CS 3360 - Design and Implementation of Programming Languages

HOMEWORK 2: NAMES, BINDINGS AND SCOPES

Due: October 18, 2018

This homework may be done individually or in pair.

The purpose of this homework is to understand various design issues
concerning program variables.

1. (5 points) Variables in PHP are represented by a dollar sign ($)
   followed by the name of the variable. Discuss the advantages and
   disadvantages of preceding a PHP variable name with a dollar sign.

2. (5 points) Define static binding and dynamic binding.

3. (5 points) A programming language can be typeless. What are the
   obvious advantages and disadvantages of having no type in a
   language?

4. (5 points) Dynamic type binding is closely related to implicit
   heap-dynamic variables. Explain this relationship.

5. (10 points) Define what binding time is. List five different
   binding times and give an example of each.

6. (15 points) Consider the following Java assignment statement with one
   arithmetic operator:

```
x = y + 1.0;
```

For each component of the statement (e.g., variable, operators, and constant), list the various bindings that are required to determine the semantics (meaning) when the statement is executed. For each binding, indicate the binding time used.

7. (15 points) Define static, stack-dynamic, explicit heap-dynamic and implicit heap dynamic variables. What are the advantages and disadvantages of these variables?

8. (10 points) Java does not support a history sensitive variable in a method. Explain how you can simulate or implement a history sensitive variable in Java, and describe the advantages of supporting a history sensitive variable as a built-in language feature (e.g., in PHP).

9. (10 points) There are several different approaches for determining the type of a variable, including type inference (e.g., Haskell), explicit type declarations (e.g., Java), and dynamic typing (e.g., PHP). Compare type inference and the other two approaches and describe its advantages and disadvantages.

10. (10 points) Consider the following Java-like program that uses static scoping.

```
   void fun() {
     int a, b, c; /* definition 1 */
     ...
     while (...) {
       int a, c, d; /* definition 2 */
       ... <------------------------ 1
       while (...) {
         int d, e, f; /* definition 3 */
         ... <----------------------- 2
       }
       ... <------------------------- 3
     }
     ... <--------------------------- 4
   }
```

   For each of the four statements labeled 1-4 in this function, list
   all visible variables along with the definition statements (1-3)
   that define them.

11. (10 points) Consider the following Java-like program:

```
   void main() {
     int a, b, c;
     ...
   }
   void fun1() {
     int b, c, d;
     ...
   }
   void fun2() {
     int c, d, e;
     ...
   }
   void fun3() {
     int d, e, f;
     ...
   }
```

Given the following calling sequences and assuming that dynamic scoping is used, what variables are visible during execution of the last function called? Include with each visible variable the name of the function in which it was defined.

(a) main calls fun1; fun1 calls fun2; fun2 calls fun3.
(b) main calls fun1; fun1 calls fun3.
(c) main calls fun2; fun2 calls fun3; fun3 calls fun1.
(d) main calls fun3; fun3 calls fun1.
(e) main calls fun1; fun1 calls fun3; fun3 calls fun2.
(f) main calls fun3; fun3 calls fun2; fun2 calls fun1.

12. (10 bonus points) Write test programs in Java and PHP to determine the scopes of variables declared in a "for" statement and a "do" statement; include loop variables, e.g., x from "for (int x = 0; ...". Specifically, your code should tell whether such variables are visible in the code following the body of the "for" or "do" statement. Summarize your findings.

WHEN AND HOW TO TURN IN

Turn in your solutions at the start of class on the due date. If you work in pair, submit only one copy by making sure to put both names. No late submission will be accepted unless arrangements have been made in advance or unless unusual circumstances warrant an exception.

GRADING

Clarity is important; if your writings are sloppy and hard to read,
your will lose points.