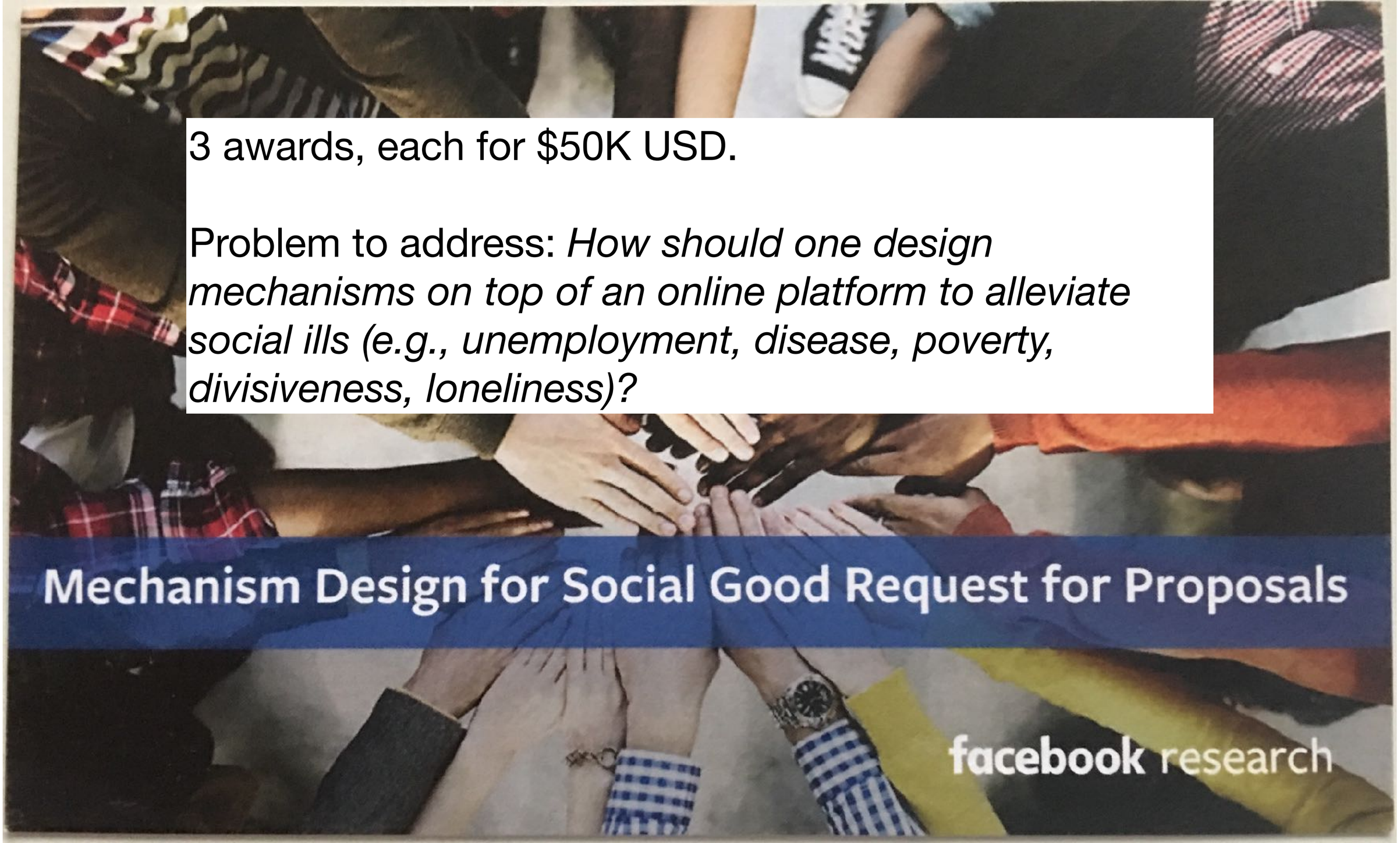
Mechanism Design

Eric Sodomka
Core Data Science @ Facebook

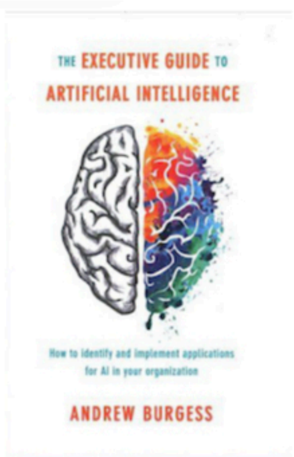
Data Science Africa 2018 - Abuja, Nigeria

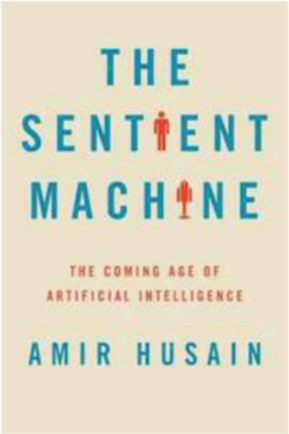


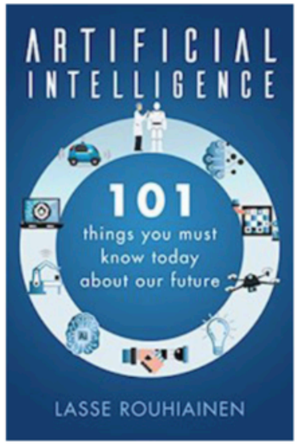
3 awards, each for $50K USD.

