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|#

;; See CLI Internal Note 185 for a tutorial introduction to the
;; Boyer-Moore prove based on this example.

EVENT: Start with the initial nqthm theory.

DEFINITION:
rotate (n, lst)
= if n ≃ 0 then lst
   else rotate (n - 1, append (cdr (lst), list (car (lst)))) endif

DEFINITION:
length (x)
= if listp (x) then 1 + length (cdr (x))
   else 0 endif

DEFINITION:
properp (x)
= if listp (x) then properp (cdr (x))
   else x = nil endif
**Definition:**
\[
\text{firstn} (n, \text{lst}) = \begin{cases} 
\text{nil} & \text{if } n \equiv 0 \\
\text{cons} (\text{car} (\text{lst}), \text{firstn} (n - 1, \text{cdr} (\text{lst}))) & \text{else} 
\end{cases}
\]

**Definition:**
\[
\text{nthcdr} (n, \text{lst}) = \begin{cases} 
\text{lst} & \text{if } n \equiv 0 \\
\text{nthcdr} (n - 1, \text{cdr} (\text{lst})) & \text{else} 
\end{cases}
\]

**Theorem:** associativity-of-append
\[
\text{append} (\text{append} (x, y), z) = \text{append} (x, \text{append} (y, z))
\]

**Theorem:** append-nil
\[
\text{properp} (x) \rightarrow (\text{append} (x, \text{nil}) = x)
\]

**Definition:**
\[
\text{rotate-append-induction} (n, \text{lst}, \text{extra}) = \begin{cases} 
\text{t} & \text{if } (n = 0) \lor (n \notin \mathbb{N}) \\
\text{t} & \text{else if } \text{lst} \equiv \text{nil} \\
\text{rotate-append-induction} (n - 1, \text{cdr} (\text{lst}), \text{append} (\text{extra}, \text{list} (\text{car} (\text{lst})))) & \text{else}
\end{cases}
\]

**Theorem:** properp-append
\[
\text{properp} (\text{append} (x, y)) = \text{properp} (y)
\]

**Theorem:** rotate-append
\[
(\text{properp} (\text{extra}) \land (\text{length} (\text{lst}) \not\equiv n)) \rightarrow (\text{rotate} (n, \text{append} (\text{lst}, \text{extra}))) = \text{append} (\text{nthcdr} (n, \text{lst}), \text{append} (\text{extra}, \text{firstn} (n, \text{lst})))
\]

**Theorem:** nthcdr-length
\[
\text{properp} (\text{lst}) \rightarrow (\text{nthcdr} (\text{length} (\text{lst}), \text{lst}) = \text{nil})
\]

**Theorem:** firstn-length
\[
\text{properp} (\text{lst}) \rightarrow (\text{firstn} (\text{length} (\text{lst}), \text{lst}) = \text{lst})
\]

**Theorem:** rotate-length
\[
\text{properp} (\text{lst}) \rightarrow (\text{rotate} (\text{length} (\text{lst}), \text{lst}) = \text{lst})
\]
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