# CIS 110 - Introduction to Computer Programming Spring 2017 - Exam 1

#### Name:

#### Recitation (e.g. 201):

#### PennKey (e.g. eeaton):

My signature below certifies that I have complied with the University of Pennsylvania's Code of Academic Integrity in completing this examination.

#### Signature

#### Instructions

- Do not open this exam until told by the proctor. You will have 110 minutes to finish it. There are 110 total points.
- Make sure your phone is turned OFF (not to vibrate!) before the exam.
- Food, gum, and drink are prohibited.
- You may not use your phone or open your bag for any reason, including to retrieve or put away pens or pencils, until you have left the exam room.
- This exam is closed-book, closed-notes, and closed computational devices.
- If you get stuck on a problem, it may be to your benefit to move on to another question and come back later.
- All answers must be written on the exam booklet; answers written on scrap paper will not be counted.
- All code must be written in proper Java, including all curly braces and semicolons.

#### Date

- Do not separate the pages. Re-attach any loose pages with the provided staplers.
- Staple all scratch paper to your exam. Do not take any sheets of paper with you.
- If you require extra paper, please use the backs of the exam pages or the extra pages provided at the end of the exam.
- Clearly indicate on the question page where the graders can find the remainder of your work (e.g., "back of page" or "on extra sheet").
- Use only a pencil, or blue or black pen.
- If you have any questions, raise your hand and a proctor will come to answer them.
- When you turn in your exam, you must show ID. If you forgot to bring your ID, talk to an exam proctor immediately.
- We wish you the best of luck.

## 1 Miscellaneous (9 points total)

```
1. (1 pt) Do the following:
```

- Check that your exam has all 13 pages (including the cover sheet and scratch paper).
- Write your name, recitation number, and PennKey (username) on the front of the exam.
- Sign the certification that you comply with the Penn Academic Integrity Code.

To let us know you did it, answer this question: If you invented a search algorithm, what would you name it?

```
(A) "Cat Scan"
```

- (B) "Lost 'n Found"
- (C) "Yet Another Search Algorithm"
- (D) "You Can't Search If You Don't Look"
- (E) "Hide and Seek"

2. (3 pts) Translate the while loop below into a for loop.

```
int x = 10;
        while (x > 0) {
            int a = x;
            a--;
            x -= 2;
        }
(A) for (int x = 10; x > 0; x -= 2) {
                                              (B) for (int x = 10; x > 0; x - -) {
        a = x;
                                                       a = x;
        x--;
                                                       a--;
    }
                                                  }
(C) for (int x = 10; x > 0; x -= 2) {
                                              (D) for (int a = 10; a > 0; a -= 2) {
        a = x;
                                                       a = x;
                                                       x--;
        a--;
    }
                                                  }
(E) None of the above are correct
```

3. (2 pts) Which of the following statements about casting is false? (Choose one)

(A) A char can be cast to an int(B) An double can be cast to a char(C) An int can be cast to a double(D) A String can be cast to a char(E) All of the above statements are true

4. (3 pts) What is the output of calling the function below with the array {3, 2, 1} (that is, calling x\_oppleganger(new int[]{3, 2, 1})?

```
public static int[] x_oppleganger(int[] arr) {
    int total = 0;
    for (int i = 0; i < arr.length; i++) {</pre>
        total += arr[i];
    }
    int[] newArr = new int[total];
    int newIndex = 0;
    for (int i = 0; i < arr.length; i++) {</pre>
        for (int j = 0; j < arr[i]; j++) {</pre>
            newArr[newIndex] = arr[i];
            newIndex++;
        }
    }
    return newArr;
}
(A) {3, 2, 1, 2, 3, 1}
(B) {3, 2, 1, 3, 2, 1}
(C) {3, 3, 2, 2, 3, 1}
(D) {3, 3, 3, 2, 2, 1}
(E) None of the above are correct
```

## 2 Variables, Operators, and Types (14 points total; 2 pts per row)

Nico and Ashu were so distracted by designing bathrobes for all the CIS 110 TAs that they didn't finish writing the data types for each code fragment below. Furthermore, they didn't carefully check to make sure that each code fragment worked, so there may be errors.

