

callback

April 24, 2023

This file is part of CasADi.

CasADi -- A symbolic framework for dynamic optimization.
Copyright (C) 2010–2023 Joel Andersson, Joris Gillis, Moritz Diehl,
KU Leuven. All rights reserved.
Copyright (C) 2011–2014 Greg Horn

CasADi is free software; you can redistribute it and/or
modify it under the terms of the GNU Lesser General Public
License as published by the Free Software Foundation; either
version 3 of the License, or (at your option) any later version.

CasADi is distributed in the hope that it will be useful,
but WITHOUT ANY WARRANTY; without even the implied warranty of
MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU
Lesser General Public License for more details.

You should have received a copy of the GNU Lesser General Public
License along with CasADi; if not, write to the Free Software
Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA 02110-1301 USA

1 Callback

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

In this example, we will demonstrate callback functionality for Ipopt. Note that you need the fix <https://github.com/casadi/casadi/wiki/enableIpoptCallback> before this works

We start with constructing the rosenbrock problem

```
[2]: x= SX.sym("x")  
     y= SX.sym("y")  
  
[3]: f = (1-x)**2+100*(y-x**2)**2  
     nlp={'x':vertcat(x,y), 'f':f, 'g':x+y}  
     fcn = Function('f', [x, y], [f])
```

```

[4]: import matplotlib
    if "Agg" not in matplotlib.get_backend():
        matplotlib.interactive(True)

[5]: from pylab import figure, subplot, contourf, colorbar, draw, show, plot, title

[6]: import time

[7]: class MyCallback(Callback):
    def __init__(self, name, nx, ng, np, opts={}):
        Callback.__init__(self)

        self.nx = nx
        self.ng = ng
        self.np = np

        figure(1)

        x_,y_ = mgrid[-1:1.5:0.01,-1:1.5:0.01]
        z_ = DM.zeros(x_.shape)

        for i in range(x_.shape[0]):
            for j in range(x_.shape[1]):
                z_[i,j] = fcn(x_[i,j],y_[i,j])
        contourf(x_,y_,z_)
        colorbar()
        title('Iterations of Rosenbrock')
        draw()

        self.x_sols = []
        self.y_sols = []

        # Initialize internal objects
        self.construct(name, opts)

    def get_n_in(self): return nlpsol_n_out()
    def get_n_out(self): return 1
    def get_name_in(self, i): return nlpsol_out(i)
    def get_name_out(self, i): return "ret"

    def get_sparsity_in(self, i):
        n = nlpsol_out(i)
        if n=='f':
            return Sparsity.scalar()
        elif n in ('x', 'lam_x'):
            return Sparsity.dense(self.nx)
        elif n in ('g', 'lam_g'):

```

```

        return Sparsity.dense(self.ng)
    else:
        return Sparsity(0,0)
def eval(self, arg):
    # Create dictionary
    darg = {}
    for (i,s) in enumerate(nlpsol_out()): darg[s] = arg[i]

    sol = darg['x']
    self.x_sols.append(float(sol[0]))
    self.y_sols.append(float(sol[1]))

    if hasattr(self, 'lines'):
        if "template" not in matplotlib.get_backend(): # Broken for template:
↳https://github.com/matplotlib/matplotlib/issues/8516/
            self.lines[0].set_data(self.x_sols, self.y_sols)

    else:
        self.lines = plot(self.x_sols, self.y_sols, 'or-')

    draw()
    time.sleep(0.25)

    return [0]

```

```

[8]: mycallback = MyCallback('mycallback', 2, 1, 0)
     opts = {}
     opts['iteration_callback'] = mycallback
     opts['ipopt.tol'] = 1e-8
     opts['ipopt.max_iter'] = 50
     solver = nlpsol('solver', 'ipopt', nlp, opts)
     sol = solver(lbx=-10, ubx=10, lb=-10, ub=10)

