1. Solve the problem using lpsolve, or any other equivalent library in R.

Please refer mchalama\_3.R using the following link

1. Identify the shadow prices, dual solution, and reduced costs

From the above program the solution is below:

**Shadow Prices**: 0.00, 0.00, 0.00, 12.00, 20.00, 60.00, 0.00, 0.00, 0.00, -0.08. 0.56

**Dual Solution**: 0.00, 0.00, 0.00, 12.00, 20.00, 60.00, 0.00, 0.00, 0.00, -0.08. 0.56

**Reduced Costs**: 0, 0, -24, -40, 0, 0, -360, -120, 0

1. Further, identify the sensitivity of the above prices and costs. That is, specify the range of shadow prices and reduced cost within which the optimal solution will not change.

cbind(get.sensitivity.rhs(mylp)$duals[1:11], get.sensitivity.rhs(mylp)$dualsfrom[1:11], get.sensitivity.rhs(mylp)$dualstill[1:11])

[,1] [,2] [,3]

[1,] 0.00 -1.000000e+30 1.000000e+30

[2,] 0.00 -1.000000e+30 1.000000e+30

[3,] 0.00 -1.000000e+30 1.000000e+30

[4,] 12.00 1.122222e+04 1.388889e+04

[5,] 20.00 1.150000e+04 1.250000e+04

[6,] 60.00 4.800000e+03 5.181818e+03

[7,] 0.00 -1.000000e+30 1.000000e+30

[8,] 0.00 -1.000000e+30 1.000000e+30

[9,] 0.00 -1.000000e+30 1.000000e+30

[10,] -0.08 -2.500000e+04 2.500000e+04

[11,] 0.56 -1.250000e+04 1.250000e+04

>

> cbind(get.sensitivity.rhs(mylp)$duals[12:20], get.sensitivity.rhs(mylp)$dualsfrom[12:20], get.sensitivity.rhs(mylp)$dualstill[12:20])

[,1] [,2] [,3]

[1,] 0 -1.000000e+30 1.000000e+30

[2,] 0 -1.000000e+30 1.000000e+30

[3,] -24 -2.222222e+02 1.111111e+02

[4,] -40 -1.000000e+02 1.000000e+02

[5,] 0 -1.000000e+30 1.000000e+30

[6,] 0 -1.000000e+30 1.000000e+30

[7,] -360 -2.000000e+01 2.500000e+01

[8,] -120 -4.444444e+01 6.666667e+01

[9,] 0 -1.000000e+30 1.000000e+30

1. Formulate the dual of the above problem and solve it. Does the solution agree with what you observed for the primal problem?

To Calculate the dual solution:

**Maximize N** = 420P1L + 360P1M + 300P1S + 420P2L + 360P2M + 300P2S + 420P3L + 360P3M +300P3S

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| P1L | P1M | P1S | P2L | P2M | P2S | P3L | P3M | P3S |  |  |  |
| 1 | 1 | 1 |  |  |  |  |  |  | ≤ | 750 | X1 |
|  |  |  | 1 | 1 | 1 |  |  |  | ≤ | 900 | X2 |
|  |  |  |  |  |  | 1 | 1 | 1 |  | 450 | X3 |
| 20 | 15 | 12 |  |  |  |  |  |  |  | 13000 | X4 |
|  |  |  | 20 | 15 | 12 |  |  |  |  | 12000 | X5 |
|  |  |  |  |  |  | 20 | 15 | 12 |  | 5000 | X6 |
| 1 |  |  | 1 |  |  | 1 |  |  |  | 900 | X7 |
|  | 1 |  |  | 1 |  |  | 1 |  |  | 1200 | X8 |
|  |  | 1 |  |  | 1 |  |  | 1 |  | 750 | X9 |
| 900 | 900 | 900 | -750 | -750 | -750 |  |  |  | = | 0 | X10 |
| 450 | 450 | 450 |  |  |  | -750 | -750 | -750 | = | 0 | X11 |

By formulating the dual of the above problem:

X1 + 20X4 + X7 + 900X10 + 450 X11 ≥ 420

X1 + 15X4 + X8 + 900X10 + 450 X11 ≥ 360

X1 + 12X4 + X9 + 900X10 + 450 X11 ≥ 300

X2 + 20X5 + X7 – 750 X10 ≥ 420

X2 + 15X5 + X8 – 750 X10 ≥ 360

X2 + 12X5 + X9 – 750 X10 ≥ 300

X3 + 20X6 + X7 – 750 X11 ≥ 420

X3 + 15X6 + X8 – 750 X11 ≥ 360

X3 + 12X6 + X9 – 750 X11 ≥ 300

**Minimize Z** :

750X1 + 900 X2 + 450 X3 + 13000X4 + 12000X5 + 5000X6 + 900X7 + 1200X8 + 750X9

And X1 ≥ 0, X2 ≥ 0, X3 ≥ 0, X4 ≥ 0¸ X5 ≥ 0¸ X6 ≥ 0¸ X7 ≥ 0¸ X8 ≥ 0¸ X9 ≥ 0, X10 ≥ 0 X11 ≥ 0

Please refer to mchalama\_3 Part4.R for the solution i.e, 696000 which matches with the primal problem.