Subjective Confidence Intervals

Administrative Things

- Assignment 7 due on Thursday, April 8.
- Should be reading from *Decision Traps* this week, Axelrod for next week's classes on game theory.

Today's Topics

- Formalizing intuitive opinions and guesses for better decisions
- Subjective confidence intervals
  - Properties of subjective intervals
  - Methods for making "better" intervals
- Pooling intervals will happen in our next class.

Review from Last Time

- Hedging to reduce variation
  - Reduce the uncertainty in future wealth from current
  - Example of farmer with uncertain quantity and production
  - Role of market forces as a natural hedge
- Futures contract (simplified view)
  - Promise to deliver bushel at chosen future date at agree "strike" price.
  - "Self-financing" in the sense that there's no up-front expense
- How many contracts does a farmer want to sell to minimize variance?
  - Goal is to minimize variance of future earnings, and thereby increase utility.

- Need better sense of the costs/acre for running a farm, but would a constant up-front cost affect the number of futures contracts in any case?

Overview of Subjective Confidence Intervals

➢ Making quick judgements in a consistent fashion

- Seldom will have enough time to gather all of the necessary data.
- Will need to rely upon informal information in addition to quantitative data.
- Want to use this sort of information systematically.

➢ How should you formulate your own opinions, intuition, and hunches?

- Subjective confidence intervals

  Subjective confidence intervals represent the judgement, opinion, or guess of someone about some as yet unknown quantity. In a business context, these intervals might estimate the
  future sales of a product,
  ultimate costs of an on-going project, or
  duration in months of laboratory development/research.

- Most managers have to make decisions with only rough information, but do not always do so in a systematic way.
- Subjective intervals formalize what we already do.

➢ Features and benefits of using subjective confidence intervals

- You'll get better if you are more systematic
- Allow tracking and calibration of forecasts

  - Recognize your own patterns as well as those of colleagues, such as in consistently under-estimating costs associated with marketing plans.

- Allow one to signal ignorance or knowledge

  - Get away from the "give me your number" corporate culture.

- Clarify the role of further information

- Calling an end to the "discovery" process

- How else is one to decide when it's time to stop gathering data and make a choice? (You can also tie these ideas to utility and CEVs as well.)

- Subjective confidence intervals an be pooled and manipulated in a fashion analogous to the intervals that we looked at in the first weeks of class.

- Combine qualitative and quantitative data.

Learning about Subjective Confidence Intervals

➢ In order to make effective use of subjective intervals, we have to learn about some of their characteristics.

➢ In particular, we need to learn how to represent the qualitative information from a subjective interval in a more quantitative way.

➢ Two aspects in particular

(1) What is the level of confidence to attach to a subjective interval?

(2) What sort of distribution should represent the uncertainty?

➢ We'll use several questionnaires to try to make some of the aspects of subjective confidence intervals more clear. When we are done with the first, I will give you a second questionnaire.

- Questionnaire #1
- Questionnaire #2

Discussion of the Questionnaires

- Common sort of questionnaire
  - These sorts of questions are common in the social psychology literature and are used, for example, in *Decision Traps* (p 69-75).
- Answers for the first questionnaire
- Coverages of intervals
  - What proportion of your intervals cover?
  - Does it matter what you know about the question?
- Coverage probabilities of subjective intervals
  - Generally hover somewhere less than 50% regardless of the setting and audience that makes the intervals.

    - Description of the task (e.g., emphasis on the 95% coverage aspect) does not seem to affect the experimental results.

    - Training/practice does not seem to raise the average coverage; still hovers down in the 50% range.

    - "Experts" also tend to have 50% coverage, just shorter intervals.
  - Science is not much better: confidence intervals for the speed of light
  - Are statistical 95% intervals really any better, particularly those used to extrapolate time series (like economic forecasts).

    Once we account for the uncertainty in the choice of model and the guesses that went into the selection of structure and data sources, the prediction intervals from statistical models are often not much better than subjective intervals. Just a lot more formalized.
  - Why should "scientific intervals" have the same sort of coverage as a subjective confidence interval?

    - Systematic error versus random, idealized error.
- Does the lack of coverage imply "overconfidence" as suggested in *Decision Traps*?

- Signaling knowledge using the length of an interval.

➢ Discussion of the second questionnaire

- What are the properties of intervals for things you are knowledgeable of?

  - Higher coverage probability, or

  - Shorter interval?

- Would anyone really want your 95% interval?

  - Studies have found that to make the subjective intervals really cover with 95% probability, they would have to be over 10 times longer!

➢ What do you look for in an interval?

- Trade-offs suggested in Questionnaire #2 between length and coverage.

- Preference for a short, "close" interval versus a long interval that covers.

- It's OK to have 50% coverage as long as we know that this is the case and learn to work with the low coverage.

- Just don't expect a "95% interval" from someone to cover so often as the statistical definition would imply.

Models for the Coverage of Subjective Intervals

➢ To learn how to best use these intervals in decision making, we first need to look at the nature of the errors made with subjective intervals.

➢ Properties of the normality-based intervals used with data

- Normal intervals have form of Estimate ± 2 SE(estimate)

- Thus, if we look at a plot of the ratio

  center / length

  of a collection of normal intervals *which were built in the idealized circumstances*, we would end up with a collection of normal random values.

  Aside: Even though the length is not the SE, it's a multiple of this and so we still get a normal ratio. The exact distribution in idealized cases is known to

be something called Student's t, but that's pretty close to normal unless you have a very small sample.

- Thus, if you look at a lot of normal-type intervals, you will find a "hidden" normal random variable underneath.

