
MODULE *linear_search*

EXTENDS *TLC, Integers, Sequences*

CONSTANT *MaxInt*
 ASSUME *MaxInt* > 1

$Seqs(s, n) \triangleq \text{UNION } \{[1 \dots m \rightarrow s] : m \in 1 \dots n\}$

$OrderedSeq(set, n) \triangleq \{seq \in Seqs(set, n) : \forall i \in 2 \dots Len(seq) : seq[i] \geq seq[i-1]\}$

$Pow2(n) \triangleq$
 LET $f[x \in 0 \dots n] \triangleq$
 IF $x = 0$
 THEN 1
 ELSE $2 * f[x-1]$
 IN $f[n]$

VARIABLES
i,
pc,
seq,
target,
found,
count

$vars \triangleq \langle i, pc, seq, target, found, count \rangle$

$Init \triangleq$
 $\wedge pc = \text{"init"}$
 $\wedge i = 1$
 $\wedge seq \in OrderedSeq(1 \dots MaxInt, MaxInt)$
 $\wedge target \in 1 \dots MaxInt$
 $\wedge found = 1$
 $\wedge count = 0$

$DoSearch \triangleq$
 $\wedge count' = count + 1$
 $\wedge \text{IF } seq[i] = target$
 THEN $\wedge found' = i$
 $\wedge pc' = \text{"done"}$
 $\wedge \text{UNCHANGED } \langle seq, target, i \rangle$
 ELSE $\wedge i' = i + 1$
 $\wedge \text{UNCHANGED } \langle seq, target, pc, found \rangle$

$Search \triangleq$
 $\wedge pc = \text{"init"}$

$$\begin{aligned}
& \wedge \text{ IF } i \leq \text{Len}(\text{seq}) \\
& \quad \text{ THEN } \text{DoSearch} \\
& \quad \text{ ELSE } \wedge pc' = \text{"done"} \\
& \quad \quad \wedge \text{UNCHANGED } \langle \text{seq}, \text{target}, i, \text{found}, \text{count} \rangle \\
\text{Done} & \triangleq \\
& \wedge pc = \text{"done"} \\
& \wedge \text{ LET } \text{seq_contains_target} \triangleq \text{target} \in \{\text{seq}[x] : x \in \text{DOMAIN seq}\} \\
& \quad \text{element_found} \triangleq \text{target} = \text{seq}[\text{found}] \\
& \quad \text{ IN } \wedge \text{Assert}(\text{seq_contains_target} \Rightarrow \text{element_found}, \langle \text{"element"}, \text{target}, \text{"not found"} \rangle) \\
& \text{this will always fail because search is linear} \\
& \wedge \text{Assert}(\text{Pow2}(\text{count} - 1) \leq \text{Len}(\text{seq}), \langle \text{"function must be log - n"}, \text{count} \rangle) \\
& \wedge \text{UNCHANGED vars} \\
\text{Next} & \triangleq \text{Search} \vee \text{Done}
\end{aligned}$$
