Bounded Rationality in Economics

Xavier Gabaix, David Laibson
Guillermo Moloche, Stephen Weinberg

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Introduction

- In an infinitely complex world, decision-makers need cognitive short-cuts.
- Humans are good at finding them (i.e., we are good at simplifying the world)
- Nobody has been able to build models (e.g., machines) that generally predict the decisions that we make.
- Only domain specific models (e.g., chess, law of small numbers) have been successful.

The rational actor model is the "best" model proposed to date.

- Precise theory (i.e., it makes quantitative predictions)
- Applicable to all problems that can be expressed with explicit payoff functions
- Comparative statics usually right

Problems with rational actor model

Question: A pill cures 15% of people who have a disease. If 1000 people have the disease and they all take the pill, how many people will be cured?

Answer: 150 selected by 51% of respondents.

Question: If the chance of getting a disease is 10 in 1,000, what percent of people will get the disease?

Answers:

1%	28.47% of respondents
100%	26.28% of respondents
10%	19.71% of respondents
Don’t Know	12.41% of respondents
20%	3.65% of respondents

I. Microfoundations

- People are basically numerically illiterate (CNN: “mysterious crop circles”)
- So rationality is an “as if” proposition.
- Non-conscious processing? Advice? Mimicry? Learning? Experts? Markets? Arbitrage?
- Where does rationality come from?

II. Applicability to practical problems.

- The optimal solution to most problems is not practically calculable.
- In other words, all of the computers on earth can’t find the true solution to almost all problems.
- E.g., the N-city travelling salesperson faces N! different paths ($100! = 10^{157}$).
- The field of operations research adopts the goal of finding good (but non-optimal) solutions to practical problems.

III. Empirical Accuracy

- Even though the rational actor model is the best *model* currently available, it still has a poor track record.
- Good at comparative statics but bad at magnitudes, even on simple problems.

Consider a simple problem...

- 1% of people are rational.
- I have a test for rationality.
- Test yields 1% false positives.
- Test yields 1% false negatives.
- Dick just took the test and passed.
- What are the odds that he is rational?

Bayes Rule:

Let R = “rational”

$$
\begin{aligned}
P(R|pass) &= P(R,pass)/P(pass) \\
&= P(pass|R)P(R)/P(pass) \\
&= (.99)(.01)/[(.99)(.01)+(.01)(.99)] \\
&= 1/2.
\end{aligned}
$$

In general, nobody (except statisticians and economists) gets questions like this right.

Outline:

- Overview of the field.
- Some stabs (i.e., pinpricks) directed at the bounded rationality monster.

What is rationality?

- Instantaneous accurate calculation?
- Instantaneous inaccurate calculation?
- Slow, but "optimal" calculation? (Problem: how do you know what to calculate? Infinite regress. See Conlisk.)
- Slow, goal-directed calculation?

Try to avoid using the words rationality and bounded rationality.

Some Research Frameworks

- Satisficing (e.g., Simon)
- Heuristics (e.g., Kahneman & Tversky)
- Cognitive costs (e.g., Stigler, Akerlof, Yellen)
- Affective reasoning (e.g., Slovic, Damasio)
- Depth of Reasoning (e.g., Stahl, Camerer)
- Automata-based modelling (Rubinstein)
- Learning (e.g., Skinner, Sargent, Roth, Camerer)

Satisficing: An Example of a Good Idea that Doesn't Work

- Cutoff rule.
- E.g., Stop searching when you identify a good/action that meets some minimum threshold of acceptability.
- Where does the minimum come from?

A decision...

- You're digging for gold in a mine.
- You expect the vein to yield 1/2 ton.
- You discover 1 ton your first day.
- Stop or continue?

Another decision

- An urn contains 2 balls.
- A $10 ball and an $11 ball.
- You sample without replacement.
- Each draw costs $0.75.
- You keep the payoff associated with the last ball you draw.
- You first draw the $10 ball.
- Do you continue?

Variant problem.

- What if the urn contains 1000 balls?
- 50% $10 and 50% $11.
- You first draw a $10 ball.
- Each draw still costs $0.75.
- Do you continue?

Problem with satisficing

The cutoff rules that we actually use are highly sensitive to economic contingencies and incentives.

More generally...

- Human behavior is not myopic or mechanistic.
- We are not well-described by blind algorithms.
- Thaler aptly calls us “quasi-rational.”
- Behavioral economists need to find a sophisticated middle ground between stupidity and perfect rationality.

What frameworks have been adopted by economic researchers?

Primarily…

- Cognition costs (near rationality).
- Learning.
- Depth of Reasoning.

Why?

- Easily formalized
- Parsimonious

Goals:

- Formalization
- Generalization
- Parsimony

Are these goals too ambitious (at least in 2002)?

Problem: rational actor model achieves all of these goals.

The problem with bounded rationality

- There is basically only one way to be rational.
- There are an infinite number of ways to be quasi-rational.

Research suggestions...

- Develop theories.
- "Test" them on interesting problems.
- Change the problems and see if your theory still works.
- Keep doing this until you find theories that "correctly" solve general classes of problems.

