

Grau d'Estadística UB-UPC

Programació Lineal

Laboratori 2 :

PROC OPTMODEL i bases de dades

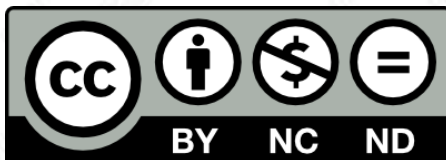
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PROC OPTMODEL i bases de dades

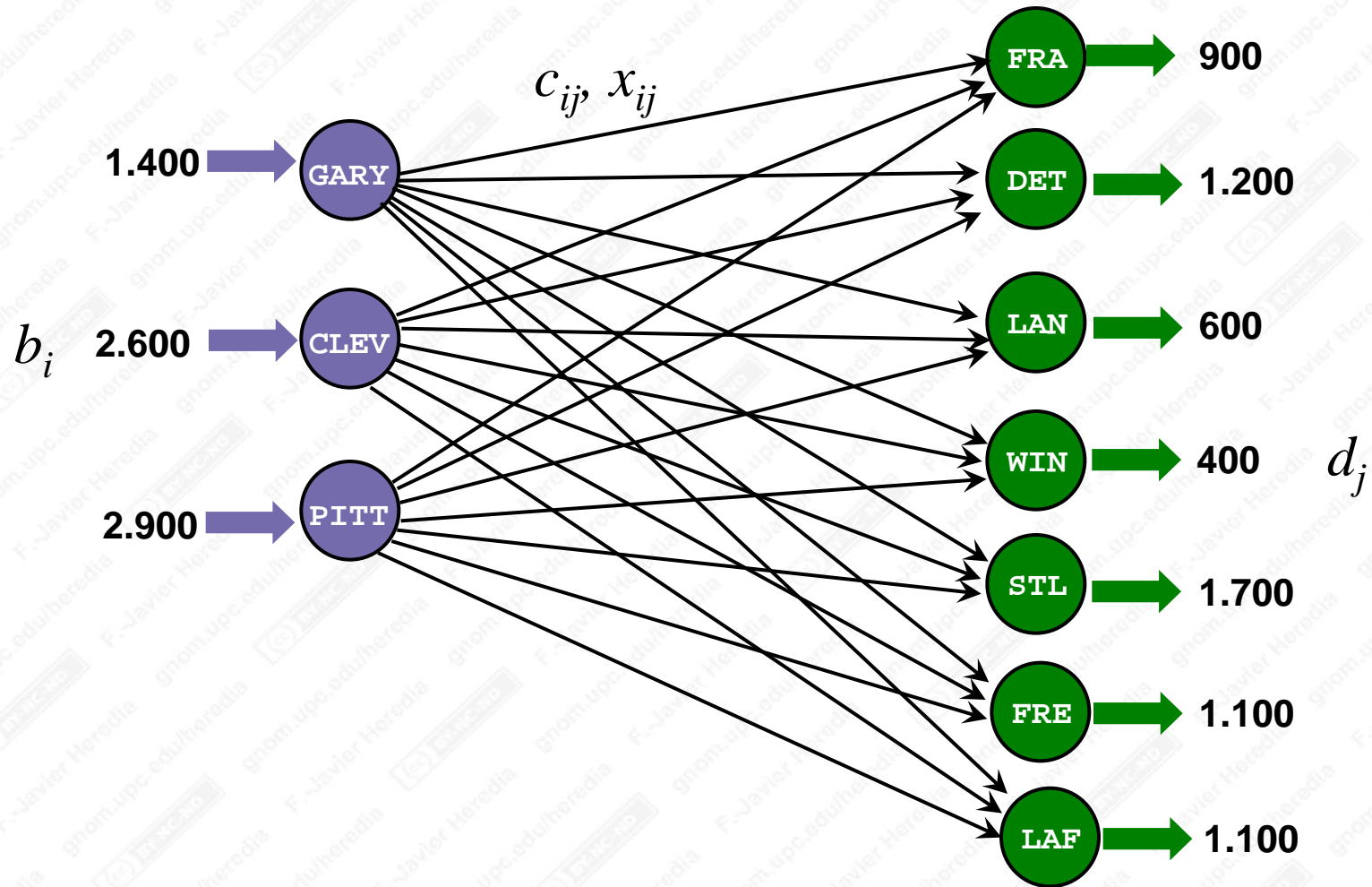
- Presentació del problema Trans.
- Resolució amb PROC OPTMODEL.

