Ejercicio 5. Para las siguientes especificaciones:

- Poner nombre al problema que resuelven
- Escribir un programa S sencillo en SmallLang, sin ciclos, que lo resuelva
- Dar la precondición más débil del programa escrito con respecto a la postcondición de su especificación

a) `proc problema1` (in s: $seq\langle\mathbb{Z}\rangle$, in i: $\mathbb{Z}$, inout a: $\mathbb{Z}$)

`requiere` $\{0 \leq i < |s| \ \land_L \ a = \sum_{j=0}^{i-1} s[j]\}$

`asegura` $\{a = \sum_{j=0}^{i} s[j]\}$

b) `proc problema2` (in s: $seq\langle\mathbb{Z}\rangle$, in i: $\mathbb{Z}$) : Bool

`requiere` $\{0 \leq i < |s| \ \land_L \ (\forall j : \mathbb{Z})(0 \leq j < i \rightarrow_L s[j] \geq 0)\}$

`asegura` $\{res = true \leftrightarrow (\forall j : \mathbb{Z})(0 \leq j \leq i \rightarrow_L s[j] \geq 0)\}$

c) `proc problema3` (inout s: $seq\langle\mathbb{Z}\rangle$, in i: $\mathbb{Z}$)

`requiere` $\{(0 \leq i < |s|) \land_L (\forall j : \mathbb{Z})(0 \leq j < i \rightarrow s[j] = fibonacci(j))\}$

`asegura` $\{(\forall j : \mathbb{Z})(0 \leq j \leq i \rightarrow s[j] = fibonacci(j))\}$

Ejercicio 6. Dado el siguiente código y postcondición

```
if (i mod 3 = 0)
    s[i] := s[i] + 6
else
    s[i] := i
endif
```

$Q \equiv \{(\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L s[j] \ mod \ 2 = 0)\}$

Mostrar que las siguientes WPs son incorrectas, dando un contraejemplo de ser posible

a) $P \equiv \{0 \leq i \leq |s| \land_L i \ mod \ 3 = 0 \land (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L s[j] \ mod \ 2 = 0)\}$

b) $P \equiv \{0 \leq i < |s| \land_L i \ mod \ 3 \neq 0 \land (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L s[j] \ mod \ 2 = 0)\}$

c) $P \equiv \{0 \leq i < |s| \land_L (i \ mod \ 3 = 0 \lor i \ mod \ 2 = 0) \land (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L s[j] \ mod \ 2 = 0)\}$ (*)

d) $P \equiv \{i \ mod \ 3 = 0 \land_L (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L s[j] \ mod \ 2 = 0)\}$

e) $P \equiv \{0 \leq i < |s|/2 \land_L i \ mod \ 3 = 0 \land (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L s[j] \ mod \ 2 = 0)\}$

(*) Para este inciso no se puede dar un contraejemplo, aunque es una WP incorrecta. Explicar por qué.

Precondición más débil en SmallLang

Ejercicio 1. Calcular las siguientes expresiones, donde a, b son variables reales, i una variable entera y A es una secuencia de reales.

a) $\text{def}(a+1)$.

b) $\text{def}(a/b)$.

c) $\text{def}(\sqrt{a/b})$.

d) $\text{def}(A[i]+1)$.

e) $\text{def}(A[i+2])$.

f) $\text{def}(0 \leq i \leq |A| \wedge_L A[i] \geq 0)$.

a) $\text{def}(a+1) \equiv \text{def}(a) \wedge \text{def}(1) = \text{True}$

b) $\text{def}(a/b) \equiv (b \neq 0)$

c) $\text{def}(\sqrt{a/b}) \equiv (\frac{a}{b} > 0 \wedge b \neq 0) \equiv (a > 0 \wedge b \neq 0)$

d) $\text{def}(A[i]+1) \equiv (0 \leq i < |A|)$

e) $\text{def}(A[i+2]) \equiv 0 \leq i+2 < |A| \equiv (-2 \leq i < |A|-2)$

f) $\text{def}(0 \leq i \leq |A| \wedge_L A[i] \geq 0) \equiv \text{def}(0 \leq i \leq |A|) \wedge \text{def}(A[i] \geq 0)$

