Optimisation 2017-18: Summative Assessment

Max Gadouleau

Deadline: 09/02/2017 at 14:00. Submission: DUO.

1 Question

Let us consider the following shipping problem. A company has four types of cargo that it wishes to ship aboard a plane, as seen below. The values of the cargo vary over time, but for simplicity let us assume they are always a multiple of 10 euros per ton. The value of item 4 is particularly volatile, but is always no more than that of item 1.

Cargo	weight (ton)	space taken (m^3/ton)	value (euros/ton)
1	20	70	value(1)
2	16	100	value(2)
3	25	85	value(3)
4	13	60	value(4)

The aircraft has three storage compartments: at the front, in the centre and at the back. Due to stability reasons, the ratio between the capacity (in tons) and the loaded weight has to be equal in all three compartments; for instance, if 6 tons are loaded at the front, then 9 tons must be loaded in the centre and 5 tons must be loaded at the back.

Compartment	capacity	
	weight (ton)	volume (m^3)
Front	12	1000
Centre	18	1300
Back	10	700

We are allowed to take any amount of any of those four cargo items, as long as it is a multiple of 100kg. For instance, we may carry 2 tons of item 1, 4.6 tons of item 2, 3.1 tons of item 3 and 10.5 tons of item 4.

Model the problem to maximise the value carried in that shipping and solve it using Matlab. The Matlab IP solver is `intlinprog` which is part of the `optimization` toolbox. Your answer must be a Matlab file called `shipping.m`. Your code must work on **Matlab R2015b** (used on the DUDE computers). Make sure your code is clearly annotated. It must :

- take as input the values of items 1, 2, and 3;
- return the optimal solution and the value of the LP for value(4) ranging from 10 euros to value(1);
- plot the optimal value of the IP against value(4).

2 Example

Here is an example, where we omit the verbatim of the Matlab IP solver and some of the entries of the output.

```
>> value = [80 50 50];
>> [x, gval] = shipping(value)
...

x(:,:,1) =

         0    0.7000   10.7000         0
   11.9000         0    5.2000         0
    8.1000    0.1000    1.3000         0

...

x(:,:,8) =

   12.0000         0         0         0
         0         0    6.2000   11.8000
    8.0000         0    0.8000    1.2000


gval =

   1.0e+03 *

    2.5000    2.5000    2.5200    2.5600    2.6000    2.7300    2.8600    2.9900
```

The output is

$$x(:,:,n) = \begin{pmatrix} x_{F1} & x_{F2} & x_{F3} & x_{F4} \\ x_{C1} & x_{C2} & x_{C3} & x_{C4} \\ x_{B1} & x_{B2} & x_{B3} & x_{B4} \end{pmatrix},$$

which is the amount of each cargo in each compartment, and $gval(n)$ is the total value (in euros) in the shipment, when item 4 has value $10n$ euros. The plot will look like this.