Statistics in Practice
Forensic Science

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Forensic Science

Criminal evidence becoming increasingly “scientific”.

- Greater use of trace evidence (paint/glass/fibres).
- DNA revolution.

The rise of DNA was coincident with a greater awareness on the part of courts that observations are subject to uncertainty.

Forensic Science

Greater realisation that uncertainty is important has lead to:

- Trace evidence (glass/paint/fibres) being treated statistically.
- More evidence types:
  - common observations - shoe types - facial features - all being treated with some form of statistical method.
  - observation of co-incidence of treatment in cases where carers are suspected of harming their charges.

Forensic Consultancies

Typically:

- Police.
- Customs and Excise.
- Criminal Defense lawyers.

Start with an approach by one of the above.

- Usually concludes with the subission of a statistical report.
- Rarely concludes with a court appearance.

Case work - Tinley

The facts were:

- Evening of 9th April 2004 Andrew Tinley was assaulted by his partner Sally Rose.
- He picked up a champagne bottle and struck her on the head.
- Rose died at the scene of the incident.

Case work - Tinley

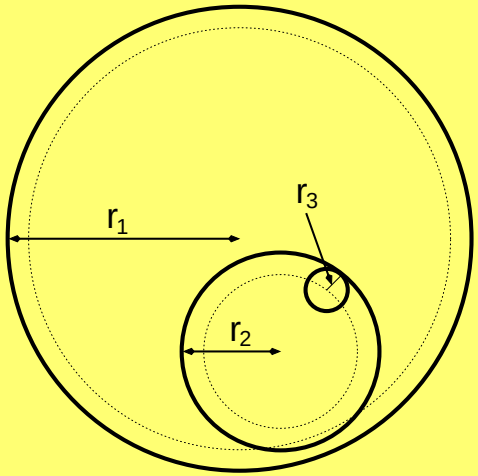
Under interrogation:

- Tinley said he had struck Rose twice with the bottle.
- The pathologist could find no evidence for two strikes.

A double blow is more incriminating than a single - obviously of interest to the court

The question was: what is the probability of administering two blows with a champagne bottle and leaving only a single wound?

Case work - Tinley



If:

1. r_1 is the radius head.
2. r_2 is the radius of the area of the wound.
3. r_3 is the radius of the area of the implement.

Case work - Tinley

$$\mathrm{Pr} = \frac{2\pi(r_2 - r_3)^2}{2\pi(r_1 - r_3)^2}$$

Given the values for $\mathbf{r}$ in the pathologists report gives a probability of about 8%.

- Only a guide for the court.
- Could spend a lot of time working out a more exact value.
- Limits of knowledge given by Tinley's account.

Firearm rifling patterns

Two firearms offenses committed in “a town”

- The first incident was the shooting of a man in “the Town” in June 2000.
- The second was a shooting of a man in “the Town” in March 2003.

Both incidents featured a 0.32 calibre revolver with a 5-right rifling pattern.

What is the evidential value of the “match”?

5-right 0.32 calibre

Firearm rifling patterns

A suspect had been located.

- That suspect was been found to possess a firearn with a five-right rifling pattern.

Start with two propositions

1. H_p is that two firearms offences employed the same weapon, and that weapon is that found in the posession of the suspect.
2. H_d is that the firearms used in the two offences were different weapons to that of the suspect.

Likelihood ratios

A standard measure of evidential value is a likelihood ratio
Let:

- $E \equiv$ the firearm used was of calibre 0.32 and rifling pattern 5 right.

Then:

$$\mathrm{LR} = \frac{\Pr(E|H_p, I)}{\Pr(E|H_p, I)}$$

where $I \equiv$ a firearm has been used in the commission of the offences.

Numerator

The numerator is: $\Pr(E|H_p, I)$.

- What is the probability of observing 5-right, 0.32 calibre, were the firearm used that of the suspect.
- The suspect has only one firearm.
- Some other individual may have used the suspect's firearm - should be from defence case if so.

The probability is quite high ≈ 1

Denominator

The denomonator is: $\Pr(E|H_d, I)$.

- What is the probability of observing 5-right, 0.32 calibre, were the firearm used some other firearm other than that of the suspect.
- This is proportional to the frequency of 5-right, 0.32 calibre, firearms from the population of illegally held firearms.

Need for data - supplied by investigators.

Denominator

- From data supplied of observations from a suitable sample of weapons recovered
- There are 716 illegal firearms known to the firearms intelligence branch
- 4 were revolvers with right handed rifling of 5 grooves, and were of 0.32 calibre.

The likelihood ratio is 716/4 = 179

Likelihood ratio

The likelihood ratio is 716/4 = 179 can be interpreted:

The observation of 0.32 calibre, and 5-right rifling, is 179 more likely were the weapon used in these offences that of the suspect rather than any other weapon from the population of illicit firearms.

This does not take into account the fact that there were two scenes - should it be 179^2.

Should I have done so? - some disquiet about using the higher figure.

How incriminating

Evett *et al.* (2000) give the following table:

likelihood ratio	verbal equivalent
$1 < \text{LR} \leq 10$	limited support for H_p
$10 < \text{LR} \leq 100$	moderate support for H_p
$100 < \text{LR} \leq 1000$	moderately strong support for H_p
$1000 < \text{LR} \leq 10000$	strong support for H_p
$10000 < \text{LR}$	very strong support for H_p

179 is in the middle of this range - thus implying moderately strong support for H_p.

Case work

The Tinley case was unusual but:

- Most have distinct features.
- Many revolve around “comparison” problems.

Academia one of the best ocupations for those involved in this sort of work:

- Quite often your conclusions favour the side who has not employed you.
- You can become quite unpopular with both sides.

Conclusions

A career in forensic statistics:

- has variety of challenging problems.
- Is in a growing field (FSS just recruited).

But:

- Is difficult to operate in, particularly independently.
- Really need institutional support.