Final

2022-12-13

round(runif(12, min = 0, max = 4), 2)

## [1] 2.19 3.59 0.92 0.83 0.48 3.65 0.31 1.40 2.91 1.66 3.82 0.44

This is the randomly generated GPA.

round(runif(12, min = 0, max = 30), 0)

## [1] 28 23 27 15 9 1 7 12 4 27 25 26

This is the randomly generated days of school missed.

round(runif(12, min = 0, max = 1), 0)

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

This is the randomly Are generated gender. 0 is women 1 is men.

The days missed have been x 4, then divide by 30 in order to match the scale. For class background 1 is yes and 0 is no.

x1: GPA = 2.53, Missed Days = 0.93, gender = 0 x2: GPA = 0.74, Missed Days = 1.07, gender = 1 x3: GPA = 3.74, Missed Days = 2.40, gender = 0 x4: GPA = 3.53, Missed Days = 0.93, gender = 0 x5: GPA = 2.36, Missed Days = 1.87, gender = 1 x6: GPA = 0.30, Missed Days = 2.40, gender = 0 x7: GPA = .56, Missed Days = 2.50, gender = 0 x8: GPA = 1.16, Missed Days = 2.50, gender = 1 x9: GPA = 0.53, Missed Days = 0, gender = 1 x10: GPA = 3.99, Missed Days = 0.26, gender = 0 x11: GPA = 2.21, Missed Days = 3.20, gender = 0 x12: GPA = 2.65, Missed Days = 0.53, gender = 0

Student x1 2.53 - 0.93 + 0 = 1.60. The 1.60 is the student’s score. The higher the score, the more likely the student will score well on an assignment. On the opposite end the lower the score the more likely they will not do well on the assignment.

1.60+0.67+1.34+2.60+1.49-2.10-1.94-.34+1.53+3.73-.99+2.09

## [1] 9.68

9.68/12

## [1] 0.8066667

Mean <- 0.8066667  
  
x1 <- 1.60 - Mean  
x2 <- 0.67 - Mean  
x3 <- 1.35 - Mean  
x4 <- 2.60 - Mean  
x5 <- 1.49 - Mean  
x6 <- -2.10 - Mean  
x7 <- -1.94 - Mean  
x8 <- -.34 - Mean  
x9 <- 1.53 - Mean  
x10 <- 3.73 - Mean  
x11 <- -0.99 - Mean  
x12 <- 2.09 - Mean  
  
x1

## [1] 0.7933333

x2

## [1] -0.1366667

x3

## [1] 0.5433333

x4

## [1] 1.793333

x5

## [1] 0.6833333

x6

## [1] -2.906667

x7

## [1] -2.746667

x8

## [1] -1.146667

x9

## [1] 0.7233333

x10

## [1] 2.923333

x11

## [1] -1.796667

x12

## [1] 1.283333

If the variance is negative the student is below average and if it is positive the student is above average. Since we are trying to minimize the variance we need to see how far the variance is from zero. So we will have to take the absolute value

Objective: (Minimize) 0.79 S1G1 + 0.79 S1G2 + 0.79 S1G3 + 0.79 S1G4 + 0.13 S2G1 + 0.13 S2G2 + 0.13 S2G3 + 0.13 S2G4 + 0.54 S3G1 + 0.54 S3G2 + 0.54 S3G3 + 0.54 S3G4 + 1.79 S4G1 + 1.79 S4G2 + 1.79 S4G3 + 1.79 S4G4 + 0.68 S5G1 + 0.68 S5G2 + 0.68 S5G3 + 0.68 S5G4 + 2.91 S6G1 + 2.91 S6G2 + 2.91 S6G3 + 2.91 S6G4 + 2.75 S7G1 + 2.75 S7G2 + 2.75 S7G3 + 2.75 S7G4 + 1.15 S8G1 + 1.15 S8G2 + 1.15 S8G3 + 1.15 S8G4 + 0.72 S9G1 + 0.72 S9G2 + 0.72 S9G3 + 0.72 S9G3 + 2.92 S10G1 + 2.92 S10G2 + 2.92 S10G3 + 2.92 S10G4 + 1.80 S11G1 + 1.80 S11G2 + 1.80 S11G3 + 1.80 S11G4 + 1.28 S12G1 + 1.28 S12G2 + 1.28 S12G3 + 1.28 S12G4

S stands for the student number and G stands for the group number.

