Definition: Heuristics

Heuristic strategies are shortcuts, tools, approximations in

- probability judgement
- prediction
- decision making under uncertainty

*Examples: A*vailability heuristics, anchor effect, gambler's fallacy, hot hand, certainty effect, disjunction effect (*), base rate neglect (*)…

May lead to biases and fallacies in decision making.

More likely to occur with inhibited ability to construct correct answers. Potential reasons:

- lack of resources (information, time, attention, ability, knowledge, memory)
- inability to process information (emotions, intoxication)

(*) See below

Conjunction: Linda

T & K series of experiments involving making probability (or rank) judgments about people's profession based on short profiles.

Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.

Please rank-order the following statements by their probability, using 1 for the most probable and 8 for the least probable.

Tversky A and Kahneman D, *Extentional versus intuitive reasoning: The conjunction fallacy in probability judgement*. Psychological Review 90 (1983), 293-315.

Linda: Rules of probability versus empirical evidence

Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.

Please rank-order the following statements by their probability, using 1 for the most probable and 8 for the least probable.

B & F *Linda is a bank teller and is active in the feminist movement.*

F *Linda is active in the feminist movement.*

B *Linda is a bank teller.*

Empirical findings contradict normative rules of probability:

Very dominant response (86% in initial study) pattern is to rank

$$P(B) < P(B \cap F) < P(F)$$

Why? What do people think? Created many years of discussions…

Concepts: Representativeness & probability

Evaluation of probability is a complex process including:

1. interpretation of the question
2. search for relevant information
3. algorithm combining the information

Linda study:

B is less representative than B&F which is less representative than F

Incorrect conclusion through analogy:
probable = representative

Concept: Representativeness

Representativeness is a directional relation between two objects:

Model M ⟵ Event X

Typical questions:

- Is X or Y more representative of M?
- Is X more representative of M or N?

Examples:

- Is sample S representative of population P?
- Is person X representative of the stereotype of librarians?

Kahneman D, Slovic P & Tversky A (eds.), *Judgement under Uncertainty: Heuristics and Biases*. CUP, Cambridge, 1982. Chapter 6.

Concept: Representativeness

Representativeness is a directional relation between two objects:

Model M ⟵ Event X

Case: ***X instance of class M.***

Representativeness reflects degree of how central characteristics of X are for M. Does not necessarily reflect frequency.

Examples:

- *R*obin is a more representative but less frequent bird than a chicken
- New York is more representative (a prototype) for an American city, though Cincinnati is more typical

Prototypical elements of a category are better learned/recalled/ recognized, even if less frequent.

Representativeness can cause bias. Example: "_ing" versus "__n_").

Concepts: Representativeness & probability

Evaluation of probability is a complex process
prone to errors through the use of heuristics

Linda study:

Incorrect conclusion through analogy:
probable = representative

Despite bias, why do people still use representativeness to elicit subjective probabilities?

- accessible, easy to evaluate
- representativeness often correlates with probability (though to an overrated degree)

Decision process: Reason-based choice

Shafir, Simonson and Tversky asked questions like:

- What is the role of uncertainty in decision making?
- What happens when **choices are in conflict** with each other?

Two approaches are available to answer these questions:

- Reason-based analysis used in theoretical explanations
- Value-based approaches involving experimental data

Search for a comprehensive view.
Can the two approaches be combined through experiments that also elicit the role of reasons in making choices?

Shafir, E., Simonson, I., and Tversky, A., Reason-based choice, Cognition, *49* (2), 1993, pp. 11-36

Discussion: Reason-based choice

Motivation for this research as described in the papers:

*"The need to choose often creates **conflict**: we are not sure how to trade off one attribute relative to another or, for that matter, which attributes matter to us most. It is a commonplace that we often attempt to resolve such conflict by **seeking reasons for choosing** one option over another."*

"Conflict plays no role in the classical theory of choice. In this theory, each option x has a value u(x) such that, for any offered set, the decision maker selects the option with the highest value. In particular, a person is expected to search for additional alternatives only if the expected value of searching exceeds that of the best option currently available.

