How Gamification Affects Physical Activity:

Large-scale Analysis of Walking Challenges in a Mobile Application

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STANFORD INFOLAB

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Inactivity Pandemic

- Physical activity is critical to human health
  - Helps prevent heart disease, stroke, and diabetes, and maintain a healthy weight

- 79% of US adults not active enough (acc. to guidelines)
  - ≥150 minutes MVPA / week
  - Similar patterns worldwide

- Inactivity contributes to ~5.3 million deaths per year worldwide (Lee et al., 2012)

Promise of Gamification

- Exergaming: Video games that are also a form of exercise
  (Sinclair et al., 2007) (Lin et al., 2007) (Göbel et al., 2010) (Staiano et al., 2011) and many others

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- Pokémon Go
  - 650M downloads
  - Added ~144 billion steps to US physical activity within first month (Althoff et al., 2016)

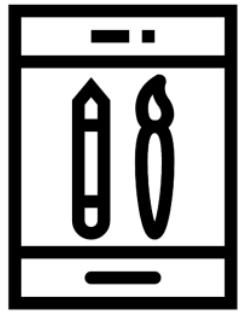
This Work: Research Question

How do competitions affect physical activity?

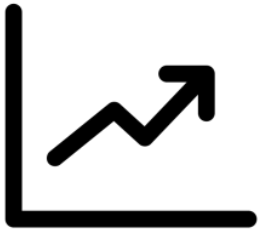
Research Questions

1. Do competitions increase activity?

2. What makes a competition engaging?



3. Can we predict competition engagement?

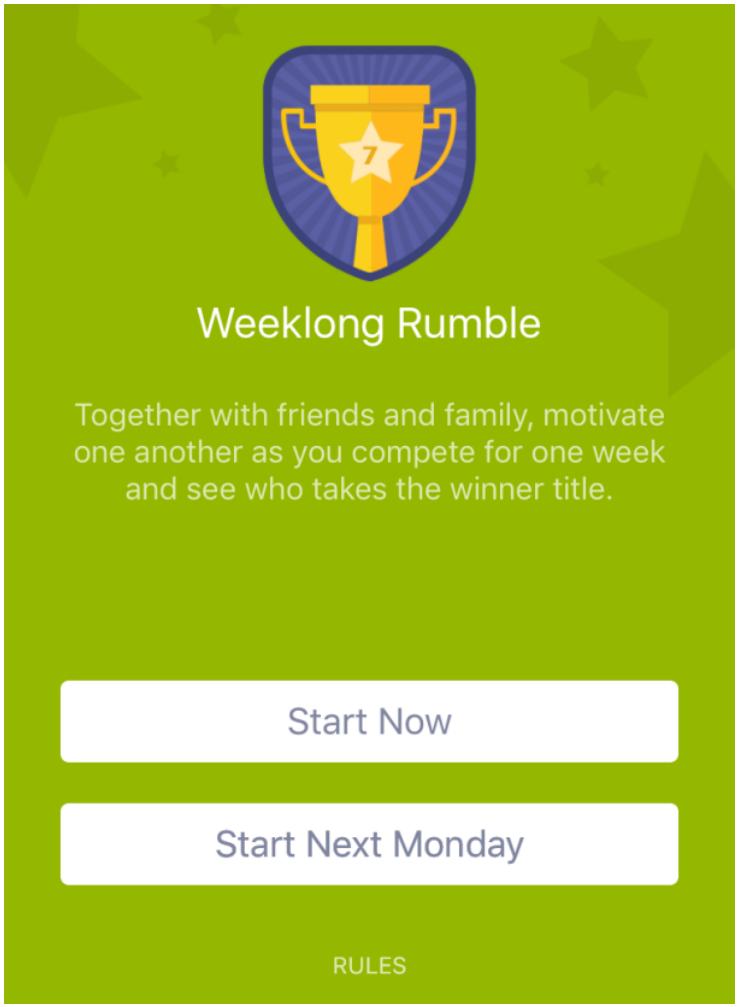


Competition Dataset

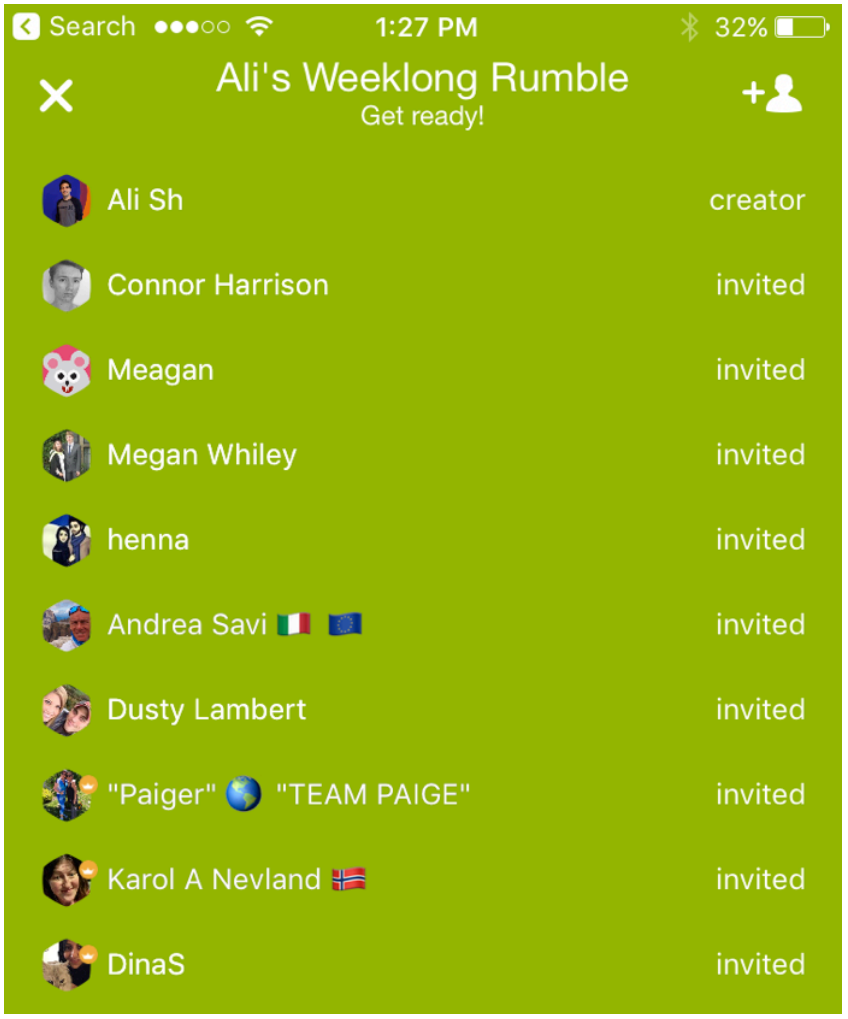
- Argus activity tracking app by Azumio
- 6763 competitions
  - All competitions run for 7 days (Mon – Sun)
  - 2432 competitions with at least 3 participants
  - Whoever takes most steps in total wins
- 3637 users: 51% female, median age 34, 53.2% overweight or obese, 6164 avg. daily steps
- 70k days tracked within competitions (535M steps)
- 818k days tracked outside competitions
- Advantages: Scale, diverse population, objective activity measures, pre-competition control