$0 \leq i \leq |A| \wedge 0 \leq i < |A|$

$0 \leq i < |A|$

Ejercicio 2. Calcular las siguientes precondiciones más débiles, donde a, b son variables reales, i una variable entera y A es una secuencia de reales.

a) $wp(\mathbf{a := a+1;\ b := a/2}, b \geq 0)$.

b) $wp(\mathbf{a := A[i] + 1;\ b := a*a}, b \neq 2)$.

$wp := (E, P) = \text{def}(E) \wedge P^b_E$

a) $wp(a := a+1;\ b := \frac{a}{2},\ b \geq 0)$

$wp(a := a+1;\ wp(b := \frac{a}{2},\ b \geq 0))$

$wp(a := a+1,\ a \geq 0)$

$\text{def}(a+1) \wedge (a+1 \geq 0)$

$\text{True} \wedge a \geq -1 \equiv (a \geq -1)$

e. AUX

$wp(b := \frac{a}{2},\ b \geq 0)$

$\text{def}(\frac{a}{2}) \wedge \frac{a}{2} \geq 0$

$\text{True} \wedge a \geq 0$

$a \geq 0$

b) $wp(a := A[i] + 1;\ b := a.a,\ b \neq 2)$

$wp(a := A[i]+1;\ wp(b := a.a,\ b \neq 2))$

$wp(a := A[i]+1;\ a.a \neq 2$

$\text{def}(A[i]+1) \wedge (A[i]+1).(A[i]+1) \neq 2$

$0 \leq i < |A| \wedge (A[i]+1) \neq \sqrt{2}$

$0 \leq i < |A| \wedge A[i] \neq \sqrt{2} - 1$

c. AUX

$wp(b := a.a,\ b \neq 2)$

$\text{def}(a.a) \wedge a.a \neq 2$

$\text{True} \wedge a.a \neq 2$

c) $wp(\mathbf{a := A[i] + 1; a := b*b}, a \geq 0)$.

d) $wp(\mathbf{a := a\text{-}b; b := a+b}, a \geq 0 \wedge b \geq 0)$.

c) $wp(a := A[i] + 1 \; ; \; a := b \cdot b \, , \, a \geqslant 0)$

$wp(a := b^2 , a \geqslant 0)$

$\mathrm{def}(b^2) \wedge b^2 \geqslant 0$
$\mathrm{True} \wedge b \geqslant 0$

$wp(a := A[i] + 1 \; ; \; wp(a := b^2 , a \geqslant 0))$

$wp(a := A[i] + 1 \; ; \; b \geqslant 0)$

$\mathrm{def}(A[i] + 1) \wedge A[i] + 1 \geqslant 0$
$0 \leqslant i < |A| \wedge A[i] \geqslant -1$

d) $wp(a := a - b \; ; \; b := a + b \, , \, a \geqslant 0 \wedge b \geqslant 0)$

$wp(a := a - b \; ; \; wp(b := a + b \, , \, a \geqslant 0 \wedge b \geqslant 0))$

$\mathrm{def}(a - b) \wedge a - b \geqslant 0 \wedge a - b \geqslant -b$
$\mathrm{True} \wedge a \geqslant b \wedge a \geqslant 0$

$(a \geqslant b \wedge a \geqslant 0) \longrightarrow$ comparar resultados.