1. The total number of students in each group must be 3.

(Group 1) S1G1 + S2G1 + S3G1 + S4G1 + S5G1 + S6G1 + S7G1 + S8G1 + S9G1 + S10G1 + S11G1 + S12G1 = 3 Students

(Group 2) S1G2 + S2G2 + S3G2 + S4G2 + S5G2 + S6G2 + S7G2 + S8G2 + S9G2 + S10G2 + S11G2 + S12G2 = 3 Students

(Group 3) S1G3 + S2G3 + S3G3 + S4G3 + S5G3 + S6G3 + S7G3 + S8G3 + S9G3 + S10G3 + S11G3 + S12G3 = 3 Students

(Group 4) S1G4 + S2G4 + S3G4 + S4G4 + S5G4 + S6G4 + S7G4 + S8G4 + S9G4 + S10G4 + S11G4 + S12G4 = 3 Students

1. Only assigned one group.

S1G1 + S1G2 + S1G3 + S1G4 = 1 S2G1 + S2G2 + S2G3 + S2G4 = 1 S3G1 + S3G2 + S3G3 + S3G4 = 1 S4G1 + S4G2 + S4G3 + S4G4 = 1 S5G1 + S5G2 + S5G3 + S5G4 = 1 S6G1 + S6G2 + S6G3 + S6G4 = 1 S7G1 + S7G2 + S7G3 + S7G4 = 1 S8G1 + S8G2 + S8G3 + S8G4 = 1 S9G1 + S9G2 + S9G3 + S9G4 = 1 S10G1 + S10G2 + S10G3 + S10G4 = 1 S11G1 + S11G2 + S11G3 + S11G4 = 1 S12G1 + S12G2 + S12G3 + S12G4 = 1

1. Each student needs a group.

(S1G1 + S1G2 + S1G3 + S1G4) + (S2G1 + S2G2 + S2G3 + S2G4) + (S3G1 + S3G2 + S3G3 + S3G4) + (S4G1 + S4G2 + S4G3 + S4G4) + (S5G1 + S5G2 + S5G3 + S5G4) + (S6G1 + S6G2 + S6G3 + S6G4) + (S7G1 + S7G2 + S7G3 + S7G4) + (S8G1 + S8G2 + S8G3 + S8G4) + (S9G1 + S9G2 + S9G3 + S9G4) + (S10G1 + S10G2 + S10G3 + S10G4) + (S11G1 + S11G2 + S11G3 + S11G4) + (S12G1 + S12G2 + S12G3 + S12G4) = 12

1. The output must be binary.

1 = the student will be placed in the group 0 = the student will not be placed the group

1. Each group to be as equal as possible. The group variance should be as close to zero as possible.

(S1G1 + S2G1 + S3G1 + S4G1 + S5G1 + S6G1 + S7G1 + S8G1 + S9G1 + S10G1 + S11G1 + S12G1) - (S1G2 + S2G2 + S3G2 + S4G2 + S5G2 + S6G2 + S7G2 + S8G2 + S9G2 + S10G2 + S11G2 + S12G2) = 0

(S1G1 + S2G1 + S3G1 + S4G1 + S5G1 + S6G1 + S7G1 + S8G1 + S9G1 + S10G1 + S11G1 + S12G1) - (S1G3 + S2G3 + S3G3 + S4G3 + S5G3 + S6G3 + S7G3 + S8G3 + S9G3 + S10G3 + S11G3 + S12G3) = 0

(S1G1 + S2G1 + S3G1 + S4G1 + S5G1 + S6G1 + S7G1 + S8G1 + S9G1 + S10G1 + S11G1 + S12G1) - (S1G4 + S2G4 + S3G4 + S4G4 + S5G4 + S6G4 + S7G4 + S8G4 + S9G4 + S10G4 + S11G4 + S12G4) = 0

