Mandatory Implementation Exercises

The 02105+02326 DTU Algorithms Team

Exercises

You must pass at least 2 out of 4 of these implementation exercises. To pass an exercise you must upload your solution to CodeJudge and get a green smiley. You may program in any of the languages Java/C/C++/C#/Python/Rust/Pascal.

M Mandatory Exercise: Implement Pseudocode  Translate the following pseudocode into a program.

```plaintext
INTEGERANALYZER()
A = IntArray(ReadInt())
for i = 0 to n - 1 do
    A[i] = ReadInt()
end for
SORT(A)
for i = 0 to ⌊(n - 1)/2 ⌋ do
    s = 0
    for j = 0 to i do
        s = s + A[j] + A[n - j - 1]
    end for
    PRINTINT(s)
end for
```

IntArray(n) creates an integer array of size n. ReadInt() reads an integer from standard input. PRINTINT(s) prints s to standard output. SORT sorts an array in ascending order (use the built-in function in your chosen programming language).

<table>
<thead>
<tr>
<th>Sample Input</th>
<th>Sample Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>-1 34 52</td>
</tr>
<tr>
<td>3 9 42 -43 32</td>
<td></td>
</tr>
</tbody>
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M Mandatory Exercise: Recursion  Implement a program that reads an integer n from standard input and then prints f(n). Your program should be recursive. f(n) is given by:

\[
f(x) = \begin{cases} 
  i & \text{if } i \leq 2 \\
  2f(i - 1) + f(i - 2) - f(i - 3) & \text{otherwise}
\end{cases}
\]

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M Mandatory Exercise: Alternating Paths  Consider a n × n grid consisting of 0's and 1's. Create a program that computes the length of a shortest path of alternating 1's and 0's from the upper left corner to the lower right corner (a path can go left/right/up/down). The grid should be read from standard input, the first line is n and the remaining lines are the grid. The program should output the shortest possible length to standard output.
M Mandatory Exercise: Binary Trees The following pseudocode constructs a binary tree from some input:

```plaintext
READBINARYTREE()
A = ReadInt()
if A = 0 then
    return NULL
else
    return NEWNODE(A, READBINARYTREE(), READBINARYTREE())
end if

READINT() reads an integer from standard input. NEWNODE(k, l, r) creates a new binary node with key k and left child l and right child r.

An example of input to the program could be "5 3 0 0 4 2 0 0 1 0 0". Before solving the rest of the exercise, you should try to draw the binary tree resulting from running the program on this input (you don’t have to hand-in this drawing).

Implement the above pseudocode. Extend the program to do a pre-order traversal of the binary tree. When visiting a node v in the traversal, you should print the sum of v's, LEFT(v)'s and RIGHT(v)'s keys (assume the key of a null node is 0, but don't print anything for NULL nodes).

<table>
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<tr>
<td>5 00010 11111 01000 01111 00000</td>
<td>13</td>
</tr>
<tr>
<td>5 3 0 0 4 2 0 0 1 0 0</td>
<td>12 3 7 2 1</td>
</tr>
</tbody>
</table>