Competition Mechanics

Start competition

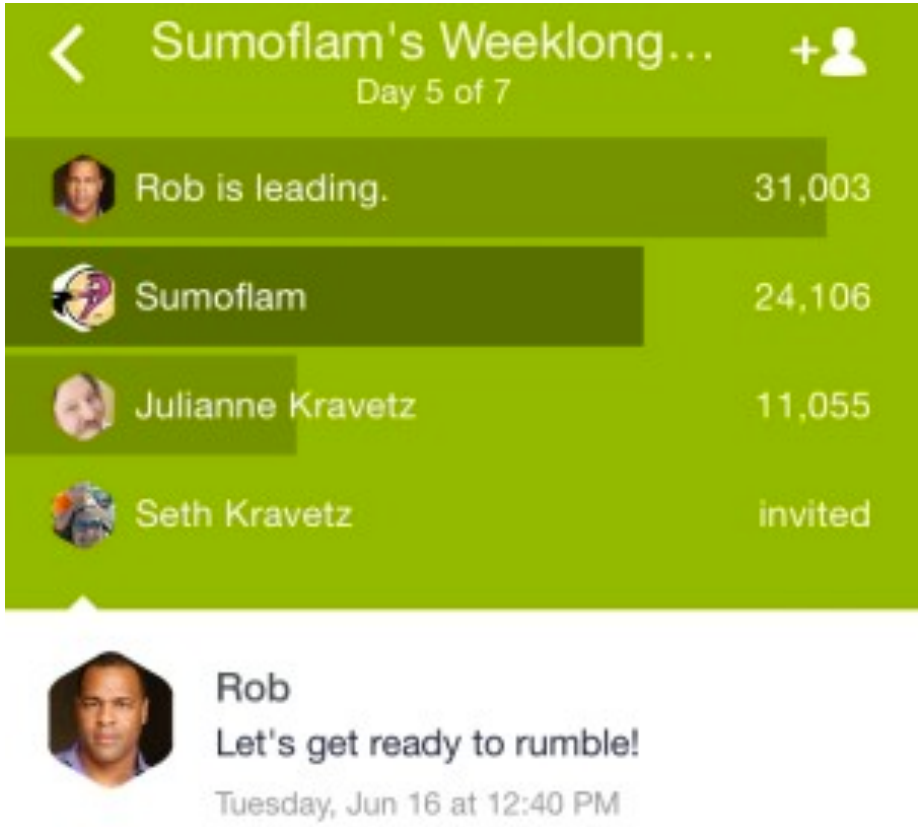


Invite others



Competition Mechanics (2)

Visible Leaderboard



Reward / Achievement

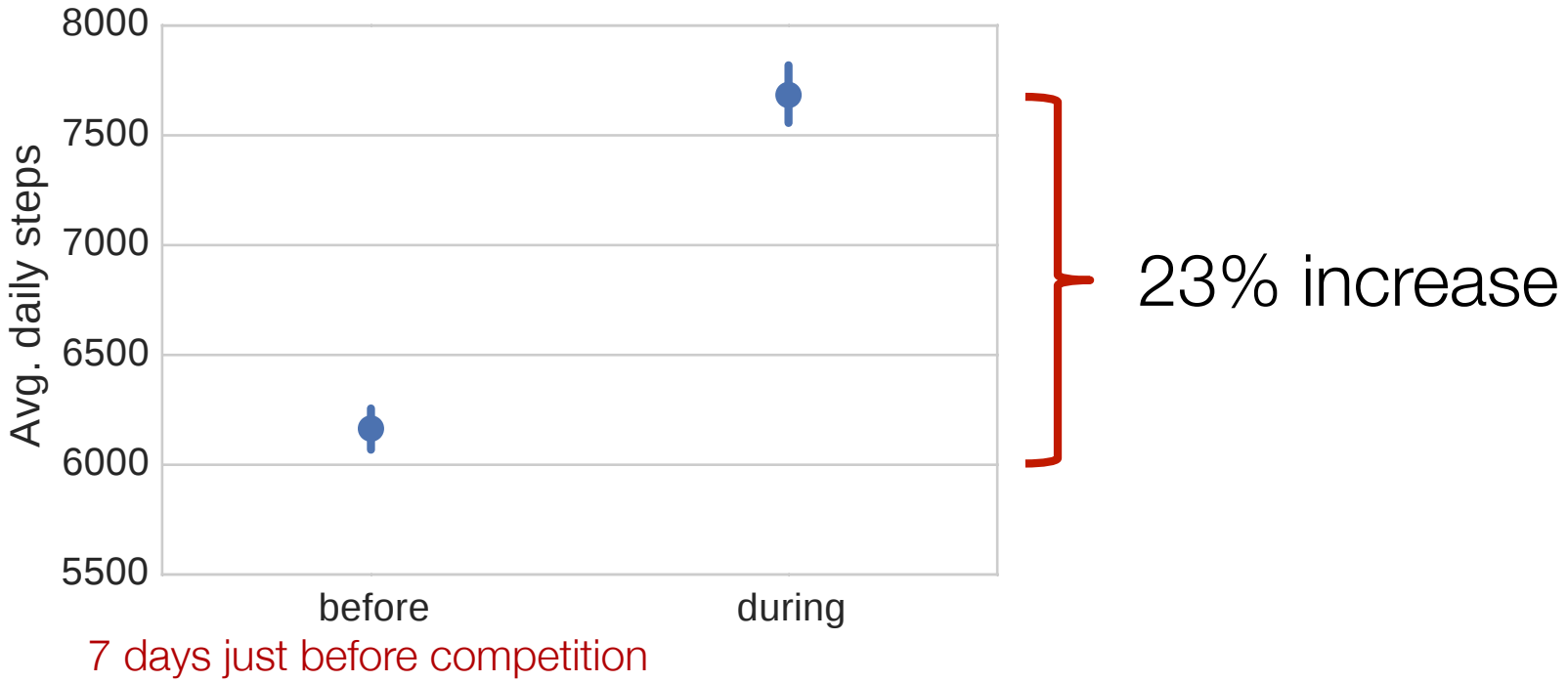
Do competitions *increase* activity?

