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 $\{\mathrm{True}\}$
        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 $\{esTableroValido(t) \wedge 0 \leq f, c \leq 8\}$
        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 $\{\sum_{i=0}^{|t|-1}(\sum_{j=0}^{|t|-1}$ 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 $(\exists i : \mathbb{Z})(0 \leq i < |t| \wedge_L filaTieneCeldaVacia(t[i]) \wedge (\forall j : \mathbb{Z})$
            $(0 \leq j < i \longrightarrow_L \neg filaTieneCeldaVacia(t[j])))$
            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 $(\exists i : \mathbb{Z})(0 \leq i < |t| \wedge_L filaTieneCeldaVacia(t[i]) \wedge (\forall j : \mathbb{Z})(0 \leq j < i \longrightarrow_L \neg filaTieneCeldaVacia(t[j])))$
            then $result = indicePrimeraCeldaVaciaEnFila(t[i])$
            else $result = -1$ fi}
        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 ;
}
```

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

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

```
proc sudoku_esTableroParcialmenteResuelto (in t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out result: Bool)) {
        Pre $\{\mathrm{True}\}$
        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 {$tieneSolucion = (\exists s : seq\langle seq\langle \mathbb{Z}\rangle\rangle)(esTableroTotalmenteResuelto(s) \land esSubTablero(s, t))$}
}
```

```
proc sudoku_resolver (inout t: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, out tieneSolucion: Bool) {
        Pre {$esTableroValido(t) \land t = t_0$}
        Post {if $(\exists s : seq\langle seq\langle \mathbb{Z}\rangle\rangle)(esTableroTotalmenteResuelto(s) \land esSubTablero(s, t))$
            then $tieneSolucion = \text{True} \land t = s$
            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 {$esTableroValido(target) \land (\forall i : \mathbb{Z})(\forall j : \mathbb{Z})(0 \le i, j < |src| \longrightarrow_L target[i][j] = src[i][j])$}
}
```

2. Predicados y Auxiliares generales

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

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

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

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

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

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

`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` ($\mathrm{t}_0, t_1 : seq\langle seq\langle\mathbb{Z}\rangle\rangle$)$\{esTableroValido(t_0) \land esTableroValido(t_1) \land (\forall i:\mathbb{Z})(\forall j:\mathbb{Z})$
$((0 \leq i, j < |t| \land_L t_0[i][j] \neq 0) \longrightarrow_L t_0[i][j] = t_1[i][j])$
}
`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 ;