DEPARTAMENTO DE COMPUTACION

Facultad de Ciencias Exactas y Naturales - UBA

TP de Especificación

Análisis Habitacional Argentino

8 de Septiembre de 2021 — Algoritmos y Estructuras de Datos I

Grupo 4

Integrante	LU	Correo electrónico
Cristian Gabriel, Diaz	856/19	cris73796@hotmail.com
Matias Javier, Quispe	453/18	matiasjq2907@gmail.com
Tomás Augusto, Romero	564/21	tomas.a.romero0711@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. Tipos

enum ItemHogar {
$HOGCODUSU, , HOGTRIMESTRE, HOGLATITUD, HOGLONGITUD, II7, REGION, MAS\_500, IV1, IV2, II2, II3$
}
enum ItemIndividuo {
$INDCODUSU, COMPONENTE, INDAÑO, INDTRIMESTRE, CH4, CH6, NIVEL\_ED, ESTADO, CAT\_OCUP, P47T, PP04G$
}

2. Ejercicios

Ejercicio 1. *:*
`proc esEncuestaVálida` (in th : eph_h, in ti : eph_i, out result : Bool) {

`Pre` $\{True\}$
`Post` $\{result = \text{true} \leftrightarrow encuestaVálida(th, ti)\}$
}

`pred encuestaVálida` (th : eph_h,ti : eph_i) {
$esMatriz(th) \wedge esMatriz(ti) \wedge |th| \geq 1 \wedge |ti| \geq 1 \wedge |th| = |variablesHogar| \wedge |ti| = |variblesIndividuo| \wedge sinRepetidosEnIndividuos(ti) \wedge sinRepetidosEnHogares(th) \wedge hogaresAsociadosIndividuos(th, ti) \wedge mismoAñoyTrimestre(th, ti) \wedge iv2MayorOIgualIi2(th) \wedge rangosValidos(th, ti)$
}

`pred esMatriz` (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {
$(\forall i : \mathbb{Z})(0 \leq i < filas(m) \longrightarrow_L (|m[i]| > 0 \wedge (\forall j : \mathbb{Z})(0 \leq j < filas \longrightarrow_L |m[i]| = |m[j]|)$
}

`aux filas` (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) : $\mathbb{Z} = |m|$;

`aux columnas` (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) : $\mathbb{Z}$ = if $filas(m) > 0$ then $|m[0]|$ else 0 fi ;

`pred sinRepetidosEnHogares` (s: $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) $\{(\forall i, j : \mathbb{Z})((0 \leq i, j < |s| \wedge i \neq j) \longrightarrow_L s[i][@hogcodusu] \neq s[j][@hogcodusu])\}$

`pred sinRepetidosEnIndividuos` (s : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {
$(\forall i, j\mathbb{Z})((0 \leq i, j < |s| \wedge i \neq j) \longrightarrow_L (s[i][@indcodusu] = s[j][@indcodusu] \longrightarrow_L s[i][@componente] \neq s[j][@componente]))\}$

`pred hogaresAsociadosIndividuos` (th : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, ti : $seq\langle seq\langle\rangle\rangle$) {
$(\forall i : \mathbb{Z})(\exists j : \mathbb{Z})(rangoMatriz(th, i) \longrightarrow_L th[i][@hogcodusu] = ti[j][@indcodusu]) \wedge (\forall i : \mathbb{Z})(\exists j : \mathbb{Z})(rangoMatriz(ti, i) \longrightarrow_L ti[i][@indcodusu] = th[j][@hogcodusu])$
}

`pred mismoAñoyTrimestre` (th : eph_h,ti : eph_i) $\{mismoAñoHogares(th) \wedge mismoAñoIndividuos(ti) \wedge mismoTrimestreHogares(th) \wedge mismoTrimestreIndividuos(ti)\}$

`pred mismoAñoHogares` (th : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {
$(\forall i, j : \mathbb{Z})((rangoMatriz(th, i) \wedge rangoMatriz(th, j) \wedge i \neq j) \longrightarrow_L th[i][@hogaño] = th[j][@hogaño])$
}

`pred mismoAñoIndividuos` (ti : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {
$(\forall i, j : \mathbb{Z})((rangoMatriz(ti, i) \wedge rangoMatriz(ti, j) \wedge i \neq j) \longrightarrow_L ti[i][@indaño] = ti[j][@indaño])$
}

