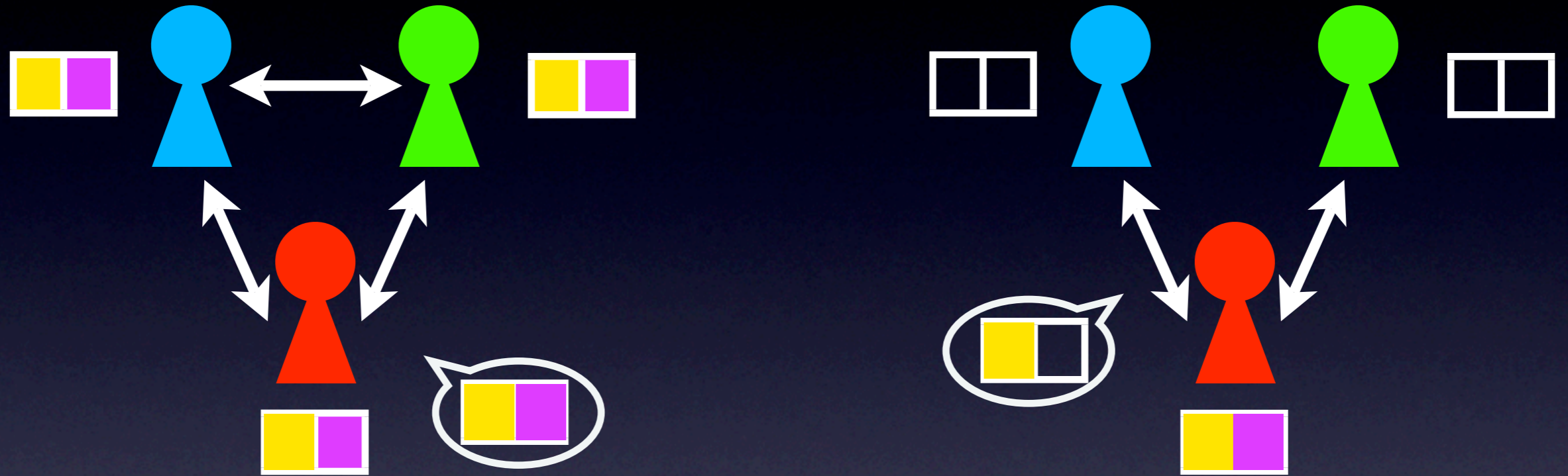
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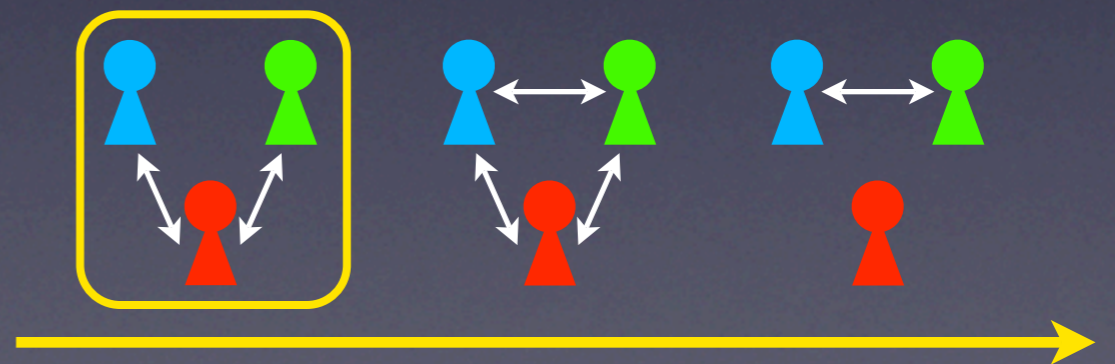
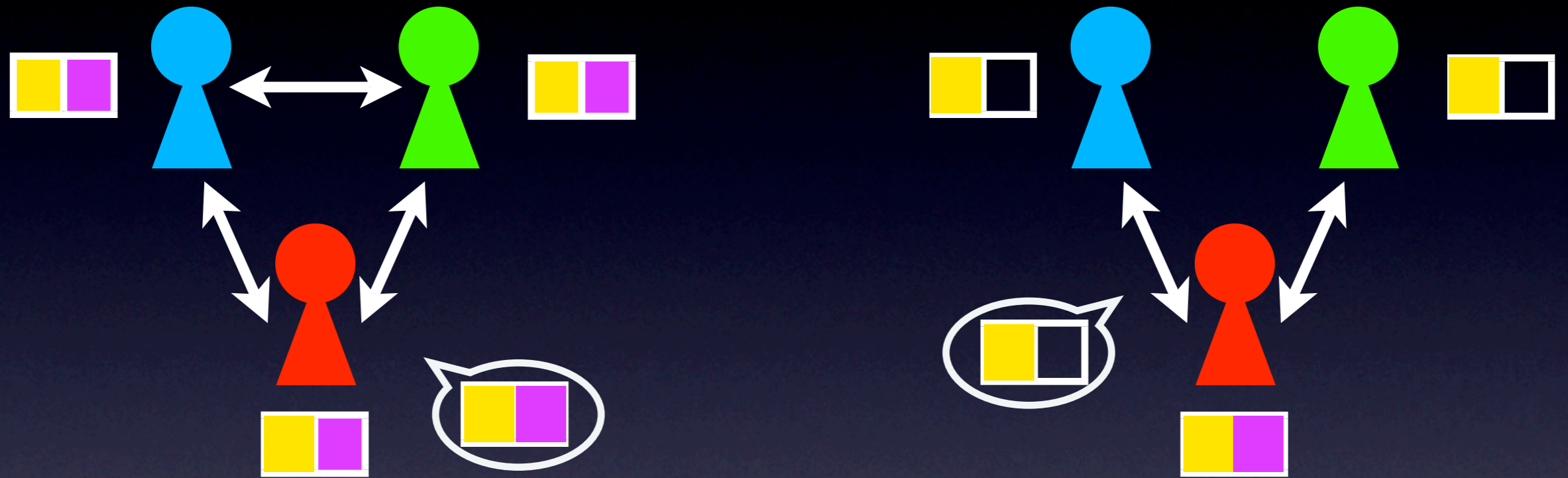
Block Revelation



