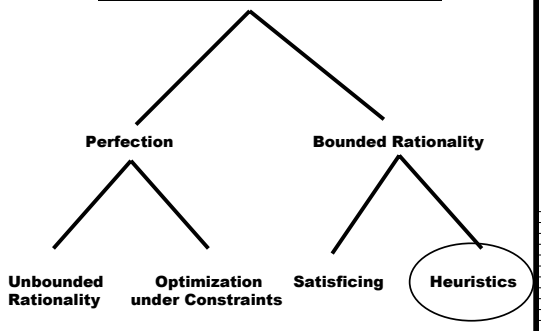
Managerial Decision Making:
Session 5

Classic Heuristics:
Representativeness

The Rationality Spectrum



Heuristic

- **Definition: a rule of thumb, a decision shortcut**
  - **in general, these are good shortcuts, they reduce effort, and essentially get to best decision**
  - **We use them because they're useful . . .**
- **Explicit Heuristics: We know them and we can articulate them**
  - **"the plus 5" heuristic**
- **Implicit Heuristics: We use them but we don't explicitly know that we use them, until we shine the spotlight on them as we will today.**
  - **the *"representativeness"* heuristic**
  - **the "*availability*" heuristic, etc . . .**

Heuristic vs. Bias

- **Students sometimes confuse the word "heuristic" with the word "bias".**
- **Heuristic is a "quick & dirty decision rule"**
- **Bias is an "error"**
- **Heuristics sometimes produce *Systematic* Biases, but not always**
  - **In fact, heuristics develop because they ARE pretty accurate most of the time.**
  - **We focus on biases because they reveal much about the underlying decision process (our departures from rationality and probabilistic thinking)**
- ***Your job: Identify heuristics, and recognize the biases that they spawn, if any…***

The Linda Problem Revisited

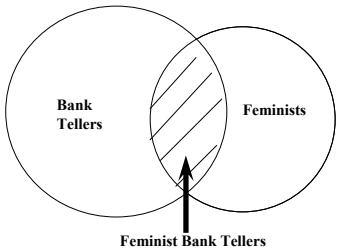
- **Linda is 31 years old, single, outspoken, and very bright.**
  As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.

Choose the most likely alternative:

- **Linda is a bank teller**
- **Linda is a bank teller and is active in the feminist movement**

Chosen more often but probabilistically less likely, why?

the conjunction fallacy



The Conjunction Fallacy: the excessive reliance on what is representative, and the unwarranted appeal of detailed scenarios, at the expense of probabilistic realities.

Results of a Quiz last year

- **What is the probability that all snow on the ground in Hanover will be melted in one week (except for where it was shoveled into heaps)?**
  - **N= 38 Section 2 Mean = 23.7%**
- **What is the probability that it will be extremely sunny in Hanover over the next week, melting all the snow on the ground (except for where it was shoveled into heaps)?**
  - **N = 32 Section 1 Mean = 25.4%**

The Conjunction Fallacy

- **"As the amount of detail in a scenario increases, its probability can only decrease steadily, but its *representativeness* and hence its *apparent* likelihood may increase"**

Representativeness

- Definition: **How likely event X belongs to set Y is judged on the basis of *how similar* X is to the stereotype of Y**
- ***Linda's description and occupation (X) seems to be the stereotype of "feminist bank teller" (Y) ?***

A Coin Flipping exercise

- ***Step 1*: Get out a piece of paper. Mentally flip a fair coin in your head 20 times, and w*rite down an *imagined H-T series in a row*.**
- ***Step 2*: Now flip the coin 20 times. Write down the actual H-T series in a row next to the previous one.**

