

Project #1, Group 3:

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Sets:

- Let I be the set of sources where i is an element of I . $I = \{1,2\}$
- Let J be the set of transshipment points where j is an element of J . $J = \{3,4,5\}$
- Let K be the set of Destinations where k is an element of K . $K = \{6,7,8\}$

Parameters:

- Param S : $\{i \text{ in } I\}$ which is the set of sources
- Param D : $\{k \text{ in } K\}$ which is the set of destinations
- Param cs : $\{i \text{ in } I, j \text{ in } J\}$ the cost of sending wheat from source i to transshipment point j
- Param cd : $\{j \text{ in } J, k \text{ in } K\}$ the cost of sending wheat from transshipment point j to destination k

Variables:

- x_{ij} = the amount of wheat sent from source i to transshipment point j
- x_{jk} = the amount of wheat sent from transshipment point j to destination k

1) Linear Programming Model:

$$\text{Minimize } z = 16x_{13} + 10x_{14} + 12x_{15} + 15x_{23} + 14x_{24} + 17x_{25} + 6x_{36} + 8x_{37} + 10x_{38} + 7x_{46} + 11x_{47} + 11x_{48} +$$

$$4x_{56} + 5x_{57} + 12x_{58} \left(\sum_{i \text{ in } I} \sum_{j \text{ in } J} cs_{ij} x_{ij} + \sum_{j \text{ in } J} \sum_{k \text{ in } K} cd_{jk} x_{jk} \right) \text{ where } z \text{ is the minimum cost of}$$

sending wheat through a source to a transshipment point to a destination.

Constraints:

$$x_{13} + x_{14} + x_{15} \leq 300 \quad (\text{for source 1 capacity})$$

$$x_{23} + x_{24} + x_{25} \leq 300 \quad (\text{for source 2 capacity})$$

$$x_{36} + x_{46} + x_{56} \leq 200 \quad (\text{for destination 6 demand})$$

$$x_{37} + x_{47} + x_{57} \leq 100 \quad (\text{for destination 7 demand})$$

$$x_{38} + x_{48} + x_{58} \leq 300 \quad (\text{for destination 8 demand})$$

$$x_{13} + x_{23} - x_{36} - x_{37} - x_{38} = 0 \quad (\text{for transshipment 3})$$

$$x_{14} + x_{24} - x_{46} - x_{47} - x_{48} = 0 \quad (\text{for transshipment 4})$$

$$x_{15} + x_{25} - x_{56} - x_{57} - x_{58} = 0 \quad (\text{for transshipment 5})$$

$$x_{ij}, x_{jk} \geq 0$$

2) AMPL Code for .mod file:

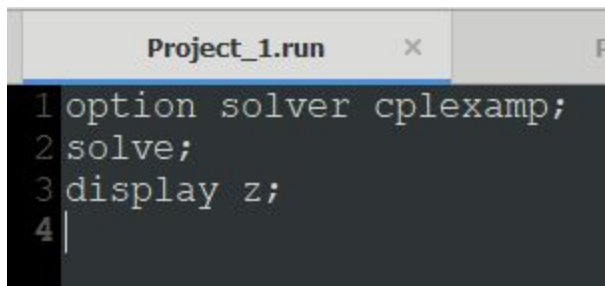
```
Project_1.mod x Project_1.dat x Project_1.run x Transportation.mo
1 set I ordered;
2 set J ordered;
3 set K ordered;
4
5 param cs {i in I, j in J};
6 param cd {j in J, k in K};
7 param S {i in I};
8 param D {k in K};
9
10 var x1 {i in I, j in J} >= 0;
11 var x2 {j in J, k in K} >= 0;
12
13 minimize z:
14 sum{i in I, j in J} cs[i,j]*x1[i,j] + sum{j in J, k in K} cd[j,k]*x2[j,k];
15
16 subject to c1 {i in I}: sum{j in J} x1[i,j] <= S[i];
17 subject to c2 {k in K}: sum{j in J} x2[j,k] >= D[k];
18 subject to c3 {j in J}: sum{i in I} x1[i,j] = sum {k in K} x2 [j,k];
19|
```

Minimize $z = \sum(i \text{ in } I, j \text{ in } J) cs[i,j]*x[i,j] + \sum(j \text{ in } J, k \text{ in } K) cd[j,k]]*x[j,k]$

AMPL Code for .dat file:

```
Project_1.dat x
1 set I := 1 2;
2 set J := 3 4 5;
3 set K := 6 7 8;
4
5 param: S :=
6 1 300
7 2 300;
8
9 param: D :=
10 6 200
11 7 100
12 8 300;
13
14 param cs:
15 3 4 5 :=
16 1 16 10 12
17 2 15 14 17;
18
19 param cd:
20 6 7 8 :=
21 3 6 8 10
22 4 7 11 11
23 5 4 5 12;
24|
```

AMPL Code for .run file:

A screenshot of a text editor window titled "Project_1.run". The window contains four lines of AMPL code: "1 option solver cplexamp;", "2 solve;", "3 display z;", and "4 |". The cursor is at the end of the fourth line.

```
1 option solver cplexamp;
2 solve;
3 display z;
4 |
```

3) Screenshot of CPLEX solver results

```
15 variables, all linear
8 constraints, all linear; 30 nonzeros
    8 equality constraints
1 linear objective; 15 nonzeros.

CPLEX 12.9.0.0: threads=4
CPLEX 12.9.0.0: optimal solution; objective 12400
3 dual simplex iterations (0 in phase I)
z = 12400
```

"We ____*Mark Holtje, Ian George, Graciela Casanova, Apoorva Nori*____ did not give or receive any assistance on this project."