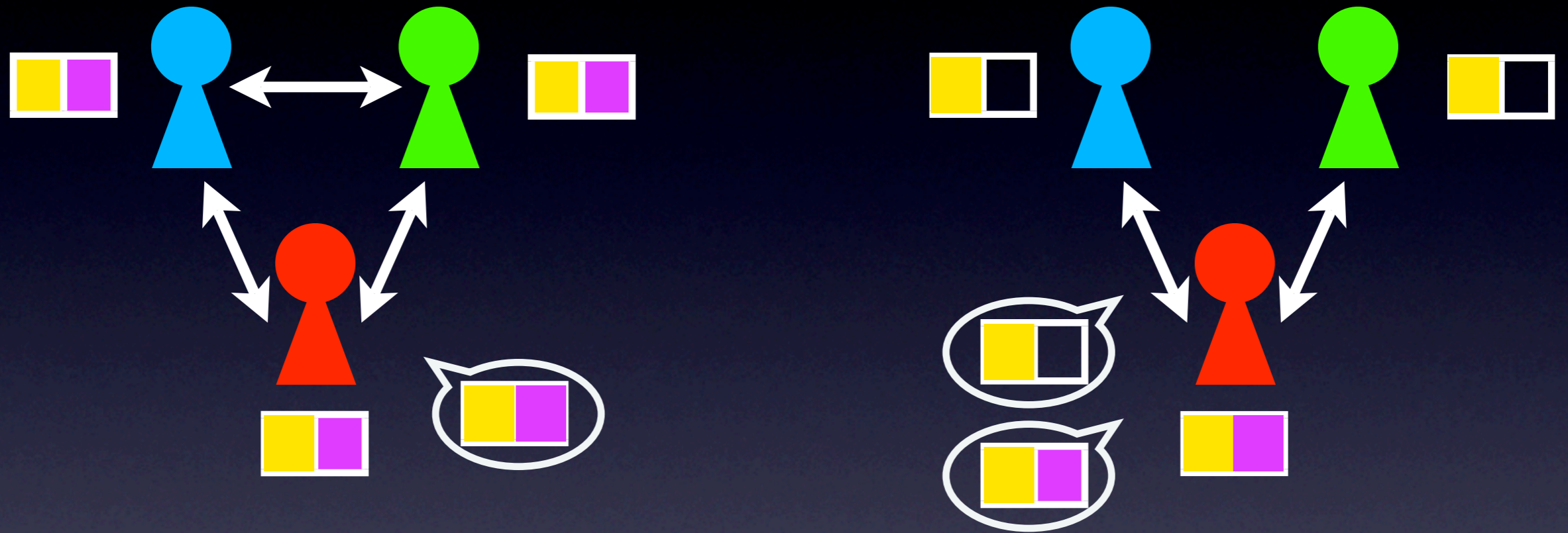
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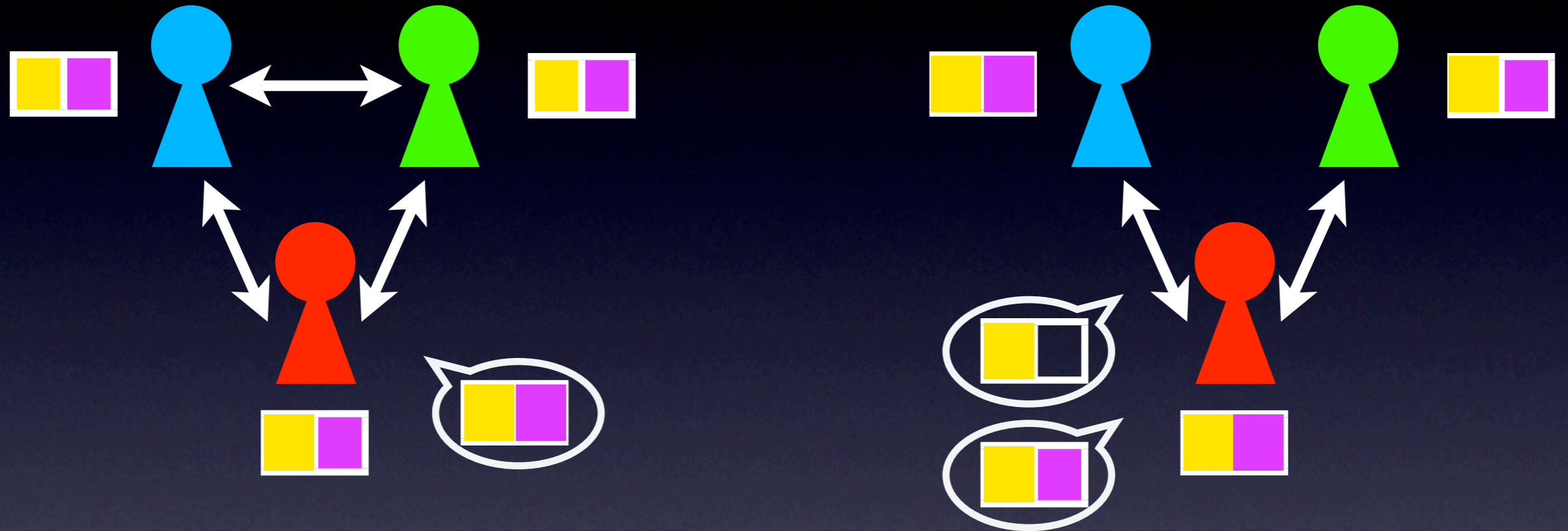
Block Revelation



