Integer Programming with What'sBest

LINDO Systems

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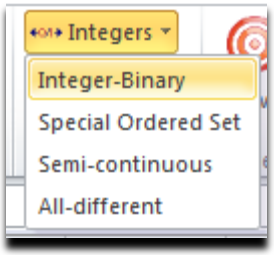
Integer Programming

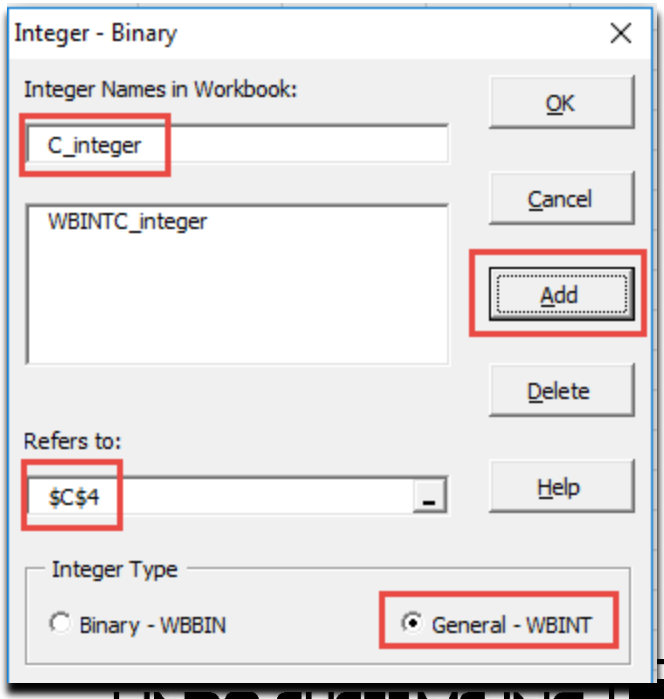
Example with general integer variables

```
MAX = 20 * A + 30 * C;
          A           <= 60;
                    C <= 50;
          A  + 2 * C <= 119;
```



Astro/ Cosmo Problem

Product :	Astro	Cosmo			
Qty to produce :	60	29.5			
				Total Profit	
Profit/ unit:	20	30		2085	
			Total Usage		Availability
Astro-line	1	0	60	=<=	60
Cosmo-line	0	1	29.5	<=	50
Labor	1	2	119	=<=	119

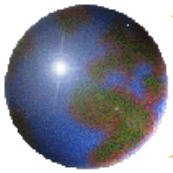


Example with general integer variables

```
MAX = 20 * A + 30 * C;
          A          <= 60;
                   C <= 50;
          A  + 2 * C <= 119;
```

Astro/ Cosmo Problem

Product :	Astro	Cosmo			
Qty to produce :	59	30			
				Total Profit	
Profit/ unit:	20	30		2080	
			Total Usage		Availability
Astro-line	1	0	59	<=	60
Cosmo-line	0	1	30	<=	50
Labor	1	2	119	=<=	119



Go/No-Go Decisions and Binary Variables


```
 1]! Make or buy decisions:
 2]    Case 1) Minimum batch size;
 3]! If we do any C, must do at least 40;
 4]MAX = 20 * A + 30 * C;
 5]           A          <= 60;
 6]                    C <= 50;
 7]           A  + 2 * C <= 120;
 8]! Define YC = 1 if we make any C, else 0;
 9]!  Make YC a BINary variable;
10]   @BIN( YC);
11]! If YC = 1, then C >= 40;
12]    C >= 40 * YC;
13]! If YC = 0, then C <= 0;
14]    C <= 50 * YC;
```

The solution says its worth “taking the plunge” with C:

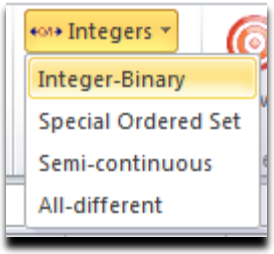
Variable	Value	Reduced Cost
A	40.00000	0.000000
C	40.00000	0.000000
YC	1.000000	400.000000

