

Evidential and Causal Reasoning

Much reasoning in AI can be seen as **evidential reasoning**, (observations to a theory) followed by **causal reasoning** (theory to predictions).

- **Diagnosis** Given symptoms, evidential reasoning leads to hypotheses about diseases or faults, these lead via causal reasoning to predictions that can be tested.
- **Robotics** Given perception, evidential reasoning can lead us to hypothesize what is in the world, that leads via causal reasoning to actions that can be executed.

Combining Evidential & Causal Reasoning

To combine evidential and causal reasoning, you can either

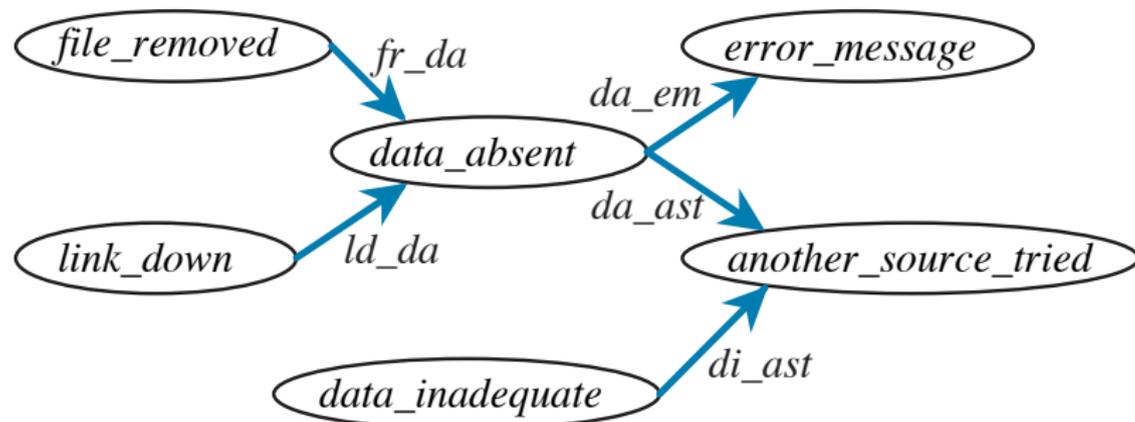
- Axiomatize from causes to their effects and
 - ▶ use abduction for evidential reasoning
 - ▶ use default reasoning for causal reasoning
- Axiomatize both
 - ▶ effects \rightarrow possible causes (for evidential reasoning)
 - ▶ causes \rightarrow effects (for causal reasoning)

use a single reasoning mechanism, such as default reasoning.

Combining abduction and default reasoning

- Representation:
 - ▶ Axiomatize causally using rules.
 - ▶ Have normality assumptions (defaults) for prediction
 - ▶ other assumptions to explain observations
- Reasoning:
 - ▶ given an observation, use all assumptions to explain observation (find base causes)
 - ▶ use normality assumptions to predict from base causes explanations.

Causal Network

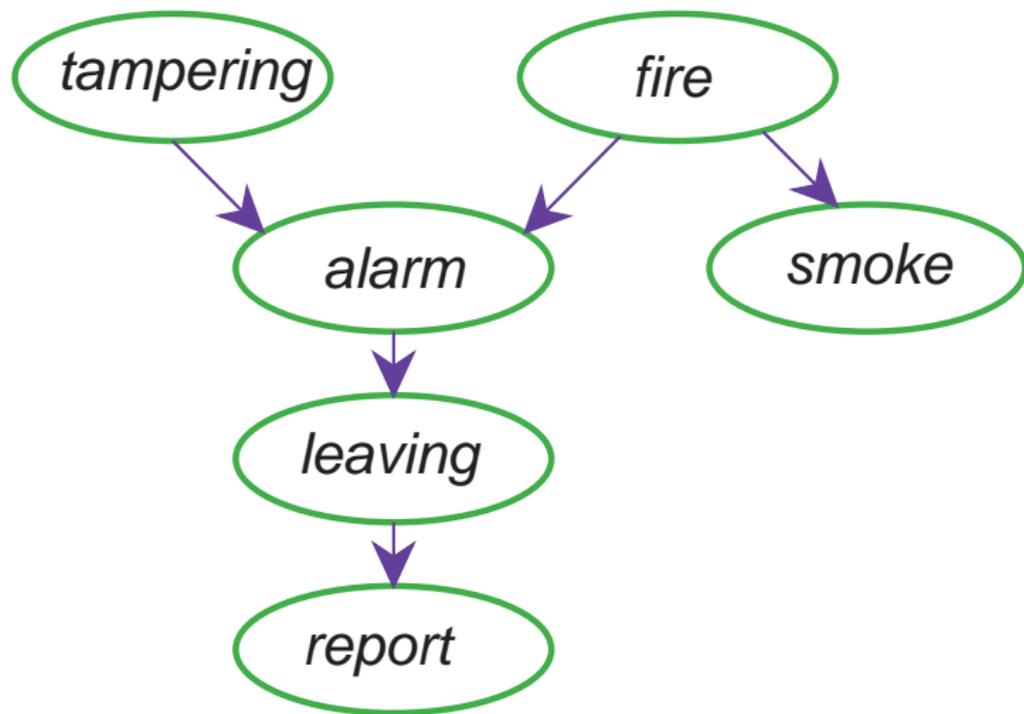


Why is the infobot trying another information source?
(Arrows are implications or defaults. Sources are assumable.)

Code for causal network

```
error_message ← data_absent ∧ da_em.  
another_source_tried ← data_absent ∧ da_ast  
another_source_tried ← data_inadequate ∧ di_ast.  
data_absent ← file_removed ∧ fr_da.  
data_absent ← link_down ∧ ld_da.  
default da_em, da_ast, di_ast, fr_da, ld_da.  
assumable file_removed.  
assumable link_down.  
assumable data_inadequate.
```

Example: fire alarm



Fire Alarm Code

assumable *tampering*.

assumable *fire*.

$alarm \leftarrow tampering \wedge tampering_caused_alarm.$

$alarm \leftarrow fire \wedge fire_caused_alarm.$

default *tampering_caused_alarm*.

default *fire_caused_alarm*.

$smoke \leftarrow fire \wedge fire_caused_smoke.$

default *fire_caused_smoke*.

$leaving \leftarrow alarm \wedge alarm_caused_leaving.$

default *alarm_caused_leaving*.

$report \leftarrow leaving \wedge leaving_caused_report.$

default *leaving_caused_report*.

Explaining Away

- If we observe *report* there are two minimal explanations:
 - ▶ one with *tampering*
 - ▶ one with *fire*
- If we observed just *smoke* there is one explanation (containing *fire*). This explanation makes no predictions about tampering.
- If we had observed $report \wedge smoke$, there is one minimal explanation, (containing *fire*).
 - ▶ The smoke **explains away** the tampering. There is no need to hypothesise *tampering* to explain report.