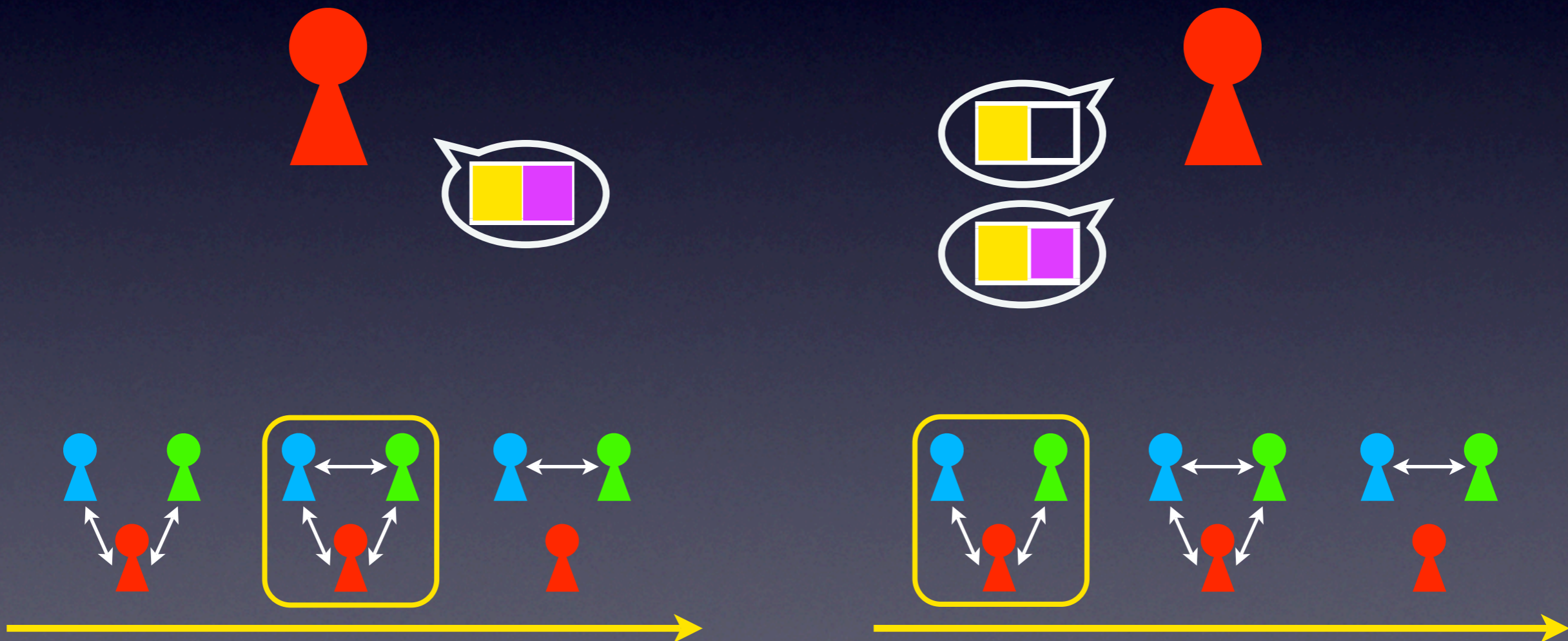
Block Revelation



Block Revelation

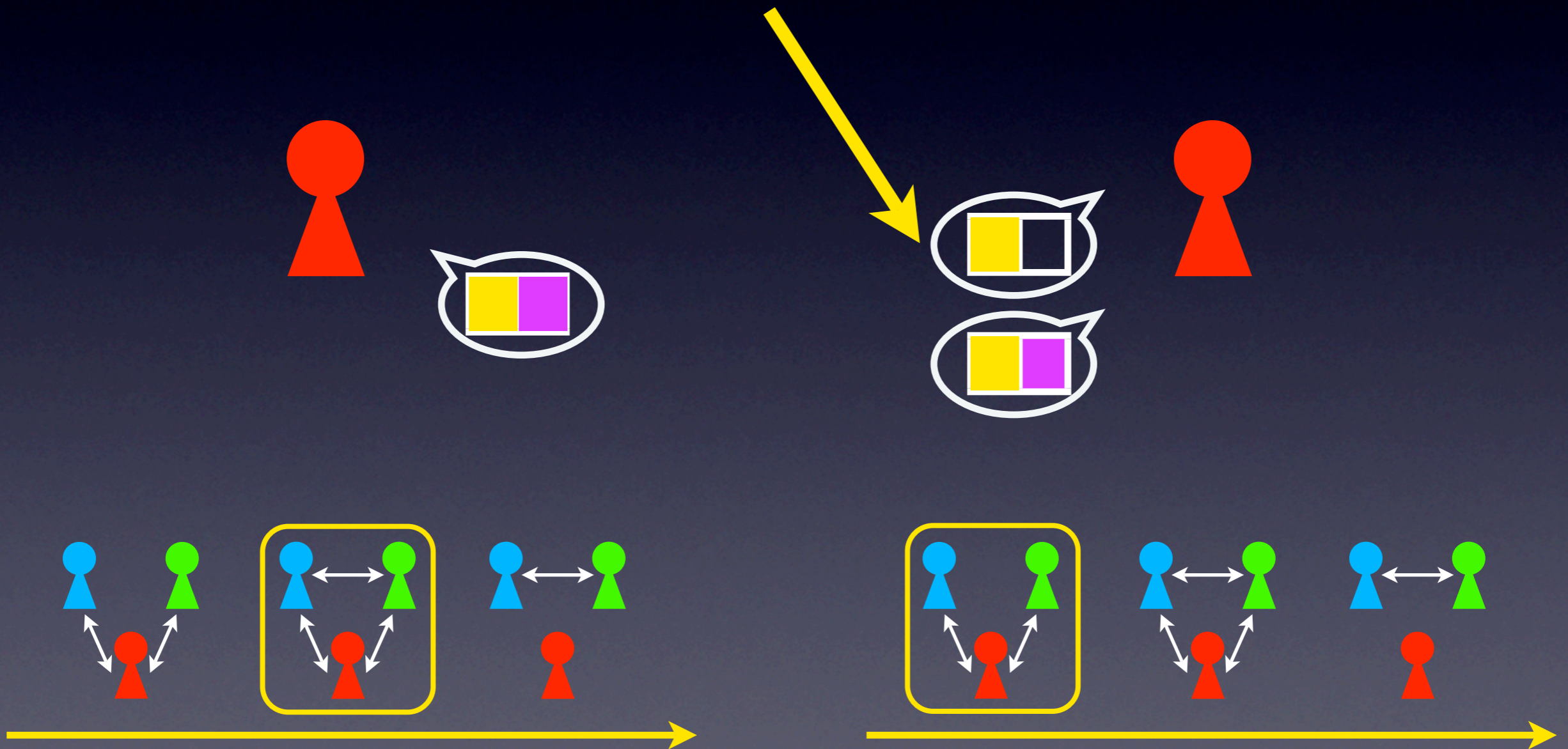


Block Revelation



Block Revelation

Strategically *under-report*

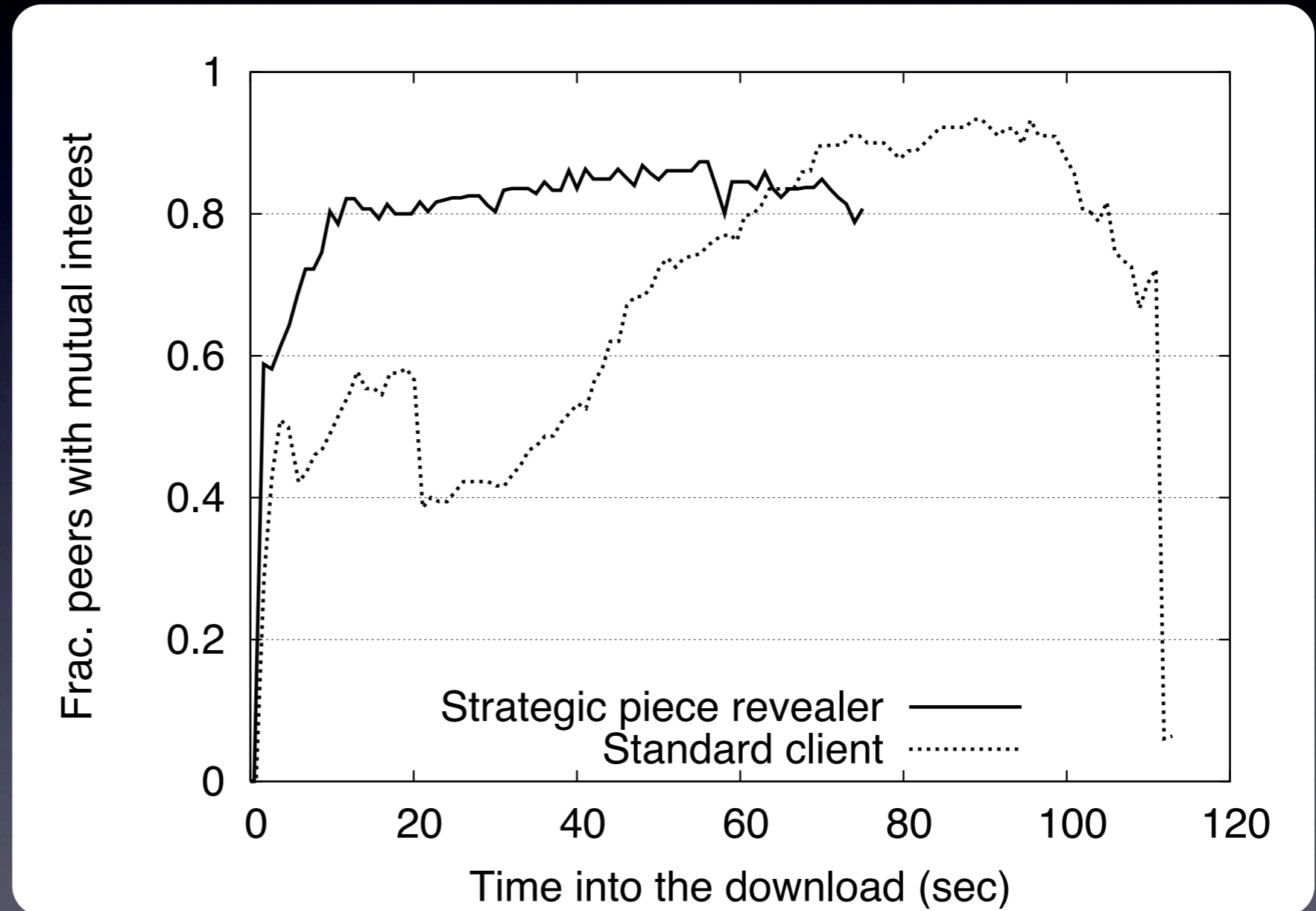


An under-reporting strategy



