Homework for 7.1

Note that we did Exercise 1 in class.

Homework: Exercise 3(*) (look at example 3), 10. There are two additional problems below- One is to use a spreadsheet to solve, the other will be a critical point about the rank of a certain matrix.

7.1.13(*) One of the main products of the P & T Company is canned peas. The peas are prepared at three canneries (near Bellingham, WA; Eugene, OR; and Albert Lea, MN), and then shipped by truck to four distribution warehouses in the western US (Sacramento, Salt Lake City, Rapid City, and Albuquerque).

Because the shipping costs are a major expense, management is initiating a study to reduce them as much as possible.

For the upcoming season, an estimate has been made of the output from each cannery, and each warehouse has been allocated a certain amount from the total supply of peas.

This information (in units of truckloads), along with the transportation costs, is given in the table below. There are 300 truckloads to be distributed. Use a spreadsheet to formulate this as a transportation problem, and solve it using the spreadsheet's solver. You may use the spreadsheet on the class website as a template.

Shipping Costs

| | Warehouse | | | | |
	1	2	3	4	Output
1	464	513	654	867	75
Cannery 2	352	416	690	791	125
3	995	682	388	685	100
Allocation	80	65	70	85	

7.1.14 Consider a balanced transportation problem in terms of its original linear program with constraints.

Show that any supply constraint exactly equals the sum of the demand constraints, minus the sum of the other supply constraints. This shows that one row is a linear combination of the others.

Hint: Do you notice anything about the sum of the supply constraints versus the sum of the demand constraints?

Setting up and Solving in Excel

Here is a good way to organize the power distribution problem. I've used one array of constants for the costs, and reserved space for the array of variables (x_{ij}). Then we keep track of the supplies down the last column (sums), and the demands across the bottom row. The total cost is then a "dot product" between the cost array and variable array (as shown in the formula boxes). (NOTE: To type an equal sign and not have a formula, type a blank space first). You can download this from our class website as a template.

	A	B	C	D	E	F	G	H	I	J
1		Power Distribution Problem (Example from Text, 7.1)								
2										
3		Unit Cost								
4				City A	City B	City C	City D			
5			Plant 1	8	6	10	9			
6			Plant 2	9	12	13	7			
7			Plant 3	14	9	16	5			
8										
9										
10		Distribution								
11		(KwH)		City A	City B	City C	City D	Total Sent		Supply
12			Plant 1					=SUM(D12:G12) =		35
13			Plant 2					=SUM(D13:G13) =		50
14			Plant 3					=SUM(D14:G14) =		40
15			Total Received	=SUM(D12:D14)	=SUM(E12:E14)	=SUM(F12:F14)	=SUM(G12:G14)			
16				=	=	=	=			Total Cost:
17			Demand	45	20	30	30			=SUMPRODUCT(D5:G7,D12:G14)

To set up the solver:

- We want to **minimize** cell J17

- The conditions are that the column sums (in cells D15 to G15) are equal to the demand (in cells D17 to G17), and the row sums (in cells H12-H14) are equal to the supply (in cells J12-14). All told, there are then 4+3=7 equality constraints.

The solver should give you the following result:

	A	B	C	D	E	F	G	H	I	J
1		Power Distribution Problem (Example from Text, 7.1)								
2										
3		Unit Cost								
4				City A	City B	City C	City D			
5			Plant 1	8	6	10	9			
6			Plant 2	9	12	13	7			
7			Plant 3	14	9	16	5			
8										
9										
10		Distribution								
11		(KwH)		City A	City B	City C	City D	Total Sent		Supply
12			Plant 1	0	10	25	0	35 =		35
13			Plant 2	45	0	5	0	50 =		50
14			Plant 3	0	10	0	30	40 =		40
15			Total Receive▶	45	20	30	30			
16				=	=	=	=			Total Cost:
17			Demand	45	20	30	30			1020