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Math 220/317: Programming II/Data Structures

Midterm

October 14, 1993. 5:00–6:15 PM

There are four problems for a total of 100 points. Show all your work, partial credit will be awarded. When there is not enough room on the test page itself, write in the provided blue books and write and sign your name on each one. No notes, no collaboration.

If a problem seems easy: take care!
If a problem seems hard: persevere!

Name: ________________________________

<table>
<thead>
<tr>
<th>Problem</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>
1. Show that these two program fragments are identical. The variables A and B are declared as boolean, and S1 and S2 represent two statements.

Program Fragment 1:

    if A OR B then
      if A then S1
      else S2 ;

Program Fragment 2:

    if A then S1
      else if B then S2 ;
2. Change the following \texttt{repeat} loop into an exactly equivalent \texttt{while} loop.

\{Precondition: \(N\) is any integer.\}
\begin{verbatim}
i := 0 ;
repeat
    i := i + 1
until (i*i) > N ;
\end{verbatim}
3. Given two lists, $L_1$ and $L_2$, the operation of concatenation is defined as third list with all the elements of $L_1$, in order, followed by all the elements of $L_2$, in order. For example, if the two lists are:

\[ L_1 = a \rightarrow b \rightarrow c, \quad L_2 = d \rightarrow e \rightarrow f \]

then the concatenation would be,

\[ \text{Concat}(L_1, L_2) = a \rightarrow b \rightarrow c \rightarrow d \rightarrow e \rightarrow f \]

A list is given by the following code fragment:

\[
\begin{align*}
\text{type List} &= ^\wedge\text{ListHeader} ; \\
\text{ListElement} &= ^\wedge\text{ListRecord} ; \\
\text{ListHeader} &= \text{record} \\
&\quad \text{first} : \text{ListElement} ; \\
&\quad \text{last} : \text{ListElement} ; \\
&\quad \text{end} ; \\
\text{ListRecord} &= \text{record} \\
&\quad \text{data} : \text{DataType} ; \\
&\quad \text{next} : \text{ListElement} \\
&\quad \text{end} ; \\
\end{align*}
\]

\[
\begin{align*}
\{ \quad \text{An empty list is a listHeader} \quad \} \\
\{ \quad \text{with first = last = nil} . \quad \}
\end{align*}
\]

Give code for the procedure

\[
\text{Procedure Concat(A, B : List ) ;}
\]

which given two lists A and B, changes A into their concatenation and changes B into the empty list. Do this with as efficiently as possible.
4. Improve the speed in the inner loop of the following code fragment.

   (a) As written, how many multiplications are performed as a function of $N$.

   (b) Give an identically functioning code fragment where only $O(N)$ multiplications are performed.

   ```pascal
   var a : array[1..N,1..N] of integer ;
   i, j : integer ;
   begin
     for i := 1 to N do
       for j := i to N do
         a[i,j] := i*i ;
   end.
   ```