Homework 3

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You are encouraged to checkout the tutorials available on theDafny page. You need to submit a document describing your detailed answer to question 1.3 and two Dafny files: for questions 1.2 and 2.

Problem 1:

The method foo below assumes a natural number $n \geq 0$ and returns the natural number stored in r.

```
method foo(n: int) returns (r: int)
requires 0 <= n
ensures ...
{
  var i := 0;
  r := 0;
  while i < n
  {
    r := r + 2*i + 1;
    i := i + 1;
  }
}
```

1. Experiment with some values for the input n, and find the "strongest relation" that always holds between the input n and the result r assuming the precondition holds. For instance, the relation $r \geq n$ holds, but it is not the strongest one.
2. Propose:
   - a strongest post-condition that always holds given foo is called with $n \geq 0$,
   - adequate invariants
   - a ranking function

   and use them to prove total correctness of the method in Dafny
3. Prove total correctness (using the same pre- and post-conditions) with "pen and paper" (using weakest-precoditions, verification conditions for invariants and for ranking functions).

Problem 2:

Verification of the Dutch National Flag algorithm was discussed in lecture 6. Check the this tutorial on using Dafny to verify it. Your task is to generalize it to 4 colours instead of 3, and to verify the result with Dafny.