

## HOMEWORK #11

### SOLUTIONS

**Q1 a)** Notice that the viscosities, which are the key quantities in determining the optimal population of the fast pick area are not affected by the change in volume. Because of this reason, the ordering of the sku's for being located in the fast pick area will not change. Hence, first result cannot be possible. However, both the second and third results are possible to obtain.

**b)** The claim of the particular sku for the fast pick area depends on two parameters: picks and the flow associated with the sku. Since neither of them changed in our case, the suitability of the sku for the fast pick area remained the same.

**c)** We can't use  $pj / \sqrt{fj}$  since the data for the sku j is not annual. We have to find annual number of picks and annual flow of sku j. We can use the seasonality assumption for the demand of sku j and directly multiply  $pj$  and  $fj$  by 6. The claim for the sku j will be:  $6pj / \sqrt{6fj}$  We need to compare this number with  $pi / \sqrt{fi}$ .

**d)** The relative amounts of space allocated to these two sku's are found from the formula  $(\sqrt{fi} / \sqrt{fj})$  (This may be derived from the optimal allocation formula which is  $vi = (\sqrt{fi} / (\sum_{j=1}^n \sqrt{fj}))V$ ). Therefore  $(\sqrt{fi} / \sqrt{fj}) = (sqrt(1/5) / sqrt(1)) = 0.4472$

**Q2 a)** First of all, we need to find the flows associated with each sku:

$$fA = (2000 / 100) * 5 = 100$$

$$fB = (1500 / 100) * 2 = 30$$

$$fC = (250 / 50) * 6 = 30$$

$$fD = (100 / 10) * 3 = 30$$

$$fE = (2000 / 10) * 4 = 800$$

In Equal Space Allocation we give equal space to each sku, that is  $V_A = V_B = V_C = V_D = V_E = 30/5 = 6$

Number of Restocks per month

$$fi / Vi$$

$$\text{Sku A} = 100/6 = 16.67$$

$$\text{Sku B} = 30/6 = 5$$

$$\text{Sku C} = 30/6 = 5$$

$$\text{Sku D} = 30/6 = 5$$

$$\text{Sku E} = 800/6 = 133.33$$

**b) Equal time supplies:**

$$v_i = (f_i / (\sum_{j=1}^n f_j)) V$$

Spaces allocated to each sku:

$$\text{Sku A} = (100 / (100 + 30 + 30 + 30 + 800)) * 30 = 3.03$$

$$\text{Sku B} = (30 / 990) * 30 = 0.909$$

$$\text{Sku C} = (30 / 990) * 30 = 0.909$$

$$\text{Sku D} = (30 / 990) * 30 = 0.909$$

$$\text{Sku E} = (800 / 990) * 30 = 24.24$$

Number of restocks per month for each sku:

$$f_i / V_i \text{ or } (\sum_{j=1}^n f_j) / V$$

For each sku number of restocks is the same =  $(100 + 30 + 30 + 30 + 800) / 30 = 33$

**c) Optimal Allocation:**

$$v_i = (\sqrt{f_i} / (\sum_{j=1}^n \sqrt{f_j})) V$$

Spaces allocated to each sku:

$$\text{Sku A} = (\sqrt{100} / (\sqrt{100} + 3 * \sqrt{30} + \sqrt{800})) * 30 = 5.48$$

$$\text{Sku B} = (5.48 / 54.72) * 30 = 3.00$$

$$\text{Sku C} = (5.48 / 54.72) * 30 = 3.00$$

$$\text{Sku D} = (5.48 / 54.72) * 30 = 3.00$$

$$\text{Sku E} = (28.28 / 54.72) * 30 = 15.5$$

Number of Restocks per month

$$f_i / V_i$$

$$\text{Sku A} = 100 / 5.48 = 18.25$$

$$\text{Sku B} = 30 / 3 = 10$$

$$\text{Sku C} = 30 / 3 = 10$$

$$\text{Sku D} = 30 / 3 = 10$$

$$\text{SKU E} = 800/15.5 = 51.61$$

**d)** Allocate 10 cubic feet of space to sku E. The remaining space of 5.5 cubic feet (15.5-10) will be allocated optimally to the other four sku's.(A, B, C and D)

e) First step is to calculate the viscosities of each sku:

$$\text{Viscosity}(i) = p_i / \sqrt{f_i}$$

Notice that  $s = 0.15 = (0.45 - 0.30)$

We have:

