Propositions

- An interpretation is an assignment of values to all variables.
- A model is an interpretation that satisfies the constraints.
- Often we don't want to just find a model, but want to know what is true in all models.
- A proposition is statement that is true or false in each interpretation.

Why Propositions?

- Specifying logical formulae is often more natural than filling in tables
- It is easier to check correctness and debug formulae than tables
- We can exploit the Boolean nature for efficient reasoning
- We need a language for asking queries (of what follows in all models) that may be more complicated than asking for the value of a variable
- It is easy to incrementally add formulae
- It can be extended to infinitely many variables with infinite domains (using logical quantification)

Representation and Reasoning System

A Representation and Reasoning System (RRS) is made up of:

- formal language: specifies the legal sentences
- semantics: specifies the meaning of the symbols
- reasoning theory or proof procedure: nondeterministic specification of how an answer can be produced.

Using an RRS

1. Begin with a task domain.
2. Distinguish those things you want to talk about (the ontology).
3. Choose symbols in the computer to denote propositions
4. Tell the system knowledge about the domain.
5. Ask the system questions.
6. — the system can tell you whether your question is true

Role of semantics

In Computer:

$l1\_broken \leftarrow sw\_up$

$\quad \wedge power \wedge unlit\_l1.$

$sw\_up.$

$power \leftarrow lit\_l2.$

$unlit\_l1.$

$lit\_l2.$

In user's mind:

- $l1\_broken$: light $l1$ is broken
- sw_up: switch is up
- $power$: there is power in the building
- $unlit\_l1$: light $l1$ isn't lit
- lit_l2: light $l2$ is lit

Conclusion: $l1\_broken$

- The computer doesn't know the meaning of the symbols
- The user can interpret the symbol using their meaning

Simple language: propositional definite clauses

- An **atom** is a symbol starting with a lower case letter
- A **body** is an atom or is of the form $b_1 \wedge b_2$ where b_1 and b_2 are bodies.
- A **definite clause** is an atom or is a rule of the form $h \leftarrow b$ where h is an atom and b is a body.
- A **knowledge base** is a set of definite clauses

Semantics

- An interpretation I assigns a truth value to each atom.
- A body $b_1 \wedge b_2$ is true in I if b_1 is true in I and b_2 is true in I.
- A rule $h \leftarrow b$ is false in I if b is true in I and h is false in I. The rule is true otherwise.
- A knowledge base KB is true in I if and only if every clause in KB is true in I.

Models and Logical Consequence

- A **model** of a set of clauses is an interpretation in which all the clauses are *true*.
- If KB is a set of clauses and g is a conjunction of atoms, g is a **logical consequence** of KB, written $KB \models g$, if g is *true* in every model of KB.
- That is, $KB \models g$ if there is no interpretation in which KB is *true* and g is *false*.

Simple Example

$$KB = \begin{cases} p \leftarrow q. \\ q. \\ r \leftarrow s. \end{cases}$$

	p	q	r	s	
I_1	*true*	*true*	*true*	*true*	is a model of KB
I_2	*false*	*false*	*false*	*false*	not a model of KB
I_3	*true*	*true*	*false*	*false*	is a model of KB
I_4	*true*	*true*	*true*	*false*	is a model of KB
I_5	*true*	*true*	*false*	*true*	not a model of KB

