Productive SimTalk Programming
2017 Plant Simulation User Conference

Unrestricted

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Simple Optimizations

Declare the data type of local variables

If you do *not* explicitly declare the data type of a local variable, the data type usually will be *any*. Sometimes the SimTalk compiler will determine the data type implicitly, for example when assigning a constant value in the declaration.

Not using the data type *any* has these advantages:

- The SimTalk compiler can better optimize the code (for example perform type checks during compile time rather than during execution).
- It increases the chance to find certain programming errors during compile time.
- It may also help to understand the source code.
Simple Optimizations

Compute loop-invariant values outside of loops

If the value of a complex expression will not change inside a loop, assign it to a local variable.

Example:

```plaintext
for var x := 1 to Store.ContentsList.XDim
    for var y := 1 to Store.ContentsList.YDim
        if Store.ContentsList[x,y] /= void and Store.ContentsList[x,y].Name = "Container"
            return Store.ContentsList[x,y]
    end
next
next
```
Simple Optimizations

Simplify expressions in waituntil-statements

An expression in a waituntil-/stopuntil-statement will possibly be evaluated many times before the expression becomes true. If you know that a part of the expression will not change, assign it to a local variable.

Example:

```plaintext
waituntil ?.cont.finished -- ?.cont might be evaluated many times

var contObj : object := ?.cont -- ?.cont is evaluated one time only
waituntil contObj.finished
```
Simple Optimizations

Returning multiple results

If you need to return multiple result values, return them in `byref` parameters instead of returning them in global variables or in an array.

Example:

```plaintext
param dividend, divisor: integer -> integer[2]
return makeArray(dividend div divisor, dividend mod divisor)

param dividend, divisor: integer, byref quotient, remainder: integer
quotient := dividend div divisor
remainder := dividend mod divisor
```

This improves:

- Readability
- Performance
Fast Searching

Searching values in tables

- Enable the row index and put the values to search for into column 0.
- Possibly enable *Fast index access*.
- Use `getRowNo` to find the row.

Example:

```var
var row := PersonTable.getRowNo("Lisa")
```

Effect of *Fast index access*:

- Searching is very fast
- Inserting and deleting a row is slow
Hashing (1)

• When *Fast index access* is disabled, searching is slow (particularly when searching for string values).

• If you need to search for more than one value, using the row index is impossible.

**Solution: Hashing**

Divide the search space into smaller partitions.
Compute a hash function for the search value that identifies the partition to look into.

**Example:**

A filing cabinet containing files of persons. Each file is put into the drawer with the first letter of the last name.

When looking for a person, you need to find the correct drawer and then you need to search inside this drawer only.
Hashing (2)

Properties of a good hash function:
• deterministic
• computes fast
• spreads well

Example: Look for a combination of a first name and a last name.

Possible hash function:
```
var HashValue: integer := (ascii(FirstName)*29 + ascii(LastName))
mod HashTable.XDim + 1
```

Alternative hash function:
```
var s: string := to_str(FirstName, ";", SecondName)
var HashValue: integer := strHash(s) mod HashTable.XDim + 1
```
Resolve collisions

“In a filing cabinet multiple files are stored in the same drawer.”

Example code:

```pascal
param FirstName, SecondName : string -> integer

var s : string := to_str(FirstName, ";", SecondName)
var HashValue: integer := strHash(s) mod 13 + 1

HashTab.setCursor(1, 1)
if HashTab.find({HashValue,1}..{HashValue,*}, s)
  return HashTab[HashValue+13, HashTab.CursorY]
else
  return 0
end
```
Recursive Functions (1)

Recursion in mathematics

\[ 0! = 1 \]
\[ n! = n \cdot (n - 1)! \]

Recursive SimTalk Methods

```
-- factorial(n)
param n : integer -> integer
if n = 0
  return 1
else
  return n * factorial(n - 1)
end
```

Principle idea

Simplify a problem by dividing it into sub-problems of the same type. This is called **divide and conquer**. It is a top-down approach, where problems are solved by solving smaller and smaller instances.
Recursive Functions (2)

Traversing a tree structure

A tree structure has a root node, and each node can have several child nodes.

If you want to visit all nodes in a tree, you can easily visit them recursively.

