Lenguajes de Programación 2016-1
Tarea 3

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Problema I

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

```
(define fibonacci
  [1](lambda (n)
    [2](cond
      [[3](<= n 2) [4]1]
      [[5]else [6](+ [7](fibonacci [8](- n 1)) [9](fibonacci [10](- n 2)))])))
```

Accion	Stack	Sustitución
Inicio	$[\boxed{1}] = [n] \to [\boxed{2}]$ $[\boxed{3}] =$ boolean $[<=] = [n] \to [2] \to [\boxed{3}] =$ number $\to$ number $\to$ boolean $[\boxed{4}] =$ number [else] $= [\boxed{5}] = [\boxed{6}]$ $[+] = [\boxed{7}] \to [\boxed{9}] \to [\boxed{6}] =$ number $\to$ number $\to$ number $[\boxed{1}] = [\boxed{8}] \to [\boxed{7}]$ $[-] = [n] \to [1] \to [\boxed{8}] = [n] \to [2] \to [\boxed{10}] =$ number $\to$ number $\to$ number $[\boxed{1}] = [\boxed{10}] \to [\boxed{9}]$ $[\boxed{2}] = [\boxed{4}] = [\boxed{6}]$	Vacio
Paso 3	$[\boxed{3}] =$ boolean $[<=] = [n] \to [2] \to [\boxed{3}] =$ number $\to$ number $\to$ boolean $[\boxed{4}] =$ number [else] $= [\boxed{5}] = [\boxed{6}]$ $[+] = [\boxed{7}] \to [\boxed{9}] \to [\boxed{6}] =$ number $\to$ number $\to$ number $[n] \to [\boxed{2}] = [\boxed{8}] \to [\boxed{7}]$ $[-] = [n] \to [1] \to [\boxed{8}] = [n] \to [2] \to [\boxed{10}] =$ number $\to$ number $\to$ number $[n] \to [\boxed{2}] = [\boxed{10}] \to [\boxed{9}]$ $[\boxed{2}] = [\boxed{4}] = [\boxed{6}]$	$[\boxed{1}] \mapsto [n] \to [\boxed{2}]$

Paso 3	[<=] = [n] → [2] → boolean = number → number → boolean ⟦4⟧ = number [else] = ⟦5⟧ = ⟦6⟧ [+] = ⟦7⟧ → ⟦9⟧ → ⟦6⟧ = number → number → number [n] → ⟦2⟧ = ⟦8⟧ → ⟦7⟧ [-] = [n] → [1] → ⟦8⟧ = [n] → [2] → ⟦10⟧ = number → number → number [n] → ⟦2⟧ = ⟦10⟧ → ⟦9⟧ ⟦2⟧ = ⟦4⟧ = ⟦6⟧	⟦1⟧ ↦ [n] → ⟦2⟧ ⟦3⟧ ↦ boolean
Paso 5	[n] = number [2] = number ⟦4⟧ = number [else] = ⟦5⟧ = ⟦6⟧ [+] = ⟦7⟧ → ⟦9⟧ → ⟦6⟧ = number → number → number [n] → ⟦2⟧ = ⟦8⟧ → ⟦7⟧ [-] = [n] → [1] → ⟦8⟧ = [n] → [2] → ⟦10⟧ = number → number → number [n] → ⟦2⟧ = ⟦10⟧ → ⟦9⟧ ⟦2⟧ = ⟦4⟧ = ⟦6⟧	⟦1⟧ ↦ [n] → ⟦2⟧ ⟦3⟧ ↦ boolean
Paso 3	[2] = number ⟦4⟧ = number [else] = ⟦5⟧ = ⟦6⟧ [+] = ⟦7⟧ → ⟦9⟧ → ⟦6⟧ = number → number → number number → ⟦2⟧ = ⟦8⟧ → ⟦7⟧ [-] = number → [1] → ⟦8⟧ = number → [2] → ⟦10⟧ = number → number → number number → ⟦2⟧ = ⟦10⟧ → ⟦9⟧ ⟦2⟧ = ⟦4⟧ = ⟦6⟧	⟦1⟧ ↦ number → ⟦2⟧ ⟦3⟧ ↦ boolean [n] ↦ number
Paso 3	⟦4⟧ = number [else] = ⟦5⟧ = ⟦6⟧ [+] = ⟦7⟧ → ⟦9⟧ → ⟦6⟧ = number → number → number number → ⟦2⟧ = ⟦8⟧ → ⟦7⟧ [-] = number → [1] → ⟦8⟧ = number → number → ⟦10⟧ = number → number → number number → ⟦2⟧ = ⟦10⟧ → ⟦9⟧ ⟦2⟧ = ⟦4⟧ = ⟦6⟧	⟦1⟧ ↦ number → ⟦2⟧ ⟦3⟧ ↦ boolean [n] ↦ number [2] ↦ number
Paso 3	[else] = ⟦5⟧ = ⟦6⟧ [+] = ⟦7⟧ → ⟦9⟧ → ⟦6⟧ = number → number → number number → ⟦2⟧ = ⟦8⟧ → ⟦7⟧ [-] = number → [1] → ⟦8⟧ = number → number → ⟦10⟧ = number → number → number number → ⟦2⟧ = ⟦10⟧ → ⟦9⟧ ⟦2⟧ = number = ⟦6⟧	⟦1⟧ ↦ number → ⟦2⟧ ⟦3⟧ ↦ boolean [n] ↦ number [2] ↦ number ⟦4⟧ ↦ number
Paso 3	[+] = ⟦7⟧ → ⟦9⟧ → ⟦6⟧ = number → number → number number → ⟦2⟧ = ⟦8⟧ → ⟦7⟧	⟦1⟧ ↦ number → ⟦2⟧ ⟦3⟧ ↦ boolean