`pred mismoTrimestreHogares` (th : eph_h) {
$(\forall i, j : \mathbb{Z})(rangoMatriz(th, i) \wedge rangoMatriz(th, j) \wedge i \neq j) \longrightarrow_L (th[i][@hogtrimestre] = th[j][@hogtrimestre]))$
}

pred mismoTrimestreIndividuos (ti : eph_i) {
$(\forall i, j : \mathbb{Z})(rangoMatriz(ti, i) \land rangoMatriz(ti, j) \land i \neq j) \longrightarrow_L (ti[i][@hogtrimestre] = ti[j][@hogtrimestre]))$
}

aux cantItemHogar : $\mathbb{Z} = 12$;

aux cantItemInd : $\mathbb{Z} = 11$;

pred mismaColumYVariables (s : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(0 \leq i < |s| \longrightarrow_L (|s[i]| = cantItemHogar \vee |s[i]| = cantItemInd))$}

pred rangosValidos (th, ti : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {
$rangoCodusu(th) \land rangoCodusu(ti) \land rangoTrimestre(th) \land rangoTrimestre(ti) \land rangoIv2(th) \land rangoIi2(th) \land$
$rangoComponente(ti) \land rangoCh6(ti) \land rangoP47t(ti) \land rangoIv1(ti) \land rangoIi3(ti) \land rangoIi7(th) \land rangoRegion(th) \land$
$rangoMas500(th) \land rangoCh4(ti) \land rangoNivelEd(ti) \land rangoEstado(ti) \land rangoCatOcup(ti) \land rangoPp04g(ti)$
}

pred rangoCodusu (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L (0 \leq m[i][@hogcodusu] \vee 0 \leq m[i][@indcodusu])$}

pred rangoTrimestre (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {
$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L (1 \leq m[i][@hogtrimestre] \leq 3 \vee 1 \leq m[i][@indtrimestre] \leq 3))$
}

pred rangoIv2 (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L 1 \leq m[i][@iv2])$}

pred rangoIi2 (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L 1 \leq m[i][@ii2] \leq m[i][@iv2])$}

pred rangoComponente (th : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$,ti : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {
$(\forall i : \mathbb{Z})(rangoMatriz(th, i) \longrightarrow_L 0 \leq habitantesDeUnaCasa(th[i], ti) \leq 20)$}

pred rangoCh6 (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L 0 \leq m[i][@ch6])$}

pred rangoP47t (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L -1 \leq m[i][@p47t])$}

pred rangoIv1 (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L 1 \leq m[i][@iv1] \leq 5)$}

pred rangoIi3 (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L (m[i][@ii3] = 1 \vee m[i][@ii3] = 2))$}

pred rangoIi7 (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L 1 \leq m[i][@ii7] \leq 3)$}

pred rangoRegion (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L 1 \leq m[i][@region] \leq 6)$}

pred rangoMas500 (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L (m[i][@mas500] = 0 \vee m[i][@mas500] = 1))$}

pred rangoCh4 (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L (m[i][@ch4] = 1 \vee m[i][@ch4] = 2))$}

pred rangoNivelEd (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L (m[i][@nivelEd] = 0 \vee m[i][@nivelEd] = 1))$}

pred rangoEstado (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L -1 \leq m[i][@estado] \leq 1)$}

pred rangoCatOcup (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L 0 \leq m[i][@catOcup] \leq 4)$}

pred rangoPp04g (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {$(\forall i : \mathbb{Z})(rangoMatriz(m, i) \longrightarrow_L 1 \leq m[i][@pp04g] \leq 10)$}

pred iv2MayorOIgualIi2 (th : eph_h) {
$(\forall i : \mathbb{Z})(rangoMatriz(th, i) \longrightarrow_L th[i][@ii2] \leq th[i][@iv2])$
}

Ejercicio 2. *:*

proc histHabitacional (in th: eph_h, in ti:eph_i,in region :$\mathbb{Z}$, out res:$seq\langle\mathbb{Z}\rangle$) {

Pre $\{encuestaVálida(th, ti) \land 1 \leq region \leq 6\}$

Post $\{esMaximo(res, th) \land (\forall i : \mathbb{Z})(rango(res, i) \longrightarrow_L res[i] = casasConiHab(th, i, region))\}$

