Quantitative Mgmt - Final Exam

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12/8/2020

## R Markdown

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library(lpSolveAPI)  
  
# make an lp object with 0 constraints and 7 decision variables  
lprec <- make.lp(0, 48)  
  
# Creating objective function. The default is a minimization problem  
set.objfn(lprec, c(3.5,4,3.7,3.1,3.8,3.2,3.6,3,3.3,3.7,4,3.5,3.5,4,3.7,3.1,3.8,3.2,3.6,3,3.3,3.7,4,3.5,3.5,4,3.7,3.1,3.8,3.2,3.6,3,3.3,3.7,4,3.5,3.5,4,3.7,3.1,3.8,3.2,3.6,3,3.3,3.7,4,3.5))  
  
# As the default is a minimization problem, we change the direction to set maximization  
lp.control(lprec,sense='max')

## $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] "maximize"  
##   
## $simplextype  
## [1] "dual" "primal"  
##   
## $timeout  
## [1] 0  
##   
## $verbose  
## [1] "neutral"

# Add the constraints  
  
#Group Constraints   
add.constraint(lprec, c(1, 1, 1, 1, 1 ,1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), "=", 3)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1 ,1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), "=", 3)  
add.constraint(lprec, c(0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1 ,1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), "=", 3)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1 ,1, 1, 1, 1, 1, 1, 1), "=", 3)  
  
#Student Constraints   
add.constraint(lprec, c( 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), "=", 1)   
add.constraint(lprec, c( 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), "=", 1)  
add.constraint(lprec, c( 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0), "=", 1)  
add.constraint(lprec, c( 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0), "=", 1)  
add.constraint(lprec, c( 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0), "=", 1)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0), "=", 1)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0), "=", 1)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0), "=", 1)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0), "=", 1)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0), "=", 1)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0), "=", 1)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1), "=", 1)  
  
#Factor1 Constraints:  
add.constraint(lprec, c(3.5, 4, 3.7, 3.1, 3.8 ,3.2, 3.6, 3, 3.3, 3.7, 4, 3.5, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), ">=", 3.53)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 3.5, 4, 3.7, 3.1, 3.8 ,3.2, 3.6, 3, 3.3, 3.7, 4, 3.5, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), ">=", 3.53)  
add.constraint(lprec, c(0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 3.5, 4, 3.7, 3.1, 3.8 ,3.2, 3.6, 3, 3.3, 3.7, 4, 3.5, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), ">=", 3.53)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 3.5, 4, 3.7, 3.1, 3.8 ,3.2, 3.6, 3, 3.3, 3.7, 4, 3.5), ">=", 3.53)  
  
#Factor2 Constraints:  
add.constraint(lprec, c(10, 2, 5, 7, 9 ,6, 7, 12, 7, 9, 6, 4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), ">=", 7)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 10, 2, 5, 7, 9 ,6, 7, 12, 7, 9, 6, 4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), ">=", 7)  
add.constraint(lprec, c(0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 10, 2, 5, 7, 9 ,6, 7, 12, 7, 9, 6, 4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), ">=", 7)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 10, 2, 5, 7, 9 ,6, 7, 12, 7, 9, 6, 4), ">=", 7)  
  
#Factor3 Constraints:  
add.constraint(lprec, c(6, 5, 2, 7, 5 ,6, 7, 6, 8, 9, 8, 4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), ">=", 6.08)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 6, 5, 2, 7, 5 ,6, 7, 6, 8, 9, 8, 4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), ">=", 6.08)  
add.constraint(lprec, c(0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 6, 5, 2, 7, 5 ,6, 7, 6, 8, 9, 8, 4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0), ">=", 6.08)  
add.constraint(lprec, c( 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 6, 5, 2, 7, 5 ,6, 7, 6, 8, 9, 8, 4), ">=", 6.08)  
  
# Set bounds for variables explicitly.  
set.bounds(lprec, lower = c(0, 0, 0, 0, 0, 0, 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0), columns = c(1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48))  
  
#Making the decision variables as Integer   
set.type(lprec,1:48,"integer")  
  
# Nameing the decision variables (column) and constraints (rows)  
lp.colnames <- c("G1S1", "G1S2", "G1S3", "G1S4", "G1S5", "G1S6", "G1S7", "G1S8", "G1S9", "G1S10", "G1S11", "G1S12", "G2S1", "G2S2", "G2S3", "G2S4", "G2S5", "G2S6", "G2S7", "G2S8", "G2S9", "G2S10", "G2S11", "G2S12","G3S1", "G3S2", "G3S3", "G3S4", "G3S5", "G3S6", "G3S7", "G3S8", "G3S9", "G3S10", "G3S11", "G3S12", "G4S1", "G4S2", "G4S3", "G4S4", "G4S5", "G4S6", "G4S7", "G4S8", "G4S9", "G4S10", "G4S11", "G4S12")  
  
#Rows represents the day shift starts   
lp.rownames <- c("Group1Students", "Group2Students", "Group3Students", "Group4Students", "Student1", "Student2", "Student3", "Student4", "Student5", "Student6","Student7","Student8","Student9","Student10","Student11","Student12","Group1Factor1","Group2Factor1","Group3Factor1","Group4Factor1","Group1Factor2","Group2Factor2","Group3Factor2","Group4Factor2","Group1Factor3","Group2Factor3","Group3Factor3","Group4Factor3")  
dimnames(lprec) <- list(lp.rownames, lp.colnames)  
  
# view the linear program object to make sure it's correct  
lprec

## Model name:   
## a linear program with 48 decision variables and 28 constraints

# Writing the model to a file  
write.lp(lprec, filename = "Group.lp", type = "lp")

Solving the linear model to get the optimum values

# Solving it as a LP model  
solve(lprec)

## [1] 0

# Objective function value:  
get.objective(lprec)

## [1] 42.4

# Total max score of GPA :42.4  
  
# Optimal decision variable values:  
get.variables(lprec)

## [1] 1 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 0 1 0 0 0 0 1 0 1  
## [39] 1 0 0 1 0 0 0 0 0 0

# Values of the Contraints   
get.constraints(lprec)

## [1] 3.0 3.0 3.0 3.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  
## [16] 1.0 10.2 11.1 10.2 10.9 31.0 22.0 18.0 13.0 21.0 21.0 18.0 13.0