Lenguajes de Programación 2016-1 Tarea 3

Ricardo Garcia Garcia

Juan Carlos López López

Luis Rodrigo Rojo Morales

22 de noviembre de 2015 Facultad de Ciencias UNAM

Problema I

Haga el juicio de tipo para la función fibonacci y el predicado empty?

Acción	Stack	Sustitución
Inicio	$\llbracket 1 rbracket = [\mathrm{n}] ightarrow \llbracket 2 rbracket$	Vacio
	[3] = boolean	
	$[\leq] = [n] \rightarrow [2] \rightarrow [3] = \text{number} \rightarrow \text{number} \rightarrow \text{boolean}$	
	[4] = number	
	[else] = [5] = [6]	
	$[+] = \boxed{7} \rightarrow \boxed{9} \rightarrow \boxed{6} = \text{number} \rightarrow \text{number} \rightarrow \text{number}$	
	$\boxed{1} = \boxed{8} \rightarrow \boxed{7}$	
	$[-] = [n] \rightarrow [1] \rightarrow [8] = [n] \rightarrow [2] \rightarrow [10] = \text{number} \rightarrow \text{number}$	
	\rightarrow number	
	$\boxed{1} = \boxed{10} \rightarrow \boxed{9}$	
	$\begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 4 \end{bmatrix} = \begin{bmatrix} 6 \end{bmatrix}$	
Paso 3	[3] = boolean	$\boxed{ \boxed{1} \mapsto [n] \to \boxed{2} }$
	$[\leq =] = [n] \rightarrow [2] \rightarrow [3] = \text{number} \rightarrow \text{number} \rightarrow \text{boolean}$	
	$[\![4]\!]$ = number	
	[else] = [5] = [6]	
	$[+] = [\boxed{7}] \rightarrow [\boxed{9}] \rightarrow [\boxed{6}] = \text{number} \rightarrow \text{number} \rightarrow \text{number}$	
	$[n] \to \boxed{2} = \boxed{8} \to \boxed{7}$	
	$[-] = [n] \rightarrow [1] \rightarrow [8] = [n] \rightarrow [2] \rightarrow [10] = \text{number} \rightarrow \text{number}$	
	\rightarrow number	
	$[n] \to [2] = [10] \to [9]$	
	$[\![2]\!] = [\![4]\!] = [\![6]\!]$	

