Evidential and Legal Reasoning in AI – the role of argumentation
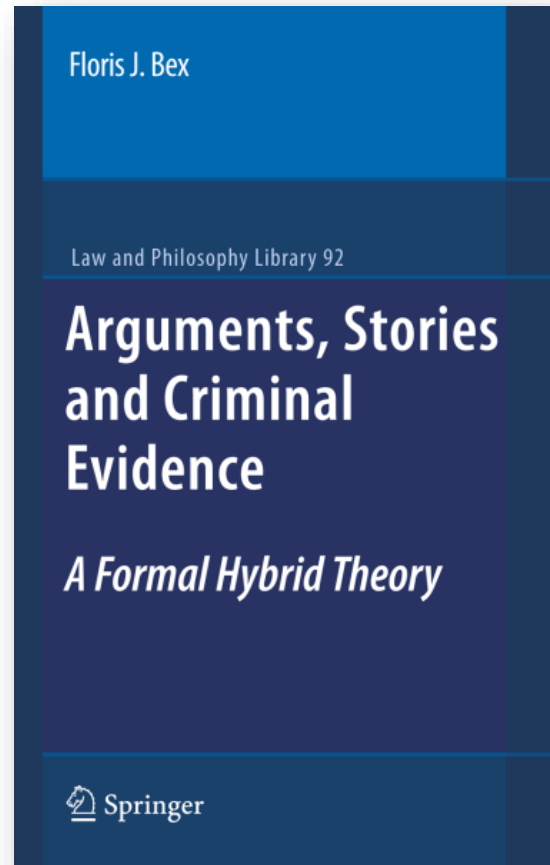
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Lecture overview

- 14 April: a logical model of stories and arguments in evidential reasoning

- 15 April: the strength of stories and arguments - introducing probabilities

- 16 April: reasoning with data – and the role of stories and arguments
  - Includes machine learning ;-)

Reasoning with evidence

- The process of proof
  - Reasoning with evidence and commonsense knowledge to determine the facts of the case

Floris J. Bex

Law and Philosophy Library 92

Arguments, Stories and Criminal Evidence

A Formal Hybrid Theory

Springer

Stories vs. Arguments

- Stories are "holistic"
- Stories provide an overview
- Stories encapsulate causal reasoning
- Stories represent how humans order a mass of evidence

- Arguments are "atomistic"
- Arguments provide a means of detailed analysis
- Arguments encapsulate evidential reasoning
- Arguments represent how humans talk about individual evidence

A hybrid model

- Combining stories and arguments
  - Hybrid model

- Arguments from the evidence to conclusions

- Stories explaining the (hypothetical) situations in a case

Argumentation

- The premise provides a reason to believe the conclusion

- In this way, pieces of evidence (e.g. a witness testimony) can be reasons for particular facts of the case

Evidential Arguments

- Arguments based on sources of evidence
  - Given the evidence…

Witness testimony "I saw the suspect in London"

Expert testimony: "The blood on this knife is the victim's blood "

Evidential Arguments

- Arguments based on sources of evidence
  - …we can infer conclusions

```
┌──────────────────┐              ┌──────────────────┐
│   The suspect    │              │   The blood on   │
│  was in London   │              │ this knife is the│
│                  │              │  victim's blood  │
└──────────────────┘              └──────────────────┘
         ↑                                 ↑
┌──────────────────┐              ┌──────────────────┐
│ Witness testimony│              │Expert testimony: "The│
│ "I saw the suspect│             │blood on this knife is the│
│   in London"     │              │  victim's blood "│
└──────────────────┘              └──────────────────┘
```
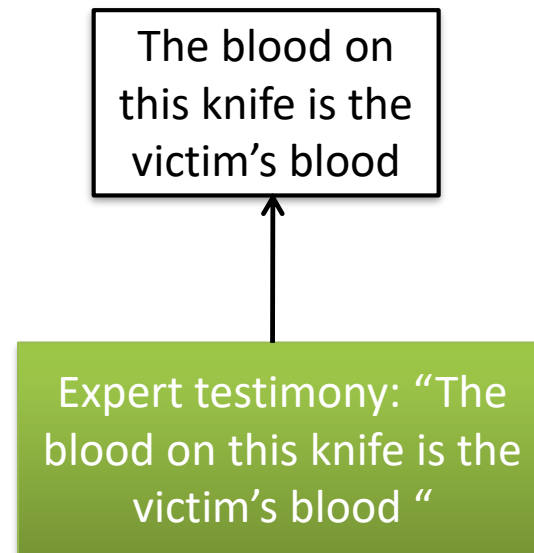
Complex arguments

- ## Chains of reasons
  - – Conclusions inferred from earlier conclusions
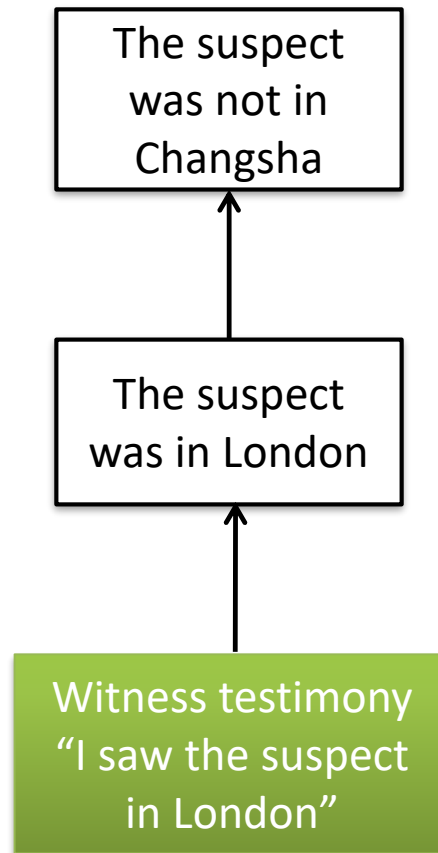
Complex Arguments

- Linked arguments: both pieces of evidence needed
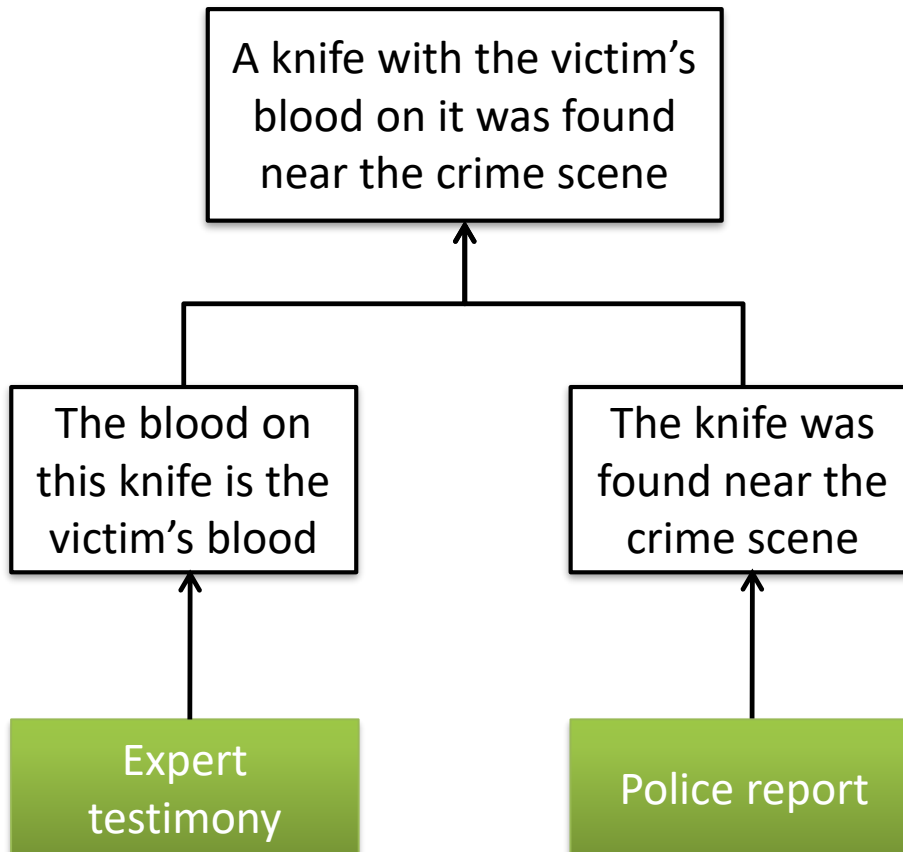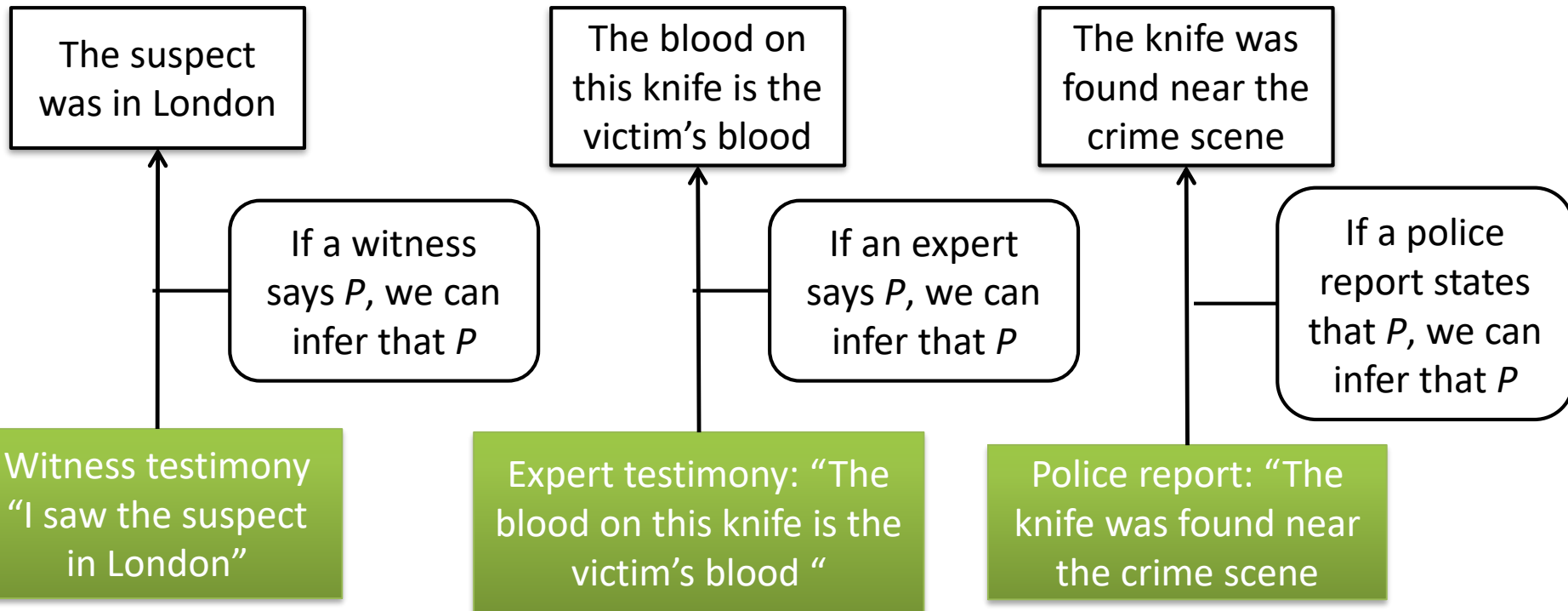
Commonsense knowledge

- Generalizations: statements about how we think the world around us works
  - the impact of a hammer can break a person's skull
  - witnesses under oath usually speak the truth
  - Police reports can be trusted
  - Chinese people are smaller than Dutch people

Generalizations

- Generalizations are not always true!
  - Exceptions
- Qualify generalizations with words such as *usually*, *sometimes*

Generalizations as warrants

The suspect was in London

The blood on this knife is the victim's blood

The knife was found near the crime scene

If a witness says *P*, we can infer that *P*

If an expert says *P*, we can infer that *P*

If a police report states that *P*, we can infer that *P*

Witness testimony "I saw the suspect in London"

Expert testimony: "The blood on this knife is the victim's blood "

Police report: "The knife was found near the crime scene

Generalizations as warrants

Source of Generalizations

- Generalizations have a source
  - Law
  - Scientific research
  - General Knowledge
  - Prejudice
  - Folk beliefs and superstition
- The source provides a backing for the warrant