$KB \models p$, $KB \models q$, $KB \not\models r$, $KB \not\models s$

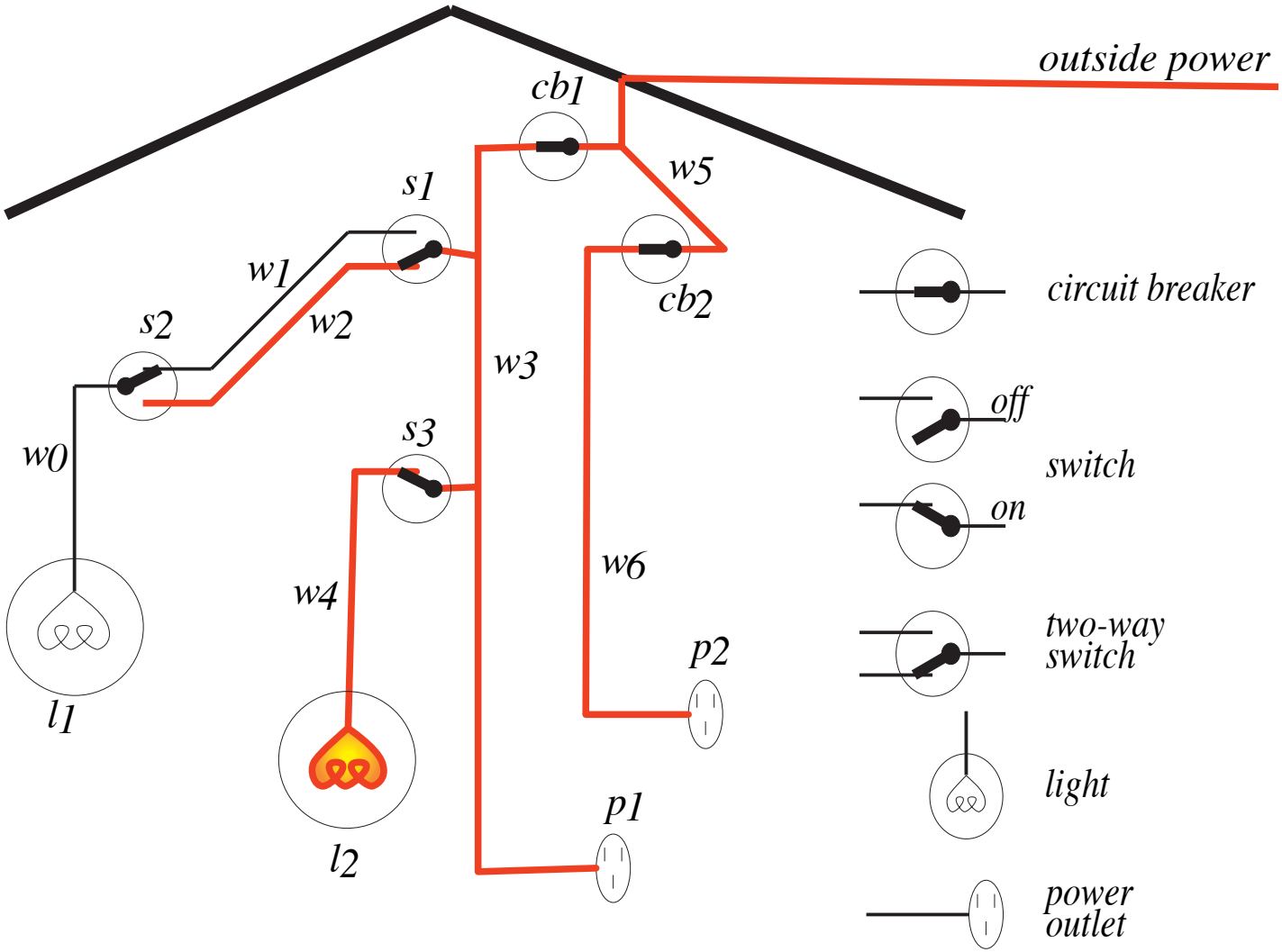
User's view of Semantics

1. Choose a task domain: intended interpretation.
2. Associate an atom with each proposition you want to represent.
3. Tell the system clauses that are true in the intended interpretation: axiomatizing the domain.
4. Ask questions about the intended interpretation.
5. If $KB \models g$, then g must be true in the intended interpretation.
6. The use can interpret the answer using their intended interpretation of the symbols.

Computer's view of semantics

- The computer doesn't have access to the intended interpretation.
- All it knows is the knowledge base.
- The computer can determine if a formula is a logical consequence of KB.
- If $KB \models g$ then g must be true in the intended interpretation.
- If $KB \not\models g$ then there is a model of KB in which g is false. This could be the intended interpretation.

Electrical Environment



Representing the Electrical Environment

$light\_l_1.$

$light\_l_2.$

$down\_s_1.$

$up\_s_2.$

$up\_s_3.$

$ok\_l_1.$

$ok\_l_2.$

$ok\_cb_1.$

$ok\_cb_2.$

$live\_outside.$

$lit\_l_1 \leftarrow live\_w_0 \wedge ok\_l_1$

$live\_w_0 \leftarrow live\_w_1 \wedge up\_s_2.$

$live\_w_0 \leftarrow live\_w_2 \wedge down\_s_2.$

$live\_w_1 \leftarrow live\_w_3 \wedge up\_s_1.$

$live\_w_2 \leftarrow live\_w_3 \wedge down\_s_1.$

$lit\_l_2 \leftarrow live\_w_4 \wedge ok\_l_2.$

$live\_w_4 \leftarrow live\_w_3 \wedge up\_s_3.$

$live\_p_1 \leftarrow live\_w_3.$

$live\_w_3 \leftarrow live\_w_5 \wedge ok\_cb_1.$

$live\_p_2 \leftarrow live\_w_6.$

$live\_w_6 \leftarrow live\_w_5 \wedge ok\_cb_2.$

$live\_w_5 \leftarrow live\_outside.$