Visiting all objects in a simulation model:

```plaintext
param frame : object
for var i := 1 to frame.numNodes
  var obj: object := frame.node(i)
  if obj.InternalClassName = "Network"
    self.execute(obj)
  else
    -- do something with 'obj'
  end
next
```
Other example for “divide and conquer”: *Towers of Hanoi*

```plaintext
-- moveStack(5, A, C)

param NumDiscs: integer, FromStack, ToStack: object

if NumDiscs = 1
    ToStack.push(FromStack.pop)
else
    var Other: object := getOtherStack(FromStack, ToStack)
    moveStack(numDiscs - 1, FromStack, Other)
    ToStack.push(FromStack.pop)
    moveStack(numDiscs - 1, Other, ToStack)
end
```
Using the Profiler (1)

Optimize the *right* methods

Example:
Method1 consumes 5% of the CPU time.
Method2 consumes 40% of the CPU time.

Which optimization is better?
• speed up Method1 by 100 times
• speed up Method2 by 30%

Answer:
• Method1: \[5\% \times 0.99 = 4.95\%\] less total CPU time
• Method2: \[40\% \times 0.3 = 12\%\] less total CPU time

Conclusion:
We need to find the Methods that consume a relevant amount of time.
Using the Profiler (2)

<table>
<thead>
<tr>
<th>%Global</th>
<th>%Local</th>
<th>Time [s]</th>
<th>Calls</th>
<th>ms/Call</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>46.6%</td>
<td></td>
<td>1.882s</td>
<td>369355</td>
<td>0.01ms</td>
<td>.Models.Frame.SankeyDiagram1.printTrace</td>
</tr>
<tr>
<td>37.7%</td>
<td></td>
<td>4.035s</td>
<td>738710</td>
<td>0.01ms</td>
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</tr>
<tr>
<td>28.4%</td>
<td></td>
<td>0.039s</td>
<td>420736</td>
<td>0.00ms</td>
<td>.Tools.SankeyDiagram.SankeyDiagram.logMove</td>
</tr>
<tr>
<td>18.3%</td>
<td></td>
<td>2.153s</td>
<td>369355</td>
<td>0.01ms</td>
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</tr>
<tr>
<td>5.1%</td>
<td></td>
<td>0.569s</td>
<td>369355</td>
<td>0.00ms</td>
<td>.Tools.SankeyDiagram.internal.MuTraceCallback</td>
</tr>
<tr>
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<td></td>
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<td>66132</td>
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<td>.Tools.EnergyAnalyzer.EnergyAnalyzer.observeEnergyState</td>
</tr>
<tr>
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<td></td>
<td>0.145s</td>
<td>44754</td>
<td>0.00ms</td>
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</tr>
<tr>
<td>1.0%</td>
<td></td>
<td>0.110s</td>
<td>39476</td>
<td>0.00ms</td>
<td>.Tools.SankeyDiagram.SankeyDiagram.logActivityData</td>
</tr>
<tr>
<td>0.8%</td>
<td></td>
<td>0.091s</td>
<td>39476</td>
<td>0.00ms</td>
<td>.Tools.SankeyDiagram.SankeyDiagram.getActivityIndex</td>
</tr>
<tr>
<td>0.6%</td>
<td></td>
<td>0.061s</td>
<td>90828</td>
<td>0.00ms</td>
<td>.Tools.SankeyDiagram.SankeyDiagram.getActivityPointID</td>
</tr>
<tr>
<td>0.4%</td>
<td></td>
<td>0.047s</td>
<td>16821</td>
<td>0.00ms</td>
<td>.Tools.TransferStation.TransferStation.stopObject</td>
</tr>
<tr>
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<td></td>
<td>0.040s</td>
<td>2626</td>
<td>0.02ms</td>
<td>.Models.Quality_Department.Material_Request</td>
</tr>
<tr>
<td>0.4%</td>
<td></td>
<td>0.040s</td>
<td>10800</td>
<td>0.00ms</td>
<td>.Tools.TransferStation.TransferStation.TargetSensorControl</td>
</tr>
</tbody>
</table>

- **time portions consumed by individual instances**
- **time consumed by all instances (click to expand)**
- **total number of calls**
- **the mean time a single call consumed**
Outdated Functions

1. Look for no longer supported functions and methods in the source code

2. Double-click one of the outdated functions

3. Replace the outdated name with the new name (click “Find Next” to open the Method Editor)
Contact

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