DEPARTAMENTO DE COMPUTACION

Facultad de Ciencias Exactas y Naturales - UBA

TP de Especificación

Sudoku

24 de Abril de 2017 — Algoritmos y Estructuras de Datos I

Grupo 17

Integrante	LU	Correo electrónico
Maqueda, Ignacio	279/14	ignaciomaqueda95@gmail.com
Parral, Guillermo	280/16	guillermoeparral@gmail.com
Quintela, Gonzalo	089/16	gquintela@dc.uba.ar
Sirio, Tomás	440/16	tomassirio@gmail.com

Facultad de Ciencias Exactas y Naturales
Universidad de Buenos Aires
Ciudad Universitaria - (Pabellón I/Planta Baja)
Intendente Güiraldes 2610 - C1428EGA
Ciudad Autónoma de Buenos Aires - Rep. Argentina
Tel/Fax: (++54 +11) 4576-3300
http://www.exactas.uba.ar

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 $\{esTableroValido(t) \land 0 \leq f, c \leq 8\}$
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 $\{result = \sum_{i=0}^{|t|-1}(\sum_{j=0}^{|t|-1} \text{if } t[i][j] = 0 \text{ then } 1 \text{ else } 0 \text{ fi})\}$
}

proc sudoku_primeraCeldaVaciaFila (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out result: $\mathbb{Z}$) {
Pre $\{esTableroValido(t)\}$
Post $\{esPrimeraFilaConCeldaVacia(t, result) \lor$
$(\neg(\exists i : \mathbb{Z})(0 \leq i < |t| \land_L filaTieneCeldaVacia(t[i])) \land result = -1)\}$
}

proc sudoku_primeraCeldaVaciaColumna (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out result: $\mathbb{Z}$) {
Pre $\{esTableroValido(t)\}$
Post $\{(\exists i : \mathbb{Z})(esPrimeraFilaConCeldaVacia(t, i) \land$
$esPrimeraCeldaVaciaEnFila(t[i], result)) \lor$
$(\neg(\exists i : \mathbb{Z})(0 \leq i < |t| \land_L filaTieneCeldaVacia(t[i])) \land result = -1)\}$
pred esPrimeraCeldaVaciaEnFila (s: $seq\langle \mathbb{Z}\rangle$, k: $\mathbb{Z}$) $\{s[k] = 0 \land (\forall i : \mathbb{Z})(0 \leq i < k \longrightarrow_L s[i] \neq 0)\}$
}

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 $\{(esTableroValido(t) \land 0 \leq f, c \leq 8) \land_L t[f][c] \neq 0\}$
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 $\{(esTableroValido(t) \land 0 \leq f, c \leq 8 \land 1 \leq value \leq 9 \land t = t_0) \land_L t[f][c] = 0\}$
Post $\{esTableroValido(t) \land t[f][c] = value \land (\forall i : \mathbb{Z})(\forall j : \mathbb{Z})((0 \leq i, j < |t| \land (i \neq f \lor j \neq c)) \longrightarrow_L t[i][j] = t_0[i][j])\}$
}

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

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 $\{tieneSolucion = (\exists s : seq\langle seq\langle \mathbb{Z}\rangle\rangle)(esTableroTotalmenteResuelto(s) \land esSubTablero(t, s))\}$
}

proc sudoku_resolver (inout t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out tieneSolucion: Bool) {
Pre $\{esTableroValido(t) \land t = t_0\}$
Post $\{((\exists s : seq\langle seq\langle \mathbb{Z}\rangle\rangle)(esTableroTotalmenteResuelto(s) \land esSubTablero(t, s)$
$\land (tieneSolucion = \text{True}) \land (t = s)) \lor (\neg(\exists s : seq\langle seq\langle \mathbb{Z}\rangle\rangle)(esTableroTotalmenteResuelto(s) \land$
$esSubTablero(t, s)) \land (tieneSolucion = \text{False}) \land (t = t_0))\}$
}

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 $\{esTableroValido(target) \land (\forall i : \mathbb{Z})(\forall j : \mathbb{Z})(0 \leq i, j < |src| \longrightarrow_L target[i][j] = src[i][j])\}$
}

2. Predicados y Auxiliares generales

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

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

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

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

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

pred noHayRepetidosEnRegion (t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) $\{(\forall i : \mathbb{Z})(\forall j : \mathbb{Z})(\forall k : \mathbb{Z})(\forall l : \mathbb{Z})$
$((0 \leq i, j, k, l < |t| \land (i \text{ div } 3 = k \text{ div } 3) \land (j \text{ div } 3 = l \text{ div } 3) \land (i \neq k \lor j \neq l)) \longrightarrow_L (t[i][j] = 0 \lor t[k][l] = 0 \lor t[i][j] \neq t[k][l]))$
}

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

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

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

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

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 ;