Summer Institute in Statistical Genetics
University of Washington, Seattle
Forensic Genetics Module

# An introduction to the evaluation of evidential weight

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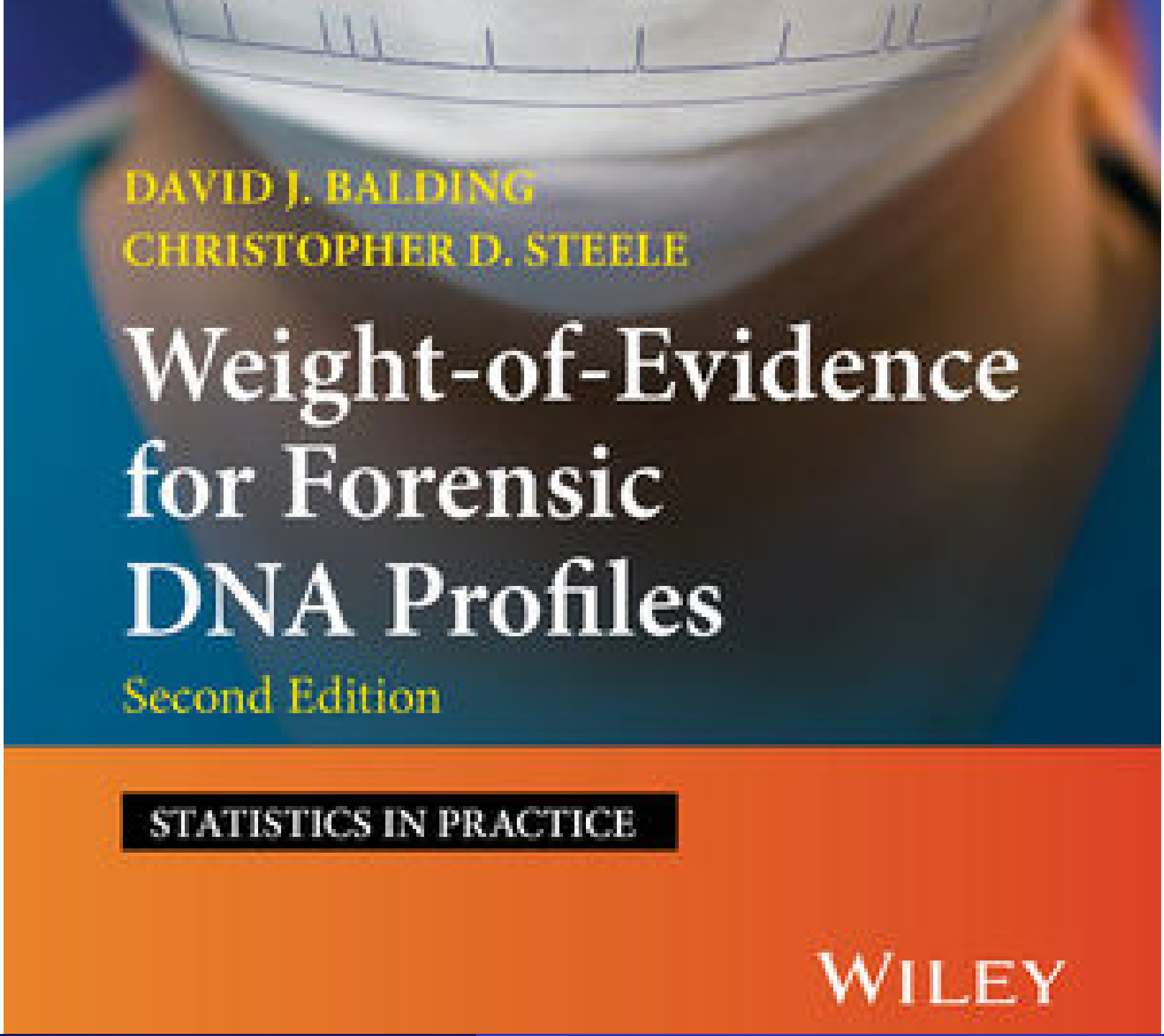
The notes for my lectures today and tomorrow are in the form of a 51-page document extracted from the book.



First we'll do some warm-up exercises.

1. The famous Collins case.
2. Rare disease testing.
3. Coloured taxis.

You have seen this sort of example before but the "base rate fallacy" seems such a natural error for human brains that frequent refreshers are useful.

- For 2 and 3 above, the problem is set up so that there is a right answer.
- That's not so for 1, we won't propose a solution here and indeed there is no full solution, but I hope by the end of this course you will have ideas about how to approach evidence evaluation in such cases.

One mantra that I would suggest you recite for an hour every evening is

*Always focus on the right question.*

Much confusion is caused by straying from this path.

# Yesterday's news headline

*Melania Trump: Astrophysicist calculates there was one in 87 billion chance speech was not plagiarised*

- What's wrong with the headline?
- What's needed to make it right?

In the UK case of Sally Clark, the medical expert Roy Meadows testified something like

> *The probability for two babies in a family to die of SIDS is 1 in 73 million.*

The number is wrong, but let's ignore that. What is the right question?