- This feature of a typical data-based confidence interval is the basis for our construction of the simulated versions of the "information sources" in the first part of the course.

➢ What are the analogous properties of subjective intervals?

- Pick a questionnaire item and record your standardized values

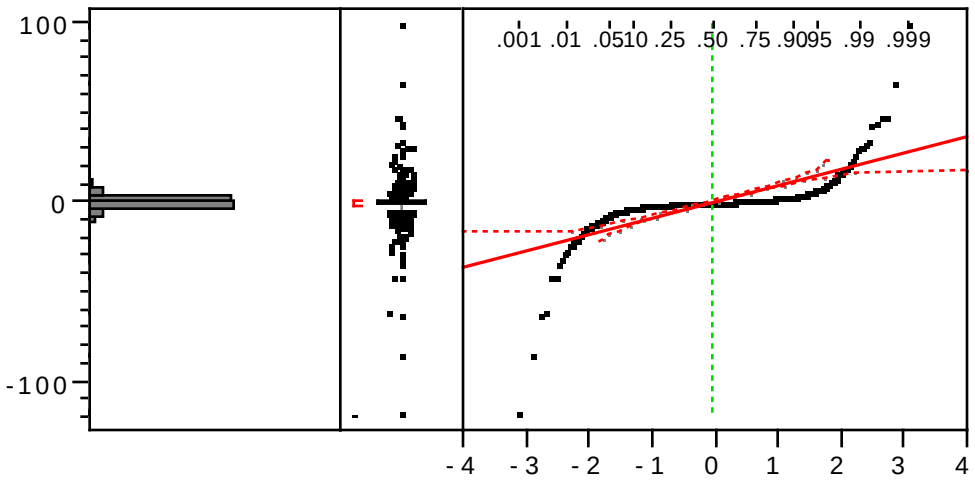
$$Z = (\text{Center of interval}) / (\text{Length of interval})$$

- How does the distribution of the class values for Z compare to the normal (using the normal quantile plot to check for normality)?

➢ Given these results, how should we try to use the subjective intervals to generate samples for our information combining, simulation methods?

- Empirical results from literature (e.g. Yaniv and Foster 1997, *J of Behavioral Decision Making*) suggest a Cauchy model for the variation

- Cauchy variation is much more likely to produce wild, outlying values. The following plot shows a histogram of 2,000 standard Cauchy values, after trimming off the most extreme (±600) so we can see the histogram.



- Very "thick" tails in the distribution as shown in the quantile plot.

- "Empirical rule" for the Cauchy is that 50% of probability lies within +1 to –1 for a standard cauchy. Here are the quantiles (percentiles) for our sample of 2000 from the standard Cauchy.

Quantiles

maximum	100.0%	645.22
	99.5%	46.52
	97.5%	16.15
	90.0%	3.20
quartile	75.0%	1.06
median	50.0%	-0.02
quartile	25.0%	-1.01
	10.0%	-3.27
	2.5%	-13.58
	0.5%	-75.55
minimum	0.0%	-740.61

- Note that the two quartiles (which between them include 50% of the data) are at –1 and +1, as claimed.

  In comparison, the probability between the –1 and +1 for a standard normal random variable is higher, at about 2/3.

➢ Simulating the information in a subjective interval

- Will want to pool the information from several subjective intervals as well as combine these with normal theory, data-driven intervals.

- Suppose that your subjective interval for costs in $M for a new project is 3.5 to 6.5. How can you simulate a sample that goes with this subjective interval?

  (1) Treat the subjective interval as a 50% coverage Cauchy interval.

  (2) Convert the length of the interval into a scale for the Cauchy. Since the length is 3, that suggests a scale of 1.5 $M for the Cauchy.

  (3) Simulate a sample which is consistent with this subjective interval in JMP using the formula

  5 + 1.5 ?cauchy

  where ?cauchy is obtained from the set of random functions in the JMP calculator (in the same group with the normal).

quartile	75.0%	6.4
median	50.0%	4.9
quartile	25.0%	3.4

  (4) Check your formula by looking at the quartiles of the sample. They should be close to your endpoints.

Improving the Information in Your Intervals

- Host of important social psychology results when it comes to thinking about how to make better decisions.
  - Curiously, this same literature is a source of predictions about human/computer interactions as well.
- Premise
  - Better intervals = better assessment of the uncertainty and the possibilities.
  - Get better intervals by avoiding some common pitfalls.
  - More likely to avoid the pitfalls if you know what they are.
  - *Decision Traps* gives many more examples of these with nice examples from the business world.
- Being aware of the possibilities
  - Questionnaire #3
  - Decision trees are an important a methodology for exploring the range of possibilities in a given problem or situation.
- Other types of biases in judgment
  - *Availability bias* occurs when we use the available information that is convenient to get your hands on, but not always the most informative.
    - Egocentric (Who does the cleaning?)
    - Gambling
    - Bus arrivals (Which one comes first?)
  - *Accepting anecdotal evidence* rather than making a more careful study of the problem. Pretty closely related to availability bias.
    - Which kills more: pigs or sharks?
    - CD players in airplanes
    - Smoking while buckled up

- *Separating the random from systematic*. This category of biases occurs when we forget Bonferroni and are fooled by the presence of false patterns.

  - Streaks in sports

  - Rewards versus punishment in manufacturing and education

- *Anchoring* our value in one problem to a number in an apparently unrelated context.

  - What's your area code?

  - In what year was Helen of Troy born?

- *Functional bias* in our view and attitudes to a problem

  - Silo mentality

  - Rational? Source of rewards (like here at Wharton)

Next Time

- Pooling subjective intervals and more discussion of their use.