Estimation and Mis-estimation

Summer 2003

How Do We Estimate?

Guesswork Experience Extrapolation Calculation

Intuition   Analysis

- Anchoring and adjustment
- Availability and confirmation biases
- Similarity and concreteness
- Illusion of control
- To boldly go…   (Carter Racing redux)

Predicting Stock Prices

- "Fundamentalists" look at factors such as P/E and calculate predictive models
- "Technicians" look at the patterns of stock prices to find timing signals that augur an upward or downward change (momentum…)
- Purists argue that stock price contains all available information, therefore cannot beat the market
- Bubbles: the "herd" follows the leaders (e.g., "irrational exuberance")
- These are different approaches to prediction

What Will the DJIA Be in 6 Months?

- Do you believe that six months from today the Dow Jones Industrial Average will be above or below 6,000? 12,000? What will it be?

Anchor at 6,000   average = 8523

Anchor at 12,000   average = 9840

- This is the "anchoring and adjustment" process with insufficient adjustment

More Anchoring

- A newly hired engineer for a computer firm in the Boston area has four years of experience and good all-around qualifications. When asked to estimate the starting salary for this employee, my administrative assistant (knowing very little about the profession or the industry) guessed an annual salary of $28,000. What is your estimate? $50,778

- For the other version, the guess was $128,000. $90,058

- What are the last three digits of your home phone number? Now, think of those numbers as a year between 000 A.D. and 999 A.D. Do you think Attila the Hun was defeated in Europe before or after that date? What date do you think Attila the Hun was actually defeated in Europe?

- Low anchors (<500 A.D.) estimate   474 A.D.

- High anchors (>500 A.D.) estimate   504 A.D.

Calculate or Anchor/Adjust?

- 15. Which of the following appears most likely? Which appears second most likely?
- A. drawing a red marble from a bag containing 50% red marbles and 50% white marbles (.50)

30%

- B. drawing a red marble 7 times in a row, putting the marble back each time, from a bag containing 90% red marbles and 10% white marbles? (.48)

25%

- C. Drawing at least 1 red marble in 7 tries, putting the marble back each time, from a bag containing 10% red marbles and 90% white marbles? (.52)

45%

Forecasting Retail Products

- Major food store chain in Chicago needed to forecast expected sales of a product, given marketing mix of promotions, coupons, pricing, displays
- Searched historical records for a product that matched this one and had a similar marketing mix, and based forecasts on this historical data
- A. C. Nielsen sells software to facilitate storage and retrieval of historical cases
- What's wrong with using this heuristic?

Other Anchoring Examples

- California Highway Patrol "selling" speeding tickets

- IRS auditors reaching agreement

- Real estate agents estimating selling prices of houses

- Standard budgeting practices, in contrast to "zero-based budgeting"

- Incrementalist policy approach - adjust current policy to alleviate concrete imperfections (management by exception)

Conclusions as Anchors

- Presentations and other communications may adopt the "direct" style of first giving conclusions and later supporting them with data, or the "indirect" style of giving data and working up to conclusions

- When would one be better than another? Why?

- In business applications, we almost always see one of these two styles rather than the other

Availability

Which is a more frequent cause of death?

- Stomach cancer   or   Motor vehicle accidents   76%
- Obesity/inactivity   or   Heart disease   70%
- Tuberculosis   or   Fire and flames   87%

- On what basis do you choose?

Availability Heuristic

- When estimating likelihood, we do an "intuitive sample" of our own experience
- The intuitive sample is either from memory or from imagination
- Memory: the easier it is to recall some examples, the more likely it must be
- Imagination: the easier it is to imagine some examples, the more likely it must be

Business Example

- Large chemical co. troubleshooting complaints about solvents
- QC manager thinks availability may be causing bad diagnoses
- A test: experienced chemical engineers given 5 solvent complaints, assign probabilities to a list of plausible causes
- Those with recent experience of a cause judge it 15-50% more likely
- What could help this situation?

