AdvancedTimer usage and technical documentation

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Dependency

You'll need to install *Matplotlib* (https://matplotlib.org/) to use the given python scripts for plotting operations. WARNING ! Without this dependency, you'll not be able to use the scripts !

If you don't want to install *Matplotlib*, you can still use the *AdvancedTimer* methods in *Python* and plot the *JSON* files without the library. *However* it is strongly recommanded to use *Matplotlib*.

Principle of the AdvancedTimer

The *AdvancedTimer* is a kind of "supervisor" that can be called in any part of the *SOFA framework*. Then you can use it to measure the time of each componants of the simulation or the initialization of a given scene in the same way.

For each measure, you'll get the decomposition of time spent by each componants of your *entire scene graph*. That means that the entire tree is covered and you can make graphics of all componants on a *same level* or the decomposition of *all children* of a specified componant.

AdvancedTimer usage

Available output types

There are three types of output that you can use with *AdvancedTimer*. You can change the outputType at anytime during the measure and the default output type is the *STDOUT*.

- *STDOUT*: the old output used by the *AdvancedTimer* before its enhancement. You can see an example of this output in figure 1. This output is returned in the standard output.
- *JSON*: this one return a *JSON* object with the representation of the entire componants graph. It can be usefull if you want to create graphics of a componant and all its sub-level componants (cf figure 2).
- *LJSON*: for *light json* return a *JSON* object, but insteed of representing all the sub-level componants, this one only give the father of each componant. It is less precise but esier and faster to parse it (cf figure 2).

```
==== Animate ====

Trace of last iteration :
  *    0    ms > begin Simulation::draw
  *    0.22 ms < end   Simulation::draw
  *    0.22 ms END

Steps Duration Statistics (in ms) :
 LEVEL   START    NUM      MIN     MAX    MEAN     DEV    TOTAL  PERCENT ID
   0       0       2       0.22    4.04    2.13    1.91    4.26  100     TOTAL
   1       0       0.50    3.79    3.79    3.79    0       1.89   88.94 .Simulation::animate
   2       0       0.50    0.02    0.02    0.02    0       0.01    0.38 ..AnimateBeginEvent
   2       0.04    0.50    0.02    0.02    0.02    0       0.01    0.38 ..MechanicalVInitVisitor
   2       0.06    0.50    0.01    0.01    0.01    0       0       0.12 ..UpdatePosition
   2       0.07    0.50    1.42    1.42    1.42    0       0.71   33.27 ..FreeMotion
   3       0.07    0.50    1.41    1.41    1.41    0       0.71   33.13 ...Mechanical
```

Figure 1: STDOUT output type example. You can see that this output is built as a 2D table where columns are values and lines are componant.

```
"1": {                                      |    "1": {
    "TOTAL": {                              |        "AnimateVisitor": {
        "Simulation::animate": {            |            "Father": "Simulation::animate",
            "AnimateVisitor": {             |            "Values": {
                "Values": {                 |                <...>
                    <...>                   |            }
                }                           |        },
            },                              |        "BehaviorUpdatePositionVisitor": {
            "Values": {                     |            "Father": "Simulation::animate",
                <...>                       |            "Values":{
            }                               |               <...>
        },                                  |            }
        "Values": {                         |        }
            <...>                           |    }
        }                                   |
    }                                       |
},                                          |
```

Figure 2: JSON example (on the left) where you can see that each JSON object are composed as following : the key is the simulation step and the value is the graph of the componants where each componant is a list with its subcomponants and its values. The LJSON example (on the right) is composed in the same way, but the list of subcomponants is replaced by the father of the componant.

Available methods

You can call the following methods both on *C++* and *Python*, there will be defined as C++/python:

- **Clear()/timerClear()**: clear the timer with the given ID.
- **isEnabled(str id)/timerIsEnabled(str id)**: tell if the timer is enabled or not.
- **setEnabled(str id, bool val)/timerSetEnabled(str id, bool val)**: Enable or disable the timer with the given ID.
- **setInterval(str id, int interval)/timerSetInterval(str id, int interval)**: set the timer capture interval (ie number of steps between each capture).
- **getInterval(str id), timerGetInterval(str id)**: return the interval of the timer with the current ID.
- **begin(str id)/timerBegin(str id)**: begin the time capture for the given timer with the given ID.
- **steBegin(str id)/timerStepBegin(str id)**: set the flag for begin a sub-time capture for the timer with the given ID. It means that the begin or *timerBegin* will analyze the section between *timerStepBegin* and *timerStepEnd*.
- **stepEnd(str id)/timerStepEnd(str id)**: set the flag gor end a sub-time capture for the timer with the given ID.
- **end(str id, node* n)/timerEnd(str id, node* n)**: return the value of the time analysis with specified output type (see setOutputTypê and timerSetOutputType for more information) of the timer with the given ID.
- **setOutputType(str id, str outputType)/timerSetOutputType(str id, str outputType)**: set the output type with the given value to the timer with the given ID.

How to use AdvancedTimer in a scene in python

If you want to use the *AdvancedTimer* in a *Python scene*, the easiest way to do it is to use the given scripts with the method measureAnimationTime. You will have to add this line:

```
from SofaPython import PythonAdvancedTimer
```

at the beginning of your script. Then you have to add the method *bwdInitGraph(self, node)* method at least as the following:

```
def bwdInitGraph(self, node):
    # Call the animate method to
    PythonAdvancedTimer.measureAnimationTime(node, "timerPoutre",
    2, "ljson", "poutre_grid_sofa_timerLog", 0.1, 1000)
    return 0
```

If you already have defined a bwdInitGraph, you juste have to add the *measureAnimationTime()* method to get your scene analyzed.

