

# **Predictably Irrational**

## **Heuristics and biases**



**Cognitive Science and Public Policy**  
**02.05.2023**



## Today's topics

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- What is rationality and decision-making?
- How are we expected to think?
- How do we actually think?
- Where do we all go wrong?
- Some of the famous heuristics and biases
- Another look at our limitations



# Rationality

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# Normative rationality

How are we supposed to make decisions?

# Normative rationality

- Expected Utility Theory
- Von Neumann and Morgenstern
- Homo economicus
- Rationality axioms – transitivity





## Decision-making (Rational Choice Theory)

- Certainty
- Uncertainty

<b>A</b>	100%	300 €
<b>B</b>	30%	40 €
	70%	400 €

Option	Outcome	Probability (p)	Option type	Expected utility
A	1000 €	1	Safe	1000 €
B	2000 €	0.5	Risky	2000*0.5 + 0*0.5 = 1000 €
	0 €	0.5		



## Decision-making (Rational Choice Theory)

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- Uncertainty

**A** 100% 300 € = 300 €

**B** 30% 40 €  
70% 400 € =  $0.3 \cdot 40 + 0.7 \cdot 400 = 12 + 280 = 292$  €

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# Bounded rationality

And how do we actually make decisions?



## Prospect theory

- Kahneman & Tversky (1981)
- Framing – negative and positive
- Which side of the situation will we shed the light on
- The values of the outcomes are subjective
- Values ( $v$ ) associated with outcomes and weights ( $\pi$ ) associated with probabilities
- Overall value of the prospect  $\pi(p) v(x) + \pi(q) v(y)$



## Framing effect

Assume we are in the following situation. The state is preparing for an outbreak of an unusual disease that is expected to take 600 lives.

Two plans of action have been proposed:

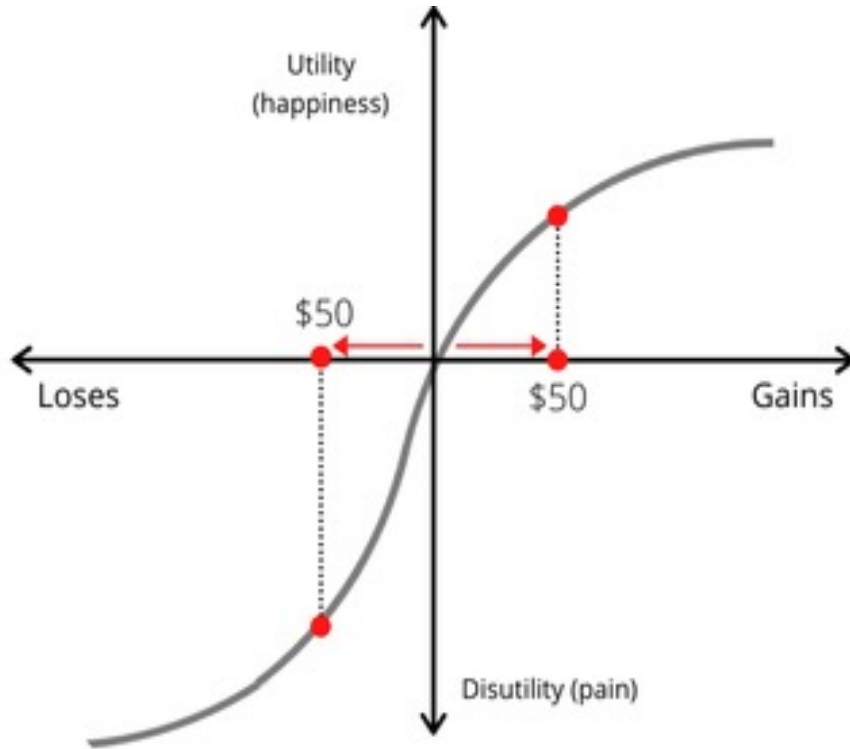
Plan A: It guarantees that 200 people will survive.

Plan B: Guarantees with a  $1/3$  probability that all 600 people will survive and with a  $2/3$  probability that no one will survive.

Plan A: Guarantees that 400 people will die.

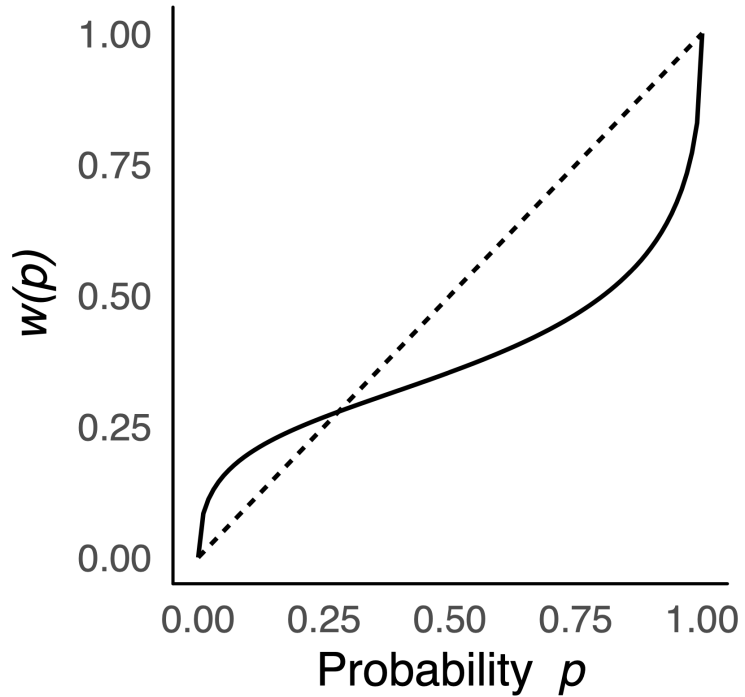
Plan B: Guarantees with a  $1/3$  probability that no one will die and with a probability of  $2/3$  that all 600 people will die.

