DEPARTAMENTO DE COMPUTACION

Facultad de Ciencias Exactas y Naturales - UBA

TP de Especificación

Sudoku

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Grupo 17

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1. Problemas

proc sudoku_esTableroValido (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out result: Bool) {
Pre {True}
Post $\{result = esTableroValido(t)\}$
}

proc sudoku_esCeldaVacia (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, in f: $\mathbb{Z}$,in c: $\mathbb{Z}$, out result: Bool) {
Pre $\{esTableroValido(t) \wedge_L 0 \leq f, c < |t|\}$
Post $\{result = (t[f][c] = 0)\}$
}

proc sudoku_nroDeCeldasVacias (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out result: $\mathbb{Z}$) {
Pre $\{esTableroValido(t)\}$
Post $\{\sum_{i=0}^{|t|-1}(\sum_{j=0}^{|t|-1}$ if $t[i][j] = 0$ then 1 else 0 fi$)\}$
}

proc sudoku_primeraCeldaVaciaFila (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out result: $\mathbb{Z}$) {
Pre $\{esTableroValido(t)\}$
Post {if $(\exists i : \mathbb{Z})(0 \leq i < |t| \wedge_L filaTieneCeldaVacia(t[i]) \wedge_L (\forall j : \mathbb{Z})$
$(0 \leq j < i \longrightarrow_L \neg filaTieneCeldaVacia(t[j])))$
then $result = i$
else $result = -1$ fi}
}

proc sudoku_primeraCeldaVaciaColumna (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out result: $\mathbb{Z}$) {
Pre $\{esTableroValido(t)\}$
Post {if $(\exists i : \mathbb{Z})(0 \leq i < |t| \wedge_L filaTieneCeldaVacia(t[i]) \wedge_L (\forall j : \mathbb{Z})(0 \leq j < i \longrightarrow_L \neg filaTieneCeldaVacia(t[j])))$
then $result = indicePrimeraCeldaVaciaEnFila(t[i])$
else $result = -1$ fi}
}

proc sudoku_valorEnCelda (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, in f: $\mathbb{Z}$, in c: $\mathbb{Z}$, out result: $\mathbb{Z}$) {
Pre $\{esTableroValido(t) \wedge_L 0 \leq f, c \leq 8 \wedge_L t[f][c] \neq 0\}$
Post $\{result = t[f][c]\}$
}

proc sudoku_llenarCelda (inout t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, in f: $\mathbb{Z}$, in c: $\mathbb{Z}$, in value: $\mathbb{Z}$) {
Pre $\{esTableroValido(t) \wedge_L 0 \leq f, c \leq 8 \wedge_L t[f][c] = 0 \wedge_L 1 \leq value \leq 9 \wedge_L t = t_0\}$
Post $\{t[f][c] = value \wedge_L (\forall i : \mathbb{Z})(\forall j : \mathbb{Z})((0 \leq i, j < |t| \wedge_L (i \neq f \vee j \neq c)) \longrightarrow_L t[i][j] = t_0[i][j])\}$
}

proc sudoku_vaciarCelda (inout t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, in f: $\mathbb{Z}$, in c: $\mathbb{Z}$) {
Pre $\{esTableroValido(t) \wedge_L 0 \leq f, c \leq 8 \wedge_L t[f][c] \neq 0 \wedge_L t = t_0\}$
Post $\{t[f][c] = 0 \wedge_L (\forall i : \mathbb{Z})(\forall j : \mathbb{Z})((0 \leq i, j < |t| \wedge_L (i \neq f \vee j \neq c)) \longrightarrow_L t[i][j] = t_0[i][j])\}$
}

proc sudoku_esTableroParcialmenteResuelto (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out result: Bool)) {
Pre {True}
Post $\{result = esTableroParcialmenteResuelto(t)\}$
}

proc sudoku_esTableroTotalmenteResuelto (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out result: Bool) {
Pre {True}
Post $\{result = esTableroTotalmenteResuelto(t)\}$
}

proc sudoku_esSubTablero (in $t_0, t_1 : seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out $result$: Bool){
Pre {True}
Post $\{result = esSubTablero(t_0, t_1)\}$
}

proc sudoku_tieneSolucion (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out tieneSolucion: Bool) {
Pre $\{esTableroValido(t)\}$
Post $\{tieneSolucion = (\exists s : seq\langle seq\langle \mathbb{Z}\rangle\rangle)(esTableroTotalmenteResuelto(s) \wedge_L esSubTablero(s, t))\}$
}

proc sudoku_resolver (inout t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out tieneSolucion: Bool) {
Pre $\{esTableroValido(t) \wedge_L t = t_0\}$
Post {if $(\exists s : seq\langle seq\langle \mathbb{Z}\rangle\rangle)(esTableroTotalmenteResuelto(s) \wedge_L esSubTablero(s, t))$
then $tieneSolucion = \text{True} \wedge t = s$
else $tieneSolucion = \text{False}$ fi}
}

proc sudoku_copiarTablero (in src: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out target: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {
Pre $\{esTableroValido(src)\}$
Post $\{esTableroValido(target) \wedge_L (\forall i : \mathbb{Z})(\forall j : \mathbb{Z})(0 \leq i, j < |src| \longrightarrow_L target[i][j] = src[i][j])\}$
}