Under-Reporting is Effective

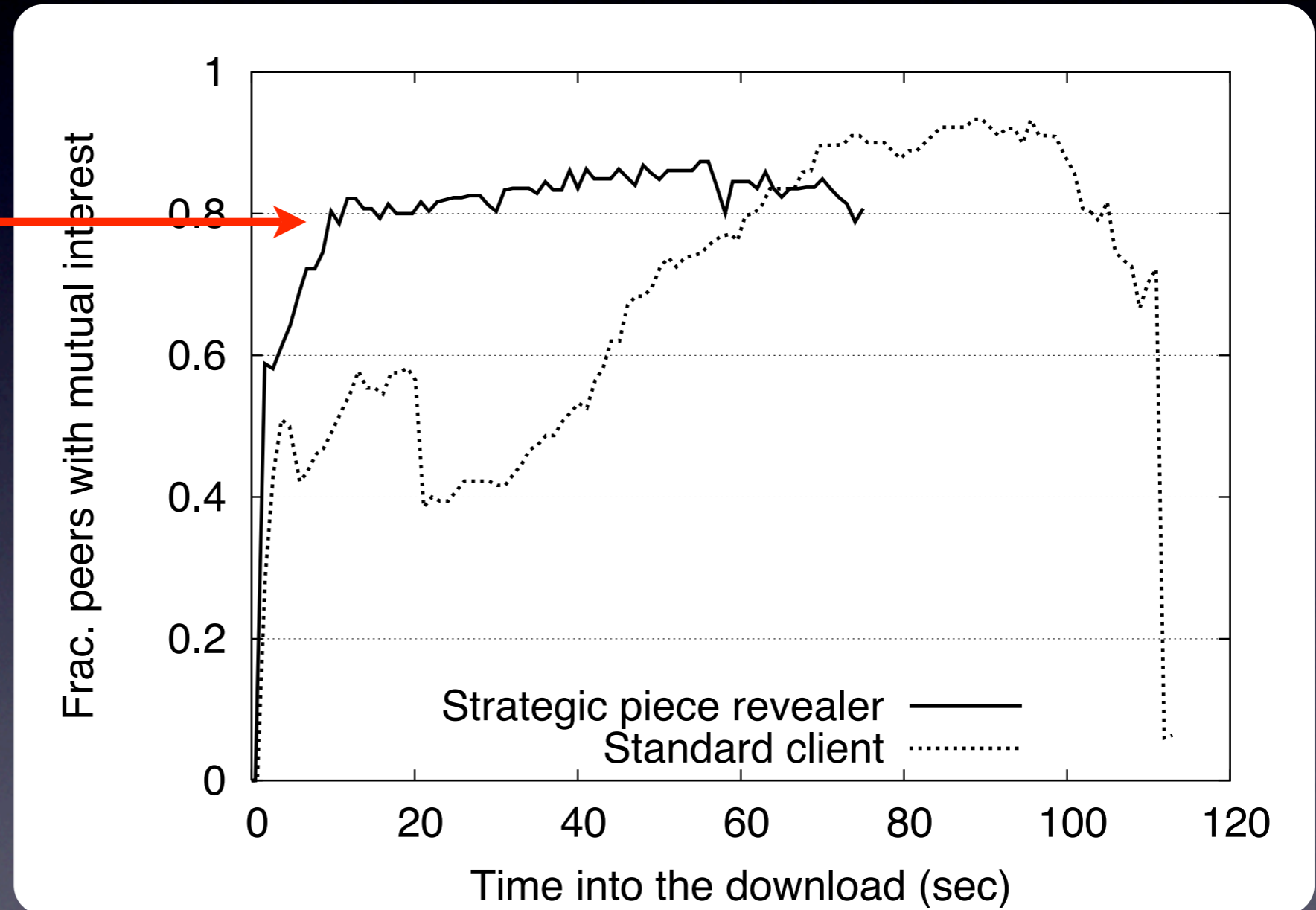
One strategic
revealer



Under-Reporting is Effective

One strategic
revealer

Reaches
peak quickly

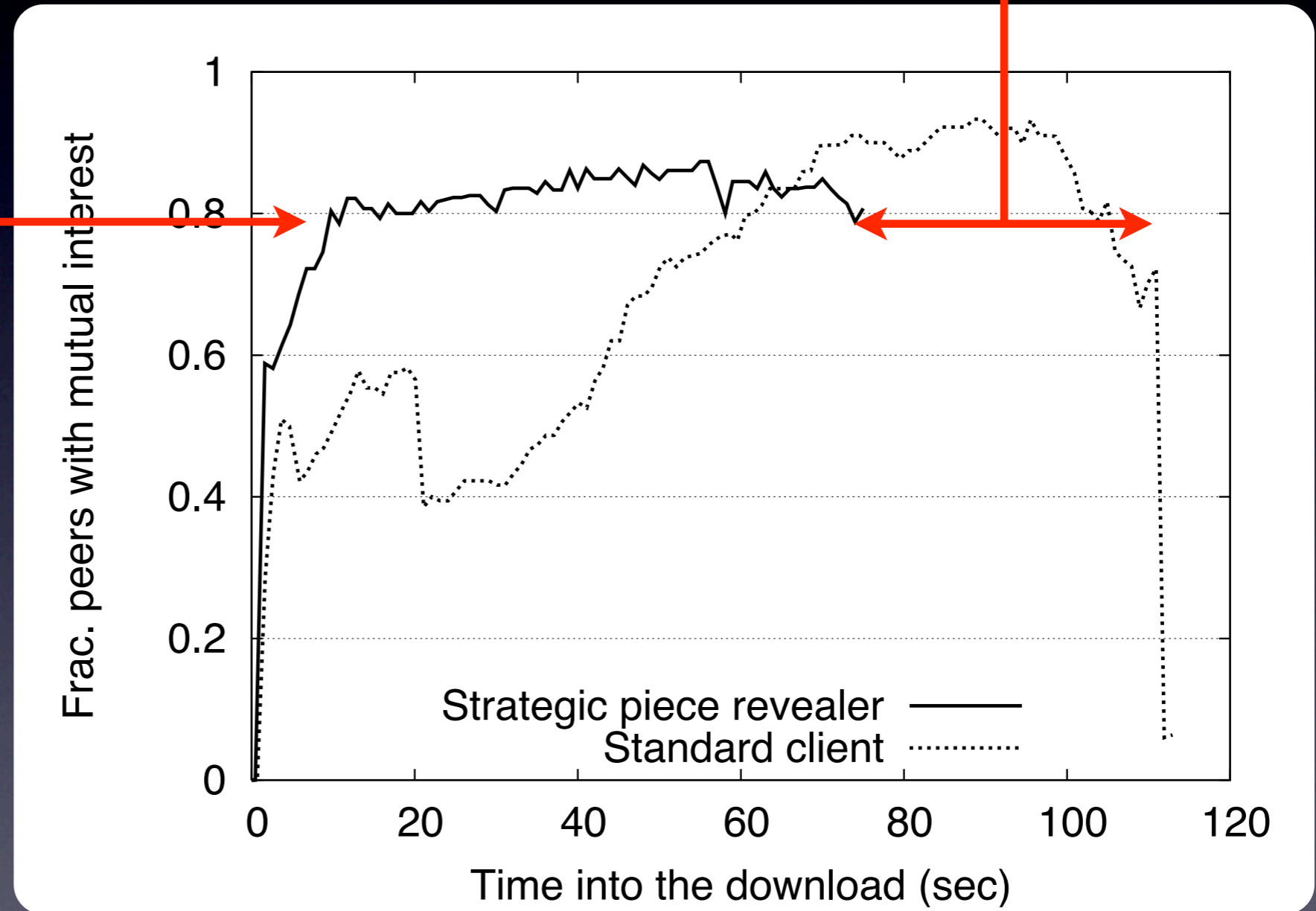


Under-Reporting is Effective

One strategic