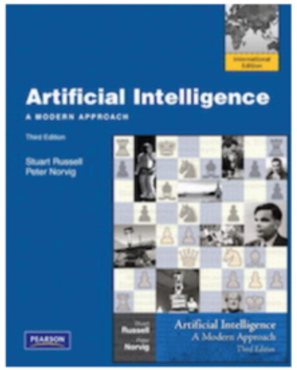
Problem to address: *How should one design mechanisms on top of an online platform to alleviate social ills (e.g., unemployment, disease, poverty, divisiveness, loneliness)?*

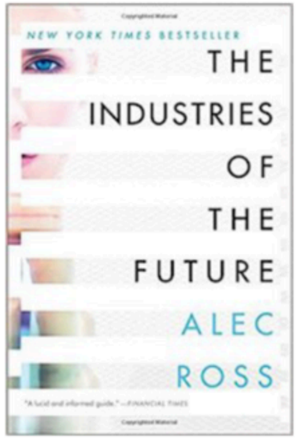
The Problem: Giving out Books

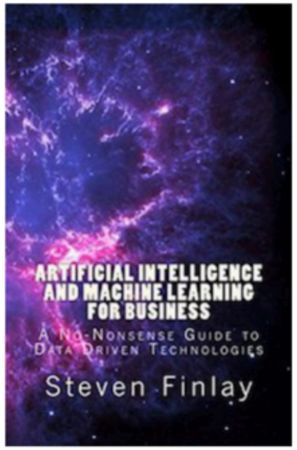


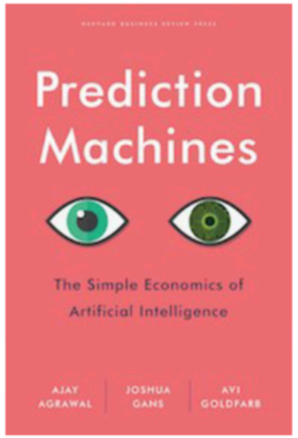


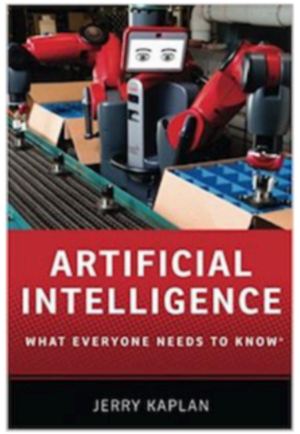


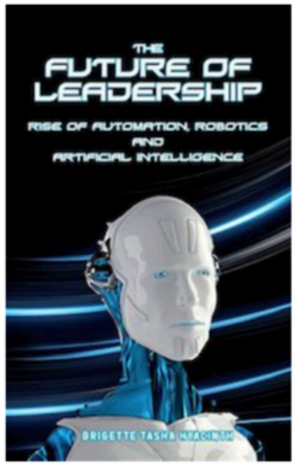


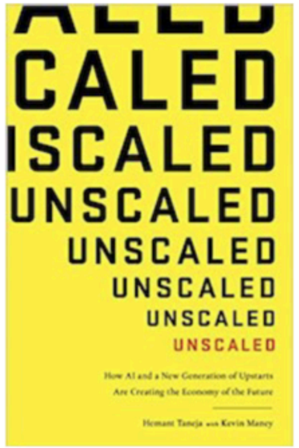












An Initial Proposal

Random Assignment

1. **Randomly order attendees**: assign each a unique number 1 through 200.

2. In that attendee order, give each attendee a **randomly chosen book** amongst those remaining.

Discuss with your Neighbor

- Do you have any complaints about Random Assignment?
- Can you come up with anything better?

Random Assignment

1. **Randomly order attendees**: assign each a unique number 1 through 200.
2. In that attendee order, give each attendee a **randomly chosen book** amongst those remaining.

Done? Join Facebook Group **Mechanism Design @ Data Science Africa** goo.gl/bGFDhU.
We'll draw winners from that group at the end of the talk to play the "book giveaway" game.

Complaints about Random Assignment?

Random Assignment

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2. In that attendee order, give each attendee a **randomly chosen book** amongst those remaining.

Complaints about Random Assignment?

- “It doesn’t consider what I want.”
- “I have to trade with people afterwards to get something better.”
- Benefit: “It’s quick and easy.”

Random Assignment

1. **Randomly order attendees**: assign each a unique number 1 through 200.
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Did you come up with anything better?

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Random Assignment

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Did you come up with anything better?

Choose Your Favorite

1. **Randomly order attendees**: assign each a unique number 1 through 200.

2. In that attendee order, give each attendee **the choice of their favorite book** amongst those remaining.

Random Assignment

1. **Randomly order attendees**: assign each a unique number 1 through 200.

2. In that attendee order, give each attendee a **randomly chosen book** amongst those remaining.

Can Eric allocate books on his own time?

Can Eric allocate books on his own time?

Choose Your Favorite (by proxy)

1. Have each participant submit their **preferences over books**.
2. **Randomly order attendees**: assign each a unique number 1 through 200.
3. In that attendee order, give each attendee **their favorite book** amongst those remaining, **according to their reported preferences**.

Can Eric allocate books on his own time?

Serial Dictatorship

1. Have each participant submit their **preferences over books**.
2. **Randomly order attendees**: assign each a unique number 1 through 200.
3. In that attendee order, give each attendee **their favorite book** amongst those remaining, **according to their reported preferences**.

