CS331
Sample Final Exam Questions

The exams were open book and open notes with 2 hours and 45 minutes available.

1. (15 pts) Short Answer. Provide brief answers (2-4 sentences) to the following questions.

   a. C# provides for automatic “boxing and unboxing” of primitive value types. Why is this potentially more efficient than simply eliminating primitive types and making everything an object?

   b. State an application that would be better to write in C++ than Java and give a brief rationale for your answer.

   c. What is the .NET framework?

   d. You are connecting to a remote web service written in C# running on .NET through your local web browser. The web service behaves as a CGI program. Describe what is happening on the (1) application level, (2) virtual machine level, and (3) machine code level for both the client and server.

   e. What is a virtual function/method?
2. (15 pts) Convert the following Java code to C++. Be sure to deallocate any memory that you create.

```java
public class IntNode
{
    int num;
    IntNode next = null;
    public IntNode(int i) { num = i; } // Constructor
}

public class LinkedList
{
    public static void main(String[] args)
    {
        String s;
        IntNode head = null, tail = null,
        temp = null, newNode = null;

        head = new IntNode(100);
tail = head;

        for (int i = 105; i < 110; i++)
        {
            newNode = new IntNode(i);
tail.next = newNode;
tail = newNode;
        }
temp = head;
while (temp != null) {
    System.out.println(temp.num);
temp = temp.next;
}
    }
}
```
3. **(9 pts) C# Parameter Passing.**

   a. In C#, write a public static method called `Swap` that takes two strings as input by reference and exchanges their values.

   b. Give a sample invocation of your `Swap` method.

   c. Java also manipulates objects, such as Strings, by reference. Would your method, converted to Java, produce the same behavior as the C# program? Explain why or why not.

4. **(6 pts) C# and Events**

   In C# using Visual Studio .NET, you can drag a button to a form and change various properties. If you double-click the button or select the click event, Visual Studio will create a method for you that is invoked when the button is clicked, e.g.:

   ```csharp
   private void myButton_Click(object sender, System.EventArgs e)
   {
   }
   ```

   What mechanism tells C# to invoke this method when the button is clicked?

   Hint: some of the code generated by the UI Designer is:

   ```csharp
   this.myButton.Click += new System.EventHandler(this.myButton_Click);
   ```
4. (9 pts) Scheme Snippets. Give the output of the following bits of code.

a. (cons 'a (cons 'b (append '(c d) '(e f)))))

b. (cdr (car (cdr '(x (y z) g)))))

c. (define (foo x)
   (cond ((null? x) '())
     (else
      (cons (cadar x) (foo (cdr x))))))

(foo '((a 1) (b 2) (c 3)))
5. (11 pts) Scheme Lists. Inserting an Element into a List.

Write a scheme function named \texttt{insert} that takes a list, an element, and a position starting at 1 and inserts the element before that position in the list. Your function should return false if the insert position would result in a non-contiguous list.

Here are examples inserting \texttt{'x} into the list \texttt{'(a b c)} at various positions:

\begin{verbatim}
> (insert '(a b c) 'x 1)
(a b c 'x)
> (insert '(a b c) 'x 2)
(a 'x b c)
> (insert '(a b c) 'x 3)
(a b c 'x)
> (insert '(a b c) 'x 4)
(a b 'x c)
> (insert '(a b c) 'x 5)
#f
\end{verbatim}

Feel free to create any helper functions that you wish.

6. (10 pts) Prolog Lists. Inserting an Element into a List.

Write a prolog predicate named \texttt{insert} that does the same thing as the previous problem. It takes a list, item to insert, and position to insert the item starting at 1. For example:

\begin{verbatim}
?- insert([1,4,6,3,2], 100, 2, X).
X = [1,100,4,6,3,2] ;
\end{verbatim}
7. (10 pts) Prolog Problem Solving and Search

Write a prolog predicate named findNum that find three digits of a number that meet the following constraints:

- It is a 3-digit whole number.
- One of the digits is 3.
- Each digit is different.
- The sum of the digits is 15.
- It's greater than 499.

Feel free to write any helper predicates as needed.
8. **(15 pts) PHP Programming.** Processing web logs.

You have created a web-based survey of favorite programming languages and are capturing the results into a text file named “logfile”. The structure of the text file is:

```
Total # Entries
Vote for Entry 1
IP Address for Entry 1
Timestamp in seconds for Entry 1
Vote for Entry 2
IP Address for Entry 2
Timestamp in seconds for Entry 2
...
```

For example, here is a sample logfile of six entries:

```
6
PHP
137.229.156.12
1000002
C#
137.229.156.18
1000005
PHP
137.229.156.12
1000006
Prolog
156.213.38.31
1000010
PHP
128.120.56.214
1000020
PHP
137.229.156.12
1000022
```

The logfile is ordered by increasing timestamp. You are concerned that some people are voting multiple times for the same item. To somewhat address this problem, throw out any new votes for the same item that come from the same IP address within 20 seconds.

In the above example, the second and last votes for PHP would be thrown out because they are for the same item from the same IP address and occur within 20 seconds of other PHP votes from the same IP address. However, the PHP vote from 128.120.56.214 would be retained since there is not another PHP vote from this IP address.

Write a PHP program to count the votes from the logfile, throwing out duplicate votes using the rules above. Display the votes in a table, as shown below for the example:

<table>
<thead>
<tr>
<th>Language</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHP</td>
<td>2</td>
</tr>
<tr>
<td>C#</td>
<td>1</td>
</tr>
<tr>
<td>Prolog</td>
<td>1</td>
</tr>
</tbody>
</table>
9. (6 pts) Parallel Programming

You would like to develop a parallel traffic simulator to study traffic flow. In the picture below the grey lines are roads and the black dots are vehicles. Vehicles operate autonomously in the simulation and may move at different speeds and take different routes to get to their destination.

To run the simulation on your 12 node cluster you are thinking of decomposing the map into approximately equal sized grids as shown below. Each node handles all traffic within its cell.

Give at least one advantage, one disadvantage, and describe one alternate decomposition that may result in better performance.