CMSC132 Summer 2017 Midterm 1

First Name (PRINT): _______________________________________________________

Last Name (PRINT): _______________________________________________________

I pledge on my honor that I have not given or received any unauthorized assistance on this examination.

Your signature: ______________________________________________________________________

Instructions

- This exam is a closed-book and closed-notes exam.
- Total point value is 100 points.
- The exam is a 80 minutes exam.
- Please use a pencil to complete the exam.
- WRITE NEATLY. If we cannot understand your answer, we will not grade it (i.e., 0 credit).

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1. T/F</td>
<td>/ 10</td>
</tr>
<tr>
<td>2. Multiple Choice</td>
<td>/ 25</td>
</tr>
<tr>
<td>3. Short Answer</td>
<td>/ 25</td>
</tr>
<tr>
<td>4. Programming</td>
<td>/ 40</td>
</tr>
<tr>
<td>Total</td>
<td>/100</td>
</tr>
</tbody>
</table>
1. **Circle True or False for the following questions (1 pts each)**

   A. True  False   The cost of finding a node from a sorted linked list is O(n).
   B. True  False   The "is-a" relationship between classes is called inheritance.
   C. True  False   This will correctly compute the sum of a nonempty list, in which first
       is the first node in the list

       ```
       int sum = 0;
       for (Node cur = first; cur != null; cur = cur.next) {
           sum = sum + cur.data;
       }
       ```
   D. True  False   Abstract classes can have constructors.
   E. True  False   If there is a tail reference, which references the last node in the linked
       list, then appending a new node to the end of a linked list costs constant time.
   F. True  False   In Java, a class can inherit any other class.
   G. True  False   Multiple classes can implement the same interface.
   H. True  False   Items must be comparable to be inserted into a sorted list.
   I. True  False   `super()` must be the first statement of the constructor.
   J. True  False   Aliasing occurs when two or more references to an object exist within a
       running program.

2. **Fill in the blanks/ Multiple Choice**

   A. (1 pts) In Java, the actual method executed is determined by the type of the object and
       not the type of the reference. This is called ____________________________.

   B. (2 pts) When you traverse a linked list starting from the first node in the list using a
       reference `current`, you know you reached the end of the list if

       a. `current.next == null`
       b. `cur.hasNext() == false`
       c. `current == first`
       d. `current.length == N`
C. (2 pts) What is the output of the following program

```java
class Base {
    final public void show() {
        println("Base");
    }
}

class Derived extends Base {
    public void show() {
        println("Derived");
    }
}

class Main {
    public static void(String[] args) {
        Base b = new Derived();
        b.show();
    }
}
```

a) Base  
b) Derived  
c) Compiler Error  
d) Runtime Error

D. (2 pts) The class "Parent" and its inherited class "Child" both implement a method "foo()", printing "parent" and "child" respectively. Which of the 4 choices below reflects the correct output of the following program:

```java
Parent v1 = new Parent();
Parent v2 = new Child();
Child v3 = new Child();
System.out.println(v1.foo()+" + v2.foo()+"+ v3.foo());
```

a. parent child child  
b. parent parent parent  
c. parent child parent  
d. child parent child

E. (1 pts) A method defined in a superclass is redefined in a subclass with an identical method signature is called___________.

a. Dynamic binding  
b. Method overloading  
c. Method overriding  
d. Late binding
F. (4 pts) Suppose class C extends class B, and class B implements interface A. Now suppose class D implements interface A, and class E extends class B.

For each of the following operations, circle valid or invalid.
1) C test = new B();  valid  invalid
2) C test = new E();  valid  invalid
3) B test = new E();  valid  invalid
4) A test = new C();  valid  invalid

G. (7 pts) Two classes Parent and Child are as follows:

```java
abstract class Parent{
    void foo(){
        System.out.println("parent");
    }
}
class Child extends Parent{
    void foo(int x){
        System.out.println("child");
    }
}
```

Check the following if each statement is valid or invalid. Circle your answer

- Parent p1 = new Parent(); valid  invalid
- Parent p2 = new Child(); valid  invalid
- Child c = new Child(); valid  invalid
- p2.foo(); valid  invalid
- p1.foo(5); valid  invalid
- c.foo(); valid  invalid
- c.foo(10); valid  invalid

H. (2 pts)
public class Bag implements Comparable<Bag> { ...
}

Based on the above class definition, which is the signature for the compareTo() method that needs to be implemented by the Bag class?

a) private int compareTo(Bag other);
b) public int compareTo(Bag other);
c) public int compareTo(Object other);
d) public boolean compareTo(Bag other);
I. (1 pts) What are the methods you must have if your class implements Iterable<String>?

