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library("gurobi")
library("Matrix")

### Relax on Constraint 9 ###
### Subproblem ###

u1 = 0

mySP = list()
mySP$model sense = "min"
mySP$obj = c(20-u1, 15-u1, 3-4*u1, 18-4*u1, 10-4*u1)
mySP$A = Matrix(c(3, 2, -1, 5, 3, 3, 2, -1, 3, 2), nrow=2, ncol=5, byrow=T, sparse=T)
mySP$sense = c(">=")
mySP$rhs = c(10, 10)
mySP$vtypes = "B"

mysol = gurobi(mySP)
x.h = mysol$x
z.SP = mysol$objval

LB = z.SP + u1

### Master Problem ###

myMP = list()
myMP$model sense = "max"
myMP$obj = c(1, 10)
myMP$A = Matrix(c(1, 10), nrow=1, ncol=2, byrow=T, sparse=T)
myMP$sense = c("<=")
myMP$rhs = c(63)
myMP$vtypes = "C"
myMP$lb = c(-Inf, 0) ### This is important !!!

mysol = gurobi(myMP)

theta = mysol$x[1]
u1 = mysol$x[2]

UB = mysol$objval

check = (LB==UB)

### Relax on Constraint 8 and 10 ###
### Subproblem ###

u1 = 0
u2 = 0

mySP = list()
mySP$model sense = "min"
mySP$obj = c(20-3*u1-3*u2, 15-2*u1-2*u2, 3+u1+u2, 18-5*u1-3*u2, 10-3*u1-2*u2)
mySP$A = Matrix(c(1, 1, 4, 4, 4), nrow=1, ncol=5, byrow=T, sparse=T)
mySP$sense = c(">=")
mySP$rhs = c(10)
mySP$vtypes = "B"

mysol = gurobi(mySP)
x.h = mysol$x
z.SP = mysol$objval

LB = z.SP + 10*u1 + 10*u2

### Master Problem ###

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myMP = list()
myMP$model sense = "max"
myMP$obj = c(1,10,10)
myMP$A = Matrix(c(1,7,4), nrow=1, ncol=3, byrow=T, sparse=T)
myMP$sense = c("<=")
myMP$rhs = c(31)
myMP$vtypes = "C"
# The lower bound for theta should be negative infinity, but this would give an unbounded solution.
# For this reason, we've set theta >= 0 in our hand-written (For easier computation) and -1000 on
# this coded version.
myMP$lb = c(-1000, 0, 0)

mysol = gurobi(myMP)

theta = mysol$x[1]
u1 = mysol$x[2]
u2 = mysol$x[3]

UB = mysol$objval

check = (LB==UB)

# Iteration 2: SP #

mySP = list()
mySP$model sense = "min"
mySP$obj = c(20-3*u1-3*u2, 15-2*u1-2*u2, 3+u1+u2, 18-5*u1-3*u2, 10-3*u1-2*u2)
mySP$A = Matrix(c(1,1,4,4,4), nrow=1, ncol=5, byrow=T, sparse=T)
mySP$sense = c(">=")
mySP$rhs = c(10)
mySP$vtypes = "B"

mysol = gurobi(mySP)
x.h = mysol$x
z.SP = mysol$objval

LB = z.SP + 10*u1 + 10*u2

# Iteration 2: MP #

myMP = list()
myMP$model sense = "max"
myMP$obj = c(1,10,10)
myMP$A = Matrix(c(1,13,10,1,7,4), nrow=2, ncol=3, byrow=T, sparse=T)
myMP$sense = c("<=", "<=")
myMP$rhs = c(63,31)
myMP$vtypes = "C"
myMP$lb = c(-1000, 0, 0)

mysol = gurobi(myMP)

theta = mysol$x[1]
u1 = mysol$x[2]
u2 = mysol$x[3]

UB = mysol$objval

check = (LB==UB)

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