```
[00, 00, 00, 00, 00, 00, 00, 00, 00, 1]])
                                                                                       to a row of the original matrix.
2
6
   from casadi import *
                                                                                         Original:
      Read all about coloring in the seminal paper "What color is your Jacobian?" http://www.cs.odu.edu/~pothen/
                                                                                         IM (
   Papers/sirev2005.pdf
                                                                                         [[1, 00, 00, 00, 1],
                                                                                          [00, 1, 00, 00, 00],
   def color(A):
17
                                                                                          [00, 00, 1, 00, 00],
     print "=" *80
18
                                                                                          [00, 00, 00, 1, 00],
19
     print "Original:"
                                                                                         [00, 00, 00, 00, 1]])
20
     print repr(IM(A, 1))
                                                                                         Colored:
21
     print "Colored: "
                                                                                         IM (
22
     print repr(IM(A.uni coloring(),1))
                                                                                         [[1, 00],
23
                                                                                         [1, 00],
   A = Sparsity.diag(5)
                                                                                          [1, 00],
25
   color (A)
                                                                                          [1, 00],
                                                                                          [00, 1]])
     ______
     Original:
     IM (
     [[1, 00, 00, 00, 00],
      [00, 1, 00, 00, 00],
                                                                                             ======
      [00, 00, 1, 00, 00],
                                                                                         Original:
      [00, 00, 00, 1, 00],
                                                                                         IM (
      [00, 00, 00, 00, 1]])
                                                                                         [[1, 00, 00, 00, 00],
      Colored:
                                                                                         [00, 1, 00, 00, 00],
     IM([1, 1, 1, 1, 1])
                                                                                          [00, 00, 1, 00, 00],
                                                                                          [00, 00, 00, 1, 00],
      One direction needed to capture all
                                                                                          [1, 00, 00, 00, 1]])
   color (Sparsity.dense (5,10))
                                                                                         Colored:
                                                                                         IM (
     ______
                                                                                         [[1, 00],
         =====
                                                                                         [1, 00],
      Original:
                                                                                          [1, 00],
     IM (
                                                                                          [1, 00],
     [[1, 1, 1, 1, 1, 1, 1, 1, 1, 1],
                                                                                          [00, 1]])
      [1, 1, 1, 1, 1, 1, 1, 1, 1, 1],
      [1, 1, 1, 1, 1, 1, 1, 1, 1, 1],
      [1, 1, 1, 1, 1, 1, 1, 1, 1, 1],
                                                                                   32
      [1, 1, 1, 1, 1, 1, 1, 1, 1, 1]])
      Colored:
     IM (
     [[1, 00, 00, 00, 00, 00, 00, 00, 00, 00],
                                                                                             =====
      [00, 1, 00, 00, 00, 00, 00, 00, 00, 00],
                                                                                         Original:
      [00, 00, 1, 00, 00, 00, 00, 00, 00, 00],
                                                                                         IM (
      [00, 00, 00, 1, 00, 00, 00, 00, 00, 00],
                                                                                         [[1, 1, 1, 1, 1],
      [00, 00, 00, 00, 1, 00, 00, 00, 00, 00],
                                                                                          [00, 1, 00, 00, 00],
       [00, 00, 00, 00, 00, 1, 00, 00, 00, 00],
                                                                                          [00, 00, 1, 00, 00],
      [00, 00, 00, 00, 00, 00, 1, 00, 00, 00],
                                                                                          [00, 00, 00, 1, 00],
      [00, 00, 00, 00, 00, 00, 1, 00, 00],
                                                                                          [00, 00, 00, 00, 1]])
      [00, 00, 00, 00, 00, 00, 00, 00, 1, 00],
                                                                                         Colored:
```

```
We need 5 directions. The colored response reads: each row corresponds to a direction; each column correspond
color (A+Sparsity.triplet(5,5,[0],[4]))
 ______
  First 4 rows can be taken together, the fifth row is taken separately
color (A+Sparsity.triplet(5,5,[4],[0]))
  First 4 rows can be taken together, the fifth row is taken separately
color (A+Sparsity . triplet (5, 5, [0] * 5, range (5)))
 ______
```

```
IM (
     [[1, 00, 00, 00, 00],
      [00, 1, 00, 00, 00],
      [00, 00, 1, 00, 00],
      [00, 00, 00, 1, 00],
      [00, 00, 00, 00, 1]])
      The first row is taken separately. The remainding rows are lumped together in one direction.
37
   color (A+Sparsity . triplet (5, 5, range(5), [0]*5))
     ______
         =====
     Original:
     IM (
     [[1, 00, 00, 00, 00],
      [1, 1, 00, 00, 00],
                                                                                 54
      [1, 00, 1, 00, 00],
      [1, 00, 00, 1, 00],
      [1, 00, 00, 00, 1]])
     Colored:
     IM (
     [[1, 00],
      [00, 1],
      [00, 1],
      [00, 1],
      [00, 1]])
      We need 5 directions.
      Next, we look at star_coloring
46
47
   def color(A):
     print "=" *80
     print "Original:"
     print repr(IM(A, 1))
50
51
     print "Star colored:
     print repr(IM(A.star coloring(1),1))
53
   color (A)
                                                                                 60
         =====
     Original:
     IM (
     [[1, 00, 00, 00, 00],
      [00, 1, 00, 00, 00],
      [00, 00, 1, 00, 00],
      [00, 00, 00, 1, 00],
      [00, 00, 00, 00, 1]])
     Star colored:
     IM([1, 1, 1, 1, 1])
      One direction needed to capture all
51
52
   color (Sparsity.dense (5,5))
     ______
         ======
```

```
Original:
  IM (
  [[1, 1, 1, 1, 1],
   [1, 1, 1, 1, 1],
   [1, 1, 1, 1, 1],
   [1, 1, 1, 1, 1],
   [1, 1, 1, 1, 1]])
   Star colored:
  IM (
  [[1, 00, 00, 00, 00],
    [00, 1, 00, 00, 00],
    [00, 00, 1, 00, 00],
    [00, 00, 00, 1, 00],
    [00, 00, 00, 00, 1]])
   We need 5 directions.
color (A+Sparsity . triplet (5,5,[0]*5, range (5)) + Sparsity . triplet (5,5, range (5),[0
  ______
  Original:
  IM (
  [[1, 1, 1, 1, 1],
   [1, 1, 00, 00, 00],
   [1, 00, 1, 00, 00],
   [1, 00, 00, 1, 00],
   [1, 00, 00, 00, 1]])
  Star colored:
  IM (
  [[1, 00],
   [00, 1],
    [00, 1],
    [00, 1],
   [00, 1]])
   The first row/col is taken separately. The remainding rows/cols are lumped together in one direction.
   Let's take an example from the paper
A = IM([[1,1,0,0,0,0],[1,1,1,0,1,1],[0,1,1,1,0,0],[0,0,1,1,0,1],[0,1,0,0,1,0]
    ,[0,1,0,1,0,1]])
A = sparsify(A)
color (A. sparsity ())
       =====
  Original:
  IM (
  [[1, 1, 00, 00, 00, 00],
   [1, 1, 1, 00, 1, 1],
   [00, 1, 1, 1, 00, 00],
    [00, 00, 1, 1, 00, 1],
    [00, 1, 00, 00, 1, 00]
    [00, 1, 00, 1, 00, 1]])
  Star colored:
  IM (
```

```
[[00, 1, 00],
[1, 00, 00],
[00, 1, 00],
[00, 00, 1],
[00, 1, 00],
[00, 1, 00]])
```