Source of Generalizations
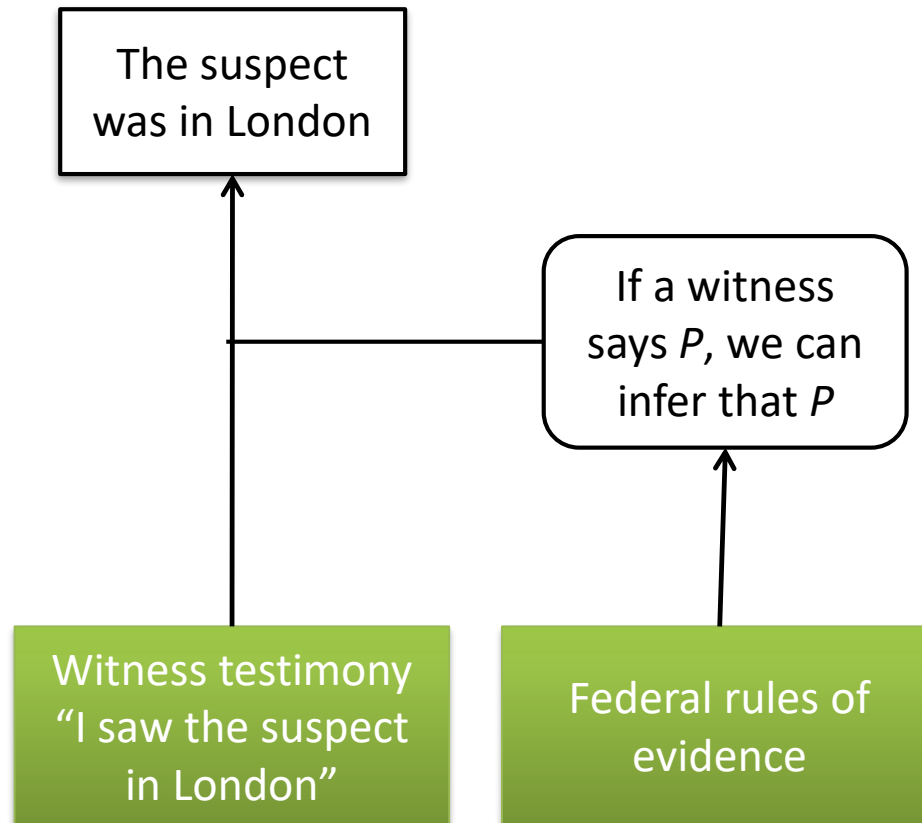
Source of Generalizations
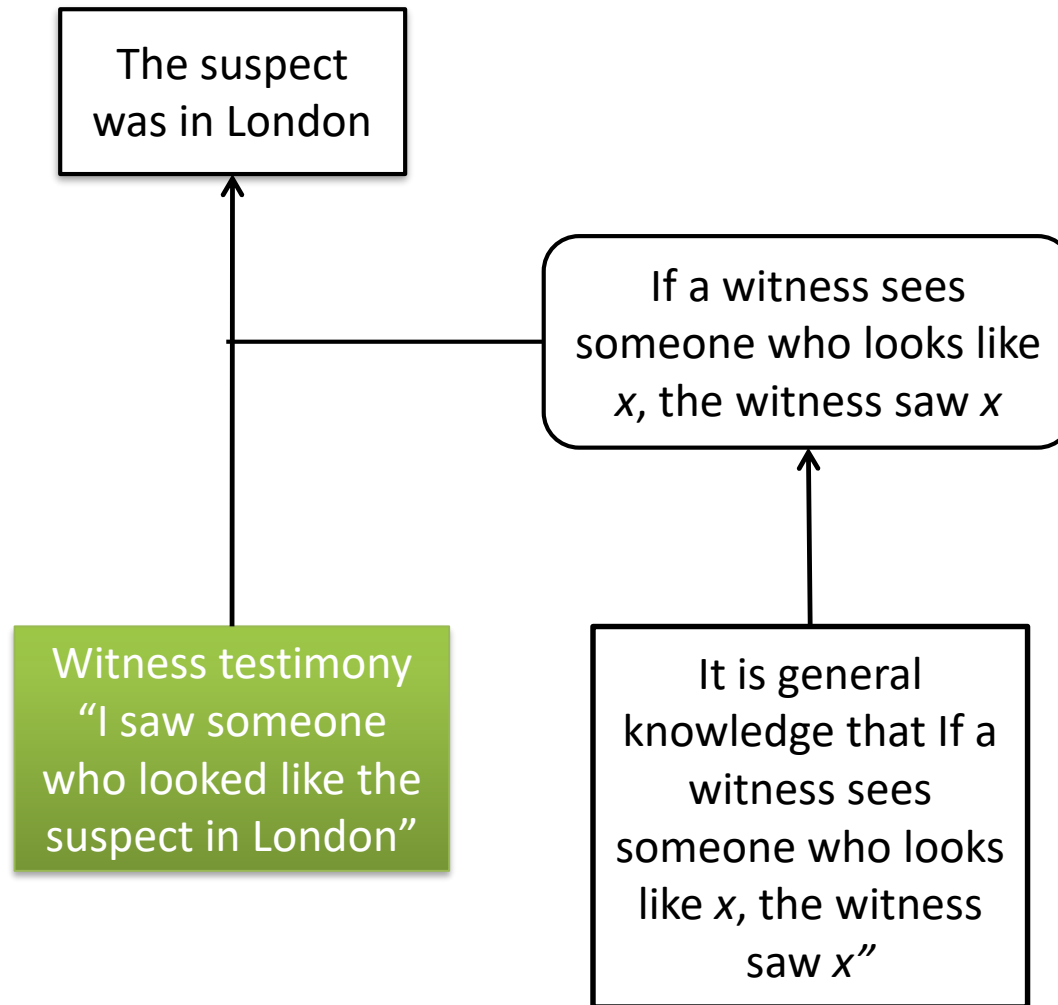
Counterarguments

- Arguments may be attacked on each of their elements.
  - Counterargument against a premise
    - Not against evidence!
  - Counterargument against a conclusion
  - Counterargument against a warrant
    - exceptions to generalizations
  - Counterargument against a backing

Conclusion attack

Subconclusion attack
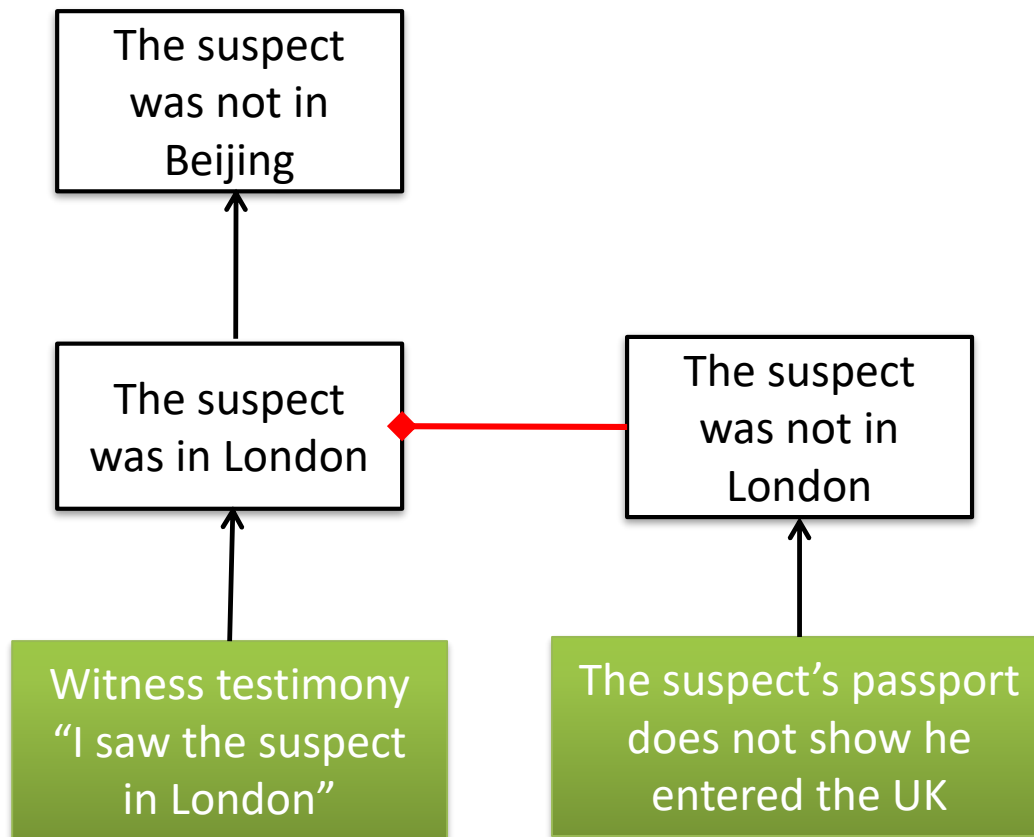
Undercutter
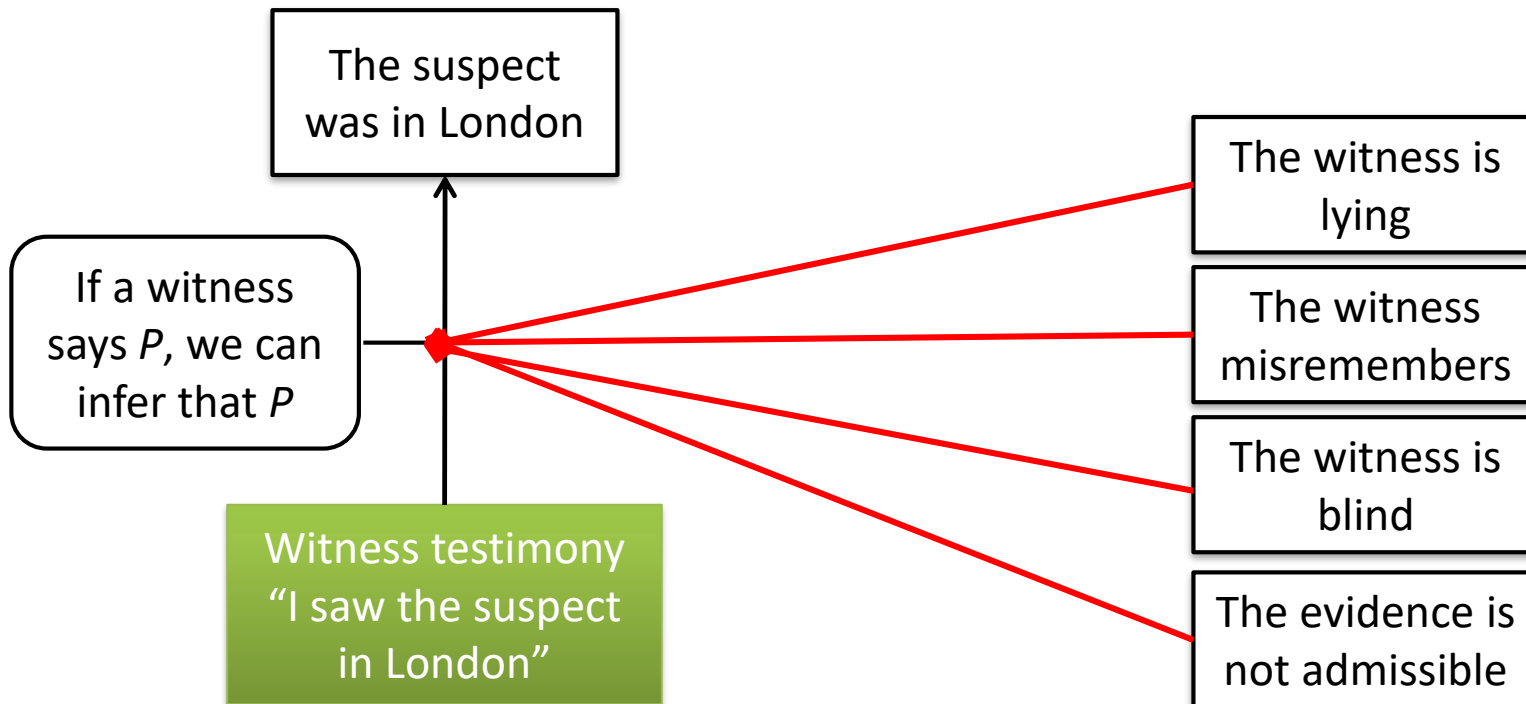
Stories

- Stories are coherent sequences of events that explain the evidence in a case

An example case (1)

- Tina, a baker's daughter, had a relationship with John, a small-time criminal

- After breaking up, Tina and her parents go to John's house to pick up some of her belongings

- A fight develops, which ends in the death of Tina's father

Stories

- Coherent sequence of events

- "We entered John's house to get some of Tina's clothes. John became angry and started pushing father. Father tried to protect his daughter and told John to stop. John was so angry that he pulled out a gun and shot father"

Stories

- Coherent sequence of events

Fight	John takes out his gun	John shoots father	Father dies

Stories

- Coherent sequence of events
  - Causally connected (*c* is a cause for *e*)
  - Causal connections may remain implicit
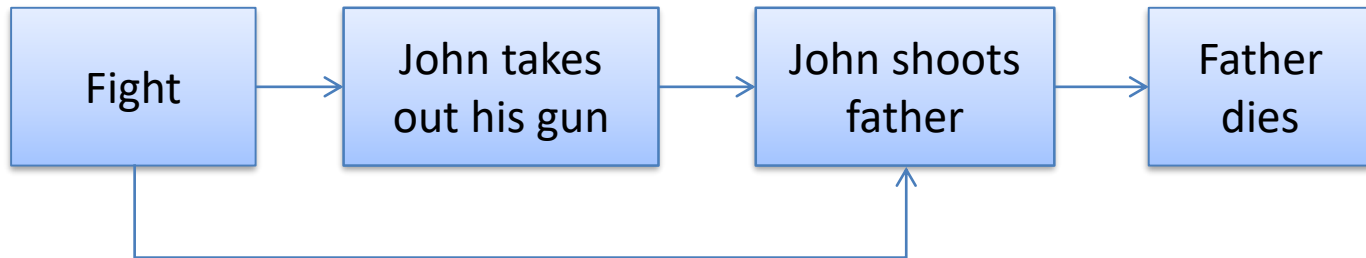
Explaining evidence

