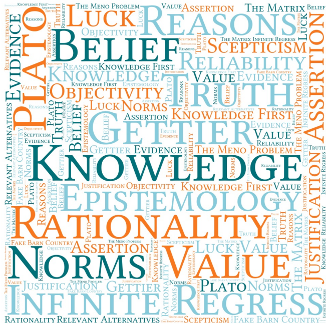


Knowledge, Information & Society

Jake Chandler

Cognitive diversity - Discussion

LA TROBE UNIVERSITY

Diversity & Group Size

Landemore's claim

- Landemore (2013, p. 104) tells us:

  "I hypothesize, very simply, that the advantage of involving large numbers is that it automatically ensures greater cognitive diversity…If three [people] are more cognitively diverse…than just one, then five hundred are likely even more cognitively diverse…than three."

  before saying

  "Of course, this assumption that cognitive diversity positively correlates with numbers will not always be verified but it is generally more plausible than the reverse assumption that cognitive diversity increases as the number of people goes down."

Are larger groups more diverse?

- Concern #1:

  Landemore doesn't offer a proof of her initial claim (or even dilemma between her claim and reverse)

- The claim perhaps isn't *immediately* obvious:

  The whole population needn't always be the most diverse group available (relatively homogenous populations can have very diverse subpopulations)

- Concern #2:

  Even if increased group size *will* likely yield increased diversity, how likely are we talking? Likely enough to counterbalance loss in average competence?

Are larger groups more diverse?

- We'll assume that Landemore is right about size and diversity
- But even if she is wrong, her claim about diversity and reliability is important
- This claim is based on 2 insights made famous by Hong & Page:
  (1) Diversity can promote independence or negative correlation between votes (Hong & Page 2009; 2012)
  (2) Diversity can lead to a broader range of options to consider (Hong & Page 2004)
- Both are sources of greater reliability

Diversity and Independence

Diversity and Independence

- The CJT requires statistical independence between votes
- Positive correlation tends to hinder group reliability:

  If all voters always vote the same way (perfect positive correlation), there is no benefit in consulting more people
- Sources of positive correlation:
  (1) causal influences between votes (e.g. communicative influence)
  (2) common causal influence on votes, due to
    - shared psychological heuristics & biases
    - shared background evidence, assumptions or ideologies
- Diversity can undermine (2) and so reduce positive correlation

Performance through negative correlation

- In contrast, negative correlation can improve group reliability
- It can actually render a group of lower reliability voters more reliable than a group of higher reliability voters!
- Example (based on G&S 2018):
  - Group 1: 3 voters with identical & independent reliabilities of 0.8
  - Group 2: 3 voters with identical reliabilities of only 0.75 but negatively correlated responses: When 1 voter gets it wrong, the other 2 get it right.
- Group 2 outperforms group 1!

Performance through negative correlation (ctd.)

Votes			Probabilities	
			Group 1	Group 2
1	1	1	0.512	0.25
1	1	0	0.128	0.25
1	0	1	0.128	0.25
0	1	1	0.128	0.25
1	0	0	0.032	0
0	1	0	0.032	0
0	0	1	0.032	0
0	0	0	0.008	0
Reliability			0.896	1

(1 = correct vote; 0 = incorrect vote)

Negative correlation and heuristics

- How situations like Group 2 *even arise*!?
- One possible source: diversity in heuristics used to decide which way to vote (G & S 2018; following Hong & Page 2009; 2012)

An example

- We have a choice between 2 options

  Example: choosing between buying car A and buying car B
- An option is better overall iff it is better along at least 2 out of 3 dimensions,

  Example: speed, price and reliability.