Question from Week 2 Survey

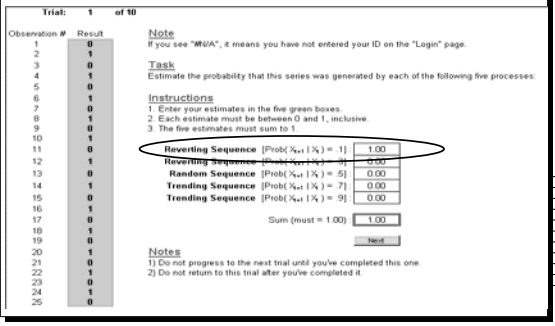
- Which of the following sequences of X's and O's seems more like it was generated by a "fair coin" random process?
  - » ❍ XOXXXOOOOXOXXOOOXXXOX
  - » ❍ XOXOXOOOXXOXOXOOXXXOX
- **64% of you said the bottom series**
- **36% said the top series (which is in fact more likely from a "fair" coin!)**

local representativeness

- **What makes data seem random to us?**
  - **Irregularity: *local representativeness***
    - » ***"local" as opposed to "global"***
- **Amateur statisticians have a tendency to believe that proportions should be approximately the same in a small sample as in a large population . . .**
  - ***"the law of small numbers"***

Is this series generated by a fair coin?

- ***It looks random to the untrained eye … but***



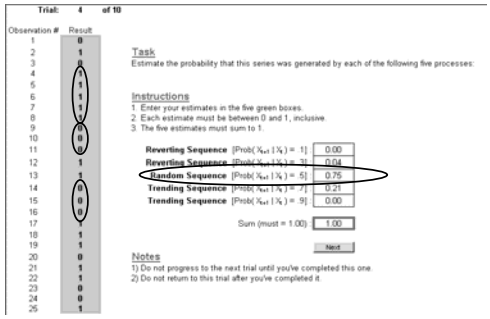
A Coin Flipping Exercise

- **Do your imagined sequence and the actual sequence look alike?**
- **In what ways are they different?**
  - **Key stats:**
    - » **Proportion of heads?**
    - » **Longest streak of heads or tails?**

Local Representativeness

- **In 20 flips of a coin,the chance of a string (or, run) of at least:**
  - **4 in a row is about 50%**
  - **5 in a row is about 25%**
  - **6 in a row is about 12%**
  - **7 in a row is about 6%**
- **If the process generating an outcome (or set of outcomes) is thought to be random, then an outcome will be *considered* more probable, <u>the more random it *seems*</u>.**

This series is actually pretty "random"



Question from Survey Week 2

» Suppose an unbiased coin is flipped three times, and each time the coin lands on Heads. If you had to bet $100 on the next toss, which side would you choose?

» ❍ Heads

» ❍ Tails

» ❍ No preference

- **80% of you said "No preference"**
- **17% said "Tails" *what were <u>they</u> thinking?***

The Gambler's Fallacy

- **A very large (>100) bag of poker chips is known to contain 60% of one color and 40% of another (either RED or BLACK). <u>You don't know which color has the higher proportion</u>.**
- **The following sequence is drawn/observed:**
  - **R B R R B B R R R (6 R, 3 B)**
- ***Which color in the bag is probably more common?***
- ***Which color is more likely to come up next?***
  - **R B R R B B R R R __?__**
- **The "Gambler's Fallacy"—we think flips/rolls should even out to the long-run averages even in small samples**

NEXT QUESTION: The mean IQ of the population of eighth graders in a large city is *known* to be 100. You have selected a *random* sample of 50 children for a study of educational achievements. The first child tested has an IQ of 150. What do you expect the mean IQ to be for the whole sample?

Answer: (enter a number)

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- **90% of you answered "100"**
  - **and, 95% of Chicago GSB students . . .**
- **One clever answer was "99"**
  - **What was she thinking?**
- **Some nonsensical answers . . . phulese!**
  - **150??? 125????**
- **Only 6% said "101", the correct answer**
  - **What has to be true for "100" to be correct?**

Another Quiz: get out paper

- **The Israeli army was attempting to make its flight training for pilots more effective. Experienced instructors noted that praise for an exceptionally smooth landing was typically followed by a poorer landing on the next try, while harsh criticism after a rough landing was usually followed by an improvement on the next try. <u>The instructors concluded that verbal rewards were detrimental to learning, while verbal punishments were beneficial</u>.**
- *Is their conclusion justified? Or, is there a better or simpler explanation? Why or why not?*

regression to the mean

- **Real conviction: an Israeli Air Force flight instructor to Daniel Kahneman on the folly of positive reinforcement.**
  - ***"With all due respect, Sir, what you are saying is literally for the birds. I've often praised people warmly for beautiful executed maneuvers, and the next time they almost always do worse. And I've screamed at pupils for bad ones, and by and large, the next time they improve. Don't tell me that reward works and punishment doesn't. My experience contradicts it."***
- **A representativeness problem, people over-generalize**

regression to the mean

- **The Sports Illustrated jinx**
- **Basketball time-outs**
- **The "Sophomore Slump"**

The Fallacy of Intervention
<u>When</u> should we intervene?

