Encode *birds fly*

\[
\text{fly}(X) :- \text{bird}(X).
\]

to allow for exceptions.
Encode *birds fly*

\[
\text{fly}(X) :- \text{bird}(X).
\]

\[
\text{bird}(X) \vdash \text{fly}(X)
\]

\[
\text{fly}(X)
\]

\[
\text{fly}(X)
\]

\[
\text{bird}(X)
\]

\[
\%
\]

to allow for exceptions.

*Default rule* (R. Reiter)

\[
\text{bird}(X) : \text{fly}(X) \nonumber\]

\[
\text{fly}(X) \nonumber\]
Rules and defaults

Encode *birds fly*

\[ \text{fly}(X) :- \text{bird}(X). \]

\[ \% \frac{\text{bird}(X)}{\text{fly}(X)} \]

to allow for exceptions.

*Default rule* (R. Reiter)

\[ \begin{align*}
\text{bird}(X) : & \text{fly}(X) \\
\hline
\text{fly}(X) & \\
\end{align*} \]

In general,

\[ \text{prerequisite } p : \text{justification } j \]

\[ \text{conclusion } c \]

applied to \( KB \) says:

\[ \text{conclude } c \text{ if } KB \models p \text{ and } j \text{ is } KB\text{-consistent} \]

\[ KB, j \not\models \text{false} \]
Encode *birds* fly

\[
\text{fly}(X) :- \text{bird}(X).
\]

\[
\text{bird}(X) : \text{fly}(X) \quad \frac{\text{fly}(X)}{}
\]

to allow for exceptions.

*Default rule* (R. Reiter)

In general,

\[
\begin{align*}
\text{prerequisite } p & : \text{justification } j \\
& \quad \frac{\text{conclusion } c}{\text{KB}} \quad \frac{KB, j \not\models \text{false}}{j \text{ is true in some model of } KB}
\end{align*}
\]

applied to \( KB \) says:

\[
\text{conclude } c \text{ if } KB \models p \text{ and } j \text{ is } KB\text{-consistent}
\]
Let $KB$ be

\begin{align*}
\text{bird(robin)}.
\text{bird(penguin)}.
\text{false} & :- \text{fly(penguin)}.
\text{fly(bee)}.
\end{align*}

Conclude:
Let $KB$ be

- `bird(robin).`
- `bird(penguin).`
- `false :- fly(penguin).`
- `fly(bee).`

Conclude:

- `fly(robin)` by default rule $(\star)$
- `bird(bee)` by abduction, if `bird(bee)` is assumable

but *not* `fly(penguin).`
Conflicting defaults

\[
\text{quaker}(X): \text{pacifist}(X) \quad \begin{array}{c}
\text{pacifist}(X) \\
\text{republican}(X): \neg\text{pacifist}(X) \\
\neg\text{pacifist}(X)
\end{array}
\]
Non-determinism

Conflicting defaults

\[
\begin{align*}
\text{quaker}(X) & : \text{pacifist}(X) \\
\text{pacifist}(X) & \\
\text{republican}(X) & : \lnot \text{pacifist}(X) \\
\lnot \text{pacifist}(X) &
\end{align*}
\]

Let $KB$ be

\[
\begin{align*}
\text{quaker}(\text{nixon}). \\
\text{republican}(\text{nixon}).
\end{align*}
\]
Conflicting defaults

\[
\begin{align*}
\text{quaker}(X) : & \text{pacificst}(X) \\
\text{pacificst}(X) : & \neg \text{pacificst}(X) \\
\text{republican}(X) : & \neg \text{pacificst}(X)
\end{align*}
\]

Let $KB$ be

\[
\begin{align*}
\text{quaker}(\text{nixon}). \\
\text{republican}(\text{nixon}).
\end{align*}
\]

Applying one default to Nixon makes the other inapplicable.

$KB$ has two incompatible extensions, breaking

least fixed point (provability model) for Horn clauses.
A default rule is *normal* if its justification is its conclusion

\[
\frac{p: c}{c}
\]

— infer \( c \) if it is consistent and \( p \) is provable
Normal default rules and inferring negations

A default rule is *normal* if its justification is its conclusion

\[ \frac{p}{c} \]

- infer \( c \) if it is consistent and \( p \) is provable

*Closed World Assumption*: any unprovable atom \( \varphi \) is false

\[ \text{true} : \neg \varphi \]

\[ \frac{\neg \varphi}{\neg \varphi} \]
A default rule is *normal* if its justification is its conclusion

\[
\frac{p}{c}
\]

\[\text{− infer } c \text{ if it is consistent and } p \text{ is provable}\]

*Closed World Assumption*: any unprovable atom \( \varphi \) is false

\[
\text{true} : \neg \varphi
\]

\[
\frac{\neg \varphi}{\neg \varphi}
\]

*Negation as failure*: \( \varphi \) is false if attempting to prove \( \varphi \) fails finitely

\[
naf(P) :- (P,!,fail); \text{ true.}
\]
A default rule is *normal* if its justification is its conclusion \( p : c \) 

\[ \frac{p}{c} \]

- infer \( c \) if it is consistent and \( p \) is provable

*Closed World Assumption*: any unprovable atom \( \varphi \) is false

\[
\text{true} : \neg \varphi
\]

\[ \neg \varphi \]

*Negation as failure*: \( \varphi \) is false if attempting to prove \( \varphi \) fails finitely

\[
\text{naf}(P) :- (P,!,,fail); \text{true}.
\]

N.B. Checking finite failure can be as hard as the Halting Problem.