An example (ctd)

- Every combination of relative performance along the dimensions has the same probability

  Example: it is as likely that car A is better on all dimensions as it is that is only better for speed, or better for both speed and price, etc
- Each voter uses a different heuristic: looks at 1 different dimension and votes for the better performing option along that dimension

  Example: Voter 1 only considers speed, Voter 2 only considers price,…

An example (ctd)

Best for			Best overall	Votes	Probability
Speed	Price	Reliability			
A	*A*	*A*	*A*	1 1 1	0.25
B	*B*	*B*	*B*		
A	*A*	*B*	*A*	1 1 0	0.25
B	*B*	*A*	*B*		
A	*B*	*A*	*A*	1 0 1	0.25
B	*A*	*B*	*B*		
B	*A*	*A*	*A*	0 1 1	0.25
A	*B*	*B*	*B*		

An example (ctd)

- Same negative correlation as Group 2 (if one voter voted incorrectly, then the other two voters voted correctly):

  Assume a voter voted incorrectly

  So the option that did best on their dimension did worst overall

  So the other option did best on the other 2 dimensions

  So the other 2 voters voted for that other option and did so correctly
- Same identical 0.75 reliability as Group 2:

  For each voter, of the 8 equiprobable arrangements, only 2 (in which they vote against the other 2 members) involve making the wrong choice: $\frac{2}{8}$ = 25% chance of error

Diversity and Search

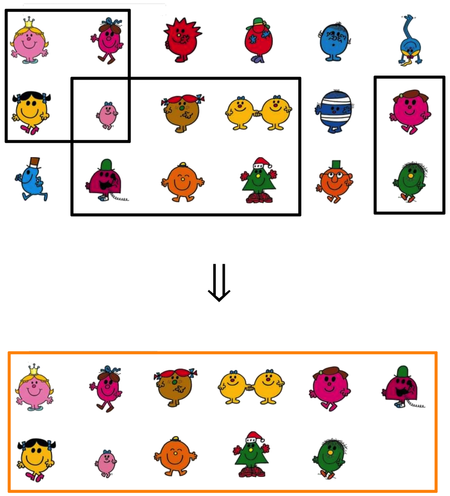
Diversity and Search

- CJT: group reliability of making the best choice from the available options
- What if there are *even better* choices to be made if we expand the range of options?
- Another diversity-driven source of performance: breadth of options
- This is the basic message of Hong & Page (2004)
- Their model is unnecessarily complex. Here's a (much!) simpler one.

A simple model

- A group of n is searching for alternatives to vote on (e.g. job candidates, movies, scientific hypotheses)
- Say there are m possible alternatives, with b being the best one
- Each agent i can “see” a set O_i of options of a certain size and report those options back to the group
- The set of options O_G available for group consideration is the union $\bigcup_{1 \leq i \leq n} O_i$ of all the individual sets
- The larger an agent’s set, the more likely that agent will report the best solution ($b \in O_i$)

A simple model (ctd)

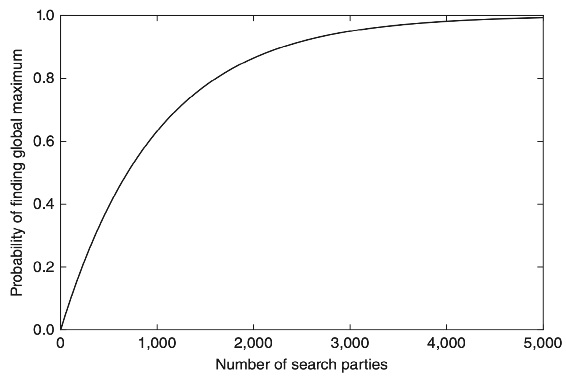


A simple model (ctd)

- Assume equal agent reliability (equal set size) of p
- What is the probability P that the group to ends up with the best option on its menu?
- The probability increases with the diversity of the agents’ sets:
  - Most diverse: disjoint sets ($P = p \times n$)
  - Least diverse: identical sets ($P = p$)
- Between these extremes: independent agents ($P = 1 - (1 - p)^n$)
  - Probability that an agent’s set doesn’t include the best solution: $1 - p$
  - Probability that n independent agents sets don’t include the best solution: $(1 - p)^n$
- A group of less reliable but more diverse searchers can easily outperform a group of perfectly correlated but more reliable ones

Numerical example assuming independence

- A group of n independent people with low reliabilities of 0.001 will have a probability of $1 - (0.999)^n$ of finding the optimum
- Even this converges to 1 fairly fast (Goodin & Spiekermann 2018):



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