tolerance

March 29, 2025

1 Integrator tolerances

[1]:
```
from casadi import *
from numpy import *
from pylab import *
```

[2]:
```
x=SX.sym('x')
dx=SX.sym('dx')
states = vertcat(x,dx)
```

[3]:
```
dae={'x':states, 'ode':vertcat(dx,-x)}
```

[4]:
```
tend = 2*pi*3
ts = linspace(0,tend,1000)
```

[5]:
```
tolerances = [-10,-5,-4,-3,-2,-1]
```

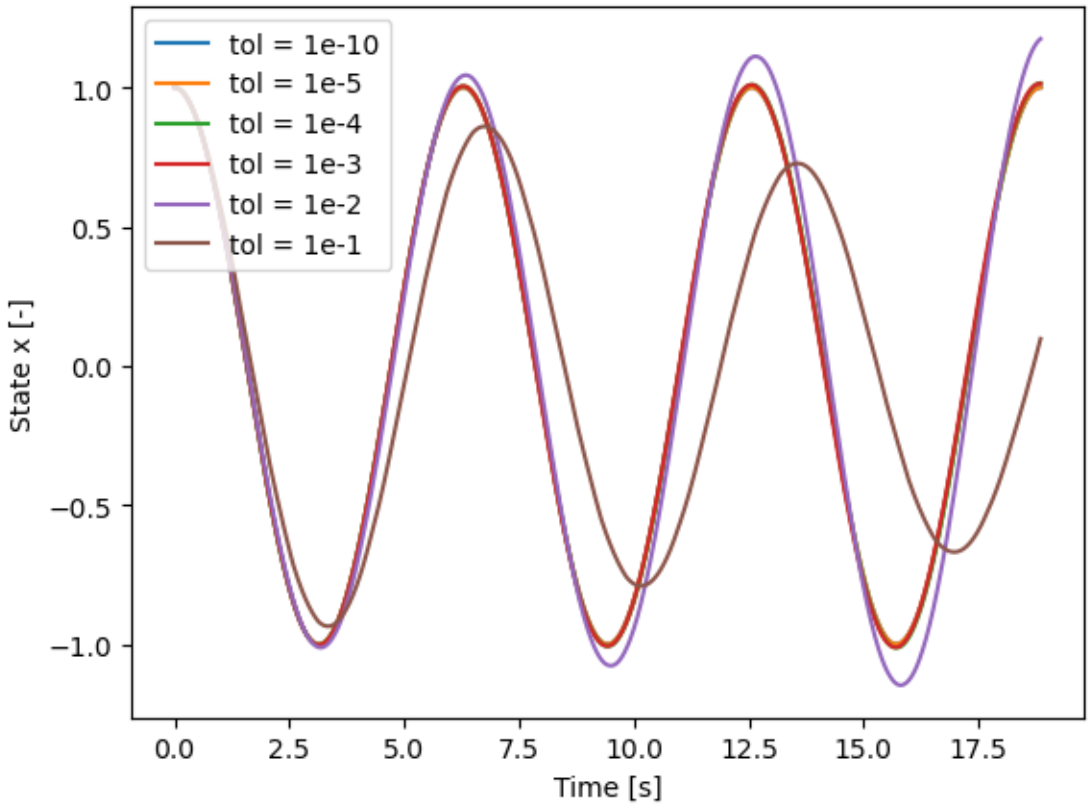
[6]:
```
figure()
```

[6]: <Figure size 640x480 with 0 Axes>

<Figure size 640x480 with 0 Axes>

[7]:
```
for tol in tolerances:
  opts = {'reltol':10.0**tol, 'abstol':10.0**tol, 'grid':ts, 'output_t0':True}
  F = integrator('F', 'cvodes', dae, opts)
  res = F(x0=[1,0])
  plot(ts,array(res['xf'])[0,:].T,label='tol = 1e%d' % tol)
legend( loc='upper left')
xlabel('Time [s]')
ylabel('State x [-]')
show()
```

```
CasADi - 2025-03-29 19:15:15 WARNING("The options 't0', 'tf', 'grid' and
'output_t0' have been deprecated.
The same functionality is provided by providing additional input arguments to
the 'integrator' function, in particular:
 * Call integrator(…, t0, tf, options) for a single output time, or
 * Call integrator(…, t0, grid, options) for multiple grid points.
The legacy 'output_t0' option can be emulated by including or excluding 't0' in
'grid'.
Backwards compatibility is provided in this release only.")
[…/casadi/core/integrator.cpp:692]
```

