Simple heuristics in a social world

Ralph Hertwig
Simon’s question

How do human beings reason when the conditions for rationality postulated by the model of neoclassical economics are not met? (Simon, 1989, p. 377)

Bounded rationality

Herbert A. Simon
1916 - 2001
Bounded rationality: Three visions

• Optimization under constraints (as-if rationality)
  – “Boundedly rational procedures are in fact fully optimal procedures when one takes account of the cost of computation in addition to the benefits and costs inherent in the problem as originally posed.” (Arrow, 2004)

• Cognitive illusions
  – Our research attempted to obtain a map of bounded rationality, by exploring the systematic biases that separate the beliefs that people have and the choices they make from the optimal beliefs and choices assumed in rational-agent models (Kahneman, 2003)

• Homo heuristicus (“Darwinian model of rationality”)
  – “Relatively simple choice mechanisms could enable an organism, searching through its life’s maze, to survive in an uncertain environment. It depicted a procedural rationality for organisms that was squarely based on satisficing rather than optimizing” (Simon, 1996)
Fast and frugal heuristics

- **Take-the-best**: Gigerenzer & Goldstein (1996). *Psychological Review*
- **Fast & frugal trees**: Martignon, Katsikopoulos, & Woike (2008). *Journal of Mathematical Psychology*
- **Recognition heuristic**: Goldstein & Gigerenzer (2002). *Psychological Review*
- **Equity heuristic**: Hertwig, Davis, & Sulloway (2002). *Psychological Bulletin*
- **QuickEst Heuristic, Categorization-by-elimination, default heuristic, social-circle heuristic ...**
Take-the-best heuristic

Example: Which city has more residents: Basel or Bern? [airport, state capital, industrial center etc.]

- **Search rule**: Look up the cue with highest validity $v_i$ (= correct inferences / all inferences)
- **Stopping rule**: If cue values discriminate (+/-; +/?), stop search. Otherwise go back to search rule.
- **Decision rule**: Predict that the alternative with the positive cue value has the higher criterion value
Fig. 2. For the city population task, the performance of take-the-best was compared to five alternative models. Each panel plots the predictive accuracy of take-the-best and a rival model as a function of the number of objects used to train the model. Take-the-best outperforms (top left) a linear perceptron (essentially logistic regression); (top right) the nearest neighbor classifier; (bottom right) two tree induction algorithms, C4.5 and CART (classification and regression trees); and (bottom left) a variant of take-the-best that uses a more resource-intensive search rule that orders cues by conditional validity. Error bars are standard errors of means.
So far, so good but ...
Cognitive simplicity falters in the face of environmental complexity

• “Thus I doubt that rational behavior can be found in ‘fast and frugal’ heuristics. I think it is no accident that the examples of such heuristics in action ignore interactions with other intelligent agents, especially competitive agents. For it is precisely in such situations that simple rules of thumb will go wrong.... Catching a ball is one problem; catching a liar is another.” (Sterelny, 2003, p. 53)

• How Sterelny (and other proponents of this thesis) got it wrong!
Gaze heuristic: Fixate your gaze on the ball, start running, and adjust your running speed so that the angle of gaze (i.e., the angle between your eye and the ball, relative to the ground) remains constant.
Heuristics flourish in the face of complexity

- **Computational intractability**
  - “Choice in social interaction harbors a level of complexity that makes it unique among natural decision-making problems.... These iteratively nested levels of complexity render many social decision-making problems *computationally intractable*” (Seymour & Dolan, p. 667)

- **Competing goals**
  - The social world adds a class of goals to decision making that are important for creating and maintaining social structure and cooperation, such as transparency, fairness, and accountability

- **Incommensurable reasons in social environments**
  - Sacred values preclude comparisons and tradeoffs (Tetlock et al., 2000)

- **Time pressure** (Todd, 2001)
Taxi drivers in the U.S. fall “victim to more deadly violent assaults (184 per 1,000) than any other occupation with the exception of police” (p. 1).