$wp(b := a + b \, , \, a \geqslant 0 \wedge b \geqslant 0)$

$\mathrm{def}(a + b) \wedge (a \geqslant 0 \wedge a + b \geqslant 0)$

$\mathrm{True} \wedge a \geqslant 0 \wedge a \geqslant -b$

Ejercicio 3. Sea $Q \equiv (\forall j : \mathbb{Z})(0 \leq j < |A| \rightarrow_L A[j] \geq 0)$. Calcular las siguientes precondiciones más débiles, donde i es una variable entera y A es una secuencia de enteros.

a) $wp(\mathbf{A[i] := 0}, Q)$.

b) $wp(\mathbf{A[i+2] := \text{-}1}, Q)$.

c) $wp(\mathbf{A[i] := A[i\text{-}1]}, Q)$. (en clase)

$wp(b[i] := E \, , Q)$

$wp(\mathrm{setAt}(b, i, E) \, , \, Q^{b}_{\mathrm{setAt}(b,i,E)})$

$\mathrm{setAt}(b, i, E) \begin{cases} E & \text{si } i = j \\ b[j] & \text{si } i \neq j \end{cases}$

a) $wp(A[i] := 0 \, , \, Q)$

$\mathrm{def}(\mathrm{setAt}(A, i, 0)) \wedge Q^{A[i]}_{\mathrm{setAt}(A,i,0)}$

$\mathrm{def}(A) \wedge \mathrm{def}(i) \wedge \mathrm{def}(0) \wedge Q^{A}_{\mathrm{setAt}(A,i,0)}$

$\mathrm{True} \wedge \mathrm{True} \wedge \mathrm{True} \wedge Q^{A}_{\mathrm{setAt}(A,i,0)}$

$(\forall j : \mathbb{Z})(0 \leqslant j < |A| \rightarrow_L \mathrm{setAt}(A, i, 0)[j] \geqslant 0)$

$\rightarrow_L [(i \neq j \wedge A[j] \geqslant 0) \vee (i = j \wedge 0 \geqslant 0)]$

$(\forall j : \mathbb{Z})(0 \leqslant j < |A| \rightarrow_L (i \neq j \wedge A[j] \geqslant 0) \vee (i = j \wedge 0 \geqslant 0))$

b) $wp(A[i+2] := -1, Q)$

$wp(\text{setAt}(A, i+2, -1), Q)$

$\text{def}(\text{setAt}(A, i+2, -1)) \wedge Q^{A}_{\text{setAt}(A, i+2, -1)}$

$\text{def}(\text{setAt}(A, i+2, -1)) \equiv \text{def}(A) \wedge \text{def}(i+2) \wedge \text{def}(-1) \equiv \text{True}$

$Q^{A}_{\text{setAt}(A, i+2, -1)} \equiv (\forall j : \mathbb{Z})(0 \leq j < |A| \rightarrow_L \text{setAt}(A, i+2, -1)[j] \geq 0)$

$\rightarrow_L ((i+2 = j \wedge -1 \geq 0) \vee$

False porque no vale $-1 \geq 0$

el $i+2$ influye en algo más?

$(i+2 \neq j \wedge A[j] \geq 0))$

$(\forall j : \mathbb{Z})(0 \leq j < |A| \wedge i+2 \neq j \rightarrow_L A[j] \geq 0)$

Ejercicio 4. Para los siguientes pares de programas S y postcondiciones Q

- Escribir la precondición más débil $P = wp(S, Q)$
- Mostrar formalmente que la P elegida es correcta

a) $S \equiv$

```
if( a < 0 )
  b := a
else
  b := -a
endif
```

$Q \equiv (b = -|a|)$

c) $S \equiv$

```
if( i > 1 )
  s[i] := s[i-1]
else
  s[i] := 0
endif
```

$Q \equiv (\forall j : \mathbb{Z})(1 \leq j < |s| \rightarrow_L s[j] = s[j-1])$

$P = \{\text{True}\}$

$wp(S, Q) \equiv \text{def}(a < 0) \wedge_L ((a < 0 \wedge wp(b := a; b = -|a|)) \vee$