J. (2 pts) What are the methods you must have if your class implements Iterator<String>?

K. (1 pts) Suppose a class has a static variable s, and a non-static variable n. It also has static method m1(), and a non-static method m2(). Which of these is true?
   a) m1 can access s and n.
   b) m2() can access s and n.
   c) m2() can access n but not s.
   d) m1() can access n only if n is a private variable.

3. Short Answer Questions

   A. (3 pts) what is the difference between equals and ==

   B. (3 pts) In a doubly linked list, head references the first node in the list, t references a new node. Write code to insert t as the first node.
C. (3 pts) What is the output of the following program

```java
public class Test{
    public String name;
    public static int score;
    public static void main(String[] args){
        Test t1 = new Test();
        Test t2 = new Test();
        t1.name = "Java";
        t1.score = 95;
        t2.name = "C++";
        t2.score = 80;
        System.out.println(t1.name);
        System.out.println(t2.name);
        System.out.println(t1.score);
        System.out.println(t2.score);
    }
}
```

D. (3 pts) If a list has more than one element, then what does the following code will do?

```java
Node n = head;
while (n.next.next != null) {
    n = n.next;
}
```

E. (3 pts) We want to insert node t immediately after x. Is this code correct? If it is not correct, explain why?

```java
x.next = t;
t.next = x.next;
```
F. (3 pts) Following program has an error. Correct the error.

```java
public class Animal{
    public String name;
    public int age;
}
public class Main{
    public static void main(String[] args) {
        Animal animal;
        animal.name="tiger";
        animal.age = 3;
        System.out.println("Name: " + animal.name);
    }
}
```

G. (4 pts) Compare the efficiency of insert and contains methods in array based bag and array based sorted bag

<table>
<thead>
<tr>
<th></th>
<th>Insert</th>
<th>Contains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Array Bag</td>
<td>O( )</td>
<td>O( )</td>
</tr>
<tr>
<td>Sorted Bag</td>
<td>O( )</td>
<td>O( )</td>
</tr>
</tbody>
</table>

H. (3 pts) Assume linked list

```
head -> 1 -> 2 -> 3 -> 4
```

Function `foo` is defined as follows:

```java
void foo(Node head){
    if(head == null) return;
    print(head.data);
    foo(head.next);
    print(head.data);
}
```

What is the output of `foo(head)`. 

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7
4. Programming Questions

A. (10 pts) Write a method public Node array2List(String[] array) that takes a string array and returns a LinkedList representation of it. The Node class is given as:

```java
public class Node{
    public String data;
    public Node next;
    public Node(String s){data = s;}
}
```

```java
public Node array2LinkedList(String[] array) {
```

B. (6 pts) Write a function “int length(Node head)”, which calculates the length of the linked list starting from head. The Node is defined as:

```java
public class Node{
    Public String data;
    Public Node next;
    public Node(String s){data = s;}
}
```

Example:
Assume first--1-->10-->5-->9, then length(first) returns 4

```java
int length(Node head){
}
```

C. (10 pts) Given a Node class defined in 4-A, and a Node head that references the first item in the list (or null if empty), write a function void insert(Node head, String e), which inserts a string into a correct location in a alphabetically-sorted linked list.

```java
void insert(Node h, String e){
}
```
D. (8 pts) Write a method `Bag<E> copy()`, which returns deep-copied clone of a the array based bag. Assume Bag is iterable and elements in the bag are cloneable. Here is the Bag class:

```java
public class Bag<E> implements Iterable<E>{
    protected E[] items;
    protected int N; // number of items in the bag
    protected int capacity = 10;
    public Bag(){
        items = (E[])new Object[capacity];
    }
}
Bag<E> copy (){ }
```

E. (6 pts) Write a function `Node<E> deleteLast()`, which deletes and returns the last node in the linked list. It returns null if the list is empty.

```java
Node<E> deleteLast(){
}
```