With solutions...

CS110 Introduction to Computing
Spring 2011
Exam 2

This is a closed book / closed notes exam. Your work on this exam must be your own. Answer all questions in the space provided, continuing your answer on the back of the page if necessary. If you want scrap paper, please ask your instructor.

All Processing statements you write should be syntactically correct. There will be no credit for incorrect use of Processing syntax.

Be certain to use proper indentation and commenting in any code you write.

Be certain to sign the log-in sheet for the examination period, and the statement of academic honesty on the exam cover page.

I wish you each the best of luck!

Sign the following statement after you have completed the examination. Your exam will not be graded without your signature.

I certify that my responses in this examination are solely the product of my own work and that I have fully abided by the Bryn Mawr College Computer Science Academic integrity policy and instructions stated above while taking this exam.

Signature: ____________________________________________

Printed Name: ________________________________________

For Instructor Use Only:

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Section 1: String Manipulation (10 points total)
Circle or write the correct answer to each question.

1.1 (1 pt) Write your name on EVERY page of the exam booklet and any scrap paper you use.

Given the commands:

```java
String aPalindrome = "a man, a plan, a canal Panama";
String[] strs = splitTokens(aPalindrome, ",");
```

Answer the following questions:

1.2 (3 pts) What will be the length of `strs`? (c)
   a) 1  
   b) 2  
   c) 3  
   d) 4

1.3 (3 pts) What will be the value of `strs[1]`? (b)
   a) "a man"  
   b) "a plan"  
   c) "a canal Panama"  
   d) 3

1.4. (3 pts) Write the expression used to obtain the number of elements in `strs`.
```java
strs.length;
```
Section 2: Conditionals (15 points total)

2.1 (7 pts) Write a conditional expression that would print to the screen "weekday" whenever the integer variable day is not equal to 0 or 6.

```java
if (day != 0 && day != 6) {
    println("weekday");
}
```

2.2 (8 pts) Consider a function which toggles (i.e., switches) the value for a global boolean variable that tracks whether a light is on or off. Two people, creatively named A and B, who are claiming to be expert light switchers have written two different implementations of this function, shown below:

```java
// the global variable
boolean lightOn = false;
...
void toggleLightA() {
    if (lightOn) {
        lightOn = false;
    } else {
        lightOn = true;
    }
}

// the global variable
boolean lightOn = false;
...
void toggleLightB() {
    if (lightOn) {
        lightOn = false;
    } else if (!lightOn) {
        lightOn = true;
    }
}
```

Are these two implementations equivalent? Are both of the people expert light switchers, or is one or are both of them frauds? Why? Explain your answer!

They are not equivalent. Person A is an expert. Person B is a fraud. The function toggleLightB() is implemented with two consecutive if-statements that set lightOn to false and then back to true whenever lightOn starts with a value of true. Consequently, the value of lightOn does not toggle between true and false.
Section 3: Multidimensional Arrays (10 points total)

3. Add the necessary lines of code within `setup()` that fills the `vals` array with random numbers of your choosing. Your implementation must use for loops.

```java
float[][] vals;

void setup() {
    vals = new float[20][300];

    // Add your code here

    for (int r=0; r<20; r++) {
        for (int c=0; c<300; c++) {
            vals[r][c] = random(100);
        }
    }
}

} // Closing brace for setup()
```
Section 4: Transformations (10 points total)

4. Add the necessary transformations to draw() to render the rectangle at the center of the sketch, twice its size, and rotated by 45 degrees (\(\pi/4\) radians).

```java
void setup() {
    size(400, 400);
    rectMode(CENTER);
}

void draw() {
    // Add transformations here
    translate(200, 200);
    scale(2);
    rotate(PI/4.0);

    rect(0, 0, 25, 25);
}
```
Section 5: Sorting and Searching (15 points total)

Consider the following array:

```java
class float[] vals = new float[] {1, 3, 6, 8, 9, 13, 19, 23, 32, 40};
```

We could use the following code to determine whether the value \( x \) is in the array:

```java
float x = 10;
boolean containsValue = false;
for (int i=0; i < vals.length; i++) {
    if (vals[i] == x) { // comparison
        containsValue = true;
    }
}
```

However, in the worst case, this method requires \( \text{vals.length} \) (10) comparisons.

5.1 (10 pts) Describe in detail how the binary search algorithm would work to find whether \( x \) is in the array. Make certain to describe how the algorithm works.

1. Init min and max variables to lowest and highest index
2. Repeat while min <= max
   - Compare item at the middle index with \( x \)
   - If item at middle equals \( x \), return middle
   - If \( x \) comes before middle, then reset max to middle-1
   - If \( x \) comes after middle, reset min to middle+1
3. If min > max, \( x \) not found

5.2 (5 pts) How many comparisons would binary search take to solve the same problem? Justify your answer if you’re not certain.

4

\[ \log_2(10) \approx 3.3, \text{ which rounds up to 4} \]
Section 6: Image Processing (10 points total)

6. Add the necessary code within the nested for-loops to color all pixels white, except for pixels on the diagonal (when \( r == c \)).

```java
void setup() {
    size(100,100);

    loadPixels();

    for (int r=0; r<width; r++) {
        for (int c=0; c<height; c++) {
            // Add code here

            if ( !(r == c) ) { // Closing brace for the c-loop
                int i = r*width + c;
                pixels[i] = color(255);
            }
        }
        // Closing brace for the r-loop
    }

    updatePixels();
}
```
Section 7: Recursion (15 points total)

7.1. (10 pts) What does the following program print? Justify your answer if you’re not certain.

```java
void setup() {
    int n = op(5, 3);
    println(n);
}

int op(int val, int divisor) {
    if (val < divisor) {
        return val;
    } else {
        return op(val - divisor, divisor);
    }
}
```

2

7.2. (5 pts) Which built-in mathematical operator does the op() function simulate?

% (modulo)
Section 8: Algorithms and Debugging (20 points total)

8. The following program was designed to count and print the number of duplicates in the myArray String array. Unfortunately, it doesn't work properly. When I test it with the given data, it tells me that I have 11 duplicates, but I know that there are only two. Fix the program so that it works correctly.

```java
// Count and print the number of duplicate strings in myArray
void setup() {
    int count = 0;
    for (int i=0; i<myArray.length; i++) {
        for (int i=0; i<myArray.length-1; i++) {
            for (int j=0; j<myArray.length; j++) {
                for (int j=i+1; j<myArray.length; j++) {
                    if (myArray[i].equals(myArray[j])) {
                        count++;
                    }
                }
            }
        }
    }
    println("There are "+ count + " duplicates.");
}
```