

# Homework 32

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## 18

The outline for this algorithm is as follows: Since the input is a list of (possibly overlapping) integers  $x_1 \dots x_n$  between 1 and  $n$ , then each processor  $p_i$  of the  $n$  processors can look at its corresponding integer  $x_i$  and confirm that the number  $x_i$  is in the input by writing a 1 to an (originally 0) memory location  $IsInInput[i]$ . When  $IsInInput[i] = 1$ , the integer  $i$  is in the input. If no processor writes to  $IsInInput[i]$ , then it stays 0, which means that the integer  $i$  is not in the input. This stage of the algorithm takes only constant time, since  $n$  processors working on  $n$  integers each do one read step and one write step.

Next, each processor  $p_i$  will read  $IsInInput[n - i + 1]$ . If  $p_i$  finds a 1, then it will write  $n - i + 1$  to the memory location  $Maximum$ .  $Maximum$  will contain the maximum of  $x_1 \dots x_n$  after this step, since the lowest numbered processor will write the highest valued number. If  $p_i$  reads a 1 from  $IsInInput[n - i + 1]$ , then it will write  $n - i + 1$  to  $Maximum$  which will be the maximum if and only if all  $p_j, j < i$  read a 0 in  $IsInInput[n - j + 1]$ , which implies there are no higher numbers in the input. If there is a larger number, then a lower register (with a higher priority) will write to  $Maximum$  instead. This step also takes constant time, because each processor performs one read and one write.

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**Algorithm 1** CRCW Priority  $O(1)$  algorithm for maximum with  $n$  processors.

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**Require:** Input  $x_1 \dots x_n$ , an  $n$ -sized memory location  $IsInInput$ , and a memory location  $Maximum$ .

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IsInInput[ $i$ ]  $\leftarrow$  0                                 $\triangleright$  First, zero out the IsInInput array.
IsInInput[ $x_i$ ]  $\leftarrow$  1                             $\triangleright$  This is a CRCW Common step, since all processors write the same number: 1.
if IsInInput[ $n - i + 1$ ] == 1 then
    Maximum  $\leftarrow$   $n - i + 1$                          $\triangleright$  This is the CRCW Priority step.
end if
if  $i == 0$  then                                      $\triangleright$  Designate one processor
    Output Maximum                                      $\triangleright$  to output the maximum.
end if
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