Information Cascades

Social Computing

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Lecture Topics

- Information Cascades
- Cascade Principles
- Simple Cascade Model

Following the Crowd

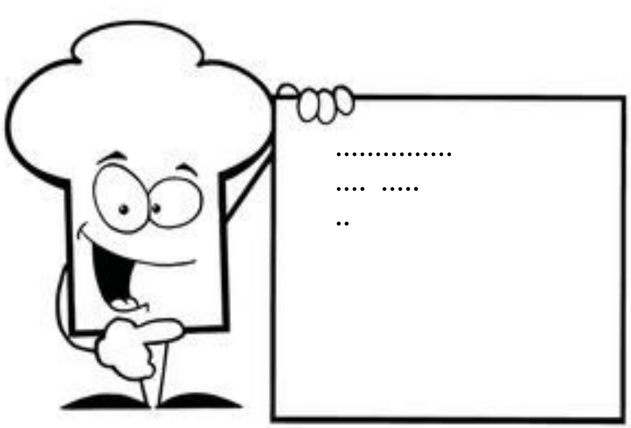
- Social relations **influence** behaviors & decisions
  - opinions, activities, technologies, etc.

- **Information cascade**
  - behaviors that cascade from one node to another like an epidemic! and produce **collective outcomes**.

- How and why such influence occurs?

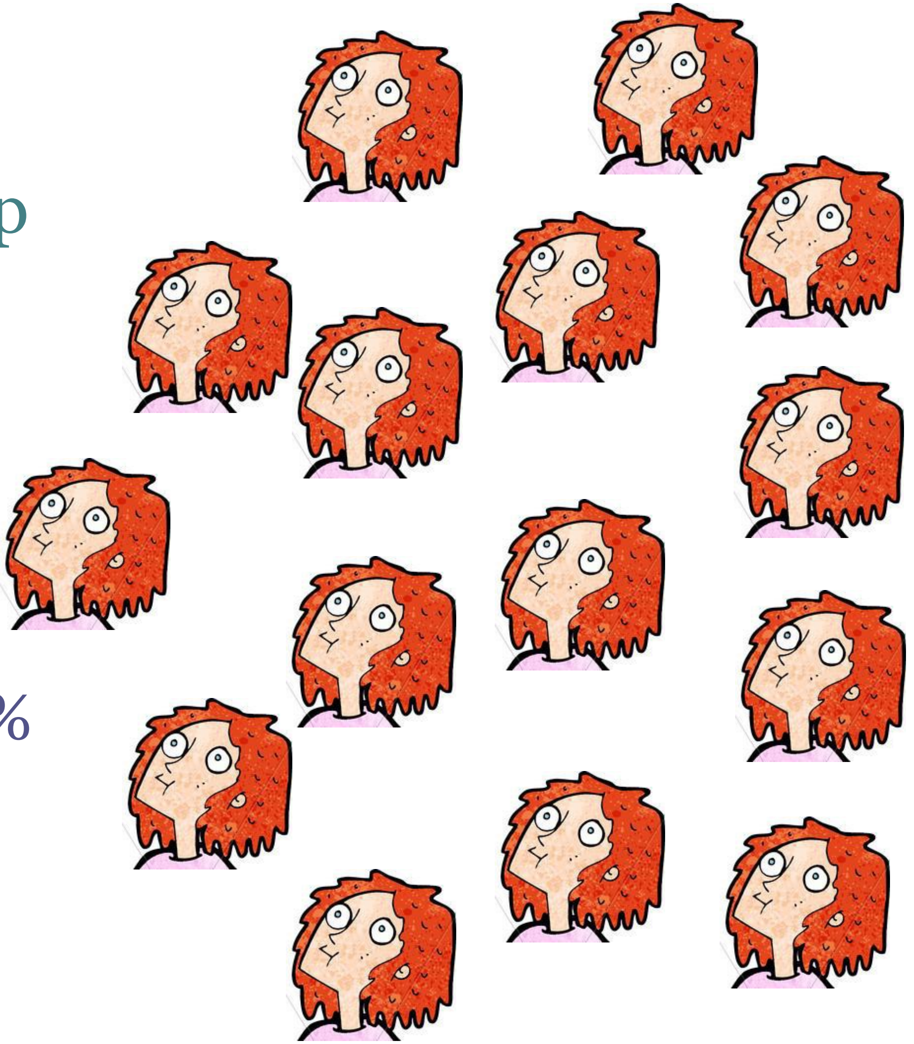
Following the Crowd- Cnt.

