University of Texas at Austin

High School Computer Science Competition - 2014

General Directions:

1) DO NOT OPEN EXAM UNTIL TOLD TO DO SO.

2) NO CALCULATORS OF ANY KIND MAY BE USED.

3) There are 40 questions on this contest exam. You have 45 minutes to complete the contest. If you are in the process of actually writing an answer when the signal to stop is given, you may finish writing that answer.

4) Papers may not be turned in until 45 minutes have elapsed. If you finish the test before the end of the allotted time, remain at your seat and keep your paper until told to do otherwise. Use this time to check your answers.

5) All answers must be written on the answer sheet provided. Indicate your answers in the appropriate blanks provided on the answer. Ensure your answers are clear and readable.

6) You may place as many notations as you desire anywhere on the test paper, but not on the answer sheet which is reserved for answers only.

7) You may use additional scratch paper provided by the contest director.

8) All questions have ONE and only ONE correct (BEST) answer. There is a penalty for all incorrect answers.

9) A reference to commonly used Java classes is provided at the end of the test, and you may use this reference sheet during the contest. You may detach the reference sheets from the test booklet, but DO NOT DO SO UNTIL THE CONTEST BEGINS.

10) Assume that any necessary import statements for standard Java packages and classes (e.g. .util, ArrayList, etc.) are included in any programs or code segments that refer to methods from these classes and packages.

Scoring:

1) Questions will receive 6 points if answered correctly; no points will be given or subtracted if unanswered; 2 points will be deducted per incorrect answer.
<table>
<thead>
<tr>
<th>QUESTION 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the sum of $1111_2$ and $1_2$?</td>
<td></td>
</tr>
<tr>
<td>A. $1F_{16}$</td>
<td>B. $1111_2$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUESTION 2</th>
<th></th>
</tr>
</thead>
</table>
| What is output by the code to the right? | int $x = 3$;  
int $y = 8$;  
System.out.print($y + 2 \times x - 4$); |
| A. $-10$ | B. $10$ | C. $26$ |
| D. $103-4$ | E. $y + 2 \times x - 4$ |

<table>
<thead>
<tr>
<th>QUESTION 3</th>
<th></th>
</tr>
</thead>
</table>
| What is output by the code to the right? | int total = 0;  
for(int $i = 0; i <= 20; i++$)  
for(int $j = 1; j < 5; j++$)  
total++;  
System.out.print(total); |
| A. $24$ | B. $80$ | C. $84$ |
| D. $100$ | E. $105$ |

<table>
<thead>
<tr>
<th>QUESTION 4</th>
<th></th>
</tr>
</thead>
</table>
| What is output by the code to the right? | String area = "Formal4Methods";  
area = area.toLowerCase().substring(7);  
System.out.print(area); |
| A. methods | B. formal4 |
| C. Methods | D. methods |
| E. Formal4Methods |

<table>
<thead>
<tr>
<th>QUESTION 5</th>
<th></th>
</tr>
</thead>
</table>
| What is output by the code to the right? | boolean[] an = new boolean[5];  
System.out.print(an[1] + " " + an.length); |
| A. true 4 | B. true 5 |
| C. false 4 | D. false 5 |
| E. There is no output due to a syntax error. |

<table>
<thead>
<tr>
<th>QUESTION 6</th>
<th></th>
</tr>
</thead>
</table>
| What is output by the code to the right? | int $z = 23$;  
int $y = 10$;  
System.out.print($z \% y$); |
| A. $33$ | B. $23$ | C. $10$ |
| D. $3$ | E. $2$ |

<table>
<thead>
<tr>
<th>QUESTION 7</th>
<th></th>
</tr>
</thead>
</table>
| How many of the 8 possible combinations of values for the variables $a$, $b$, and $c$ result in $d$ being set to true? | boolean $a$, $b$, $c$;  
//code to initialize $a$, $b$, and $c$  
boolean $d = !(a \| b \| c)$; |
| A. $1$ | B. $2$ | C. $4$ |
| D. $7$ | E. $8$ |
**QUESTION 8**

What is output by the code to the right?

