
Rule 0.4 *(Refactoring Loops with Repeated Computations)*

<pre> [...] contract A { [...] function f(pds) { [...] for(init; cond; update) { stmts[expr] } stmts' } [...] } </pre>	=	<pre> [...] contract A' { [...] function f(pds) { [...] T local = expr; for(init; cond; update) { stmts[local] } stmts' } [...] } </pre>
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where

expr is an expression that is loop-invariant (yields the same result in every iteration);

T is the type of the computed expression *expr*;

local is a local variable of type *T* used to cache the computation result;

stmts[expr] represents statements inside the loop that use *expr*;

stmts[local] represents the same statements with *expr* replaced by *local*;

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

stmts' represents statements following the loop.

provided

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

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

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

No variable in *expr* is modified between the assignment to *local* and the 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

$$\forall s_i, s'_i . (s_i = s'_i) \rightarrow (s_f = s'_f)$$