$(a \geq 0 \wedge wp(b := -a; b = -|a|)))$

$\text{True} \wedge_L ((a < 0 \wedge a = -a) \vee (a \geq 0 \wedge a = -a)$

$((a < 0 \wedge a = a) \vee (a \geq 0 \wedge a = -a)$

True

$wp(b := a; b = -|a|) = \text{def}(a) \wedge a = -|a|$

$(\text{True} \wedge a = -|a|) \equiv (a = -|a|) \equiv (a = -a)$

$wp(b := -a; b = -|a|) = \text{def}(-a) \wedge a = -|a| \equiv (a = -|a|) \equiv (a = -a)$

b) $S \equiv$

```
if( i > 0 )
  s[i] := 0
else
  s[0] := 0
endif
```

$Q \equiv (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L s[j] \geq 0)$

$$wp(s,Q) = \underbrace{def(i>0)}_{\text{True}} \wedge ((i>0 \wedge wp(s[i]:=0, Q)) \vee$$
$$i \leq 0 \wedge wp(s[0]:=0, Q)) \checkmark$$

sale de unificar $i>0$, $0 \leq i < |s|$ y $0<|s|$

$$\boxed{\begin{array}{l} 0<i<|s| \wedge [(\forall j:\mathbb{Z})(0 \leq j < |s| \rightarrow_L i \neq j \wedge s[j] \geq 0)) \vee \\ (i \leq 0 \quad (\forall j:\mathbb{Z})(0 \leq j < |s| \rightarrow_L (0 \neq j \wedge s[j] \geq 0))] \end{array}}$$

↳ sería el resultado final.

C. Aux:

$$wp(s[i]:=0, Q) \equiv wp(setAt(s,i,0), Q)$$

$$\equiv def(s) \wedge def(i) \wedge def(0) \wedge (0 \leq i < |s|) \wedge Q^{s}_{setAt(s,i,0)}$$

$$\equiv \text{True} \wedge \text{True} \wedge \text{True} \wedge (\forall j:\mathbb{Z})(0 \leq j < |s| \rightarrow_L setAt(s,i,0)[j] \geq 0)$$

$$\equiv 0 \leq i < |s| \wedge (\forall j:\mathbb{Z})(0 \leq j < |s| \rightarrow_L [\underbrace{(i=j \wedge 0 \geq 0)}_{\text{tautología}} \vee (i \neq j \wedge s[j] \geq 0)]$$

$$setAt(s,0,0) \begin{cases} 0 & 0=j \\ s[j] & 0 \neq j \end{cases}$$

$$wp(s[0]:=0, Q) \equiv wp(setAt(s,0,0), Q)$$

$$\equiv def(s) \wedge def(0) \wedge def(0) \wedge 0 < |s| \wedge Q^{s}_{setAt(s,0,0)}$$

$$\equiv 1 \quad 0<|s| \wedge (\forall j:\mathbb{Z})(0 \leq j < |s| \rightarrow_L (\underbrace{(0=j \wedge 0 \geq 0)}_{\substack{\text{tautología!} \\ \text{(puedo obviarlo)}}} \vee (0 \neq j \wedge s[j] \geq 0))$$

c) $S \equiv$

```
if ( i > 1 )
  s[i] := s[i-1]   } S1
else
  s[i] := 0        } S2
endif
```

$Q \equiv (\forall j : \mathbb{Z})(1 \leq j < |s| \rightarrow_L s[j] = s[j-1])$

$B = i > 1$

$wp(S, Q) = \underbrace{def(i>1)}_{True} \wedge ((i>1 \wedge wp(S_1,Q)) \vee (i \leq 1 \wedge wp(S_2, Q)))$

$\wedge ((i>1 \wedge wp(s[i] := s[i-1], Q) \vee (i \leq 1 \wedge wp(s[i] := 0, Q))$

$(i>1 \wedge wp(setAt(s, i, s[i-1]), Q) \vee (i \leq 1 \wedge wp(setAt(s, i, 0), Q)$

$[(1 < i < |s| \wedge (\forall j : \mathbb{Z})(1 \leq j < |s| \wedge i \neq j \rightarrow_L s[j] = s[j-1]) \vee$

$(0 \leq i < |s| \wedge (\forall j : \mathbb{Z})(1 \leq j < |s| \wedge i \neq j \rightarrow_L s[j] = s[j-1]))]$

C.Aux :

1.