*A reliance on reasons, on the other hand, entails that we should be more likely to opt for an available option when we have a convincing reason for its selection, and that we should be **more likely to search further** when a compelling **reason for choice is not readily available**."*

Empirical study: Reason-based choice

Decisional conflict and search for options:

- Seeking for additional options requires time and effort, and may result in loosing previously available options.
- Does presence of decisional conflict increase seeking for additional options?

Experiment:

- Subjects are university students
- Subject were presented with pairs of options
- Two domains: bets with different probabilities/payoffs, appartments with different monthly rent/distance from campus
- At each trial, subject can either choose one option or request another option from a known catalogue, at some cost

Some questions from the study: Featuring appartments

Conflict condition: (Half of the subjects)

Imagine that you face a choice between two apartments with the following characteristics:

(x) $290 a month, 25 minutes from campus

(y) $350 a month, 7 minutes from campus

Both have one bedroom and a kitchenette. You can choose now between the two apartments or you can continue to search for apartments (to be selected at random from the list you reviewed). In that case, there is some risk of losing one or both of the apartments you have found.

Dominance condition: (Other half of the subjects)

Similar question except replaced (y) by (x') as below:

(x) $290 a month, 25 minutes from campus

(x') $330 a month, 25 minutes from campus

Potential choice behaviours and underlying motivations:

Principle of value maximisation suggests:

- Subjects search for additional alternatives if and only if the expected value of searching exceeds that of the best alternative currently available.
- Because the **best alternative** offered in the dominance condition is **also available in the conflict condition**, the percentage of subjects who seek an additional alternative cannot be greater in the conflict than in the dominance condition.

Alternative hypothesis:

- In conflict situations: Subjects may feel paralysed because they **can not justify their choice**. This may lead to requesting additional alternatives to delay decision making.

Study tests this. Results:

Subjects requested an additional alternative 64% of the time in the conflict condition, and only 40% of the time in the dominance condition ($p < 0.05$).

Study show that people tend to ask for more options when the choice was **harder to rationalise**.

Discussion:

- Data contradicts the principle of value maximisation.
- Requesting additional alternatives may be motivated by the difficulty of in the choosing process.
- People may request additional alternatives for the sake of improving the *justification* for their choice rather than to *improve the outcome* of the decision itself

Next question:

What if people had a justification, but one that is conditional on some random event?

Empirical study: Reason-based choice

Definitive versus disjunctive reasons:

"People sometimes encounter situations of uncertainty in which they eventually opt for the same course of action, but for very different reasons, depending on how the uncertainty is resolved."

Experiment: (with UG students)

Three groups:

Uncertainty pass/fail
Passed
Failed

Choices:
- *Buy vacation package*
- *Do not buy it*
- *Buy option to postpone decision*

Question text versions

Disjunctive version: (First group of subjects [66])

Imagine that you have just taken a tough qualifying examination. It is the end of the fall quarter, you feel tired and run-down, and you are not sure that you passed the exam. In case you failed you have to take the exam again in a couple of months - after the Christmas holidays. You now have an opportunity to buy a very attractive 5-day Christmas vacation package in Hawaii at an exceptionally low price. The special offer expires tomorrow, while the exam grade will not be available until the following day.

Would you?:

(a) buy the vacation package.

(b) not buy the vacation package.

(c) pay a $5 non-refundable fee in order to retain the rights to buy the vacation package at the same exceptional price the day after tomorrow - after you find out whether or not you passed the exam.

Question versions from the study

Fass/fail versions:
(Second group of subjects [67], half pass half fail condition)

Imagine that you have just taken a tough qualifying examination. It is the end of the fall quarter, you feel tired and run-down, and you find out that you [passed the exam. / failed the exam. You will have to take it again in a couple of months - after the Christmas holidays.] You now have an opportunity to buy a very attractive 5-day Christmas vacation package in Hawaii at an exceptionally low price. The special offer expires tomorrow.

Would you?:

(a) buy the vacation package.

(b) not buy the vacation package.

(c) pay a $5 non-refundable fee in order to retain the rights to buy the vacation package at the same exceptional price the day after tomorrow.

