Quantitative Mgmt - Final Exam

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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, 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, 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, 1,
0, 0, 0, 0, 0, 0, 0, 0,0, 0, 0, 0, 1, 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, 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, 0, 1, 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, 0, 1, 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, 0, 1, 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, 0, 0, 0, 1, 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), ">=", 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, 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, 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, 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, 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, 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, 0, 6, 5, 2, 7, 5 ,6, 7,
6, 8, 9, 8, 4), ">=", 6.08)
```

```r
# 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), 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","Student1
2","Group1Factor1","Group2Factor1","Group3Factor1","Group4Factor1","Group1Fac
tor2","Group2Factor2","Group3Factor2","Group4Factor2","Group1Factor3","Group2
Factor3","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

```r
# 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
```

```r
# 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
```

```r
# 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
```