**PRÁCTICA EN EL AULA DE INFORMÁTICA**

**2 de mayo de 2016**

Sea una empresa dedicada a la fabricación de 3 productos. Los inputs necesarios en el proceso de producción son, por unidad fabricada, los siguientes:

|  |  |  |
| --- | --- | --- |
| **PRODUCTO** | **MATERIA PRIMA** | **MANO DE OBRA** |
| **1**  **2**  **3** | 4  2  1 | 3  2  2 |

La materia prima se adquiere a un proveedor que es capaz de suministrar hasta 245 unidades físicas a un precio de 10 u.m./u.f.. La plantilla de la empresa supone 315 horas de trabajo efectivo a un coste de 5 u.m./hora. Por razones de demanda la fabricación del primer producto debe ser como mínimo de 20 unidades. Los beneficios brutos unitarios son 20 u.m./u.f., 30 u.m./u.f. y 10 u.m./u.f., respectivamente.

El modelo de programación lineal que permita determinar cuál es la producción que maximiza el beneficio bruto mensual es el siguiente.

|  |
| --- |
| MAX Z=20X1+30X2+10X3  Sujeto a:  4X1+2X2+1X3≤245  3X1+2X2+2X3≤315  1X1≥20  X1, X2, X3≥0 |

1. Con la información anterior, vuelve a plantear y resuelve el modelo de modo que el objetivo sea el cumplimiento, en la medida de lo posible, de las siguientes metas:
2. Alcanzar un beneficio bruto total de 2500 u.m.
3. Evitar que sobre materia prima mensualmente.
4. No subutilizar la capacidad productiva contratada.
5. Servir el pedido mensual de 20 unidades de producto 1.
6. Si fuera necesario realizar horas extras, que estas no superen las 10 horas.

Interpreta los resultados obtenidos.

1. Resuelve el modelo de programación lineal del inicio del enunciado considerando que las variables de decisión toman valores enteros. Utiliza el PROC LP de SAS/OR. Interpreta la solución. Describe las iteraciones realizadas por el algoritmo Branch and Bound.

**SOLUCIÓN:**

|  |
| --- |
| Mín Z=(1/2500)d1-+(1/245)d2-+(1/315)d3-+(1/20)d4-+(1/10)d5+  Sujeto a:  20X1+30X2+10X3+d1--d1+=2500  4X1+2X2+1X3+d2-=245  3X1+2X2+2X3+d3--d3+=315  X3+d4--d4+=20  d3++d5--d5+=10  X1,X2,X3≥0  di-,di+≥0 y di-×di+=0, ∀i=1,…,5 |

\*METAS;

**data** pr.pr3\_METAS;

input \_row\_ $13. x1 x2 x3 d1me d1ma d2me d3me d3ma d4me d4ma d5me d5ma \_type\_ $ \_rhs\_;

datalines;

Objetivo 0 0 0 4.00E-04 0 4.08E-03 3.17E-03 0 5E-02 0 0 1E-01 MIN .

Beneficio 20 30 10 1 -1 0 0 0 0 0 0 0 EQ 2500

Materia\_Prima 4 2 1 0 0 1 0 0 0 0 0 0 EQ 245

Mano\_de\_Obra 3 2 2 0 0 0 1 -1 0 0 0 0 EQ 315

Pedido 1 0 0 0 0 0 0 0 1 -1 0 0 EQ 20

Horas Extras 0 0 0 0 0 0 0 1 0 0 1 -1 EQ 10

;

**run**;

**proc** **print** data=pr.pr3\_METAS;

**run**;

**proc** **lp** data=pr.pr3\_METAS;

**run**;

Obs \_row\_ x1 x2 x3 d1me d1ma d2me d3me d3ma d4me d4ma d5me d5ma \_type\_ \_rhs\_