- Local Mind!
  - Restaurant choice!



Following the Crowd- Cnt.

- Local Mind!
  - 15 people stand on a street corner and stare up into the sky!!!
  - How many passersby looked up?
    - More people staring up more passersby follow!
    - All people looking up 45% of passersby follow!



Following the Crowd- Demo!

- How to start a movement!

TED
Ideas worth spreading

Source: Derek Sivers: How to start a movement, http://www.ted.com/talks/derek_sivers_how_to_start_a_movement

Following the Crowd- Cnt.

1. Cascades can occur when people **make decisions sequentially**, with later people watching the actions of earlier people.

2. People **infer** something about what the earlier people know from their actions!

Cascade Framework

1. There is a **decision** to be made
   - whether to adopt a new technology, etc!
2. People make decisions **sequentially**.
3. Each person has some **private info**.
4. People **don't know** other's private info.
5. People can **observe choices** made by those who acted earlier.

Cascade Example

- Urn with 3 (blue or red) marbles
- A large group of participants
- Each participant:
  - Draw a marble & see the color
  - Place it back without showing others
  - Guess if the urn is majority-red or majority-blue.
  - Publicly announces their guess.

Those who guess correctly will receive rewards!

Cascade Example

- What's the likelihood of urn being **majority-red** or **majority-blue**?

Cascade Example- Cnt.

- What should we expect to happen?

Cascade Example- Cnt.

- First participant
  - If it's red marble
  - If it's blue marble

$$P(MR \mid r) = \frac{P(MR)\,P(r \mid MR)}{P(r)}$$

$$P(r) = P(MR) \times P(r \mid MR) + P(MB) * P(r \mid MB)$$

$\frac{1}{2}$ $\frac{2}{3}$ $\frac{1}{2}$ $\frac{2}{3}$ $\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{2}$

$$P(MR \mid r) = \frac{\frac{1}{2} \times \frac{2}{3}}{\frac{1}{2}}$$

Cascade Example- Cnt.

- First participant
  - If it's red marble
    - guess majority-red.
  - If it's blue marble
    - guess majority-blue.

- 1^{st} participant's guess conveys **perfect info** about what has been seen.

Cascade Example- Cnt.

- Second participant
  - see the same color as the first participant announced
  - see the opposite color

Cascade Example- Cnt.

- Second participant
  - see the same color as the first participant announced
    - should guess this color as well.
  - see the opposite color
    - Will be indifferent.
    - Assumption: break the tie by guessing the color seen.

- 2nd participant guess conveys **perfect info** about what has been seen.

Cascade Example- Cnt.

- Third participant
  - First two guesses are opposite colors

  - First two guesses are same color

Cascade Example- Cnt.

- Third participant
  - First two guesses are opposite colors
    - Guess the color (s)he sees!
  - First two guesses are same color (say blue)
    - If third participant draws blue.
    - If third participant draws red.

B, B, R ___

Cascade Example- Cnt.

- Third participant
  - First two guesses are opposite colors
    - Guess the color (s)he sees!
  - First two guesses are same color (say blue)
    - If third participant draws blue.
      - Simple!
    - If third participant draws red.
      - blue, blue, red. All perfect info!
      - Guess majority-blue! ignore his own private info
        - Which, taken by itself, suggested that the urn is majority-red!