Competing Hypotheses

Do competitions *increase* activity?

1. Of course!
   - Feedback on others' activity
   - Want to be perceived favorably
   - Reason to be more active
   - Making exercise more fun
2. Of course not!
   - Top ranked competitors might get "lazy"
   - Bottom ranked competitors might get discouraged

Yes, Competitions Increase Activity!



7 days just before competition

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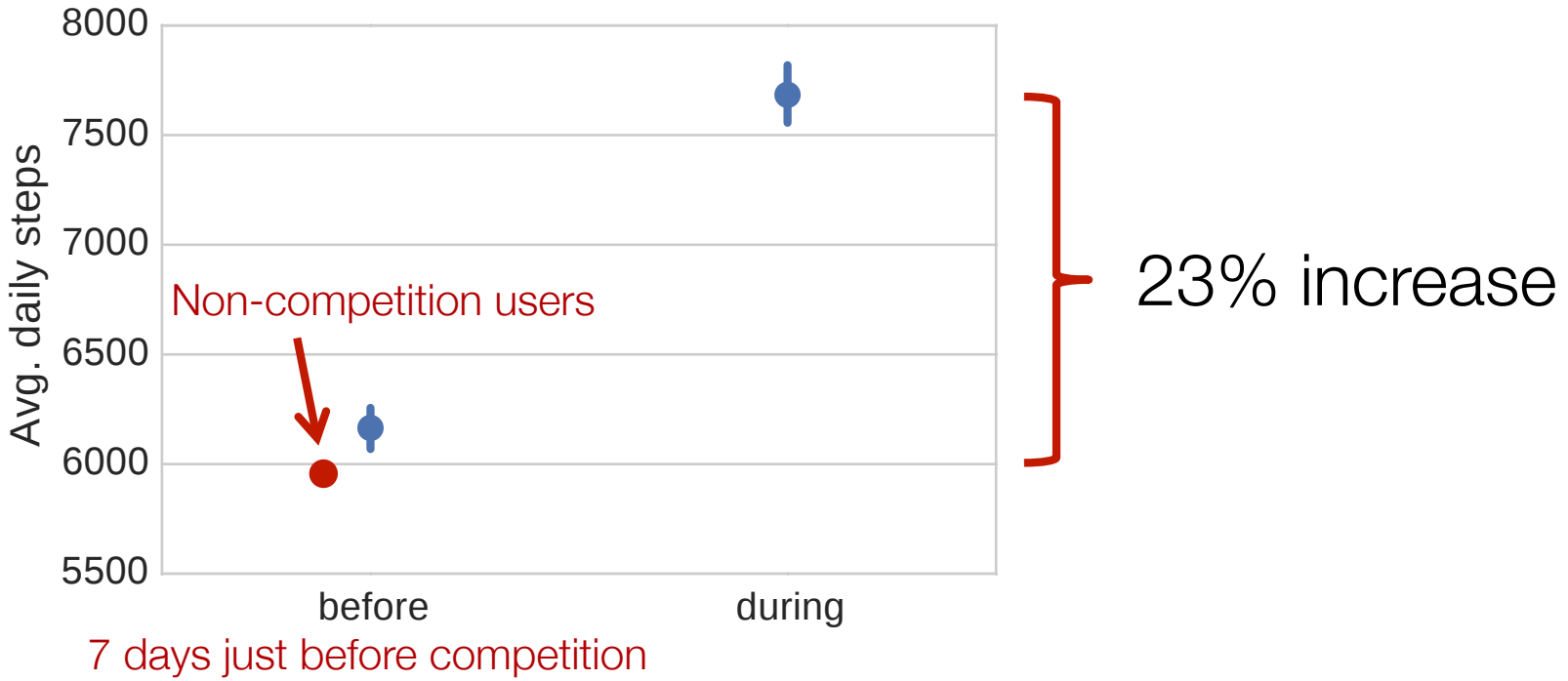

- Users self-select into competitions
- Evidence that effect also holds for non-competition users
  - Users with & without competitions were very similar in terms of age, gender, weight status, and physical activity levels (6164 vs. 5924 avg. daily steps)

Competition Effect Across Demographics

- Gender: Female (23%), male (23%)
- Age: 22-30% increases across all age groups (10-60 years)
- Body Mass Index: 29% increase for severely obese users (BMI > 35)
- Activity level: Inactive users (1-3k steps/day) increase activity by 60%

→ Large effects across wide variety of demographics

What makes a competition *engaging*?

Engaging Competitions

- How predictable are competitions?