revealer

Reaches
peak quickly

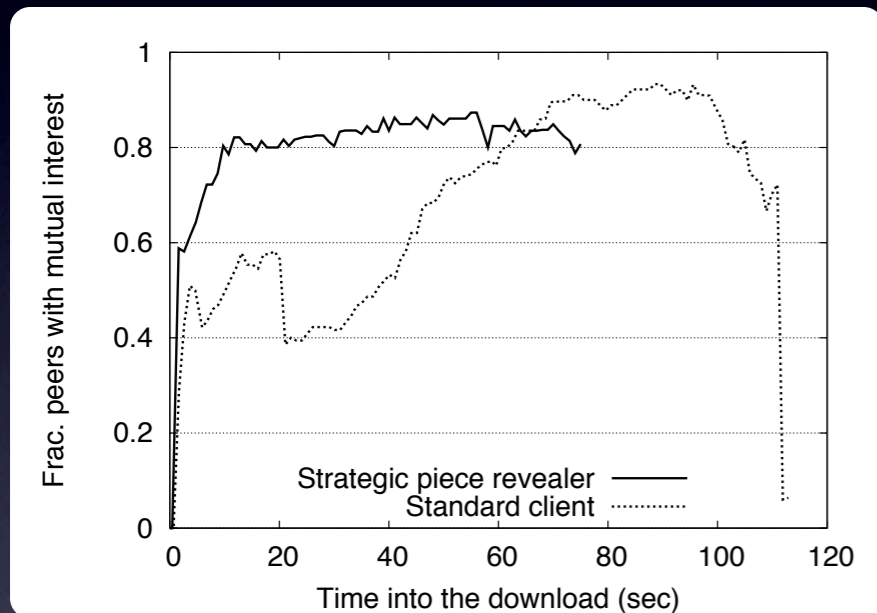
Faster download



Under-Reporting is Effective

One strategic
revealer

All strategic revealers



- 12% increase in download times
- Providing incentives to be truthful is an open problem