Paso 3 $ \langle - = n \rightarrow 2 \rightarrow \text{boolean} = \text{number} \rightarrow \text{bunber} \rightarrow \text{boolean}$ $ 1 \rightarrow n \rightarrow 2 $ $ 3 \rightarrow \text{boolean}$ $ 4 = \text{number}$ $ 6 \text{s} = 6 $ $ + = 7 \rightarrow 9 \rightarrow 6 $ $ + = 7 \rightarrow 9 $ $ + = 7 $ $ + = 7 \rightarrow 9 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7 $ $ + = 7$			
clse = 5 = 6 + = 7 → 9 → 6 = number → number n → 2 = 8 → 7 - = n → 1 → 8 = n → 2 → 10 = number → number n → 2 = 10 → 9	Paso 3		$\boxed{\boxed{1}} \mapsto [n] \to \boxed{\boxed{2}}$
$ + = 7 \rightarrow 9 \rightarrow 6 = \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ n \rightarrow 2 = 8 \rightarrow 7 \\ - n \rightarrow 1 \rightarrow 8 = n \rightarrow 2 \rightarrow 10 = \text{number} \rightarrow \text{number} \\ n \rightarrow 2 = 10 \rightarrow 9 \\ 2 = 4 = 6 $ $ 2 = 4 = 6 $ Paso 5 $ n = \text{number} \rightarrow 1 \rightarrow 1 \rightarrow 1 \rightarrow 2 $ 3 $\rightarrow \text{boolean} $ 1 $\rightarrow \text{number} \rightarrow 1 \rightarrow $			$[3] \mapsto \text{boolean}$
$ + = 7 \rightarrow 9 \rightarrow 6 = \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ n \rightarrow 2 = 8 \rightarrow 7 \\ - n \rightarrow 1 \rightarrow 8 = n \rightarrow 2 \rightarrow 10 = \text{number} \rightarrow \text{number} \\ n \rightarrow 2 = 10 \rightarrow 9 \\ 2 = 4 = 6 $ $ 2 = 4 = 6 $ Paso 5 $ n = \text{number} \rightarrow 1 \rightarrow 1 \rightarrow 1 \rightarrow 2 $ 3 $\rightarrow \text{boolean} $ 1 $\rightarrow \text{number} \rightarrow 1 \rightarrow $		[else] = [5] = [6]	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		$[+] = [7] \rightarrow [9] \rightarrow [6] = \text{number} \rightarrow \text{number} \rightarrow \text{number}$	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		$[n] \rightarrow [2] = [8] \rightarrow [7]$	
→ number →		$[-] = [n] \rightarrow [1] \rightarrow [8] = [n] \rightarrow [2] \rightarrow [10] = \text{number} \rightarrow \text{number}$	
2 4 6		\rightarrow number	
2 4 6		$[n] \rightarrow [2] = [10] \rightarrow [9]$	
2 = number 4 = number 6 = 5 = 6 1 = 7 → 9 → 6 = number → number → number 1 → 1 → 8 = 1 → 1 → 8 = 1 → 1 → 1 → 1 → 1 → 1 → 1 → 1		$[\![2]\!] = [\![4]\!] = [\![6]\!]$	
2 = number 4 = number else = 5 = 6	Paso 5	[n] = number	$[\![1]\!]\mapsto [\![n]\!] \to [\![2]\!]$
$ \begin{bmatrix} 4 \end{bmatrix} = \text{number} \\ [\text{else}] = \boxed{5} = \boxed{6} \\ [+] = \boxed{7} \rightarrow 9 \rightarrow 6 \end{bmatrix} = \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ [n] \rightarrow 2 = \boxed{8} \rightarrow 7 \\ [-] = [n] \rightarrow [1] \rightarrow \boxed{8} = [n] \rightarrow [2] \rightarrow \boxed{10} = \text{number} \rightarrow \text{number} \\ \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ \rightarrow \text{number} = \boxed{2} = \boxed{10} \rightarrow \boxed{9} \\ 2 = 4 = \boxed{6} $ $ \begin{bmatrix} 2 \end{bmatrix} = \text{number} \\ 4 \end{bmatrix} = \text{number} \rightarrow \boxed{2} = \boxed{6} $ $ \begin{bmatrix} 1 \end{bmatrix} \rightarrow \text{number} \rightarrow \boxed{2} \\ 4 \end{bmatrix} = \text{number} \rightarrow \boxed{2} = \boxed{6} $ $ \begin{bmatrix} 1 \end{bmatrix} \rightarrow \text{number} \rightarrow \boxed{2} \\ 4 \end{bmatrix} = \text{number} \rightarrow \boxed{2} = \boxed{6} $ $ \begin{bmatrix} 1 \end{bmatrix} \rightarrow \text{number} \rightarrow \boxed{2} \\ 4 \end{bmatrix} = \text{number} \rightarrow \boxed{2} = \boxed{8} \rightarrow \boxed{7} \\ [-] = \text{number} \rightarrow \boxed{10} \rightarrow \boxed{9} \\ 2 \end{bmatrix} = 4 \end{bmatrix} = 6 $ $ \begin{bmatrix} 1 \end{bmatrix} \rightarrow \text{number} \rightarrow \boxed{2} \\ 3 \Rightarrow \text{boolean} \\ [n] \rightarrow \text{number} \rightarrow \boxed{2} \\ 3 \Rightarrow \text{boolean} \\ [n] \rightarrow \text{number} \rightarrow \boxed{2} \end{bmatrix} = \boxed{10} \rightarrow \boxed{9} $ $ \begin{bmatrix} 2 \end{bmatrix} = 4 \end{bmatrix} = \boxed{6} $ $ \begin{bmatrix} 1 \end{bmatrix} \rightarrow \text{number} \rightarrow \boxed{2} \\ 3 \Rightarrow \text{boolean} \\ [n] \rightarrow \text{number} \rightarrow \boxed{2} \\ 2 \Rightarrow 4 \end{bmatrix} = \boxed{6} $ $ \begin{bmatrix} 1 \end{bmatrix} \rightarrow \text{number} \rightarrow \boxed{2} \\ 3 \Rightarrow \text{boolean} \\ [n] \rightarrow \text{number} \rightarrow \boxed{2} \\ 2 \Rightarrow \text{number} \rightarrow \boxed{2} \\ 3 \Rightarrow \text{boolean} \\ [n] \rightarrow \text{number} \rightarrow \boxed{2} \Rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \boxed{2} \Rightarrow \text{number} \rightarrow \text{number} \rightarrow \boxed{2} \Rightarrow \text{number} \rightarrow \boxed{2} \Rightarrow \text{number} \rightarrow \text{number} \rightarrow \boxed{2} \Rightarrow \text{number} \rightarrow \text{number} \rightarrow \boxed{2} \Rightarrow \text{number} \rightarrow \boxed{2} \Rightarrow \text{number} \rightarrow \boxed{2} \Rightarrow \text{number} \rightarrow \boxed{2} \Rightarrow \text{number} \rightarrow \text{number} \rightarrow \boxed{2} \Rightarrow n$		[2] = number	$[3] \mapsto \text{boolean}$
$[else] = \begin{bmatrix} 5 \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\$			
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		[else] = [5] = [6]	
$ \begin{bmatrix} \cdot \end{bmatrix} = \begin{bmatrix} n \end{bmatrix} \rightarrow \begin{bmatrix} 1 \end{bmatrix} \rightarrow \begin{bmatrix} 8 \end{bmatrix} = \begin{bmatrix} n \end{bmatrix} \rightarrow \begin{bmatrix} 2 \end{bmatrix} \rightarrow \begin{bmatrix} 10 \end{bmatrix} = \text{number} \rightarrow \text{number} \\ \rightarrow \text{number} \\ \rightarrow \text{number} \\ \begin{bmatrix} n \end{bmatrix} \rightarrow \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 10 \end{bmatrix} \rightarrow \begin{bmatrix} 9 \end{bmatrix} \\ \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 4 \end{bmatrix} = \begin{bmatrix} 6 \end{bmatrix} $ $ \begin{bmatrix} 4 \end{bmatrix} = \text{number} \\ 4 \end{bmatrix} = \text{number} $ $ \begin{bmatrix} 4 \end{bmatrix} = \text{number} \\ 4 \end{bmatrix} = \text{number} $ $ \begin{bmatrix} 4 \end{bmatrix} = \text{number} \rightarrow \begin{bmatrix} 4 \end{bmatrix} = \text{number} \rightarrow \begin{bmatrix} 1 \end{bmatrix} \rightarrow \text{number} \rightarrow \begin{bmatrix} 2 \end{bmatrix} \\ 3 \end{bmatrix} \rightarrow \text{boolean} $ $ \begin{bmatrix} n \end{bmatrix} \rightarrow \text{number} \rightarrow \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots$		$[\pm] - [7] \rightarrow [9] \rightarrow [6] - number \rightarrow number \rightarrow number$	
$ \begin{bmatrix} \cdot \end{bmatrix} = \begin{bmatrix} n \end{bmatrix} \rightarrow \begin{bmatrix} 1 \end{bmatrix} \rightarrow \begin{bmatrix} 8 \end{bmatrix} = \begin{bmatrix} n \end{bmatrix} \rightarrow \begin{bmatrix} 2 \end{bmatrix} \rightarrow \begin{bmatrix} 10 \end{bmatrix} = \text{number} \rightarrow \text{number} \\ \rightarrow \text{number} \\ \rightarrow \text{number} \\ \begin{bmatrix} n \end{bmatrix} \rightarrow \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 10 \end{bmatrix} \rightarrow \begin{bmatrix} 9 \end{bmatrix} \\ \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 4 \end{bmatrix} = \begin{bmatrix} 6 \end{bmatrix} $ $ \begin{bmatrix} 4 \end{bmatrix} = \text{number} \\ 4 \end{bmatrix} = \text{number} $ $ \begin{bmatrix} 4 \end{bmatrix} = \text{number} \\ 4 \end{bmatrix} = \text{number} $ $ \begin{bmatrix} 4 \end{bmatrix} = \text{number} \rightarrow \begin{bmatrix} 4 \end{bmatrix} = \text{number} \rightarrow \begin{bmatrix} 1 \end{bmatrix} \rightarrow \text{number} \rightarrow \begin{bmatrix} 2 \end{bmatrix} \\ 3 \end{bmatrix} \rightarrow \text{boolean} $ $ \begin{bmatrix} n \end{bmatrix} \rightarrow \text{number} \rightarrow \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \vdots \rightarrow \begin{bmatrix} 6 \end{bmatrix} \\ \vdots \rightarrow \vdots$			
Paso 3 [2] = 10 \rightarrow 9 [2] = 10 \rightarrow 10 \rightarrow 11 \rightarrow 12 \rightarrow 13 \rightarrow boolean [1] \rightarrow number \rightarrow 12 \rightarrow 13 \rightarrow boolean [1] \rightarrow number \rightarrow 12 \rightarrow 13 \rightarrow boolean [1] \rightarrow number \rightarrow 12 \rightarrow 13 \rightarrow boolean [1] \rightarrow number \rightarrow 12 \rightarrow 10 \rightarrow number \rightarrow number \rightarrow 11 \rightarrow 18 \rightarrow number \rightarrow 10 \rightarrow 11 \rightarrow 12 \rightarrow 10 \rightarrow 11 \rightarrow 12 \rightarrow 11 \rightarrow 12 \rightarrow 13 \rightarrow boolean [1] \rightarrow number \rightarrow 12 \rightarrow 13 \rightarrow boolean [1] \rightarrow number \rightarrow 13 \rightarrow boolean [1] \rightarrow number \rightarrow 13 \rightarrow boolean [1] \rightarrow number \rightarrow 10 \rightarrow 11 \rightarrow 18 \rightarrow number \rightarrow 10 \rightarrow 11 \rightarrow 18 \rightarrow number \rightarrow number \rightarrow number \rightarrow number \rightarrow 10 \rightarrow 12 \rightarrow 13 \rightarrow boolean [1] \rightarrow number \rightarrow 12 \rightarrow 13 \rightarrow boolean [1] \rightarrow number \rightarrow 10 \rightarrow 12 \rightarrow 13 \rightarrow boolean [1] \rightarrow number \rightarrow 10 \rightarrow 13 \rightarrow 14 \rightarrow 15 \rightarrow 16 \rightarrow 17 \rightarrow 17 \rightarrow 18 \rightarrow 17 \rightarrow 19 \rightarrow 16 \rightarrow number \rightarrow		$\begin{bmatrix} 11 \end{bmatrix} \rightarrow \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 0 \end{bmatrix} \rightarrow \begin{bmatrix} 1 \end{bmatrix}$	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		$[-] = [n] \rightarrow [1] \rightarrow [8] = [n] \rightarrow [2] \rightarrow [10] = \text{number} \rightarrow \text{number}$	
Paso 3 [2] = number [4] = number 2] 3			
Paso 3 [2] = number [4] = number [2] = number [2] = [6] [3] \rightarrow boolean [n] \rightarrow number [2] = [8] \rightarrow [7] [1] = number \rightarrow 1] \rightarrow [8] = number \rightarrow number number \rightarrow number number \rightarrow		$\begin{bmatrix} \mathbf{n} \end{bmatrix} \to \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 10 \end{bmatrix} \to \begin{bmatrix} 9 \end{bmatrix}$	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			
$[else] = \begin{bmatrix} 5 \end{bmatrix} = \begin{bmatrix} 6 \\ \\ [+] = \begin{bmatrix} 7 \end{bmatrix} \rightarrow 9 \end{bmatrix} \rightarrow \begin{bmatrix} 6 \end{bmatrix} = \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ \text{number} \rightarrow \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 8 \end{bmatrix} \rightarrow \begin{bmatrix} 7 \end{bmatrix} \\ [-] = \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ \text{number} \rightarrow \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 10 \end{bmatrix} \rightarrow \begin{bmatrix} 9 \end{bmatrix} \\ 2 \end{bmatrix} = \begin{bmatrix} 4 \end{bmatrix} = \begin{bmatrix} 6 \end{bmatrix} \\ [+] = \begin{bmatrix} 7 \end{bmatrix} \rightarrow \begin{bmatrix} 9 \end{bmatrix} \rightarrow \begin{bmatrix} 6 \end{bmatrix} = \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ \text{number} \rightarrow \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 8 \end{bmatrix} \rightarrow \begin{bmatrix} 7 \end{bmatrix} \\ [-] = \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ \text{number} \rightarrow nu$	Paso 3	[2] = number	$[1] \mapsto \text{number} \rightarrow [2]$
