Proposition: Let $A_1, A_2, ..., A_n$ be sets in universe U, where $n \geq 2$. Then $S_n : \overline{A_1 \cap A_2 \cap ... \cap A_n} = \overline{A_1} \cup \overline{A_2} \cup ... \cup \overline{A_n}$.

Proof. (Strong induction).
Basis step. Suppose $n = 2$. Observe that

$$
\begin{aligned}
\overline{A_1 \cap A_2} &= \{x : x \in U \wedge x \notin (A_1 \cap A_2)\} & \text{(Def. of set complement)} & \quad (1) \\
&= \{x : x \in U \wedge \neg(x \in (A_1 \cap A_2))\} & & \quad (2) \\
&= \{x : x \in U \wedge \neg(x \in A_1 \wedge x \in A_2)\} & \text{(Def. of set intersection)} & \quad (3) \\
&= \{x : x \in U \wedge (x \notin A_1 \vee x \notin A_2)\} & \text{(DeMorgan's law)} & \quad (4) \\
&= \{x : (x \in U \wedge x \notin A_1) \vee (x \in U \wedge x \notin A_2)\} & \text{(Distributive property)} & \quad (5) \\
&= \{x : x \in U \wedge x \notin A_1\} \cup \{x : x \in U \wedge x \notin A_2\} & \text{(Def. of set union)} & \quad (6) \\
&= \overline{A_1} \cup \overline{A_2}. & & \quad (7)
\end{aligned}
$$

Thus S_2.
Inductive step. Suppose S_m for all $m, n \in \mathbb{N}$ where $2 \leq m \leq n$.
We now show S_m implies S_{n+1}. Observe that

$$
\begin{aligned}
\overline{A_1} \cup \overline{A_2} \cup ... \cup \overline{A_n} \cup \overline{A_{n+1}} &= (\overline{A_1} \cup \overline{A_2} \cup ... \cup \overline{A_n}) \cup \overline{A_{n+1}} & & \quad (8) \\
&= (\overline{A_1 \cap A_2 \cap ... \cap A_n}) \cup (\overline{A_{n+1}}) & \text{(Inductive hypothesis)} & \quad (9) \\
&= \overline{A_1 \cap A_2 \cap ... \cap A_n \cap A_{n+1}}. & & \quad (10)
\end{aligned}
$$

Thus S_{n+1}.
It follows by mathematical induction that S_n for all sets $A_1, A_2, ..., A_n$ in universe U, where $n \geq 2$. ∎