

Homework 4

Due 11/11/2021

PROBLEM 1: Wells Fargo Employee Problem

Decision Variables

- Full time employee work 9 AM to 5 PM and take breaks at different times: 12-1 or 1-2

$X_{12,F}$ = the number of full time employees that take a break from 12 PM to 1PM

$X_{1,F}$ = the number of full time employees that take a break from 1P PM to 2 PM

- Part time employees do not have breaks and work 3 hour shifts. This means that they work from 9-12, 10-1, 11-2, 12-3, 1-4 and 2-5

$X_{9,P}$ = the number of part time employees that work a complete shift starting at 9 AM

$X_{10,P}$ = the number of part time employees that work a complete starting at 10 AM

$X_{11,P}$ = the number of part time employees that work a complete starting at 11 AM

$X_{12,P}$ = the number of part time employees that work a complete starting at 12 PM

$X_{1,P}$ = the number of part time employees that work a complete starting at 1 PM

$X_{2,P}$ = the number of part time employees that work a complete starting at 2 PM

Objective Function

- The objective is to MINIMIZE the cost of employee payroll while meeting requirements

$$(24*8)(X_{12,F} + X_{1,F}) + (15*3)(X_{9,P} + X_{10,P} + X_{11,P} + X_{12,P} + X_{1,P} + X_{2,P})$$

Constraint Functions

- 4 Employees required from 9-10

$$X_{12,F} + X_{1,F} + X_{9,P} \geq 4$$

- 3 Employees required from 10-11

$$X_{12,F} + X_{1,F} + X_{9,P} + X_{10,P} \geq 3$$

- 4 Employees required from 11-12

$$X_{12,F} + X_{1,F} + X_{9,P} + X_{10,P} + X_{11,P} \geq 4$$

- 6 Employees required from 12-1

$$X_{1,F} + X_{10,P} + X_{11,P} + X_{12,P} \geq 6$$

- 5 Employees required from 1-2

$$X_{12,F} + X_{11,P} + X_{12,P} + X_{1,P} \geq 5$$

- 6 Employees required from 2-3

$$X_{12,F} + X_{1,F} + X_{12,P} + X_{1,P} + X_{2,P} \geq 6$$

- 8 Employees required from 3-4

$$X_{12,F} + X_{1,F} + X_{1,P} + X_{2,P} \geq 8$$

- 8 Employees required from 4-5

$$X_{12,F} + X_{1,F} + X_{2,P} \geq 8$$

- There are at most 5 partime employees

$$X_{9,P} + X_{10,P} + X_{11,P} + X_{12,P} + X_{1,P} + X_{2,P} \leq 5$$

Spreadsheet

	Minimum Employees Needed	Nr. Of people that are working												
Day		Full Time Break 12 PM	Full Time Break 1 PM	Part Time Start 9 AM	Part Time Start 10 AM	Part Time Start 11 AM	Part Time Start 12 PM	Part Time Start 1 PM	Part Time Start 1 PM	Total				
9AM-10AM	4	2.333333333	3.333333333	0	0	2.666666667	0	0	2.333333333	1313				
10 AM - 11 AM	3	TOTAL PART TIME												
11 AM - 12 PM	4			5										
12 PM - 1 PM	6													
1 PM - 2 PM	5	9AM-10AM	1	1	1						5.666667	>=	4	
2 PM - 3 PM	6	10 AM - 11 AM	1	1	1	1					5.666667	>=	3	
3 PM - 4 PM	8	11 AM - 12 PM	1	1	1	1	1				8.333333	>=	4	
4 PM - 5 PM	8	12 PM - 1 PM		1		1	1				6	>=	6	
		1 PM - 2 PM	1				1	1			5	>=	5	
		2 PM - 3 PM	1	1				1	1	1	8	>=	6	
		3 PM - 4 PM	1	1					1	1	8	>=	8	
		4 PM - 5 PM	1	1						1	8	>=	8	

Optimal Solution

Cost minimized to 1313

Time	Employee Number
9-10	5.6666666667
10-11	5.6666666667
11-12	8.3333333333
12-1	6
1-2	5
2-3	8
3-4	8
4-5	8

PROBLEM 2: Transport Problem

Decision Variables

X_{F1} = number of tons of product 1 stored at the front of the ship

X_{F2} = number of tons of product 2 stored at the front of the ship

X_{F3} = number of tons of product 3 stored at the front of the ship

X_{F4} = number of tons of product 4 stored at the front of the ship

X_{M1} = number of tons of product 1 stored in the middle of the ship

X_{M2} = number of tons of product 2 stored in the middle of the ship

X_{M3} = number of tons of product 3 stored in the middle of the ship

X_{M4} = number of tons of product 4 stored in the middle of the ship

X_{B1} = number of tons of product 1 stored at the back of the ship

X_{B2} = number of tons of product 2 stored at the back of the ship

X_{B3} = number of tons of product 3 stored at the back of the ship

X_{B4} = number of tons of product 4 stored at the back of the ship

Objective Function

- The objective is to MAXIMIZE profit

$$70(X_{F1} + X_{M1} + X_{B1}) + 50(X_{F2} + X_{M2} + X_{B2}) + 60(X_{F3} + X_{M3} + X_{B3}) + 80(X_{F4} + X_{M4} + X_{B4})$$