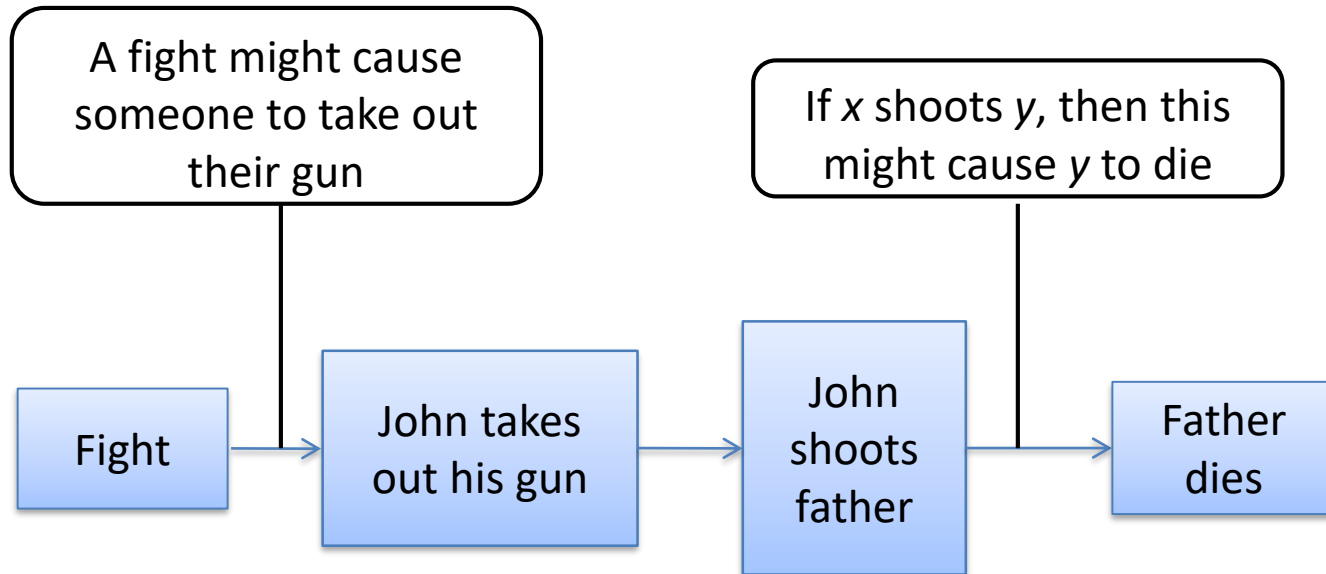- Coherent sequence of events that explains the observed evidence

```
[Fight] → [John takes out his gun] → [John shoots father] → [Father dies] → [Forensics report]
```
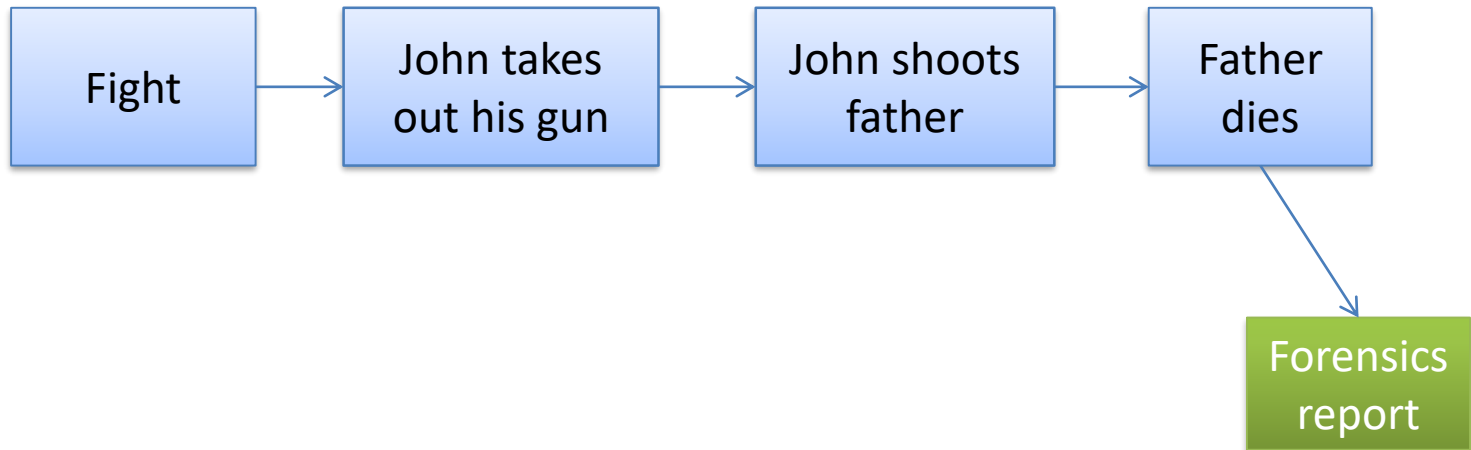
Explaining evidence

- Coherent sequence of events that predicts possible evidence

```
[Fight] → [John takes out his gun] → [John shoots father] → [Father dies]
                                             ↓                     ↓
                                      [Bullet casings?]    [Forensics report]
```
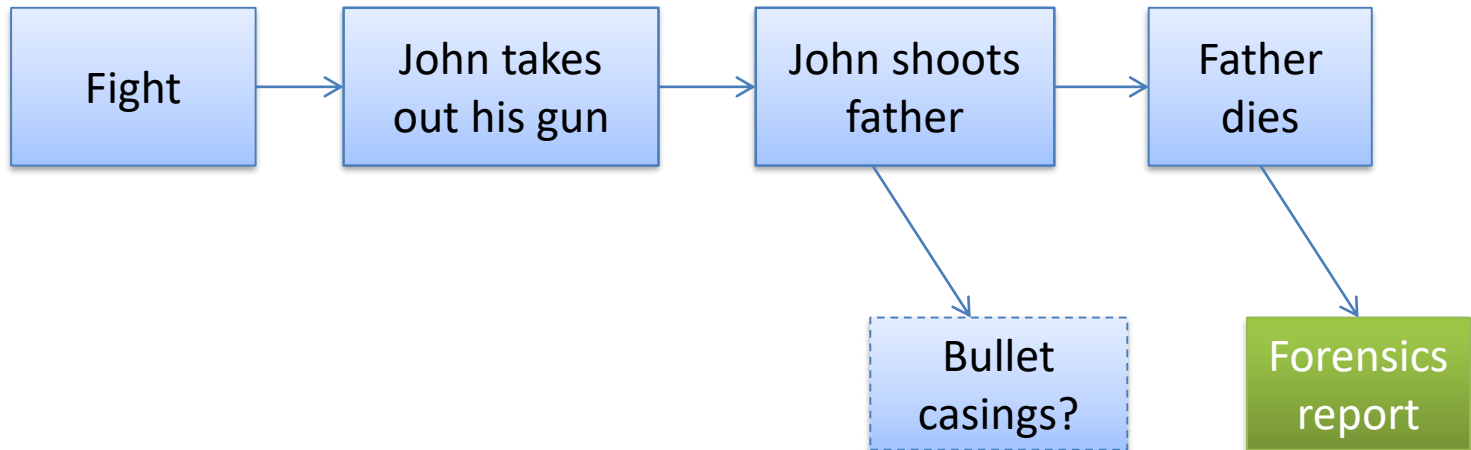
Story coherence

- A story is *coherent* if it conforms to our world knowledge

- World knowledge can be encoded as rules/generalizations
    - If you shoot someone they might die
- World knowledge can be encoded as scripts
    - person *x* has a motive *m* to kill person *y*
    - person *x* kills person *y* (at time *t*) (at place *p*) (with weapon *w*)
    - person *y* is dead

Generalizations in stories

A fight might cause someone to take out their gun

If *x* shoots *y*, then this might cause *y* to die

Fight → John takes out his gun → John shoots father → Father dies

Story scripts

Fight → John takes out his gun → John shoots father → Father dies

Story Scheme   Motive → Actions → Consequences
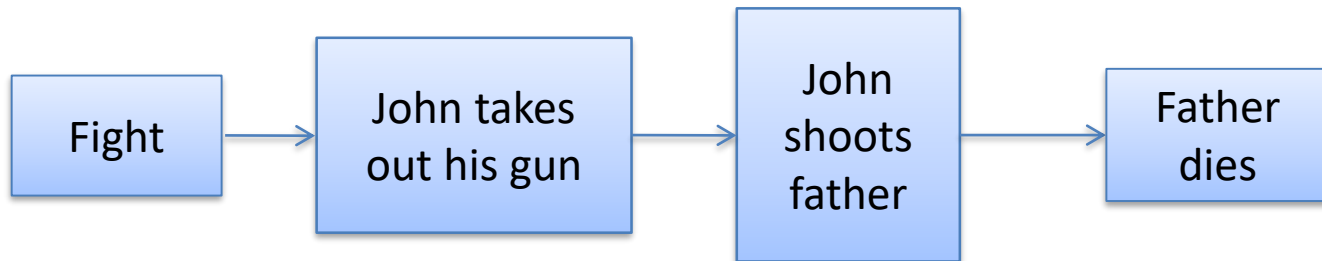
Alternative explanations

- Hypothesize alternatives and compare

Father dies

Alternative explanations

- Hypothesize alternatives and compare

```
  Fight  →  John takes   →  John shoots  →  Father
             out his gun      father          dies
```

```
  Fight  →  Mother takes  →  John pushes  →  Gun goes off  →  Father
             out her gun       gun away                          dies
```
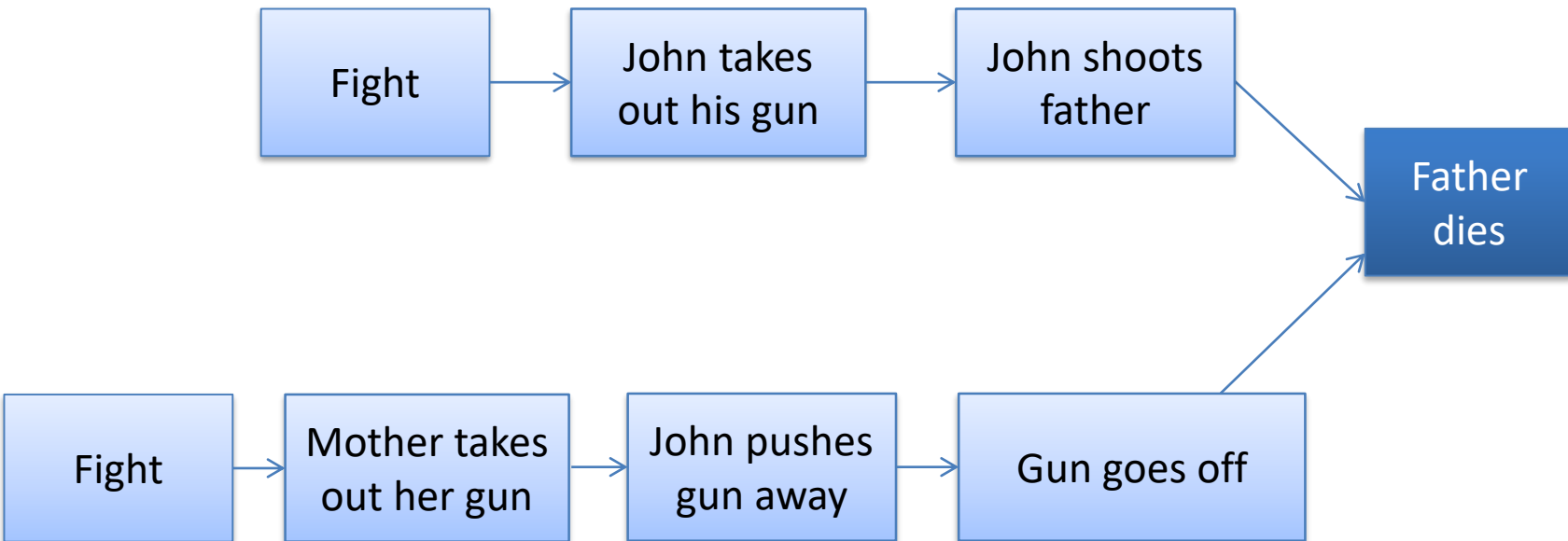
Alternative explanations

- Inference to the best explanation
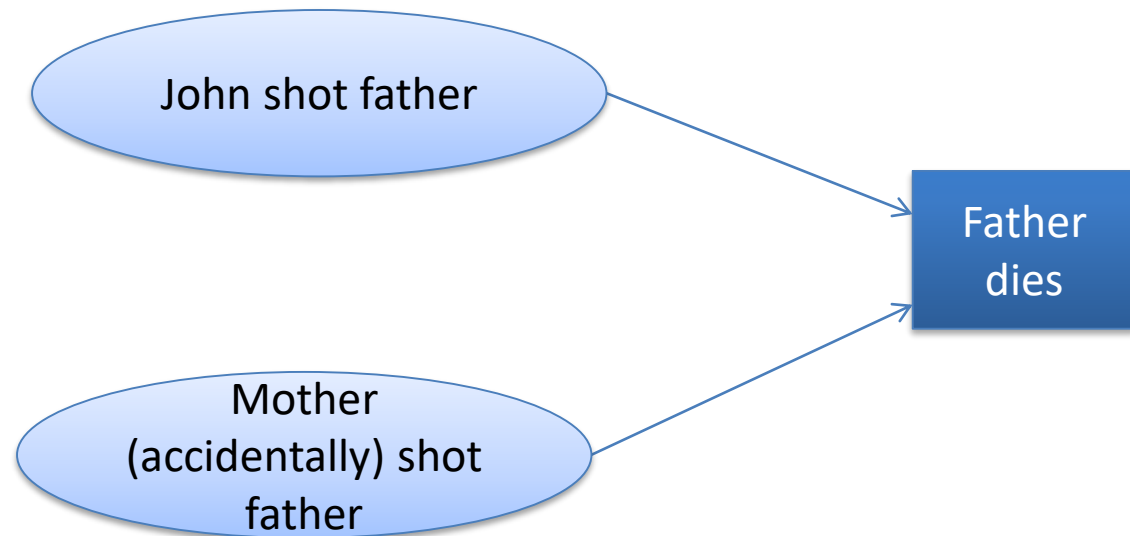
Alternative explanations