	[-] = number → [1] → ⟦8⟧ = number → number → ⟦10⟧ = number → number → number number → ⟦2⟧ = ⟦10⟧ → ⟦9⟧ ⟦2⟧ = number = ⟦6⟧	[n] ↦ number [2] ↦ number ⟦4⟧ ↦ number ⟦5⟧ ↦ ⟦6⟧
Paso 5	⟦7⟧ = number ⟦9⟧ = number ⟦6⟧ = number number → ⟦2⟧ = ⟦8⟧ → ⟦7⟧ [-] = number → [1] → ⟦8⟧ = number → number → ⟦10⟧ = number → number → number number → ⟦2⟧ = ⟦10⟧ → ⟦9⟧ ⟦2⟧ = number = ⟦6⟧	⟦1⟧ ↦ number → ⟦2⟧ ⟦3⟧ ↦ boolean [n] ↦ number [2] ↦ number ⟦4⟧ ↦ number ⟦5⟧ ↦ ⟦6⟧
Paso 3	⟦9⟧ = number ⟦6⟧ = number number → ⟦2⟧ = ⟦8⟧ → number [-] = number → [1] → ⟦8⟧ = number → number → ⟦10⟧ = number → number → number number → ⟦2⟧ = ⟦10⟧ → ⟦9⟧ ⟦2⟧ = number = ⟦6⟧	⟦1⟧ ↦ number → ⟦2⟧ ⟦3⟧ ↦ boolean [n] ↦ number [2] ↦ number ⟦4⟧ ↦ number ⟦5⟧ ↦ ⟦6⟧ ⟦7⟧ ↦ number
Paso 3	⟦6⟧ = number number → ⟦2⟧ = ⟦8⟧ → number [-] = number → [1] → ⟦8⟧ = number → number → ⟦10⟧ = number → number → number number → ⟦2⟧ = ⟦10⟧ → number ⟦2⟧ = number = ⟦6⟧	⟦1⟧ ↦ number → ⟦2⟧ ⟦3⟧ ↦ boolean [n] ↦ number [2] ↦ number ⟦4⟧ ↦ number ⟦5⟧ ↦ ⟦6⟧ ⟦7⟧ ↦ number ⟦9⟧ ↦ number
Paso 3	number → ⟦2⟧ = ⟦8⟧ → number [-] = number → [1] → ⟦8⟧ = number → number → ⟦10⟧ = number → number → number number → ⟦2⟧ = ⟦10⟧ → number ⟦2⟧ = number = number	⟦1⟧ ↦ number → ⟦2⟧ ⟦3⟧ ↦ boolean [n] ↦ number [2] ↦ number ⟦4⟧ ↦ number ⟦5⟧ ↦ number ⟦7⟧ ↦ number ⟦9⟧ ↦ number ⟦6⟧ ↦ number
Paso 5	number = ⟦8⟧ ⟦2⟧ = number [-] = number → [1] → ⟦8⟧ = number → number → ⟦10⟧ = number → number → number number → ⟦2⟧ = ⟦10⟧ → number ⟦2⟧ = number = number	⟦1⟧ ↦ number → ⟦2⟧ ⟦3⟧ ↦ boolean [n] ↦ number [2] ↦ number ⟦4⟧ ↦ number ⟦5⟧ ↦ number

