


IEE 222 - Tutorial

Tutorial 3: LP Modeling (compact form)

A steel manufacturer produces four sizes of I beams: small, medium, large, and extra large . These beams can be produced on any one of three machine types: A, B, and C. The lengths in feet of the I beams that can be produced on the machines per hour are summarized below.

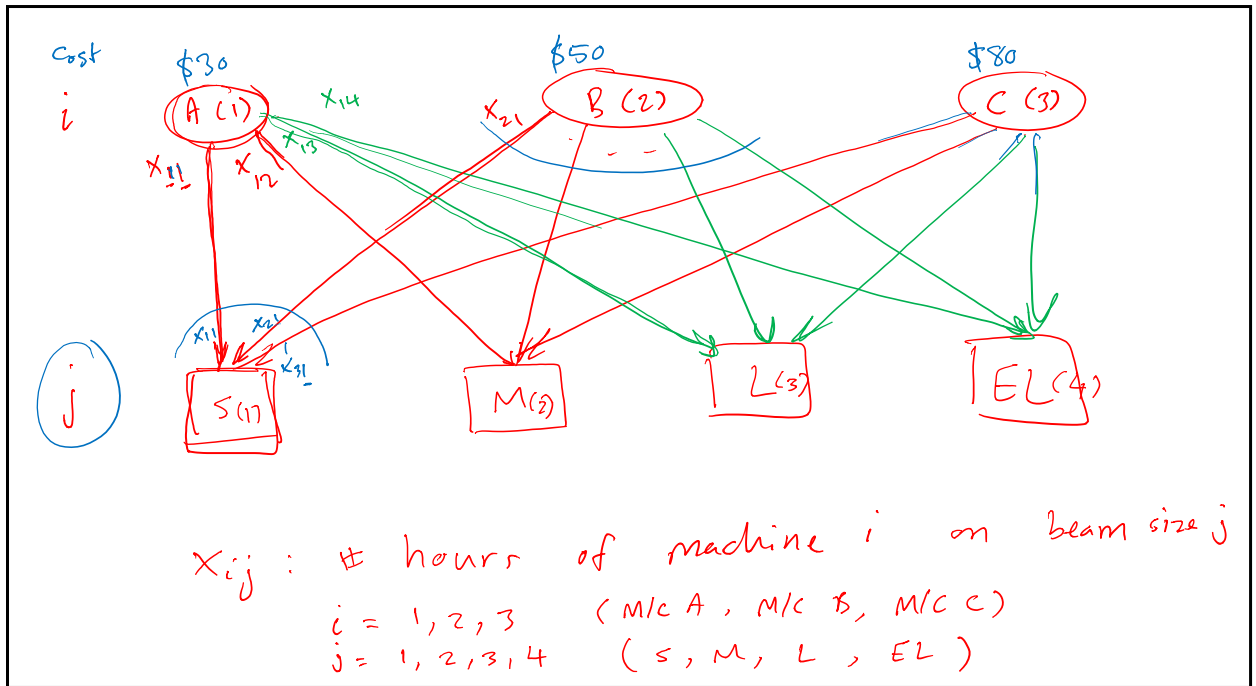
L_{ij}

Beam	Machine		
	A	B	C
Small	300	600	800
Medium	250	400	700
Large	200	350	600
Extra Large	100	200	300

H

Assume that each machine can be used up to 50 hours per week and that the hourly operating costs of these machines are respectively \$30, \$50, and \$80. Further suppose that 10,000, 8,000, 6,000, and 6,000 feet of the different-size I beams are required weekly. Formulate the machine scheduling problem as a linear program.

D_j



$$\min \quad 30 \left(\sum_{j=1}^4 x_{1j} \right) + 50 \left(\sum_{j=1}^4 x_{2j} \right) + 80 \left(\sum_{j=1}^4 x_{3j} \right)$$

$$\text{s.t.} \quad \sum_{j=1}^4 x_{ij} \leq H, \quad \forall i = 1, 2, 3$$

$$\sum_{i=1}^3 x_{ij} \geq D_j, \quad \forall j = 1, 2, 3, 4$$

$$x_{ij} \geq 0 \quad \begin{matrix} i = 1, 2, 3 \\ j = 1, 2, 3, 4 \end{matrix}$$

demand constraints

Size	
1	$300 X_{11} + 600 X_{21} + 800 X_{31} \geq 10,000$
2	$250 X_{12} + 400 X_{22} + 700 X_{32} \geq 8000$
3	$200 X_{13} + 350 X_{23} + 600 X_{33} \geq 6000$
4	$100 X_{14} + 200 X_{24} + 300 X_{34} \geq 6000$