Constraint Functions

- Amount of Product 1 Available (tons)

$$X_{F1} + X_{M1} + X_{B1} \leq 4800$$

- Amount of Product 2 Available (tons)

$$X_{F2} + X_{M2} + X_{B2} \leq 2500$$

- Amount of Product 3 Available (tons)

$$X_{F3} + X_{M3} + X_{B3} \leq 1200$$

- Amount of Product 4 Available (tons)

$$X_{F4} + X_{M4} + X_{B4} \leq 1700$$

- Weight Capacity of Front Stowage (tons)

$$X_{F1} + X_{F2} + X_{F3} + X_{F4} \leq 3000$$

- Weight Capacity of Middle Stowage (tons)

$$X_{M1} + X_{M2} + X_{M3} + X_{M4} \leq 6000$$

- Weight Capacity of Back Stowage (tons)

$$X_{B1} + X_{B2} + X_{B3} + X_{B4} \leq 4000$$

- Volume Capacity of Front Stowage (cubic feet)

$$40(X_{F1}) + 25(X_{F2}) + 60(X_{F3}) + 55(X_{F4}) \leq 145000$$

- Volume Capacity of Middle Stowage (cubic feet)

$$40(X_{M1}) + 25(X_{M2}) + 60(X_{M3}) + 55(X_{M4}) \leq 180000$$

- Volume Capacity of Back Stowage (cubic feet)

$$40(X_{B1}) + 25(X_{B2}) + 60(X_{B3}) + 55(X_{B4}) \leq 155000$$

- Safety Front must be within 10% of the weight in the back area

$$0.9(X_{B1} + X_{B2} + X_{B3} + X_{B4}) \leq X_{F1} + X_{F2} + X_{F3} + X_{F4} \leq 1.10(X_{B1} + X_{B2} + X_{B3} + X_{B4})$$

- Safety Middle area must hold $\leq 40\%$ of the total weight on board but must not exceed 60% of the total weight on board

$$0.4(X_{F1} + X_{F2} + X_{F3} + X_{F4} + X_{M1} + X_{M2} + X_{M3} + X_{M4} + X_{B1} + X_{B2} + X_{B3} + X_{B4}) \leq X_{F1} + X_{F2} + X_{F3} + X_{F4} \\ \leq 0.6(X_{F1} + X_{F2} + X_{F3} + X_{F4} + X_{M1} + X_{M2} + X_{M3} + X_{M4} + X_{B1} + X_{B2} + X_{B3} + X_{B4})$$

Spreadsheet

Stowage Area						
Product Type	Front	Middle	Back	Product Stowed Total	Profit/Ton	Volume/Ton
1	1,198.95	380.00	3,221.05	4,800.00	\$70.00	40
2	0.00	2,500.00	0.00	2,500.00	\$50.00	25
3	0.00	1,200.00	0.00	1,200.00	\$60.00	60
4	1,700.00	0.00	0.00	1,700.00	\$80.00	55

Specifications			
Volume Used In Area	Volume Used Total		Volume Capacity
Front	141457.8947	<=	145000
Middle	149700	<=	180000
Back	128842.1053	<=	155000

Weight Used In Area (tons)	Weight Used		Weight Capacity
Front	2,898.95	<=	3000
Middle	4,080.00	<=	6000
Back	3,221.05	<=	4000

Product Type	Product Stowed Total		Amount Available
1	4,800.00	<=	4800
2	2,500.00	<=	2500
3	1,200.00	<=	1200
4	1,700.00	<=	1700

Front Weight		90% Back Weight
2,898.95	>=	2898.947368
Front Weight		110% Back Weight
2,898.95	<=	3543.157895
Middle Weight		40% Total Weight
4,080.00	>=	4080
Middle Weight		60% Total Weight
4,080.00	<=	6120

Total Profit			669,000
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Optimal Solution

Total Profit maximized to 669,000

Stowage Area				
Product Type	Front	Middle	Back	Product Stowed Total
1	1,198.95	380.00	3,221.05	4,800.00
2	0.00	2,500.00	0.00	2,500.00
3	0.00	1,200.00	0.00	1,200.00
4	1,700.00	0.00	0.00	1,700.00