Strategic Use of Availability

- When might an opponent deliberately increase the availability bias?
- Promotion decisions: "Put good news in writing, deliver bad news orally"
- Towing insurance in winter, home security systems after publicized burglaries
- The power of vivid, memorable stories in shifting estimates of future events

Confirmation Bias

■ We like confirmation and confirming evidence

■ Confirming evidence is seen as higher quality

■ MIS: "Access to more information results in its selective use to support preconceived positions... (Managers) assume that the quality of decisions has improved because of the amount of information that supports it."

- Emshoff, J. R., and Ian I. Mitroff. "Improving the Effectiveness of Corporate Planning."
Business Horizons, October 1978.

Representativeness Heuristic

- Probability that a person, event, or sample belongs to a class of events is judged from similarity
- This ignores important factors such as prior probability, sample size, reliability of data

Examples

■ 11. Which coin toss sequence is more likely (H=Heads, T=Tails)?

→   A. H T H T T H

  B. H H H H T H

23%   C. H H H T H

■ 7. 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 5 for the least probable:

  _____ Linda is a teacher in elementary school.

  __>x__ Linda is a bank teller.

  _____ Linda is a member of the League of Women Voters.

  _____ Linda works in a bookstore and takes Yoga classes.

73%   __x__ Linda is a bank teller and active in the feminist movement.

One More Example

- 16. A town is served by two hospitals. In the larger hospital about 45 babies are born each day and in the smaller hospital 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 higher than 50%, sometimes lower. For a period of one year, each hospital recorded the days in which more than 60% of babies born were boys. Which hospital do you think recorded more such days?

  16%   A. the larger hospital

  28%   B. the smaller hospital

  56%   C. about the same (within 5% of each other)

Concrete vs. Abstract Info

■ CASE: specific information about a person, product, event

e.g., during a cocktail party, a friend tells you about his bad experience with one of two cars you are considering buying

■ BASE RATE: general information about the category to which this belongs (prior probability)

e.g., frequency of repair records in <u>Consumer Reports</u>

Other Examples

- Government publications describing new advances in agricultural techniques had little effect. Subsidizing a few local farmers to use new seeds had great impact.

- Which worked better: Warning about swimming at a Mediterranean beach by base rate of accidents or story of a recent fatality?

- Structure of <u>Wall St. Journal</u> articles

- 13. Mark is finishing his MBA at a prestigious university. He is very interested in the arts and at one time considered a career as a musician. Is he more likely to take a job

39%   A. in the management of the arts

B. with a management consulting firm

Reliability of Data

- 20. Which of the following is more likely:

61%   A. A tall father will have a son who is taller than him

        B. A tall father will have a son who is shorter than him

    Representativeness gives little hint, but statistically there is "regression to the mean"

- Israeli pilot training
- Sophomore jinx in baseball
- Consulting firms

Reliability of Stock Market Data

- Interview with an expert stock trader in the morning, April 4, 1994

Q: "Will the stock market continue its plunge? What sort of trading day do you expect?"

A: "The [bond index] is the only lead indicator we have for today and it dropped an amount equivalent to a 125 point drop in the market. So, that's what I'm anticipating."

- How does this prediction sound to you?

The "Hot Hand"

