

HY586: Distributed Computing

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Assignment 1

Deadlines: Exercise 1: Wednesday 6/10/09 at 17:00

Exercise 2, 3 & 4: Monday 12/10/2009 at 17:00

Exercise 1

- a. Suppose a computer program has a method M that cannot be parallelized, and this method accounts for 40% of the program's execution time. What is the limit for the overall speedup that can be achieved by running the program on an n-processor multiprocessor machine?
- b. You have a choice between buying one uni-processor that executes $5 \cdot 10^{15}$ instructions per second, or a ten-processor multiprocessor where each processor executes 10^{15} instructions per second. Using Amdahl's Law, explain how you would decide which to buy for a particular application.

Exercise 2

- a. Does the following ME algorithm for two processes ensure mutual exclusion and no deadlock? If yes, prove that it is so. If no, present counter-example executions in which these properties are violated. Is starvation of individual processes possible? Prove your claim.

 Let $i \in \{0,1\}$ and $j = 1 - i$ be the identifiers of the processes. The algorithm makes use of three shared bits *turn*, *flag[0]* and *flag[1]*.

Code for process i

Initially: flag[i] = FALSE

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flag[i] = TRUE;
while (flag[j] == TRUE) {
    if (turn == j) {
        flag[i] = FALSE;
        await (turn==i);
        flag[i] = TRUE;
    }
}
critical section;
turn = j;
flag[i] = FALSE;
  
```

- b. Modify the tournament tree mutual exclusion algorithm for n processors so that it can use an arbitrary two-processor mutual exclusion algorithm as subroutines at the nodes of the tree. Prove that your algorithm is correct. Try to minimize any assumptions you need to make about the two-processor algorithm.

Exercise 3

Lucifer Technology Inc. is a company which has recently produced a new multiprocessor. Unfortunately, this machine encounters a weird problem: If more than two processes access any shared variable concurrently, then the machine crashes and catches fire. The machine has already been bought to some good customers of the company and it is difficult to withdraw it from the market. Present a mutual exclusion protocol which will avoid any further machine crashes.

Exercise 4

- a. Is the Bakery Algorithm correct if all choosing[j] variables ($1 \leq j \leq n$), as well as all code lines referring to them, are omitted in the code? Prove your claim.
- b. Present an execution of the Bakery algorithm where the sequence of values that are stored in each number[j] variable, $1 \leq j \leq n$, is strictly increasing.