Dual ascent example

Lagrangian Dual of SCP

(Solved via dual ascent)

```
Set(s) 23 24 25 removed from problem
(P= 16 17 22 > 14 = incumbent!)
# sets remaining is 22
```

Iteration # 1

Current multipliers:

i	1	2	3	4	5	6	7	8
w[i]	0	0	0	0	0	0	0	0

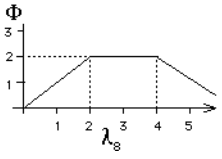
Solving Lagrangian relaxation:

```
*** Dual value is 0 ***
Sets in cover: #
Points not covered: 1 2 3 4 5 6 7 8

Heuristic solution cost is 12
*** New incumbent! *** Cover is 2 4 7
  with cost 12
```


Dual ascent step

indicates that point 8 is not now covered... its multiplier is too small

```
Selecting multiplier w[8] = 0 with subgradient = 1
Sets not in solution which cover #8 are:
         1 6 7 10 13 14 18 20 21 22

   X[1] enters when  w[8] is 2
   X[6] enters when  w[8] is 4

Updated w[8] = 2 = Max{0,(1-α)× 2 + α×4} where α= 0
   Anticipated improvement: 2
```



Point #8 is arbitrarily selected as one of the uncovered points. Its multiplier should be increased to provide incentive for a set to cover it.

Iteration # 2

Current multipliers:

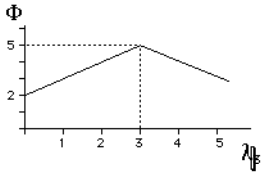
i	1	2	3	4	5	6	7	8
w[i]	0	0	0	0	0	0	0	2

Solving Lagrangian relaxation:

```
*** Dual value is 2 ***
Sets in cover: # 1
Points not covered: 1 3 4 5 6 7

Set(s) 16 17 19 22 removed from problem
(P= 13 13 14 14 > 12 = incumbent!)
# sets remaining is 18
```


Dual ascent step

```
Selecting multiplier w[3] = 0  with subgradient = 1
Sets not in solution which cover #3 are: 2 3 4 7 14

   X[2] enters when w[3] is 3
   X[3] enters when w[3] is 3

Updated w[3] = 3 = Max{0,(1-α)× 3 + α×3} where α= 0
   Anticipated improvement: 3
```



Iteration # 3

Current multipliers:

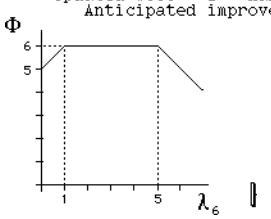
i	1	2	3	4	5	6	7	8
w[i]	0	0	3	0	0	0	0	2

Solving Lagrangian relaxation:

```
*** Dual value is 5 ***   (Improvement: 3)

Sets in cover: # 1 2
Points not covered: 5 6

Set(s) 18 20 21 removed from problem
(P= 14 15 15 > 12 = incumbent!)
# sets remaining is 15
```


Dual ascent step

```
Selecting multiplier w[6] = 0  with subgradient = 1

Sets not in solution which cover #6 are: 4 8 13 15
   X[4] enters when w[6] is 1
   X[8] enters when w[6] is 5

Updated w[6] = 1 = Max{0,(1-α)× 1 + α×5} where α= 0
   Anticipated improvement: 1
```



Iteration # 4

Current multipliers:

i	1	2	3	4	5	6	7	8
w[i]	0	0	3	0	0	1	0	2

Solving Lagrangian relaxation:

```
*** Dual value is 6 ***   (Improvement: 1)

Sets in cover: # 1 2 4
Points not covered: 5
```