$[+] = [7] \rightarrow [9] \rightarrow [6] = \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [8] \rightarrow [7]$ $[-] = \text{number} \rightarrow [1] \rightarrow [8] = \text{number} \rightarrow [2] \rightarrow [10] = \text{number}$ $\rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [10] \rightarrow [9]$ $[2] = [4] = [6]$ Paso 3 $[4] = \text{number}$ $[4] = \text{number}$ $[4] = [7] \rightarrow [9] \rightarrow [6] = \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [8] \rightarrow [7]$ $[-] = \text{number} \rightarrow [1] \rightarrow [8] = \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [10] \rightarrow [9]$ $[2] = [4] = [6]$ $[3] \rightarrow \text{boolean}$ $[n] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$ $[2] \rightarrow \text{number} \rightarrow [2]$ $[3] \rightarrow \text{boolean}$ $[n] \rightarrow \text{number}$ $[2] \rightarrow \text{number} \rightarrow [2]$ $[3] \rightarrow \text{boolean}$ $[n] \rightarrow \text{number} \rightarrow [2]$ $[4] \rightarrow \text{number} \rightarrow [2]$ $[2] \rightarrow \text{number}$ $[3] \rightarrow \text{boolean}$ $[n] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$ $[3] \rightarrow \text{boolean}$ $[n] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$		$\boxed{4}$ = number	$[3] \mapsto \text{boolean}$
$[+] = [7] \rightarrow [9] \rightarrow [6] = \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [8] \rightarrow [7]$ $[-] = \text{number} \rightarrow [1] \rightarrow [8] = \text{number} \rightarrow [2] \rightarrow [10] = \text{number}$ $\rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [10] \rightarrow [9]$ $[2] = [4] = [6]$ Paso 3 $[4] = \text{number}$ $[4] = \text{number}$ $[4] = [7] \rightarrow [9] \rightarrow [6] = \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [8] \rightarrow [7]$ $[-] = \text{number} \rightarrow [1] \rightarrow [8] = \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [10] \rightarrow [9]$ $[2] = [4] = [6]$ $[3] \rightarrow \text{boolean}$ $[n] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$ $[2] \rightarrow \text{number} \rightarrow [2]$ $[3] \rightarrow \text{boolean}$ $[n] \rightarrow \text{number}$ $[2] \rightarrow \text{number} \rightarrow [2]$ $[3] \rightarrow \text{boolean}$ $[n] \rightarrow \text{number} \rightarrow [2]$ $[4] \rightarrow \text{number} \rightarrow [2]$ $[2] \rightarrow \text{number}$ $[3] \rightarrow \text{boolean}$ $[n] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$ $[3] \rightarrow \text{boolean}$ $[n] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$ $[2] \rightarrow \text{number}$		[else] = [5] = [6]	$[n] \mapsto \text{number}$
$\begin{array}{c} \operatorname{number} \to 2 = 8 \to 7 \\ [\cdot] = \operatorname{number} \to [1] \to 8 = \operatorname{number} \to [2] \to 10 = \operatorname{number} \\ \to \operatorname{number} \to \operatorname{number} \\ \operatorname{number} \to \operatorname{number} \\ \operatorname{number} \to 2 = 10 \to 9 \\ 2 = 4 = 6 \\ \end{array}$ $\begin{array}{c} \operatorname{Paso} 3 \\ 4 = \operatorname{number} \\ [\operatorname{else}] = 5 = 6 \\ [+] = 7 \to 9 \to 6 = \operatorname{number} \to \operatorname{number} \\ \operatorname{number} \to \operatorname{number} \to 11 \to 8 = \operatorname{number} \to \operatorname{number} \\ \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \\ \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to 10 = \\ \operatorname{number} \to 2 = 10 \to 9 \\ 2 = 4 = 6 \\ \end{array}$ $\begin{array}{c} \operatorname{Paso} 3 \\ [\operatorname{else}] = 5 = 6 \\ [+] = 7 \to 9 \to 6 = \operatorname{number} \to \operatorname{number} \to \operatorname{number} \\ \operatorname{number} \to 2 = 8 \to 7 \\ [-] = \operatorname{number} \to 11 \to 8 = \operatorname{number} \to \operatorname{number} \to \operatorname{number} \\ \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \\ \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to 10 = \\ \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \\ \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to 10 = \\ \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to 10 = \\ \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to 10 = \\ \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to \operatorname{number} \to 10 = \\ \operatorname{number} \to 1 \to 10 = 10 = 10 = 10 = 10 = 10 = 10 $		$[+] = [7] \rightarrow [9] \rightarrow [6] = \text{number} \rightarrow \text{number} \rightarrow \text{number}$	
$[-] = \text{number} \rightarrow [1] \rightarrow [8] = \text{number} \rightarrow [2] \rightarrow [10] = \text{number}$ $\rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [10] \rightarrow [9]$ $2 = [4] = [6]$ Paso 3 $[4] = \text{number}$ $[else] = [5] = [6]$ $[+] = [7] \rightarrow [9] \rightarrow [6] = \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [8] \rightarrow [7]$ $[-] = \text{number} \rightarrow [1] \rightarrow [8] = \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [10] \rightarrow [9]$ $[-] = \text{number} \rightarrow [1] \rightarrow [8] = \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [3] \rightarrow [4] \rightarrow [4]$ $\text{Paso 3} [else] = [5] = [6]$ $[+] = [7] \rightarrow [9] \rightarrow [6] = \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow [2] = [8] \rightarrow [7]$ $[-] = \text{number} \rightarrow [1] \rightarrow [8] = \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow $		number $\rightarrow \boxed{2} = \boxed{8} \rightarrow \boxed{7}$	
Paso 3			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			
Paso 3 4 = number 2 = 6 3 4 = number 4 = 6 3 4 = number 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 4 = 6 = 6 4 = 6 = 6 6 = 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 6 = 6 = 6 6 = 6 6 = 6 6 = 6 = 6 6 = 6 = 6 6 = 6 = 6 6 = 6 = 6 6 = 6 = 6 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 = 6 =			
Paso 3 $ \begin{bmatrix} 4 \end{bmatrix} = \text{number} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $ $ \begin{bmatrix} 1 \end{bmatrix} \Rightarrow \text{number} \Rightarrow 2 \end{bmatrix} $			
$[else] = \begin{bmatrix} 5 \end{bmatrix} = \begin{bmatrix} 6 \end{bmatrix}$ $[+] = \begin{bmatrix} 7 \end{bmatrix} \rightarrow \begin{bmatrix} 9 \end{bmatrix} \rightarrow \begin{bmatrix} 6 \end{bmatrix} = \text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 8 \end{bmatrix} \rightarrow \begin{bmatrix} 7 \end{bmatrix}$ $[-] = \text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 10 \end{bmatrix} \rightarrow \begin{bmatrix} 9 \end{bmatrix}$ $\begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 4 \end{bmatrix} = \begin{bmatrix} 6 \end{bmatrix}$ $[+] = \begin{bmatrix} 7 \end{bmatrix} \rightarrow \begin{bmatrix} 9 \end{bmatrix} \rightarrow \begin{bmatrix} 6 \end{bmatrix} = \text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 8 \end{bmatrix} \rightarrow \begin{bmatrix} 7 \end{bmatrix}$ $[-] = \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number}$ $$	D 0		dah 1 dah
$[+] = \boxed{7} \rightarrow \boxed{9} \rightarrow \boxed{6} = \text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \boxed{2} = \boxed{8} \rightarrow \boxed{7}$ $[-] = \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \text{number} $	Paso 3		
$\begin{array}{c} \operatorname{number} \to [2] = [8] \to [7] \\ [-] = \operatorname{number} \to [1] \to [8] = \operatorname{number} \to \operatorname{number} \to$			
$\begin{array}{c} \operatorname{number} \to [2] = [8] \to [7] \\ [-] = \operatorname{number} \to [1] \to [8] = \operatorname{number} \to \operatorname{number} \to$		$[+] = [\![7]\!] [\![9]\!] [\![6]\!] = \text{number} \rightarrow \text{number} \rightarrow \text{number}$	$[n] \mapsto number$
		$number \to [2] = [8] \to [7]$	$[2] \mapsto \text{number}$
number \rightarrow number \rightarrow number number number \rightarrow [2] = [10] \rightarrow [9] [2] = [4] = [6] Paso 3 [else] = [5] = [6] [+] = [7] \rightarrow [9] \rightarrow [6] = number \rightarrow number \rightarrow number \rightarrow number \rightarrow [2] = [8] \rightarrow [7] [-] = number \rightarrow [1] \rightarrow [8] = number \rightarrow [2] = [10] \rightarrow [9] [4] \rightarrow number \rightarrow numbe		$[-]$ = number \rightarrow $[1]$ \rightarrow $[8]$ = number \rightarrow number \rightarrow $[10]$ =	
Paso 3 [else] = $\begin{bmatrix} 5 \end{bmatrix}$ = $\begin{bmatrix} 6 \end{bmatrix}$			
Paso 3 [else] = $\begin{bmatrix} 5 \end{bmatrix}$ = $\begin{bmatrix} 6 \end{bmatrix}$		$number \to \boxed{2} = \boxed{10} \to \boxed{9}$	
Paso 3 [else] = $\begin{bmatrix} 5 \end{bmatrix}$ = $\begin{bmatrix} 6 \end{bmatrix}$ [1] \mapsto number \rightarrow $\begin{bmatrix} 2 \end{bmatrix}$ [1] \mapsto number \rightarrow $\begin{bmatrix} 2 \end{bmatrix}$ [1] \mapsto number \rightarrow $\begin{bmatrix} 2 \end{bmatrix}$ [2] = number \rightarrow $\begin{bmatrix} 2 \end{bmatrix}$ = $\begin{bmatrix} 1 \end{bmatrix}$ \mapsto number \rightarrow $\begin{bmatrix} 2 \end{bmatrix}$ \mapsto number \rightarrow number \rightarrow number \rightarrow number \rightarrow			
$[+] = \boxed{7} \rightarrow \boxed{9} \rightarrow \boxed{6} = \text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \boxed{2} = \boxed{8} \rightarrow \boxed{7}$ $[-] = \text{number} \rightarrow \boxed{1} \rightarrow \boxed{8} = \text{number} \rightarrow \text{number} \rightarrow \boxed{10} =$ $\text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \text{number} \rightarrow \text{number}$ $\text{number} \rightarrow \boxed{2} = \boxed{10} \rightarrow \boxed{9}$ $\boxed{2} = \text{number} = \boxed{6}$	Paso 3		$1 \mapsto \text{number} \rightarrow 2$
$\begin{array}{c} \operatorname{number} \to \boxed{2} = \boxed{8} \to \boxed{7} \\ [-] = \operatorname{number} \to [1] \to \boxed{8} = \operatorname{number} \to \operatorname{number} \to [10] = \\ \operatorname{number} \to \operatorname{number} \to \operatorname{number} \\ \operatorname{number} \to \boxed{2} = \boxed{10} \to \boxed{9} \\ \boxed{2} = \operatorname{number} = \boxed{6} \end{array}$ $[n] \mapsto \operatorname{number} \\ [2] \mapsto \operatorname{number} $		· · · <u>· · · · · · · · · · · · · · · · </u>	
$[-] = \text{number} \rightarrow [1] \rightarrow [8] = \text{number} \rightarrow \text{number} \rightarrow [10] = \\ \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ \text{number} \rightarrow [2] = [10] \rightarrow [9] \\ [2] = \text{number} = [6]$ $[4] \mapsto \text{number}$			-
$\begin{array}{c} \mathrm{number} \to \mathrm{number} \\ \mathrm{number} \to \left[\begin{array}{c} 2 \end{array} \right] = \left[\begin{array}{c} 10 \end{array} \right] \to \left[\begin{array}{c} 9 \end{array} \right] \\ \left[\begin{array}{c} 2 \end{array} \right] = \mathrm{number} = \left[\begin{array}{c} 6 \end{array} \right] \end{array}$			
$\begin{array}{c} \operatorname{number} \to \boxed{2} = \boxed{10} \to \boxed{9} \\ \boxed{2} = \operatorname{number} = \boxed{6} \end{array}$			$[z] \mapsto \text{number}$
[2] = number = [6]			1
			$[4] \mapsto \text{number}$
	Paso 3	$[+] = [7] \rightarrow [9] \rightarrow [6] = \text{number} \rightarrow \text{number} \rightarrow \text{number}$	$[1] \mapsto \text{number} \rightarrow [2]$
$ \text{ number } \rightarrow [\![2]\!] = [\![8]\!] \rightarrow [\![7]\!] $ $ [\![3]\!] \mapsto \text{boolean} $		$number \to \lfloor \!\lfloor 2 \!\rfloor \!\rfloor = \lfloor \!\lfloor 8 \!\rfloor \!\rfloor \to \lfloor \!\lceil 7 \!\rfloor \!\rfloor$	$[3] \mapsto \text{boolean}$