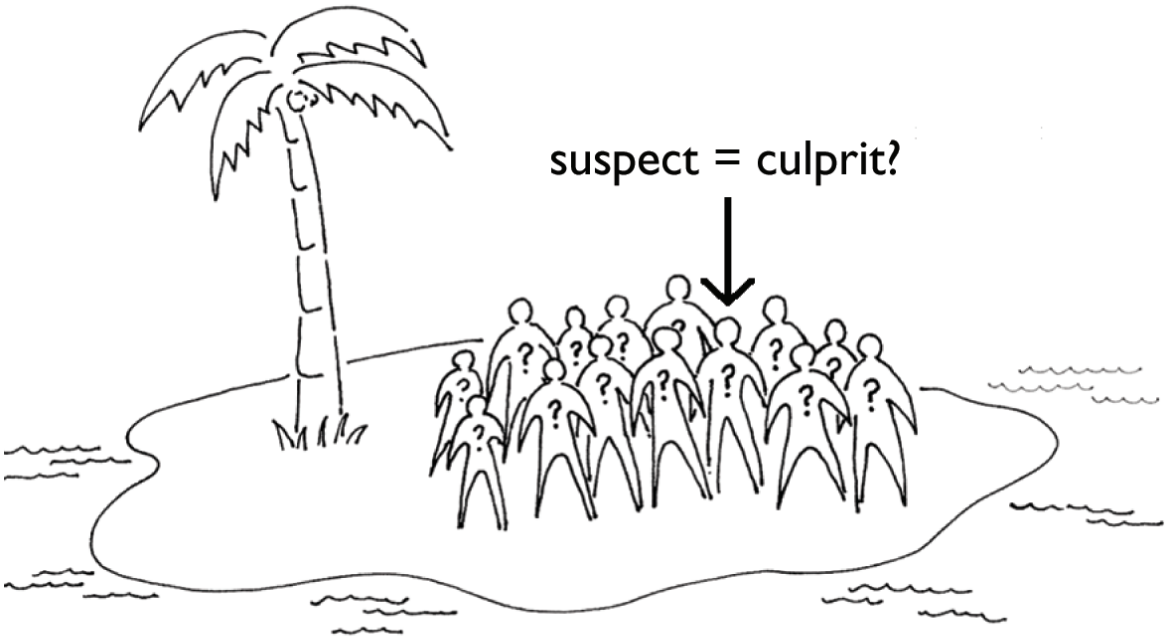
For DNA profile evidence the question is usually

> *Did the DNA in the crime sample come from the alleged contributor(s)?*

We'll approach answering this question slowly, by way of a remote island where crime is rare, but did once happen.

- The "island problem" represents a simplification of a forensic identification problem.
- Don't be tricked into thinking it isn't important in practical problems – many of the key ideas are present.

# The island problem: facts summary




- All 101 islanders are initially equally under suspicion;
- The culprit has $\Upsilon$;
- The suspect has $\Upsilon$;
- The $\Upsilon$-states of the other islanders are unknown;
- We expect on average about 1 person in 100 to have $\Upsilon$.

What is the probability that the suspect is guilty?

# Lessons from the island problem

1. The fact that $\Upsilon$ is rare (i.e. $p$ is small) does not, taken alone, imply that $Q$ is likely to be guilty.
2. Uncertainty about $p$ does not "cancel out". Ignoring uncertainty is unfavourable to defendants.
3. The overall weight of evidence against $Q$ involves adding together the probability of a "chance match" and the probability of a match due to a typing error.
4. In the case of a search of possible culprits to find a "match" with crime scene evidence, the longer the search (i.e. the more individuals found not to match) the stronger the case against the one who is found to match.

# Section 2.1.3: Application of the formula

There are a lot of ideas in this section so a summary may be useful:

- The order in which different items of evidence are analysed ultimately doesn't matter, but we need to be clear about order to avoid misunderstandings:
  - If the DNA evidence is considered first there may be a large set of alternative possible contributors, whereas the other evidence may, if accepted by the finder of fact, narrow it down to a small number of individuals.
- The weight-of-evidence formula doesn't solve all the problems, but it can guide thinking in the right direction.
- It can help delineate the roles of juror and expert witness.

# Section 2.2.4: Laboratory and handling errors

The strength of DNA evidence requires the probabilities of

1. a chance match with an alternative possible contributor, and
2. a false match due to an error.

The probability of any error occurring in the handling and analysis of a DNA profile is typically much higher than 1 above.

- Not relevant: only the probability of *an error causing a false match*.
- Example of newspaper report of winning lottery ticket.

2 above is essentially limited to the suspect's DNA being present in the crime sample for reasons other than committing the crime, such as:

- Cross contamination in the lab of evidence samples from different crime scenes (UK 2012 case of Adam Scott)
- Deliberate planting of DNA to frame a suspect.

Even if considered very unlikely (no evidence to suggest either), the above 2 possibilities may be considered by jurors to be more likely than 1 above.

- If so, a DNA match probability may be essentially irrelevant.

## Why not declare uniqueness of the profile?

- How to decide the threshold for uniqueness?
  - Low-template and mixed samples often generate modest LRs.
- What to do about other evidence?
  - All evidence in favour of Q is evidence against uniqueness.

## What's wrong with RMNE?

It doesn't answer the right question!

- All evidence counts as evidence against the defendant - not always realistic.
- Particularly problematic for mixed and low-template profiles.
- Weight of evidence doesn't depend on the profile of the alleged contributor.
  - e.g. two co-defendants both alleged to be contributors.