Advanced Game Theory

8. Herding and Informational Cascades

Andrea Canidio
andrea.canidio@insead.edu

www.andreacanidio.com

INSEAD

“Men nearly always follow the tracks made by others and proceed in their affairs by imitation.” Machiavelli

Exercise for today

In a little town, two restaurants A and B face each other. At around 6 PM, a stream of tourists starts arriving. One by one, each tourist observes the two restaurants, observes the choices made by all previous tourists, and then chooses where to eat.

Tourists have no prior information about the two restaurants, but they can ask local bystanders for their opinion on which restaurant is the best. On average, the bystanders are correct: if you survey enough people, the majority will point to the restaurant that is truly the best one. However, each individual bystander may be wrong.

More formally, each bystander correctly identifies the truly best restaurant with probability 2/3, but is wrong with probability 1/3. Also, let's assume that each tourist meets one bystander, and each tourist meets a different bystander.

- **Additional assumption**: if a tourist is indifferent between what restaurant to go to, he/she will follow the recommendation received.

Alternative interpretations

- The withdrawal behavior of bank depositors.
- Politics: “The solid New Hampshirites can not be too far wrong”
- Individuals are more likely to commit crimes when those around them do.
- Investors in companies.
- ...

How to approach the exercise

- Suppose you are the first tourist. What do you do?
- Suppose you are the second tourist, and you observe the first tourist in restaurant A.
  - what was the recommendation received by tourist 1?
  - what should you infer if the bystander you meet tells you to go to restaurant A?
  - what should you infer if the bystander you meet tells you to go to restaurant B?

How to approach the exercise

- Suppose you are the *third* tourist, and you observe the first *two* tourists in restaurant A.
  - what was the recommendation received by tourist 1 and 2?
  - what should you infer if the bystander you meet tells you to go to restaurant A?
  - what should you infer if the bystander you meet tells you to go to restaurant B?

How to approach the exercise

- The third tourist ignores his signal if he sees that the first two are in restaurant A
  - how about the 4th tourist?
  - ... and the 5th tourist?
  - ... and the 6th?

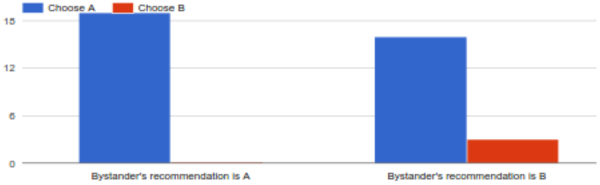
Your answers

You are the first tourist. What do you do?

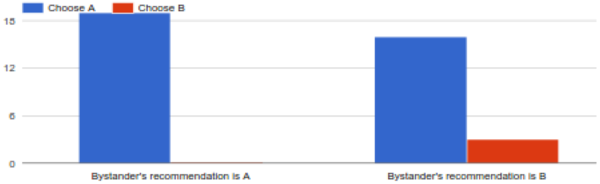
You are the second tourist. The first tourist is in restaurant A. What do you do?

Your answers

You are the third tourist. The first two tourists are in restaurant A. What do you do?

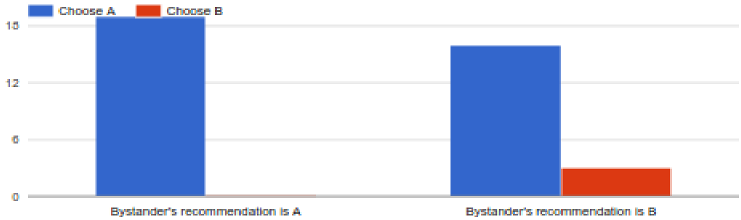


You are the fourth tourist. The first three tourists are in restaurant A. What do you do?



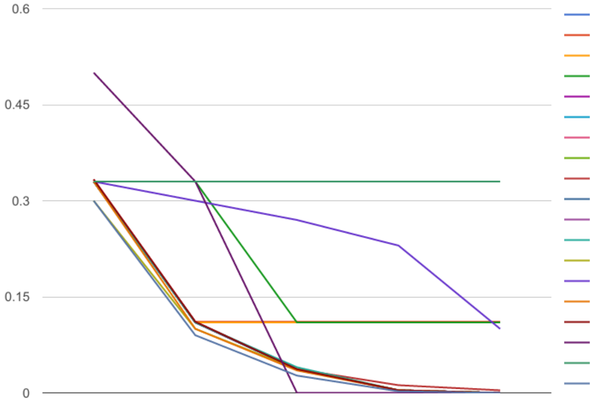
Your answers

You are the fifth tourist. The first four tourists are in restaurant A. What do you do?



Your answers

Suppose that the first X tourists are in restaurant A. Estimate the probability that the best restaurant is instead B.



Today's class: informational cascade & herding

- **Informational cascade**: except for the first two tourists, all other tourists ignore the information received.
  - what happen instead when each tourist observes the recommendation received by all previous tourists?
- **Herding**: all tourists choose the same restaurant.

Questions:

1. What is the probability that an informational cascade occurs?
2. Does the quality of the recommendation received (i.e. the probability that the bystander can correctly identify the best restaurant) matter? How?

A simple model of herding

A simple model of herding

- A group of people who sequentially make a decision: *accept* or *reject* an option.
  - The decision to accept or reject is observable by everybody else once it is made.
- Two possible *states of the world*: G (accepting the option is a **g**ood idea) or B (accepting the option is a **b**ad idea).
  - the state of the world is unknown, but is revealed at the end of the game.
- *Payoffs*:
  - if the person rejects the option, her payoff is zero.
  - If she accepts, her payoff is $v_g > 0$ if the state turns out to be G, and $v_b < 0$ if the state of the world turns out to be B.

