SLang - the Next Generation

Tutorial

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0.1 Solution of initial value problems

Consider a simple oscillator governed by the differential equation

$$m\ddot{x} + c\dot{x} + kx = 0; \quad x(0) = 1,\ \dot{x}(0) = sin(t) \tag{1}$$

This can be written on first order form as

$$\dot{y}_1 = y_2; \quad \dot{y}_2 = -\frac{1}{m}\left(ky_1 + cy_2\right) \tag{2}$$

The *SLangTNG*-code to solve this inital value problem is given below.

```
--[[
SLangTNG
Simple test example for the solution of initial value problems
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--]]

-- This function defines the derivatives of the state variables
-- It is called automatically by the ODE solver Radau5
  function derivative(t, y)
    local yd=tmath.Matrix(2)
    yd[0] = y[1]
    yd[1] = 1/m*(-k*y[0] -c*y[1] + math.sin(t))
    return yd
    end

-- Main program
  T = 20*math.pi
  dt = 0.1
  N = T/dt
  k = 1
  m = 1
  c = 0.1
-- Initialize a data object for the ODE solver
-- (implicit Runge Kutta code RADAU5 by E. Hairer und G. Wanner)
  system=ode.Radau5(2, "derivative")

-- Define the initial conditions
  start=tmath.Matrix(2)
  start[0] = 1
  start[1] = 0
  system:SetState(start)

-- Compute the solution
  control.Interactive(false)
  t=tmath.Matrix(1,N)
  t:SetLinearCols(0,dt*N)
  result = system:Compute(0,dt*N, N)
  print("result", result);

-- Plot the result
  vis=tnggraphics.TNGVisualize(20,20,800,800, "Solution")
  vis:SetLabels("Solution of the ODE using Radau5 w/o Jacobian", "Time [sec]", "State
      variables [-]")
  vis:Plot(t, result)
  vis:File("ode.pdf")
```

The result is shown in Fig. 1. Note that due to limitations in the current implementation of the ODE solver, the function providing the derivatives of the state variables must have the name `func`. A full reverse-communication mode of operation is not yet available.

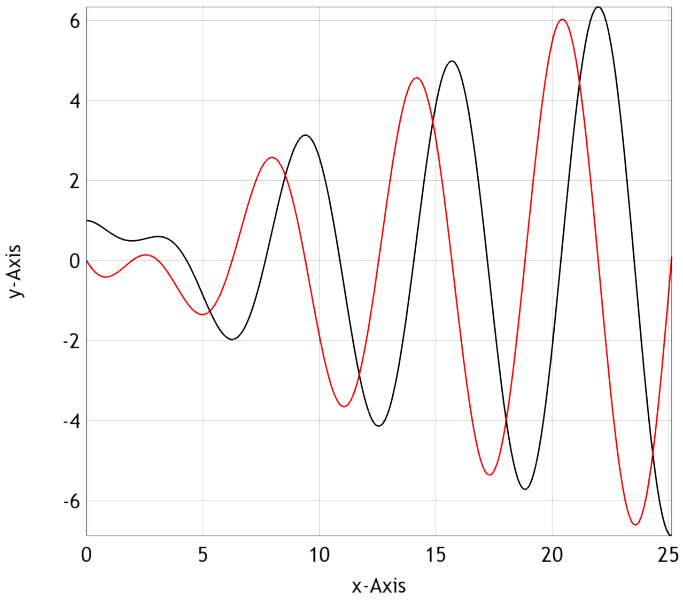

Figure 1: Solution of initial value problem