First two guesses are the same → third should follow, regardless of private info.
An information cascade has begun!

Cascade Example- Cnt.

- Fourth participant! The cascade case:
  - 4^{th} participant, heard
    - blue, blue, blue!
    - First 2 guesses conveyed perfect info
    - 3^{rd} guess conveys **no** info.
  - 4^{th} is in exactly the same situation as 3^{rd}!
  - Same for all subsequent participants!

b✓ b✓ b✓ b✓ ....

N

Cascade Example- Cnt.

Summary

- If participants 1 & 2 make the same decision:
  - All will follow regardless of their private info.
- 3's decision conveys no info!
- 4^{th} and subsequent participants will be in the same position as participant 3.

Lecture Topics

- Information Cascades
- **Cascade Principles**
- Simple Cascade Model

General Cascades Principles

1. Cascades can easily occur!
   - Based on very little info,
   - **Pre-cascade info** influences the behavior of the population.

General Cascades Principles- Cnt.

2. Cascades can lead to non-optimal (wrong) outcomes!
   - Say the urn is majority-red!
   - First two participants *draw* blue:
     - All others wrongly *guess* blue!

General Cascades Principles- Cnt.

3. Some (*but not all*) cascades can be very fragile!
   - Suppose first 2 guesses are blue
   - Participant x and x+1 draw red and "show" it to others!
   - deicion of x+2?

bbb.....bb r r

pI pI A r r r

x+2

General Cascades Principles- Cnt.

3. Some (*but not all*) cascades can be very fragile!
   - Suppose first 2 guesses are blue
   - Participant *x* and *x*+1 draw red and "show" it to others!
   - deicion of *x*+2?
     - Four pieces of perfect info:
       - blue (1), blue (2), red (*x*), red (*x*+1)!
     - Decide based on his/her own draw!

Lecture Topics

- Information Cascades
- Cascade Principles
- **Simple Cascade Model**

Cascade Model

- n individuals make decisions **sequentially**
  - decision: **accept** or **reject** some **option**
- Private signal (info)
  - *imperfect* signals on if accepting is good or bad.
- Two States:
  - Good idea, accept with probability $\Pr[G]=p$
  - Bad idea, reject with probability $\Pr[B]=1-p$

The aggregation of private signals convey perfect information about the correct action.

Cascade Model- Cnt.

- Payoffs: based on accept/reject decisions
  - If reject, payoff = 0.
  - If accept and option is a good idea, payoff= $v_g > 0$
  - If accept and option is a bad idea, payoff= $v_b < 0$

- Expected payoff in the absence of other info is 0;
  - $v_g p + v_b(1 - p) = 0.$
  - initially payoff from accepting/rejecting is same.

Sequential Decision-Making

- Suppose n knows that everyone before her has followed their own accept/reject signals!
- If $a = r$ (among people before n)
  - n will follow her own signal.
- If |a – r|=1

  $|a-r|=0$ $|a-r|=2$

  - n will follow her private signal
    - Makes n indifferent OR reinforces majority signal.
- If |a – r|>=2, then
  - n follow the earlier majority & ignore her own signal.

Sequential Decision-Making- Cnt.

