CS 565, Jens Palsberg Feb 17, 1999

Homework 3: Java Structural Subtyping

A grammar for a list of MiniJava interfaces together with a list of subtype queries, in JavaCC notation, is on the CS 565 webpage (interface.jj).

A subtype query is of the form

```
A <= B ?
```

where `A` and `B` are names of interfaces. This query has the answer Yes if `A` is a subtype of `B` in the *structural* subtyping order for Java described below, and No otherwise.

Use JTB and JavaCC and write in Java one or more visitors which decides the subtype queries.

Your main file should be called `DecideSubtyping.java`, and if `P` contains an input file then

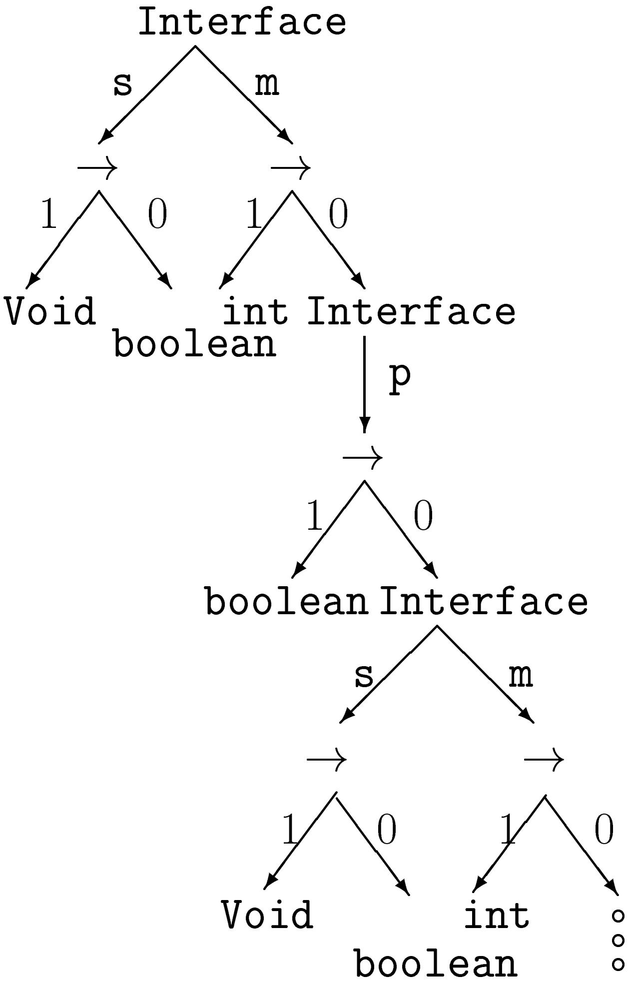
```
java DecideSubtyping < P
```

should print a sequence of `Yes` and `No`, each on a new line.

In this Homework, we view a MiniJava interface as an infinite, regular tree which is obtained by replacing occurrences of interface names by their definition.

```
interface I {
  void s(boolean a);
  int m(J a);
}

interface J {
  boolean p(I a);
}
```



A path is in the set

$$(Identifier\ \{0,1\})^*$$

where the identifiers are method names, 0 denotes "argument type", and 1 denotes "result type". We use id to range over $Identifier$.

Labels are from the set $\Sigma = \{\texttt{int}, \texttt{boolean}, \texttt{Void}, \rightarrow, \texttt{Interface}\}$.

An interface can now be represented as a partial function

$$t : (Identifier\ \{0,1\})^* \ \rightarrow\ \Sigma$$

with domain $\mathcal{D}(t)$ satisfying

- $\mathcal{D}(t)$ is nonempty and prefix-closed;
- if $t(\alpha) = \rightarrow$, then $\alpha 0, \alpha 1 \in \mathcal{D}(t)$;
- if $\alpha 0 \in \mathcal{D}(t)$, then $t(\alpha 0) \in \{\texttt{int}, \texttt{boolean}, \texttt{Void}, \texttt{Interface}\}$;
- if $\alpha 1 \in \mathcal{D}(t)$, then $t(\alpha 1) \in \{\texttt{int}, \texttt{boolean}, \texttt{Void}, \texttt{Interface}\}$;
- if $\alpha\ id \in \mathcal{D}(t)$, then $t(\alpha\ id) = \rightarrow$.

We can now define a structural subtyping order of MiniJava interfaces by combining the ideas from Lecture Note 3, p.16 with the idea that a interface with a certain number of fields should be a subtype of an interface with fewer fields.

For example, we want to have

```
A <= B ?  // No
B <= A ?  // Yes
C <= D ?  // No
D <= C ?  // Yes

interface A {
  A m(int a);
}

interface B {
  B m(int a);
  void p(boolean a);
}

interface C {
  int q(B a);
}

interface D {
  int q(A a);
  void r(int a);
}
```

We leave it to the reader to work out the details of the definition of structural subtyping.