Structuring the Evaluation of Location-Related Mobile Device Evidence

Principles

Accuracy?

Structure

Example 1

Example 2

Example 3

Conclusion

Eoghan Casey
David-Olivier Jaquet-Chiffelle
Hannes Spichiger
Elénore Ryser
Thomas Souvignet
Mobile Device Location

“Was the device at a given location during the relevant time period?”

Accuracy of locate-related mobile device evidence

Consideration of alternative explanations
"I was at home alone with my phone"
Mobile Device Location

“Was the device at a given location during the relevant time period?”

Accuracy of locate-related mobile device evidence

Consideration of alternative explanations
"I was at home alone with my phone"
Forensic Evaluation Principles

1) Evaluation conditioned by framework of circumstances

2) Evaluate $E$ given at least two competing propositions

3) Evaluate $\Pr(E \mid H, I)$, not the opposite
Mobile Device Location

“Was the device at a given location during the relevant time period?”

Accuracy of locate-related mobile device evidence

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Murder of Noel Alkaramla

Scientifically-based?
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Scientifically-based?

New York v Johnny Oquendo
Murder of Noel Alkaramla

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Scientifically-based?

New York v Johnny Oquendo
Location-related Mobile Device Evidence

Defendant's attorney
"We're just asking for the courtroom to determine if this is good science"

Judge
“[prosecution] failed to meet their burden of demonstrating that the science underlying Google location services has gained general acceptance in the relevant scientific community”
Murder of Noel Alkaramla

Scientifically-based?

New York v Johnny Oquendo
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# Accuracy?

**Technology best-case accuracy**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Accuracy without interference</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS (civilian)</td>
<td>5 meters - 10 meters</td>
</tr>
<tr>
<td>A-GPS</td>
<td>5 meters - 30 meters</td>
</tr>
<tr>
<td>WiFi</td>
<td>30 meters - 75 meters</td>
</tr>
<tr>
<td>Cellular</td>
<td>&gt;100 meters</td>
</tr>
<tr>
<td>Bluetooth Low-Energy</td>
<td>&lt;1 meter - 10 meters</td>
</tr>
</tbody>
</table>
INACCURACY INFLUENCES

Distance
- Near
- Far

Signal strength
- Strong
- Weak

Direction
- Direct
- Oblique

Weather
- Clear conditions
- Stormy weather

Obstacles
- Buildings
- Trees

CONTEXT DEPENDENT
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**Structuring Evaluation**

- Clearly define alternative hypotheses
  - Formally stated as propositions
  - The statement is either true or false

- Suppose that each hypothesis is true in turn
  - Imagine alternative universes
  - Search for predicted observations
Structuring Evaluation

- Clearly define alternative hypotheses
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  - The statement is either true or false

- Suppose that each hypothesis is true in turn
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Hypothesis 1

The device was operating at Location X during the time interval $t$. 
Structuring Evaluation

- Clearly define alternative hypotheses
  - Formally stated as propositions
  - The statement is either true or false

- Suppose that each hypothesis is true in turn
  - Imagine alternative universes
  - Search for predicted observations
Hypothesis 2

The device was operating at Location Y (distinct from X) during the time interval t.

"I was at home alone with my phone"
Structuring Evaluation

- Clearly define alternative hypotheses
  - Formally stated as propositions
  - The statement is either true or false

- Suppose that each hypothesis is true in turn
  - Imagine alternative universes
  - Search for predicted observations
Hypothesis 3

The device was operating elsewhere (anywhere but Location X) during the time interval t.
Structuring Evaluation

- Clearly define alternative hypotheses
  - Formally stated as propositions
  - The statement is either true or false

- Suppose that each hypothesis is true in turn
  - Imagine alternative universes
  - Search for predicted observations
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I was elsewhere (with my phone)

The victim's body was found in Geneva, but Mr. A claims he was in Zurich when the crime occurred.

Telephone records both on his device and from his service provider show that his mobile device was active, with outgoing calls and messages sent.

The observed evidence looks accurate, placing the device in Geneva during the relevant time period.
I was elsewhere (with my phone)

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The observed evidence looks accurate, placing the device in Geneva during the relevant time period.
Structuring the Evaluation

Prosecution hypothesis (Hp)
- *The device was operating near Location X during the time interval t.*

Defense hypothesis (Hd)
- *The device was operating near Location Y (distinct from X) during time t.*

Evidence to be evaluated (E)
*Signals of Mr. A’s mobile device and activity have been detected near Location X at the relevant time, and observed location-related evidence on the device itself also place this device near Location X at the relevant time*
Evaluating Evidence

Assign conditional probability for $E$ given $Hp$ and task-relevant information $I$
- $\Pr(E \mid Hp, I)$ very large

Assign conditional probability for $E$ given $Hd$ and task-relevant information $I$
- $\Pr(E \mid Hd, I)$ extremely small

Communicate the balance of probabilities
- Verbal expression or numerical value (LR)
I was elsewhere (with my phone)

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I forgot my phone

Crime occurs at Location X during time t

Mobile device evidence indicates Location X
  • No user activities observed on device during time t

Suspect claims to have left device at Location X
  • She claims she was at home during time t

Structured evaluation sheds light on the device location
  • Might shed light on suspect’s whereabouts
    (depends where the device was left/dropped)
I forgot my phone

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Mr. A was accused of throwing a hand grenade at his wife...

... I was elsewhere (without my phone)

No location-related mobile device evidence was observed during the relevant time.
Structuring the Evaluation

Hp: Mr. A was near the area of the crime scene during the relevant time
  • Mr. A’s mobile device was operating near the relevant area at the relevant time

Hd: Mr. A was nowhere near the area of the crime scene during the relevant time
  • Mr. A’s mobile device was not operating near the relevant area at the relevant time
**Evaluating Evidence**

This assessment of LR depends on whether the attack was premeditated and the offender took measures to prevent location-related mobile device evidence.

If premeditated, $LR = 1$

If non-premeditated, $LR = 10$
Offense Level Propositions

Hp: Mr. A is the person who threw the hand grenade at the victim.

Hd: An unknown person threw the hand grenade at the victim; Mr. A has nothing to do with the incident

- If premeditated, then E is uninformative
- If non-premeditated, then E is in support of Hd
Mr. A was accused of throwing a hand grenade at his wife...

... I was elsewhere (without my phone)

Digital evidence, ‘absence’ of data & ambiguous patterns of reasoning
Biedermann & Vuille
DFRWS EU 2016

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Conclusion

Forensic evaluation must be performed on location-related mobile device evidence to provide transparency and balance and to avoid mistakes and misinterpretations

Abide by forensic evaluation principles and framework
assign conditional probabilities to evidence given each hypothesis with consideration of case-specific circumstances

Verbal or numerical expression of relative probabilities? (depends on circumstances)
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