Evaluating Mechanisms

- How is **Serial Dictatorship** better than **Random Assignment**?
- What does it mean for a mechanism to be “good”?

One Notion of Goodness

- An outcome is **pareto optimal** if you can’t make someone better off without making someone else worse off.

- An outcome is pareto optimal if there is no alternative outcome for which (1) everyone is at least as happy, and (2) someone is happier.

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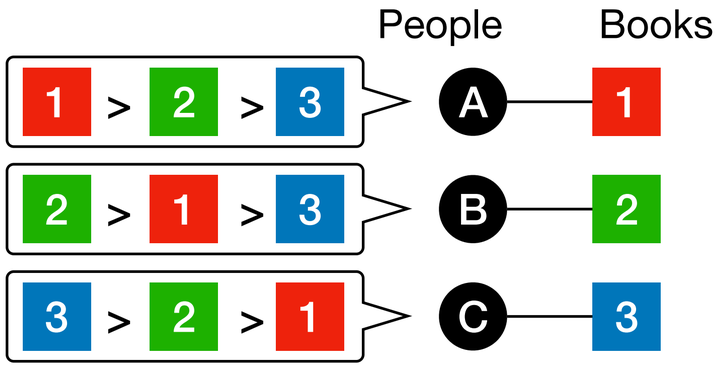
Is this outcome pareto optimal?



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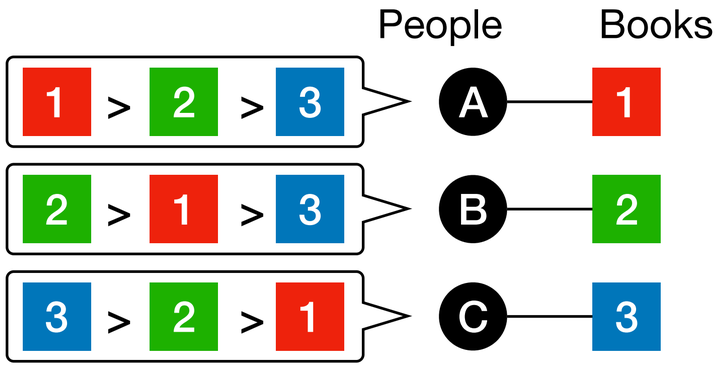

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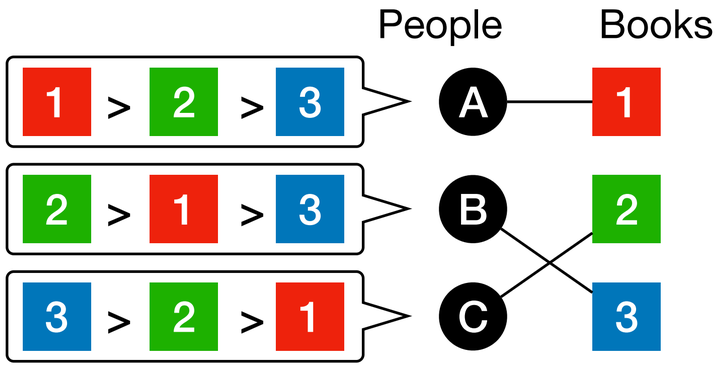

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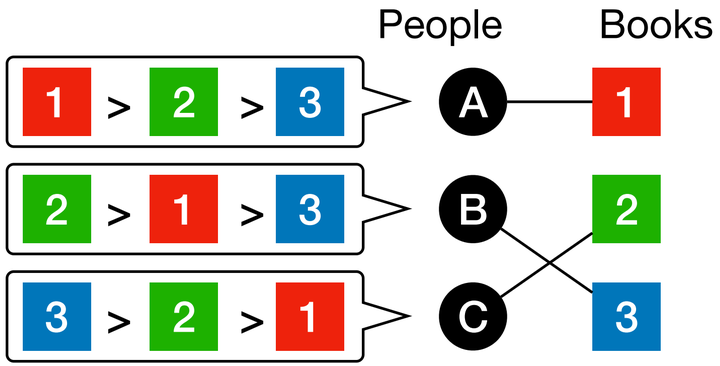

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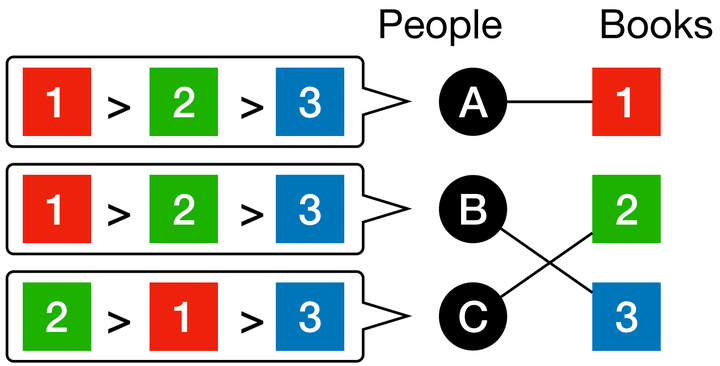

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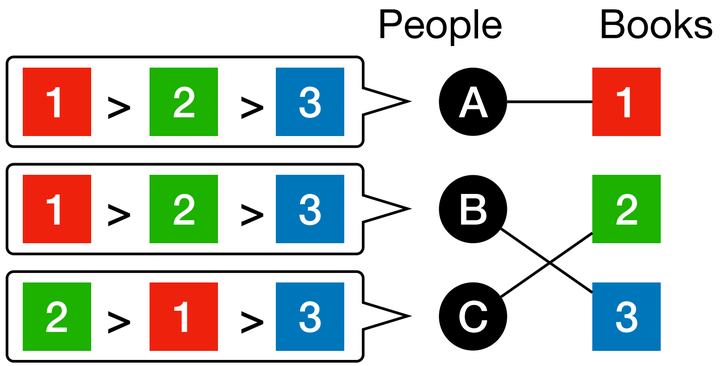

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Is the Serial Dictatorship outcome always Pareto Optimal?

