Ignoring base rates

- People were told that they would be reading descriptions of a group that had 30 engineers and 70 lawyers.
- People had to judge whether each description was of an engineer or a lawyer. They gave a number that reflected their confidence in their judgement.
- They should have factored in the base rate: the overall likelihood that a given case will fall in a given category

Ignoring base rates (cont.)

- If the description matched people’s stereotype of an engineer, they judged that the description was of an engineer
- People's judgments were not influenced by different base rate information (70 engineers and 30 lawyers vs. 70 lawyers and 30 engineers)

Improving our judgments

- People are more likely to use statistical knowledge when it is triggered by the situation.
- When people had to judge descriptions as belonging to a lawyer vs. engineer, they did better when they drew the descriptions out of a jar -- they made use of base rate information
- Highlighting the role of chance improves judgment.

Base Rate Neglect

- 85% cabs green
- 15% cabs are blue
- Witness: “Cab was blue.”
- Witness: 80% accurate when identifying colors in similar conditions
- What’s the probability that the cab in the accident was blue?
  - Survey Says: 80%
  - Bayes Says: 41%

When Base Rate Matters

- 85% of accidents involve green cabs
- 15% of accidents involve blue cabs
- Witness: Cab was blue.
- Witness: 80% accurate when ID-ing colors
- What’s the probability the cab was blue?
  - Survey says: 60%
  - Bayes (still) says: 41%

Probabilities vs. Frequencies

The probability of breast cancer is 1% for a woman at age 40 who participates in routine screening. If a woman has breast cancer, the probability is 80% that she will get a positive mammography. If a woman does not have breast cancer, the probability is 9.6% that she will get a positive mammography. A woman in this age group had a positive mammography in a routine screening. What is the probability that she actually has breast cancer?
Frequency & Probability Formats for a Bayesian Inference Problem

Three Major Heuristics/Biases
(Tversky and Kahneman, 1974)

- **Representativeness**
  - The more object X is similar to class Y, the more likely we think X belongs to Y

- **Availability**
  - The easier it is to consider instances of class Y, the more frequent we think it is

- **Anchoring**
  - Initial estimated values affect the final estimates, even after considerable adjustments

The Representativeness Heuristic

- We often judge whether object X belongs to class Y by how representative X is of class Y
- For example, people order the potential occupations by probability and by similarity in exactly the same way
- The problem is that similarity produces multiple biases

Representative Bias (1):
Insensitivity to Prior Probabilities

- The base rate of outcomes should be a major factor in estimating their frequency
- However, people often ignore it (e.g., there are more farmers than librarians)

Representative Bias (2):
Insensitivity to Sample Size

- The size of a sample withdrawn from a population should greatly affect the likelihood of obtaining certain results in it
- People, however, ignore sample size and only use the superficial similarity measures
- For example, people ignore the fact that larger samples are less likely to deviate from the mean than smaller samples

Representative Bias (3):
Misconceptions of Chance

- Random patterns appear nonrandom & people may inappropriately attribute a cause for the apparent pattern
- People expect random sequences to be "representatively random" even locally
  - E.g., they consider a coin-toss run of HHTHTH to be more likely than HHHHTT or HHHHHTH
- Gambler’s Fallacy – idea that prior outcomes can influence an independent probabilistic event
  - After a run of reds in a roulette, black will make the overall run more representative (chance as a self-correcting process??)
“The urge to find order in the environment appears to be a rather deep-seated human drive.” Herb Simon

Representative Bias (4): Insensitivity to Predictability

- People predict future performance mainly by similarity of description to future results.
- For example, predicting future performance as a teacher based on a single practice lesson.
  - Evaluation percentiles (of the quality of the lesson) were identical to predicted percentiles of 5-year future standings as teachers.

Conjunction Fallacy

- Use of representativeness heuristic: we think that people who exhibit certain characteristics will exhibit other, related characteristics.
  - We think that “like goes with like.”
- Example: People were told that Linda majored in philosophy and was a social activist. Then they ranked the probability of 8 statements about Linda.
  - Linda is a bank teller
  - Linda is a bank teller and a feminist

Conjunction Fallacy

- 80% of people rated the statement “Linda is a bank teller and a feminist” as more likely than “Linda is a bank teller.”
- This contradicts the fact that the probability of $x$ is greater than the probability of $x$ and $y$ co-occurring (when $x$ and $y$ are independent events).
- When this is pointed out to people, they admit they have made an error.

The Availability Heuristic

- The frequency of a class or event is often assessed by the ease with which instances of it can be brought to mind.
- The problem is that this mental availability might be affected by factors other than the frequency of the class.