Social learning of cues to trustworthiness or lack thereof (e.g., a fully zipped, bulky coat) rather than individual (trial-and-error) learning.
Research questions: Simple heuristics in a social world

I. What heuristics do people use in social environments?
   The descriptive study of the adaptive toolbox

II. When are these heuristics successful?
   The normative study of ecological rationality

III. How to design heuristics, strategies, decision systems, and social environments?
   Intuitive design

Hertwig, Hoffrage, & the ABC Research Group (in press). 
## The mini-ultimatum game

<table>
<thead>
<tr>
<th>Offer 1</th>
<th>Offer 2</th>
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<tbody>
<tr>
<td>500</td>
<td>800</td>
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**Proposer**

**Responder**
Social preference models are as-if models

- The established, as-if modeling approach in economics extends the utility function by introducing psychological variables such as
  - Inequity aversion (e.g., Fehr & Schmidt, 1999), intention-based reciprocity (Rabin, 1993), or a combination of both (Falk & Fischbacher, 2006)

\[
U_i = \pi_i - \frac{\alpha_i}{N-1} \sum_j \max[\pi_j - \pi_i,0] - \frac{\beta_i}{N-1} \sum_j \max[\pi_i - \pi_j,0]
\]

- This approach resembles the parameterized as-if models in the risky choice literature
  - Models such as cumulative prospect theory accept the Bernoullian framework and “inject” psychology into these functions (e.g., inverse S-shaped weighting function)
  - But there are heuristic alternatives, e.g., priority heuristic (Brandstätter, Gigerenzer, & Hertwig, 2006, 2008)
What would a psychologically plausible approach look like?

- Classification decision: Does this allocation belong to the class of allocations that I reject/accept?

- Subcategory of heuristics: Fast and frugal classification trees (e.g., Martignon, Vitouch, Takezawa, & Foster, 2003)
  - Sequential processing
  - Noncompensatory
  - Limited information (a “pruned” tree)
  - Provide a good descriptive account of decisions in medicine and law, among other domains (e.g., Green & Mehr, 1997)

What social criteria might responders use?

<table>
<thead>
<tr>
<th>Status</th>
<th>Proposer</th>
<th>Responder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mirror</td>
<td>His payoff</td>
<td>My payoff</td>
</tr>
<tr>
<td>Kindness</td>
<td>His foregone payoff</td>
<td>My foregone payoff</td>
</tr>
<tr>
<td>Positive payoff</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
How we proceeded

1. People made decisions in 12 mini-ultimatum games (and 12 dictator games)

2. Via a finite mixture model analysis of their decisions, we sorted participants into four classes of responders (due to heterogeneity)

3. We constructed four fast and frugal trees to describe the heterogeneous decisions

4. We made response-time predictions from these trees and tested these against empirical response-time data
The selfish tree

More than nothing?

no

yes

Reject

Accept

100%
The priority tree

As good or better than his?

- no
- yes

Kind?

- no
- yes

Reject

Accept

97%

100%

80%
The priority+1 tree

- As good or better than his?
  - no
  - yes

- Kind?
  - no
  - yes

- Would I have?
  - no
  - yes

- Reject
- Accept

- Accept
  - 100%

- Accept
  - 94%

- Accept
  - 70%

- No
  - yes

- Reject
  - 46%
The mirror tree

Would I have?

- no
  - Reject: 46%
- yes
  - Accept: 88%
Being selfish is being fast

All decisions (in sec): 3.5 vs. 5.2
Acceptances (in sec): 3.5 vs. 5.0
Examining more priorities takes time

Priority tree (in sec)
1. Status: 3.5
2. Kind: 5.0

Priority tree+1 (in sec)
1. Status: 4.5
2. Kind: 4.7
3. Mirror: 6.1

Time
Simple heuristics in social games

• The response-time data suggest a sequential reasoning process among respondents who rely on social criteria
• This reasoning process can hardly be captured by as-if models (such as inequity aversion)
• How well do the trees predict behavior (relative to as-if models), and can we generalize our modeling approach—i.e., fast and frugal classification trees—to other social games?
Conclusions

- Three aspects of bounded rationality in a social world, each of which represents a very rich set of research questions:
  - descriptive study of the adaptive toolbox
  - normative study of ecological rationality
  - intuitive design
- Simple heuristics can be an alternative to if-af models in economics and game theory (and beyond), focusing on cognitive processes and behavioral outcomes rather than merely outcomes
- Simple heuristics interacting with social and non-social environments can give rise to complex behavior (e.g., allocation heuristics, pedestrian heuristics)