SKU	Viscosity	Rank
A	$1000/10 = 100$	2
B	$1200/\sqrt{30} = 219.09$	1
C	$300/\sqrt{30} = 54.77$	4
D	$500/\sqrt{30} = 91.29$	3
E	$1000/\sqrt{800} = 35.36$	5

$$C_i(x) = \begin{cases} 0 & \text{if } V_i = 0 \\ s p_i - c r (f_i / V_i) & \text{otherwise} \end{cases}$$

1<sup>st</sup> Step:

Put nothing. Net benefit is 0.

2<sup>nd</sup> Step:

Put Sku B.

$$\text{Net Benefit} = (0.45 - 0.30) * 1200 - 1.5 * (30/30) = 178.5$$

3<sup>rd</sup> Step:

Put Sku B and Sku A

$$V_A = (\sqrt{100} / (\sqrt{100} + \sqrt{30})) * 30 = 19.38$$

$$V_B = 30 - 19.38 = 10.62$$

$$\begin{aligned} \text{Net Benefit} &= (0.45 - 0.30) * 1000 - 1.5 * (100/19.38) + (0.45 - 0.30) * 1200 - 1.5 * (30/10.62) \\ &= 318.023 \end{aligned}$$

4<sup>th</sup> Step:

Put Sku B, Sku A and Sku D

$$V_A = (\sqrt{100} / (\sqrt{100} + \sqrt{30} + \sqrt{30})) * 30 = 14.32$$

$$V_B = (\sqrt{30} / (\sqrt{100} + \sqrt{30} + \sqrt{30})) * 30 = 7.84$$

$$V_D = 30 - 14.32 - 7.84 = 7.84$$

$$\begin{aligned} \text{Net Benefit} &= (0.45 - 0.30) * 1000 - 1.5 * (100 / 14.32) + (0.45 - 0.30) * 1200 - 1.5 * (30 / 7.84) + \\ &\quad (0.45 - 0.30) * 500 - 1.5 * (30 / 7.84) \\ &= 383.05 \end{aligned}$$

5<sup>th</sup> Step

Put Sku B, Sku A, Sku D and Sku C

$$V_A = (\sqrt{100}) / (\sqrt{100} + \sqrt{30} + \sqrt{30} + \sqrt{30}) * 30 = 11.35$$

$$V_B = (\sqrt{30}) / (\sqrt{100} + \sqrt{30} + \sqrt{30} + \sqrt{30}) * 30 = 6.22$$

$$V_B = V_C = V_D = 6.22$$

$$\begin{aligned} \text{Net Benefit} &= (0.45 - 0.30) * 1000 - 1.5 * (100 / 11.35) + (0.45 - 0.30) * 1200 - 1.5 * (30 / 6.22) + \\ &\quad (0.45 - 0.30) * 500 - 1.5 * (30 / 6.22) + (0.45 - 0.30) * 300 - 1.5 * (30 / 6.22) \\ &= 415.08 \end{aligned}$$

6<sup>th</sup> Step:

Put everything: (from part c)

$$V_A = 5.48$$

$$V_B = 3.00$$

$$V_C = 3.00$$

$$V_D = 3.00$$

$$V_E = 15.5$$

$$\begin{aligned} \text{Net Benefit} &= (0.45 - 0.30) * 1000 - 1.5 * (100 / 5.48) + (0.45 - 0.30) * 1200 - 1.5 * (30 / 3.00) + \\ &\quad (0.45 - 0.30) * 500 - 1.5 * (30 / 3.00) + (0.45 - 0.30) * 300 - 1.5 * (30 / 3.00) + \\ &\quad (0.45 - 0.30) * 1000 - 1.5 * (800 / 15.5) \\ &= 450.21 \end{aligned}$$

I would choose to put all five of the sku's into the flow rack.

**f) Space allocations:**

$$V_A = 5.48$$

$$V_B = 3.00$$

$$V_C = 3.00$$

$$V_D = 3.00$$

$$V_E = 15.5$$

**g)** I would be willing to pay at most \$450.21, which is the net benefit we can get from the flow rack.