Interpreting in uncertainty

Human Communication Lecture 24

The Gambler's Fallacy

Toss a *fair* coin

- 10 heads in a row - what probability another head?

Which is more likely?

a. a head

b. a tail

c. both equally likely

The Gambler's Fallacy

Everyday reasoning: more likely tails because it has to even out….

- Actually c. both equally likely
- Issue of *independence* of each coin toss v. likelihood of a particular sequence of coin tosses

This is the Gambler's Fallacy - belief in the 'Law of *small* numbers"

- How many heads in a row before you believed the coin to be biased?
- Amos Tversky - based theory of many aspects of people's thinking and judgement on this basic fallacy
- Through concepts of *representativeness* and *availability*

Sequences, populations and representiveness

Consider sequences of N (say 6) tosses

- There is a *population* of *kinds* of sequences
  e.g. 011011, 000111, 000000, … (total of 2^6)
- Each sequence is equally probable
- Might think that 6 heads in a row is less likely than say HTTHTH but it is not…

Characteristics of populations of kinds of sequences - some *kinds* of sequence are much more probable

e.g. sequences with 3 heads more common then ones with 6

(another e.g. of systematic errors in reasoning)

Sequences, populations and representativeness

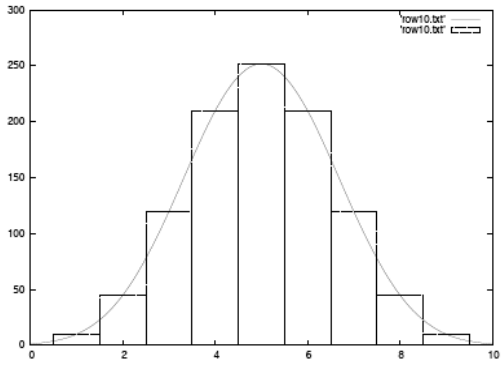
The *distribution* is a *bell curve*

- So 011001 is more *representative* than 000000 in that there are more cases with 3 heads than no heads
- Even though this particular sequence is equally probable

Binomial distribution: the bell curve

- Here's what the bell curve looks like for sequences of length 10
- Horizontal axis shows number of heads out of 10 coins tossed
- 10 sequences have 1 head - same have 9 heads (they are symmetrical)
- There are 1024 possible sequences ($2^{10} = 10^3$) from 0000000000 to 1111111111
- The most likely case is a 50-50 split, that is, five 1s and five 0s
- It accounts for nearly 1/4 of the data

Binomial distribution: the bell curve



Tversky: representativeness

Tversky's theory is that we often judge likelihood by representativeness

- Identified failure to use *base rate information*, information about how likely an outcome is regardless of *specific predictor information*

  e.g. witness sees taxi drive away from road accident, at night under sodium street light
  - judges it to be blue
  - all taxis are either blue or green
  - 90% are green and 10% blue
  - Tversky asked: How likely was taxi blue?

Tversky: representativeness

Tversky's asked others for same judgement, same problem, with % reversed

Showed that participants were insensitive to base rate information, that is information about background distribution of colours of taxis

In both conditions assigned same probabilities to likelihood of taxi being blue, based on lighting conditions, not frequency of colours

Counterargument: if had not seen taxi and guessed about colour would guess most common colour

Weight visual evidence accordingly to perceived reliability
- if daylight and close up should weight visual evidence more strongly
- In uncertain conditions combine both kinds of information

Note: assumes witness knows frequency of colours….

Taxis and *base rates*

- Results: subjects not much affected by base-rate
- People tend to better taking base-rate into account when judging in a familiar context (remember the selection task?)

Hospitals large and small

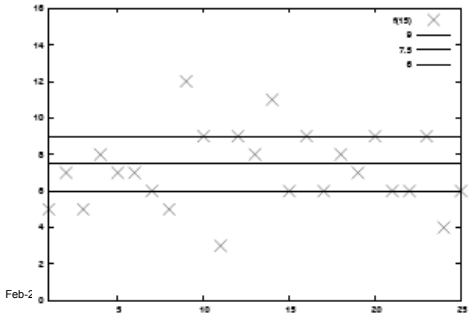
- One hospital has an average of 45, another 15 births per day
- Boys and girls equally likely
- Question: How often will each hospital expect more than 60% boys?
- Will the big or the small expect this more often?
- Many subjects say equally often

Hospitals large and small

- In fact the small hospital is about twice as likely to get 60%-or-more-boy-days
- In even smaller hospital, expected birth of 2 babies a day
  - Nunber of expected boys is one
  - But will be lots of days when there are 2 or zero
  - Curve for this would not be a symmetrical bell curve, but much flatter, which is why diverges from distribution in larger hospital
- Small samples are much less likely to reflect populations statistics - cannot assume same normal distributions
- Larger numbers = more likely to assume normal distribution - *in long run*, equal number of boys and girls
- People underestimate how long sequence needs to be to have confidence of match to 50%
- Expecting them to match populations exhibits belief in Law of Small Numbers (or Gambler's Fallacy)

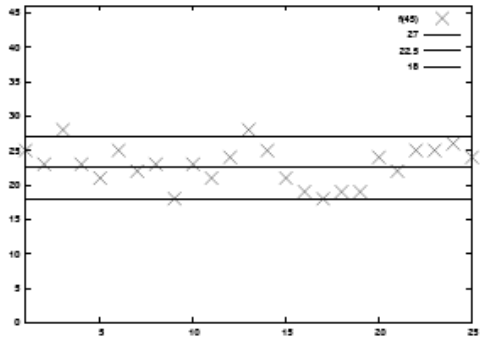
Hospitals large and small, illustrated

Contrast the outcome of 25 simulated days (same no. of births each day)
The small hospital had 60% or more boys on 7 days



Hospitals large and small, illustrated

The large hospital had 60% or more boys only on 2 days



Accountancy and assumptions

Consider the following biographical description:

– Bill is 34 years old. He is intelligent but unimaginative, compulsive and generally rather boring. In school, he was strong in mathematics but weak in social studies and humanities. How likely is it that each of the following is true?

