Infer

HackerRank

If we know that `one` is of type `int` and `id` is of type `forall[a] a -> a`, we can infer that `id(one)` is of type `int`.

A function `fun x y -> x` has a generic type of `forall[a b] (a, b) -> a`.

Let's write a program to help us infer the type of expression in a given envrionment!

First, we define the syntax of expression:

```
ident : [_A-Za-z][_A-Za-z0-9]*              // variable names

expr : "let " ident " = " expr " in " expr  // variable defination
     | "fun " argList " -> " expr           // function defination
     | simpleExpr

argList : { 0 or more ident seperated by ' ' }

simpleExpr : '(' expr ')'
           | ident
           | simpleExpr '(' paramList ')'   // function calling

paramList : { 0 or more expr seperated ", " }
```

Then, we define the syntax of type:

```
ty : "() -> " ty                            // function without arguments
   | '(' tyList ") -> " ty                  // uncurry function
   | "forall[" argList "]" ty               // generic type
   | simpleTy " -> " ty                     // curry function
   | simpleTy

tyList : { 1 or more ty seperated by ", " }

simpleTy : '(' ty ')'
         | ident
         | simpleTy '[' tyList ']'          // such as list[int]
```

Hint in parsing:

- Spacing is strict.
- Pay attention to avoid dead loop.

Type of given expression should be infered in an environment. The environment is consisted of a set of functions with types:

```
head: forall[a] list[a] -> a
tail: forall[a] list[a] -> list[a]
nil: forall[a] list[a]
cons: forall[a] (a, list[a]) -> list[a]
cons_curry: forall[a] a -> list[a] -> list[a]
map: forall[a b] (a -> b, list[a]) -> list[b]
map_curry: forall[a b] (a -> b) -> list[a] -> list[b]
one: int
zero: int
```

```
succ: int -> int
plus: (int, int) -> int
eq: forall[a] (a, a) -> bool
eq_curry: forall[a] a -> a -> bool
not: bool -> bool
true: bool
false: bool
pair: forall[a b] (a, b) -> pair[a, b]
pair_curry: forall[a b] a -> b -> pair[a, b]
first: forall[a b] pair[a, b] -> a
second: forall[a b] pair[a, b] -> b
id: forall[a] a -> a
const: forall[a b] a -> b -> a
apply: forall[a b] (a -> b, a) -> b
apply_curry: forall[a b] (a -> b) -> a -> b
choose: forall[a] (a, a) -> a
choose_curry: forall[a] a -> a -> a
```

Sample Input #00

```
let x = id in x
```

Sample Output #00

```
forall[a] a -> a
```

Explanation #00:
`x` is just `id` in the environment.

Sample Input #01

```
fun x -> let y = fun z -> z in y
```

Sample Output #01

```
forall[a b] a -> b -> b
```

Explanation #01:
Function with variables which are not bounded in the environment should be generic function. The variable names appear in `forall[]` should be from `a` to `z` subject to their appearance order in type body.

Sample Input #02

```
choose(fun x y -> x, fun x y -> y)
```

Sample Output #02

```
forall[a] (a, a) -> a
```

Explanation #02:
The type of `choose` is `forall[a] (a, a) -> a`. So `x` and `y` should be of the same type.

Sample Input #03

```
fun f -> let x = fun g y -> let _ = g(y) in eq(f, g) in x
```

Sample Output #03

```
forall[a b] (a -> b) -> (a -> b, a) -> bool
```

Explanation #03:
The longest test case.

Final note:

All given expression are valid, non-recursive and can be infered successfully in given environment. But an *optional* requirement is that your program should *fail* on incomplete uncurry version function calling. For example, `choose_curry(one)` should be infered as `int -> int` but `choose(one)` just *fail* in infering.

Tested by Bo You