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 in I} which is the set of sources
- Param D: {k in K} which is the set of destinations
- Param cs: {i in I, j in J} the cost of sending wheat from source i to transshipment point j
- Param cd: {j in J, k 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:
   Minimize z = $16x_{13}+10x_{14}+12x_{15}+15x_{23}+14x_{24}+17x_{25}+6x_{36}+8x_{37}+10x_{38}+7x_{46}+11x_{47}+11x_{48}+4x_{56}+5x_{57}+12x_{58}$ ($\sum_{i\ in\ I}\sum_{j\ in\ J} cs_{ij}\,x_{ij} + \sum_{j\ in\ J}\sum_{k\ in\ K} cd_{jk}\,x_{jk}$) where z is the minimum cost of sending wheat through a source to a transshipment point to a destination.

   Constraints:
   $x_{13}+x_{14}+x_{15}$ =< 300 (for source 1 capacity)
   $x_{23}+x_{24}+x_{25}$ =< 300 (for source 2 capacity)
   $x_{36}+x_{46}+x_{56}$ =< 200 (for destination 6 demand)
   $x_{37}+x_{47}+x_{57}$ => 100 (for destination 7 demand)
   $x_{38}+x_{48}+x_{58}$ => 300 (for destination 8 demand)
   $x_{13} + x_{23} - x_{36} - x_{37} - x_{38} = 0$ (for transshipment 3)
   $x_{14} + x_{24} - x_{46} - x_{47} - x_{48} = 0$ (for transshipment 4)
   $x_{15} + x_{25} - x_{56} - x_{57} - x_{58} = 0$ (for transshipment 5)
   $x_{ij},\ x_{jk} >= 0$

2) AMPL Code for .mod file:

Project_1.mod | Project_1.dat | Project_1.run | Transportation.mo

```
set I ordered;
set J ordered;
set K ordered;

param cs {i in I, j in J};
param cd {j in J, k in K};
param S {i in I};
param D {k in K};

var x1 {i in I, j in J} >= 0;
var x2 {j in J, k in K} >= 0;

minimize z:
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];

subject to c1 {i in I}: sum{j in J} x1[i,j] <= S[i];
subject to c2 {k in K}: sum{j in J} x2[j,k] >= D[k];
subject to c3 {j in J}: sum{i in I} x1[i,j] = sum {k in K} x2 [j,k];
```

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

AMPL Code for .dat file:

Project_1.dat

```
set I := 1 2;
set J := 3 4 5;
set K := 6 7 8;

param: S :=
1 300
2 300;

param: D :=
6 200
7 100
8 300;

param cs:
  3 4 5 :=
1 16 10 12
2 15 14 17;

param cd:
  6 7 8 :=
3 6 8 10
4 7 11 11
5 4 5 12;
```

AMPL Code for .run file:

Project_1.run

```
option solver cplexamp;
solve;
display z;
```

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.”