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College of Computer Engineering and Science
Department of Computer Science

CS-616: Optimization Algorithms

Assignment #01 (Excel LP Solver)

Deadline: September 27, 2025 **Semester 1 - AY: 2025/2026** **Grade: 20%**

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1 Hiring

A recently established company aims to determine the optimal number of customer service operators to hire, with the goal of minimizing daily expenses while ensuring a service that adheres to stringent standards. The table below outlines the minimum required operators for a typical day:

Periods	1	2	3	4	5	6	7	8
Hours	0am-3am	3am-6am	6am-9am	9am-12pm	12pm-3pm	3pm-6pm	6pm-9pm	9pm-0am
Min. # of operators	6	4	12	20	20	24	14	14

Each operator will cover 3 consecutive periods of 3 hours of work and will receive a daily salary of $25. The company provides a bonus of $5 to operators who start their shift at 6pm or 9pm. This bonus is increased to $11 for those who start at midnight, 3am, or 6am.

1. Formulate the linear programming model that meets the company's objectives.

- **Decision variables**

the decision varibles (X) which refer to the number of Op needs per shift from X1 thourgh X8 as follow:
$25X_1, $36X_2, $36X_3, $25_X4, $25X_5, $25X_6, $30X_7,$30X_8

- **Objective Function**

Min Z = sum($36X_1, $36X_2, $36X_3, $25_X4, $25X_5, $25X_6, $30X_7,$30X_8) to minimize the total number of ops with satisfied all the constrains and taking in consideration the cost per shift.

- **Constraints**

when Calculating the min_op for a shift(i) wh should consider the sum of the shift(i), 3 hours before, and 6 hours before are greater or equal to shift(i) min_op as follow:

sum(i, (i-1)/n, (i-2)/n) >= i_min_op
where n = 8 which is represent the total number of shifts
as follow:
sum(shift1, shift8, shift7) >= 6
sum(shift2, shift1, shift8) >= 4
…... etc
- Integer constraint: X value must be an integer because an operator cannot be a fraction

2. Using Excel LP Solver, solve the provided model and give the optimal solution (provide your Excel working file named **Assignment1_Ex1.xlsx**).

2 Feeding

Rabbits are fed exclusively on carrots and potatoes. One unit of carrots provides 10^3 *calories*, *4mg* of vitamin B, and *3mg* of vitamin A. One unit of potatoes provides 2×10^3 *calories*, *3mg* of vitamin B, and *1mg* of vitamin A.

The rabbit's nutritional requirements are at least 2×10^3 *calories*, *6 mg* of vitamin B, and *3 mg* of vitamin A. One unit of carrots costs the same as two units of potatoes. We consider that carrots and potatoes can be sold in fractional units, which means we can, for example, buy 1.2 units of carrots and 0.8 units of potatoes.

1. Formulate a linear program that minimizes the cost of the rabbit's menu.

   - **Decision variables**

     X_c = the number of carrots
     X_p = the number of potatos

   - **Objective Function**

     Min Z = 2X_c + 1X_p

   - **Constraints**

     Calories: 1X_c + 2X_p >= 2
     Vitamin B : 4X_c + 3X_p >= 6
     Vitamin A : 3X_c + 1X_p >= 3

2. Using Excel LP Solver, solve the provided model and give the optimal solution (provide your Excel working file named **Assignment1_Ex2.xlsx**).

3 Municipality

The municipality of a city decides to renew the furniture of a public garden. To do this, it is necessary to purchase at least 30 picnic tables, 40 public benches, and 90 trash cans. The two contacted suppliers each offer a type of package:

Proposed Package	Tables	Benches	Trash Cans	Package Cost
Package A proposed by supplier #1	1	3	4	$2,000
Package B proposed by supplier #2	3	2	6	$3,600

The municipality is looking to determine the number of packages to buy from each supplier to minimize its expenses, considering it has a maximum budget of $50,000.

1. Formulate a linear program that minimizes the municipality expenses.

   - **Decision variables**

     X_s1 = X refer to the number of pacages to be buy from supplier #1
     X_s2 = X refer to the number of pacages to be buy from supplier #2

   - **Objective Function**

     Min Z = (2*X_s1) + (3.6*X_s2)

   - **Constraints**

     Tables : 1*X_s1 + 3*X_s2 >= 30
     Benches: 3*X_s1 + 4*X_s2 >= 40
     Trash Cans: 4*X_s1 + 6*X_s2 >= 90
     Total cost to Budget: Sum(2*X_s1, 3.6X_s2) <= 50
     Integer constraint: X_s1 & X_s2 must be an integer because we can ' t buy a fraction of a package.

2. Using Excel LP Solver, solve the provided model and give the optimal solution (provide your Excel working file named **Assignment1_Ex3.xlsx**).

