

IP Applications

Planning a Pancakes Empire

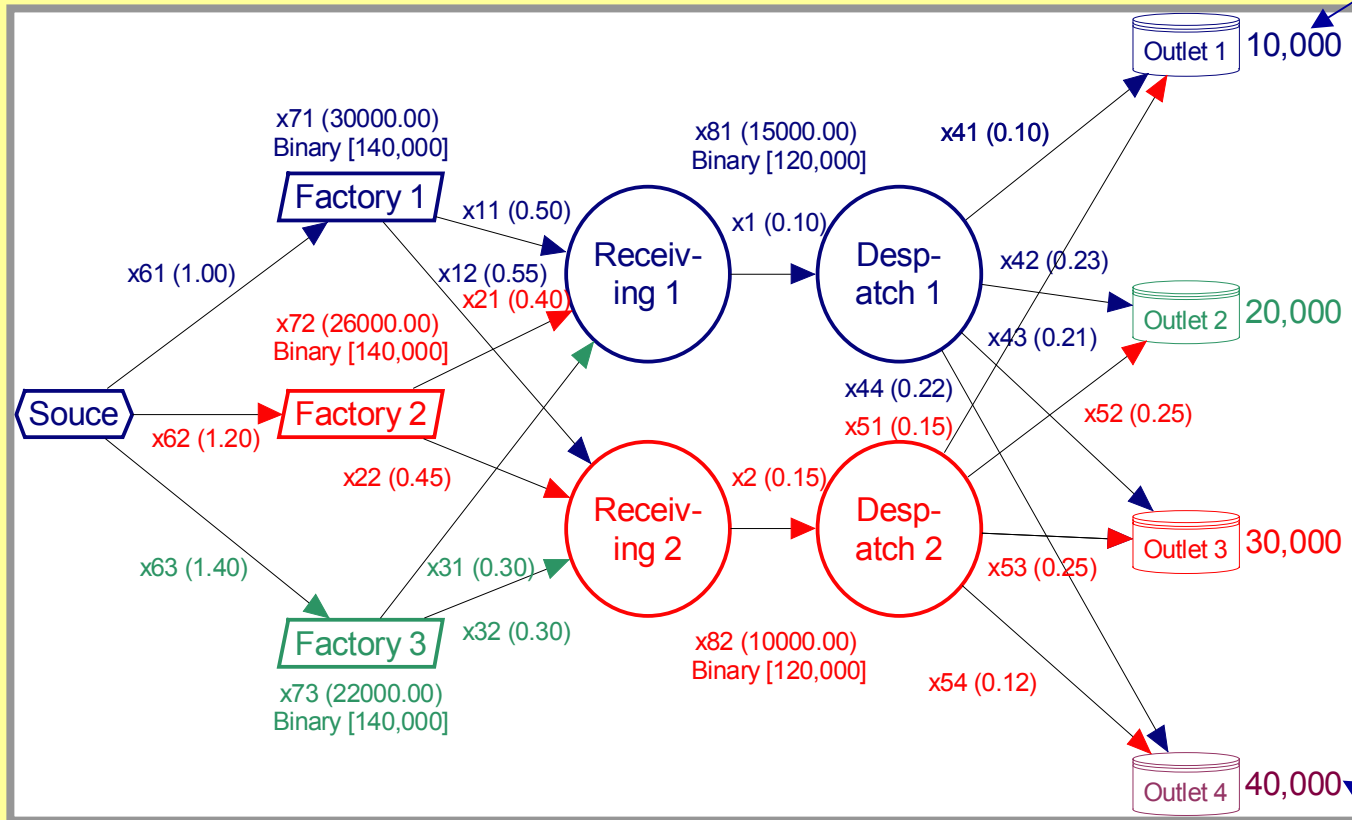
January 8, 2002