A simple model of herding

- *Signals*: before deciding, each person observes a signal which can be either H or L. The probability of receiving a given signal in a given state is:

		States	
		B	G
Signals	L	q	$1-q$
	H	$1-q$	q

with $q > \frac{1}{2}$.

Beliefs

- Call p_1 the common initial probability that the state is the state is G.
  - Before observing her signal, the first person assigns probability p_1 to the state being G.

Beliefs

Call p_t the probability that the state is G in period t.

- It is computed by observing all behavior prior to t.
- Before observing her signal, the t-th person assigns probability p_t to the state being G.

- When is p_2 different from p_1? When is p_t different from p_{t-1}?

Learning from signals

- If person t observes H, how does he/she revise the probability that the state is G? Does she accept or reject?
- Use Bayes rule!

$$\underbrace{\text{pr}\{G|H\}}_{\substack{\text{probability that the}\\ \text{state of the world is G}\\ \text{given the observation H}}} = \frac{p_t q}{\underbrace{\underbrace{p_t q}_{\substack{\text{probability of observing}\\ \text{H and that the state is G}}} + \underbrace{(1-p_t)(1-q)}_{\substack{\text{probability of observing}\\ \text{H and that the state is B}}}}_{\text{Probability of observing H}}}$$

$$= \frac{p_t q}{1 - p_t - q + 2p_t q} > p_t$$

- similarly:

$$\text{pr}\{G|L\} = \frac{p_t(1-q)}{p_t + q - 2p_t q} < p_t$$

Optimal behavior

What should the first person do?

- If the observation is H:
  - Accept if

$$\begin{aligned} \text{pr}\{G|H\} \cdot v_g + (1 - \text{pr}\{G|H\}) \cdot v_B &= \\ \frac{p_t q}{1 - p_t - q + 2p_t q} \cdot v_G + \left(1 - \frac{p_t q}{1 - p_t - q + 2p_t q}\right) \cdot v_B &\geq 0 \end{aligned}$$

    reject otherwise.

- If the observation is L:
  - Accept if

$$\begin{aligned} \text{pr}\{G|L\} \cdot v_g + (1 - \text{pr}\{G|L\}) \cdot v_B &= \\ \frac{p_t(1-q)}{p_t + q - 2p_t q} \cdot v_G + \left(1 - \frac{p_t(1-q)}{p_t + q - 2p_t q}\right) \cdot v_B &\geq 0 \end{aligned}$$

    reject otherwise.

Learning from others

- If the first person always accepts or always rejects:
  - there is no learning,
  - everybody's problem repeats identically,
  - everybody ends up doing the same thing.
  - What if they could observe the sequence of signals?
- If the first person accepts or rejects depending on the signal:
  - the second person learns what the first person observed,
  - p_2 incorporates the first person's observation

Informational cascade

- The problem repeats in every period,
- Eventually, a person's prior belief crosses one of the thresholds
- From that moment onward, behaviors are not informative anymore, everybody behaves in the same way.
- **Information is lost**: because signals do not affect behavior, they are ignored.

Herding with black sheep

Black sheep = someone with superior information

Back to our exercise:

- Suppose that one of the bystander is a food critic - he knows the good restaurant for sure. He'll tell you that he is a food critic.
- If you observe the 10th person switching, what do you infer?
- One person deviating may cause a sudden rush to the other restaurant.

Herding with multiple actions

Adding an action

Back to the exercise:

- In each restaurant, each tourist can ask for the tasting menu or eat a la carte.
  - this choice is observable,
  - the tasting menu is chosen only if the tourist is quite convinced that that specific restaurant is the best one.

		Recommendation received						
		A	B	A	A	B	A	B
Case 1	A	✓		✓	✓	✓	✓	✓
	B		✓					
Case 2	A tasting				✓		✓	
	A	✓		✓		✓		✓
	B		✓					
	B tasting							

Having more observable actions increases the flow of information.

Discussion: choice by committee.

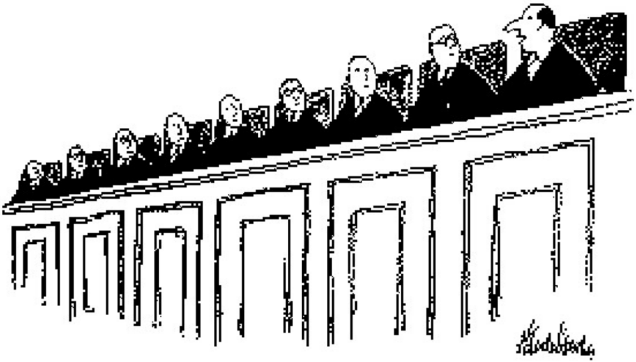
Choice by committee

Suppose you are chairing a committee, the goal of the committee is deciding whether or not to finance a project. Each member of the committee made their research on the topic and formed his/her own opinion.

- A fellow member of the committee proposes to start by asking everybody, one-by-one for their opinion. What do you say?
- Suppose that, for some reason, you must ask everybody, one-by-one for their opinion. How can you decrease the risk of heading?

Whether information aggregates depends on the design of the meeting.

Well heck, if all you smart cookies agree, who am I to dissent?



Administration

- Last problem set is due on Monday 8 pm.

Thank you!