Results

		Disjunctive	Fail	Pass
buy	(a)	32%	54%	57%
not buy	(b)	7%	16%	12%
postpone	(c)	61%	30%	31%

Answer preferences hardly differ between pass and fail conditions!

Results

		Disjunctive	Fail	Pass
buy	(a)	32%	54%	57%
not buy	(b)	7%	16%	12%
postpone	(c)	61%	30%	31%

- Not knowing their exam result, over 60% were willing to pay a fee to postpone the decision.
- Only half of that would do so knowing the result, but ***regardless of what the actual result actual is***.

Interpretation:

Whether they are actually pass or fail is not that important for the decision *outcome*, but it has an effect on how people conduct their decision process.
They do differ between disjunctive vs pass/fail condition.

Interpretation

- Once the outcome of the exam is known, the student has good - albeit different - **reasons for taking the trip**:
  - *Having passed:* vacation = reward
  - *Having failed:* vacation = consolation
- Not knowing the outcome of the exam, however, the student lacks a *definite* reason for going to Hawaii.
- Uncertainty leads to delaying decisions, irrespectively of whether or not the missing information would actually change the outcome of the decision.

Disjunction effect

A disjunction of different reasons is often less compelling than either definite reason alone. This leads to avoiding decision options that include a disjunction.

Question 10: Base rate neglect

Question from Tversky & Kahneman 1973

Type a:

A panel has interviewed and administered personality tests to 70 doctors and 30 lawyers, all successful in their respective fields. On the basis of this information, thumbnail descriptions of the 70 doctors and 30 lawyers have been written. Below is a description, chosen at random from the 100 available descriptions.

Dick is a 30-year-old man. He is married with no children. A man of high ability and high motivation, he promises to be quite successful in his field. He is well liked by his colleagues.

What is the probability that Dick is one of the 70 doctors in the sample? …….

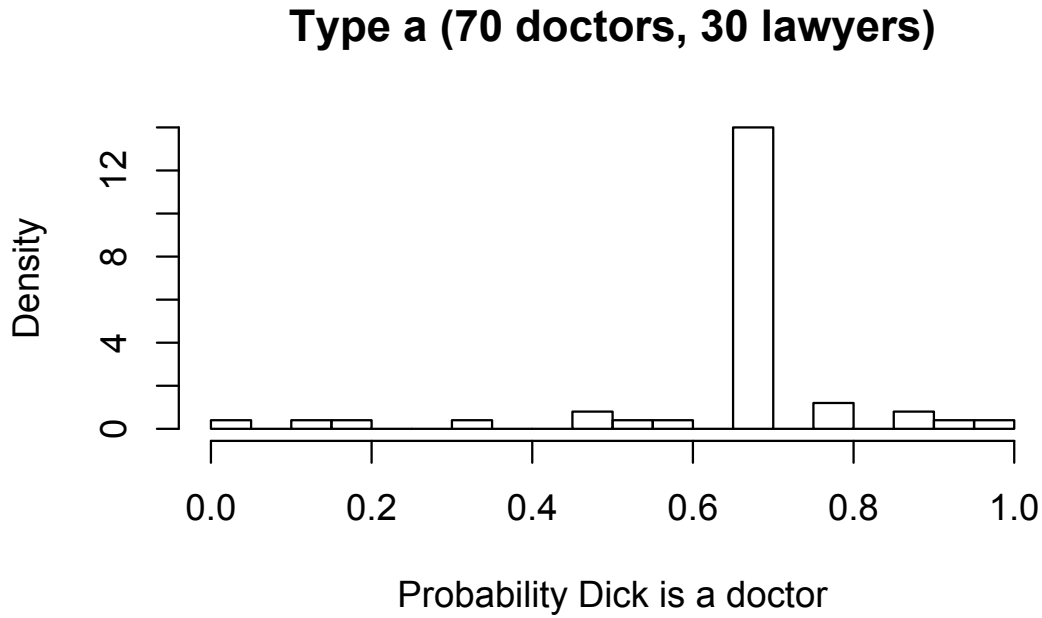
Type b:

