```
1  ---------- MODULE Op ----------
   Model checking basic operations on strings (i.e., list of characters).
6  EXTENDS Naturals, Sequences, AdditionalSequenceOperators
7  ----------
8  CONSTANTS   Char,      set of characters allowed
9              MaxPos,    max position to insert into or delete
10             MaxPr,     max priority
11             MaxLen     max length of list

13 ASSUME  ∧ MaxPos ∈ Nat \ {0}   WARNING: index from 1
14         ∧ MaxPr ∈ Nat \ {0}
15         ∧ MaxLen ∈ Nat \ {0}
16 ----------
17  List ≜ Seq(Char) \ * The set of all lists.
18 List ≜ UNION {[1 .. m → Char] : m ∈ 0 .. MaxLen}

   The set of all operations. In this specification, we will focus on "Ins" and "Del".
24 Op ≜  [type: {"Rd"}] ∪ \ * a read specifies no arguments
25       [type : {"Del"}, pos : 1 .. MaxPos] ∪  a deletion specifies a position
26       [type : {"Ins"}, pos  : 1 .. MaxPos, ch : Char, pr : 1 .. MaxPr]  an insertion specifies a position, a character, a

28 Nop ≜ CHOOSE v : v ∉ Op   Nop: an operation representing "doing nothing"
29 ----------
   Some operations for test.
33 Del1 ≜ [type ↦ "Del", pos ↦ 1]
34 Del2 ≜ [type ↦ "Del", pos ↦ 2]
35 Del3 ≜ [type ↦ "Del", pos ↦ 3]
36 Del4 ≜ [type ↦ "Del", pos ↦ 4]
37 Ins1 ≜ [type ↦ "Ins", pos  ↦ 1, ch ↦ "a", pr ↦ 1]
38 Ins2 ≜ [type ↦ "Ins", pos  ↦ 2, ch ↦ "b", pr ↦ 2]
39 Ins3 ≜ [type ↦ "Ins", pos  ↦ 3, ch ↦ "c", pr ↦ 3]
40 Ops ≜ ⟨Ins2, Del3, Ins1, Del2, Ins3, Del1⟩
41 ----------
   The "Apply" operator which applies an operation op on the list l. Del: If pos > Len(l), the last
   element of l is deleted.
      This is realized by the DeleteElement operator.
   Ins: If pos > Len(l), the new element is appended to l. This is realized by the InsertElement
      operator.
49 Apply(op, l) ≜ CASE op = Nop → l
50                  □  op.type = "Del" → DeleteElement(l, op.pos)
51                  □  op.type = "Ins"  → InsertElement(l, op.ch, op.pos)

   The "ApplyOps" operator which applies an operation sequence ops on the list l.
57 RECURSIVE ApplyOps(_, _)
58 ApplyOps(ops, l) ≜
```

```
59      IF ops = ⟨⟩
60       THEN l
61       ELSE Apply(Last(ops), ApplyOps(AllButLast(ops), l))
62 ⌊_____________________________________________________________⌋
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* Modification History
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