For each code fragment, (1) fill in the most appropriate data type in the 1st column and (2) fill in the value that z contains after the code has been executed in the 2nd column. If the code would result in an error, write "ERROR" in the 1st column and give the reason for the error in the 2nd column (you do not need to write the exact error message). The first two have been done for you.

Code	DataType / Error	Value of $z \ / \ \mathbf{Reason}$
$\boxed{\frac{1}{z++;}} z = 0.0;$	double	1.0
$\frac{1}{z=1;} z = true;$	ERROR	z appears to have been declared as a boolean originally and so can't be set to an int.
$\frac{z}{z = 3;}$		
int[] arr = $\{1, 2, 3, 4, 5\};$ z = arr.length();		
$\frac{z}{z+=5};$		
$\frac{z = \text{``hello"};}{z = z + 11.0;}$		
$\frac{1}{\text{int } z = \arg[\arg[3]];}$		
$\begin{array}{c} \text{String s} = \text{``CIS'';} \\ \underline{\qquad} z = \text{``CI''} + \text{``S'';} \end{array}$		
String str = "apple"; $z = str.charAt(5);$		

## 3 Find the Bugs (16 points total; 2 pts each)

Anastasiya attempted to write a program that takes in an integer array and returns the most frequent integer in it. For example, the most frequent integer in {1, 2, 3, 1, 1} is 1. If values are equally frequent, it returns the first one encountered in the array. Because she was busy taking care of her many cats, she had no time to test her code. There are 8 bugs causing the program to malfunction. Identify the bugs' line numbers, and how to fix them.

```
1. public static int findMostFrequentValues(int[] arr) {
2.
        int mostFreq = arr[0];
        int count = 1;
3.
4.
        int temp = 0;
5.
        int tempCount = 0;
6.
7.
        for (int i = 0; i \le arr.length; i++) {
8.
             temp = arr[1];
9.
             tempCount = 10;
10.
             for (int j = 0; i < arr.length; j--) {
11.
12.
                 if (temp = arr[j]) {
                     tempCount++;
13.
14.
                 }
15.
             }
16.
             if (tempCount < count) {</pre>
17.
18.
                 mostFreq = temp;
19.
                 tempCount = count;
20.
             }
        }
21.
22.
23.
        return mostFreq;
24. }
```

Corrections to fix the bugs:



#### 4 Fill in the Blanks (10 points total)

Meghana wrote the code below that calls the function reverse(), which reverses an array without using another array and then prints it out. Unfortunately, she was petsitting Anastasiya's cats, who walked across the keyboard and erased some of the words. Please help her fill them back in!

```
/*
* Non-recursive method that returns the reverse of the array input
* without using another array.
* For example:
* Input - {1, 2, 3, 4, 5};
* Output - {5, 4, 3, 2, 1}
*/
public _____ int[] reverse(_____ arr) {
   for (int i = 0; i < _____) {</pre>
      int x = arr[i];
      arr[i] = arr[_____];
      arr[____] = x;
   }
   return _____;
}
public static void main(_____ args) {
   int[] arr = \{1, 2, 3, 4, 5\};
   arr = reverse(arr);
  for (int i = 0; i < ____; i++) {</pre>
      System.out.println(_____);
   }
}
```

6

## 5 Tracing (15 points total)

Cristina decided to sign up for a half marathon without having exercised in the last five months, so she decided to make a training plan. Unfortunately, she got a concussion during her training and can't run, so she updated her training plan to include strength. Although she was able to fix her training plan, she can't trace through the code without getting a headache, so she needs your help. Given the code on the next page, trace through the program and write the contents of the miles array every time the printArray() function is called. The original contents of the array are both below and in the code.