		$[n] \mapsto \text{number}$
	$\begin{array}{c} \text{number} \to \text{number} \\ \text{number} \to \boxed{2} = \boxed{10} \to \boxed{9} \end{array}$	$[2] \mapsto \text{number}$
	2 = number = 6	$\begin{bmatrix} 1 \\ 4 \end{bmatrix} \mapsto \text{number}$
		$5 \mapsto 6$
Paso 5	$ \boxed{ \boxed{7} } = \text{number} $	$\boxed{\boxed{1}} \mapsto \text{number} \rightarrow \boxed{2}$
	$\begin{bmatrix} 9 \end{bmatrix}$ = number	$\begin{bmatrix} 3 \end{bmatrix} \mapsto \text{boolean}$
	$\begin{bmatrix} 6 \end{bmatrix} = \text{number}$	$ \begin{array}{c} [n] \mapsto \text{number} \\ [2] \mapsto \text{number} \end{array} $
		$ \begin{bmatrix} 2 \\ 4 \end{bmatrix} \mapsto \text{number} $
	$\begin{array}{c} \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ \text{number} \rightarrow \text{number} \end{array}$	
	$\underline{\text{number}} \to \underline{[2]} = \underline{[10]} \to \underline{[9]}$	$5 \mapsto 6$
	[2] = number = $[6]$	
Paso 3	$\begin{bmatrix} 9 \end{bmatrix}$ = number	$\boxed{\begin{array}{c} \boxed{1} \\ \boxed{2} \end{array}} \mapsto \text{number} \rightarrow \boxed{2}$
	$\begin{bmatrix} 6 \end{bmatrix} = \text{number}$	$ \begin{array}{c} [3] \mapsto \text{boolean} \\ [n] \mapsto \text{number} \end{array} $
	$ \begin{array}{c c} \text{number} \rightarrow & \boxed{2} = & \boxed{8} \rightarrow \text{number} \\ [-] = \text{number} \rightarrow & \boxed{1} \rightarrow & \boxed{8} = \text{number} \rightarrow \text{number} \rightarrow & \boxed{10} = \\ \end{array} $	$[1] \mapsto \text{number}$ $[2] \mapsto \text{number}$
	$\begin{array}{c} \text{number} \rightarrow \text{number} \\ \end{array}$	[-]
	$\boxed{\text{number} \rightarrow \boxed{2}} = \boxed{10} \rightarrow \boxed{9}$	$\boxed{4} \mapsto \text{number}$
		$\begin{bmatrix} 5 \\ \end{bmatrix} \mapsto \begin{bmatrix} 6 \\ \end{bmatrix}$
D 2	1 C h	$\boxed{7} \mapsto \text{number}$
Paso 3	$ \begin{bmatrix} 6 \end{bmatrix} = \text{number} \\ \text{number} \to \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 8 \end{bmatrix} \to \text{number} $	$ \begin{bmatrix} 1 \\ \hline \end{bmatrix} \mapsto \text{number} \rightarrow \begin{bmatrix} 2 \\ \end{bmatrix} $ $ \begin{bmatrix} 3 \end{bmatrix} \mapsto \text{boolean} $
	$[-] = \text{number} \rightarrow [1] \rightarrow [8] = \text{number} \rightarrow \text{number} \rightarrow [10] = [1]$	$[n] \mapsto \text{number}$
	$number \rightarrow number \rightarrow number$	
	$\boxed{\text{number} \rightarrow \boxed{2}} = \boxed{10} \rightarrow \text{number}$	$[2] \mapsto \text{number}$
		$\begin{bmatrix} 4 \end{bmatrix} \mapsto \text{number}$
		$ \begin{bmatrix} 5 \\ 7 \end{bmatrix} \mapsto \begin{bmatrix} 6 \\ \end{bmatrix} $ number
		$9 \mapsto \text{number}$
Paso 3	$number \to [2] = [8] \to number$	$1 \rightarrow \text{number} \rightarrow 2$
	$\boxed{[-] = \text{number} \rightarrow [1] \rightarrow \boxed{8}} = \text{number} \rightarrow \text{number} \rightarrow \boxed{10} =$	$\boxed{3} \mapsto \text{boolean}$
	$number \rightarrow number \rightarrow number$	
	$\begin{array}{c} \text{number} \to \boxed{2} = \boxed{10} \to \text{number} \\ \boxed{2} = \text{number} = \text{number} \end{array}$	$ \begin{array}{c} [n] \mapsto \text{number} \\ [2] \mapsto \text{number} \end{array} $
		$\begin{bmatrix} 4 \end{bmatrix} \mapsto \text{number}$
		$5 \mapsto \text{number}$
		$7 \mapsto \text{number}$
		$9 \rightarrow \text{number}$
D F		$ \begin{bmatrix} 6 \end{bmatrix} \mapsto \text{number} $
Paso 5	$ \begin{array}{c} \text{number} = [8] \\ [2] = \text{number} \end{array} $	$ \begin{bmatrix} 1 \\ \hline \end{bmatrix} \mapsto \text{number} \rightarrow \begin{bmatrix} 2 \end{bmatrix} $ $ \begin{bmatrix} 3 \end{bmatrix} \mapsto \text{boolean} $
	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$[n] \mapsto \text{number}$
	$\begin{array}{c} \text{number} \rightarrow \text{number} \rightarrow \text{number} \\ \end{array}$	
	$\begin{array}{c} \text{number} \to \boxed{2} = \boxed{10} \to \text{number} \end{array}$	$[2] \mapsto \text{number}$
	[2] = number = number	$\boxed{4} \mapsto \text{number}$
		$\left[\begin{array}{c} \underline{[5]} \mapsto \text{number} \end{array}\right]$

