Descriptive Statistics and Probability: A Look at Real-World Examples

INFO 1301

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The purpose of descriptive statistics

- To understand a complex situation through one or a few numbers
- Many different possible descriptive statistics to give
- Best baseball player, you could consider:
  - Hitting and running: batting average, home runs, hits, slugging percentage, on base percentage, stolen bases, stolen base percentage, strikeouts, runs batted in, etc.
  - Pitching: wins, winning percentage, saves, earned run average, saves, walks per 9 innings, home runs allowed, complete games, strikeouts, opponents batting average, etc.
  - Fielding: assists, putouts, errors, passed balls, ultimate zone rating, etc.
  - And now many exotic statistics that came out of the Sabermetrics movement
- Which features you value go into which descriptive statistics you select

Using descriptive statistics to give ratings 1

- Unit of analysis matters
  - Illinois state tax rate increased from 3% to 5% by efforts of the Democrats
  - In publicity, Democrats focus on the absolute change in the tax rate, only 2 percentage points
  - In publicity, Republicans focus on percentage change in the tax rate, 67% increase
  - Both are correct!

Using descriptive statistics to give ratings 2

- Another example using unit of analysis

- Populist politician: "Our economy is in the crapper! 30 states had falling incomes last year!"

- Elitist politician: "Our economy is showing appreciable gains: 70% of Americans had rising incomes last year."

- One is very negative statement; the other very positive; yet both could be true.

- How?

Answer

- Less populous states (Rhode Island, Delaware, etc.) have falling incomes while more populous states (California, Texas, etc.) have rising incomes

Another unit of analysis example

- Verizon: we cover a higher percentage of **America** with cell phone service

- AT&T: we cover a higher percentage of **Americans** with cell phone service

- Geographical coverage vs. human coverage

- All other things considered (e.g. quality of service, cost, family plans), more people should choose AT&T, unless you spend time in an out-of-the-way place

Weighting of units of analysis matters

- Also how you weight units of analysis
- *Car and Driver* used 21 features to rate sports cars
  - Ranked Porsche Cayman #1
  - Only weighted exterior styling 4% - low for a sports car
  - If you weighted exterior styling 25% - Lotus Evora top rated
  - If you give higher weighting to sticker price (value for money), Chevrolet Corvette top rated

Problem with using means as descriptive statistics

- Example: George W. Bush tax cuts
  - Bush administration argued that 92 million Americans would receive an average tax reduction of over $1000 (actually $1083)
  - Did 92 million Americans get tax cuts? YES
  - Did most families get a large cut? NO
  - The median tax cut was less than $100
  - Reason: Outliers affected the mean. Very wealthy individuals received much larger tax cuts, raising the mean tax cut.
  - Lesson: Mean is susceptible to outliers!

Median also problematic

- Example: Harvard paleontologist Steven Jay Gould found out that he had a rare form of abdominal cancer (peritoneal mesothelioma)
- Median time from discovery to death: 8 months
- Should he get his life in order because he has less than a year to live?
- Half of the people live longer than the median
- Turns out the mortality distribution is right skewed, so some people live much longer
- Gould lived 20 more years (died from a different cancer)
- He wrote article (playing on Marshall McLuhan) entitled, "The Median Isn't the Message"

Beware the Base when considering percentages

- Example: Charles Wheelan received a notice that his tax bill to pay for the Tuberculosis Sanitarium District was increasing by 527 percent
  - However, there are not many cases of tuberculosis any more; so the tax bill increase from $1.15 to about $6.
- Example: Boss tells you that the company had a good year, so everybody is getting a 10% raise.
  - Your salary is $35,000 so you are getting $3500. Your boss's salary is $200,000 so she is getting $20,000

Other Statistical Chicanery

- Houston public schools reported 1.5% dropout rate – the best rate in the country
- 60 Minutes tv show investigated
  - Rod Paige, the Houston school superintendent, gave financial incentives to school principals to have high test scores and low dropout rates; did not monitor how the principals did this
  - Schools classified almost all dropouts as transferring to another school, returning to their native country, or leaving to pursue a General Equivalency Diploma
  - Actual annual dropout rate in Houston public schools exceeded 25%
  - Paige kept standardized test scores high by flunking out poor students before 10th grade (the year in which the standardized test is administered) and in at least one case by making a student take 9th grade 3 times and then promoting him directly to 11th grade
  - Nevertheless, George W. Bush appointed Paige as US Education Secretary for his success in the Houston schools with both dropout rates and high standardized test scores

Probability as Advertising

- The Joseph Schlitz Brewing Company, created in 1849, was once the largest beer manufacturer in the US: "the beer that made Milwaukee famous"

- Started having hard times in this competitive industry in the 1960s

- Disastrous 1977 tv ad campaign a burly Schlitz drinker threatens an off-screen speaker who wants the burly guy to switch to a different brand of beer. Viewers found the ads menacing, and were spoken of as the "Drink Schlitz or I'll kill you" ad campaign.