}

pred casaConMasHabs (th:$seq\langle\mathbb{Z}\rangle$) $\{(\exists i : \mathbb{Z})(\forall j : \mathbb{Z})(rango(th, i) \land (th[i][@iv2] > th[j][@iv2])) \longrightarrow_L th[i][@iv2]\}$

aux CasasConiHabEnRegion (th : $seq\langle seq\langle\mathbb{Z}\rangle\rangle$, i : $\mathbb{Z}$, region : $\mathbb{Z}$) : $\mathbb{Z}$ =
$\sum_{i=0}^{|m|-1}$if $(th[i][@iv1] = 1 \land th[i][@iv2] = i \land th[i][@region] = region)$ then 1 else 0 fi ;

pred esMaximo (res : $seq\langle\mathbb{Z}\rangle$, th : eph_h){
$(\forall j : \mathbb{Z})(0 \leq j < |th| \longrightarrow_L th[j][@iv2] \leq |res|) \land (\exists i : \mathbb{Z})(rangoMatriz(th, i) \land_L |res| = th[i][@iv2])\}$

Ejercicio 3. *:*

proc laCasaEstaQuedandoChica (in th:eph_h,in ti:eph_i,out res:$seq\langle\mathbb{R}\rangle$) {

Pre $\{encuestaVálida(th, ti)\}$

Post $\{rangoRegion(th[@region]) \land |res| = 6 \land$
$res =< \frac{CasasPorRegionesConHacinamiento(th,1)}{CasasPorRegiones(th,1)}, \frac{CasasPorRegionesConHacinamiento(th,2)}{CasasPorRegiones(th,2)},$
$\frac{CasasPorRegionesConHacinamiento(th,3)}{CasasPorRegiones(th,3)}, \frac{CasasPorRegionesConHacinamiento(th,4)}{CasasPorRegiones(th,4)},$
$\frac{CasasPorRegionesConHacinamiento(th,5)}{CasasPorRegiones(th,5)}, \frac{CasasPorRegionesConHacinamiento(th,6)}{CasasPorRegiones(th,6)} >\}$

}

aux CasasPorRegiones (m: $seq\langle seq\langle\mathbb{Z}\rangle\rangle$,n:$\mathbb{Z}$) : $\mathbb{Z}$ =
$\sum_{i=0}^{|m|-1}$ if $(m[i][@region] = n \land m[i][@mas500] = 0 \land m[i][@iv1] = 1)$ then 1 else 0 fi ;

aux CasasPorRegionesConHacinamiento (m: $seq\langle seq\langle\mathbb{Z}\rangle\rangle$,n:$\mathbb{Z}$) : $\mathbb{Z}$ =
$\sum_{i=0}^{|m|-1}$ if $(m[i][@region] = n \land m[i][@mas500] = 0 \land m[i][@iv1] = 1 \land \frac{habitantesDeUnaCasa(th[i],ti)}{m[i][@iv2]} \geq 3)$ then 1 else 0 fi ;

Ejercicio 4. *:*

proc creceElTeleworkingEnCiudadesGrandes (in t1h:eph_h,in t1i:eph_i,in t2h:eph_h,in t2i:eph_i,out res:Bool) {

Pre $\{encuestaVálida(th1, ti1) \land encuestaVálida(th2, ti2) \land (t1h[0][@hogaño] > t2h[0][@hogaño] \land$
$t1h[0][@hogtrimestre] = t2h[0][@indtrimestre])\}$

Post $\{res = \text{true} \leftrightarrow (\frac{cantTeleworkingEnCiudades(t1h,t1i)}{poblacionTrabajandoEnCiudades(t1h,t1i)} < \frac{cantTeleworkingEnCiudades(t2h,t2i)}{poblacionTrabajandoEnCiudades(t2h,t2i)})\}$

}

pred teleworkingEnCiudades (th_i : $seq\langle\mathbb{Z}\rangle$){
$th_i[@ii3] = 1) \land (th_i[@mas500] = 1 \land (th_i[@iv1] = 1 \lor th_i[@iv1] = 2))$
}

aux cantTeleworkingEnCiudades (th , ti : $seq\langle seq\langle\mathbb{Z}\rangle\rangle$) : $\mathbb{Z}$ =
$\sum_{i=0}^{|th|-1}$if $teleworkingEnCiudades(th[i])$ then
$\sum_{j=0}^{|th|-1}$if $ti[j][@indcodusu] = th[i][@hogcodusu] \land t[j][@pp04g] = 6$ then 1 else 0 fi
else 0 fi