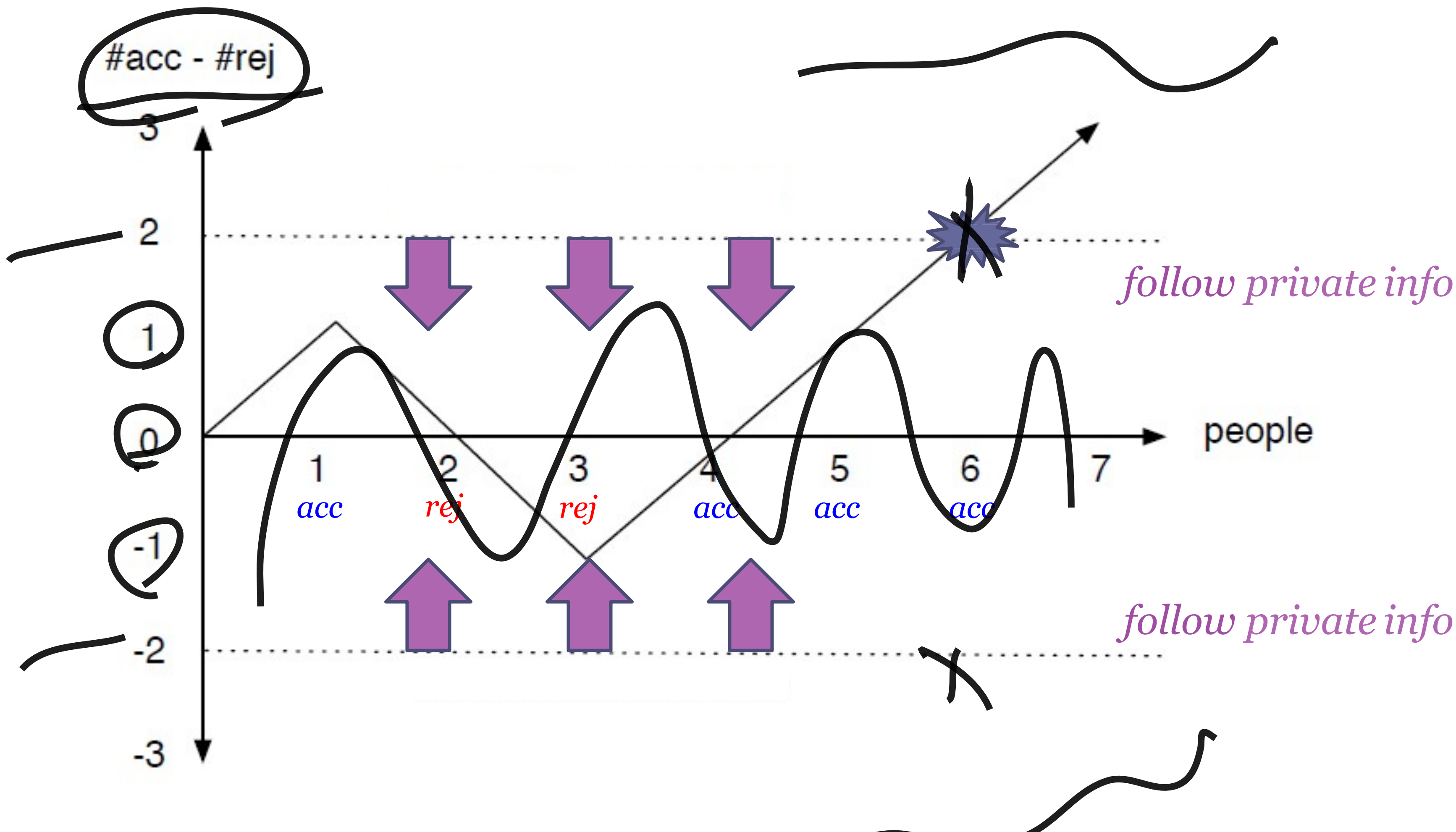


Figure 16.3: A cascade begins when the difference between the number of acceptances and rejections reaches two.

Sequential Decision-Making- Cnt.

