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IPAD

Information Processing and the Analysis of Democracy

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The Editor's Cut – A view of philosophical research from journal editors

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General Motivation

- As far as we know, democracy is an installment particular to man
- A deliberative democracy is characterized by group deliberation, decision and action
- From formal epistemology we know that this epistemic composite requires information
- Correct information processing is an essential fabric of rational deliberation, decision and action

Specific Motivation

- A robust deliberative democracy is characterized by each agent making “enlightened” decisions
- Enlightened decisions require information
- Manipulation with the information fed to (acquired by) agents for “enlightened” decision is potentially manipulation with their democratic vote
- Information may do plenty of good but may also cause disasters

Derailing Agents

- One may manipulate agents with (Hansen & Hendricks, 2011)
 - ▣ too little information
 - ▣ too much information
 - ▣ mode of information presentation
 - ▣ way of information selection
- Giving rise to four well-known informational phenomena studied in social psychology, behavioral economics, and neighboring interdisciplinary fields ... and now formal epistemology

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Information Phenomena

Nature of Information

Pluralistic ignorance

... derailing with ...

too little information

Informational cascades

... derailing with ...

too much information

Framing effects

... derailing with ...

information presentation

Polarization

... derailing with ...

information selection

IPAD / Pluralistic Ignorance

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Pluralistic
Ignorance

Phenomenon



- Q: What is the clock-frequency on the bus?
- A: I really have no idea!
- Q: Well it would be good to know now that you are selling the product, no?
- A: Listen, I don't think you can find any of my co-workers that would know either!

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Pluralistic
Ignorance

Reasoning

And then I got really angry with the guy behind the counter who seems to be reasoning accordingly:

1. None of my colleagues know and thus you have no reason to **expect** that I know, and
2. None of my colleagues know and thus you have no reason to **expect that I ought** to know

Either way, you as a customer shouldn't know!

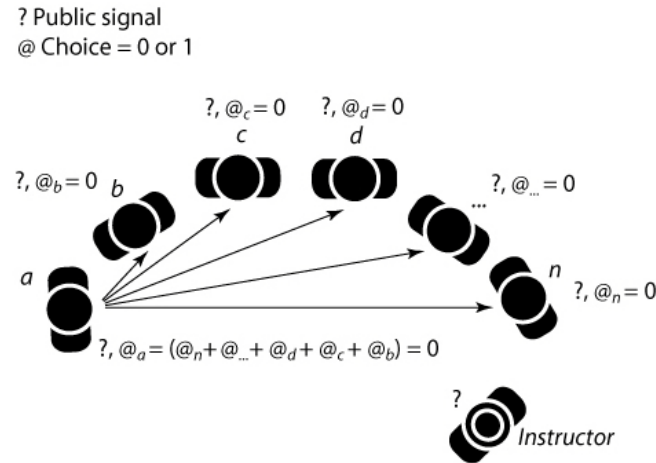
Now (1) is an inductive deader, but (2) is pluralistic ignorance

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Pluralistic Ignorance

Structure



Pluralistic ignorance arises when the individual decision-maker in a group lacks the necessary information for solving a problem at hand, and thus observes others hoping for more information

When everybody else do the same, everybody observe the lack of Reaction and is consequently lead to erroneous beliefs

Pluralistic ignorance thus describes conditions under which it is legitimate for all and everybody to remain ignorant

Truly terrible tendency on **too little information**

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Pluralistic Ignorance

Definition

Daniel Katz and Floyd Allport described pluralistic ignorance some 80 years ago as a

"a situation where a majority of group members privately reject a norm, but assume (incorrectly) that most others accept it."

A formulation emphasizing the epistemic nature of the phenomenon is reported by Sunstein in

"The underlying problem here is pluralistic ignorance: ignorance, on the part of most or all, of what most people actually think. In the face of pluralistic ignorance, people can assume wrongly, that others have a certain view and they alter their statements and actions accordingly." (Sunstein 09: 81)

Even better, with iterated doxastic operators, pluralistic ignorance, amounts to a situation in which"

... no one believes, but everyone thinks that everyone believes."
(Krech & Crutchfield 48: 388--389)

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Pluralistic
Ignorance

Model

(neg) Everybody in the group G doubts that ϕ but believes that others believe that ϕ

(pos) Everybody in the group G believes that ϕ but believes that others doubt that ϕ

$$PI_{neg} =_{df} ED_G\phi \wedge \bigwedge_{g \in G} B_g EB_{G-g}\phi$$

(Hendricks, Proietti & Zenker 2011)

$$PI_{pos} =_{df} EB_G\phi \wedge \bigwedge_{g \in G} B_g ED_{G-g}\phi$$

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Pluralistic
Ignorance

Resolution



- **Theorem (A):**

$$\forall \delta_i \in \Delta : [I_{\delta_i} A \wedge [K_{\alpha} A!] A] \rightarrow [K_{\alpha} A!] K_{\delta_i} A$$