Where does this phenomenon become crucial in the business world? Or, at Tuck?

Quiz:

- Subjects were asked to predict a student's GPA (Y) from the Percentile Rank of three different items (Xs) :
  - Percentile rank of GPA
  - Percentile rank of test of mental concentration
  - Percentile rank of sense of humor
- What do you think happened?
  - How did they use the data?

Non-regressive predictions

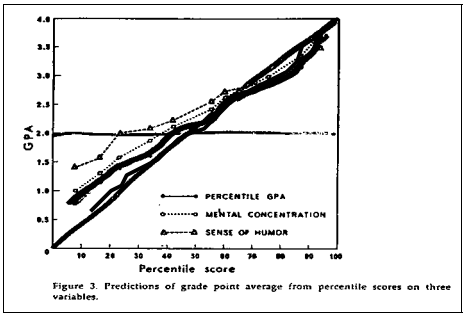


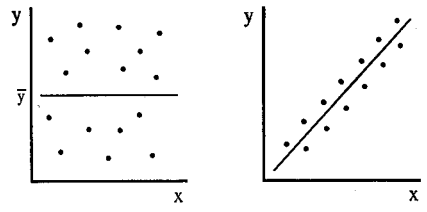
Figure 3. Predictions of grade point average from percentile scores on three variables.

Quiz followup:

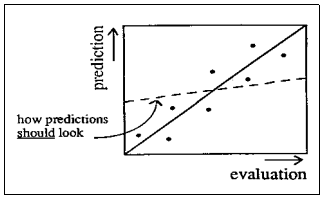
- Subjects were asked to predict a student's GPA (Y) from the Percentile Rank of three different items (Xs) :
  - Percentile rank of GPA
  - Percentile rank of test of mental concentration
  - Percentile rank of sense of humor
- Takeaway: We are often insensitive to the *predictability* of the X (independent) variable
  - Again, overusing the data just like in Bayesian updating. We "like" to create "connections."

Regression predictability

Two extreme examples of x as a predictor of y.



- Subjects read a description of a book. Groups are asked,
  - "How impressed are you with this description?"
  - "How many copies will it sell?"



3. Suppose that scores on a high school academic achievement test are moderately related to college grade point averages (GPAs) Given the students' percentiles below, what GPA would you predict for a student who scored 725 on the test?

Student Percentile	Achievement test	GPA
Top 10%	> 750	> 3.7
Top 20%	> 700	> 3.5
Top 30%	> 650	> 3.2
Top 40%	> 600	> 2.9
Top 50%	> 500	> 2.5

"725" Student's Estimated GPA (use one decimal)

80% of you said "about 3.6"
725 is between 700 and 725, so . . . 3.6 GPA

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- **Why is 3.6 an unlikely outcome?**
  - **Only 10% chose a GPA below 3.5!**
- **What *is* the right answer?**
- ***Why don't we understand this?***

Where does this phenomenon become crucial in the business world? Or, at Tuck?

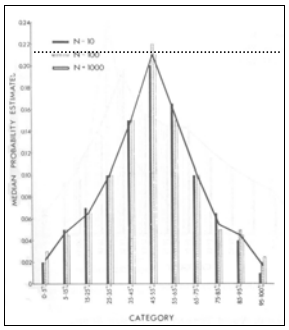
i.e. using some (worthless) data as just as valuable as good data?

samples from populations

- **Subjects were asked to approximate the distribution of boys (vs. girls) born in a certain region. The number born, N, was either 10, 100, or 1000 per day.**
- *For N = 10, what percentage of days were there n boys?*
  - *0 1 2 3 4 5 6 7 8 9 10 boys*
- *For N = 100, what percentage of days?*
  - *0-5 6-15 16-25 ……. 76-85 86-95 96-100*
- *For N = 1000, what percentage of days?*
  - *0-50 51-150 151-250 . . . . . 851-950 951-1000*

results of % in each bin . . .