```

```

*****
This program contains Ipopt, a library for large-scale nonlinear optimization.
Ipopt is released as open source code under the Eclipse Public License (EPL).
For more information visit https://github.com/coin-or/Ipopt
*****

```

This is Ipopt version 3.14.11, running with linear solver MUMPS 5.4.1.

```

Number of nonzeros in equality constraint Jacobian...:      0
Number of nonzeros in inequality constraint Jacobian.:      2
Number of nonzeros in Lagrangian Hessian...:           3

```

```

Total number of variables...:      2

```

```

        variables with only lower bounds:      0
        variables with lower and upper bounds: 2
        variables with only upper bounds:      0
Total number of equality constraints...:      0
Total number of inequality constraints...:      1
        inequality constraints with only lower bounds:      0
        inequality constraints with lower and upper bounds: 1
        inequality constraints with only upper bounds:      0

```

iter	objective	inf_pr	inf_du	lg(mu)	d	lg(rg)	alpha_du	alpha_pr	ls
0	1.0000000e+00	0.00e+00	1.33e+00	-1.0	0.00e+00	-	0.00e+00	0.00e+00	0
1	8.1696108e-01	0.00e+00	8.18e+00	-1.0	8.33e-01	-	9.22e-01	2.50e-01f	3
2	5.0928866e-01	0.00e+00	1.31e+00	-1.0	1.58e-01	-	1.00e+00	1.00e+00f	1
3	3.8213489e-01	0.00e+00	5.32e+00	-1.0	4.89e-01	-	1.00e+00	5.00e-01f	2
4	2.2689357e-01	0.00e+00	1.54e+00	-1.0	1.92e-01	-	1.00e+00	1.00e+00f	1
5	1.9526345e-01	0.00e+00	9.02e+00	-1.0	3.85e-01	-	1.00e+00	1.00e+00f	1
6	6.2791707e-02	0.00e+00	2.66e-01	-1.0	1.22e-01	-	1.00e+00	1.00e+00f	1
7	3.3688142e-02	0.00e+00	3.14e+00	-1.7	4.88e-01	-	1.00e+00	5.00e-01f	2
8	1.1215647e-02	0.00e+00	6.93e-01	-1.7	1.45e-01	-	1.00e+00	1.00e+00f	1
9	3.3356343e-03	0.00e+00	1.69e+00	-1.7	1.91e-01	-	1.00e+00	1.00e+00f	1
iter	objective	inf_pr	inf_du	lg(mu)	d	lg(rg)	alpha_du	alpha_pr	ls
10	3.2713823e-04	0.00e+00	8.94e-02	-1.7	5.61e-02	-	1.00e+00	1.00e+00f	1
11	9.2093197e-06	0.00e+00	1.06e-01	-2.5	4.91e-02	-	1.00e+00	1.00e+00f	1
12	1.0134200e-07	0.00e+00	3.06e-04	-2.5	3.33e-03	-	1.00e+00	1.00e+00f	1
13	2.0350914e-10	0.00e+00	3.66e-05	-3.8	9.12e-04	-	1.00e+00	1.00e+00f	1
14	2.9616464e-14	0.00e+00	7.79e-08	-5.7	4.22e-05	-	1.00e+00	1.00e+00h	1
15	5.4181655e-20	0.00e+00	1.17e-11	-8.6	5.16e-07	-	1.00e+00	1.00e+00f	1

Number of Iterations...: 15

	(scaled)	(unscaled)
Objective...:	5.4181654535916011e-20	5.4181654535916011e-20
Dual infeasibility...:	1.1724482496621431e-11	1.1724482496621431e-11
Constraint violation...:	0.0000000000000000e+00	0.0000000000000000e+00
Variable bound violation:	0.0000000000000000e+00	0.0000000000000000e+00
Complementarity...:	2.5060224083090714e-09	2.5060224083090714e-09
Overall NLP error...:	2.5060224083090714e-09	2.5060224083090714e-09