;

aux poblacionTrabajandoEnCiudades (th,ti : $seq\langle seq\langle\mathbb{Z}\rangle\rangle$) : $\mathbb{Z}$ =
$\sum_{i=0}^{|m|-1}$if $(ti[i][@estado] = 1)$ then
$\sum_{j=0}^{|th|-1}$if $ti[i][@indcodusu] = th[j][@hogcodusu] \land th[j][@mas500] = 1$ then 1 else 0 fi
else 0 fi

;

Ejercicio 5. *:*

`proc costoSubsidioMejora` (in th:eph_h, in ti:eph_i,in monto:$\mathbb{Z}$, out res:$\mathbb{Z}$) {

`Pre` $\{encuestaVálida(th, ti) \land monto \geq 0\}$
`Post` $\{res = hogaresSubsidiables(th) \times monto\}$
}

`aux hogaresSubsidiables` (th,ti:eph_h) : $\mathbb{Z}$ =
$\sum_{i=0}^{|th|-1}$if $th[i][@ii7] = 1 \land th[i][@ii2] < (habitantesDeUnaCasa(th[i]) - 2)$ then 1 else 0 fi ;

`aux habitantesDeUnaCasa` ($\text{th}_i : seq\langle\mathbb{Z}\rangle, ti :\text{eph}_i$) : $\mathbb{Z}$ = $\sum_{j=0}^{|ti|-1}$if $th_i[@hogcodusu] = ti_j[@indcodusu]$ then 1 else 0 fi ;

Ejercicio 6. *:*

`proc generarJoin` (in th : eph_h, in ti : eph_i, out junta : joinHI) {

`Pre` $\{encuestaValida(th, ti)\}$
`Post` $\{|ti| = |junta| \land_L 2 - uplaValida(junta, th, ti)\}$
}

`pred 2-uplaValida` (junta : joinHI, th : eph_h, ti : eph_i) {
$(\forall i : \mathbb{Z})(rangoMatriz(th, i) \longrightarrow_L coincidenEnCodusu(ti, th[i], junta)) \land$
$(\forall i : \mathbb{Z})(0 \leq i < |junta| \longrightarrow_L (estanEnTh(junta[i]_0, th) \land estanEnTi(junta[i]_1, ti))) \land$
$todosIndividuosEnJunta(junta, ti)\}$

`pred coincidenEnCodusu` (ti : eph_i, th_i : $seq\langle\mathbb{Z}\rangle$, junta : joinHI) {
$(\exists j : \mathbb{Z})(rangoMatriz(ti, j) \land \text{th}_i[@\text{hogcodusu}]=\text{ti[j][@indcodusu}] \land$
$ti[j][@indcodusu] = junta[j]_1[@indcodusu] = junta[j]_0[@hogcodusu])\}$

`pred todosIndividuosEnJunta` (junta : joinHI, ti : eph_i) {
$(\forall r : \mathbb{Z})(rangoMatriz(ti, r) \longrightarrow_L ti[r] = junta[r]_1)\}$

Ejercicio 7. *:*

`proc ordenarRegionYTipo` (inout th : eph_h, inuot ti : eph_i) {

`Pre` $\{encuestaValida(th, ti) \land th = TH_0 \land ti = TI_0\}$
`Post` $\{|th| = |TH_0| \land |ti| = |TI_0| \land estaOrdenadoTh(th) \land estaOrdenadoTi(th, ti)\}$
}

`pred estaOrdenaroTh` (th : eph_h) {
$regionesOrdenadas(th) \land codusuOrdenadoEnRegion(th)\}$

`pred regionesOredenadas` (th : eph_h) {
$(\forall i, j : \mathbb{Z})((rangoMatriz(th, i) \land rangoMatriz(th, j) \land i < j) \longrightarrow_L th[i][@region] \leq th[j][@region])\}$

`pred codusuOrdenadoEnRegion` (th : eph_h) {
$(\forall k, r : \mathbb{Z})(((rangoMatriz(th, k) \land rangoMatriz(th, r) \land k < r) \land_L th[k][@region] = th[r][@region]) \longrightarrow_L$
$th[k][@hogcodusu] \leq th[r][@hogcodusu])\}$

