Gurobi – Revisited:

We introduced Gurobi in Module 3. We will now look at three examples and different ways of using Gurobi to solve each of them.

Question 1:

Problem:

- Scheduling lifeguards
- Work 5 days consecutively, with 2 days off
- Open 7 days a week
- Weekends are busiest!
- At least 1 lifeguard per 8000 daily attendance

Attendance:

Sun	58K
Mon	42K
Tue	35K
Wed	25K
Thu	44K
Fri	51K
Sat	68K

Minimize total # of personnel and still meet insurance requirements for minimum personnel.

How?

Decision Variables:

# of lifeguards who *begin* work on day i

(like carryover inventory)

Constraints:

e.g. if a lifeguard is on duty Sunday, they did not start on Monday or Tuesday

$X_1 + X_4 + X_5 + X_6 + X_7 >= 8$

All integers.

Minimize X1 + X2 + X3 + X4 + X5 + X6 + X7

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X1 + X4 + X5 + X6 + X7 ≥ 8 (Sunday)

X1 + X2 + X5 + X6 + X7 ≥ 6 (Monday)

X1 + X2 + X3 + X6 + X7 ≥ 5 (Tuesday)

X1 + X2 + X3 + X4 + X7 ≥ 4 (Wendnesday)

X1 + X2 + X3 + X4 + X5 ≥ 6 (Thursday)

X2 + X3 + X4 + X5 + X6 ≥ 7 (Friday)

X3 + X4 + X5 + X6 + X7 ≥ 9 (Saturday)

All variables are non negative integers

Question 2: Computer Production

Production Capacity:

160 computers per week

50 more computers with overtime

Assembly Costs:

$190 per computer regular time;

$260 per computer overtime

Inventory Holding Cost: $10/computer per week

Forecast Demand

Week	Computer Orders
1	105
2	170
3	230
4	180
5	150
6	250

Model summary:

Minimize $Z = \$190(r_1 + r_2 + r_3 + r_4 + r_5 + r_6) + \$260(o_1 + o_2 + o_3 + o_4 + o_5 + o_6) + 10(i_1 + i_2 + i_3 + i_4 + i_5)$

subject to:

$r_j \leq 160$ computers in week j (j = 1, 2, 3, 4, 5, 6)

$o_j \leq 50$ computers in week j (j = 1, 2, 3, 4, 5, 6)

$r_1 + o_1 - i_1 = 105$ week 1

$r_2 + o_2 + i_1 - i_2 = 170$ week 2

$r_3 + o_3 + i_2 - i_3 = 230$ week 3

$r_4 + o_4 + i_3 - i_4 = 180$ week 4

$r_5 + o_5 + i_4 - i_5 = 150$ week 5

$r_6 + o_6 + i_5 = 250$ week 6

$r_j, o_j, i_j \geq 0$

Question 3:

After an initial consultation with a client, Charles selects a group of stocks, bonds, mutual funds, savings plans, and other investments that he feels may be appropriate for consideration in the portfolio. He then secures information on each investment and determines his own rating. With this information, he develops a chart giving the risk factors (0..100) based on his evaluation, expected returns based on current and projected company operations, and liquidity information. At the second meeting, Charles defines the client's goals more specifically. The responses are entered into a linear programming model, and a recommendation is made to the client based on the results of the model.

Frank Baklarz has just inherited $100,000. Based on their initial meeting, Charles has found Frank to be quite *risk-averse*. Charles, therefore, suggests the following potential investments that can offer good returns with small risk.

Investment	Exp. Return	Jones' Rating	Liquidity Analysis	Risk Factor
Savings Account	4%	A	Immediate	0
Cert. of Deposit	5.20%	A	5-year	0
Atlantic Lighting	7.10%	B+	Immediate	25
Arkansas REIT	10%	B	Immediate	30
Bedrock Insurance annuity	8.20%	A	1-year	20
Nocal Mining Bond	6.50%	B+	1-year	15
Minicomp Systems	20%	A	Immediate	65
Antony Hotels	12.50%	C	Immediate	40

$\min 25X_3 + 30X_4 + 20X_5 + 15X_6 + 65X_7 + 40X_8$ (Risk)

$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 = 100000$ (Total)

$.04X_1 + .052X_2 + .071X_3 + .1X_4 + .082X_5 + .065X_6 + .2X_7 + .125X_8 >= 7500$ (Return)

$X_1 + X_2 + X_5 + X_7 >= 50{,}000$ (A-Rated)

$X_1 + X_3 + X_4 + X_7 + X_8 >= 40{,}000$ (Liquid)

$X_1 + X_2 <= 30{,}000$ (Savings/CD)

All X's > 0