Digital evidence, ‘absence’ of data and ambiguous patterns of reasoning

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by

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Purpose

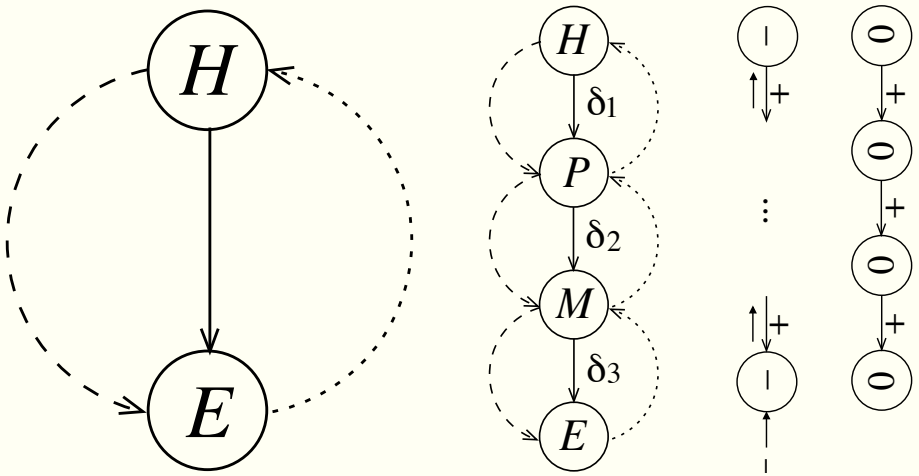
Cell site location data at trial: subtleties in the process of going from observations to conclusions

- Study and present the use of ‘digital evidence’ in a case of the Swiss Federal Criminal Court
- Analyse competing argument constructions using probability, graphical models and qualitative probabilistic reasoning

Swiss Federal Criminal Court[1]

[1] http://www.bstger.ch

Graphical probability models



Our full paper

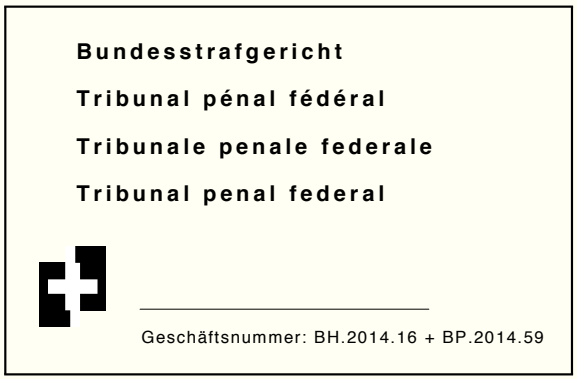
The Office of the Attorney General

- The OAG is the investigation and prosecution authority of the Swiss Confederation.
- Prosecution of criminal acts which fall under Federal jurisdiction.

→ National security, organised crime, terrorism, money laundering, corruption, large-scale cross-border crime

Case reference

- Federal Criminal Court, Case No. BH.2014.16 + BP.2014.59
- Suspicion of attempted homicide; endangering by explosives and toxic gases with criminal intent
- http://www.bstger.ch



Case details

- A.'s estranged wife, B., is walking down the street
- B. is injured by an **exploding hand grenade**, but did not recognise her attacker
- Type of grenade used by the former Yugoslavian army
- Injuries to abdomen and left hand
- Swab of the surface of the lever of the hand grenade: a DNA profile was obtained

www.aargauerzeitung.ch

www.blick.ch

Case details

The digital evidence

- **Technical report** about telecommunication and navigation data of A.'s mobile devices.
- **No signals of A.'s mobile devices were detected on the crime scene at the time B. was attacked.**

www.aargauerzeitung.ch

www.blickamabend.ch

→ What conclusions ought to be drawn from this result?

The court's summing up

- "At the time of the crime, no mobile device belonging to A. could be located at the scene."[1]
- "This investigative result does not necessarily exclude that the complainant [Mr. A.] could have been present at the crime scene at the time when the crime was committed."[1]

[1] Swiss Federal Criminal Court, decisions BH.2014.16 and BP.2014.59, Section 3.3.

The court's summing up

- "This investigative result does not necessarily exclude that the complainant [Mr. A.] could have been present at the crime scene at the time when the crime was committed."[1]

So, the opinion of the court is that the digital evidence does **not** – literally – **falsify the prosecution's case**.

[1] Swiss Federal Criminal Court, decisions BH.2014.16 and BP.2014.59, Section 3.3.

The court's summing up

The court's statement may be read as…

- …suggesting that the **prosecution's case stands unaffected** by the evidence, meaning that the **evidence is actually neutral**.

Is this conclusion warranted?

Questions

Wait a second: what is going on here?

If the digital evidence does not falsify the prosecution's case, what effect – if any – does it have on the **prosecution's case**?

What – if anything – does the digital evidence say with respect to **A.'s case** (i.e., the defence)?