Availability Biases (1): Ease of Retrievability

- Classes whose instances are more easily retrievable will seem larger.
  - For example, judging if a list of names had more men or women depends on the relative frequency of famous names.
- Salience affects retrievability.
  - E.g., watching a car accident increases subjective assessment of traffic accidents.
Availability Biases (2): Effectiveness of a Search Set
• We often form mental "search sets" to estimate how frequent are members of some class
• But, effectiveness of search set might not relate directly to the class frequency
  – Which is more prevalent: Words that start with \( r \) or words where \( r \) is the 3rd letter?
  – Are abstract words such as love more frequent than concrete words such as door?

Availability Biases (3): Ease of Imaginability
• Instances often need to be constructed on the fly using some rule; the difficulty of imagining instances is used as an estimate of their frequency
• Imaginability might cause overestimation of likelihood of vivid scenarios, and underestimation of the likelihood of difficult-to-imagine ones

Availability Biases (4): Illusory Correlation
• People tended to overestimate co-occurrence of diagnoses such as paranoia or suspiciousness with features in persons drawn by hypothetical mental patients, such as peculiar eyes
• Subjects might overestimate the correlation due to easier association of suspicion with the eyes than other body parts

A Trip to the Airport

Relativity of Judgment & Use of Norms
• John vs. Jill
  – John can imagine more similar possible worlds where he makes his flight
• Judgments based on comparisons of alternative possible worlds
• Judgments reflect mutability
  – Atypical > Typical
  – Foreground > Background

The Anchoring and Adjustment Heuristic
• People often estimate by adjusting an initial value until a final value is reached
• Initial values might be due to the problem presentation or due to partial computations
• Adjustments are typically insufficient and are biased towards initial values, the anchor
Anchoring and Adjustment Biases (1):
Insufficient Adjustment

- Anchoring occurs even when initial estimates (e.g., percentage of African nations in the UN) were explicitly made at random by spinning a wheel!
- Anchoring may occur due to incomplete calculation, such as estimating by two high-school student groups – the expression $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$ (median answer: 512)
- with the expression $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8$ (median answer: 2250)
- Anchoring occurs even with outrageously extreme anchors (Quattrone et al., 1984)
- Anchoring occurs even when experts (real-estate agents) estimate real-estate prices (Northcraft and Neale, 1987)

Anchoring/Adjustment Biases (2):
Evaluation of Conjunctive and Disjunctive Events

- People tend to overestimate the probability of conjunctive events (e.g., success of a plan that requires success of multiple steps)
- People underestimate the probability of disjunctive events (e.g. the Birthday Paradox)
- In both cases there is insufficient adjustment from the probability of an individual event

A Special Type of Bias: Framing

- Risky prospects can be framed in different ways as gains or as losses
- Changing the description of a prospect should not change decisions, but it does, in a way predicted by Tversky and Kahneman’s (1979) Prospect Theory
- In Prospect Theory, the negative effect of a loss is larger than the positive effect of a gain
- Framing a prospect as a loss rather than a gain, by changing the reference point, changes the decision by changing the evaluation of the same prospect

A Value Function in Prospect Theory

People are risk-averse for gains (don’t want to risk losing gains)

People are risk-seeking for losses (will gamble to avoid a loss)

Summary: Heuristics and Biases

- There are several common heuristics people employ to estimate probabilities
  - Representativeness of a class by an object
  - Availability of instances as a frequency measure
  - Adjustment from an initial anchoring value
- All heuristics are quite effective, usually, but lead to predictable, systematic errors and biases
- Understanding biases might decrease their effect

Decision Making and Explanations

- Pennington & Hastie
  - Complex decision making involves construction of explanations
- Legal Judgment Task
  - Varied order of evidence
  - People favored the more easily constructed story
  - Confidence related to existence of competing explanations
Satisficing

- Abandon goal of making optimal choice in favor of one that is satisfactory
- Search alternatives until you find a satisfactory one

Dealing with Complexity

- Elimination of Aspects
  - Pick aspect and threshold
  - Eliminate sub-threshold members
  - Pick next aspect and threshold
  - Eliminate sub-threshold members
  - (Rinse & Repeat)

Elimination of Aspects

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<tr>
<td>Apt B</td>
<td>High</td>
<td>Good</td>
<td>30 min</td>
</tr>
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Adaptive Decision Making

- Payne and colleagues
- Simulations
  - Expected Utility
    - Tanks under pressure...
  - Satisficing
    - Elimination of Aspects
    - Performed well under time pressure!
- Experiments
  - Little time pressure: attempt to use optimal strategies
  - Lots of time pressure: use heuristics

Decision Making

- Expected Value Theory does not capture subjective value of many goods
- Expected Utility Theory does not capture subjective understanding of probability
- People often use heuristics to make decisions
  - Anchoring & Adjustment
  - Availability
  - Representativeness
- Use of heuristics can lead to biases & fallacies
  - A&A → Insufficient Adjustment
  - Availability → Hindsight Bias
  - Representativeness → Conjunction Fallacy, Gambler’s Fallacy