A. A  
B. B  
C. C  
D. There is no output due to a syntax error.  
E. The code runs, but there is no visible output.

```java
int[] data = {5, 2, 5, 1, 3};
if(data[1] == data[2])
    System.out.print("A");
if(data.length != data[2])
    System.out.print("B");
if(data[2] < data[data.length -1])
    System.out.print("C");
```

**QUESTION 9**

Given the classes Shirt and TShirt to the right, what is output by the following client code?

TShirt ts = new TShirt(4, 5);
System.out.print(ts.getShade());

A. 0  
B. 1  
C. 4  
D. There is no output due to a syntax error.  
E. There is no output due to a runtime error.

```java
public class Shirt {
    private int shade;
    public Shirt(int s) { shade = s; }
    public void wash() { shade--; }
    public int getShade() { return shade; }
}

public class TShirt extends Shirt {
    private int mult;
    public TShirt(int s, int m) {
        super(s);
        mult = m;
    }
    public void wash() {
        for(int i = 0; i < mult; i++)
            super.wash();
    }
}
```

**QUESTION 10**

Given the classes Shirt and TShirt to the right, what is output by the following client code?

Shirt s2 = new TShirt(10, 4);
s2.wash();
s2.wash();
System.out.print(s2.getShade());

A. 18  
B. 10  
C. 8  
D. 6  
E. 2

```java
public class Shirt {
    private int shade;
    public Shirt(int s) { shade = s; }
    public void wash() { shade--; }
    public int getShade() { return shade; }
}

public class TShirt extends Shirt {
    private int mult;
    public TShirt(int s, int m) {
        super(s);
        mult = m;
    }
    public void wash() {
        for(int i = 0; i < mult; i++)
            super.wash();
    }
}
```

**QUESTION 11**

What is output by the code to the right?

A. 32 256  
B. 32 3  
C. 4 0  
D. 32 4  
E. true 3

```java
int pt = 32;
int xt = pt >> 3;
System.out.print(pt + " " + xt);
```

**QUESTION 12**

What is output by the code to the right?

A. 9  
B. 9.0  
C. 8  
D. 8.0  
E. 6

```java
int xv = 65;
String rv = Math.ceil(Math.sqrt(xv)) + "";
System.out.print(rv);
```
### QUESTION 13
What is output by the code to the right?
- A. \t\t\n
- B. \t\t

- C. \n\n
- D. There is no output due to a syntax error.

- E. The code runs, but there is no visible output.

```java
System.out.println("\t\t\n\n");
```

### QUESTION 14
What is output by the code to the right?
- A. 15.86 15.86

- B. 15.86000 15.9

- C. 15.86000 15.8

- D. 15.8600015.8

- E. There is no output due to a syntax error.

```java
double a2 = 15.86;
System.out.printf("%8.5f %3.1f", a2, a2);
```

### QUESTION 15
What is returned by the method call `ft1(-3)`?
- A. 14

- B. 12

- C. -3

- D. 4

- E. -6

```java
public int ft1(int x) {
    x++;
    x = ft2(x, x);
    x--;
    return x;
}
```

```java
public int ft2(int x, int y) {
    x++;
    y *= 2;
    return x + y;
}
```

### QUESTION 16
What is output by the code to the right?
- A. false false

- B. false true

- C. true false

- D. true true

- E. There is no output due to a syntax error.

```java
boolean p1 = false;
boolean q1 = true;
boolean r1 = false;
System.out.print(p1 || q1 && r1);
System.out.print(" " + !q1);
```