FOMGT 353 Introduction to
Management Science

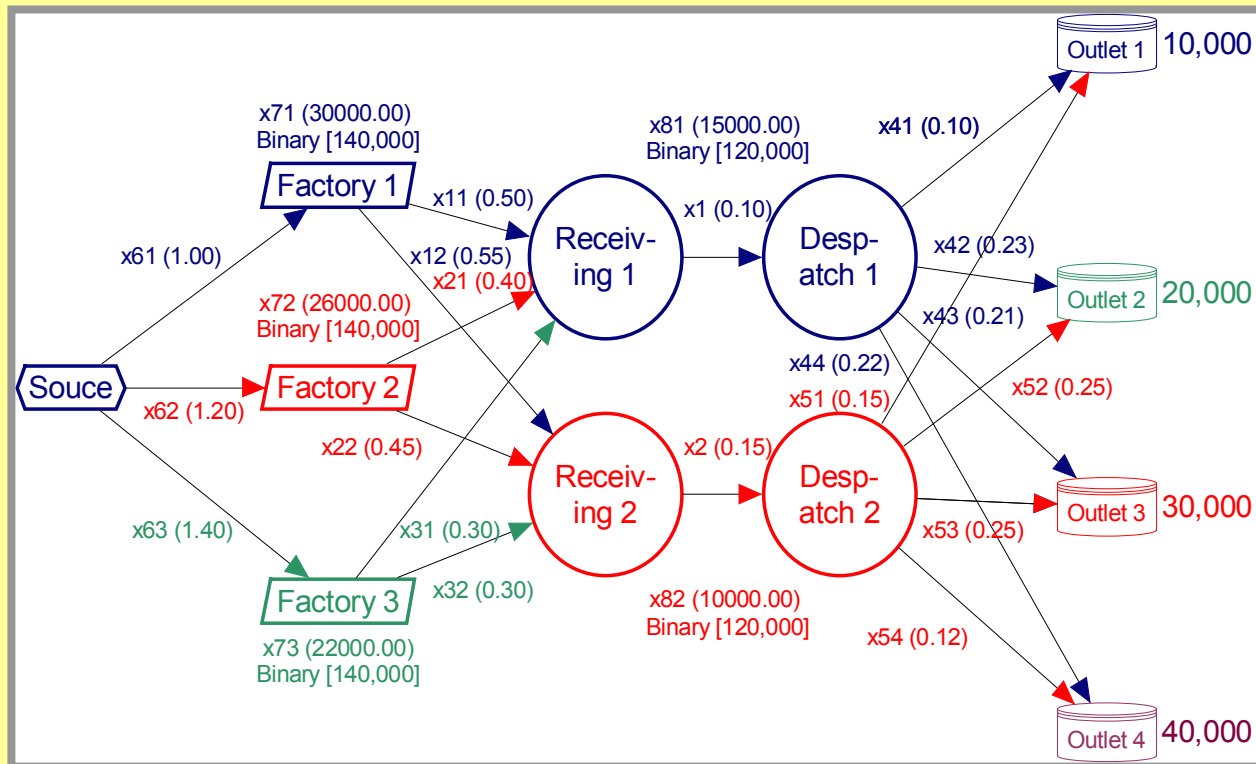


And Finally, The Demands.