Problema de transport

- La producció setmanal dels tres tallers de laminat de l'empresa Steel ha de ser transportada a set factories d'automòbils per l'empresa de logística Trans, d'acord amb les següents dades:

<i>Trans</i> (costos en €/Tm)		<i>Tallers laminat</i>			<i>Demanda</i> (Tm)
		Gary	Cleveland	Pittsburg	
Factories	Framingham	39	27	24	900
	Detroit	14	9	14	1.200
	Lansing	11	12	17	600
	Windsor	14	9	13	400
	St. Louis	16	26	28	1.700
	Fremont	82	95	99	1.100
	Lafayette	8	17	20	1.000
Producció (Tm)		1.400	2.600	2.900	

Problema de transport: xarxa associada



Formulació del problema

Paràmetres:

- $\mathcal{M} = \{Gary, Clev, Pitt\}$, cjt. tallers (*mills*)
- $\mathcal{F} = \{Fra, Det, \dots, Laf\}$, cjt. factories
- $c = \begin{bmatrix} 39 & 14 & 11 & 14 & 16 & 82 & 8 \\ 27 & 9 & 12 & 9 & 26 & 95 & 17 \\ 24 & 14 & 17 & 13 & 28 & 99 & 20 \end{bmatrix}$, cost unitari transport $\mathcal{M} \rightarrow \mathcal{F}$
- $s = [1400 \ 2600 \ 2900]'$, producció taller.
- $d = [900 \ \dots \ 1000]'$, demanda factories.

Variables: $x_{ij} \geq 0, i \in \mathcal{M}, j \in \mathcal{F}$, tones transportades $i \rightarrow j$

Model matemàtic:

(costos en €/Tm)		Tallers laminat			Demanda (Tm)
		Gary	Clev	Pitt	
Factories	Fra	39	27	24	900
	Det	14	9	14	1.200
	Lan	11	12	17	600
	Win	14	9	13	400
	Slo	16	26	28	1.700
	Fre	82	95	99	1.100
	Laf	8	17	20	1.000
Producció (Tm)		1.400	2.600	2.900	

$$\begin{aligned}
 \text{(PL)} \quad & \left\{ \begin{array}{ll} \min z = & \sum_{i \in \mathcal{M}} \sum_{j \in \mathcal{F}} c_{ij} x_{ij} & \text{es minimitza el cost total} \\ \text{s. a.:} & \\ & \sum_{j \in \mathcal{F}} x_{ij} = s_i, i \in \mathcal{M} & \text{es lliure tota la producció} \\ & \sum_{i \in \mathcal{M}} x_{ij} = d_j, j \in \mathcal{F} & \text{es satisfà tota la demanda} \\ & x_{ij} \geq 0, i \in \mathcal{M}, j \in \mathcal{F} \end{array} \right.
 \end{aligned}$$

Dades del prob. de transport: transBD.sas

- Creació de les BD: carreguem el fitxer transBD.sas

Factories:

Fra	39	27	24	900
Det	14	9	14	1200
Lan	11	12	17	600
Win	14	9	13	400
SLo	16	26	28	1700
Fre	82	95	99	1100
Laf	8	17	20	1000

Mills:

Gary	1400
Clev	2600
Pitt	2900

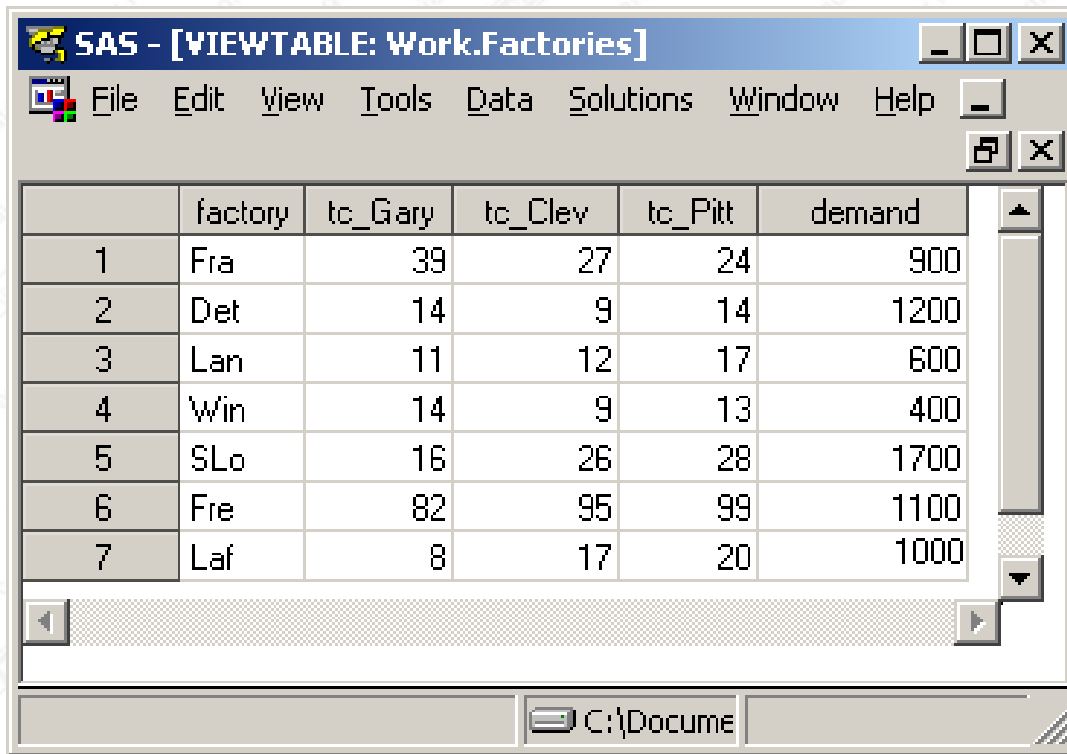
$d_j, j \in \mathcal{F}$

$c_{ij}, i \in \mathcal{M}, j \in \mathcal{F}$

$s_i, i \in \mathcal{M}$

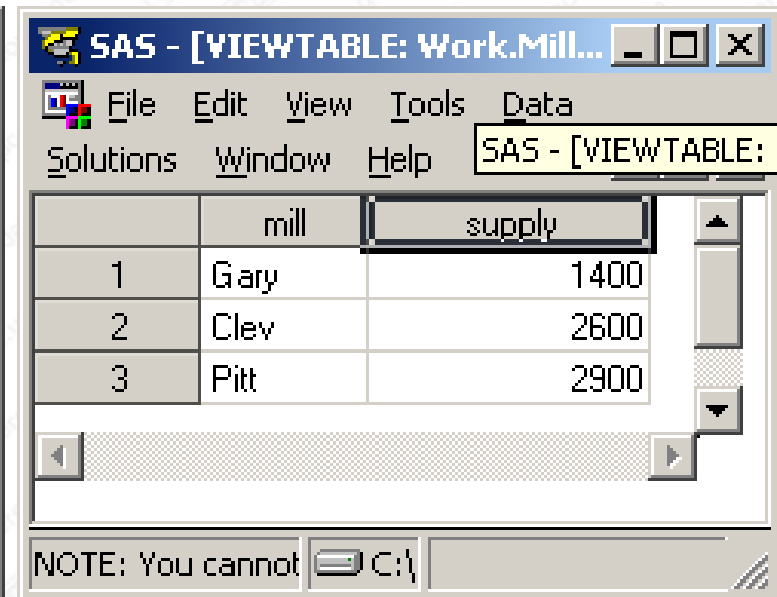
Dades del prob. de transport: transBD.sas