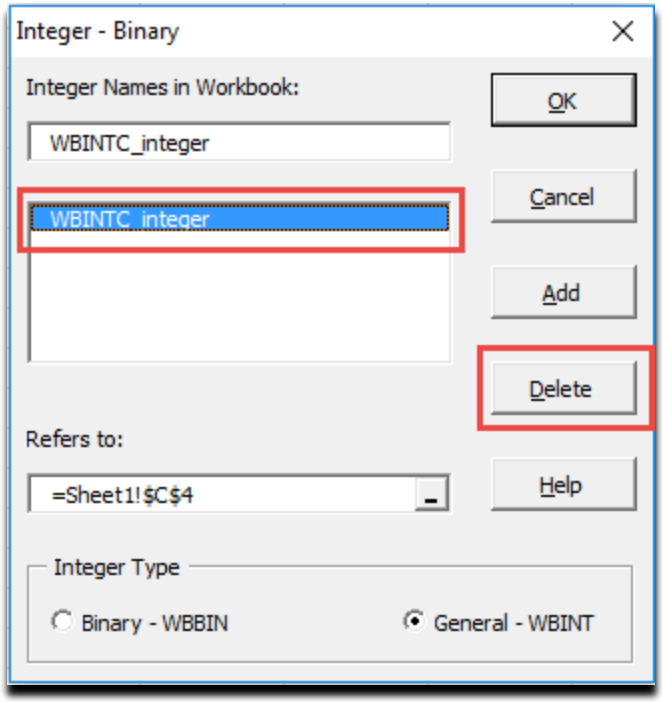
Row	Slack or Surplus	Dual Price
1	2000.000000	1.000000
2	20.000000	0.000000
3	10.000000	0.000000
4	0.000000	20.000000
5	0.000000	-10.000000
6	10.00000	0.0000000

Delete Integer-Binary

Astro/ Cosmo Problem

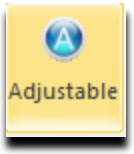
Product :	Astro	Cosmo			
Qty to produce :	59	30			
			Total Profit		
Profit/ unit:	20	30	2080		
			Total Usage		Availability
Astro-line	1	0	59	<=	60
Cosmo-line	0	1	30	<=	50
Labor	1	2	119	=<=	119

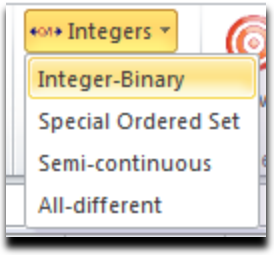


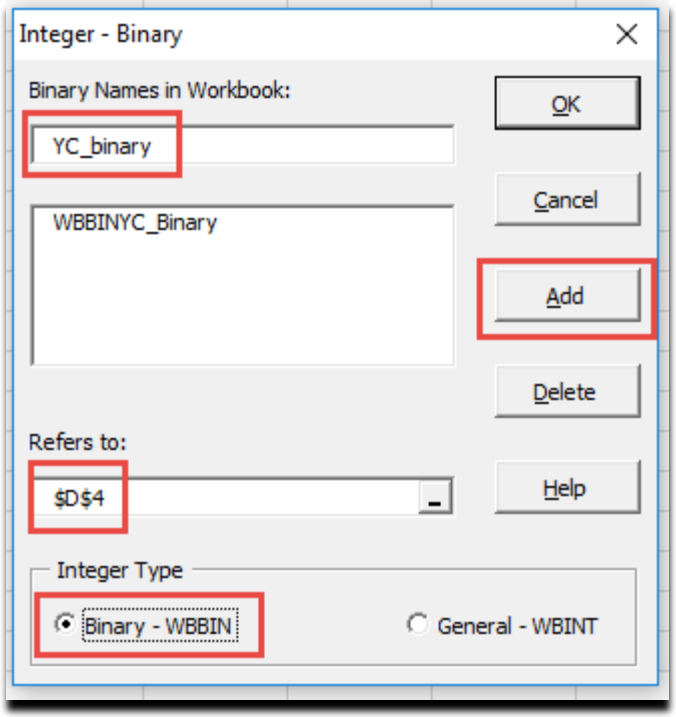


Define YC (binary variable)