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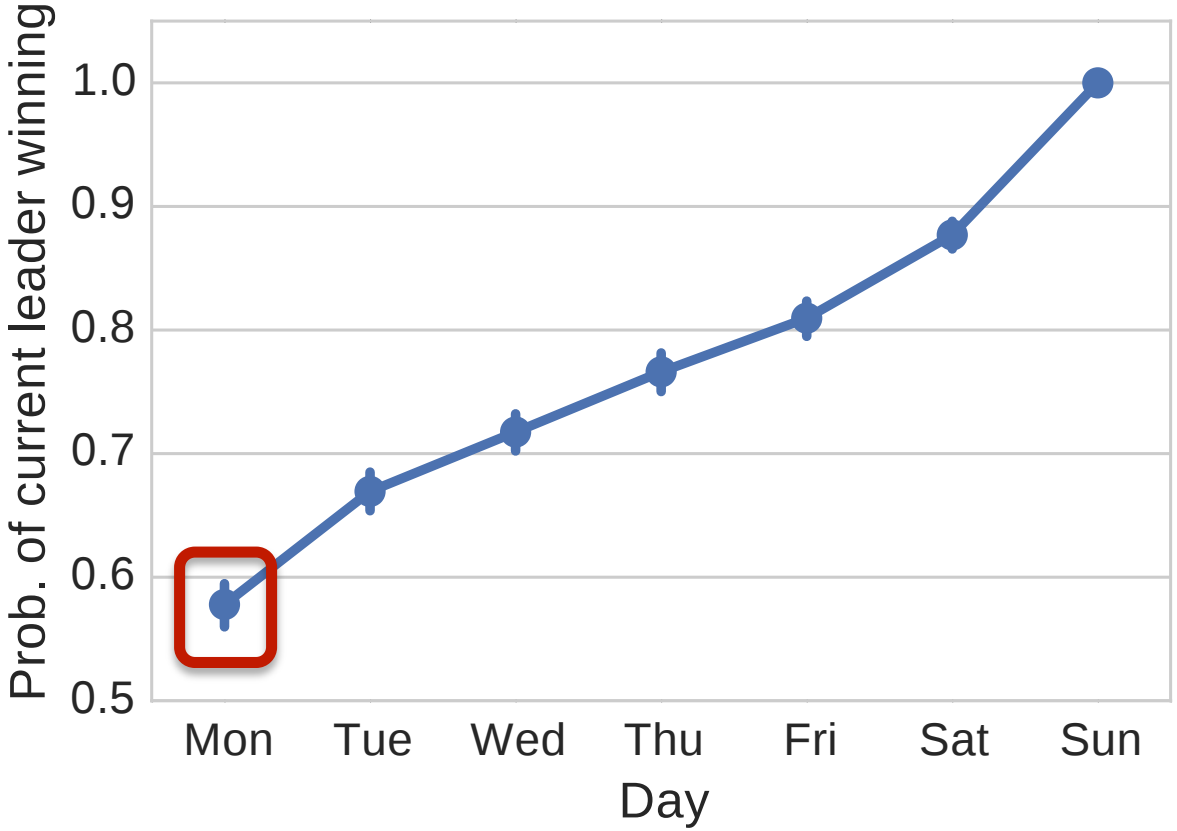
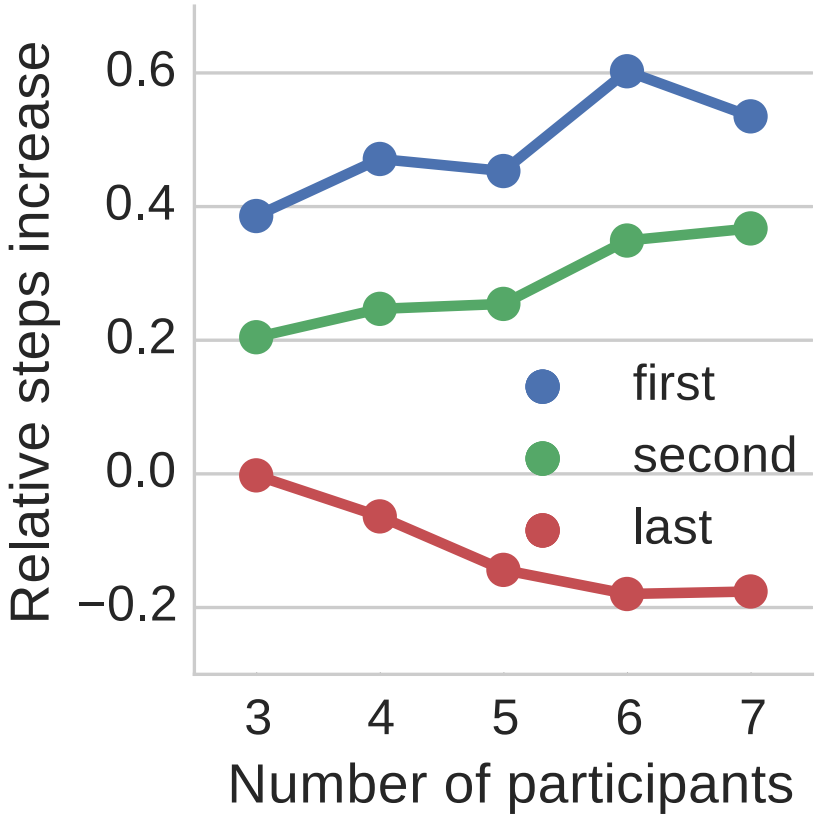


- Monday evening favorite wins 58%

What Does It Take To Win?



