$p \implies q$ is true

iff

whenever $p$ is true, $q$ is also true.

What if $p$ is never true?

Is $p \implies q$ true?

$p \implies q$

$p$ is $\neg p \implies q$ evals to $T$

$\forall x \ (P(x) \implies Q(x))$

What if $P(x)$ is always $\neg p$?

evaluates to $T$

there are unicorns implies I am a billionaire
\[ R = \{(1,2), (1,3), (2,3), (2,4), (3,1)\} \]
\[ S = \{(2,1), (3,1), (3,2), (4,2)\} \]
\[ S \circ R = \{(1,1), (2,2), (2,1), (1,2)\} \]
\[ f \circ g(x) = f(g(x)) \]

**Diagram:**
- \( R \) and \( S \) are represented as directed graphs.
- The transitively closure of \( S \circ R \) is shown.

**Transitive closure:**
\[ \{(2,1), (3,1), (3,2), (4,2), (4,1), (3,3)\} \]
SCCs

\[ \text{SCCs} \]

\[
\begin{align*}
&\text{a} \rightarrow \text{b} \rightarrow \text{c} \rightarrow \text{d} \\
&\text{e} \rightarrow \text{f} \rightarrow \text{g} \rightarrow \text{h} \\
&\text{c}, \text{d}, \text{g}, \text{h} \rightarrow \text{a}, \text{b}, \text{e} \\
&\text{f} \rightarrow \text{c}, \text{d}, \text{g}, \text{h}
\end{align*}
\]

\[(x + xy) + (x/y) \sim \text{infix}\]

binary tree

prefix

\[
\text{++} \text{x} \text{*} \text{x} \text{y} / \text{y}
\]

postfix

\[
\text{x} \text{y} \text{x} \text{y} \text{+} \text{+}
\]

many how vertices in a binary tree from \( h+1 \) to \( 2^{h+1} - 1 \)

\[
\begin{align*}
&\Theta(h) \\
&\Omega(h) \\
&O(2^h)
\end{align*}
\]
bit strings with exactly 3 0 bits

\[
S \rightarrow 1AS \quad S \rightarrow 0BA \\
A \rightarrow 1BA \quad A \rightarrow 0BB \\
B \rightarrow 1B \quad B \rightarrow 0C \\
C \rightarrow 1c \quad C \rightarrow \lambda
\]

10010

FSA

RE $1^*01^*01^*01^*$