ARE YOU READY?

BELGIUM CAMPUS
iTversity

It's the way we're wired

Botlhale Village

Working together for ICT innovation and growth in Africa

Fixed Charge

Amandla Clothing Company manufactures clothing to sell to supporters at political rallies. Amandla is capable of manufacturing three types of clothing: shirts, shorts, and pants. The manufacture of each type of clothing requires that Amandla have the appropriate type of machinery available. The machinery needed to manufacture each type of clothing must be rented at the following rates: shirt machinery, R200 per week; shorts machinery, R150 per week; pants machinery, R100 per week.

Resource requirements for Amandla		
Clothing type	Labour (hours)	Cloth (m^2)
Shirts	3	4
Shorts	2	3
Pants	6	4

The manufacture of each type of clothing also requires the amounts of cloth and labour shown in the first table. Each week, 150 hours of labour and 160 m^2 of cloth are available. The variable unit cost and selling price for each type of clothing are shown in the second table below.

Revenue and cost information for Amandla		
Clothing type	Sales Price (R)	Variable cost (R)
Shirts	12	6
Shorts	8	4
Pants	15	8

Formulate an IP whose solution will maximize Amandla's weekly profits.

- Declaring decision variables:
  - $x_i = number\ of\ item\ i\ manufactured\ i = 1 = shirts, 2 = shorts, 3 = pants$
  - $y_j = machine\ j\ rented\ or\ not\ j = 1 = shirt\ machine, 2 = short\ machine, 3 = pants\ machine$

Fixed Charge

- Objective function:
  - $\max z = 6x_1 + 4x_2 + 7x_3 - 200y_1 - 150y_2 - 100y_3$
- Labour constraint:
  - $s.t.\ 3x_1 + 2x_2 + 6x_3 \leq 150$
- Cloth constraint:
  - $4x_1 + 3x_2 + 4x_3 \leq 160$
- Sign restrictions:
  - $x_1, x_2, x_3 \geq 0$
  - x_1, x_2, x_3 integers
  - $y_1, y_2, y_3 = 0\ or\ 1$

Fixed Charge - Solver

Check 1st year slides if you don't remember how to add Solver or how to do the Sumproduct to have the correct cell referencing in cells I5 to I7

Fixed Charge

- Y constraints:
  - $x_1 \leq 40y_1 \Longrightarrow x_1 - 40y_1 \leq 0$ **If shirts are made, then shirt machine is rented**
  - $x_2 \leq 53,33y_2 \Longrightarrow x_2 - 53,33y_2 \leq 0$ **If shorts are made, then shorts machine is rented**
  - $x_3 \leq 25y_3 \Longrightarrow x_3 - 25y_3 \leq 0$ **If pants are made, then pants machine is rented**

x1	<=	40y1	
		If 0 shirts are made	
0<=	40(0)	TRUE	If 0 shirts are made, the machine is not rented
		If 20 shirts are made	
20<=	40(0)	FALSE	will change y1=0 to y1=1
20<=	40(1)	TRUE	if 20 shirts are made, a shirt machine is rented
		If 50 shirts are made	
50<=	40(0)	FALSE	will change y1=0 to y1=1
50<=	40(1)	FALSE	Also false, will not allow this value

Fixed Charge - Solver

		X1	X2	X3	y1	y2	y3	ref	sign	b
var		0	0	25	0	0	1			
obj		6	4	7	-200	-150	-100	75		
	1	3	2	6	0	0	0	150	≤	150
	2	4	3	4	0	0	0	100	≤	160
	3	1	0	0	-200	0	0	0	≤	0
	4	0	1	0	0	-200	0	0	≤	0
	5	0	0	1	0	0	-200	-175	≤	0

Solver Parameters

Set Objective: $I$5

To: Max   Min   Value Of: 0

By Changing Variable Cells:
$C$4:$H$4

Subject to the Constraints:

$C$4:$E$4 = integer
$F$4:$H$4 = binary
$I$6:$I$7 <= $K$6:$K$7
$I$8:$I$10 <= $K$8:$K$10

- Add
- Change
- Delete
- Reset All
- Load/Save

☑ Make Unconstrained Variables Non-Negative

Select a Solving Method: Simplex LP   Options

Solving Method

Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Help   Solve   Close

Fixed Charge - Either or constraints

- If pants are made (if x_3 has a values), more than or exactly 20 must be made.

- M = 25, 25 pants can be made at most.

- $x_3 \leq 0$ or $x_3 \geq 20$, but we cannot just add these two constraints

- d3 = dummy variable 0 or 1

- use the following for an either-or constraint:

$x - (U \times 2)d \leq L$ and $-x + (U \times 2)d \leq U$

x_3	$-$	$40d_3$	$\leq$	0			
$-x_3$	$+$	$40d_3$	$\leq$	20			

If $x_3 = 0$

(0)	$-$	40(0)	$\leq$	0	T	TRUE	Takes $d_3 = 0$
-(0)	$+$	40(0)	$\leq$	20	T		

If $x_3 = 10$

(10)	$-$	40(0)	$\leq$	0	F	FALSE	Changes $d_3 = 1$
-(10)	$+$	40(0)	$\leq$	20	T		
(10)	$-$	40(1)	$\leq$	0	T	FALSE	10 is not accepted
-(10)	$+$	40(1)	$\leq$	20	F		

If $x_3 = 30$

(30)	$-$	40(0)	$\leq$	0	F	FALSE	Changes $d_3 = 1$
-(30)	$+$	40(0)	$\leq$	20	T		
(30)	$-$	40(1)	$\leq$	0	T	TRUE	30 is accepted
-(30)	$+$	40(1)	$\leq$	20	T		

Fixed Charge –
Either or constraints

Change the previous

formulae to fit the example
$L = 0, U = 20$

$$x_3 - 40d_3 \leq 0 \text{ and}$$
$$-x + 40d_3 \leq 20$$

Exercises

A manufacturer can sell product 1 at a profit of $2/unit and product 2 at a profit of $5/unit. Three units of raw material are needed to manufacture one unit of product 1, and six units of raw material are needed to manufacture one unit of product 2. A total of 120 units of raw material are available. If any of product 1 is produced, a setup cost of $10 is incurred, and if any of product 2 is produced, a setup cost of $20 is incurred.

- Formulate an Integer Programming Model that will solve the requirements of the Manufacturer.

- Solve the formulated Integer Programming Model using Solver.

- Add the following to the IP: If product 1 is produced, more than 20 should be produced or less than 5.

- Solve the formulated Integer Programming Model using Solver.

- Change the IP so that product 1 and product 2 uses the same setup cost of $40 once off for any of the two or both.

- Solve using Branch & Bound Simplex Algorithm.

Exercises

In the document 'Fixed-Charge Problems (Exercises)

END

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