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PL HW 8

1. (Fun r -> r.x + r.y) {x=4; y=7}

building the proof tree until we see inconsistency

* we denote record type as Record({...})

$$\dfrac{\dfrac{\dfrac{r:a' \vdash r.x : int \setminus \{a' = Record(\{x:int\})\} \quad r:b' \vdash r.y : int \setminus \{a' = Record(\{y:int\})\}}{r:a' \vdash r.x + r.y : b' \setminus \{b' = Int\}} \quad \dfrac{\vdash 4 : int \setminus \emptyset \quad \vdash 7 : int \setminus \emptyset}{\vdash \{x=4;\ y=7\} : Record(\{x:int,\ y:int\})}}{\vdash (Fun\ r \to (r.x + r.y)) : a' \to b' \setminus \{\}}}{\vdash (Fun\ r \to r.x + r.y)\{x=4;\ y=7\} : c'}$$

As we build the tree we can see the difficulty in inferring local equations and check for inconsistency is in deciding our constraints for record types. when we evaluate r.x + r.y, when we evaluate r.x we expect an Int type and a constraint that r is a Record with Int field x whereas when we evaluate r.y we expect an Int and a constraint that r is a Record with int field y. when we type check both r.x r.y seperately they both expect different Record types which leads to inconsistencies even though r.x + r.y generates no runtime errors.

Some reasonable equations we get are (notation from the above tree):

$b' = Int$, $a' = Record(\{x: Int\})$, $a' = Record(\{y: Int\})$

when we compute closure:

we get inconsistency: $Record(\{x: Int\}) = a' = Record(\{y: Int\})$

2.

a. Type:

$Int \to \{x: Int\} \to \{x: int; y: int; z: int\}$
$\to \{x: int; y: int; z: int\}$

b. Subtype:

$Int \to \{\} \to \{\} \to \{x: int; y: int; z: int; s: int\}$

c. Supertype:

$Int \to \{x: int; y: int\} \to \{x: int; y: int; z: int; s: int\} \to \{\}$

3.

a. $\{x: Int; y: \{z: Bool\}\}$ and $\{x: Int; y: \{\}; w: Int\}$

Neither

$\vdash Int <: Int, \vdash \{z: Bool\} <: \{\}$ no match for w *

$\{x: Int; y: \{z: Bool\}\} <: \{x: Int; y: \{\}; w: Int\}$

thus not a subtype of right

b. $\{x: Int\} \to \{\}$ and $\{\} \to \{x: Int\}$

~~Subtyp~~ Supertype

$$\dfrac{\dfrac{\dfrac{}{\{\} <: \{\}}}{\{x: Int\} <: \{\}} \qquad \dfrac{\dfrac{}{\{\} <: \{\}}}{\{x: Int <: \{\}}}}{\{\} \to \{x: Int\} <: \{x: Int\} \to \{\}}$$

$$\cancel{\dfrac{\{\}}{\{x: Int\} \to \{\} <: \{\} \to \{x: Int\}}}$$

C. $(\{x : Int\} \to \{\}) \to \{\}$ and $(\{\} \to \{x : Int\}) \to \{\}$

<u>Subtype</u>

$$\dfrac{\dfrac{\dfrac{\dfrac{}{\{\} <: \{\}}}{\{x : Int\} <: \{\}} \qquad \dfrac{\dfrac{}{\{\} <: \{\}}}{\{x : Int\} <: \{\}}}{(\{\} \to \{x : Int\}) <: (\{x : Int\} \to \{\})} \qquad \dfrac{}{\{\} <: \{\}}}{(\{x : Int\} \to \{\}) \to \{\} <: (\{\} \to \{x : Int\}) \to \{\}}$$