- **Subjects indicated a 'universal distribution": no matter what N, the spread (variance) was the same.**



Survey: samples from populations

- A certain town in served by two hospitals. In the larger hospital about 45 babies are born each day. In the smaller one, about 15 babies are born each day. As you know, about 50% of all babies are boys. However, the exact percentage varies from day to day. Sometimes it may be higher than 50%, sometimes lower. For a period of 1 year, each hospital recorded the days on which 60% or more of the babies born were boys.
- *Which hospital do you think recorded more such days?*
- ***Your Answers**: ???*

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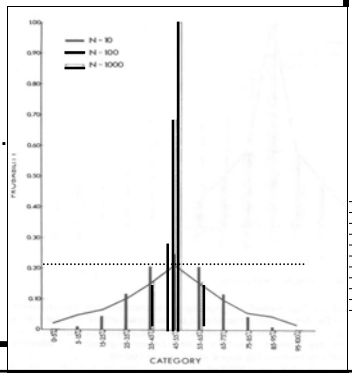
- **6 out of 100 picked the larger hospital**
  - **They will remain nameless . . . Hmmmmmmm . . .**
- **60% chose the smaller hospital**
  - **Yes, this is correct, this is good . . .**
- **BUT . . . 35% SAID IT DIDN'T MATTER!**
  - **Should I tell your Statistics professor?????**

what proportion should be in each bin ?

- **Decision makers *should* understand the effect of sample size . .**
- **Sampling variance *decreases* in proportion to sample size**
- *They don't understand it! Do you?*



An interesting diagnostic change

- **Same setup: A certain town in served by two hospitals. In the larger hospital about 45 babies are born each day. In the smaller one, about 15 babies are born each day. As you know, about 50% of all babies are boys. However, the exact percentage varies from day to day. Sometimes it may be higher than 50%, sometimes lower.**
- **For a period of 1 year, each hospital recorded the days on which 100% of the babies born were boys. *Which hospital do you think recorded more such days?***
  - ***Larger? Smaller? About the same?***
- ***Answer: Now, the answer is transparent!***

Simpson's paradox

- **In 1973, the University of California at Berkeley was sued for discriminating against female applicants to graduate programs.**
- **Two facts were presented:**
  - **Every single department accepted a higher proportion of female applicants than male applicants**
  - **But, the overall admission rate for graduate applicants was higher for males than for females.**
- *How is this possible?*

An Example

	Men	Women
Phys Ed	35/50	8/10
	70% →	80%
Physics	5/20	3/10
	25% →	30%
Overall	40/70	11/20
	57% ←	55%

Simpson's paradox

- **In Israel, the overall mortality rate for Jews is higher than for Arabs, although in every age cohort the reverse is true. How?**

Quiz

- **You have to have an operation, and are given a choice between two surgeons. You are told that Dr. A has a mortality rate of 3.7% while Dr. B has a mortality rate of 1.9%.**
  - *Your doctor recommends Dr. B, do you take this advice?*

Dr. A vs. Dr. B?

- **Suppose there are two types of operations, X and Y.**
  Y is far more dangerous, with mortality rates 6-7 times higher than for X. Dr. A performs 90% Y's while B performs 90% Xs.

Mortality Rates	X	Y	Overall Avg.
Dr. A-10/90	0.6%	4%	3.7%
Dr. B-90/10	1.2%	8%	1.9%

- *But, note that Dr A is better at both operations!*

better to break the law?

- **In 1957 in Rhode Island, more pedestrians were killed crossing with the light than against it.**
  - **Therefore, it is *safer* to cross against the light?**
- ***Probably not. Explanation?***
- **The number of people attempting to cross "with the light" is 10x (?) more than crossing "against it".**