To use it by your own way, you can take a look at the *PythonAdvancedTimer.py* script. You'll find it in the *Sofa project* at *SofaPython/python/SofaPython/PythonAdvancedTimer.py*.

Given scripts for data plotting

Two plotting scripts are allready implemented in *SOFA* : *TimerLJSONPlot.py* and *timerLjsonManyFilesPlot.py*. The first one create a plot from one *light JSON* file with the given componant(s) and the second one create a plot with the given files (at least two) and the given componant(s). The difference between the two scripts is that the first one was made to create a graph for precise analysis of a simulation and the second one for performance comparisons.

With the *TimerLJSONPlot.py*, you can choose the deepness of the analysis (if you want a deep analysis, it will create a graph with the componant(s) and it(their) children). The script can be call in command line with the terminal as follow :

```
python timerLjsonPlot.py [LJSONFileName] -d [deepness] -v [Value]
  -c [Componant1] [Componant2] ...
```

where *LJSONFileName* is the file to plot, *-d deepness* is used to specify the deepness of the analysis (0 is for an analysis with componants on the same level and 1 with the children of hte componant. Default value is 0), *-v [ValueToSearch]* is used to specify the value to search in the *Values* key in LJSON file (the *Values* key store the data of the time measure of the componant. Available values are : Dev, Level, Max, Mean, Min, Num, Percent, Start, Total) and *-c [Componant1] [Componant2] ...* is used to give the componant(s) to analyse (you can give one or more componant(s)).

With the *timerLjsonManyFilesPlot.py*, you can plot multiple *light JSON* files for one componant. It's usefull to make performance comparison between two or more simulations. You can also use it in command line with the terminal as follow :

```
python timerLjsonManyFilesPlot.py [Componant] -v [Val] -j [LJSONFile1]
[LJSONFile2] ...
```

where *Componant* is the componant to analyse, *-v [val]* is the same than with *TimerLJSONPlot.py* and *-j [LJSONFile1] [LJSONFile2] ...* is used to give the *light JSON* file names to plot (you have to give one or more file names).

Example scene

```
import Sofa
import os
import sys
from contextlib import contextmanager
from SofaPython import PythonAdvancedTimer


class poutreGridSofa(Sofa.PythonScriptController):

    def createGraph(self, node):

        self.rootNode = node.getRoot()

        # Creation of stuff needed for collision management
        node.createObject('APIVersion', name="17.06")
        node.createObject('RequiredPlugin', name="SofaPython")
        node.createObject('DefaultAnimationLoop')
        node.createObject('CollisionPipeline', depth='6', verbose='0',
        draw='0')
        node.createObject('BruteForceDetection')
        node.createObject('CollisionResponse', response='default')
        node.createObject('DiscreteIntersection')
        node.createObject('VisualStyle', displayFlags="showBehaviorModels
        showForceFields showVisual" )

        # Creation of the 'poutreRegGrid' node
        poutreRegGridNode = node.createChild('poutreRegGrid')
        # Add solver
        poutreRegGridNode.createObject('EulerImplicit', name='cg_solver',
        printLog='false')
        poutreRegGridNode.createObject('CGLinearSolver', iterations='25',
        name='linearSolver', tolerance='1.0e-9', threshold='1.0e-9')
        # Creation of the regular grid
        poutreRegGridNode.createObject('MechanicalObject', name='mecaObj')
        poutreRegGridNode.createObject('RegularGrid', name='regGrid', nx='3',
        ny='5', nz='10', min='2.495 -0.005 -0.005', max='2.535 0.065 0.205')
        # Set a topology for boxROI
        poutreRegGridNode.createObject('HexahedronSetTopologyContainer',
        src='@regGrid', name='Container')
        poutreRegGridNode.createObject('HexahedronSetTopologyModifier',
        name='Modifier')
        poutreRegGridNode.createObject('HexahedronSetTopologyAlgorithms',
        template='Vec3d', name='TopoAlgo')
```

```python
        poutreRegGridNode.createObject('HexahedronSetGeometryAlgorithms',
        template='Vec3d', name='GeomAlgo')
        # Physic manager
        poutreRegGridNode.createObject('HexahedronFEMForceField', name='HFEM',
        youngModulus='1000', poissonRatio='0.2')
        # BoxConstraint for fixed constraint (on the left)
        poutreRegGridNode.createObject('BoxROI', name="FixedROI", box="2.495
        -0.005 -0.005 2.535 0.065 0.0205", position='@mecaObj.rest_position')
        poutreRegGridNode.createObject('FixedConstraint', template='Vec3d',
        name='default6', indices='@FixedROI.indices')
        # BoxROI for constant constraint (on the right)
        poutreRegGridNode.createObject('BoxROI', template='Vec3d', box='2.495
        -0.005 0.18 2.535 0.065 0.205', name='box_roi2', position='@mecaObj.rest_position')
        poutreRegGridNode.createObject('ConstantForceField', indices="@box_roi2.indices",
        force='0 -0.1 0', arrowSizeCoef='0.01')

        # Visual node
        VisualNode = poutreRegGridNode.createChild('Visu')
        VisualNode.createObject('OglModel', name='poutreRegGridVisual',
        fileMesh='../../mesh/poutre_surface.obj', color='red', dx='2.5')
        VisualNode.createObject('BarycentricMapping', input='@..',
        output='@poutreRegGridVisual')


    def bwdInitGraph(self, node):
        # Call the animate method to
        PythonAdvancedTimer.measureAnimationTime(node, "timerPoutre", 2,
        "ljson", "poutre_grid_sofa_timerLog", 0.1, 1000)
        return 0


def createScene(node):
    obj = poutreGridSofa(node)
    obj.createGraph(node.getRoot())
```