I		l d=h
		$[7] \mapsto \text{number}$
		$[9] \mapsto \text{number}$
		$[6] \mapsto \text{number}$
Paso 4		$\left[\begin{array}{c} 1 \end{array}\right] \mapsto \text{number} \rightarrow \left[\begin{array}{c} 2 \end{array}\right]$
	$[-]$ = number \rightarrow [1] \rightarrow number = number \rightarrow number \rightarrow [10] =	$[3] \mapsto \text{boolean}$
	$number \rightarrow number \rightarrow number$	
	$ \underline{\text{number}} \to [2] = [10] \to \text{number} $	$[n] \mapsto \text{number}$
	[2] = number = number	$[2] \mapsto \text{number}$
		$[4] \mapsto \text{number}$
		$\begin{bmatrix} 5 \end{bmatrix} \mapsto \text{number}$
		$[7] \mapsto \text{number}$
		$[9] \mapsto \text{number}$
		$\boxed{6} \mapsto \text{number}$
		$\boxed{8} \mapsto \text{number}$
Paso 3	$[-]$ = number \rightarrow $[1]$ \rightarrow number = number \rightarrow number \rightarrow $[10]$ =	$1 \mapsto \text{number} \to \text{number}$
	$number \rightarrow number \rightarrow number$	
	$number \rightarrow number = \boxed{10} \rightarrow number$	$\boxed{3} \mapsto \text{boolean}$
	number = number = number	$[n] \mapsto \text{number}$
		$[2] \mapsto \text{number}$
		$[4] \mapsto \text{number}$
		$\begin{bmatrix} 5 \end{bmatrix} \mapsto \text{number}$
		$[7] \mapsto \text{number}$
		$[9] \mapsto \text{number}$
		$\begin{bmatrix} 6 \end{bmatrix} \mapsto \text{number}$
		$[8] \mapsto \text{number}$
		$[2] \mapsto \text{number}$
Paso 5	[1] = number	$[1] \mapsto \text{number} \to \text{number}$
	number = [10]	$[3] \mapsto \text{boolean}$
	$number \to \overline{num}ber = \boxed{10} \to number$	$[n] \mapsto \text{number}$
	number = number = number	$[2] \mapsto \text{number}$
		$[4] \mapsto \text{number}$
		$[5] \mapsto \text{number}$
		$[7] \mapsto \text{number}$
		$[9] \mapsto \text{number}$
		$[6] \mapsto \text{number}$
		$[8] \mapsto \text{number}$
		$\boxed{2} \mapsto \text{number}$
Paso 3	number = [10]	$1 \mapsto \text{number} \to \text{number}$
	$number \to \overline{number} = [10] \to number$	$\boxed{3} \mapsto \text{boolean}$
	number = number = number	$[\overline{\mathrm{n}}] \mapsto \mathrm{number}$
		$[2] \mapsto \text{number}$
		$[4] \mapsto \text{number}$
		$[5] \mapsto \text{number}$
		$[7] \mapsto \text{number}$
		$[9] \mapsto \text{number}$
		$[6] \mapsto \text{number}$
		$\boxed{8} \mapsto \text{number}$
		·