### QUESTION 17
What is output by the code to the right?
- A. 14 6

- B. 12 8

- C. 14 5

- D. 12 2

- E. There is no output due to a syntax error.

```java
int x3 = 12;
int y3 = x3 / 2;
x3++; ++x3;
System.out.print(x3 + " " + y3);
```
<table>
<thead>
<tr>
<th>Question 18</th>
<th>What is returned by the method call \texttt{mst(7)}?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. -3</td>
<td>B. -1</td>
</tr>
<tr>
<td>C. 0</td>
<td>D. 1</td>
</tr>
<tr>
<td>E. There is no output due to a runtime error.</td>
<td></td>
</tr>
</tbody>
</table>

```java
public int mst(int n) {
    if(n == 0)
        return -3;
    return n / 2 + mst(n - 2);
}
```

<table>
<thead>
<tr>
<th>Question 19</th>
<th>What is returned by the method call \texttt{mst(10)}?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 12</td>
<td>B. 8</td>
</tr>
<tr>
<td>C. 3</td>
<td>D. -3</td>
</tr>
<tr>
<td>E. There is no output due to a runtime error.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 20</th>
<th>What is output by the code to the right?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 6</td>
<td>B. 5</td>
</tr>
<tr>
<td>C. 1</td>
<td>D. 9</td>
</tr>
<tr>
<td>E. There is no output due to a syntax error.</td>
<td></td>
</tr>
</tbody>
</table>

```java
String cls = "tsP&^k2dj";
int rs2 = 0;
cls = cls.toUpperCase();
for(int i = 0; i < cls.length(); i++)
    if(Character.isUpperCase(cls.charAt(i)))
        rs2++;
System.out.print(rs2);
```

<table>
<thead>
<tr>
<th>Question 21</th>
<th>What is output by the code to the right?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. -126</td>
<td>B. -3</td>
</tr>
<tr>
<td>C. 128</td>
<td>D. 130</td>
</tr>
<tr>
<td>E. The output is different each time the program is run.</td>
<td></td>
</tr>
</tbody>
</table>

```java
byte b5 = 120;
for(int i = 0; i < 10; i++)
    b5++;
System.out.print(b5);
```

<table>
<thead>
<tr>
<th>Question 22</th>
<th>What is output by the code to the right?</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. [E, B, C, A]</td>
<td></td>
</tr>
</tbody>
</table>

```java
ArrayList<String> al;
al = new ArrayList<String>();
al.add("D");
al.add("A");
al.add("E");
al.add(1, "C");
al.add("D");
al.add(2, "B");
al.remove("D");
System.out.print(al);
```

<table>
<thead>
<tr>
<th>Question 23</th>
<th>What is output by the code to the right?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 1 1</td>
<td>B. 0 0</td>
</tr>
<tr>
<td>C. 1 0</td>
<td>D. 0 1</td>
</tr>
<tr>
<td>E. There is no output due to a syntax error.</td>
<td></td>
</tr>
</tbody>
</table>

```java
int t2 = 12;
int s2 = 6;
int r2 = (t2 % s2 < 2) ? 0 : 1;
int u2 = (t2 < s2) ? 0 : 1;
System.out.print(r2 + " " + u2);
```
**Question 24**

Given the `VideoStats` class to the right, what is output by the following client code?

```
public class VideoStats{
    private int views;
    private int length;
    public VideoStats(int len) {
        length = len;
    }
    public void watch() {
        views++;
    }
    public void clip() {
        if(views == 0)
            length = 5;
        else if(views < 10)
            length = 15;
        else
            length = 30;
    }
    public String toString() {
        return views + " " + length;
    }
}
```

```java
VideoStats v1 = new VideoStats(100);
v1.watch();
v1.watch();
v1.clip();
System.out.print(v1);
```

A. 2 100  
B. 0 100  
C. 2 15  
D. There is no output due to a syntax error.  
E. The output varies each time the program is run.