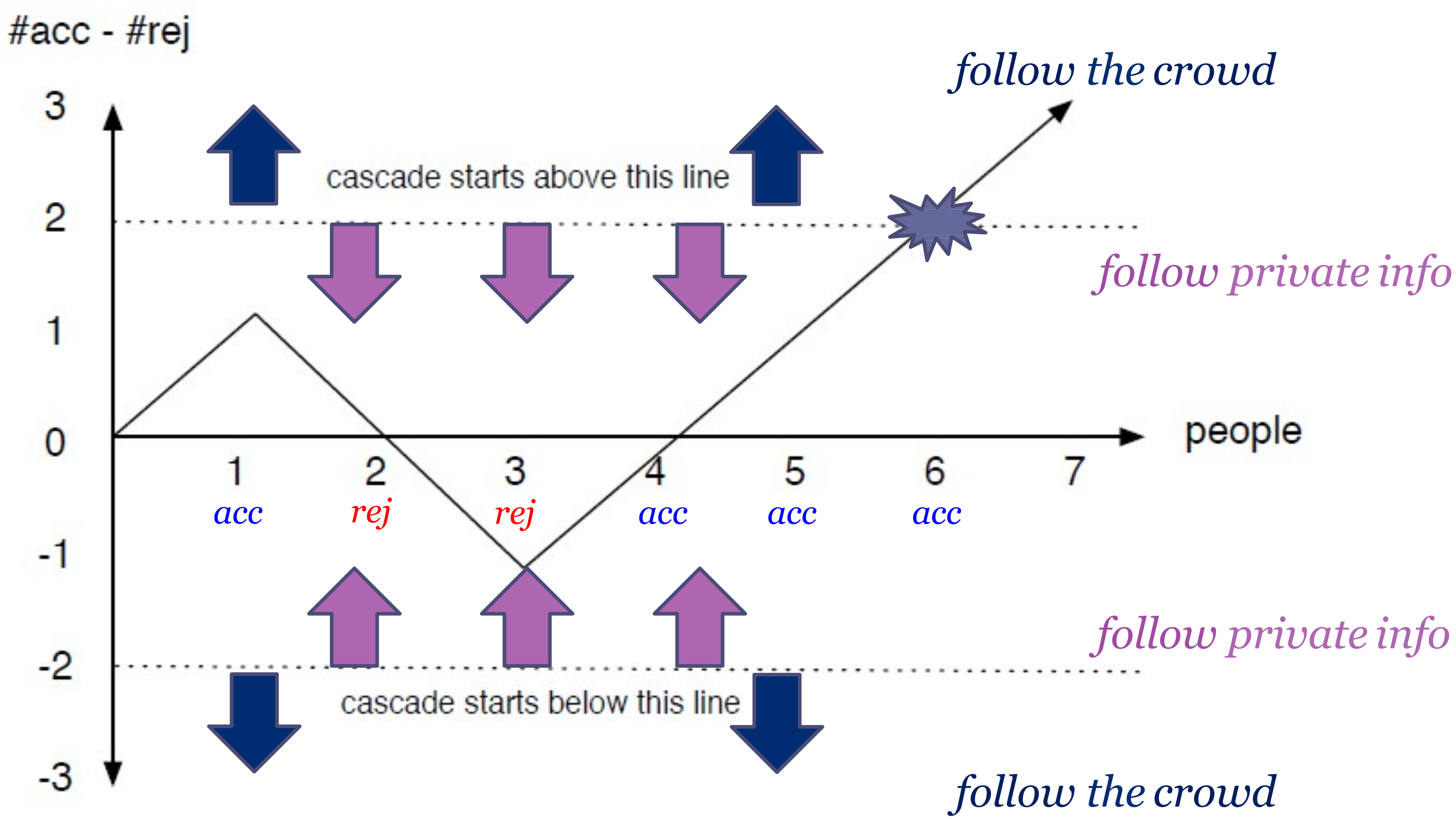


Figure 16.3: A cascade begins when the difference between the number of acceptances and rejections reaches two.

Sequential Decision-Making- Cnt.

- It is very hard for $(a - r)$ to remain in [-1, +1] range.
    - If 3 people in a row get the same signal, a cascade will certainly begin.

$$|a-1| \geq 2$$

Sequential Decision-Making- Cnt.

- The probability of finding 3 matching signals in a row converges to 1 as the number of people N goes to infinity.

- **Hint**:
  - Divide the first N people into blocks of 3 people

Sequential Decision-Making- Cnt.

