1. So Much Grading!

Month	Grading Hrs
March	450
April	600
May	550
June	400
July	450

→ UW pays $1500 per month per grader D

→ Each grader → 17 hours / month

→ 25 graders employed

→ FC of $500 for the department, for hiring a new grader D

→ Fire or retire for a one time cost of $1000/grader D

→ All grading must be done by the end of the 5th month (July)

→ Carried over grading work must not exceed 600 hours at the end of each intermediate month

1-1 Parameters

H_i = Number of grading hours required in month $i = (1,2,3,4,5)$

$H = (450, 600, 550, 400, 450)$

N_i: Number of active graders at the beginning of month i

DV

x_i = # of graders hired, at the beginning of each month i $[i = 1,2,3,4,5]$

y_i = # of graders retired at the beginning of the month i $[i = 1,2,3,4,5]$

z_i = # of graders working in month i

c_i: # of grading hours carried over

Obj min total cost to the department

$$\sum_{i=1}^{5} 1500 \cdot z_i + \sum_{i=1}^{5} 500 \cdot x_i + \sum_{i=1}^{5} 1000 \cdot y_i$$

Constraints

$x_i, y_i, z_i, c_i \geq 0 \quad \forall i = 1,2,3,4,5$

$c_i \leq 600$

$z_i = z_{i-1} + x_i - y_i$

$z_0 = 25$

$c_i = c_{i-1} - 17 z_i$

2) Cheese Production

2-1 x_1 = # of vats of milk produced with method 1

x_2 = # of vats " " " " " 2

y_1 = # of cups of specialty spread produced

Revenue : $3(9x_1 + 4x_2) + 10(2x_1 + 3x_2) + (30x_1 + 40x_2 - 12y_1) + 20y_1$

Processing costs → $3x_1 + 4x_2 + 3y_1$

Raw material → $25(x_1 + x_2)$

Objective → Profit = Revenue - cost

$$\max \; 49x_1 + 53x_2 + 5y_1$$

Subject to →

$x_1, x_2, y \geq 0$

$0.5(x_1 + x_2) + 1.2x_1 + 2x_2 + 3y_1 \leq 300$

$9x_1 + 4x_2 \leq 500$

$2x_1 + 3x_2 \leq 250$

$30x_1 + 40x_2 + 12y_1 \leq 3000$

$y_1 \leq 400$

$y_1 = \frac{(30x_1 + 40x_2)}{12}$

2-2

Optimal objective is $ 4283.3

x_1 = 33.3 vats

x_2 = 50 vats

y_1 : 250 cups of spread

3)

DV	Activity	Cost / Revenue	Produces	Consumes
x_1	Sell mix 1	+7.5	mix 1	$a_1 + b_1$
x_2	Sell mix 2	+5	mix 2	$a_2 + b_2$
P_a	Produced A	–	P_A	–
P_b	Produced B	–	P_B	–
a_1	A in mix 1	–	–	–
a_2	A in mix 2	–	–	–
b_1	B in mix 1	–	–	–
b_2	B in mix 2	–	–	–
T_A	Chemical A produced	–	A	$R_1 + R_2$
T_B	Chemical B produced	–	B	$R_1 + R_2$
R_1	Process 1	–	4A, 4B	3RM + 3hr
R_2	Process 2	–	4A, 1.5B	2RM + 4 hr
S_1	Purchase Raw material	–	–	1 RM

Objective max $7.5x_1 + 5x_2$

Subject to $S_1 \leq 110$

$3R_1 + 4R_2 \leq 130$

Raw material $S_1 = 3.5R_1 + 2R_2$

$P_a = 4R_1 + 4R_2$

$P_b = 4R_1 + 1.5R_2$

mix 1 $a_1 \geq 0.7x_1$

mix 2 $a_2 \geq 0.5x_2$

$x_1, x_2, P_a, P_b, a_1, a_2, b_1, b_2, T_A, T_B, R_1, R_2, S_1 \geq 0$

4) x_i = amt of mixture i produced $i \in m$

y_k = amt of chemical j produced using process k $k \in P$

Objective → max $\sum_{i \in m} c_i x_i$

Subject to $\sum_{i \in m} x_i = \sum_{k \in P} y_k$

$c_j \cdot x_i = \sum_{j \in J} \left(\frac{y_k}{r_k} \right)$

$\sum_{k \in P} t_k y_k \leq S$

$\sum_{k \in P} r_k y_k \leq R$

$x_i, y_k \geq 0$