**Question 25**

Given the `VideoStats` class to the right, what is output by the following client code?

```
public class VideoStats{
    private int views;
    private int length;
    public VideoStats(int len) {
        length = len;
    }
    public void watch() {
        views++;
    }
    public void clip() {
        if(views == 0)
            length = 5;
        else if(views < 10)
            length = 15;
        else
            length = 30;
    }
    public String toString() {
        return views + " " + length;
    }
}
```

```java
VideoStats v2 = new VideoStats(50);
VideoStats v3 = v2;
v2.watch();
v3 = new VideoStats(50);
v3.watch();
boolean e1 = v2 == v3;
boolean e2 = v1.equals(v3);
System.out.print(e1 + " " + e2);
```

A. false false  
B. false true  
C. true false  
D. true true  
E. There is no output due to a syntax error.

**Question 26**

What is output by the code to the right?

```
ArrayList<Integer> a5;
a5 = new ArrayList<Integer>(20);
System.out.print(a5.size());
```

A. 20  
B. 10  
C. 1  
D. 0  
E. There is no output due to a syntax error.

**Question 27**

What is output by the code to the right?

```
String name = "Melinda";
char c1 = name.substring(2).charAt(3);
char c2 = name.charAt(4);
System.out.print(c1 + " " + c2);
```

A. n i  
B. d n  
C. d a  
D. i n  
E. There is no output due to a runtime error.
### Question 28
What is output by the code to the right?

<table>
<thead>
<tr>
<th></th>
<th>A. 13</th>
<th>B. 6</th>
<th>C. 5</th>
<th>D. 4</th>
<th>E. 0</th>
</tr>
</thead>
</table>

```java
String garbage;
garbage = "&aj*ja&gg87:uu#hack"
String[] res;
res = garbage.split("[a-z]+");
System.out.print(res.length);
```

### Question 29
What is output by the code to the right?

<table>
<thead>
<tr>
<th></th>
<th>A. 512</th>
<th>B. 1024</th>
<th>C. 2048</th>
<th>D. 4096</th>
<th>E. There is no output due to an infinite loop.</th>
</tr>
</thead>
</table>

```java
int total = 1;
int limit = 1000;
while(total <= limit) {
    total *= 2;
    limit += 10;
}
System.out.print(total);
```

### Question 30
What is output by the code to the right?

<table>
<thead>
<tr>
<th></th>
<th>A. 00</th>
<th>B. 01</th>
<th>C. 10</th>
<th>D. 11</th>
<th>E. 33</th>
</tr>
</thead>
</table>

```java
String n1 = "gates";
String n2 = "dell";
String n3 = "deal";
if(n1.compareTo(n2) < 0)
    System.out.print(0);
else
    System.out.print(1);
if(n2.compareTo(n3) < 0)
    System.out.print(0);
else
    System.out.print(1);
```

### Question 31
Given the `Nd` class to the right what is output by the following client code?

```java
public class Nd {
    public int d;
    public Nd n;
    public Nd(int d, Nd n) {
        this.d = d;
        this.n = n;
    }
}
Nd n1 = new Nd(3, null);
Nd n2 = new Nd(1, n1);
n1.n = new Nd(5, new Nd(4, n2));
int res1 = n1.n.n.n.d;
int res2 = n2.n.d;
System.out.print(res1 + " " + res2);
```

<table>
<thead>
<tr>
<th></th>
<th>A. 1 3</th>
<th>B. 3 4</th>
<th>C. There is no output due to a syntax error.</th>
<th>D. There is no output due to a runtime error.</th>
<th>E. There is no output due to an infinite loop.</th>
</tr>
</thead>
</table>

### Question 32
Assume method `sample(int[] data)` is $O(N^3)$ where $N = data.length$. When method `sample` is passed an array with `length = 10,000` it takes 3 seconds for method `sample` to complete. If method `sample` is then passed an array with `length = 40,000` what is the expected time it will take method `sample` to complete?

<table>
<thead>
<tr>
<th></th>
<th>A. 576 seconds</th>
<th>B. 192 seconds</th>
<th>C. 64 seconds</th>
<th>D. 27 seconds</th>
<th>E. 12 seconds</th>
</tr>
</thead>
</table>
**QUESTION 33**
What is the best case order (Big O) of the method to the right? N = data.length.
Pick the most restrictive correct answer.
A. O(1)  B. O(N)  C. O(N log N)
D. O(N^2)  E. O(N!)