1 Objetivo 0 0 0 0.0004 0 0.00408 0.00317 0 0.05 0 0 0.1 MIN .

2 Beneficio 20 30 10 1.0000 -1 0.00000 0.00000 0 0.00 0 0 0.0 EQ 2500

3 Materia\_Prima 4 2 1 0.0000 0 1.00000 0.00000 0 0.00 0 0 0.0 EQ 245

4 Mano\_de\_Obra 3 2 2 0.0000 0 0.00000 1.00000 -1 0.00 0 0 0.0 EQ 315

5 Pedido 1 0 0 0.0000 0 0.00000 0.00000 0 1.00 -1 0 0.0 EQ 20

6 Horas Extras 0 0 0 0.0000 0 0.00000 0.00000 1 0.00 0 1 -1.0 EQ 10

The LP Procedure

Problem Summary

Objective Function Min Objetivo

Rhs Variable \_rhs\_

Type Variable \_type\_

Problem Density (%) 33.33

Variables Number

Non-negative 12

Total 12

Constraints Number

EQ 5

Objective 1

Total 6

Solution Summary

Terminated Successfully

Objective Value 0.03

Phase 1 Iterations 2

Phase 2 Iterations 4

Phase 3 Iterations 0

Integer Iterations 0

Integer Solutions 0

Initial Basic Feasible Variables 7

Time Used (seconds) 0

Number of Inversions 3

Epsilon 1E-8

Infinity 1.797693E308

Maximum Phase 1 Iterations 100

Maximum Phase 2 Iterations 100

Maximum Phase 3 Iterations 99999999

Maximum Integer Iterations 100

Time Limit (seconds) 120

Variable Summary

Reduced

Col Variable Name Status Type Price Activity Cost

1 x1 BASIC NON-NEG 0 20 0

2 x2 BASIC NON-NEG 0 37.5 0

3 x3 BASIC NON-NEG 0 90 0

4 d1me BASIC NON-NEG 0.0004 75 0

5 d1ma NON-NEG 0 0 0.0004

6 d2me NON-NEG 0.00408 0 0.01208

7 d3me NON-NEG 0.00317 0 0.00117

8 d3ma NON-NEG 0 0 0.002

9 d4me NON-NEG 0.05 0 0.032

10 d4ma NON-NEG 0 0 0.018

11 d5me BASIC NON-NEG 0 10 0

12 d5ma NON-NEG 0.1 0 0.1

Constraint Summary

Constraint S/S Dual

Row Name Type Col Rhs Activity Activity

1 Objetivo OBJECTVE . 0 0.03 .

2 Beneficio EQ . 2500 2500 0.0004

3 Materia\_Prima EQ . 245 245 -0.008

4 Mano\_de\_Obra EQ . 315 315 0.002

5 Pedido EQ . 20 20 0.018

6 Horas Extras EQ . 10 10 0



**data** pr.pr3;

input \_row\_ $13. x1 x2 X3 \_type\_ $ \_rhs\_;

datalines;

Beneficio 20 30 10 MAX .

Materia\_Prima 4 2 1 LE 245

Mano\_de\_Obra 3 2 2 LE 315

Pedido 1 0 0 GE 20

limsup 10000 10000 10000 UPPERBD .

enteras 1 2 3 INTEGER .

;

**run**;

**proc** **print** data=pr.pr3;

**run**;

/\*To help monitor the growth of the branch-and-bound tree, the LP procedure reports on the status of each problem that is solved. The report, displayed in the Integer Iteration Log, can be used to reconstruct the branch-and-bound tree. Each row in the report describes the results of the attempted solution of the linear program at a node in the tree. In the following discussion, a problem on a given line in the log is called the current problem. The following columns are displayed in the report: Iter identifies the number of the branch-and-bound iteration. Problem identifies how the current problem fits in the branch-and-bound tree. Condition reports the result of the attempted solution of the current problem. Values for Condition are:

ACTIVE: The current problem was solved successfully.

INFEASIBLE: The current problem is infeasible.

FATHOMED: The current problem cannot lead to an improved integer solution and therefore it is dropped.

SINGULAR: A singular basis was encountered in attempting to solve the current problem. Solution of this relaxed problem is suspended and will be attempted later if necessary.

SUBOPTIMAL: The current problem has an integer feasible solution. Objective reports the objective value of the current problem. Branched names the variable that is branched in subtrees defined by the descendants of this problem. Value gives the current value of the variable named in the column labeled Branched. Sinfeas gives the sum of the integer infeasibilities in the optimal solution to the current problem Active reports the total number of nodes currently active in the branch-and-bound tree Proximity reports the gap between the best integer solution and the current lower (upper for maximizations) bound of all active nodes. \*/

**proc** **lp** data=pr.pr3;

**run**;

Obs \_row\_ x1 x2 X3 \_type\_ \_rhs\_

1 Beneficio 20 30 10 MAX .

2 Materia\_Prima 4 2 1 LE 245

3 Mano\_de\_Obra 3 2 2 LE 315

4 Pedido 1 0 0 GE 20

5 limsup 10000 10000 10000 UPPERBD .

6 enteras 1 2 3 INTEGER .

The LP Procedure

Problem Summary

Objective Function Max Beneficio

Rhs Variable \_rhs\_

Type Variable \_type\_

Problem Density (%) 55.56

Variables Number

Integer 3

Slack 2

Surplus 1

Total 6

Constraints Number

LE 2

GE 1

Objective 1

Total 4

The LP Procedure

Integer Iteration Log

Iter Problem Condition Objective Branched Value Sinfeas Active Proximity

1 0 ACTIVE 2875 x2 82.5 0.5 1 .

2 1 SUBOPTIMAL 2870 . . . 0 .

The LP Procedure

Solution Summary

Integer Optimal Solution

Objective Value 2870

Phase 1 Iterations 1

Phase 2 Iterations 2

Phase 3 Iterations 1

Integer Iterations 2

Integer Solutions 1

Initial Basic Feasible Variables 5

Time Used (seconds) 0

Number of Inversions 3

Epsilon 1E-8

Infinity 1.797693E308

Maximum Phase 1 Iterations 100

Maximum Phase 2 Iterations 100

Maximum Phase 3 Iterations 99999999

Maximum Integer Iterations 100

Time Limit (seconds) 120

The LP Procedure

Variable Summary

Reduced

Col Variable Name Status Type Price Activity Cost

1 x1 BASIC INTEGER 20 20 0

2 x2 INTEGER 30 82 10

3 X3 BASIC INTEGER 10 1 0

4 Materia\_Prima SLACK 0 0 -10

5 Mano\_de\_Obra BASIC SLACK 0 89 0

6 Pedido SURPLUS 0 0 -20

The LP Procedure

Constraint Summary

Constraint S/S Dual

Row Name Type Col Rhs Activity Activity

1 Beneficio OBJECTVE . 0 2870 .

2 Materia\_Prima LE 4 245 245 10

3 Mano\_de\_Obra LE 5 315 226 0

4 Pedido GE 6 20 20 -20