Homework Assignment #6

Due Time/Date

5:00PM Thursday, December 17, 2020. Late submission will be penalized by 20% for each working day overdue.

Note

This assignment must be carried out using Coq and Frama-C. Please email your completed homework in one single .zip file to the instructor by the due time. You may discuss the problems with others, but copying answers is strictly forbidden.

Problems

1. (40 points) Prove the following lemmas using Coq:

   ```
   Require Import Arith.
   Lemma t0: forall m n: nat, m <= n -> S m <= S n.
   Lemma t1: forall m n: nat, m < n -> S m < S n.
   Lemma t2: forall m n: nat, m <= n -> 1+m <= 1+n.
   Lemma t3: forall m n: nat, m <= n -> m+1 <= n+1.
   ```

2. (30 points) Annotate the following C function to show its behavior and prove correctness of your annotation using Frama-C.

   ```
   int find(int* a, int n, int z)
   { int m, i;

     m = -1;
     for (i=0; i<n; i++)
       if (a[i] == z) {
         m = i; break;
       }
     return m;
   }
   ```

3. (30 points) Annotate the following C function to show that it preserves sortedness of the input array (i.e., the input array remains sorted if it was sorted) and prove correctness of your annotation using Frama-C.

```
void add1(int* a, int n)
{ int i;

  for (i=0; i<n; i++)
    a[i]++;
}
```