(S1G2 + S2G2 + S3G2 + S4G2 + S5G2 + S6G2 + S7G2 + S8G2 + S9G2 + S10G2 + S11G2 + S12G2) - (S1G3 + S2G3 + S3G3 + S4G3 + S5G3 + S6G3 + S7G3 + S8G3 + S9G3 + S10G3 + S11G3 + S12G3) = 0

(S1G2 + S2G2 + S3G2 + S4G2 + S5G2 + S6G2 + S7G2 + S8G2 + S9G2 + S10G2 + S11G2 + S12G2) - (S1G4 + S2G4 + S3G4 + S4G4 + S5G4 + S6G4 + S7G4 + S8G4 + S9G4 + S10G4 + S11G4 + S12G4) = 0

(S1G3 + S2G3 + S3G3 + S4G3 + S5G3 + S6G3 + S7G3 + S8G3 + S9G3 + S10G3 + S11G3 + S12G3) - (S1G4 + S2G4 + S3G4 + S4G4 + S5G4 + S6G4 + S7G4 + S8G4 + S9G4 + S10G4 + S11G4 + S12G4) = 0

library(lpSolveAPI)

lprec <- make.lp(0, 48)  
set.objfn(lprec, c(.79,.79,.79,.79,0.13,0.13,0.13,0.13,0.54,0.54,0.54,0.54,1.79,1.79,1.79,1.79,.68,.68,.68,.68,2.90,2.90,2.90,2.90,2.75,2.75,2.75,2.75,1.15,1.15,1.15,1.15,0.72,0.72,0.72,0.72,2.92,2.92,2.92,2.92,1.80,1.80,1.80,1.80,1.28,1.28,1.28,1.28))  
lp.control(lprec, sense = 'min', all.bin=TRUE)

## $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"

add.constraint(lprec, c(1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0), "=", 3)  
add.constraint(lprec, c(0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0), "=", 3)  
add.constraint(lprec, c(0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0), "=", 3)  
add.constraint(lprec, c(0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,0,0,1), "=", 3)

add.constraint(lprec, c(1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0), "=", 1)  
add.constraint(lprec, c(0,0,0,0,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0), "=", 1)  
add.constraint(lprec, c(0,0,0,0,0,0,0,0,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0), "=", 1)  
add.constraint(lprec, c(0,0,0,0,0,0,0,0,0,0,0,0,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0), "=", 1)  
add.constraint(lprec, c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0), "=", 1)  
add.constraint(lprec, c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0), "=", 1)  
add.constraint(lprec, c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0), "=", 1)  
add.constraint(lprec, c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0), "=", 1)  
add.constraint(lprec, c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0), "=", 1)  
add.constraint(lprec, c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,1,1,1,0,0,0,0,0,0,0,0), "=", 1)  
add.constraint(lprec, c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,1,1,1,0,0,0,0), "=", 1)  
add.constraint(lprec, c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,1,1,1), "=", 1)

add.constraint(lprec, c(1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1), "=", 12)

add.constraint(lprec, c(1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0), "=", 0)  
add.constraint(lprec, c(1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0), "=", 0)  
add.constraint(lprec, c(1,0,0,-1,1,0,0,-1,1,0,0,-1,1,0,0,-1,1,0,0,-1,1,0,0,-1,1,0,0,-1,1,0,0,-1,1,0,0,-1,1,0,0,-1,1,0,0,-1,1,0,0,-1), "=", 0)  
add.constraint(lprec, c(0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0), "=", 0)  
add.constraint(lprec, c(0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1,0,1,0,-1), "=", 0)  
add.constraint(lprec, c(0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1,0,0,1,-1), "=", 0)

solve(lprec)

## [1] 0

get.objective(lprec)

## [1] 17.45

get.variables(lprec)

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

Group 1: 6, 7, 10 Average GPA: 1.66 Average days missed: 13 Gender: All women

Group 2: 4, 5, 11 Average GPA: 2.31 Average days missed: 15 Gender: 2 women and 1 man

Group 3: 1, 8, 9 Average GPA: 1.41 Average days missed: 8.66 Gender: 1 women and 2 men

Group 4: 2, 3, 12 Average GPA: 2.37 Average days missed: 10 Gender: 2 women and 1 man