How to Solve the Transportation Problem with MPL/CPLEX
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Problem 1
Suppose you have three canneries (sources) and four warehouses (destinations). The shipment costs, outputs (1 for each source) and demands (1 for each destination) are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Warehouses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Canneries</td>
<td>1</td>
<td>464</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>352</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>995</td>
</tr>
<tr>
<td>Demand</td>
<td>80</td>
<td>65</td>
</tr>
</tbody>
</table>

Open MPL, go to file -> new then type the following:

```
index source := 1..3;
        destination := 1..4;

data
    Shipcost[source,destination] := (464,513,654,867,352,416,690,791,995,682,388,685);
    Output[source] := (75,125,100);
    Demand[destination] := (80,65,70,85);

variables
    Ship[source,destination];

model
    min C = sum(source,destination: Shipcost*Ship);
    subject to
        C1[source]:
            sum(destination: Ship) = Output;
        C2[destination]:
            sum(source: Ship) = Demand;

end
```

The summation in constraint 1 is like summing over the columns in the table above. You take the sum over the destination index, so this is the index that you specify in the sum command: "sum(destination: Ship)". Similarly, for constraint 2 the sum is over the source index, like summing over rows in the table above.

To solve the problem, go to Run -> Solve -> Solve CPLEX 300, or press .

You should get the following optimal solution:

```
MIN C = 152535.00000

source destination Activity
-------------------------------
  1     1     0.00000
  1     2     20.00000
  1     3     0.00000
  1     4     55.00000
  2     1    80.00000
  2     2     45.00000
  2     3     0.00000
  2     4     0.00000
  3     1     0.00000
  3     2     0.00000
  3     3    70.00000
  3     4    30.00000
```

Problem 2
Now, here is how you would solve a problem with a dummy source and big M's in MPL. We use the water allocation example from Chapter 8. Specifically, you should look at Table 8.12 on page 318. Type the following in MPL:

```
index
    source := (Colombo,Sacron,Calorie,Dummy);
    destination := (B_min,B_extra,Los_Devils,San_Go,Hollyglass);

data
    DeliveryCost[source,destination] := (16,16,13,22,17,
                                         14,14,13,19,15,
                                         19,19,20,23,-1,
                                         -1,0 ,-1, 0, 0);
    Supply[source] := (50 50 50 50);
    Demand[destination] := (30 20 70 30 60);

variables
```

To solve the problem, go to Run -> Solve -> Solve CPLEX 300, or press .

You should get the following optimal solution:

```
MIN C = 152535.00000

source destination Activity
-------------------------------
  1     1     0.00000
  1     2     20.00000
  1     3     0.00000
  1     4     55.00000
  2     1    80.00000
  2     2     45.00000
  2     3     0.00000
  2     4     0.00000
  3     1     0.00000
  3     2     0.00000
  3     3    70.00000
  3     4    30.00000
```
Ship[source,destination]
    where (DeliveryCost[source,destination] >= 0);    ! this is the only new line
model
    min cost = sum(source,destination: DeliveryCost*Ship);
subject to:
    C1[source]:
        sum(destination: Ship) = Supply;
    C2[destination]:
        sum(source: Ship) = Demand;
end

The only difference is that M's are replaced with -1's and that the line
"where (DeliveryCost[source,destination] >= 0);" must be added when defining the Ship[source,destination]
variable. This line makes it so that the impossible "routes" from rivers to cities are not among the
decision variables, as these routes do not satisfy DeliveryCost[source,destination] >= 0.
Run CPLEX and you should get the following solution:

MIN cost = 2460.000000

<table>
<thead>
<tr>
<th>source</th>
<th>destination</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombo</td>
<td>B_min</td>
<td>0.000000</td>
</tr>
<tr>
<td>Colombo</td>
<td>B_extra</td>
<td>0.000000</td>
</tr>
<tr>
<td>Colombo</td>
<td>Los_Devils</td>
<td>50.000000</td>
</tr>
<tr>
<td>Colombo</td>
<td>San_Go</td>
<td>0.000000</td>
</tr>
<tr>
<td>Colombo</td>
<td>Hollyglass</td>
<td>0.000000</td>
</tr>
<tr>
<td>Sacron</td>
<td>B_min</td>
<td>0.000000</td>
</tr>
<tr>
<td>Sacron</td>
<td>B_extra</td>
<td>0.000000</td>
</tr>
<tr>
<td>Sacron</td>
<td>Los_Devils</td>
<td>20.000000</td>
</tr>
<tr>
<td>Sacron</td>
<td>San_Go</td>
<td>0.000000</td>
</tr>
<tr>
<td>Sacron</td>
<td>Hollyglass</td>
<td>40.000000</td>
</tr>
<tr>
<td>Calorie</td>
<td>B_min</td>
<td>30.000000</td>
</tr>
<tr>
<td>Calorie</td>
<td>B_extra</td>
<td>20.000000</td>
</tr>
<tr>
<td>Calorie</td>
<td>Los_Devils</td>
<td>0.000000</td>
</tr>
<tr>
<td>Calorie</td>
<td>San_Go</td>
<td>0.000000</td>
</tr>
<tr>
<td>Dummy</td>
<td>B_extra</td>
<td>0.000000</td>
</tr>
<tr>
<td>Dummy</td>
<td>San_Go</td>
<td>30.000000</td>
</tr>
<tr>
<td>Dummy</td>
<td>Hollyglass</td>
<td>20.000000</td>
</tr>
</tbody>
</table>

This is consistent with the solution given in table 8.23 on page 333.