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Recall

Serial Dictatorship mechanism**:**
(1) Randomly order people. (2) Match each person with their most-preferred available book.

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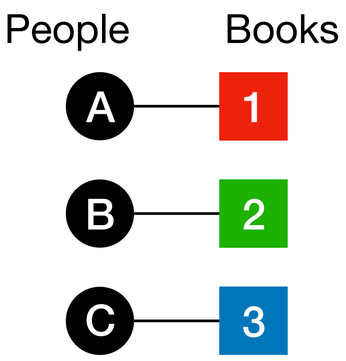

Outcome from Serial Dictatorship

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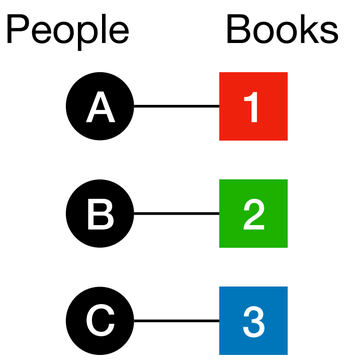

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Can we find a “better” outcome where everyone is just as happy, and some are happier?

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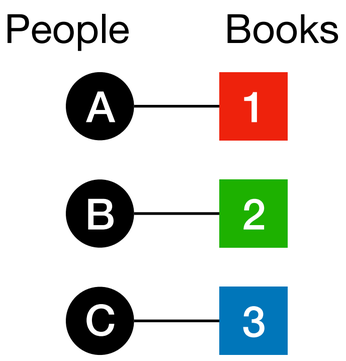

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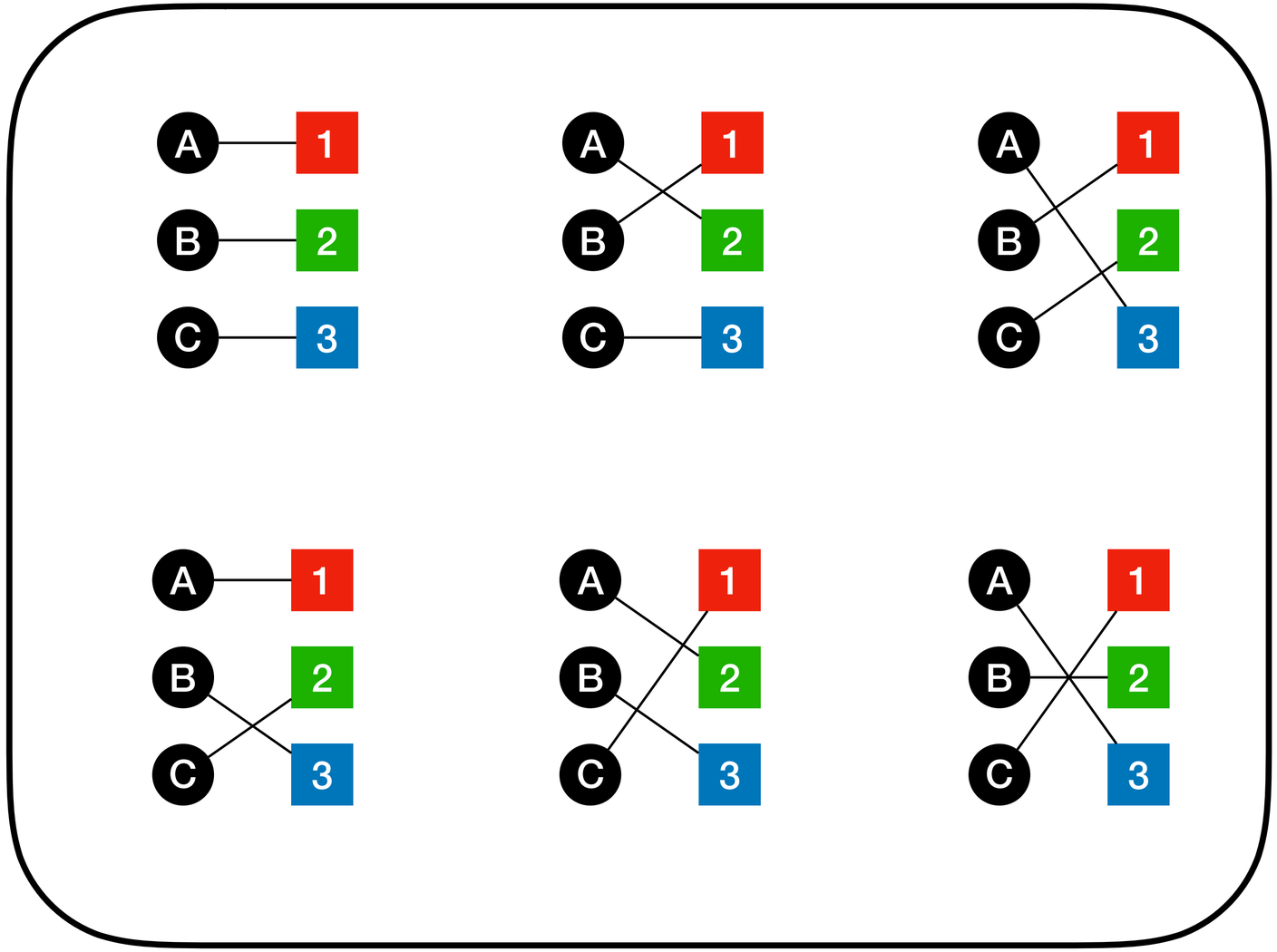
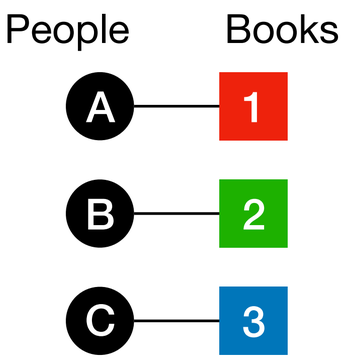