`pred estaOrdenaroTi` (th:eph_i;ti:eph_i) $\{componenteEnHogarOrdenado(th, ti) \land coponenteOrdenadoPorHogar(th, ti)\}$

`pred componenteEnHogarOrdenado` (th:eph_i,ti:eph_i) {
$(\forall i, j : \mathbb{Z})((rangoMatriz(ti, i) \land rangoMatriz(ti, j) \land_L (ti[i][@indcodusu] = ti[j][@indcodusu]) \land i < j) \longrightarrow_L$
$ti[i][@componente] < ti[j][@componente])\}$

`pred componeteOrdenadoPorHogar` (th:eph_i,ti:eph_i) {
$(\forall i, j, k, r : \mathbb{Z})((rangoMatriz(ti, i) \land rangoMatriz(ti, j) \land rangoMatriz(th, k) \land rangoMatriz(th, r) \land_L$
$ti[i][@indcodusu] = th[k][@hogcodusu] \land_L ti[j][@indcodusu] = th[r][@hogcodusu] \land_L th[k][@hogcodusu] \neq th[r][@hogcodusu] \land$
$k < r) \longrightarrow_L i < j)\}$

Ejercicio 8. *:*

proc muestraHomogenea (in th : eph_h, in ti : eph_i, out res : $seq\langle hogar\rangle$) {

Pre $\{encuestaValida(th, ti)\}$

Post $\{(\exists s : seq\langle seq\langle\mathbb{Z}\rangle\rangle)((esLaMasLargaPosible(s, ti, th) \land |s| \geq 3) \longrightarrow_L esLaMasLargaPosible(res)) \lor$
$(\neg(\exists s : seq\langle seq\langle\mathbb{Z}\rangle\rangle)(esLaMasLargaPosible(s, ti, th) \land |s| \geq 3) \longrightarrow_L |res| = 0\}$

}

aux ingresosDeUnHogar (th[i]:$seq\langle\mathbb{Z}\rangle$,ti:$eph_i$) : $\mathbb{Z}$ =
$\sum_{j=0}^{|ti|-1}$if $th[i][@hogcodusu] = ti[j][@indcodusu]$ then $ti[j][@p47t]$ else 0 fi ;

pred diferenciaDeIngresosDeHogaresIgualesConsecutivos (res : $seq\langle hogar\rangle$, ti : eph_i) {
$(\forall i, j : \mathbb{Z})((0 \leq i < |res| - 2 \longrightarrow_L (ingresosDeUnHogar(res[i + 1], ti) - ingresosDeUnHogar(res[i], ti)) =$
$(ingresosDeUnHogar(res[i + 2], ti) - ingresosDeUnHogar(res[i + 1], ti)))\}$

pred estanEnTh (in res : $seq\langle hogar\rangle$, in th : eph_h) {
$(\forall i : \mathbb{Z})(rangoMatriz(res, i) \longrightarrow_L (\exists j : \mathbb{Z})(rangoMatriz(th, j) \land_L res[i] = th[j]))\}$

pred esLaMasLargaPosible (in res : $seq\langle hogar\rangle$,in ti:eph_i,in th:eph_h) {
$estanEnTh(res, th) \land diferenciaDeIngresosDeHogaresIgualesConsecutivos(res, ti) \land ingresosDeHogaresOrdenados(res))$
$\longrightarrow_L \neg(\exists m : seq\langle hogar\rangle)(estanEnTh(m, th) \land diferenciaDeIngresosDeHogaresIgualesConsecutivos(m, ti)) \land$
$ingresosDeHogaresOrdenados(m) \land |res| < |m|)\}$

pred ingresosDeHogaresOrdenados (in res : $seq\langle hogar\rangle$) {
$(\forall i : \mathbb{Z})(0 \leq i < |res| - 1 \longrightarrow_L res[i][@p47t] \leq res[i + 1][@p47t])\}$

Ejercicio 9. *:*

proc corregirRegion (inuot th : eph_h, in ti : eph_i) {

Pre $\{encuestaValida(th, ti) \land th = TH_0\}$

Post $\{|th| = |TH_0| \land cambiarRegion(th, TH_0) \land loDemasIgual(th, TH_0)\}$