		$[\![\boxed{7}]\!] \mapsto$ number $[\![\boxed{9}]\!] \mapsto$ number $[\![\boxed{6}]\!] \mapsto$ number
Paso 4	$[\![\boxed{2}]\!]$ = number [-] = number $\to$ [1] $\to$ number = number $\to$ number $\to$ $[\![\boxed{10}]\!]$ = number $\to$ number $\to$ number number $\to$ $[\![\boxed{2}]\!]$ = $[\![\boxed{10}]\!]$ $\to$ number $[\![\boxed{2}]\!]$ = number = number	$[\![\boxed{1}]\!] \mapsto$ number $\to$ $[\![\boxed{2}]\!]$ $[\![\boxed{3}]\!] \mapsto$ boolean [n] $\mapsto$ number [2] $\mapsto$ number $[\![\boxed{4}]\!] \mapsto$ number $[\![\boxed{5}]\!] \mapsto$ number $[\![\boxed{7}]\!] \mapsto$ number $[\![\boxed{9}]\!] \mapsto$ number $[\![\boxed{6}]\!] \mapsto$ number $[\![\boxed{8}]\!] \mapsto$ number
Paso 3	[-] = number $\to$ [1] $\to$ number = number $\to$ number $\to$ $[\![\boxed{10}]\!]$ = number $\to$ number $\to$ number number $\to$ number = $[\![\boxed{10}]\!]$ $\to$ number number = number = number	$[\![\boxed{1}]\!] \mapsto$ number $\to$ number $[\![\boxed{3}]\!] \mapsto$ boolean [n] $\mapsto$ number [2] $\mapsto$ number $[\![\boxed{4}]\!] \mapsto$ number $[\![\boxed{5}]\!] \mapsto$ number $[\![\boxed{7}]\!] \mapsto$ number $[\![\boxed{9}]\!] \mapsto$ number $[\![\boxed{6}]\!] \mapsto$ number $[\![\boxed{8}]\!] \mapsto$ number $[\![\boxed{2}]\!] \mapsto$ number
Paso 5	[1] = number number = $[\![\boxed{10}]\!]$ number $\to$ number = $[\![\boxed{10}]\!]$ $\to$ number number = number = number	$[\![\boxed{1}]\!] \mapsto$ number $\to$ number $[\![\boxed{3}]\!] \mapsto$ boolean [n] $\mapsto$ number [2] $\mapsto$ number $[\![\boxed{4}]\!] \mapsto$ number $[\![\boxed{5}]\!] \mapsto$ number $[\![\boxed{7}]\!] \mapsto$ number $[\![\boxed{9}]\!] \mapsto$ number $[\![\boxed{6}]\!] \mapsto$ number $[\![\boxed{8}]\!] \mapsto$ number $[\![\boxed{2}]\!] \mapsto$ number
Paso 3	number = $[\![\boxed{10}]\!]$ number $\to$ number = $[\![\boxed{10}]\!]$ $\to$ number number = number = number	$[\![\boxed{1}]\!] \mapsto$ number $\to$ number $[\![\boxed{3}]\!] \mapsto$ boolean [n] $\mapsto$ number [2] $\mapsto$ number $[\![\boxed{4}]\!] \mapsto$ number $[\![\boxed{5}]\!] \mapsto$ number $[\![\boxed{7}]\!] \mapsto$ number $[\![\boxed{9}]\!] \mapsto$ number $[\![\boxed{6}]\!] \mapsto$ number $[\![\boxed{8}]\!] \mapsto$ number

		$[\boxed{2}] \mapsto$ number $[1] \mapsto$ number
Paso 4	number $\to$ number = number $\to$ number number = number = number	$[\boxed{1}] \mapsto$ number $\to$ number $[\boxed{3}] \mapsto$ boolean $[n] \mapsto$ number $[2] \mapsto$ number $[\boxed{4}] \mapsto$ number $[\boxed{5}] \mapsto$ number $[\boxed{7}] \mapsto$ number $[\boxed{9}] \mapsto$ number $[\boxed{6}] \mapsto$ number $[\boxed{8}] \mapsto$ number $[\boxed{2}] \mapsto$ number $[1] \mapsto$ number $[\boxed{10}] \mapsto$ number
Paso 1	number = number = number	$[\boxed{1}] \mapsto$ number $\to$ number $[\boxed{3}] \mapsto$ boolean $[n] \mapsto$ number $[2] \mapsto$ number $[\boxed{4}] \mapsto$ number $[\boxed{5}] \mapsto$ number $[\boxed{7}] \mapsto$ number $[\boxed{9}] \mapsto$ number $[\boxed{6}] \mapsto$ number $[\boxed{8}] \mapsto$ number $[\boxed{2}] \mapsto$ number $[1] \mapsto$ number $[\boxed{10}] \mapsto$ number
Paso 1	vacio	$[\boxed{1}] \mapsto$ number $\to$ number $[\boxed{3}] \mapsto$ boolean $[n] \mapsto$ number $[2] \mapsto$ number $[\boxed{4}] \mapsto$ number $[\boxed{5}] \mapsto$ number $[\boxed{7}] \mapsto$ number $[\boxed{9}] \mapsto$ number $[\boxed{6}] \mapsto$ number $[\boxed{8}] \mapsto$ number $[\boxed{2}] \mapsto$ number $[1] \mapsto$ number $[\boxed{10}] \mapsto$ number

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:

```
{fun {f : C1 } : C2
  {fun {x : C3 } : C4
    {fun {y : C5 } : C6
      {cons x {f {f y}}}}}}
```

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 especifico (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.