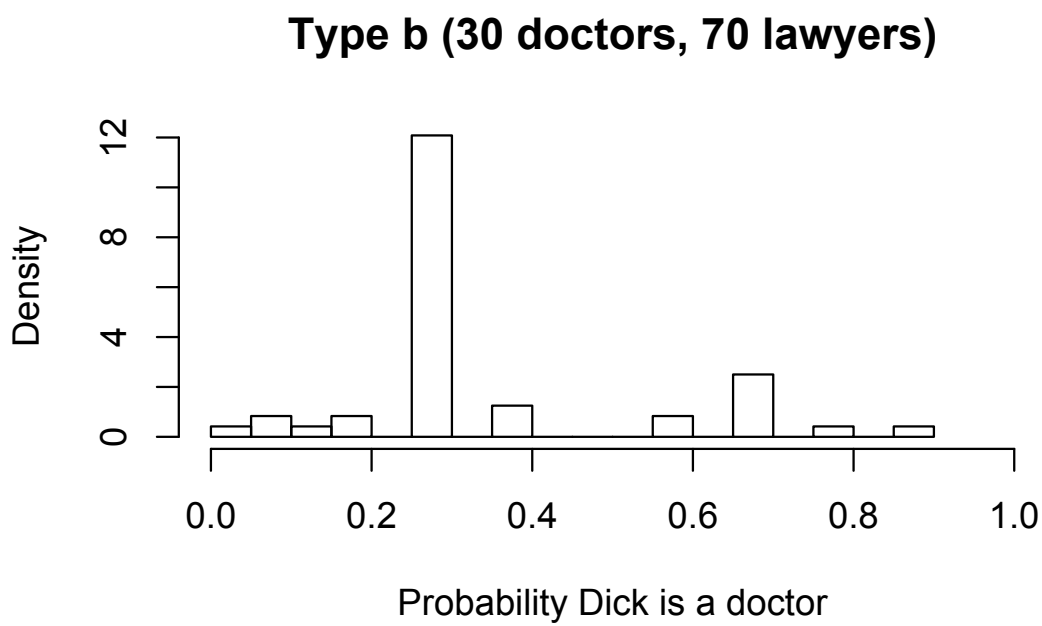
The same except numbers swapped (30 doctors and 70 lawyers)

Subjects at study at University of Oregon 1973 **neglect the base rates:** Answer to Type a and Type b had similar distributions.

What about Warwick students (in Maths and in Stats depts)?

ST222'14@Warwick:





ST222'15@Warwick:

Type a (30 doctors, 70 lawyers):

```
> round(100*table(D[1:38,11])/n, digits=1)

  0.3  0.5  0.6  0.7  0.8  0.85  0.875  0.9  1.0
  5.2 10.6  2.6 65.8  5.2  2.6   2.6    2.6  2.6  %
```

Type b (30 doctors, 70 lawyers):

```
> round(100*table(D[39:76,11])/n, digits=1)

  0.0  0.1  0.3  0.6  0.69  0.7  0.8  1.0
  5.2  5.2 71.0  5.2  2.6   2.6  2.6  2.6  %
```

ST222@Warwick: Huge majority used base rate, and of those who did not, some gave reasons.

Neglect of base rates: cab problem (T & K, 1982)

A cab was involved in a hit and run accident at night. Two cab companies, the Green and the Blue, operate in the city. You are given the following data:

1. *85% of the cabs in the city are Green and 15% are Blue.*
2. *a witness identified the cab as Blue. The court tested the reliability of the witness under the same circumstances that existed on the night of the accident and concluded that the witness correctly identified each one of the two colors 80% of the time and failed 20% of the time.*

   What is the probability that the cab involved in the accident was Blue rather than Green?

A. Tversky, D. Kahneman, Evidential impact of base rates, in ***Judgement under uncertainty: Heuristics and biases***, D. Kahneman, P. Slovic, A. Tversky (editors), Cambridge University Press, 1982

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   What is the probability that the cab involved in the accident was Blue rather than Green?

Most people answer probability for blue is 50%-80%.