- Winners increase activity by 40% or more
- Last-in reduces activity by up to 20%

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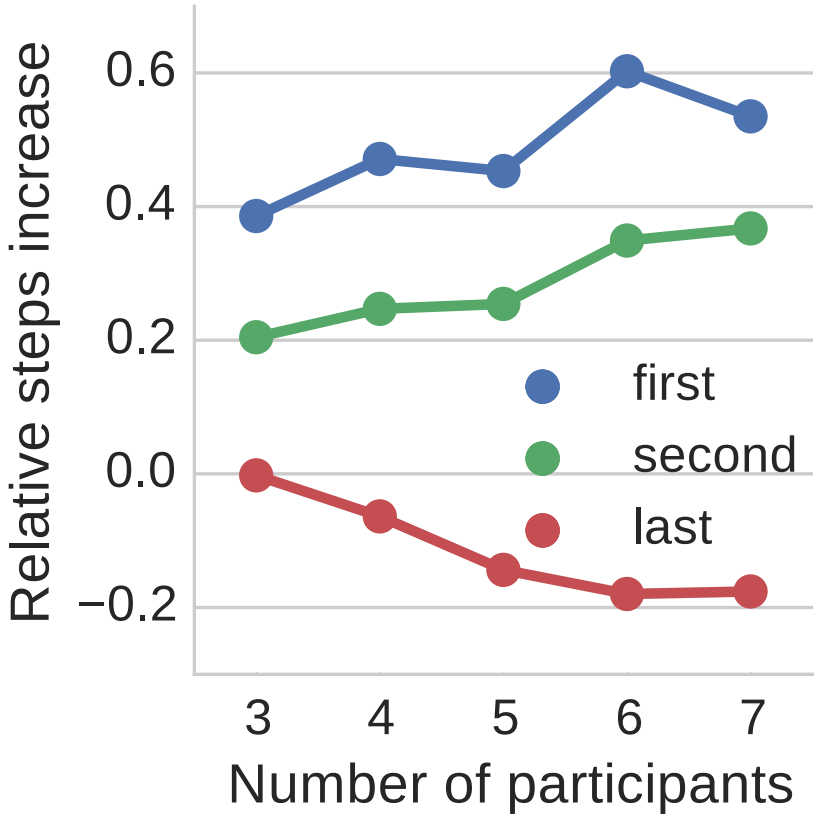

Are competitions demotivating the last-in person?

- Winners increase activity by 40% or more
- Last-in reduces activity by up to 20%

Two Hypotheses

1. Do winners increase activity at the expense of demotivating others?

2. Or did the last-ranked person "just have a bad week"? That is, they would *not* have been more active without competition?

Are Competitions Only Good for Winners?

Simulation

- Sample everyone's activity from their pre-competition history (non-parametric)
  - No (de)motivation here, just repetition
- Sum & rank from first to last
- For last: How much worse is week from previous activity?

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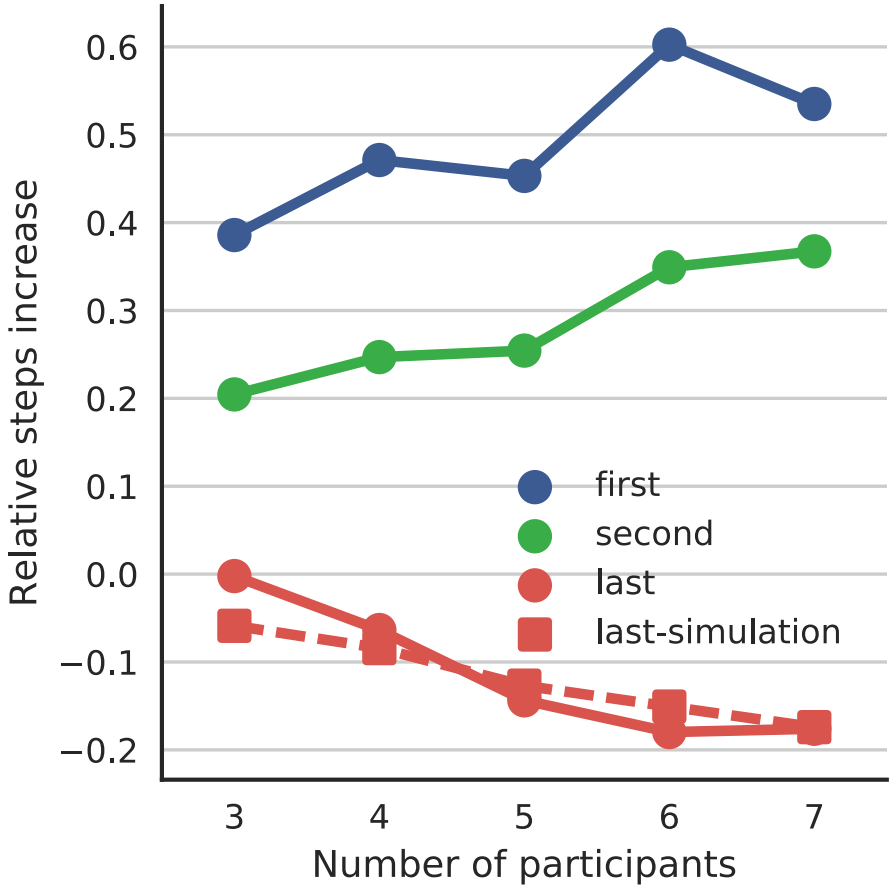