}

pred cambiarRegion (in th,TH_0 :eph_h) {
$(\forall i : \mathbb{Z})((rangoMatriz(th, i) \land_L TH_0[i][@region] = 1) \longrightarrow_L th[i][@region] = 5) \land$
$(\forall j : \mathbb{Z})((rangoMatriz(th, j) \land_L TH_0[j][@region] \neq 1) \longrightarrow_L th[j][@region] = TH_0[j][@region])\}$

pred loDemasIgual (in th,TH_0 :eph_h) {
$(\forall i, j : \mathbb{Z})((rangoMatriz(th, i) \land 0 \leq j \leq cantItemHogar \land j \neq @region) \longrightarrow_L th[i][j] = TH_0[i][j]\}$

Ejercicio 10. *:*

proc histogramaDeAnillosConcentricos (in th : eph_h, in centro : $\mathbb{Z}\times\mathbb{Z}$, in $distancias$: $seq\langle\mathbb{Z}\rangle$, out $result$: $seq\langle\mathbb{Z}\rangle$){

Pre $\{|distancias| > 0 \land distanciasNoNulasYCrecientes(distancias)\}$

Post $\{|distancias| = |result| \land listacantCasasEnAnillos(th, distancias, centro, result)\}$

}

aux distanciaAlPuntoCentral (centro:$\mathbb{Z}\times\mathbb{Z}$, $casa : hogar$) : $\mathbb{R}$ =
$\sqrt[2]{(casa[@latitud] - centro_0)^2 + (casa[@longitud] - centro_1)^2}$;

aux cantCasasEnAnillo (in th : eph_h, in distancias$_i$: $\mathbb{Z}$, in $distancias_{i+1}$: $\mathbb{Z}$, in $centro$: $\mathbb{Z} \times \mathbb{Z}$) : $\mathbb{Z}$ =
$\sum_{j=0}^{|th|-1}$(if $distancias_i \leq distanciaAlPuntoCentral(centro, th[j]) \leq distancias_{i+1}$ then 1 else 0 fi) ;

pred distaciasNoNulasYCreciente (in distancia : $seq\langle\mathbb{Z}\rangle$) {
$(\forall i : \mathbb{Z})(0 \leq i < |distancias| - 1 \longrightarrow_L (distancia[i] \neq 0 \land distancia[i + 1] \neq 0 \land disctancia[i] < distancia[i + 1]))\}$

pred listacantCasasEnAnillos (in th : eph_h, in distancias:$seq\langle\mathbb{Z}\rangle$, in centro : $\mathbb{Z}\times\mathbb{Z}$, in $result$: $seq\langle\mathbb{Z}\rangle$){
$result[0] = cantCasasEnAnillo(th, 0, distancias[0], centro) \land$
$(\forall i : \mathbb{Z})((1 \leq i < |result|) \longrightarrow_L (result[i] = cantCasasEnAnillo(th, distancias[i - 1], distancias[i], centro)))\}$

Ejercicio 11. *:*

proc quitarIndividuos (inout th :eph_h, inout ti :eph_i, in busqueda : $seq\langle(ItemItemIndividuo, dato)\rangle$, out result : ($eph_h$,$eph_i$))

{

Pre $\{encuestaValida(th, ti) \land th = TH_0 \land ti = TI_0 \land busquedaValida(busqueda)\}$

Post $\{quitarEnThyTi(ti, TI_0, th, TH_0, busqueda) \land loBuscado(ti, TI_0, th, TH_0, busqueda) \land encuestaValidaHomeless(th, ti)\}$

}

pred busquedaValida (in busqueda : $seq\langle(ItemIndividuo, dato)\rangle$, in ti : eph_i) {
$itemsValidos(busqueda) \land sinRepetidos(busqueda) \land valorEnRango(busqueda_0, busqueda_1, ti)\}$

pred itemsValidos (in busqueda : $seq\langle(ItemIndividuo, dato)\rangle$) {
$(\forall i : \mathbb{Z})(rango(busqueda, i) \longrightarrow_L 0 \leq busqueda[i]_0 \leq cantItemInd)\}$

pred sinRepetidos (in busqueda : $seq\langle(ItemIndividuo, dato)\rangle$) {
$(\forall i, j : \mathbb{Z})((rango(busqueda, i) \land rango(busqueda, j) \land i \neq j) \longrightarrow_L busqueda[i]_0 \neq busqueda[j]_0\}$