- Visualització de les BD:



SAS - [VIEWTABLE: Work.Factories]

	factory	tc_Gary	tc_Clev	tc_Pitt	demand
1	Fra	39	27	24	900
2	Det	14	9	14	1200
3	Lan	11	12	17	600
4	Win	14	9	13	400
5	SLo	16	26	28	1700
6	Fre	82	95	99	1100
7	Laf	8	17	20	1000



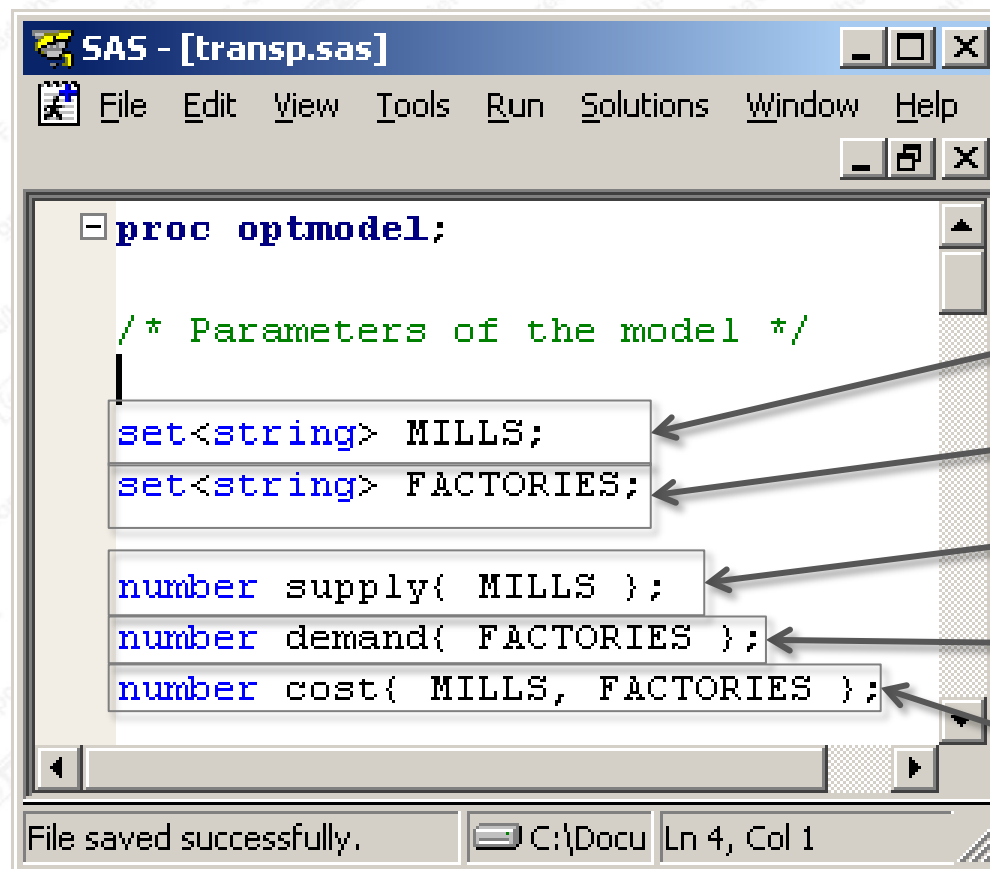
SAS - [VIEWTABLE: Work.Mill...]

	mill	supply
1	Gary	1400
2	Clev	2600
3	Pitt	2900

NOTE: You cannot C:\

transOPTMODEL.sas (1/3)

- Definició dels paràmetres:



```
SAS - [transp.sas]
File Edit View Tools Run Solutions Window Help

proc optmodel;

/* Parameters of the model */
set<string> MILLS;
set<string> FACTORIES;

number supply( MILLS );
number demand( FACTORIES );
number cost( MILLS, FACTORIES );
```