All possible outcomes (where everyone is matched)

Is the Serial Dictatorship outcome always Pareto Optimal?



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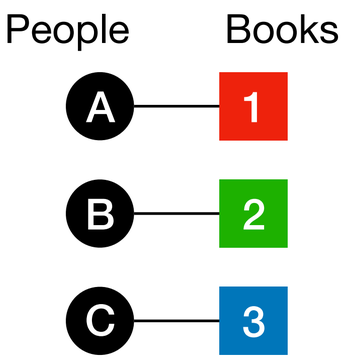

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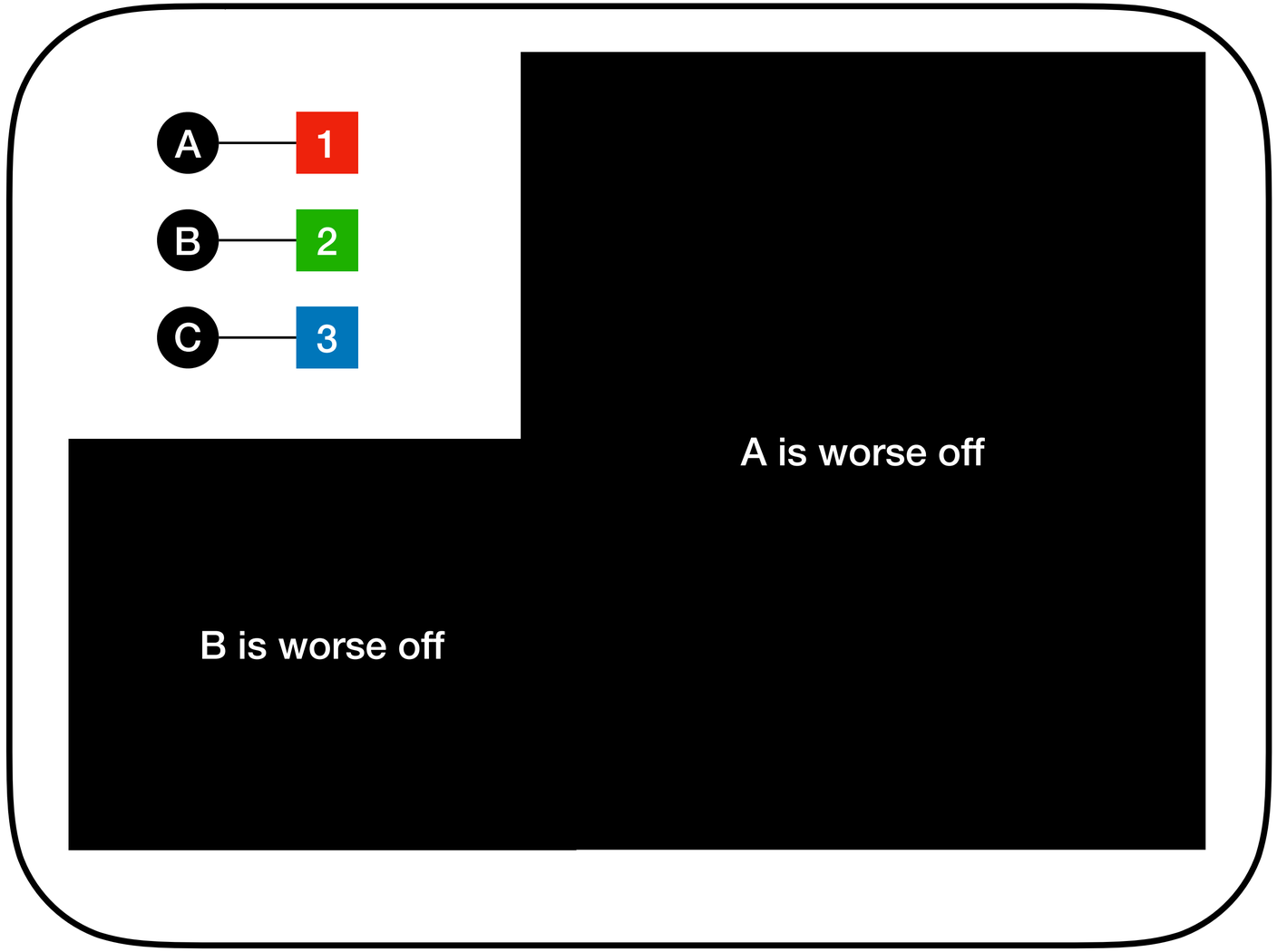