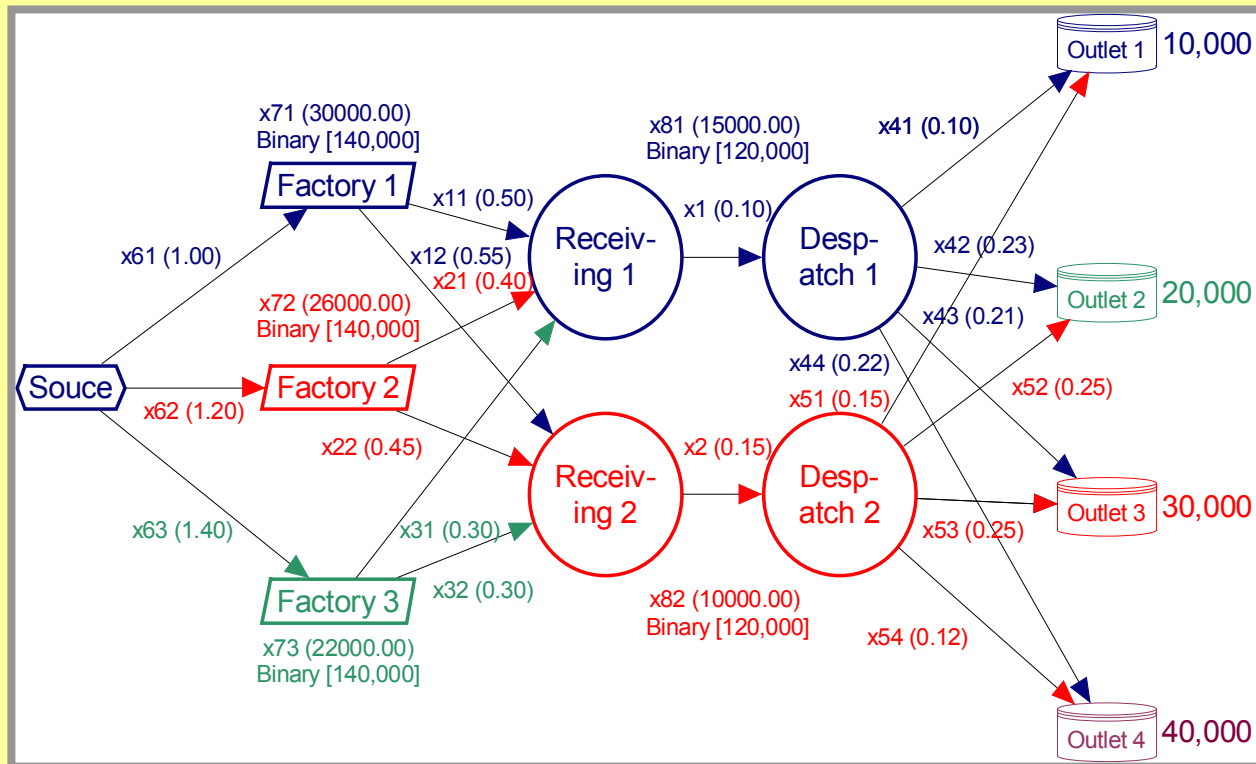
Write Down The Objective Function!

- $$\text{Min } 1x_{61} + 1.2x_{62} + 1.4x_{63} + 30000x_{71} + 26000x_{72} + 22000x_{73} + 0.5x_{11} + 0.55x_{12} + 0.4x_{21} + 0.45x_{22} + 0.3x_{31} + 0.3x_{32} + 15000x_{81} + 0.1x_1 + 0.15x_2 + 10000x_{82} + 0.1x_{41} + 0.23x_{42} + 0.21x_{43} + 0.22x_{44} + 0.15x_{51} + 0.25x_{52} + 0.25x_{53} + 0.12x_{54}$$