Miles Array

5	5	6	7	7	8	9	10	9	13
	1			1			1		

```
public class Exercise {
    public static void main(String[] args) {
        int[] miles = {5, 5, 6, 7, 7, 8, 9, 10, 9, 13};
        for (int m = 0; m < miles.length; m += 2) {
            if (m > 3 && m < 7) {
                strength(miles, m);
                printArray(miles)
            } else {
                run(miles, m);
                printArray(miles)
            }
        }
    }
    public static void run(int[] p, int r) {
        int[] numbers = {2, 4, 5, 1, 3};
        int n = 0;
        for (int i = 1; i < p.length; i*= 2) {</pre>
            p[numbers[n]] = p[i]++;
            n++;
        }
    }
    public static void strength(int[] p, int a) {
        int[] numbers = {3, 4, 1, 5, 2};
        int n = 5;
        while (a > 0) {
            n--;
            p[(2 * numbers[n]) - 1] = a / 5;
            a /= 2;
        }
    }
    public static void printArray(int[] miles) {
        for (int i = 0; i < miles.length; i++) {</pre>
            System.out.print(miles[i]);
        }
        System.out.println();
    }
}
```

## 6 Recursive Tracing (14 points total)

Bhidster, a famous Youtuber, wants to calculate the amount of money he gets paid per minute of watch time. He writes a function that he *thinks* will tell him how much money he makes per minute of watch time. However, since he does not practice good style, he names the function after himself.

```
public static int bhidster(int minutesWatchTime) {
    if (minutesWatchTime == 0) {
        System.out.println("Time is 0");
        return 0;
    } else if (minutesWatchTime % 10 == 0) {
        System.out.println("Time is divisible by 10 and is " + minutesWatchTime);
        return bhidster(minutesWatchTime/10) + 1;
    } else {
        System.out.println("Time is " + minutesWatchTime);
        return bhidster(minutesWatchTime/200) + minutesWatchTime/10;
    }
}
```

1. (5 pts) What will be the output of calling bhidster(2200)?

2. (5 pts) What will be the output of calling bhidster(6300)?

3. (4 pts total; 2 pts each) How	much money does Bhidster and	ticipate making from:
2200 minutes of watch time?	6330 minutes of watch time?	

2200 minutes of watch time?	6330 minutes of watch time?

### 7 Functions! (20 points total)

A palindrome is a word that is the same forward or backwards. For example, "madam" and "hannah" are palindromes but "start" and "banana" are not.

Rahul and Rohan are arguing about the best way to write a function to determine whether or not some String is a Palindrome. Rahul wants to write it iteratively and Rohan would like to write it recursively. They need your help!

Write two functions, which each take in a String and check whether that String is a palindrome:

- isPalindromeIterative() should iteratively check if the given String is a palindrome, and
- isPalindromeRecursive() should recursively check if the given String is a palindrome.

Hint: You may find it useful to use the String.substring() in your implementation. Recall that, when called on a String, the function .substring(a, b) will return a new String containing the characters of the old String starting at integer index a and up to but not including integer index b. For example,

```
String s = "Hello!";
String z = s.substring(1, 5); // z would be equal to "ello"
```

#### 8 Searching and Sorting (12 points total)

- 1. (2 pts) Which ordering is correct from **slowest to fastest** worst-case computational complexity? Assume that the array is in random order for sorting algorithms and already sorted for searching algorithms.
  - (A) Binary search, linear search, insertion sort
  - (B) Selection sort, linear search, binary search
  - (C) Selection sort, linear search, insertion sort
  - (D) Selection sort, insertion sort, linear search
  - (E) None of the above are correct
- 2. (4 pts) Assume that we're using selection sort on the array {6, 1, 4, 2}. Each step of the algorithm ensures than one additional item is in the correct place in the array. What would be the state of the array after TWO steps of selection sort?
  - (A) {1, 2, 4, 6}
    (B) {1, 6, 4, 2}
    (C) {1, 4, 6, 2}
    (D) {1, 2, 6, 4}
    (E) None of the above are correct
- 3. (4 pts) Which array would be sorted by insertion sort using the fewest total number of comparisons?
  - (A) {4, 2, 1, 6}
    (B) {1, 6, 4, 2}
    (C) {1, 4, 6, 2}
    (D) {6, 2, 1, 4}
- 4. (2 pts) Suppose we are sorting an array of ten integers with an unknown algorithm. Recall that each step of either insertion sort or selection sort ensures that one additional element is in sorted order. After four steps of the algorithm, the array elements are ordered as follows:

 $\{1, 2, 2, 4, 4, 0, 7, 8, 9, 12\}$ 

Which statement is correct?

