QMM Assign3

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## Question

The Weigelt Corporation has three branch plants with excess production capacity. Fortunately, the corporation has a new product ready to begin production, and all three plants have this capability, so some of the excess capacity can be used in this way. This product can be made in three sizes–large, medium, and small–that yield a net unit profit of $420, $360, and $300, respectively. Sizes [ large, medium, small ] = [ 420, 360, 300 ] $ Plant [P1, P2, P3 ] = [750, 900, 450 ] units per day of this product,  
Amount of available in-process storage space also imposes a limitation on the production rates of the new product. Storage [s1, s2, s3 ] = [13,000, 12,000, 5,000 ] square feet Each unit of the [large, medium, small ] sizes produced per day requires [20, 15, 12] square feet

Sales forecasts [large, medium, and small] = [900, 1,200, 750 ] units of the sizes, would be sold per day.

At each plant, some employees will need to be laid off unless most of the plant’s excess production capacity can be used to produce the new product. To avoid layoffs if possible, management has decided that the plants should use the same percentage of their excess capacity to produce the new product.

Management wishes to know how much of each of the sizes should be produced by each of the plants to maximize profit.

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

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

3.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.

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

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

## [1] 0

## [1] 696000

## [1] 516.6667 177.7778 0.0000 0.0000 666.6667 166.6667 0.0000 0.0000  
## [9] 416.6667

## [1] 6.944444e+02 8.333333e+02 4.166667e+02 1.300000e+04 1.200000e+04  
## [6] 5.000000e+03 5.166667e+02 8.444444e+02 5.833333e+02 -2.037268e-10  
## [11] 0.000000e+00

## $duals  
## [1] 0.00 0.00 0.00 12.00 20.00 60.00 0.00 0.00 0.00  
## [10] -0.08 0.56 0.00 0.00 -24.00 -40.00 0.00 0.00 -360.00  
## [19] -120.00 0.00  
##   
## $dualsfrom  
## [1] -1.000000e+30 -1.000000e+30 -1.000000e+30 1.122222e+04 1.150000e+04  
## [6] 4.800000e+03 -1.000000e+30 -1.000000e+30 -1.000000e+30 -2.500000e+04  
## [11] -1.250000e+04 -1.000000e+30 -1.000000e+30 -2.222222e+02 -1.000000e+02  
## [16] -1.000000e+30 -1.000000e+30 -2.000000e+01 -4.444444e+01 -1.000000e+30  
##   
## $dualstill  
## [1] 1.000000e+30 1.000000e+30 1.000000e+30 1.388889e+04 1.250000e+04  
## [6] 5.181818e+03 1.000000e+30 1.000000e+30 1.000000e+30 2.500000e+04  
## [11] 1.250000e+04 1.000000e+30 1.000000e+30 1.111111e+02 1.000000e+02  
## [16] 1.000000e+30 1.000000e+30 2.500000e+01 6.666667e+01 1.000000e+30

## $objfrom  
## [1] 3.60e+02 3.45e+02 -1.00e+30 -1.00e+30 3.45e+02 2.52e+02 -1.00e+30  
## [8] -1.00e+30 2.04e+02  
##   
## $objtill  
## [1] 4.60e+02 4.20e+02 3.24e+02 4.60e+02 4.20e+02 3.24e+02 7.80e+02 4.80e+02  
## [9] 1.00e+30

## [1] 1.00 0.00 0.00 0.00 12.00 20.00 60.00 0.00 0.00  
## [10] 0.00 -0.08 0.56 0.00 0.00 -24.00 -40.00 0.00 0.00  
## [19] -360.00 -120.00 0.00