$$X_{11}, X_{12}, X_{13}, \dots, X_{34} \geq 0$$

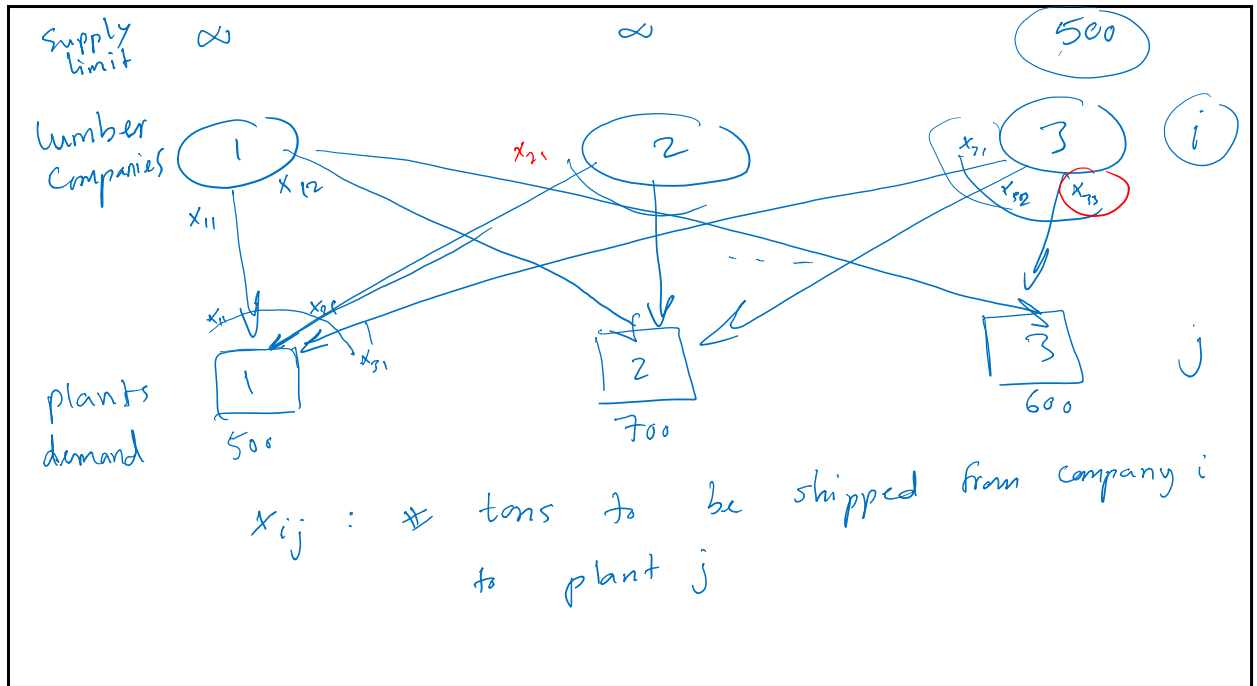
D_j (D_1, D_2, D_3)



A furniture manufacturer has three plants, which need 500, 700, and 600 tons of lumber weekly. The manufacturer may purchase the lumber from three lumber companies. The first two lumber manufacturers virtually have unlimited supply, and because of other commitments the third manufacturer cannot ship more than 500 tons weekly. The first lumber manufacturer uses rail for transportation and there is no limit on tonnage that can be shipped to the furniture facilities. On the other hand, the last two lumber companies use trucks that limit the maximum tonnage that can be shipped to any of the furniture companies to 200 tons. The following table gives the transportation cost from the lumber companies to the furniture manufacturers (\$ per ton).

Lumber	Furniture Facility		
Company	1	2	3
1	2	3	5
2	2.5	4	4.8
3	3	3.6	3.2

Formulate the problem as a linear program.



min $\sum_{i=1}^3 \sum_{j=1}^3 c_{ij} x_{ij}$

$\sum_{i=1}^3 x_{ij} \geq D_j \quad \forall j = 1, 2, 3$

$\sum_{j=1}^3 x_{ij} \leq 500 \quad i=1$

$x_{ij} \leq 200 \quad i=2, 3, \forall j=1, 2, 3$

$x_{ij} \geq 0 \quad \forall i, \forall j$

Lumber Company	Furniture Facility		
	1	2	3
1	2 x_{11} +	3 x_{12} +	5 x_{13}
2	+ 2.5 x_{21} +	4 x_{22} +	4.8 x_{23}
3	+ 3 x_{31} +	3.6 x_{32} +	3.2 x_{33}

transp. costs