**QUESTION 34**
What is output by the code to the right?
A. {A=3, B=3, C=2, F=5}
B. {A=3, C=2, F=5}
C. {2=C, 3=A, 5=F}
D. {2=C, 3=A, 5=F, 7=C}
E. The output is different each time the program runs.

**QUESTION 35**
What is output by the code to the right?
A. [6]
B. [2, 2]
C. [3]
D. []
E. [2]

**QUESTION 36**
What is returned by the method call recH(5)?
A. 2  B. 29  C. 71
D. 88  E. 91

**QUESTION 37**
What is the order (Big O) of method recH? N = n. Pick the most restrictive correct answer.
A. O(log N)  B. O(N^2)  C. O(2^N)
D. O(N!)  E. O(N^N)
**Question 38**

Given the `Level` class to the right what is output by the following client code?

```java
public class Level {
    private int[] data;
    public Level(int s) {
        s = Math.abs(s);
        double[] data = new double[s];
    }
    public String toString() {
        return data[0] + " " + data.length;
    }
}
```

Level vel2 = new Level(-15);
System.out.print(vel2);

A. 0.0 15  
B. 0 15  
C. There is no output due to a syntax error.  
D. There is no output due to a runtime error.  
E. The output is different each time the program runs.

---

**Question 39**

Given the `Structure` class to the right, what is output by the following client code?

```java
public class Structure {
    private ArrayList<Comparable> con = new ArrayList<Comparable>();
    public void add(Object o) {
        Comparable c = (Comparable) o;
        int p = 0;
        while(p < con.size() && c.compareTo(con.get(p)) >= 0)
            p++;
        con.add(p, c);
    }
    public Object remove() {
        return con.remove(0);
    }
    public Object get() {
        return con.get(0);
    }
    public String toString() {
        return con.toString();
    }
}
```

Structure str = new Structure();
str.add(3);
str.add(5);
str.add(-1);
str.add(3);
str.remove();
System.out.print(str);

A. [3, 3, -1, -2]  
B. [5, -1, 3, -2]  
C. [-1, 3, 3, 5]  
D. There is no output due to a syntax error.  
E. There is no output due to a runtime error.

---

**Question 40**

What kind of data structure does the `Structure` class implement?

A. a list  
B. a priority queue  
C. a set  
D. a stack  
E. a queue
Standard Classes and Interfaces — Supplemental Reference

class java.lang.Object
  o boolean equals(Object other)
  o String toString()
  o int hashCode()

interface java.lang.Comparable<T>
  o int compareTo(T other)
    Return value < 0 if this is less than other.
    Return value = 0 if this is equal to other.
    Return value > 0 if this is greater than other.

class java.lang.Integer implements Comparable<Integer>
  o Integer(int value)
  o int intValue()
  o boolean equals(Object obj)
  o String toString()
  o int compareTo(Integer anotherInteger)
  o static int parseInt(String s)

class java.lang.Double implements Comparable<Double>
  o Double(double value)
  o double doubleValue()
  o boolean equals(Object obj)
  o String toString()
  o int compareTo(Double anotherDouble)
  o static double parseDouble(String s)

class java.lang.String implements Comparable<String>
  o int compareTo(String anotherString)
  o boolean equals(Object obj)
  o int length()
  o String substring(int begin, int end)
    Returns the substring starting at index begin and ending at index (end - 1).
  o String substring(int begin)
    Returns substring(from, length()).
  o int indexOf(String str)
    Returns the index within this string of the first occurrence of str.
    Returns -1 if str is not found.
  o int indexOf(String str, int fromIndex)
    Returns the index within this string of the first occurrence of str.
    starting the search at the specified index.. Returns -1 if str is not found.
  o charAt(int index)
  o int indexOf(int ch)
  o int indexOf(int ch, int fromIndex)
  o String toLowerCase()
  o String toUpperCase()
  o String[] split(String regex)
  o boolean matches(String regex)