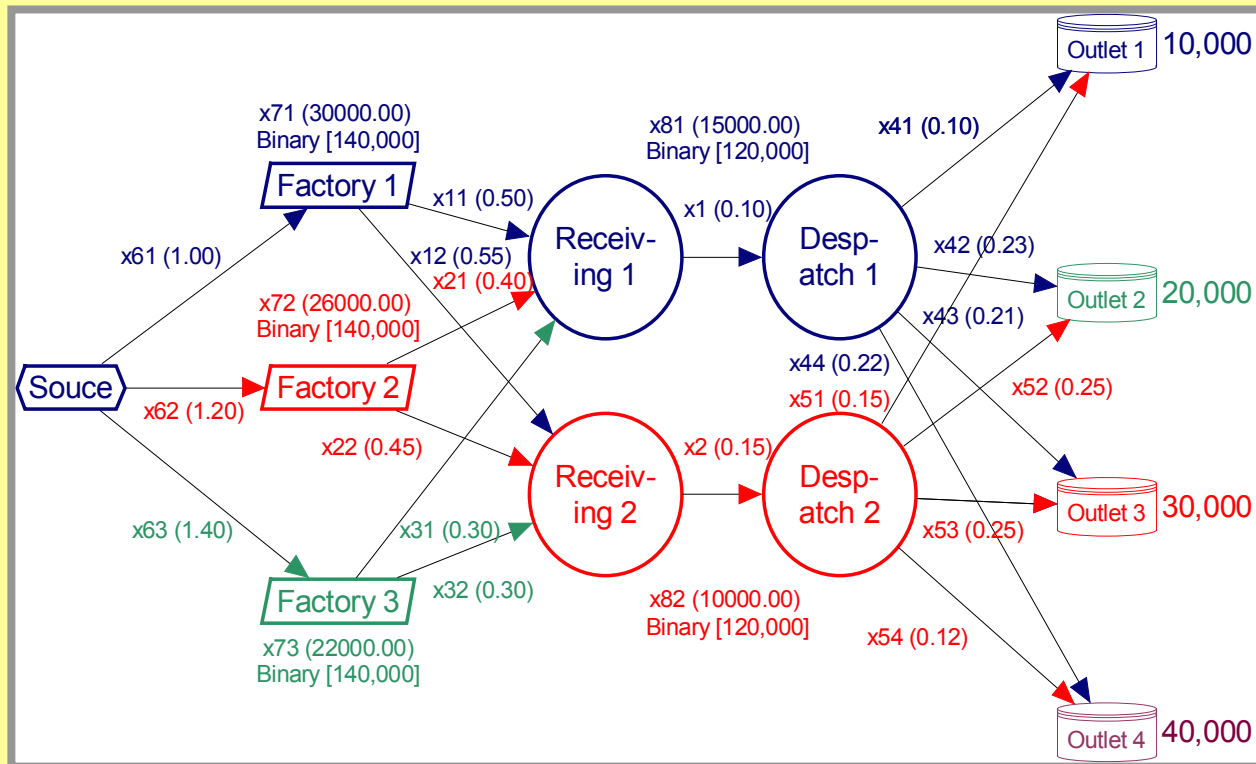
Write Down The Supply Constraints!

- $140000x_{71} - x_{61} \geq 0$
- $140000x_{72} - x_{62} \geq 0$
- $140000x_{73} - x_{63} \geq 0$