But the answer using normative theory is about 41%.

(See next page).

Most people answer probability for blue is 50%-80%.

(Cabs are 85% green, 15% blue)

Answer using conditional probabilities:

Let G be the event of the delinquent being Green. Let B be the event of the delinquent being Blue. Finally, let W be the witness' report. Clearly,

$$\begin{aligned}\frac{p(B|W)}{p(G|W)} &= \frac{p(W|B)}{p(W|G)} \cdot \frac{p(B)}{p(G)} \\ &= \frac{0.8}{0.2} \cdot \frac{0.15}{0.85} \\ &= \frac{12}{17}.\end{aligned}$$

$$\frac{x}{y} = r, \quad x + y = 1$$

$$x + x/r = 1$$

$$x = \frac{r}{r+1}$$

Since $p(G|W) + p(B|W) = 1$, it follows that

$$p(B|W) = \frac{12}{12+17} \approx 0.41.$$

$$\frac{12/17}{12/17+1} = \frac{12}{12+17}$$

meaning that, in spite of the witness testimony, the hit-and-run cab is more likely to be Green than Blue.

On normative theory

"Give me an axiom, and I'll design the experiment that refutes it."

Amos Tversky

Overview: Heuristics & biases in finance

A list of links of common biases in financial decision making with links to definitions and research papers has been compiled by ABFE (Academy of Behavioral Finance & Economics) at www.behaviouralfinance.net/

Introduction	History	Bibliography	Links	Glossary
BF or BS?	Important Publications	Mailing List	People	Universities

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Adaptive Attitudes	Affect Heuristic	Aversion to Ambiguity	Anchoring (and Adjustment)	Attention Anomalies
Attribution Substitution Heuristic	Availability Heuristic	Barn Door Closing	Base Rate Neglect	Bid-Ask Spread
Book-to-market	Bubbles	Calendar Effects	Cascades	Causality Heuristic
Certainty Effect	Choosing by Default Heuristic	Choosing By Liking Heuristic	Closed end	Clustering
Cognitive Dissonance	Cognitive Diversity	Communal Reinforcement	Confirmation Bias	Conjunction Fallacy
Conservatism Bias	Contagions	Contrarian	Culture	Curse of knowledge
Daylight Saving Anomaly	Demand	Disappointment	Disjunction Effect	Disposition Effect
Dividends	Dotcom	Earnings	Endowment Effect	Equity premium
Event Selection	Evolutionary	Expected Utility Hypothesis	False Consensus	Favourite-Longshot Bias
Fear	Fluency Heuristic	Framing	Frequency Illusions	Fungibility
Gamblers Fallacy	Gambling/Speculation	Geomagnetic Storms	Glamour vs. Value	Global/Domestic
Growth	Halloween	Herding/Crowd	Heuristics	Hindsight Bias
Holidays	Hot Hand	Illusion of Control	Illusion of Knowledge	Illusion of Validity
Intraday Effects	Intramonth Effects	Irrelevance of History	January Barometer	January Effect
Law of Small Numbers	Loss Aversion	Loss Realization	Lunar	Magical Thinking
Mean Reversion	Mental Accounting	Mental Compartments	Momentum	Monday effect
Money Illusion	Mutual Funds	Noise	Optimism	Outrage Heuristic
Overconfidence	Overreaction	Over- and Underreaction	Persistence	Persuasion Effect
Pessimism and Doubt	Press Coverage	Price Reversals	Probability and Statistics	Prospect Theory
Prototype Heuristic	Quarterly Effects	Rational	Recognition Heuristic	Regret
Representativeness Heuristic	Reward Pursuit	Risk	Saving	Selective Thinking
Self Control	Self-attribution Bias	Self Deception	Sentiment	Serial Correlation
Similarity Heuristic	Size Effect	Solar	Sport	Status Quo Bias
Style	Sunk Cost	Super Bowl	Surprise Heuristic	Survival
Technical Analysis	Touchy-feely Syndrome	Trend	Uncertainty	Underreaction
Unpacking Effect	Value	Weather	Weekend Effect	Window Dressing
Winner's Curse				