Mark Van Selst
San Jose State University

COGNITION

Chapter 14: Decision Making

Cognition (Reed, 9th)

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Algorithm: precise set of rules guaranteed to produce the correct answer

Heuristic: rule of thumb, and informal strategy or approach that works under some circumstances (not all)

Models of Decision-Making

Normative Models: What we SHOULD do

Descriptive Models: What we ACTUALLY do
- e.g., Compensatory Model
  - (attractive/unattractive balance out)
Compensatory Model

- **Additive Model**: a strategy that adds attribute values to assign a weighted (+/-) value to each alternative.

- **Additive-Difference Model**: A strategy that compares two alternatives by adding their differences for each attribute.

<table>
<thead>
<tr>
<th></th>
<th>Apartment A</th>
<th>Apartment B</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>RENT</td>
<td>+1</td>
<td>+2</td>
<td>-1</td>
</tr>
<tr>
<td>NOISE</td>
<td>-2</td>
<td>+3</td>
<td>-5</td>
</tr>
<tr>
<td>Distance</td>
<td>+3</td>
<td>-1</td>
<td>+4</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>+2</td>
<td>+2</td>
<td>+0</td>
</tr>
</tbody>
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The conclusion is the same but the process is different.
Noncompensatory Model

• A strategy that rejects alternatives that have negative attributes without considering their positive attributes
  • Elimination by aspects: A strategy that evaluates aspects of an alternative one at a time and rejects those alternatives that fall outside of a set criterion
  • Conjunctive (1 alternative at a time) → SATISFICING
Payne’s work shows that his subjects changed strategies as the number of alternatives decreased. With many alternatives the subjects used conjunctive or elimination-by-aspects to eliminate some alternatives quickly.

When only a few alternatives remained, the subjects moved to the more cognitively demanding strategies (additive or additive-difference strategy) to make their final decision.
• **Induction** – the process of reasoning from the particular to the general

• **Deduction** – the process of drawing, by reasoning, particular conclusion from more general principles assumed to be true

• Francis Bacon proposed *logical induction* as the logic of scientific discovery and *deduction* as the logic of argumentation.

  • In fact, both processes are used synergistically in the behavioral sciences: by observation of particular events (induction) and from already known principles (deduction).
Syllogistic Reasoning

• three statement logical form
  Major Premise
  Minor Premise
  Conclusion

• The **logical validity of the conclusion** is determined entirely after 'accepting' the premises as true (it is a *logical deductive conclusion* – that is a conclusion that *necessarily* follows from the premises)
  All bears are animals
  Some animals are white
  Thus, some bears are white (Invalid conclusion)

• Syllogistic reasoning is highly subject to the confirmation bias; you can guard against this
  • (1) through the use of Euler Circles (*Venn diagrams*) while
  • (2) trying to falsify the conclusion.
Euler Circles

Mortal

Gods

Humans

All Humans are mortal
No Gods are mortal
No God is a human

Cognition
Van Selst (Kellogg Chapter 10)
Syllogisms

Major and Minor Premises

- “All”
- “Some”
- “None”

People do poorly with syllogisms, even when the content is “meaningless” letters.
Cognitive Constraints
(Syllogistic Reasoning)

• Atmosphere Hypothesis
  • “All, Some” $\rightarrow$ incorrectly assume syllogism is valid
  • “no, none” $\rightarrow$ if “conclusion” is negative is more likely to be accepted (even though not valid)

• Illicit Conversion (all A are B does NOT mean all B are A, but people tend to perform this “illicit conversion”)

• Belief Bias: meaningful information can lead to accepting logically invalid conclusions

Cognition
Van Selst (Kellogg Chapter 10)
two major parts:
   conditional clause (if-then)
   evidence

• Determine whether the evidence supports, refutes or is irrelevant to the stated relationship.
  • The "if" clause of the conditional is the antecedent
  • The "then" clause of the condition is the consequent

• The question is whether you can draw a logical conclusion from the evidence
The four possible conditional reasoning situations:

If $P$ then $Q$

- $P$
  - Thus, $Q$
    - valid inference AFFIRM THE ANTECEDENT (modus ponens)

- Not $P$
  - Thus, NOT $Q$
    - invalid inference DENY THE ANTECEDENT

- $Q$
  - Thus, $P$
    - invalid inference AFFIRM THE CONSEQUENT

- Not $Q$
  - Thus, NOT $P$
    - valid inference DENY THE CONSEQUENT (modus tollens)**

** people miss DENY the CONSEQUENT frequently
Conditional Reasoning

• People are generally good about affirming the antecedent, but have difficulty denying the consequent. People also have a tendency to engage in the two invalid forms. In addition, people have a tendency to perform an "ILLICIT CONVERSION" and switch the condition from if P, then Q to If Q then P.
Conditional Reasoning
(Wason & Laird)

Four-Card Problem
Which card or cards do you need to turn over to test "if VOWEL on one side then EVEN on other side".

E K 4 7

Typically subjects will show a confirmation bias – avoid seeking evidence in opposition to our beliefs

Martini Coke 31 17

- Meaningful material seems to help people.
- People are not good at abstract logic.

Cognition
Van Selst (Kellogg Chapter 10)
Wason (1968)
Inductive Reasoning Test

- “8, 10, 12, …”
- Participants are to propose additional elements/sequences to identify the rule
- The evidence supported the confirmation bias
The concept of “utility” (value or gain associated with each possible outcome)

One view of human decision making is to maximize utility… BUT:

• bet with 1/3 chance of winning $8
  OR

• bet with 5/6 chance of winning $3
Subjective Utility

- The “joy” of winning or “pain” of losing levels off with greater amounts
- Losses steeper than gains – people are risk averse
- The shape of the function yields Framing Effects -- the way a question is worded has an important effect on people's decisions.
  - This effect is both robust & pervasive. (Asian Disease, theatre ticket, calculator).
Framing Effects

• Making a different decision depending on where people see themselves to be in relation to the curvilinear subjective utility function.