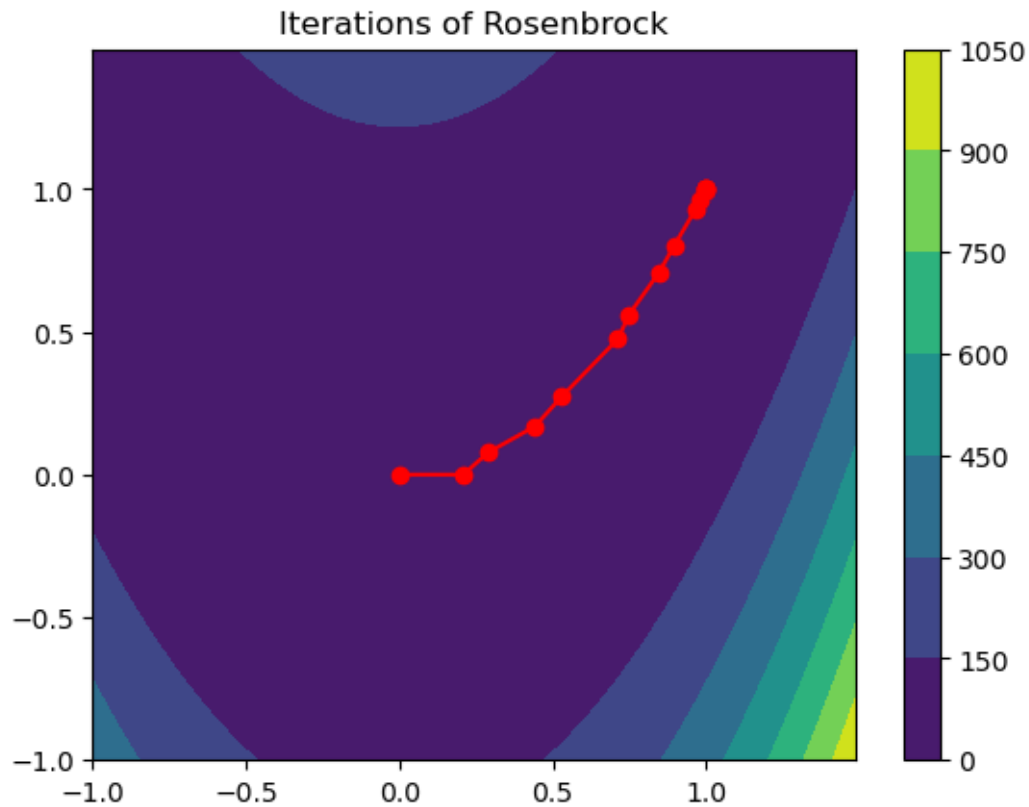
```

Number of objective function evaluations      = 22
Number of objective gradient evaluations      = 16
Number of equality constraint evaluations      = 0
Number of inequality constraint evaluations    = 22
Number of equality constraint Jacobian evaluations = 0
Number of inequality constraint Jacobian evaluations = 16
Number of Lagrangian Hessian evaluations     = 15
Total seconds in IPOPT                       = 4.411

```

EXIT: Optimal Solution Found.

	solver	:	t_proc	(avg)	t_wall	(avg)	n_eval
callback_fun		492.39ms	(30.77ms)	4.40 s	(274.80ms)	16	
nlp_f		43.00us	(1.95us)	38.00us	(1.73us)	22	
nlp_g		99.00us	(4.50us)	70.40us	(3.20us)	22	
nlp_grad_f		49.00us	(2.88us)	39.20us	(2.31us)	17	
nlp_hess_l		129.00us	(8.60us)	127.80us	(8.52us)	15	
nlp_jac_g		30.00us	(1.76us)	27.70us	(1.63us)	17	
total		508.92ms	(508.92ms)	4.41 s	(4.41 s)	1	



By setting matplotlib interactivity off, we can inspect the figure at ease

```
[9]: matplotlib.interactive(False)
show()
```