1		1 2 1 - Anymhon
		$ \begin{bmatrix} 2 \end{bmatrix} \mapsto \text{number} \\ \begin{bmatrix} 1 \end{bmatrix} \mapsto \text{number} $
D 4	1 , 1 , 1	LJ
Paso 4	$number \rightarrow number = number \rightarrow number$	1 \mapsto number \rightarrow number
	number = number = number	$\begin{bmatrix} 3 \end{bmatrix} \mapsto \text{boolean}$
		$ \begin{array}{c} [n] \mapsto \text{number} \\ [2] \mapsto \text{number} \end{array} $
		$[4] \mapsto \text{number}$
		$\begin{bmatrix} 5 \end{bmatrix} \mapsto \text{number}$
		$\begin{bmatrix} 7 \end{bmatrix} \mapsto \text{number}$
		$[9] \mapsto \text{number}$
		$[6] \mapsto \text{number}$
		$[8] \mapsto \text{number}$
		$[2] \mapsto \text{number}$
		$[1] \mapsto \text{number}$
		$[10] \mapsto \text{number}$
Paso 1	number = number = number	$[1] \mapsto \text{number} \to \text{number}$
		$[3] \mapsto \text{boolean}$
		$[\overline{\mathrm{n}}] \mapsto \mathrm{number}$
		$[2] \mapsto \text{number}$
		$[4] \mapsto \text{number}$
		$[5] \mapsto \text{number}$
		$[7] \mapsto \text{number}$
		$[9] \mapsto \text{number}$
		$6 \mapsto \text{number}$
		$8 \mapsto \text{number}$
		$2 \mapsto \text{number}$
		$[1] \mapsto \text{number}$
		$10 \mapsto \text{number}$
Paso 1	vacio	$1 \mapsto \text{number} \to \text{number}$
		$3 \mapsto boolean$
		$[n] \mapsto \text{number}$
		$[2] \mapsto \text{number}$
		$\boxed{4} \mapsto \text{number}$
		$5 \mapsto \text{number}$
		$7 \mapsto \text{number}$
		$\boxed{9} \mapsto \text{number}$
		$6 \mapsto \text{number}$
		$8 \mapsto \text{number}$
		$2 \mapsto \text{number}$
		$[1] \mapsto \text{number}$
		$10 \rightarrow \text{number}$
		<u> - </u>

