Synchronization: Finding the Maximum of an Array

CMPU-377
Parallel Programming
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1 Introducing some notation

Finding the maximal element in array $a$ is the problem. Let $m$ be the variable to hold the max. Let the $\text{co}$ statement specify some number of concurrent processes. Let $<$ and $>$ denote atomic actions. The goal of the program can then be expressed in predicate logic as:

$$(\forall j : 1 \leq j \leq n : m \geq a[j]) \land (\exists j : 1 \leq j \leq n : m == a[j])$$

Let’s look carefully at each successive version of this program, and see what we can discover regarding the issues of synchronization.

2 Sequential version

```c
int m = 0;
for [i = 0 to n-1] {
    if (a[i] > m)
        m = a[i];
}
```

3 Version 2

Let’s fully parallelize the loop with the $\text{co}$ statement:
int m = 0;
c o [i = 0 to n-1] {
    if (a[i] > m)
        m = a[i];
}

4 Version 3
Let’s make the processes’ actions atomic:

int m = 0;
c o [i = 0 to n-1] {
    if (a[i] > m)
        m = a[i];
}

5 Version 4
Let’s make only part of each processes’ actions atomic:

int m = 0;
c o [i = 0 to n-1] {
    if (a[i] > m)
        m = a[i];
}

6 Version 5
Let’s combine parts of the last two versions:

int m = 0;
c o [i = 0 to n-1] {
    if (a[i] > m)
        if (a[i] > m)
            m = a[i];
        
}