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.

What is the sum of 1111_2 and 1_2?

A. $1F_{16}$ B. 11111_2 C. 10_{16} D. 32_{10} E. 16_8

What is output by the code to the right?

A. -10   B. 10   C. 26

D. 103-4   E. y + 2 * x - 4

```
int x = 3;
int y = 8;
System.out.print(y + 2 * x - 4);
```

What is output by the code to the right?

A. 24   B. 80   C. 84

D. 100   E. 105

```
int total = 0;
for(int i = 0; i <= 20; i++)
  for(int j = 1; j < 5; j++)
    total++;
System.out.print(total);
```

What is output by the code to the right?

A. ethods   B. formal4

C. Methods   D. methods

E. Formal4Methods

```
String area = "Formal4Methods";
area = area.toLowerCase().substring(7);
System.out.print(area);
```

What is output by the code to the right?

A. true 4   B. true 5

C. false 4   D. false 5

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

```
boolean[] an = new boolean[5];
System.out.print(an[1] + " " + an.length);
```

What is output by the code to the right?

A. 33   B. 23   C. 10

D. 3   E. 2

```
int z = 23;
int y = 10;
System.out.print(z % y);
```

How many of the 8 possible combinations of values for the variables a, b, and c result in d being set to true?

A. 1   B. 2   C. 4

D. 7   E. 8

```
boolean a, b, c;
//code to initialize a, b, and c

boolean d = !(a || b || c);
```

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?

```java
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; }
}
```

```java
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?

```java
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

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);
```

What is output by the code to the right?

A. \t\t\n\n   B.   \t\t   C.   \\\\

D.   There is no output due to a syntax error.

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

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

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 syntaz error.

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

What is returned by the method call ft1(-3)?

A.   14

B.   12

C.   -3

D.   4

E.   -6

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

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

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.

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

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.

```
int x3 = 12;
int y3 = x3 / 2;
x3++;
++x3;
System.out.print(x3 + " " + y3);
```

What is returned by the method call `mst(7)`?

A. -3   B. -1

C. 0   D. 1

E. There is no output due to a runtime error.

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

What is returned by the method call `mst(10)`?

A. 12   B. 8

C. 3   D. -3

E. There is no output due to a runtime error.

What is output by the code to the right?

A. 6   B. 5

C. 1   D. 9

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

```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);
```

What is output by the code to the right?

A. -126   B. -3

C. 128   D. 130

E. The output is different each time the program is run.

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

What is output by the code to the right?

A. [C, B, A, E]

B. [C, A, B, E]

C. [E, B, C, A, D]

D. [C, B, A, E, D]

E. [E, B, C, A]

```java
ArrayList<String> a1;
a1 = new ArrayList<String>();
a1.add("D");
a1.add("A");
a1.add("E");
a1.add(1, "C");
a1.add("D");
a1.add(2, "B");
a1.remove("D");
System.out.print(a1);
```

What is output by the code to the right?

A. 1 1   B. 0 0   C. 1 0

D. 0 1   E. There is no output due to a syntax error.

```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);
```

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

```
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.

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

```
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.

```java
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;
  }
}
```

What is output by the code to the right?

A. 20   B. 10   C. 1

D. 0   E. There is no output due to a syntax error.

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

What is output by the code to the right?

A. n i   B. d n   C. d a

D. i n   E. There is no output due to a runtime error.

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

QUESTION 28

What is output by the code to the right?

A. 13   B. 6   C. 5

D. 4   E. 0

```
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?

A. 512   B. 1024   C. 2048

D. 4096   E. There is no output due to an
                    infinite loop.

```
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?

A. 00

B. 01

C. 10

D. 11

E. 33

```
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?

```
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);
```

A. 1 3

B. 3 4

C. There is no output due to a syntax error.

D. There is no output due to a runtime error.

E. There is no output due to an infinite loop.

```
public class Nd {
  public int d;
  public Nd n;

  public Nd(int d, Nd n) {
    this.d = d;
    this.n = n;
  }
}
```

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?

