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**Rule 0.24** *Cache Storage Variables in Loops*


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<pre> [...]  <b>contract</b> <i>A</i> {    [...]    <b>function</b> <i>f</i>(<i>pds</i>) {      [...]      <b>for</b>(<i>init</i>; <i>cond</i>; <i>upd</i>) {        <i>stmts</i>[<i>storageVar</i>]      }      <i>stmts</i>'    }    [...]  } </pre>	=	<pre> [...]  <b>contract</b> <i>A'</i> {    [...]    <b>function</b> <i>f</i>(<i>pds</i>) {      [...]      <i>T</i> <i>cache</i> = <i>storageVar</i>;      <b>for</b>(<i>init</i>; <i>cond</i>; <i>upd</i>) {        <i>stmts</i>[<i>cache</i>]      }      <i>storageVar</i> = <i>cache</i>;      <i>stmts</i>'    }    [...]  } </pre>
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**where**

*storageVar* is a storage variable accessed repeatedly within the loop;  
*cache* is a local memory variable of type *T* that caches *storageVar*;  
*T* is the type of the storage variable;  
*stmts*[*storageVar*] represents loop body statements that access *storageVar*;  
*stmts*[*cache*] represents the same statements with *storageVar* replaced by *cache*;  
*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 storage variable *storageVar* is accessed multiple times within the loop;  
 No external calls or state-modifying operations within the loop affect *storageVar*;  
 The cached value is written back to storage after the loop completes;  
 All modifications to *storageVar* within the loop can be safely performed on *cache*;  
 The loop does not modify *storageVar* through aliasing or indirect references.

**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

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


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