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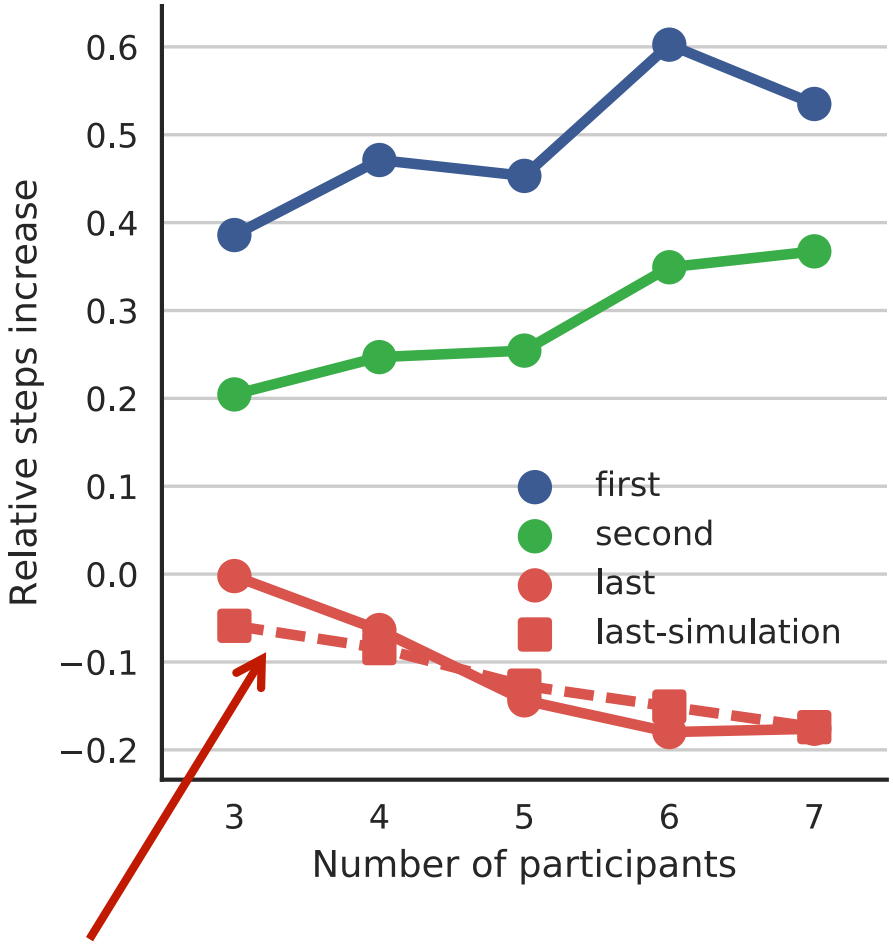
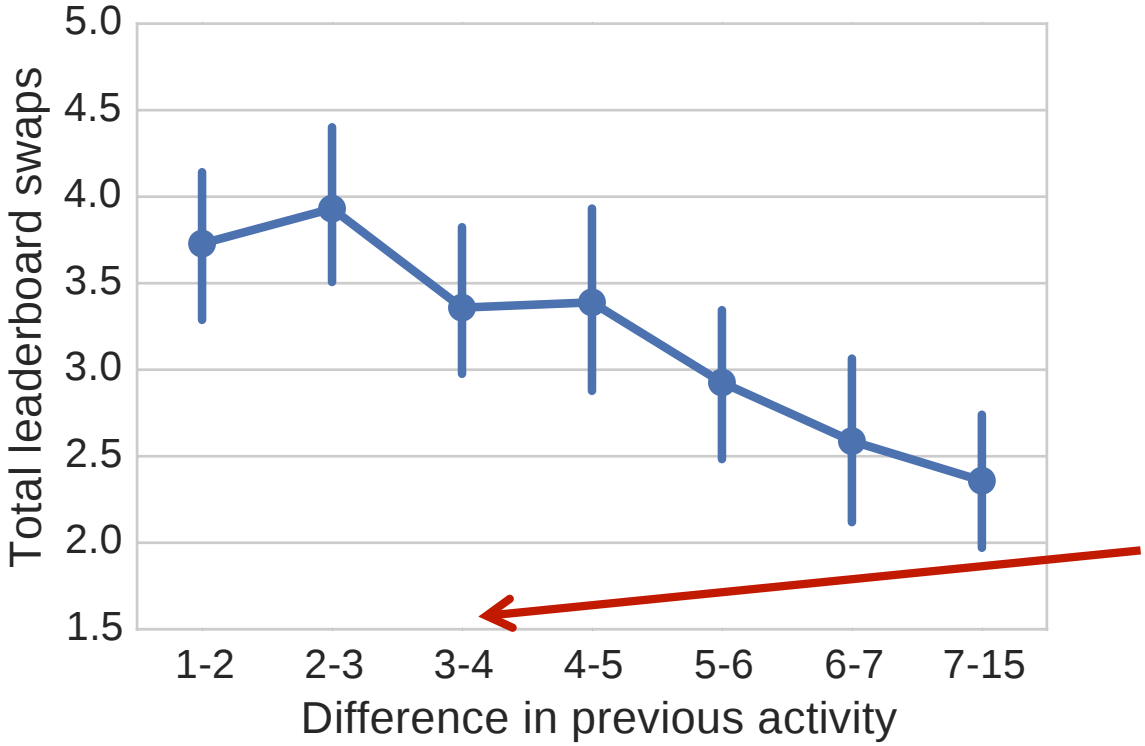


Competitions are not demotivating for the last person!

Evenly Matched Competitions

- How small should difference between most and least active (pre-competition) for an engaging competition?



Example:
Most active 8k steps/day,
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→ difference of 3k steps/day

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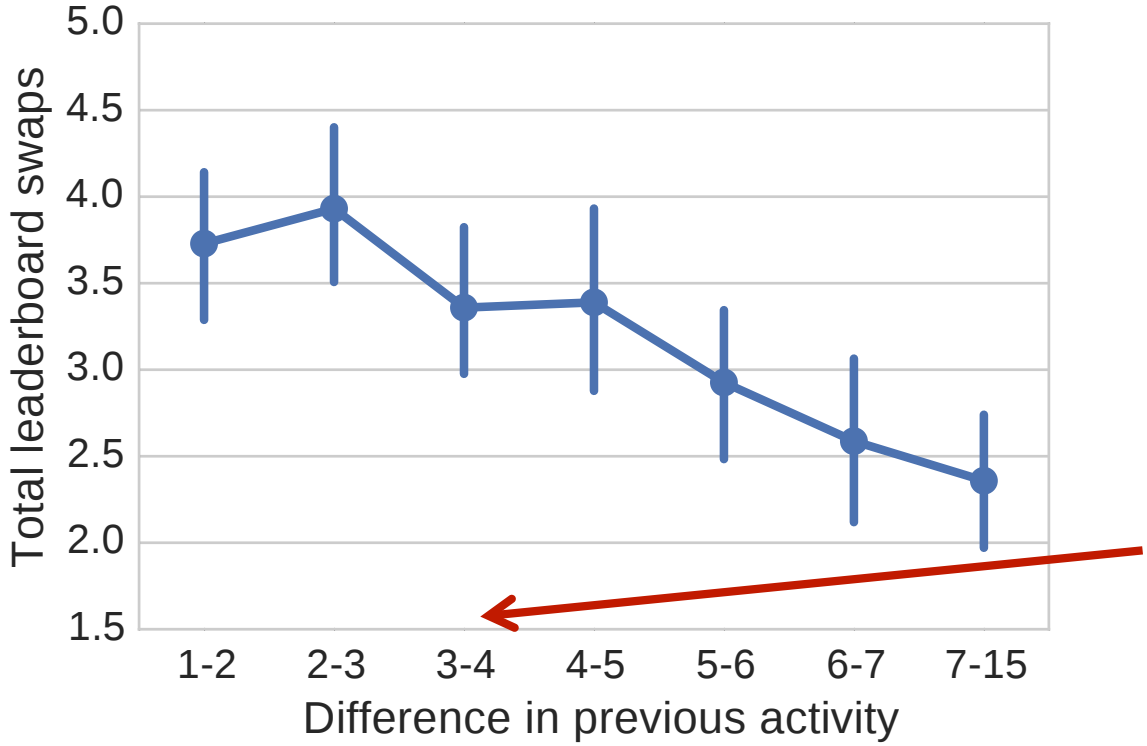