pred valorEnRango (in item : $\mathbb{Z}$, in dato : $\mathbb{Z}$, in ti : eph_h) {
$(\forall j : \mathbb{Z})((rango(busqueda, j) \longrightarrow_L ((busqueda[j]_0 = @indcodusu \longrightarrow_L 0 \leq busqueda[j]_1) \land_L$
$(busqueda[j]_0 = @componente \longrightarrow_L 0 \leq busqueda[j]_1 \leq 20) \land_L$
$(busqueda[j]_0 = @ch6 \longrightarrow_L 0 \leq busqueda[j]_1) \land_L$
$(busqueda[j]_0 = @p47t \longrightarrow_L -1 \leq busqueda[j]_1) \land_L$
$(busqueda[j]_0 = @ch4 \longrightarrow_L 1 \leq busqueda[j]_1 \leq 2) \land_L$
$(busqueda[j]_0 = @nivelEd \longrightarrow_L 0 \leq busqueda[j]_1 \leq 1) \land_L$
$(busqueda[j]_0 = @estado \longrightarrow_L -1 \leq busqueda[j]_1 \leq 1) \land_L$
$(busqueda[j]_0 = @catOcup \longrightarrow_L 0 \leq busqueda[j]_1 \leq 4) \land_L$
$(busqueda[j]_0 = @pp04g \longrightarrow_L 1 \leq busqueda[j]_1 \leq 10)))\}$

pred quitarEnThyTi (in ti :eph_i,in TI_0 :eph_i,in th :eph_h,in TH_0 :eph_h,in busqueda : $seq\langle(ItemItemIndividuo, dato)\rangle$)
$\{(\forall i, j, k : \mathbb{Z})((rangoMatriz(ti, i) \land rango(busqueda, j) \land rangoMatriz(th, k) \land_L TI_0[i][busqueda[j]_0] = busqueda[j]_1 \land_L$
$(TI_0[i][@indcodusu] = TH_0[k][@hogcodusu])) \longrightarrow_L$
$(noEsta(TI_0[i], ti) \land noEstaEnTh(TH_0[k], th))) \land loDemasIgual(ti, TI_0, th, TH_0, busqueda)\}$

pred loDemasIgual (in ti :eph_i,in TI_0 :eph_i,in th :eph_h,in TH_0 :eph_h,in busqueda : $seq\langle(ItemItemIndividuo, dato)\rangle$)
$\{(\forall i, j, k : \mathbb{Z})(rangoMatriz(ti, i) \land rango(busqueda, j) \land rangoMatriz(th, k) \land_L TI_0[i][busqueda[j]_0] \neq busqueda[j]_1$
$\land_L (TI_0[i][@indcodusu] = TH_0[k][@hogcodusu]) \longrightarrow_L (estaEnTi(TI_0[i], ti) \land estaEnTh(TH_0[k], th)))\}$

pred estanEnTi (in TI_{0i} : $seq\langle hogar\rangle, inth$:eph_h) {
$(\forall i : \mathbb{Z})(rangoMatriz(TI_{0i}, i) \longrightarrow_L (\exists j : \mathbb{Z})(rangoMatriz(ti, j) \land_L TI_{0i}[i] = ti[j]))\}$

pred estaEnTi (in TI_{0i} : $individuo, inti$:eph_i) {
$(\exists j : \mathbb{Z})(rangoMatriz(ti, j) \land_L TI_{0i} = ti[j]))\}$

pred estaEnTh (in TI_{0i} : $hogar, inth$:eph_h) {
$(\exists j : \mathbb{Z})(rangoMatriz(ti, j) \land_L TH_{0i} = th[j]))\}$

pred noEstaTi (in $TI_0[i]$: $seq\langle\mathbb{Z}\rangle, inti$:eph_i) $\{(\forall j : \mathbb{Z})(rangoMatriz(ti.j) \longrightarrow_L TI_0[i] \neq ti[j])\}$

pred noEstaTh (in $TH_0[k]$: $seq\langle\mathbb{Z}\rangle, inth$:eph_h) $\{(\forall j : \mathbb{Z})(rangoMatriz(th.j) \longrightarrow_L TH_0[k] \neq th[j])\}$

