Assignment 2 COMP 302

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2. 1 Theorem: $\forall l1, l2(rev\_append\ l1\ l2 = rev\_append'\ l1\ l2)$

   Base case:

$$\begin{aligned}
& l1 = [] \\
& rev_append\ []\ l2 \\
\implies & l2 && \text{by rev_append} \\
\\
& rev_append'\ []\ l2 \\
\implies & append\ rev([])\ l2 && \text{by rev_append'} \\
\implies & append\ []\ l2 && \text{by rev} \\
\implies & l2 && \text{by append}
\end{aligned}$$

   l1 = [h::t]

   Induction hypothesis: $rev\_append\ t\ l2\ =\ rev\_append'\ t\ l2$

   Case 1 with rev_append [h::t] l2

$$\begin{aligned}
& rev_append\ [h :: t]\ l2 \\
\implies & rev_append\ t\ (h :: l2) && \text{By rev_append} \\
\implies & rev_append'\ t\ (h :: l2) && \text{By induction hypothesis} \\
\implies & append\ rev(t)\ (h :: l2) && \text{By rev_append'} \qquad (1)
\end{aligned}$$

   Case 1 with rev_append' [h::t] l2

$$\begin{aligned}
& rev_append'\ [h :: t]\ l2 \\
\implies & append\ rev([h :: t])\ l2 && \text{By rev_append'} \\
\implies & append\ rev(t)@[h]\ l2 && \text{By rev} \\
\implies & \ rev(t)@[h]\ @l2 && \text{By append} \\
& =rev(t)@([h]@l2) && \text{By associativity of append} \\
& =rev(t)@(h :: l2) \\
\implies & append\ rev(t)\ (h :: l2) && \text{by append} \qquad (2)
\end{aligned}$$

So we can see that (1) = (2) therefore the induction holds.