(Hendricks 2010)

- **Theorem (B):**

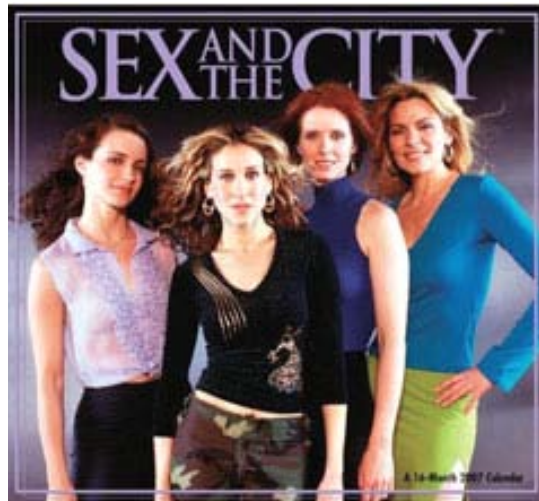
$$\forall \alpha_i \in \Lambda : [I_{\alpha_i} A \wedge [K_{\delta} A!] A] \rightarrow [K_{\delta} A!] K_{\alpha_i} A$$

IPAD / Informational Cascade

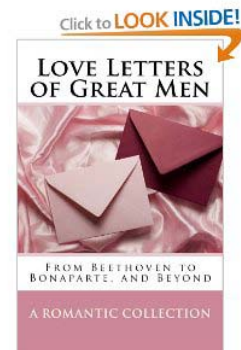
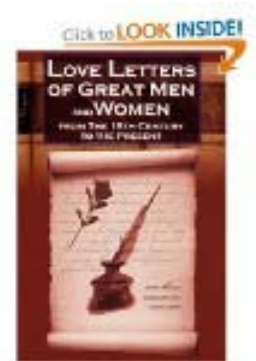
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Informational
Cascades

Phenomenon



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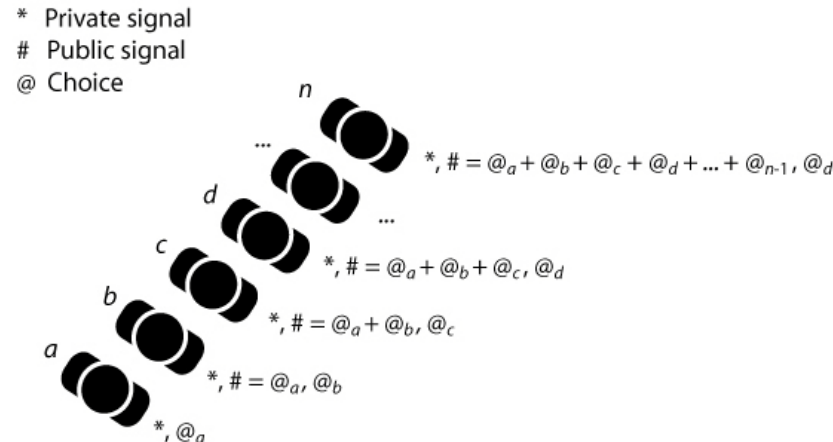
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Informational Cascades

Structure



An informational cascade occurs when agents observe the actions of others as a public signal and then make the same choice that the others have made, independently of their own private information signals.

Information cascade is commonly seen in groups under immediate stress from external forces, such as in herd behavior and may cause disasters – Bubbles in estate, stock etc

Also a truly terrible tendency on **too much information**

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Informational Cascades

Model

(Rendsvig &
Hendricks
2012)

Introduction



Informational Cascade

- Each agent acts in turn, based on a *private* and a *public signal*.
- There is a *tipping point* after which previous agents' choices dominate, and a *cascade* is started.

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Informational Cascades

Model

Basic Idea

We have a set of agents $I = \{1, 2, \dots, n\}$, which act in turn. Each turn goes:

1. Agent i has some beliefs based on a *private signal* (prior beliefs, issued ticket,...).
2. The agent receives a *public signal* by the actions of agents $1, \dots, i-1$.
This produces first model for agent i , M_i .
3. The agent *deliberates* by considering presented information.
This produces second model for agent i , M'_i .
4. Based on M'_i , the agent applies a *decision rule* and acts.

The outcome depends on the *interpretation rule* used in step 2, the *merge rule* in step 3 and the *decision rule* in step 4

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Informational Cascades

Model

Signals and Actions

Actions:

$\alpha = \{L, R\}, \alpha_i \in \alpha.$

Denote by σ the full string of chosen actions: $\sigma = \alpha_1, \alpha_2, \dots, \alpha_n$

Private Signal:

$\sigma_i \in \alpha \cup \{\lambda\}$

σ_i forms the agent's initial, "private" beliefs about L/R :

If $\sigma_i = L/R$, then $M_i, s_0 \models B_i(L/R)$

Public signal:

Initial segment of σ of length $i - 1$:

$\rho_i = \alpha_1, \dots, \alpha_{i-1}.$

$\rho_1 = \lambda$, the empty string.

