

Homework Assignment #6
Due: November 24, 2016 at 1:00 p.m.

1. Consider an asynchronous deterministic shared-memory system, where the n processes have unique ids in the range $\{1, 2, \dots, n\}$ and any number of halting failures may occur.
 - (a) Consider the object type **Arithmetic** which stores a natural number and provides two types of operations:
 - **FETCH&ADD**(x) adds x to the value stored in the object and returns the previous value stored (before the addition).
 - **FETCH&MULT**(x) multiplies the value stored in the object by x and returns the previous value stored (before the multiplication).

Show that **Arithmetic** objects and registers can be used to solve consensus among any number of processes.

Hint: One way to solve this problem is by proving the following lemma: If there is a consensus algorithm for $n - 1$ processes that uses k registers and j **Arithmetic** objects, then there is a consensus algorithm for n processes that uses $k + 2$ registers and $j + 1$ **Arithmetic** objects.

- (b) Consider the **Multiplication** object type, which stores a natural number and provides only the **FETCH&MULT**(x) operation (as described above). Show that registers and **Multiplication** objects cannot solve consensus among 3 processes.