Rationality, Bounded rationality…

What are we talking about?

An overview of existing models

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Rationality

- For several decades Expected Utility Theory (Neumann and Morgenstern, 1944) was accepted as a normative and as a descriptive model of rational choice
- The key assumptions:
  - Rational choice
  - Risk aversion

Expected Utility Theory

- Define a finite space of final outcomes $x_i \in X, i = 1,\ldots,n$
- Define a probability associated with each of the outcomes $\sum \pi(x_i) = 1$
- Define utility function associated with each of the outcomes. $U(x_i): X \to R;$ $EU(x) = \sum_i U(x_i)\pi(x_i)$

Axioms of rational choice

Notation

S={1,…,n} - a finite state space (subsets of *S* are events)

X - a set of outcomes

F: S→X - a set of prospects (assigns outcome x_j to state *j*)

O – status quo element of *X*

$\prec$ - binary relation on *F*

xy $\succcurlyeq^*$ x'y', there exist *f,g* ang *j*, such that

$x_j f \succcurlyeq y_j g$ and $x'_j f \prec y'_j g$,

Axioms of rationality

- Further notation

Probability measure *P* on *S*

Value function *v: X→R*

$$V: f \to \sum \pi_j v(f(j)),$$
$$\pi_j = P(j)$$

Axioms of rational choice

- Completeness $\forall f,g \in F: f \succ g, or\ g \succ f, or\ f \sim g$
- Transitivity $\forall f,g,h \in F: f \succ g\ and\ g \succ h \Rightarrow f \succ h$
- Continuity $\forall g \in F: \{f \in F: f \succ g\} and \{f \in F: f \prec g\}$ *are closed subsets*
- Independence – *the order of states in subset* ***s of S*** *is immaterial*
- Tradeoff consistency- *there is no outcome x,y,x',y':* $x,y,x',y': xy \succ^* x'y'\ and\ xy \preceq^* x'y'$

Axioms of rational choice

+ uniquely defined probability measure

$$\sum \pi_j = 1$$

+ value function is an interval scale

both addition and multiplication are allowed

Bounded rationality

- Herbert Simon (1955)
- Individuals have limits:
  - In formulating the problem
  - In solving complex models
  - In processing (receiving, storing, retrieving, transforming) information

Bounded rationally

- Generalized models of rational choice can work if:
  - Limit what sort of utility functions might be used
  - Recognize the costs of gathering and processing information
  - Allow for having a "vector" or "multi-valued" utility functions
- Heuristics
- Consistent bias

Allias paradox (1953)

Experiment 1				Experiment 2			
Gamble 1A**		Gamble 1B		Gamble 2A		Gamble 2B**	
Winnings	Chance	Winnings	Chance	Winnings	Chance	Winnings	Chance
$1 million	100%	$1 million	89%	Nothing	89%	Nothing	90%
		Nothing	1%	$1 million	11%		
		$5 million	10%			$5million	10%
U($1,000,000)		U($1,000,000)x.89+ +U($5,000,000)x.10		U($ 1,000,000) x.11		U($5,000,000)x.10	

11/100 U(1,000,000) > 10/100 U(5,000,000)
11/100 U(1,000,000) < 10/100 U(5,000,000)

Limits of rationality (Kahneman &Tversky, 1979)

- Certainty effect – overweight the certain outcomes
- Reflection effect – reflection of preferences around 0 – risk averse in positive side and risk loving on negative side
- Isolation effect – disregard the common features of two choice – lead to the possibility that choices might be altered by varying the representation

Prospect theory

- I Phase: editing
  - Combination (200, .25; 200, .25)~(200, .50)
  - Segregation (300, .80; 200, .20)~(200,1)+(100,.80)
  - Cancellation (101,.49)~(100, .50);p=0.001~p=0
  - Detection of dominance (dominated choice are rejected without evaluation)
- II Phase: evaluation
  - Decision weights do not add up to 1
  - Value function measures the value of deviation from the reference point

Axioms of the bounded rationality

- completeness
- transitivity
- continuity
- gain-loss consistency

  $\forall f, g \in F : f \sim 0, f^{+} \sim g^{+} and\ f^{-} \sim g^{-} \Rightarrow g \sim 0$
- Sign-comonotonic tradeoff consistency
  - Sign dependence

  Do not exist $f, g \in F\ and\ i : f(i) \succ 0\ and\ g(i) \prec 0$
  - Rank dependence:

  do not exist $f, g \in F\ and\ i, j : f(i) \succ f(j)\ and\ g(i) \prec g(j)$

Axioms of bounded rationality: CPT

+ probability measure is uniquely determined, but not additive

+ Value function is a ration scale

  Only multiplication is allowed

Bounded rationality

- Cumulative Prospect Theory (Kahneman and Tversky, 1992) is now accepted as a descriptive model of individual choice

- What's next?????

Violations of bounded rationality (Birnbaum, 2005)

Properties:

- Coalescing: (x,p;y,1-p)~(x,p-r;x,r;y,1-p)

  (x,p;y,1-p)~(x,p;x,r;y,1-p-r; y, r)
- Restricted branch independence:

(x,p;y,q;z,r) $\succ$ (x',p;y',q;z,r) $\Leftrightarrow$ (x,p;y,q;z',r) $\succ$ (x',p;y',q;z',r)

- EU satisfies both properties
- PT satisfies restricted branch independence
- CPT satisfies coalescing

Violations of bounded rationality

First gamble	Second Gamble	% second
A: .15 to win $50 .85 to win $ 7	B: .10 to win $100 .90 to win $7	78%
A': .10 to win $50 .05 to win $50 .85 to win $7	B': .10 to win $100 .05 to win $7 .85 to win $7	43%
C': .85 to win $100 .05 to win $50 .10 to win $50	D': .85 to win $100 .10 to win $100 .05 to win $7	64%
C: .85 to win $100 .15 to win $50	D: .95 to win $100 .05 to win $7	26%

Other theories of bounded rationality

- Subjective Expected Utility (Edwards, 1955; Savage, 1954)
- Certainty Equivalence Theory (Schneeweiss, 1974; Handa 1977)
- Subjectively Weighted Utility (Karmarkar, 1978)
- Loomes, Graham and Robert Sugden. (1983)
- TAX model (Birnbaum, 1997)

Rationality as a normative model Shogren (2006)

- Proposes to treat rationality violations in the same manner as market failures
- Create institutions that will induce individuals to behave “as if they were rational” by putting an arbitrage on non rational behavior

Rationality as a normative model

Lessons from the lab

- Lesson #1: We can induce more rational behavior by creating an institution with real market-like arbitrage that disciplines irrational behavior
- Lesson #2: We can induce more rational behavio by making the institutional context more complex rather than less complex
- Lesson #3: We can induce more rational behavior by creating an institutional context that allows people to be less sympathetic to others

Emotional intelligence

- Plato’s argument about existence in continuous interactions between rational self and emotional self.
- Implies non existence of individual decision making with unique set of preferences