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\mathcal{M}

\mathcal{F}

$s_i, i \in \mathcal{M}$

$d_j, j \in \mathcal{F}$

$c_{ij}, i \in \mathcal{M}, j \in \mathcal{F}$

transOPTMODEL.sas (1/2)

- Càrrega de paràmetres desde les BD:

The screenshot shows the SAS interface with a program window titled "SAS - [trans.sas *]". The program code is as follows:

```
/* Load the data from the databases */

/* Mills */
read data Mills into MILLS=[mill] supply;
print supply;

/* Factories */
read data Factories
into
    FACTORIES=[factory]
    {mill in MILLS} <cost[mill,factory]=col("tc_"||mill)>
    demand;
print supply cost demand;
```

Two callout boxes show the data loaded into the variables:

data Mills;

mill	supply
Gary	1400
Clev	2600
Pitt	2900

data Factories;

factory	tc_Gary	tc_Clev	tc_Pitt	demand
Fra	39	27	24	900
Det	14	9	14	1200
Lan	11	12	17	600
Win	14	9	13	400
SLo	16	26	28	1700
Fre	82	95	99	1100
Laf	8	17	20	1000

The status bar at the bottom indicates "Autosave complete".

transOPTMODEL.sas (1/3)

- Definició del model d'optimització:

$$x_{ij} \geq 0, i \in \mathcal{M}, j \in \mathcal{F}$$

$$\min z = \sum_{i \in \mathcal{M}} \sum_{j \in \mathcal{F}} c_{ij} x_{ij}$$

$$\sum_{j \in \mathcal{F}} x_{ij} = s_i, i \in \mathcal{M}$$

$$\sum_{i \in \mathcal{M}} x_{ij} = d_j, j \in \mathcal{F}$$

```
SAS - [transp.sas]
File Edit View Tools Run Solutions Window Help

/* Optimization model */

var Trans {MILLS, FACTORIES} >= 0;

min Total_cost = sum {i in MILLS, j in FACTORIES} cost[i,j] * Trans[i,j];

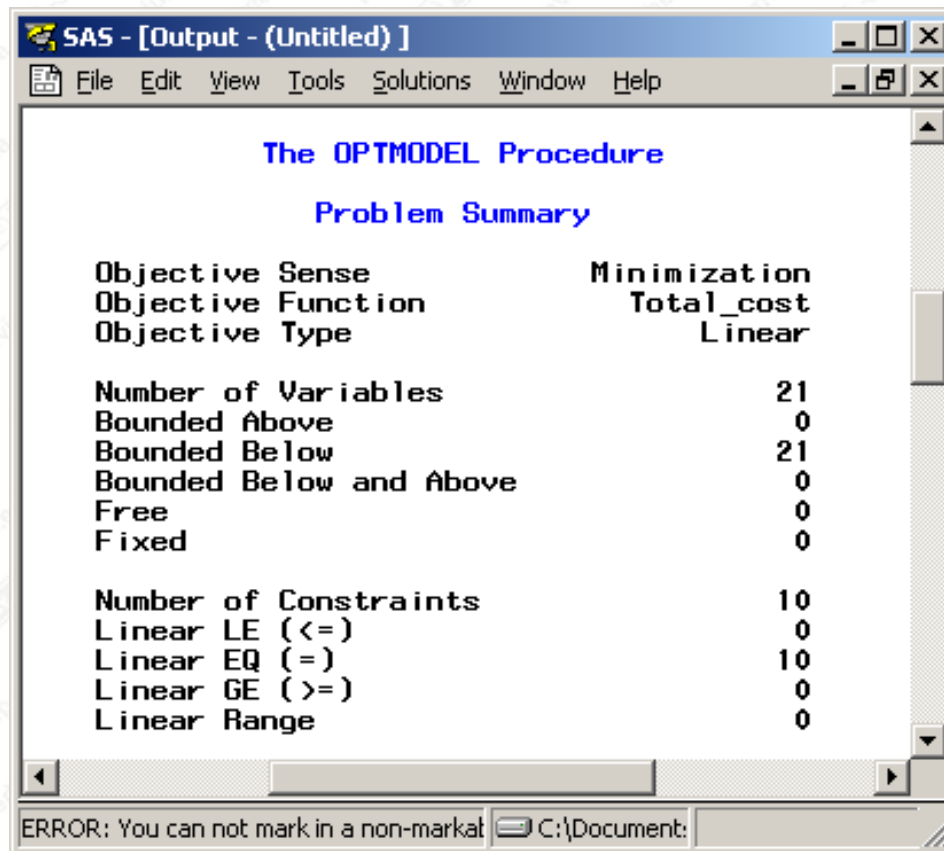
con Supply_cons {i in MILLS}:
  sum {j in FACTORIES} Trans[i,j] = supply[i];

con Demand_cons {j in FACTORIES}:
  sum {i in MILLS} Trans[i,j] = demand[j];
```