→ *Note that our beliefs regarding the two cases are (logically) connected and must be coherent.*

General observations

The eternal ‘consistent with’

- “(…) the complainant [Mr. A.] **could have been present** at the crime scene at the time when the crime was committed.”[1]

…but isn’t the absence of signals of mobile devices **also consistent with not being on the crime scene**?

[1] Swiss Federal Criminal Court, decisions BH.2014.16 and BP.2014.59, Section 3.3.

General observations

Critique of ‘consistent with’

- Mine, your and many other persons’ mobile device signals, too, are **not** detected on the crime scene!
- So, would you (**anybody in this room!**) take comfort in the conclusion that ‘*you could have been present at the crime scene at the time the crime was committed*’?

General observations

Generality of the ‘consistent with approach’:
convenience conclusions

- **Whatever the finding** (here: presence or absence of signals of a mobile device), **it is found ‘consistent with’ the prosecution’s case.**
- $\rightarrow$ **This is also commonly observed for other types of forensic traces.**

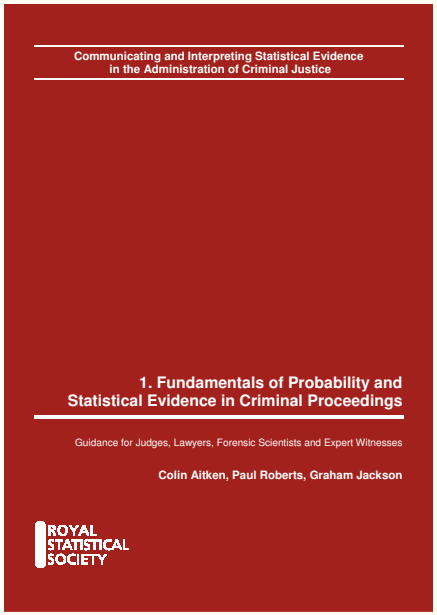
Convenience conclusions

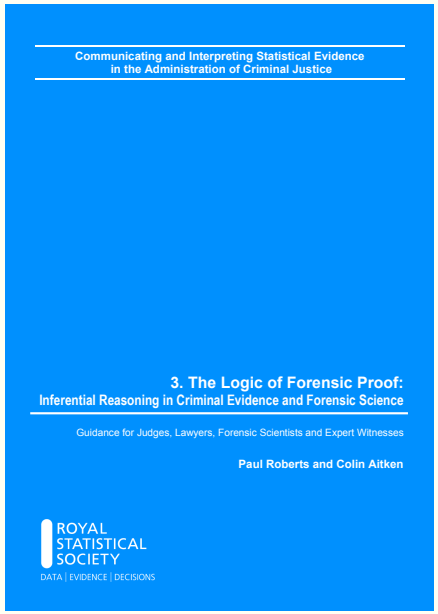
Implications of convenience conclusions

- Whatever the findings, they are found ‘consistent with’ the prosecution’s case:
- $\Rightarrow$ **Does this mean that we could never obtain evidence in favour of the defense?!**

A re-analysis

Let’s try the logical approach





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Forensic evaluation

Evaluating and reporting the strength of the findings

The expert assigns and reports the strength of the observations and findings in terms of the **likelihood ratio**.

(1) Probability of the findings given the first proposition (and information).

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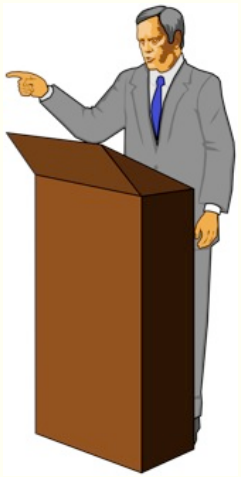
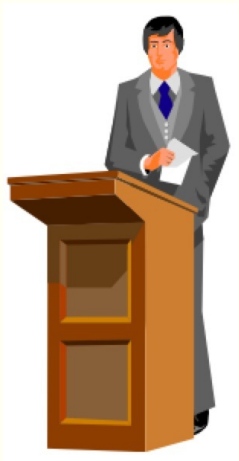
(2) Probability of the findings given the second proposition (and information).



Forensic evaluation

Comparing answers to questions (1) and (2)

$$\boxed{\text{(3) Strength of the findings}} = \frac{\boxed{\text{Question 1}}}{\boxed{\text{Question 2}}}$$



Focus: *The probability of the findings given the propositions — and not the contrary.*

Desirable properties

Balance — Transparence — Flexibility — Case-tailored

Legal literature

"Question triad"

Experts should inform as to the three key questions.

Focus on the logic of the argument

"The aim (...) is not the calculation of probabilities in court; but the use as a framework to describe the reasoning process about items of evidence, in order to be able to argue in a more rational way." [1]

A. Nack

Former presiding judge at the German Federal High Court.

