Module 2 Assignment – Linear Programming

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Date: September 4, 2025

Introduction

This assignment demonstrates how Linear Programming (LP) can help solve two practical business optimization problems. For each scenario, we will: 1. Clearly define decision variables, objective functions, and constraints. 2. Express the problem mathematically. 3. Explain the results in straightforward terms.

Scenario 1: Backpack Production Planning

Problem Understanding - Constraints

A company named Back Savers manufactures two types of backpacks:
Collegiate (Profit \$32, needs 3 sq ft fabric, 45 min labor)
Mini (Profit \$24, needs 2 sq ft fabric, 40 min labor)
Resources: Fabric = 5,000 sq ft, Labor = 84,000 min per week, Max Collegiate sales = 1,000, Max Mini sales = 1,200.
Objective: Maximize total weekly profit.

Decision Variables

x = number of Collegiate backpacks produced per week
y = number of Mini backpacks produced per week

Objective Function

Maximize $Z = 32x + 24y$

Math Model

$3x + 2y \leq 5000$ (Fabric)
$45x + 40y \leq 84000$ (Labor)
$x \leq 1000$ (Max Collegiate)
$y \leq 1200$ (Max Mini)
$x, y \geq 0$

Scenario 2: Multi-Plant Production Optimization

Problem Understanding

A manufacturer operates three plants and produces three product sizes (Large, Medium, Small). The goal is to maximize daily profit while meeting storage, demand, and production capacity requirements.

Decision Variables

Let x_{ij} = units of size j produced at plant i.
i = 1,2,3 (Plant number)
j = L,M,S (Large, Medium, Small)
Example: $x1L$ = units of Large produced at Plant 1.

Objective Function

Profit per unit: Large $420, Medium $360, Small $300
Maximize $Z = 420(x1L+x2L+x3L) + 360(x1M+x2M+x3M) + 300(x1S+x2S+x3S)$

Constraints:

Plant 1 = 750 Units , Plant 2 = 900 units, Plant 3 = 450 units

$X1l + X1m + X1s = 750p$, $X2l + X2m + X2s = 900p$, $X3l + X3m + X3s = 450p$

Math Model

Capacity utilization (equal % usage):
$x1L+x1M+x1S = 750p$
$x2L+x2M+x2S = 900p$
$x3L+x3M+x3S = 450p$

Storage constraints:
$20x1L+15x1M+12x1S \leq 13000$
$20x2L+15x2M+12x2S \leq 12000$
$20x3L+15x3M+12x3S \leq 5000$

Demand constraints:
$x1L+x2L+x3L \leq 900$
$x1M+x2M+x3M \leq 1200$
$x1S+x2S+x3S \leq 750$
$0 \leq p \leq 1$