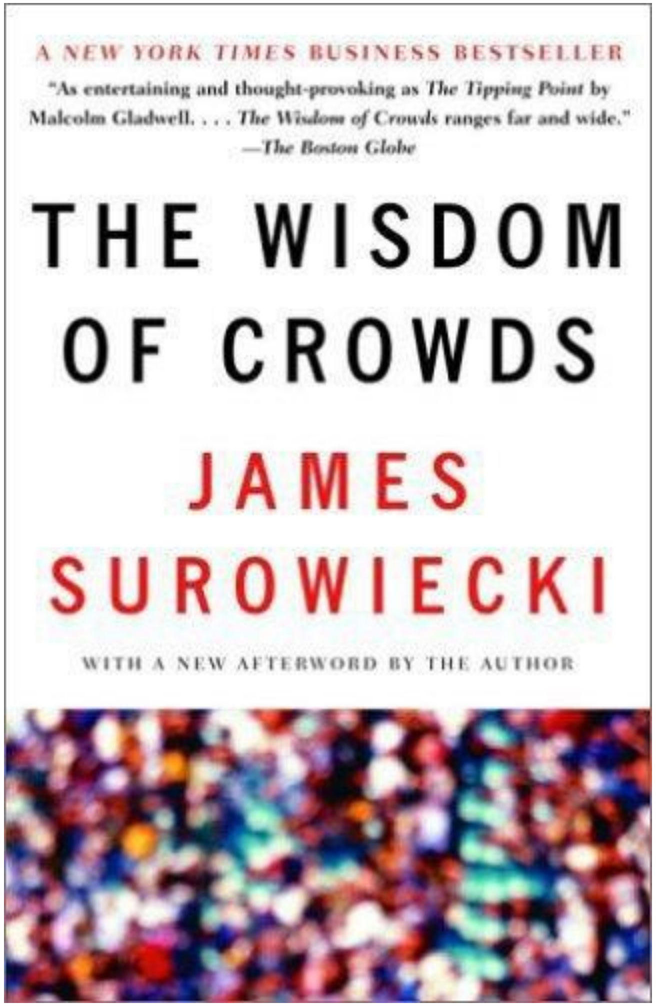
- The probability of finding 3 matching signals in a row converges to 1 as the number of people N goes to infinity.
- **Solution**:
  - Divide people into blocks of 3
    - [1, 2, 3], [4, 5, 6], etc.
    - People in one block receive same signal with probability $q^3 + (1 - q)^3$
    - The probability that none of these blocks consists of identical signals $[1 - (q^3 + (1 - q)^3)]^{N/3}$.

Sequential Decision-Making- Cnt.

- Different variations of the same problem:
  - What if people **don't see all the decisions** made earlier but only some of them?
  - What if private signals convey **information with different level of certainty**?
  - What if different people receive **different payoffs**?

Lessons from Cascades

- The **aggregate behavior** of many people with limited info can produce **very accurate results**.
  - If many people are guessing **independently**, then the average of their guesses is often a good estimate
    - Number of jelly beans in a jar!
    - Weight of a bull at a fair!



Lessons from Cascades- Cnt.

- But in cascades, people guess **sequentially**, and
  - Can **observe the earlier guesses** of others,
  - **being influenced** by them,
  - **Conform to majority**!

Lessons from Cascades- Cnt.

- Tension in collaboration
  - Hiring Committee
    - decide if to make a job offer to candidate A or B
    - cascade may develop quickly
- Easy fix
  - Ask experts to make partial decisions independently before collaboration phase!

Lessons from Cascades- Cnt.

- Marketers & cascades!
  - Initiate a **buying cascade** for a new product.
  - Induce an initial set of people to adopt a new product,
  - Other consumers may follow & adopt the product!
    - Even if its worse than competing products!

- Most effective if later consumers are able to observe
  - the adoption decisions (guesses),
  - but not how satisfied the early buyers are (ball color).

Reading

- Ch.16 Information Cascades [NCM]