- Inference to the best explanation
  - How to compare?
    - Completeness
    - Evidence
    - Plausibility
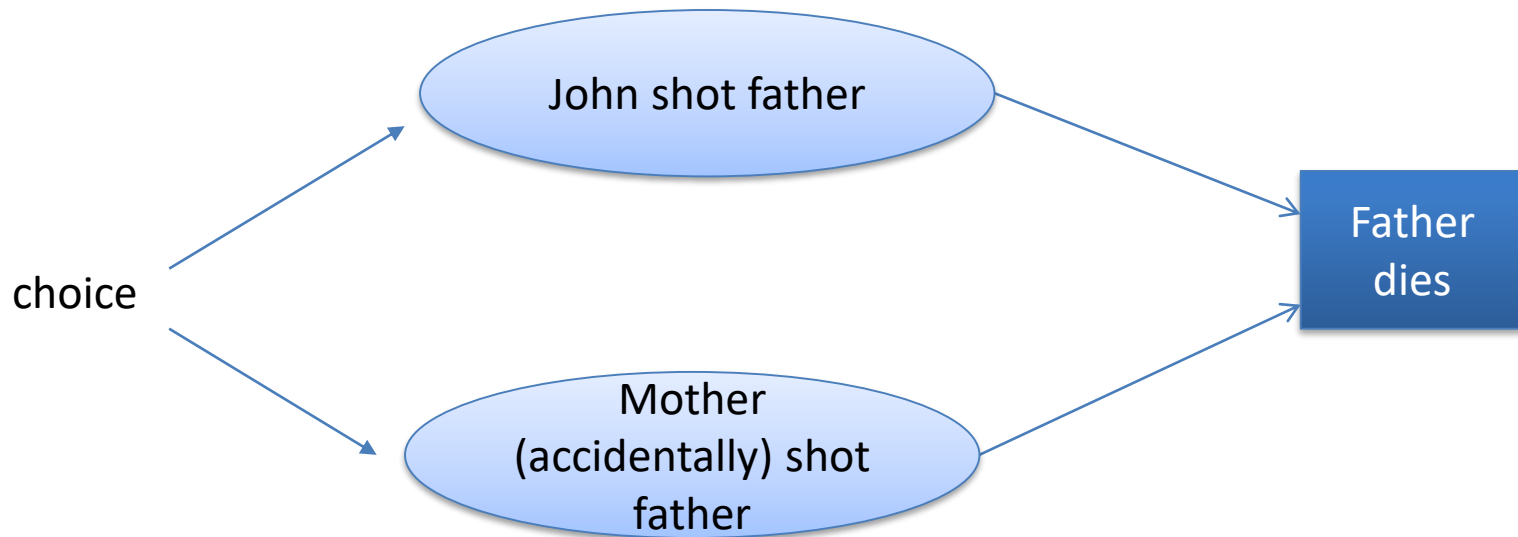
Combining arguments & stories

- Stories: "what happened"?

- Arguments: "what is the evidence"?

- Connection: Arguments based on evidence support and attack events in the story
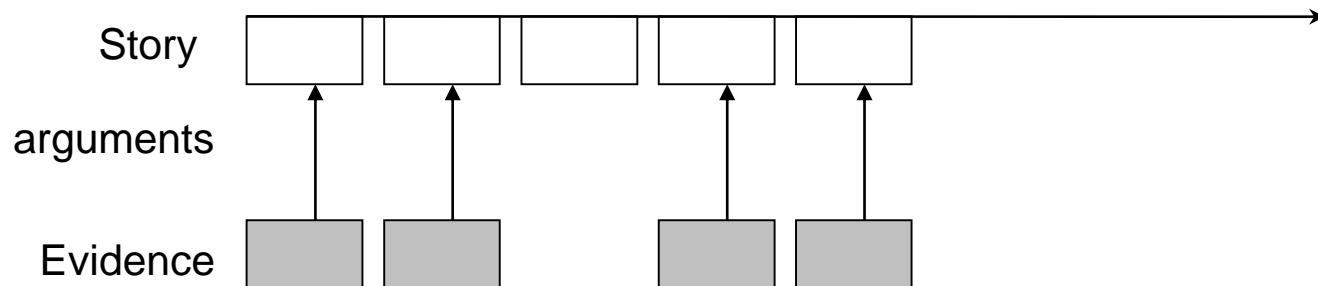
Critical reasoning with evidence

1. There is no coherent story about the facts.
2. The story is implausible.
3. Alternative stories have not been considered.
4. Important elements of the story are not supported by evidence.
5. Evidential arguments have not been analysed.
6. Counterarguments to the story have not been taken into consideration.

- These pitfalls are the critical questions for the hybrid theory

Pitfalls

1. **There is no complete story about the facts.**
2. The story is implausible.
3. Alternative stories have not been considered.
4. Important elements of the story are not supported by evidence.
5. Evidential arguments have not been analysed.
6. Counterarguments to the story have not been taken into consideration.

1. Complete story

- **Good:** "We entered John's house to get some of Tina's clothes. John became angry and started pushing father. Father tried to protect his daughter and told John to stop. John was so angry that he pulled out a gun and shot father"

- **Bad:** "We were in the house and suddenly John shot father"
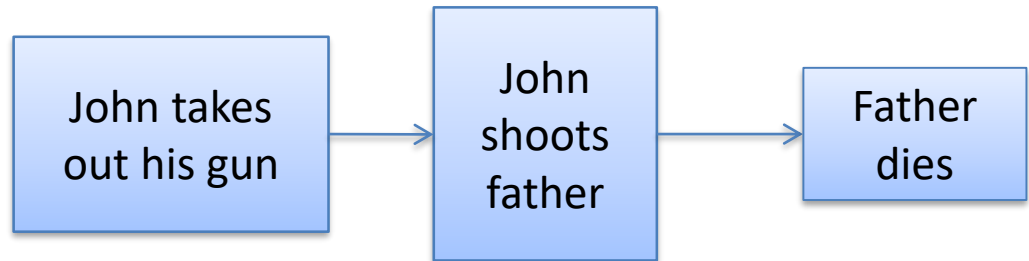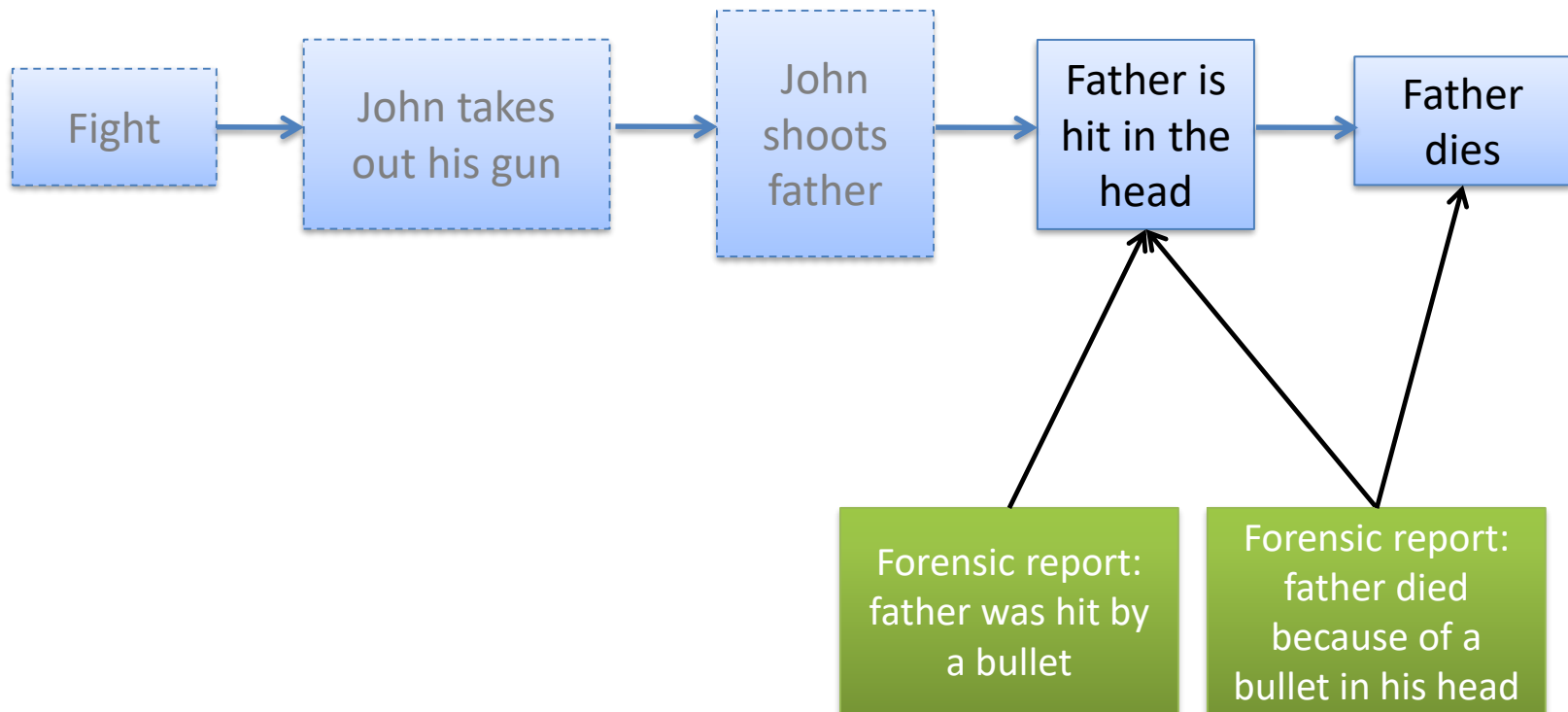
Story completeness

Story completeness
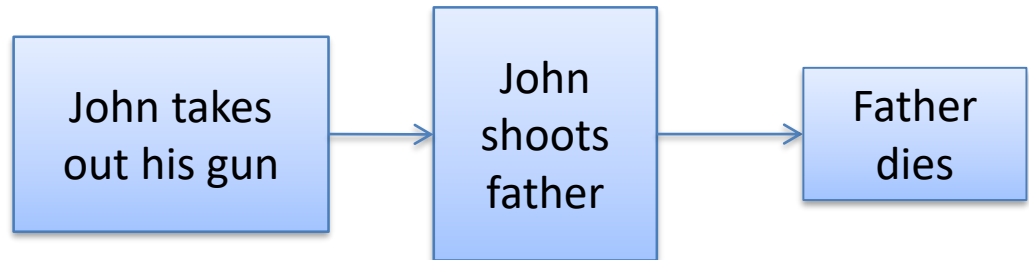
Pitfalls

1. There is no complete story about the facts.
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2. The story is implausible

- "The fight between father and John started, Tina's mother pulled a small gun out of her handbag and aimed the gun at John, who tried to push the gun away. The gun accidentally went off and father was hit in the head and died"

2. The story is implausible

- "The fight between father and John started, Tina's mother pulled a small gun out of her handbag and aimed the gun at John, who tried to push the gun away. The gun accidentally went off and father was hit in the head and died"

- Baker's wives usually do not carry guns

2. The story is implausible

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- Baker's wives usually do not carry guns

- The chances of a gun accidentally going off and hitting the father are small

2. The story is implausible
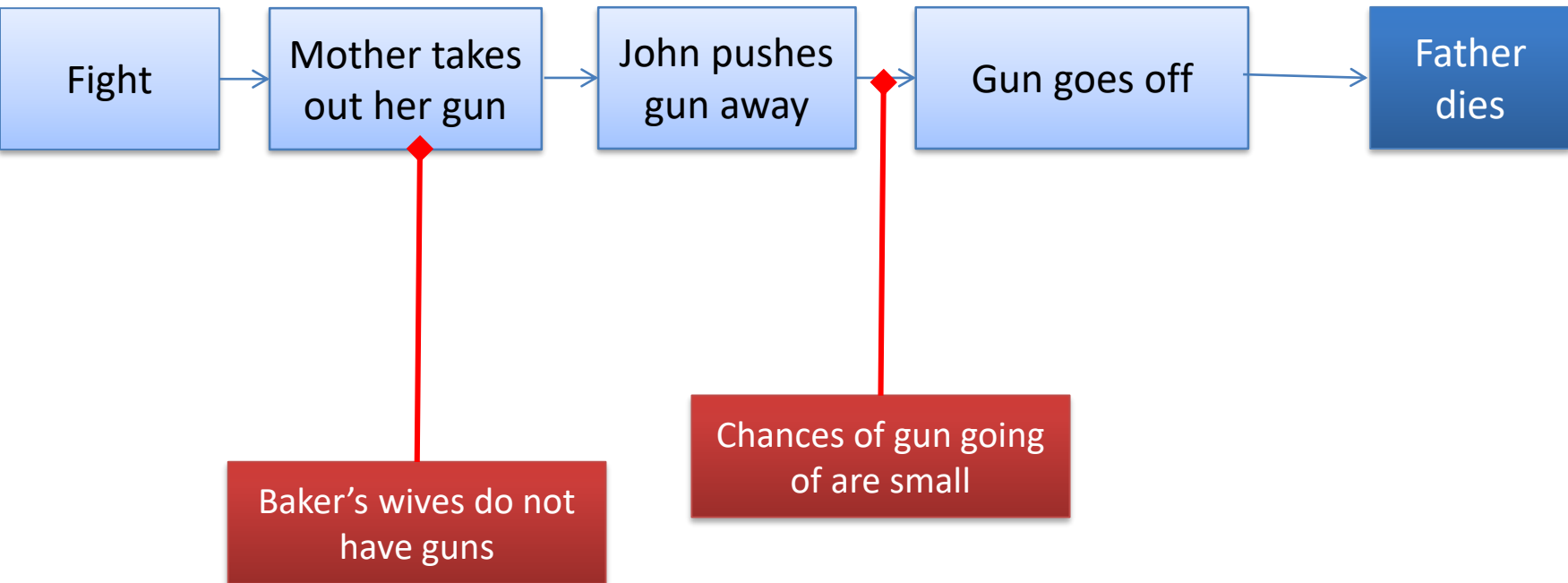
Fight → Mother takes out her gun → John pushes gun away → Gun goes off → Father dies