Buying a Firm (Bazerman)

- Jane owns a firm.
- It's worth 50% more to you than to her.
- The value to Jane is distributed uniformly between $0 and $100m.
- You make one take-it-or-leave-it offer
- What is your offer?

Optimal Bid: b=0.

- If you bid b, and the bid is accepted, then the distribution of the value of the firm to Jane is distributed uniformly between \$0 and \$b.
- The expectation of the value of the firm to Jane is b/2.
- The expected value to you is (3/2)(b/2).
- So conditional on acceptance of your bid, your expected payoff is (3/4)b-b☯0.

Subject responses

- Biggest pile of mass near 50
- Most of the rest of the mass distributed between 50 and 75.

Explanation

- Ex Ante average (median) value = 50.
- Bid 50+ε?

Robustness

- Suppose that the distribution has 1/2-ε/2 of its mass at \$0, ε of its mass at \$50, and 1/2- ε/2 of its mass at \$100 million.
- Now suppose that the firm is worth 5 times more to you than Jane.
- Now suppose that you can make any contractual take it or leave it offer.

Taking the subway

- You have an appointment at noon.
- Must take subway from your home office to the appointment (unif[10,30]).
- Every minute that you are not in your home office costs you $1.
- Every minute that you arrive late for your appointment costs you $2.
- When do you leave your office to minimize expected costs?

Subway solution

- Marginal cost of leaving a minute earlier is $1
- Marginal benefit of leaving a minute earlier is prob(late)*$2
- Set marginal cost equal marginal benefit
- Assume worker leaves M minutes before noon
- $1 = [1 - (M-10)/20]*$2
- M = 20 minutes

Newspaper Problem

- You sell newspapers.
- Buy for $1
- Sell for $2
- Demand uniform[10,30]
- Can’t return unsold newspapers
- To maximize expected profits, how many newspapers should you buy?

Big question…
How do people simplify complex problems?

- Frame problem (Dennett; Gabaix & Laibson)
- First generation robot is asked to recover it’s battery pack.
- Second generation robot is told to consider the consequences of its actions.
- Third generation robot is told to be quick about it!

The Allocation of Attention: Theory and Evidence

Gabaix, Laibson, Moloche, Weinberg (2002)

- Limited processing speed implies that attention is a scarce resource.
- Agents must selectively analyze information
- Microfounds a general model of "bounded rationality."

- Agents with limited processing speed economically allocate their limited attention.
- But even economic attention allocation leads to imperfect choices.
- Think of players in a chess tournament or students taking a test.
- Because time is limited, even a Grand Master won't be able to consider all of the possible consequences of his moves.

Attention allocation explains...

- Salience
- Anchoring
- Discounting
- Planning window
- Marketing
- Product design
- Slow adjustment

6D bias and equity premium (Gabaix and Laibson)

- Suppose that people think about consumption every *D* periods.
- During 1st period, if you adjust at time t [0,1], you can respond to fraction t of stock returns, and you can influence fraction (1-t) of consumption.
- Total response: (t)(1-t)

Total response:

$$\frac{1}{D}\int_0^1 (t)(1-t)\,dt = \frac{1}{6D}$$

- Consumption covaries less than it should with equity returns.
- Equities appear less risky than they actually are.
- Imputed coefficient of relative risk aversion is biased up by factor 6*D*.

- Hard to directly test models of limited processing speed and scarce attention, since we usually don’t observe what information goes into decision-making.
- In this paper, we provide the first direct test of an economic attention allocation model.
- We use Mouselab software, developed by Payne, Bettman, and Johnson.
- Follow in the economic footsteps of Camerer et al. (1994) and Costa-Gomez et al. (2002).

- Mouselab tracks subjects’ information search during an experiment
- Information is hidden “behind” boxes.
- Subjects use the mouse to open one box at a time.
- Mouselab records what information subjects access and when they access it.
- Mouselab has the drawback that it may create an artificial environment.
- But, Mouselab allows the experimenter to measure second-by-second attention allocation.

Experimentally test an economic model of attention allocation.

- Model predicts pattern of information acquisition within games.
- Model predicts endogenous stopping rules.
- Model outperforms myopic information acquisition models including satisficing.
- But subjects also exhibit system neglect (only partial responsiveness to changing economic incentives).

Contact me for slides describing detailed results of this experiment. Paper will be available on my web site by mid-September.

The Road Ahead

- Long list of domain-specific heuristics (no general model).
- “Rational” cortical system coupled with “Quasi-rational” (emotional, affective, associationist, connectionist, limbic system).
- Small adjustments to rational actor model (quasi-Bayesian).

Piecemeal Preferences Puzzle

- Matthew points out that if we were optimal we would make choices according to wealth maximization (even when I allocate money among others).
- But wealth maximization is a very simple heuristic.
- Why do boundedly rational agents fail to use the “simple” optimal rules

Rationality vs. Affect

Two Lotteries

A. 100% chance to win $200

B. 100% chance to meet and kiss your favorite movie star

What would you pay for each?

Two more lotteries:

C. 1% chance to win $200

D. 1% chance to meet and kiss your favorite movie star

How much would you pay for each?

Rottenstreich & Hsee, 2001