Acción	Stack	Sustitución
Inicio	$\boxed{1} = [l] \rightarrow \boxed{2}$	Vacio
	[3] = boolean	
	$[=] = [4] \rightarrow [0] \rightarrow [3] = \text{number} \rightarrow \text{number} \rightarrow \text{boolean}$	
	$[\underline{\operatorname{length}}] = [1] \to [4] = \operatorname{list} \to \operatorname{number}$	
	$\begin{bmatrix} 5 \end{bmatrix}$ = boolean	
	$ \boxed{ 6 } = \text{boolean} $	
	$ \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 5 \end{bmatrix} \mid \begin{bmatrix} 6 \end{bmatrix} $	
Paso 3	$\begin{bmatrix} 3 \end{bmatrix} = \text{boolean}$	$\boxed{ \boxed{1} \mapsto [1] \to \boxed{2} }$
	$[=] = [4] \rightarrow [0] \rightarrow [3] = \text{number} \rightarrow \text{number} \rightarrow \text{boolean}$ $[\text{length}] = [l] \rightarrow [4] = \text{list} \rightarrow \text{number}$	
	$[\operatorname{length}] = [\operatorname{l}] \to [\operatorname{4}] = \operatorname{nst} \to \operatorname{number}$	
	$ \begin{bmatrix} 5 \\ 6 \end{bmatrix} = boolean $	
	$ \begin{bmatrix} 0 \\ 2 \end{bmatrix} = \begin{bmatrix} 5 \end{bmatrix} \mid \begin{bmatrix} 6 \end{bmatrix} $	
Paso 3	$[=] = [4] \rightarrow [0] \rightarrow \text{boolean} = \text{number} \rightarrow \text{number} \rightarrow \text{boolean}$	$ \begin{bmatrix} 1 & \downarrow & \downarrow \end{bmatrix} \rightarrow \begin{bmatrix} 2 & \downarrow \end{bmatrix} $
	$[length] = [l] \rightarrow [4] = list \rightarrow number$	$ \begin{bmatrix} 1 \\ 3 \end{bmatrix} \mapsto \text{boolean} $
	5 = boolean	
	6 = boolean	
	$\boxed{2} = \boxed{5} \mid \boxed{6}$	
Paso 5	$\boxed{4}$ = number	$\boxed{\hspace{-0.3cm} \begin{bmatrix} 1 \end{bmatrix} \mapsto [l] \to [\hspace{-0.3cm} \begin{bmatrix} 2 \end{bmatrix} \hspace{-0.3cm}}$
	[0] = number	$ \begin{bmatrix} 1 \\ 3 \end{bmatrix} \mapsto [1] \to [2] $
	$[\underline{length}] = [\underline{l}] \to [\underline{4}] = \text{list} \to \text{number}$	
	$\begin{bmatrix} 5 \end{bmatrix}$ = boolean	
	$\begin{bmatrix} 6 \end{bmatrix} = \text{boolean}$	
D 0	$ \begin{bmatrix} 2 \end{bmatrix} = \begin{bmatrix} 5 \end{bmatrix} \mid \begin{bmatrix} 6 \end{bmatrix} $	dah dah
Paso 3	[0] = number	$ \begin{array}{c} \boxed{1} \mapsto [1] \to \boxed{2} \\ \boxed{3} \mapsto \text{boolean} \end{array} $
	$ [length] = [l] \rightarrow number = list \rightarrow number $ $ 5 = boolean $	$ \begin{bmatrix} 3 \end{bmatrix} \mapsto \text{boolean} \\ \begin{bmatrix} 4 \end{bmatrix} \mapsto \text{number} $
	$\begin{bmatrix} 6 \end{bmatrix} = \text{boolean}$	<u> </u> 4 → number
	$ \begin{bmatrix} 0 \\ 2 \end{bmatrix} = \begin{bmatrix} 5 \end{bmatrix} \mid \begin{bmatrix} 6 \end{bmatrix} $	
Paso 3	$[length] = [l] \rightarrow number = list \rightarrow number$	$\boxed{1} \mapsto [l] \to \boxed{2}$
	5 = boolean	$3 \mapsto boolean$
		$\boxed{4} \mapsto \text{number}$
		$[0] \mapsto \text{number}$
Paso 5	[l] = list	$\boxed{\hspace{-0.3cm} \begin{bmatrix} 1 \end{bmatrix} \mapsto [l] \to [\hspace{-0.3cm} \begin{bmatrix} 2 \end{bmatrix} \hspace{-0.3cm}}$
	5 = boolean	$[3] \mapsto \text{boolean}$
	$ \boxed{ 6 } = \text{boolean} $	$\boxed{4} \mapsto \text{number}$
	$ \begin{bmatrix} 2 \\ \end{bmatrix} = \begin{bmatrix} 5 \end{bmatrix} \mid \begin{bmatrix} 6 \end{bmatrix} $	$[0] \mapsto \text{number}$
Paso 3	$\begin{bmatrix} 5 \end{bmatrix}$ = boolean	$\left[\begin{array}{c} 1 \\ \end{array} \right] \mapsto \operatorname{list} \to \left[\begin{array}{c} 2 \\ \end{array} \right]$
	$\begin{bmatrix} 6 \end{bmatrix} = \text{boolean}$	$3 \mapsto boolean$
	$[\![2]\!] = [\![5]\!] \mid [\![6]\!]$	$ \begin{bmatrix} 4 \\ 0 \end{bmatrix} \mapsto \text{number} $
		$[0] \mapsto \text{number}$ $[1] \mapsto \text{list}$
Paso 3	[6] = boolean	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$
	2 = boolean 6	$3 \mapsto boolean$
1		

