Examination 4

CSC140 Foundations of Computer Science

04 February 2015

1. I shared with you a favorite definition of computer science. The definition is in the form of several questions whose answers computer scientists seek. One of these questions is "How do we solve the problem we have been given?" To answer that question, computer scientists have developed algorithms, data structures, programming languages like Java, and development tools like NetBeans.

   What is another one of the questions that motivates computer scientists?

   Write your answer here.

2. In what year did each of the following events occur?.

   (a) Publication of Alan Turing's paper "On Computable Numbers, with an Application to the Entscheidungsproblem"

   (b) Completion of the ENIAC computer.

   (c) A team at IBM creates FORTRAN, the first high-level programming language.

   (d) First message sent on the ARPANET, the precursor to the Internet.

   (e) Introduction of the Apple II computer.

   (f) Introduction of the IBM PC.

   (g) Introduction of the Apple Macintosh computer.

   (h) Tim Berners-Lee writes "Information Mangagement: A Proposal," a request to begin work on what became the World Wide Web.

   (i) Sun Microsystems (now a part of Oracle) releases the Java programming language.

   (a) Turing's paper in 19??

(b) ENIAC in 19??

(c) FORTRAN in 19??

(d) ARPANET in 19??

(e) Apple II in 19??

(f) IBM PC in 19??

(g) Berners-Lee proposal for World Wide Web in 19??

(h) Java programming language in 19??

3. The complexity of the selection sort and insertion sort algorithms is $O(N^2)$. The complexity of the merge sort algorithm is $O(N \log N)$. Very roughly, this means that the number of operations that the computer must execute to sort a list of length N is approximately N^2 in the one case and $N \log N$ in the other case.

For $N = 1000000$ (one million), ...

(a) What is the value of N^2?

(b) What is the value of $N \log_2 N$?
(Hint: $\log_2 N = \log_{10} N / \log_{10} 2$)

(a) $1000000^2 = (10^6)^2 = 10^{??}$

(b) $1000000 \cdot \log 1000000 = ??$

4. The driver for a package delivery service would like to select the shortest route that will take the driver from the garage to each of N stops for the day and then back to the garage. If the driver can look up the distance between each pair of addresses on the day's list, then the driver can find the shortest route simply by constructing all $N!$ possible routes, finding the distance for each route, and then selecting the shortest route from among the $N!$.

(a) About how many stops does a driver for UPS make in a day?
(Look here for an answer.)

(b) For that value of N, what is the value of $N!$?
(Use the Wolfram Alpha Web site to calculate the value.)

(c) Do you think that drivers for UPS follow the shortest possible route each day? Explain.

(a) Number of stops $N =$??

(b) $N! \approx 10^{??}$

(c) Write your answer here: Yes or no?

5. Object-oriented programming is a discipline for dividing a problem into components and defining relationships among those components. Classes and their instantiations are the principal components in an object-oriented language.

Java and other object-oriented languages give a programmer a means to define a new class that automatically gets all of the public instance variables and methods of an existing class. The new, derived class is then a specialized version of the existing class. The programmer may override methods it receives from the parent class—this means that a method in the derived class has the same name, same return type, and same number and types of parameters as the corresponding method in the parent class, but it works differently.

(a) What is the name of this special relationship between classes?

(b) Identify two classes in the GridWorld case study that are related in this way.

(a) The special relationship is called ??.

(b) Two classes that are related in this way are ?? and ??.

6. Write a class that models a time that is measured in hours and minutes. Your class should have:

- instance variables

- a constructor

- accessor methods ("getters")

- a method for adding one Time to another—this method will have one parameter (the other Time to be summed with **this** Time and will return to its caller the sum (a Time)

- a toString() method that overrides the definition inherited from the Object class.

```
// Write your answer here.
```

7. The kth triangular number is $k(k+1)/2$. Using the following method as a model, write a method that produces an array of integers that contains the first n triangular numbers.

```java
/**
 * Produce an array that contains the first n Fibonacci numbers.
 *
 * @param n is the size of the array to be created and returned.
 * @return an array that contains the first n Fibonacci numbers.
 */
public static int [] fibonacci ( int n ) {
    int [] result = new int [n];
    result [0] = 1;
    result [1] = 1;
    for ( int i = 2; i < n; i++ ) {
        result [i] = result [i −1] + result [i −2];
    } // for
    return result;
} // fibonacci ( int )
```

```
// Write your answer here.
```

8. Complete the following method:

```java
/**
 * Determine whether or not there is an integer
 * in the array a that is also in the array b.
 */
public static boolean containsCommonElement ( int [] a, int [] b ) {
    return false;
} // containsCommonElement ( int [], int [] )
```

4

```
// Write your answer here.
```