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- This allows proof by contradiction.
- A definite clause knowledge base is always consistent. This won't be true with the rules that imply *false*.

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- A Horn clause is either a definite clause or an integrity constraint.

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Example: If $\{c, d, e, f, g, h\}$ are the assumables

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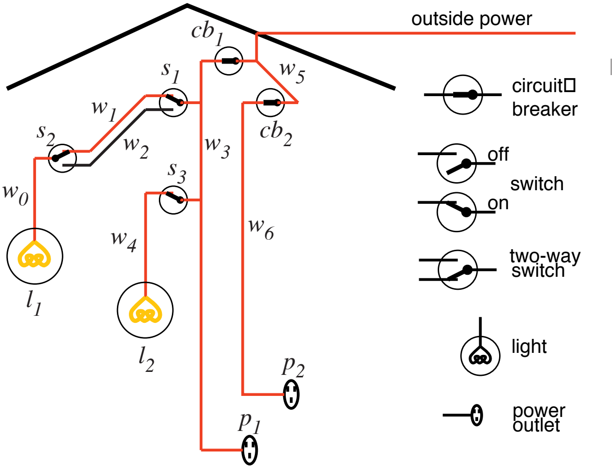
- Suppose switches s_1, s_2, and s_3 are all up:

$up\_s_1.\ up\_s_2.\ up\_s_3.$

Electrical Environment



in aipython.org, run code at the end of

`logicAssumables.py`

Representing the Electrical Environment

$light\_l_1.$

$light\_l_2.$

$up\_s_1.$

$up\_s_2.$

$up\_s_3.$

$live\_outside.$

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

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

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

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

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

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

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

$live\_p_1 \leftarrow live\_w_3.$

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

$live\_p_2 \leftarrow live\_w_6.$

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

$live\_w_5 \leftarrow live\_outside.$

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- You can derive:

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- Either cb_1 is broken or there is one of six double faults.

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- Example: For the proceeding example there are seven minimal diagnoses: $\{ok\_cb_1\}$, $\{ok\_s_1, ok\_s_3\}$, $\{ok\_s_1, ok\_l_2\}$, $\{ok\_s_2, ok\_s_3\}$,...

Recall: top-down consequence finding

To solve the query $?q_1 \wedge \ldots \wedge q_k$:

> $ac :=$ "$yes \leftarrow q_1 \wedge \ldots \wedge q_k$"
> **repeat**
> > **select** atom a_i from the body of ac;
> > **choose** clause C from KB with a_i as head;
> > replace a_i in the body of ac by the body of C
>
> **until** ac is an answer.

Implementing conflict finding: top down

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Implementing conflict finding: top down

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  - this is a conflict

Example

$false \leftarrow a.$

$a \leftarrow b \,\&\, c.$

$b \leftarrow d.$

$b \leftarrow e.$

$c \leftarrow f.$

$c \leftarrow g.$

$e \leftarrow h \,\&\, w.$

$e \leftarrow g.$

$w \leftarrow f.$

assumable $d, f, g, h.$

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- If $\langle \mathit{false}, A_1\rangle$ and $\langle a, A_2\rangle$ are in C, where $A_1 \subseteq A_2$, then $\langle a, A_2\rangle$ can be removed from C.

$C := \{\langle a, \{a\}\rangle : a \text{ is assumable }\};$
repeat
  select clause "$h \leftarrow b_1 \wedge \ldots \wedge b_m$" in T such that
    $\langle b_i, A_i\rangle \in C$ for all i and
    there is no $\langle h, A'\rangle \in C$ or $\langle \mathit{false}, A'\rangle \in C$
      such that $A' \subseteq A$ where $A = A_1 \cup \ldots \cup A_m$
  $C := C \cup \{\langle h, A\rangle\}$
  Remove any elements of C that can now be pruned
until no more selections are possible

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- In abduction an agent makes assumptions to explain observations. For example, it hypothesizes what could be wrong with a system to produce the observed symptoms.
- In default reasoning an agent makes assumptions of normality to make predictions. For example, the delivery robot may want to assume Mary is in her office, even if it isn't always true.

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  Assume F are Horn clauses.
- H is a set of formulae called the possible hypotheses or assumables. Ground instance of the possible hypotheses can be assumed if consistent.

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  A minimal explanation is an explanation such that no strict subset is also an explanation.
- An extension of $\langle F, H\rangle$ is the set of logical consequences of F and a maximal scenario of $\langle F, H\rangle$.

Example

$a \leftarrow b \wedge c.$
$b \leftarrow e.$
$b \leftarrow h.$
$c \leftarrow g.$
$c \leftarrow f.$
$d \leftarrow g.$
$false \leftarrow e \wedge d.$
$f \leftarrow h \wedge m.$
assumable e, h, g, m, n.

- Is $\{e, m, n\}$ a scenario?

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$false \leftarrow e \wedge d.$
$f \leftarrow h \wedge m.$
assumable $e, h, g, m, n.$

- Is $\{e, m, n\}$ a scenario? yes
- Is $\{e, g, m\}$ a scenario. no
- Is $\{h, m\}$ an explanation for a. yes
- Is $\{e, h, m\}$ an explanation for a. yes
- Is $\{e, g, h, m\}$ an explanation for a. no
- Is $\{e, h, m, n\}$ a maximal scenario. yes
- Is $\{h, g, m, n\}$ a maximal scenario.

Example

$a \leftarrow b \wedge c.$
$b \leftarrow e.$
$b \leftarrow h.$
$c \leftarrow g.$
$c \leftarrow f.$
$d \leftarrow g.$
$false \leftarrow e \wedge d.$
$f \leftarrow h \wedge m.$
assumable e, h, g, m, n.

- Is $\{e, m, n\}$ a scenario? yes
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- Default reasoning Where the truth of g is unknown and is to be determined.
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Give observations, we typically do abduction, then default reasoning to find consequences.

Computing Explanations

To find assumables to imply the query $?q_1 \wedge \ldots \wedge q_k$:

$ac :=$ "$yes \leftarrow q_1 \wedge \ldots \wedge q_k$"
repeat
  select non-assumable atom a_i from the body of ac

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>> **choose** clause C from KB with a_i as head

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>> replace a_i in the body of ac by the body of C

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To find assumables to imply the query $?q_1 \wedge \ldots \wedge q_k$:

> $ac :=$ "$yes \leftarrow q_1 \wedge \ldots \wedge q_k$"
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>   **select** non-assumable atom a_i from the body of *ac*
>   **choose** clause C from KB with a_i as head
>   replace a_i in the body of *ac* by the body of C
> **until** all atoms in the body of *ac* are assumable.

To find an explanation of query $?q_1 \wedge \ldots \wedge q_k$:

- find assumables to imply $?q_1 \wedge \ldots \wedge q_k$
- ensure that no subset of the assumables found implies *false*