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More dynamic leaderboard in evenly matched competitions

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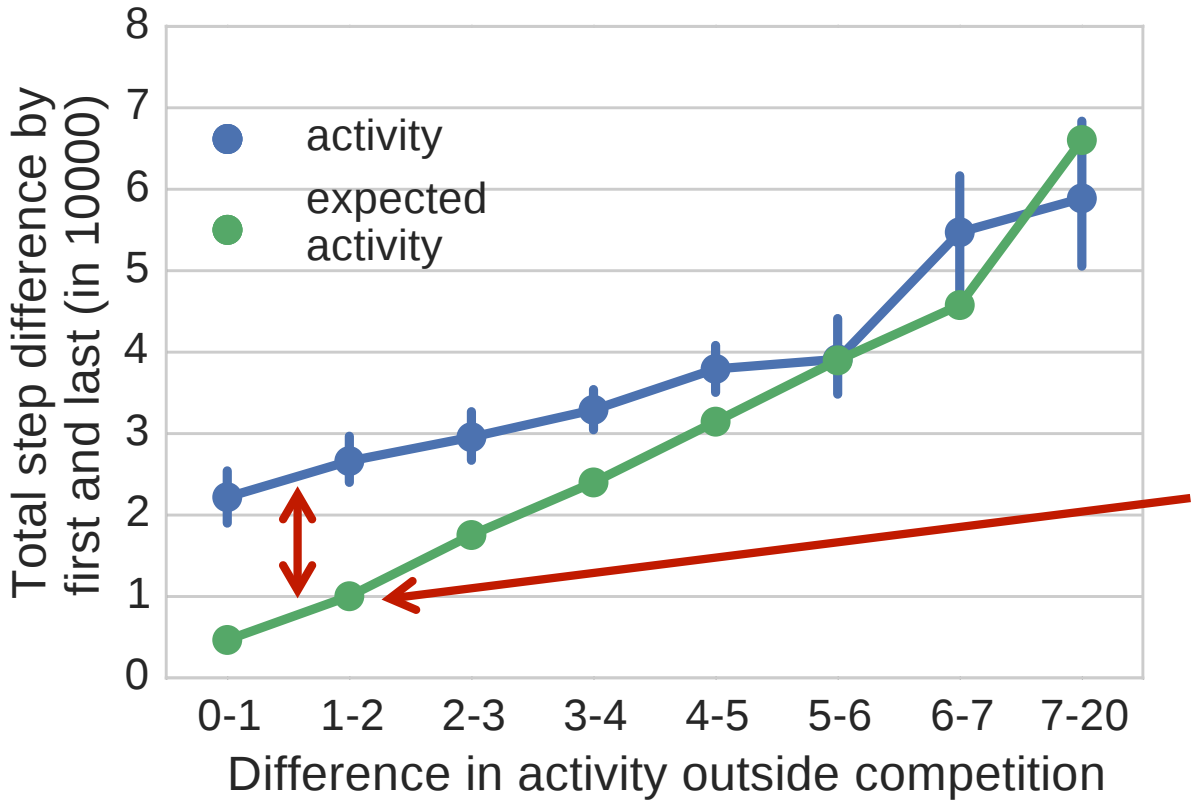

Example:

