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

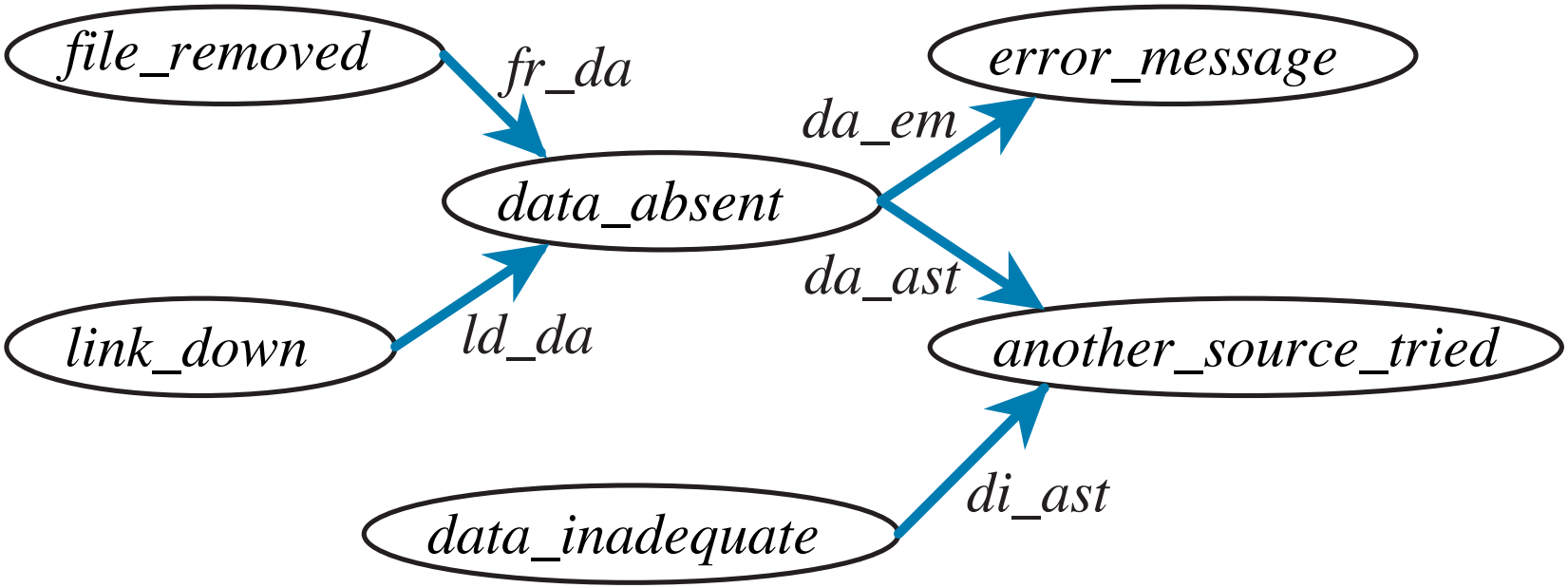
- Axiomatize from causes to their effects and
  - use abduction for evidential reasoning
  - use default reasoning for causal reasoning
- Axiomatize both
  - effects $\longrightarrow$ possible causes (for evidential reasoning)
  - causes $\longrightarrow$ effects (for causal reasoning)

  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

$error\_message \leftarrow data\_absent \wedge da\_em.$

$another\_source\_tried \leftarrow data\_absent \wedge da\_ast$

$another\_source\_tried \leftarrow data\_inadequate \wedge di\_ast.$

$data\_absent \leftarrow file\_removed \wedge fr\_da.$

$data\_absent \leftarrow link\_down \wedge ld\_da.$

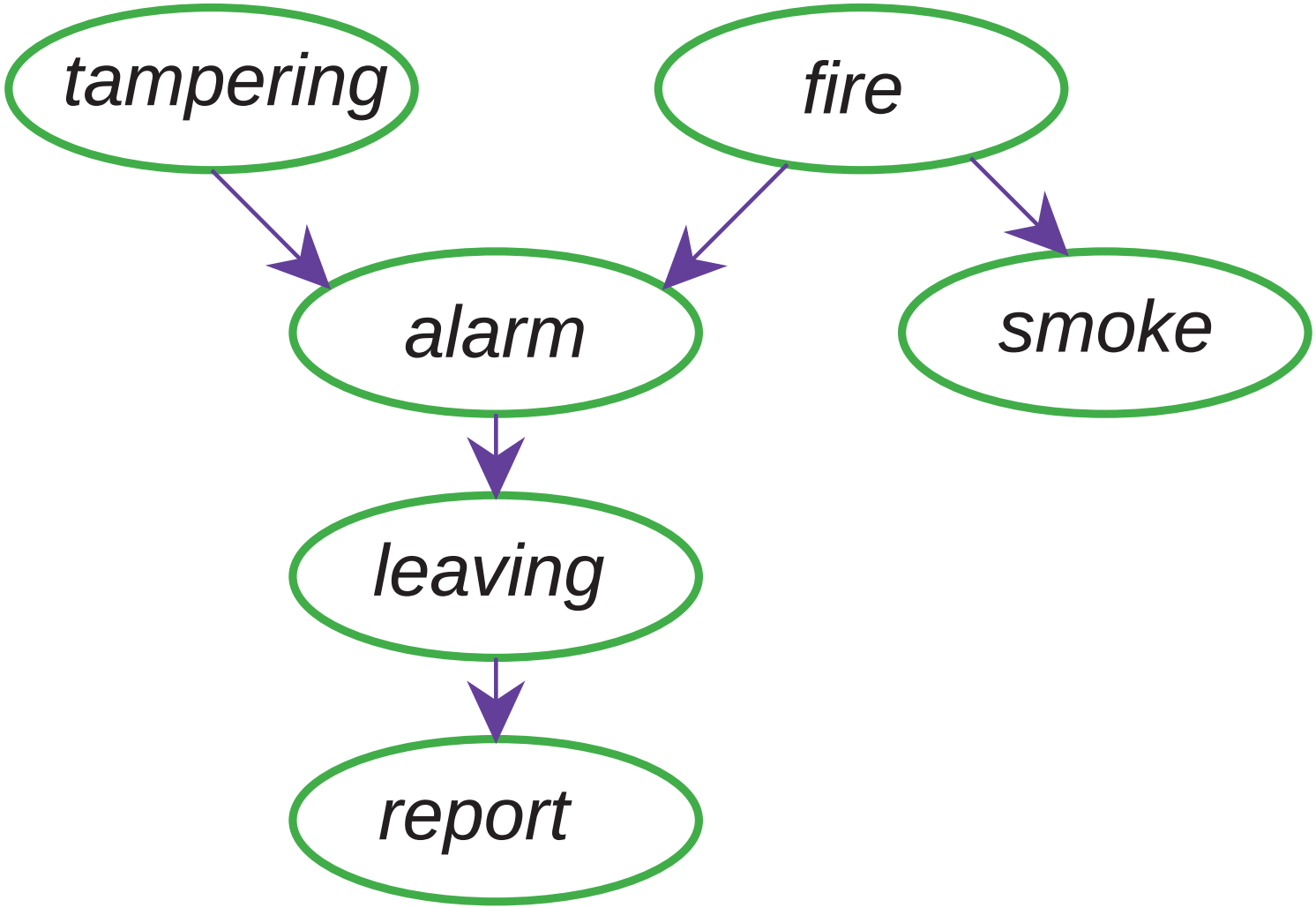
default $da\_em, da\_ast, di\_ast, fr\_da, ld\_da.$

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.