Baker's wives do not have guns

Chances of gun going of are small
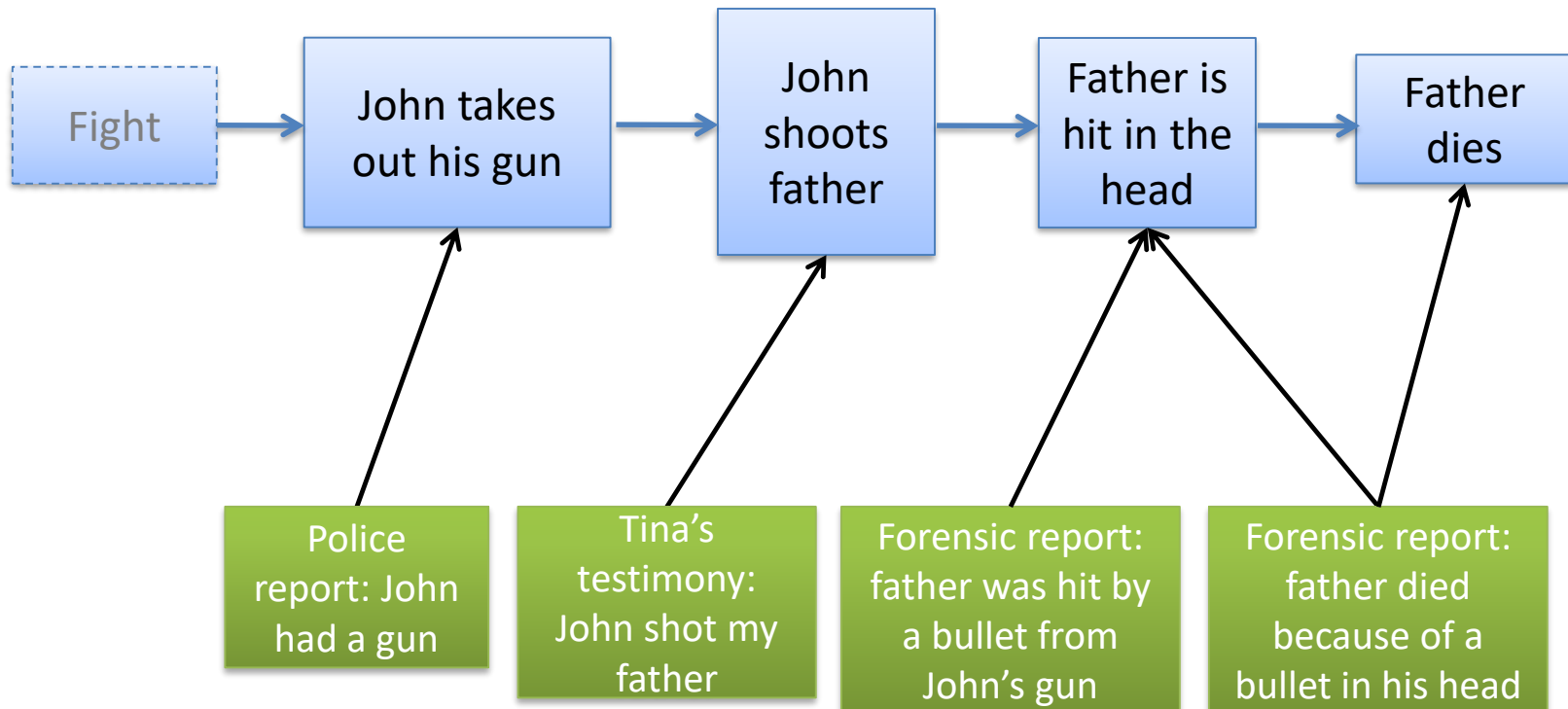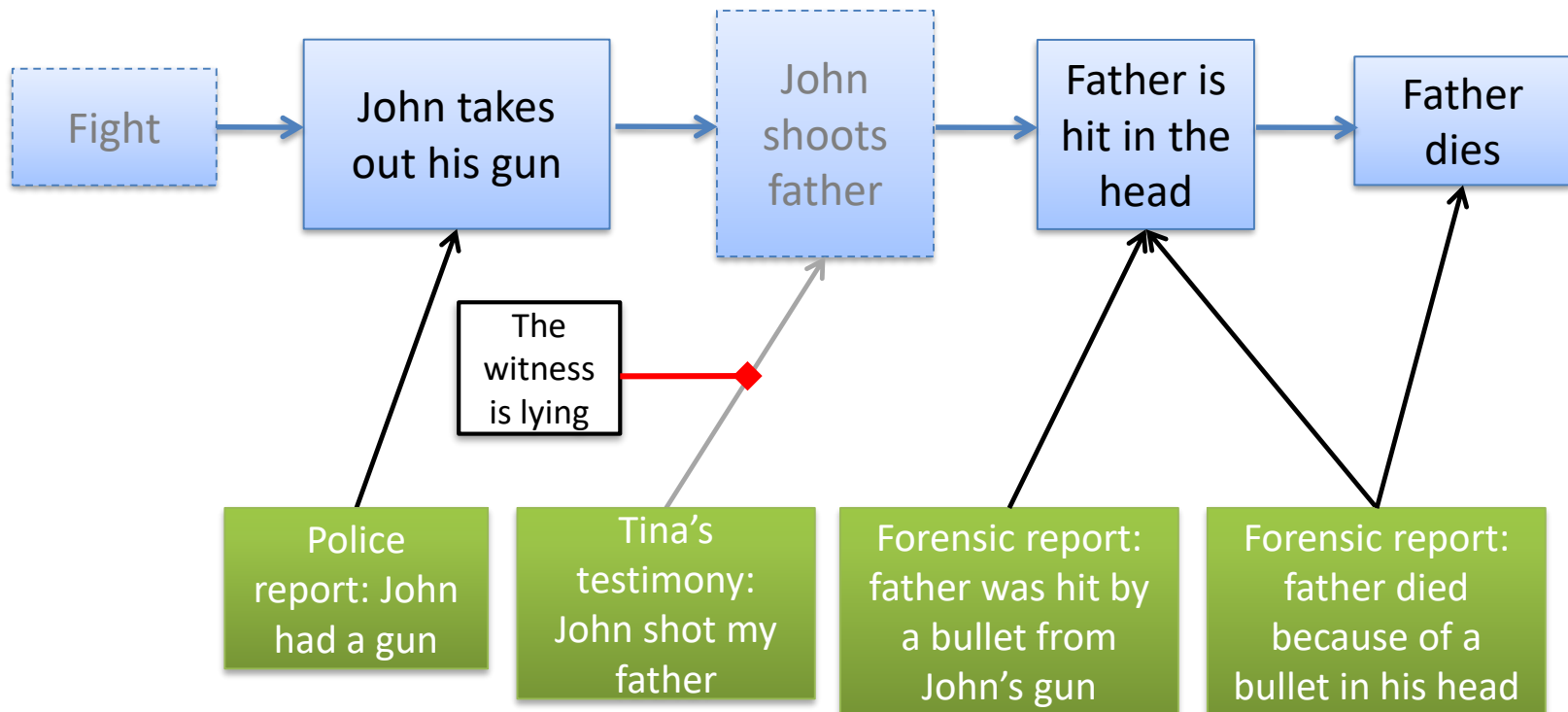
Pitfalls

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3. Alternative stories

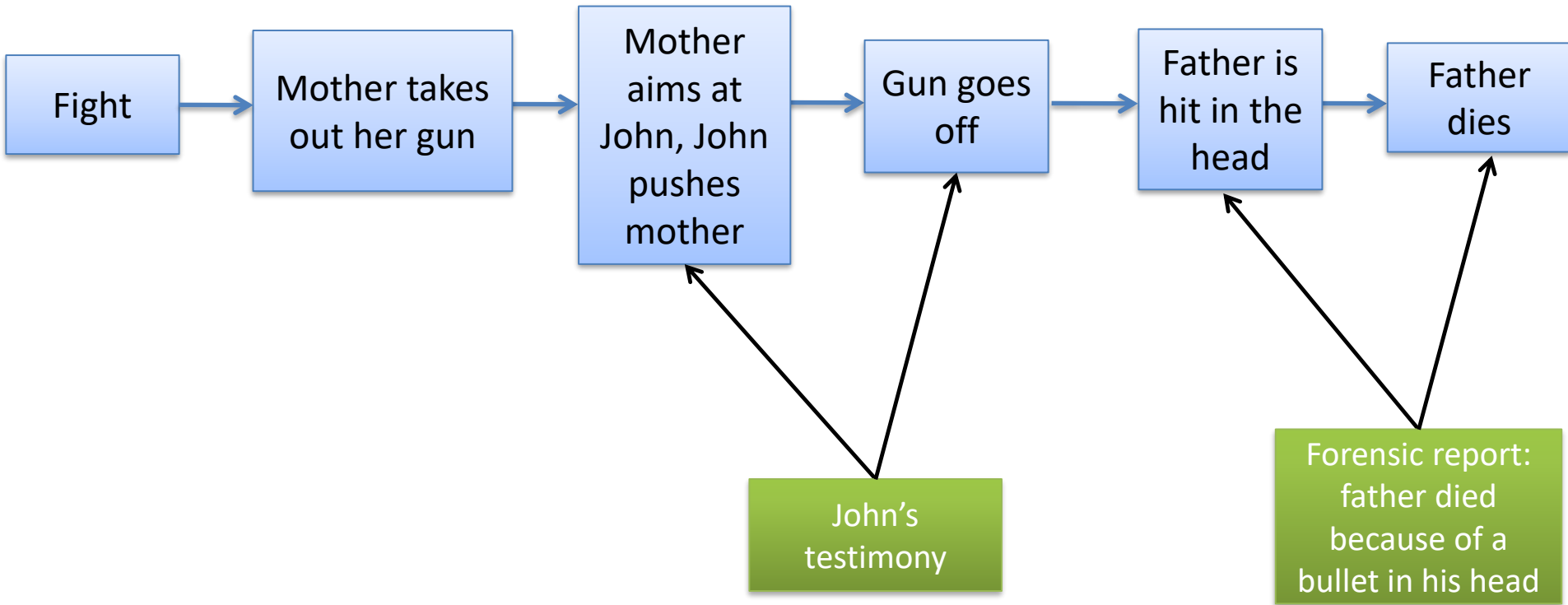- Watch out for tunnel vision!

Prosecution's story

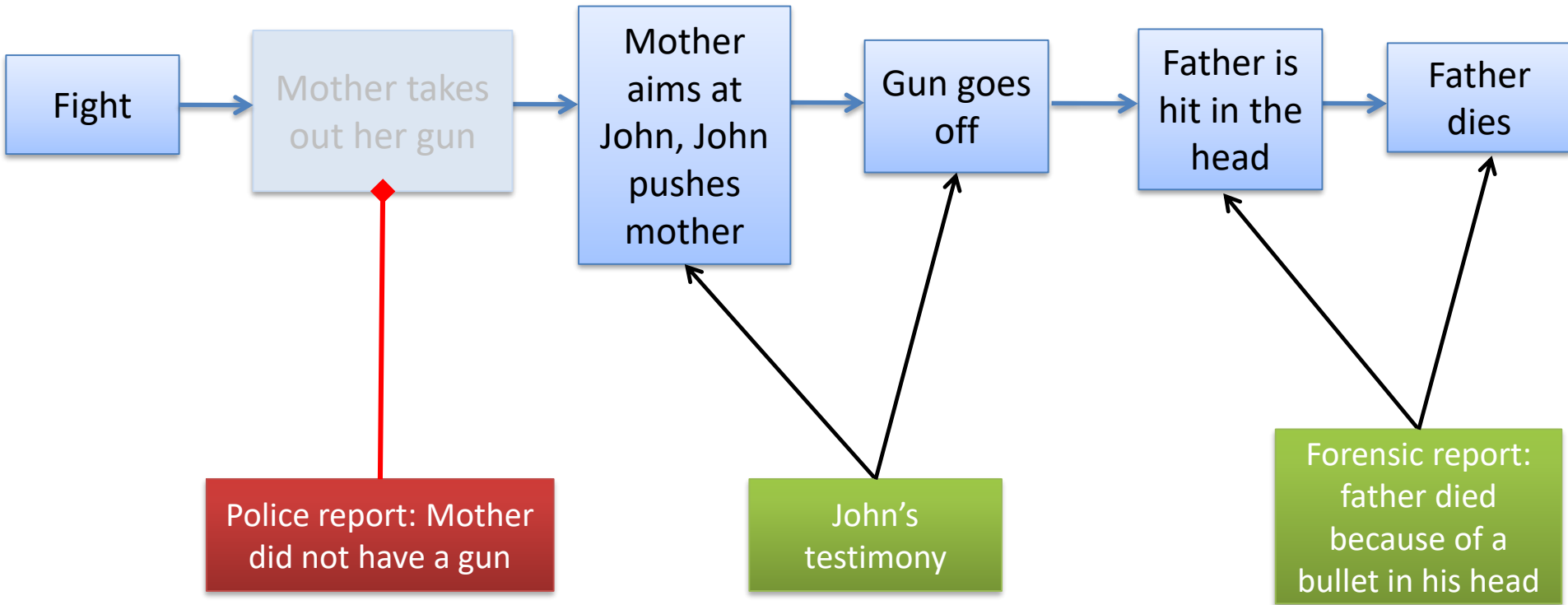Defence's story

The truth

Pitfalls

1. There is no complete story about the facts.
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4. Important elements of the story are not supported by evidence.
5. Evidential arguments have not been analysed.
6. Counterarguments to the story have not been taken into consideration.