$wp(setAt(s, i, s[i-1]), Q) \equiv def(s) \wedge def(i) \wedge def(s[i-1]) \wedge 0 \leq i < |s| \wedge Q^{s}_{setAt(s,i,s[i-1])}$.

$\equiv True \wedge true \wedge (1 \leq i < |s|) \wedge (\forall j : \mathbb{Z})(1 \leq j < |s| \rightarrow_L setAt(s,i,s[i-1])[j] = setAt(s,i,s[i-1])[j-1]$

tautología

$(1 \leq i < |s|) \wedge (\forall j : \mathbb{Z})(1 \leq j < |s| \rightarrow_L [\underbrace{(i = j \wedge s[i-1] = s[j-1])}_{True\ siempre} \vee (i \neq j \wedge s[j] = s[j-1])]$

$(1 \leq i < |s|) \wedge (\forall j : \mathbb{Z})(1 \leq j < |s| \wedge i \neq j \rightarrow_L s[j] = s[j-1]$

$i > 1 \wedge (1 \leq i < |s|) \equiv 1 < i < |s|$

2. ?

$(i \leq 1 \wedge wp(setAt(s, i, 0), Q)) \equiv (i \leq 1 \wedge def(s) \wedge def(i) \wedge def(0) \wedge 0 \leq i < |s| \wedge Q^{s}_{setAt(s,i,0)})$

$\equiv (i \leq 1) \wedge (0 \leq i < |s|) \wedge (\forall j : \mathbb{Z})(1 \leq j < |s| \rightarrow_L setAt(s,i,0)[j] = setAt(s,i,0)[j-1])$

$0 \leq i < |s| \wedge (\forall j : \mathbb{Z})(1 \leq j < |s| \rightarrow_L [\underbrace{(i = j \wedge 0 = 0)}_{tautología} \vee (i \neq j \wedge s[j] = s[j-1])]$

d) $S \equiv$

```
if( s[i] > 0 )
  s[i] := -s[i]   → S1
else
  skip            → S2
endif
```

$Q \equiv (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L s[j] \geq 0)$

¿Qué hace el código

Si el elemento de s (s[i]) es positivo, entonces a ese elemento se le asigna su opuesto aditivo (-s[i]). En el caso contrario, el código no hace nada.

Axioma setAt: $b[i] := E \equiv setAt(b, i, E)$

$def(setAt(b, i, E)) = def(E) \wedge def(b) \wedge def(i) \wedge_L 0 \leq i < |b|$

Dados $0 \leq i, j < |b|$: $setAt(b, i, E)[j] = \begin{cases} E & i = j \\ b[j] & i \neq j \end{cases}$

$wp(S, Q) \equiv def(s[i] > 0) \wedge_L ((s[i] > 0 \wedge wp(S_1, Q)) \vee (s[i] \leq 0 \wedge wp(S_2, Q))$

$\equiv (0 \leq i < |s|) \wedge_L ((s[i] > 0 \wedge wp(s[i] := -s[i], Q)) \vee (s[i] \leq 0 \wedge wp(skip, Q))$

$\equiv (0 \leq i < |s|) \wedge_L (s[i] > 0 \wedge wp(setAt(s, i, -s[i]), Q) \vee (s[i] \leq 0 \wedge wp(skip, Q))$

$\equiv (0 \leq i < |s|) \wedge_L (s[i] \leq 0 \wedge (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L s[j] \geq 0) \vee (s[i] > 0 \wedge wp(setAt(s, i, -s[i]), Q)$

$\equiv (0 \leq i < |s| \wedge_L [(s[i] \leq 0 \wedge (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L s[j] \geq 0) \vee$

$(s[i] > 0 \wedge 0 \leq i < |s| \wedge (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L (i = j \wedge s[j] \leq 0) \vee (i \neq j \wedge s[j] \geq 0))]$