4 Data Storage

Before going on vacation, you want to back up important files on USB flash drives. You have three empty flash drives with a capacity of 2100MB each. Here are the sizes of the sixteen files you want to back up: 26MB, 35MB, 52MB, 77MB, 88MB, 94MB, 137MB, 164MB, 253MB, 364MB, 372MB, 388MB, 406MB, 432MB, 461MB, and 701MB.

Assuming you don't have a program to compress the data and that the number of flash drives you have is sufficient to back up everything, the problem is to determine how to distribute these files on flash drives in order to minimize the number of flash drives used.

1. Formulate a linear program to distribute the 16 files optimally and minimize the number of used USB flash drives.

   - **Decision variables**

File : X_I_j , where X is a binray varibale {0,1} equal 1 if the file i in drive j is assigned, 0 otherwise.
{X_1_1, X_1_2 ,X_1_3, X_2_1, X_2_2, X_2_3, X_3_1, X_3_2, X_3_3, X_4_1, X_4_2, X_4_3, X_5_1, X_5_2, X_5_3, X_6_1, X_6_2, X_6_3, X_7_1, X_7_2, X_7_3, X_8_1, X_8_2, X_8_3, X_9_1, X_9_2, X_9_3, X_10_1, X_10_2, X_10_3, X_11_1, X_11_2,
X_11_3, X_12_1, X_12_2, X_12_3, X_13_1, X_13_2, X_13_3, X_14_1, X_14_2, X_14_3, X_15_1, X_15_2, X_15_3, X_16_1, X_16_2, X_16_3}

USB Drive: Y_j where Y is a binary variable {0,1} equal to 1 if the Drive is used, 0 otherwise.
USB Drive 1: Y_1
USB Drive 2: Y_2
USB Drive 3: Y_3

- **Objective Function**

Min Z = sum(Y_1,Y_2,Y_3), to minimize the USB drive used to backup all the files with satisfying all the constraints.

- **Constraints**

- One copy assignment: this constrint enforce each file to be assigned in one USB drive.
File 1: X_1_1 + X_1_2 + X_1_3 = 1 - - - - File 2: X_2_1 + X_2_2 + X_2_3 = 1
File 3: X_3_1 + X_3_2 + X_3_3 = 1 - - - - File 4: X_4_1 + X_4_2 + X_4_3 = 1
File 5: X_5_1 + X_5_2 + X_5_3 = 1 - - - - File 6: X_6_1 + X_6_2 + X_6_3 = 1
File 7: X_7_1 + X_7_2 + X_7_3 = 1 - - - - File 8: X_8_1 + X_8_2 + X_8_3 = 1
File 9: X_9_1 + X_9_2 + X_9_3 = 1 - - - - File 10: X_10_1 + X_10_2 + X_10_3 = 1
File 11: X_11_1 + X_11_2 + X_11_3 = 1 - - - - File 12: X_12_1 + X_12_2 + X_12_3 = 1
File 13: X_13_1 + X_13_2 + X_13_3 = 1 - - - - File 14: X_14_1 + X_14_2 + X_14_3 = 1
File 15: X_15_1 + X_15_2 + X_15_3 = 1 - - - - File 16: X_16_1 + X_16_2 + X_16_3 = 1

- Capacity constrint: The total size of selected file must be less or equal to the driver capcity.
USB1: 26 X_1_1 + 35 X_2_1 + 52 X_3_1 + 77 X_4_1 + 88 X_5_1 + 94 X_6_1 + 137 X_7_1 + 164 X_8_1 + 253 X_9_1 + 364 X_10_1 + 372 X_11_1 + 388 X_12_1 + 406 X_13_1 + 432 X_14_1 + 461 X_15_1 + 701 X_16_1 <= 2100 * Y_1

USB2: 26 X_1_2 + 35 X_2_2 + 52 X_3_2 + 77 X_4_2 + 88 X_5_2 + 94 X_6_2 + 137 X_7_2 + 164 X_8_2 + 253 X_9_2 + 364 X_10_2 + 372 X_11_2 + 388 X_12_2 + 406 X_13_2 + 432 X_14_2 + 461 X_15_2 + 701 X_16_2 <= 2100 * Y_2

USB3: 26 X_1_3 + 35 X_2_3 + 52 X_3_3 + 77 X_4_3 + 88 X_5_3 + 94 X_6_3 + 137 X_7_3 + 164 X_8_3 + 253 X_9_3 + 364 X_10_3 + 372 X_11_3 + 388 X_12_3 + 406 X_13_3 + 432 X_14_3 + 461 X_15_3 + 701 X_16_3 <= Y_3 * 2100

- Binary decision variable: X_i_j & Y_j belong to {0,1}

2. Using Excel LP Solver, solve the provided model and give the optimal solution (provide your Excel working file named **Assignment1_Ex4.xlsx**).