ISE 5405 – OPTIMIZATION I

Semester Project – Part 1

"On my honor, as a Hokie, I have neither given nor received unauthorized aid on this academic work"

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PROBLEM 1

Indices

i – types of cables

Index sets

I	Cable types	$I = \{1,2,3 \ldots N_T\}$
I_D	Cable types that can be made on duplex machines	$I_D = I = \{1,\ldots N_{DO} + N_{DR}\}$
I_{DO}	Cable types that can be made only on duplex machines	$I_{DO} = \{1,\ldots N_{DO}\}$
I_{DR}	Cable types that can be made either on Duplex or Regular machines	$I_{DR} = I_R$
I_R	Cable types that can be made on regular machines	$I_R = I_{DR} = \{N_{DO} + 1, \ldots, N_{DO} + N_{DR}\}$

Parameters

c_i	cost to produce a yard of cable i, i∈ I
s_i	cost to outsource a yard of cable i, i∈ I
p_i	selling price of a yard of cable i, i∈ I
Dm_i	demand in yards for cable i, i∈ I
D	Total available Duplex machine hours = 32760
R	Total available Regular machine hours = 196560
t_{di}	hours/yard required for cable type i on a Duplex machine, i∈ I (inverse of production rate)
t_{ri}	hours/yard required for cable type i on a Regular machine, i∈ I (inverse of production rate)
N_D	Number of Duplex machines = 15
N_{DO}	Number of cable types that can be only made on Duplex machines = 4
N_{DR}	Number of cable types that can be only made on Regular machines = 11
N_R	Number of Regular machines = 90
N_T	Number of cable types = 15

Total available time

Number of hours/day the machines operate = 24
Number of days/week the machines operate = 7
Number of weeks/quarter the machines operate = 13

Computed Parameters

Pr_i	Profit for cable type i if produced in-house	$p_i - c_i$
T_i	Profit for cable type i if outsourced	$p_i - s_i$
D	N_D x $(24)(7)(13)$	= 32760
R	N_R x $(24)(7)(13)$	= 196560

Decision Variables

d_i	yards of cable i to produce on a Duplex machine, i∈ I
r_i	yards of cable i to produce on a Regular machine, i∈ I
o_i	yards of cable i to outsource

Objective function

Maximizing Profit

$$Max\ z = \sum_{i \in I_D} Pr_i d_i + \sum_{i \in I_R} Pr_i r_i + \sum_{i \in I} T_i o_i$$

Constraints

Time Constraints

Production time of Duplex machine should be less than or equal to the available Duplex machine hours

$$\sum_{i \in I_D} (t_{di}\ d_i) \leq D$$

Production time of Regular machine should be less than or equal to the available Regular machine hours

$$\sum_{i \in I_R} (t_{ri}\ r_i) \leq R$$

Demand Constraints

$d_i + r_i \geq Dm_i$; $i \in I_R$

Total demand should be met.

$d_i + r_i + o_i \geq Dm_i$; $i \in I_{DO}$

Non-negativity constraints

$d_i, r_i, o_i \geq 0$; $i \in I$

PROBLEM 2 - *Sudoku Puzzle (9x9 matrix)*

Objective Function

Max 0

Constraints

For Columns

$\sum_{i=1}^{9} X_{ijk} = 1$ for j,k = 1 to 9

For rows

$\sum_{j=1}^{9} X_{ijk} = 1$ for i,k = 1 to 9

For 3x3 squares

$\sum_{j=3p-2}^{3p} \sum_{i=3q-2}^{3q} X_{ijk}$ for i,k = 1 to 9 and p,q = 1 to 3 (only one k in each submatrix)

For $\sum_{k=1}^{9} X_{ijk} = 1 \ for\ i,j = 1\ to\ 9$

$X_{ijk} = 1$ for all (i,j,k) $\in G$ $(all\ the\ known\ cells)$

Sudoku Puzzle (4x4 matrix)

Objective Function

Max 0

Constraints

For Columns

$\sum_{i=1}^{4} X_{ijk} = 1$ for j,k = 1 to 4

For rows

$\sum_{j=1}^{4} X_{ijk} = 1$ for i,k = 1 to 4

For 2x2 squares

$\sum_{j=2p-1}^{2p} \sum_{i=2q-1}^{2q} X_{ijk}$ for i,k = 1 to 4 and p,q = 1 to 2 (only one k in each submatrix)

For $\sum_{k=1}^{4} X_{ijk} = 1 \ for\ i,j = 1\ to\ 4$

$X_{ijk} = 1$ for all (I,j,k) ∈ G $(all\ the\ known\ cells)$