C. AUX

$wp(setAt(s, i, -s[i]), Q) \equiv def(setAt(s, i, -s[i])) \wedge Q^{s}_{setAt(s, i, -s[i])}$

$\equiv def(s) \wedge def(i) \wedge def(-s[i]) \wedge 0 \leq i < |s| \wedge (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L setAt(s, i, -s[i])[j] \geq 0)$

$\equiv True \wedge True \wedge 0 \leq i < |s| \wedge (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L (i = j \wedge -s[j] \geq 0) \vee (i \neq j \wedge s[j] \geq 0))$

$\equiv 0 \leq i < |s| \wedge (\forall j : \mathbb{Z})(0 \leq j < |s| \rightarrow_L (i = j \wedge s[j] \leq 0) \vee (i \neq j \wedge s[j] \geq 0)$

Ejercicio 5. Para las siguientes especificaciones:

- Poner nombre al problema que resuelven
- Escribir un programa S sencillo en SmallLang, sin ciclos, que lo resuelva
- Dar la precondición más débil del programa escrito con respecto a la postcondición de su especificación

a) proc problema1 (in s: $seq\langle\mathbb{Z}\rangle$, in i: $\mathbb{Z}$, inout a: $\mathbb{Z}$) 'sumarElementos'

requiere $\{0 \leq i < |s| \ \wedge_L \ a = \sum_{j=0}^{i-1} s[j]\}$

asegura $\{a = \sum_{j=0}^{i} s[j]\}$

b) proc problema2 (in s: $seq\langle\mathbb{Z}\rangle$, in i: $\mathbb{Z}$) : Bool 'subsecuenciaDeElementosPositivos'

requiere $\{0 \leq i < |s| \ \wedge_L \ (\forall j : \mathbb{Z})(0 \leq j < i \rightarrow_L s[j] \geq 0)\}$

asegura $\{res = true \leftrightarrow (\forall j : \mathbb{Z})(0 \leq j \leq i \rightarrow_L s[j] \geq 0)\}$

c) proc problema3 (inout s: $seq\langle\mathbb{Z}\rangle$, in i: $\mathbb{Z}$) 'esSucesionDeFibonacci'

requiere $\{(0 \leq i < |s|) \wedge_L (\forall j : \mathbb{Z})(0 \leq j < i \rightarrow s[j] = fibonacci(j))\}$

asegura $\{(\forall j : \mathbb{Z})(0 \leq j \leq i \rightarrow s[j] = fibonacci(j))\}$

a) $S \equiv$

```
if i>0 :
    a = a + S[i]
else :
    a = S[0]
```

b) $S \equiv$

```
if i > 0 :
    S[i] = 0
else :
    S[0] = 0
```

c) $S \equiv$

```
if i>=0 :
    S[i] = fibonacci(i)
else:
    skip
```

$$Q = \{a = \sum_{j=0}^{i} s[j]\}$$

$$wp(s, a = \sum_{j=0}^{i} s[j]) = def(i>0) \wedge (i>0 \wedge wp(a := a+s[i] ; a = \sum_{j=0}^{i} s[j])) \vee$$

$$(i \leq 0 \wedge wp(a := s[0] ; a = \sum_{j=0}^{i} s[j]))$$

$$True \wedge (i>0 \wedge (a = \sum_{j=0}^{i-1} s[j])) \vee (i=0 \wedge s[0] = s[0])$$

$$wp(s, Q) \equiv (0 < i < |s| \wedge a = \sum_{j=0}^{i-1} s[j])$$

- $i>0$:

$$wp(s_1, Q) \equiv def(a + s[i]) \wedge a + s[i] = \sum_{j=0}^{i} s[j]$$

$$True \wedge a = \sum_{j=0}^{i} s[j] - s[i]$$

$$a = \sum_{j=0}^{i-1} s[j]$$

- $i \leq 0$ y además $0 \leq i < |s|$ (por el requiere) $\Rightarrow i = 0$

$$wp(s_2, Q) \equiv def(s[0]) \wedge s[0] = \sum_{j=0}^{0} s[j] = s[0]$$

Ejercicio 6. Dado el siguiente código y postcondición

```
if (i mod 3 = 0)        → si i es divisible por 3
    s[i] := s[i] + 6    → entonces a s[i] sumale 6
else
    s[i] := i           → si i no es divisible por 3, entonces asignale i a s[i]
endif
```

