

# Primitive and Derived Atoms

- A **primitive atom** is an atom that is defined using facts.
- A **derived atom** is an atom that is defined using rules.
- Typically, the designer writes axioms for the derived atoms and then expects a user to specify which primitive atoms are true.

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- What if the world changes to make  $a$  no longer true?  
What happens to  $b$ ?

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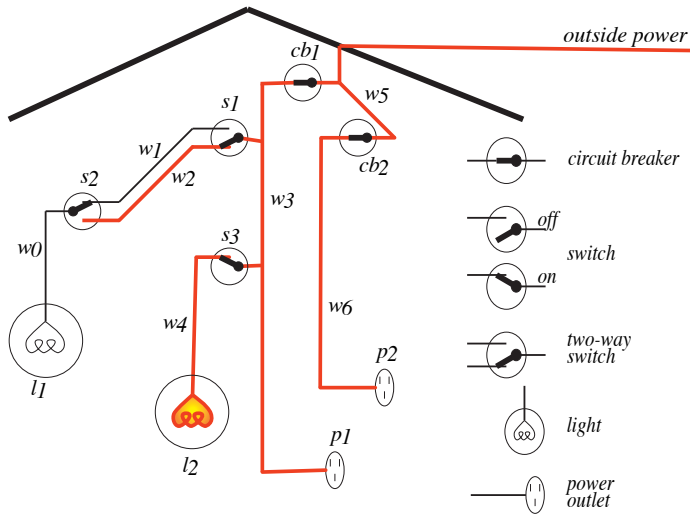
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- Other variables may be affected by an intervention on a variable.
- A **structural causal model** defines a **causal mechanism** for each atom. This causal mechanism specifies when the atom is true in terms of other atoms.
- If the model is manipulated to make an atom true or false, the clauses for that atom are replaced by the atomic fact or are removed.

# Electrical Environment



$$lit\_l_1 \leftrightarrow (up\_s_1 \leftrightarrow up\_s_2) \quad (1)$$

is logically equivalent to

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- The relationship between these propositions is **not** symmetric:
  - ▶ Suppose both switches were up and the light was lit.
  - ▶ Putting  $s_1$  down does not make  $s_2$  go down to preserve  $lit\_l_1$ .
  - ▶ Putting  $s_1$  down makes  $lit\_l_1$  false, and  $up\_s_2$  remains true.

# Combining Evidential & Causal Reasoning

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- Structural causal model:

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# Structural causal model as logic program

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- An evidential model

$$up\_s_1 \leftarrow lit\_l_1 \wedge up\_s_2.$$

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can be used to answer questions about whether  $s_1$  is up based on the position of  $s_2$  and whether  $l_1$  is lit.

It does not accurately predict the effect of interventions.