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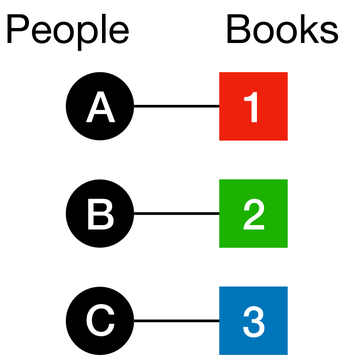

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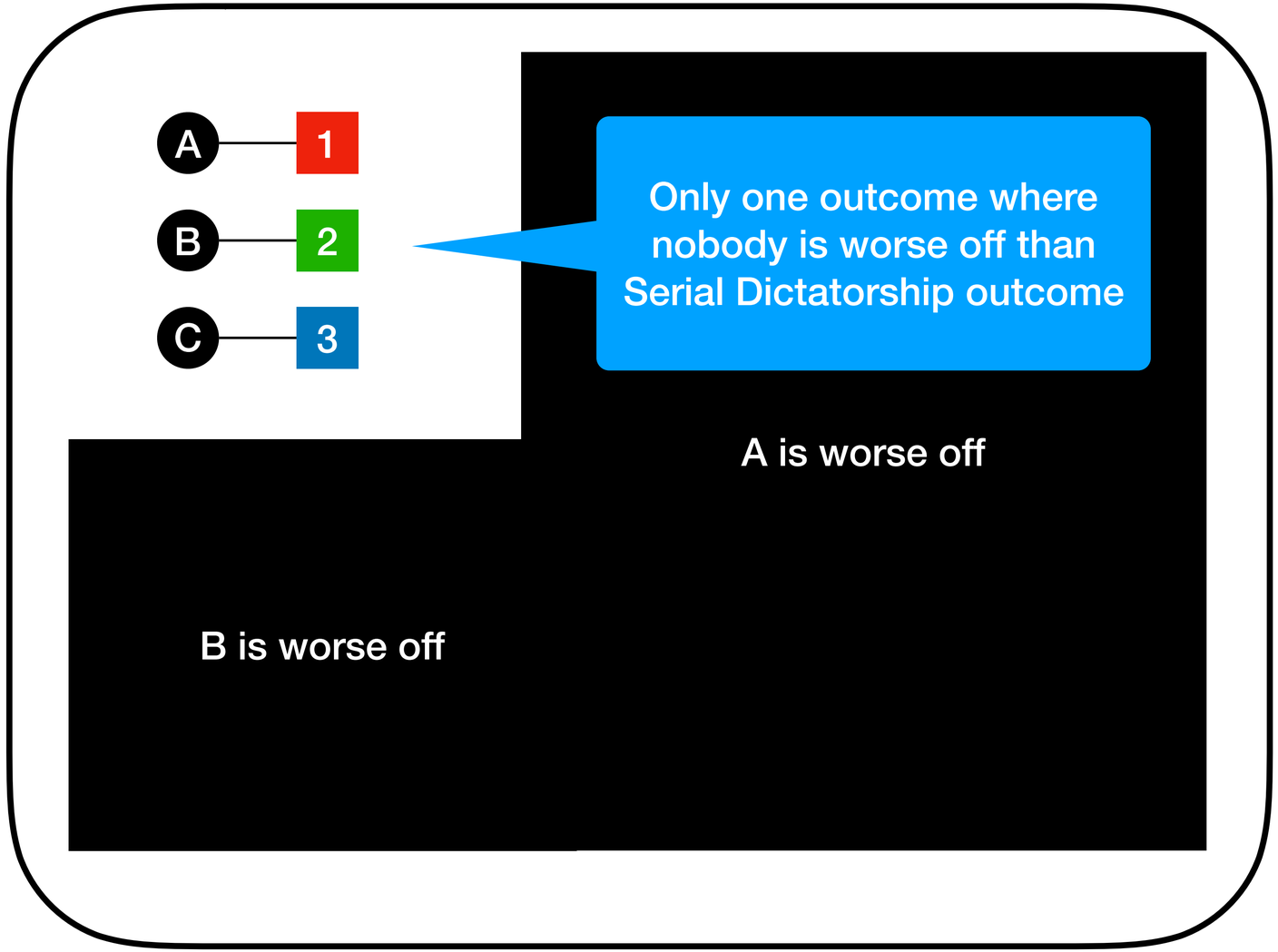

All possible outcomes (where everyone is matched)

Another Notion of Goodness

- A mechanism is **strategyproof** if honesty is the best policy.
- A mechanism is strategyproof if lying about your preferences can’t make you better off.

Is the Serial Dictatorship strategyproof?

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- Your reported book preferences don’t affect your turn order.

Is the Serial Dictatorship strategyproof?

- Your reported book preferences don’t affect your turn order.
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- Your reported book preferences don’t affect your turn order.
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- Thus, your reported book preferences don’t affect what books are available on your turn.

Is the Serial Dictatorship strategyproof?

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- Serial Dictatorship gives you the best available book on your turn (according to reported preferences).