$Q \equiv \{(\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L s[j] \; mod \; 2 = 0)\}$

Mostrar que las siguientes WPs son incorrectas, dando un contraejemplo de ser posible

a) $P \equiv \{0 \le i \le |s| \wedge_L i \; mod \; 3 = 0 \wedge (\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L s[j] \; mod \; 2 = 0)\}$ → falta ver qué pasa para los $i \bmod 3 \neq 0$

b) $P \equiv \{0 \le i < |s| \wedge_L i \; mod \; 3 \neq 0 \wedge (\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L s[j] \; mod \; 2 = 0)\}$ → falta ver qué pasa para los $i \bmod 3 = 0$

c) $P \equiv \{0 \le i < |s| \wedge_L (i \; mod \; 3 = 0 \vee i \; mod \; 2 = 0) \wedge (\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L s[j] \; mod \; 2 = 0)\}$ (*) → Porque no es la más débil?

d) $P \equiv \{i \; mod \; 3 = 0 \wedge_L (\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L s[j] \; mod \; 2 = 0)\}$ → no se acota el rango de i

e) $P \equiv \{0 \le i < |s|/2 \wedge_L i \; mod \; 3 = 0 \wedge (\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L s[j] \; mod \; 2 = 0)\}$ → acoto el rango de i a la mitad de s,

(*) Para este inciso no se puede dar un contraejemplo, aunque es una WP incorrecta. Explicar por qué.

$$wp(S,Q) \equiv def(i \bmod 3 = 0) \wedge [(i \bmod 3 = 0 \wedge wp(s[i] := s[i]+6, Q)) \vee$$
$$(i \bmod 3 \neq 0 \wedge wp(s[i] := i; Q))]$$

$$0 \le i < |s| \wedge [(i \bmod 3 = 0 \wedge (\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L s[j] \bmod 2 = 0) \vee$$
$$(i \bmod 3 \neq 0 \wedge (\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L \underbrace{(i = j \wedge j \bmod 2 = 0)}_{\text{no sé qué pasa con este término.}} \vee (i \neq j \wedge s[j] \bmod 2 = 0))]$$

$i \bmod 3 = 0$

$$wp(S_1, Q) \equiv def(setAt(s, i, s[i]+6)) \wedge Q^{s}_{setAt(s,i,s[i]+6)}$$
$$\equiv def(s) \wedge def(i) \wedge def(s[i]+6) \wedge 0 \le i < |s| \wedge (\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L setAt()[j] \bmod 2 = 0)$$
$$\equiv 0 \le i < |s| \wedge (\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L (i = j \wedge s[j]+6 \bmod 2 = 0) \vee (i \neq j \wedge s[j] \bmod 2 = 0)$$
$$(i = j \wedge s[j] \bmod 2 = 0) \vee (i \neq j \wedge s[j] \bmod 2 = 0)$$
$$\equiv 0 \le i < |s| \wedge (\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L s[j] \bmod 2 = 0$$

$i \bmod 3 \neq 0$

$$setAt = \begin{cases} i & i = j \\ s[j] & i \neq j \end{cases}$$

$$wp(S_2, Q) \equiv def(setAt(s, i, i)) \wedge Q^{s}_{setAt(s,i,i)}$$
$$\equiv 0 \le i < |s| \wedge (\forall j:\mathbb{Z})(0 \le j < |s| \rightarrow_L (i = j \wedge j \bmod 2 = 0) \vee (i \neq j \wedge s[j] \bmod 2 = 0)$$