- In 1980-1981, Schlitz had a series of contests in the NFL playoffs, in which 100 consumers loyal to a different beer (first Budweiser, then Miller, and at half time at the 1981 Superbowl Michelob) were given a live blind taste test with an actual football referee presiding – cost for the Superbowl time was $1.7 million

Statistics Gusto for Schlitz

- Schlitz believed that all of these inexpensive beers tasted alike, and that in a blind test, the probability of selecting Schlitz over Michelob was similar to flipping a coin

- Statisticians told the company that the probability distribution of those choosing Schlitz in the blind test was approximately a normal distribution, so it was very unlikely that a big majority would select Michelob (like getting almost all heads when flipping 100 coins)

- Probability of getting at least 40% of blind tasters to choose Schlitz is .83 if n=10; .98 if n=100; .9999999999 if n=1000 [standard error drops with sq rt of n]

- Indeed, on live tv, exactly 50 of the avowed Michelob drinkers chose Schlitz

- Despite its imaginative advertising, Schlitz failed. Stroh's bought Schlitz in 1982; Pabst bought Stroh's in 1999; Pabst brought back the Schlitz brand in a classic "gusto" version

Unforeseen 9/11 Dangers

- After the 9/11/91 terrorist bombings, many people were afraid to fly or did not want to deal with the hassles of airport security
- Many people began to drive rather than fly
- But the probability of a fatal crash, per mile, is much higher in a private automobile than on a commercial airplane
- Three Cornell statisticians did calculations that indicated that there was an increase of 344 additional traffic deaths in each of the first three months after the bombings than there would have been
- People eventually returned to flying, so the extra traffic deaths tailed off; but the statistical model indicates a total of approximately 2000 additional deaths because of people's fear to fly

Monty Hall Problem

- At end of tv show Let's Make a Deal
  - Contestant has to choose between 3 doors
  - Desirable prize behind one door, a goat behind the other two
  - Contestant obviously has 1 in 3 chances of winning the big prize
  - Twist to the game: once contestant had chosen a door, Hall opened one of the other two doors – always choosing one with a goat behind it
  - Hall then asked if the contestant wants to switch from the contestant's choice to the other closed door
  - Should the contestant switch?

Hall continued

- The contestant should switch!
- Empirical evidence shows this. Person A played game 100 times, switching each time. Got prize 72 times. Person B played the game, never switching, and got prize 33 times.
- Prob(chosen door)=1/3
- Prob(remaining door) = 1 – all other choices = 1 – Prob(chosen) = 1 – 1/3 = 2/3
- Play it yourself at http://www.nytimes.com/2008/04/08/science/08tier.html

Incorrect Belief in Independence

- Sometimes independence of events is inappropriately assumed

- Sudden Infant Death Syndrome has a 1 in 8500 chance of occurring in Britain

- A famous pediatrician (Sir Roy Meadow) claims that if there are two SIDS deaths in the same family, there is a criminal problem because the odds would be 1/8500 x 1/8500 = 1/73 million; and govt complied by convicting a number of dual death parents of murder

- However, this assumes that the two SIDS deaths are independent. There is a strong likelihood that genetic predisposition might make a second death quite likely if there is a first death. After arguments by the Royal Statistical Society, govt reviewed 258 trials in which parents were convicted of murdering their infant children and overturned many of them.

Sometimes, improbable things happen

- The odds of getting hit by lightning once is 1/600,000 according to the Federal Emergency Management Administration

- Linda Cooper of South Carolina has been hit by lightning four times

- If independent events, her odds would be $(1/600,000)^4$, which is 1 chance in $1.3 \times 10^{23.}$

- Do you believe these events are independent?

Incorrect Belief in Dependence

- Example: "streaks" or "hot hands" in sports
- Widespread belief that someone might be on his basketball game on a particular day, and the fact that the athlete made one shot, making the next shot is more likely also to be made
- Three statisticians looked at shooting from the field data for the Phila 76ers for the 1980-81 season, as well as free throw data for the Boston Celtics.
  - Found no positive correlation between the outcome of successive shots
- Then did a study of the Cornell men's and women's basketball teams
  - 48% of shots made given previous shot made
  - 47% of shots made given previous shot missed
  - Of 26 players studied, 14 had negative correlation between successive shots, 11 no correlation, 1 positive correlation