- Do athletes get "in the zone" and "on a hot streak"?
- Should we trust the recent record of mutual funds, stock advisors, etc.?
- How much is transferable, how much luck?
- Evidence from basketball shooting records shows little evidence of a "hot hand" -- there are more "streaks" than we expect, but not more than chance!
- Gambler's Fallacy -- Maryland lottery winning numbers are bet 1/3 less for 3 days, then gradually recover (Clotfelter & Cook, Management Science, 1993)
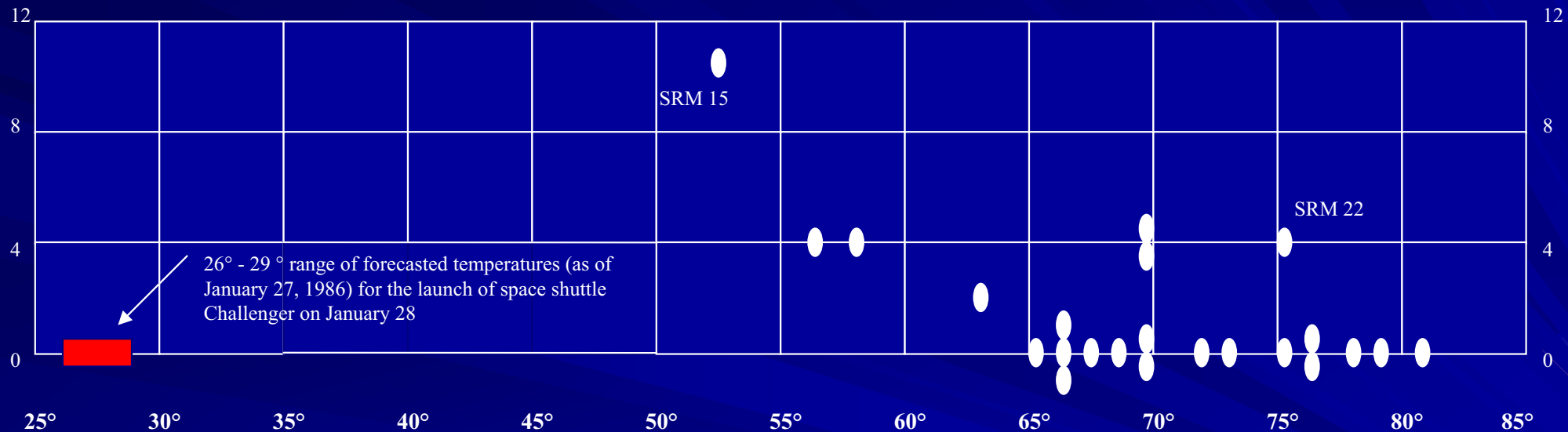
Extrapolating

- We see patterns in data, such as regular variation, general increases, etc.
- These patterns or "mental models" allow us to understand the data and to extrapolate or predict
- However, our mental models may be in error
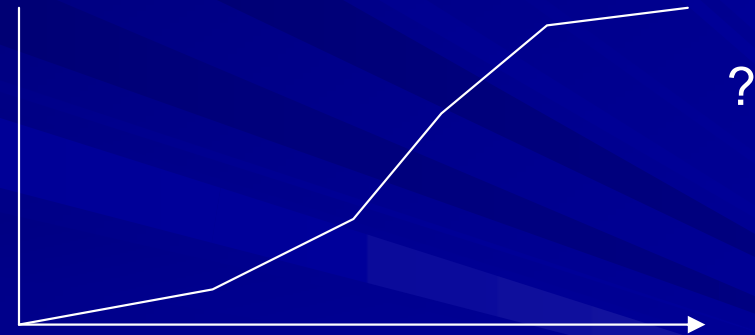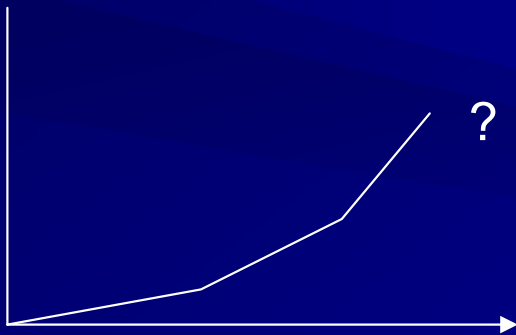
In system dynamics, this could be a self-reinforcing process that will grow exponentially, but if there are balancing processes, then the result can be very different!

Carter Racing Redux (Challenger)

**O-ring damage
index, each launch**

26° - 29 ° range of forecasted temperatures (as of
January 27, 1986) for the launch of space shuttle
Challenger on January 28

SRM 15

SRM 22

12 · 8 · 4 · 0

25° · 30° · 35° · 40° · 45° · 50° · 55° · 60° · 65° · 70° · 75° · 80° · 85°

Temperature (°F) of field joints at time of launch

Illusion of Control

- Belief in determinism, perception that chance tasks involve skill: Spanish lottery, dice players

- Skill cues induce **illusion of control**: choice, familiarity, practice, early success, control language

  e.g., betting high card against Mr. Confident or Mr. Shnook (50% larger against Mr. Shnook),

  e.g., $1 lottery ticket when you pick your own is worth $8.67 vs. $1.96 when you are given it

Is The Illusion A Strategic Error?

