

### 1degener

+1 :max|min (+1|-1) but degeneracy doesn't appear !

```
1.5 1 0 0 0 0 c
3 2 1 0 0 0 +32
7 -2 0 1 0 0 +28
0 1 0 0 1 0 +16
3 1 0 0 0 1 +25 A
```

0 artificials

1+3 :bigM

3 4 5 6 :initial basis

0 :ibasgraph

0 2 :ishow, itest

### 2degenLiu

+1 :max|min (+1|-1) Shun-Chen Niu

```
2 1 0 0 0 c z=4 (2 0 4 ...) https://www.utdallas.edu/~scniu/...
4 3 1 0 0 +12
4 1 0 1 0 +8
4 2 0 0 1 +8 A ...OPRE-6201/documents/LP10-Special-Situations.pdf
```

0 artificials

1+3 :bigM

3 4 5 :initial basis

0 :ibasgraph

0 2 :ishow, itest

### Anstee\_cycl

+1 :max|min https://www.math.ubc.ca/~anstee/math340/cyclingLP.pdf

```
10 -57 -9 -24 0 0 0 c
0.5 -5.5 -2.5 9 1 0 0 +0
0.5 -1.5 -0.5 1 0 1 0 +0
1 0 0 0 0 0 1 +1 A z = 1 (1 0 1 0 2 0 0)
```

0 artificials

1+3 :bigM

5 6 7 :initial basis

0 :ibasgraph

0 2 :ishow, itest

### Beale

-1 :max|min (+1|-1) Dantzig & Thapa, 1997, "LP 1: introduction", Springer,

```
-0.75 150 -0.02 6 0 0 0 c
0.25 -60 -0.04 9 1 0 0 0
0.5 -90 -0.02 3 0 1 0 0
0 0 1 0 0 0 1 1 A
```

0 artificials

1+3 :bigM

5 6 7 :initial basis

0 :ibasgraph

0 2 :ishow, itest

### Bronson1\_06

+1 :max|min (+1|-1) Bronson, Prb 1.6 Multiple solutions

```
7 7 6 9 0 0 c z* = 55000 (0 0 1666.(6) 500 0 0) & (5000 0 3333.(3) 0 0)
4 5 3 5 1 0 +30000
2 1.5 3 3 0 1 +20000 A To get the 2.nd soln, increase c_1 (e.g., 7.001)
```

0 artificials

1+3 :bigM

5 6 :initial basis

0 :ibasgraph

0 2 :ishow, itest

### BronsonN3\_01

+1 :max|min (+1|-1) Bronson & Naadimuthu, 2001, ISBN 972-773-067-1, p 42

```
1 9 1 0 0 c z* = 40.5 (0 4.5 0 0 6)
1 2 3 1 0 9
3 2 2 0 1 15 A
```

0 artificials

1+3 :bigM

4 5 :initial basis

0 :ibasgraph

0 2 :ishow, itest

BronsonN3\_02

-1 :max|min (+1|-1) Bronson & Naadimuthu, 2001, ISBN 972-773-067-1, p 44  
 80 60 0 0 c z\* = 71.67 (0.5833 0.4167 0 0)  
 0.20 0.32 1 0 0.25  
 1 1 0 1 1 A  
 4 artificials  
 1+3 :bigM  
 3 4 :initial basis  
 0 :ibasgraph  
 0 2 :ishow, itest

BronsonN3\_07

+1 :max|min (+1|-1) Bronson & Naadimuthu, 2001, ISBN 972-773-067-1, pp 51 & 8  
 4 -3 +6 -1 0 0 0 0 0 0 0 0 0 0 0 0 c z\* = 125, (37.727 12.273 2.272.7 =)  
 1 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 +100  
 0 0 1 1 0 1 0 0 0 0 0 0 0 0 0 0 +20  
 1 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 +40  
 0 1 0 1 0 0 0 1 0 0 0 0 0 0 0 0 +60  
 1 -10 0 0 0 0 0 0 1 0 0 0 0 0 0 0 +0  
 0 0 6 -5 0 0 0 0 0 1 0 0 0 0 0 0 +0  
 2 -8 0 0 0 0 0 0 0 0 1 0 0 0 0 0 +0  
 0 0 2 -8 0 0 0 0 0 0 0 1 0 0 0 0 +0  
 1 1 0 0 0 0 0 0 0 0 0 0 -1 0 1 0 +50  
 0 0 1 1 0 0 0 0 0 0 0 0 0 -1 0 1 +5 A c\_3 = 6 + eps ==> sister solution  
 15 16 artificials  
 1+3 :bigM  
 5 6 7 8 9 10 11 12 15 16 :initial basis  
 0 :ibasgraph  
 0 2 :ishow, itest

