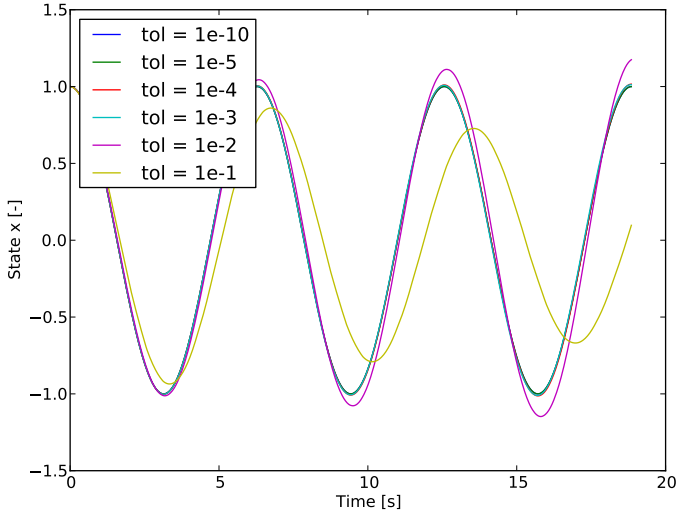
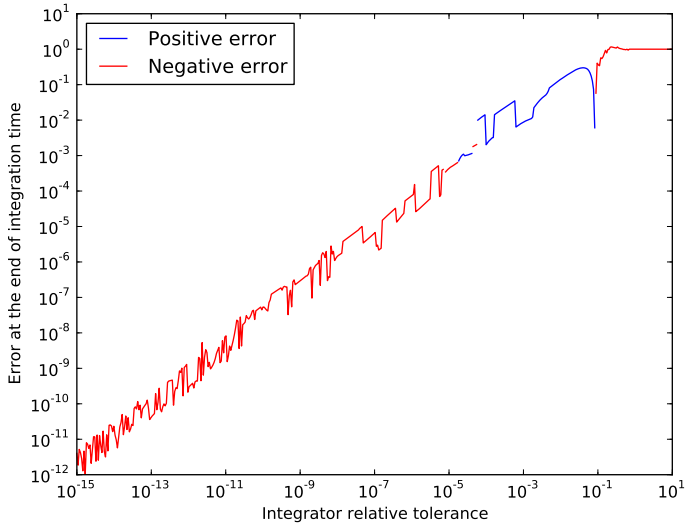
# Integrator tolerances




```
0  #
1  #
2  #
3  #
4  #
5  #
6  #
```

```
11 from casadi import *
12 from numpy import *
13 from pylab import *
14
15 x=SX.sym('x')
16 dx=SX.sym('dx')
17 states = vertcat(x,dx)
18
19 dae={'x':states, 'ode':vertcat(dx,-x)}
20
21 tend = 2*pi*3
22 ts = linspace(0,tend,1000)
23
24 tolerances = [-10,-5,-4,-3,-2,-1]
25
26 figure()
27
28 for tol in tolerances:
29   opts = {'reltol':10.0**tol, 'abstol':10.0**tol, 'grid':ts, 'output_t0':True
         }
30   F = integrator('F', 'cvodes', dae, opts)
31   res = F(x0=[1,0])
32
33   plot(ts,array(res['xf'])[0,:].T,label='tol = 1e%d' % tol)
34
35 legend( loc='upper left')
36 xlabel('Time [s]')
37 ylabel('State x [-]')
38 show()
```

```
41
42
43 tolerances = logspace(-15,1,500)
44 endresult=[]
45
46 for tol in tolerances:
47   opts = {}
48   opts['reltol'] = tol
49   opts['abstol'] = tol
50   opts['tf'] = tend
51   F = integrator('F', 'cvodes', dae, opts)
52   res = F(x0=[1,0])
53   endresult.append(res['xf'][0])
54
55 figure()
56 loglog(tolerances,(array(endresult)-1),'b',label='Positive error')
57 loglog(tolerances,-(array(endresult)-1),'r',label='Negative error')
58 xlabel('Integrator relative tolerance')
59 ylabel('Error at the end of integration time')
60 legend(loc='upper left')
61 show()
```


Positive error
Negative error
Error at the end of integration time
Integrator relative tolerance
$10^{1}$
$10^{0}$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
$10^{-6}$
$10^{-7}$
$10^{-8}$
$10^{-9}$
$10^{-10}$
$10^{-11}$
$10^{-12}$
$10^{-15}$
$10^{-13}$
$10^{-11}$
$10^{-9}$
$10^{-7}$
$10^{-5}$
$10^{-3}$
$10^{-1}$
$10^{1}$