Forensic Genetics

Module 16 – Section 6 Answers

Exercise 1a: Formulating Propositions

An individual is discovered looking into a house one night. The police are called and find a single cigarette butt under the window where the incident occurred. No one in the family smokes. The police have a person of interest captured on a neighbor's CCTV.

A single-source profile is obtained from the cigarette butt and the reference profile of a person of interest (POI) matches.

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H_p : The evidence came from the POI.

H_d : The evidence came from an unknown person.

Or, for simplicity:

H_p : POI

H_d : Unknown (U)

Exercise 1b: Formulating Propositions

A complainant calls 911 to report a sexual assault in her home. She is taken to a hospital where an intimate swab is collected.

A POI is identified from the investigation and the obtained profile from the swab is fully explained by a mixture of the complainant (K) and the POI.

Exercise 1b: Formulating Propositions

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$$H_p: \quad K + POI$$
$$H_d: \quad K + U$$

Exercise 1c: Formulating Propositions

A complainant is cut with a knife during an altercation. Based upon eyewitness testimony, a POI is identified.

A stain on the clothing of the POI is tested for blood, and a DNA profile is developed that is consisted with a mixture of the POI and the complainant.

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$$H_p: \quad \text{POI} + \text{K}$$
$$H_d: \quad \text{POI} + \text{U}$$

Note how the direction of transfer provides important information.

Exercise 1d: Formulating Propositions

Molotov cocktails have been thrown at random cars. An unexploded container is found in the street, and a 2 person mixture is developed from the evidence.

Two persons of interest are arrested.

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$$
\begin{aligned}
H_p &: \quad \text{POI 1 + POI 2} \\
H_{d1} &: \quad \text{POI 1 + U} \\
H_{d2} &: \quad \text{POI 2 + U} \\
H_{d3} &: \quad \text{2U}
\end{aligned}
$$

What if circumstances indicate that they cannot both be present?

Exercise 1e: Formulating Propositions

A complainant walking through a city park is attacked from behind and is sexually assaulted on a blanket. She didn't get a good look at the perpetrator. The police recognize the blanket as possibly belonging to a vagrant known to live near the park.

A profile obtained from the blanket is fully explained by mixing of K and POI's DNA.

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$$\begin{aligned} H_p &: \quad \text{K + POI} \\ H_{d1} &: \quad \text{POI + U} \\ H_{d2} &: \quad \text{K + U} \\ H_{d3} &: \quad \text{2U} \end{aligned}$$

Exercise 2: Base Rate Fallacy

- Of the women complaining of painful hardening of the breast, 1% have a malignant tumor: $\Pr(C) = 0.01$.

- The accuracy ($+$ or $-$) of a mammography is 90%: $\Pr(+|C) = \Pr(-|C') = 0.9$.

- Estimate $\Pr(C|+)$ to decide whether or not to order a biopsy.

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$$\Pr(C|+) = \frac{\Pr(+|C)\,\Pr(C)}{\Pr(+|C)\,\Pr(C) + \Pr(+|C')\,\Pr(C')} = 0.0833.$$

Representativeness leads people to neglect the base rate, by assessing a conditional probability by the 'degree of similarity' ($\Pr(A|B) \neq \Pr(B|A)$). This is known as the *base rate fallacy*.

Exercise 2: Base Rate Fallacy

Using the odds form of Bayes' theorem:

$$\frac{\Pr(C)}{\Pr(C')} = \frac{1}{99}$$

$$\frac{\Pr(+|C)}{\Pr(+|C')} = \frac{0.9}{0.1} = 9$$

Even though the LR > 1, the prior odds (i.e. the base rate) is relatively small. The posterior odds are $\frac{1}{11}$, such that $\Pr(C|+) = \frac{1}{12} = 0.0833$.

Exercise 3a: Prosecutor's Fallacy

Are these statements correct/incorrect/ambiguous? What is wrong?

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Exercise 3b: Prosecutor's Fallacy

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- The probability of this DNA profile if it came from someone else is very low.

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Exercise 3c: Prosecutor's Fallacy

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- The probability that this DNA profile came from someone else is very low.

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Exercise 3d: Prosecutor's Fallacy

Are these statements correct/incorrect/ambiguous? What is wrong?

- The probability of someone else having this DNA profile is very low.

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Exercise 3e: Prosecutor's Fallacy

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Exercise 3f: Prosecutor's Fallacy

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