- Perceived control leads to effort, persistence
- Lack of control leads to giving up, "learned helplessness"
- Cost of erring on the side of the illusion of control may be low relative to the cost of assuming no control, ie., overconfidence may be preferable to depression and self-fulfilling prophesies may motivate achievements
- But there is value to realism!

How Can We Communicate About "Risk" ?

- Variance (distribution of outcomes)
- $p*U$(negative outcomes)
- Exposure (max. negative outcome)
- Risk dimensions:

    controllability

    dread

    unfamiliarity

    disaster potential

Why Not Wear Seatbelts ?

- It really isn't worth it (EU)
- Optimism (it won't happen to me)

  97% of consumer respondents rate themselves average or above average in ability to avoid bicycle and power mower accidents

- Controllability

  people accept 1000 times the risk for activities such as driving compared to food-based carcinogens

Seatbelts, continued

- Temporal discounting of future pain

- Availability - usually we get there OK

- Self-image/social norms

    don't be a wimp

    do what your friends do

- Biochemically-induced optimism

    drugs

    adolescence

    good mood

Loss Aversion

- You are exposed to a 25% chance of losing $4. Would you buy insurance for $1 to protect you? 15%

- You are exposed to a .01% chance of losing $10,000. Would you buy insurance for $1 to protect you? 94%

Loss Aversion, continued

- This class was very different from studies with students, in which 70% buy in the 1st case, 15% in the 2nd

- Purpose of insurance is to protect against rare but large losses; many people want to protect themselves against likely losses of any size (loss aversion)

  e.g., preference for low deductibles

Bundling Risks

- Buy insurance for $2 to protect against 20% chance of losing $10 ?
- Buy insurance for $1 to protect against .1% chance of losing $1000 ?
- Buy insurance for $3 to protect both ?

Bundling Risks, continued

- 47%, 24%, 51%: bundling risks makes people more likely to protect themselves
- Persuasive communication to drivers about seat belts:

   p(auto fatality) = .00000025 per trip

   p(auto fatality) = .01 per lifetime

Optimism

- ~3000 new business owners rate their prospects as very favorable (ave. = 81%; 1/3 see odds of success of 10/10, Cooper et al, 1988)
- Odds of business like yours succeeding were closer to reality (59%)
- Realism associated with depression !
- Could optimism offset loss aversion ?

Insuring Natural Hazards

Kunreuther study of flood and earthquake areas

- 1/3 of people in communities with subsidized insurance did not know it was available
- 12-29% of uninsured assume they will have no damage from severe flood or quake vs. 2-9% of insured (optimism?)
- using insured people's estimates of p, costs, damages, etc., only 40% are in the EMV ballpark; 10% could be risk-averse enough. Another 50% lack information, expect no damage, or assume high ratio of net cost if no disaster to net gain if disaster.

Source: Howard C. Kunreuther, et al. *Limited Knowledge and Insurance Protection – Implications for Natural Hazard Policy*, University of Pennsylvania, March 1977.

How <u>Are</u> These Decisions Made?

- **Information is costly**

  insurance agents are a pain; use friends and neighbors who provide low cost information
- **Heuristic decision strategies**

  buy if others do; buy if within budget; buy if cheap compared to home insurance
- **Purchasers are more aware of hazards, had a serious loss, know other purchasers, discussed insurance with friend, relative, and/or neighbor**
- **Implications for insurers**

Implications for Communicating

- Know your audience! Try to understand what they want, what they know, how they think, and their attitude toward you and your message

- Most people frame decisions and make estimates in very intuitive ways that are concrete and based on simple heuristics

- You can choose to educate the audience to other ways of framing and analyzing a problem, or to "start where they are at" and give them information in ways that will be persuasive