1.5k steps/day difference

* 7 days

= 10.5k steps expected final difference

Actual difference: 27k steps

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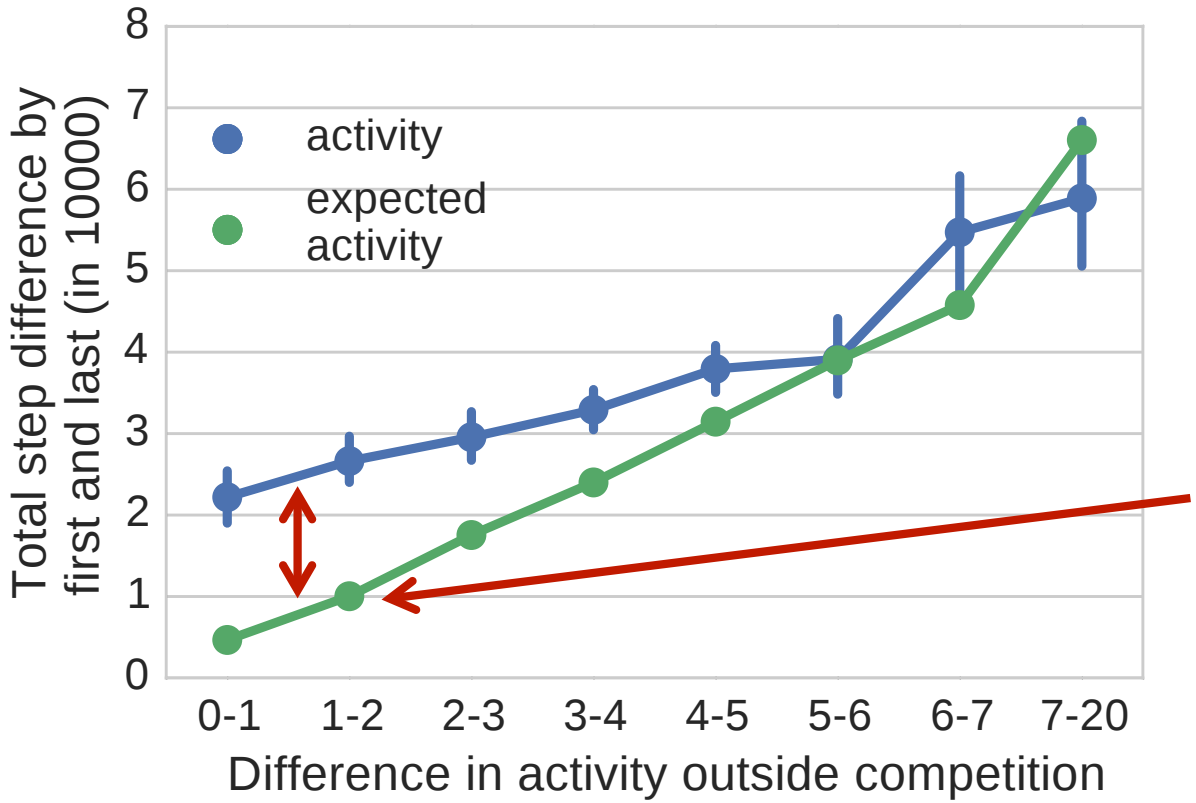

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Bigger competition effect when evenly matched

Group Composition

- Some evidence that males are more competitive than females in athletic contexts [Cashdan, 1998]
- Should men compete against other men in order to create the highest engagement?

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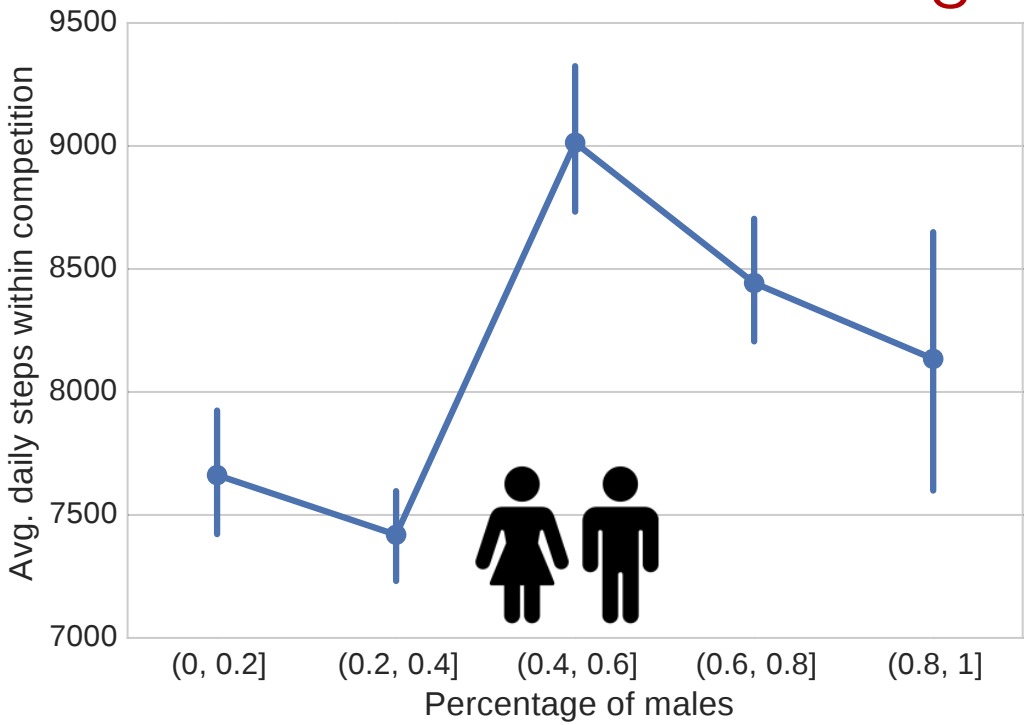


Participants are most active when competition has balanced gender ratio

Can we *predict*
competition engagement?

Prediction Task

- Factors of engaging competitions
  - Average relative increase of activity during the competition
    - Higher or lower than 20% increase?
  - Difference in total steps between first and last
    - Higher or lower than 37k steps?
  - # total leaderboard swaps
    - Higher or lower than 4 swaps?

- Prediction Setup (more details in paper)
  - Binary prediction task split at median (balanced dataset)
  - Gradient Boosted Tree models

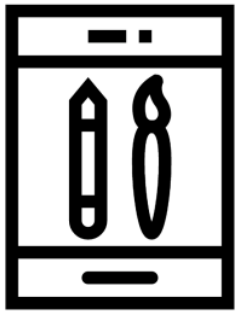
Prediction Results

- Our model can predict:
  - Average relative increase of activity during the competition (72% ROC AUC)
  - Difference in total steps between first and last (74% ROC AUC)
  - # total leaderboard swaps (61% ROC AUC)

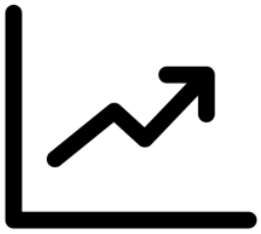
Summary: Our Results

1. Competitions lead to an average increase of 23% in physical activity across a wide variety of user demographics.

2. Design implications for more engaging competitions: E.g. match participants with similar activity levels, and balanced gender ratio.



3. Can predict which competitions will be particularly engaging ahead of time with up to 74% accuracy.



Acknowledgments

- We thank Azumio for donating data from their Argus app for independent research.

Joining faculty job market end of 2017. Please let me know about opportunities at your institution.

Ask me anything!

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