Let’s Evaluate Some Possibilities

• Each of you will get a question sheet
  ▪ Please don’t read questions until you are told to do so
  ▪ Please don’t discuss the questions once you read them
  ▪ You will get ~20 seconds to answer each question
Heuristics and Biases in Judgment

• Effects observed by Tversky and Kahneman
  ▪ Misconceptions of chance
    ◦ Process must locally match global characteristic
    ◦ E.g., Flipping fair coin should not have long runs of heads/tails
    ◦ E.g., Gambler’s fallacy (being “due for a win”)
  ▪ Misconceptions of regression (regression toward mean)
    ◦ E.g., flight instructors criticize bad landing, praise good landing
      • After criticism, next landing better
      • After praise, next landing worse
      • Belief: only criticism is effective
Availability Biases Probability Assessment

- People assess probability based on ease of recalling instances → “Availability”
  - Bias due to retrievability
    - Recent experience makes us believe probability of those events is higher
    - E.g., Think accidents happen more often after seeing one
  - Bias due to effectiveness of a search set
    - E.g., Easier to think of wording ending in “ing” than “g”
  - Bias due to imaginability
    - E.g., Easier to visualize diverse paths through 8 columns with 3 rows than 2 columns with 9 rows
Imaginability Impacts Risk Taking

- Documentary made about jump
- Alan (paraphrase): I may not have done it if I’d seen the documentary first.  
  (He was joking)
Question 1 Results

• Question 1 really had two variants:
  ▪ Probability of word ending with the letter “g”
  ▪ Probability of word ending with the letters “ing”

• Probabilities using Scrabble Players Dictionary
  ▪ Words ending in “g”: 19,422/267,751 = 7.25%
  ▪ Words ending in “ing”: 18,619/267,751 = 6.95%

• Concept of availability would predict that ending with the letters “ing” would get higher probability

• Let’s determine our average predictions
Question 2 Results

• Question 2 had only one variant

• Structure path comparison
  - Structure A: 3 rows, 8 elements/row \( \Rightarrow 8^3 = 512 \)
  - Structure B: 9 rows, 2 elements/row \( \Rightarrow 2^9 = 512 \)
    - 46 of 54 subjects say more paths in structure A
    - Median estimates – A: 40, B: 18
    - T & K suggest this is due to differential availability
      - Structure A has more columns, paths in A seem more distinct, and paths in A are shorter than B

• Let’s see how we did in comparison
Prospect Theory

- Developed by Tversky and Kahneman in 1979
  - Kahneman won 2002 Nobel Prize in Economics
  - Tversky died in 1996 (Nobel not given posthumously)
  - Kahneman said “I feel it is a joint prize.”
- **Descriptive** (not normative) theory of behavior
  - Tries to explain why people deviate from principle of maximizing expected utility
- Focuses on two stages in decision making
  - Framing: how problem is presented
  - Evaluation: how probabilities and outcomes are considered/evaluated
Framing

• Preparing for disease
  ▪ Scenario 1: 600 people expected to die in outbreak
    ○ Can choose between two programs:
      • Program A: 200 people saved
      • Program B: 1/3 chance 600 saved, 2/3 chance no one saved
    ○ 152 respondents, 72% chose Program A (risk averse)
  ▪ Scenario 2: outbreak response
    ○ Can choose between two programs:
      • Program C: 400 people die
      • Program D: 1/3 chance no one dies, 2/3 chance 600 die
    ○ 155 respondents, 78% chose Program D (risk preferring)

• Programs A & B are really same as C & D
  ○ Risk preferring when problem framed as loss rather than gain
Frame Invariance Does Not Hold

• Two descriptions of game
  ▪ Game 1: 75% chance of nothing, 25% chance of stage 2
    o If you reach stage 2, you can choose between two programs:
      • A: win $30 (with probability 1)
      • B: 80% chance to win $45
    o 85 respondents, 74% chose A
  ▪ Game 2: Just choose an option
    • C: 25% chance to win $30
    • D: 20% chance to win $45
    o 81 respondents, 58% chose D
  ▪ Games 1 and 2 are identical in probability/payoffs
    o Stage 1 ignored in Game 1 framing, and certainty effect kicks in
    o Over-weighting certainty in stage 2 (pseudo-certainty effect)
Dealing with Frame Invariance

- Invariance is needed in normative frameworks
  - Consider using canonical representation
    - E.g., Consider total assets in outcomes, not gains/losses
  - Difficult to apply in practice
    - Compounded outcomes (e.g., multiple stage effects)
    - “Bounded rationality”: best computation we can do given limited time and computational resources
    - What canonical representation to use in non-monetary contexts?
  - Test robustness of decision in different framings to determine sensitivity to frame
Anchoring

- Two groups of high school students given problem:
  - Group 1 received problem: $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$
  - Group 2 received problem: $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8$
  - Both groups given 5 seconds to estimate answer
    - Generally, not enough time to do full computation
    - Median group 1 estimate: 40,320
    - Median group 2 estimate: 512
  - Group 1 estimate anchored by higher value for product of initial terms in expression

- Difficulty assessing probabilities due to anchoring
  - Confidence intervals (e.g., 90%) too narrow
  - “Black swans” appear more often than we think
Evaluation of Outcomes