Summary

- **BitTorrent** is an auction
- **Proportional share** outperforms other clients
 - Oblivious to others' strategies
 - Sybil-proof
- Peers have incentive to **under-report** what they have
 - Strategic block revelation prolongs interest
- **Bootstrapping** does not require as much altruism

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<http://www.cs.umd.edu/projects/propshare>



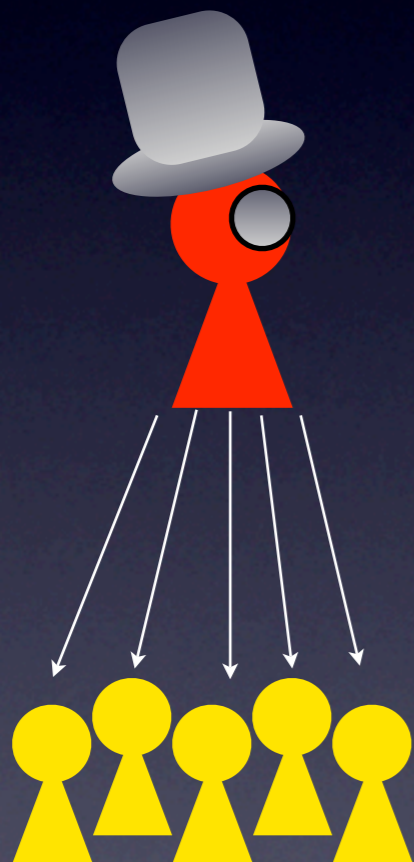
Can we obtain a block monopoly?



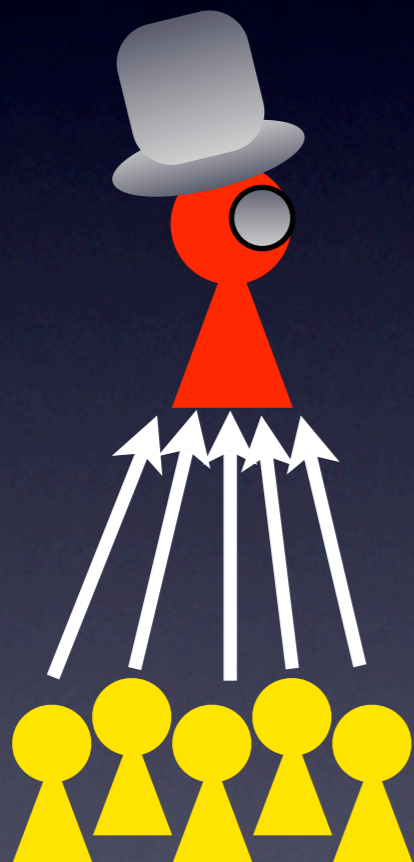
Can we obtain a block monopoly?



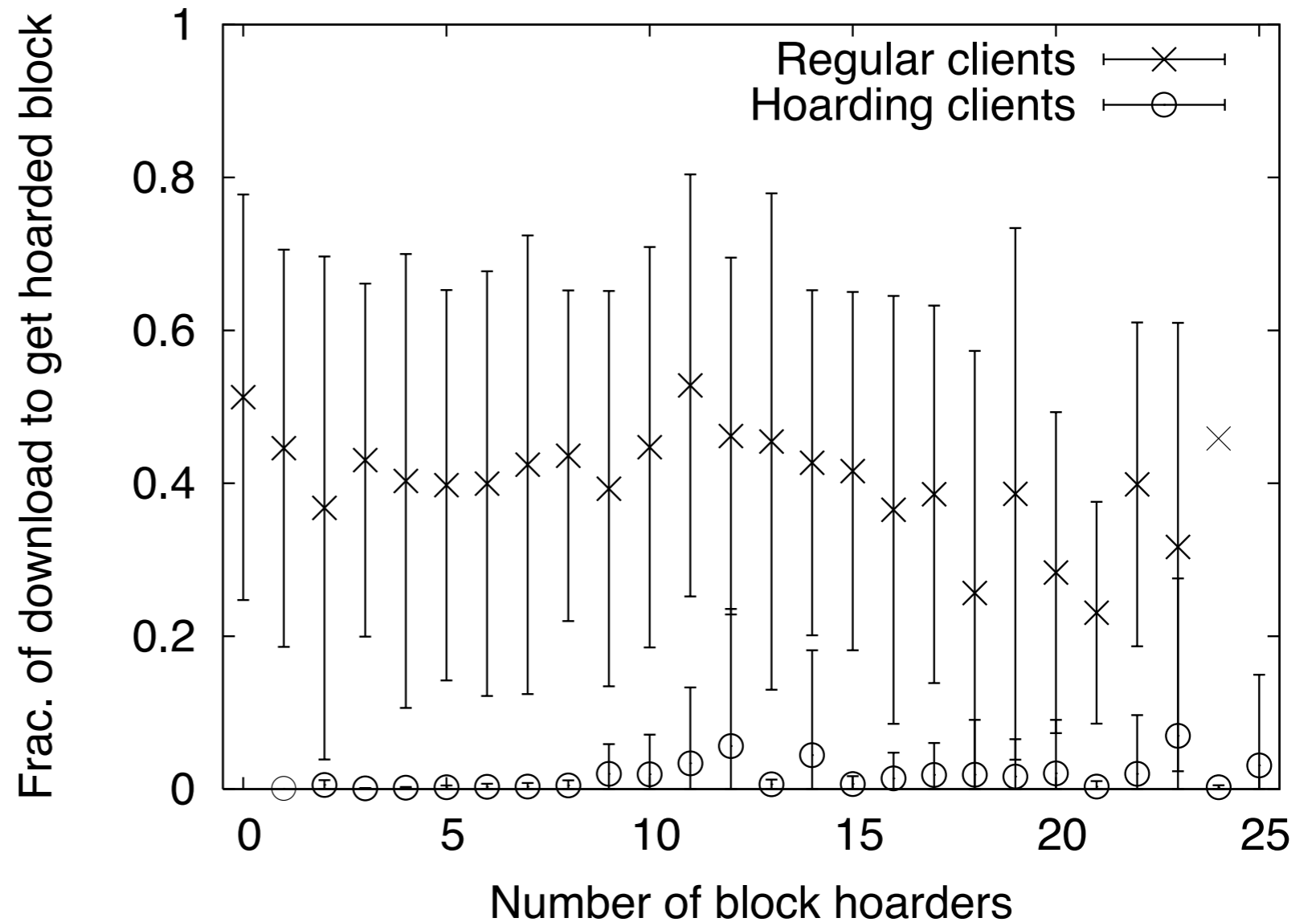
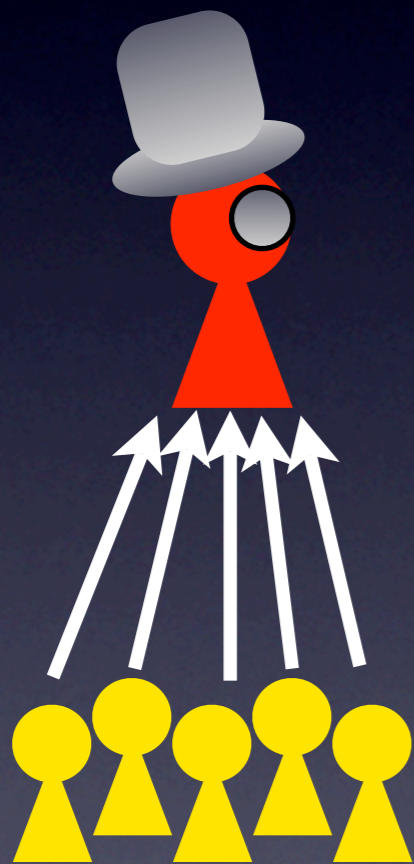
Can we obtain a block monopoly?