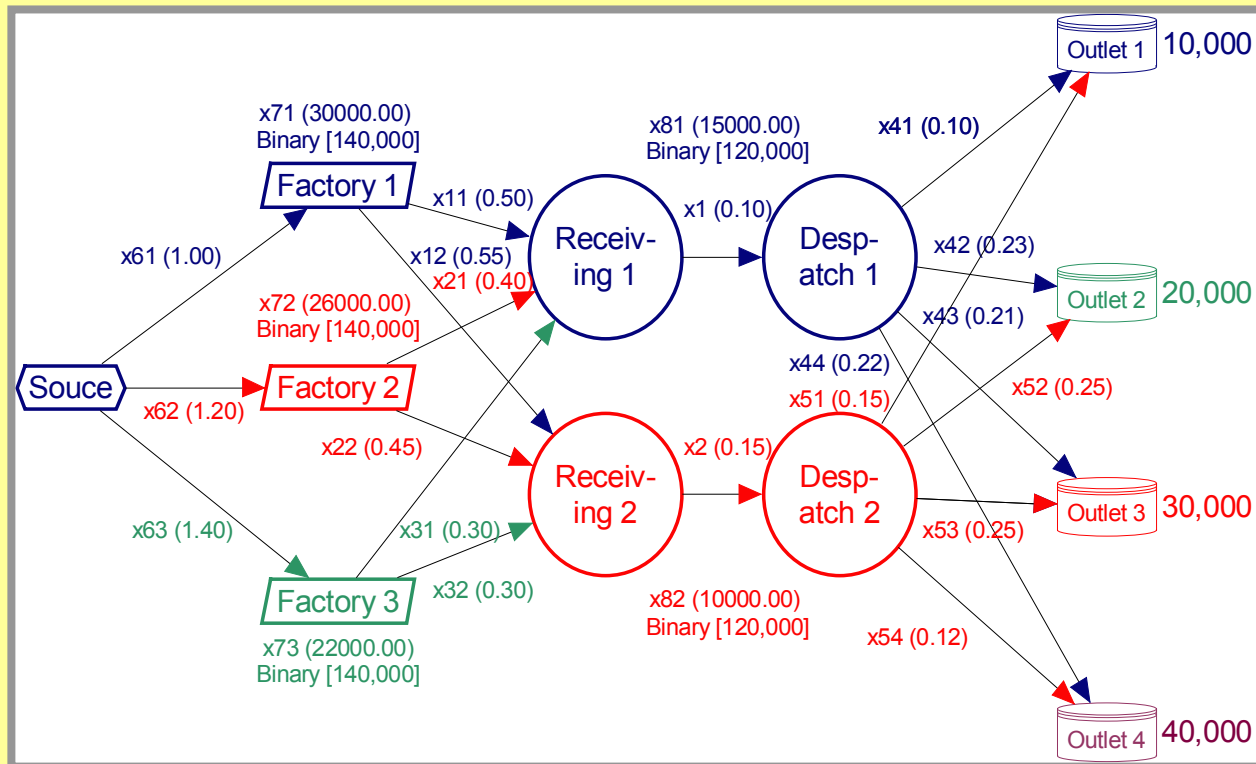
Write Down The Demand Constraints!

- $x_{41} + x_{51} = 10000$
- $x_{42} + x_{52} = 20000$
- $x_{43} + x_{53} = 30000$
- $x_{44} + x_{54} = 40000$



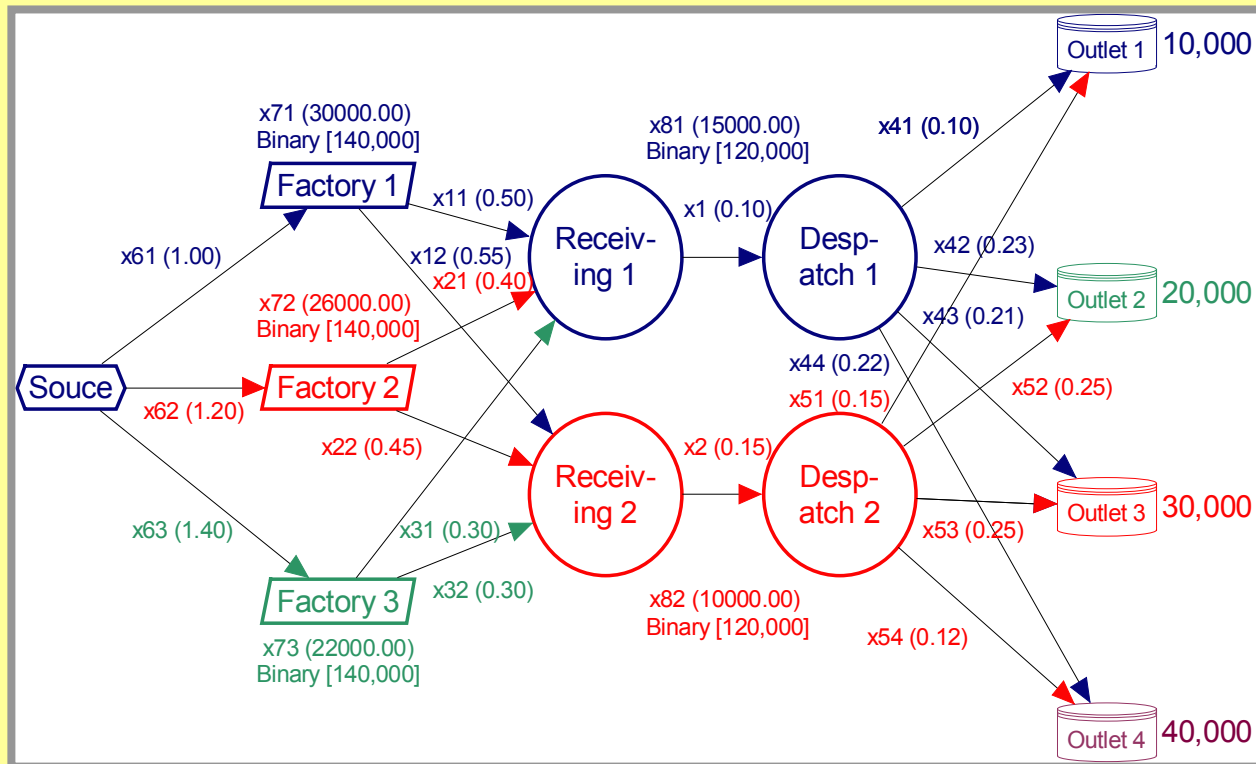
Write Down The Warehouse Capacity Constraints!