BronsonN5\_03

+1 :max|min (+1|-1) Bronson & Naadimuthu, 2001, ISBN 972-773-067-1, p 111  
 2 3 4 0 0 0 0 c z\* = 2 - 2M (1 0 0 0 1 0 1) Impossible  
 1 1 1 1 0 0 0 1  
 1 1 2 0 1 0 0 2  
 3 2 1 0 0 -1 1 4 A  
 5 7 artificials  
 1+3 :bigM  
 4 5 7 :initial basis  
 0 :ibasgraph  
 0 2 :ishow, itest

BronsonN5\_04

+1 :max|min (+1|-1) Bronson & Naadimuthu, 2001, ISBN 972-773-067-1, p 113  
 2 1 0 0 0 c z\* = 5 (5 0 1 0 7)/2  
 1 1 1 0 0 3  
 2 1 0 1 0 5  
 1 3 0 0 1 6 A  
 0 artificials  
 1+3 :bigM  
 3 4 5 :initial basis  
 0 :ibasgraph  
 0 2 :ishow, itest

BronsonN5\_05

-1 :max|min (+1|-1) Bronson & Naadimuthu, 2001, ISBN 972-773-067-1, p 115  
 1 1 0 0 0 0 c z\* = 5 (4 1 5 ...)  
 1 3 1 0 0 0 12  
 3 1 0 -1 1 0 13  
 1 -1 0 0 0 1 3 A  
 5 6 artificials  
 1+3 :bigM  
 3 5 6 :initial basis  
 0 :ibasgraph  
 0 2 :ishow, itest

BronsonN5\_06

+1 :max|min (+1|-1) Bronson & Naadimuthu, 2001, ISBN 972-773-067-1, p 118  
 7 2 3 1 0 0 0 c z\* = 37.53 = 713/19 (0.7368 0.7895 10.26) = (14 15 195)/19  
 2 7 0 0 1 0 0 7  
 5 8 0 2 0 1 0 10  
 1 0 1 0 0 0 1 11 A

```
5 6 7 artificials
1+2 :bigM
5 6 7 :initial basis
0 :ibasgraph
0 2 :ishow, itest
```

#### KleeMinty

```
+1 :max|min (+1|-1) Chris Osborn http://www.cse.msu.edu/~torng/960/
100 10 1 0 0 0 c z* = 1e+4 (0 0 1e+4 0 ...)
 1 0 0 1 0 0 +1
 20 1 0 0 1 0 +100
200 20 1 0 0 1 +10000 A
0 artificials
1+3 :bigM
4 5 6 :initial basis
0 :ibasgraph
0 2 :ishow, itest
```

#### Kuhn\_cycl

```
+1 :max|min (+1|-1) Dantzig & Thapa, 1997, "LP 1: introduction", Springer,
 2 3 -1 -12 0 0 c z* = (...) New York (NY). ISBN 0-387-94833-3
-2 -9 1 9 1 0 +0
 1 3 -1 -6 1 0 +0 A "Kuhn's exa. of cycling", Prb 3.14, p 102
0 artificials
1+3 :bigM
5 6 :initial basis
0 :ibasgraph
0 2 :ishow, itest
```

#### Zionts

```
+1 :max|min (+1|-1)
0.56 0.42 0 0 0 c
 1 2 1 0 0 240
 1.5 1 0 1 0 180
 1 0 0 0 1 110 A
0 artificials
1+3 :bigM
3 4 5 :initial basis
0 :igraphbasis
0 0 :ishow, itest
```