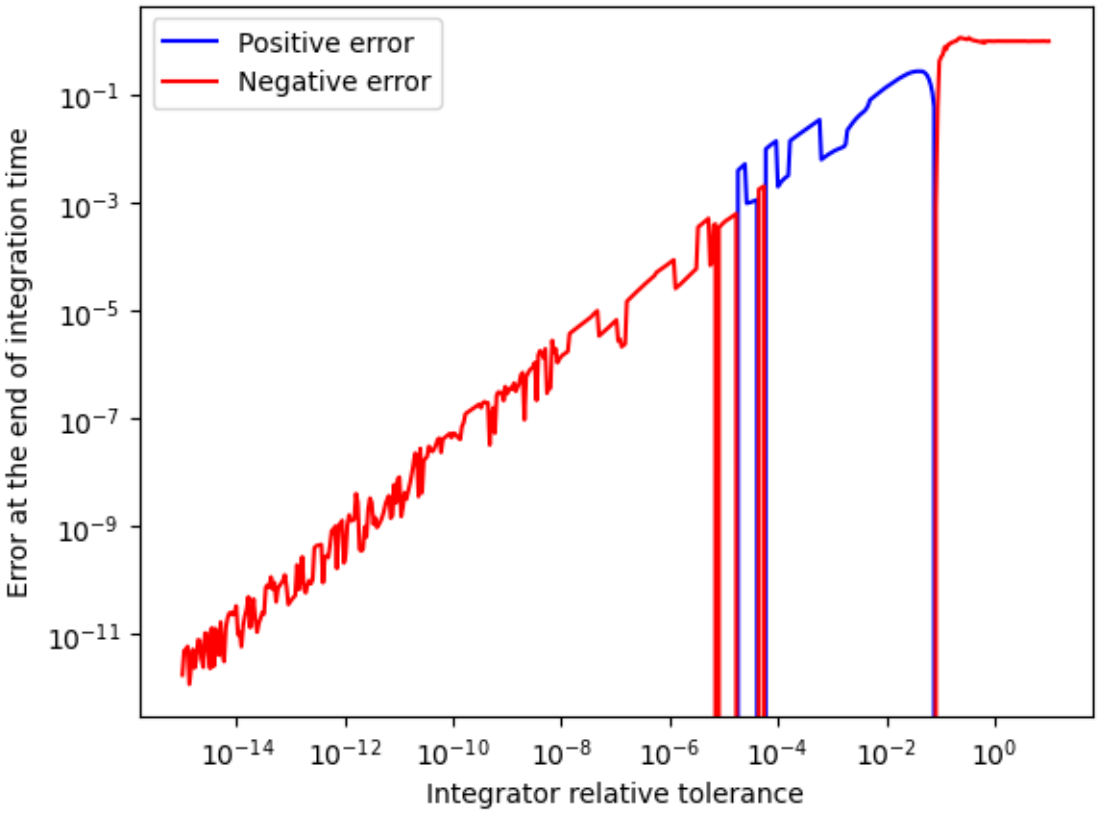


[8]:
```
tolerances = logspace(-15,1,500)
endresult=[]
```

[9]:
```
for tol in tolerances:
  opts = {}
  opts['reltol'] = tol
  opts['abstol'] = tol
  opts['tf'] = tend
  F = integrator('F', 'cvodes', dae, opts)
  res = F(x0=[1,0])
  endresult.append(res['xf'][0])
```

[10]:
```
endresult = vcat(endresult)
```

[11]:
```
figure()
loglog(tolerances,(array(endresult)-1),'b',label='Positive error')
loglog(tolerances,-(array(endresult)-1),'r',label='Negative error')
xlabel('Integrator relative tolerance')
ylabel('Error at the end of integration time')
legend(loc='upper left')
show()
```


Positive error
Negative error
Error at the end of integration time
10^{-1}
10^{-3}
10^{-5}
10^{-7}
10^{-9}
10^{-11}
10^{-14}
10^{-12}
10^{-10}
10^{-8}
10^{-6}
10^{-4}
10^{-2}
10^{0}
Integrator relative tolerance