DEPARTAMENTO DE COMPUTACION

Facultad de Ciencias Exactas y Naturales - UBA

TP de Especificación

Sudoku

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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 $\{esTableroValido(t) \wedge_L 0 \leq f, c < |t|\}$
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 $\{esTableroValido(t) \wedge_L 0 \leq f, c \leq 8 \wedge_L t[i][j] \neq 0\}$
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 $\{esTableroValido(t) \wedge_L 0 \leq f, c \leq 8 \wedge_L t[i][j] = 0 \wedge_L 1 \leq value \leq 9 \wedge_L t = t_0\}$
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 $\{esTableroValido(t) \wedge_L 0 \leq f, c \leq 8 \wedge_L t[i][j] \neq 0 \wedge_L t = t_0\}$
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 $\{esParcialmenteResuelto(t) \wedge_L \forall i : \mathbb{Z})(0 \leq i < |t| \longrightarrow_L \neg filaTieneCeldaVacia(t[i])\}$
}

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

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

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 $(\exists s : seq\langle seq\langle \mathbb{Z}\rangle\rangle)(esTotalmenteResuelto(s) \wedge_L esSubTablero(s, t))$
then $tieneSolucion = true \wedge t = s$
else $tieneSolucion = false$ 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 $\{(\forall i : \mathbb{Z})(\forall j : \mathbb{Z})(0 \leq i, j < |src| \longrightarrow_L (target[i][j] = src[i][j] \wedge_L esTableroValido(target))\}$
}

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

pred noHayRepetidosEnFila (s: $\mathbb{Z}$) $\{(\forall i : \mathbb{Z})(\forall j : \mathbb{Z})(0 \leq i, j < |s| \wedge_L j \neq i \longrightarrow_L (s[i] = 0 \vee s[j] = 0 \vee s[i] \neq s[j]))$
}

pred noHayRepetidosEnColumna (t: $\mathbb{Z}$) {$(\forall j : \mathbb{Z})(0 \leq j < |t| \longrightarrow_L (\forall l : \mathbb{Z})(\forall k : \mathbb{Z})$
$(0 \leq l, k < |t| \wedge_L l \neq k \longrightarrow_L (t[i][j] = 0 \vee t[k][l] = 0 \vee t[i][j] \neq t[k][j]))$
}

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

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

3. Decisiones tomadas