[1] A. Nack, Beweisrecht. Kriminalistik, 1/1999, 32-39, at p. 36

Ingredients in this case

- **Propositions: H**
  – 'Mr. A. is the person who threw the hand grenade at the victim' (H_p)
  – 'Mr. A. was nowhere near the scene of the crime when the grenade was thrown' (H_d)
- **Potential outcomes: E**
  – Signals of Mr. A.'s mobile devices are detected (E)
  – No signals of Mr. A.'s mobile devices are detected ($\bar{E}$)
- **Information**
  – Time (6:30AM) and location (place Z.) where the grenade was thrown
  – Victim did not see the person who threw the grenade

Evidence pre-assessment [1]

Taking a broad view

Let's start by thinking about E (i.e., detected signals):

Propositions:	H_p	H_d
Findings: E:	(1) $\Pr(E \mid H_p, I)$	(2) $\Pr(E \mid H_d, I)$
$\bar{E}$:	$\Pr(\bar{E} \mid H_p, I)$	$\Pr(\bar{E} \mid H_d, I)$

(1) What is my probability of observing E if H_p is true?

(2) What is my probability of observing E if H_d is true?

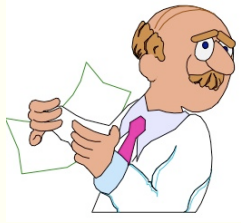
$\rightarrow$ **Avoiding post-hoc rationalisation.**

[1] R. Cook et al., A Model for Case Assessment and Interpretation. Science & Justice, 38, 151–156.

Forensic evaluation

Comparing answers to questions (1) and (2)

$$\boxed{(3)\ \text{Strength of the findings}} = \frac{\boxed{(1)\ \Pr(E \mid H_p, I)}}{\boxed{(2)\ \Pr(E \mid H_d, I)}}$$



Question (3): How does (1) compare to (2) *for you*?

Your likelihood ratio for finding E:

If **for you** (1) $>$ (2) then **finding** E **supports** H_p **over** H_d**: the likelihood ratio is greater than 1.**

Qualitative probability

Summary: Expressing your beliefs in terms of probability

(1) $\Pr(E \mid H_p, I)$

If Mr. A. threw the hand grenade, what is my probability for the event of detecting signals of his mobile devices?

$\rightarrow$ *For me, this probability is smaller than* 1 *because Mr. A. might have switched off his mobile devices.*

(2) $\Pr(E \mid H_d, I)$

If Mr. A. did not throw the hand grenade, what is my probability for the event of detecting signals?

$\rightarrow$ *I have no reason to expect signals of his mobile devices to be detected, hence my probability for this event is very (very!) small.*

$$\rightarrow (1)\ \Pr(E \mid H_p, I) \gg (2)\ \Pr(E \mid H_d, I)$$

Qualitative probability

How to use the result

Qualitative probabilistic reasoning allows one to assess **which, if any, of the two propositions the evidence supports over the alternative**. Making assessments numerically precise is only necessary if one wishes to clarify by how much one proposition is supported over the respective alternative.

Implications

What about the absence of signals $\bar{E}$?

Remember, we have assigned (1) $\gg$ (2).

Propositions:	H_p	H_d
Findings: E:	(1) $\Pr(E \mid H_p, I)$	(2) $\Pr(E \mid H_d, I)$
$\bar{E}$:	(1') $\Pr(\bar{E} \mid H_p, I)$	(2') $\Pr(\bar{E} \mid H_d, I)$
	$\sum = 1$	$\sum = 1$

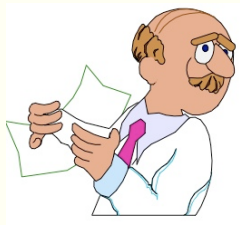
Since (1)+(1') $= 1$ and (2)+(2') $= 1$, and (1) $\gg$ (2),

it follows that (1') $\ll$ (2').

Implications

Likelihood ratio for the absence of signals $\bar{E}$: Comparing (1') and (2')

$$\text{(3') Strength of the findings} = \frac{\text{(1')}\ \Pr(\bar{E} \mid H_p, I)}{\text{(2')}\ \Pr(\bar{E} \mid H_d, I)}$$



Your likelihood ratio for finding $\bar{E}$:

If **for you** (2') is **greater** than (1'), then the likelihood ratio is smaller than 1. That is, the **finding** $\bar{E}$ **supports** H_d **over** H_p**.**

Implications

Your likelihood ratio for finding $\bar{E}$

- The finding $\bar{E}$ supports H_d over H_p.
- **Thus, $\bar{E}$ is information favourable to the defence.**

Reviewing the court's summing up

Reviewing the findings in a balanced perspective

- The court: the absence of signals of Mr. A.'s mobile devices does not 'falsify' the prosecution's case.
- **However**: In a balanced assessment, we can find that the findings **support the alternative proposition**.

The court's silence regarding the impact of the findings on the alternative proposition implies that **information favourable to the defendant is not duly acknowledged.**

Discussion and conclusions

Output of the analysis: conclusions

- Our analysis does not ‘falsify’ or ‘refute’ the court’s conclusion: In fact, **we agree with the court’s conclusion** in that the prosecution’s case is not categorically refuted.
- **But, we also see that the court’s view was incomplete**: It kept vital observation from the defense.
- **Use of investigative results at trial requires careful consideration.**

Thank you for your attention

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