Truth is ever to be found in simplicity, and not in the multiplicity and confusion of things. Isaac Newton

UNCERTAINTY AND HUMAN RATIONALITY IN DECISION-MAKING

Konstantinos Katsikopoulos
RISK VS UNCERTAINTY

RISK:
How should we make decisions when all relevant alternatives, consequences, and probabilities are known?

Neoclassical economics, behavioral economics, neuro-economics

UNCERTAINTY:
How should we make decisions when NOT all alternatives, consequences, and probabilities are known?

DECISIONS UNDER UNCERTAINTY ≠ DECISIONS UNDER RISK

1. UNCERTAINTY. The best decision under risk is not the best decision under uncertainty.

2. HEURISTICS. Heuristics are indispensable for good decisions under uncertainty. They are not the product of a flawed mental system.

3. SIMPLICITY. Complex problems do not require complex solutions.

4. LESS-IS-MORE. More information, time, and computation is not always better.
When a man throws a ball high in the air and catches it again, he behaves as if he had solved a set of differential equations in predicting the trajectory of the ball... At some subconscious level, something functionally equivalent to the mathematical calculation is going on.

*Richard Dawkins*, *The Selfish Gene*
AS-IF vs PROCESS THEORIES

AS-IF:
\[ z(x) = x \left( \tan \alpha_0 + \frac{mg}{\beta v_0 \cos \alpha_0} \right) + \frac{m^2g}{\beta^2} \ln \left( 1 - \frac{\beta}{m v_0 \cos \alpha_0} \frac{x}{x} \right) \]

PROCESS:
1. Fix your gaze on the ball,
2. start running, and
3. adjust your running speed so that the angle of gaze remains constant.

Gaze heuristic
Gaze heuristic
Gaze heuristic
As-if Models and Process Models Generate Different Predictions About Behavior

<table>
<thead>
<tr>
<th></th>
<th>As-if model</th>
<th>Gaze heuristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Player’s goal</td>
<td>Compute landing point</td>
<td>Intercept ball</td>
</tr>
<tr>
<td>Prediction 1</td>
<td>Runs to landing point and waits to catch ball</td>
<td>Intercepts ball while running ✓</td>
</tr>
<tr>
<td>Prediction 2</td>
<td>Runs in a straight line</td>
<td>Runs in a slight arc ✓</td>
</tr>
<tr>
<td>Prediction 3</td>
<td>Knows where the ball is landing</td>
<td>Does not know ✓</td>
</tr>
</tbody>
</table>
“The Miracle on the Hudson River”
US Airways Flight 1549

January 15, 2009
Will the plane make it to LaGuardia Airport?

“It’s not so much a mathematical calculation as visual, in that when you are flying in an airplane, a point that you can’t reach will actually rise in your windshield. A point that you are going to overfly will descend in your windshield.”

Jeffrey Skiles
Co-pilot, US Airways Flight 1549
Where it went wrong—and how the crisis is changing it
How to make investment decisions?

Optimal Asset Allocation Policy
“Mean-Variance-Model”

Harry Markowitz
Optimization or Heuristic?

Optimal Asset Allocation Policy
“Mean-Variance-Model”

1/N
Allocate your money equally to each of N funds

Harry Markowitz
When Is 1/N Better Than Mean-Variance?

1/N is ecologically rational if:

1. Predictive uncertainty: large
2. N: large
3. Learning sample: small

DeMiguel et al., 2009, Review of Financial Studies
Mit nobelpreisgekrönter Strategie zum Anlageerfolg!


So viel zur Theorie. Die Depots der meisten Anleger sehen jedoch anders aus. Da sie oftmals eher willkürlich denn systematisch zusammengestellt worden sind besteht starker Optimierungsbedarf.
20 Studies: Robust Prediction by Ignoring Information

Accuracy (% correct)

Fitting Prediction

One-Good-Reason
Tallying (1/N)
Multiple Regression
Minimalist

Czerlinski, Gigerenzer, & Goldstein (1999)
The Science of Heuristics

*The Adaptive Toolbox*
What are the heuristics we use, their building blocks, and the evolved capacities they exploit?

*Ecological Rationality*
What types of environments does a given heuristic work in?

*Intuitive Design*
How can heuristics and environments be designed to improve decision making?


Classes of Heuristics in the Adaptive Toolbox

1. Recognition
   Recognition heuristic: Goldstein & Gigerenzer 2002 Psychological Review
   Fluency heuristic: Schooler & Hertwig 2005 Psychological Review

2. Tracking
   Gaze heuristic: Shaffer et al. 2004 Psychological Science

3. Trust
   White-coat-heuristic: Gigerenzer et al 2007 Psychological Science in the Public Interest

4. Equal Division
   1/N: DeMiguel et al, Review of Financial Studies 2009
   Tallying: Gigerenzer & Goldstein 1996 Psychological Review

5. One-good-reason
   Take-the-best: Gigerenzer & Goldstein, 1996 Psychological Review
   Fast & Frugal Trees: Martignon, Katsikopolou & Woike 2008, J of Mathematical Psychology
   Priority Heuristic: Brandstätter, Gigerenzer & Hertwig, 2006 Psychological Review

6. Default
   Johnson & Goldstein, 2003 Science

7. Imitation
   Imitate the majority/successful: Boyd & Richerson 2005, The origin and evolution of culture
Why Heuristics?

Risk: Accuracy-effort trade-off
Uncertainty: Bias-variance trade-off

total error = (bias)^2 + variance + noise

Gigerenzer & Brighton 2009 *Topics in Cognitive Science*
More Is Better in Hindsight (Fitting)

Gigerenzer & Brighton 2009 Topics in Cognitive Science
Less-Is-More in Prediction

Gigerenzer & Brighton 2009 *Topics in Cognitive Science*
Decision Making Under Uncertainty

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