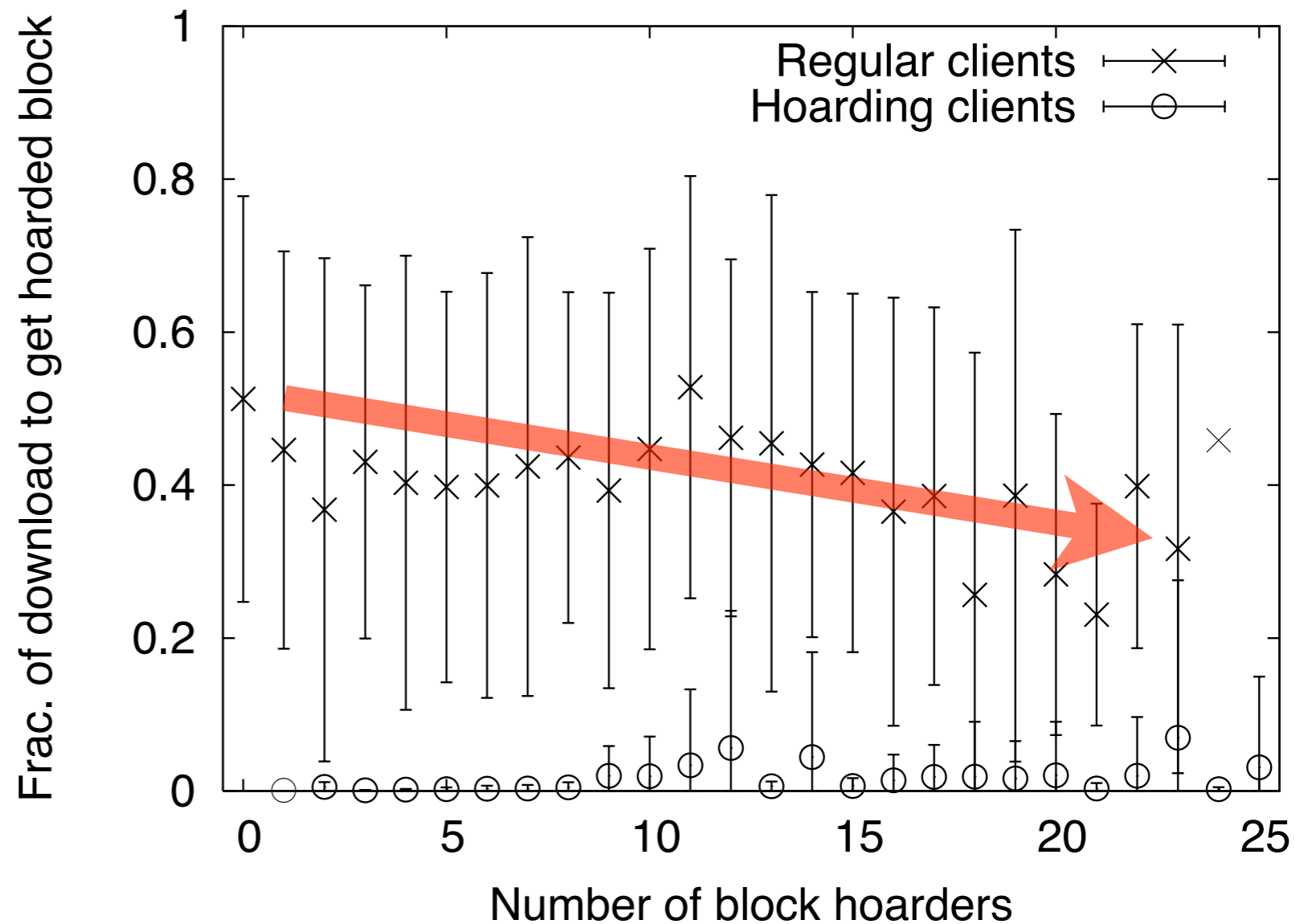
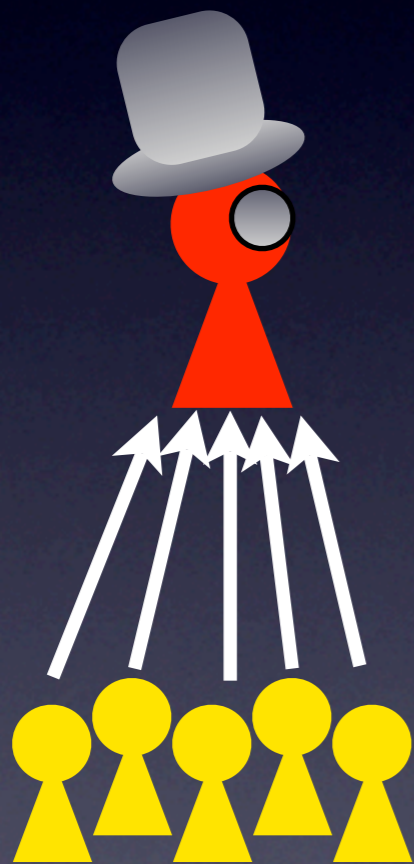
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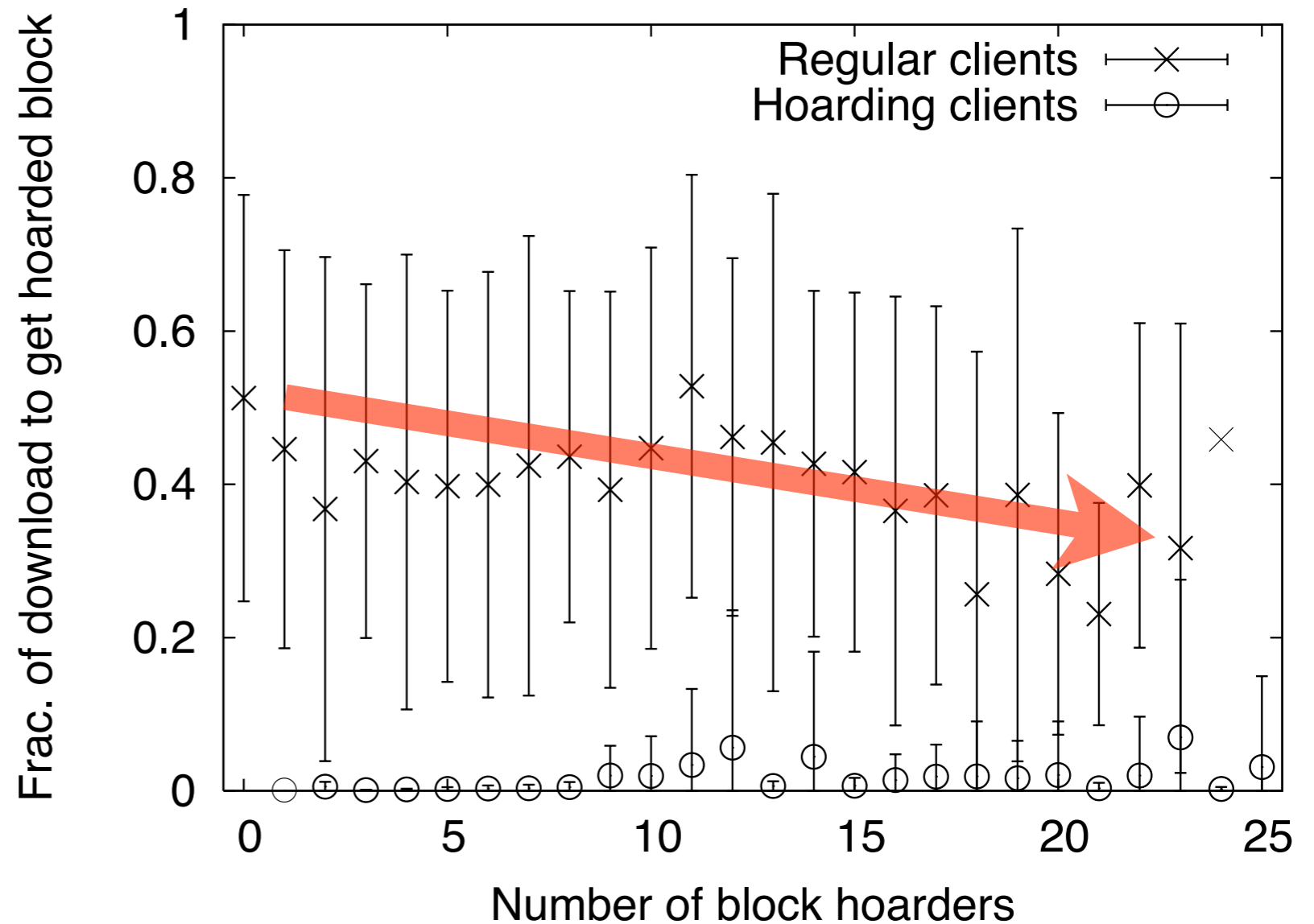
