Lab 1: Optimizing Newspaper and Magazine Shelf Space and Pricing for Maximum Profit

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1 Introduction

In this study, we explore a retail scenario where a store must manage its shelf space and pricing strategies for two newspapers and a magazine. The objective is to optimize expected profit while accounting for uncertain demand, budget constraints, and promotional pricing strategies.

2 Background

A retail store faces the challenge of deciding how much shelf space to allocate to two different newspapers and a magazine, each with its own demand uncertainty. The two newspapers share the same shelf space, while the magazine has a slightly larger, independent shelf. One of the newspapers is priced 10% cheaper than the other by the publishers and thus the retailer keeps the same proportion on the selling prices. There is an 8% discount when a customer purchases the more expensive newspaper together with the magazine. Unsold units of the cheaper newspaper may be returned to the publisher, getting a 10% returon over its initial cost. For the second newspaper, the retailer gets 40% of the cost. Unsold magazines cannot be returned.

3 Objectives

The goal is to develop a linear programming model that optimizes the store's expected profit under uncertain demand, given the following constraints:

- **Budget constraint**: The total expenditure on inventory is limited by a fixed budget.
- **Shelf space constraint**: The total amount of shelf space is limited and needs to be allocated efficiently between the newspapers and the magazine.
- **Demand uncertainty**: The store faces uncertain demand, which needs to be modeled probabilistically.

4 Step-by-Step Formulation

1. **Parameters**: Define the cost, selling price, budget, shelf capacity, etc. necessary for the formulation of the model.
2. **Decision Variables**: Define the quantities of newspapers and magazines to be bought from the plublishers. The quantities of sold newspapers, magazines, and newspapers plus magazine packs. The quantities to be returned, etc.
3. **Objective Function**: Maximize the expected profit, which depends on the prices, demand distributions, and promotional discounts.
4. **Constraints**: Include constraints on the total budget, available shelf space, and demand fulfillment.
5. **Solving the Linear Program**: Use linear programming methods to find the optimal inventory and pricing strategies.

5 Deliverables

1. **Write a Mathematical Formulation**:
   - Define the objective function and constraints.
   - Model the problem as a one stage or two-stage decision-making process.
2. **Solve the Risk Neutral Stochastic Programming Problem**:
   - Consider de cenarios provided and use an appropriate solver to find the optimal purchaise planning.
3. **Analyze the Solution Quality**:
   - Compute the **Wait and See solution (WS)**, the **Perfect Information Distribution (PID)** and the **Expected Value of PerfectInformation (EVPI)**.
   - Solve the **Mean Value Problem** to find the **Expected Value Solution (EVS)**. Compute the **Expected Value Distribution (EVD)** and the **Value of the Stochastic Solution (VSS)**.