class java.lang.Character
  o static boolean isDigit(char ch)
  o static boolean isLetter(char ch)
  o static boolean isLetterOrDigit(char ch)
  o static boolean isLowerCase(char ch)
  o static char toUpperCase(char ch)
  o static char toLowerCase(char ch)

class java.lang.Math
  o static int abs(int a)
  o static double abs(double a)
  o static double pow(double base, double exponent)
  o static double sqrt(double a)
  o static double ceil(double a)
  o static double floor(double a)
  o static double min(double a, double b)
  o static double max(double a, double b)
  o static int min(int a, int b)
  o static int max(int a, int b)
  o static long round(double a)
  o static double random()

interface java.util.List<E>
  o boolean add(E e)
  o int size()
  o Iterator<E> iterator()
  o ListIterator<E> listIterator()
  o E get(int index)
  o E set(int index, E e)
    Replaces the element at index with the object e.
  o void add(int index, E e)
    Inserts the object e at position index, sliding elements at position index and higher to the right (adds 1 to their indices) and adjusts size.
  o E remove(int index)
    Removes element from position index, sliding elements at position (index + 1) and higher to the left (subtracts 1 from their indices) and adjusts size.

class java.util.ArrayList<E> implements List<E>

class java.util.LinkedList<E> implements List<E>, Queue<E>

Methods in addition to the List methods:
  o void addFirst(E e)
  o void addLast(E e)
  o E getFirst()
  o E getLast()
  o E removeFirst()
  o E removeLast()
class java.util.Stack<E>
  - boolean isEmpty()
  - E peek()
  - E pop()
  - E push(E item)

interface java.util.Queue<E>
  - boolean add(E e)
  - boolean isEmpty()
  - E peek()
  - E remove()

class java.util.PriorityQueue<E>
  - boolean add(E e)
  - boolean isEmpty()
  - E peek()
  - E remove()

interface java.util.Set<E>
  - boolean add(E e)
  - boolean contains(Object obj)
  - boolean remove(Object obj)
  - int size()
  - Iterator<E> iterator()
  - boolean addAll(Collection<? extends E> c)
  - boolean removeAll(Collection<?> c)
  - boolean retainAll(Collection<?> c)

class java.util.HashSet<E> implements Set<E>

class java.util.TreeSet<E> implements Set<E>

interface java.util.Map<K,V>
  - Object put(K key, V value)
  - V get(Object key)
  - boolean containsKey(Object key)
  - int size()
  - Set<K> keySet()
  - Set<Map.Entry<K, V>> entrySet()

class java.util.HashMap<K,V> implements Map<K,V>

class java.util.TreeMap<K,V> implements Map<K,V>

interface java.util.Map.Entry<K,V>
  - K getKey()
  - V getValue()
  - V setValue(V value)

interface java.util.Iterator<E>
  - boolean hasNext()
  - E next()
  - void remove()

interface java.util.ListIterator<E> extends java.util.Iterator<E>
  Methods in addition to the Iterator methods:
  - void add(E e)
  - void set(E e)

class java.lang.Exception
  - Exception()
  - Exception(String message)

class java.util.Scanner
  - Scanner(InputStream source)
  - boolean hasNext()
  - boolean hasNextInt()
  - boolean hasNextDouble()
  - String next()
  - int nextInt()
  - double nextDouble()
  - String nextLine()
  - Scanner useDelimiter(String pattern)
Computer Science Answer Key
UTCS Contest - 2014

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<td>17.</td>
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<td>20.</td>
<td>A</td>
<td>30.</td>
<td>D</td>
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Notes:

The clause "Choose the most restrictive correct answer." is necessary because per the formal definition of Big O, an algorithm that is \( O(N^2) \) is also \( O(N^3) \), \( O(N^4) \), and so forth.

18. A StackOverflowException will occur.

25. The variable \( v_1 \) has not been declared.

38. A NullPointerException will occur. The local variable named data in the constructor shadows the instance variable named data. The instance variable data is not given a value in the constructor so it is set to null.