# Value function



- People are loss averse
- Gains and losses are perceived in view of a *reference point* (what 50e means to us)
- **Risk averse in gains domain, risk seeking in losses domain**
- How is Prospect Theory different from Expected Utility Theory?
- What can we read from the function being S-shaped? (10 vs 20e; 1000 vs 1010e)

## Weighting function



- People are not good in estimating probabilities
- Low probabilities overweighted, medium to high probabilities underweighted (lottery, vaccines vs drunk driving)

## Biases related to risk sensitivity

- ◎ Certainty Effect (Tversky Kahneman, 1981)
  - Especially relevant in which domain of decision making?
- ◎ Overestimating the probability when the potential loss is large (Plous, 1993) → Insurance



# Irrationality

- KT man – irrational
- Bias paradigm
- Systematic errors
- Cognitive savings
- The world is uncertain
- Specialized strategies
- Set of principles – **heuristics**



# Heuristics

- Cognitive bases of biases
  - Mental shortcut, cognitive savings
  - Specific algorithms
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1. Representativeness
  2. Availability
  3. Anchoring



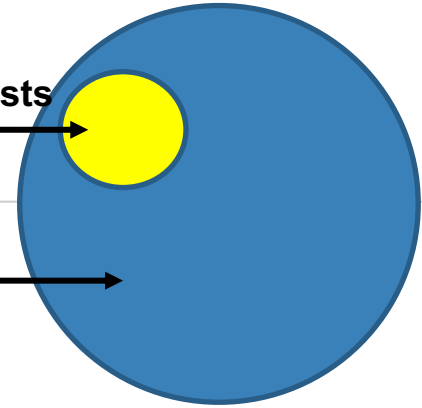


## Representativeness

- With what probability does A belong to B?
- Is A a good member, representative of B?
- Base rate fallacy error (farmers vs librarians)
- Related Event Error – Linda (B= 13%; BF= 87%)
- Neglecting regression to average – pilots
- Random events PPPPPP/ PPGPGG

Bank officers + feminists

Bank officers





## Availability

- "The quicker thing comes into our heads – it's more accurate"
- Ease of recall
- The letter R
- Number of inhabitants (Fresno VS Miami)
- Plane and car accidents
- Media



## Anchoring

- Starting point — an anchor to which we adapt
- We don't know much -- we're holding to any information
- $1*2*3*4*5*6*7*8*9*10$  (M= 1 942 882)
- $10*9*8*7*6*5*4*3*2*1$  (M= 8 451 432 695)
- Exactly = 3 628 800
- Small (M=38.9m) and large (M=61.6m) sequoia (randomly chosen number 2/78)



## Some other biases

- Omission bias (Baron & Ritov, 1994) – vaccines
- Hindsight bias (Arkes, Wortmann, Saville, & Harkness, 1981)
- Number of alternatives and a choice structure
  - Redelmeier and Shafir (1995) – doctors prescribing treatment
  - Decoy effect (Huber, Payne, & Puto, 1982)
  - Ariely (2008) – buying a magazine
- Outcome bias, Confirmatory bias
- Simpler framing effects (marketing)



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# Ecological rationality

Maybe we are not so irrational?



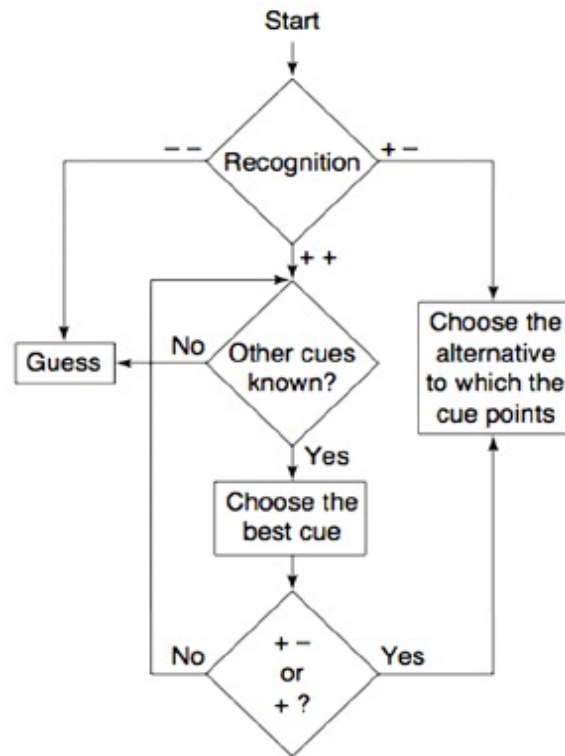
## Fast and frugal heuristics

- Gerd Gigerenzer
- We do great in relation to our surrounding
- It's not that we can't reason – it depends on how we're told
- Absolute figures and probabilities – better 1/100 than 1%
- Change of criteria – not only accurate, but **ALSO FAST!**



## Fast and frugal heuristics

- Take the best heuristic (TTB)
- Linear regression: Select the optimal number of predictors and, based on their absolute predictivity and intercorrelation, adequately weight them
- TTB: Sort predictors by validity. Stop as soon as the first predictor discriminates





## Savings

- Quick overview of symptoms
- Too many decisions in a day
- **Changing perspective – it's not that we're wrong, it's the conditions**
- Adapt the environment to our cognitive system – take into account its limitations (Ariely)
- Biases are not design *flaws*, but design *features* (Haselton, Nettle, & Andrews, 2005)





# Rationality

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