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

## $anti.degen  
## [1] "fixedvars" "stalling"   
##   
## $basis.crash  
## [1] "none"  
##   
## $bb.depthlimit  
## [1] -50  
##   
## $bb.floorfirst  
## [1] "automatic"  
##   
## $bb.rule  
## [1] "pseudononint" "greedy" "dynamic" "rcostfixing"   
##   
## $break.at.first  
## [1] FALSE  
##   
## $break.at.value  
## [1] -1e+30  
##   
## $epsilon  
## epsb epsd epsel epsint epsperturb epspivot   
## 1e-10 1e-09 1e-12 1e-07 1e-05 2e-07   
##   
## $improve  
## [1] "dualfeas" "thetagap"  
##   
## $infinite  
## [1] 1e+30  
##   
## $maxpivot  
## [1] 250  
##   
## $mip.gap  
## absolute relative   
## 1e-11 1e-11   
##   
## $negrange  
## [1] -1e+06  
##   
## $obj.in.basis  
## [1] TRUE  
##   
## $pivoting  
## [1] "devex" "adaptive"  
##   
## $presolve  
## [1] "none"  
##   
## $scalelimit  
## [1] 5  
##   
## $scaling  
## [1] "geometric" "equilibrate" "integers"   
##   
## $sense  
## [1] "minimize"  
##   
## $simplextype  
## [1] "dual" "primal"  
##   
## $timeout  
## [1] 0  
##   
## $verbose  
## [1] "neutral"

# Adding constraints  
  
add.constraint(lprec1,c(1, 0, 0, 20, 0, 0, 1, 0, 0, 900, 450), '>=',420 )  
add.constraint(lprec1,c(1, 0, 0, 15, 0, 0, 0, 1, 0, 900, 450), '>=',360 )  
add.constraint(lprec1,c(1, 0, 0, 12, 0, 0, 0, 0, 1, 900, 450), '>=',300 )  
  
add.constraint(lprec1,c(0, 1, 0, 0, 20, 0, 1, 0, 0, -750, 0), '>=',420 )  
add.constraint(lprec1,c(0, 1, 0, 0, 15, 0, 0, 1, 0, -750, 0), '>=',360 )  
add.constraint(lprec1,c(0, 1, 0, 0, 12, 0, 0, 0, 1, -750, 0), '>=',300 )  
  
add.constraint(lprec1,c(0, 0, 1, 0, 0, 20, 1, 0, 0, 0, -750), '>=',420 )  
add.constraint(lprec1,c(0, 0, 1, 0, 0, 15, 0, 1, 0, 0, -750), '>=',360 )  
add.constraint(lprec1,c(0, 0, 1, 0, 0, 12, 0, 0, 1, 0, -750), '>=',300 )  
  
write.lp(lprec1,'duality.lp',type="lp" )

solve(lprec1)

## [1] 0

get.objective(lprec1)

## [1] 698000

get.variables(lprec1)

## [1] 0.0 0.0 0.0 12.0 24.0 49.0 0.0 0.0 12.0 0.0 0.4

get.constraints(lprec1)

## [1] 420 360 336 480 360 300 680 435 300

get.sensitivity.rhs(lprec1)

## $duals  
## [1] 516.66667 177.77778 0.00000 0.00000 533.33333 333.33333  
## [7] 0.00000 0.00000 416.66667 55.55556 33.33333 33.33333  
## [13] 0.00000 0.00000 0.00000 383.33333 488.88889 0.00000  
## [19] 25000.00000 0.00000  
##   
## $dualsfrom  
## [1] 3.600e+02 3.375e+02 -1.000e+30 -1.000e+30 3.150e+02 2.880e+02  
## [7] -1.000e+30 -1.000e+30 2.400e+02 -1.000e+30 -3.000e+02 -1.000e+30  
## [13] -1.000e+30 -1.000e+30 -1.000e+30 -6.000e+01 -1.500e+01 -1.000e+30  
## [19] -8.000e-02 -1.000e+30  
##   
## $dualstill  
## [1] 4.800000e+02 4.200000e+02 1.000000e+30 1.000000e+30 3.750000e+02  
## [6] 3.600000e+02 1.000000e+30 1.000000e+30 1.000000e+30 1.800000e+02  
## [11] 6.000000e+01 3.000000e+02 1.000000e+30 1.000000e+30 1.000000e+30  
## [16] 6.000000e+01 4.500000e+01 1.000000e+30 1.333333e-01 1.000000e+30

get.sensitivity.obj(lprec1)

## $objfrom  
## [1] 694.4444 866.6667 416.6667 10555.5556 11500.0000 4680.0000  
## [7] 516.6667 711.1111 583.3333 -25000.0000 -20000.0000  
##   
## $objtill  
## [1] 1.000000e+30 1.000000e+30 1.000000e+30 1.388889e+04 1.250000e+04  
## [6] 5.181818e+03 1.000000e+30 1.000000e+30 9.166667e+02 1.000000e+30  
## [11] 1.250000e+04