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Resolució del prob. : Output

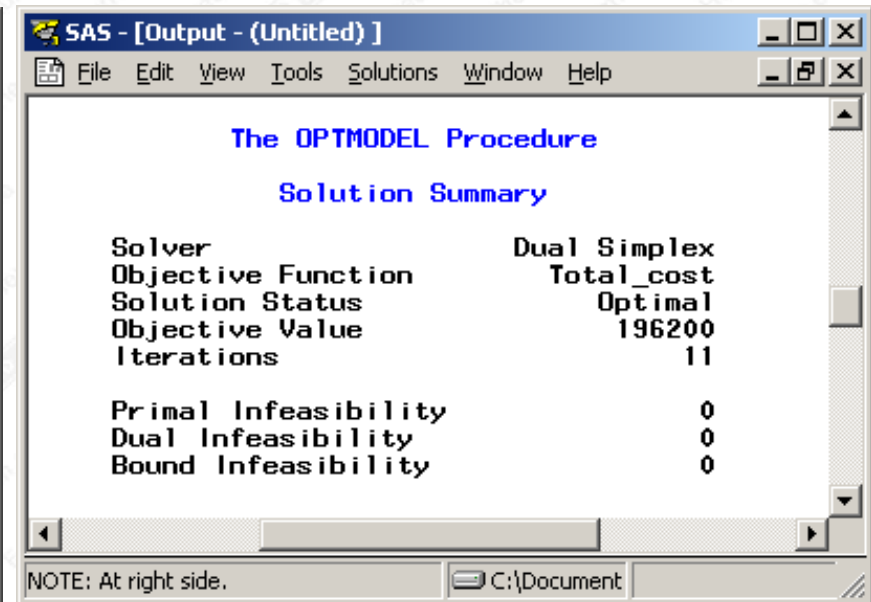
- Característiques del model d'optimització:



The screenshot shows the SAS [Output - (Untitled)] window with the title bar and menu bar (File, Edit, View, Tools, Solutions, Window, Help). The main content area displays 'The OPTMODEL Procedure' and 'Problem Summary'. The summary includes the objective sense (Minimization), objective function (Total_cost), and objective type (Linear). It also lists the number of variables (21) and constraints (10), along with their bounds and ranges.

The OPTMODEL Procedure	
Problem Summary	
Objective Sense	Minimization
Objective Function	Total_cost
Objective Type	Linear
Number of Variables	21
Bounded Above	0
Bounded Below	21
Bounded Below and Above	0
Free	0
Fixed	0
Number of Constraints	10
Linear LE (\leq)	0
Linear EQ ($=$)	10
Linear GE (\geq)	0
Linear Range	0

ERROR: You can not mark in a non-markat C:\Document:



The screenshot shows the SAS [Output - (Untitled)] window with the title bar and menu bar (File, Edit, View, Tools, Solutions, Window, Help). The main content area displays 'The OPTMODEL Procedure' and 'Solution Summary'. The summary includes the solver (Dual Simplex), objective function (Total_cost), solution status (Optimal), objective value (196200), and iterations (11). It also lists primal, dual, and bound infeasibility values (all 0).

