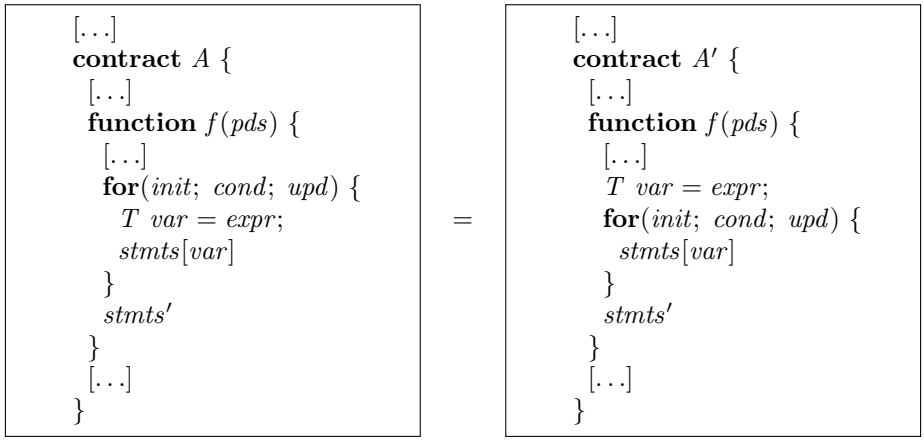
Rule 0.23 ⟨*Avoid Repetitive Arithmetic Operations in Loops*⟩



where

expr is an arithmetic or logical expression computed inside the loop;

var is a variable of type T storing the result of *expr*;

stmts[*var*] represents loop body statements that use *var*;

init, *cond*, and *upd* are the loop initialization, condition, and update expressions;

pds are the parameter declarations of function f;

stmts′ represents statements following the loop.

provided

The expression *expr* does not depend on the loop variable or any value modified within the loop;

The value of *expr* remains constant throughout all loop iterations;

Moving *expr* outside the loop does not change program semantics;

expr is side-effect free (does not modify state or call external functions);

No variable in *expr* is modified between the pre-computation and loop execution.

Invariant:

Let s_i and s_i' be the initial state of A and A', respectively.

Let s_f and s_f' be the state reached by A and A', respectively, after $A.f()$ and $A'.f()$ are executed from s_i and s_i', respectively.

Then, the coupling invariant is

$$\forall\, s_i, s_i' \;.\; (s_i = s_i') \rightarrow (s_f = s_f')$$