CMPSC 461: Programming Languages Concepts

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Homework 3: **Due on Feb 25th at 6pm in Canvas.**

1. (6 points) Consider the following function written in the C syntax:

```
1. int foo(int a, int b) {
2.    b = b + 10;
3.    a = b * 2;
4.    return a + b;
5. }
```

In each of the cases below, assume that the initial values of the variables are x=1, y=2, and z=3. Write down the values of x, y, and z after the following calls to foo(). If necessary, assume that output parameters are copied back to arguments in the left-to-right order.

(a) z = foo(x,y) where all parameters are passed by value

(b) z = foo(x,y) where all parameters are passed by reference

(c) z = foo(x,y) where all parameters are passed by value-result

(d) z = foo(y,y) where all parameters are passed by value

(e) z = foo(y,y) where all parameters are passed by reference

(f) z = foo(y,y) where all parameters are passed by value-result

2. (2 points)
   Consider the following C++ program, where &i means i is passed by reference:

```
int bar (int &i, int j) {
  i = i - j;
  return 2 * i;
}
void foo1 () {
  int x = 3, y = 6, sum;
  sum = bar(x, y) + y;
```

```
}
void foo2 () {
  int x = 2, y = 7, sum;
  sum = bar(x, y);
  sum = sum + x;
}
```

(a) What is the value of sum at the end of the function foo1? Briefly explain why.

(b) What is the value of sum at the end of the function foo2? Briefly explain why.

3. (4 points) Consider the following Java code:

```
1. public int summation(int start, int end) {
2.    if (start == end)
3.       return start;
4.    else
5.       return start + summation(start+1, end);
6. }
```

Show the runtime stack that is built in order to calculate summation(3,6). You should show the stack's state whenever an activation record is pushed on or popped off. Be sure your representation of the stack includes all dynamic links, current values for all parameters, and, when appropriate, give the return value of the function.

1. $x=1 \; y=2 \; z=3$

a) pass by value

$\quad (a,b) \rightarrow (1,2)$

$\quad b = 2+10 = 12$

$\quad a = 12 \cdot 2 = 24$

$\quad$ return $a+b = 36$

$\quad z = 36, \; x=1, \; y=2$

b) reference (x,y)

$\qquad\qquad a \quad b$

$\qquad y = y+10 = 12$

$\qquad x = y \cdot 2 = 24$

$\qquad z = 36 \quad x=24 \quad y=12$

c) value-result $(x,y) \qquad x=1 \; y=2$

$\qquad\qquad a,b$

$\qquad\qquad b = 2+10 = 12$

$\qquad\qquad a = 12 \cdot 2 = 24$

$\qquad\qquad$ return $12+24 = 36$

$x = 24 \quad y = 12 \quad z = 36.$

d) (y, y)

$b = 2 + 10 = 12$

$a = 12 \cdot 2 = 24$

return 36

$x = 1 \quad y = 2 \quad z = 36$

e) $(y, y) \quad (a, b)$

$y = 2 + 10 = 12$

$y = 12 \cdot 2 = 24$

$z = 48 \quad x = 1 \quad y = 24$

f) (y,y) $(2,2)$

$$b = 12$$
$$a = 24$$
$$x = 1 \quad y = 24 \quad z = 36$$

2.a) $(x, 6)$

$$x = x - 6 = -3$$

return $2 \cdot -3 = -6$

$$sum = -6 + y = 0$$

$$x = -3 \quad y = 6 \quad sum = 0$$

b) $sum = (x, 7)$

$$y = x - 7 = -5$$

$$sum = -10$$

$$sum = -10 + -5 = -15$$

$$x = -5 \quad y = 7 \quad sum = -15$$

3.

Start with (3,6)

Start 3	
end 6	

→

4	
6	
Start 3	
end 6	

→

5	
6	
4	
6	
3	
6	

→

6	
6	
5	
6	
4	
6	
Start 3	
end 6	

| 6 |
5	
6	
4	
6	
Start 3	
end 6	

→

| 11 |
4	
6	
Start 3	
end 6	

→

| 15 → 18 |
| Start 3 | |
| end 6 | |

(return)