The OPTMODEL Procedure	
Solution Summary	
Solver	Dual Simplex
Objective Function	Total_cost
Solution Status	Optimal
Objective Value	196200
Iterations	11
Primal Infeasibility	0
Dual Infeasibility	0
Bound Infeasibility	0

NOTE: At right side. C:\Document

Resolució del prob. : Output

- Solució òptima (1/2):

```
/* Optimize and output */
```

```
solve;
```

```
print Trans.lb Trans.sol Trans.ub Trans.rc Trans.status;
```

```
print Supply_cons.lb Supply_cons.body Supply_cons.ub Supply_cons.dual Supply_cons.status;
```

```
print Demand_cons.lb Demand_cons.body Demand_cons.ub Demand_cons.dual Demand_cons.status;
```


[1]	[2]	Trans.LB	Trans.SOL	Trans.UB	Trans.RC	STATUS
Clev	Det	0	1200	1.79769E308	0	B
Clev	Fra	0	0	1.79769E308	6	L
Clev	Fre	0	0	1.79769E308	4	L
Clev	Laf	0	400	1.79769E308	0	B
Clev	Lan	0	600	1.79769E308	0	B
Clev	SLo	0	0	1.79769E308	1	L
Clev	Win	0	400	1.79769E308	0	B
Gary	Det	0	0	1.79769E308	14	L
Gary	Fra	0	0	1.79769E308	27	L
Gary	Fre	0	1100	1.79769E308	0	B
Gary	Laf	0	0	1.79769E308	0	L
Gary	Lan	0	0	1.79769E308	8	L
Gary	SLo	0	300	1.79769E308	0	B
Gary	Win	0	0	1.79769E308	14	L
Pitt	Det	0	0	1.79769E308	2	L
Pitt	Fra	0	900	1.79769E308	0	B
Pitt	Fre	0	0	1.79769E308	5	L
Pitt	Laf	0	600	1.79769E308	0	B
Pitt	Lan	0	0	1.79769E308	2	L
Pitt	SLo	0	1400	1.79769E308	0	B
Pitt	Win	0	0	1.79769E308	1	L

NOTE: At right side.

C:\Documents and Settings\Javi

Resolució del prob. : Output


- Solució òptima (2/2):



[1]	Supply_ cons.LB	Supply_ cons. BODY	Supply_ cons.UB	Supply_ cons. DUAL	Supply_ cons. STATUS
Clev	2600	2600	2600	17	U
Gary	1400	1400	1400	8	U
Pitt	2900	2900	2900	20	U

```
/* Optimize and output */
```

```
solve;  
print Trans.lb Trans.sol Trans.ub Trans.rc Trans.status;  
print Supply_cons.lb Supply_cons.body Supply_cons.ub Supply_cons.dual Supply_cons.status;  
print Demand_cons.lb Demand_cons.body Demand_cons.ub Demand_cons.dual Demand_cons.status;
```



[1]	Demand_ cons.LB	Demand_ cons. BODY	Demand_ cons.UB	Demand_ cons. DUAL	Demand_ cons. STATUS
Det	1200	1200	1200	-8	L
Fra	900	900	900	4	U
Fre	1100	1100	1100	74	U
Laf	1000	1000	1000	0	B
Lan	600	600	600	-5	L
SLo	1700	1700	1700	8	U
Win	400	400	400	-8	L

Càrrega de la sol òptima a la BD **Factories** (1)

- Es guarda la solució a una BD temporal:

```
SAS - [transp.sas]
File Edit View Tools Run Solutions Window Help

/* Storing the solution to a DB */

/* First, a DB with the sol of each factory is created */
create data Transp_sol
  from [ factory ] = FACTORIES
  {mill in MILLS} <col("sup_"||mill)=Trans[mill, factory]> pi=Demand_cons.dual;
```