- Consider prospect (gamble):
  - Outcome $x$ with probability $p$
  - Outcome $y$ with probability $q$
  - Status Quo with probability $1 - p - q$

- Values of outcomes given by function $v(outcome)$

- Decision weights given by function $\pi(probability)$
  - Monotonic function of probability

- Overall prospect value: $\pi(p)v(x) + \pi(q)v(y)$
Value Function

• Hypothetical value function, \( v \)

  - Value function is S-shaped
  - Concave above reference point, convex below
  - Risk averse above reference point, risk seeking below
    - Pain of losing $N > Pleasure of winner $N
    - Loss aversion: willing to take more risk to avoid loss
Gain vs. Loss Impacting Behavior

• Loss aversion helps explain disease program choices described earlier
  ▪ Willing to take risk to prevent death (seen as loss)
  ▪ Not willing to take risk to save life (seen as gain)

• Race track betting
  ▪ Long shot bets most popular on last race of day
  ▪ Risk seeking to try to make-up for losses earlier in day

• Price setting and credit cards
  ▪ Surcharge for credit card use vs. “cash back” for cash
    ○ Creates reference point for overall cost
    ○ Paying surcharge creates perceived “loss” that is seen as worse than “gain” of getting cash back
Weighting Function

- Hypothetical weighting function, \( \pi \)

  - For low probabilities, \( \pi(p) > p \)
    - Low probabilities over-weighted
  - For moderate and high probabilities \( \pi(p) + \pi(1 - p) \leq 1 \)
    - Moderate and high probabilities under-weighted
  - \( \pi(0) = 0, \pi(1) = 1 \), so not well-behaved at end-points
Non-Linearities in Weighting

• At high-end: "certainty effect"
  • Underweight high probabilities, but $\pi(1) = 1$ means there is a significant jump in weight to get certainty
    o Going from $p = 0.95$ to $p = 1$ means much higher weight increase than going from $p = 0.80$ to $p = 0.85$
  • Saw this in Allais paradox when choosing "sure thing"
Recall, Allais Paradox

- Which option would you choose?

Choice A preferred:
\[ 1.00 \, U(1,000,000) > 0.89 \, U(1,000,000) + 0.01 \, U(0) + 0.10 \, U(5,000,000) \]

Choice D preferred:
\[ 0.89 \, U(0) + 0.11 \, U(1,000,000) < 0.90 \, U(0) + 0.10 \, U(5,000,000) \]
Non-Linearities in Weighting

- At low-end: overvalue elimination of risk
  - Insurance more attractive when framed as risk elimination rather than risk reduction
    - Example of insuring on odd days of month for half the cost
  - E.g., Vaccine reducing probability of disease from 20% to 10% less attractive than vaccine that eliminates one of two equally likely viruses that causes disease
Losses vs. Costs

• “Losses” viewed differently than “costs”
  ▪ Consider following problems:
    ○ Problem 1: Would you accept a gamble that offers a 10% chance to win $95 and a 90% chance to lose $5?
    ○ Problem 2: Would you pay $5 to participate in a lottery that offers a 10% chance to win $100 and a 90% chance to win nothing
  ▪ Two problems monetarily/probabilistically equivalent
  ▪ 42 out of 132 respondents rejected problem 1 but accepted problem 2
    ○ “Cost” of participating in problem 2 lottery not seen as equivalent to “loss” from losing problem 1 gamble
Accounting

• Consequences of choices are accounted by topic
  • Problem: You are about to purchase jacket for $125 and calculator for $15. The calculator is on sale for $10 at other branch of the store, located 20 minutes drive away. Would you make trip to the other store?
    • 68% of respondents would make trip
    • If jacket was $120 in other store, only 29% would make trip
  • Problem: Paid $10 for movie ticket. You discover you lost ticket as you’re about to enter theater. Would you pay $10 for another ticket? (46% say “yes”, 54% say “no”)
  • Problem: Want to see movie with ticket cost $10. You discover you lost $10 bill as you’re about to enter theater. Would you pay $10 for ticket to movie? (88% say “yes”, 12% say “no”)
    • Buying 2nd ticket seen as increase movie cost, so less willing to do it. Loss of $10 not accounted as cost of movie.
Outright Manipulation

• Probability assessments can be manipulated
  ▪ Consider following set-up:
    o Get mailing list of 1024 people
    o In week 1, evenly split list in two. Pick a stock to consider.
      • Send recommendation of “buy” to first (half) list
      • Send recommendation of “sell” to second (half) list
    o In each of next 9 weeks, split each of the lists you’ve formed so far in two. Pick a new stock to consider.
      • For each split of existing lists, send buy/sell recommendations for new stock to each half, respectively
    o After 10 week, one person will have received 10 correct recommendations for you.
      • Now you contact that person with an offer to give them 10 more stock recommendations for a large fee…
  ▪ This sort of fraud actually happens
Final Presentations

• Tuesday, March 19, 8:30am-11:30am
  ▪ Location: Littlefield Center 103

• Project presentations
  ▪ 30 minute presentation
  ▪ Followed by 10 minutes of questions

• Order of groups:
  ▪ Aaira, Jack, Kevin, Sabas
  ▪ Anjali, Anna, Athena, Maya
  ▪ Agam, Hugo, Madhuhaas, Raiyan
  ▪ Anna, Ashley, Kate, Myra

• Thanks!