A. 576 seconds   B. 192 seconds   C. 64 seconds   D. 27 seconds   E. 12 seconds

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(NlogN)

D. O(N^2) E. O(N!)

```java
public int test(int[] data) {
  final int LEN = data.length;
  int res = 0;
  for(int i = 0; i < LEN; i++) {
    if(data[i] < 10)
      res += i;
    for(int j = LEN - 1; j > i; j--) {
      if(data[j] * data[i] < data[0])
        res += i + j;
    }
  }
  return res;
}
```

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.

```java
TreeMap<Integer, String> stuff;
stuff = new TreeMap<Integer, String>();
stuff.put(5, "F");
stuff.put(3, "B");
stuff.put(7, "C");
stuff.put(2, "C");
stuff.put(3, "A");
System.out.print(stuff);
```

QUESTION 35

What is output by the code to the right?

A. [6]

B. [2, 2]

C. [3]

D. []

E. [2]

```java
int[] data = {6, 2, 1, 2, 2, 2, 2, 2, 1, 4,
              2, 1, 6, 2, -2, 2, 4 / 2, 3};
Stack<Integer> st = new Stack<Integer>();
for(int x : data) {
  if(st.isEmpty())
    st.push(x);
  else if(st.peek().equals(x))
    st.push(x);
  else
    st.pop();
}
System.out.print(st);
```

QUESTION 36

What is returned by the method call recH(5)?

A. 2 B. 29 C. 71

D. 88 E. 91

```java
public int recH(int n) {
  if(n <= -1)
    return 2;
  return n/2 + recH(n - 2)
             + recH(n - 1) + 1;
}
```

QUESTION 37

What is the order (Big O) of method recH? N = n. Pick the most restrictive correct answer.

A. O(logN) 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?

```
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.

```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;
  }
}
```

QUESTION 39

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

```
Structure str = new Structure();
str.add(3);
str.add(5);
str.add(-1);
str.add(3);
str.add(-2);
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.

```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();
  }
}
```

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 boolean isUpperCase(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, in b)
- o   static int max(int a, int b)
- o   static long round(double a)
- o   static double random()
  Returns a double value with a positive sign, greater than
  or equal to 0.0 and less than 1.0.

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>
- o   boolean isEmpty()
- o   E peek()
- o   E pop()
- o   E push(E item)

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

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

interface java.util.Set<E>
- o   boolean add(E e)
- o   boolean contains(Object obj)
- o   boolean remove(Object obj)
- o   int size()
- o   Iterator<E> iterator()
- o   boolean addAll(Collection<? extends E> c)
- o   boolean removeAll(Collection<?> c)
- o   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>
- o   Object put(K key, V value)
- o   V get(Object key)
- o   boolean containsKey(Object key)
- o   int size()
- o   Set<K> keySet()
- o   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>
- o   K getKey()
- o   V getValue()
- o   V setValue(V value)

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

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

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

class java.util.Scanner
- o   Scanner(InputStream source)
- o   boolean hasNext()
- o   boolean hasNextInt()
- o   boolean hasNextDouble()
- o   String next()
- o   int nextInt()
- o   double nextDouble()
- o   String nextLine()
- o   Scanner useDelimiter(String pattern)

Computer Science Answer Key
UTCS Contest - 2014

1.	C	11.	D	21.	A	31.	A
2.	B	12.	B	22.	D	32.	B
3.	C	13.	E	23.	D	33.	D
4.	D	14.	B	24.	C	34.	D
5.	D	15.	E	25.	A	35.	B
6.	D	16.	A	26.	D	36.	C
7.	A	17.	A	27.	B	37.	C
8.	E	18.	E	28.	B	38.	D
9.	C	19.	A	29.	C	39.	C
10.	E	20.	A	30.	D	40.	B

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.

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`.