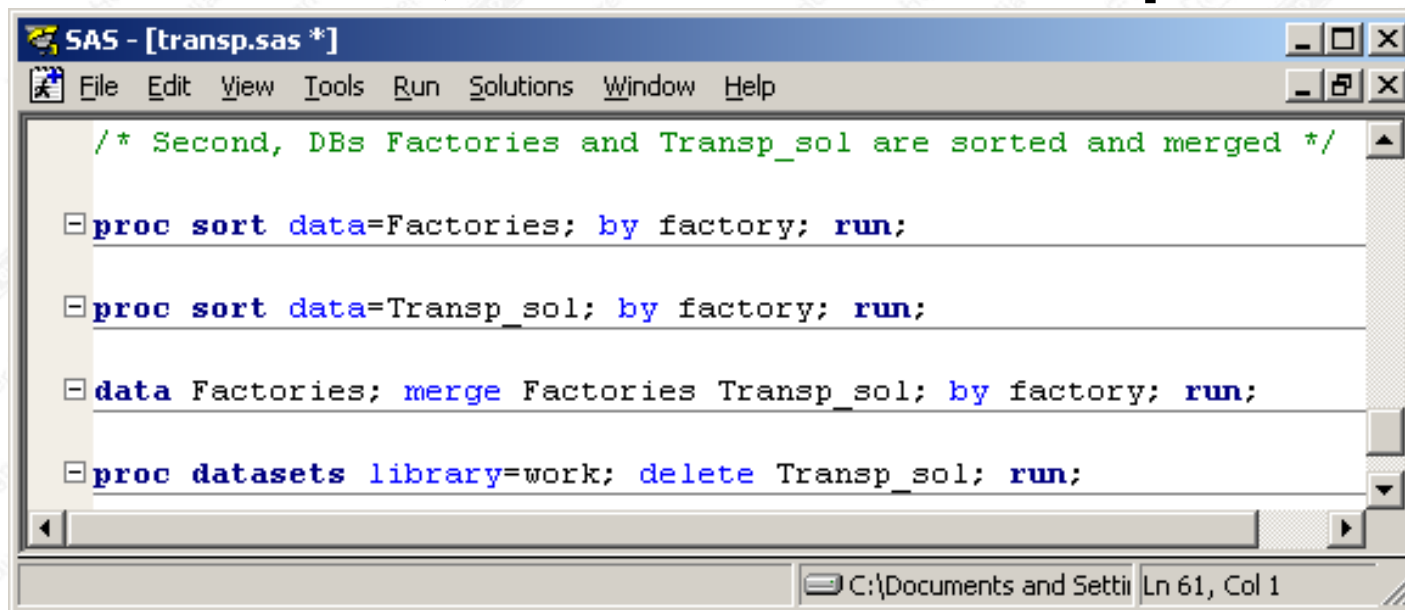
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	factory	sup_Gary	sup_Clev	sup_Pitt	pi
1	Det	0	1200	0	-8
2	Fra	0	0	900	4
3	Fre	1100	0	0	74
4	Laf	0	400	600	0
5	Lan	0	600	0	-5
6	SLo	300	0	1400	8
7	Win	0	400	0	-8

Càrrega de la sol òptima a la BD Factories (2)

- S'ordena, es volca la BD temporal i s'elimina:



```
SAS - [transp.sas *]  
File Edit View Tools Run Solutions Window Help  
/* Second, DBs Factories and Transp_sol are sorted and merged */  
proc sort data=Factories; by factory; run;  
proc sort data=Transp_sol; by factory; run;  
data Factories; merge Factories Transp_sol; by factory; run;  
proc datasets library=work; delete Transp_sol; run;  
C:\Documents and Settings\Ln 61, Col 1
```



	factory	tc_Gary	tc_Clev	tc_Pitt	demand	sup_Gary	sup_Clev	sup_Pitt	pi
1	Det	14	9	14	1200	0	1200	0	-8
2	Fra	39	27	24	900	0	0	900	4
3	Fre	82	95	99	1100	1100	0	0	74
4	Laf	8	17	20	1000	0	400	600	0
5	Lan	11	12	17	600	0	600	0	-5
6	SLo	16	26	28	1700	300	0	1400	8
7	Win	14	9	13	400	0	400	0	-8