pred loBuscado (in ti :eph_i,in TI_0 :eph_i,in th :eph_h,in TH_0 :eph_h,in busqueda : $seq\langle(ItemItemIndividuo, dato)\rangle$,out result:($eph_h$,$eph_i$)) {
$(\forall i, j, k : \mathbb{Z})((rangoMatriz(ti, i) \land rango(busqueda, j) \land rangoMatriz(th, k) \land_L TI_0[i][ItemIndividuo] = busqueda[j]_0 \land_L$
$(TI_0[i][@indcodusu] = TH_0[k][@hogcodusu])) \longrightarrow_L (estaenRes1(TI_0[i], ti) \land estaEnRes0(TH_0[k], th)))\}$

pred estaEnRes1 (in $TI_0[i]$: $seq\langle\mathbb{Z}\rangle, outresult$: (eph_h,eph_i)) $\{(\exists j : \mathbb{Z})(rangoMatriz(result.j) \longrightarrow_L TI_0[i] = result_1[j])\}$

pred estaEnRes0 (in $TH_0[k]$: $seq\langle\mathbb{Z}\rangle, outresult$: (eph_h,eph_i)) $\{(\exists j : \mathbb{Z})(rangoMatriz(result.j) \longrightarrow_L TH_0[k] = result_0[j])\}$

pred encuestaVálidaHomeless (th : eph_h,ti : eph_i) {
$esMatriz(th) \wedge esMatriz(ti) \wedge |th| \geq 1 \wedge |ti| \geq 1 \wedge |th| = |variablesHogar| \wedge |ti| = |variblesIndividuo| \wedge$
$sinRepetidosEnIndividuos(ti) \wedge sinRepetidosEnHogares(th) \wedge hogaresAsociadosIndividuosConHomeless(th, ti) \wedge$
$mismoAñoyTrimestre(th, ti) \wedge iv2MayorOIgualIi2(th) \wedge rangosValidos(th, ti)$
}

pred hogaresAsociadosIndividuosConHomeless (th : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, ti : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$) {
$(\forall i : \mathbb{Z})(\exists j : \mathbb{Z})(rangoMatriz(th, i) \longrightarrow_L th[i][@hogcodusu] = ti[j][@indcodusu])$
}

3. Auxiliares

pred apariciones (m : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, s : $seq\langle \mathbb{Z}\rangle$) {$\sum_{k=0}^{|m-1|}$ if $m[k] = s$ then 1 else 0 fi}
pred rango (s:$seq\langle \mathbb{Z}\rangle$,i:$\mathbb{Z}$) {$0 \leq i < |s|$}
pred rangoMatriz (s : $seq\langle seq\langle \mathbb{Z}\rangle\rangle$, i : $\mathbb{Z}$) {$0 \leq i < |s|$}
aux @hogcodusu : $\mathbb{Z} = ord(HOGCODUSU)$;
aux @hogaño : $\mathbb{Z} = ord(HOGAÑO)$;
aux @hogtrimestre : $\mathbb{Z} = ord(HOGTRIMESTRE)$;
aux @hoglongitud : $\mathbb{Z} = ord(HOGLONGITUD)$;
aux @hoglatitud : $\mathbb{Z} = ord(HOGLATITUD)$;
aux @ii7 : $\mathbb{Z} = ord(II7)$;
aux @region : $\mathbb{Z} = ord(REGION)$;
aux @mas500 : $\mathbb{Z} = ord(MAS\_500)$;
aux @iv1 : $\mathbb{Z} = ord(IV1)$;
aux @iv2 : $\mathbb{Z} = ord(IV2)$;
aux @ii2 : $\mathbb{Z} = ord(II2)$;
aux @ii3 : $\mathbb{Z} = ord(II3)$;
aux @indcodusu : $\mathbb{Z} = ord(INDCODUSU)$;
aux @componente : $\mathbb{Z} = ord(COMPONENTE)$;
aux @indaño : $\mathbb{Z} = ord(INDAÑO)$;
aux @indtrimestre : $\mathbb{Z} = ord(INDTRIMESTRE)$;
aux @ch4 : $\mathbb{Z} = ord(CH4)$;
aux @ch6 : $\mathbb{Z} = ord(CH6)$;
aux @nivelEd : $\mathbb{Z} = ord(NIVEL\_ED)$;
aux @estado : $\mathbb{Z} = ord(ESTADO)$;
aux @catOcup : $\mathbb{Z} = ord(CAT\_OCUP)$;
aux @p47t : $\mathbb{Z} = ord(P47T)$;
aux @pp04g : $\mathbb{Z} = ord(PP04G)$;