4. Support story with evidence

4. Support story with evidence
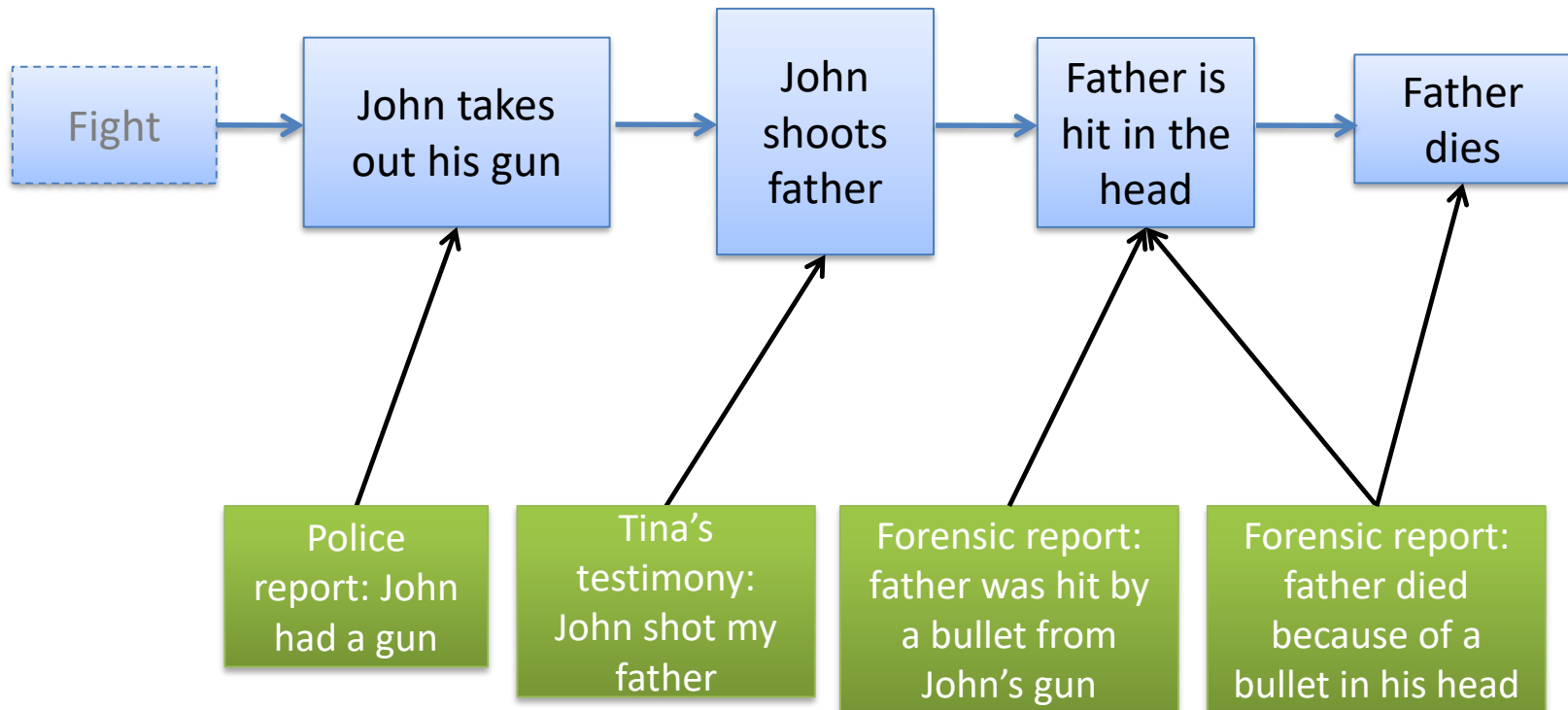
Pitfalls

1. There is no complete story about the facts.
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5. Analyse Arguments

5. Analyse Arguments

Pitfalls

1. There is no complete story about the facts.
2. The story is implausible.
3. Alternative stories have not been considered.
4. Important elements of the story are not supported by evidence.
5. Evidential arguments have not been analysed.
6. Counterarguments to the story have not been taken into consideration.

Fight → Mother takes out her gun → Mother aims at John, John pushes mother → Gun goes off → Father is hit in the head → Father dies

John's testimony

Forensic report: father died because of a bullet in his head

6. Counterarguments to the story

Stories & arguments

- Stories and arguments can be captured as separate structures
  - Stories: causally coherent chains of events
  - Arguments: chains of reasoning from evidence or other propositions to conclusion

Evidential reasoning

One
account
of the facts

Another
account
of the facts

Arguments

*Test:
critical questions*

Evidence

Legal reasoning

One legal
account
of the case

Another legal
account
of the case

Arguments
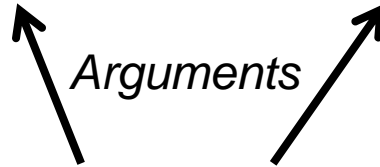
Facts

*Test:
critical questions*

One legal
account
of the case

Another legal
account
of the case

Arguments

*Test:
critical questions*

Facts

‖

One
account
of the facts

Another
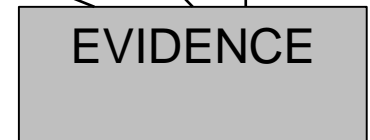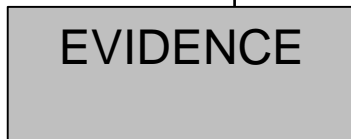account
of the facts

Arguments

*Test:
critical questions*

Evidence

One legal **account** of the case

Another legal **account** of the case

Arguments

Test: critical questions

Facts

‖

One **account** of the facts

Another **account** of the facts

Arguments

Test: critical questions

Evidence

Evidence – facts – law
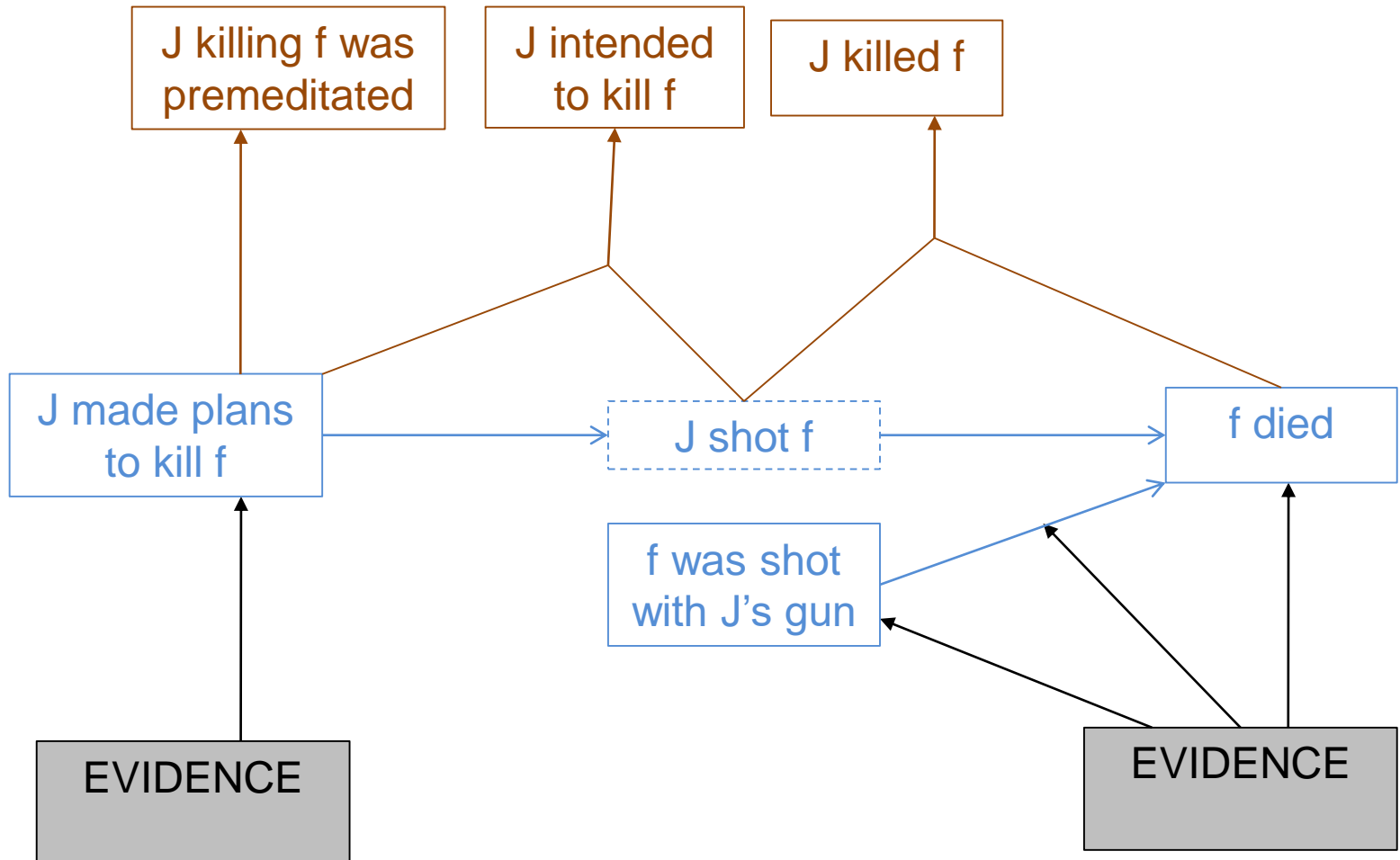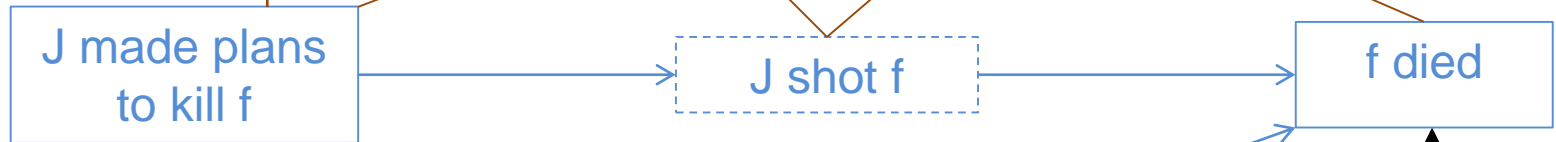
Start with evidence

