

READ ME --- merge two sorted list

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Problem

Consider the problem of merging two sorted arrays of numbers A and B of length m and n, respectively. Design a parallel merging algorithm on a CREW PRAM using $(m+n) / \log(m+n)$ processors. What is the time complexity of your algorithm?

Time complexity is

$$O(\log^2(m + n))$$

Methodology

Naive

Firstly, we can think about how to do this by using $(m+n)$ processors.

List1: [2, 4, 6, 8, 10]

List2: [1, 2, 3, 4, 5]

List3: []

Every process takes only one element.

For example, process 0 take the first element 2 in list1 of index 0.

Then, perform binary search and find out that 2 should be in the 2nd position (starts from 0) in list2 if we insert 2 into list2.

Then, we put it into list3 (i.e. $\text{list3}[0+2] = 2$).

For one more example, process 7 take the second element 3 in list2 of index 2.

Then 3 should be in the 1st position (starts from 0) in list1 if we insert 3 into list1.

Then, we put it into list3 (i.e. $\text{list3}[1+2] = 3$)

```

list3 = [ ]
forall element in list1 and list2 do in parallel:
  if the element is from list1:
    let's say this element is list1[i]
    find the position j if we want to insert it into list2
    list3[i+j] <- this element
  if the element is from list2:
    let's say this element is list2[j]
    find the position i if we want to insert it into list1
    list3[i+j] <- this element

```

Using $(m+n) / \log(m+n)$ processors

The only thing we need to do is partitioning all $m+n$ elements into $(m+n) / \log(m+n)$ parts. Each processor computes only one part where there are $\log(m+n)$ numbers. The time complexity for binary search is $O(\log(m+n))$. Therefore, the time complexity is

$$O(\log(m+n) * \log(m+n)).$$

Result

```

list1: [0, 2, 4, 6, 10, 13, 18]
list2: [0, 1, 6, 11, 15, 18, 22, 26, 28]
sequential version result: [0, 0, 1, 2, 4, 6, 6, 10, 11, 13, 15, 18, 18, 22, 26,
28]
parallel version result: [0, 0, 1, 2, 4, 6, 6, 10, 11, 13, 15, 18, 18, 22, 26, 28]
True

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