- Assign probabilities between 0 and 1 for each of the following statements…. (where 1 is certainly true) - order them from most likely to least likely…

Assumptions and likelihoods…

1. Bill is an accountant
2. Bill is an accountant who plays jazz for a hobby
3. Bill is a doctor who plays poker for a hobby
4. Bill is an architect
5. Bill is a journalist
6. Bill climbs for a hobby
7. Bill surfs for a hobby
8. Bill plays jazz for a hobby

The results?

Tversky's subjects judged (2)

Bill is an accountant who plays jazz for a hobby

more likely than (8)

Bill plays jazz for a hobby

But (2) is just (8) *plus* the restriction of being an accountant, so it can't be *more* likely

Tversky's explanation: ease of imagining a *scenario*

- *Adding* information helps assimilate scenario to stereotype - adding accountancy makes jazz playing more plausible?
- But *adding* conditions must reduce likelihood (or at best leave same)

Tversky argues that because people's reasoning does not conform to probability theory, must reason some other way - theory of representativeness is starting point

Anecdotalism - persuasion by prejudice

- Journalism deals in anecdotes (OK this is a stereotypical statement)
- Not in generalities and statistics
- TEENAGE MOTHER GETS PREGNANT FOR FLAT
- SUN reports one such case
- The reader is supposed to infer that a major reason for teenage pregnancy is council waiting lists priorities

Anecdotalism - persuasion by prejudice

- What information do we need to assess this idea?
- Number of teenage mothers in population gaining council housing
- But what else? What are the relevant base-rate (s)?

BSE and CJD - weighing the evidence

- Can humans get Creutzfeldt-Jakobs (CJD) disease from eating beef from cows with Bovine Spongiform Encephalopathy (BSE)?
  - BSE is thought to have been passed to cattle from sheep (scrapie)
  - Passage caused changing in regulations governing feeding of offal
  - CJD is known to pass from human to human in canabilistic ritual

BSE and CJD - weighing the evidence

- The symptoms of BSE and CJD are quite similar
- Incubation periods are long 5 - 30? Years
- In UK there has been an increase in CJD from about 30 to about 60 cases per year
- But some other countries without BSE have higher CJD rates
- Alternative theory is BSE is due to organophophorous insecticide poisoning

Base rates and CJD

- If eating beef is transmits BSE causing CJD, then a high proportion of the UK population could (*in the worst case*) be carrying a fatal degenerative disease. (Depends on infectiousness and incubation time)
  - One case of CJD reported in press as a teenage hamburger binger
  - One or more cases connected with beef farming

Base rates and CJD

- One case was an abbatoir worker
- What is the relevant base rate information we need to assess evidence?
- Are small number of cases suggesting stronger evidence than they should?
- What if next case is abbatoir worker v hamburger binger - lot of people eat burgers and do not get CJD…
- If fashion designer got CJD should we conclude due to work conditions?
- Current best scientific estimate is that the epidemic is waning but will go for ten to twenty more years

Political vs. scientific utterance

- Minister for Agriculture (Oct 95):
  "There is absolutely no conceivable possibility that eating BSE infected beef causes CJD in humans"
- Eminent Epidemiologist (Sept 95):
  "Of the current theories about cause of BSE in cattle, the scrapie link is rather probable and the organophosphorpus poisoning one rather far-fetched"

Political vs. scientific utterance

- How are these to be reconciled?
- Politician's justification: "People want to know what to eat - not what is scientifically conceivable."
- Science picks its problems on basis of theoretical value - life picks problems for us
- But does person on street want to be told what to eat, or that appropriate decisions have been made independently of special interest?

Another example

Science: Global warming is happening but the proportion due to *Homo sapiens* is uncertain

- G.W. Bush:

  "Global warming is not certain enough to be a basis for policy yet"
- Questions: Is it really relevant whether humans are at fault?

Global warming example

More a matter of whether they can influence the outcome?

- Does the man on the street want to be told whether global warming is a threat?
- Or are they more concerned how decisions are related to special interests?

Higher level question - relation of science and politics

Politicians have to say something

People have to weigh evidence, consider impartiality and vested interests and weigh costs

- small saving of feeding animals offal not worth all costs since regardless of whether causes CJD or not…

Recap

- Tversky starts from the Gambler's Fallacy and throws light on phenomena as diverse as newspaper styles and judgements based on personality
- Fundamental distinction is between likelihood of *sequences* and *representativeness* in population
- People appear to use latter to judge the former

Recap

People also appear:

- To under-use base-rate information
- To treat the rules they know as deterministic/not statistical
- But they are better in rich context - like the BSE problem

Recap

Where do rules come from: sometimes from distributed behaviour rather than from legislation

- Game theory helps to explain how rules can arise from shared beliefs *without explicit communication*
- Learning can result in implicit knowledge without explicit knowledge

[Reading: chapter 4 of Stenning, K., Lascarides, A. and Calder, J. (2006), Introduction to Cognition and Communication, MIT Press.]

Exercises

- What is the Law of Small Numbers?
- What is its connection to the Gamblers Fallacy?
- And to representativeness?
- Pick three anecdotal current news stories: what are they trying to persuade you of? What are all the steps in the arguments being made? What are the assumptions and assumed premises (hidden, explicit, false?) What base rate information do you need to assess the claims?