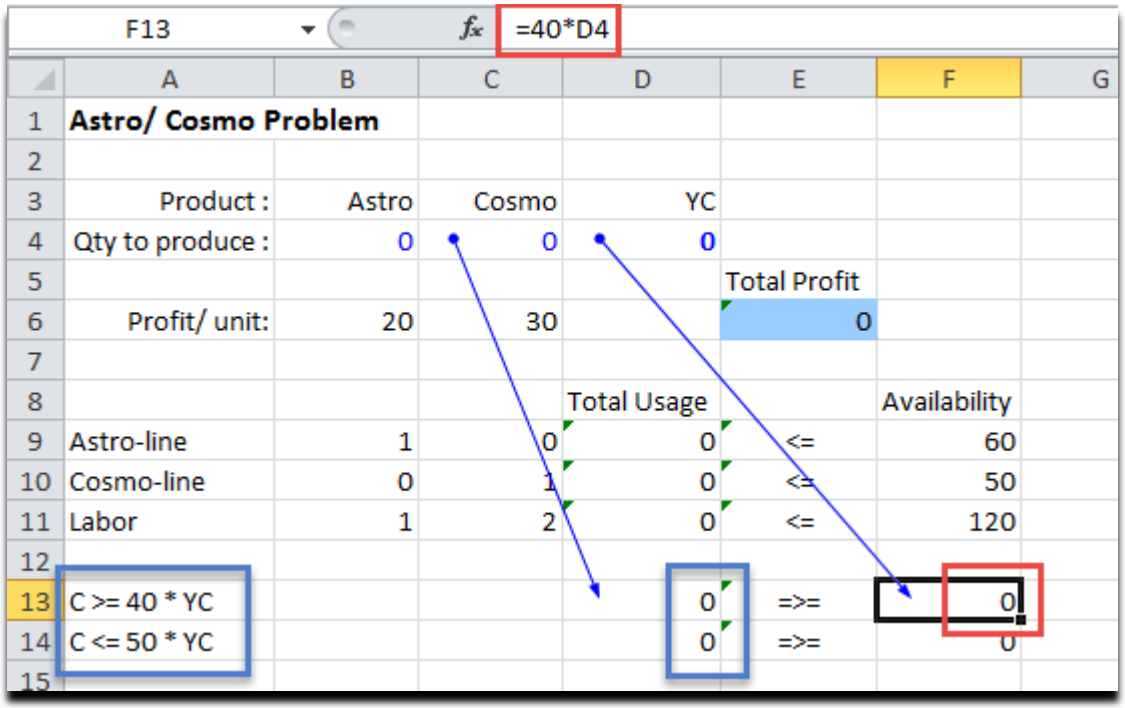
Astro/ Cosmo Problem				
Product :	Astro	Cosmo	YC	
Qty to produce :	0	0	0	
				Total Profit
Profit/ unit:	20	30		0







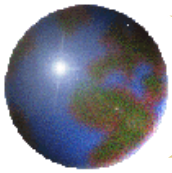
Define Constraint of YC



Solve !!!

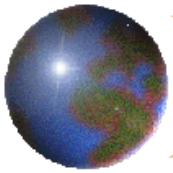
Astro/ Cosmo Problem

Product :	Astro	Cosmo	YC			
Qty to produce :	40	40	1			
				Total Profit		
Profit/ unit:	20	30		2000		
Reduced Cost	0	0	400			
			Total Usage		Availability	Dual Price
Astro-line	1	0	40	<=	60	0
Cosmo-line	0	1	40	<=	50	0
Labor	1	2	120	=<=	120	20
C >= 40 * YC			40	=>=	40	-10
C <= 50 * YC			40	<=	50	0



A Second Common Use of Binary Variables: LSW4-6

```
 1]! Make or buy decisions:
 2]    Case 2) Fixed cost;
 3]! If we do any A, must pay $700 fixed cost;
 4]! Define YA = 1 if we make any A, else 0;
 5]MAX = 20 * A + 30 * C - 700 * YA;
 6]            A           <= 60;
 7]                      C <= 50;
 8]            A  + 2 * C <= 120;
 9]!  Make YA a BINary variable;
10]@BIN( YA);
11]! If YA = 0, then A <= 0;
12]    A <= 60 * YA;
```

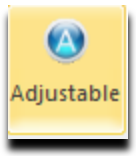


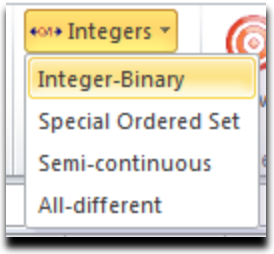
Solution says it is not worth "paying the entry fee" for A:

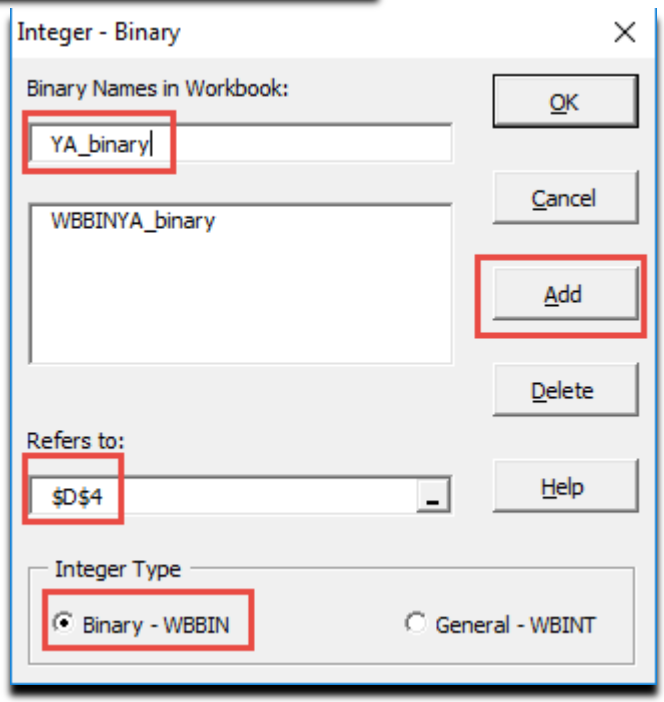

```
Optimal solution found at step:          8
Objective value:                  1500.000
Branch count:                            1

 Variable           Value        Reduced Cost
        A        0.000000           0.0000000
        C       50.000000           0.0000000
       YA        0.000000        -500.0000

      Row    Slack or Surplus      Dual Price
        1      1500.000000           1.000000
        2        60.000000           0.000000
        3         0.000000          30.000000
        4        20.000000           0.000000
        5         0.000000          20.000000
```

