

# Fallacies

# Prosecutor's Fallacy

One of the most common errors is to transpose the conditional:

$$\Pr(A|B) \neq \Pr(B|A),$$

e.g. saying that there is a very high probability that an animal has four legs *if* it is an elephant, is not the same as the probability that an animal is an elephant *if* it has four legs.

$$\Pr(4 \text{ legs} \mid \text{Elephant}) \neq \Pr(\text{Elephant} \mid 4 \text{ legs}).$$

# Prosecutor's Fallacy

This example may seem obvious, but it's often not so easy in court proceedings:

$$\Pr(E|H_p) \neq \Pr(H_p|E),$$

or, alternatively,

$$\begin{aligned} \Pr(\text{Evidence} \mid \text{Proposition}) &\neq \Pr(\text{Proposition} \mid \text{Evidence}) \\ &\neq \Pr(\text{Proposition}) \end{aligned}$$

# Prosecutor's Fallacy

- Subtle misstatements can lead (and have led) to misunderstandings.
- Forensic scientists should be (and are trained to be) very careful about the wording of probability statements.

## Defendant's Fallacy

Suppose  $\Pr(E|H_d)$  is reported as 1 in 1 000. The defendant's fallacy is a logical error that usually favors the defendant:

- The city where the crime occurred has population size 100 000;
- So there are 100 people with a matching profile;
- This means that  $\Pr(H_p|E)$  is only 1 in 100 or 1%.

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## Defendant's Fallacy

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- The city where the crime occurred has population size 100 000;
- So we *expect* 100 people with a matching profile;
- $\Pr(H_p|E)$  is 1 in 100 or 1% *only* if each of these individuals has the same prior probability.

# Uniqueness Fallacy

Suppose  $\Pr(E|H_d)$  is reported as 1 in 100 000. The uniqueness fallacy argues:

- The city where the crime occurred has population size 100 000;
- So there is only one individual with a matching profile;
- This means that this DNA profile is unique in this city and must come from the suspect.



# Uniqueness Fallacy

Suppose  $\Pr(E|H_d)$  is reported as 1 in 100 000. The uniqueness fallacy argues:

- The city where the crime occurred has population size 100 000;
- So **there is** only one individual with a matching profile;
- This means that this DNA profile **is unique** in this city and must come from the suspect.

# Uniqueness Fallacy

Suppose  $\Pr(E|H_d)$  is reported as 1 in 100 000.

- The city where the crime occurred has population size 100 000;
- So we *expect* 1 *other* individual with a matching profile;
- This usually also incorporates the belief that DNA profiles yield unique identification, which is untrue in light of LTDNA, often leading to complex mixtures and partial profiles (and ignores relatives, coancestry and phenomena such as drop-in).

# Association Fallacy

An association fallacy occurs when a probability statement is transposed from one scale of the hierarchy of propositions to a higher level.

This is usually a result from assuming that there is a dependency between two observations or events, e.g.:

- Statements about evidence samples (sub-source) that are interpreted as the 'evidence being more likely if the suspect is the *source* of the crime stain';
- Or even on *activity* level as 'the evidence is more likely if the suspect left the crime stain'.

## Miscarriage of Justice - Case Example

The association fallacy assumes a dependency between two observations or events. The opposite version may also lead to errors, i.e. assuming independence where none exists.

Sally Clark was arrested and convicted for the murder of her two infant sons. In this case (UK, 1999) it was assumed that two sudden infant death syndrome (SIDS) deaths in a single family were independent events. A consulting pediatrician estimated the likelihood of a cot death as 1 in 8 500, and calculated the combined probability by squaring this number (i.e. yielding a likelihood of 1 in 73 million).

## Miscarriage of Justice - Case Example

It was later found that her second son might have died from natural causes, and moreover, assuming independence of these events is unreasonable, due to possible underlying genetic causes:

$$P(A, B) = P(A|B)P(B) \neq P(A)P(B).$$

Sally Clark was released from prison after having served more than three years of her sentence.

# The Innocence Project

The Innocence Project was founded in 1992 as a non-profit legal organization committed to exonerating wrongly convicted people. The work focuses on cases in which DNA evidence is available to be tested or retested.

- There have been 367 post-conviction exonerations due to DNA testing to date (July, 2020);
- Incorrect identification by eyewitnesses was a factor in around 70% of wrongful convictions;
- Of those exonerated 70% are part of minority groups;

Source: <https://www.innocenceproject.org>.