EVIDENCE of plans

Gun EVIDENCE

Start with evidence

Start with story

STORY

| J made plans to kill f | → | J shot f | → | f died |
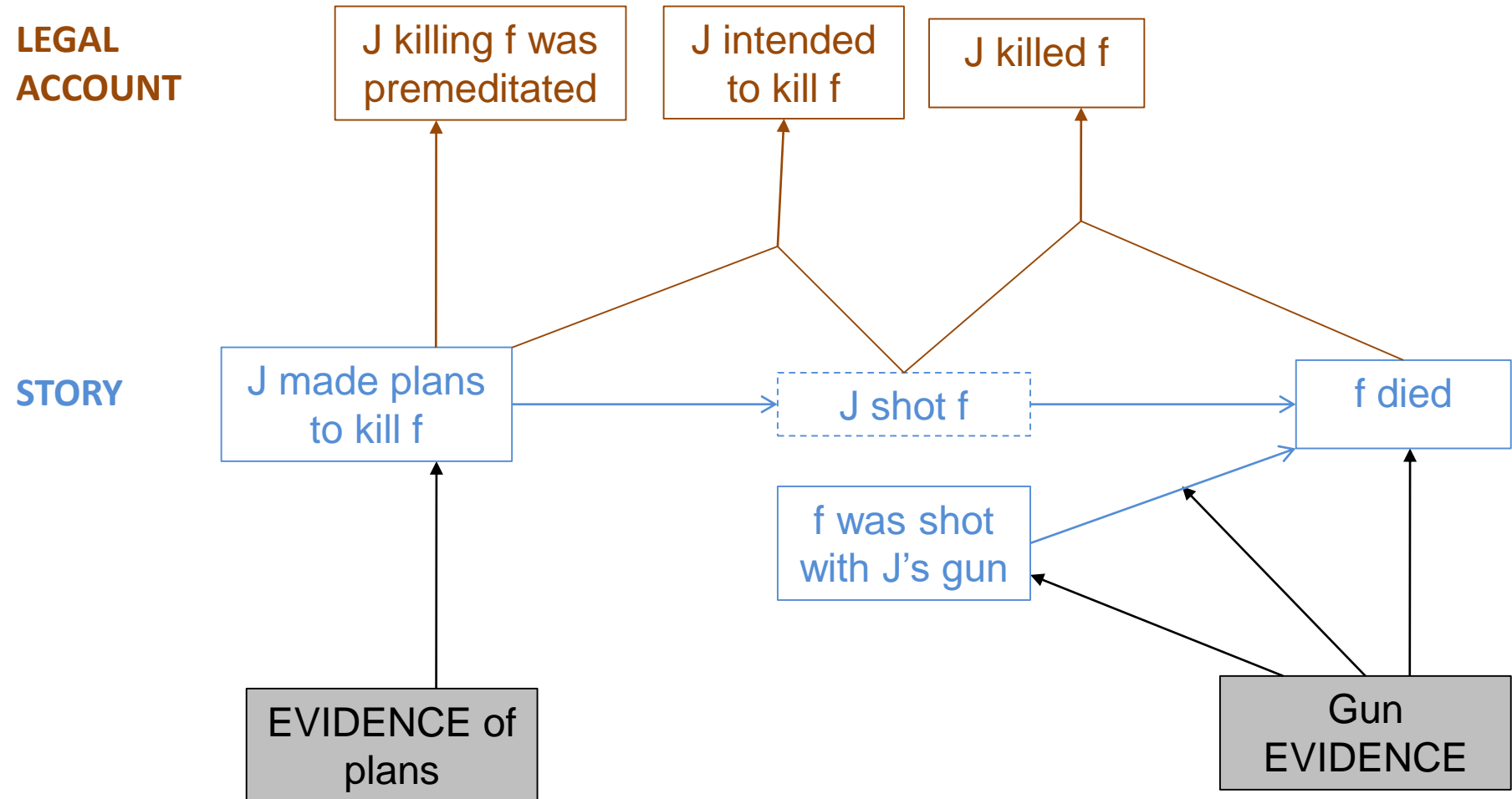
f was shot with J's gun → f died
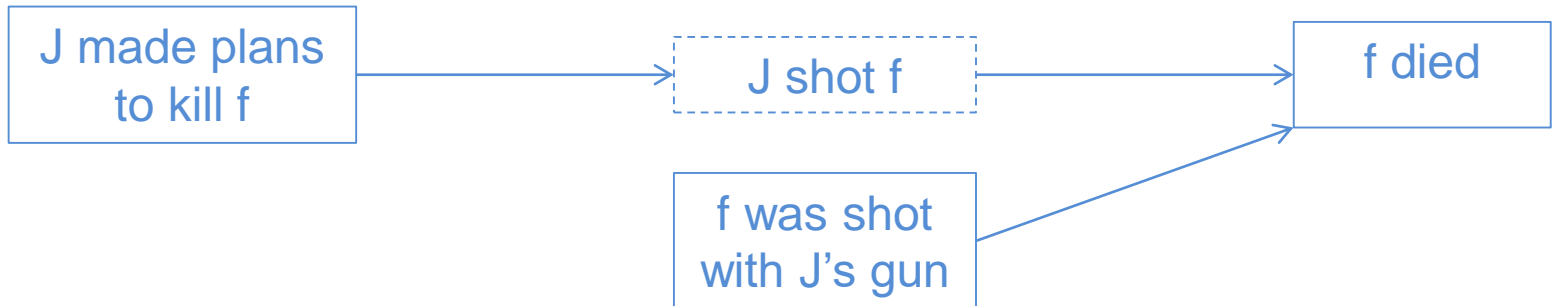
Start with story

LEGAL ACCOUNT

- J killing f was premeditated
- J intended to kill f
- J killed f

STORY

- J made plans to kill f
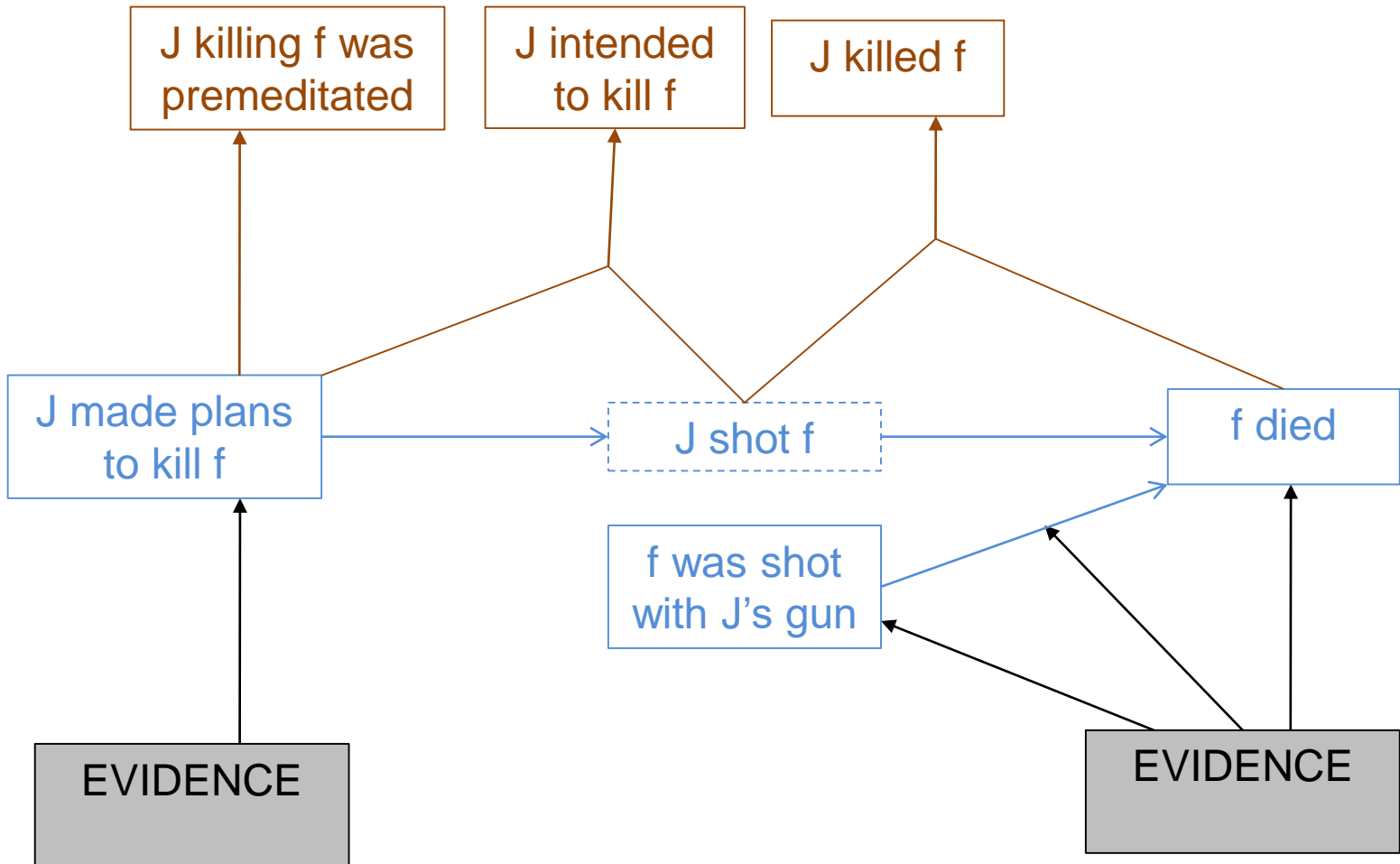- J shot f
- f died
- f was shot with J's gun

EVIDENCE

EVIDENCE

Start with indictment
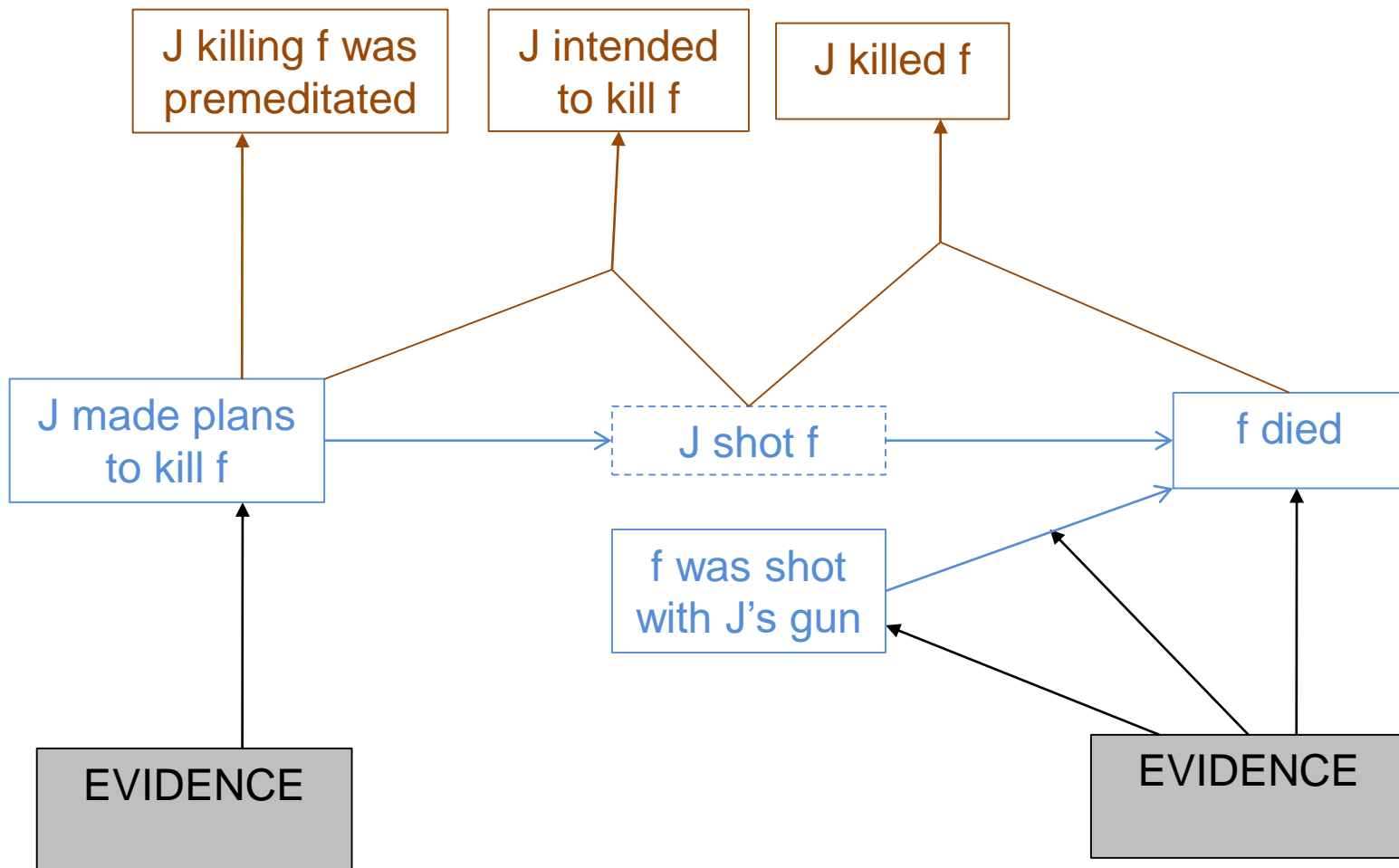
LEGAL ACCOUNT

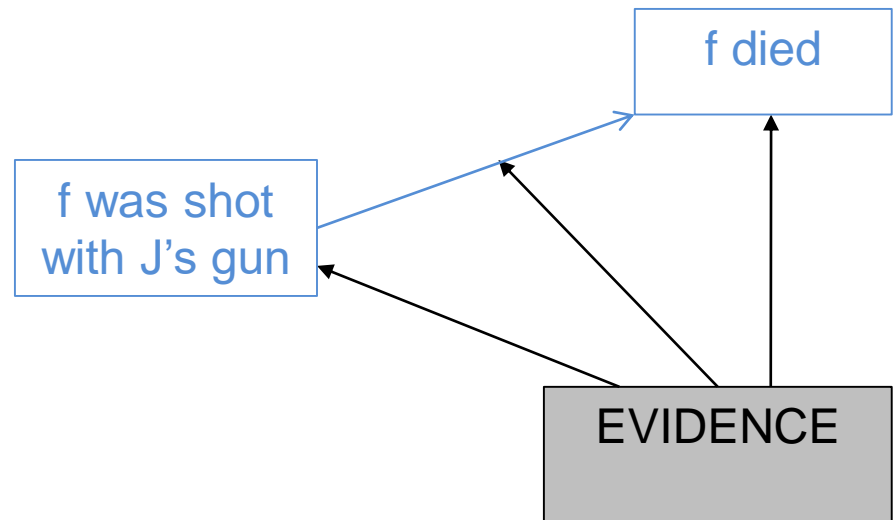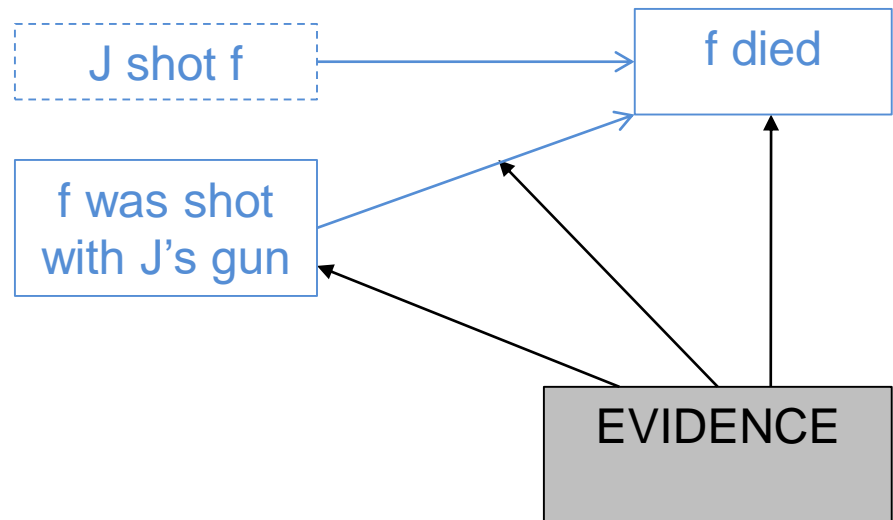| J killing f was premeditated | J intended to kill f | J killed f |

