CSCI 3155 Problem Set 1

Anthony Tracy

01/27/2018

1. ***Feedback: Complete survey linked from the moodle after completing this assignment. Any non-empty answer will receive full credit.***

   This has been done.

2. ***Scala Basics: Binding and Scope. For each the following uses of names, give the line where that name is bound. Briefly explain your reasoning (in no more than 12 sentences).***

   (a) Looking at the following code: The use of pi at line 4 is bound at which line? The use of pi at line 7 is bound at which line?

   ```
   1 val pi = 3.14
   2 def circumference(r: Double): Double = {
   3    val pi = 3.14159
   4    2.0 * pi * r
   5 }
   6 def area(r: Double): Double =
   7    pi * r * r
   ```

   The use of pi as line 4 is bound as line 3, where val pi is defined within the declared function. The use of pi at line 7 is bound to the value of pi declared at line 1, since the function declared for $pi * r * r$ doesn't have another form of pi declared so it uses the one declared from line 1.

(b) Consider the following Scala code. The use of x at line 3 is bound
at which line? The use of x at line 6 is bound at which line? The
use of x at line 10 is bound at which line? The use of x at line 13
is bound at which line?

```
1  val x = 3
2  def f(x: Int): Int =
3    x match {
4      case 0 => 0
5      case x => {
6        val y = x + 1
7        ({
8          val x = y + 1
9          y
10       } * f(x-1))
11     }
12   }
13 val y = x + f(x)
```

The use of x at line 3 is bound to the input x declared in line 2 to
the definition function. The use of x at line 6 is bound to line 5
where if the input to the defined function is not 0, then that value
gets defined by the case that passes x to the next portion of code.
The use of x at line 10 is bound to line 8 where x is redefined by
$x = y + 1$, and the use of x at line 13 is bound by line 1 where the
val x = 3.

3. **Scala Basics: Typing. In the following, I have left off the
return type of function g . The body of g is well-typed if
we can come up with a valid return type. Is the body of g
well-typed? If so, give the return type of g and explain how
you determined this type. For this explanation, first, give
the types for the names a and b.**

```
1  def g(x: Int) = {
2    val (a, b) = (1, (x, 3))
3    if (x == 0) (b, 1) else (b, a + 2)
4  }
```

The return type would need to be set to ((int,int),int) as shown below:

```
if x == 0:
(b,1):  ((int,int),int) because:
    1:  int
    b:  (x,3):  (int,int) because:
        x: int
        3: int
else:
(b,a+2):  ((int,int),int) because:
    a:  int
    2:  int
    b:  (int,int)
```

4. ***Run-Time Library. Most languages come with a standard library with support for things like data structures, mathematical operators, string processing, etc. Standard library functions may be implemented in the object language (perhaps for portability) or the meta language (perhaps for implementation efficiency). For this question, we will implement some library functions in Scala, our meta language, that we can imagine will be part of the run-time for our object language interpreter. In actuality, the main purpose of this exercise is to warm-up with Scala.***

   (a) **Write a function abs:** Code is written and passing test.

   (b) **Write a function xor:** Code is written and passing test.

5. ***Run-Time Library: Recursion.***

   (a) **Write a recursive function repeat:** Code is written and passing test.

   (b) **Write a square-root function using Newton-Raphson's method:** To do this we used the following equations:

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)} \tag{1}$$

   where the are root of a real number c for c ¿ 0, written c, is a positive x such that x 2 = c. Thus, to compute the square root of a number c can be written withe the equation:

3

$$f(x) = x^2 - c \tag{2}$$

which can be plugged into equation 1, creating:

$$x_{n+1} = x_n - \frac{x_n^2 - c}{2 * x_n} \tag{3}$$

All portions of this code have passes test.

6. **Data Structures Review: Binary Search Trees.**

   (a) **Write a function repOk(t: SearchTree):** Code is written and passing test.

   (b) **Write a function insert(t: SearchTree,n: Int):** Code is written and passing test.

   (c) **Write a function deleteMin((t: SearchTree):** Code is written and passing test.

   (d) **Write a function delete(t: SearchTree,n: Int):** Code is written and passing test.

7. **JavaScripty Interpreter: Numbers.**

   The function eval(e: Expr): Double has been completed and tested. It is passing tests and all of the code will be included in the Scala files.

4