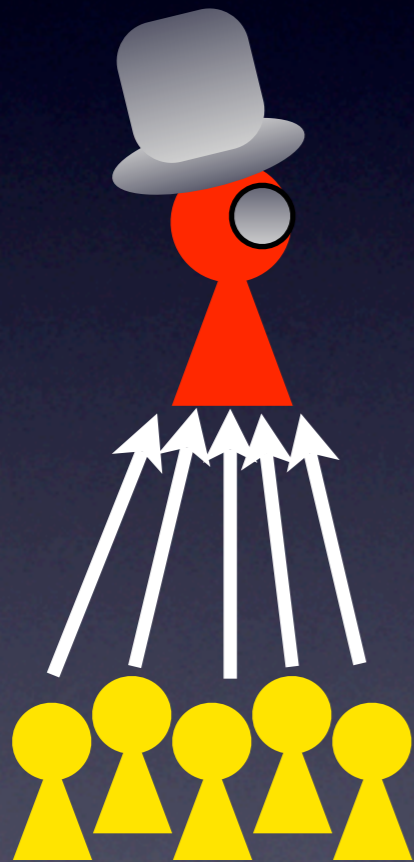
Can we obtain a block monopoly?



Can we obtain a block monopoly?



Can we obtain a block monopoly?



Rarest-first overcomes monopoly attempts