2. Predicados y Auxiliares generales

pred esMatriz (t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {
$(\forall i : \mathbb{Z})(\forall j : \mathbb{Z})(0 \leq i, j < |t| \longrightarrow_L |t[i]| = |t[j]|)$
}

fun cantidadFilas (t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) : $\mathbb{Z} = |t|$;

fun cantidadColumnas (t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) : $\mathbb{Z}$ = if $cantidadFilas(t) > 0$ then $|t[0]|$ else 0 fi ;

pred esMatrizCuadrada (t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {
$esMatriz(t) \wedge (cantidadFilas(t) = cantidadColumnas(t))$
}

pred esTableroValido (t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) $\{esMatrizCuadrada(t) \wedge_L |t| = 9 \wedge_L$
$(\forall i : \mathbb{Z})(\forall j : \mathbb{Z})(0 \leq i, j < |t| \longrightarrow_L 0 \leq t[i][j] \leq 9)$
}

pred filaTieneCeldaVacia (f: $seq\langle \mathbb{Z}\rangle$) {
$(\exists i : \mathbb{Z})(0 \leq i < |f| \wedge_L f[i] = 0)$
}

fun indicePrimeraCeldaVaciaEnFila (s: $seq\langle \mathbb{Z}\rangle$) : $\mathbb{Z}$ = if $((\exists i : \mathbb{Z})(0 \leq i < |s| \wedge_L s[i] = 0 \wedge_L$
$(\forall j : \mathbb{Z})(0 \leq j < i \longrightarrow_L s[j] \neq 0)))$ then i else -1 fi ;

pred noHayRepetidosEnRegion (t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) $\{(\forall i : \mathbb{Z})(\forall j : \mathbb{Z})(\forall k : \mathbb{Z})(\forall l : \mathbb{Z})$
$(0 \leq i, j, k, l < 9 \wedge (idiv3 = kdiv3) \wedge (jdiv3 = ldiv3) \wedge (i \neq k \vee j \neq l) \longrightarrow_L (t[i][j] = 0 \vee_L t[k][l] = 0 \vee_L t[i][j] \neq t[k][l]))$
}

pred noHayRepetidosEnFila (s: $seq\langle\mathbb{Z}\rangle$) {$(\forall i : \mathbb{Z})(\forall j : \mathbb{Z})(0 \leq i, j < |s| \land j \neq i \longrightarrow_L (s[i] = 0 \lor_L s[j] = 0 \lor_L s[i] \neq s[j]))$
}

pred noHayRepetidosEnColumna (t: $seq\langle seq\langle\mathbb{Z}\rangle\rangle$) {$(\forall j : \mathbb{Z})(0 \leq j < |t| \longrightarrow_L (\forall l : \mathbb{Z})(\forall k : \mathbb{Z})$
$(0 \leq l, k < |t| \land l \neq k \longrightarrow_L (t[l][j] = 0 \lor_L t[k][j] = 0 \lor_L t[l][j] \neq t[k][j])))$
}

pred esTableroParcialmenteResuelto (t: $seq\langle seq\langle\mathbb{Z}\rangle\rangle$) {$esTableroValido(t) \land (\forall i : \mathbb{Z})(0 \leq i < |t| \longrightarrow_L$
$noHayRepetidosEnFila(t[i])) \land_L noHayRepetidosEnColumna(t) \land_L noHayRepetidosEnRegion(t)$
}

pred esTableroTotalmenteResuelto (t: $seq\langle seq\langle\mathbb{Z}\rangle\rangle$) {$esTableroParcialmenteResuelto(t) \land (\forall i : \mathbb{Z})(0 \leq i < |t| \longrightarrow_L$
$\neg filaTieneCeldaVacia(t[i]))$
}

pred esSubTablero ($t_0, t_1 : seq\langle seq\langle\mathbb{Z}\rangle\rangle$){$esTableroValido(t_0) \land esTableroValido(t_1) \land (\forall i : \mathbb{Z})(\forall j : \mathbb{Z})$
$((0 \leq i|t| \land_L t_0[i][j] \neq 0) \longrightarrow_L t_0[i][j] = t_1[i][j])$
}

3. Decisiones tomadas