		$\boxed{4} \mapsto \text{number}$
		$[0] \mapsto \text{number}$
		$[l] \mapsto \text{list}$
		$[5] \mapsto \text{boolean}$
Paso 3	2 = boolean boolean	$[1] \mapsto \operatorname{list} \to [2]$
		$[3] \mapsto \text{boolean}$
		$[4] \mapsto \text{number}$
		$[0] \mapsto \text{number}$
		$[l] \mapsto list$
		$[5] \mapsto \text{boolean}$
		$[6] \mapsto \text{boolean}$
Paso 3	Vacio	$[1] \mapsto \text{list} \to \text{boolean}$
		$\boxed{3} \mapsto \text{boolean}$
		$4 \mapsto \text{number}$
		$[0] \mapsto \text{number}$
		$[l] \mapsto list$
		$[5] \mapsto \text{boolean}$
		$[6] \mapsto \text{boolean}$
		$\boxed{2} \mapsto \text{boolean}$

Problema II

Considera el siguiente programa:

```
(+ 1 (first (cons true empty)))
```

Este programa tiene un error de tipos.

Genera restricciones para este programa. Aísla el conjunto mas pequeño de estas restricciones tal que, resultas juntas, identifiquen el error de tipos.

Siéntete libre de etiquetar las sub-expresiones del programa con superíndices para usarlos cuando escribas y resuelvas tus restricciones.

Problema III

Considera la siguiente expresión con tipos:

Dejamos los tipos sin especificar (Cn) para que sean llenados por el proceso de inferencia de tipos. Deriva restricciones de tipos para el programa anterior. Luego resuelve estas restricciones. A partir de estas soluciones, rellena los valores de las Cn. Asegúrate de mostrar todos los pasos especificados por los algoritmos (i.e., escribir la respuesta basándose en la intuición o el conocimiento es insuficiente). Deberás usar variables de tipo cuando sea necesario. Para no escribir tanto, puedes etiquetar cada expresión con una variable de tipos apropiada, y presentar el resto del algoritmo en términos solamente de estas variables de tipos.

Problema IV

Considera los juicios de tipos discutidos en clase para un lenguaje glotón (en el capitulo de **Juicios de Tipos** del libro de Shriram). Considera ahora la versión perezosa del lenguaje. Pon especial atención a las reglas de tipado para:

- definición de funciones
- aplicación de funciones

Para cada una de estas, si crees que la regla original no cambia, explica por que no (Si crees que ninguna de las dos cambia, puedes responder las dos partes juntas). Si crees que algún otro juicio de tipos debe cambiar, menciónalo también.

Problema V

¿Cuáles son las ventajas y desventajas de tener polimorfismo explícito e implícito en los lenguajes de programación?

Problema VI

Da las ventajas y desventajas de tener lenguajes de dominio específico (DSL) y de propósito general. También da al menos tres ejemplos de lenguajes DSL, cada ejemplo debe indicar el propósito del DSL y un ejemplo documentando su uso.

Lenguajes de Dominio Especifico (DSL)

Ventajas	Desventajas
-Proporciona apropiadas abstracciones y anotaciones.	-Aprenderlo para que solo pueda resolver un problema
	espepecifico.
-Nos permiten seguridad en nivel de dominio, mientras	-Encontrar, ajustar o mantener un alcance adecuado.
los metodos del lenguaje esten seguros esto nos permi-	
tira seguridad cada vez que los usemos.	
-Es mas sencillo desarrollar programas en un area en	-Gente no experta en el lenguaje no puede modificar o
especifico para programadores que no sean expertos en	crear codigo facilmente.
ella.	

Lenguajes de Propisito General (GPL)

Ventajas	Desventajas
-Nos ayuda a resolver problemas de diferentes areas.	-?.
-?.	-?.
-?.	-?.

Ejemplos DSL:

- 1. ?
- 2. ?
- 3. ?