Claim len(x·y)=len(x) + len(y) for all $x, y \in \Sigma^*$.

Define Let $P(y)$ be "len(x·y)=len(x) + len(y) for all $x \in \Sigma^*$."

We prove $P(y)$ for all $y \in \Sigma^*$ by structural induction.

Base Case: Let x be an arbitrary string, len($x \cdot \epsilon$)=len(x)
=len(x)+0=len(x)+len(ε). So we have $P(\varepsilon)$.

Inductive Hypothesis: Suppose $P(w)$ for an arbitrary $w \in \Sigma^*$.

Inductive Step:

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Σ^*:Basis: $\varepsilon \in \Sigma^*$.
Recursive: If $w \in \Sigma^*$ and $a \in \Sigma$ then $wa \in \Sigma^*$