# Module 2 Assignment – Linear Programming

Shahbaz

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

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 ≤ 5000 (Fabric)  
45x + 40y ≤ 84000 (Labor)  
x ≤ 1000 (Max Collegiate)  
y ≤ 1200 (Max Mini)  
x, y ≥ 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

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

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

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