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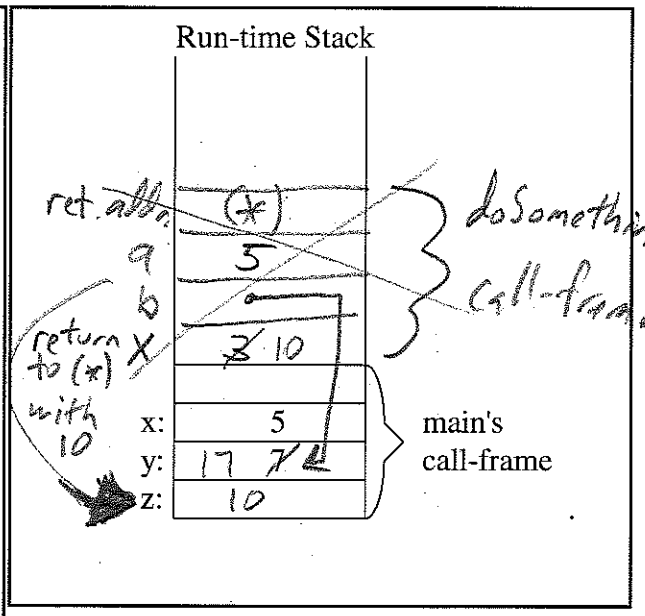
Introduction to Computing Test 2

Question 1. (15 points) Complete the tracing of the following code to show the expected output and the run-time stack as the program executes. Recall that a function's call-frame contains the return address, formal parameter(s), and local variable(s).

```
#include <iostream>
using namespace std;

int doSomething(int a, int & b);

int main() {
   int x = 5, y = 7, z;
                    (*)
   z = doSomething(x, y);

   cout << "x = " << x << " y = " << y
        << " z = " << z << endl;
} // end main

int doSomething(int a, int & b) {
   int x = 3;

   x = 2 * a;
   b = x + b;
   return x;

} // end doSomething
```

Continue trace from here

15



Expected Output

x = 5 y = 17 z = 10

+5 run-time stack (ret. addr., ~~param~~ local var.)
+5 parameter passing
+5 output

Question 2. (10 points) Use the gradebook example discussed in class to describe what is meant by the term "*parallel arrays*".

columnTitles:

0	1	2	3	4	5		49
HW 1	HW 2	Lab 1	Lab 2	Test 1			

studentNames:

0	"Doe, Jane"
1	"Morse, Cody"
2	"Smith, John"
3	
99	

scores:

	0	1	2	3	4	5		49
0	1.0	2.0	3.0	4.0	5.0			
1	1.1	2.2	3.3	4.4	5.5			
2	10.0	20.0	30.0	40.0	50.0			
3								
99								

The same index value across multiple arrays is used to relate information about the same entity.
For example, row 0 in studentNames and row 0 in scores both refer to "Doe, Jane's information

10

25

Question 3. (10 points) All simple sorts consist of two nested loops. The role of each loop is:

- outer loop - keeps track of the dividing line between the sorted part and unsorted part of the array
- inner loop - extends the size of the sorted part by one element

For each simple sort listed below, describe **in English** how the inner loop extends the size of the sorted part by one element. Assume that all sorts are sorting from smallest to largest elements (ascending order).

a) bubble sort:

Unsorted Part	Sorted Part

5 The inner-loop scans the unsorted part from l-to-r. comparing adjacent elements. If they are out-of-order, then it swaps them. This causes the largest element in the unsorted part to "bubble" to the right end of the unsorted part.

b) selection sort:

Sorted Part	Unsorted Part

5 The inner-loop scans the unsorted part to find the minimum element in it. After the inner-loop, the min. element is swapped with the first unsorted element.

Question 4. (40 points) Complete the following program by (1) writing the calls in the main to both functions, and (2) writing both of the functions: FillArray and FindFirstAndCount. These functions' prototypes are shown below, and they should behave as follows:

FillArray - reads values interactively into the "numbers" array until the specified sentinelValue is read. After the function, "elementCount" should reflect the number of values read into "numbers."

FindAll - scans the array "numbers" looking for all occurrences of "target". The index locations of all occurrence of "target" is returned in "foundIndexes", and "foundCount" returns a count of the number of times "target" occurs in the array "numbers".

```
#include <iostream>
using namespace std;

const int SIZE = 100;  // maximum number of elements in array

// function prototypes
void FillArray(double numbers[], int & elementCount, double sentinelValue);
void FindAll(double numbers[], int elementCount, double target, int foundIndexes[],
             int & foundCount);

int main ( ) {
   int countOfNumbers, targetCount, targetLocations[SIZE];
   double numbers[SIZE], sentinel = -999, target = 100;

   // COMPLETE THE CALLS TO THE FUNCTIONS
   FillArray( numbers, countOfNumbers, sentinel );
   FindAll( numbers, countOfNumbers, target, targetLocations, targetCount);

   if (targetCount == 0) {
      cout << "The target of " << target << " was not found." << endl;
   } else {
      cout << "The target " << target << " was found " << targetCount
           << " times with the first occurrence at " << targetLocations[0] << endl;
   } // end if
} // end main
```

+2 local names of main
+3 correct # + type of parameters
+5

15

// WRITE THE CODE FOR THE FUNCTIONS FillArray and FindAll BELOW

```
void FillArray(double numbers[], int & elementCount, double sentinelValue) {
    double value;
    elementCount=0;
    while (true) {
        cout << "Enter a value (or " << sentinelValue
             << " to quit): ";
        cin >> value;
        if (value == sentinelValue) {
            return;
        }
        numbers[elementCount] = value;
        elementCount++;
    } //end while
} // end FillArray
```

(15)

```
void FindAll(double numbers[], int elementCount, double target, int foundIndexes[],
        int & foundCount) {
    int testIndex;
    foundCount = 0;

    for (testIndex=0; testIndex < elementCount; testIndex++)
    {
        if (target == numbers[testIndex]) {
            foundIndexes[foundCount] = testIndex;
            foundCount++;
        } //end if
    } //end for

} // end FindAll
```

(20)

Question 5. (10 points) Suppose you have a sorted array containing 1,000 elements.

a) In the worst case, how many comparisons between the target and an array element would be performed in an **unsuccessful binary search**? 10

b) In the worst case, how many comparisons between the target and an array element would be performed in an **unsuccessful linear search** (assume the linear search algorithm **does not** expect the array is sorted)? 10

1000

Question 6. (15 points) Below is the textbook's code for a *binary search* on a sorted array.

```
int binarySearch(int array[], int size, int value) {
   int first = 0,              // First array element
       last = size - 1,        // Last array element
       middle,                 // Mid point of search
       position = -1;          // Position of search value
   bool found = false;         // Flag

   while (!found && first <= last) {
      middle = (first + last) / 2;      // Calculate mid point
      if (array[middle] == value) {     // If value is found at mid
         found = true;
         position = middle;
      } else if (array[middle] > value) {  // If value is in lower half
         last = middle - 1;
      } else {
         first = middle + 1;            // If value is in upper half
      } // end if
   } // end while
   return position;
} // end binarySearch
```

Trace the `binarySearch` code using the following actual parameters by showing the changes to first, last, middle, position, and found.

	0	1	2	3	4	5	6	(MAX-1)
array:	2	3	4	5	7	8	9	

size: 7 value: 7

15

first	last	middle	position	found
~~0~~	~~6~~	~~3~~	~~-1~~	~~false~~
4				
		~~5~~		
	4			
		4		

25

4 true