Is the Serial Dictatorship strategyproof?

- Your reported book preferences don’t affect your turn order.
- Your reported book preferences don’t affect what anyone before you gets.
- Thus, your reported book preferences don’t affect what books are available on your turn.
- Serial Dictatorship gives you the best available book on your turn (according to reported preferences).
- Thus, any misreport of preferences could only result in you getting a book you like less.

What if we swapped steps 1 and 2?
Is it strategyproof?

Serial Dictatorship

1. Have each participant submit their **preferences over books**.
2. **Randomly order attendees**: assign each a unique number 1 through 200.
3. In that attendee order, give each attendee **their favorite book** amongst those remaining, **according to their reported preferences**.

The Abridged Serial Dictatorship

Abridged Serial Dictatorship

1. Have each participant submit their preferences over their **top K** books.

2. Randomly order attendees.

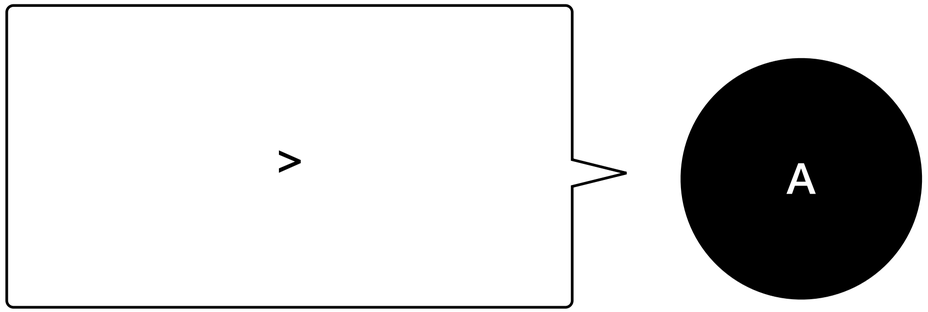
3. In that order, give each attendee their favorite book amongst those remaining, according to their reported preferences. **If all their favorite books are gone, give them nothing.**

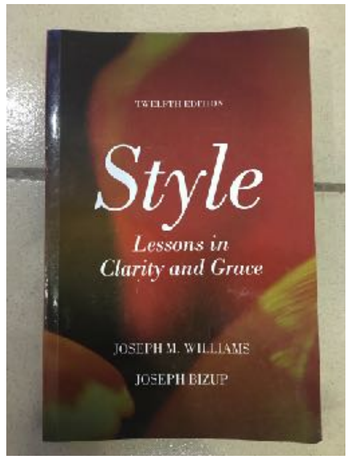
Serial dictatorship: full list

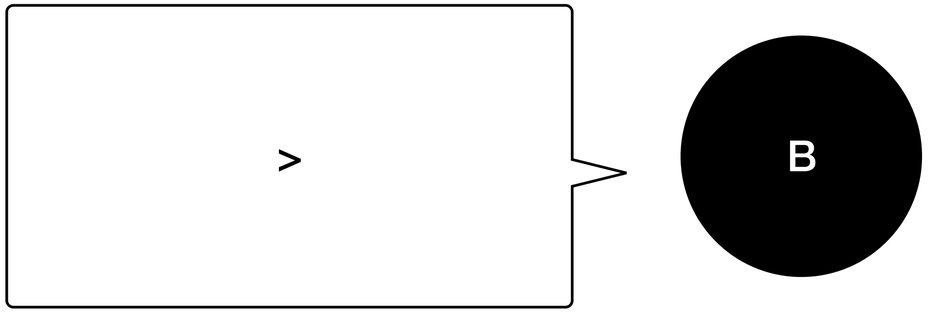
Abridged Serial dictatorship: truncated list

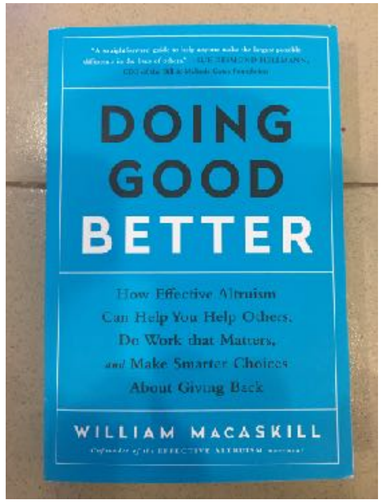
Is the Abridged Serial Dictatorship strategyproof? (example)

Example 1: Serial Dictatorship

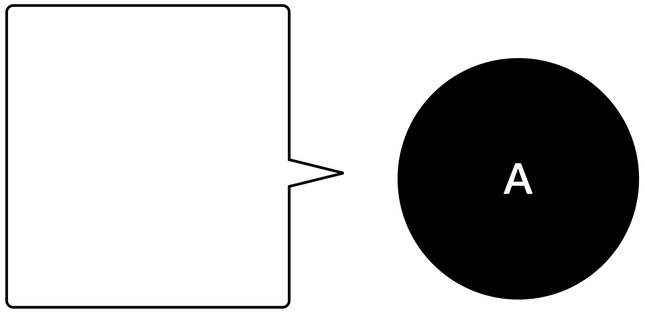


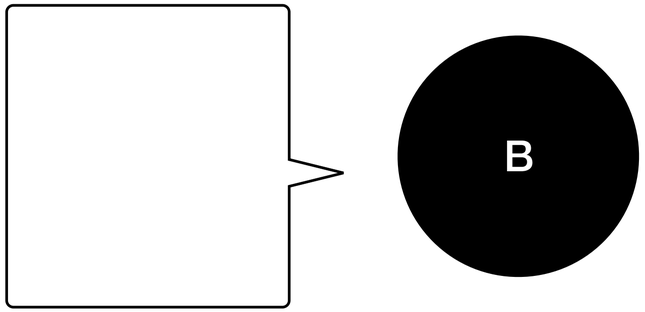






Example 2: Abridged Serial Dictatorship





Things to remember

- The rules of the game matter
- Small changes to the rules can make a big difference

Discussion

- Can you think of other systems that you regularly participate in that are clearly not strategyproof, or that do not produce Pareto optimal outcomes?

