Problem 9.1
Consider program \( P \) consisting of the following three clauses:
\[
\begin{align*}
p(X) & \leftarrow \neg q(X) \land r(X) \land t(X). \\
p(X) & \leftarrow \neg s(X) \land r(X). \\
t(a) & \leftarrow \top.
\end{align*}
\]
Assume that \( IC = \emptyset \) and that \( O = \{ p(a) \} \), and that the set of abducibles \( A_P \) consists of the following facts and assumptions:
\[
\begin{align*}
q(a) & \leftarrow \top. \\
r(a) & \leftarrow \top. \\
s(a) & \leftarrow \top.
\end{align*}
\]
\[
\begin{align*}
q(a) & \leftarrow \bot. \\
r(a) & \leftarrow \bot. \\
s(a) & \leftarrow \bot.
\end{align*}
\]
1. What are the (minimal) explanations for \( O \) given \( P \)?
2. What follows skeptically and credulously from \( P \) and \( O \)?

Problem 9.2
Show that the following proposition holds:

**Proposition**

Let \( \mathcal{P} \) be a propositional logic program. Computing the least model of \( wc\mathcal{P} \) under the Lukasiewicz logic can be done in polynomial time.

Problem 9.3
Consider the following proposition:

**Proposition**

Let \( \langle \mathcal{P}, \mathcal{A}, IC, \models_{wc\mathcal{P}} \rangle \) be an abductive framework, where \( \mathcal{P} \) is a propositional logic program. Deciding whether \( \mathcal{E} \) is an explanation for \( O \) given \( \mathcal{P} \) can be done in polynomial time.

Show that the proposition holds by showing the following:
\[
\begin{align*}
1. & \mathcal{E} \text{ is a consistent subset of } \mathcal{A}, \\
2. & wc(\mathcal{P} \cup \mathcal{E}) \text{ is consistent under Lukasiewicz logic and} \\
3. & \mathcal{P} \cup \mathcal{E} \models_{wc\mathcal{P}} O.
\end{align*}
\]

Problem 9.4
Show that the following proposition holds

**Proposition**

Let \( \langle \mathcal{P}, \mathcal{A}, IC, \models_{wc\mathcal{P}} \rangle \) be an abductive framework, where \( \mathcal{P} \) is a propositional logic program. Deciding whether \( \mathcal{E} \) is a minimal explanation of \( O \) can be done in polynomial time.