Define YC (binary variable)

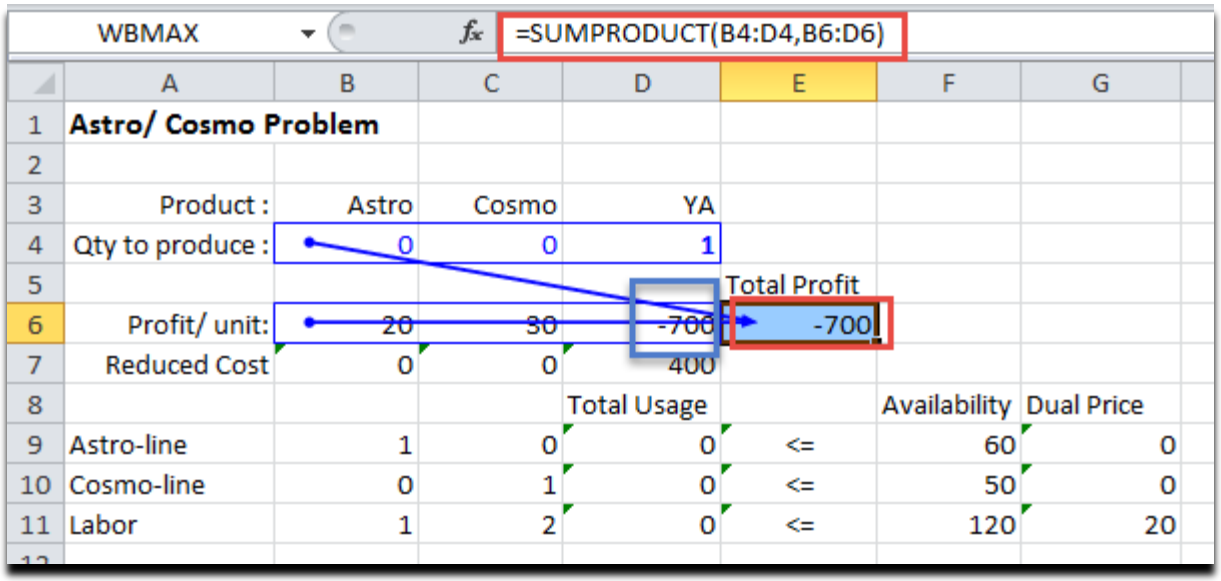
Astro/ Cosmo Problem				
Product :	Astro	Cosmo	YA	
Qty to produce :	0	0	0	
				Total Profit
Profit/ unit:	20	30	-700	0
Reduced Cost	0	0	0	







Define Best (Max Profit)



WBMAX | =SUMPRODUCT(B4:D4,B6:D6)

	A	B	C	D	E	F	G
1	**Astro/ Cosmo Problem**						
2							
3	Product :	Astro	Cosmo	YA			
4	Qty to produce :	0	0	1			
5					Total Profit		
6	Profit/ unit:	20	30	-700	-700		
7	Reduced Cost	0	0	400			
8				Total Usage		Availability	Dual Price
9	Astro-line	1	0	0	<=	60	0
10	Cosmo-line	0	1	0	<=	50	0
11	Labor	1	2	0	<=	120	20

Define Constraint of YA

F13 =60*D4

	A	B	C	D	E	F	G
1	**Astro/ Cosmo Problem**						
2							
3	Product :	Astro	Cosmo	YA			
4	Qty to produce :	0	0	1			
5					Total Profit		
6	Profit/ unit:	20	30	-700	-700		
7	Reduced Cost	0	0	0			
8				Total Usage		Availability	Dual Price
9	Astro-line	1	0	0	<=	60	0
10	Cosmo-line	0	1	0	<=	50	0
11	Labor	1	2	0	<=	120	0
12							
13	A <= 60 * YA			0	<=	60	0
14							

Solve !!!

Astro/ Cosmo Problem

Product :	Astro	Cosmo	YA			
Qty to produce :	0	50	0			
				Total Profit		
Profit/ unit:	20	30	-700		1500	
Reduced Cost	0	0	0			
			Total Usage		Availability	Dual Price
Astro-line	1	0	0	<=	60	0
Cosmo-line	0	1	50	=<=	50	30
Labor	1	2	100	<=	120	0
A <= 60 * YA			0	=<=	0	0

Thank you for your attention.

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