811129289_5_Q2

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Question 1:

Max Z = P - 6E - 3Y

P = total profit over the entire new product life, which is discounted,

E = change in employment level in both directions,

Y = reduction in next year's earnings with respect to current year's level.

P is formulated as: $P = 20X_1 + 15X_2 + 25X_3$

Level of employment is formulated as: $6X_1 + 4X_2 + 5X_3 = 50$

Next year Earnings goal is formulated as: $8X_1 + 7X_2 + 5X_3 >= 75$

1) LP Formulation:

Let us consider A_1 - Level of employment - Target A_2 - Earnings in the next year - Target B_1 - Penalty if level of employment goal exceeds 50 B_2 - Penalty if level of employment goal decreases below 50 C_1 - Exceed the next year earnings C_2 - Penalty if the next year's goals are not reached

$A_1 = 6X_1 + 4X_2 + 5X_3 - 50$

$A_2 = 8X_1 + 7X_2 + 5X_3 - 75$

For Employment level goal $A_1 = B_1 - B_2$ where $B_1, B_2 >= 0$ $B_1 - B_2 = 6X_1 + 4X_2 + 5X_3 - 50$

For Next year earnings goal $A_2 = C_1 - C_2$ where $C_1, C_2 >= 0$ $C_1 - C_2 = 8X_1 + 7X_2 + 5X_3 - 75$

Final Formulation is expressed as

Max $P = 20X_1 + 15X_2 + 25X_3$

$6X_1 + 4X_2 + 5X_3 - (B_1 - B_2) = 50$

$8X_1 + 7X_2 + 5X_3 - (C_1 - C_2) = 75$

$X_i >= 0$, where i=1,2,3

$Y_i >= 0$, where Y = B, C and i = 1,2

Question 2:

Maximize $Z = P - 6E - 3Y$

Max $Z = 20X_1 + 15X_2 + 25X_3 - 6B_1 - 6B_2 - 3C_2$

Subject to:

$6X_1 + 4X_2 + 5X_3 - B_1 + B_2 = 50$

$8X_1 + 7X_2 + 5X_3 - C_1 + C_2 = 75$

$X_i >= 0$, where i=1,2,3

$Y_i >= 0$, where Y = B, C and i= 1,2

Question 3:

```
library(lpSolveAPI)
LP_1 <- read.lp("Emax.lp")
solve(LP_1)

## [1] 0

get.objective(LP_1)

## [1] 225

get.constraints(LP_1)

## [1] 50 75

get.variables(LP_1)

## [1]  0  0 15 25  0  0  0
```

We can see that the penalty is 225 if the goal is not achieved X3 is 15 and B1 is 25, rest of the variables are all zeroes. Employment level is exceeded by 25. Profits reduced by 15 as a result