1. Give the abstract syntax tree for the statement $\{[p \vee (q \vee r)] \supset [(p \vee q) \vee r]\}$.
   Solution:
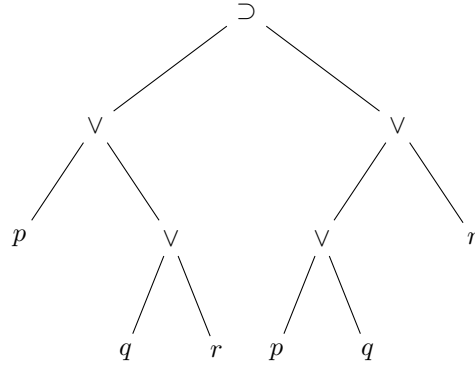
The parse tree, which is also acceptable as an answer, is
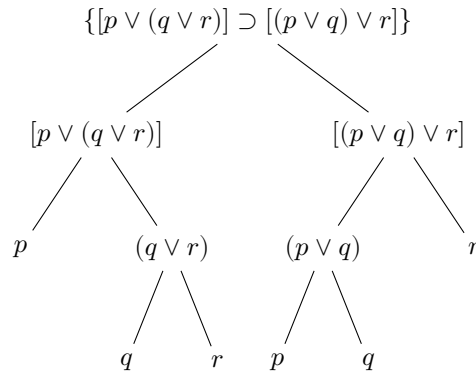
2. Show, by means of a truth table, that the statement $\{[p \vee (q \vee r)] \supset [(p \vee q) \vee r]\}$
   is a tautology.
   Solution:

p	q	r	$(q \vee r)$	$[p \vee (q \vee r)]$	$(p \vee q)$	$[(p \vee q) \vee r]$	$\{[p \vee (q \vee r)] \supset [(p \vee q) \vee r]\}$
F	F	F	F	F	F	F	T
F	F	T	T	T	F	T	T
F	T	F	T	T	T	T	T
F	T	T	T	T	T	T	T
T	F	F	F	T	T	T	T
T	F	T	T	T	T	T	T
T	T	F	T	T	T	T	T
T	T	T	T	T	T	T	T

3. Show, by means of a tableau, that the statement $\{[p \lor (q \lor r)] \supset [(p \lor q) \lor r]\}$ is a tautology.

Solution: Note that there are multiple orders in which you could do things so your tableau may not look exactly like the one below.

$$
\begin{array}{c|l}
 & \{[p \lor (q \lor r)] \supset [(p \lor q) \lor r]\} \\
[p \lor (q \lor r)] & \\
 & [(p \lor q) \lor r] \\
 & (p \lor q) \\
 & r \\
 & p \\
 & q
\end{array}
$$

$\underline{p} \mid \qquad\qquad (q \lor r) \mid$

$\underline{q} \mid \qquad\qquad \underline{r} \mid$