- (A) The algorithm might be either selection sort or insertion sort.
- (B) The algorithm might be selection sort, but could not be insertion sort.
- (C) The algorithm might be insertion sort, but could not be selection sort.
- (D) The algorithm is neither selection sort nor insertion sort.

That's it! If you have time, go back and check your answers. Please do not post anything on Piazza about the exam or discuss it in public, since we still have a number of students who need to take the makeup exam. Please have your ID out when you turn in your exam.

### ANSWER KEY

## 1 Miscellaneous Multiple Choice

- 1. Any answer
- 2. C
- 3. D
- 4. D

## 2 Variables, Operators, Types

Code	DataType/Error	Value/Reason
$_{$		
z++;	double	1.0
$\_$ z = true;		z was originally declared
z = 1;	Error	as a boolean and can't be set to an int.
$_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{$		
z = 3;	$\operatorname{int}$	2
int[] arr = $[1, 2, 3, 4, 5];$		
$\_$ z = arr.length();	Error	.length for arrays, not .length()
z = 'a';		
z += 5;	int OR char	102 OR 'f'
z = "hello"		
z = z + 11.0	String	hello11.0
arr = [0, 4, 3, 1, 2]		
int $z = arr[arr[3]]$	int	4
String $s = "CIS";$		
z == "CI" + "S";	ERROR	Incomplete expression
String $str = "apple"$		Strings are zero-indexed, so there is no character
$\_$ z = str.charAt(5);	Error	at index 5 since the length of the string is 5

#### 3 Find the bugs

- Line 7: for loop should be < not <=
- Line 8: temp is always initialized to the second element in the array instead of i
- Line 9: tempCount should be initialized to 0 not 10.
- Line 11: for loop should be j < arr.length, not i < arr.length
- Line 11: for loop should be j++, not j -
- Line 12: boolean check should be ==, not =
- Line 17: should check tempCount > count, not tempCount < count
- Line 19: should be count = tempCount, not tempCount = count

#### 4 Fill in the blanks

```
public static int[] reverse(int[] arr) {
    for (int i = 0; i < arr.length / 2; i++) {
        int x = arr[i];
        arr[i] = arr[arr.length - 1 - i];
        arr[arr.length - 1 - i] = x;
    }
    return arr;
}
public static void main(String[] args) {
    int[] arr = {1, 2, 3, 4, 5};
    arr = reverse(arr);
    for (int i = 0; i < arr.length; i++) {
        System.out.println(arr[i]);
    }
}</pre>
```

## 5 Tracing

```
\begin{array}{c} 5 \ 9 \ 6 \ 7 \ 6 \ 5 \ 9 \ 10 \ 10 \ 13 \\ 5 \ 10 \ 10 \ 7 \ 10 \ 9 \ 9 \ 10 \ 11 \ 13 \\ 5 \ 0 \ 10 \ 0 \ 10 \ 9 \ 9 \ 10 \ 11 \ 0 \\ 5 \ 0 \ 10 \ 1 \ 10 \ 9 \ 9 \ 10 \ 11 \ 0 \\ 5 \ 11 \ 1 \ 1 \ 1 \ 0 \ 9 \ 10 \ 12 \ 0 \end{array}
```

## 6 Recursive Tracing

1.)

Time is divisible by 10 and is 2200 Time is divisible by 10 and is 220 Time is 22 Time is 0 2.) Time is divisible by 10 and is 6300 Time is divisible by 10 and is 630 Time is 63 Time is 0

3.) 4 and 64, respectively (The answer 8 was also accepted for the 2nd answer due to 6330/6300 typo in the question.)

## 7 Functions

```
public static boolean isPalindromeIterative(String str) {
    int strLen = str.length();
    for (int i = 0; i < strLen; i++) {</pre>
        if (str.charAt(i) != str.charAt(strLen - 1- i)) {
            return false;
        }
    }
    return true;
}
public static boolean isPalindromeRecursive(String str) {
    int strLen = str.length();
    if (strLen <= 1) {
        return true;
    }
    if (str.charAt(0) != str.charAt(strLen - 1)) {
        return false;
    }
    return isPalindromeRecursive(str.substring(1, strLen- 1));
}
```

## 8 Searching and Sorting

- 1. B
- 2. A
- 3. A
- 4. C