ρ_i forms the agent's higher order beliefs depending on interpretation of actions.

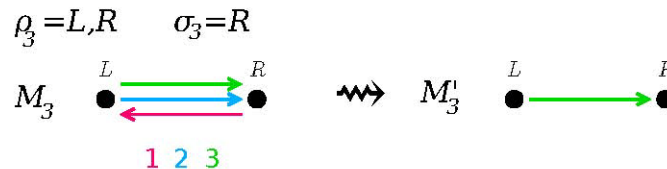
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Informational Cascades

Model

Majority Merge



Majority merge is a belief upgrade method by which a single agent can change his beliefs regarding p based on the perceived beliefs of a group of other agents.

The idea behind the merge is 'head counting': agent i compares how many agents j in group G hold that $s <_j t$ for some two states s and t , and **adopts the opinion of the majority**.

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Informational Cascades

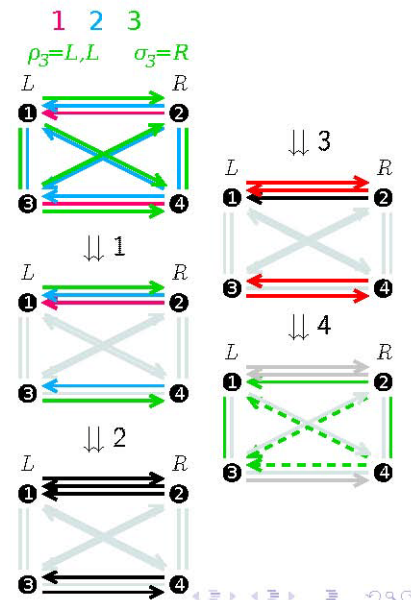
Model

Majority Merge: Example 2

- Step 1. Take the horizontal arrows
- Step 2. Ignore their colors (mash them together)
- Step 3. Remove conflicting pairs
- Step 4. Restore information cell and establish preorder

Being given $\rho_3 = L, L$ and $\sigma_3 = R$, after deliberation $M'_3, 1 \models B_3 L$
3 changes his mind after deliberation!

Based on M'_3 , 3 chooses his action based on a *decision rule*.



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Informational Cascades

Model

Decision Rules

If decided:

If the agent thinks he should go φ , he goes φ :

If $M'_{i,1} \models B_i \varphi$ then $\alpha_i = \varphi$

What if he is indifferent?

If $M'_{i,1} \models \neg B_i L \wedge \neg B_i R$ then $\alpha_i = \text{default}$

default rules:

- $\alpha_i = \sigma_i$ (used here for naïve agents)
- Randomize over $\{L, R\}$ (used here for open-minded agents)
- $\alpha_i = \alpha_{i-1}$
- Play mixed strategy with probabilities given by $\alpha_1, \dots, \alpha_{i-1}$
- ...

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Model

Tipping Point

Tipping Point: Define action α_i to be a *tipping point* in the (partial) string

$$\sigma_{<i+1} = \alpha_1 \dots \alpha_{i-1} \alpha_i$$

if, and only if, for all possible *consistent* strings

$$\sigma_{i>} = \alpha_{i+1} \dots \alpha_n$$

extending $\sigma_{<i+1}$, it holds that for all

$$\alpha_j \in \sigma_{i>}, \alpha_j = \alpha_i$$

Consistent string: (loosely) a string is consistent if, given each agent's interpretation of their public signals, they acted in accordance with the decision rules.

In Example 2, the string L, L, R is *not* consistent.

If agent 3 had interpreted $p_3 = L, L$ differently so he was indifferent between L and R after deliberation and then randomized, then it would be.



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Result I

Conclusion, case 1

- There was a tipping point, being the action of agent 4: if $\alpha_4 = R$, then all subsequent agents would go right.
- General: if there are **two more** agents choosing one action than there are agents choosing the other action, a cascade will commence.
- This is caused by, amongst others, equal weights of the arrows and the naïve interpretation rule.

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Informational Cascades

Result II

Conclusions

- Naïve agents will cause a cascade if *two more* choose one action over the other.
- Open-Minded agents will *never* cause a cascade.
 - ▶ Open-minded agents will not fall in the lemming trap: they will consider it possible that previous agents acted on a weak basis, and will therefore be indifferent after deliberation.
- **Overall:** considering higher-order information has an effect: considering more possibilities eliminates cascade.

The Future of Philosophy

Pluralistic ignorance and informational cascades are but two informational phenomena in the matrix

Bystander-effects, framing, polarization, bias, bandwagon ...

Information processing and the Analysis of Democracy is a truly interdisciplinary study drawing scholars from

- Philosophy
- Economics
- Mathematics
- Psychology
- Computer Science
- Biology
- ...

That's a future for philosophical inquiry ...