Start with indictment

LEGAL ACCOUNT

J killing f was premeditated

J intended to kill f

J killed f

STORY

J made plans to kill f

J shot f

f died

f was shot with J's gun

EVIDENCE

EVIDENCE

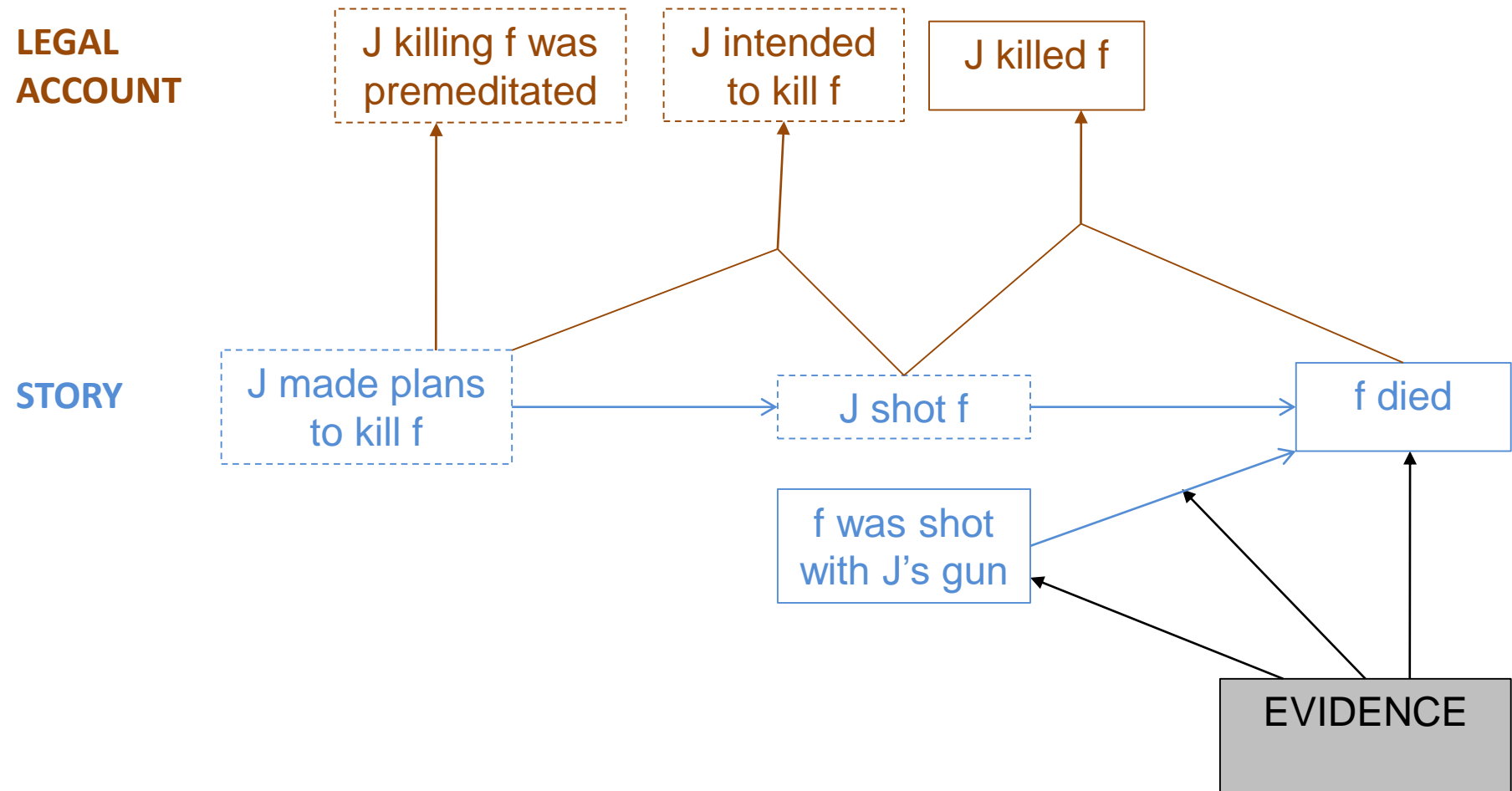# Theory building

EVIDENCE

Theory building

f died

f was shot
with J's gun
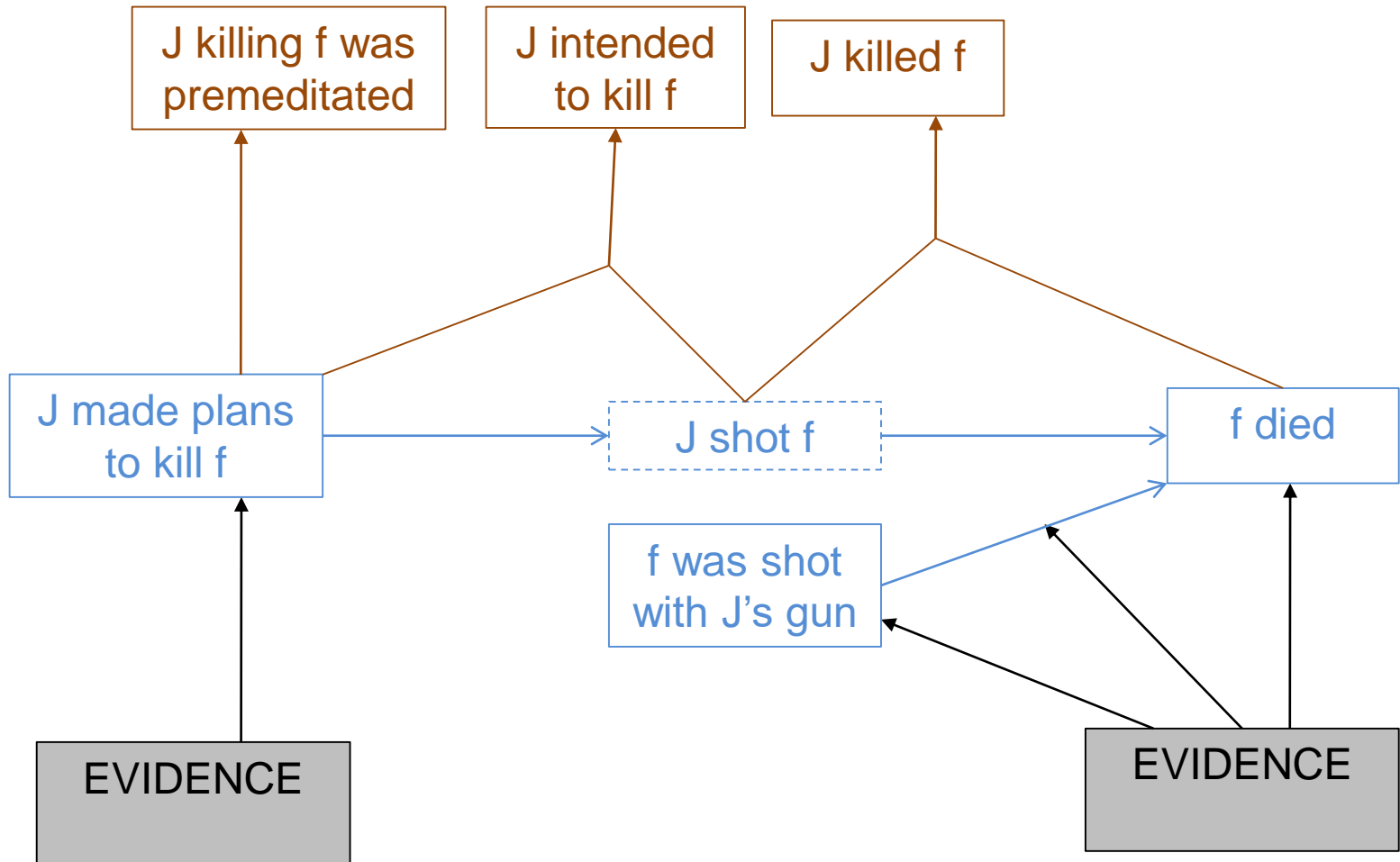
EVIDENCE

Theory building

Theory building

Theory building

A theory construction perspective on legal reasoning

| Legal consequences (initial version) |
| Facts (initial version) |
| Evidence (initial version) |

| Legal consequences (final version) |
| Facts (final version) |
| Evidence (final version) |
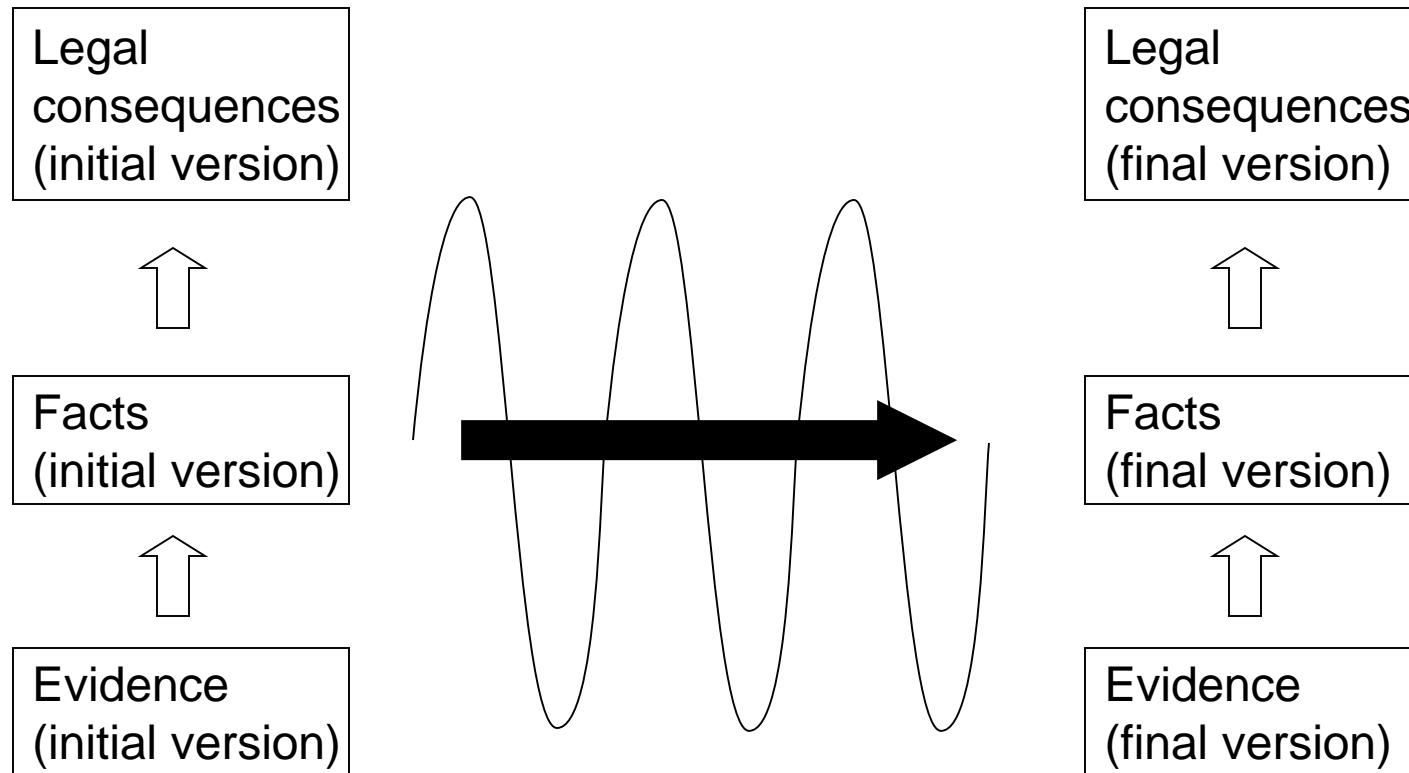
Conclusion

- Evidential and legal reasoning both use arguments, stories and cases
  - They are very similar

- Arguments, stories and cases are central to all AI & Law