- $x1 - 120000x81 \geq 0$
- $x2 - 120000x82 \geq 0$



Write Down The Factory Conservation of Flow Constraints!

- $x_{11} + x_{12} - x_{61} = 0$
- $x_{21} + x_{22} - x_{62} = 0$
- $x_{31} + x_{32} - x_{63} = 0$



Finally, the Warehouse Conservation of Flow Constraints

- Receiving...

- $x_{11} + x_{21} + x_{31} - x_1 = 0$

- $x_{12} + x_{22} + x_{32} - x_2 = 0$

- $x_{13} + x_{23} + x_{33} - x_3 = 0$

- Despatch...

- $x_1 - x_{41} - x_{42} - x_{43} - x_{44} = 0$

- $x_2 - x_{51} - x_{52} - x_{53} - x_{54} = 0$



Why No Min # Factory and No Min # Warehouse Constraints?

- You might have expected to need a min # of Factories constraint in the form:
 - $x_{71} + x_{72} + x_{73} \Rightarrow 1$
- Or a min # of Warehouses constraint in the form:
 - $x_{81} + x_{82} \Rightarrow 1$
- Why are these unnecessary??



Why No Fixed # Factory and No Fixed # Warehouse Constraints?

- You might have thought we should have fixed the number of factories using constraints in the form:
 - $x_{71} + x_{72} + x_{73} = 1$, or $=2$ or $=3$
- Or a fixed # of Warehouses constraint in the form:
 - $x_{81} + x_{82} = 1$, or $=2$
- Why is it that these do not fit the brief??



Phew!!!

- This is quite an intricate model.
- We used divide and conquer to make it simpler.
- The diagram really helped too!
- I won't give you anything this large in an exam!!
- I don't think the Excel Solver is up to the job of solving this problem, so...



LINDO

- You can download a trial version from <http://lindo.com/>
- Lindo will solve large LP, IP, and Mixed LP/IP problems.
- They are good people, so if you need a tool at work, consider Lindo!!
- End of commercial break.



Lindo Model Structure.

- Min or Max ... The Objective Function
- "s.t." ... standing for "subject to".
- Constraints.
- END
- Optional Modeling Statements like:
 - $GIN\ x_1$ or $INTEGER\ x_1$ which force x_1 to be a general integer (GIN) or a binary $\{0-1\}$ integer ($INTEGER$)



Lindo Model Structure.

- The default Variable Type is a non-negative linear variable!
- Comments in the form "! Comment".
- Constraints can be given names, e.g.
 - Fctry1) $x_1 + x_2 \dots$
 - The name may be no more than 8 characters long, starting with a letter and may not include the following characters
! + - = < >) ..



Lindo Model Structure.