- What are some problems that feel similar to“book giving” problems? What’s the general version of the problem?

prediction markets

voting

online labor markets

two-sided matching

cryptocurrency

online learning

crowdsourcing

auctions

reputation systems

team formation

money-burning mechanisms

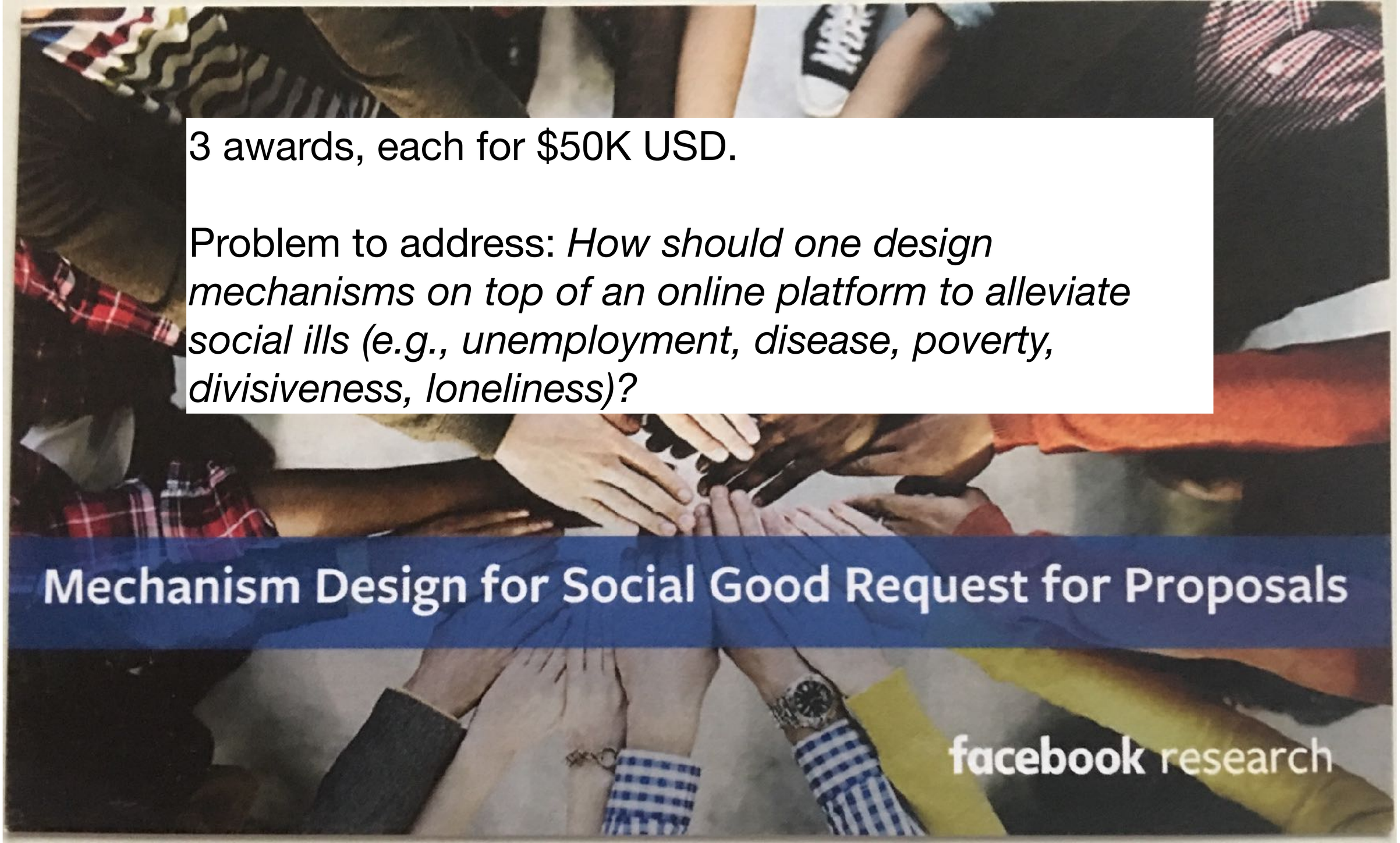
Next Step: Join Facebook Group

Mechanism Design @ Data Science Africa goo.gl/bGFDhU

- This talk based on first lecture of course by Tim Roughgarden: *Incentives in Computer Science.* Available online!
- Resources for learning more about mechanism design
- Resources for getting involved in the mechanism design community
- Announcements for Mechanism Design for Social Good proposals ($150K in grants in 2018)

WINE 2018: The 14th Conference on Web and Internet Economics

December 15-17, 2018, Oxford, United Kingdom



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