

Module 2 Assignment – Linear Programming

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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

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 $Z = 32x + 24y$

Constraints

$3x + 2y \leq 5000$ (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: x_{1L} = units of Large produced at Plant 1.

Objective Function

Profit per unit: Large \$420, Medium \$360, Small \$300

Maximize $Z = 420(x_{1L} + x_{2L} + x_{3L}) + 360(x_{1M} + x_{2M} + x_{3M}) + 300(x_{1S} + x_{2S} + x_{3S})$

Constraints

Capacity utilization (equal % usage):

$$x_{1L} + x_{1M} + x_{1S} = 750p$$

$$x_{2L} + x_{2M} + x_{2S} = 900p$$

$$x_{3L} + x_{3M} + x_{3S} = 450p$$

Storage constraints:

$$20x_{1L} + 15x_{1M} + 12x_{1S} \leq 13000$$

$$20x_{2L} + 15x_{2M} + 12x_{2S} \leq 12000$$

$$20x_{3L} + 15x_{3M} + 12x_{3S} \leq 5000$$

Demand constraints:

$$x_{1L} + x_{2L} + x_{3L} \leq 900$$

$$x_{1M} + x_{2M} + x_{3M} \leq 1200$$

$$x_{1S} + x_{2S} + x_{3S} \leq 750$$

$$0 \leq p \leq 1$$