```
#
#
#
#
#
#
#
from casadi import *
```

Read all about coloring in the seminal paper “What color is your Jacobian?” http://www.cs.odu.edu/~pothen/Papers/sirev2005.pdf

```
def color(A):
  print "="*80
  print "Original:"
  print repr(IM(A,1))
  print "Colored: "
  print repr(IM(A.uni_coloring(),1))

A = Sparsity.diag(5)
color(A)
```

```
================================================================================
    ======
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]])
Colored:
IM([1, 1, 1, 1, 1])
```

One direction needed to capture all

```
color(Sparsity.dense(5,10))
```

```
================================================================================
    ======
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, 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]])
Colored:
IM(
[[1, 00, 00, 00, 00, 00, 00, 00, 00, 00],
 [00, 1, 00, 00, 00, 00, 00, 00, 00, 00],
 [00, 00, 1, 00, 00, 00, 00, 00, 00, 00],
 [00, 00, 00, 1, 00, 00, 00, 00, 00, 00],
 [00, 00, 00, 00, 1, 00, 00, 00, 00, 00],
 [00, 00, 00, 00, 00, 1, 00, 00, 00, 00],
 [00, 00, 00, 00, 00, 00, 1, 00, 00, 00],
 [00, 00, 00, 00, 00, 00, 00, 1, 00, 00],
 [00, 00, 00, 00, 00, 00, 00, 00, 1, 00],
 [00, 00, 00, 00, 00, 00, 00, 00, 00, 1]])
```

We need 5 directions. The colored response reads: each row corresponds to a direction; each column correspond to a row of the original matrix.

```

color(A+Sparsity.triplet(5,5,[0],[4]))
```

```
================================================================================
    ======
Original:
IM(
[[1, 00, 00, 00, 1],
 [00, 1, 00, 00, 00],
 [00, 00, 1, 00, 00],
 [00, 00, 00, 1, 00],
 [00, 00, 00, 00, 1]])
Colored:
IM(
[[1, 00],
 [1, 00],
 [1, 00],
 [1, 00],
 [00, 1]])
```

First 4 rows can be taken together, the fifth row is taken separately

```
color(A+Sparsity.triplet(5,5,[4],[0]))
```

```
================================================================================
    ======
Original:
IM(
[[1, 00, 00, 00, 00],
 [00, 1, 00, 00, 00],
 [00, 00, 1, 00, 00],
 [00, 00, 00, 1, 00],
 [1, 00, 00, 00, 1]])
Colored:
IM(
[[1, 00],
 [1, 00],
 [1, 00],
 [1, 00],
 [00, 1]])
```

First 4 rows can be taken together, the fifth row is taken separately

```

color(A+Sparsity.triplet(5,5,[0]*5,range(5)))
```

```
================================================================================
    ======
Original:
IM(
[[1, 1, 1, 1, 1],
 [00, 1, 00, 00, 00],
 [00, 00, 1, 00, 00],
 [00, 00, 00, 1, 00],
 [00, 00, 00, 00, 1]])
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]])
```

The first row is taken separately. The remainding rows are lumped together in one direction.

```

color(A+Sparsity.triplet(5,5,range(5),[0]*5))
```

```
================================================================================
      ======
Original:
IM(
[[1, 00, 00, 00, 00],
 [1, 1, 00, 00, 00],
 [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

```

def color(A):
  print "="*80
  print "Original:"
  print repr(IM(A,1))
  print "Star colored: "
  print repr(IM(A.star_coloring(1),1))

color(A)
```

```
================================================================================
      ======
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

```

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
    ]*5))
```

```
================================================================================
      ======
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]])
```