- Variables can also be given 8 character names!
- It would probably help our understanding of the solution to rename:
 - x71 as OpenF1, x72 as OpenF2 and x73 as OpenF3, and
 - X81 as OpenWhs1 and x82 as OpenWhs2
 - As with constraint names, a variable name may be no more than 8 characters long, starting with a letter and may not include the following characters
! + - = < >) . .



Objective Function

Subject To

Constraints

Comments

End Statement

Optional Modeling Statements

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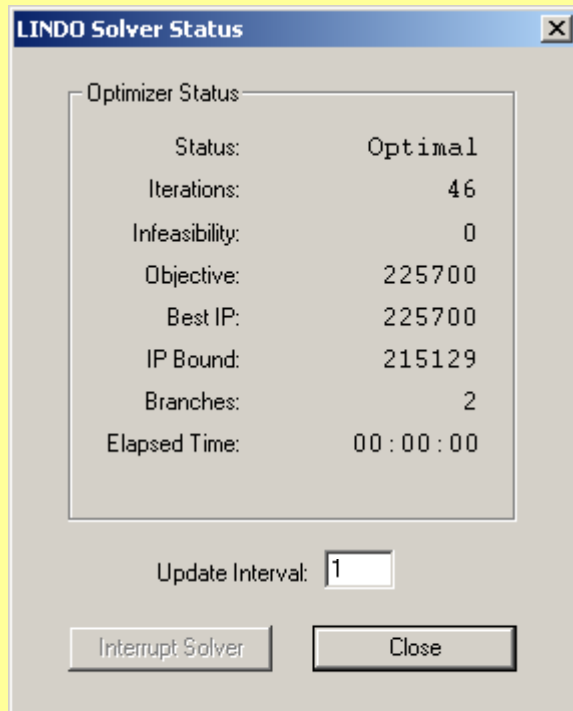
C:\FOMGT353\Lectures Presentations Word Excel\Lecture15\Pancakes.ltx
min 1x61 + 1.2x62 + 1.4x63 + 30000 OpenF1 + 26000 OpenF2 + 22000 OpenF3 + 0.5x11 + 0.55x12
+ 0.4x21 + 0.45x22 + 0.3x31 + 0.3x32 + 15000 OpenWhs1 + 0.1x1 + 0.15x2 + 10000 OpenWhs2
+ 0.1x41 + 0.23x42 + 0.21x43 + 0.22x44 + 0.15x51 + 0.25x52 + 0.25x53 + 0.12x54
s.t.
!
!                                     Supply Constraints
Factory1) 140000 OpenF1 - x61 >= 0
Factory2) 140000 OpenF2 - x62 >= 0
Factory3) 140000 OpenF3 - x63 >= 0
!
!                                     Demand Constraints!
Outlet1) x41 + x51 = 10000
Outlet2) x42 + x52 = 20000
Outlet3) x43 + x53 = 30000
Outlet4) x44 + x54 = 40000
!
!                                     Warehouse Capacity Constraints
Warehse1) 120000 OpenWhs1 - x1 >= 0
Warehse2) 120000 OpenWhs2 - x2 >= 0
!
!                                     The Factory Conservation of Flow Constraints
CFFact1) x11 + x12 - x61 = 0
CFFact2) x21 + x22 - x62 = 0
CFFact3) x31 + x32 - x63 = 0
!
!                                     Warehouse Conservation of Flow Constraints
!                                     Receiving
CFWRec1) x11 + x21 + x31 - x1 = 0
CFWRec2) x12 + x22 + x32 - x2 = 0
!
!                                     Despatch
CFWDes1) x1 - x41 - x42 - x43 - x44 = 0
CFWDes2) x2 - x51 - x52 - x53 - x54 = 0
!
END

INTEGER OpenWhs1
INTEGER OpenWhs2
INTEGER OpenF1
INTEGER OpenF2
INTEGER OpenF2

```



Select Solve From the Solve Pull-down Menu or Ctrl-S.



- There were no technical issues with the model, which doesn't mean to say that it is correct!
- Optimal Solution at 225,700 Cents or 2,257 Dollars.