• e.g.,
  • shopping for $15 calculator… drive 5 min to save $5?
  • Shopping for $150 jacket… drive 5 min to save $5?
Once you have lost money it is ok to keep losing more (relatively little added subjective cost) – this appears in stock trades for professional brokerage houses!

The subjective utility curve has a zero point (reference for gains and losses) – after purchase lowered expectations lead to early sell when the stock does well and being late to “cut bait”
Emotion and Thinking

- When people are in a good mood they try to maintain “the good vibe” and thus actually become increasingly risk averse
  - Risk averse in the domain of gains
Subjective Probability

Highly probable events are underestimated

Low probability events are overestimated

(Kahneman & Tversky, 1982)
In making predictions and judgments under uncertainty, people do not appear to follow the calculus of chance or the statistical theory of prediction. Instead, they rely on a limited number of heuristics which sometimes yield reasonable judgments and sometimes lead to severe and systematic errors (p.237, 1982)

Reed notes that this reflects an associative rather than rule-based reasoning
Heuristics and Biases
Representativeness Heuristic

Judgment strategy based on estimates of how similar an event seems to be to its population: whether the event seems similar to the process that produced it, or, how similar is event to the population of events it came from. A sample looks representative if it is similar in important characteristics to the population from which it was selected. For example, a random process should produce a random looking result.

- Which sequence of coin tosses is more likely?
  - HHHHHH
  - HHHTTT THHTHT

- **The gambler’s fallacy:** Ignoring the effect of sample size
  - **Law of large numbers:** the TRUTH is that large samples are very likely to be representative of the population from which they are selected (Central Limit Theorem, etc.); small samples may not be.
  - “**Law**” of small numbers: **Mistaken** belief that small samples will be representative of the population from which they are selected. (this is a mistake that people make... it is not a real law)

- Stereotypes can lead to Base-Rate neglect (failure to obey Bayes Theorem) via a “**conjunctive fallacy**” (bank teller)
The Gambler's Fallacy and its sibling, the Hot Hand Fallacy, have two distinctions that can be claimed of no other fallacies:

- They have built a city in the desert (Las Vegas)
- They are the economic mainstay of Monaco, an entire, albeit tiny, country, from which we get the alias "Monte Carlo" fallacy.

Both fallacies are based on the same mistake, namely, a failure to understand statistical independence. Two events are statistically independent when the occurrence of one has no statistical effect upon the occurrence of the other. Statistical independence is connected to the notion of randomness in the following way: what makes a sequence random is that its members are statistically independent of each other. For instance, a list of random numbers is such that one cannot predict better than chance any member of the list based upon a knowledge of the other list members.
Heuristics and Biases: Availability Heuristic

making a decision based on ease of retrieval from memory. You estimate the frequency or probability of an event by how easy or fast it is to think of examples of the event. This is often accurate, but can lead to errors when availability is not correlated with true, objective frequency.

- Frequency
- Familiarity
- Salience
- Vividness
  - Examples:
  - Words with K 1st vs. 3rd (Tversky & Kahneman, 1973)
    - How many words with K first vs. K third?
    - (people say first-k but really more third-k [harder to think of them])
Heuristics and Biases: Simulation Heuristic

- **Simulation Heuristic** – constructing a mental model of an event and then “running the model” to make a prediction of some future event, or imagine a different outcome of some event or action.

- **The undoing heuristic** - changing events (more likely *downhill* changes than *horizontal* or *uphill* changes [p.375])

- **Hindsight Bias** - because the scenario happened, we feel that the outcome should have been predictable since it is now very easy to picture how the event could have happened.

- **Anticipating Outcomes** (using simulation) both positive and negative and then deciding what to do based on these anticipated outcomes tends to produce more realistic (rather than biased) evaluations.
A central issue in the use of heuristics is the matter of representation: do we process the PROBABILITY or the RELATIVE FREQUENCY?

There are two opinion polls, in one set, 6 include candidate “A” and “A” wins 5 of the 6. In another set, 18 include candidate “B” and “B” wins 9 of the 18. Who do you expect to win?

Bizarrely, people OFTEN claim that “B” is more likely to win… this shows a reliance on raw scores rather than probabilities.
More Heuristics and Biases

Halo Effect -- Opinion/Evaluation generalized from a high score on one trait to a high score on all traits (also "negative halo effect")

Anchoring and Adjustment - People usually begin by guessing a first approximation -- an anchor -- and then make adjustments to that number of the basis of additional information. Often leads to a reasonable answer, but can lead to errors in some cases.

- Is the average price of an undergraduate textbook more than, or less than, $10.00?
- What is the average price of an undergraduate textbook?
- Typical finding: those with the $10 anchor produce lower estimated prices than those students given a $100 anchor. Part of this is due to the availability heuristic. It also works to bias estimates of frequency or number (e.g., the number of countries in Africa... anchor at 5 versus anchor at 80...).
Terminology

- Syllogistic reasoning
- Conditional reasoning
- Deductive
- Inductive
- Illicit conversion
- Belief bias
- Affirm the antecedent
- Deny the consequent
- Affirm the consequent
- Deny the antecedent

- Subjective Probability
- Subjective utility
- Decisions under risk
- Decisions under uncertainty
- Representativeness
- Availability
- Halo effect
- Gambler’s fallacy // “law” of small numbers
- Simulation heuristic